APPENDIX A

Data Supporting Development of Longfin Smelt Habitat Suitability Map

This appendix, Appendix A to the *Incidental Take Permit Application for Long-Term Operation of the California State Water Project*, includes a brief description of the methods used to define habitat suitability in Section 2.2.5.3 of the ITP Application.

Methods

Salinity tolerance ranges for two LFS life stages were determined from examinations of the SLS (larvae) and Bay Study (juveniles) LFS catch datasets in representative water years. For this analysis the salinity tolerance criteria were defined as the upper and lower limits within which 90% of catch occurred in each of a Wet water year (2006), Moderate water year (2011) and a Dry water year (2014).

The following electronic files comprise the supporting material for the information included in Section 2.2.5.3 of the ITP Application.

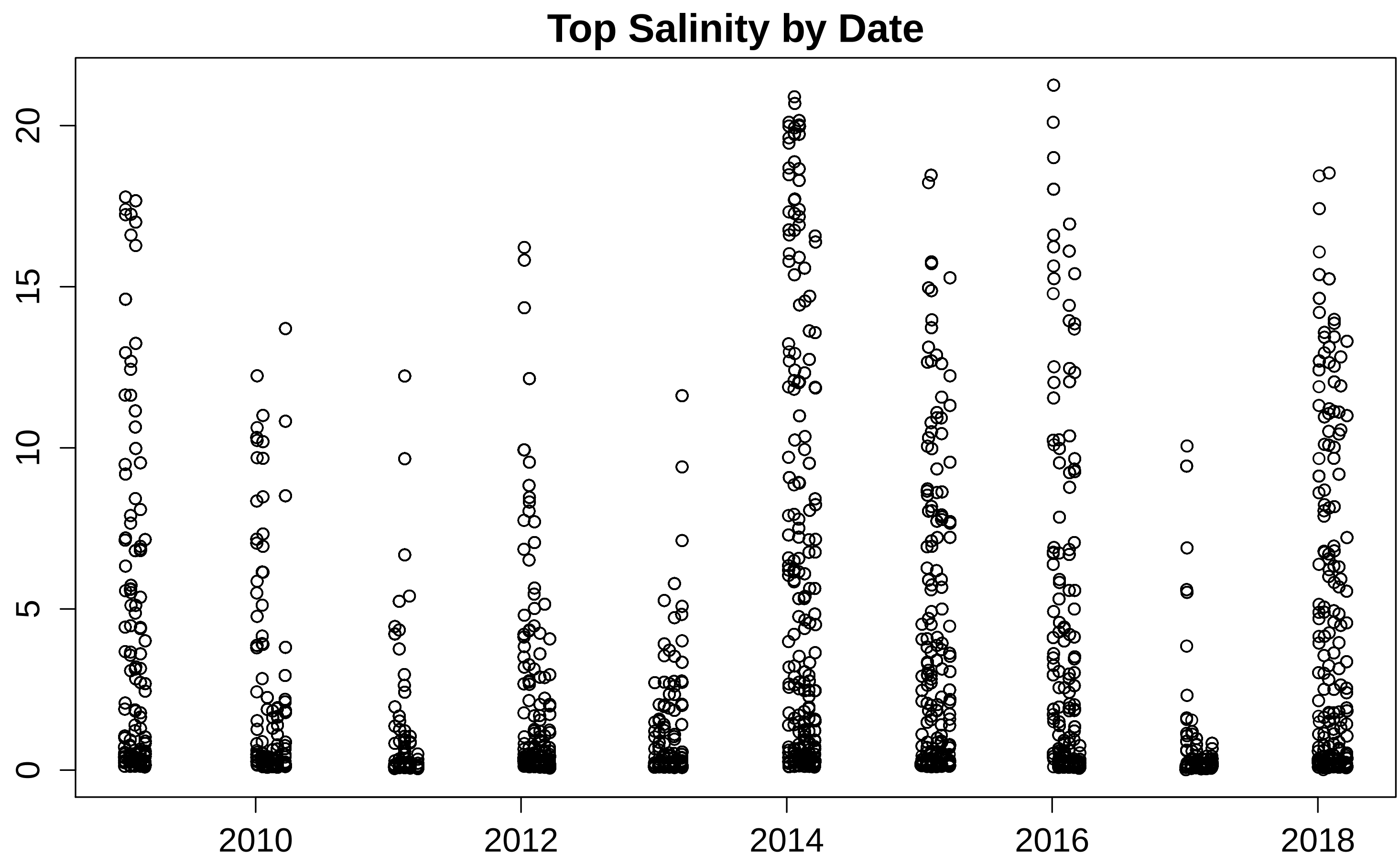
SLS_TopSalinity_RangeSampled.pdf
Percentiles_SLS_Top_V2.csv
SLS_GAM_TopSalinity.pdf
SLS_ECDF_TopSalinity.pdf

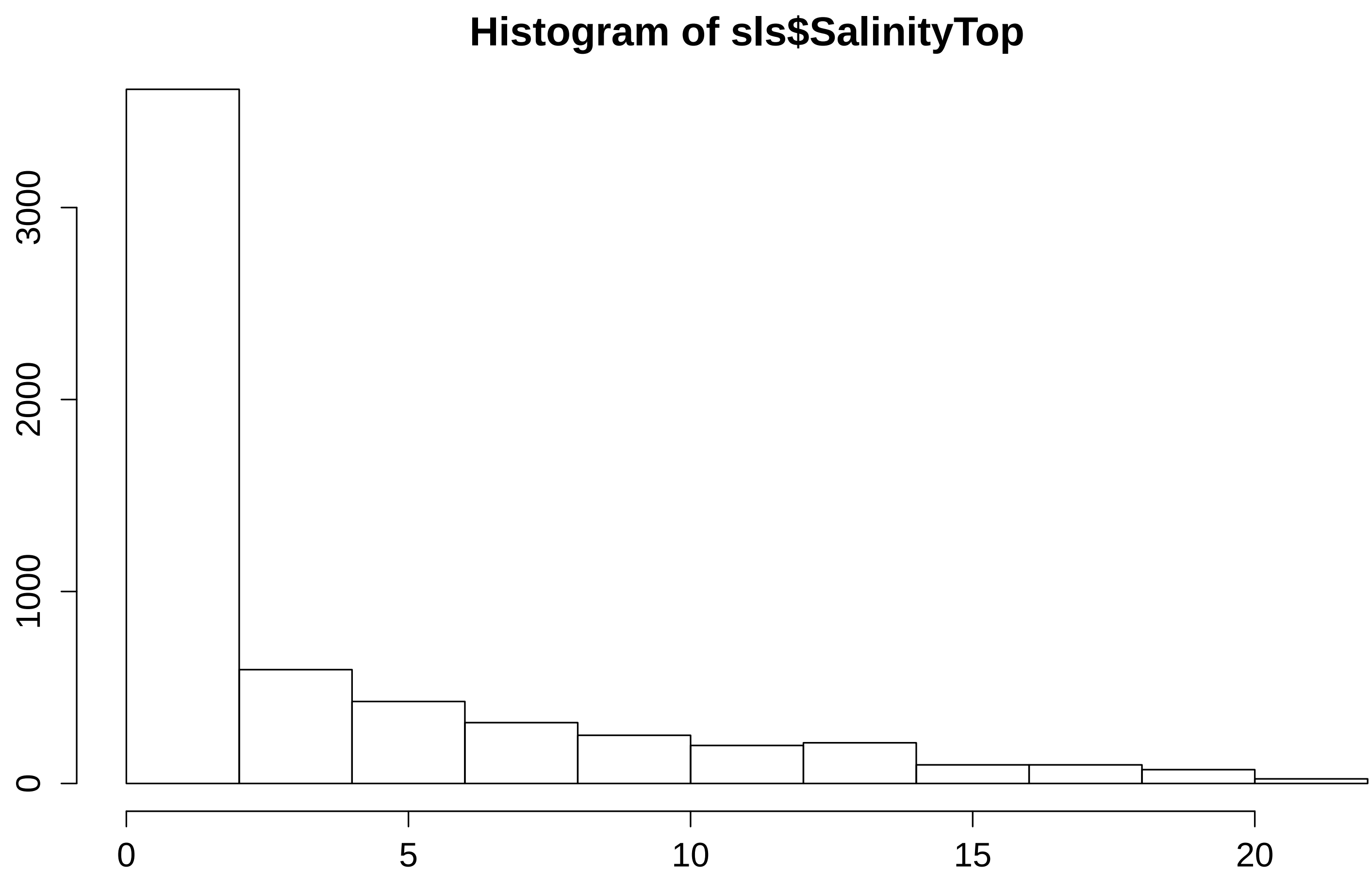
SLS_BottomSalinity_RangeSampled.pdf
Percentiles_SLS_Bottom_V2.csv
SLS_GAM_BottomSalinity.pdf
SLS_ECDF_BottomSalinity.pdf

Percentiles_TopSalinity.pdf
Percentiles_MWT_Surface.csv
MWT_SurfaceSal_RangeSampled.pdf
MWT_ECDF.pdf

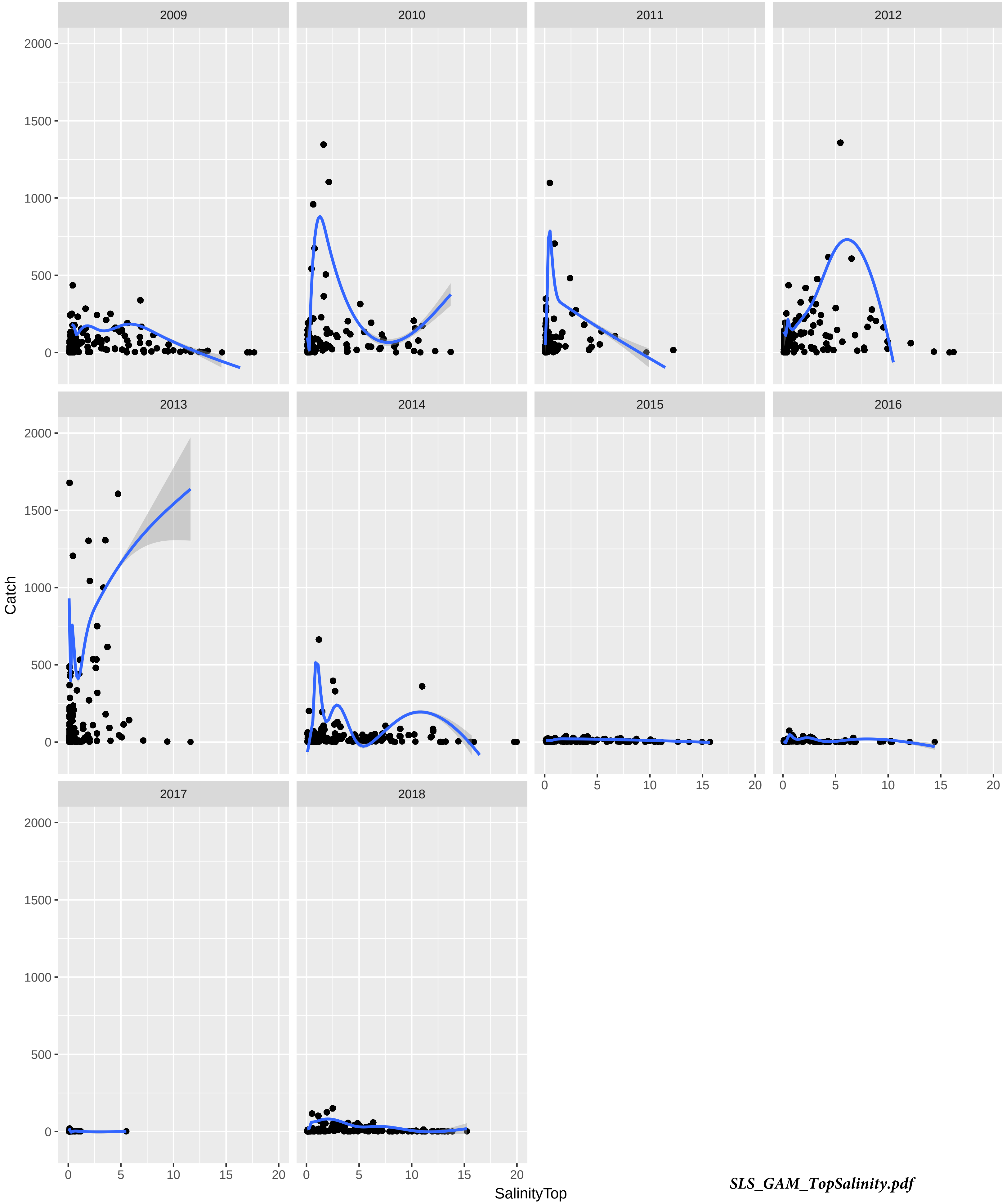
Percentiles_Bottom.pdf
Percentiles_OT_Bottom.csv
OT_BottomSal_RangeSampled.pdf
OT_ECDF.pdf

Percentiles_BayStudy_AllYears.pdf

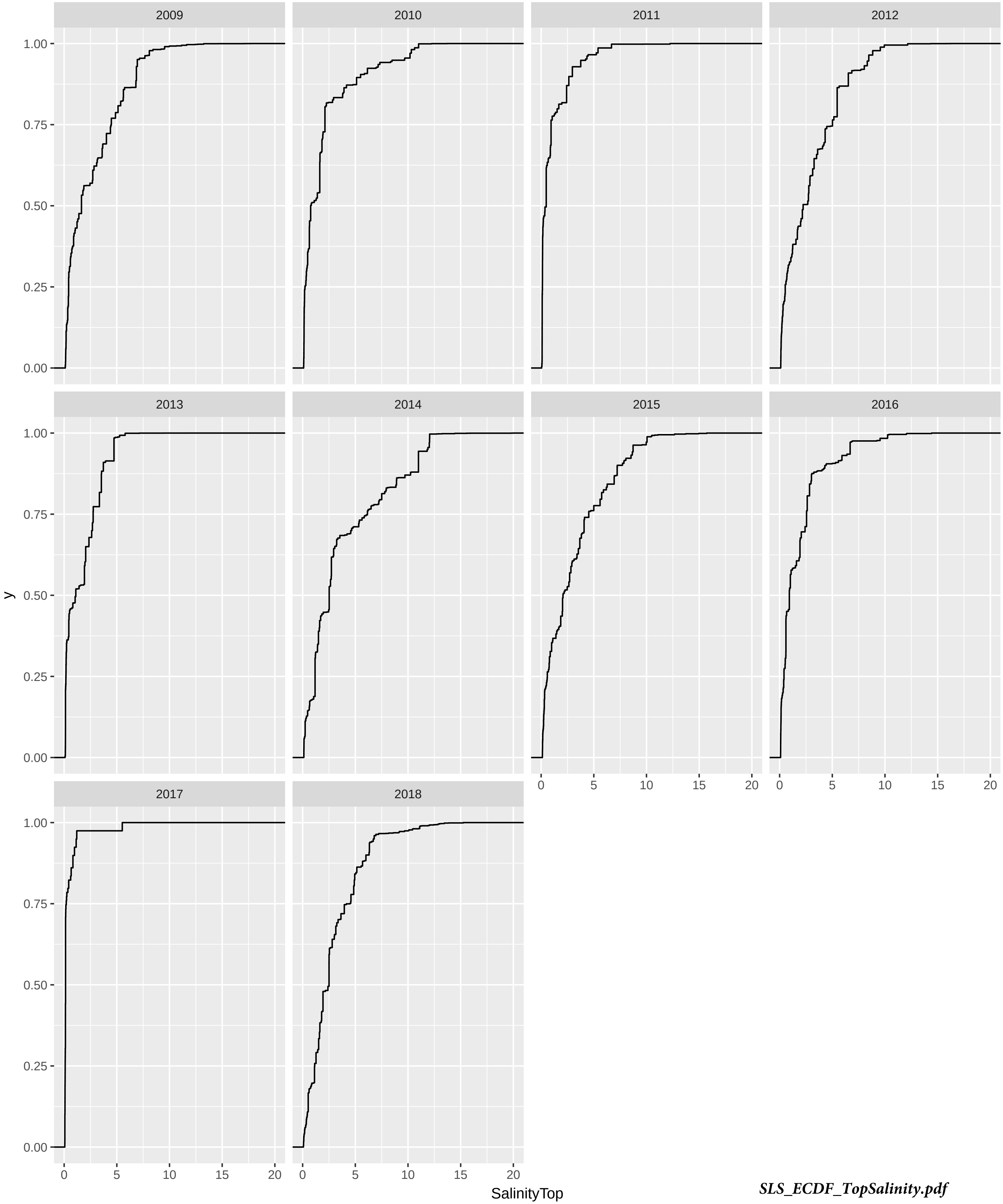

Top Salinity by Date
0
5
10
15
20
2010
2012
2014
2016
2018


Histogram of sls$SalinityTop
0
1000
2000
3000
0
5
10
15
20

	Year	Metric	Salinity	Total.Catch
1	2009	catch.25perc	0.42446647	212402
2	2009	catch.10perc	0.339787609	115348
3	2009	catch.90perc	6.851866149	1077615
4	2009	catch.75perc	4.348689767	916214
5	2010	catch.25perc	0.629706504	723027
6	2010	catch.10perc	0.474824906	421789
7	2010	catch.90perc	2.103868679	4467725
8	2010	catch.75perc	2.103868679	4467725
9	2011	catch.25perc	0.478397386	673641
10	2011	catch.10perc	0.122088266	288490
11	2011	catch.90perc	2.413660151	2495578
12	2011	catch.75perc	0.937437289	1955429
13	2012	catch.25perc	2.673889549	1251157
14	2012	catch.10perc	0.528566432	330522
15	2012	catch.90perc	6.49556254	4403670
16	2012	catch.75perc	5.400979384	2554606
17	2013	catch.25perc	0.22627911	4145113
18	2013	catch.10perc	0.12587717	568602
19	2013	catch.90perc	4.705279076	14070503
20	2013	catch.75perc	3.514457903	11941870
21	2014	catch.25perc	1.164212669	70815
22	2014	catch.10perc	1.164212669	70815
23	2014	catch.90perc	10.96099699	948766
24	2014	catch.75perc	2.724112018	759469
25	2015	catch.25perc	0.978919422	3270
26	2015	catch.10perc	0.29935691	1204
27	2015	catch.90perc	7.203640523	13344
28	2015	catch.75perc	4.071011091	10144
29	2016	catch.25perc	0.595019154	1874
30	2016	catch.10perc	0.532160637	1669
31	2016	catch.90perc	2.832782556	14710
32	2016	catch.75perc	2.3995129	12424
33	2017	catch.25perc	0.131572926	101
34	2017	catch.10perc	0.119723676	43
35	2017	catch.90perc	0.131572926	101
36	2017	catch.75perc	0.131572926	101
37	2018	catch.25perc	1.265710013	26894
38	2018	catch.10perc	0.524460476	1715
39	2018	catch.90perc	4.842574838	100785
40	2018	catch.75perc	2.504912967	83401
41	sum	catch.25perc	0.478397386	8092416
42	sum	catch.10perc	0.12587717	1053861
43	sum	catch.90perc	4.998169456	29735810
44	sum	catch.75perc	3.514457903	24228887

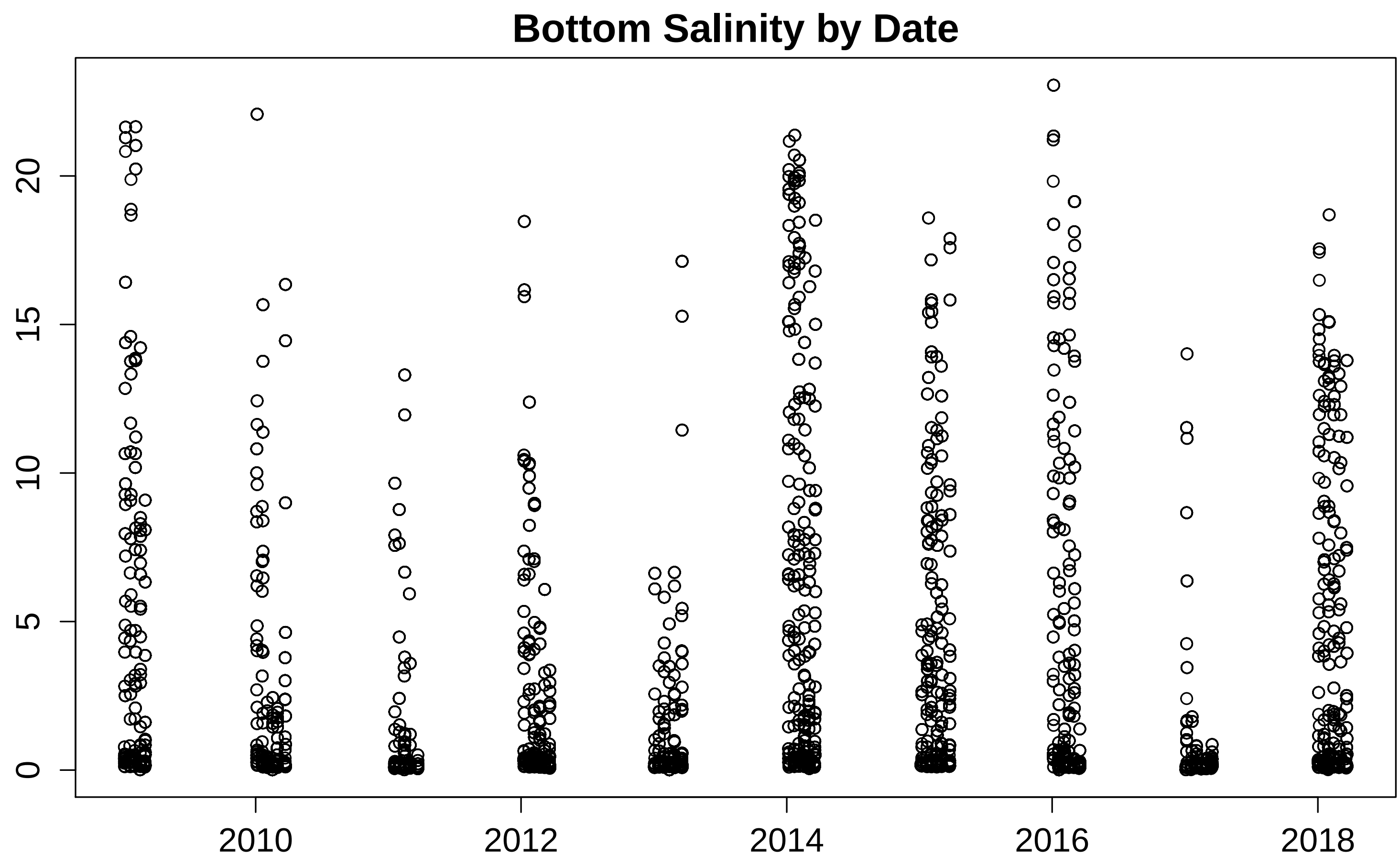


SLS_GAM_TopSalinity.pdf

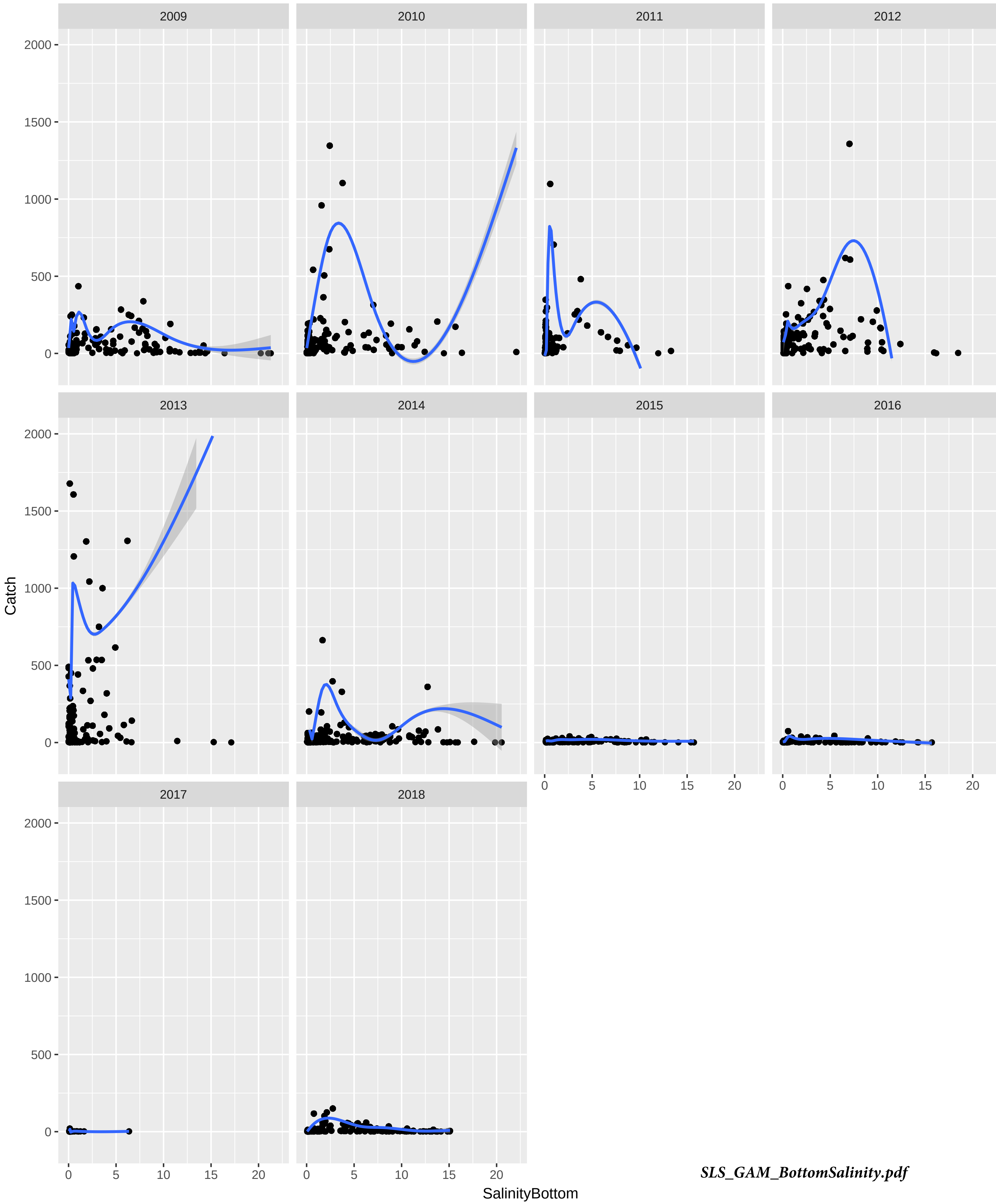


SLS_ECDF_TopSalinity.pdf

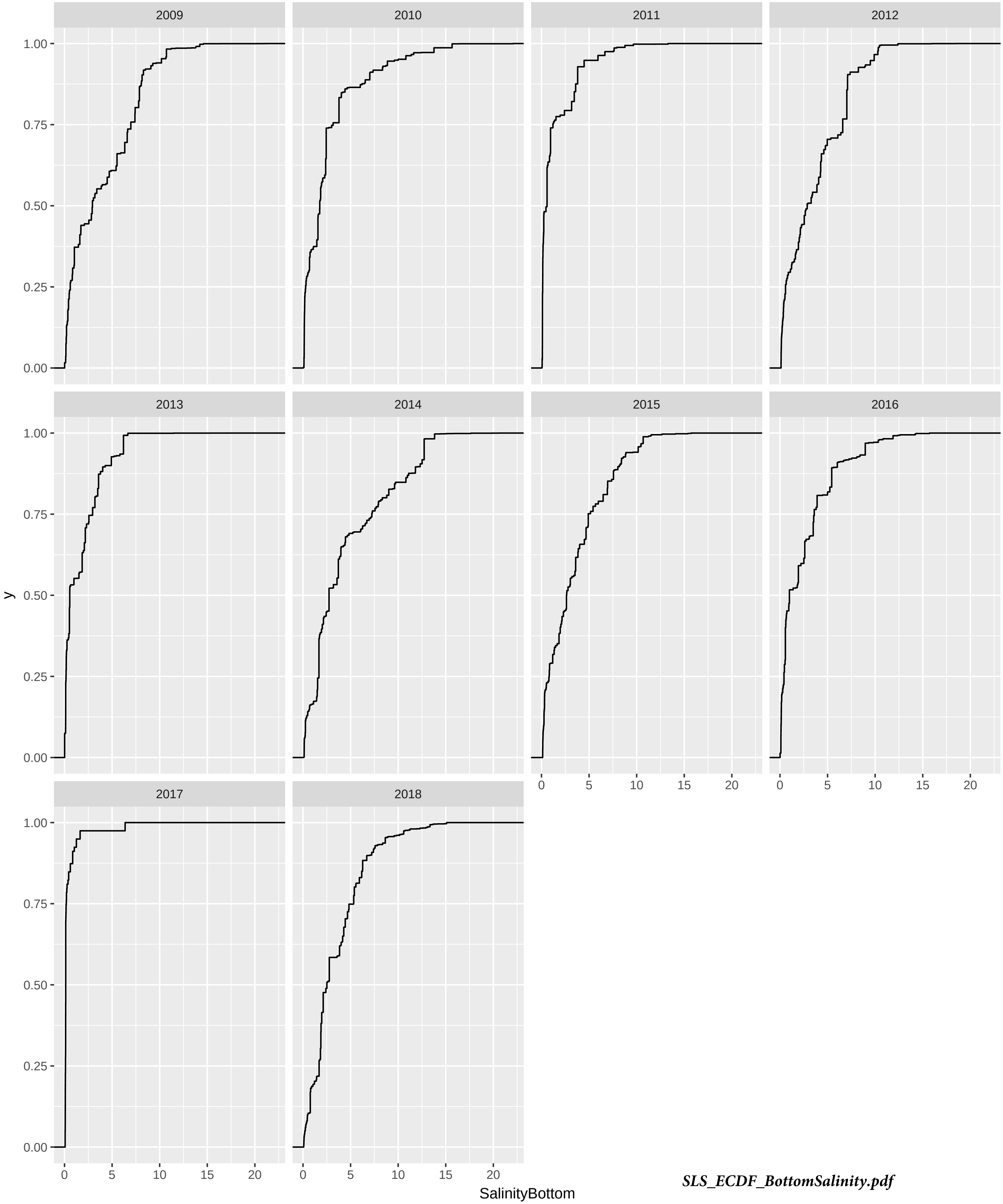
SLS_BottomSalinity_RangeSampled.pdf



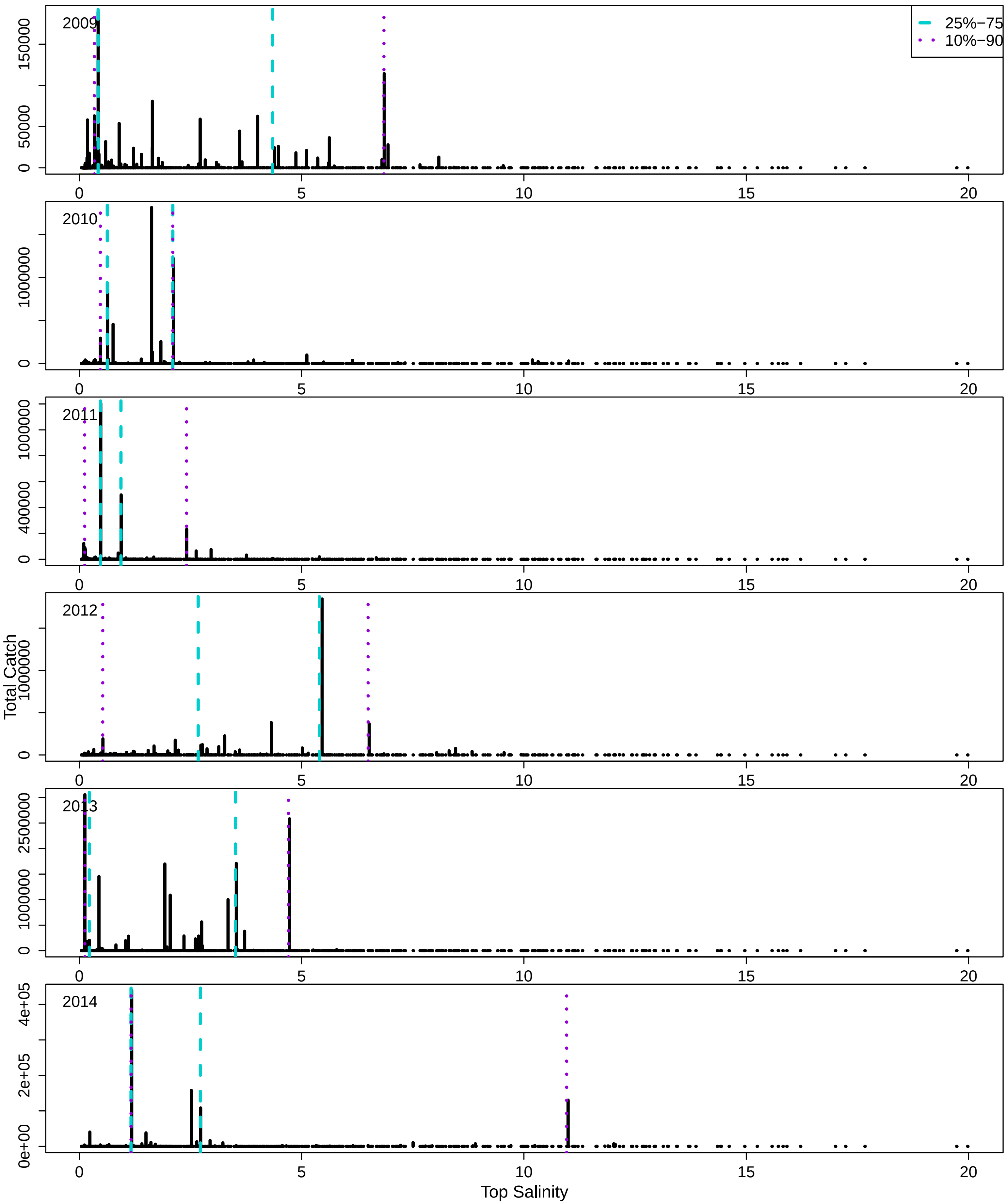
	Year	Metric	Salinity	Total.Catch
1	2009	catch.25perc	1.026919781	284064
2	2009	catch.10perc	0.349812554	101262
3	2009	catch.90perc	7.805814701	1027833
4	2009	catch.75perc	6.950450531	911276
5	2010	catch.25perc	1.565057753	788263
6	2010	catch.10perc	0.683769438	370533
7	2010	catch.90perc	3.777277203	4508694
8	2010	catch.75perc	3.777277203	4508694
9	2011	catch.25perc	0.583138202	673741
10	2011	catch.10perc	0.123034857	284900
11	2011	catch.90perc	3.783134492	2634663
12	2011	catch.75perc	0.951783842	1907468
13	2012	catch.25perc	3.212670865	1251886
14	2012	catch.10perc	0.578492922	330522
15	2012	catch.90perc	7.067681616	4388161
16	2012	catch.75perc	7.01829981	2543997
17	2013	catch.25perc	0.258729826	4151674
18	2013	catch.10perc	0.124929313	993027
19	2013	catch.90perc	6.171470607	14960592
20	2013	catch.75perc	2.947513122	12283339
21	2014	catch.25perc	1.672358375	115293
22	2014	catch.10perc	1.528851737	76827
23	2014	catch.90perc	12.65926542	961922
24	2014	catch.75perc	3.642760328	758991
25	2015	catch.25perc	1.835578967	3723
26	2015	catch.10perc	0.312303913	1200
27	2015	catch.90perc	7.54454251	13266
28	2015	catch.75perc	4.890406306	10356
29	2016	catch.25perc	0.559933438	1702
30	2016	catch.10perc	0.534728776	1621
31	2016	catch.90perc	5.419076669	13820
32	2016	catch.75perc	3.520281949	12486
33	2017	catch.25perc	0.127299735	101
34	2017	catch.10perc	0.116417869	43
35	2017	catch.90perc	0.127299735	101
36	2017	catch.75perc	0.127299735	101
37	2018	catch.25perc	1.871681843	26679
38	2018	catch.10perc	0.746987636	1540
39	2018	catch.90perc	5.358772428	101168
40	2018	catch.75perc	3.835882452	85052
41	sum	catch.25perc	0.517279466	6114035
42	sum	catch.10perc	0.124929313	1457113
43	sum	catch.90perc	6.636653704	29801153
44	sum	catch.75perc	3.777277203	24490660



SLS_GAM_BottomSalinity.pdf



SLS_ECDF_BottomSalinity.pdf

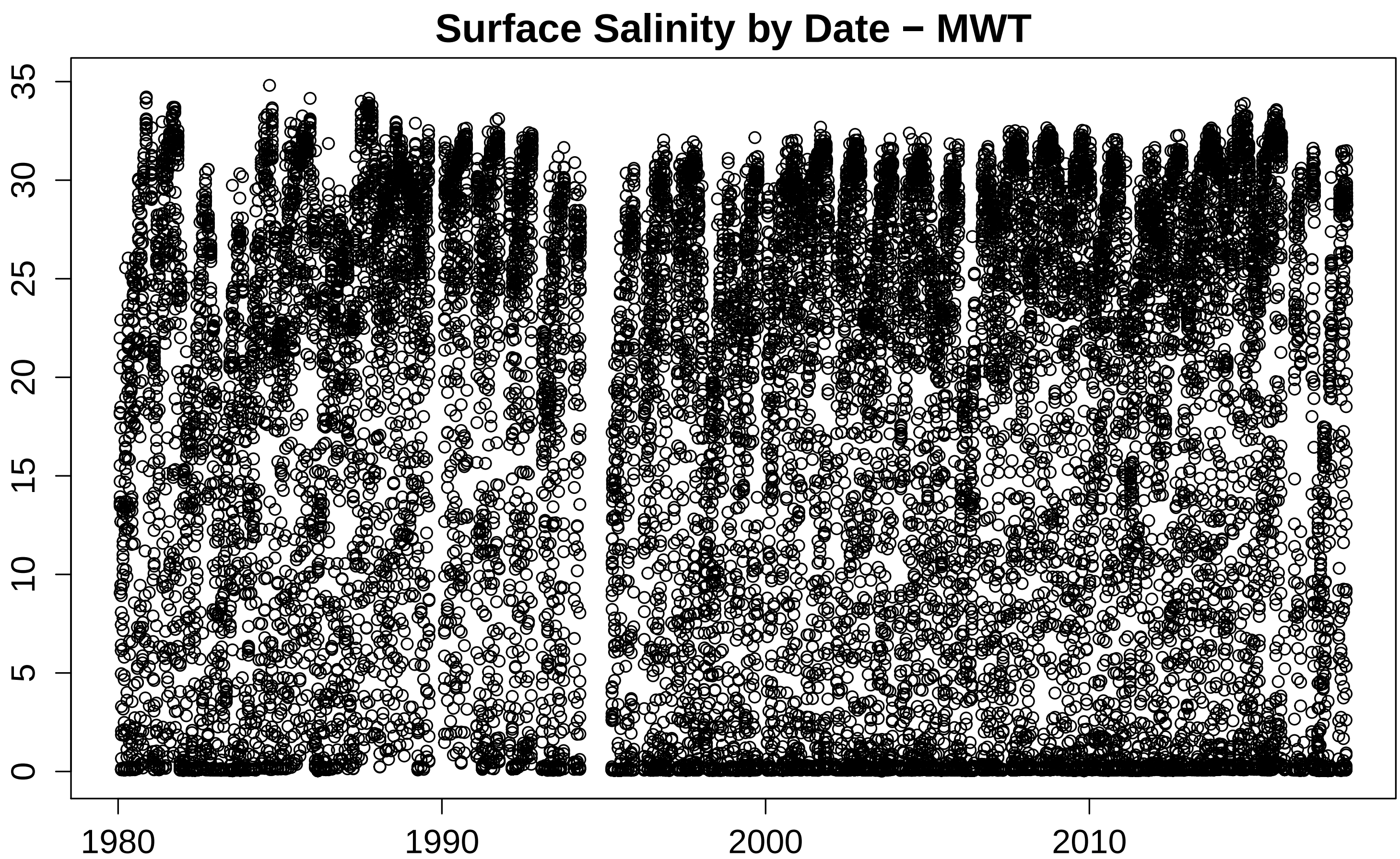

25%−75
10%−90
2009
2010
2011
2012
2013
2014
Total Catch
Top Salinity
0
5
10
15
20
0
50000
150000
1000000
400000
2500000
0e+00
2e+05
4e+05

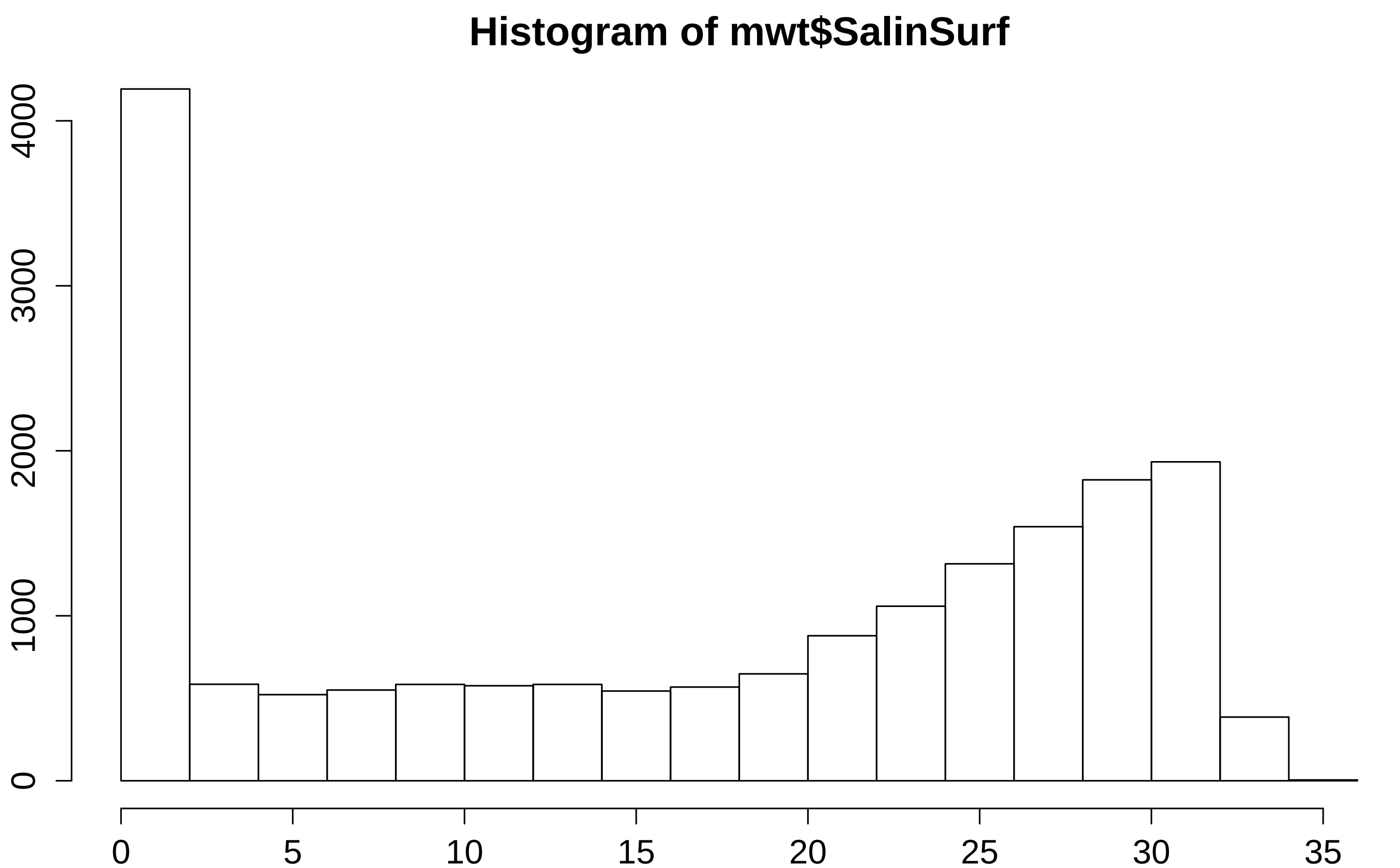
	Year	Metric	Salinity	Total.Catch
1	1980	catch.25perc	2.74	1620.24
2	1980	catch.10perc	1.9	650.8
3	1980	catch.90perc	23.98	5922.55
4	1980	catch.75perc	21.35	4808.07
5	1981	catch.25perc	3.46	41
6	1981	catch.10perc	0.5	13
7	1981	catch.90perc	11.05	163.81
8	1981	catch.75perc	9.76	136.81
9	1982	catch.25perc	1.89	3963.34
10	1982	catch.10perc	0.71	1327.21
11	1982	catch.90perc	16.38	14263.12
12	1982	catch.75perc	12.66	11560.12
13	1983	catch.25perc	1.2	371.96
14	1983	catch.10perc	0.18	61
15	1983	catch.90perc	26.92	1420.59
16	1983	catch.75perc	19.02	1206.09
17	1984	catch.25perc	5.67	215
18	1984	catch.10perc	0.99	81
19	1984	catch.90perc	30.1	708.76
20	1984	catch.75perc	26.78	572.76
21	1985	catch.25perc	4.04	41
22	1985	catch.10perc	3.65	14
23	1985	catch.90perc	31.7	155.8
24	1985	catch.75perc	21.43	110
25	1986	catch.25perc	2.66	242.7
26	1986	catch.10perc	1.75	84.78
27	1986	catch.90perc	19.84	1105.44
28	1986	catch.75perc	10.54	911.44
29	1987	catch.25perc	3.46	43
30	1987	catch.10perc	1.83	11
31	1987	catch.90perc	30.44	166
32	1987	catch.75perc	23.91	138
33	1988	catch.25perc	6.46	24
34	1988	catch.10perc	2.24	2
35	1988	catch.90perc	29.66	92
36	1988	catch.75perc	25.5	74
37	1989	catch.25perc	7.2	6
38	1989	catch.10perc	2.15	1
39	1989	catch.90perc	26.71	21
40	1989	catch.75perc	25.78	18
41	1990	catch.25perc	16.73	4
42	1990	catch.10perc	3.2	0
43	1990	catch.90perc	31.65	16
44	1990	catch.75perc	30.38	13
45	1991	catch.25perc	2.98	1

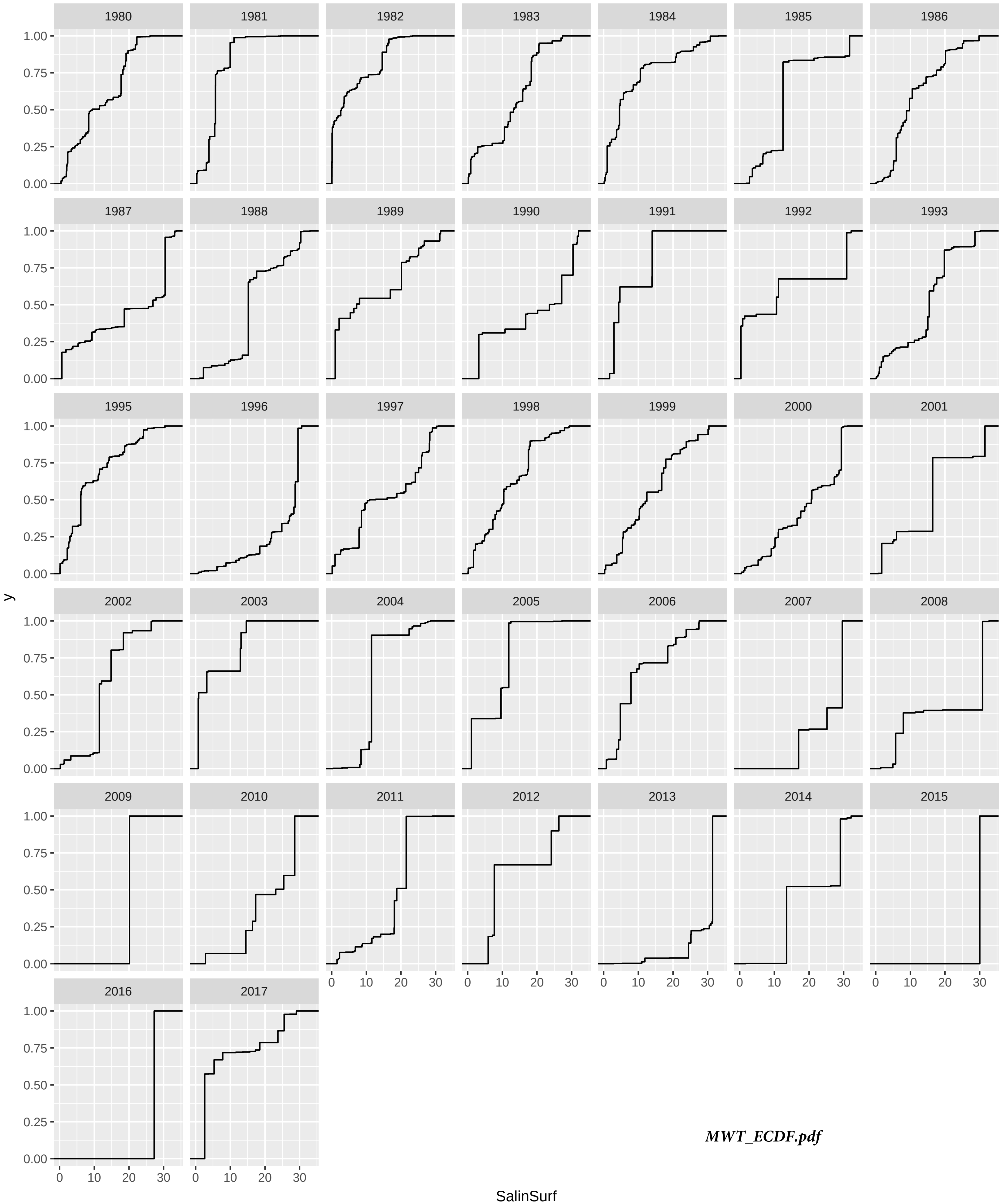
46	1991	catch.10perc	1.7	0
47	1991	catch.90perc	13.98	6
48	1991	catch.75perc	13.93	5
49	1992	catch.25perc	0.87	1
50	1992	catch.10perc	0.87	1
51	1992	catch.90perc	32.15	9
52	1992	catch.75perc	30.88	8
53	1993	catch.25perc	0.76	7
54	1993	catch.10perc	0.76	7
55	1993	catch.90perc	27.6	242.54
56	1993	catch.75perc	16.73	201.54
57	1994	catch.25perc	34.81	0
58	1994	catch.10perc	34.81	0
59	1994	catch.90perc	34.81	0
60	1994	catch.75perc	34.81	0
61	1995	catch.25perc	22.39	1760.86
62	1995	catch.10perc	6.32	683.86
63	1995	catch.90perc	26.51	3136.86
64	1995	catch.75perc	26.51	3136.86
65	1996	catch.25perc	8.01	49
66	1996	catch.10perc	1.65	9
67	1996	catch.90perc	28.7	172.84
68	1996	catch.75perc	25.4	144.84
69	1997	catch.25perc	9.58	33.1
70	1997	catch.10perc	7.52	13.1
71	1997	catch.90perc	28.23	116.1
72	1997	catch.75perc	26.27	103.1
73	1998	catch.25perc	5.25	859
74	1998	catch.10perc	1.03	265
75	1998	catch.90perc	22.61	3164.58
76	1998	catch.75perc	13.66	2649
77	1999	catch.25perc	9.89	473
78	1999	catch.10perc	5.63	172
79	1999	catch.90perc	26.45	1935.48
80	1999	catch.75perc	21.33	1628.3
81	2000	catch.25perc	6.18	346.8
82	2000	catch.10perc	1.47	113.8
83	2000	catch.90perc	28.05	1286.74
84	2000	catch.75perc	21.91	1073.74
85	2001	catch.25perc	1.74	5
86	2001	catch.10perc	1.74	5
87	2001	catch.90perc	31.52	80
88	2001	catch.75perc	16.44	69
89	2002	catch.25perc	9.4	22
90	2002	catch.10perc	0.19	0
91	2002	catch.90perc	26.41	70
92	2002	catch.75perc	21.89	66

93	2003	catch.25perc	3.6	9
94	2003	catch.10perc	0.87	3
95	2003	catch.90perc	14.61	32
96	2003	catch.75perc	12.87	18
97	2004	catch.25perc	9.34	18
98	2004	catch.10perc	4.61	7
99	2004	catch.90perc	27.73	72
100	2004	catch.75perc	23.23	61
101	2005	catch.25perc	3.96	10
102	2005	catch.10perc	1.05	1
103	2005	catch.90perc	24.69	37
104	2005	catch.75perc	11.85	28
105	2006	catch.25perc	3.72	16
106	2006	catch.10perc	3.72	16
107	2006	catch.90perc	27.47	148
108	2006	catch.75perc	20.18	121
109	2007	catch.25perc	19.2	6
110	2007	catch.10perc	11.53	2
111	2007	catch.90perc	29.59	20
112	2007	catch.75perc	29.59	20
113	2008	catch.25perc	5.76	8
114	2008	catch.10perc	1.43	1
115	2008	catch.90perc	30.84	36
116	2008	catch.75perc	17.49	31
117	2009	catch.25perc	13.79	3
118	2009	catch.10perc	6.22	1
119	2009	catch.90perc	30.08	11
120	2009	catch.75perc	28.44	9
121	2010	catch.25perc	14.46	12
122	2010	catch.10perc	2.8	2
123	2010	catch.90perc	28.58	47
124	2010	catch.75perc	25.41	38
125	2011	catch.25perc	2.27	36
126	2011	catch.10perc	1.54	2
127	2011	catch.90perc	18.77	150
128	2011	catch.75perc	18.08	114
129	2012	catch.25perc	7.12	4
130	2012	catch.10perc	6.95	3
131	2012	catch.90perc	26.31	27
132	2012	catch.75perc	24.12	23
133	2013	catch.25perc	11.87	19
134	2013	catch.10perc	9.18	8
135	2013	catch.90perc	31.42	63
136	2013	catch.75perc	31.39	61
137	2014	catch.25perc	12.76	7
138	2014	catch.10perc	1.75	1
139	2014	catch.90perc	30.98	25

140	2014	catch.75perc	29.03	18
141	2015	catch.25perc	30.02	1
142	2015	catch.10perc	24.87	0
143	2015	catch.90perc	31.23	3
144	2015	catch.75perc	31.23	3
145	2016	catch.25perc	10.23	3
146	2016	catch.10perc	8.09	1
147	2016	catch.90perc	28.72	12
148	2016	catch.75perc	28.64	10
149	2017	catch.25perc	7.8	17
150	2017	catch.10perc	3.72	8
151	2017	catch.90perc	27.19	77
152	2017	catch.75perc	23.71	62
153	sum	catch.25perc	3.44	10766.71
154	sum	catch.10perc	1.2	4266.29
155	sum	catch.90perc	26.51	38090.57
156	sum	catch.75perc	19.81	31975.01


Surface Salinity by Date − MWT
0
5
10
15
20
25
30
35
1980
1990
2000
2010


Histogram of mwt$SalinSurf
0
1000
2000
3000
4000
0
5
10
15
20
25
30
35



1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
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1991
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1995
1996
1997
1998
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2000
2001
2002
2003
2004
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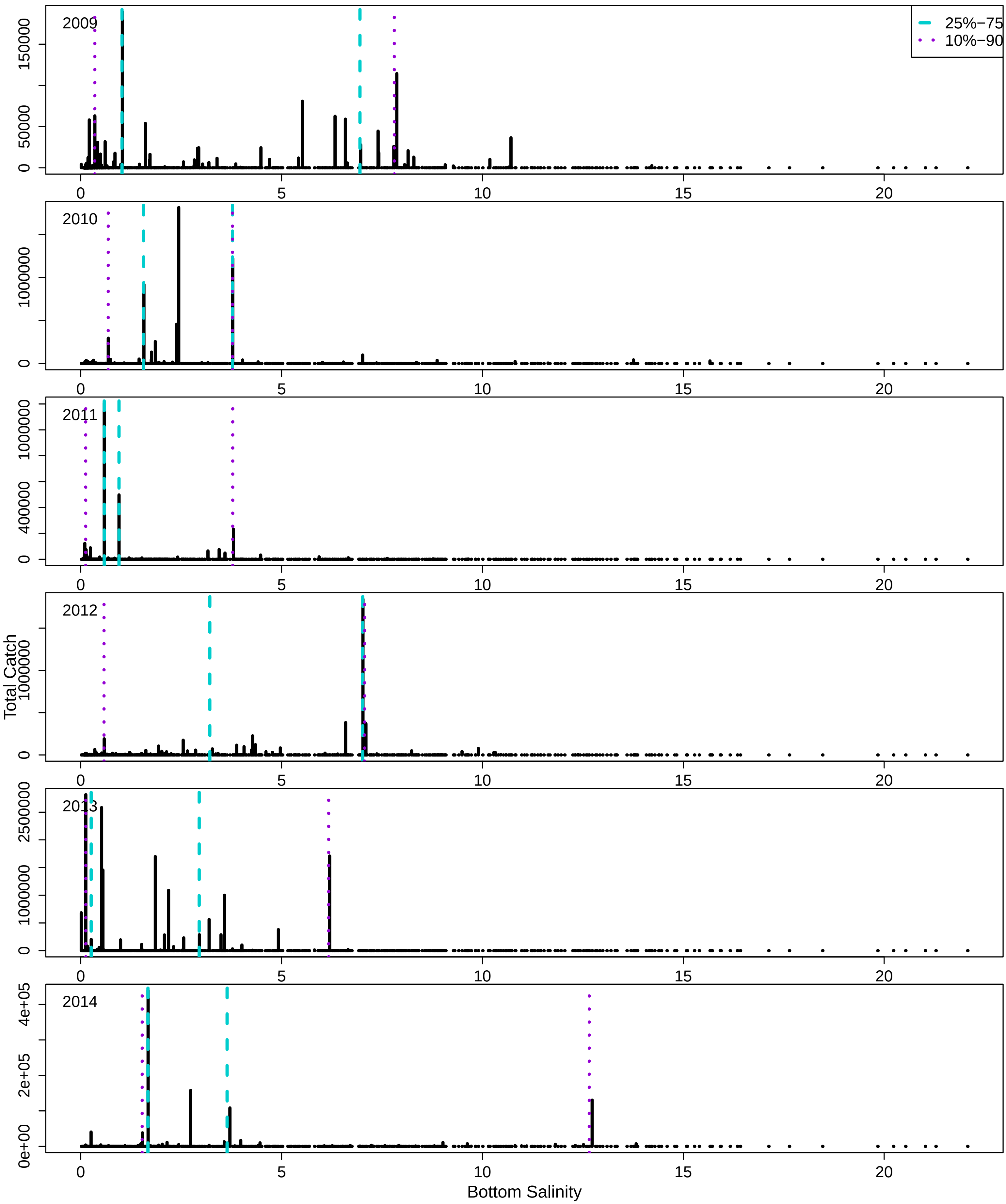
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
y
SalinSurf

MWT_ECDF.pdf

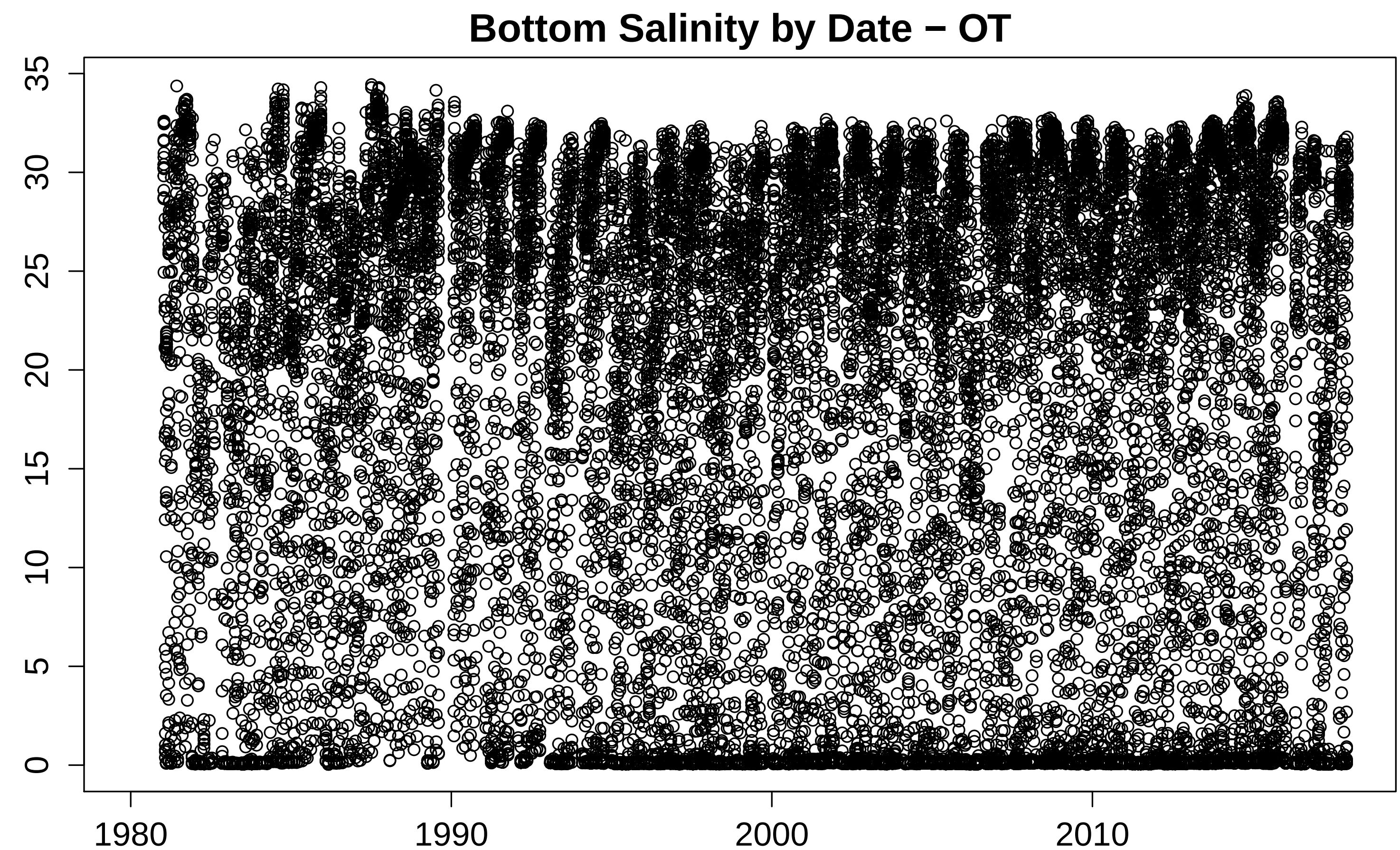

25%−75
10%−90
2009
2010
2011
2012
2013
2014
Total Catch
Bottom Salinity
0
5
10
15
20
0
50000
150000
1000000
400000
2500000
0e+00
2e+05
4e+05

	Year	Metric	Salinity	Total.Catch
5	1981	catch.25perc	9.63	31
6	1981	catch.10perc	6.63	15
7	1981	catch.90perc	32.22	121
8	1981	catch.75perc	32	103
9	1982	catch.25perc	10.47	1493.24
10	1982	catch.10perc	2.25	454
11	1982	catch.90perc	30.61	5218.67
12	1982	catch.75perc	23.31	4250.56
13	1983	catch.25perc	17.87	239.63
14	1983	catch.10perc	5.33	95.97
15	1983	catch.90perc	29.3	874.55
16	1983	catch.75perc	24.65	540.47
17	1984	catch.25perc	26.14	364
18	1984	catch.10perc	10.78	160
19	1984	catch.90perc	32.19	1466.58
20	1984	catch.75perc	31.59	763.68
21	1985	catch.25perc	26.07	173
22	1985	catch.10perc	15.44	64
23	1985	catch.90perc	32.58	590
24	1985	catch.75perc	32.36	528
25	1986	catch.25perc	16.31	120
26	1986	catch.10perc	5.27	49
27	1986	catch.90perc	30.75	459
28	1986	catch.75perc	29.44	378
29	1987	catch.25perc	7.73	31
30	1987	catch.10perc	7.59	9
31	1987	catch.90perc	32.66	139
32	1987	catch.75perc	27.19	117
33	1988	catch.25perc	9.52	16
34	1988	catch.10perc	2.52	4
35	1988	catch.90perc	30.83	63
36	1988	catch.75perc	28.72	53
37	1989	catch.25perc	3.53	8
38	1989	catch.10perc	0.6	2
39	1989	catch.90perc	32.36	27
40	1989	catch.75perc	31.78	24
41	1990	catch.25perc	21.88	5
42	1990	catch.10perc	9.02	2
43	1990	catch.90perc	31.75	18
44	1990	catch.75perc	31.45	16
45	1991	catch.25perc	1.91	3
46	1991	catch.10perc	1.32	0
47	1991	catch.90perc	32.33	15
48	1991	catch.75perc	31.06	13
49	1992	catch.25perc	6.41	5

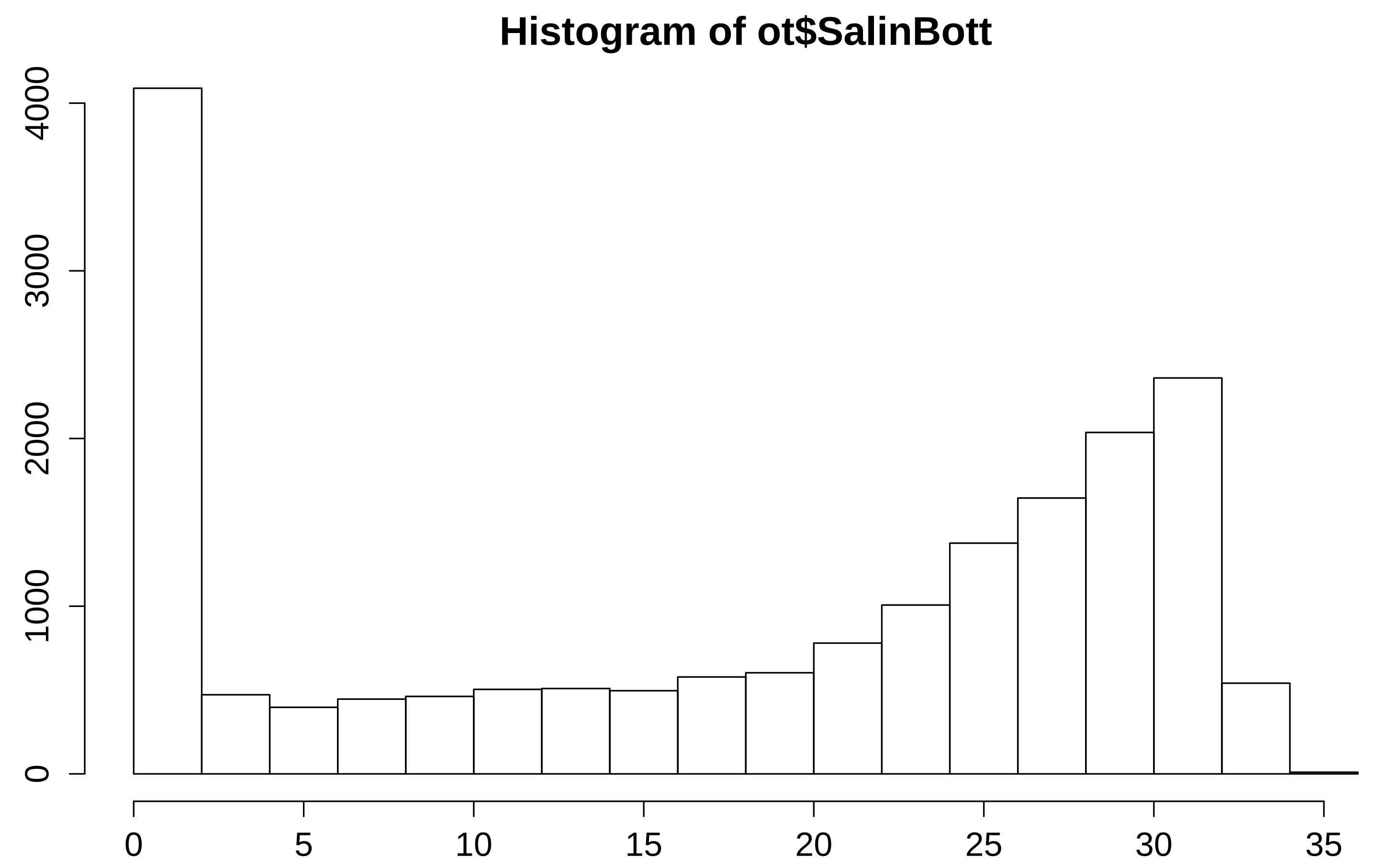
50	1992	catch.10perc	2.75	2
51	1992	catch.90perc	30.07	19
52	1992	catch.75perc	29.06	14
53	1993	catch.25perc	21.47	64
54	1993	catch.10perc	13.4	25
55	1993	catch.90perc	30.92	231
56	1993	catch.75perc	30.32	187
57	1994	catch.25perc	30.64	20
58	1994	catch.10perc	29.58	6
59	1994	catch.90perc	31.91	71
60	1994	catch.75perc	31.8	55
61	1995	catch.25perc	25.29	1345
62	1995	catch.10perc	21.23	545
63	1995	catch.90perc	30.33	4310.96
64	1995	catch.75perc	30.03	4054.96
65	1996	catch.25perc	27.4	128
66	1996	catch.10perc	22.64	53
67	1996	catch.90perc	31.2	472.52
68	1996	catch.75perc	30.88	386.52
69	1997	catch.25perc	28.26	134
70	1997	catch.10perc	26.53	48
71	1997	catch.90perc	30.56	595
72	1997	catch.75perc	28.57	281
73	1998	catch.25perc	17.31	144
74	1998	catch.10perc	10.43	73
75	1998	catch.90perc	26.67	682
76	1998	catch.75perc	26.45	451
77	1999	catch.25perc	24.83	752.6
78	1999	catch.10perc	15.3	279.8
79	1999	catch.90perc	30.17	2388.96
80	1999	catch.75perc	29.71	2200.96
81	2000	catch.25perc	20.95	156
82	2000	catch.10perc	9.4	59
83	2000	catch.90perc	31.19	554
84	2000	catch.75perc	30.31	441
85	2001	catch.25perc	7.14	8
86	2001	catch.10perc	7.14	8
87	2001	catch.90perc	31.22	75
88	2001	catch.75perc	25.28	63
89	2002	catch.25perc	18.7	158
90	2002	catch.10perc	11.42	63
91	2002	catch.90perc	32.09	502
92	2002	catch.75perc	31.97	478
93	2003	catch.25perc	20.66	42
94	2003	catch.10perc	12.95	17
95	2003	catch.90perc	31.18	154
96	2003	catch.75perc	28.23	84

97	2004	catch.25perc	24.68	90.55
98	2004	catch.10perc	11.58	22
99	2004	catch.90perc	30.62	326.55
100	2004	catch.75perc	29.38	150.55
101	2005	catch.25perc	25.62	49
102	2005	catch.10perc	19.92	20
103	2005	catch.90perc	30.69	208
104	2005	catch.75perc	28.95	176
105	2006	catch.25perc	25.53	146
106	2006	catch.10perc	14.99	59
107	2006	catch.90perc	31.02	493
108	2006	catch.75perc	30.14	443
109	2007	catch.25perc	31.04	26
110	2007	catch.10perc	29.49	9
111	2007	catch.90perc	32.33	95
112	2007	catch.75perc	31.66	77
113	2008	catch.25perc	28.54	52
114	2008	catch.10perc	15.56	23
115	2008	catch.90perc	32.11	214
116	2008	catch.75perc	31.93	177
117	2009	catch.25perc	26.12	7
118	2009	catch.10perc	15.43	3
119	2009	catch.90perc	32.24	27
120	2009	catch.75perc	31.33	21
121	2010	catch.25perc	16.76	7
122	2010	catch.10perc	16.41	1
123	2010	catch.90perc	30.74	26
124	2010	catch.75perc	29.07	21
125	2011	catch.25perc	26.31	123
126	2011	catch.10perc	25	51
127	2011	catch.90perc	31.11	504
128	2011	catch.75perc	30	419
129	2012	catch.25perc	28.58	19
130	2012	catch.10perc	28.58	19
131	2012	catch.90perc	29.93	180
132	2012	catch.75perc	29.13	115
133	2013	catch.25perc	31.22	65
134	2013	catch.10perc	24.54	25
135	2013	catch.90perc	31.75	225
136	2013	catch.75perc	31.66	134
137	2014	catch.25perc	29.3	6
138	2014	catch.10perc	12.74	2
139	2014	catch.90perc	32.25	23
140	2014	catch.75perc	31.94	18
141	2015	catch.25perc	31.75	0
142	2015	catch.10perc	31.75	0
143	2015	catch.90perc	32.17	8

144	2015	catch.75perc	32.17	8
145	2016	catch.25perc	20.28	5
146	2016	catch.10perc	18.53	0
147	2016	catch.90perc	30.44	19
148	2016	catch.75perc	30.33	13
149	2017	catch.25perc	23.92	30
150	2017	catch.10perc	15.02	14
151	2017	catch.90perc	29.74	123
152	2017	catch.75perc	28.54	54
153	sum	catch.25perc	19.64	5850.54
154	sum	catch.10perc	8.61	2510.22
155	sum	catch.90perc	31.59	22701.3
156	sum	catch.75perc	30.17	18827.01



Bottom Salinity by Date − OT
35
30
25
20
15
10
5
0
1980
1990
2000
2010



Histogram of ot$SalinBott
4000
3000
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1000
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0
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20
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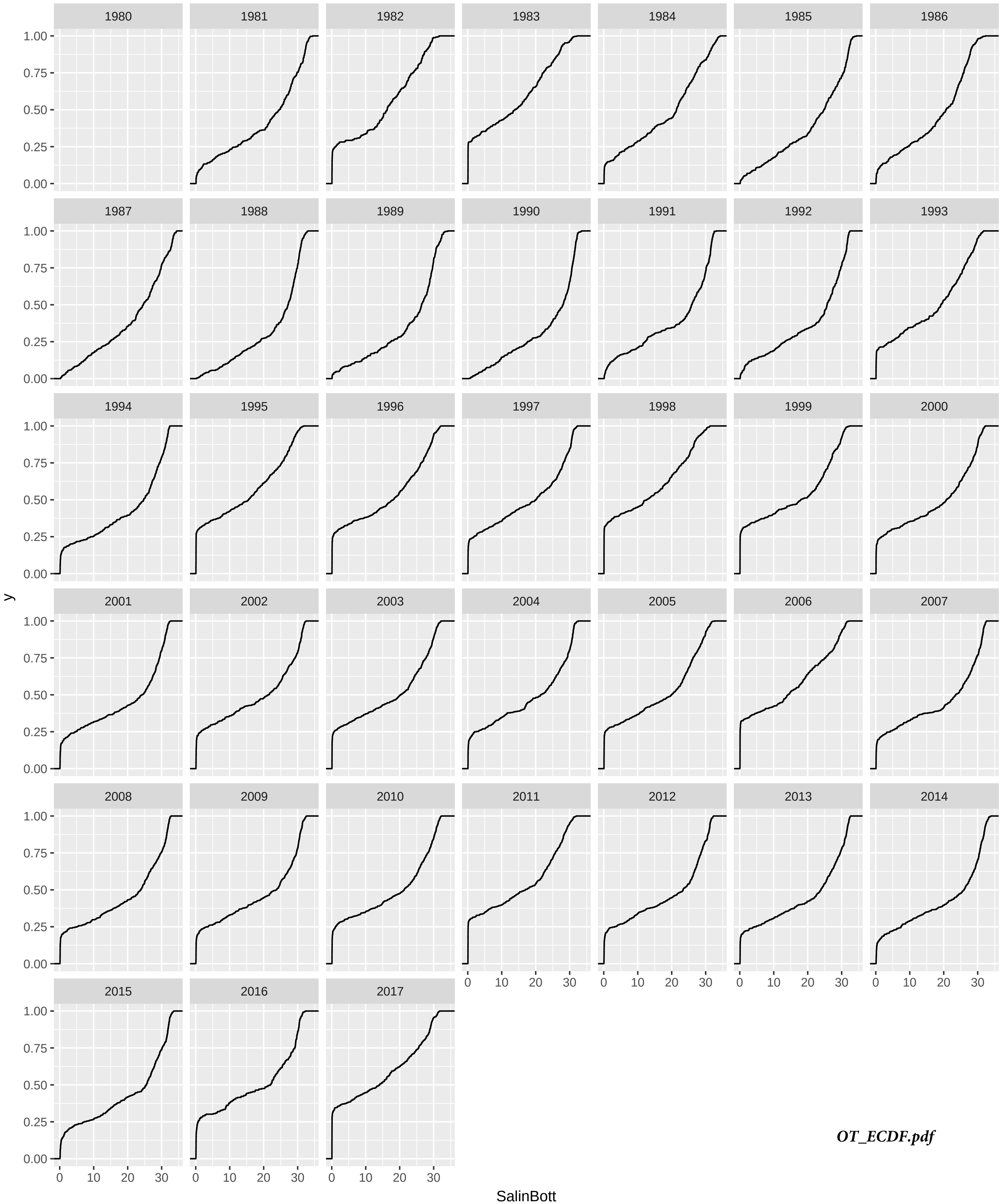
30
35


1980
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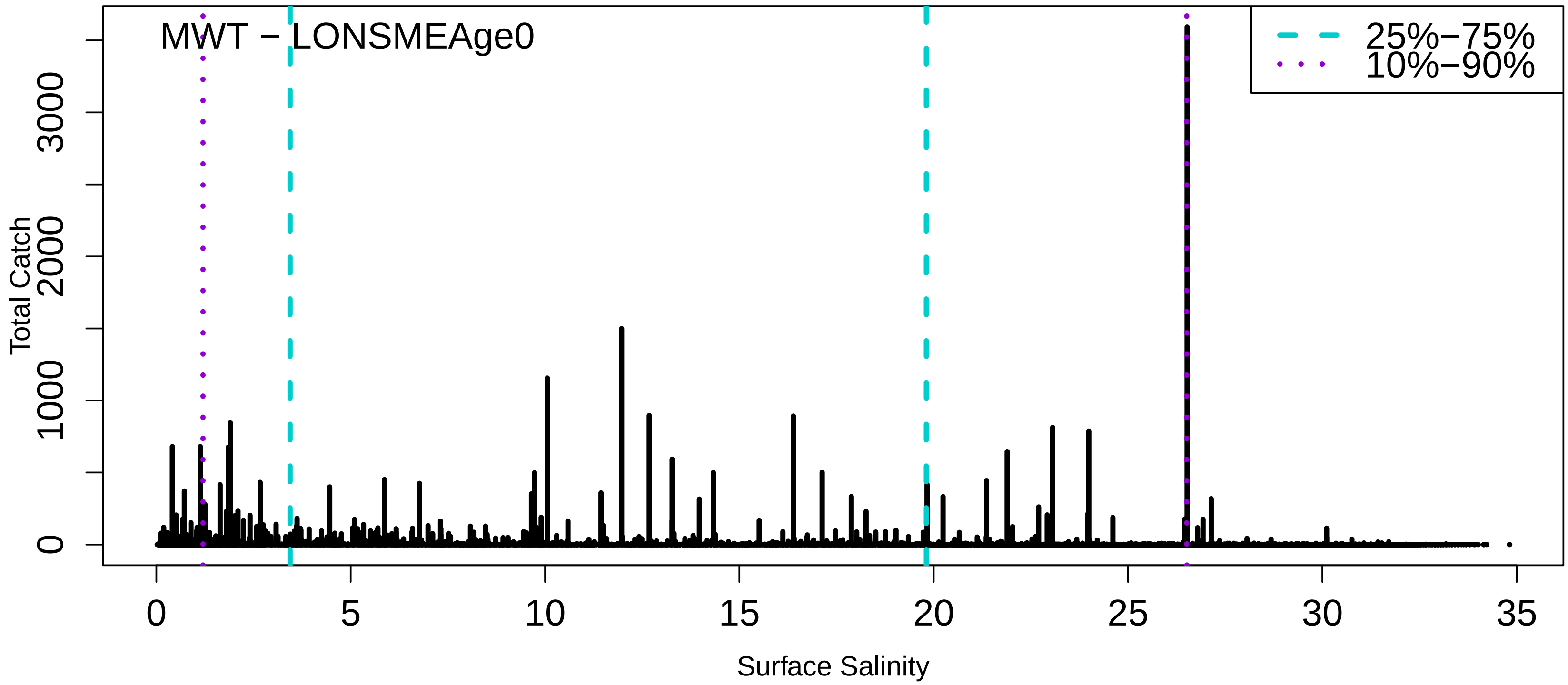
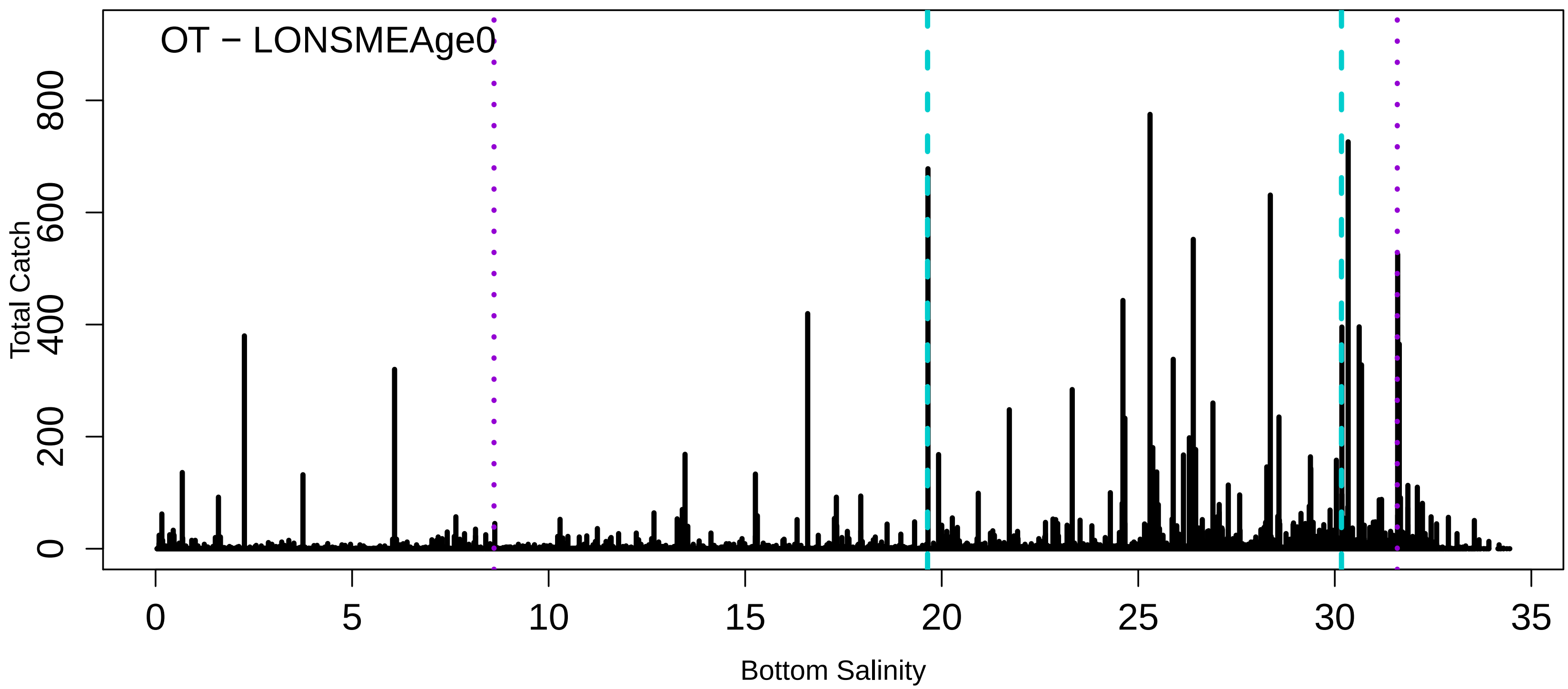
20
30
SalinBott

OT_ECDF.pdf


MWT − LONSMEAge0
25%−75%
10%−90%
Total Catch
0
1000
2000
3000
0
5
10
15
20
25
30
35
Surface Salinity


OT − LONSMEAge0
Total Catch
0
200
400
600
800
0
5
10
15
20
25
30
35
Bottom Salinity

Appendix B

Hydrology Model Results

Modeling Results

1. Introduction

The results of model simulations are provided for informational purposes. Please do not use any information contained in these products for any purpose other than this ITP application process. If there are any questions regarding the results of these model simulations, please contact DWR.

Any use of results of model simulations should observe limitations of the models used as well as the limitations to the modeled alternatives. These results should only be used for comparative purposes. More information regarding limitations of the models used as well as the limitations to the modeled alternatives is included Appendix H Attachment 1-7 Model Limitations.

2. Modeled Alternatives

The following alternatives were prepared:

- Existing Conditions (EX)
- Proposed Project (PP)

Existing Conditions

The Existing Conditions represents CVP and SWP operations to comply with the “current” regulatory environment as of (April 22, 2019). The Existing Conditions assumptions include existing facilities and ongoing programs that existed as of April 22, 2019- publication date of the Notice of Preparation (NOP). The Existing Conditions assumptions also include facilities and programs that received approvals and permits by April, 2019 because those programs were consistent with existing management direction as of the NOP.

Proposed Project

The proposed project is the DWR on-going long-term operation of the State Water Project (SWP) consistent with existing regulatory requirements that address water rights, water quality, and the protection and conservation of designated species in compliance with California Endangered Species Act (CESA). The goal of the proposed project is to continue the long-term operation of the SWP for water supply and power generation, consistent with applicable laws, contractual obligations, and agreements, and to increase operational flexibility by focusing on nonoperational measures to avoid significant adverse effects. DWR proposes to store, divert, and convey water in accordance with existing water contracts and agreements up to full contract amounts and other deliveries, consistent with water rights and applicable laws and regulations.

The following model simulations were prepared for each alternative:

- CalSim II
- DSM2

3. Model Results for Modeled Alternatives

Model Results

The results for each alternative for each model are compiled in tables and charts in the following attachments:

- Appendix C Attachment 2-1 Storage and Elevation Results (CalSim II)
- Appendix C Attachment 2-2 Flow Results (CalSim II)
- Appendix C Attachment 2-3 Diversion Results (CalSim II)
- Appendix C Attachment 2-4 Water Supply Results (CalSim II)
- Appendix C Attachment 2-5 X2 Results (CalSim II)
- Appendix C Attachment 2-6 Stage Results (DSM2)
- Appendix C Attachment 2-7 EC Results (DSM2)
- Appendix C Attachment 2-8 Chloride Results (DSM2)
- Appendix C Attachment 2-9 D1641 Compliance Results (DSM2)
- Appendix C Attachment 2-10 D1641 Compliance Results (CalSim II)

Each attachment includes a catalog of results included.

As noted in the Introduction, any use of results of model simulations should observe limitations of the models used as well as the limitations to the modeled alternatives. These results should only be used for comparative purposes. More information regarding limitations of the models used as well as the limitations to the modeled alternatives is included Appendix C Attachment 1-7 Model Limitations.

Formats Provided

The following formats are provided:

- Monthly tables comparing two alternatives (exceedance values, long-term average, and average by water year type)
- Monthly pattern charts (long-term average and average by water year type) including all alternatives
- Monthly exceedance charts (all months) including all alternatives

4. References

Anderson, James. (2018). Using river temperature to optimize fish incubation metabolism and survival: a case for mechanistic models. 10.1101/257154.

California Department of Water Resources, DSM2:Delta Simulation Model 2 Web Page Last updated September 2019. Site accessed October 2019. URL = https://water.ca.gov/Library/Modeling-and-Analysis/Bay-Delta-Region-models-and-tools/Delta-Simulation-Model-II

Draper, A.J., Munévar, A., Arora, S.K., Reyes, E., Parker, N 1 .L., Chung, F.I., and Peterson, L.E. 2004. CalSim: Generalized Model for Reservoir System Analysis. American Society of Civil Engineers, Journal of Water Resources Planning and Management, Vol. 130, No. 6.

U. S. Bureau of Reclamation, 2015. Coordinated Long Term Operation of the CVP and SWP EIS, Appendix 5A CalSim II and DSM2 Modeling.

Appendix C – Modeling

Attachment 2-1 – Storage and Elevation Results (CalSim II)

The following results of the CalSim II model are included for reservoir storage conditions for the following alternatives:

- Existing Conditions
- Proposed Project

Table 2-1.1. Storage and Elevation Results (CalSim II)

Title	Model Parameter	Table Numbers	Figure Numbers
San Luis Reservoir Storage	S11+S12	1a-1	1a-1 to 1a-18
San Luis Reservoir Elevation	Post-processed	1b-1	1b-1 to 1b-18
SWP San Luis Reservoir Storage	S12	1c-1	1c-1 to 1c-18

Report formats

- Monthly tables comparing two scenarios (exceedance values, long-term average, and average by water year type)
- Monthly exceedance charts (all months) including all scenarios

Table 1a-1. San Luis Storage (CVP and SWP), End of Month Storage

Existing

	End of Month Storage (TAF)											
Statistic	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Probability of Exceedance												
10%	712	873	1,152	1,609	1,840	2,039	1,780	1,416	1,144	903	631	699
20%	599	734	1,065	1,375	1,637	1,930	1,724	1,284	958	712	515	607
30%	529	654	968	1,274	1,533	1,839	1,630	1,225	840	653	457	500
40%	485	618	902	1,198	1,492	1,712	1,496	1,148	810	597	398	449
50%	443	543	850	1,103	1,402	1,644	1,424	1,108	774	498	349	411
60%	362	463	762	1,022	1,291	1,507	1,347	1,021	708	469	322	353
70%	314	422	684	959	1,222	1,378	1,221	950	630	438	284	304
80%	255	393	574	884	1,124	1,306	1,173	860	567	398	215	240
90%	213	301	464	776	1,041	1,266	1,103	788	469	309	188	187
Long Term												
Full Simulation Period[a]	473	591	844	1,138	1,407	1,617	1,435	1,103	796	581	408	446
Water Year Types[b,c]												
Wet (32%)	546	675	896	1,223	1,521	1,790	1,576	1,207	909	707	564	639
Above Normal (15%)	479	599	912	1,200	1,471	1,682	1,443	1,034	689	482	390	489
Below Normal (17%)	416	542	803	1,076	1,367	1,587	1,378	1,013	664	523	409	418
Dry (22%)	448	572	844	1,130	1,359	1,546	1,400	1,102	801	586	280	293
Critical (15%)	410	489	711	976	1,212	1,316	1,244	1,057	807	469	276	246

Proposed Project

	End of Month Storage (TAF)											
Statistic	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Probability of Exceedance												
10%	1,113	1,366	1,639	1,848	2,039	2,039	1,994	1,890	1,590	1,264	1,015	1,056
20%	911	1,120	1,386	1,638	1,865	2,028	1,932	1,813	1,402	1,079	757	803
30%	731	977	1,297	1,506	1,702	1,907	1,858	1,580	1,179	896	628	677
40%	628	831	1,167	1,401	1,586	1,744	1,736	1,517	1,047	732	545	566
50%	501	713	944	1,271	1,509	1,682	1,614	1,422	966	675	464	491
60%	450	564	852	1,094	1,404	1,546	1,487	1,269	902	577	387	401
70%	331	486	717	1,002	1,299	1,404	1,372	1,162	781	494	309	319
80%	249	398	615	882	1,143	1,239	1,226	1,038	732	436	244	229
90%	209	314	479	793	972	1,141	1,117	918	598	397	185	202
Long Term												
Full Simulation Period[a]	611	795	1,024	1,274	1,498	1,619	1,583	1,401	1,040	761	548	565
Water Year Types[b,c]												
Wet (32%)	756	961	1,153	1,397	1,623	1,796	1,802	1,662	1,316	1,054	865	909
Above Normal (15%)	595	791	1,072	1,338	1,562	1,669	1,630	1,425	991	726	571	633
Below Normal (17%)	596	795	1,027	1,264	1,516	1,594	1,542	1,338	923	680	512	507
Dry (22%)	538	708	986	1,253	1,457	1,562	1,494	1,274	924	620	275	269
Critical (15%)	440	570	746	988	1,203	1,303	1,244	1,072	805	466	291	261

Proposed Project minus Existing

	End of Month Storage (TAF)											
Statistic	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Probability of Exceedance												
10%	401	494	487	239	199	0	214	474	447	361	384	357
20%	312	386	321	263	227	97	208	530	444	367	242	197
30%	202	323	328	233	168	68	229	355	339	243	171	177
40%	143	213	266	203	94	31	241	368	237	135	147	116
50%	59	170	94	168	107	38	190	315	192	177	115	80
60%	87	101	90	72	113	40	140	248	195	108	65	47
70%	16	65	32	43	77	26	150	212	151	56	25	15
80%	**-6**	5	42	**-2**	19	**-67**	53	178	164	38	29	**-11**
90%	**-4**	12	15	17	**-69**	**-125**	14	129	128	88	**-3**	15
Long Term												
Full Simulation Period[a]	138	203	180	136	91	3	148	297	244	179	140	118
Water Year Types[b,c]												
Wet (32%)	210	286	258	174	102	6	226	456	408	346	300	270
Above Normal (15%)	115	191	160	138	91	**-14**	187	391	302	243	181	144
Below Normal (17%)	180	252	223	188	149	7	164	326	258	157	103	88
Dry (22%)	90	136	142	122	98	15	94	172	123	34	**-5**	**-24**
Critical (15%)	30	81	35	12	**-10**	**-12**	0	15	**-2**	**-3**	15	15

a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

c These results are displayed with water year - year type sorting.

Figure 1a-7. San Luis Storage (CVP and SWP), End of October Storage

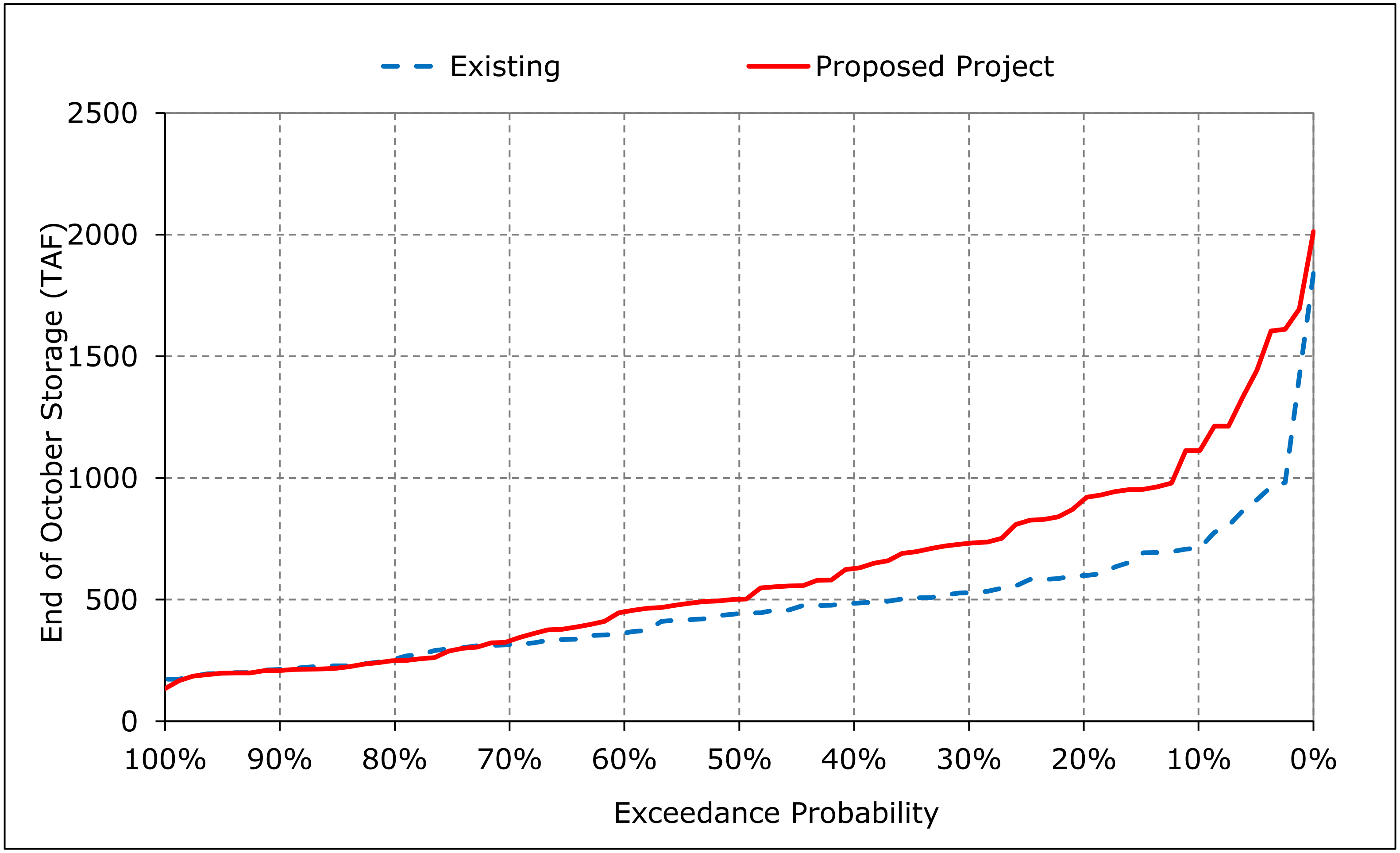


Figure 1a-8. San Luis Storage (CVP and SWP), End of November Storage

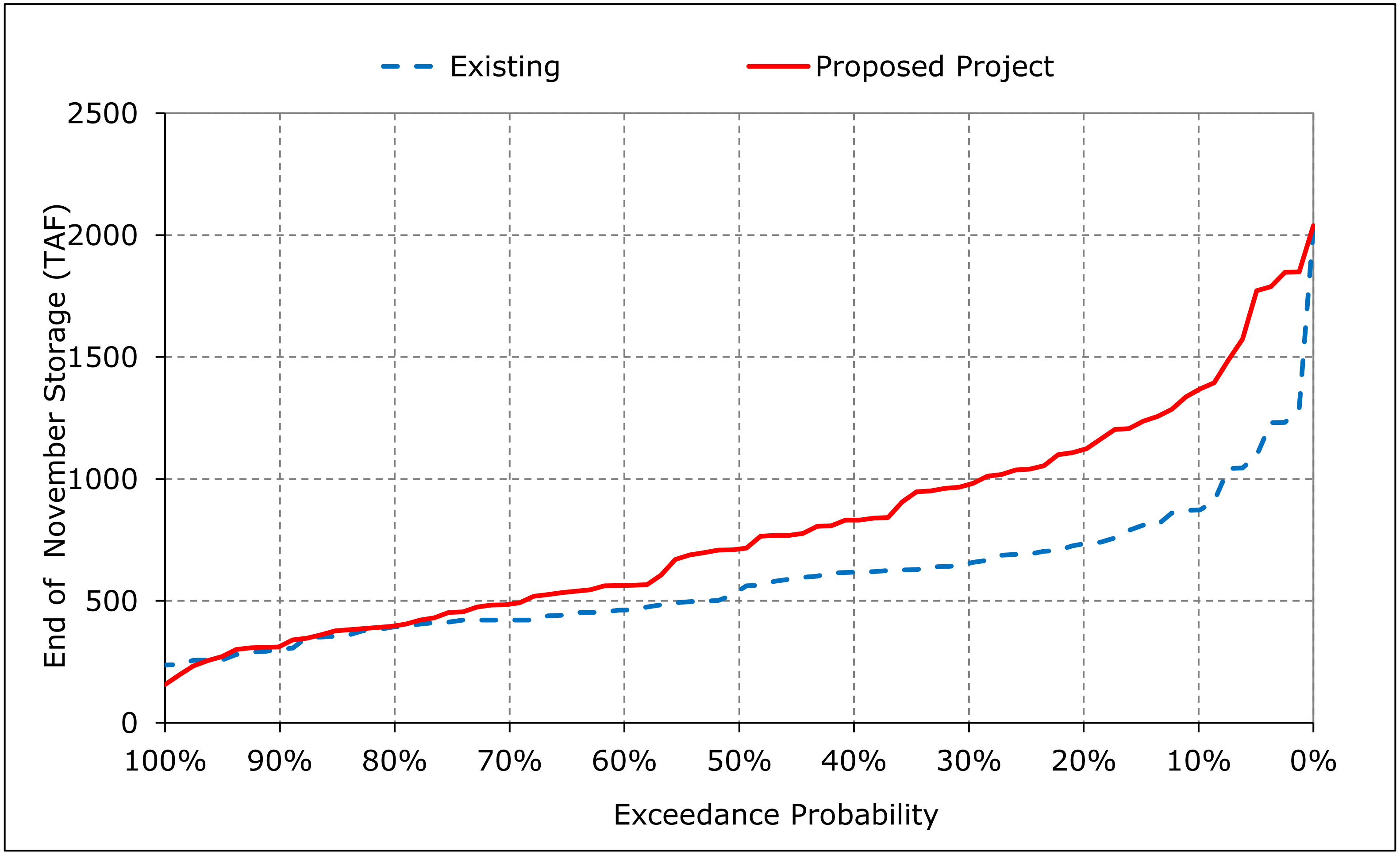


Figure 1a-9. San Luis Storage (CVP and SWP), End of December Storage

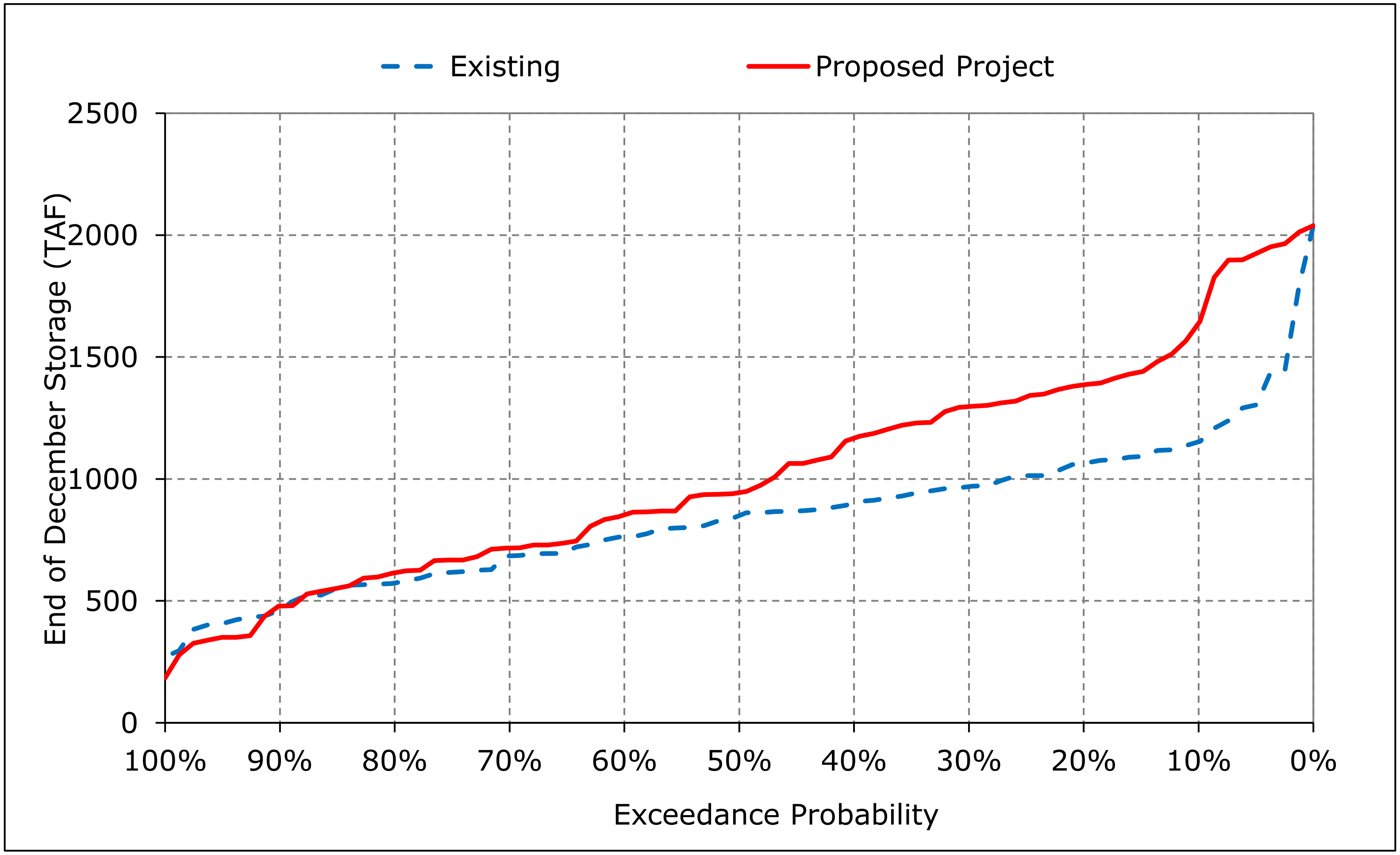


Figure 1a-10. San Luis Storage (CVP and SWP), End of January Storage

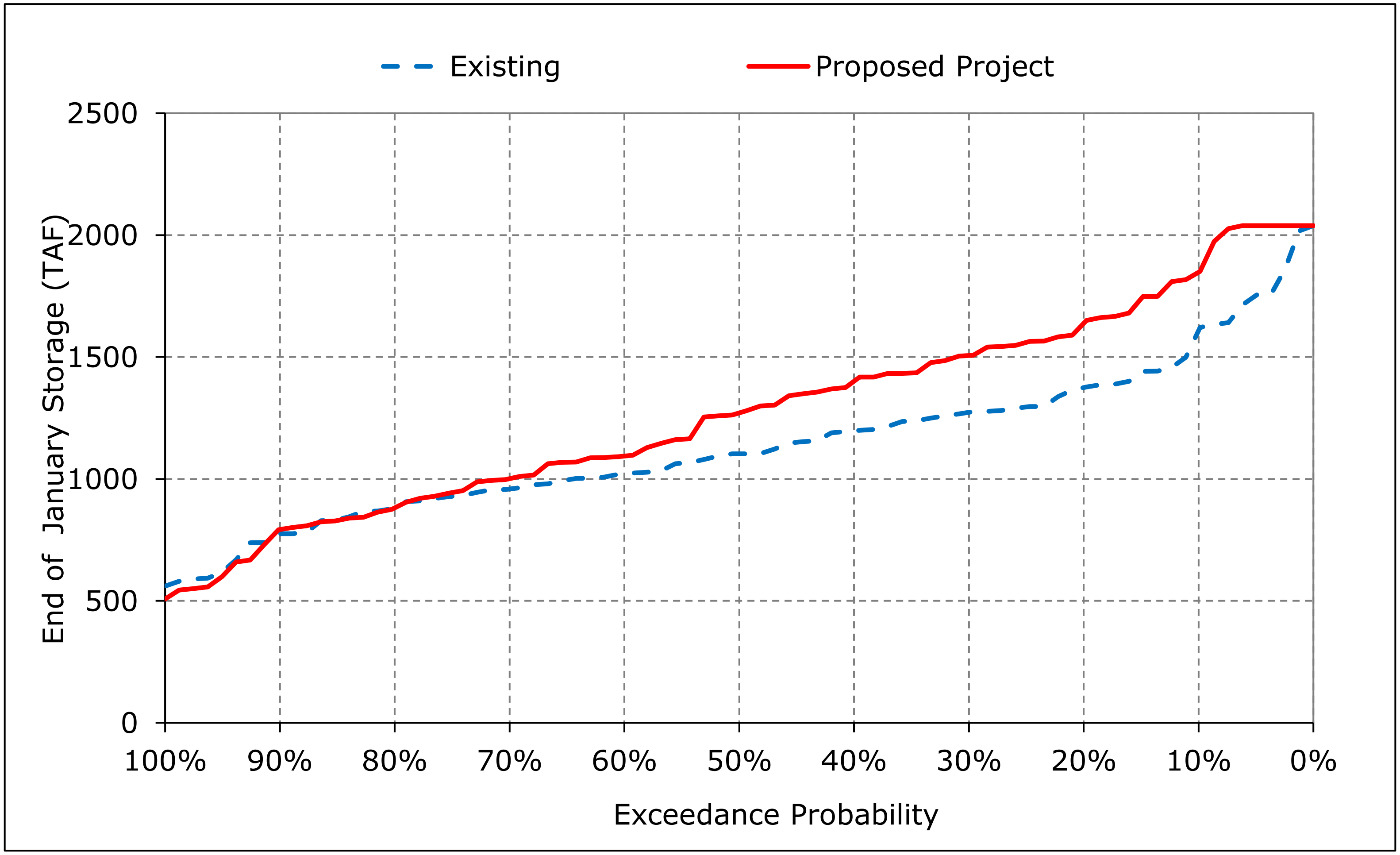


Figure 1a-11. San Luis Storage (CVP and SWP), End of February Storage

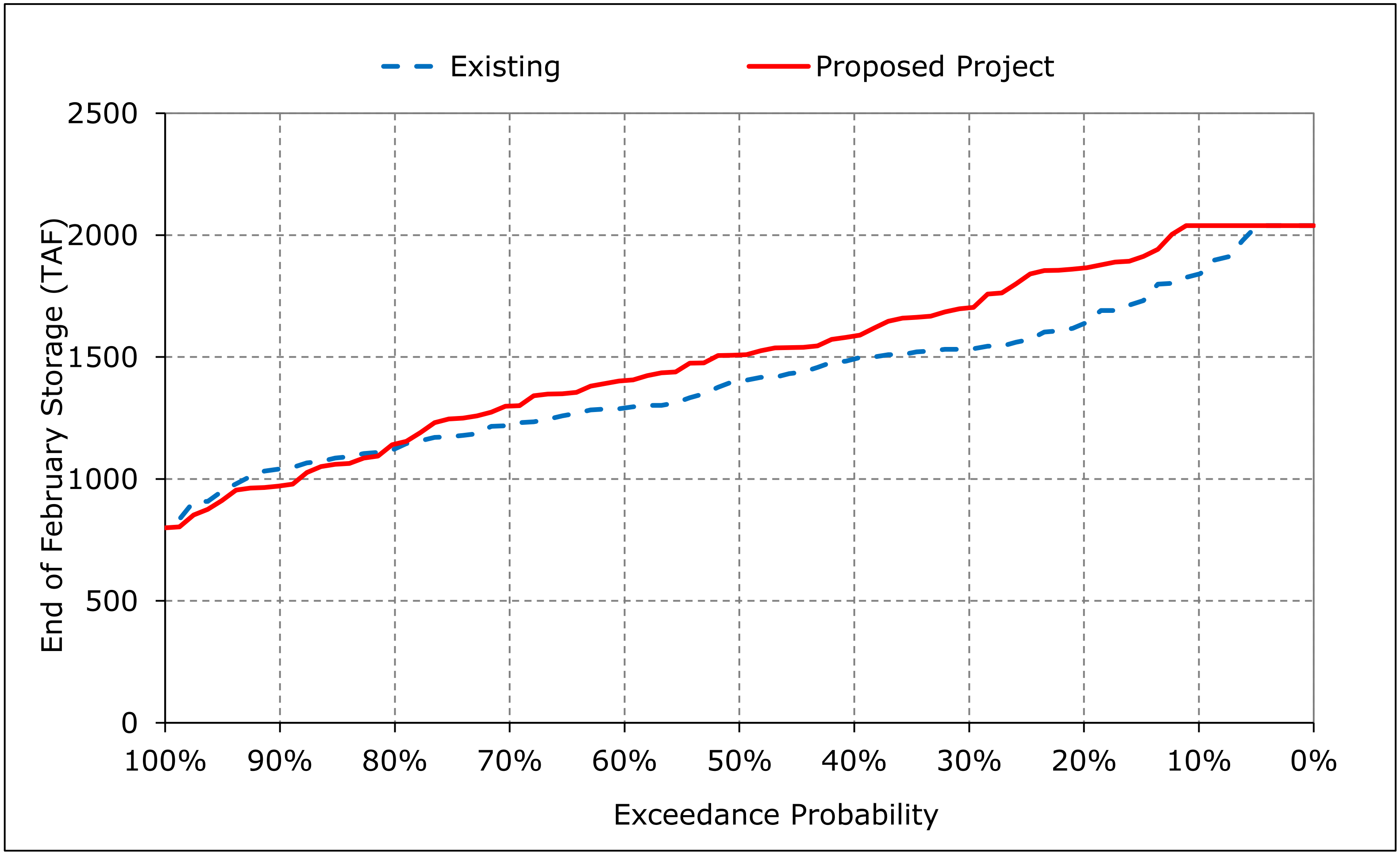


Figure 1a-12. San Luis Storage (CVP and SWP), End of March Storage

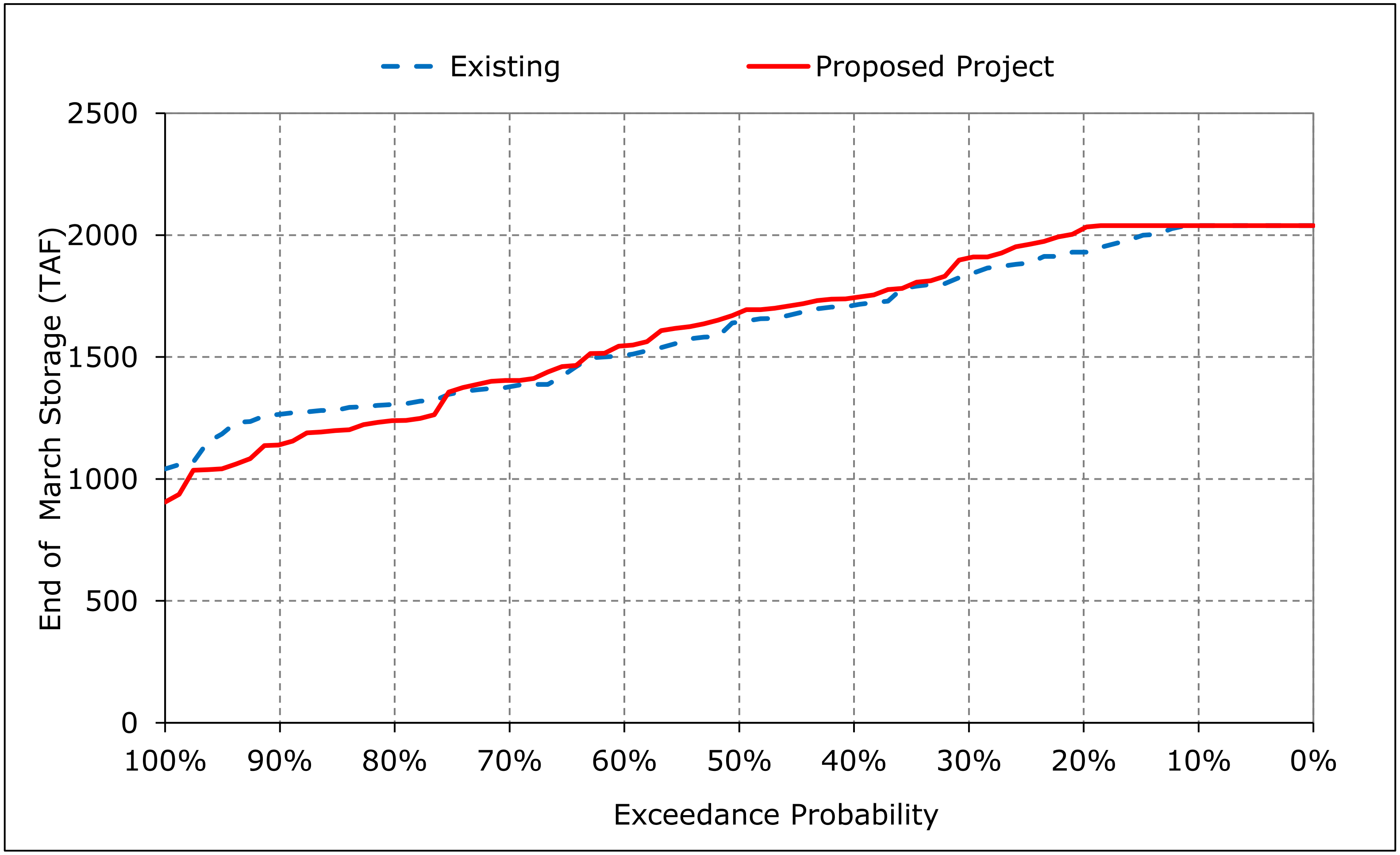


Figure 1a-13. San Luis Storage (CVP and SWP), End of April Storage

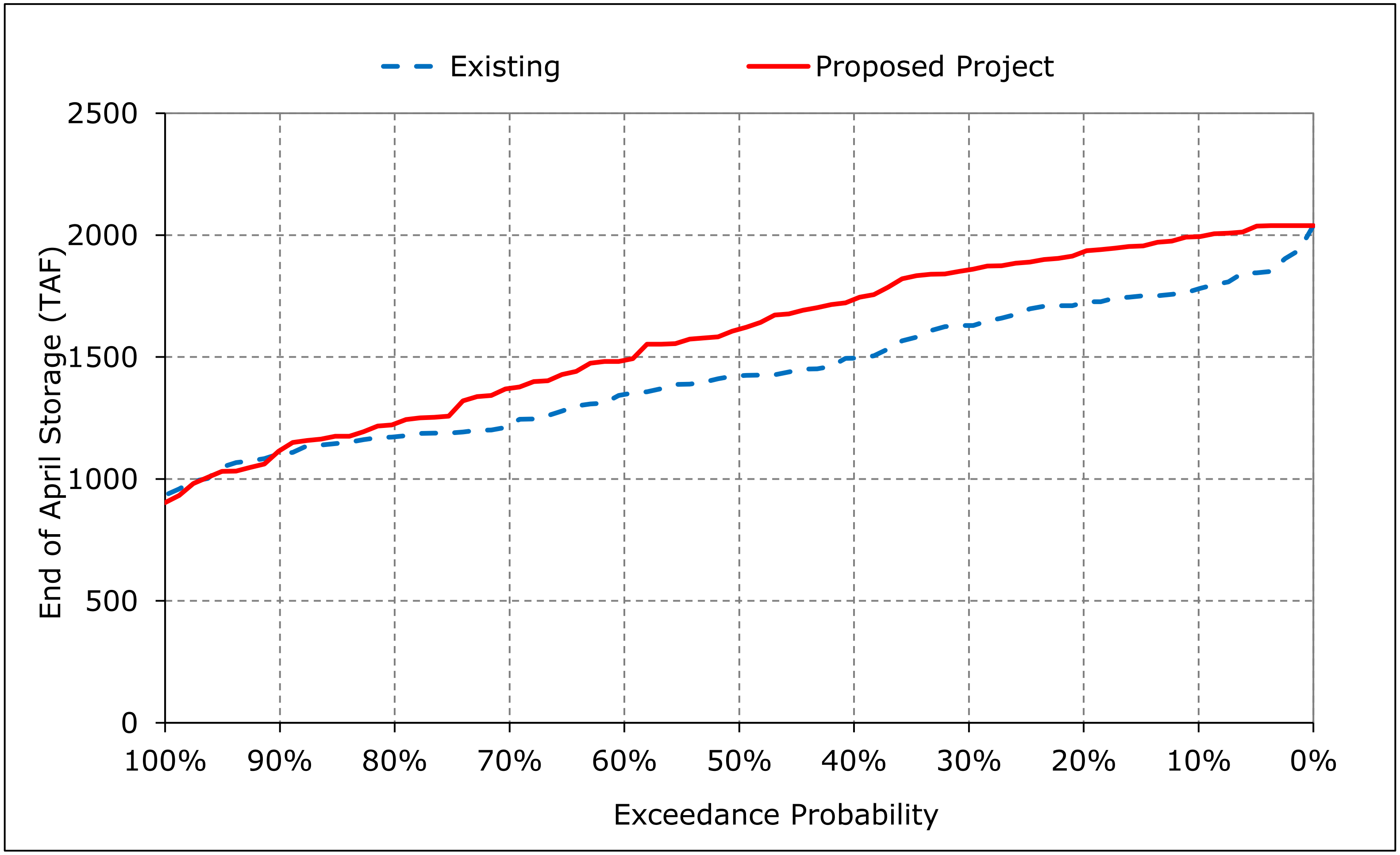


Figure 1a-14. San Luis Storage (CVP and SWP), End of May Storage

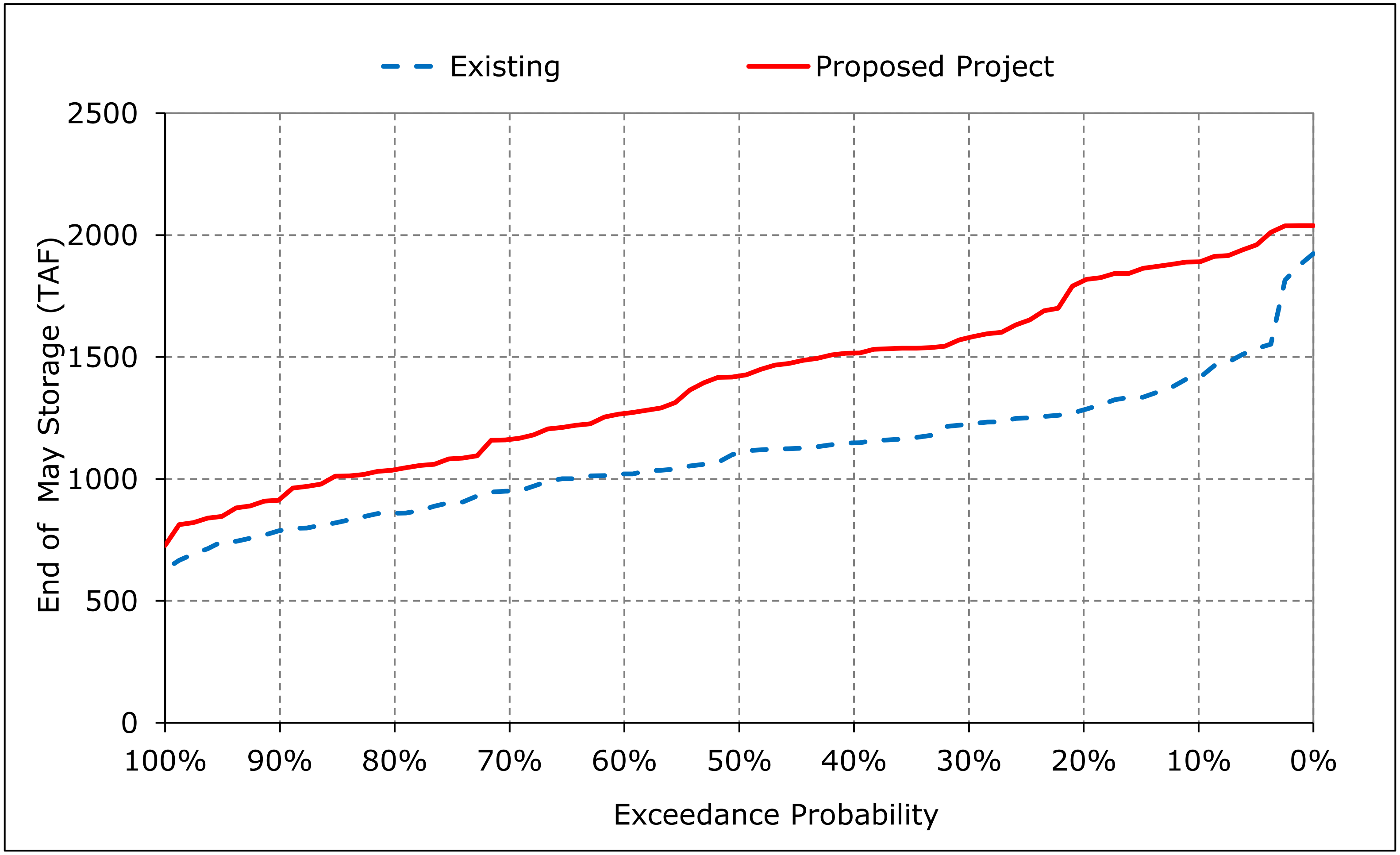


Figure 1a-15. San Luis Storage (CVP and SWP), End of June Storage

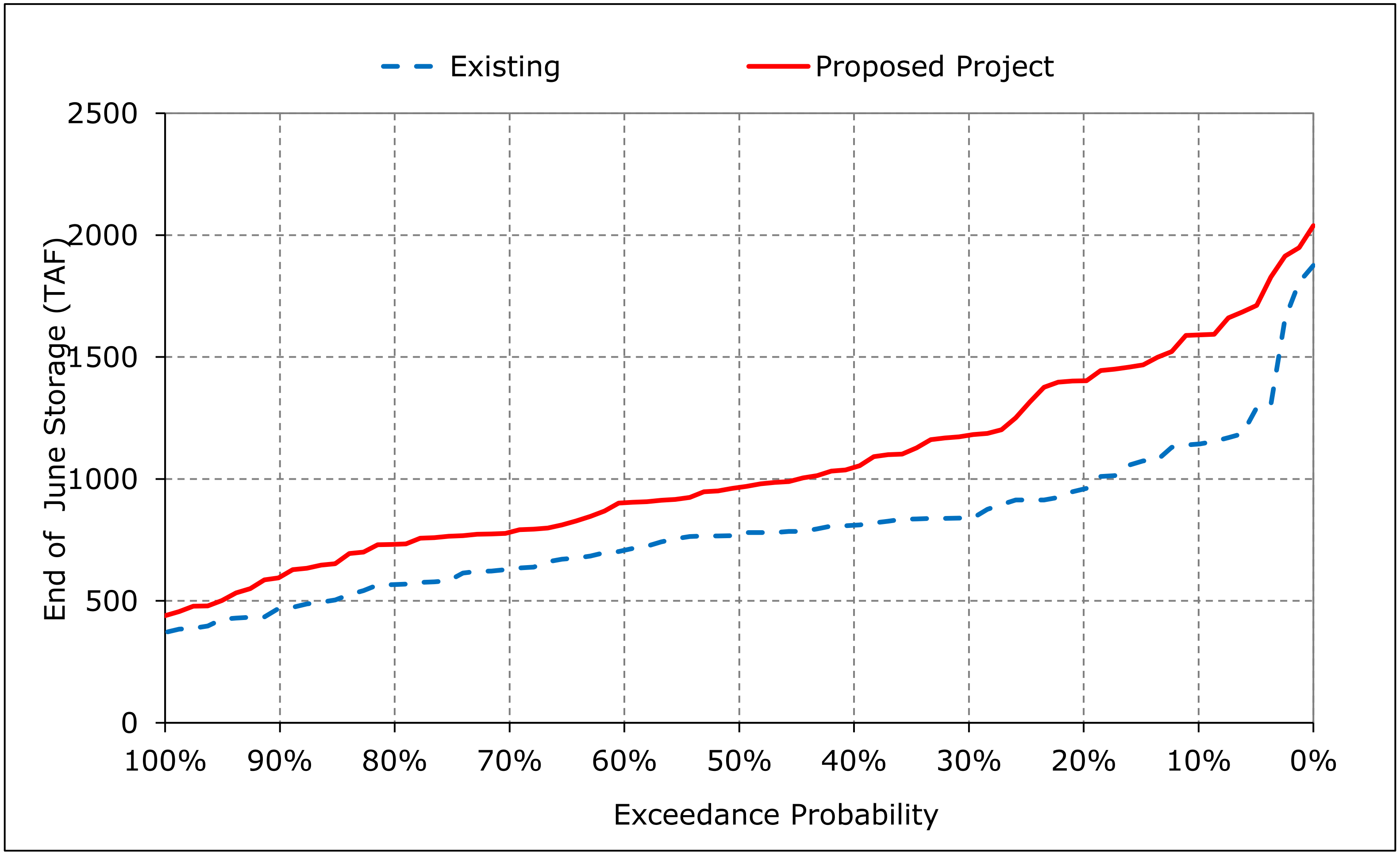


Figure 1a-16. San Luis Storage (CVP and SWP), End of July Storage

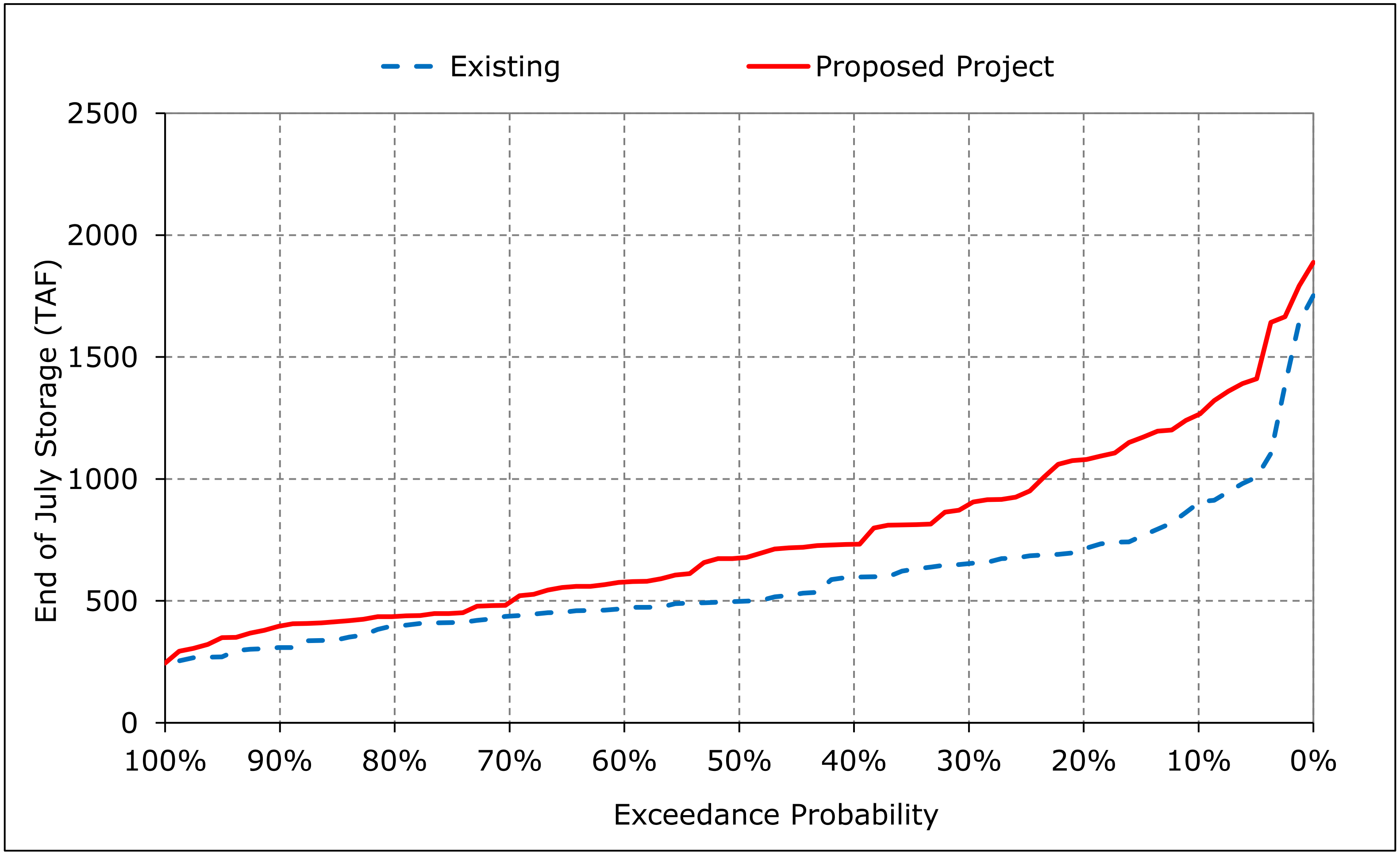


Figure 1a-17. San Luis Storage (CVP and SWP), End of August Storage

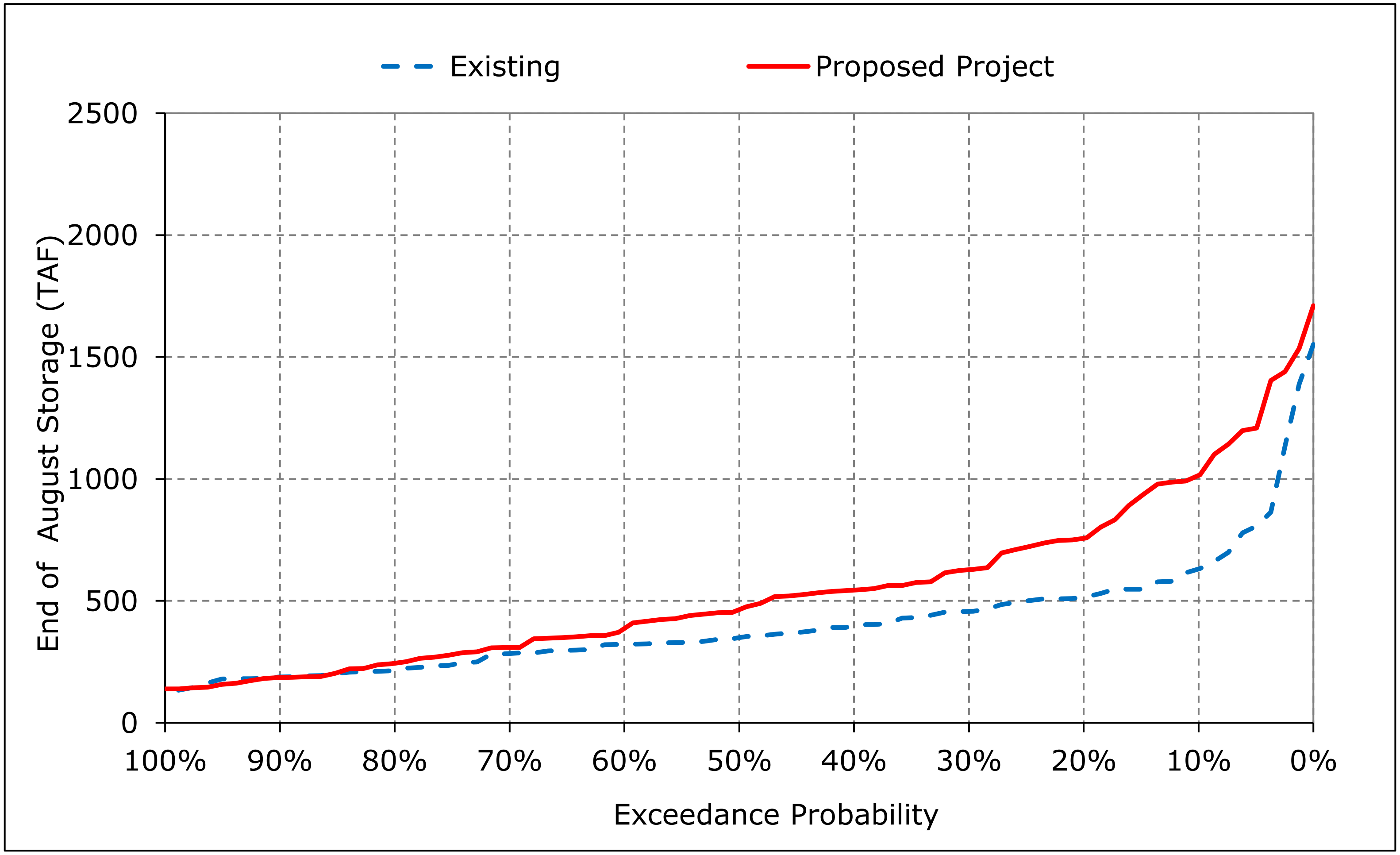


Figure 1a-18. San Luis Storage (CVP and SWP), End of September Storage

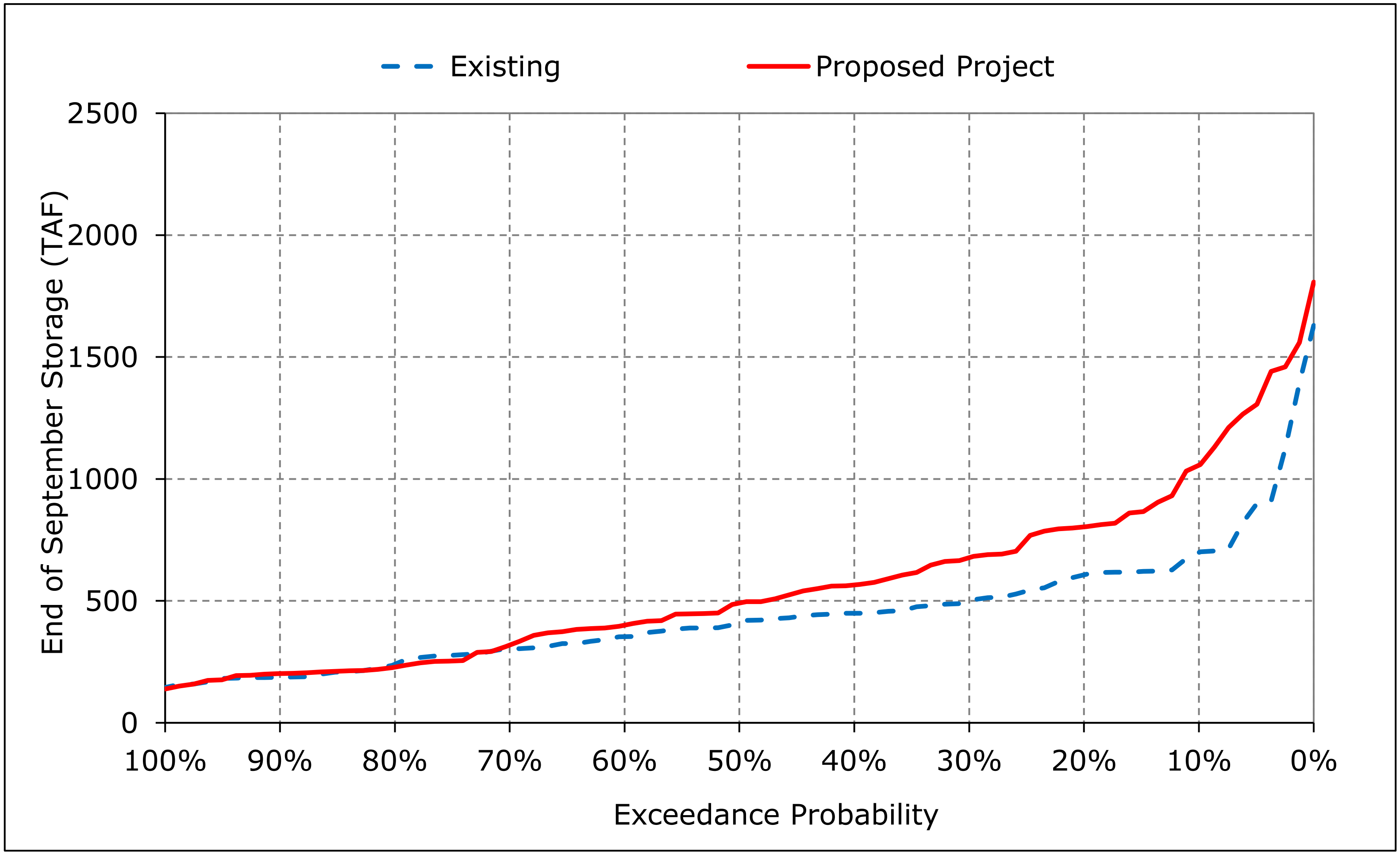


Table 1b-1. San Luis Reservoir (SWP and CVP), End of Month Elevation

Existing

Statistic	End of Month Elevation (FEET)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	428	442	484	517	544	544	537	514	494	436	401	407
20%	409	429	471	504	534	544	526	502	472	421	390	390
30%	396	429	468	502	526	544	523	493	457	406	374	384
40%	388	429	468	495	520	540	521	487	454	403	363	376
50%	383	427	466	493	513	534	517	481	444	400	360	372
60%	381	418	459	486	506	529	513	476	435	394	356	367
70%	379	412	453	484	502	523	506	469	432	389	352	364
80%	376	397	437	472	497	516	500	463	430	382	345	358
90%	371	382	422	445	477	498	481	456	420	377	339	353
Long Term												
Full Simulation Period[a]	392	420	458	488	512	528	513	482	450	404	368	378
Water Year Types[b,c]												
Wet (32%)	397	426	465	496	520	538	525	496	467	419	380	389
Above Normal (15%)	385	415	456	488	513	533	516	479	446	393	358	372
Below Normal (17%)	393	422	458	487	512	528	510	475	442	399	359	376
Dry (22%)	392	418	458	488	509	524	508	474	440	396	357	369
Critical (15%)	389	411	444	475	499	507	494	474	443	397	377	374

Proposed Project

Statistic	End of Month Elevation (FEET)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	448	474	508	542	544	544	544	544	524	468	426	431
20%	427	458	491	518	544	544	544	540	504	449	409	409
30%	409	444	480	506	533	544	542	532	488	430	391	396
40%	402	433	470	499	522	540	536	517	471	419	381	386
50%	391	429	467	496	516	533	531	508	462	408	375	382
60%	382	422	461	491	511	523	520	497	458	403	364	374
70%	379	414	453	477	503	518	511	493	451	397	357	371
80%	374	402	435	473	489	505	503	484	443	392	351	361
90%	369	384	414	447	474	488	482	467	431	386	340	349
Long Term												
Full Simulation Period[a]	402	430	465	493	514	525	522	507	471	418	380	387
Water Year Types[b,c]												
Wet (32%)	411	438	474	501	521	535	538	529	495	439	397	402
Above Normal (15%)	394	424	460	490	512	528	528	513	472	412	370	377
Below Normal (17%)	406	437	468	495	518	526	521	508	471	418	375	390
Dry (22%)	395	423	460	488	508	516	508	487	452	404	365	374
Critical (15%)	396	424	456	481	502	510	499	481	447	401	382	380

Proposed Project minus Existing

Statistic	End of Month Elevation (FEET)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	20	32	24	25	0	0	8	30	31	33	25	25
20%	18	29	20	13	10	0	18	38	32	28	19	19
30%	13	15	12	4	7	0	19	39	31	25	17	12
40%	14	4	2	4	2	0	14	30	17	17	18	10
50%	8	2	1	4	3	**0**	13	27	19	8	15	10
60%	1	4	2	5	5	**-6**	7	21	23	10	9	7
70%	**0**	2	**0**	**-7**	0	**-4**	5	24	20	8	5	6
80%	**-2**	5	**-2**	0	**-7**	**-12**	4	21	13	10	6	3
90%	**-1**	2	**-8**	2	**-2**	**-10**	1	11	11	9	1	**-4**
Long Term												
Full Simulation Period[a]	10	10	8	4	2	**-3**	9	25	21	15	12	9
Water Year Types[b,c]												
Wet (32%)	14	12	9	5	1	**-3**	13	32	28	20	17	13
Above Normal (15%)	9	9	5	2	**0**	**-5**	13	34	26	19	12	4
Below Normal (17%)	13	15	10	8	6	**-2**	11	32	29	19	16	14
Dry (22%)	3	4	2	0	**0**	**-8**	1	14	12	8	8	6
Critical (15%)	6	13	12	6	3	3	5	7	4	4	5	6

a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with water year - year type sorting.

Figure 1b-7. San Luis Reservoir (SWP and CVP), Reservoir Pool Elevation, October

Figure 1b-8. San Luis Reservoir (SWP and CVP), Reservoir Pool Elevation, November

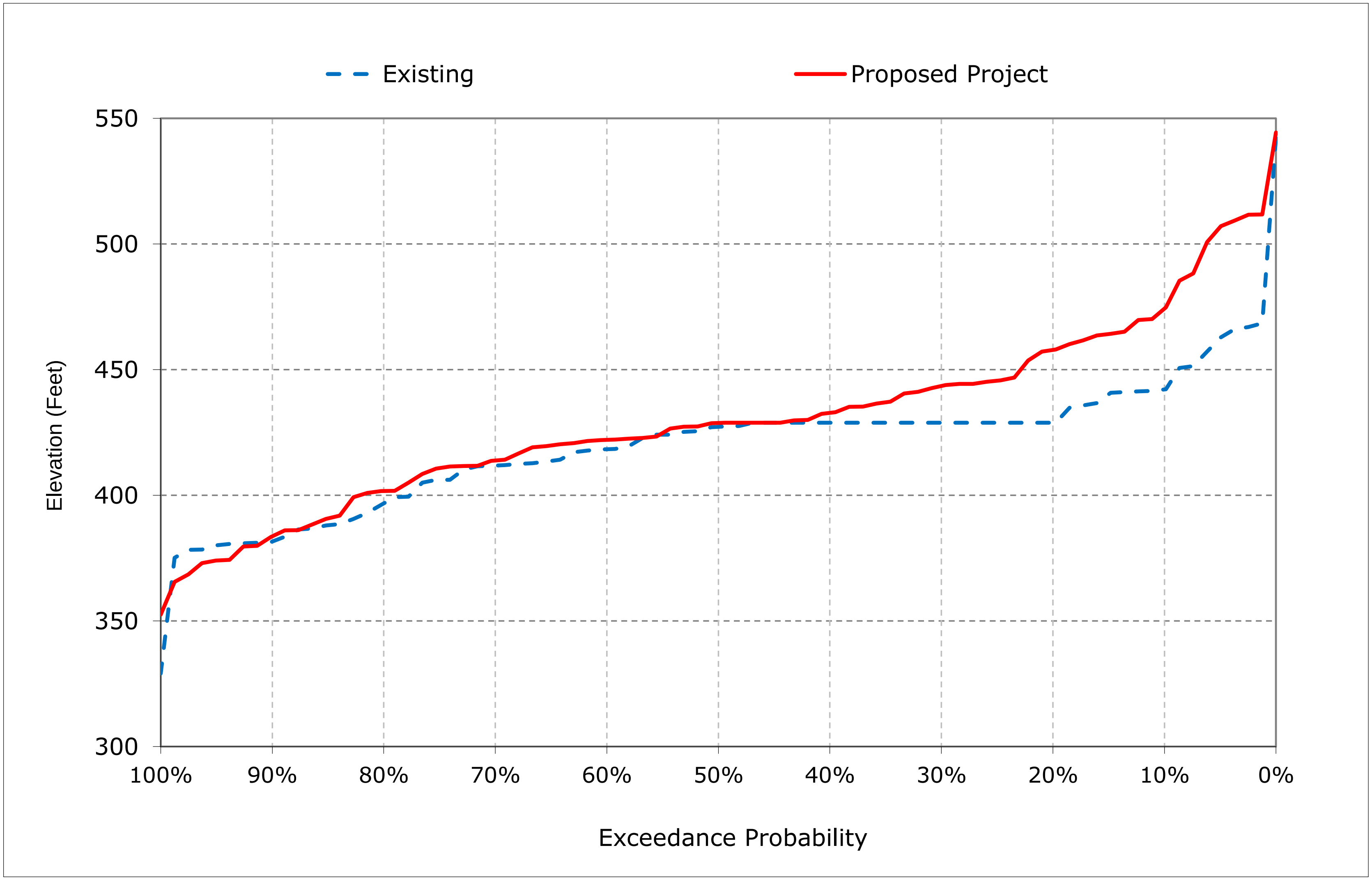


Figure 1b-9. San Luis Reservoir (SWP and CVP), Reservoir Pool Elevation, December

Figure 1b-10. San Luis Reservoir (SWP and CVP), Reservoir Pool Elevation, January

Figure 1b-11. San Luis Reservoir (SWP and CVP), Reservoir Pool Elevation, February

Figure 1b-12. San Luis Reservoir (SWP and CVP), Reservoir Pool Elevation, March

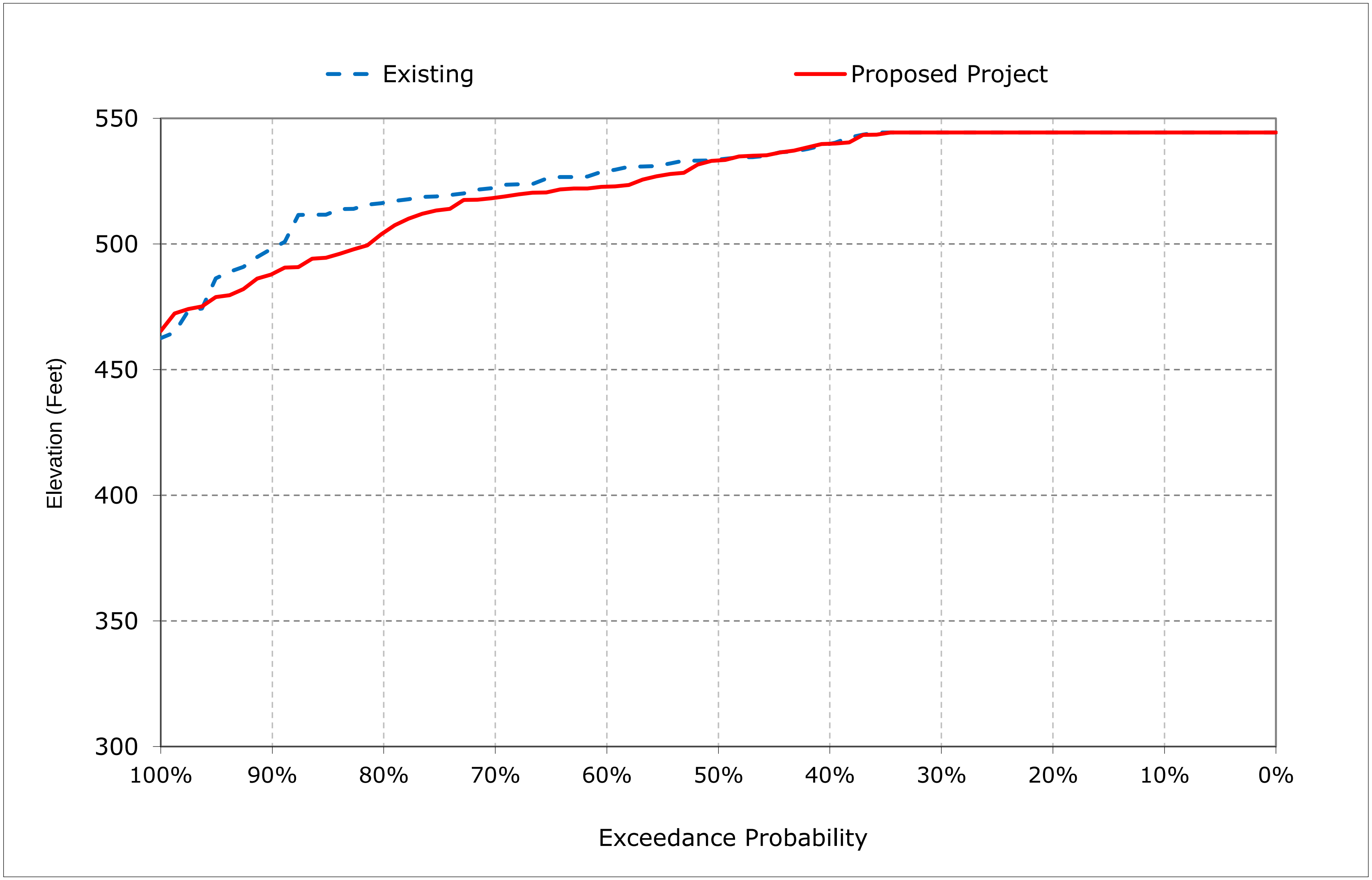


Figure 1b-13. San Luis Reservoir (SWP and CVP), Reservoir Pool Elevation, April

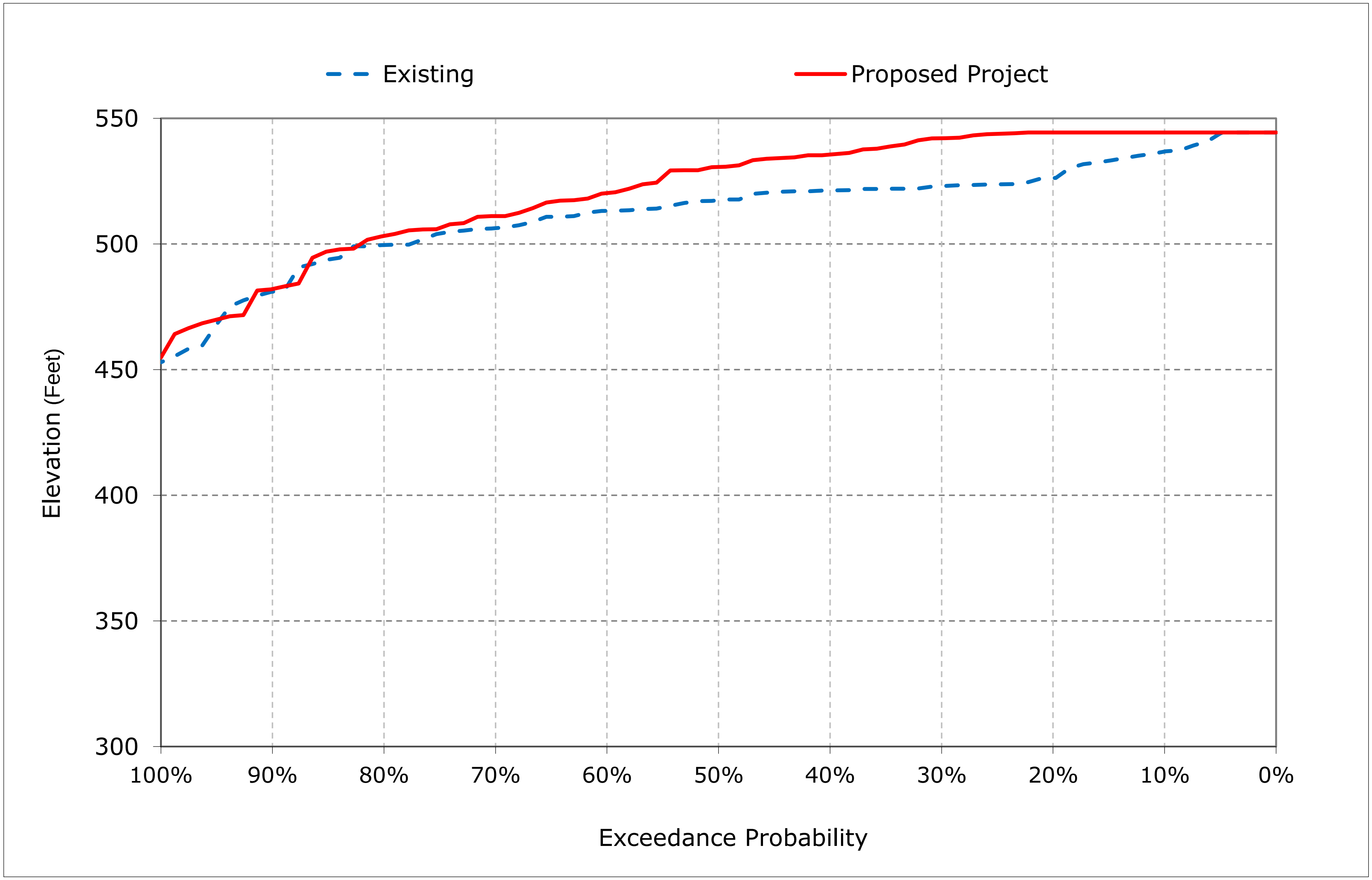


Figure 1b-14. San Luis Reservoir (SWP and CVP), Reservoir Pool Elevation, May

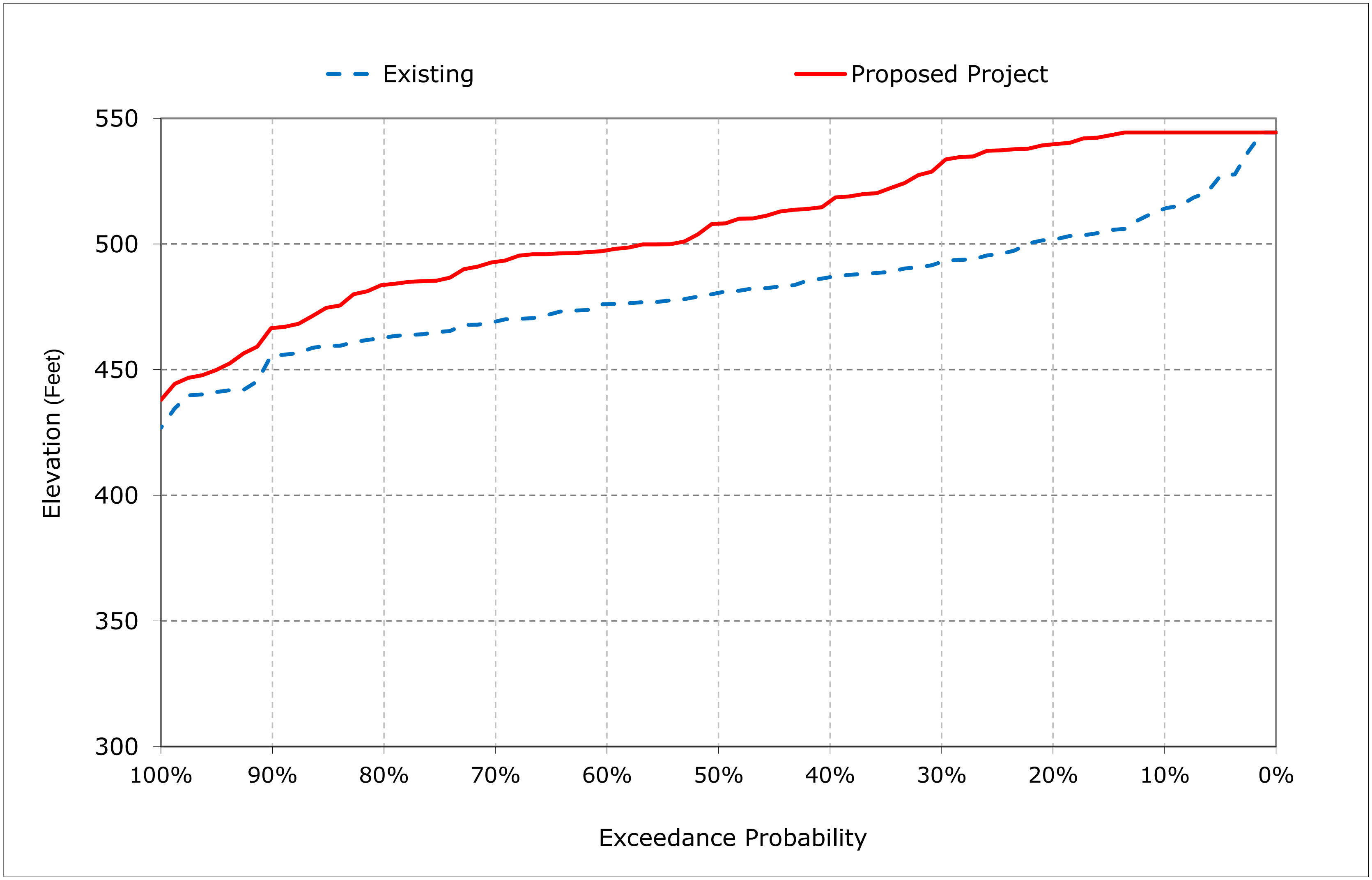


Figure 1b-15. San Luis Reservoir (SWP and CVP), Reservoir Pool Elevation, June

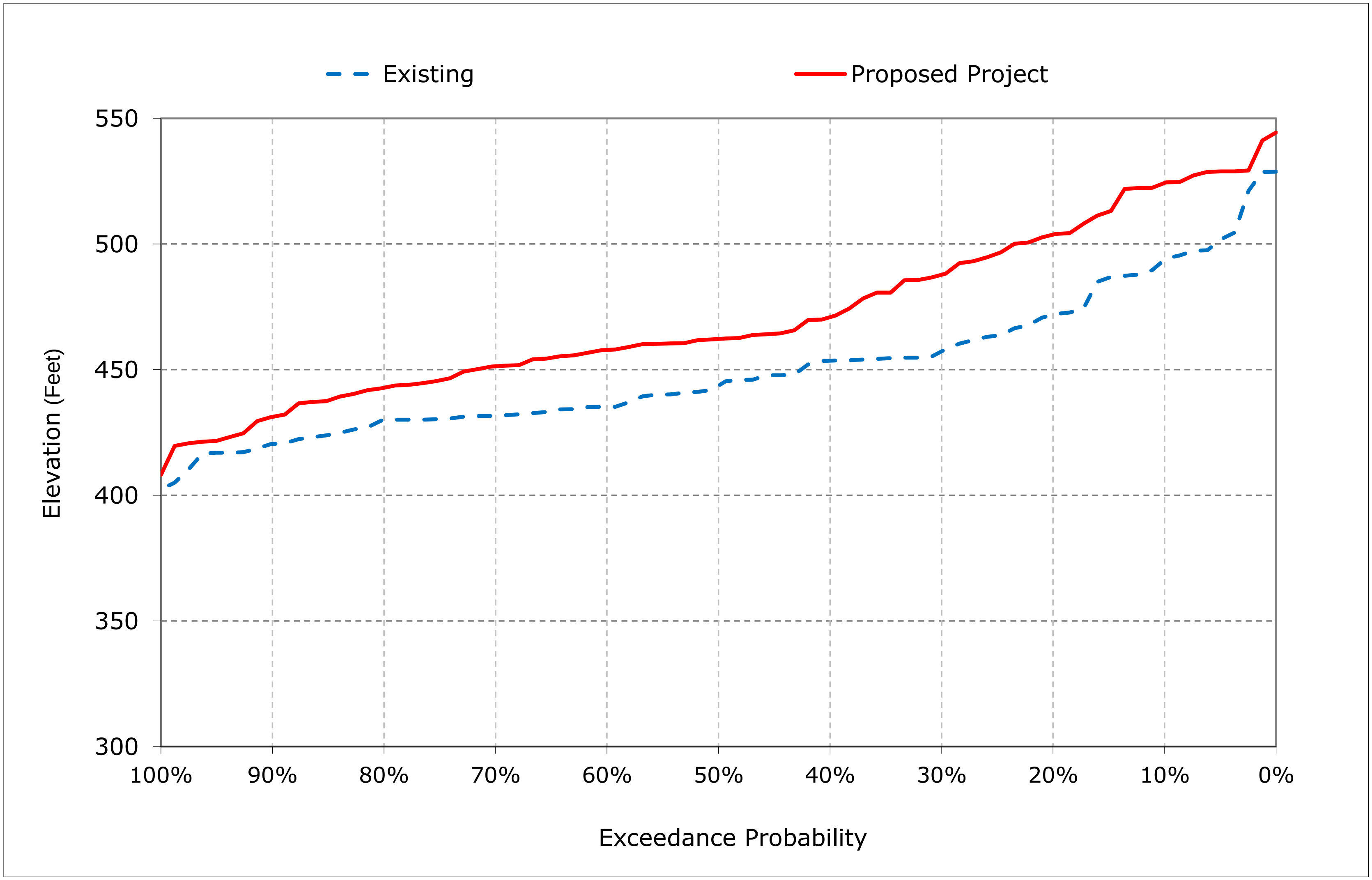


Figure 1b-16. San Luis Reservoir (SWP and CVP), Reservoir Pool Elevation, July

Figure 1b-17. San Luis Reservoir (SWP and CVP), Reservoir Pool Elevation, August

Figure 1b-18. San Luis Reservoir (SWP and CVP), Reservoir Pool Elevation, September

Table 1c-1. San Luis SWP Storage, End of Month Storage

Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	End of Month Storage (TAF)											
Probability of Exceedance												
10%	508	498	626	794	1,008	1,067	904	668	547	554	462	532
20%	372	396	539	676	843	1,020	877	638	455	427	385	426
30%	316	329	433	566	694	921	810	590	392	373	317	332
40%	269	252	352	486	655	809	725	531	361	315	258	285
50%	211	196	328	439	596	716	583	480	323	272	223	237
60%	153	145	275	383	542	659	565	398	256	234	195	188
70%	85	97	186	313	455	565	521	347	206	207	130	129
80%	55	55	85	230	379	507	447	318	156	158	84	55
90%	55	55	55	199	345	444	378	267	95	100	55	55
Long Term												
Full Simulation Period[a]	244	255	339	479	619	740	645	478	326	309	255	266
Water Year Types[b,c]												
Wet (32%)	297	310	357	525	687	856	718	505	355	365	365	414
Above Normal (15%)	276	279	414	545	681	779	638	425	242	249	268	330
Below Normal (17%)	187	201	295	422	579	709	601	421	233	275	290	251
Dry (22%)	225	246	342	476	593	692	638	521	383	349	166	147
Critical (15%)	190	191	268	383	497	554	552	475	372	227	98	77

Proposed Project

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	End of Month Storage (TAF)											
Probability of Exceedance												
10%	704	841	972	1,042	1,067	1,067	1,023	944	748	712	660	689
20%	602	695	797	893	1,052	1,067	979	869	685	653	552	581
30%	512	568	686	811	889	973	940	807	606	555	518	540
40%	392	463	555	673	819	866	875	729	505	488	417	396
50%	298	361	448	559	702	805	783	636	431	422	330	311
60%	164	262	323	444	631	723	662	577	397	313	241	208
70%	92	170	233	340	475	555	593	476	320	237	138	121
80%	55	55	107	270	394	464	470	372	249	192	79	55
90%	55	55	55	199	321	420	400	328	158	156	55	55
Long Term												
Full Simulation Period[a]	342	409	476	590	701	761	742	641	467	426	353	349
Water Year Types[b,c]												
Wet (32%)	446	534	560	666	785	879	868	781	620	620	599	627
Above Normal (15%)	361	440	553	669	772	794	751	632	415	418	413	458
Below Normal (17%)	314	381	462	565	694	729	701	572	350	353	344	291
Dry (22%)	300	358	468	594	691	750	728	621	448	352	139	103
Critical (15%)	195	219	248	366	472	526	527	454	351	211	95	74

Proposed Project minus Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	End of Month Storage (TAF)											
Probability of Exceedance												
10%	196	343	347	249	59	0	118	277	202	158	198	156
20%	230	300	258	216	209	47	101	231	230	226	167	155
30%	196	239	254	245	195	51	130	217	214	182	200	207
40%	124	211	202	187	165	57	150	197	144	173	159	111
50%	87	166	120	120	106	89	200	156	109	150	107	73
60%	11	116	48	61	89	63	98	179	142	79	46	20
70%	8	73	47	26	20	**-10**	72	129	114	30	7	**-8**
80%	0	0	22	40	15	**-43**	23	54	93	34	**-5**	0
90%	0	0	0	**0**	**-24**	**-24**	22	62	63	56	0	0
Long Term												
Full Simulation Period[a]	99	154	138	111	82	22	97	163	140	117	98	83
Water Year Types[b,c]												
Wet (32%)	149	224	203	142	98	23	150	277	265	255	234	213
Above Normal (15%)	85	161	139	125	91	15	113	207	172	169	145	128
Below Normal (17%)	127	180	167	143	115	20	100	151	117	79	54	40
Dry (22%)	75	112	125	118	98	58	89	100	65	3	**-27**	**-44**
Critical (15%)	5	28	**-20**	**-17**	**-25**	**-28**	**-25**	**-21**	**-22**	**-16**	**-3**	**-2**

a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with water year - year type sorting.

Figure 1c-7. San Luis SWP Storage, End of October Storage

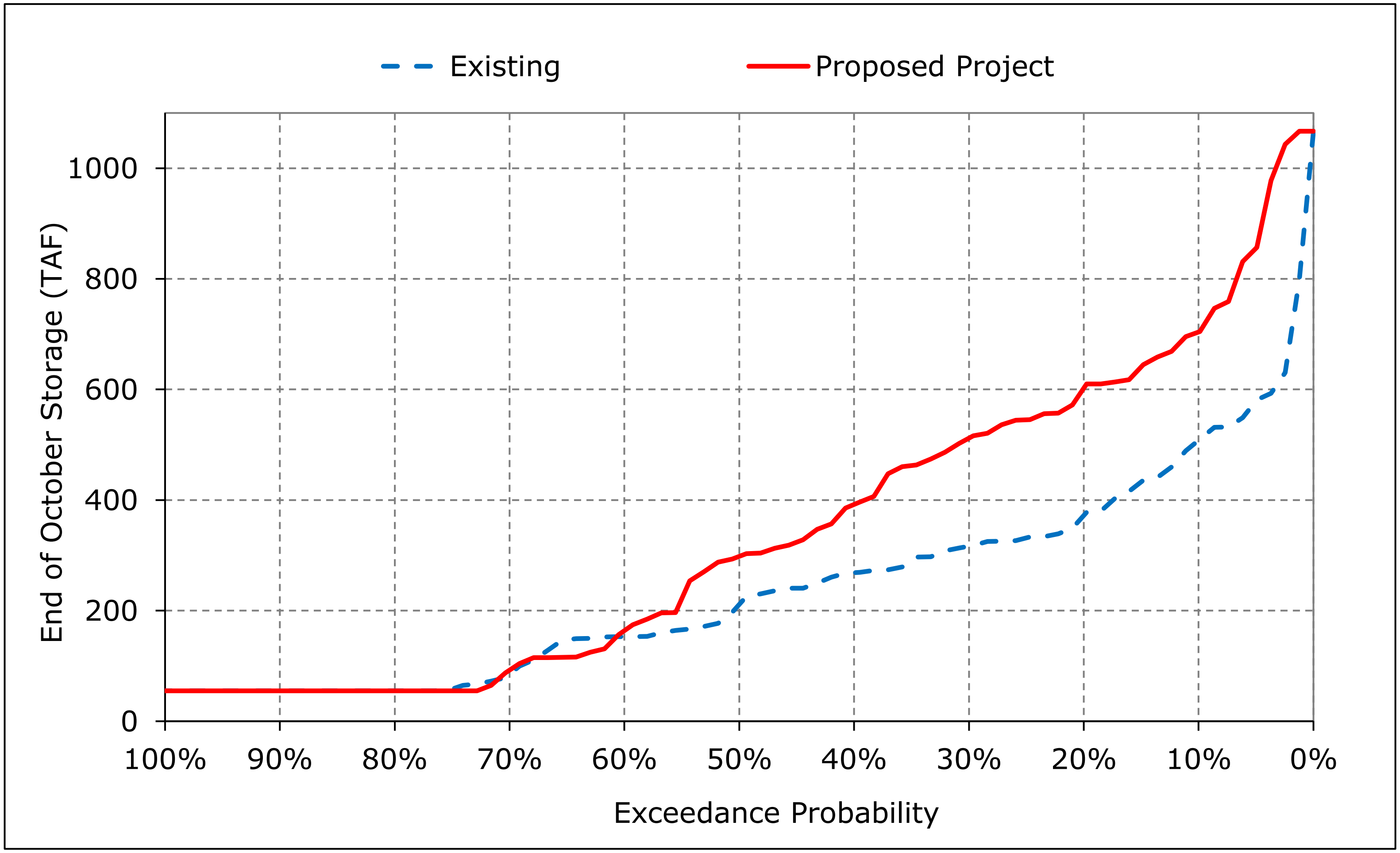


Figure 1c-8. San Luis SWP Storage, End of November Storage

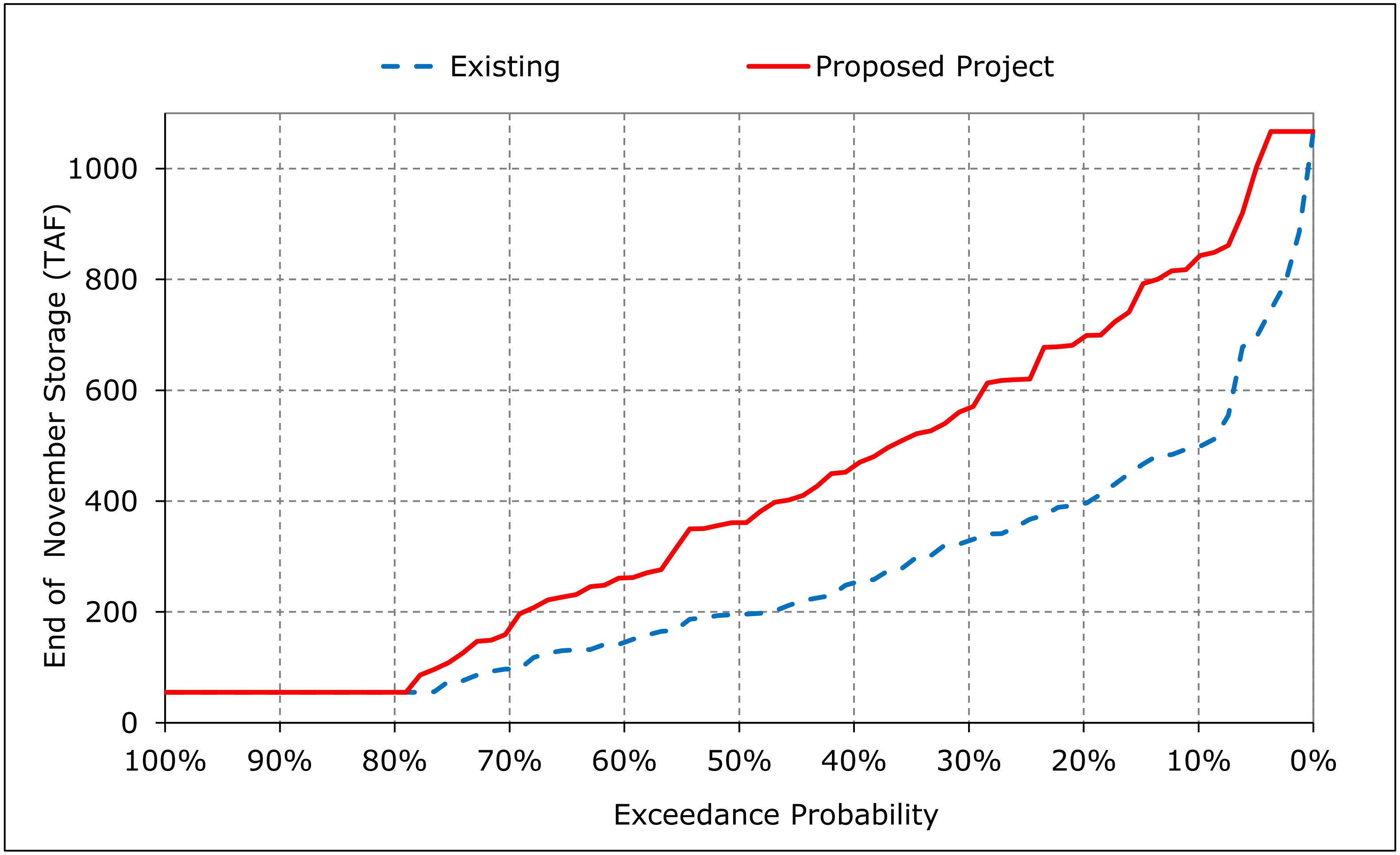


Figure 1c-9. San Luis SWP Storage, End of December Storage

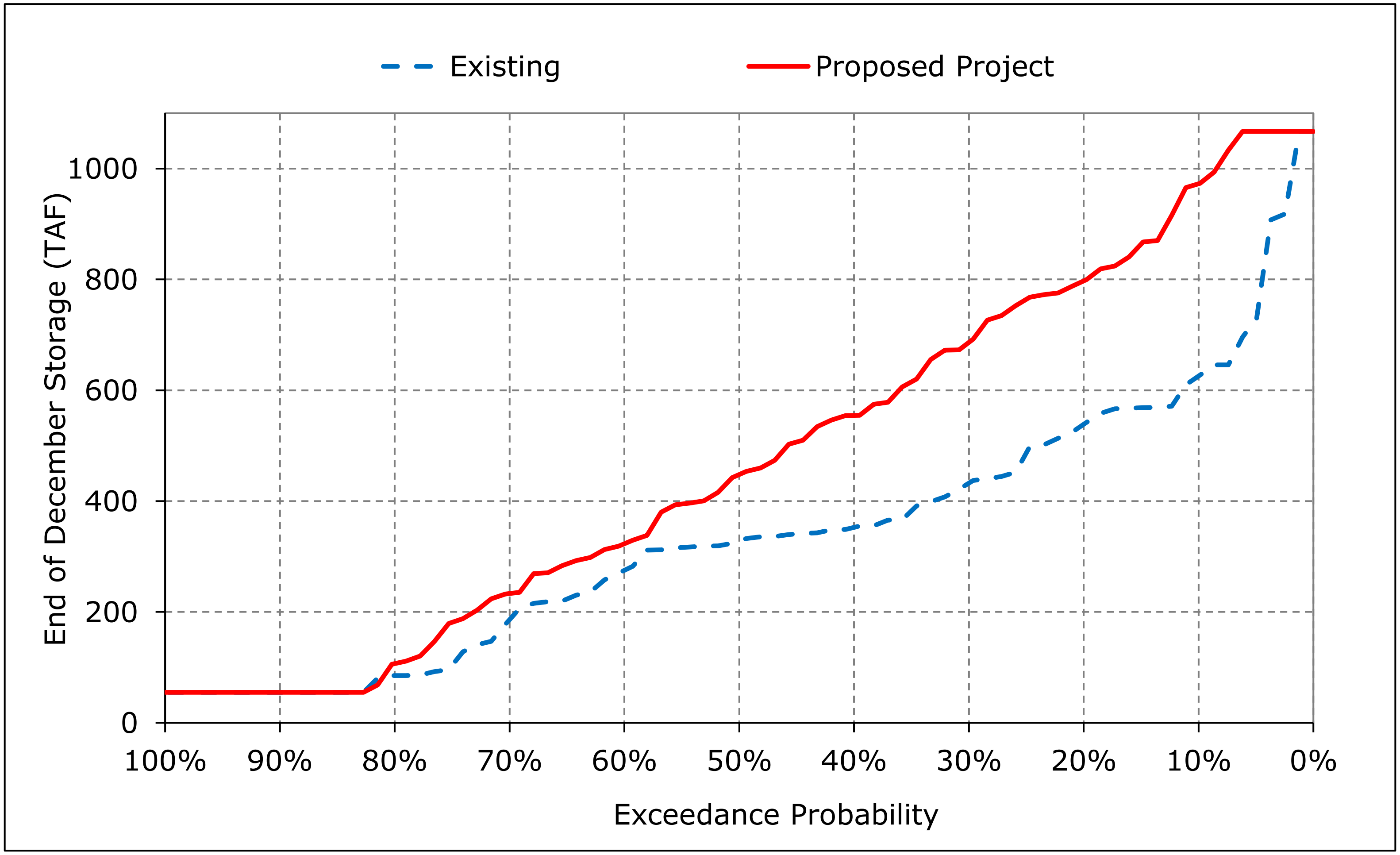


Figure 1c-10. San Luis SWP Storage, End of January Storage

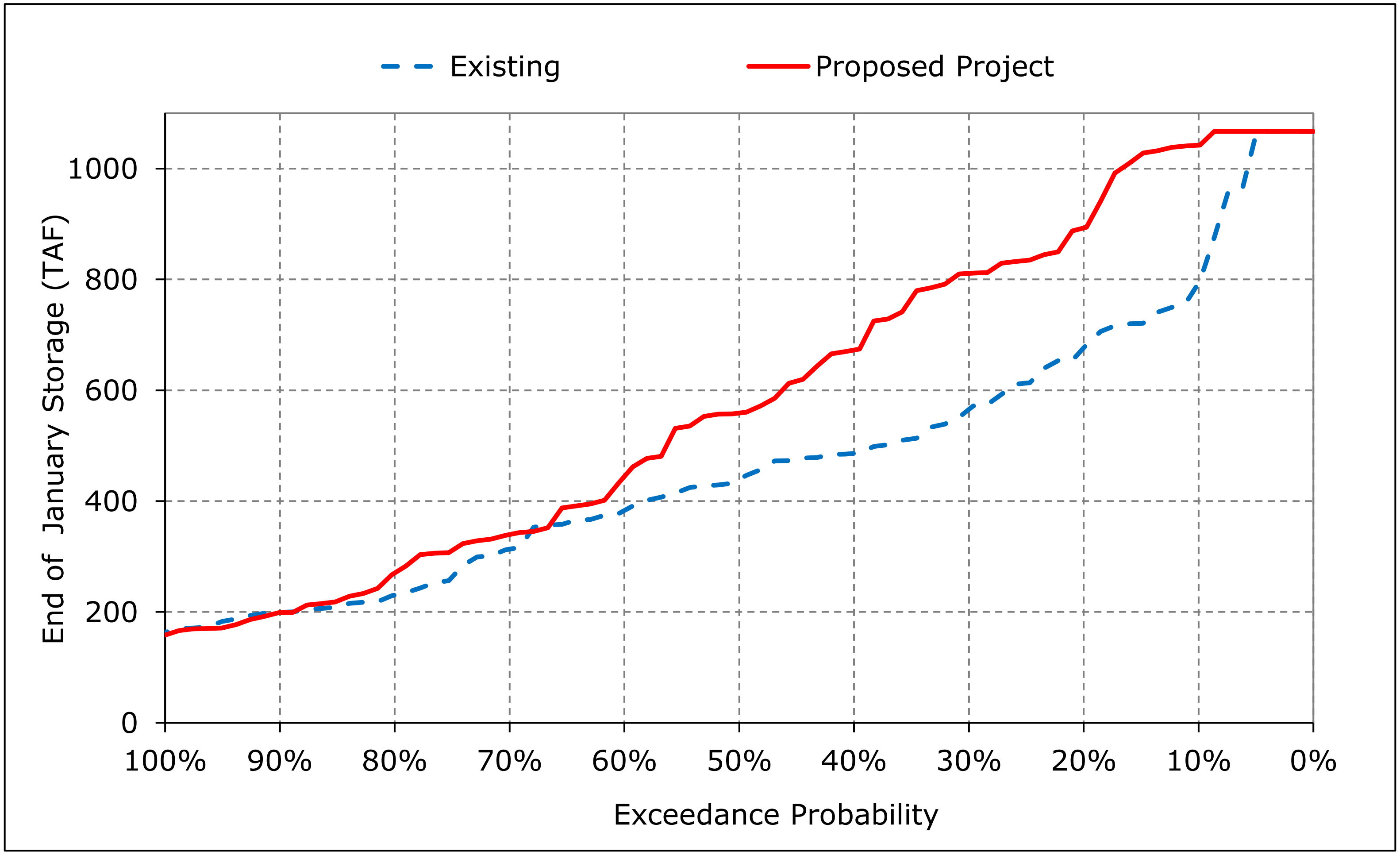


Figure 1c-11. San Luis SWP Storage, End of February Storage

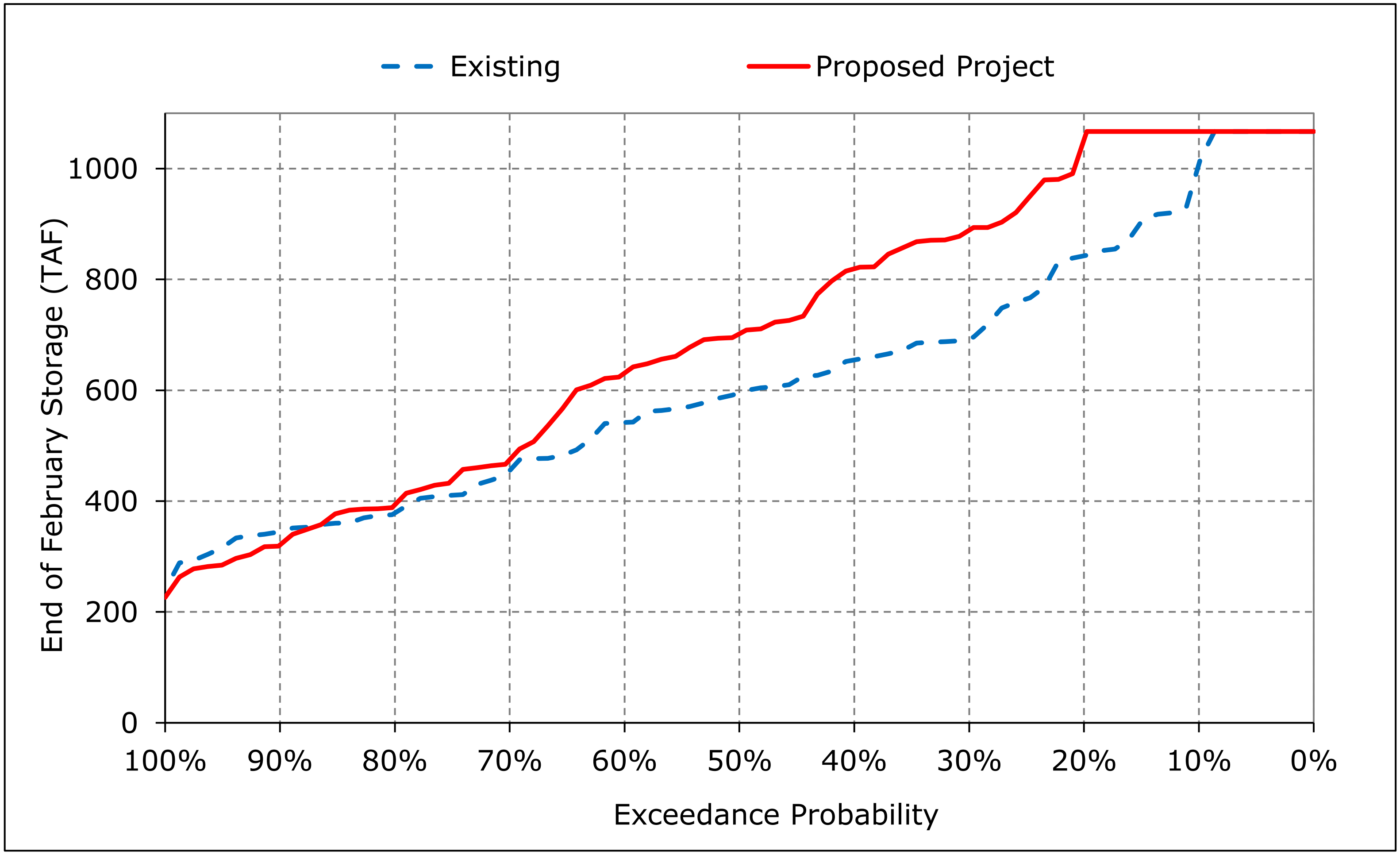


Figure 1c-12. San Luis SWP Storage, End of March Storage

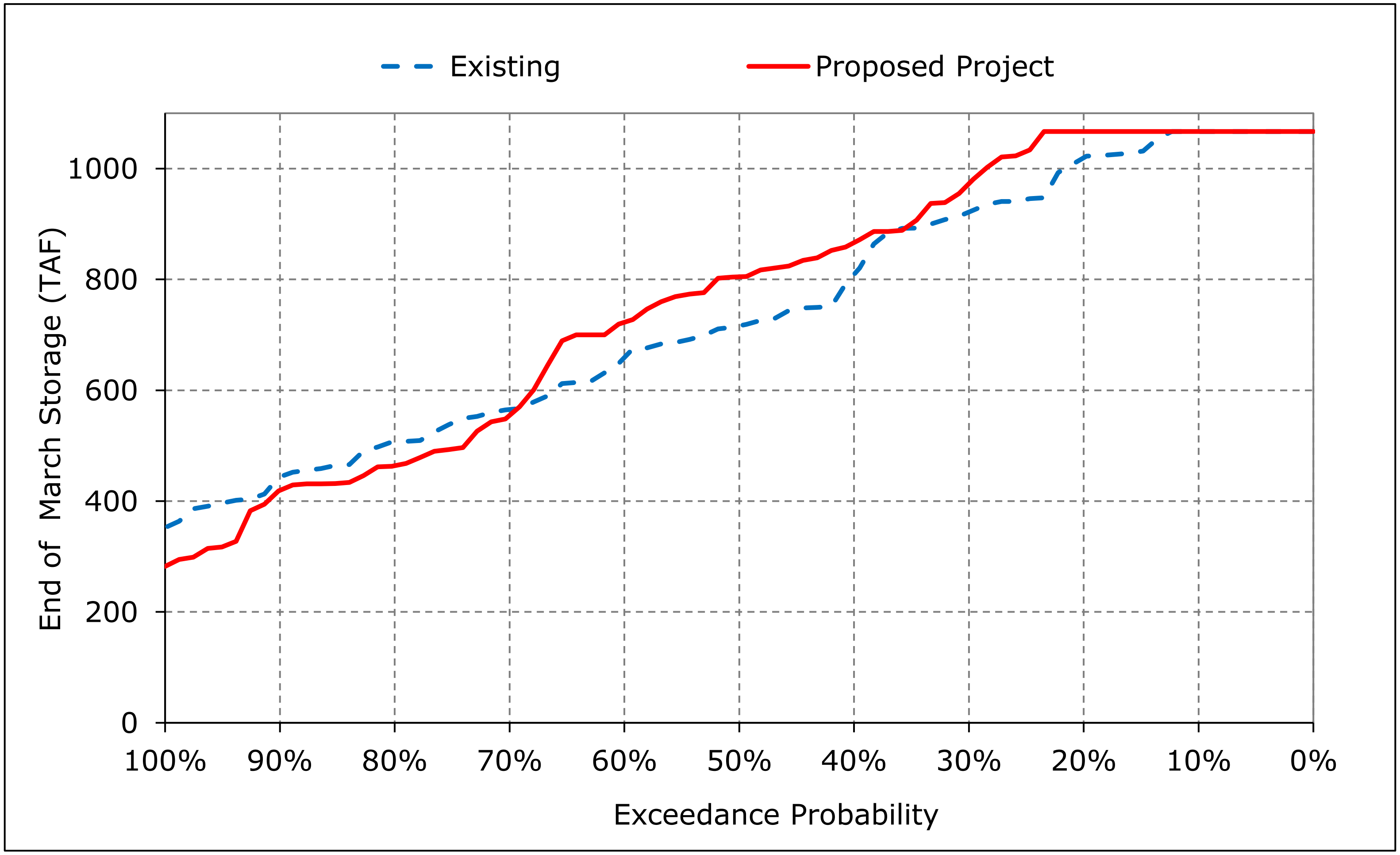


Figure 1c-13. San Luis SWP Storage, End of April Storage

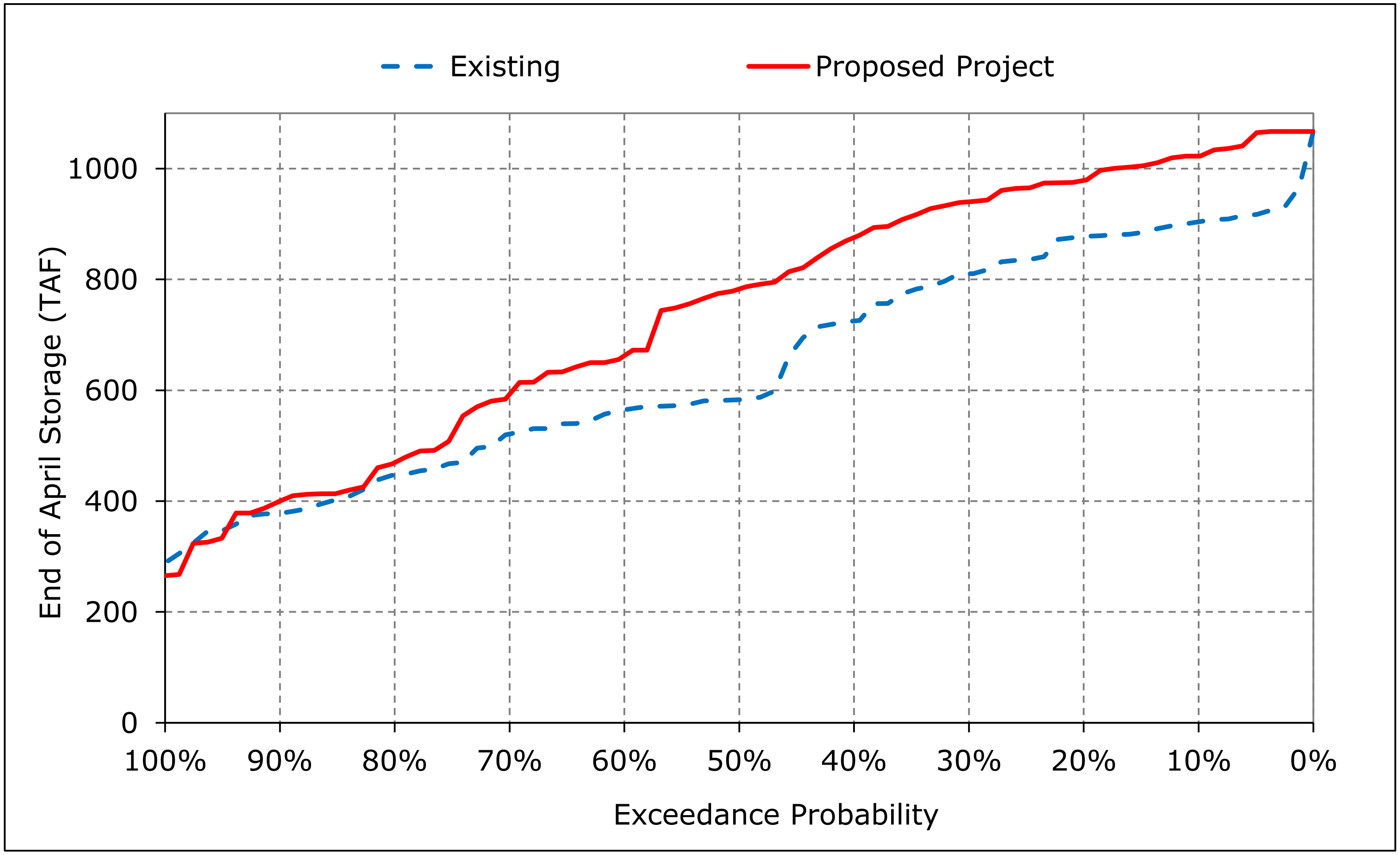


Figure 1c-14. San Luis SWP Storage, End of May Storage

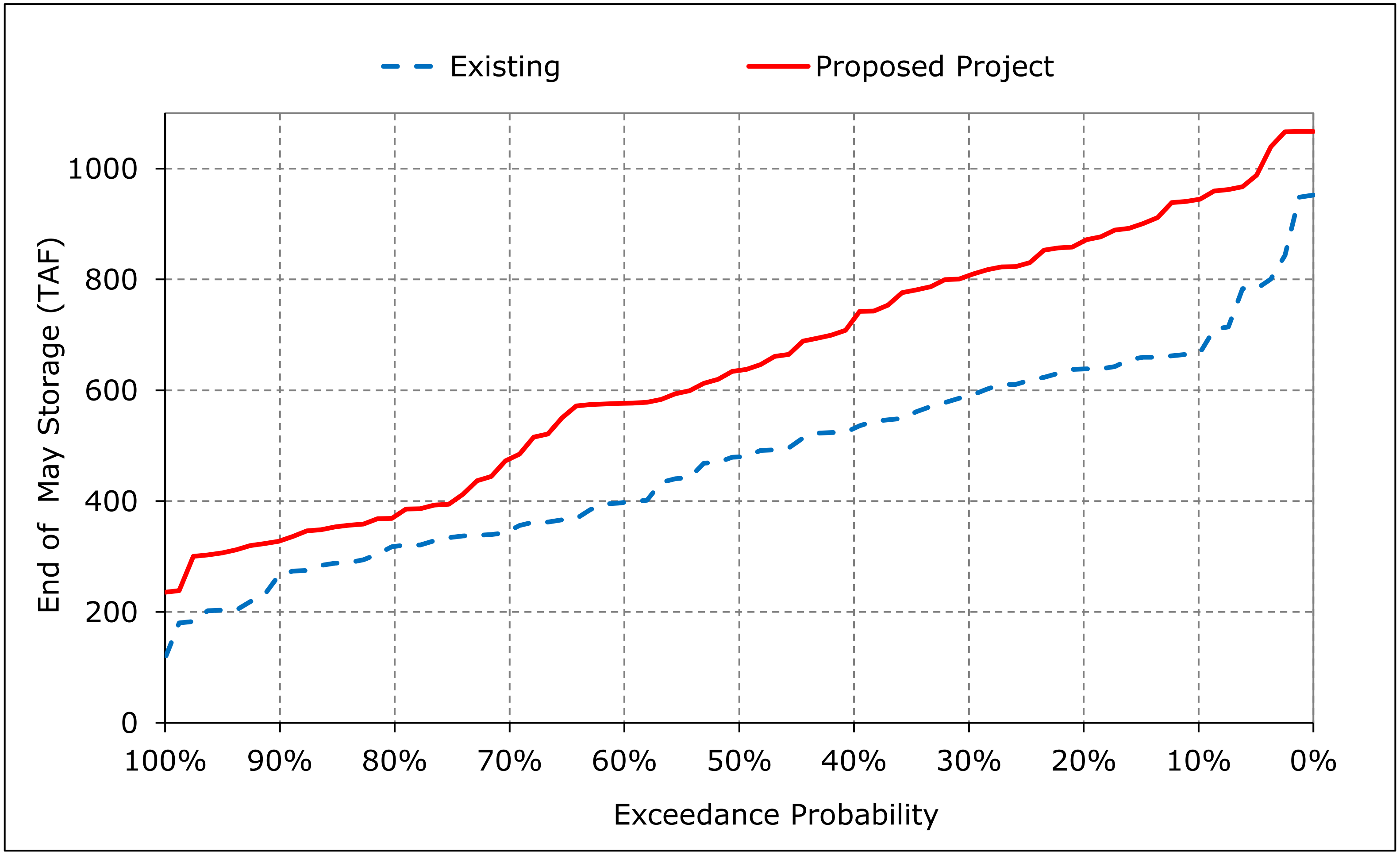


Figure 1c-15. San Luis SWP Storage, End of June Storage

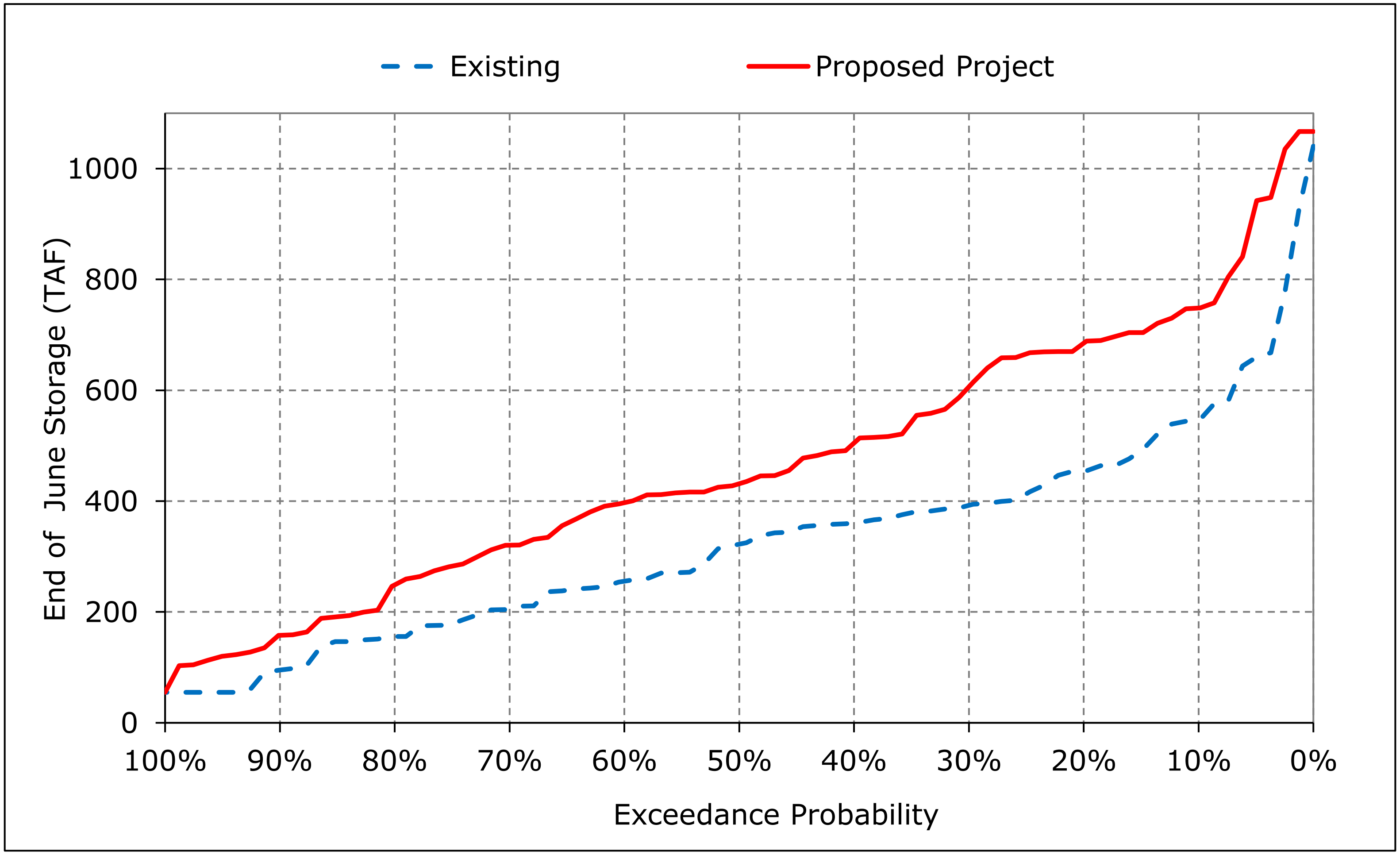


Figure 1c-16. San Luis SWP Storage, End of July Storage

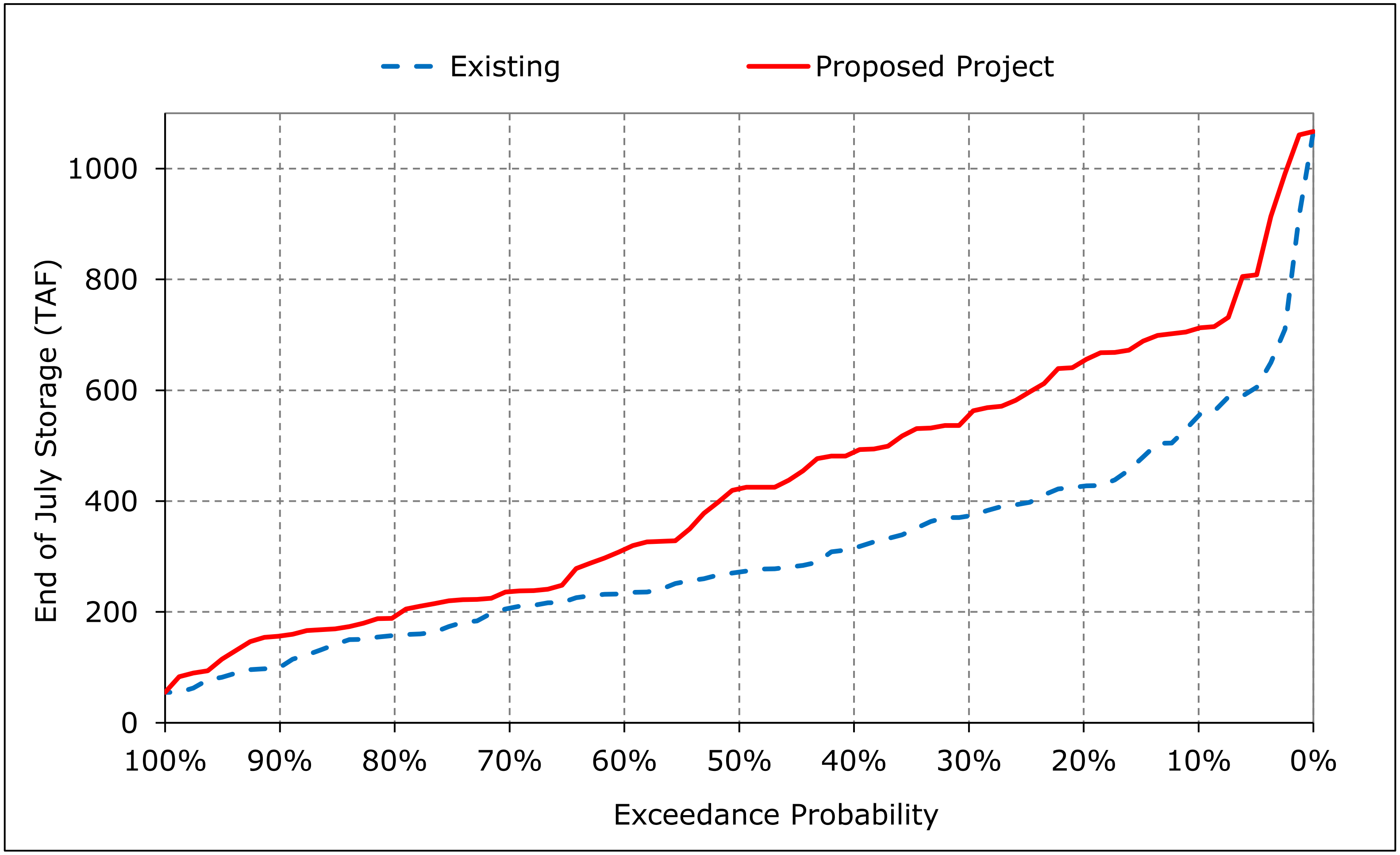


Figure 1c-17. San Luis SWP Storage, End of August Storage

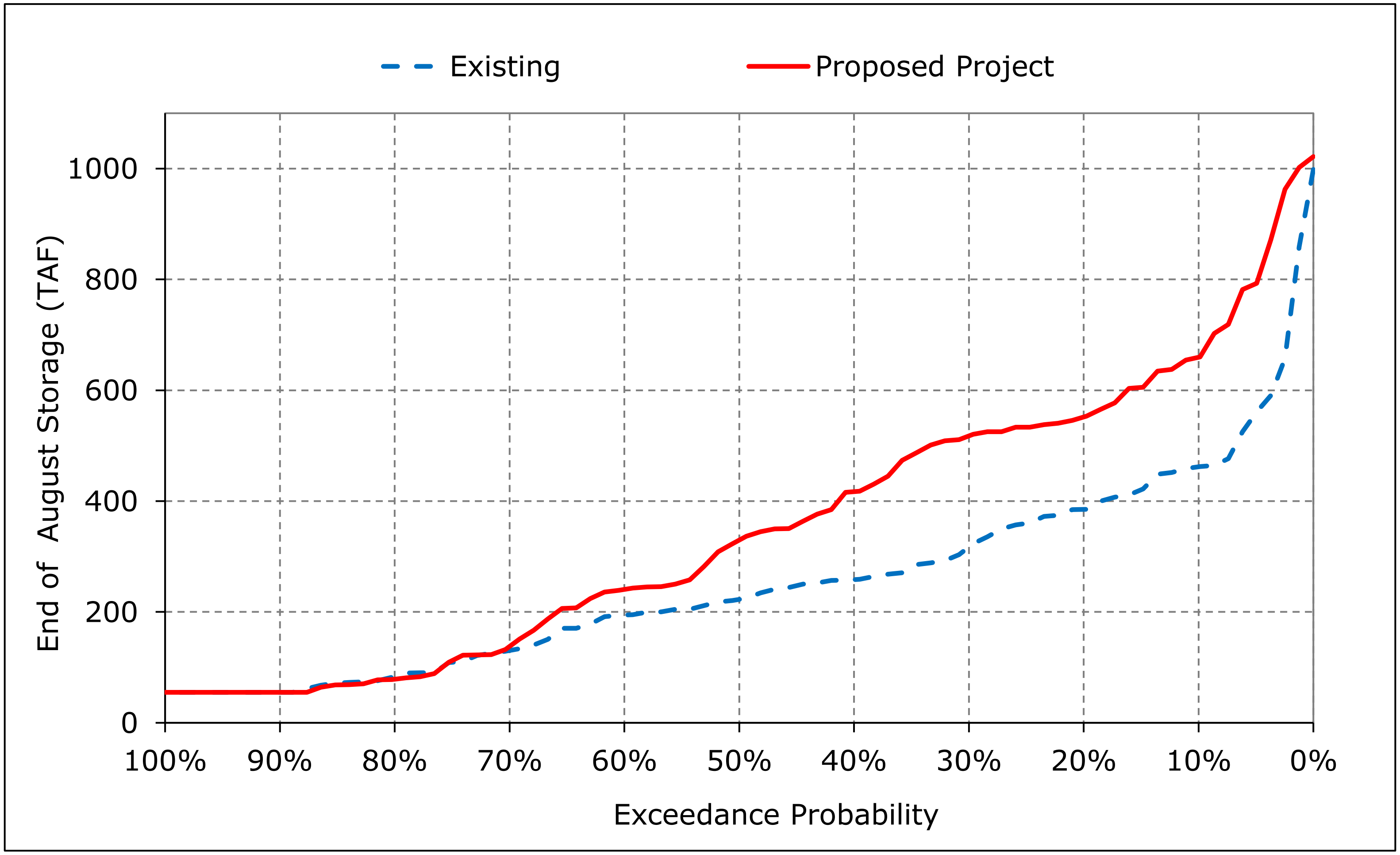
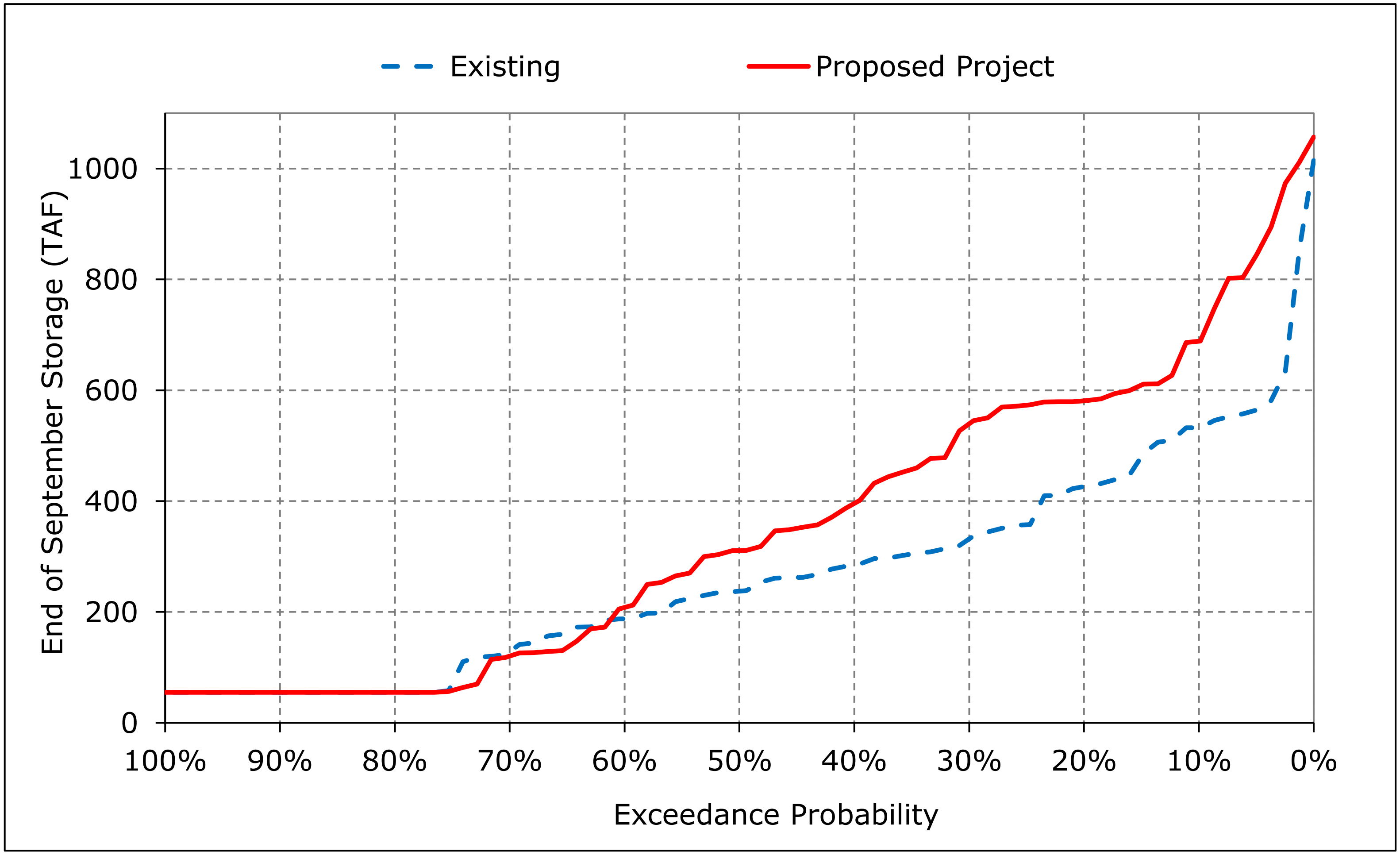


Figure 1c-18. San Luis SWP Storage, End of September Storage



Appendix C – Modeling

Attachment 2-2 – Flow Results (CalSim II)

The following results of the CalSim II model are included for river flow conditions for the following alternatives:

- Existing Conditions
- Proposed Project

Table 2-2.1. Flow Results (CalSim II)

Title	Model Parameter	Table Numbers	Figure Numbers
Sacramento River Flow at Freeport	C169	1-1	1-1 to 1-18
Georgiana Slough Flow	D401B_GEO	2-1	2-1 to 2-18
Yolo Bypass Flow	C157	3-1	3-1 to 3-18
Sacramento River Flow at Rio Vista	C405	4-1	4-1 to 4-18
San Joaquin River at Vernalis	C639	5-1	5-1 to 5-18
Mokelumne River Below Consumnes	C504	6-1	6-1 to 6-18
Old and Middle River Flow	C408	7-1	7-1 to 7-18
Qwest	C416A	8-1	8-1 to 8-18
Delta Outflow	C406	9-1	9-1 to 9-18

Report formats

- Monthly tables comparing two scenarios (exceedance values, long-term average, and average by water year type)
- Monthly pattern charts (long-term average and average by water year type) including all scenarios
- Monthly exceedance charts (all months) including all scenarios

Table 1-1. Sacramento River Flow at Freeport, Monthly Flow

Existing

	Monthly Flow (CFS)											
Statistic	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Probability of Exceedance												
10%	13,766	22,073	48,752	63,157	68,384	62,394	52,923	41,803	26,593	24,522	16,963	30,152
20%	13,332	19,621	32,185	55,411	60,806	52,865	40,600	29,832	19,988	22,968	16,238	29,429
30%	12,763	18,605	21,963	38,417	49,902	39,929	26,021	19,236	15,420	21,584	16,006	24,061
40%	11,546	16,220	18,343	26,706	45,009	33,941	23,119	14,886	14,831	19,917	15,770	21,992
50%	10,520	14,888	15,589	20,626	34,615	26,439	18,461	12,887	14,467	19,155	15,543	14,610
60%	9,213	12,135	15,117	18,712	26,295	21,695	15,302	11,820	14,035	17,518	14,469	11,310
70%	8,522	10,419	13,252	14,718	20,073	19,289	13,396	10,805	13,099	16,490	10,614	9,977
80%	8,051	9,021	10,982	13,213	16,888	15,732	11,576	10,231	12,322	14,778	9,349	9,445
90%	6,705	7,877	9,715	12,233	14,026	11,430	10,003	8,633	11,596	10,527	8,394	7,551
Long Term												
Full Simulation Period[a]	10,902	16,017	22,564	30,820	37,978	32,595	24,891	19,312	17,132	18,361	13,660	17,819
Water Year Types[b,c]												
Wet (32%)	12,658	21,062	36,113	50,121	57,672	49,926	40,193	31,908	23,827	20,207	16,271	28,817
Above Normal (15%)	10,615	16,983	22,363	37,320	45,427	43,052	27,490	21,850	16,431	21,886	16,401	22,366
Below Normal (17%)	10,453	14,106	16,596	21,953	32,254	22,985	19,573	14,371	14,588	20,870	15,568	12,979
Dry (22%)	10,048	13,410	15,147	16,518	23,267	20,656	14,489	10,764	14,050	16,782	9,809	9,645
Critical (15%)	9,190	10,263	11,497	14,298	16,601	13,704	10,947	8,065	10,921	10,281	8,813	7,354

Proposed Project

	Monthly Flow (CFS)											
Statistic	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Probability of Exceedance												
10%	14,579	21,983	50,342	63,821	68,500	62,720	52,922	41,633	26,579	24,388	16,949	23,785
20%	13,668	14,736	34,367	56,341	60,972	52,961	40,610	30,275	19,984	23,606	16,353	23,138
30%	12,876	13,914	22,492	40,731	51,407	41,411	25,847	19,232	15,561	21,872	16,088	22,442
40%	11,976	13,504	18,497	27,766	46,113	33,998	23,116	14,880	15,242	19,624	15,804	21,117
50%	11,366	12,870	15,651	24,206	34,576	26,432	18,443	14,135	14,912	18,583	15,099	14,655
60%	9,382	11,090	15,089	18,809	26,302	22,024	14,967	12,796	14,571	16,979	13,855	11,091
70%	8,393	10,514	13,953	15,191	21,628	19,329	13,279	11,520	13,743	15,871	10,684	9,899
80%	8,051	8,899	12,087	12,613	17,573	15,516	11,979	10,749	12,733	13,951	9,622	9,456
90%	6,939	7,611	9,698	11,643	14,471	11,722	10,428	9,369	11,311	10,603	9,031	7,600
Long Term												
Full Simulation Period[a]	11,184	14,330	23,129	31,210	38,462	32,897	24,958	19,719	17,441	18,162	13,655	15,851
Water Year Types[b,c]												
Wet (32%)	13,033	18,891	37,629	50,737	57,966	50,069	40,162	31,903	23,912	20,073	16,188	22,361
Above Normal (15%)	11,171	14,703	22,541	38,453	46,067	43,786	27,480	21,949	17,174	21,957	16,329	23,113
Below Normal (17%)	10,767	12,629	16,668	22,954	33,682	23,290	19,629	15,142	15,417	20,508	15,268	12,740
Dry (22%)	10,072	11,942	15,377	16,311	23,289	20,945	14,680	11,796	14,238	16,076	9,910	9,604
Critical (15%)	9,348	9,644	11,463	13,640	16,932	13,938	11,128	8,315	10,854	10,618	9,228	7,485

Proposed Project minus Existing

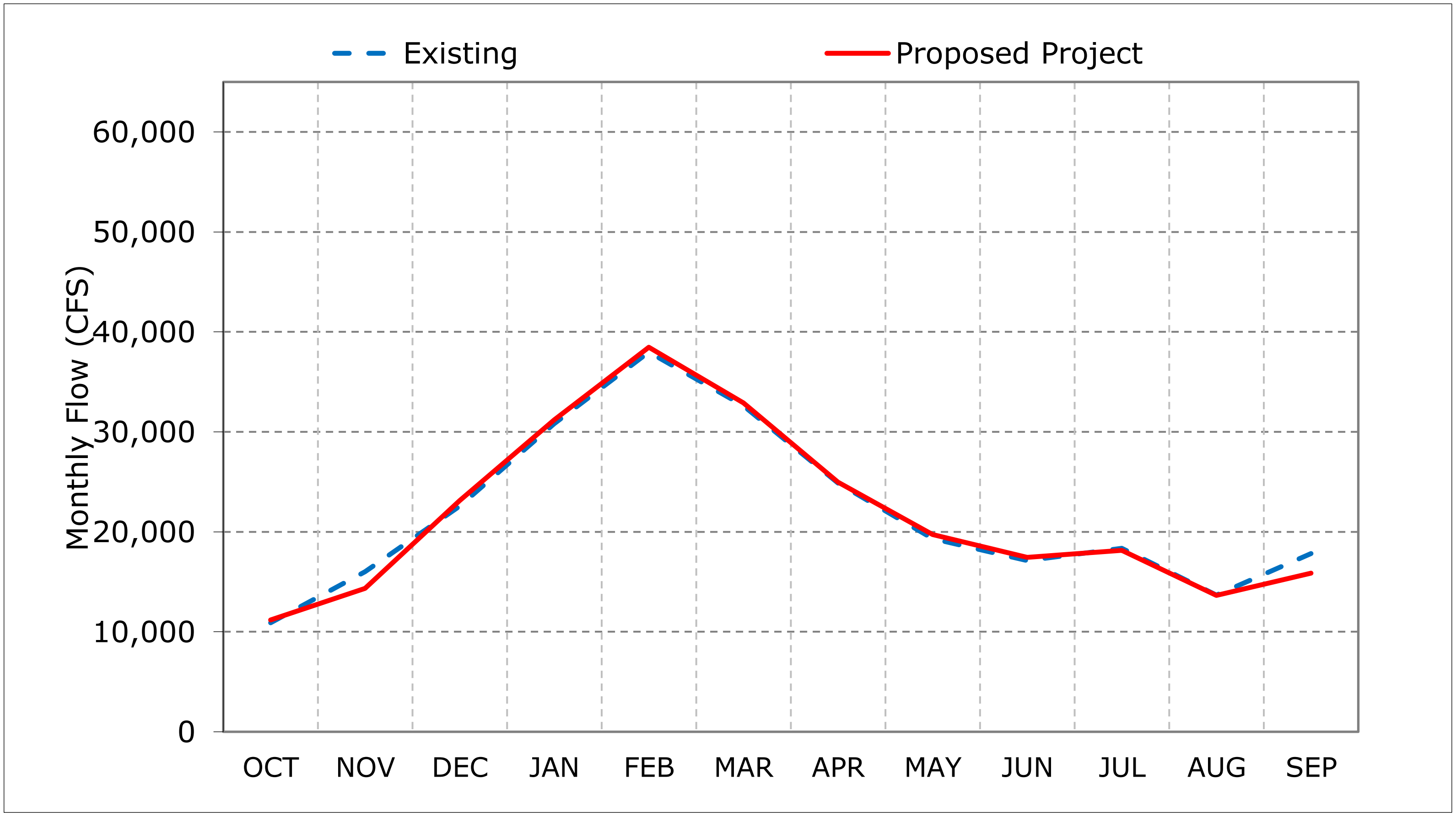
	Monthly Flow (CFS)											
Statistic	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Probability of Exceedance												
10%	812	**-91**	1,590	664	116	326	**-1**	**-169**	**-14**	**-134**	**-14**	**-6,367**
20%	336	**-4,885**	2,182	931	166	95	11	443	**-3**	638	115	**-6,291**
30%	112	**-4,691**	529	2,314	1,504	1,482	**-174**	**-4**	141	287	82	**-1,619**
40%	430	**-2,716**	154	1,061	1,105	57	**-3**	**-6**	410	**-293**	34	**-874**
50%	846	**-2,017**	62	3,581	**-39**	**-7**	**-18**	1,248	445	**-573**	**-444**	45
60%	169	**-1,045**	**-27**	97	7	329	**-335**	976	537	**-539**	**-613**	**-219**
70%	**-129**	95	701	473	1,555	40	**-117**	715	644	**-619**	70	**-78**
80%	0	**-123**	1,104	**-600**	684	**-216**	403	517	411	**-827**	273	11
90%	235	**-266**	**-17**	**-590**	445	292	426	736	**-286**	76	638	49
Long Term												
Full Simulation Period[a]	283	**-1,687**	564	391	484	302	67	407	308	**-199**	**-5**	**-1,968**
Water Year Types[b,c]												
Wet (32%)	375	**-2,171**	1,516	616	294	143	**-31**	**-5**	85	**-134**	**-83**	**-6,457**
Above Normal (15%)	556	**-2,280**	178	1,133	640	733	**-10**	98	743	71	**-73**	747
Below Normal (17%)	314	**-1,476**	72	1,002	1,427	305	56	771	829	**-362**	**-300**	**-239**
Dry (22%)	24	**-1,467**	230	**-206**	22	289	191	1,031	187	**-705**	101	**-41**
Critical (15%)	159	**-620**	**-34**	**-658**	331	234	181	249	**-67**	337	415	131

a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

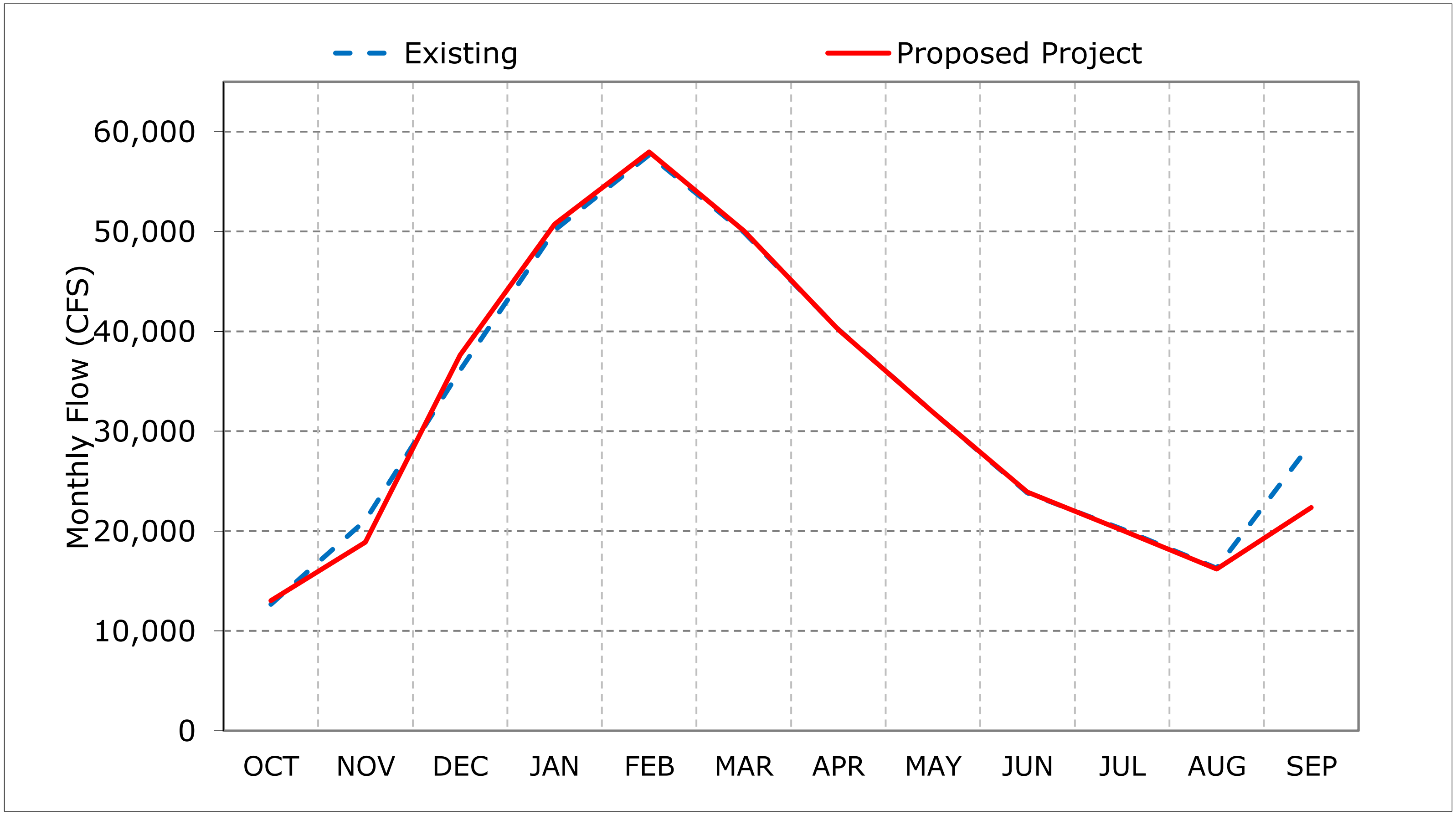
c These results are displayed with water year - year type sorting.

Figure 1-1. Sacramento River Flow at Freeport, Long-Term Average Flow



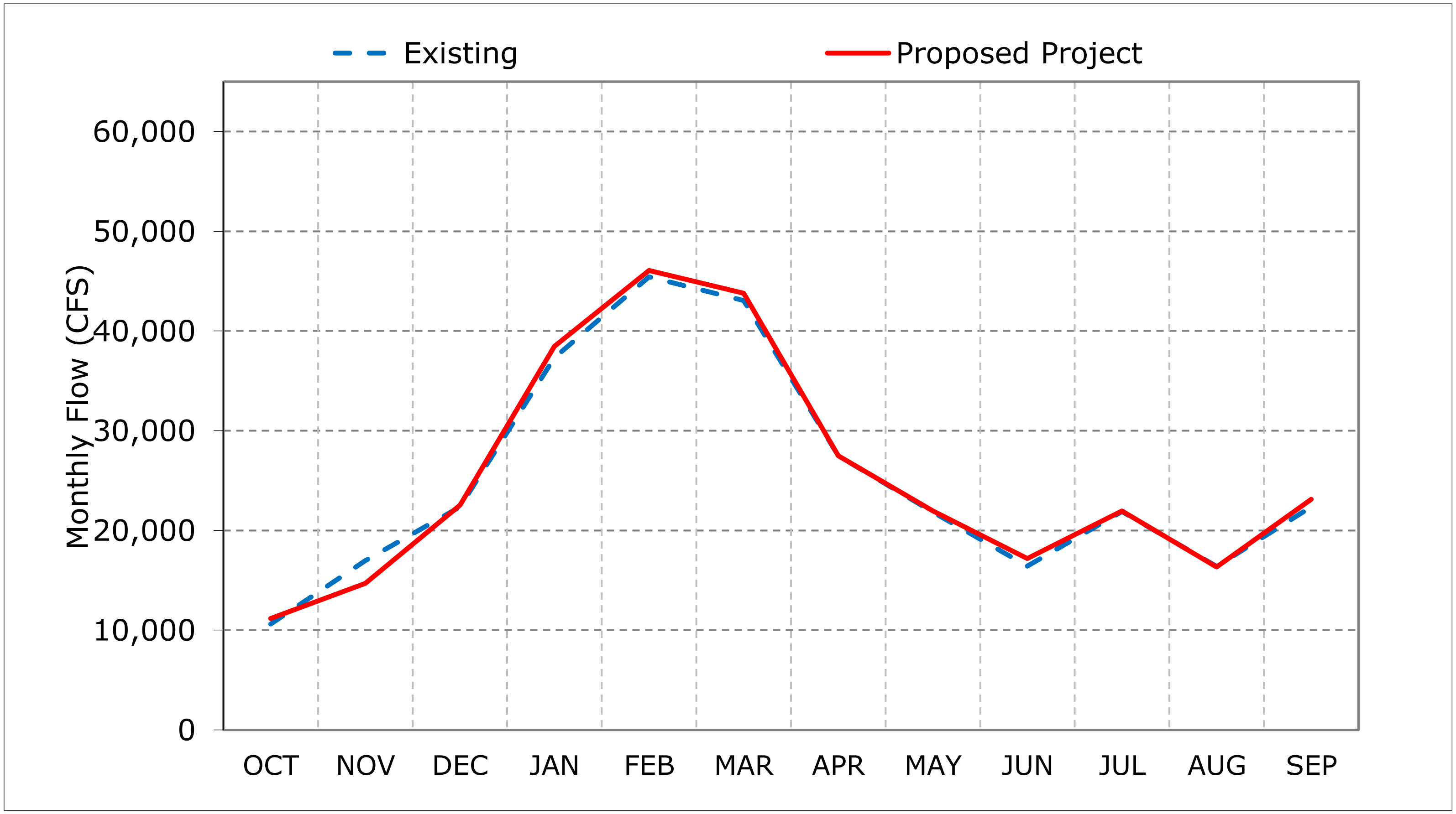
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 1-2. Sacramento River Flow at Freeport, Wet Year Average Flow



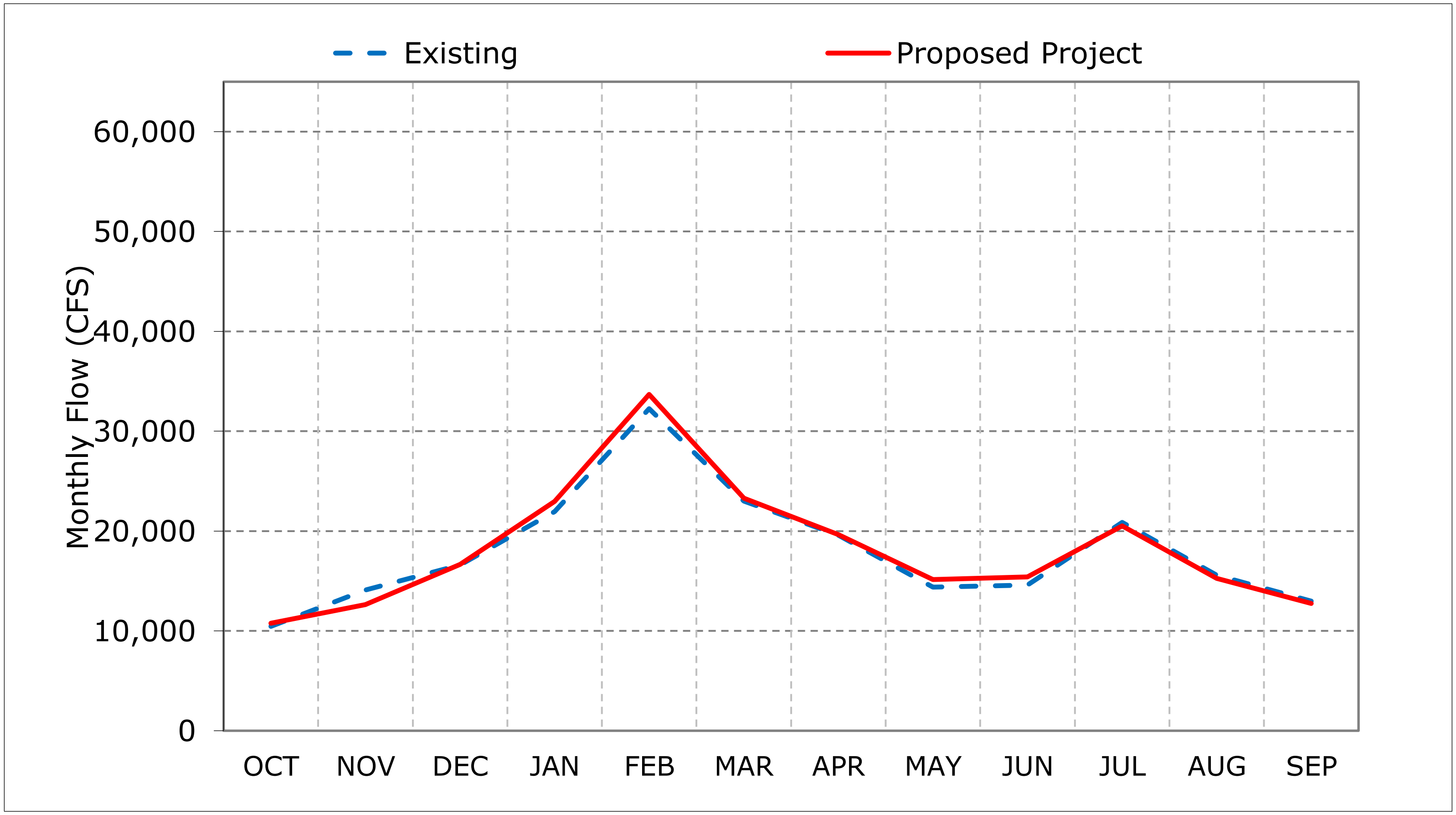
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 1-3. Sacramento River Flow at Freeport, Above Normal Year Average Flow



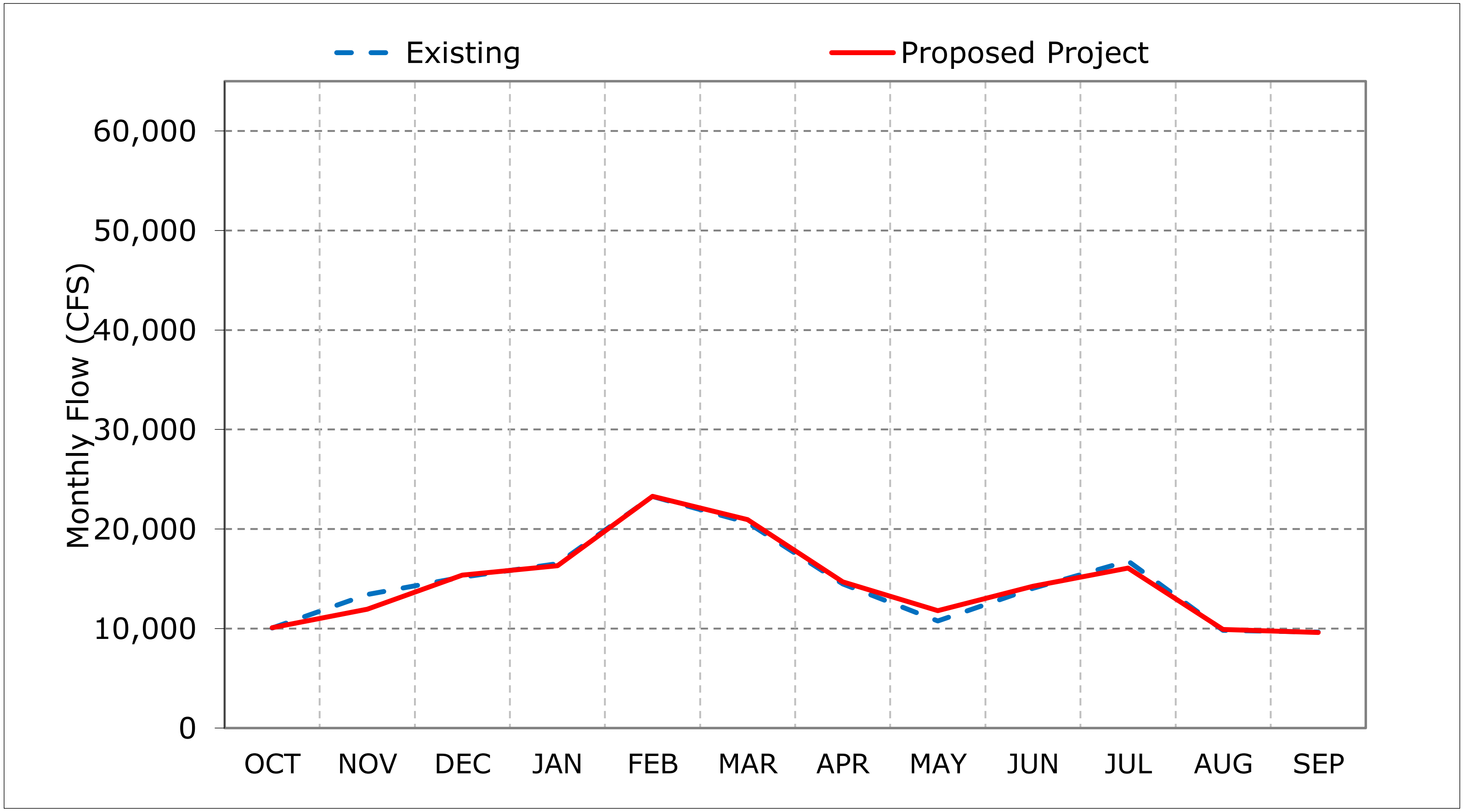
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 1-4. Sacramento River Flow at Freeport, Below Normal Year Average Flow



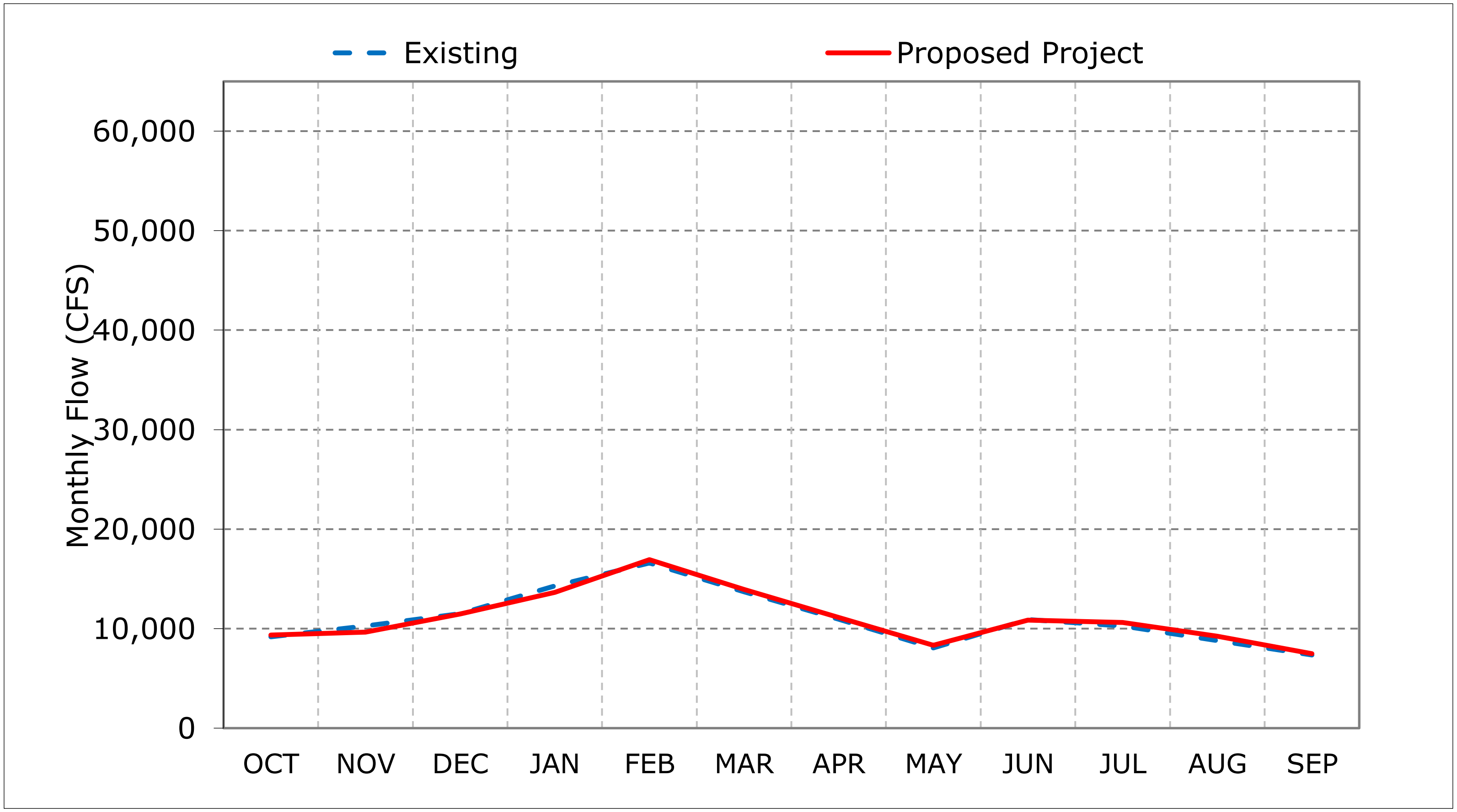
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 1-5. Sacramento River Flow at Freeport, Dry Year Average Flow



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 1-6. Sacramento River Flow at Freeport, Critical Year Average Flow



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 1-7. Sacramento River Flow at Freeport, October

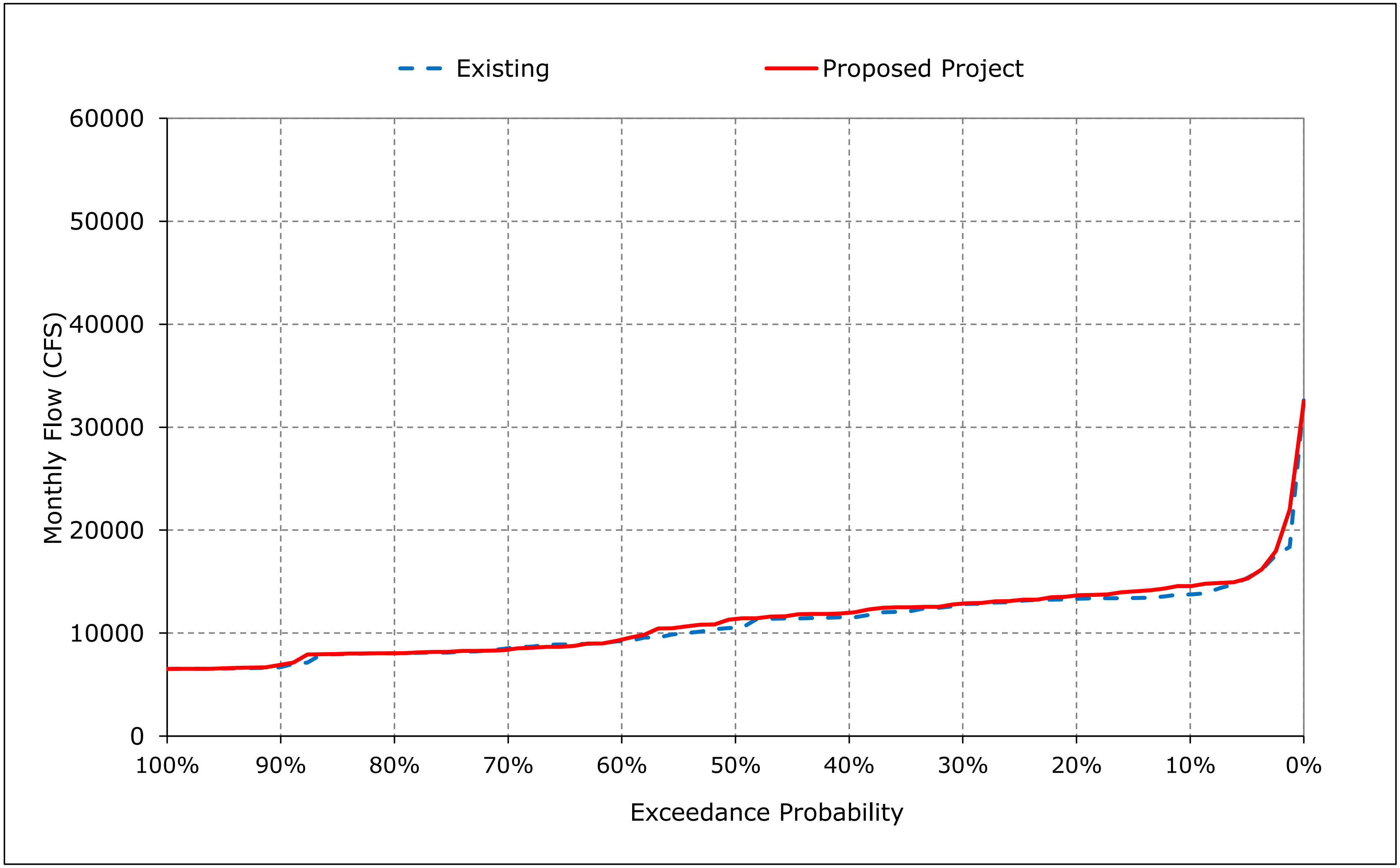


Figure 1-8. Sacramento River Flow at Freeport, November

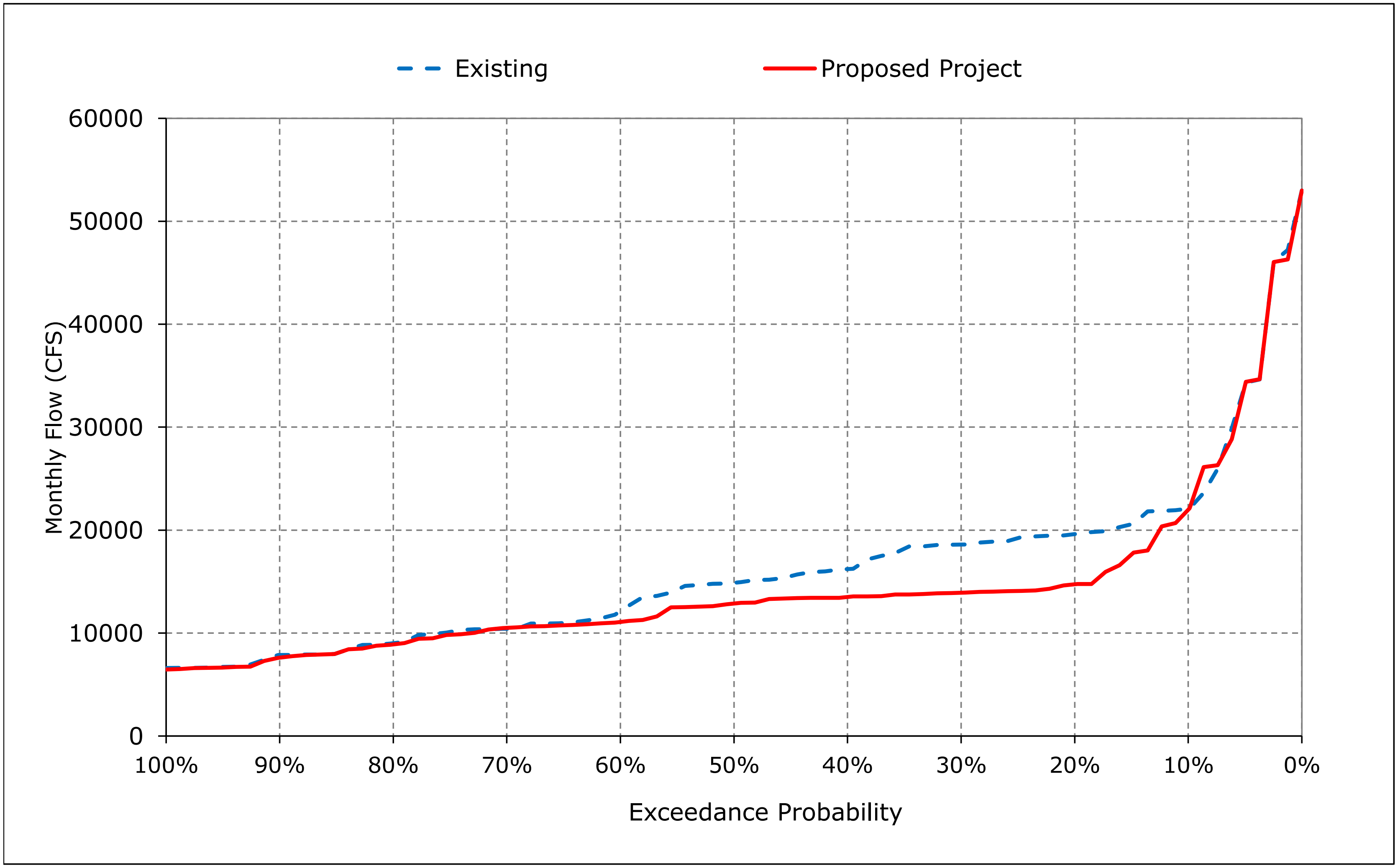


Figure 1-9. Sacramento River Flow at Freeport, December

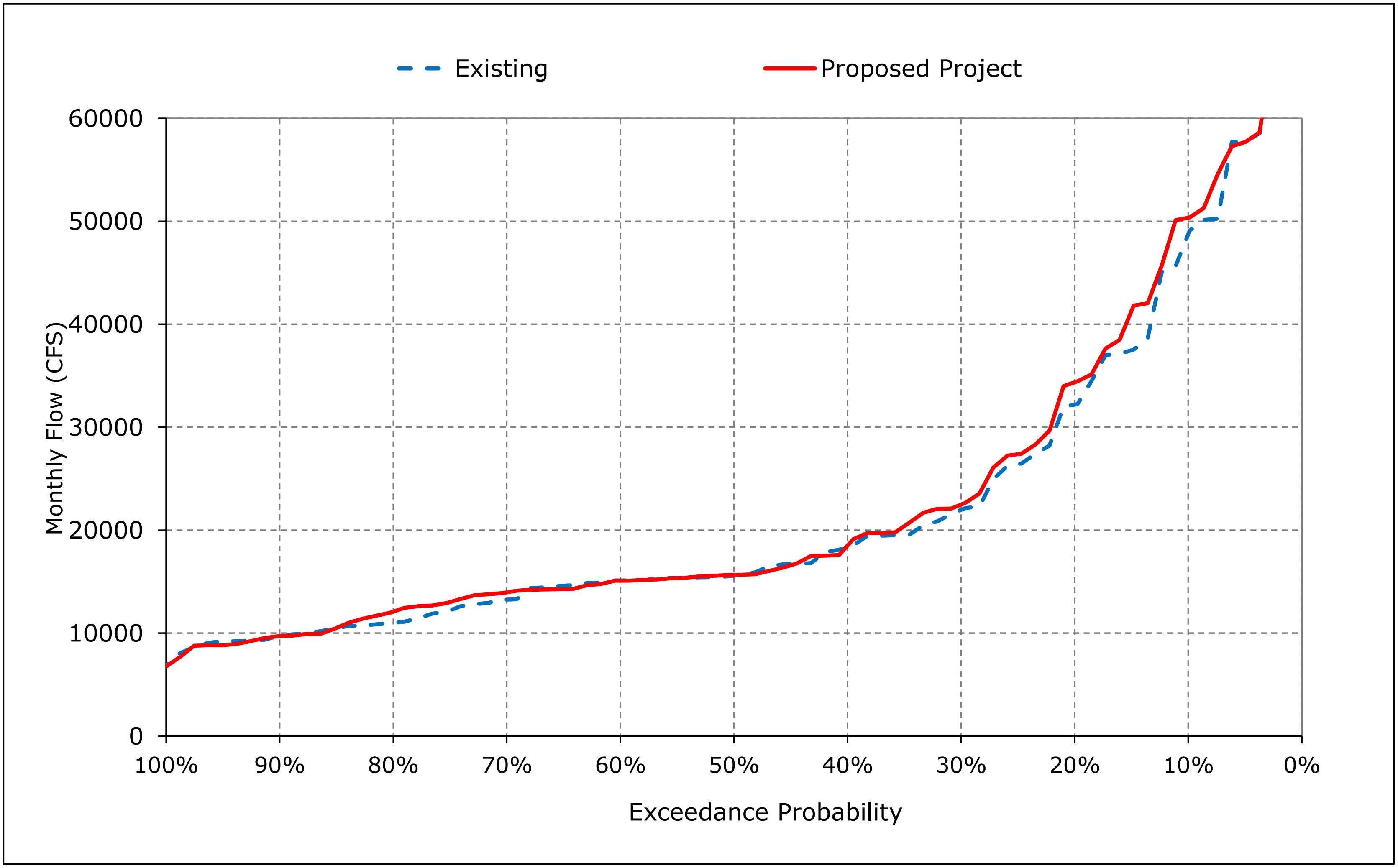


Figure 1-10. Sacramento River Flow at Freeport, January

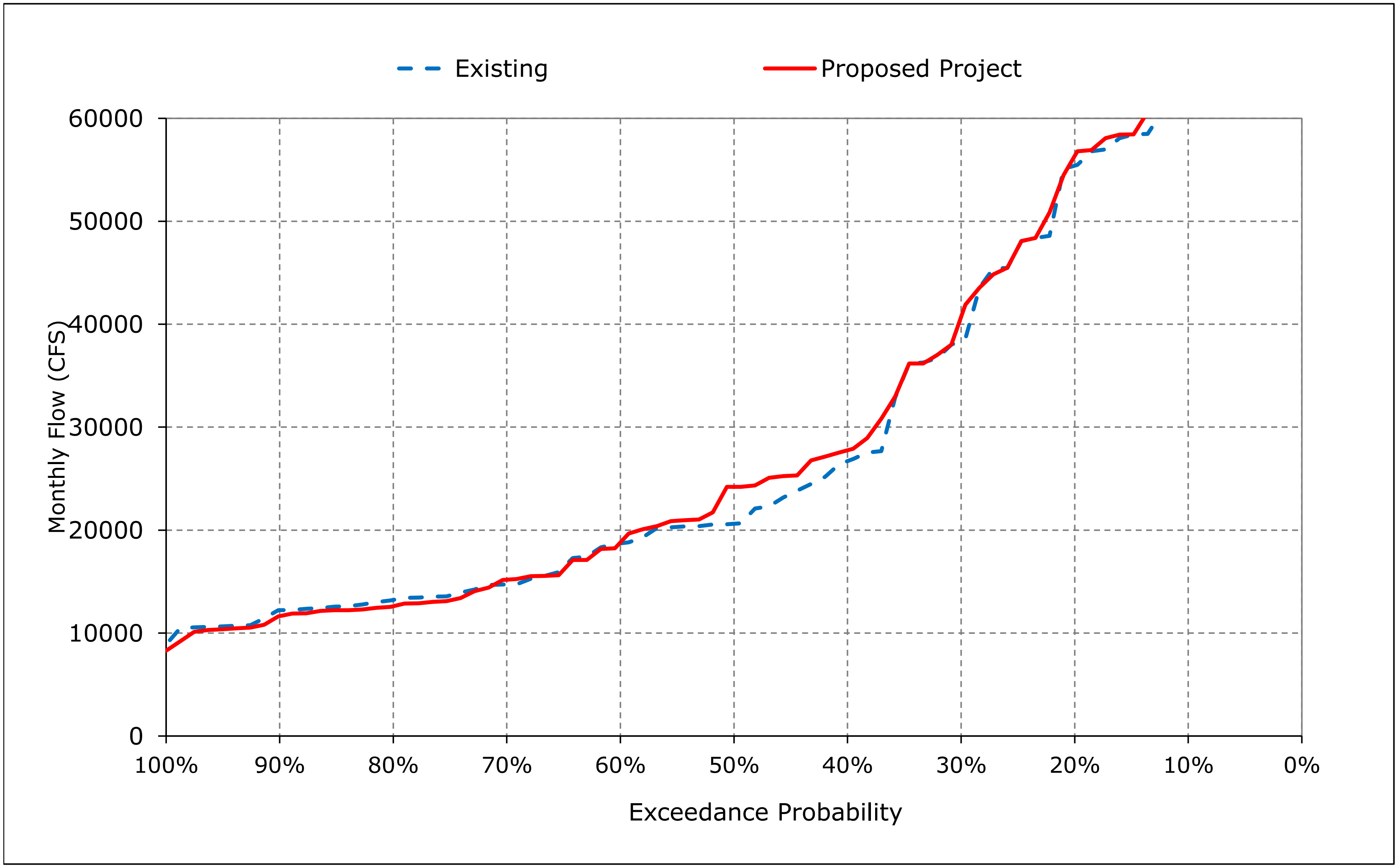


Figure 1-11. Sacramento River Flow at Freeport, February

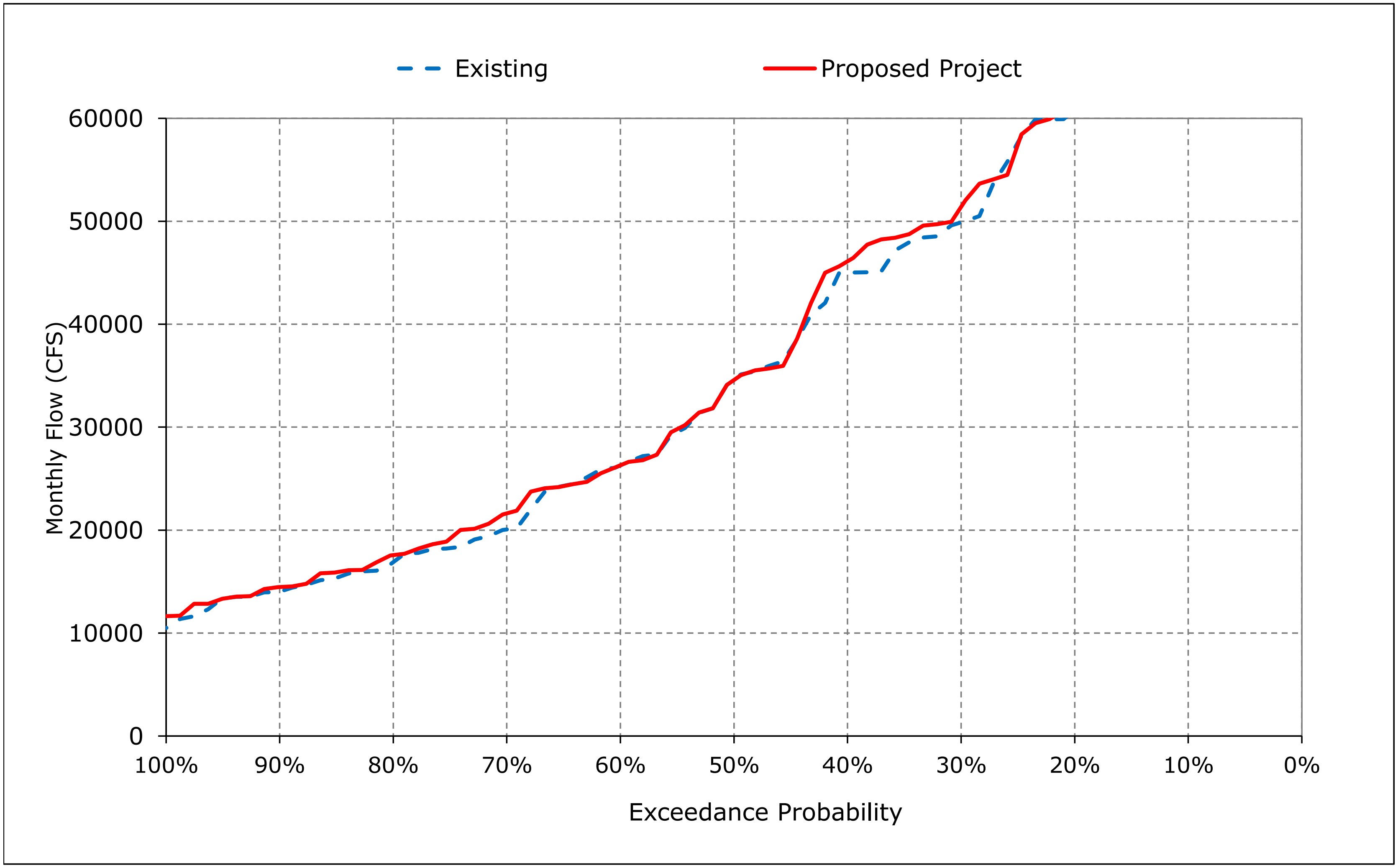


Figure 1-12. Sacramento River Flow at Freeport, March

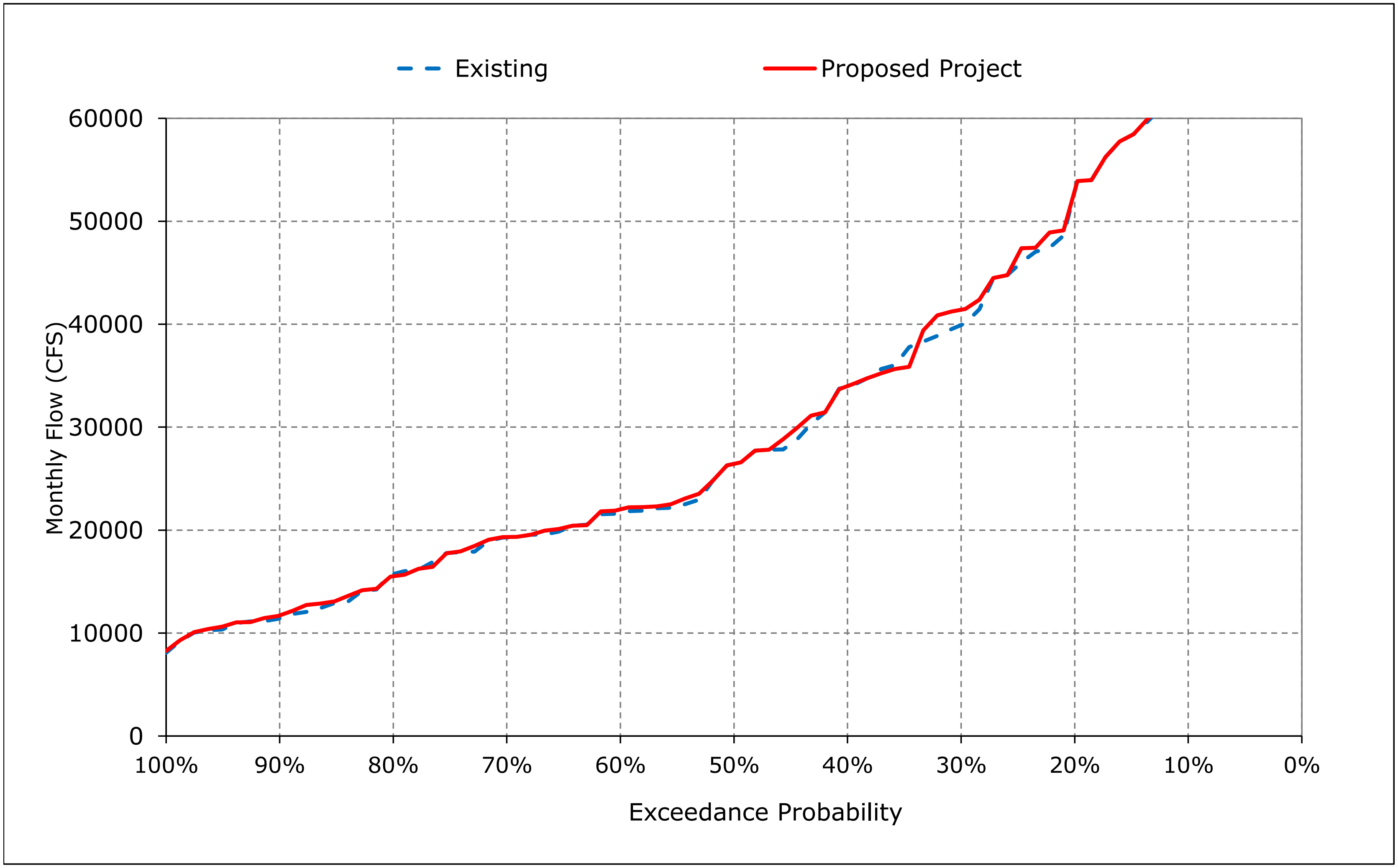


Figure 1-13. Sacramento River Flow at Freeport, April

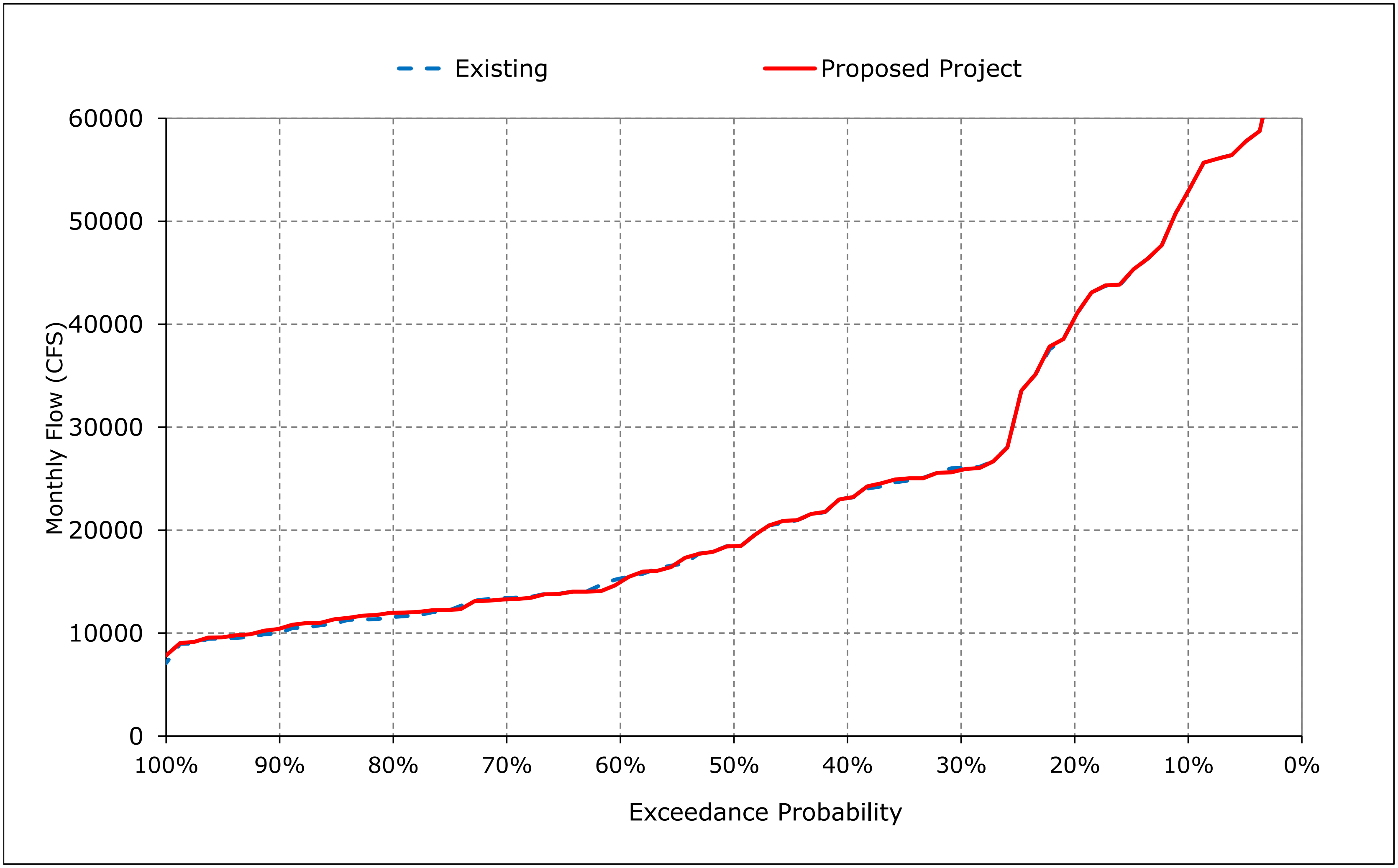


Figure 1-14. Sacramento River Flow at Freeport, May

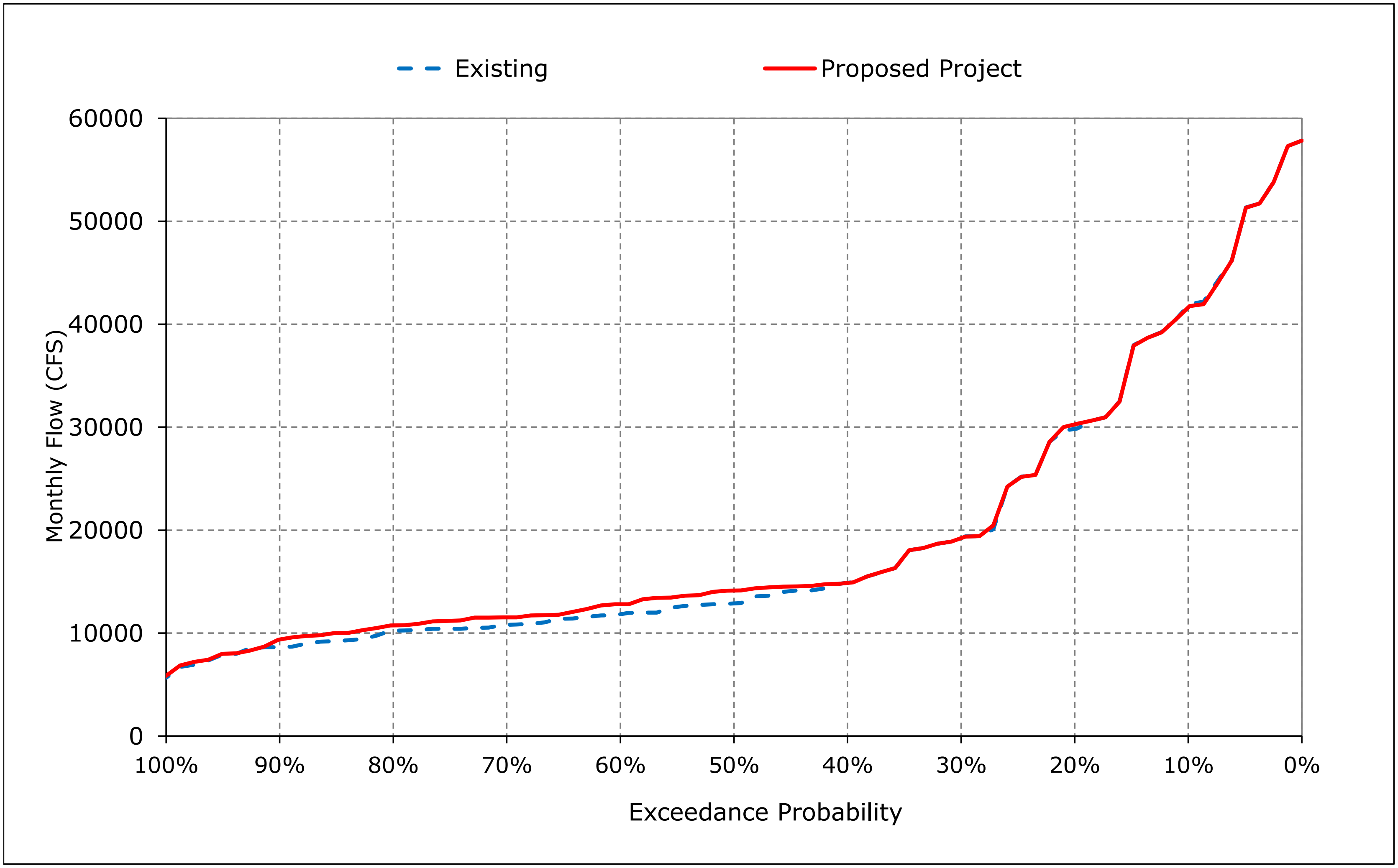


Figure 1-15. Sacramento River Flow at Freeport, June

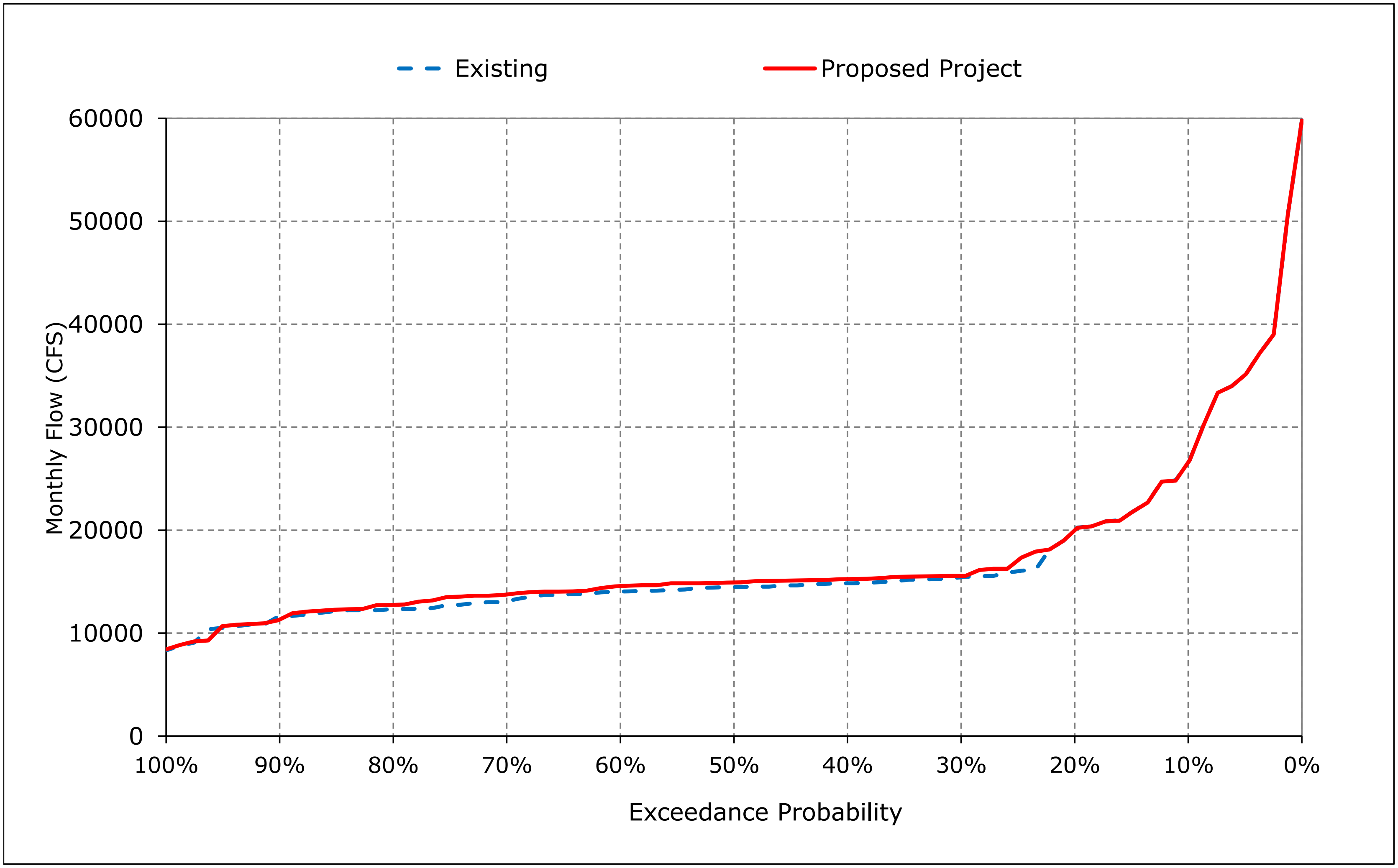


Figure 1-16. Sacramento River Flow at Freeport, July

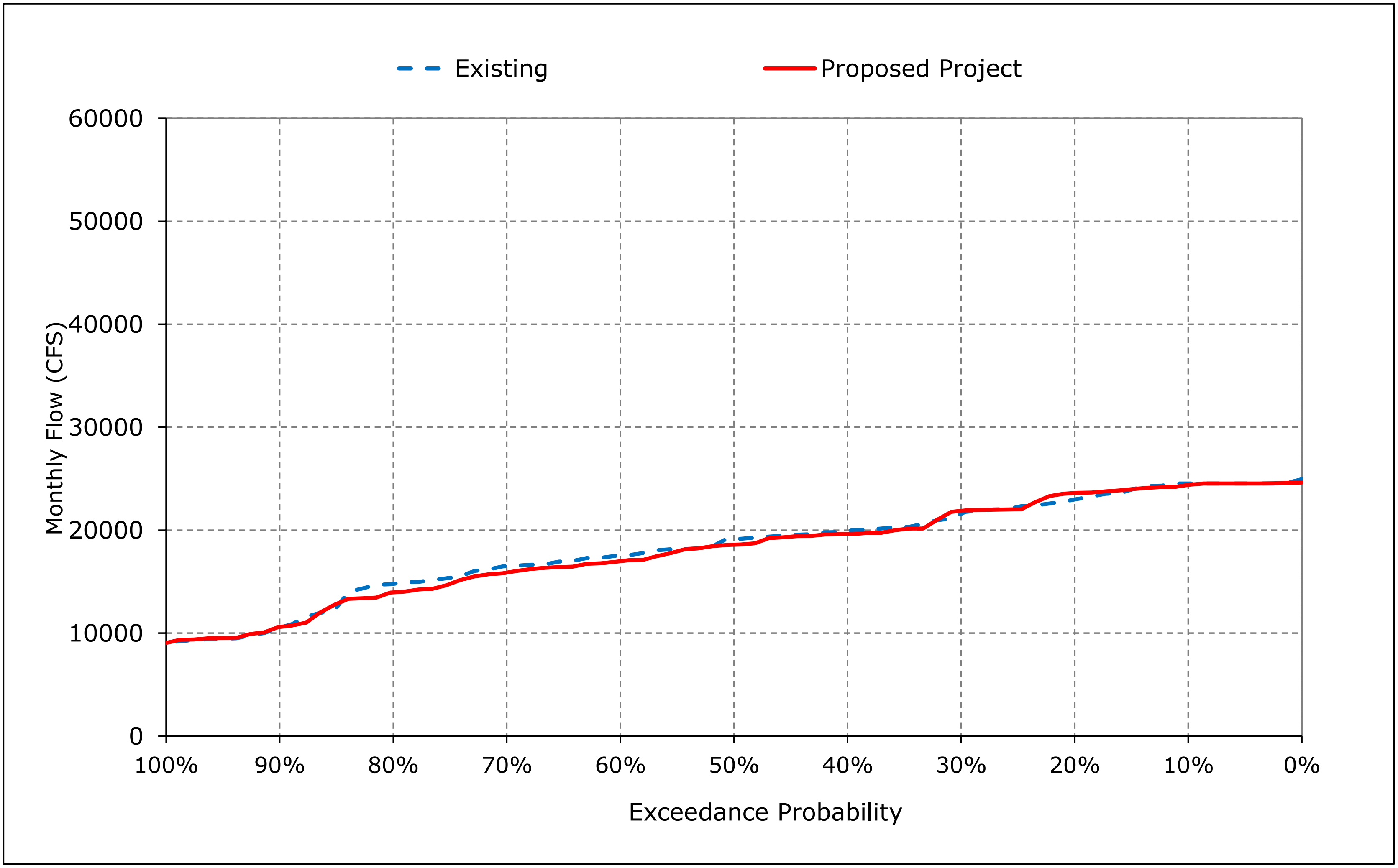


Figure 1-17. Sacramento River Flow at Freeport, August

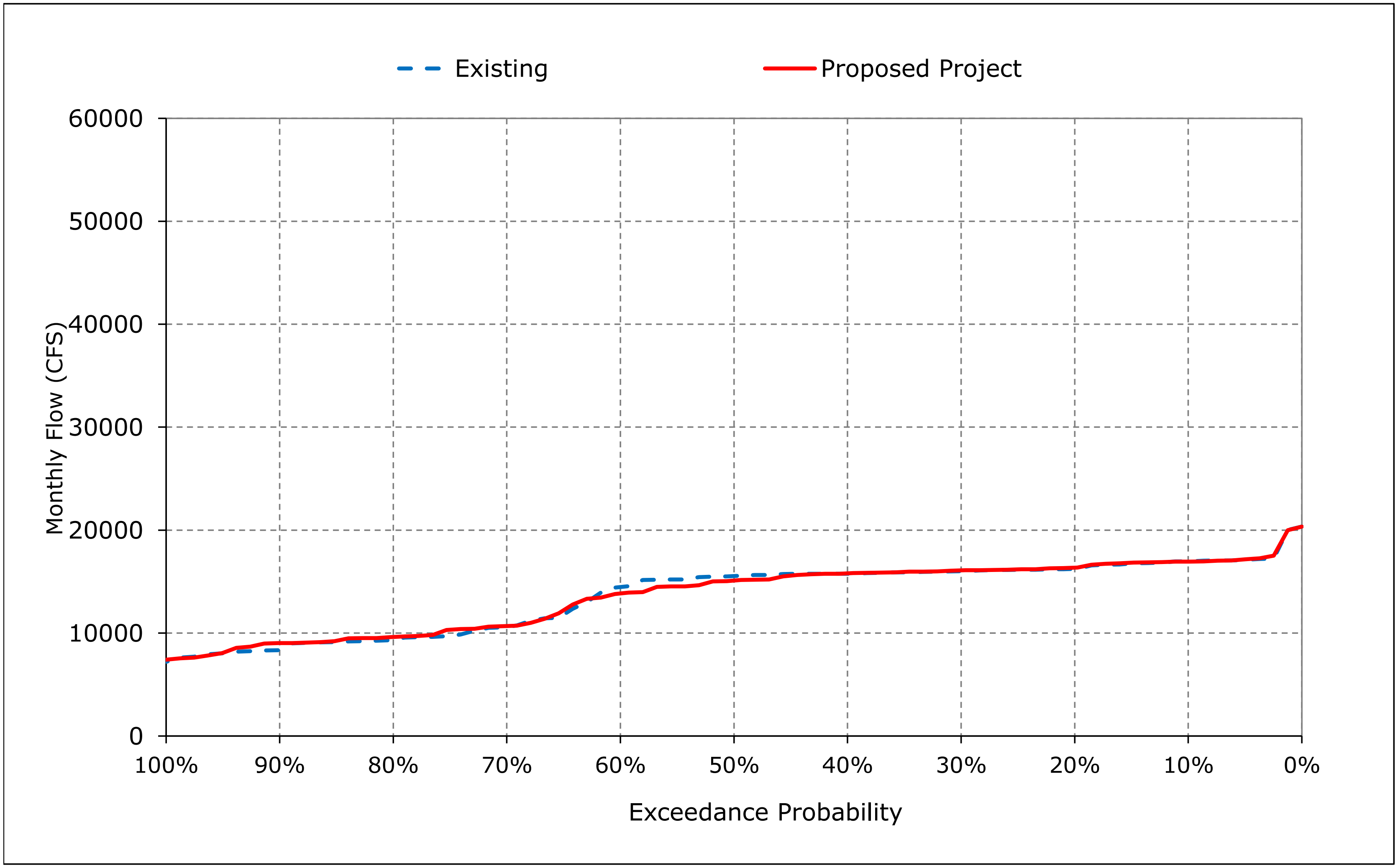


Figure 1-18. Sacramento River Flow at Freeport, September

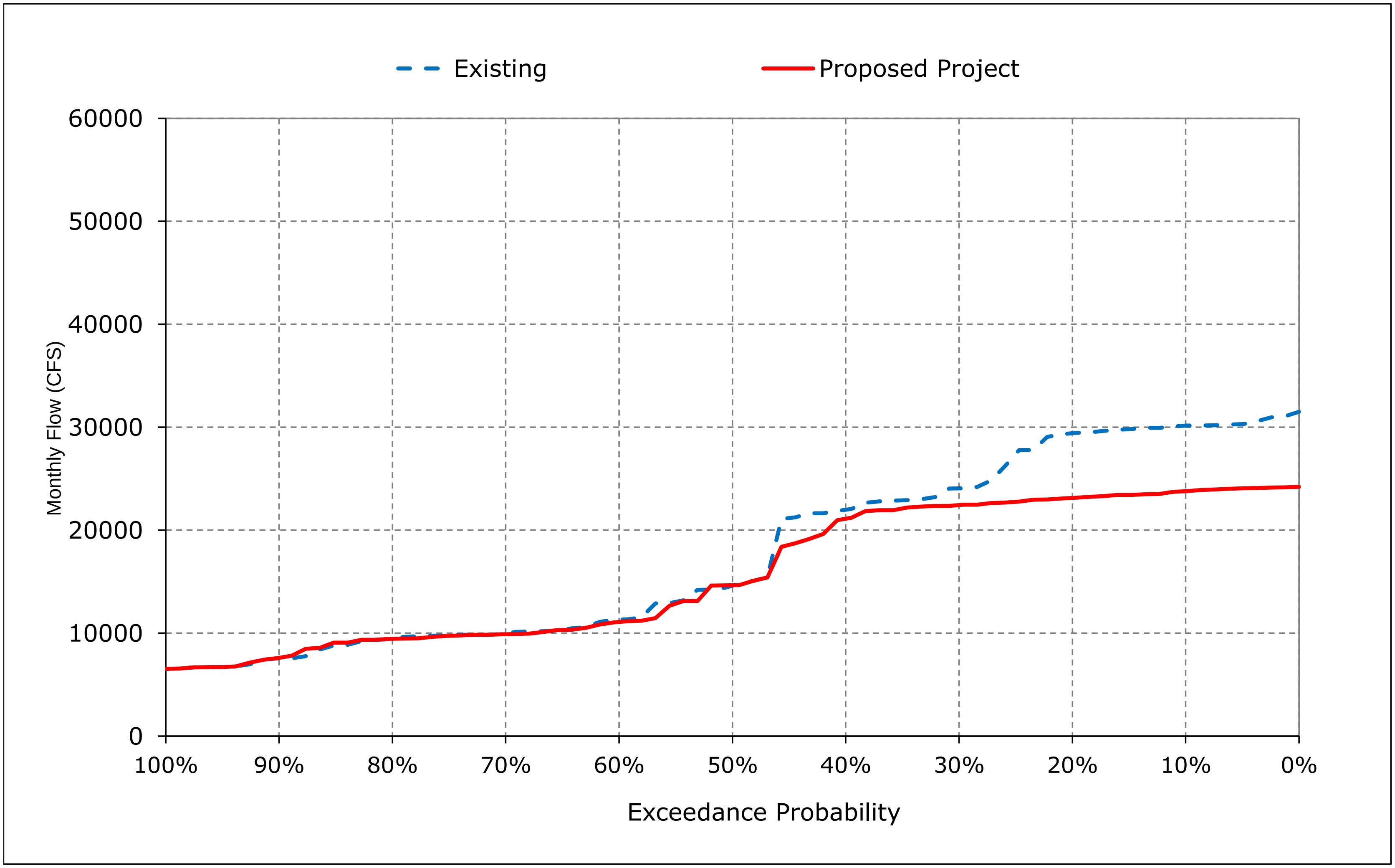


Table 2-1. Georgiana Slough, Monthly Flow

Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Flow (CFS)											
Probability of Exceedance												
10%	2,894	4,016	7,532	9,442	10,171	9,326	8,070	6,594	4,577	4,298	3,309	5,056
20%	2,838	3,672	5,350	8,425	9,129	8,051	6,444	5,015	3,701	4,091	3,213	4,961
30%	2,761	3,549	3,984	6,172	7,686	6,360	4,518	3,610	3,093	3,908	3,181	4,254
40%	2,601	3,219	3,504	4,639	7,040	5,565	4,133	3,038	3,020	3,691	3,150	3,979
50%	2,467	3,047	3,144	3,834	5,668	4,581	3,519	2,772	2,970	3,588	3,122	3,004
60%	2,293	2,686	3,074	3,562	4,573	3,949	3,099	2,627	2,912	3,372	2,979	2,568
70%	2,203	2,455	2,835	3,037	3,735	3,629	2,844	2,491	2,789	3,236	2,469	2,395
80%	2,138	2,273	2,526	2,837	3,316	3,159	2,605	2,421	2,682	3,011	2,302	2,321
90%	1,960	2,118	2,364	2,700	2,935	2,586	2,397	2,213	2,592	2,441	2,176	2,071
Long Term												
Full Simulation Period[a]	2,516	3,197	4,067	5,171	6,112	5,389	4,366	3,621	3,321	3,483	2,872	3,428
Water Year Types[b,c]												
Wet (32%)	2,749	3,866	5,862	7,729	8,718	7,680	6,391	5,287	4,208	3,727	3,217	4,881
Above Normal (15%)	2,478	3,324	4,042	6,036	7,102	6,770	4,710	3,958	3,229	3,949	3,235	4,029
Below Normal (17%)	2,457	2,943	3,277	3,997	5,357	4,119	3,663	2,967	2,986	3,815	3,124	2,789
Dry (22%)	2,403	2,852	3,084	3,275	4,164	3,812	2,991	2,492	2,913	3,274	2,363	2,349
Critical (15%)	2,290	2,434	2,598	2,978	3,277	2,890	2,521	2,133	2,497	2,411	2,232	2,046

Proposed Project

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Flow (CFS)											
Probability of Exceedance												
10%	3,002	3,991	7,766	9,530	10,186	9,374	8,070	6,579	4,576	4,278	3,307	4,215
20%	2,882	3,024	5,622	8,537	9,149	8,065	6,446	5,074	3,701	4,175	3,227	4,130
30%	2,775	2,924	4,064	6,478	7,882	6,554	4,494	3,610	3,113	3,947	3,193	4,038
40%	2,658	2,861	3,547	4,764	7,186	5,573	4,132	3,037	3,071	3,650	3,154	3,863
50%	2,576	2,780	3,151	4,298	5,663	4,580	3,517	2,936	3,029	3,512	3,062	3,011
60%	2,317	2,546	3,072	3,578	4,574	3,993	3,054	2,761	2,985	3,298	2,897	2,539
70%	2,184	2,472	2,920	3,092	3,943	3,634	2,829	2,590	2,874	3,156	2,482	2,382
80%	2,138	2,253	2,674	2,757	3,408	3,128	2,657	2,487	2,739	2,900	2,340	2,325
90%	1,993	2,083	2,361	2,628	2,995	2,628	2,450	2,303	2,554	2,451	2,260	2,078
Long Term												
Full Simulation Period[a]	2,554	2,974	4,142	5,223	6,176	5,429	4,375	3,675	3,362	3,456	2,871	3,168
Water Year Types[b,c]												
Wet (32%)	2,798	3,580	6,062	7,811	8,757	7,699	6,387	5,286	4,219	3,710	3,206	4,028
Above Normal (15%)	2,552	3,023	4,066	6,186	7,187	6,867	4,709	3,971	3,327	3,959	3,225	4,127
Below Normal (17%)	2,498	2,748	3,287	4,130	5,546	4,160	3,671	3,069	3,095	3,767	3,084	2,758
Dry (22%)	2,406	2,658	3,115	3,248	4,167	3,850	3,016	2,628	2,938	3,181	2,377	2,343
Critical (15%)	2,310	2,352	2,593	2,891	3,321	2,921	2,544	2,166	2,488	2,456	2,287	2,063

Proposed Project minus Existing

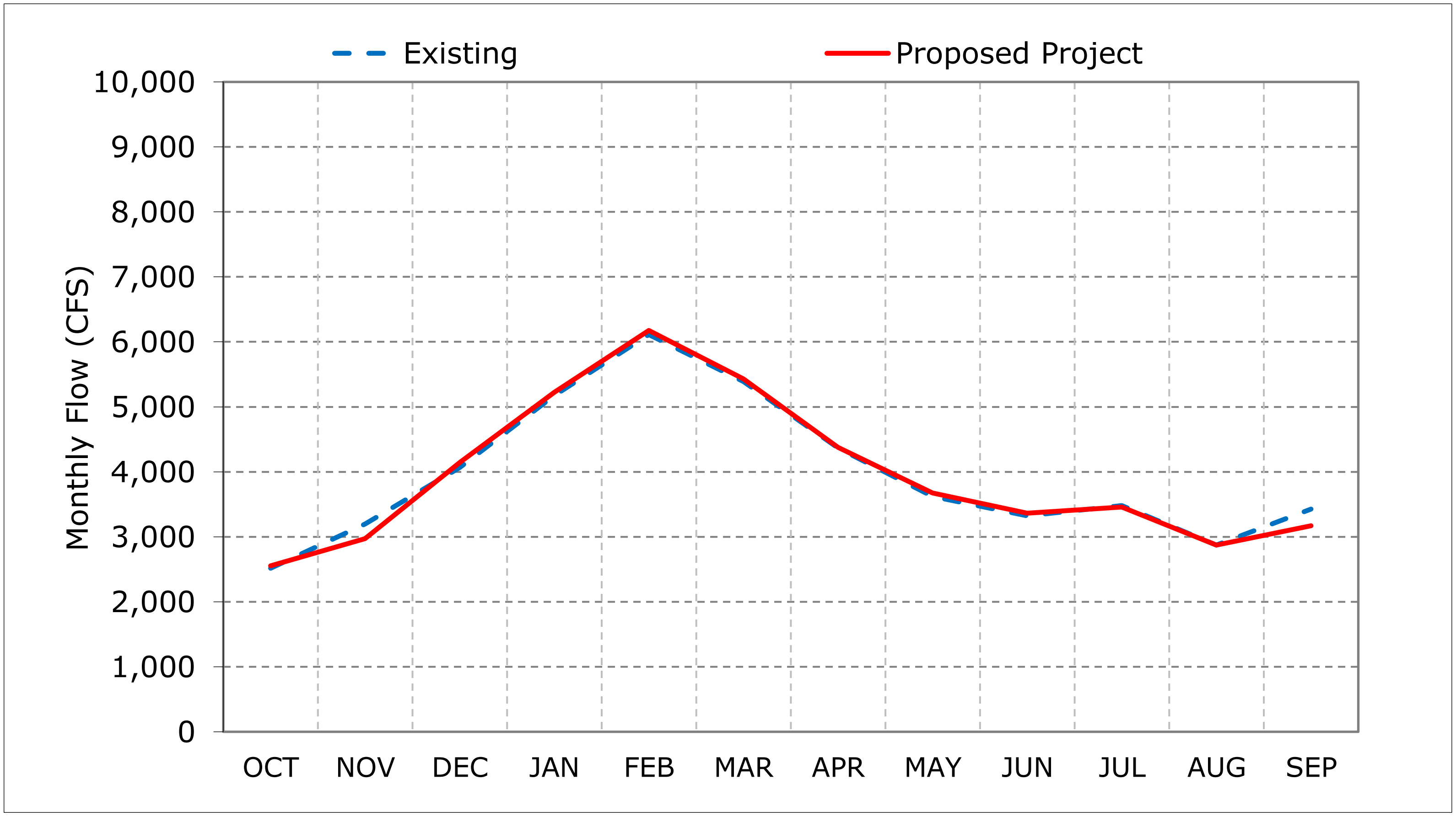
Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Flow (CFS)											
Probability of Exceedance												
10%	108	**-25**	234	88	15	47	**0**	**-15**	**-2**	**-20**	**-2**	**-841**
20%	44	**-648**	272	113	20	14	1	58	**0**	84	14	**-831**
30%	15	**-625**	80	306	196	194	**-24**	**0**	21	38	12	**-216**
40%	58	**-358**	42	125	146	7	**0**	**-1**	52	**-41**	4	**-116**
50%	110	**-267**	7	465	**-5**	**-1**	**-2**	163	60	**-76**	**-60**	7
60%	24	**-140**	**-2**	16	1	44	**-44**	135	73	**-74**	**-82**	**-29**
70%	**-19**	18	85	56	208	5	**-15**	98	85	**-80**	14	**-13**
80%	0	**-20**	148	**-80**	92	**-31**	52	66	58	**-111**	38	4
90%	33	**-35**	**-3**	**-73**	61	42	52	90	**-38**	10	84	7
Long Term												
Full Simulation Period[a]	37	**-223**	75	52	64	40	9	54	41	**-26**	**-1**	**-260**
Water Year Types[b,c]												
Wet (32%)	50	**-287**	200	81	39	19	**-4**	**-1**	11	**-18**	**-11**	**-853**
Above Normal (15%)	73	**-301**	24	150	85	97	**-1**	13	98	9	**-10**	99
Below Normal (17%)	42	**-195**	9	132	189	40	7	102	110	**-48**	**-40**	**-32**
Dry (22%)	3	**-194**	30	**-27**	3	38	25	136	25	**-93**	13	**-5**
Critical (15%)	21	**-82**	**-4**	**-87**	44	31	24	33	**-9**	45	55	17

a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

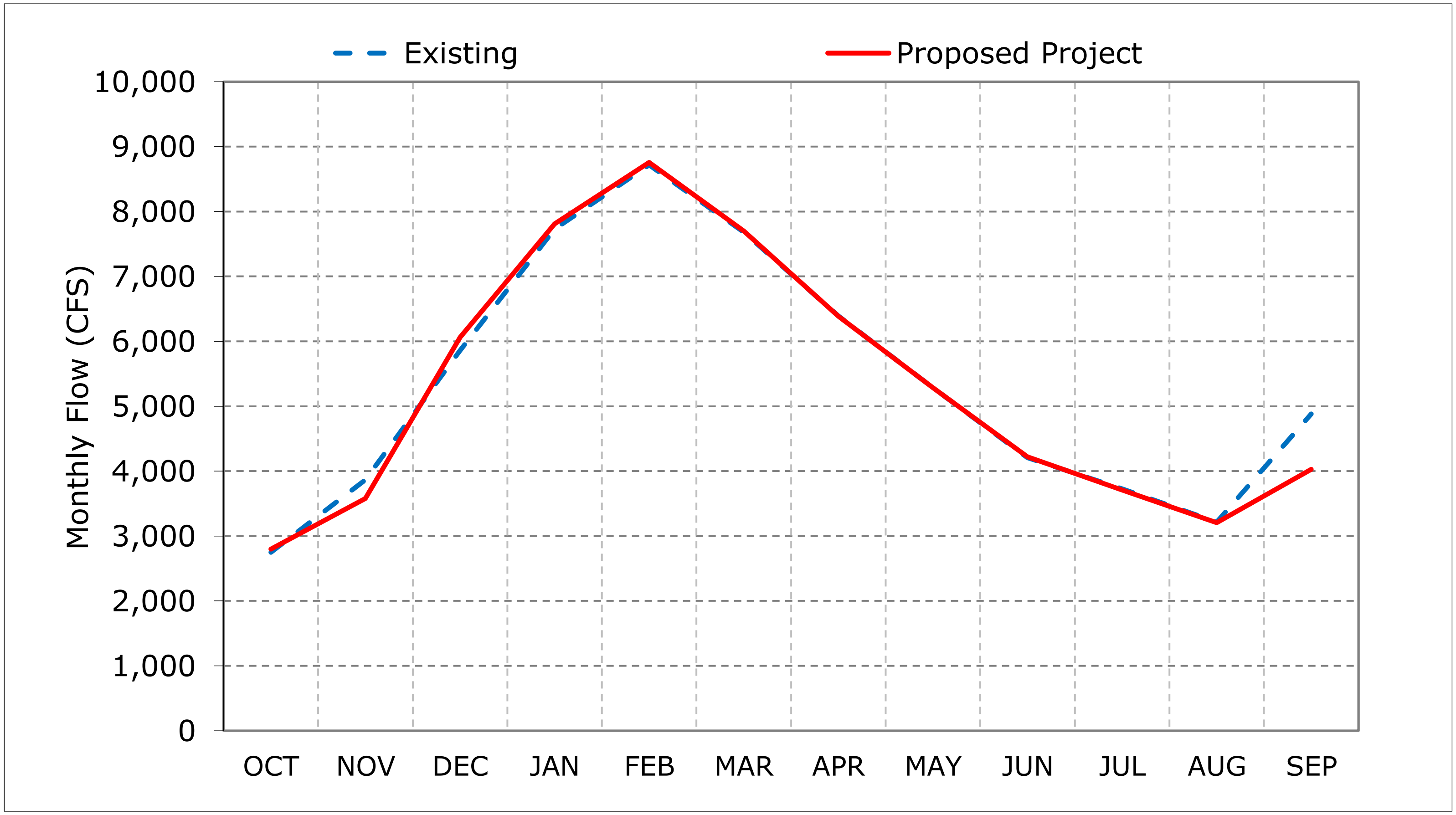
c These results are displayed with water year - year type sorting.

Figure 2-1. Georgiana Slough, Long-Term Average Flow



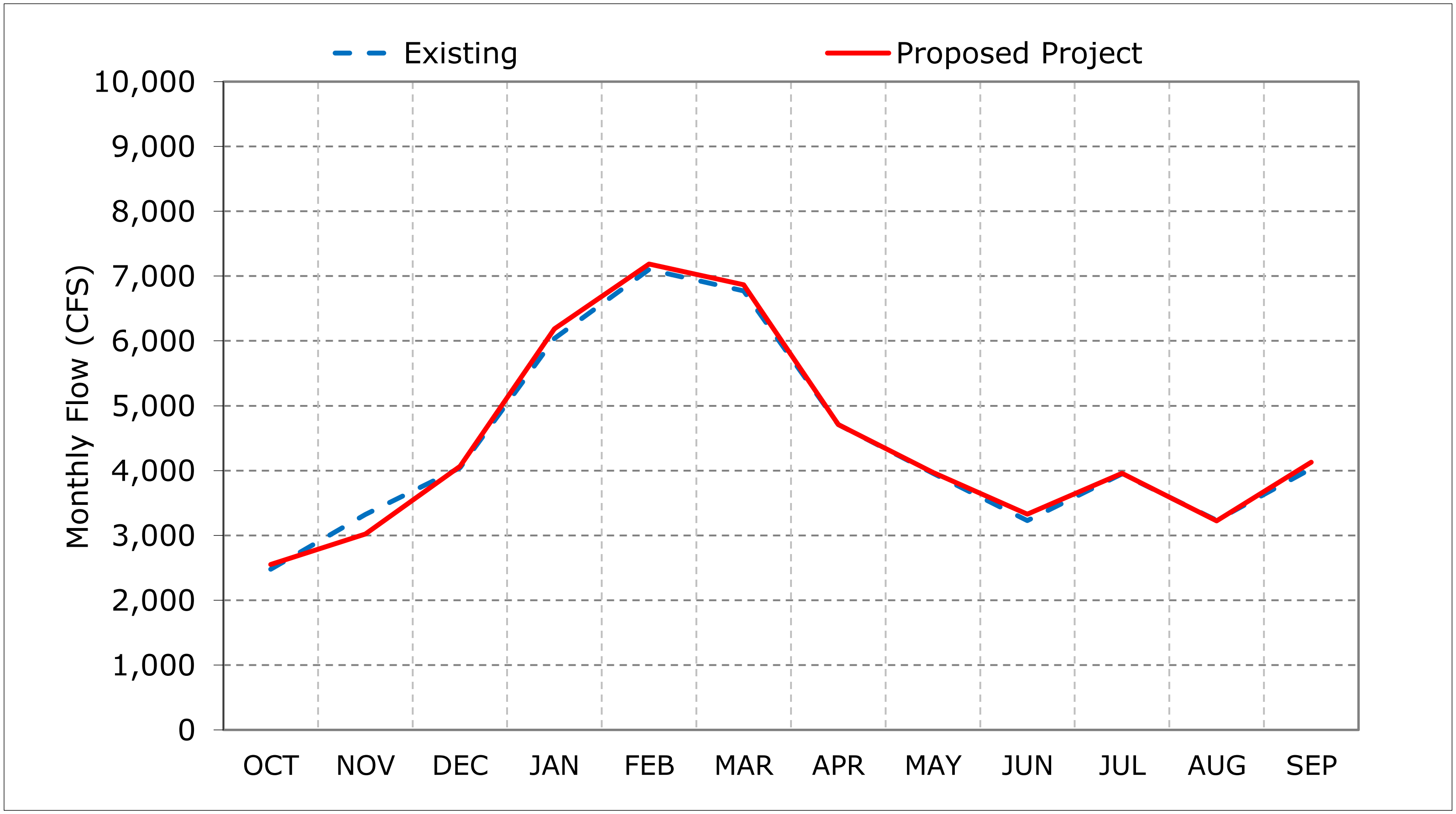
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 2-2. Georgiana Slough, Wet Year Average Flow



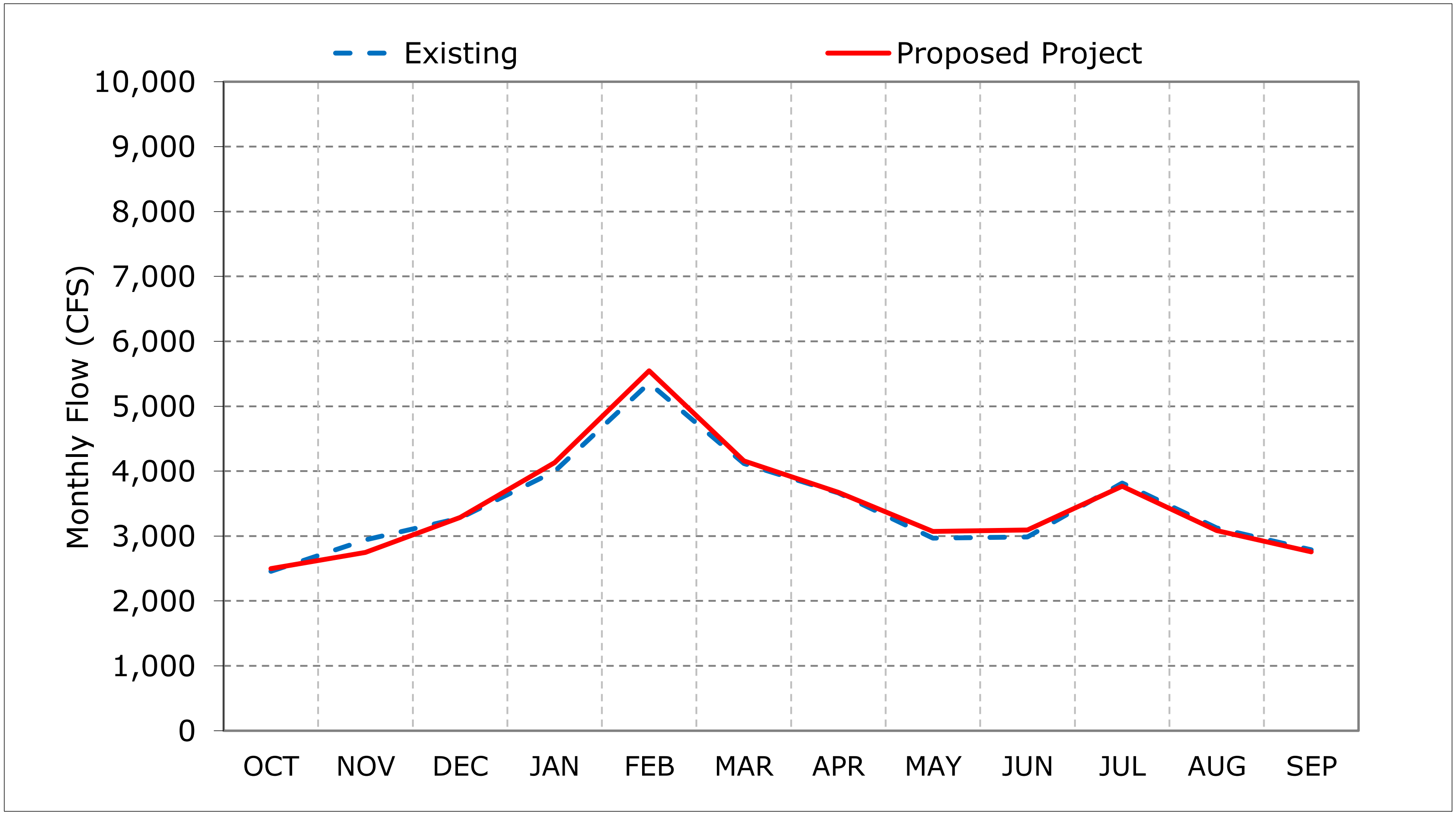
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 2-3. Georgiana Slough, Above Normal Year Average Flow



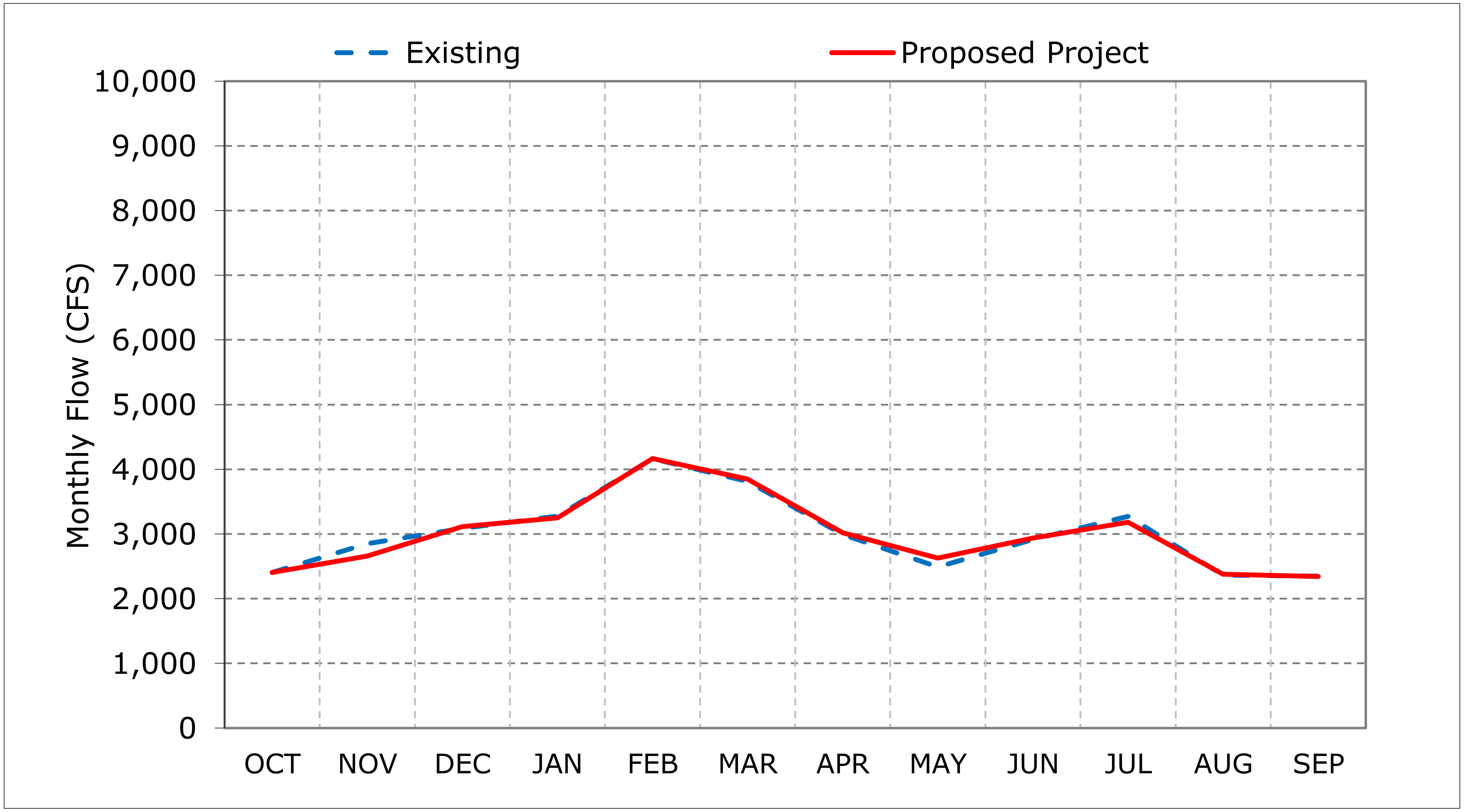
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 2-4. Georgiana Slough, Below Normal Year Average Flow



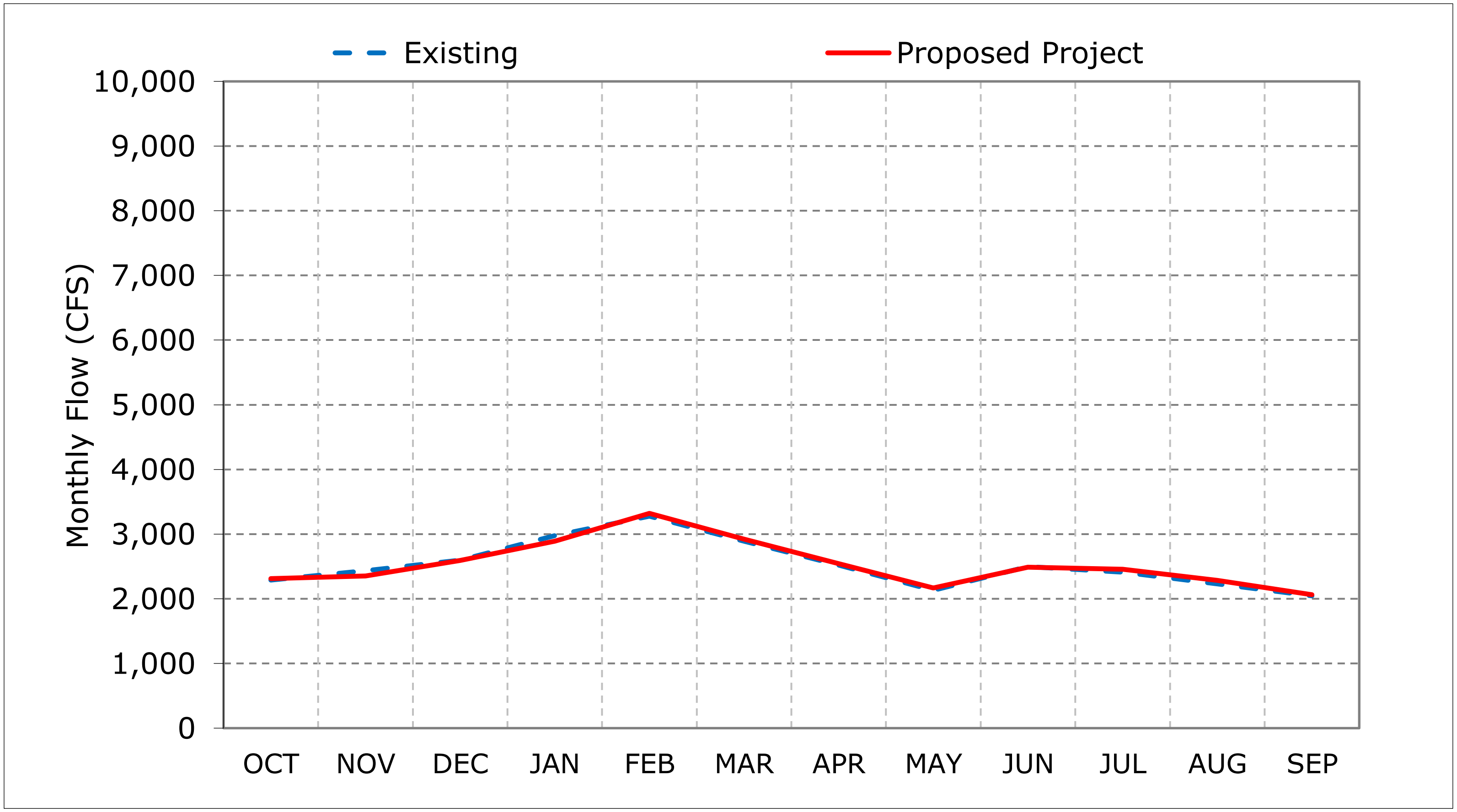
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 2-5. Georgiana Slough, Dry Year Average Flow



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 2-6. Georgiana Slough, Critical Year Average Flow



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 2-7. Georgiana Slough, October

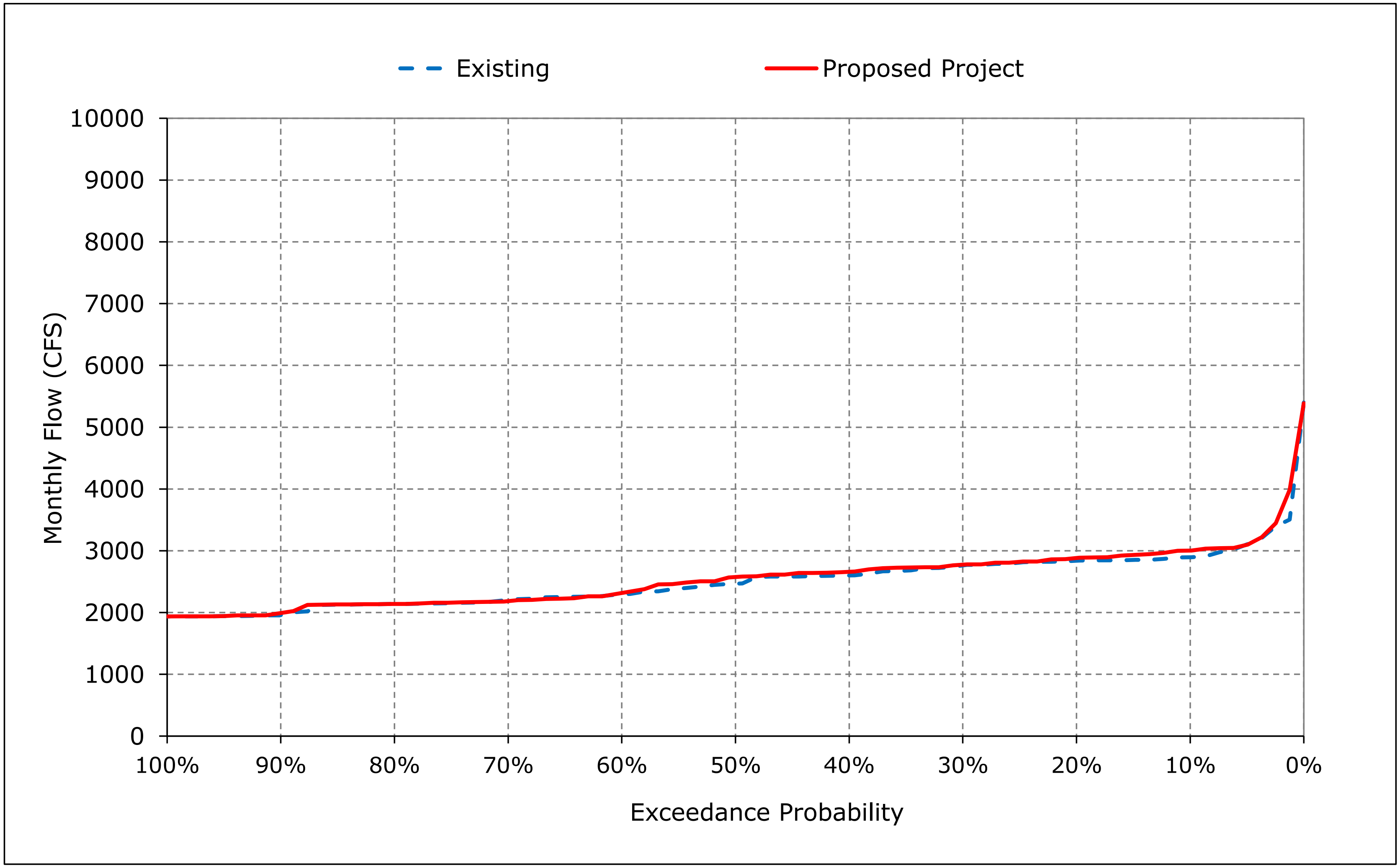


Figure 2-8. Georgiana Slough, November

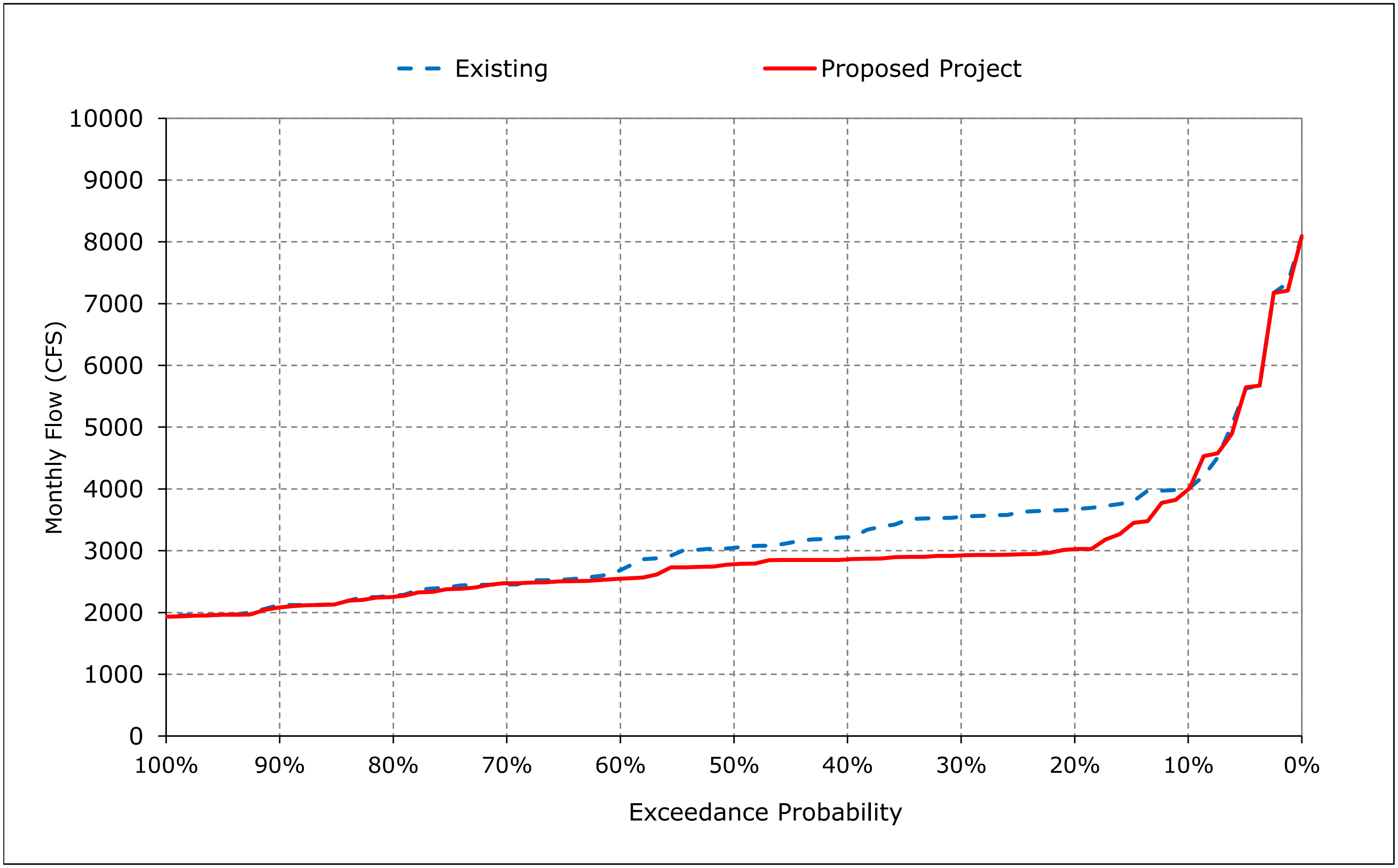


Figure 2-9. Georgiana Slough, December

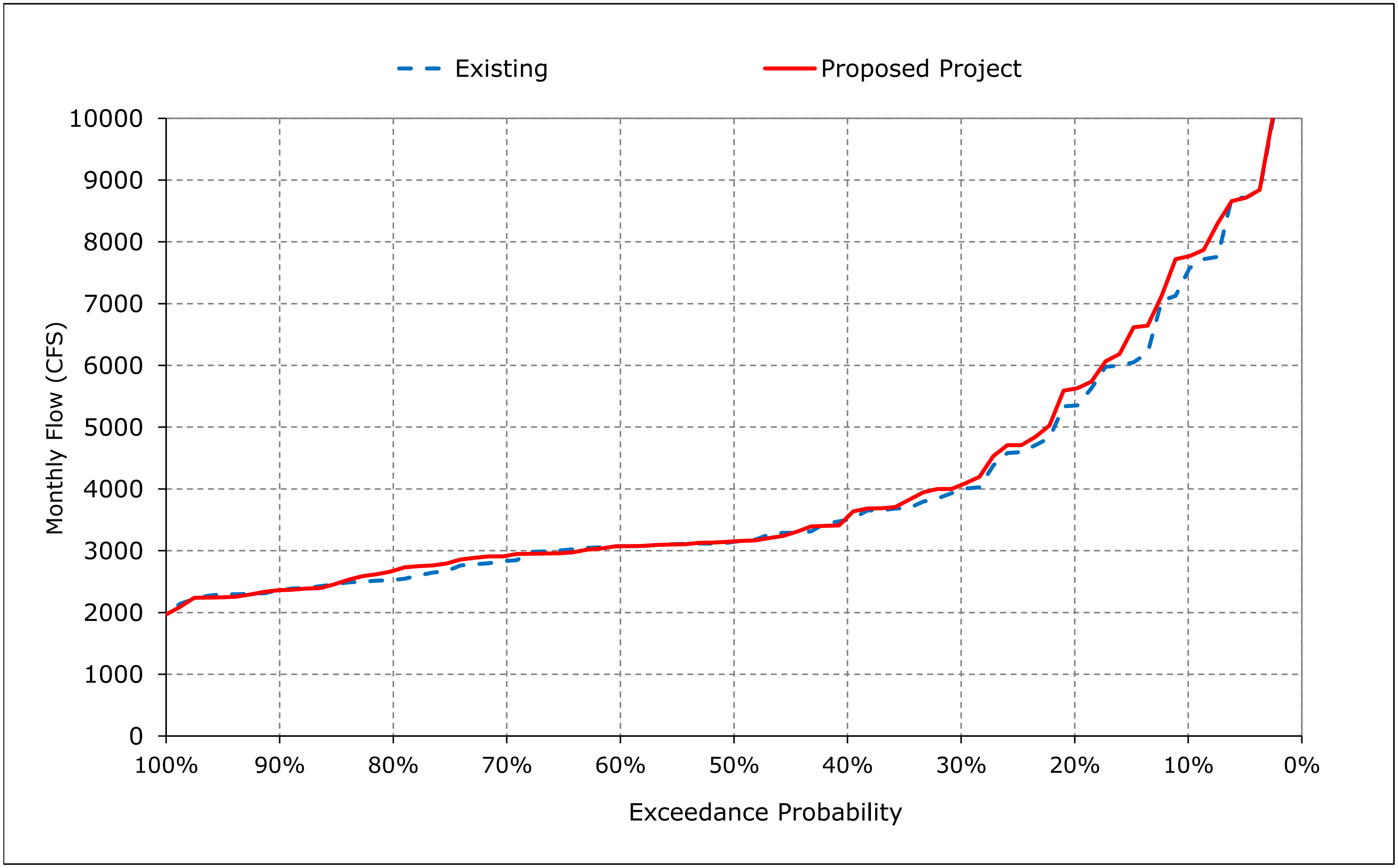


Figure 2-10. Georgiana Slough, January

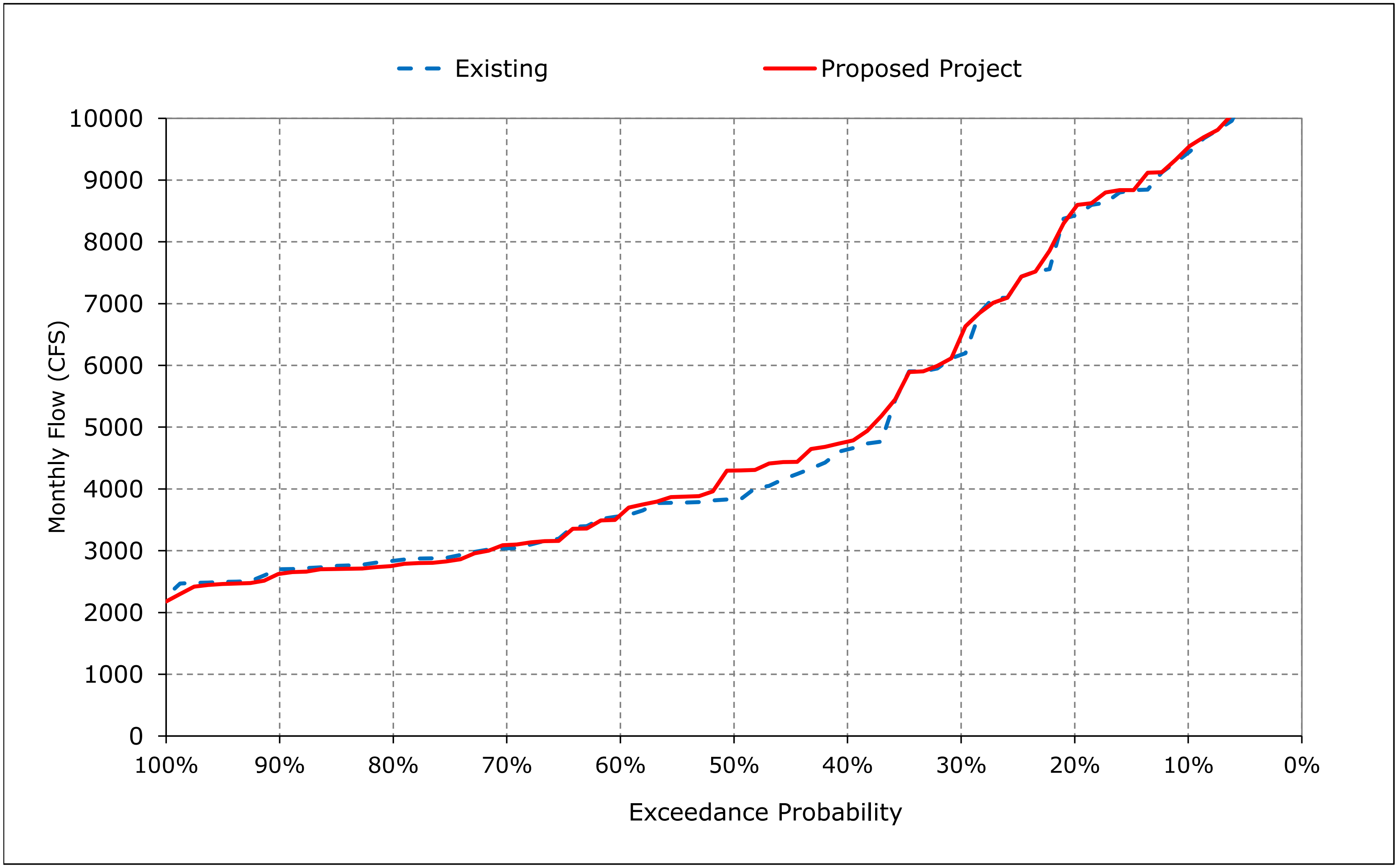


Figure 2-11. Georgiana Slough, February

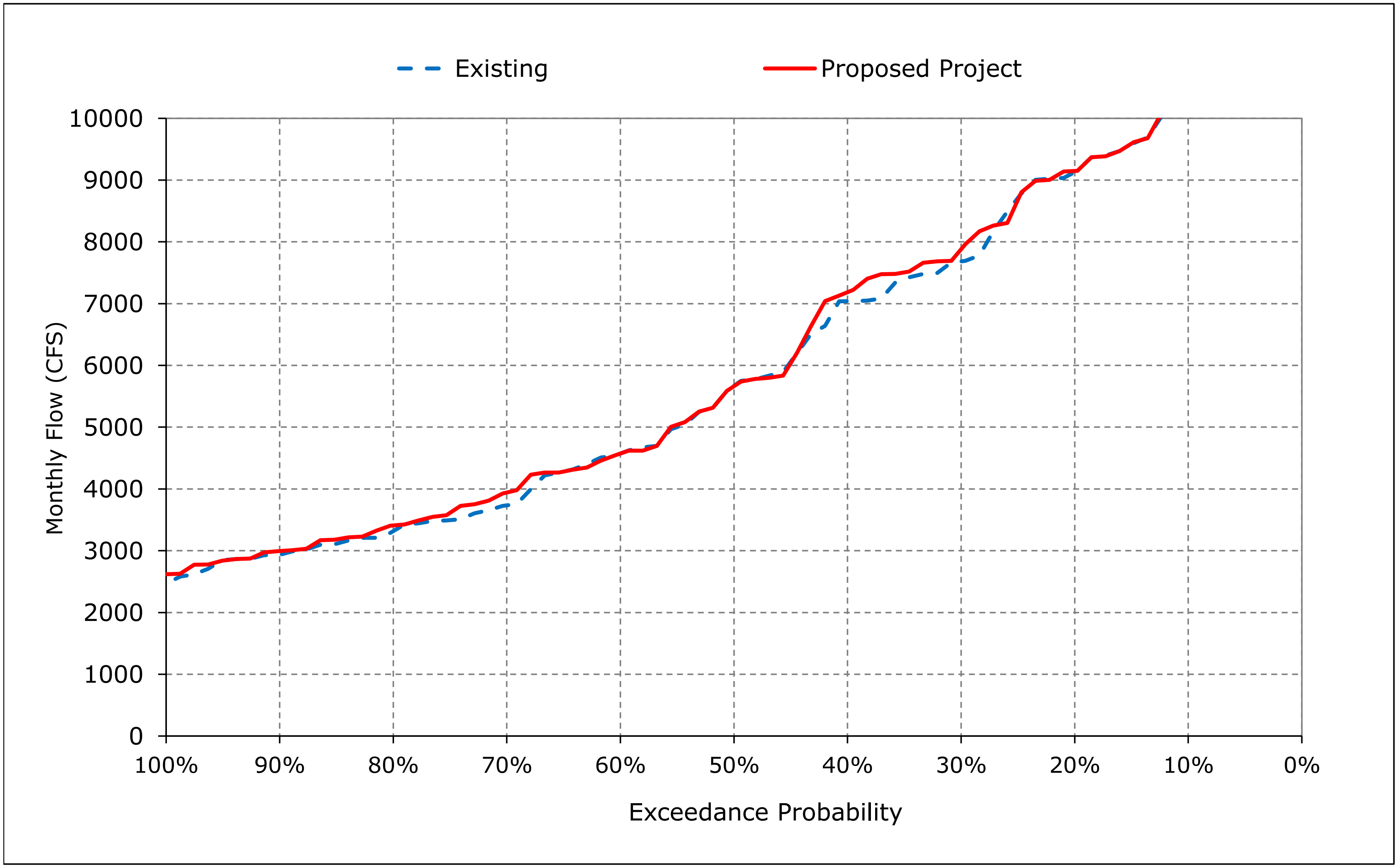


Figure 2-12. Georgiana Slough, March

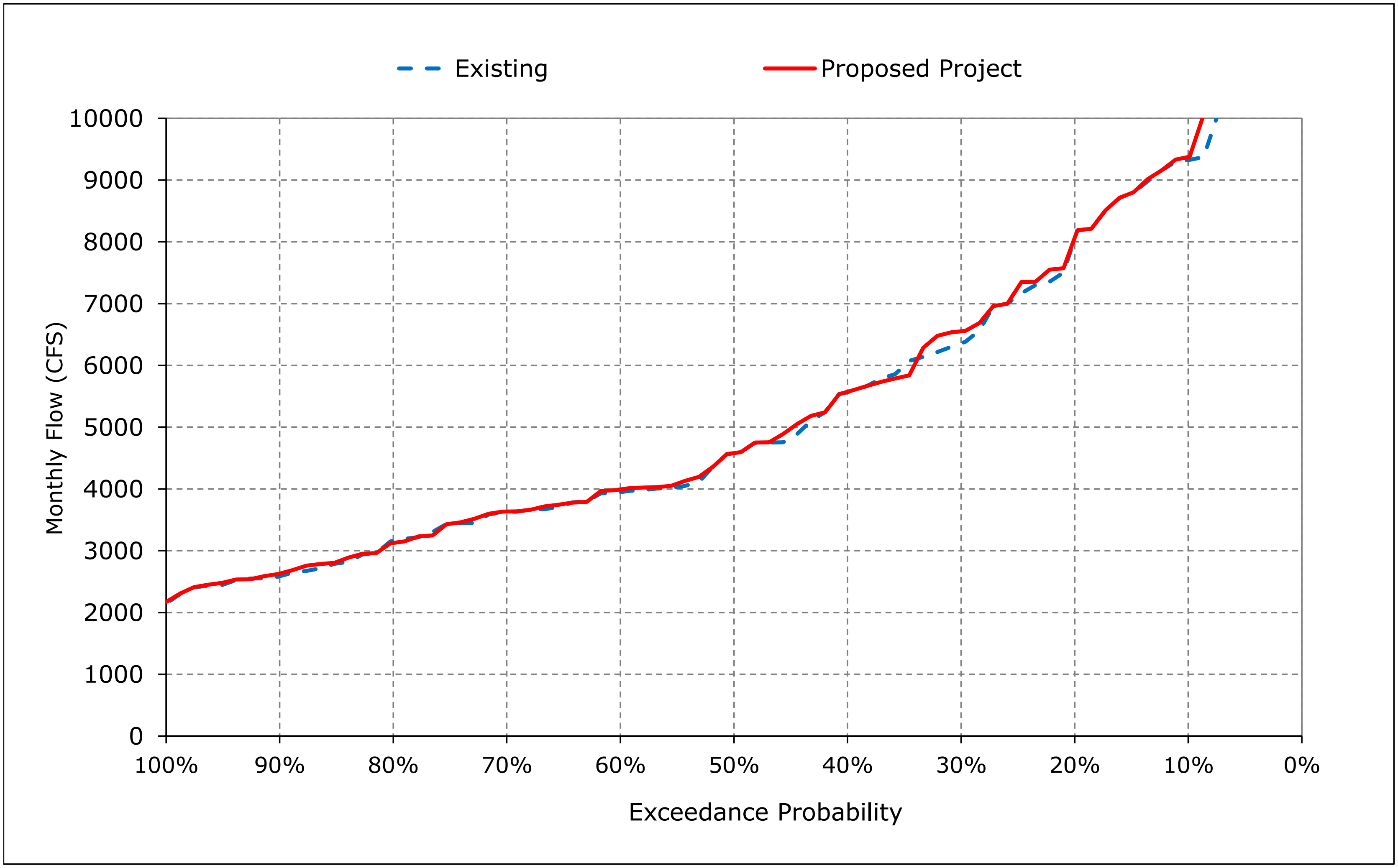


Figure 2-13. Georgiana Slough, April

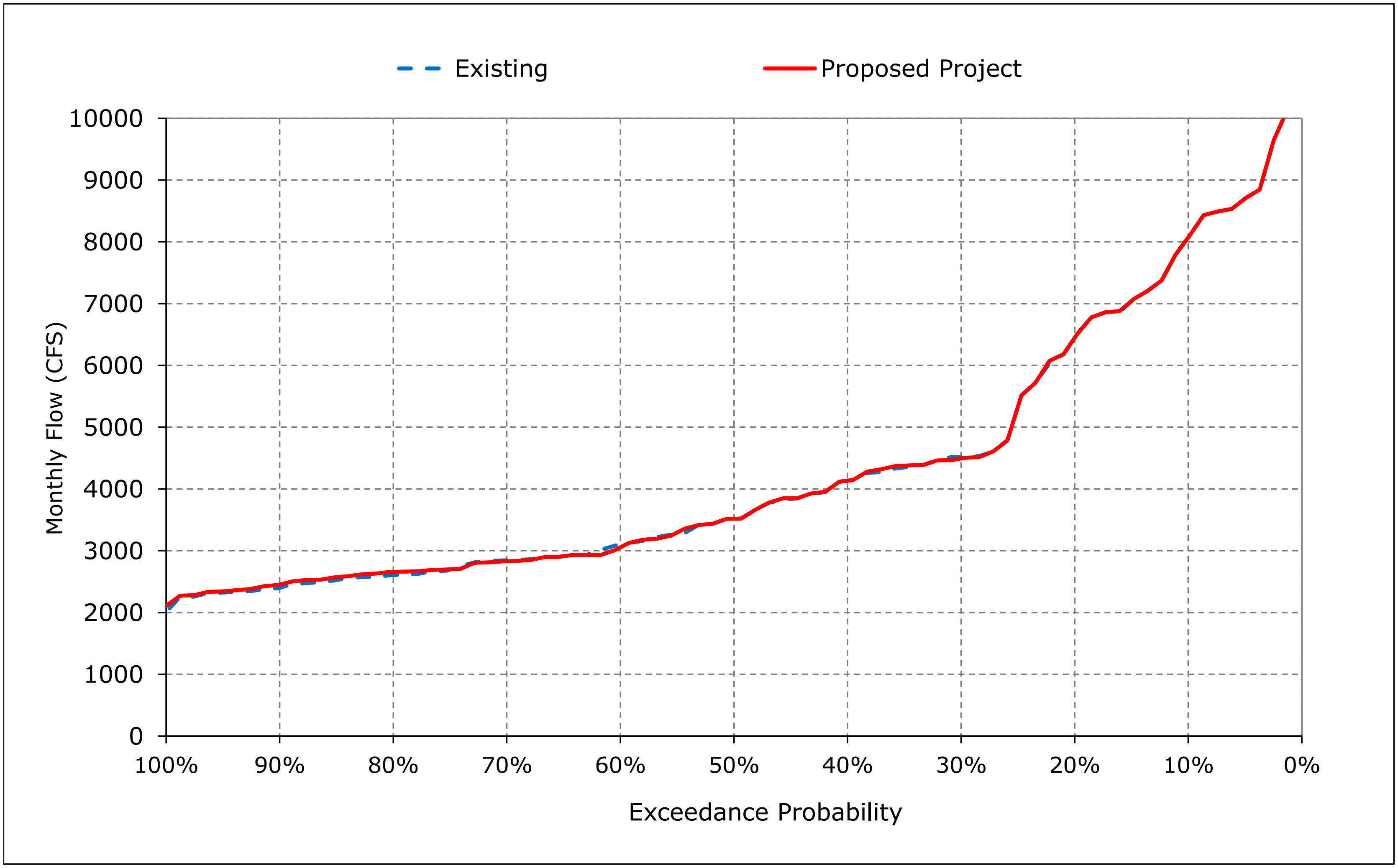


Figure 2-14. Georgiana Slough, May

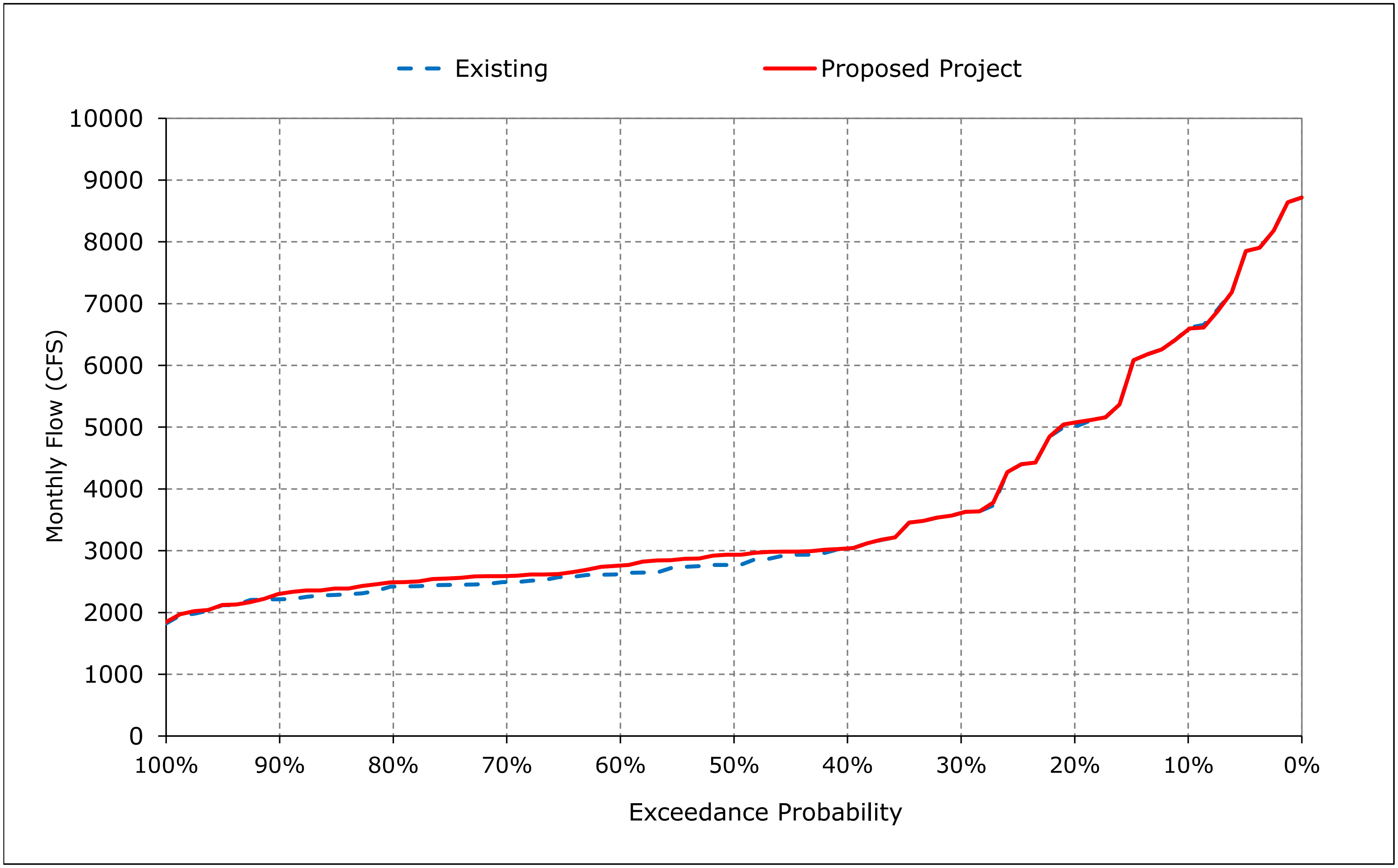


Figure 2-15. Georgiana Slough, June

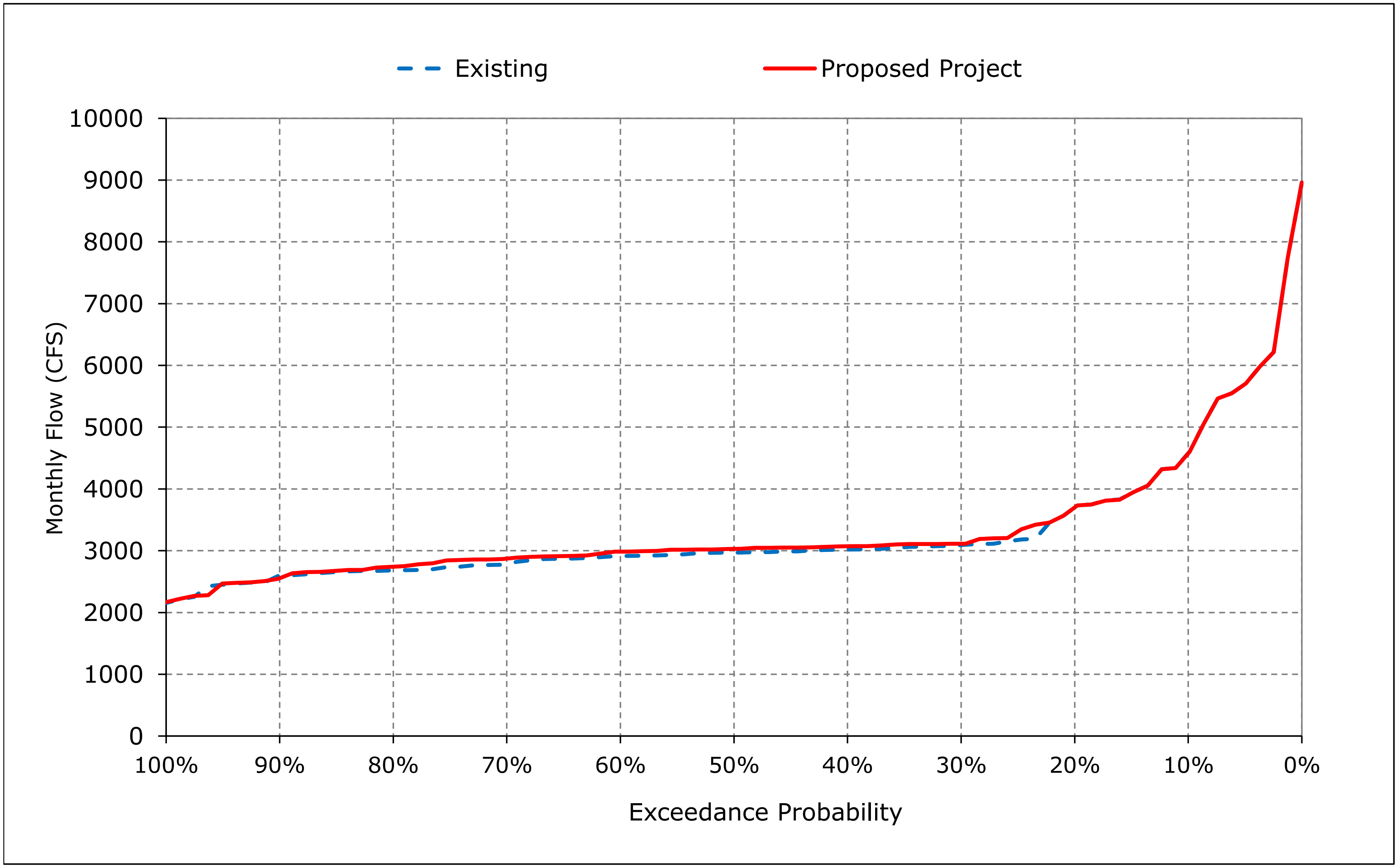


Figure 2-16. Georgiana Slough, July

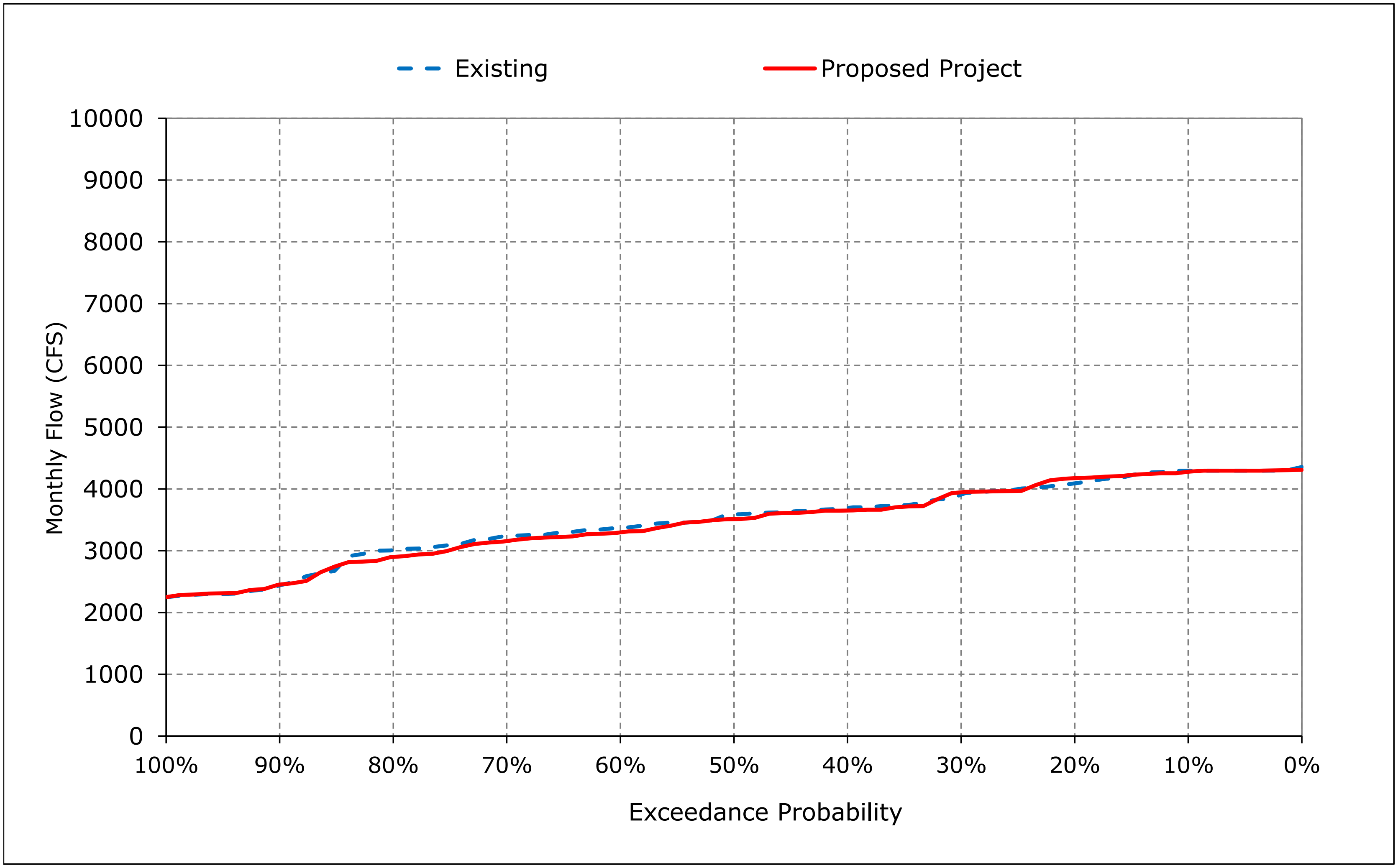


Figure 2-17. Georgiana Slough, August

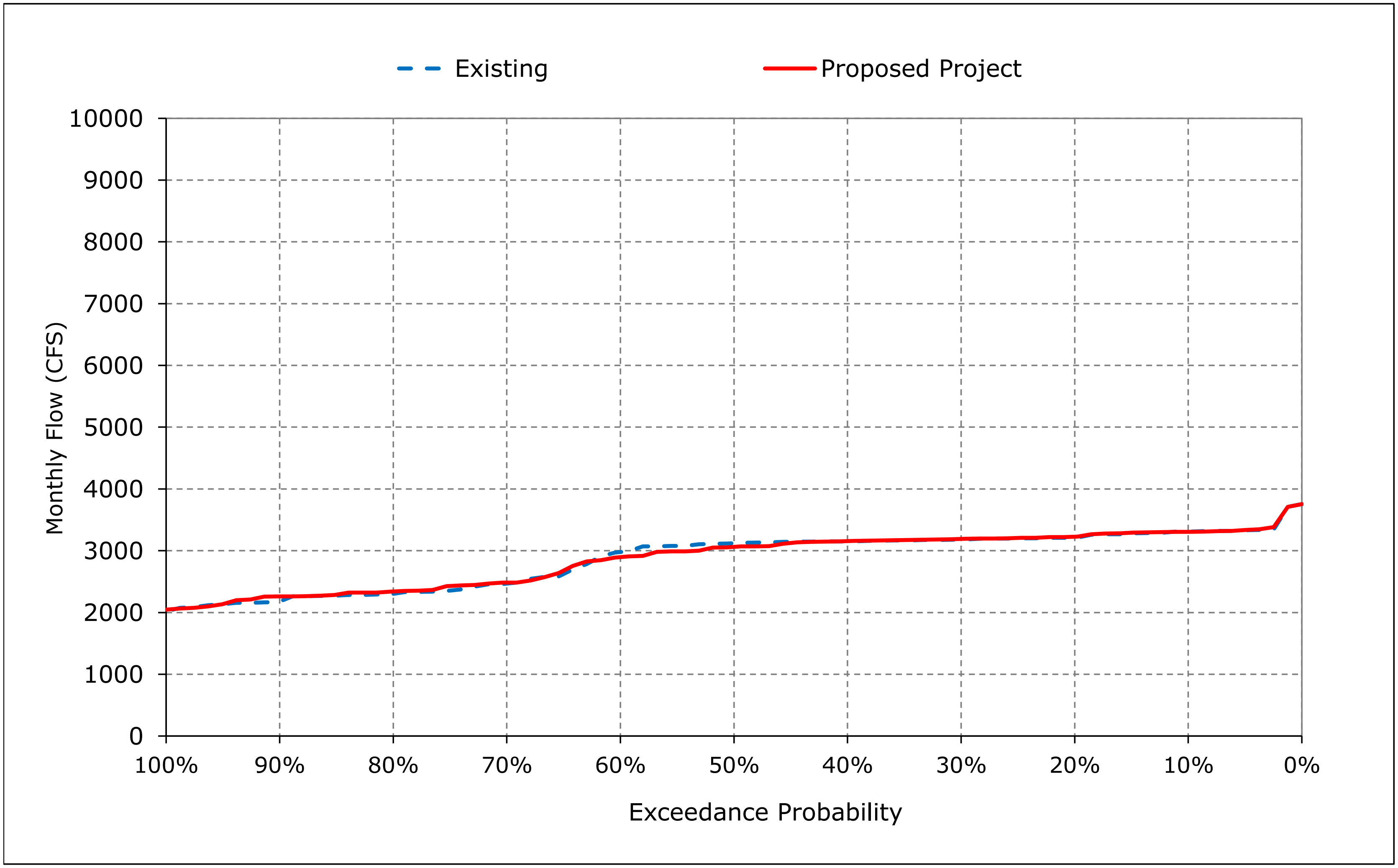


Figure 2-18. Georgiana Slough, September

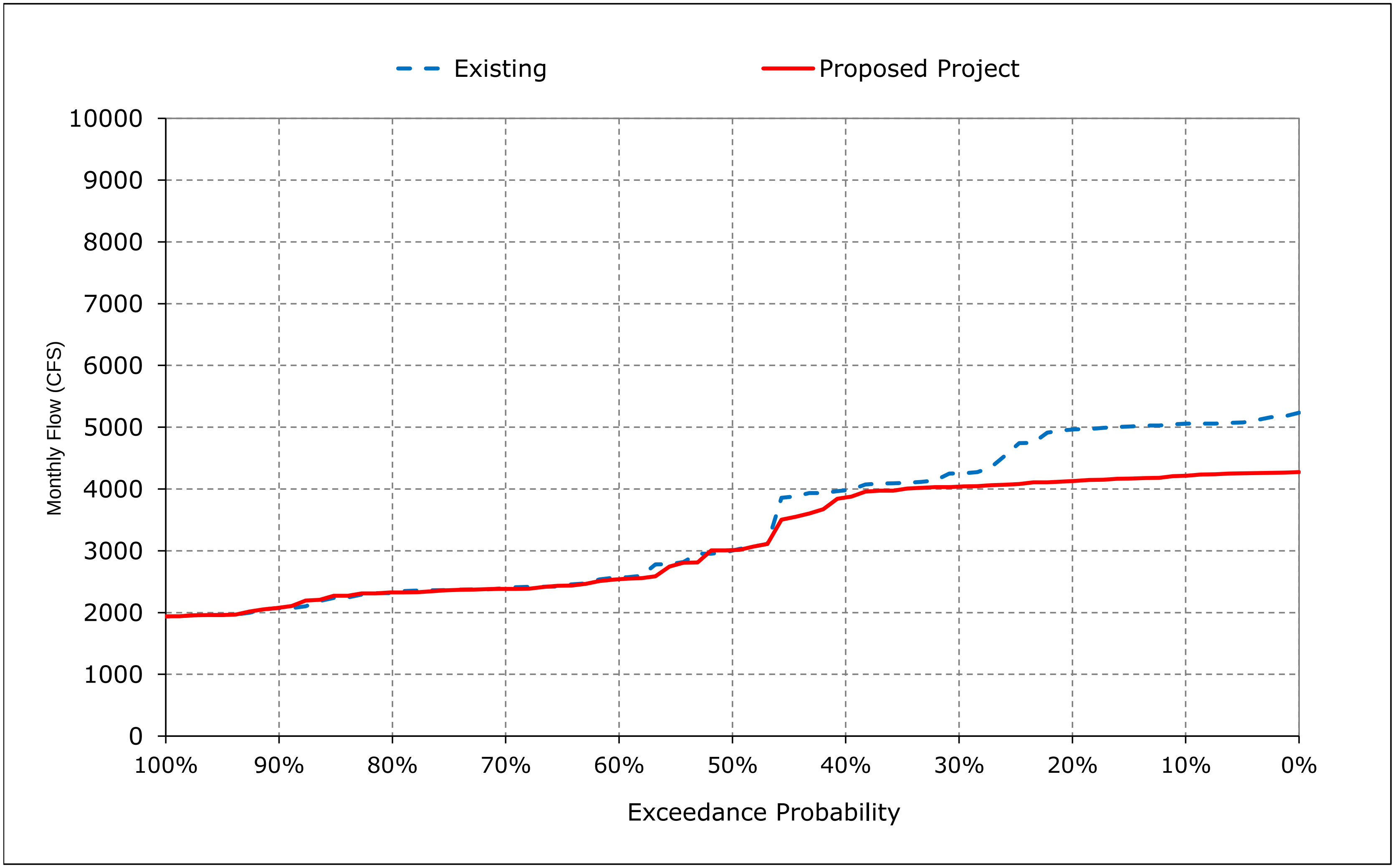


Table 3-1. Yolo Bypass Flow, Monthly Flow

Existing

Statistic	Monthly Flow (CFS)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	63	475	7,065	32,116	44,401	22,630	7,266	275	68	48	183	190
20%	61	145	2,778	10,983	16,552	8,079	3,162	78	68	48	55	110
30%	58	46	917	3,830	7,981	3,276	1,068	73	68	48	55	59
40%	53	10	316	1,912	4,787	1,767	229	70	68	48	55	59
50%	45	8	148	495	2,163	918	135	68	67	48	55	59
60%	40	5	60	269	609	279	111	65	67	48	55	59
70%	29	0	15	62	233	115	88	63	66	48	55	58
80%	16	0	0	27	82	45	78	59	64	48	55	56
90%	5	0	0	0	0	7	56	53	62	48	54	52
Long Term												
Full Simulation Period[a]	128	384	3,071	9,666	12,947	8,304	2,671	284	126	48	100	105
Water Year Types[b,c]												
Wet (32%)	263	1,057	8,104	26,331	32,235	21,722	7,047	684	255	48	143	177
Above Normal (15%)	32	176	1,191	6,758	11,720	7,440	1,747	194	66	48	95	65
Below Normal (17%)	47	33	1,415	932	3,239	704	574	67	66	48	114	85
Dry (22%)	116	68	331	557	1,842	751	308	77	67	48	62	65
Critical (15%)	41	19	89	317	365	292	107	68	64	48	54	70

Proposed Project

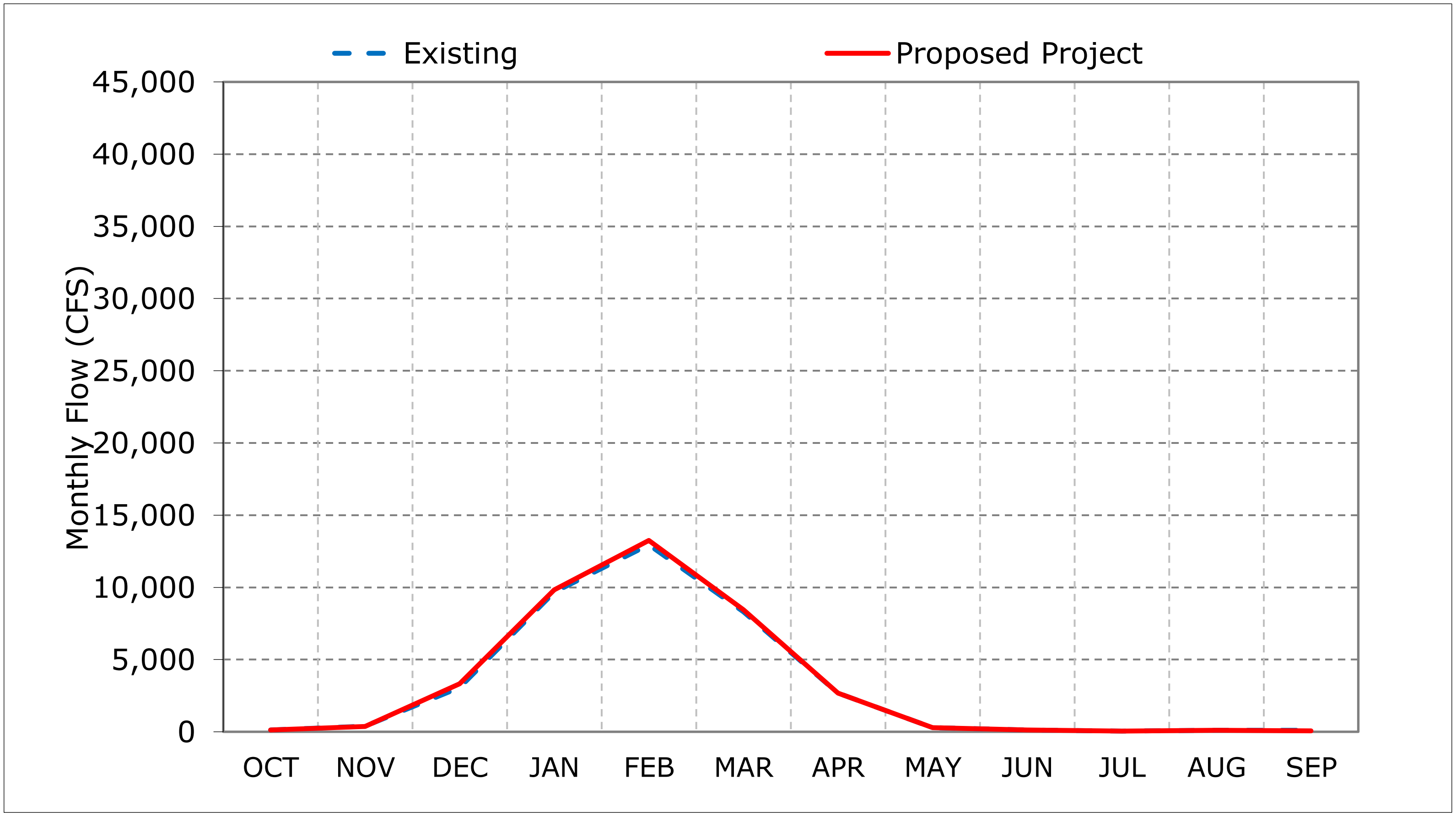
Statistic	Monthly Flow (CFS)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	63	475	8,674	32,255	45,986	23,519	7,266	275	68	48	183	127
20%	62	145	2,779	11,430	16,948	8,135	3,162	78	68	48	55	59
30%	59	50	974	3,877	8,111	3,320	1,068	73	68	48	55	59
40%	53	17	342	1,912	6,221	1,981	229	70	68	48	55	59
50%	46	9	148	509	2,328	1,005	135	68	67	48	55	59
60%	40	5	60	327	729	373	111	65	67	48	55	59
70%	31	0	15	80	261	122	88	63	66	48	55	58
80%	16	0	0	51	82	47	78	59	64	48	55	55
90%	5	0	0	13	0	7	56	53	62	48	54	52
Long Term												
Full Simulation Period[a]	130	373	3,315	9,834	13,249	8,460	2,671	279	126	48	100	73
Water Year Types[b,c]												
Wet (32%)	269	989	8,882	26,798	32,580	21,816	7,047	669	255	48	143	73
Above Normal (15%)	32	160	1,178	6,789	12,359	8,182	1,747	194	66	48	95	65
Below Normal (17%)	47	33	1,412	1,013	3,839	703	575	67	66	48	114	85
Dry (22%)	118	120	331	566	1,828	831	308	77	67	48	62	65
Critical (15%)	41	27	89	317	367	292	107	68	64	48	54	77

Proposed Project minus Existing

Statistic	Monthly Flow (CFS)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	0	0	1,609	140	1,585	889	**-1**	0	0	0	0	**-63**
20%	0	0	1	447	396	57	0	0	0	0	0	**-51**
30%	1	5	57	47	130	44	0	0	0	0	0	0
40%	0	7	26	0	1,433	215	0	0	0	0	0	0
50%	1	0	0	14	166	87	0	0	0	0	0	0
60%	0	1	0	57	120	94	0	0	0	0	0	**0**
70%	1	0	0	18	28	8	0	0	0	0	0	**-1**
80%	0	0	0	24	0	2	0	0	0	0	0	**-1**
90%	0	0	0	13	0	0	0	0	0	0	0	0
Long Term												
Full Simulation Period[a]	2	**-11**	244	168	302	156	**0**	**-5**	**0**	0	0	**-32**
Water Year Types[b,c]												
Wet (32%)	6	**-68**	778	467	344	93	**-1**	**-15**	**0**	0	0	**-105**
Above Normal (15%)	0	**-16**	**-13**	31	639	742	0	0	0	0	0	0
Below Normal (17%)	0	0	**-3**	81	600	**0**	0	0	0	0	0	0
Dry (22%)	2	53	0	9	**-14**	80	0	0	0	0	0	0
Critical (15%)	0	8	0	**-1**	2	0	0	0	0	0	0	7

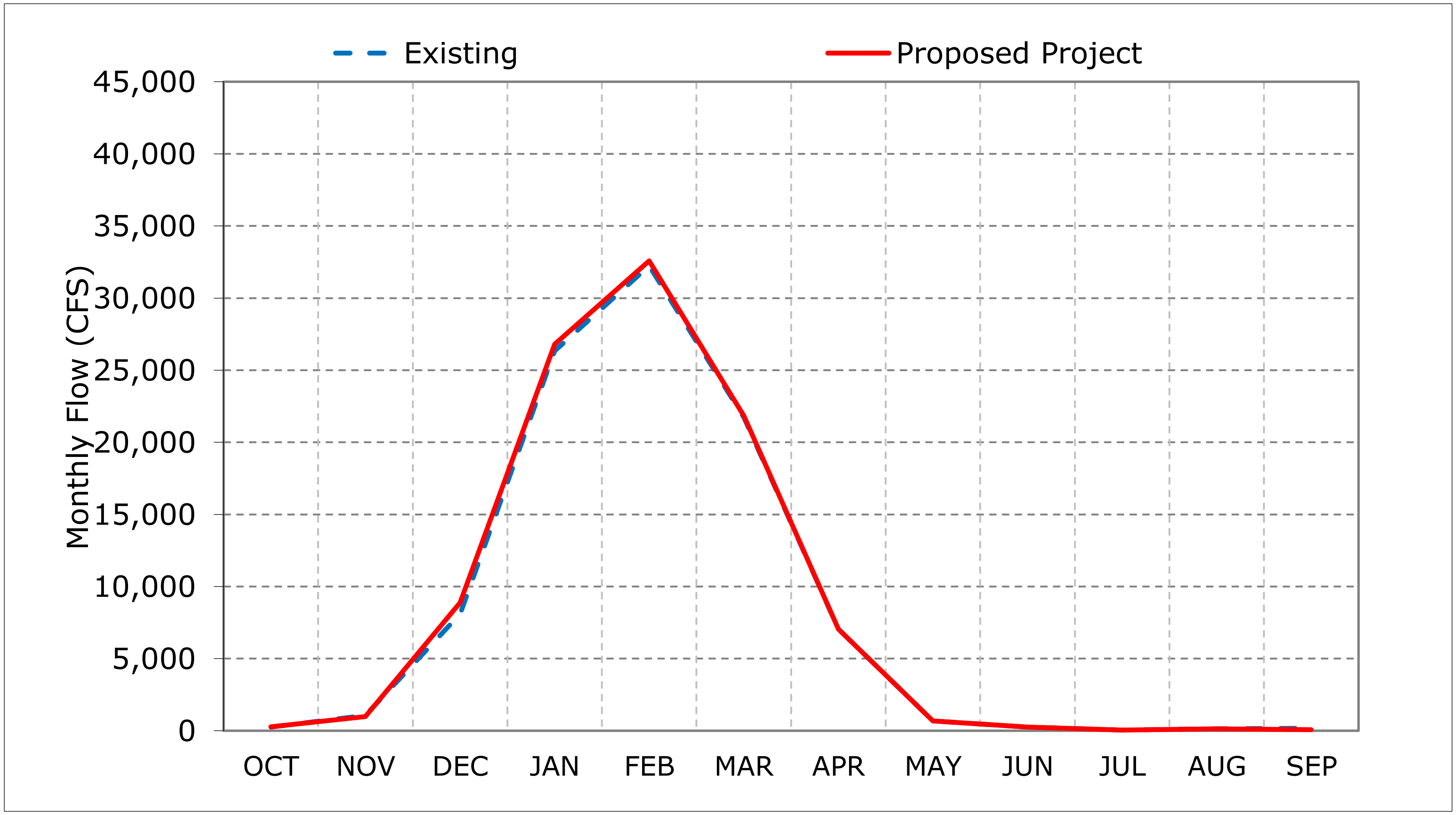
a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with water year - year type sorting.

Figure 3-1. Yolo Bypass Flow, Long-Term Average Flow



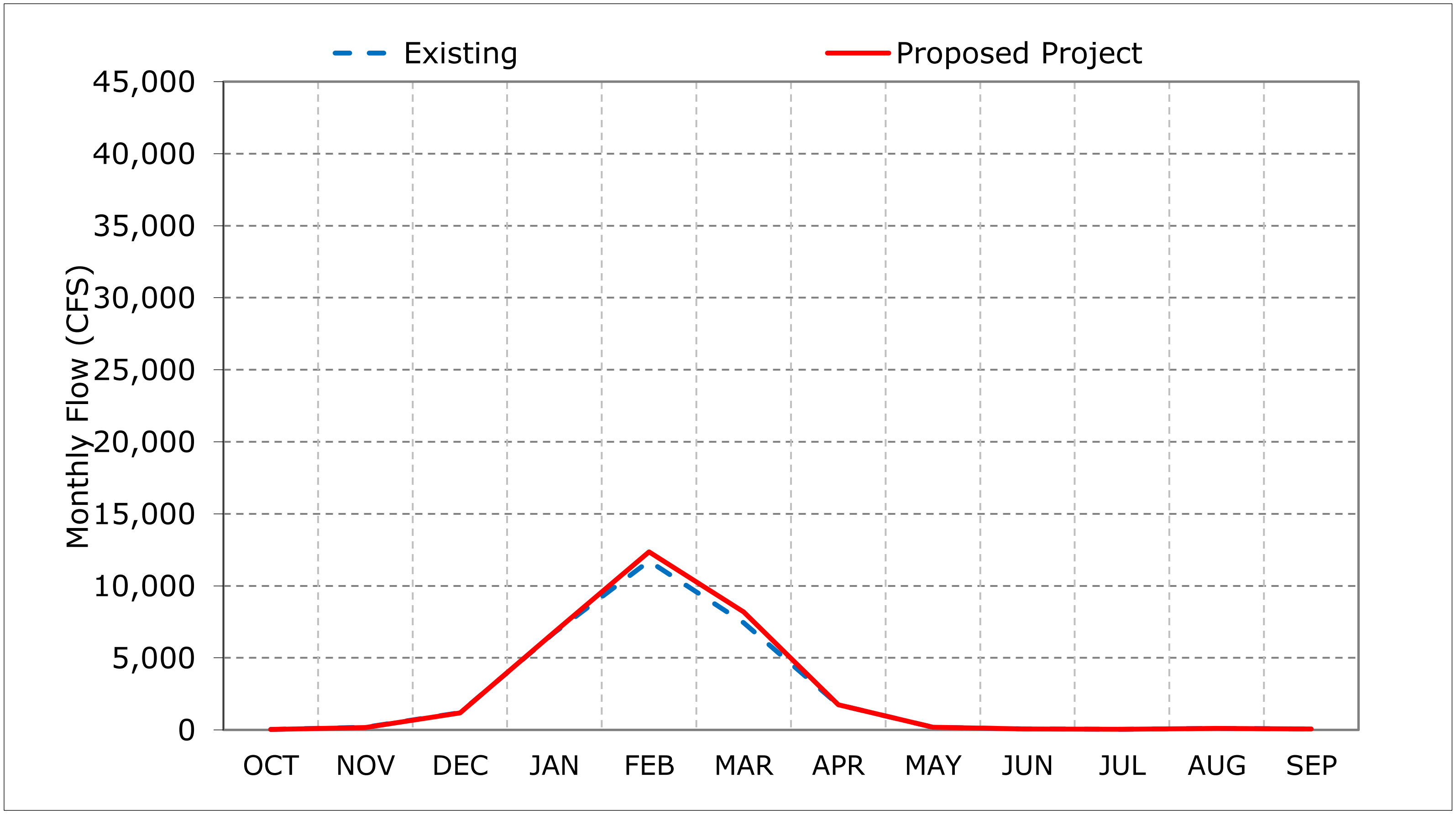
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 3-2. Yolo Bypass Flow, Wet Year Average Flow



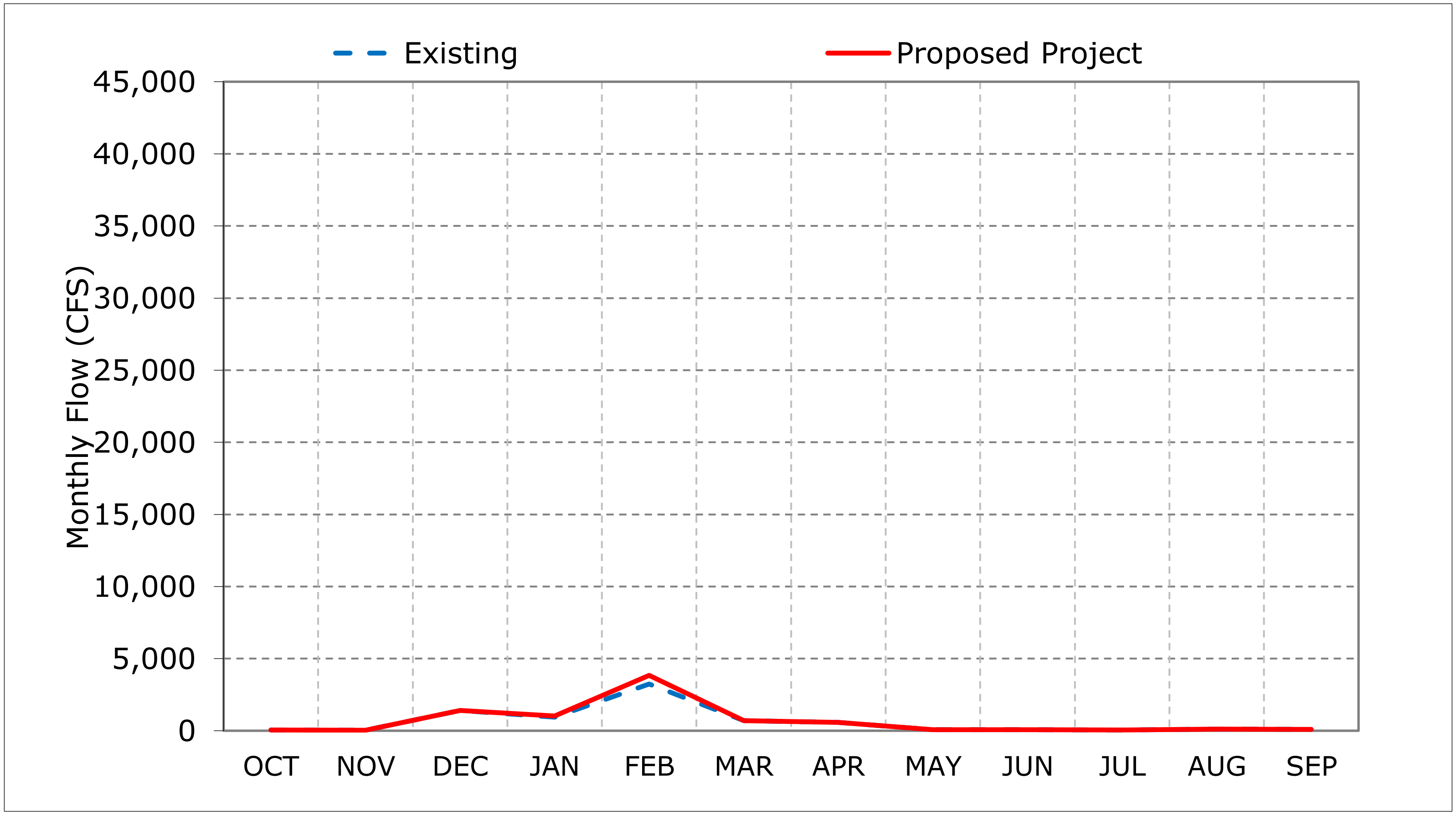
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 3-3. Yolo Bypass Flow, Above Normal Year Average Flow



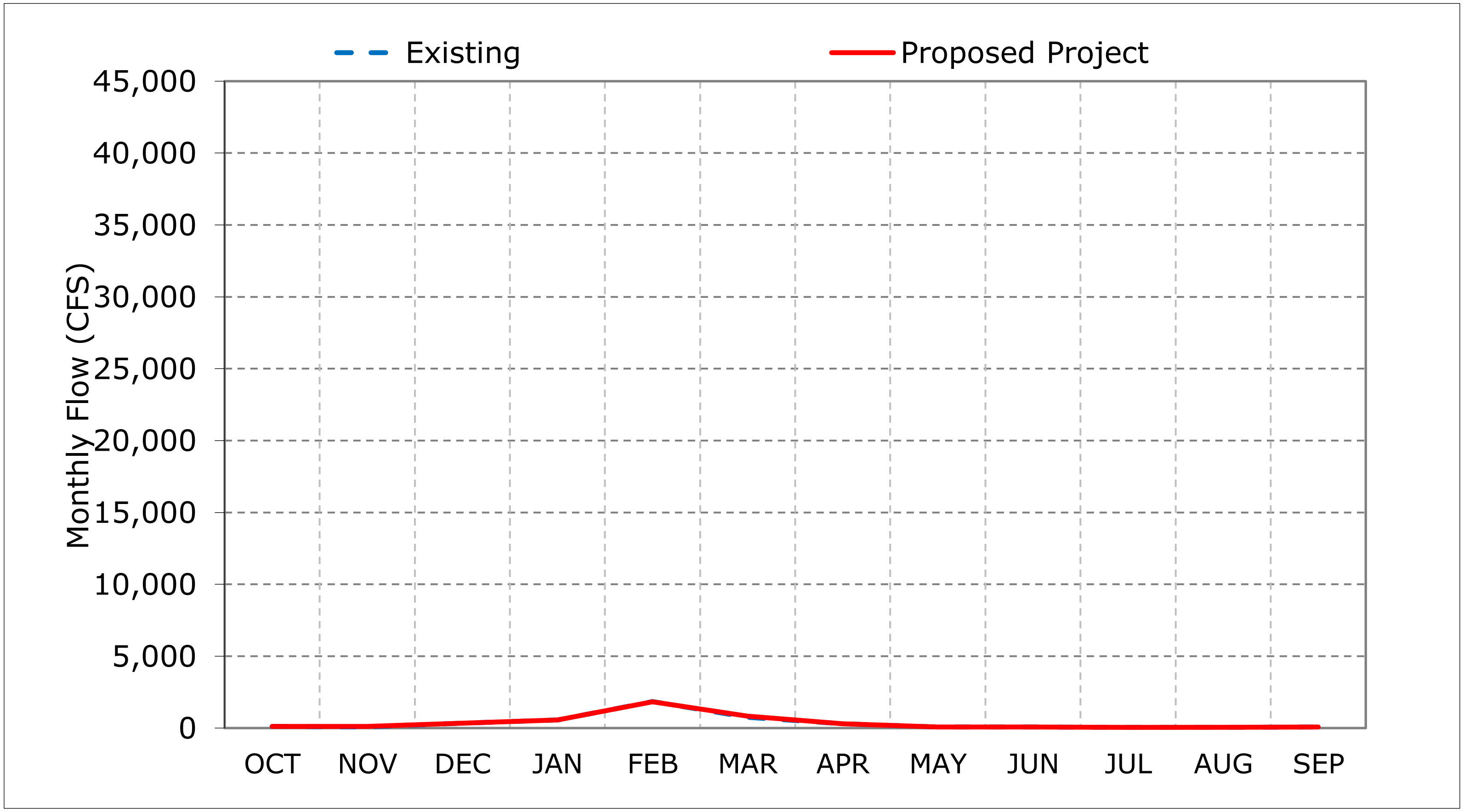
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 3-4. Yolo Bypass Flow, Below Normal Year Average Flow



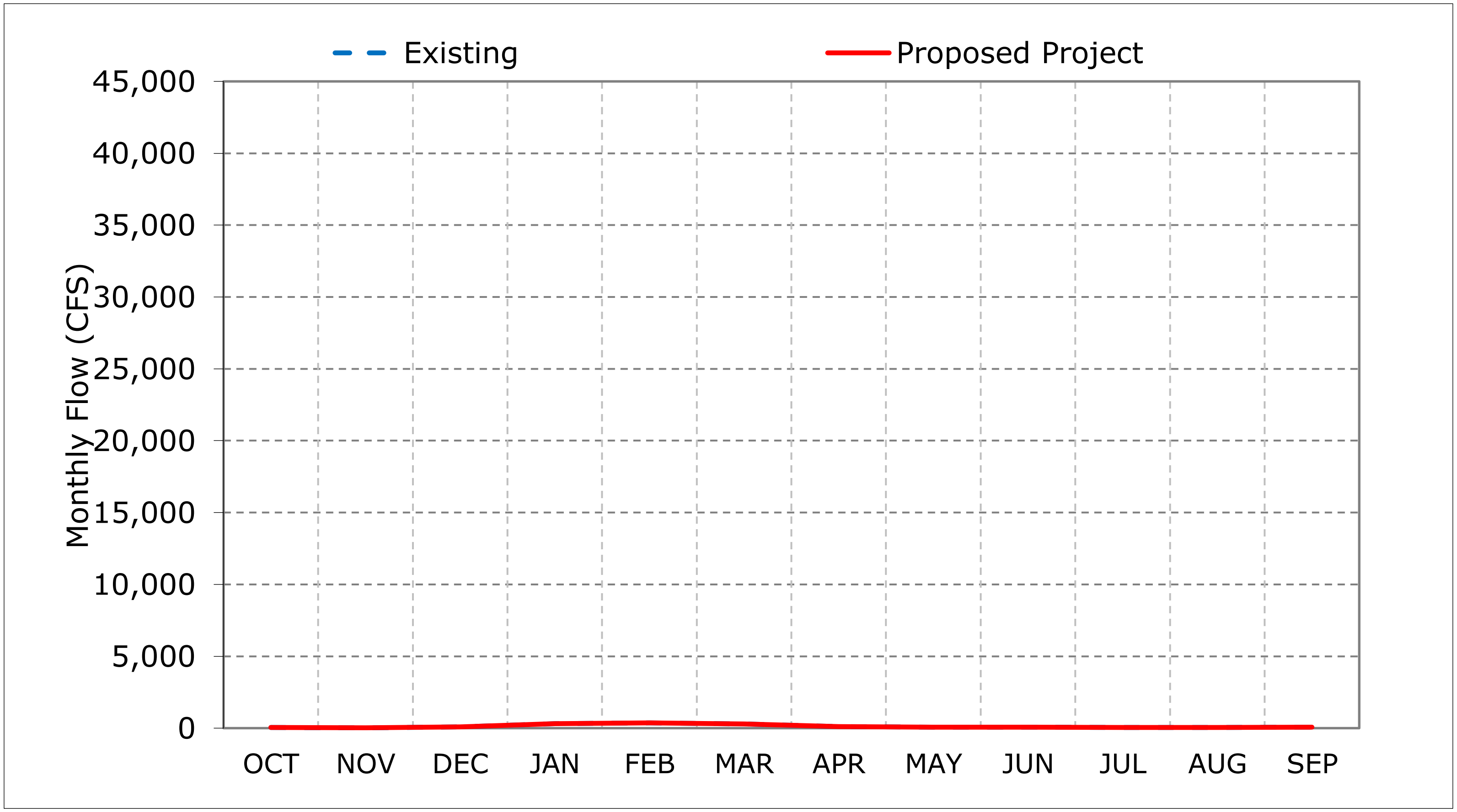
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 3-5. Yolo Bypass Flow, Dry Year Average Flow



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 3-6. Yolo Bypass Flow, Critical Year Average Flow



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 3-7. Yolo Bypass Flow, October

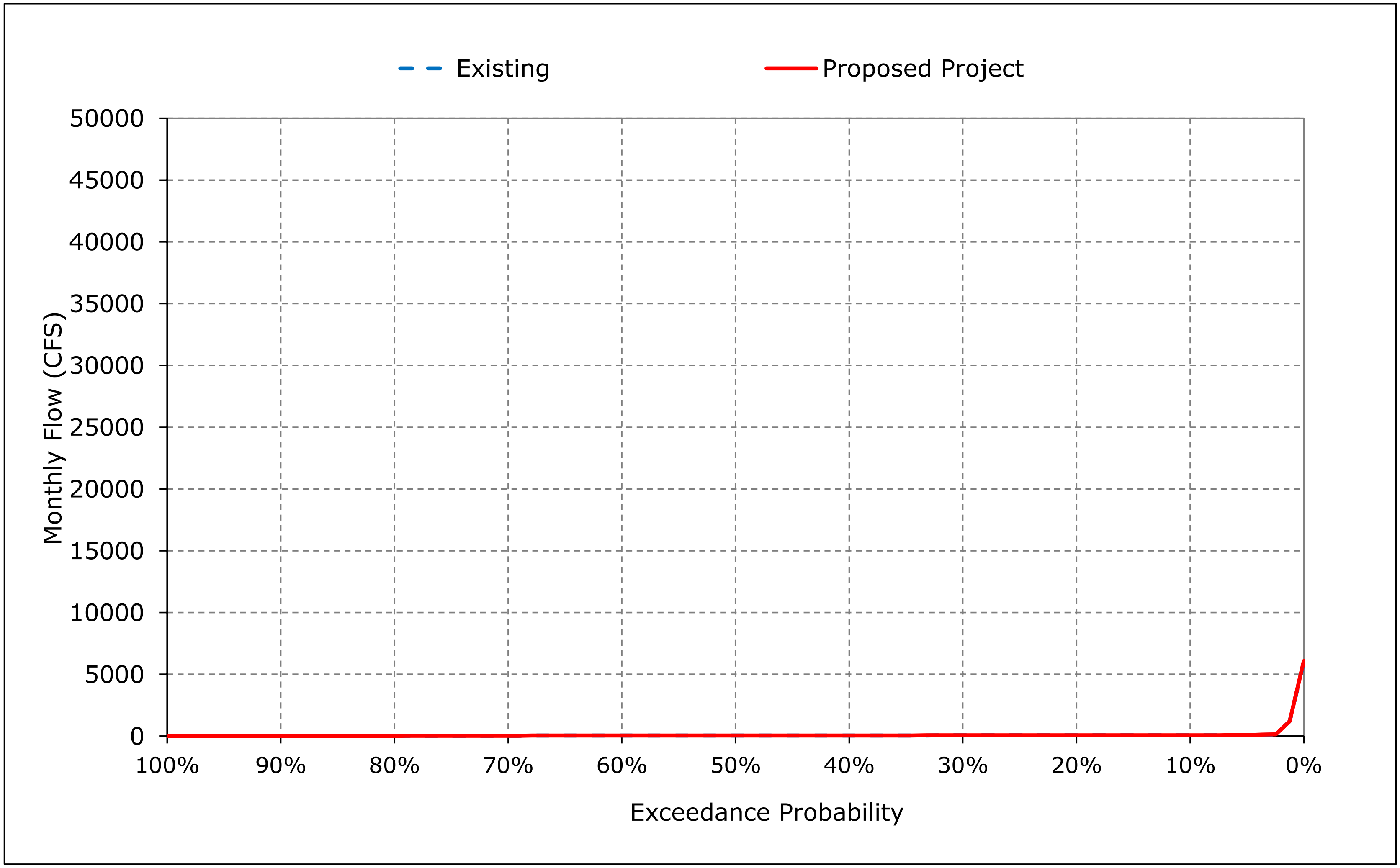


Figure 3-8. Yolo Bypass Flow, November

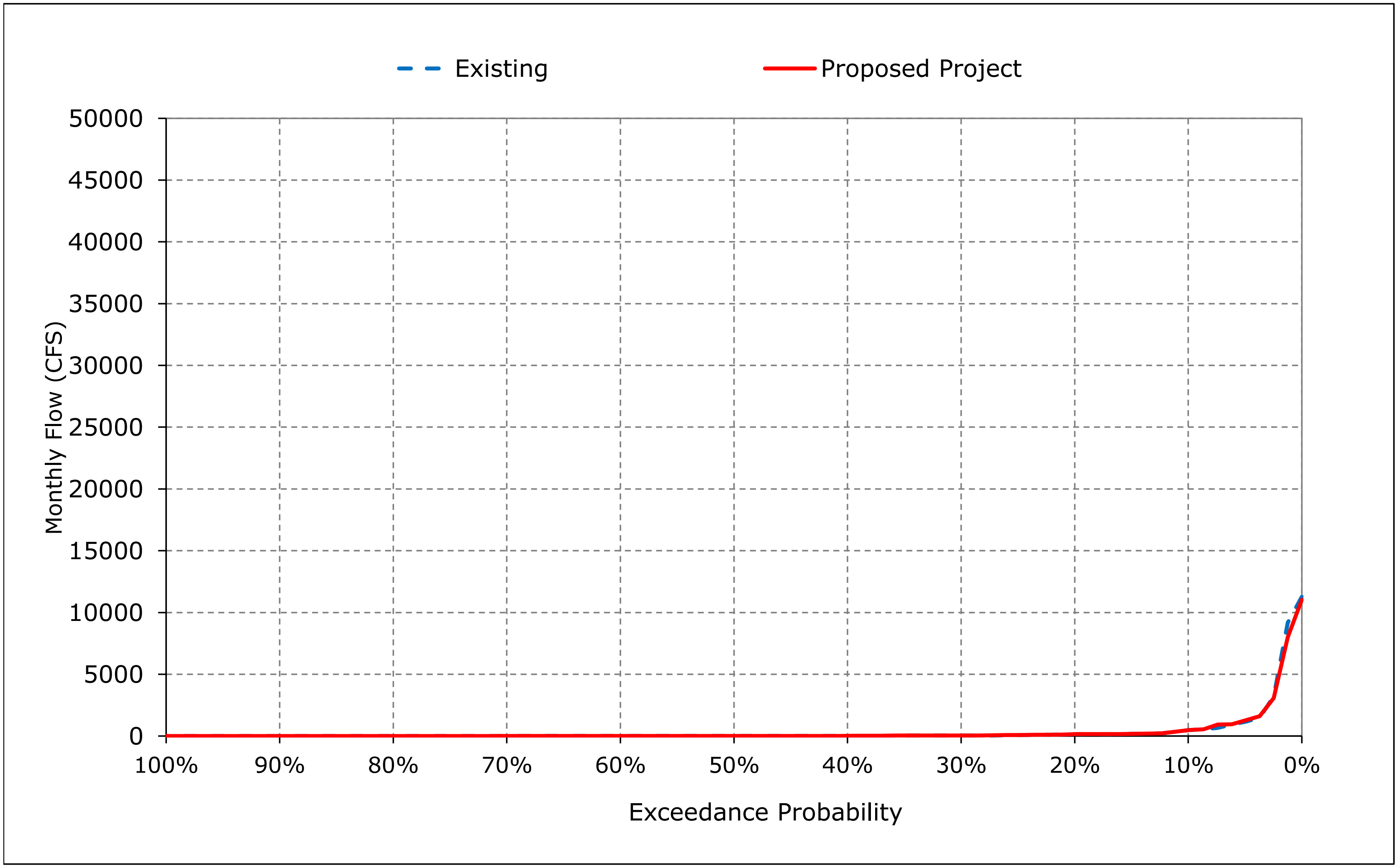


Figure 3-9. Yolo Bypass Flow, December

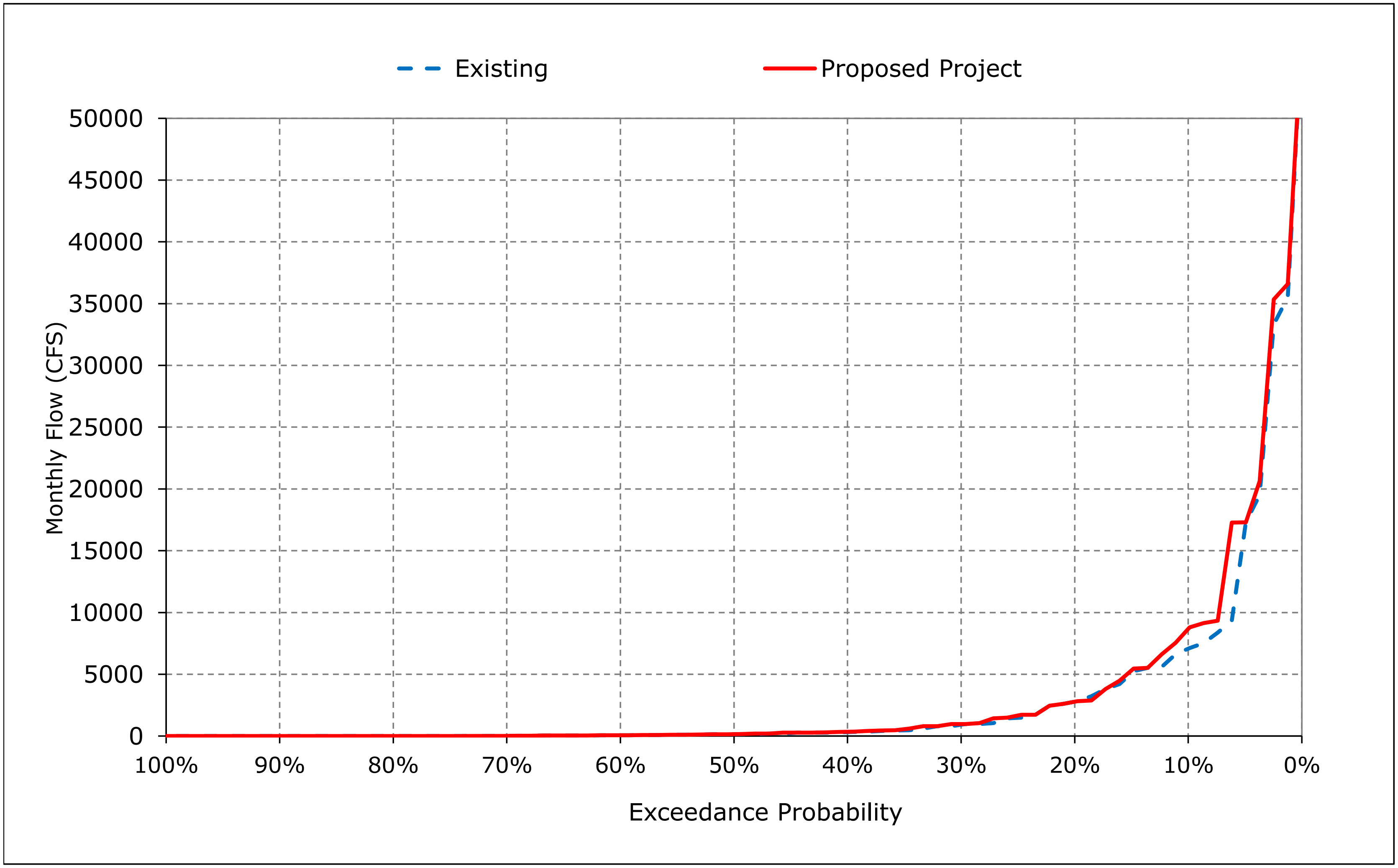


Figure 3-10. Yolo Bypass Flow, January

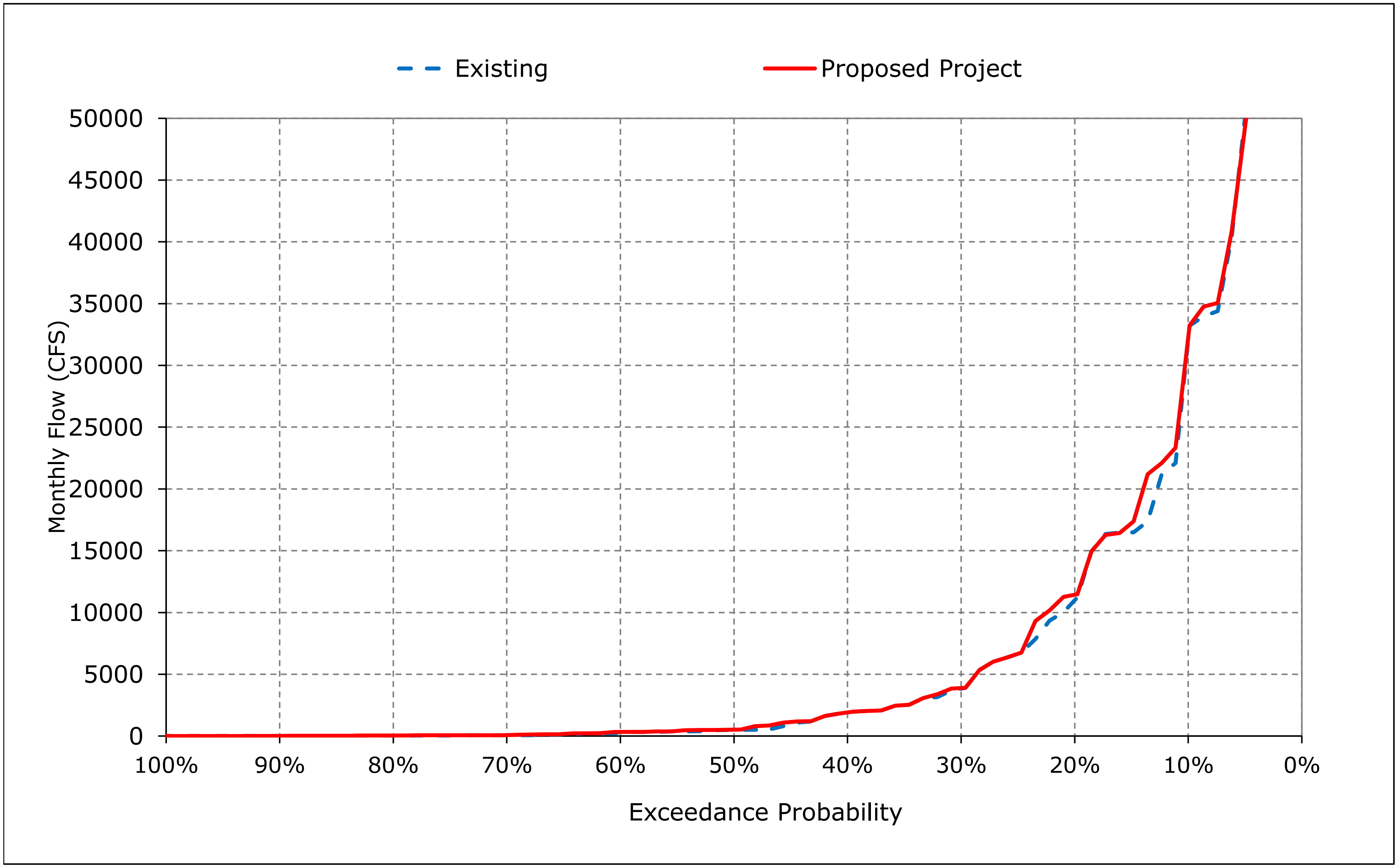


Figure 3-11. Yolo Bypass Flow, February

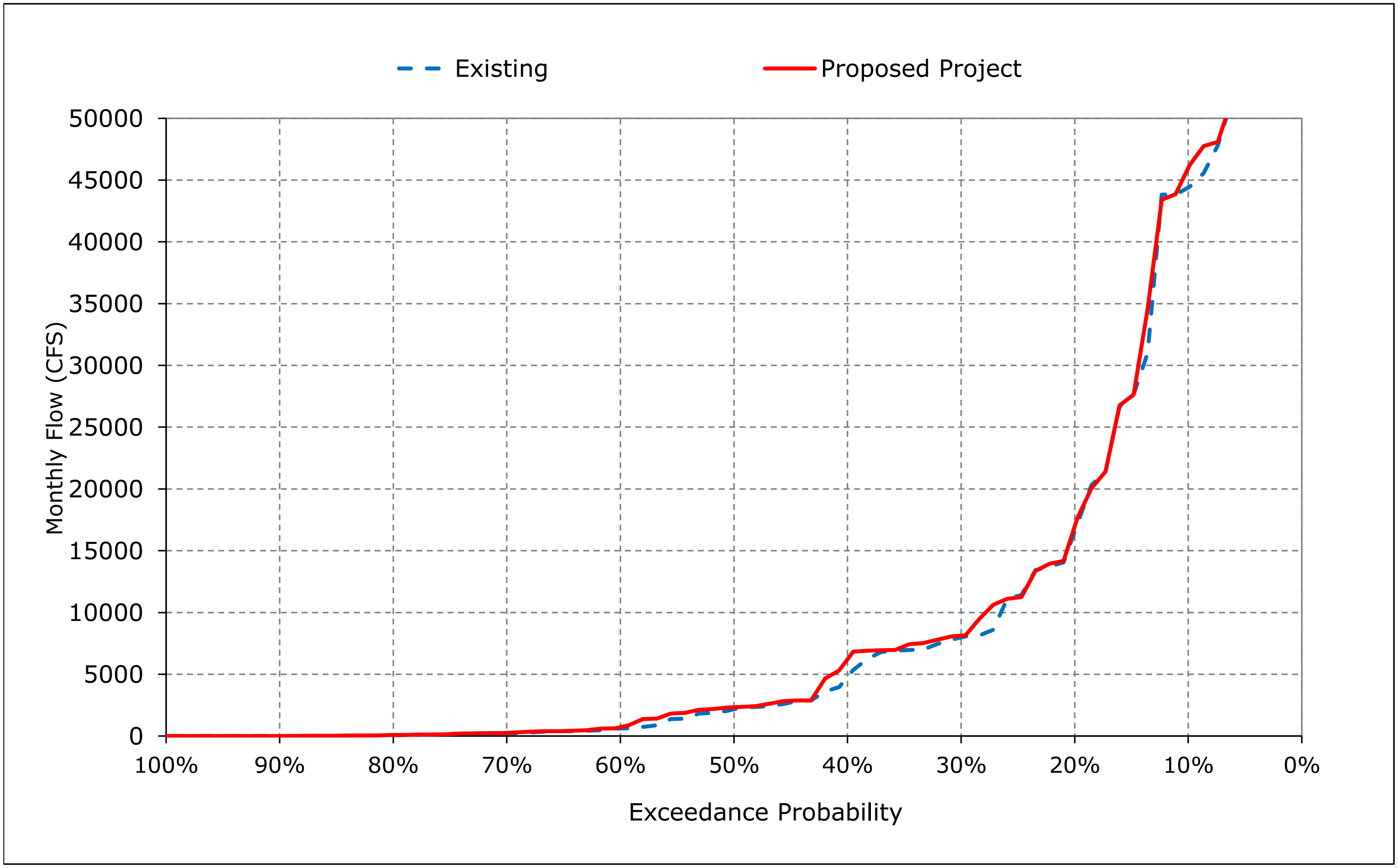


Figure 3-12. Yolo Bypass Flow, March

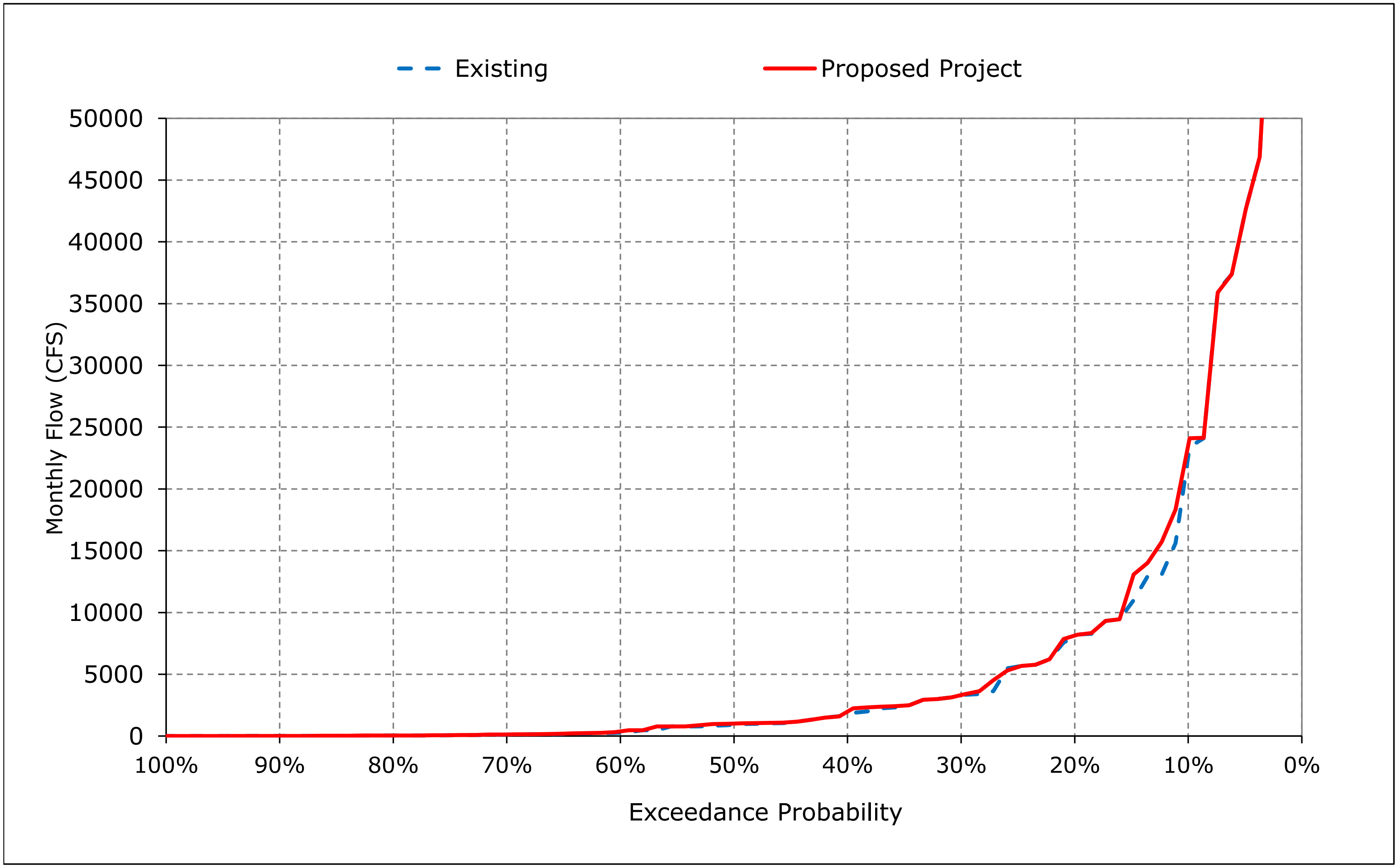


Figure 3-13. Yolo Bypass Flow, April

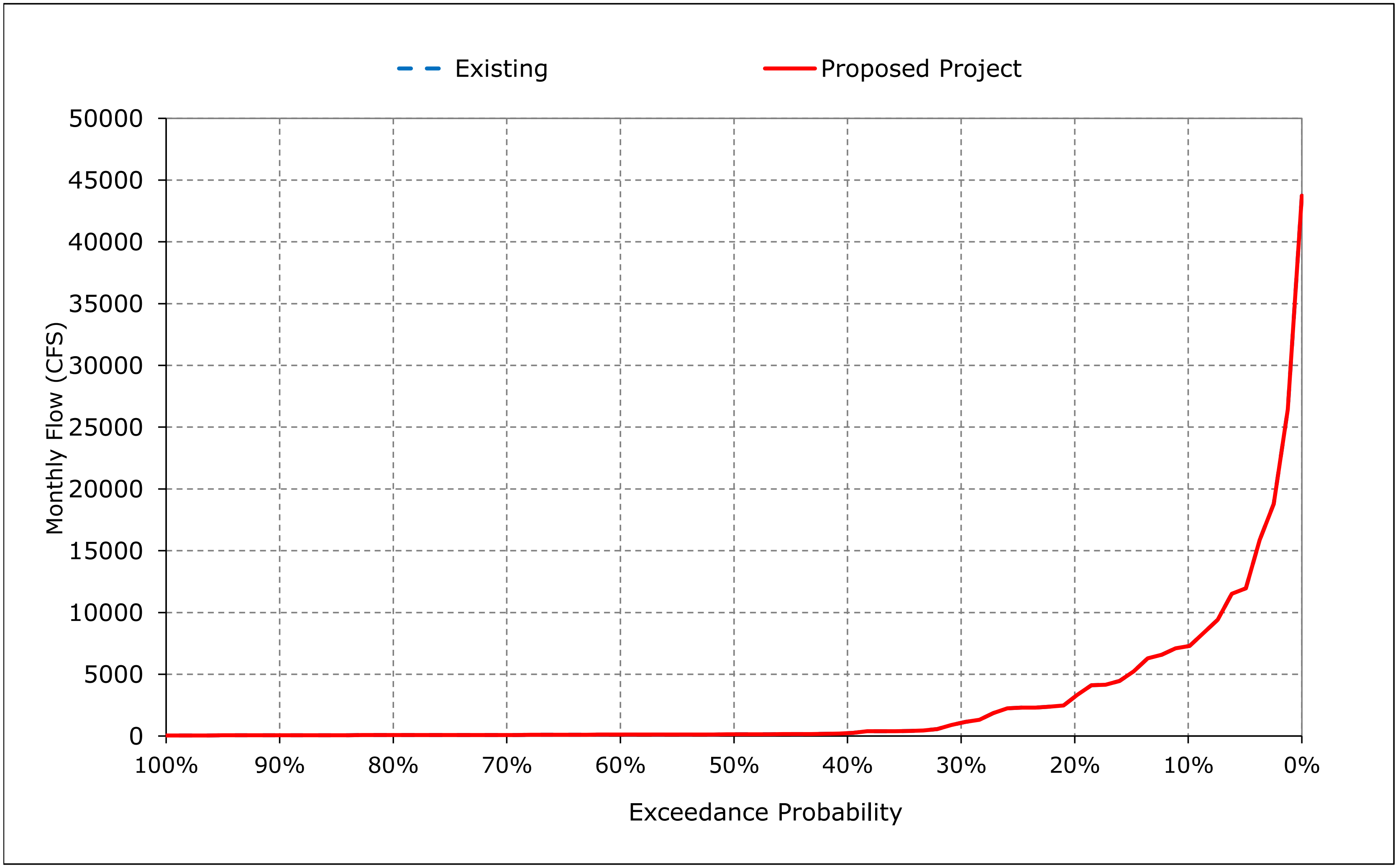


Figure 3-14. Yolo Bypass Flow, May

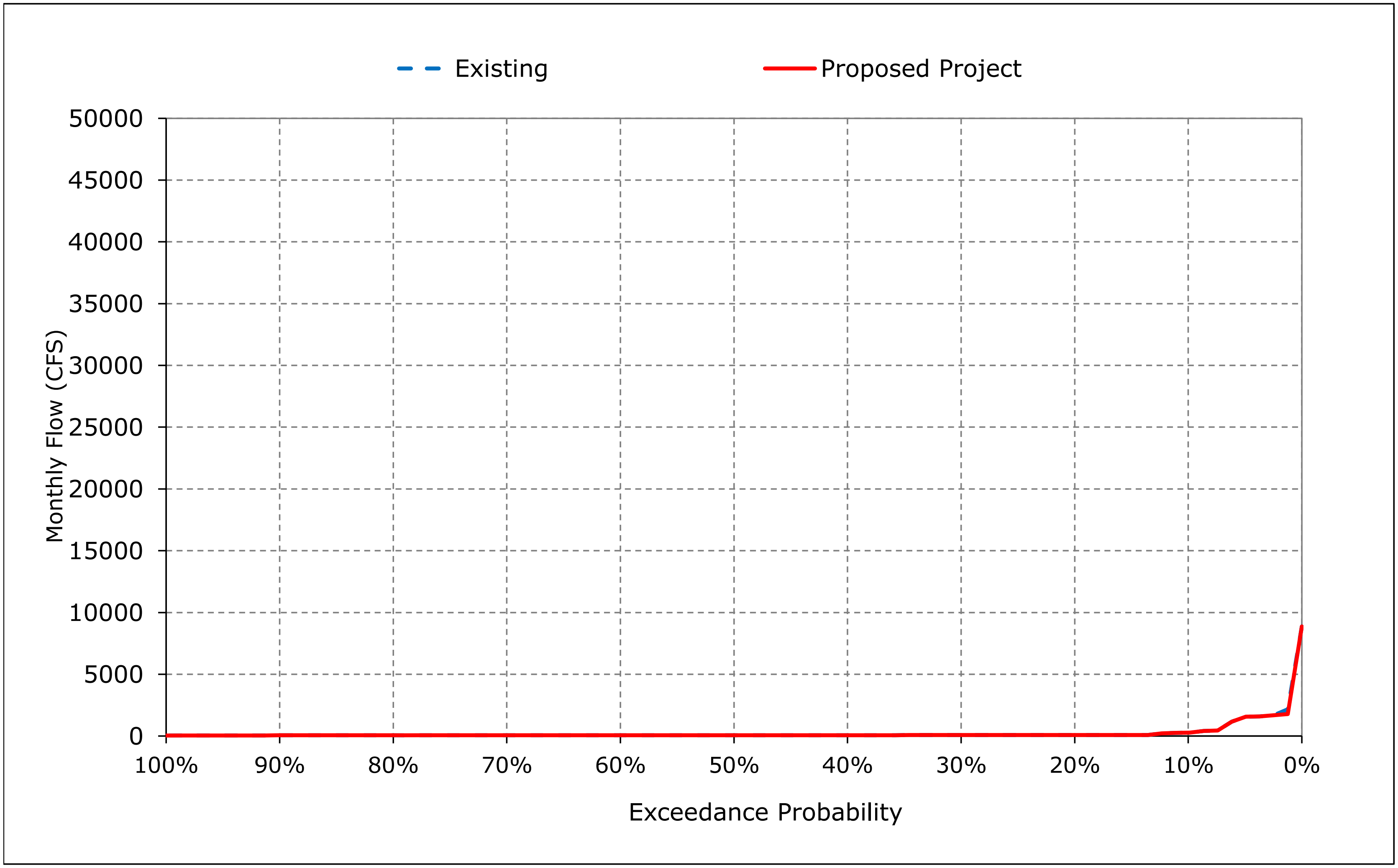


Figure 3-15. Yolo Bypass Flow, June

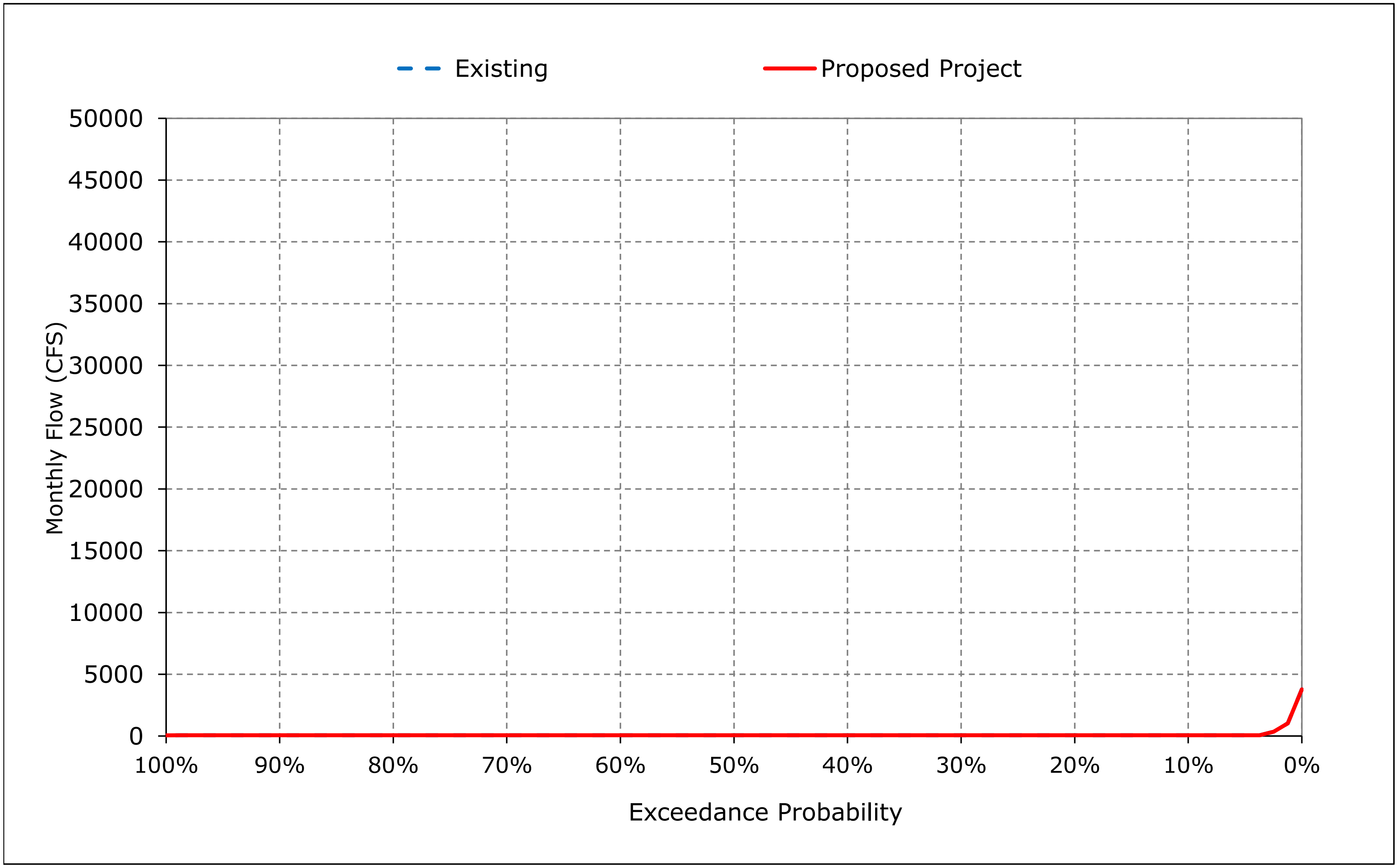


Figure 3-16. Yolo Bypass Flow, July

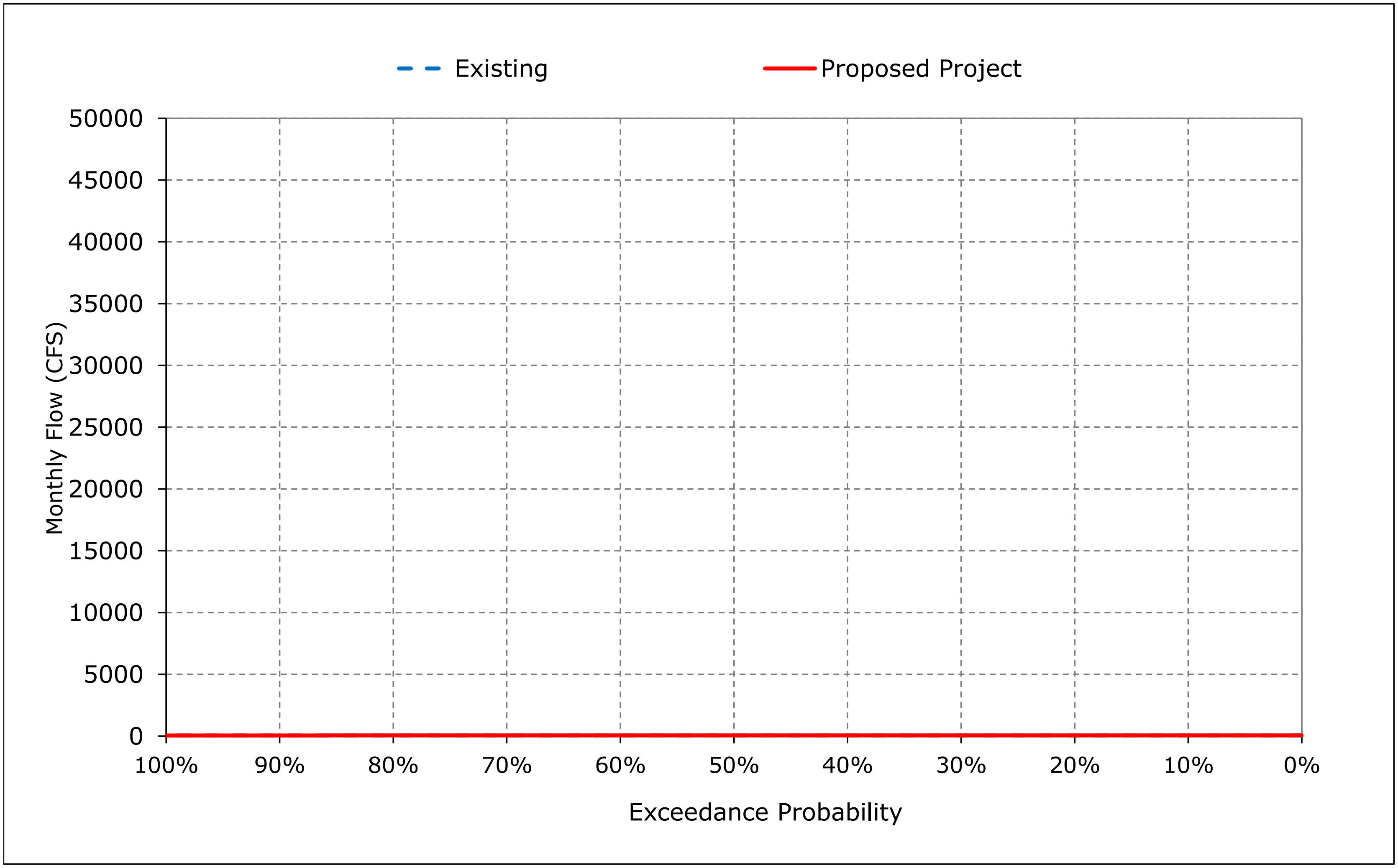


Figure 3-17. Yolo Bypass Flow, August

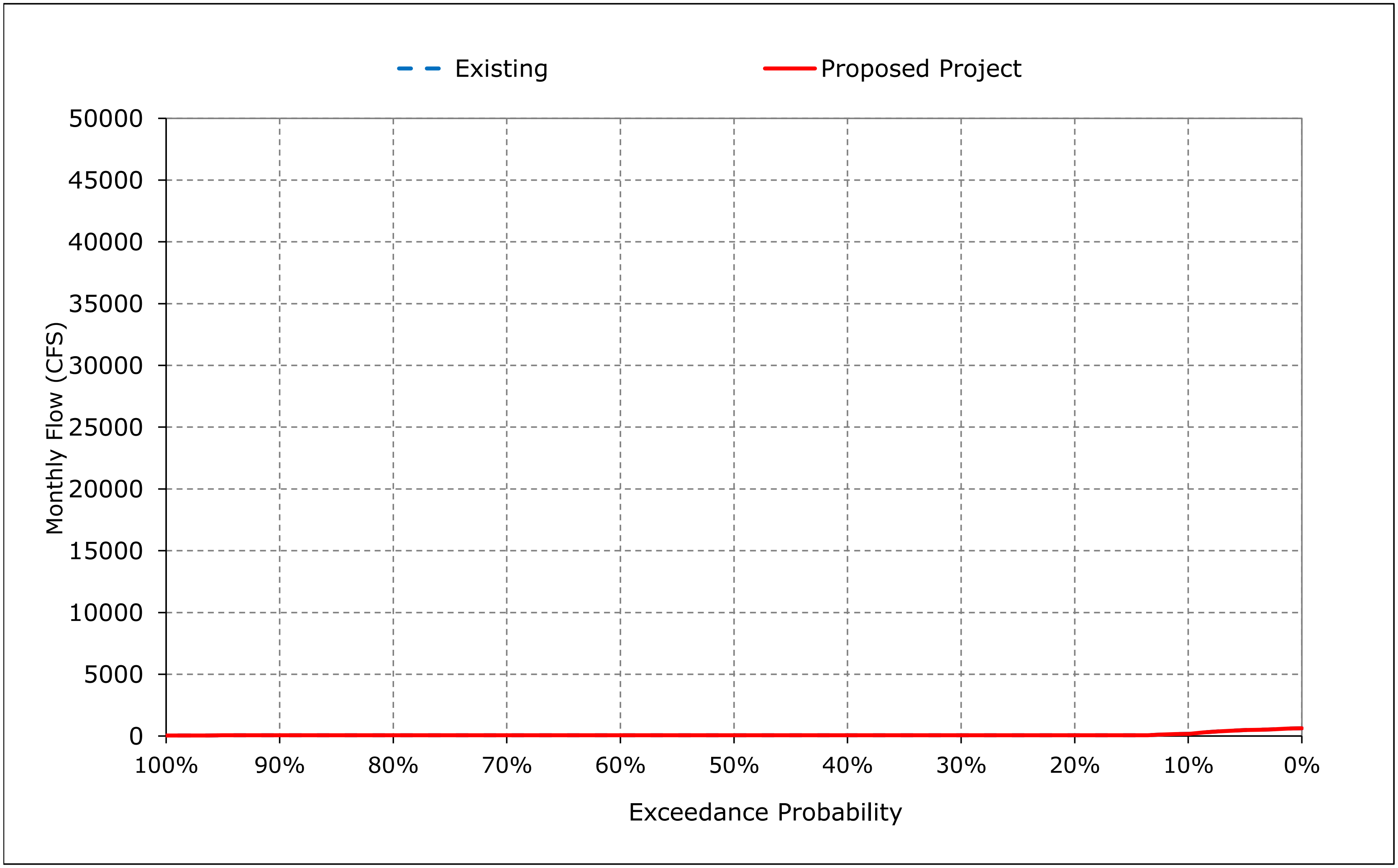


Figure 3-18. Yolo Bypass Flow, September

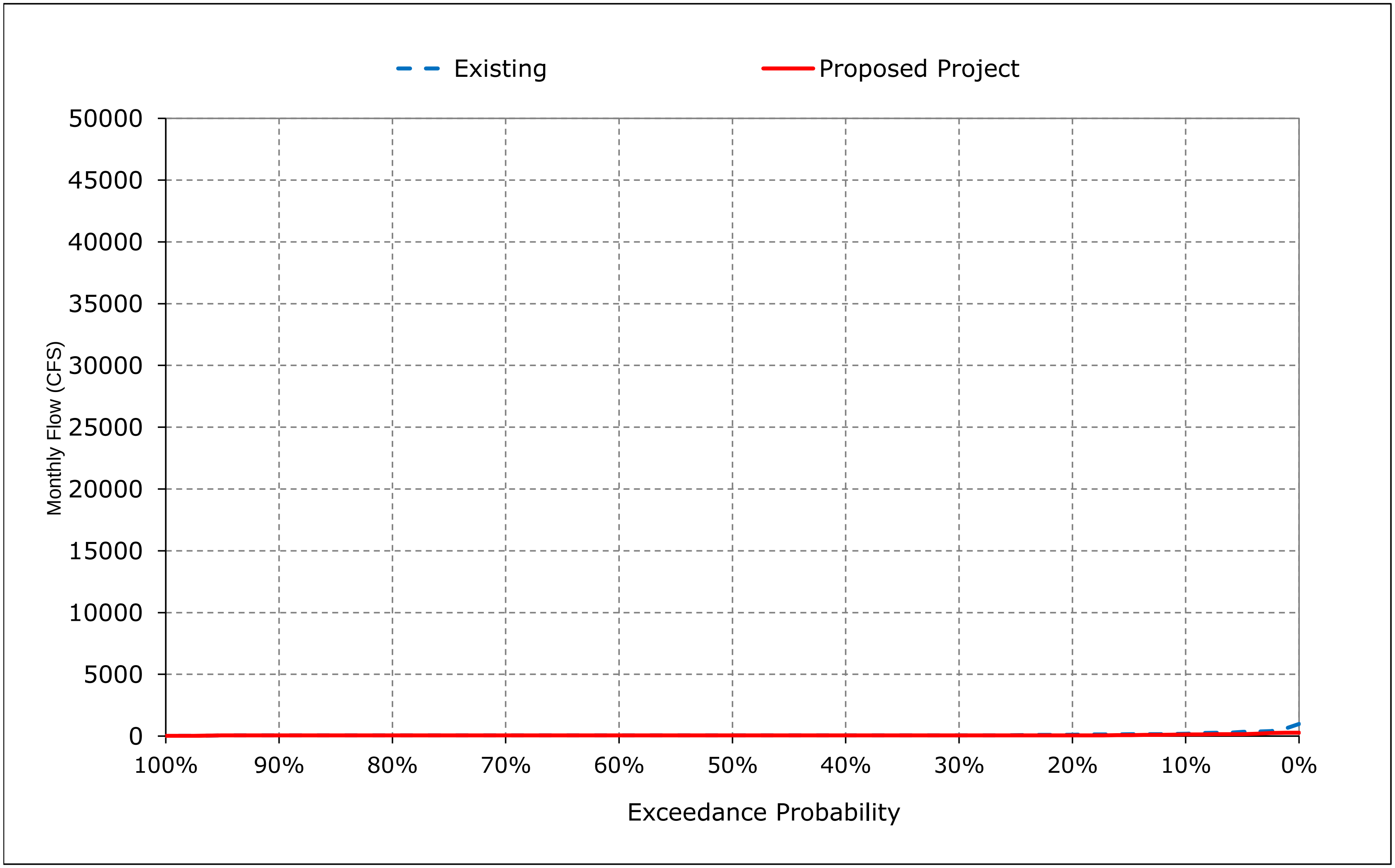


Table 4-1. Sacramento River Flow at Rio Vista, Monthly Flow

Existing

Statistic	Monthly Flow (CFS) Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	9,140	18,806	52,284	86,457	105,186	73,918	54,112	34,926	20,648	14,280	9,718	24,620
20%	8,138	15,685	29,468	55,667	67,393	52,550	37,257	24,211	11,911	13,237	9,428	23,952
30%	7,537	14,649	18,168	40,343	52,127	35,838	21,850	14,901	8,567	12,292	9,053	14,756
40%	6,476	12,272	14,804	25,624	42,524	30,001	19,665	11,196	8,253	11,254	8,870	13,303
50%	5,940	10,585	12,150	18,372	30,086	22,487	14,597	9,601	7,982	10,683	8,695	8,343
60%	4,923	7,745	10,857	15,373	22,618	17,884	11,737	8,431	7,635	9,608	7,960	6,083
70%	4,401	6,657	9,754	12,155	16,358	15,500	10,094	7,427	6,990	8,871	5,327	5,285
80%	4,000	5,787	7,341	10,446	13,659	12,316	8,529	7,028	6,450	7,752	4,466	4,822
90%	3,039	4,471	6,370	9,425	11,071	8,460	7,156	5,787	6,145	4,765	3,992	3,521
Long Term												
Full Simulation Period[a]	6,443	12,240	21,031	35,843	45,193	35,436	22,760	15,220	10,618	10,157	7,442	12,045
Water Year Types[b,c]												
Wet (32%)	8,294	17,532	38,344	69,721	81,768	64,062	40,542	26,583	16,592	11,403	9,239	22,778
Above Normal (15%)	6,029	13,013	19,036	38,894	50,702	43,650	24,065	17,363	10,171	12,539	9,314	13,569
Below Normal (17%)	5,727	10,062	13,889	19,160	30,527	19,416	15,992	10,661	8,060	11,839	8,755	7,242
Dry (22%)	5,567	9,566	11,619	13,948	21,093	17,438	11,327	7,586	7,664	9,106	4,779	4,991
Critical (15%)	4,995	6,556	7,962	11,698	13,697	10,887	7,974	5,223	5,535	4,689	4,142	3,451

Proposed Project

Statistic	Monthly Flow (CFS) Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	9,937	17,954	56,836	86,691	105,510	76,139	54,110	34,923	20,636	14,174	9,685	14,502
20%	9,027	10,679	31,820	57,625	67,442	52,546	37,257	24,595	11,911	13,667	9,395	14,071
30%	7,780	9,424	19,243	40,753	54,662	38,414	21,618	14,898	8,754	12,506	9,156	13,611
40%	6,922	8,747	15,330	26,124	45,380	29,980	19,762	11,191	8,454	11,067	8,881	12,676
50%	6,264	8,425	11,736	20,661	30,078	22,481	14,582	10,449	8,321	10,295	8,392	8,418
60%	5,265	7,142	10,934	15,659	22,930	18,285	11,446	9,443	8,069	9,203	7,519	5,894
70%	4,323	6,598	9,655	12,166	17,577	15,546	10,031	8,270	7,478	8,558	5,467	5,180
80%	4,095	5,593	8,094	9,957	14,129	12,099	8,872	7,453	6,813	7,127	4,708	4,842
90%	3,283	4,334	6,288	9,119	11,419	8,804	7,457	6,288	5,965	4,816	4,226	3,564
Long Term												
Full Simulation Period[a]	6,829	10,495	21,780	36,351	45,915	35,853	22,820	15,570	10,834	10,021	7,439	9,182
Water Year Types[b,c]												
Wet (32%)	8,724	15,248	40,463	70,723	82,367	64,279	40,515	26,564	16,652	11,311	9,182	13,574
Above Normal (15%)	6,635	10,705	19,188	39,908	51,897	45,029	24,057	17,449	10,693	12,587	9,262	14,076
Below Normal (17%)	6,244	8,481	13,946	20,111	32,366	19,680	16,041	11,334	8,638	11,593	8,551	7,079
Dry (22%)	5,659	8,121	11,850	13,778	21,098	17,770	11,497	8,484	7,795	8,628	4,851	4,965
Critical (15%)	5,353	5,894	7,928	11,129	13,987	11,084	8,138	5,445	5,488	4,915	4,426	3,550

Proposed Project minus Existing

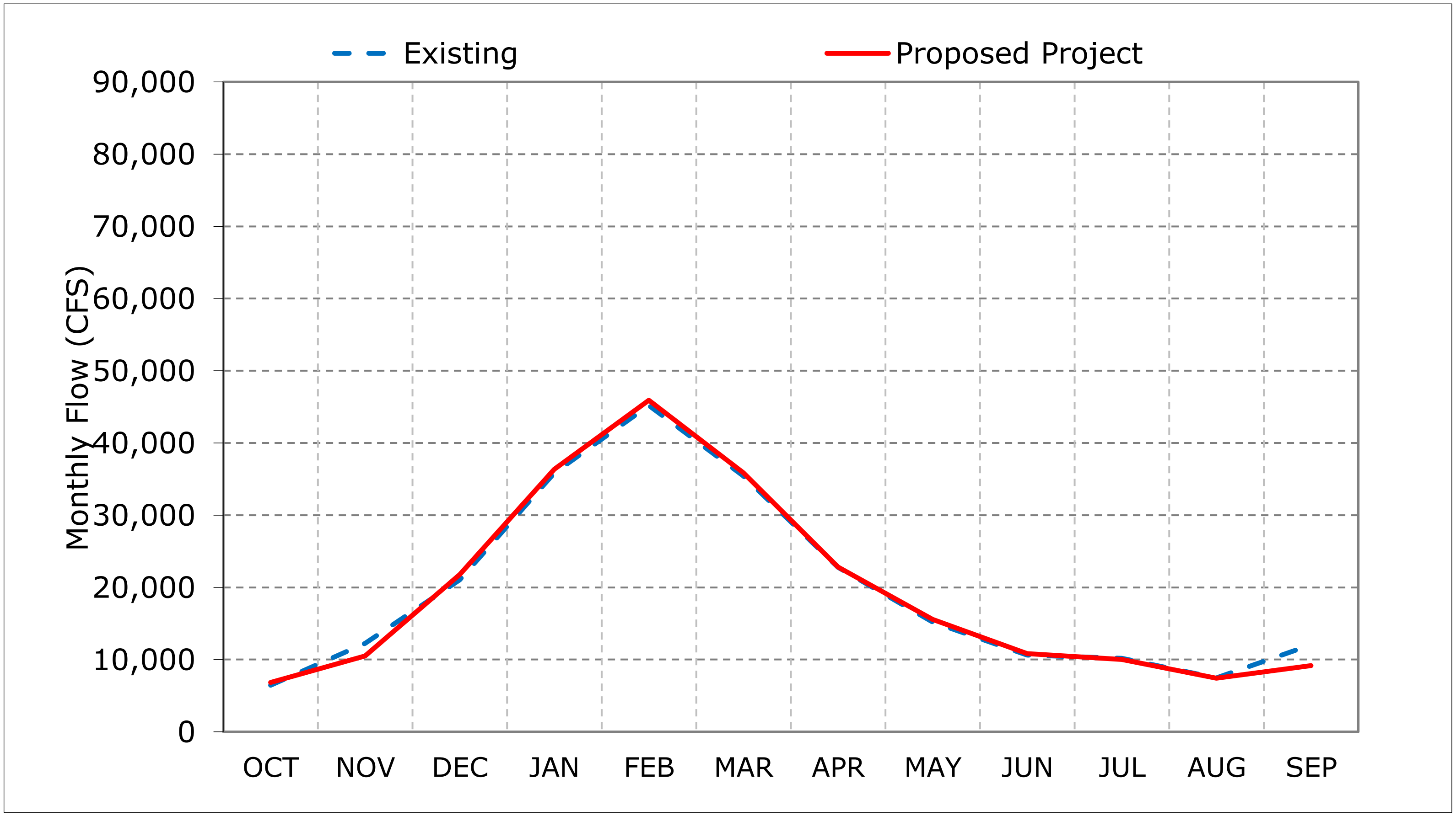
Statistic	Monthly Flow (CFS) Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	797	**-852**	4,552	234	324	2,222	**-1**	**-3**	**-12**	**-106**	**-33**	**-10,118**
20%	890	**-5,006**	2,353	1,958	49	**-5**	**0**	384	**0**	430	**-32**	**-9,881**
30%	243	**-5,225**	1,075	410	2,536	2,576	**-233**	**-3**	187	214	103	**-1,145**
40%	446	**-3,525**	526	500	2,856	**-21**	98	**-5**	201	**-187**	11	**-628**
50%	324	**-2,159**	**-414**	2,289	**-8**	**-6**	**-15**	848	339	**-388**	**-304**	75
60%	342	**-602**	77	285	312	401	**-291**	1,012	434	**-405**	**-440**	**-189**
70%	**-78**	**-59**	**-99**	11	1,219	46	**-62**	842	488	**-314**	141	**-105**
80%	95	**-193**	753	**-489**	470	**-217**	343	425	364	**-625**	242	21
90%	243	**-137**	**-83**	**-306**	348	344	301	501	**-180**	52	234	42
Long Term												
Full Simulation Period[a]	386	**-1,746**	750	508	722	417	60	351	216	**-136**	**-3**	**-2,863**
Water Year Types[b,c]												
Wet (32%)	430	**-2,283**	2,119	1,002	599	217	**-27**	**-20**	59	**-91**	**-57**	**-9,203**
Above Normal (15%)	607	**-2,307**	151	1,015	1,195	1,379	**-8**	86	522	48	**-52**	507
Below Normal (17%)	517	**-1,581**	57	950	1,839	264	49	672	578	**-246**	**-203**	**-162**
Dry (22%)	93	**-1,445**	231	**-170**	5	331	170	898	131	**-478**	73	**-27**
Critical (15%)	358	**-663**	**-33**	**-569**	290	197	164	223	**-47**	226	284	99

a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

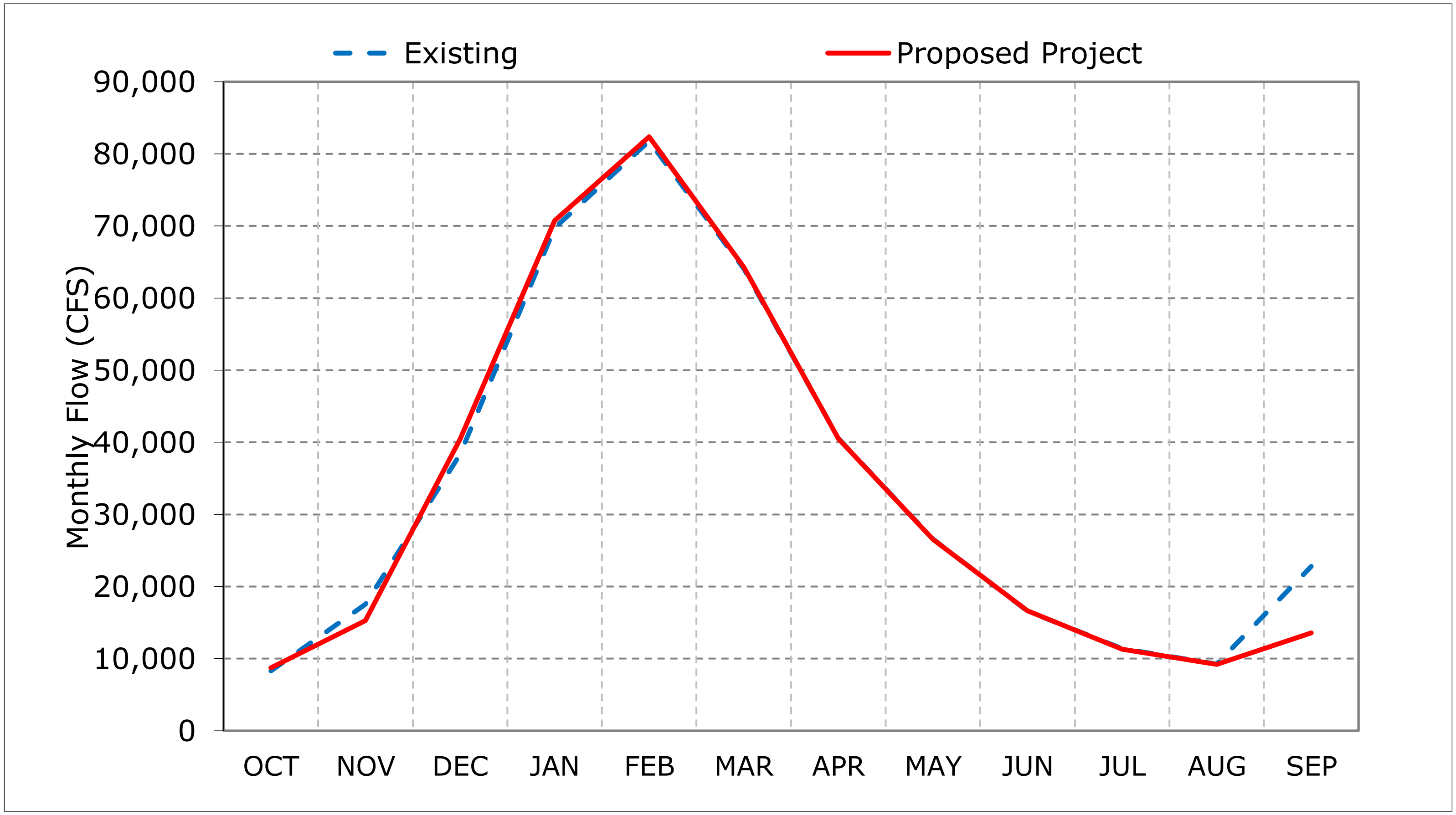
c These results are displayed with water year - year type sorting.

Figure 4-1. Sacramento River Flow at Rio Vista, Long-Term Average Flow



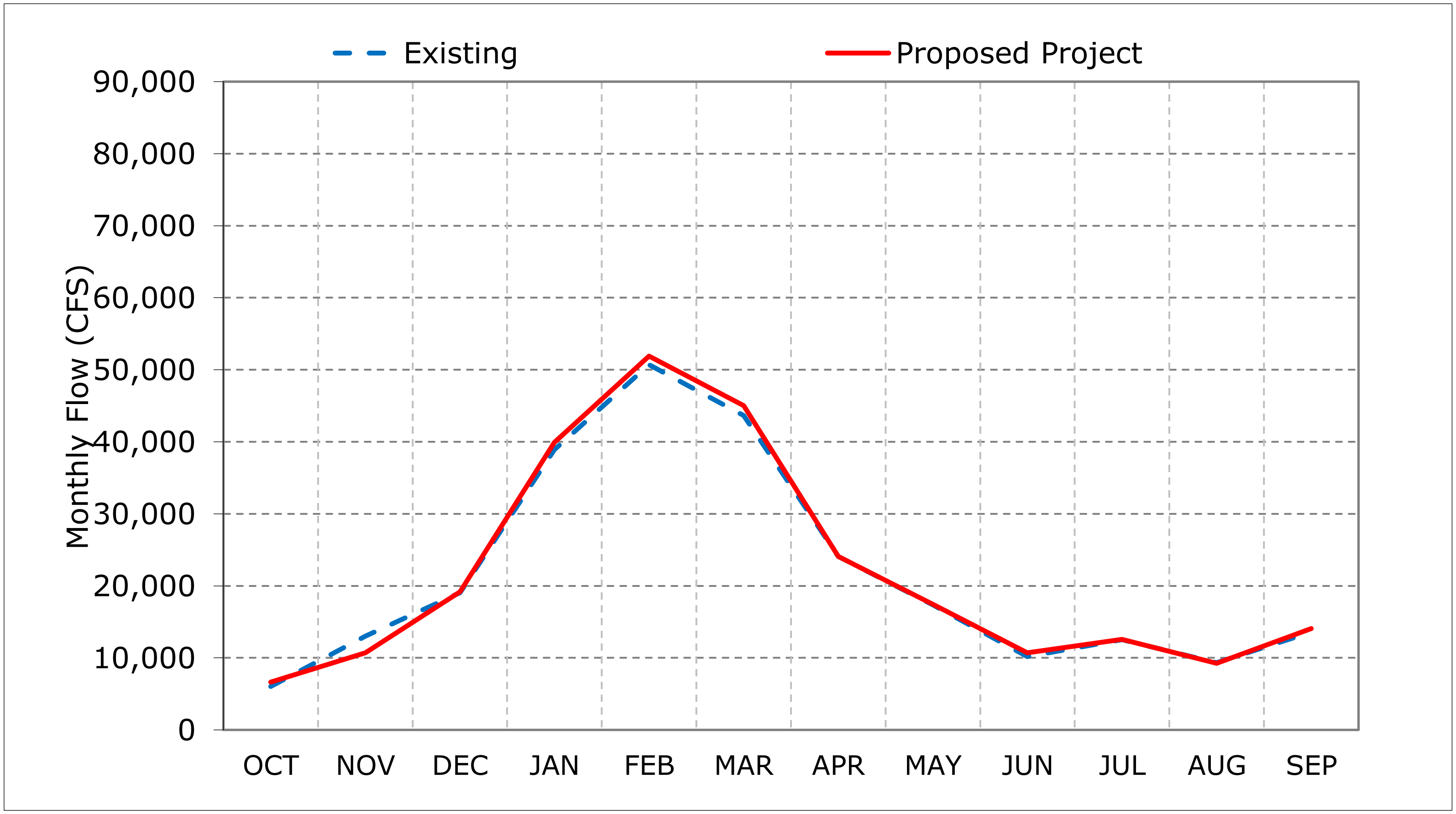
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 4-2. Sacramento River Flow at Rio Vista, Wet Year Average Flow



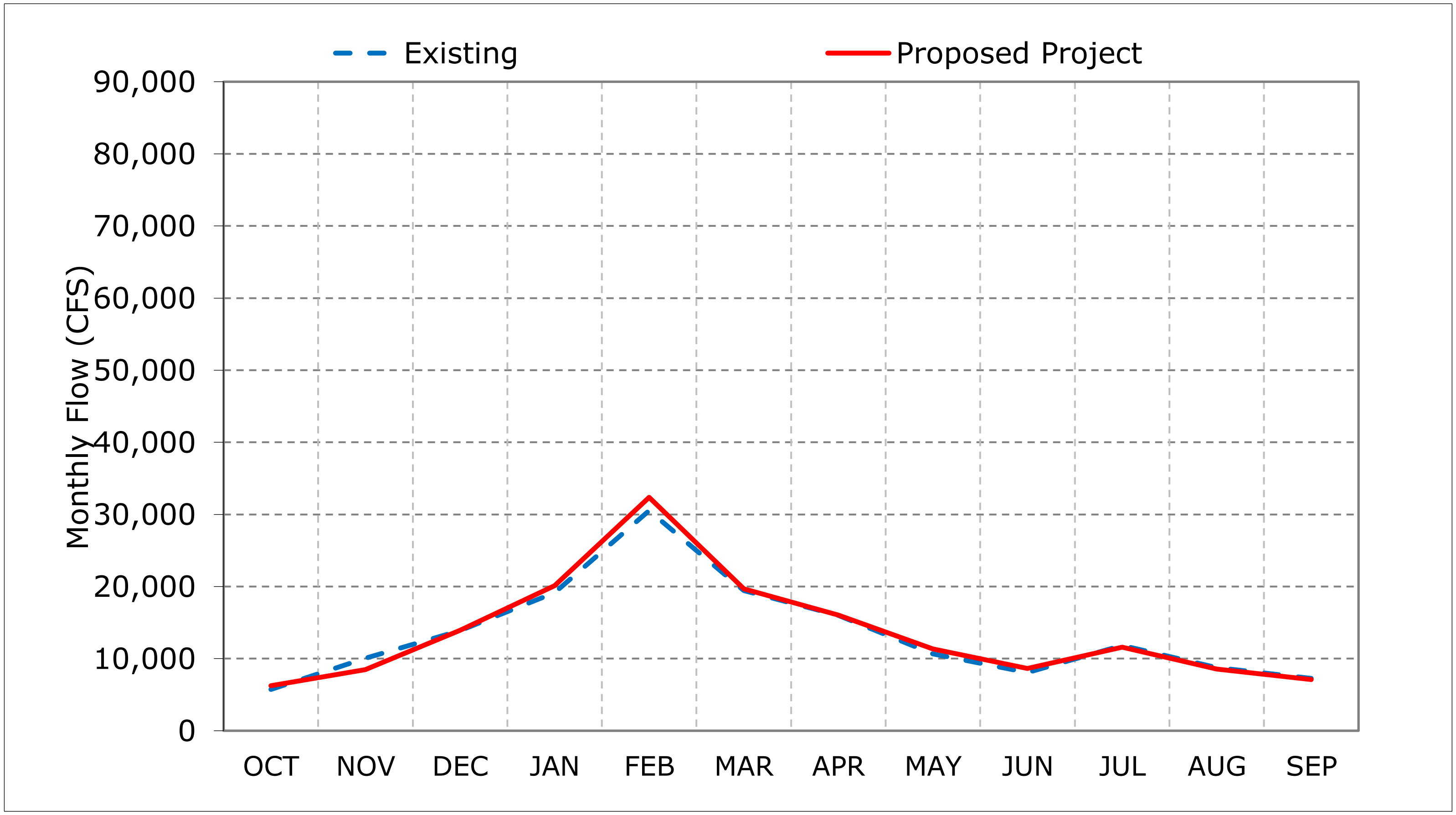
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 4-3. Sacramento River Flow at Rio Vista, Above Normal Year Average Flow



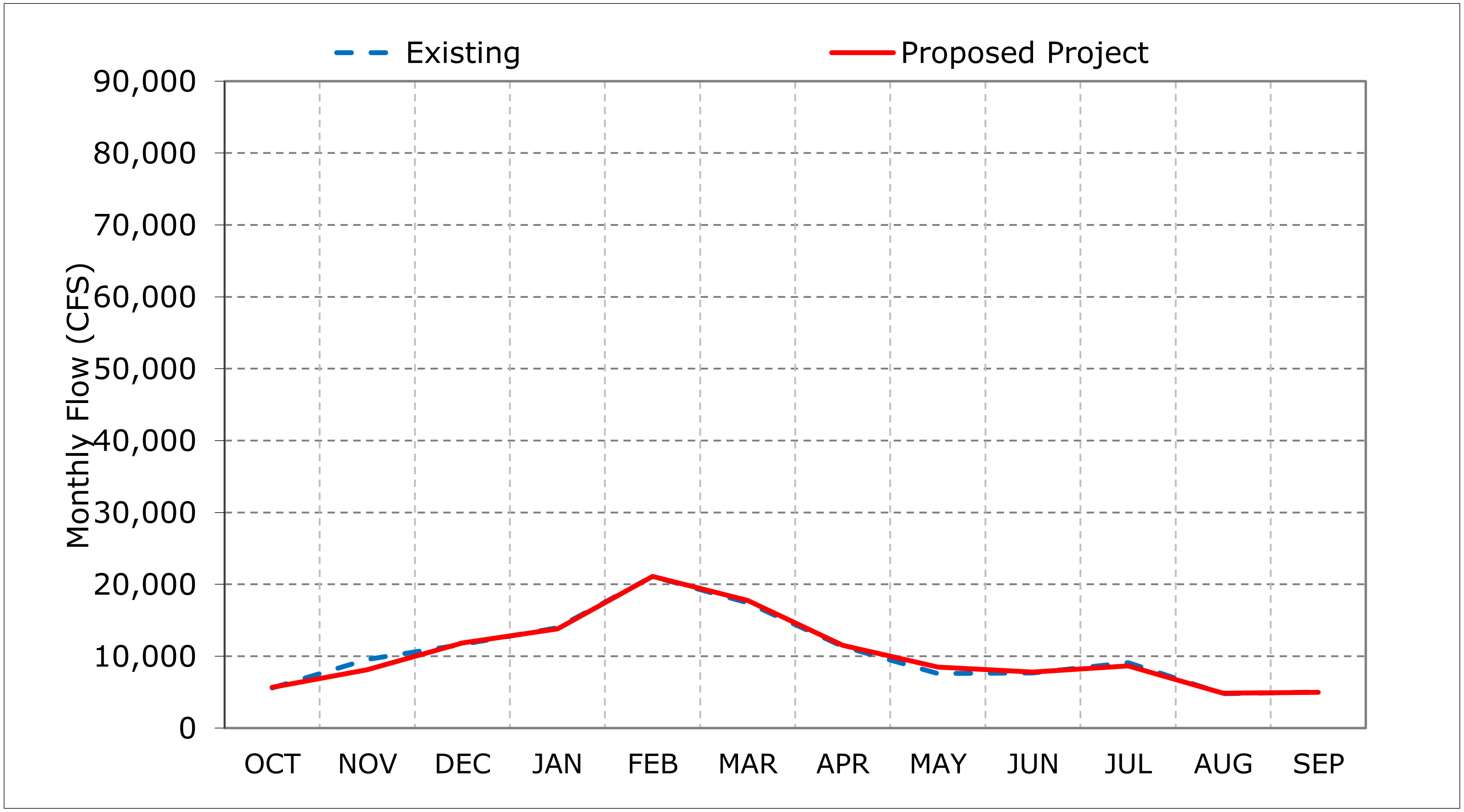
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 4-4. Sacramento River Flow at Rio Vista, Below Normal Year Average Flow



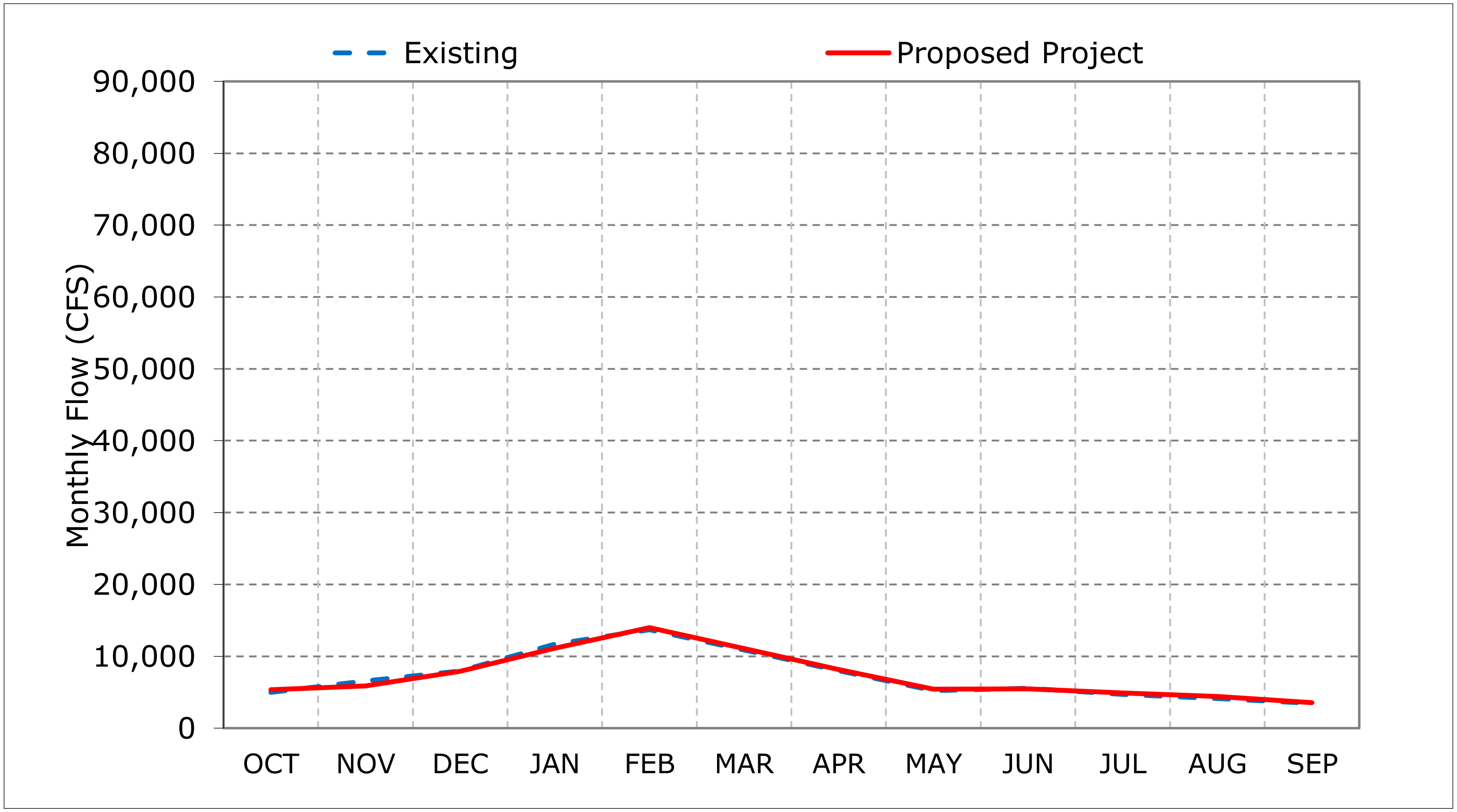
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 4-5. Sacramento River Flow at Rio Vista, Dry Year Average Flow



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 4-6. Sacramento River Flow at Rio Vista, Critical Year Average Flow



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164

*These results are displayed with water year - year type sorting.

Figure 4-7. Sacramento River Flow at Rio Vista, October

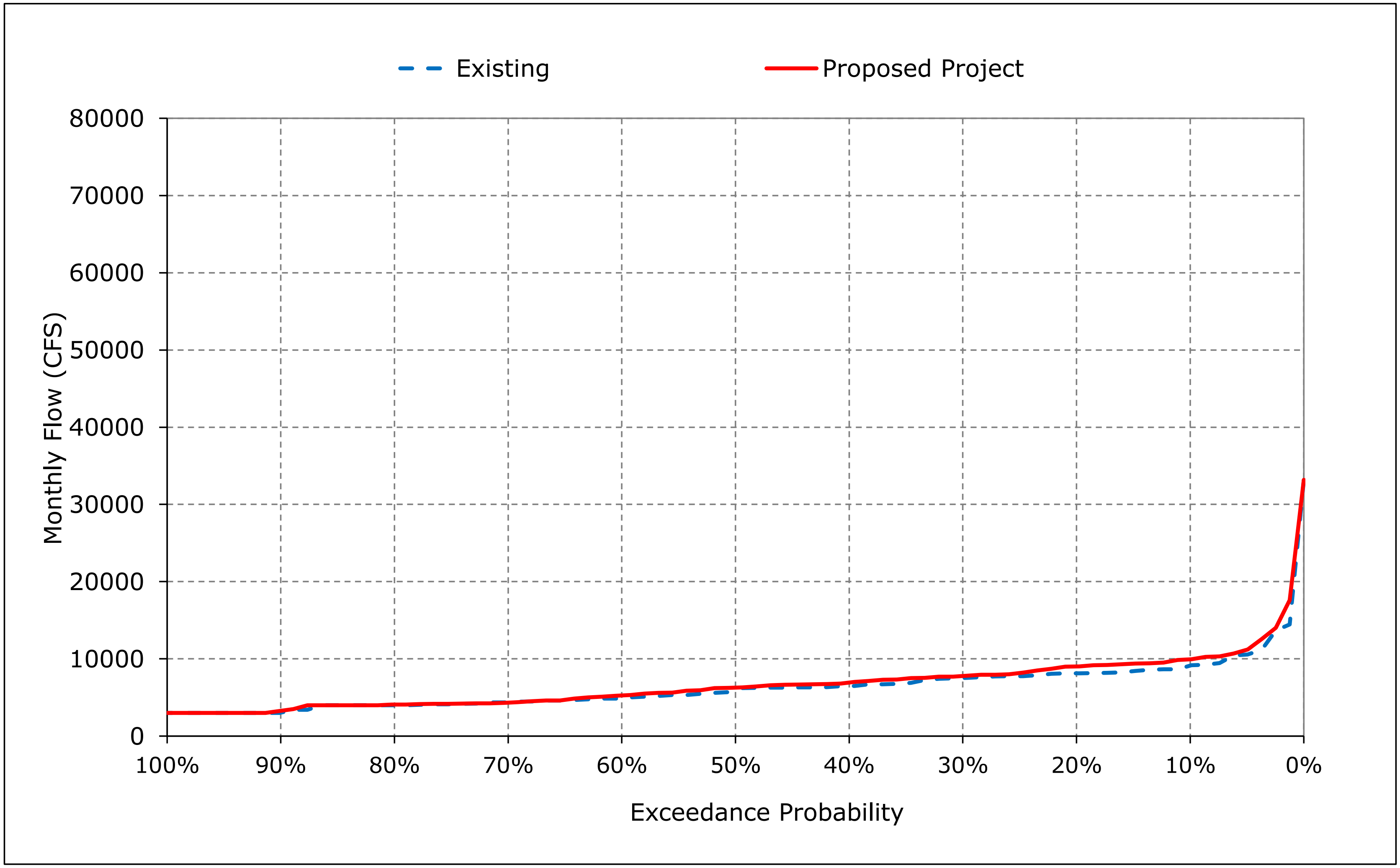


Figure 4-8. Sacramento River Flow at Rio Vista, November

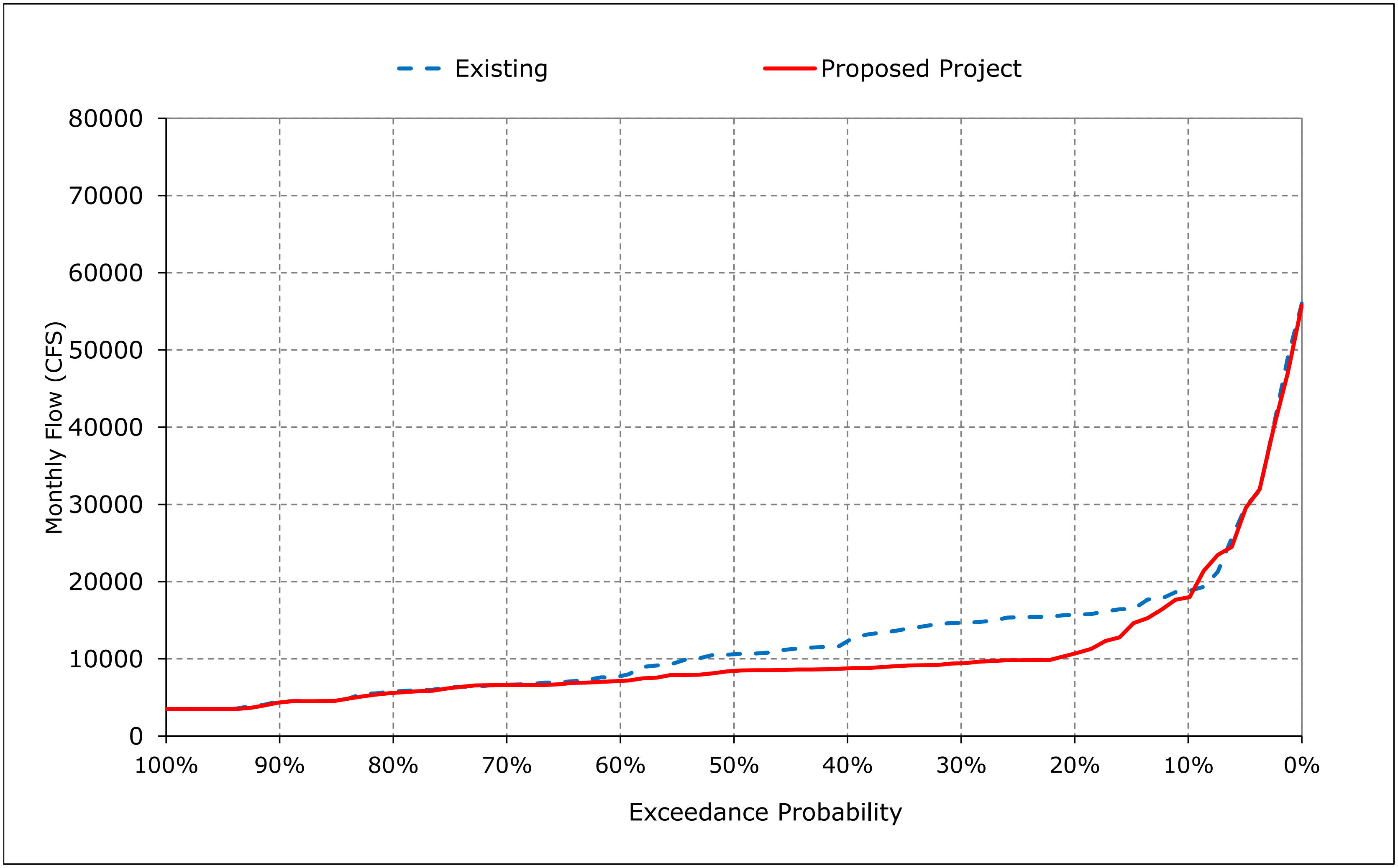


Figure 4-9. Sacramento River Flow at Rio Vista, December

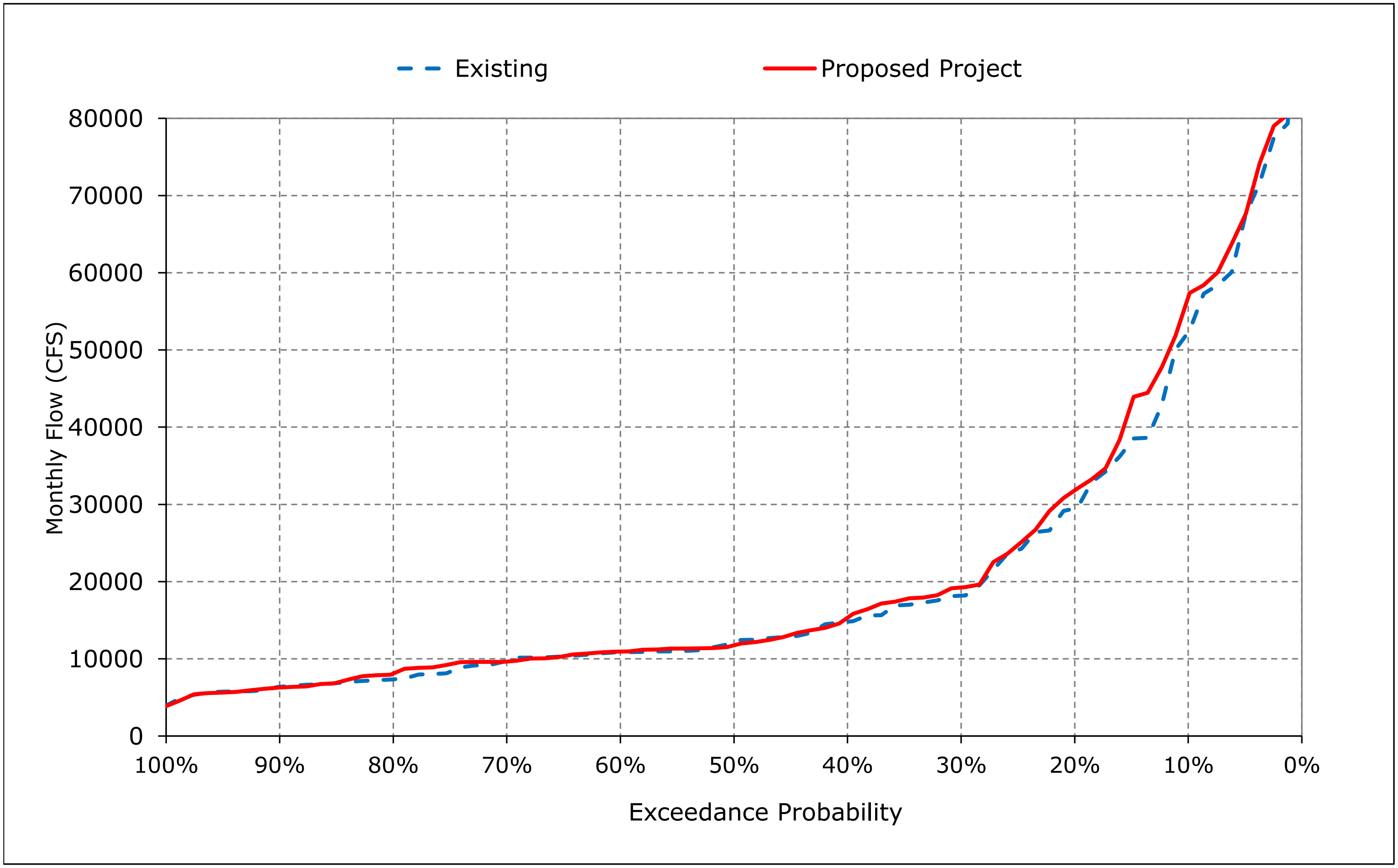


Figure 4-10. Sacramento River Flow at Rio Vista, January

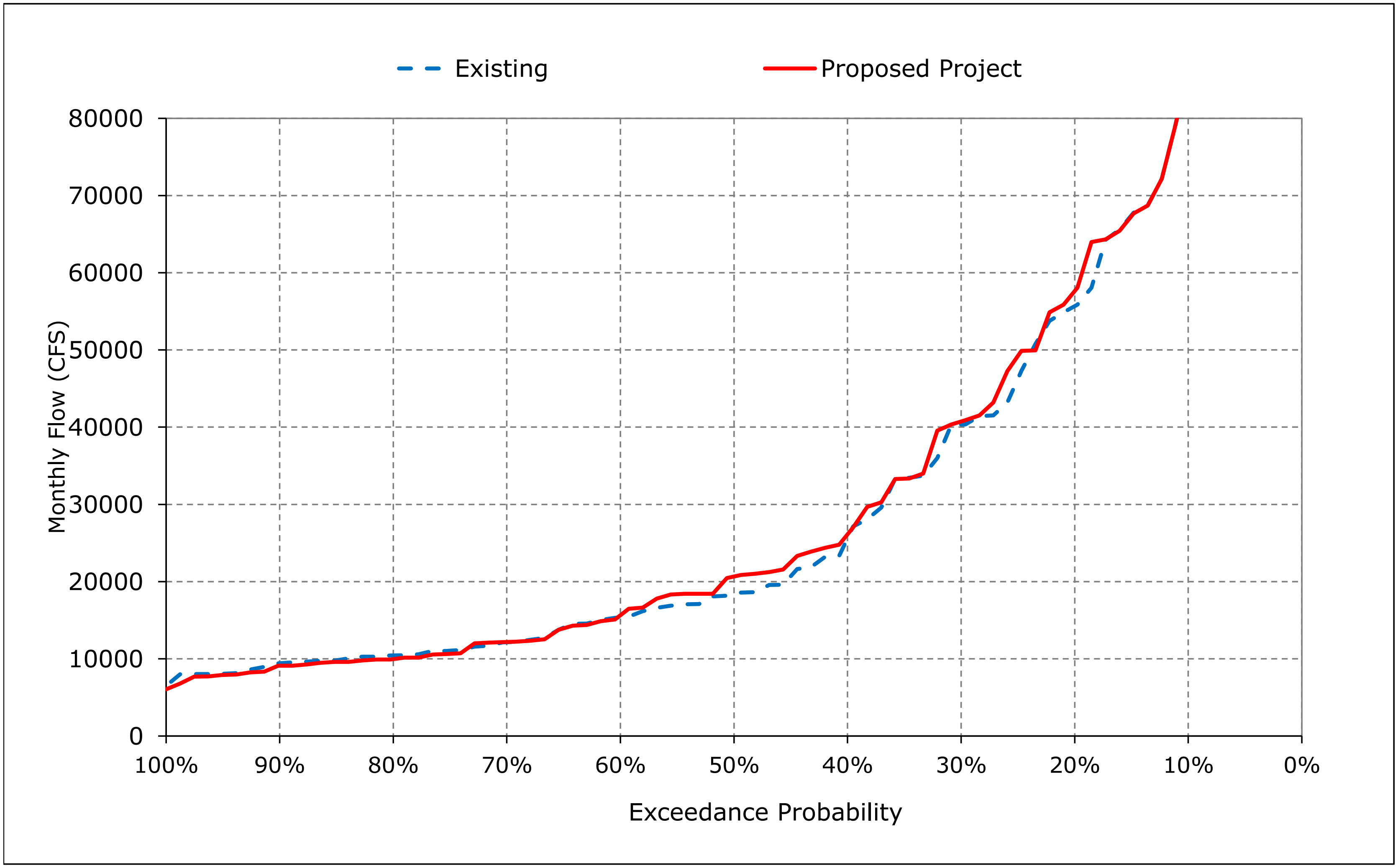


Figure 4-11. Sacramento River Flow at Rio Vista, February

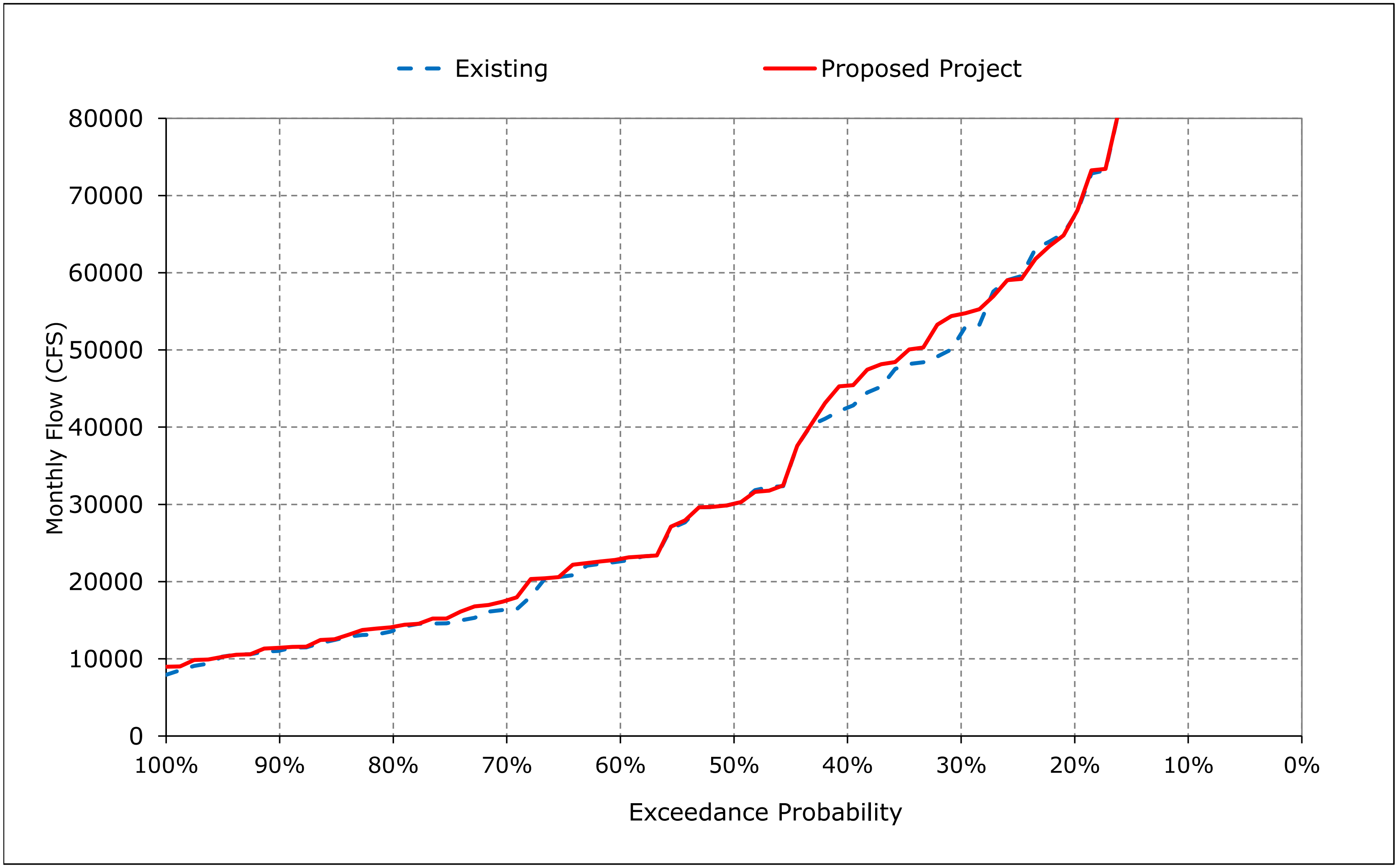


Figure 4-12. Sacramento River Flow at Rio Vista, March

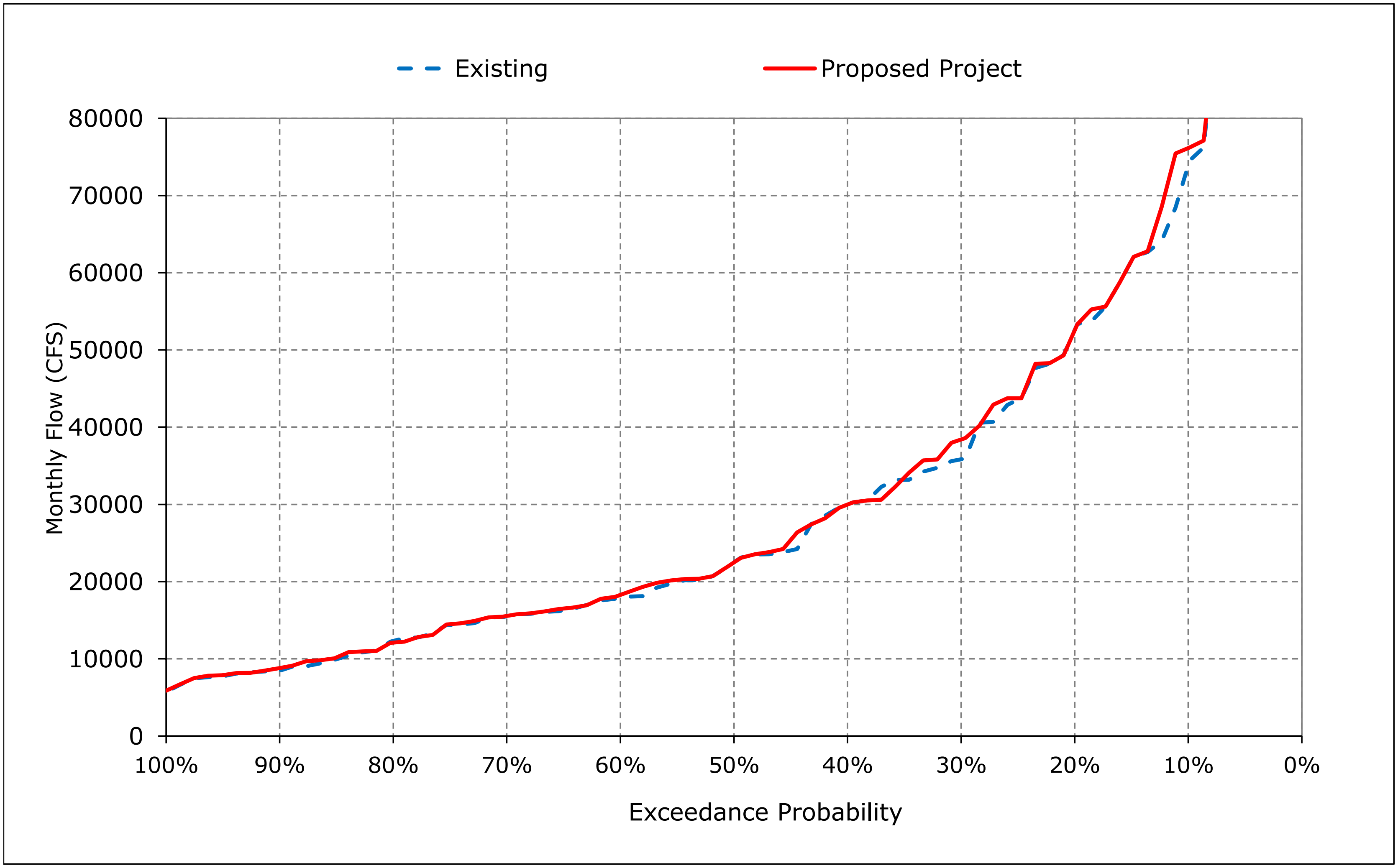


Figure 4-13. Sacramento River Flow at Rio Vista, April

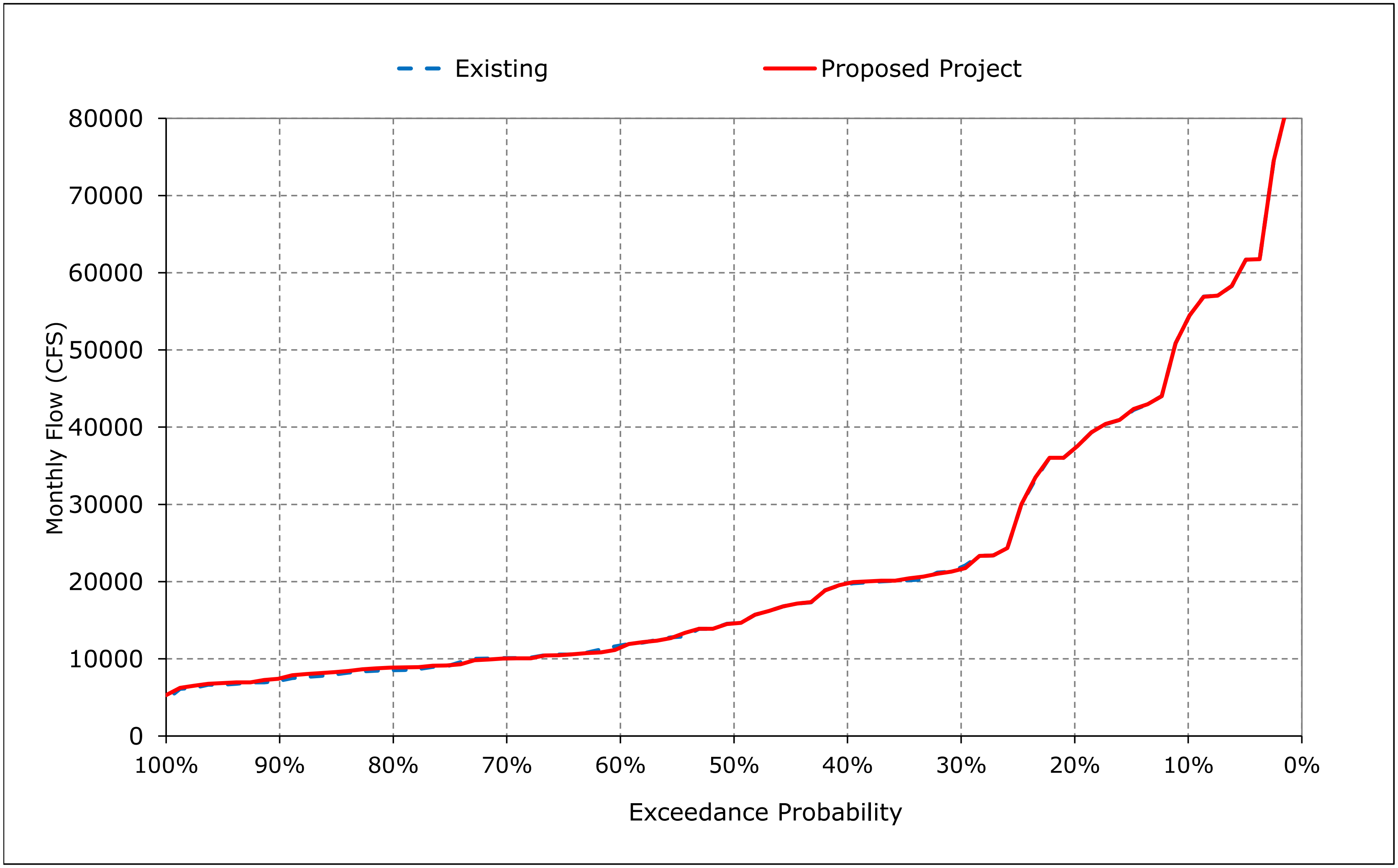


Figure 4-14. Sacramento River Flow at Rio Vista, May

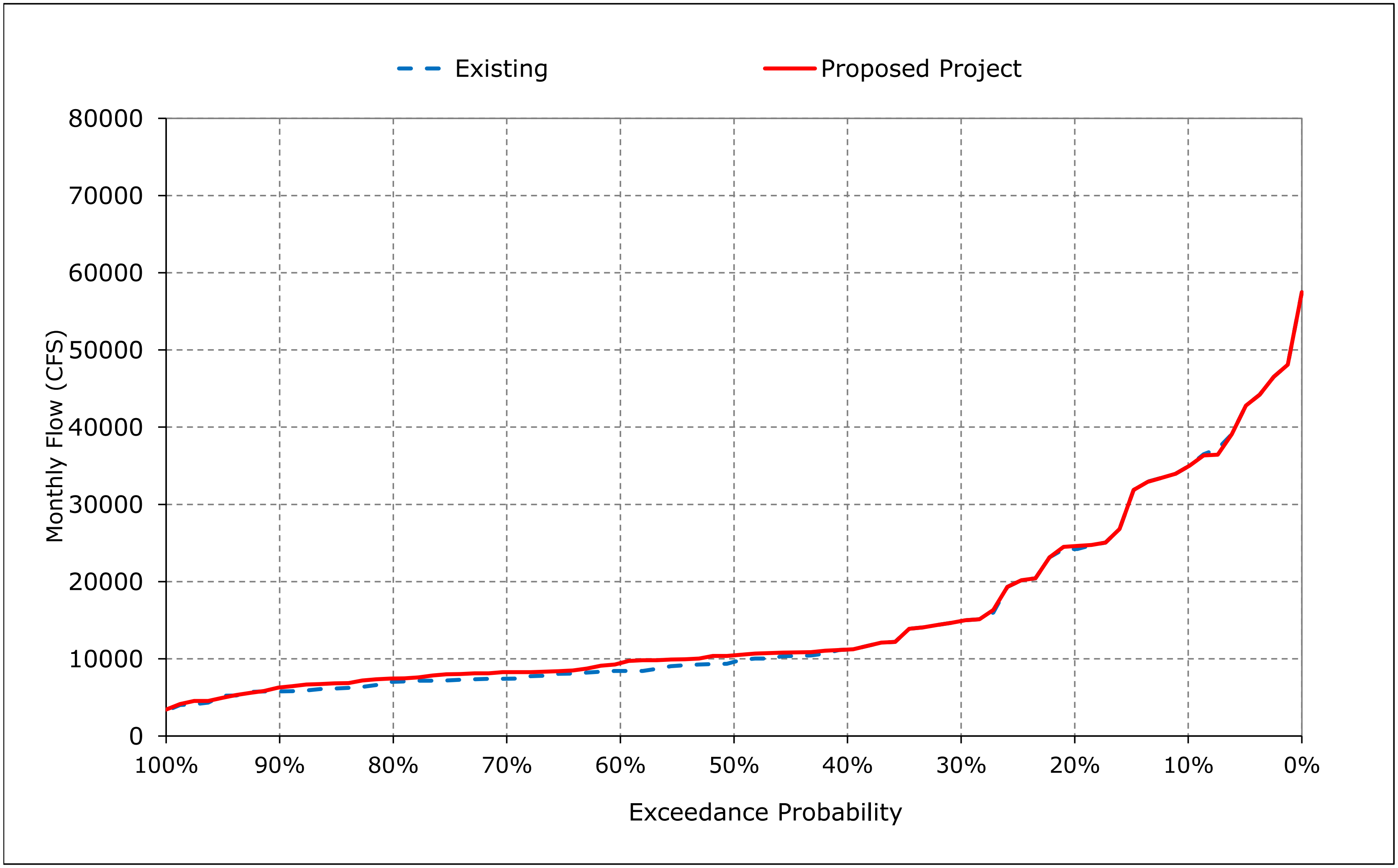


Figure 4-15. Sacramento River Flow at Rio Vista, June

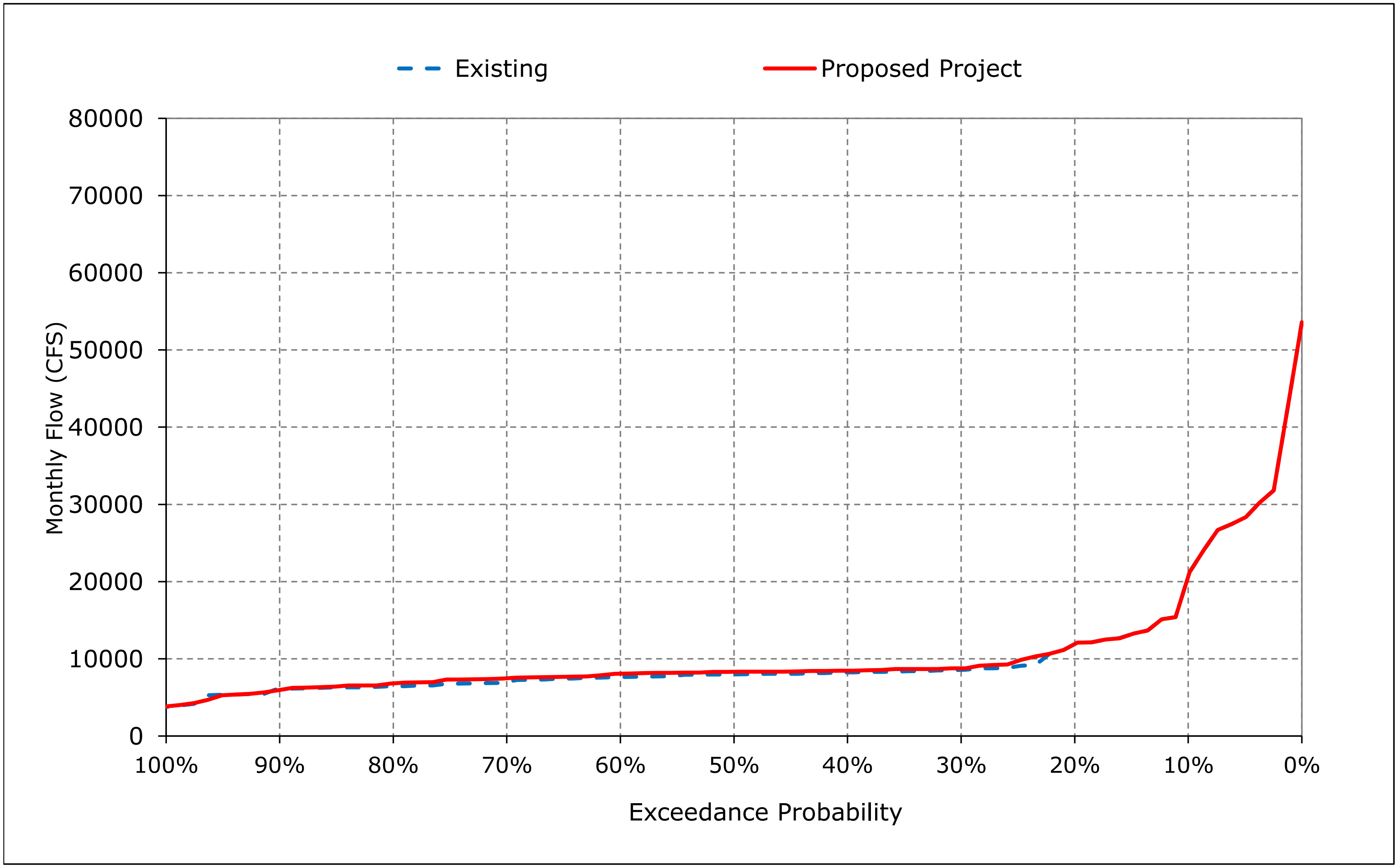


Figure 4-16. Sacramento River Flow at Rio Vista, July

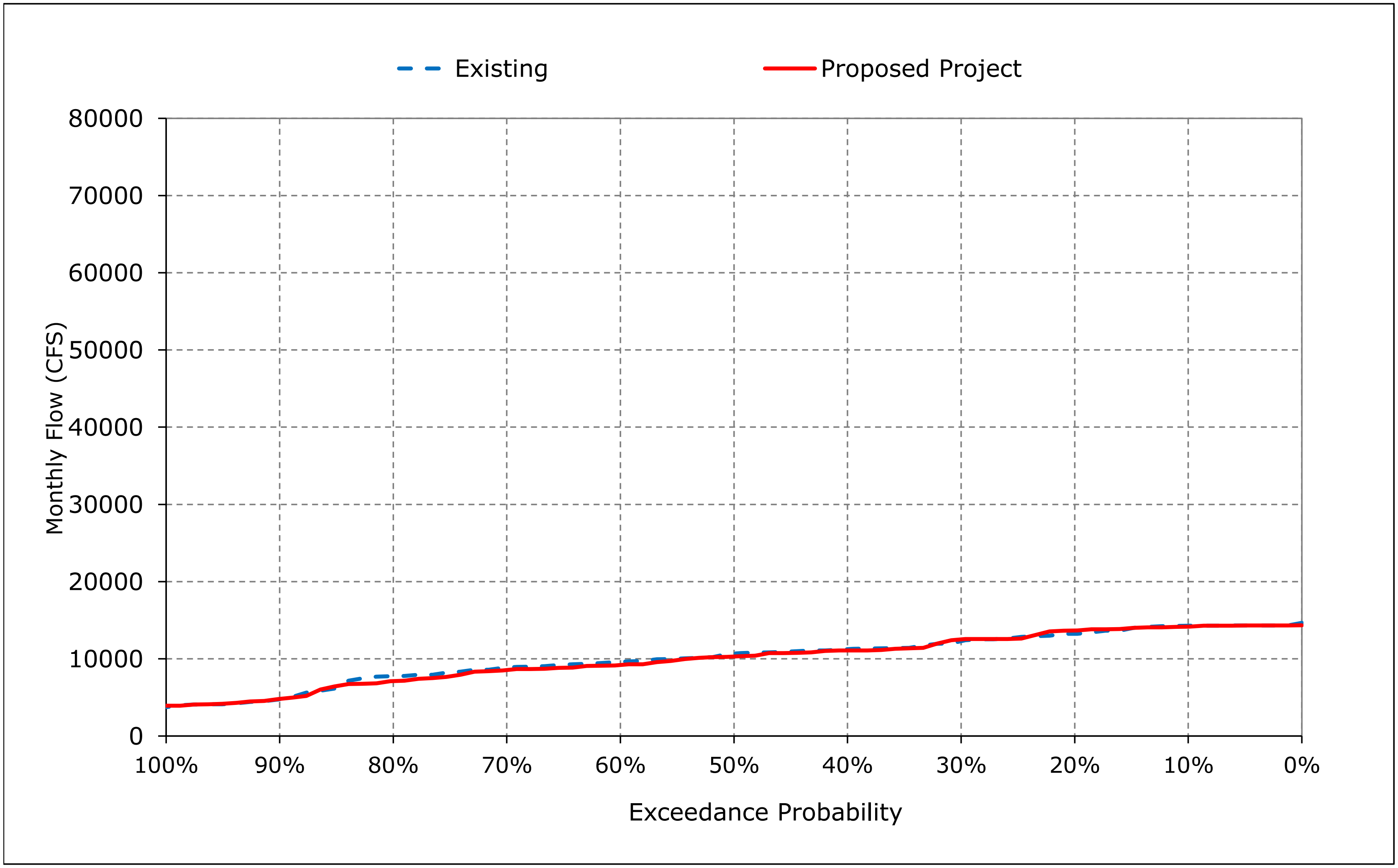


Figure 4-17. Sacramento River Flow at Rio Vista, August

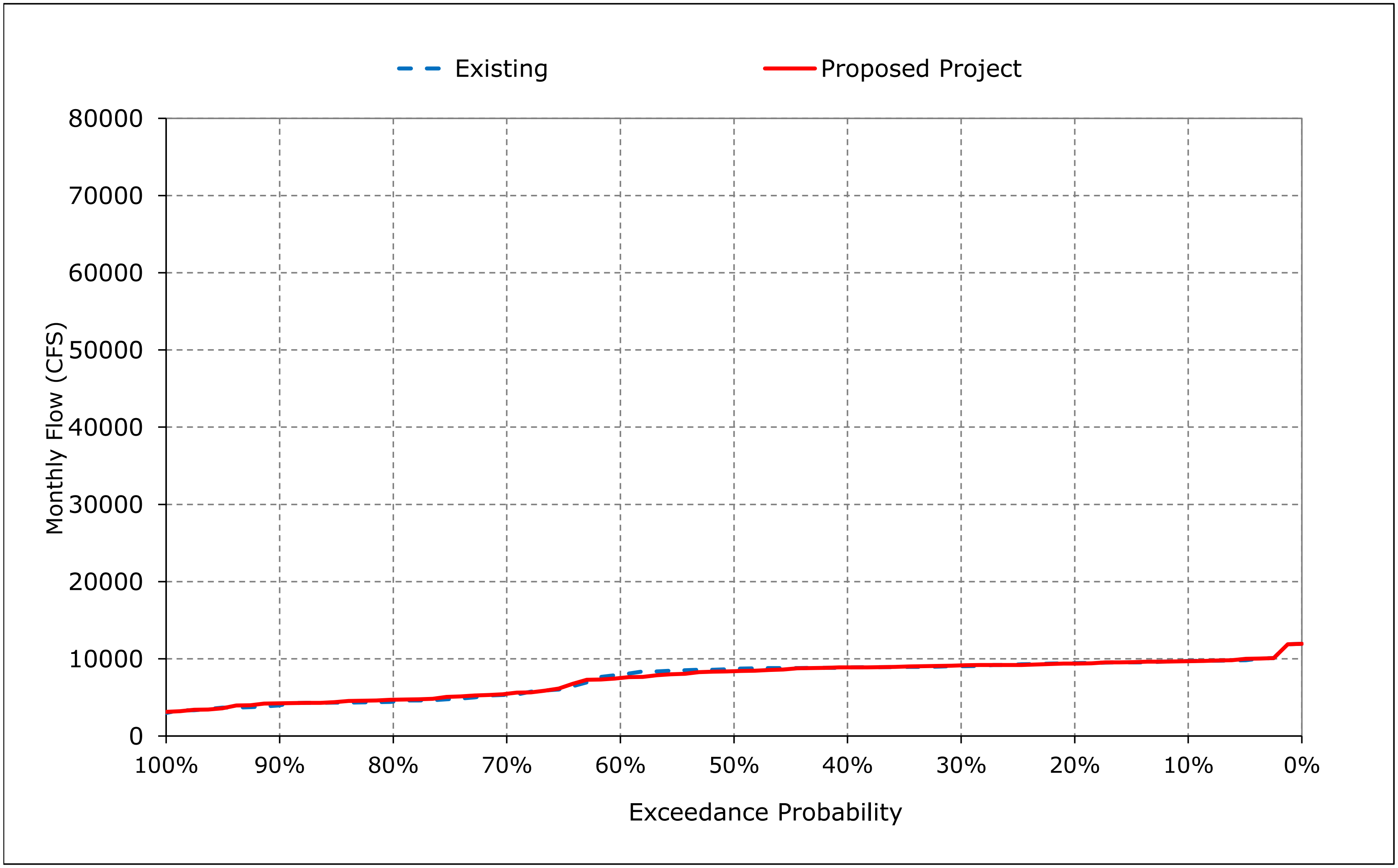


Figure 4-18. Sacramento River Flow at Rio Vista, September

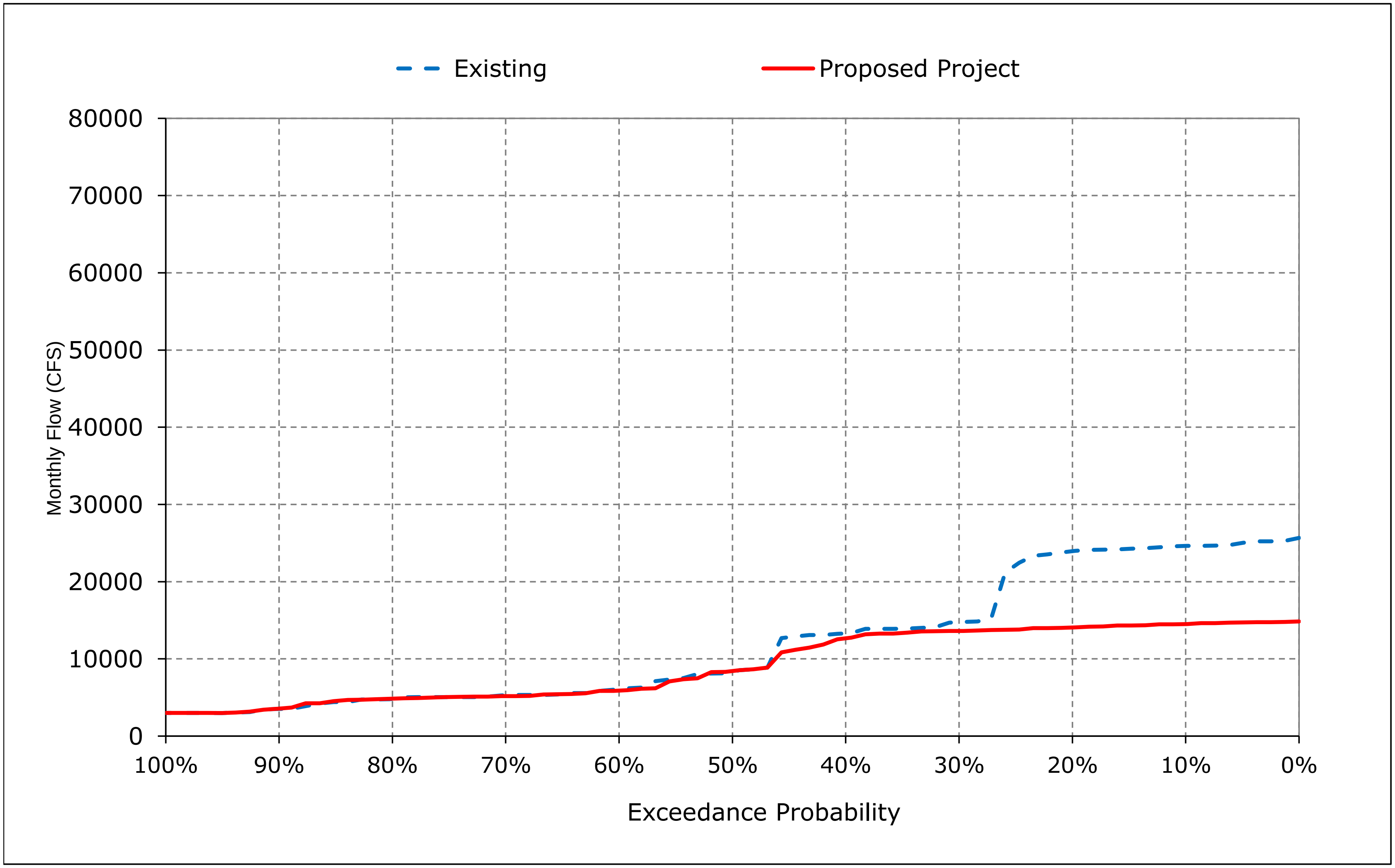


Table 5-1. San Joaquin River at Vernalis, Monthly Flow

Existing

Statistic	Monthly Flow (CFS)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	3,478	2,775	4,265	10,211	14,013	14,227	12,024	11,059	10,024	7,130	3,076	3,290
20%	3,115	2,561	2,816	5,121	9,911	9,351	7,937	7,369	6,949	3,529	2,780	2,817
30%	2,940	2,367	2,311	3,370	6,914	8,049	6,466	5,322	3,334	2,404	2,422	2,570
40%	2,757	2,182	2,116	2,572	4,292	6,202	5,382	4,426	2,962	1,783	1,880	2,321
50%	2,531	2,028	2,006	2,324	3,522	3,942	4,391	3,685	2,323	1,587	1,520	1,940
60%	2,405	1,957	1,936	2,179	2,808	3,420	3,513	2,937	1,845	1,393	1,437	1,842
70%	2,219	1,853	1,840	1,955	2,280	2,363	3,001	2,618	1,505	1,209	1,345	1,779
80%	2,049	1,746	1,740	1,749	2,228	1,888	2,262	2,176	1,426	1,140	1,265	1,670
90%	1,780	1,609	1,612	1,575	1,956	1,674	1,622	1,680	1,043	923	1,087	1,495
Long Term												
Full Simulation Period[a]	2,647	2,387	3,115	4,766	6,366	6,884	5,961	5,364	4,211	3,170	2,057	2,345
Water Year Types[b,c]												
Wet (32%)	2,976	3,062	4,916	9,348	11,567	13,134	10,528	9,615	8,281	6,511	3,177	3,318
Above Normal (15%)	2,337	1,975	2,828	4,077	6,178	7,223	5,874	5,054	4,541	2,744	2,026	2,377
Below Normal (17%)	2,623	2,191	2,628	3,008	5,667	4,920	4,897	4,380	2,478	1,779	1,840	2,096
Dry (22%)	2,632	2,157	2,036	2,065	2,477	2,650	3,125	2,672	1,589	1,220	1,330	1,767
Critical (15%)	2,293	1,907	1,686	1,627	1,937	1,643	1,646	1,652	1,021	907	1,004	1,358

Proposed Project

Statistic	Monthly Flow (CFS)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	3,479	2,776	4,265	10,216	14,903	14,724	12,153	11,839	10,077	7,137	3,464	3,511
20%	3,111	2,546	2,824	5,151	9,887	9,602	8,478	7,364	6,957	3,546	2,791	2,830
30%	2,941	2,353	2,290	3,541	7,093	7,868	6,633	5,277	2,856	2,422	2,432	2,528
40%	2,792	2,183	2,106	2,630	4,533	6,153	5,517	4,504	2,411	1,776	1,870	2,295
50%	2,556	2,028	2,006	2,407	3,486	3,942	4,456	3,532	2,101	1,578	1,517	1,943
60%	2,400	1,957	1,936	2,183	2,685	3,280	3,749	3,196	1,790	1,377	1,425	1,835
70%	2,197	1,853	1,840	1,941	2,272	2,363	2,799	2,355	1,438	1,202	1,345	1,747
80%	2,034	1,747	1,740	1,753	2,006	1,733	2,001	2,068	1,315	1,099	1,248	1,670
90%	1,759	1,609	1,612	1,569	1,768	1,499	1,515	1,523	999	908	1,079	1,479
Long Term												
Full Simulation Period[a]	2,650	2,383	3,103	4,759	6,447	6,777	5,970	5,328	4,070	3,189	2,067	2,360
Water Year Types[b,c]												
Wet (32%)	2,975	3,059	4,887	9,328	11,916	13,096	10,523	9,494	8,148	6,606	3,235	3,378
Above Normal (15%)	2,320	1,975	2,828	4,075	6,266	7,190	6,109	5,220	4,353	2,752	2,032	2,381
Below Normal (17%)	2,660	2,191	2,628	3,013	5,575	4,753	5,178	4,554	2,274	1,781	1,842	2,095
Dry (22%)	2,611	2,146	2,025	2,061	2,405	2,510	2,887	2,501	1,454	1,198	1,308	1,754
Critical (15%)	2,322	1,907	1,686	1,628	1,856	1,431	1,514	1,554	968	851	973	1,351

Proposed Project minus Existing

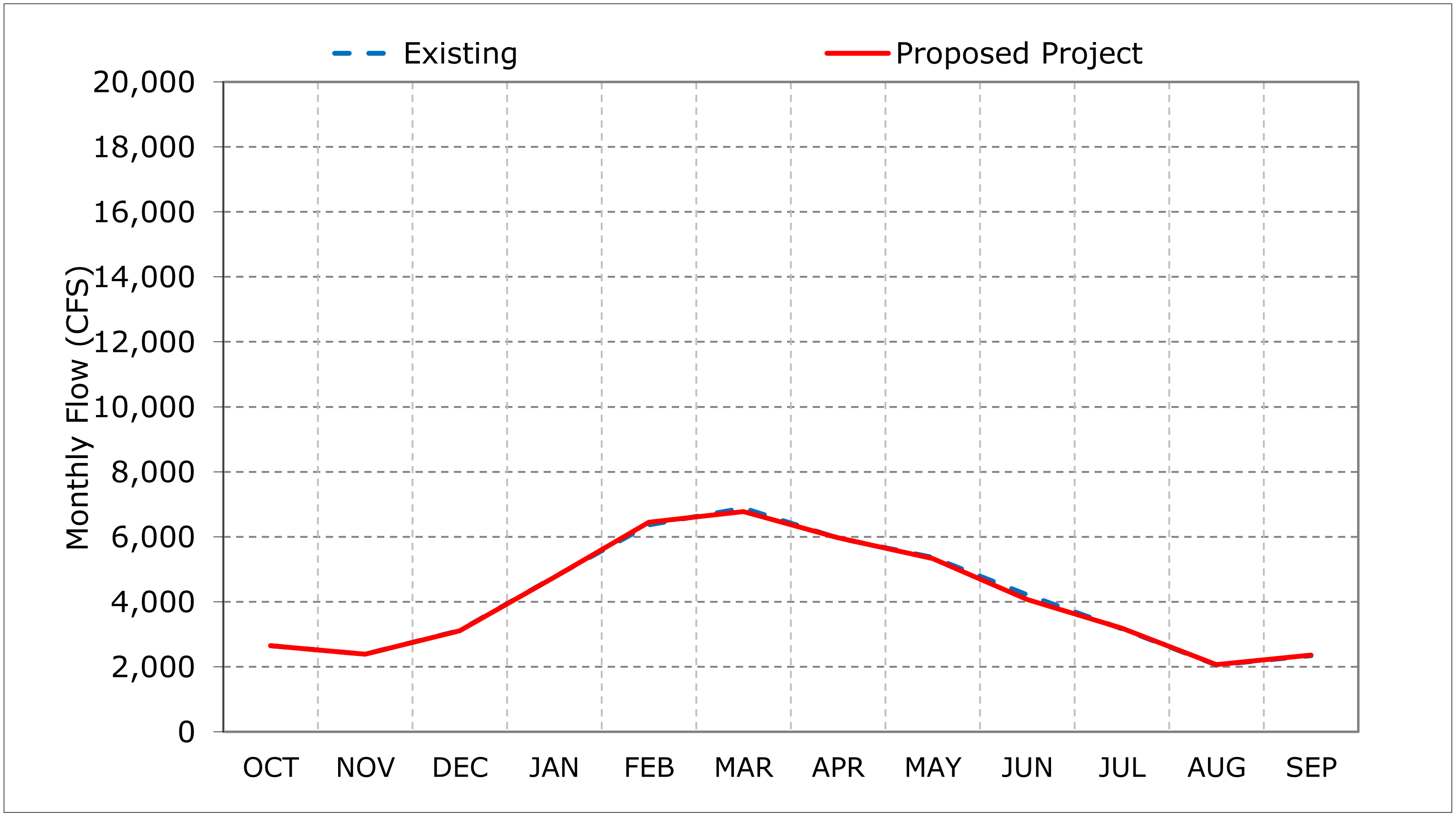
Statistic	Monthly Flow (CFS)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	0	0	0	5	889	496	129	780	54	8	388	222
20%	-5	-15	8	30	-24	251	541	-6	8	18	11	13
30%	2	-14	-21	171	179	-181	167	-45	-478	18	10	-43
40%	35	0	-10	58	241	-49	135	78	-551	-7	-10	-27
50%	25	0	0	82	-36	0	65	-153	-222	-9	-3	3
60%	-5	0	0	4	-123	-140	235	259	-55	-16	-12	-7
70%	-22	0	0	-14	-8	0	-203	-263	-67	-7	0	-32
80%	-15	0	0	3	-223	-155	-261	-109	-111	-40	-16	1
90%	-21	0	0	-6	-187	-175	-107	-156	-43	-15	-7	-16
Long Term												
Full Simulation Period[a]	3	-3	-12	-7	80	-107	9	-36	-142	18	10	15
Water Year Types[b,c]												
Wet (32%)	-1	-3	-30	-20	349	-38	-5	-121	-133	95	59	60
Above Normal (15%)	-17	0	0	-2	88	-33	235	167	-188	8	6	3
Below Normal (17%)	36	0	0	5	-92	-167	281	174	-205	2	2	-2
Dry (22%)	-21	-11	-11	-4	-72	-140	-238	-171	-135	-22	-22	-13
Critical (15%)	29	0	0	2	-81	-212	-132	-98	-53	-57	-32	-7

a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

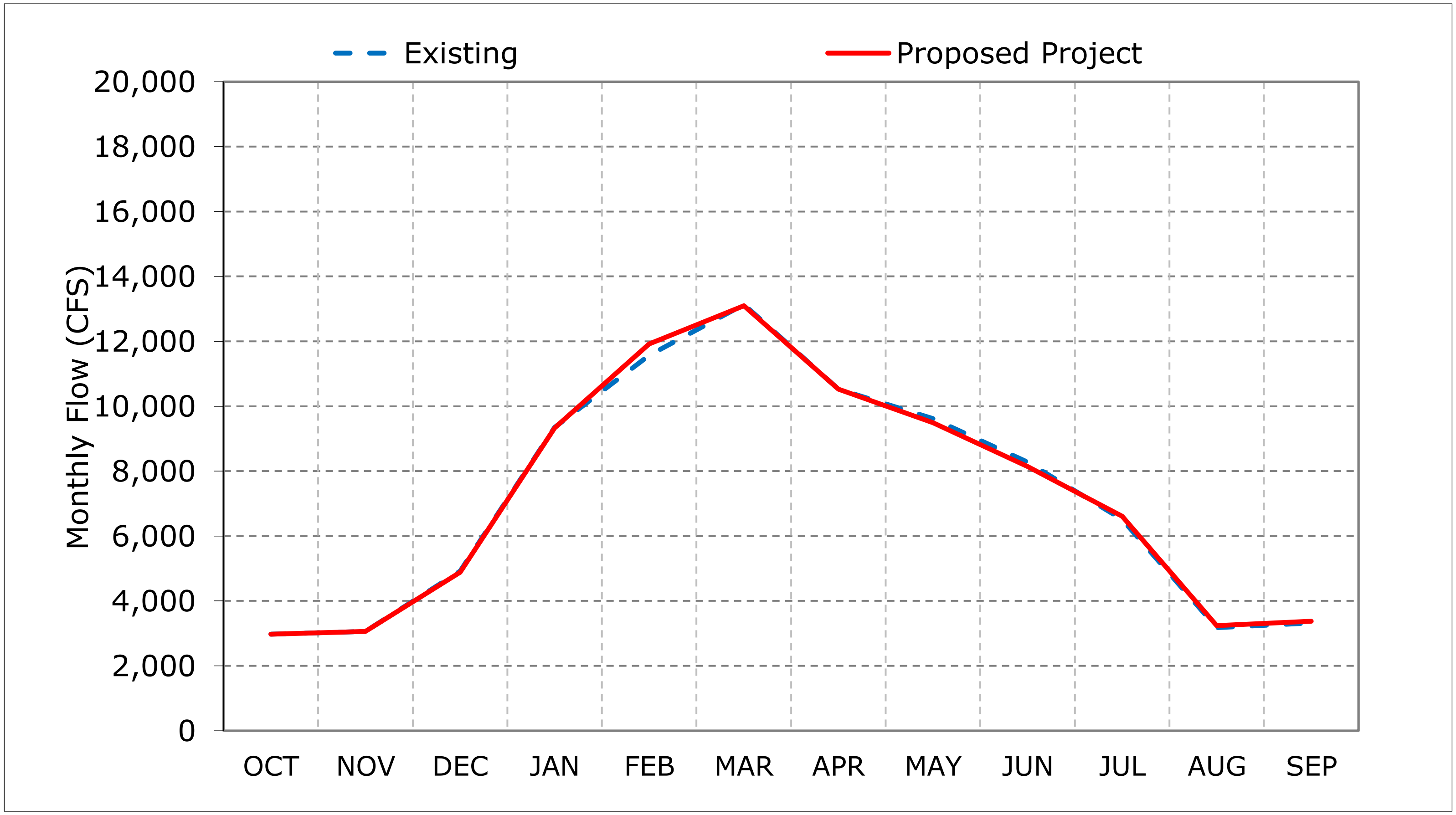
c These results are displayed with water year - year type sorting.

Figure 5-1. San Joaquin River at Vernalis, Long-Term Average Flow



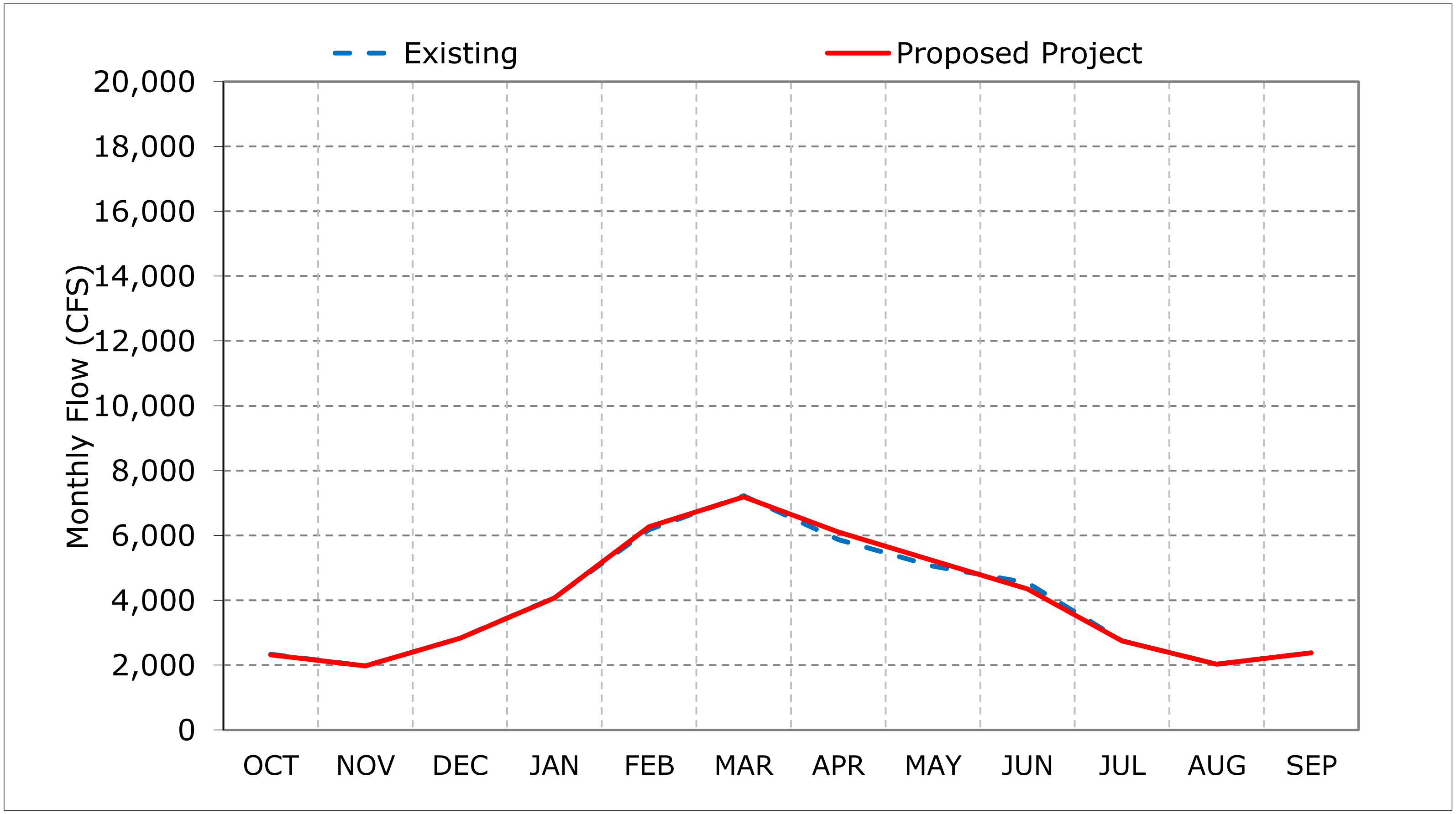
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 5-2. San Joaquin River at Vernalis, Wet Year Average Flow



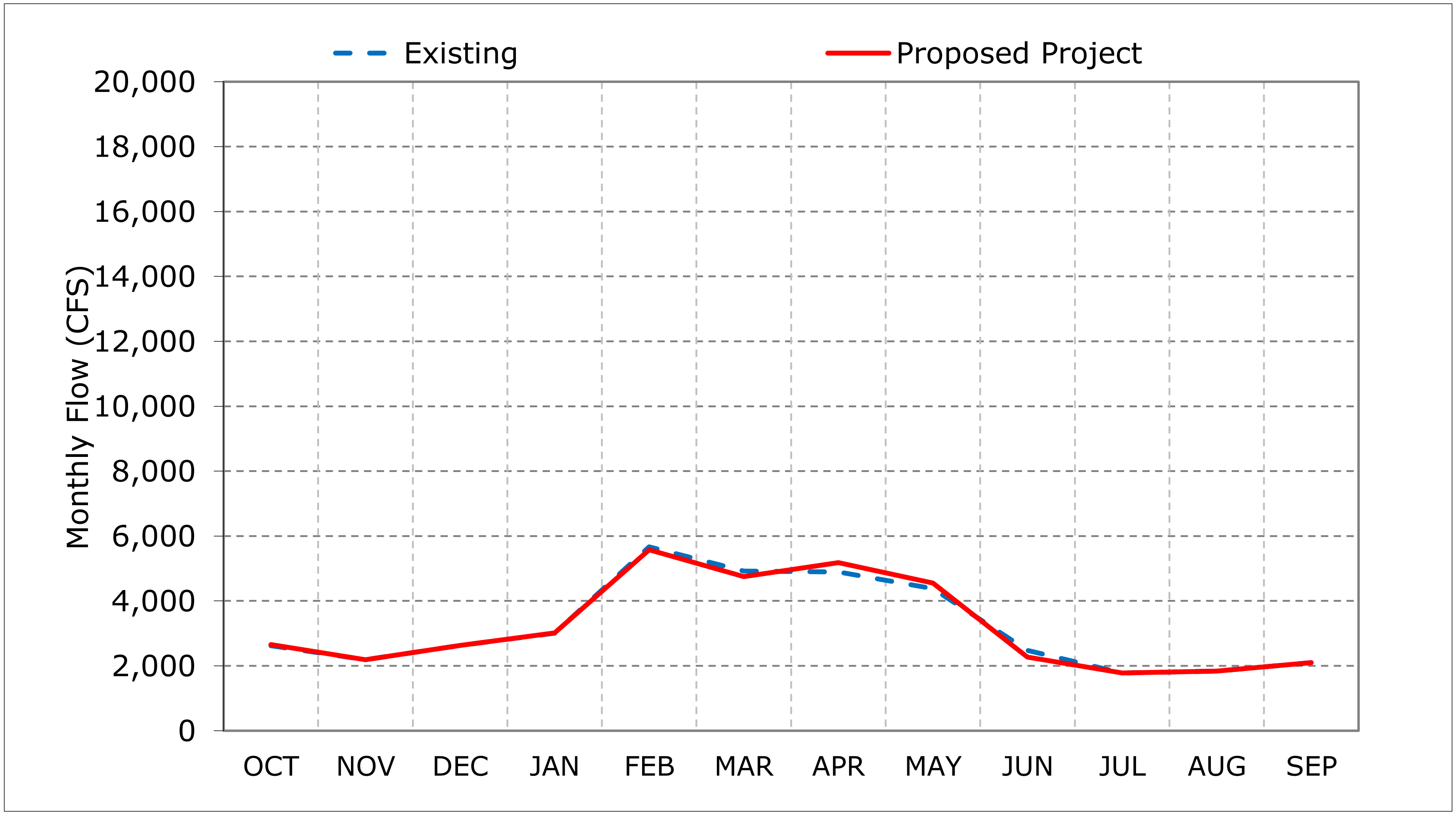
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 5-3. San Joaquin River at Vernalis, Above Normal Year Average Flow



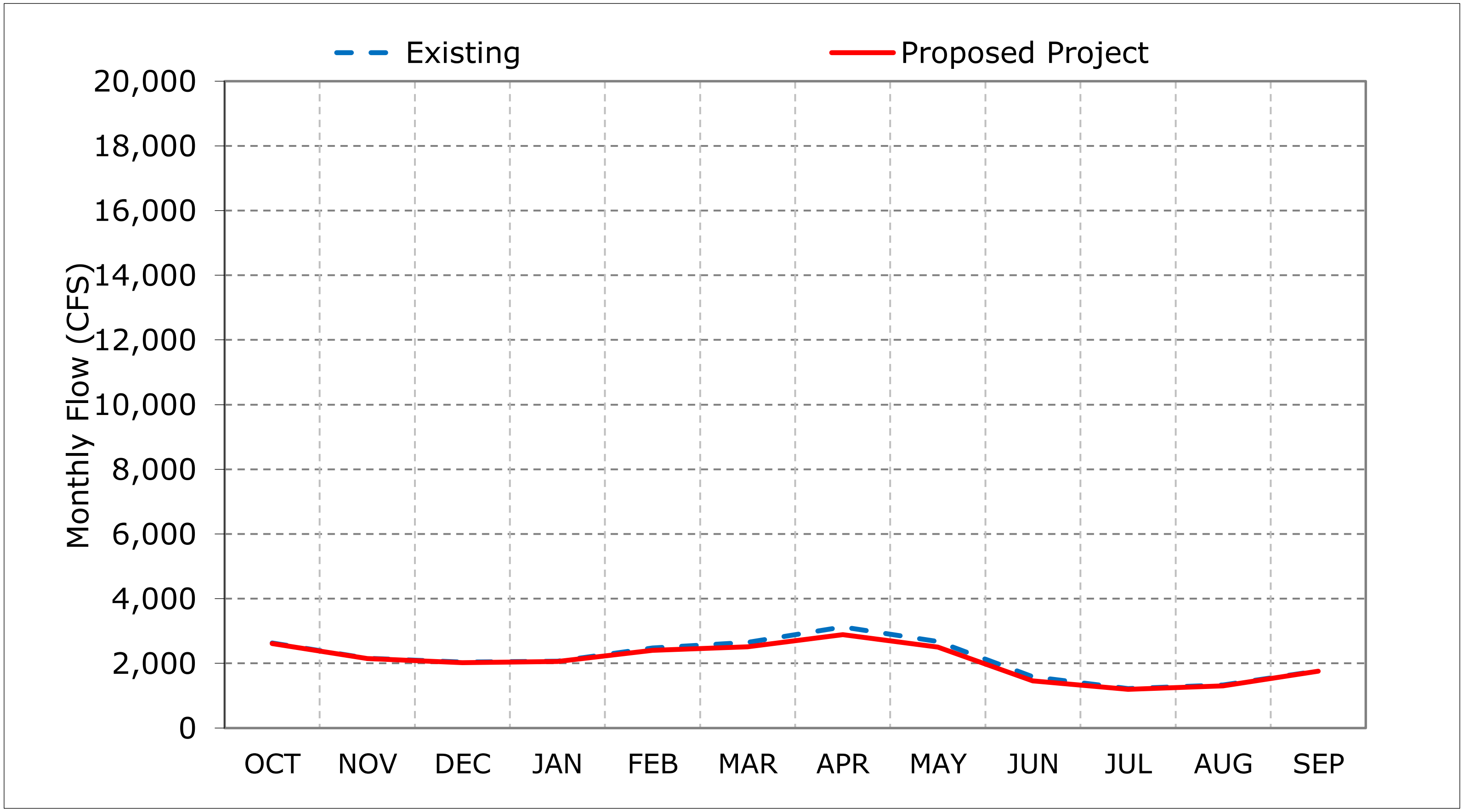
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 5-4. San Joaquin River at Vernalis, Below Normal Year Average Flow



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

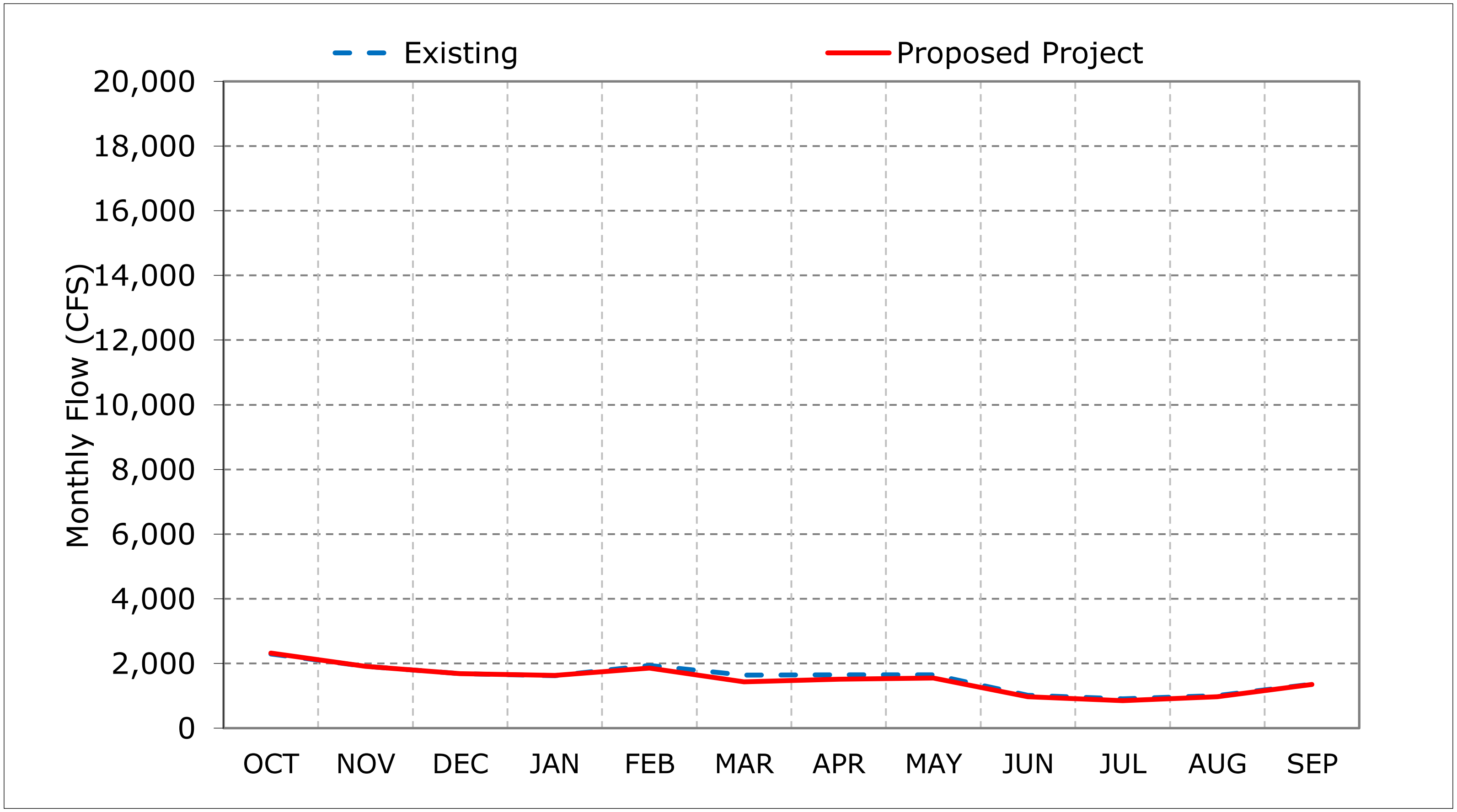
Figure 5-5. San Joaquin River at Vernalis, Dry Year Average Flow



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164

*These results are displayed with water year - year type sorting.

Figure 5-6. San Joaquin River at Vernalis, Critical Year Average Flow



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 5-7. San Joaquin River at Vernalis, October

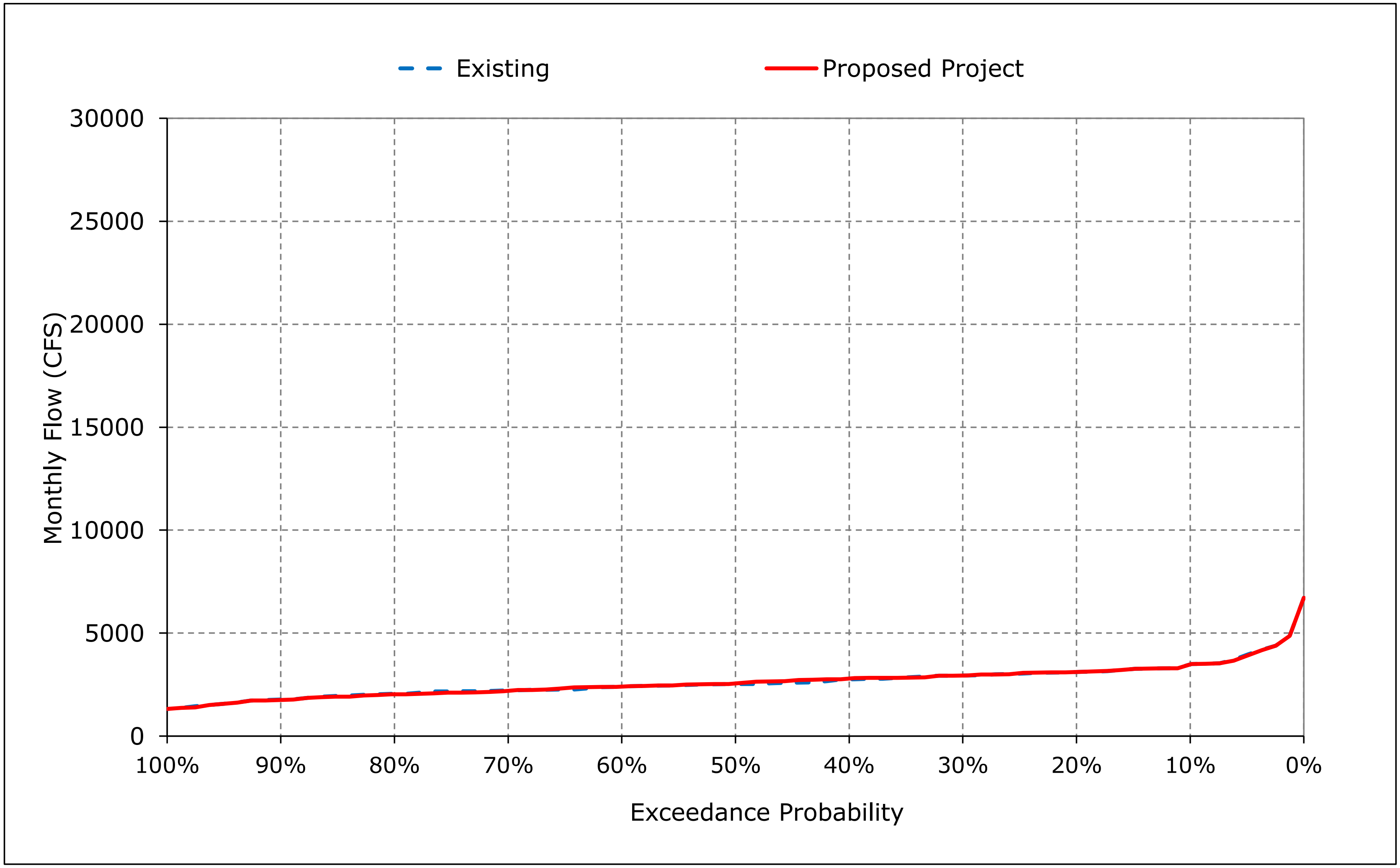


Figure 5-8. San Joaquin River at Vernalis, November

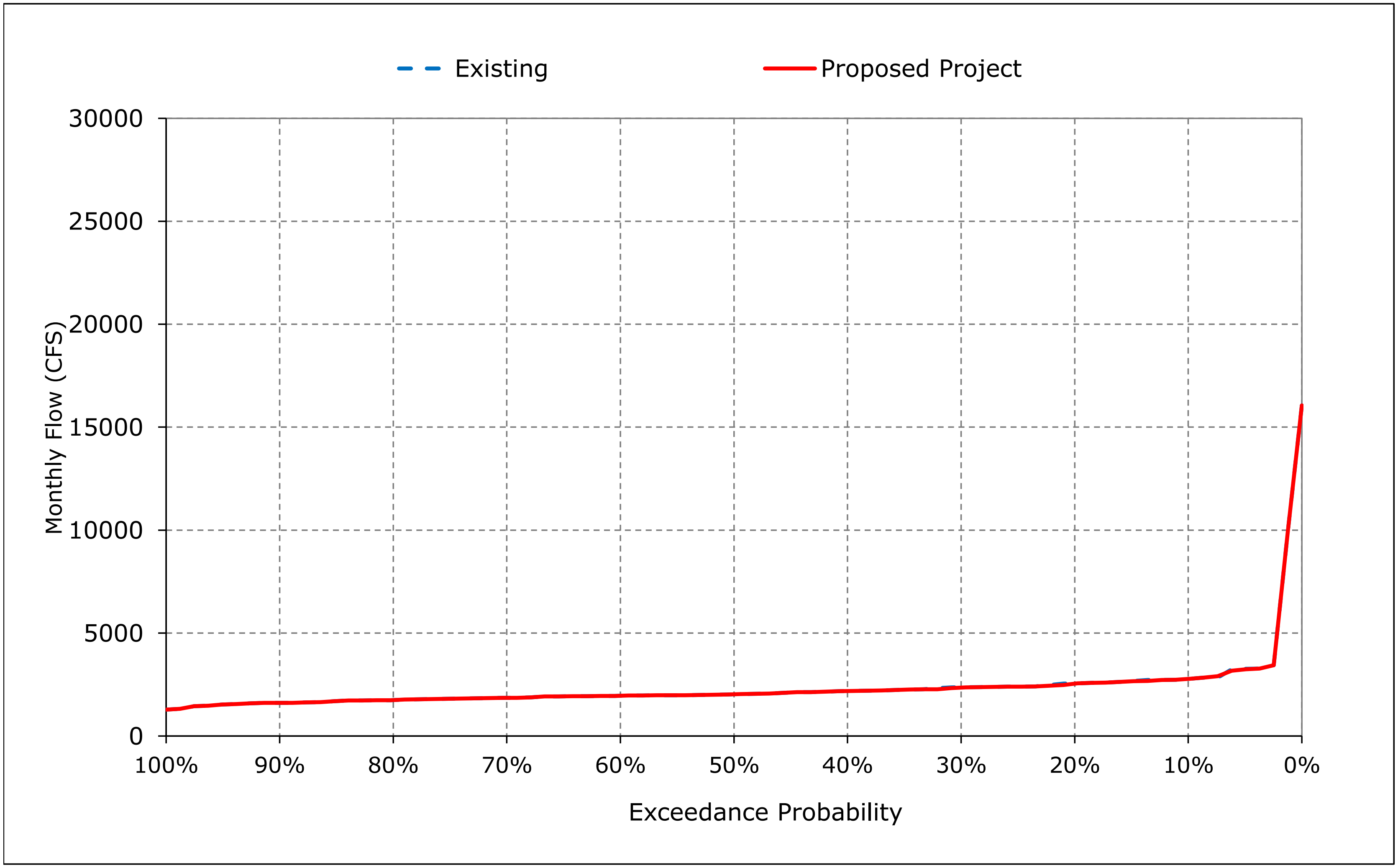


Figure 5-9. San Joaquin River at Vernalis, December

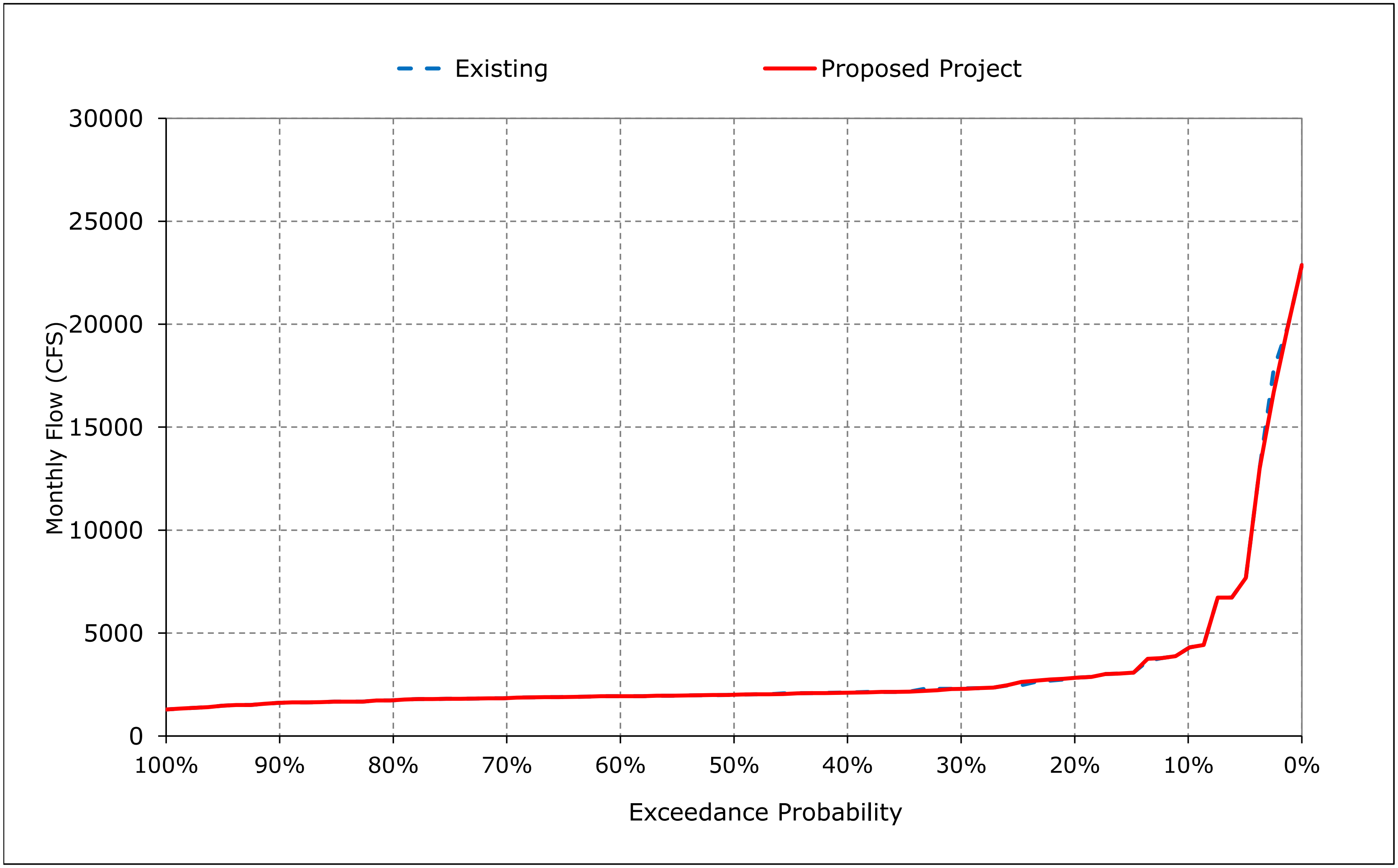


Figure 5-10. San Joaquin River at Vernalis, January

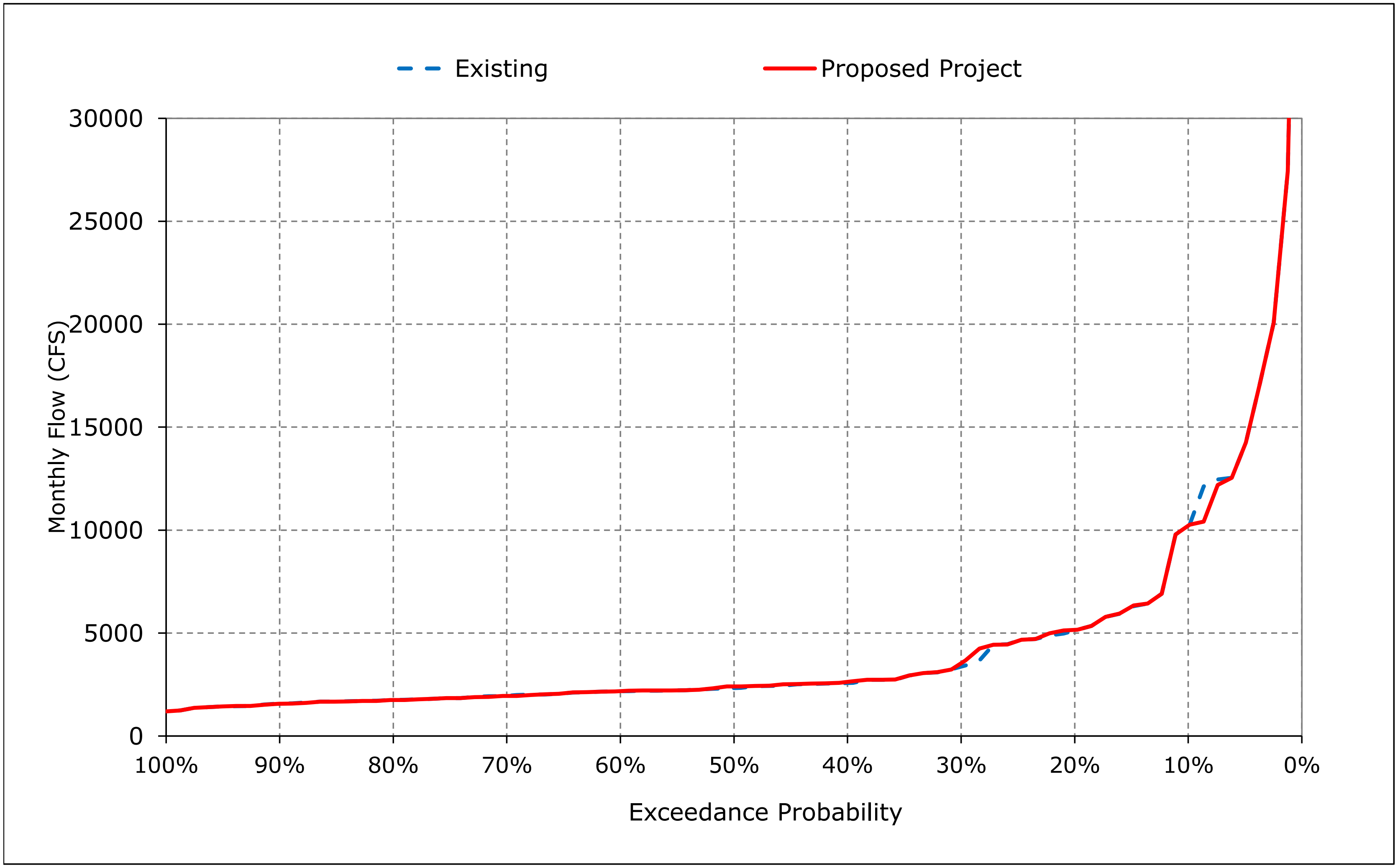


Figure 5-11. San Joaquin River at Vernalis, February

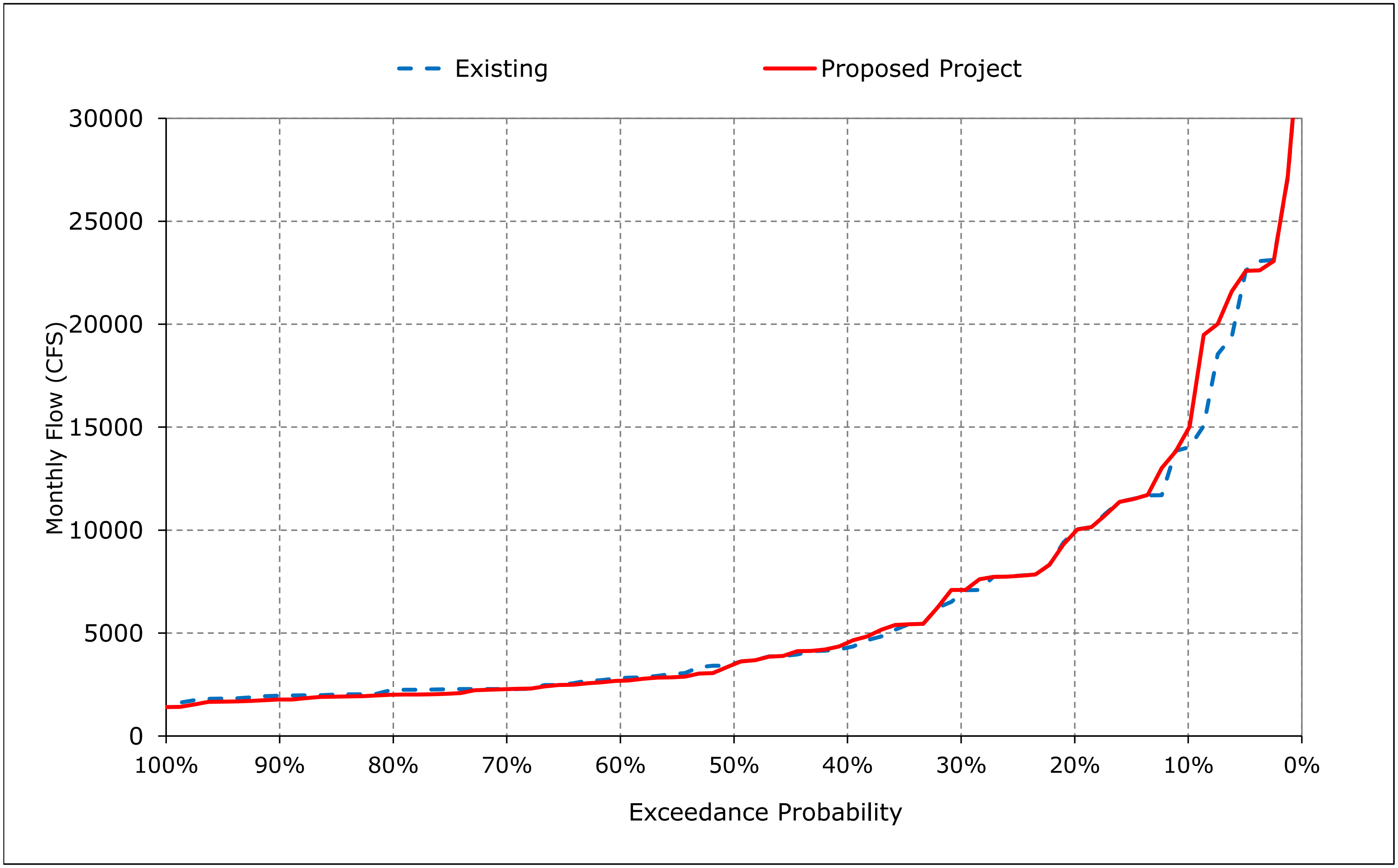


Figure 5-12. San Joaquin River at Vernalis, March

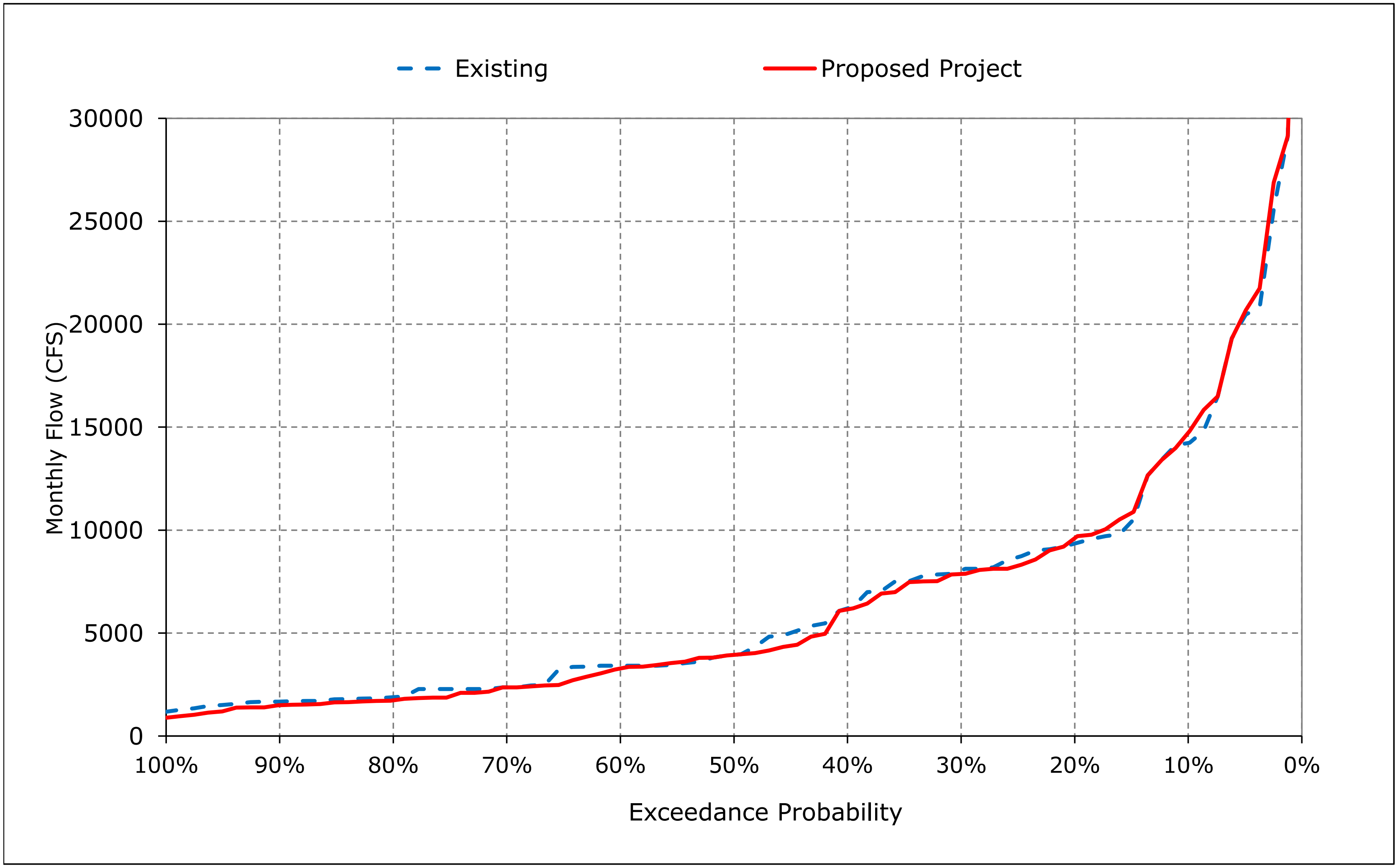


Figure 5-13. San Joaquin River at Vernalis, April

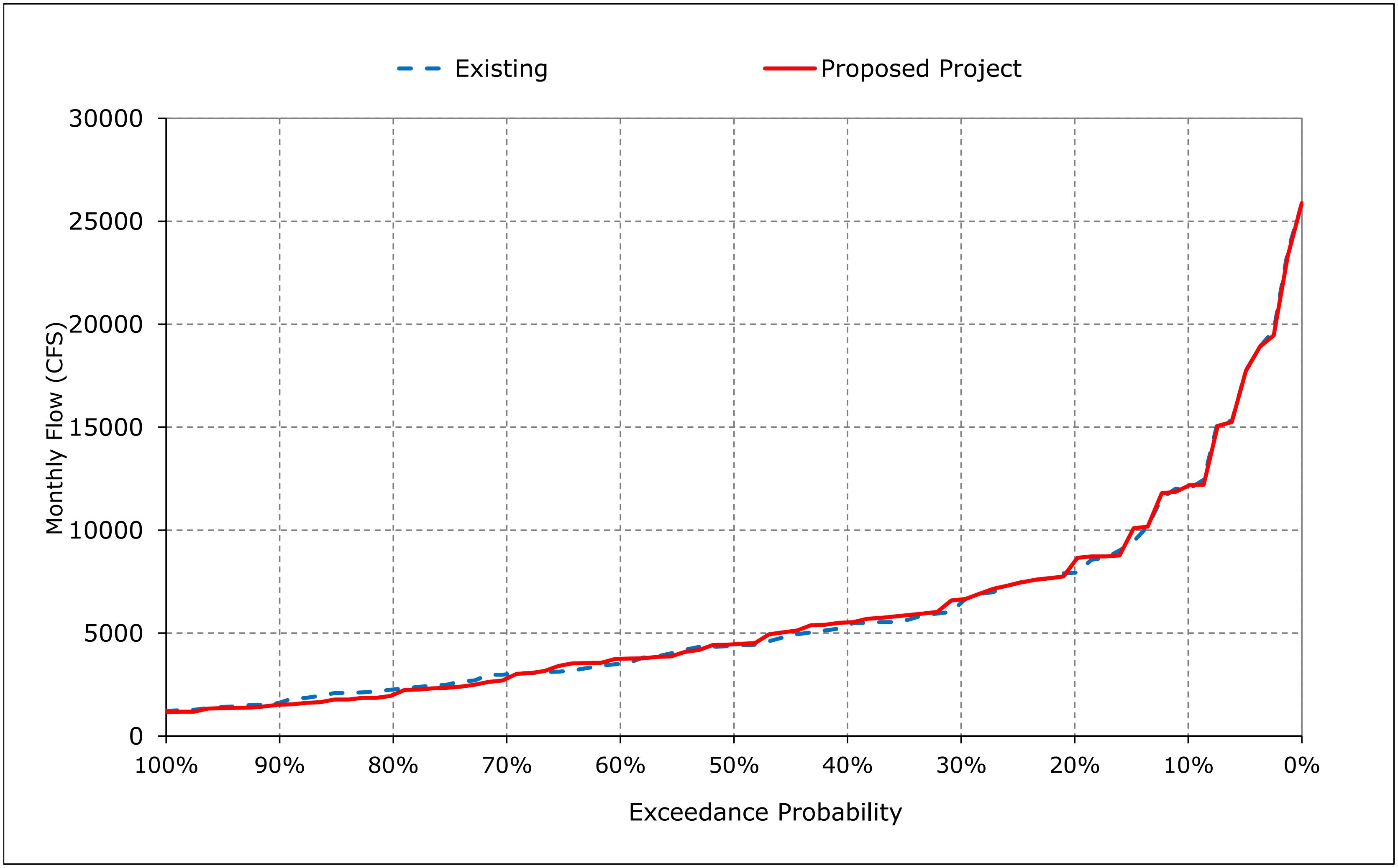


Figure 5-14. San Joaquin River at Vernalis, May

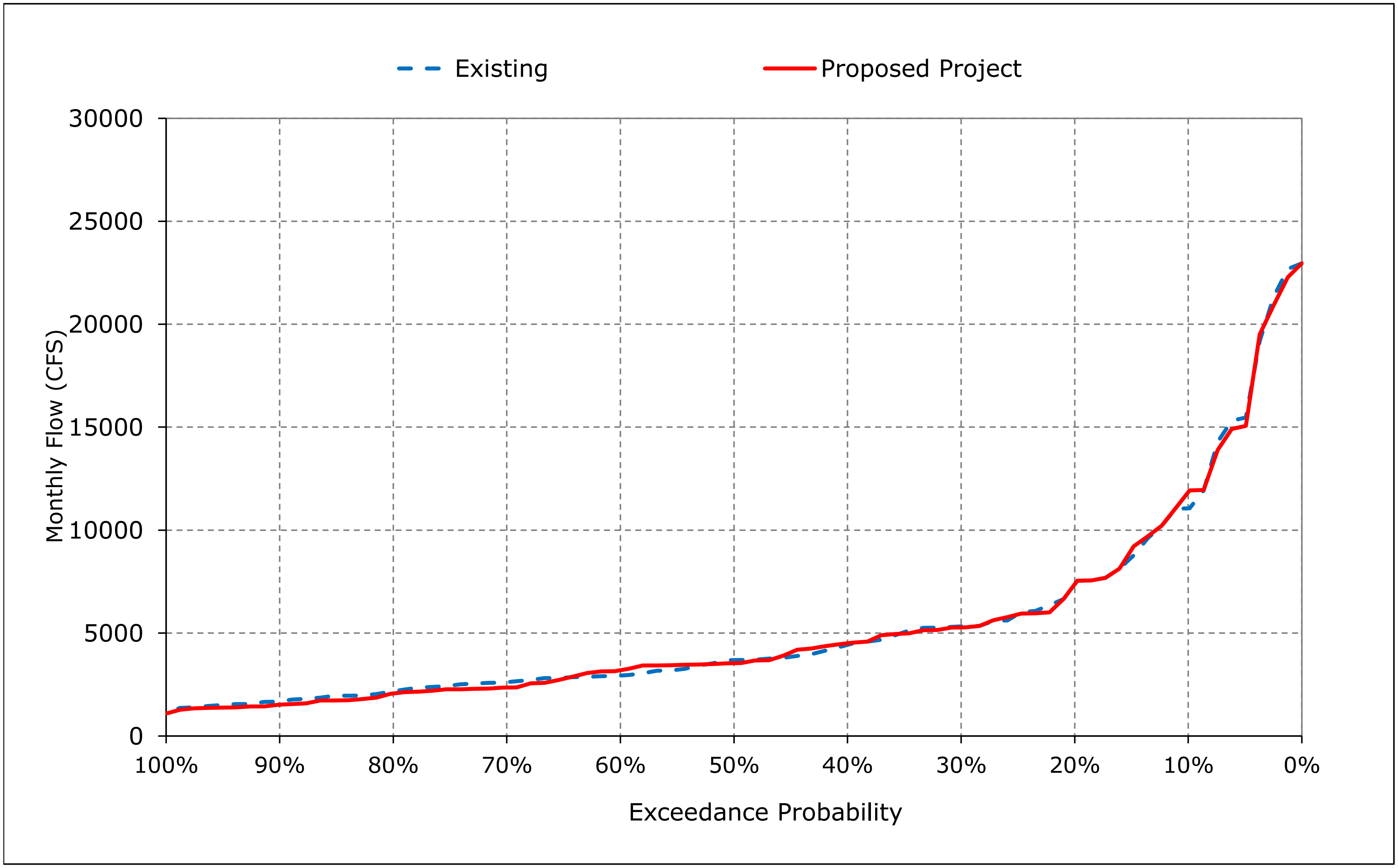


Figure 5-15. San Joaquin River at Vernalis, June

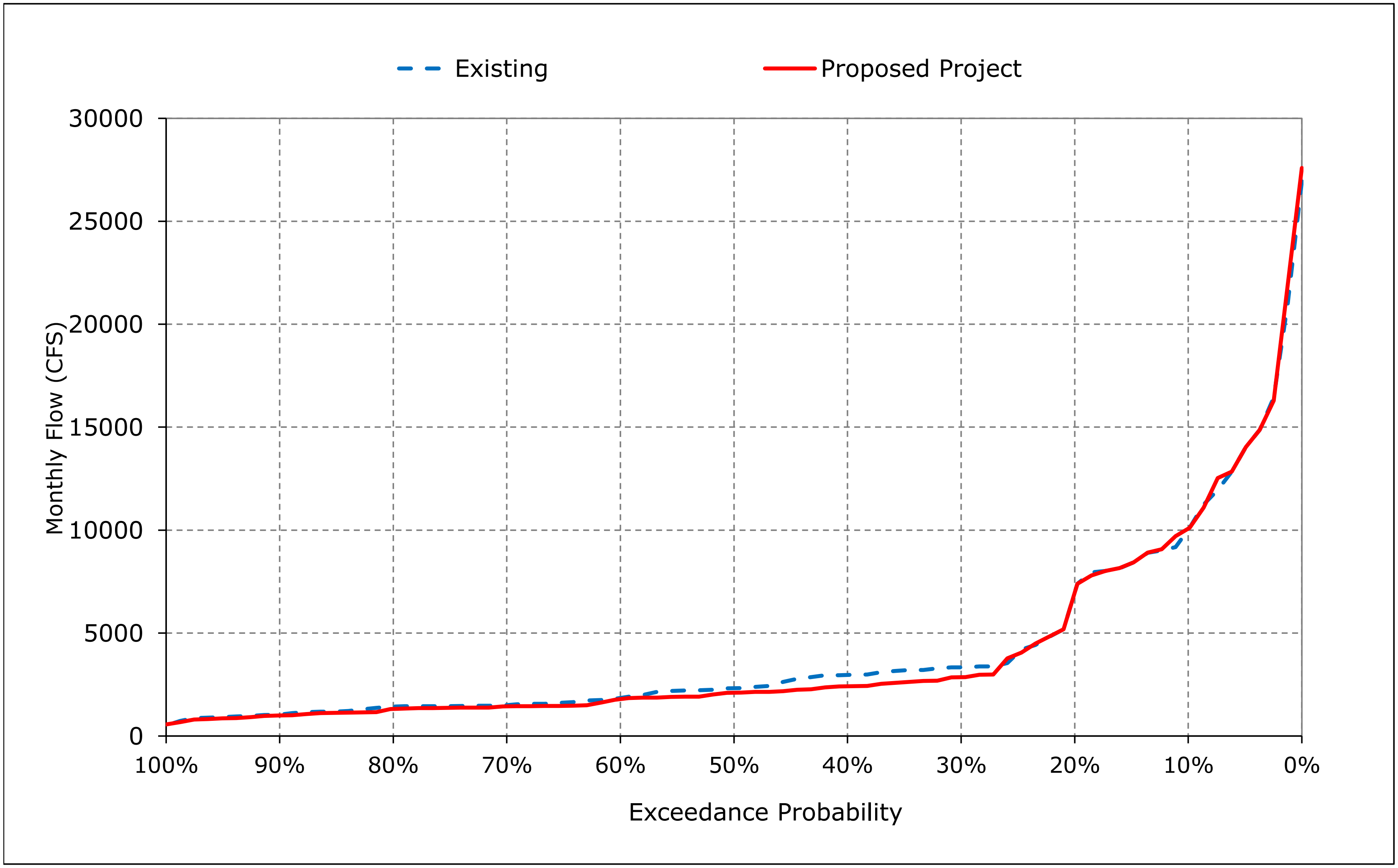


Figure 5-16. San Joaquin River at Vernalis, July

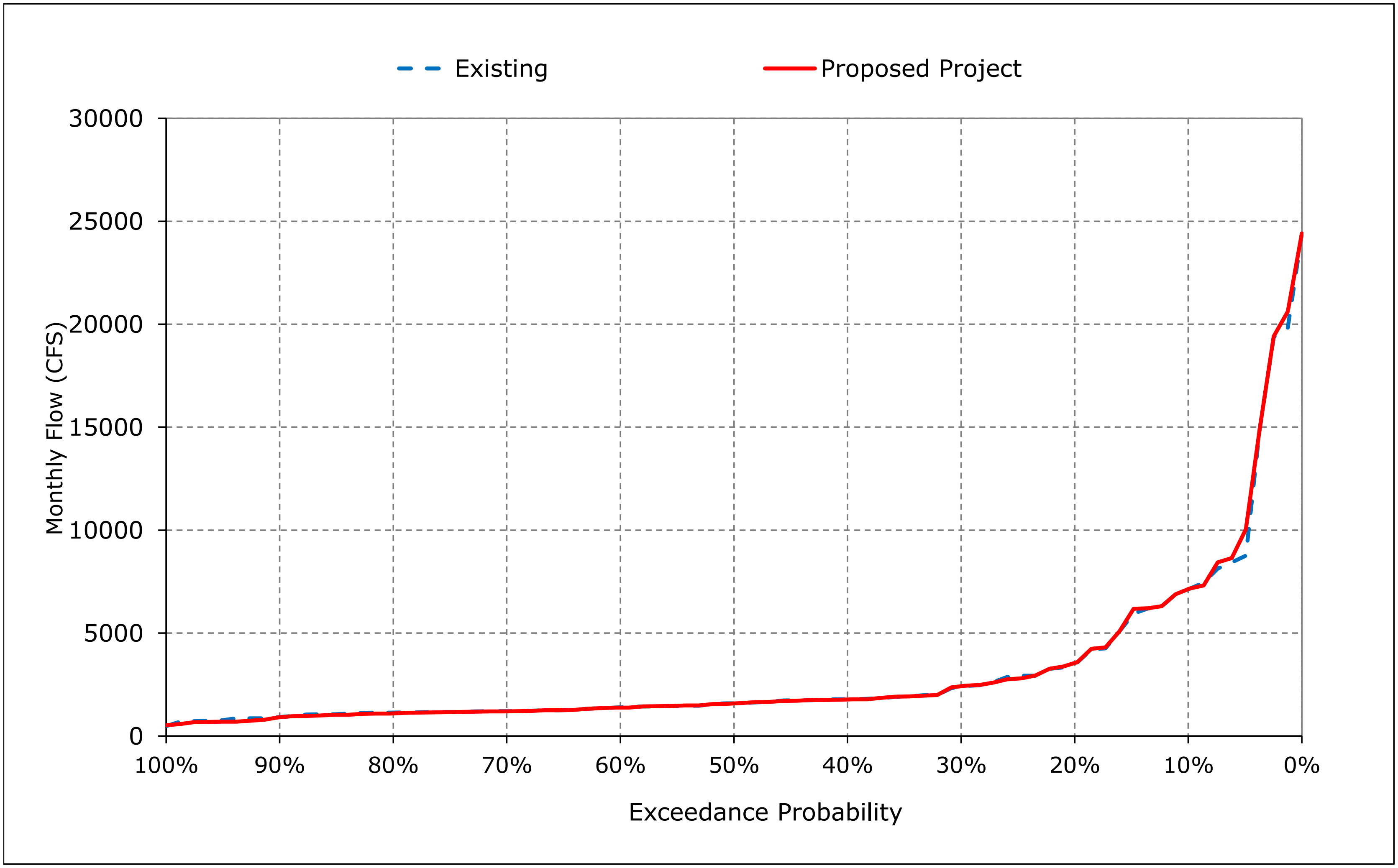


Figure 5-17. San Joaquin River at Vernalis, August

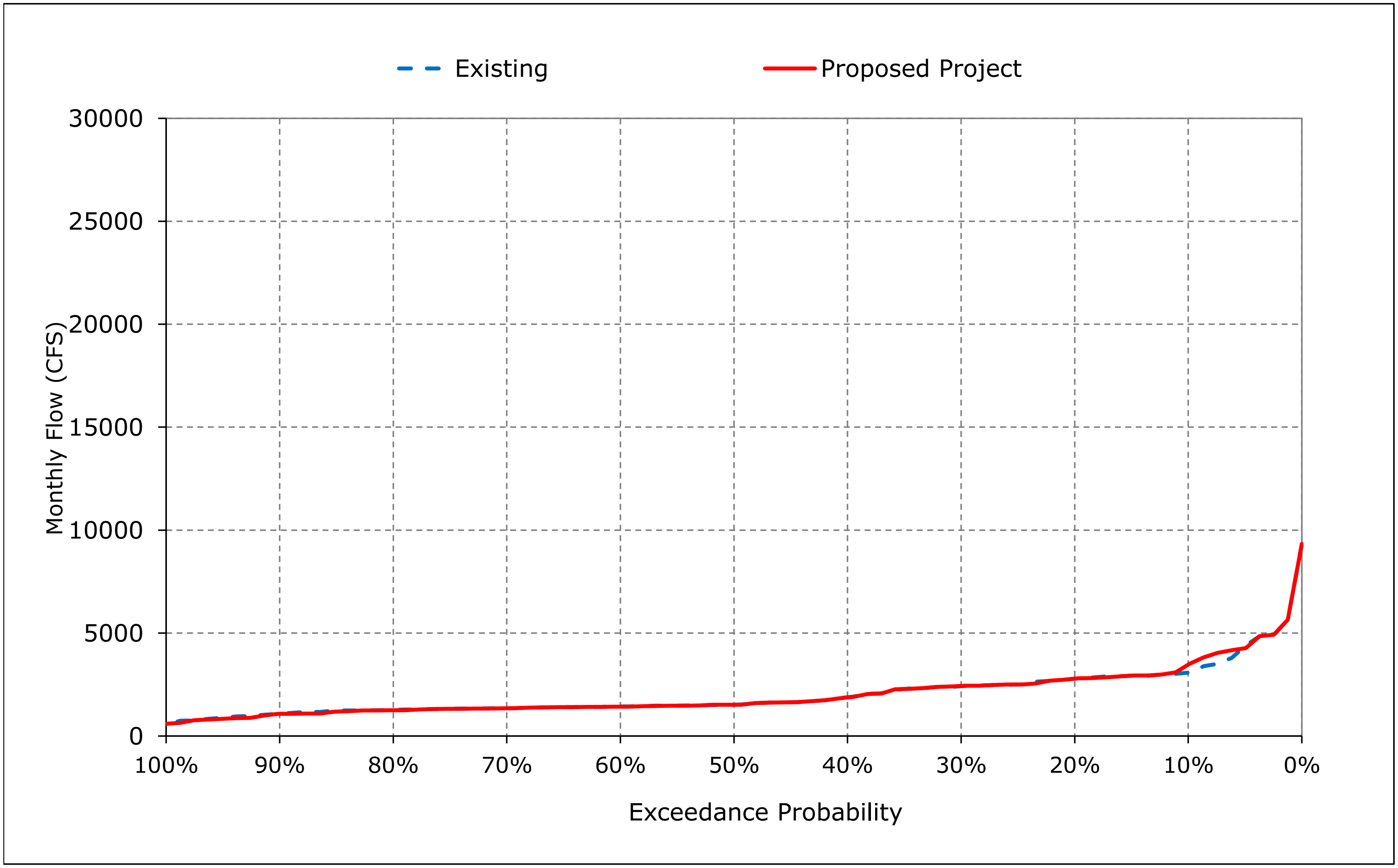


Figure 5-18. San Joaquin River at Vernalis, September

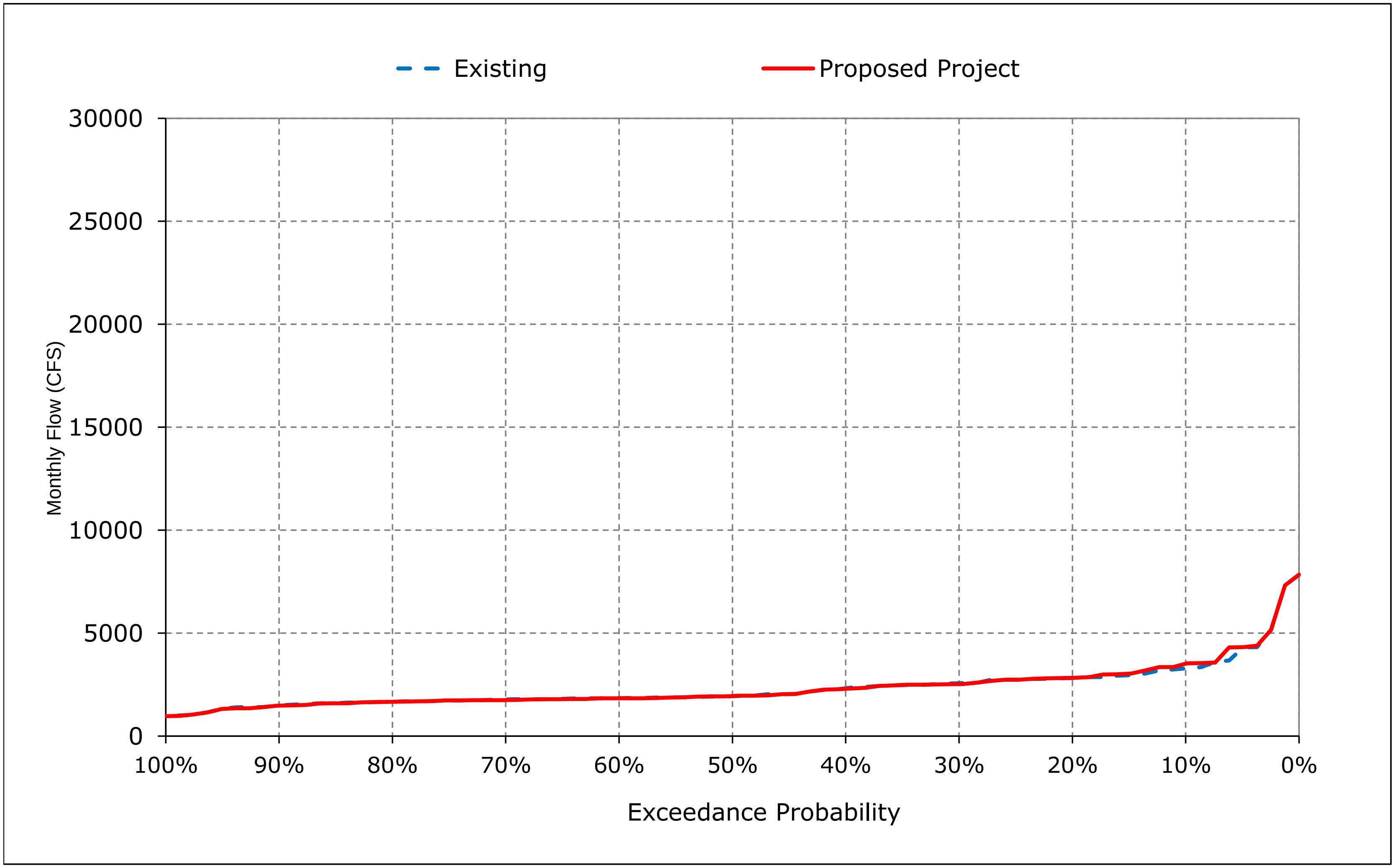


Table 6-1. Mokelumne River below Consumnes, Monthly Flow

Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Flow (CFS)											
Probability of Exceedance												
10%	803	1,033	2,131	3,558	4,038	3,475	3,831	3,723	2,588	828	305	385
20%	631	714	879	2,337	3,063	2,618	2,518	2,729	1,706	578	237	282
30%	556	571	581	1,479	2,338	2,419	2,004	1,769	1,308	340	143	219
40%	475	509	488	886	1,605	1,704	1,592	1,406	713	268	73	164
50%	414	459	435	703	1,246	1,297	1,322	1,029	465	95	54	102
60%	321	407	388	520	868	1,018	923	790	349	56	46	85
70%	277	365	330	432	685	842	707	502	163	50	44	50
80%	222	241	265	355	509	687	607	354	83	46	41	42
90%	183	188	216	292	393	522	313	200	53	43	37	38
Long Term												
Full Simulation Period[a]	444	598	902	1,479	1,858	1,892	1,693	1,527	977	385	136	172
Water Year Types[b,c]												
Wet (32%)	545	831	1,643	2,918	3,368	3,357	2,962	2,824	2,025	905	276	318
Above Normal (15%)	398	773	966	1,811	2,019	2,280	1,836	1,627	1,083	331	129	174
Below Normal (17%)	464	529	702	833	1,536	1,325	1,596	1,314	670	151	72	107
Dry (22%)	404	413	377	455	775	889	739	620	215	79	46	68
Critical (15%)	305	280	257	315	422	495	345	225	103	44	50	85

Proposed Project

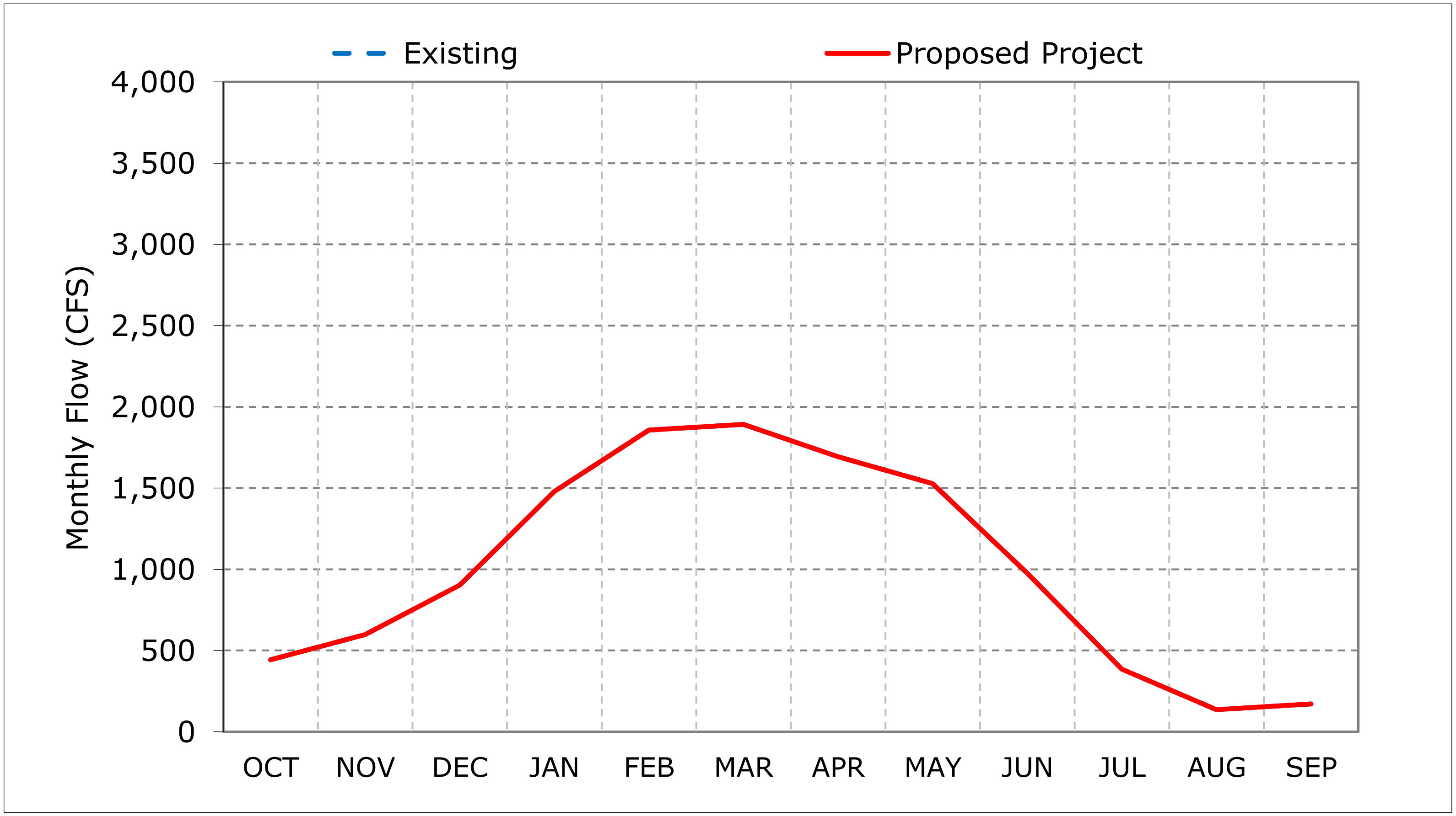
Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Flow (CFS)											
Probability of Exceedance												
10%	803	1,033	2,131	3,558	4,038	3,475	3,831	3,723	2,588	828	305	385
20%	631	714	879	2,337	3,063	2,618	2,518	2,729	1,706	578	237	282
30%	556	571	581	1,479	2,339	2,419	2,004	1,769	1,309	341	143	219
40%	475	509	488	886	1,605	1,704	1,592	1,406	713	268	73	164
50%	414	459	435	703	1,246	1,297	1,322	1,029	465	94	54	102
60%	321	408	388	520	868	1,018	923	791	349	56	47	86
70%	277	365	331	433	685	842	707	502	163	50	44	50
80%	222	242	266	355	509	687	608	354	83	46	41	42
90%	183	188	217	292	393	522	313	200	53	43	38	38
Long Term												
Full Simulation Period[a]	444	599	903	1,479	1,858	1,892	1,693	1,527	977	385	136	172
Water Year Types[b,c]												
Wet (32%)	546	831	1,643	2,918	3,368	3,357	2,962	2,824	2,025	905	276	318
Above Normal (15%)	398	773	966	1,811	2,019	2,281	1,836	1,627	1,083	331	129	174
Below Normal (17%)	464	529	702	834	1,536	1,325	1,596	1,314	670	151	72	107
Dry (22%)	404	413	377	455	775	889	740	620	215	80	46	68
Critical (15%)	305	280	257	315	422	495	345	225	103	44	50	85

Proposed Project minus Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Flow (CFS)											
Probability of Exceedance												
10%	0	0	0	0	0	0	0	0	0	0	0	0
20%	0	0	0	0	0	0	0	**0**	0	0	0	0
30%	0	**0**	0	0	1	0	**0**	0	0	0	0	0
40%	0	0	0	0	0	0	0	0	0	0	0	0
50%	0	0	0	0	0	0	0	0	0	**0**	0	**0**
60%	0	0	0	0	0	**0**	0	1	0	0	1	1
70%	0	0	2	1	0	0	0	0	1	0	0	**0**
80%	0	0	0	0	0	0	0	0	0	0	0	0
90%	0	0	0	0	0	0	0	0	0	0	0	0
Long Term												
Full Simulation Period[a]	0	0	0	0	0	0	0	0	0	0	0	0
Water Year Types[b,c]												
Wet (32%)	0	0	0	0	0	**0**	**0**	0	0	0	0	0
Above Normal (15%)	0	0	0	0	0	0	0	0	0	0	0	0
Below Normal (17%)	0	0	0	0	0	0	0	0	0	0	0	0
Dry (22%)	0	0	0	0	0	0	0	0	0	0	0	0
Critical (15%)	0	0	0	0	0	0	0	0	0	0	0	0

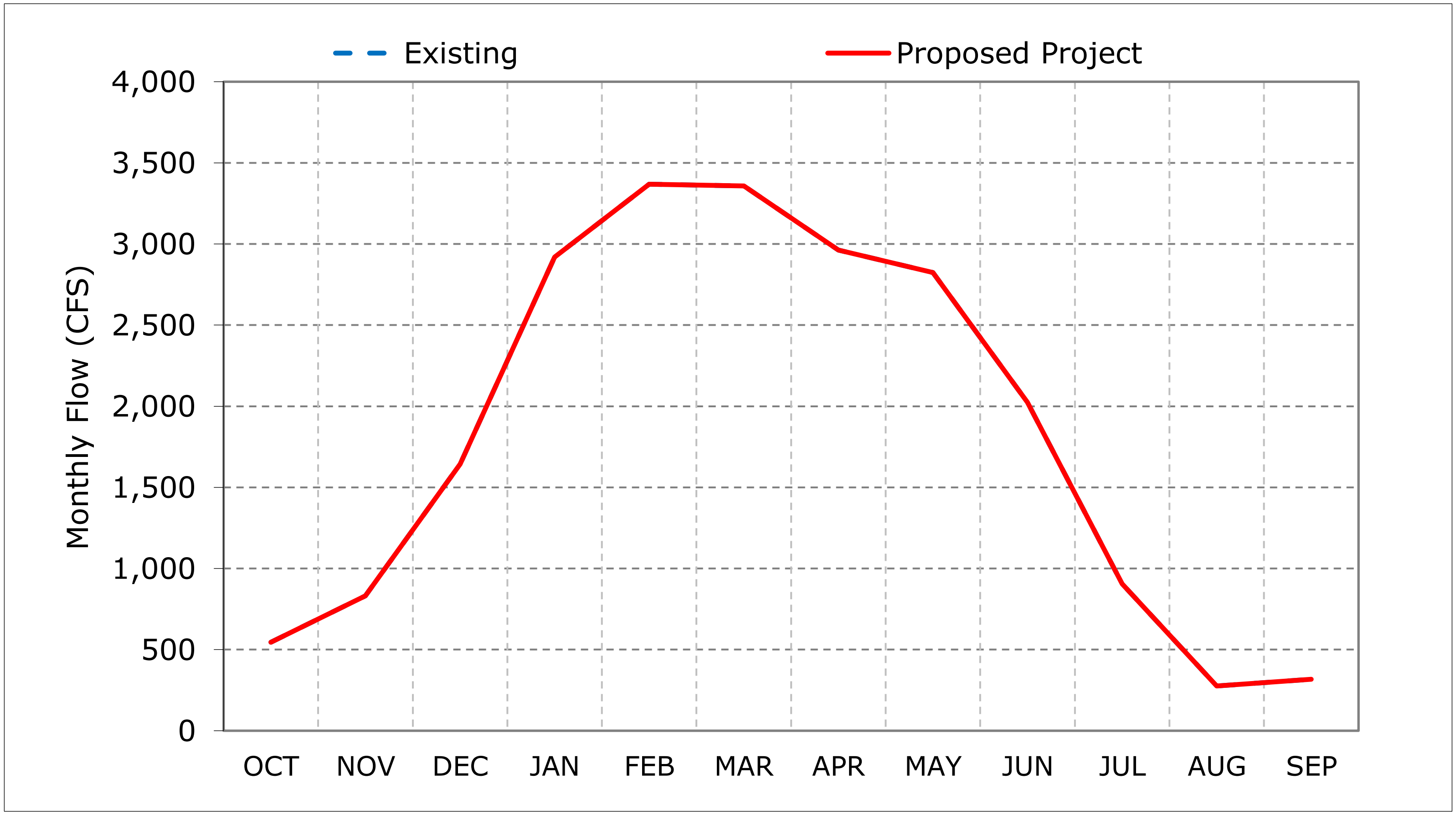
a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with water year - year type sorting.

Figure 6-1. Mokelumne River below Consumnes, Long-Term Average Flow



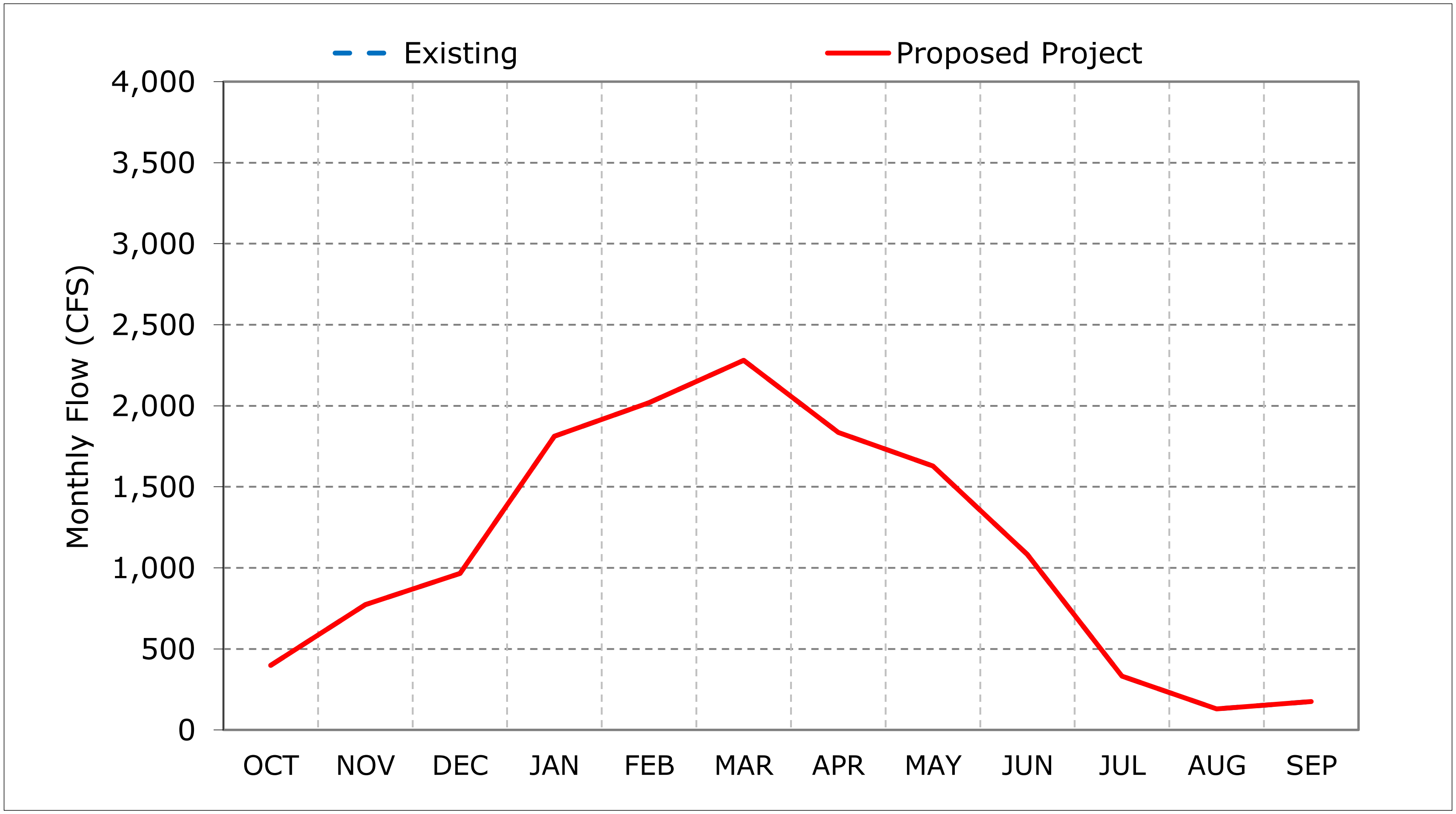
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 6-2. Mokelumne River below Consumnes, Wet Year Average Flow



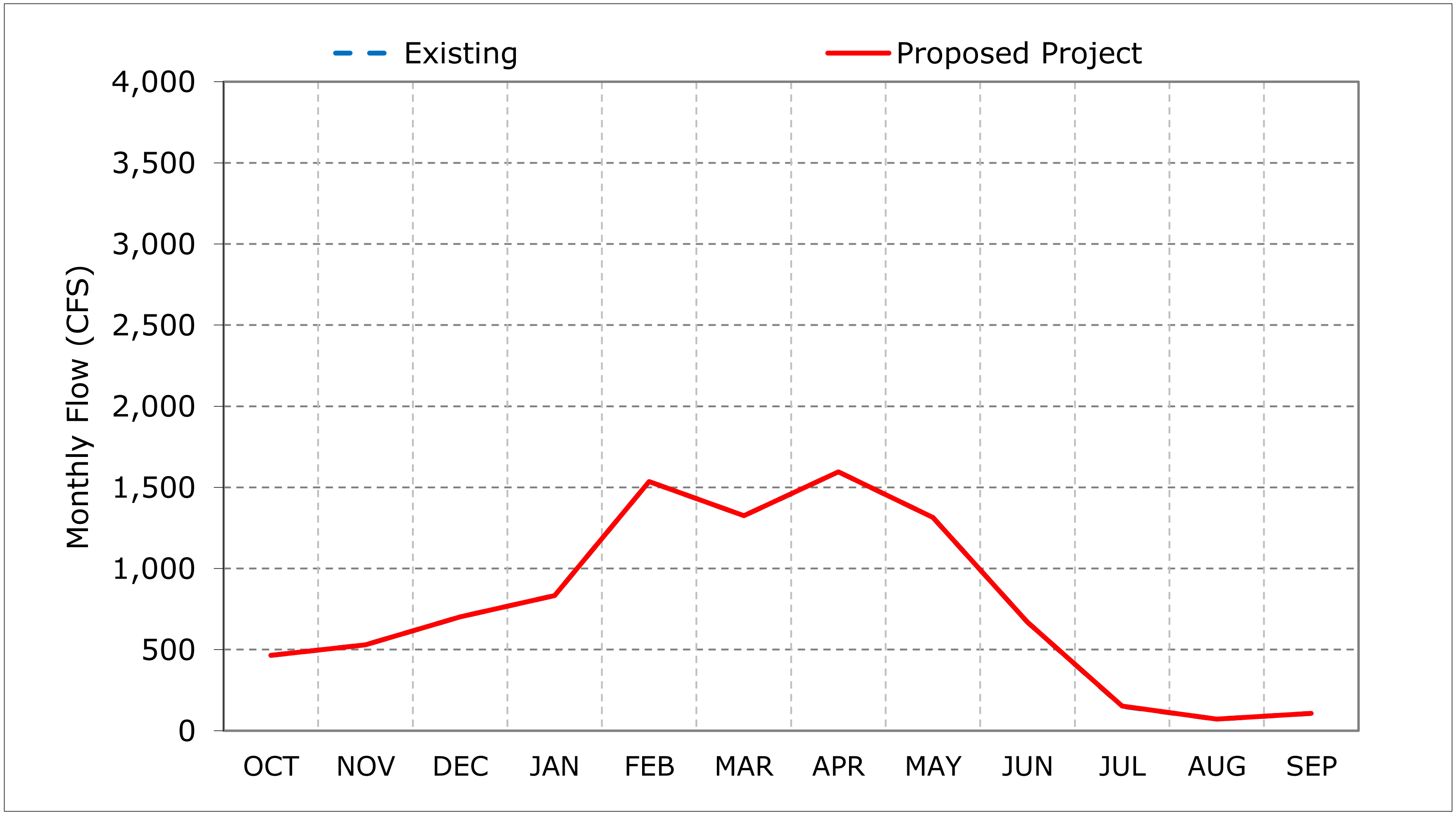
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 6-3. Mokelumne River below Consumnes, Above Normal Year Average Flow



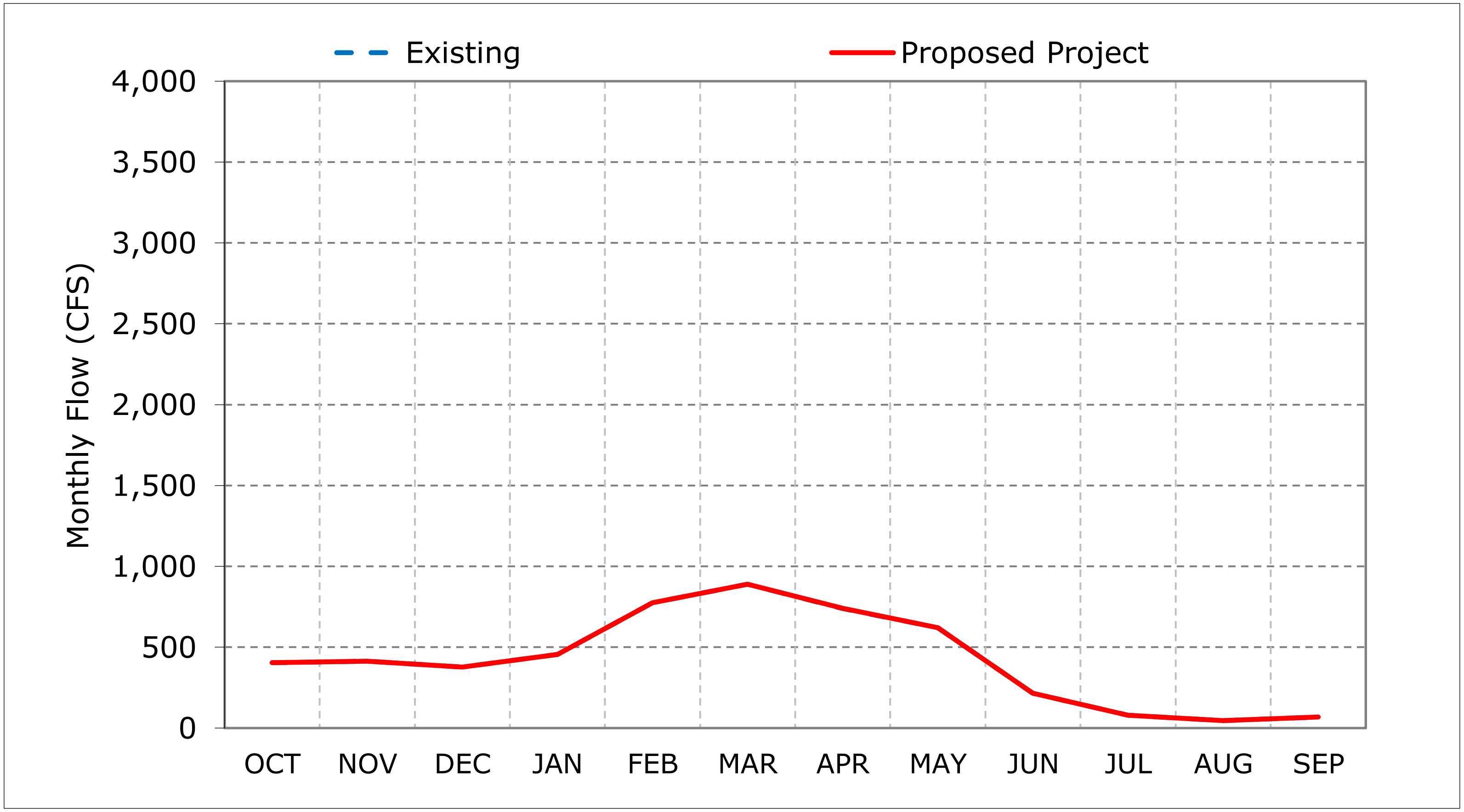
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 6-4. Mokelumne River below Consumnes, Below Normal Year Average Flow



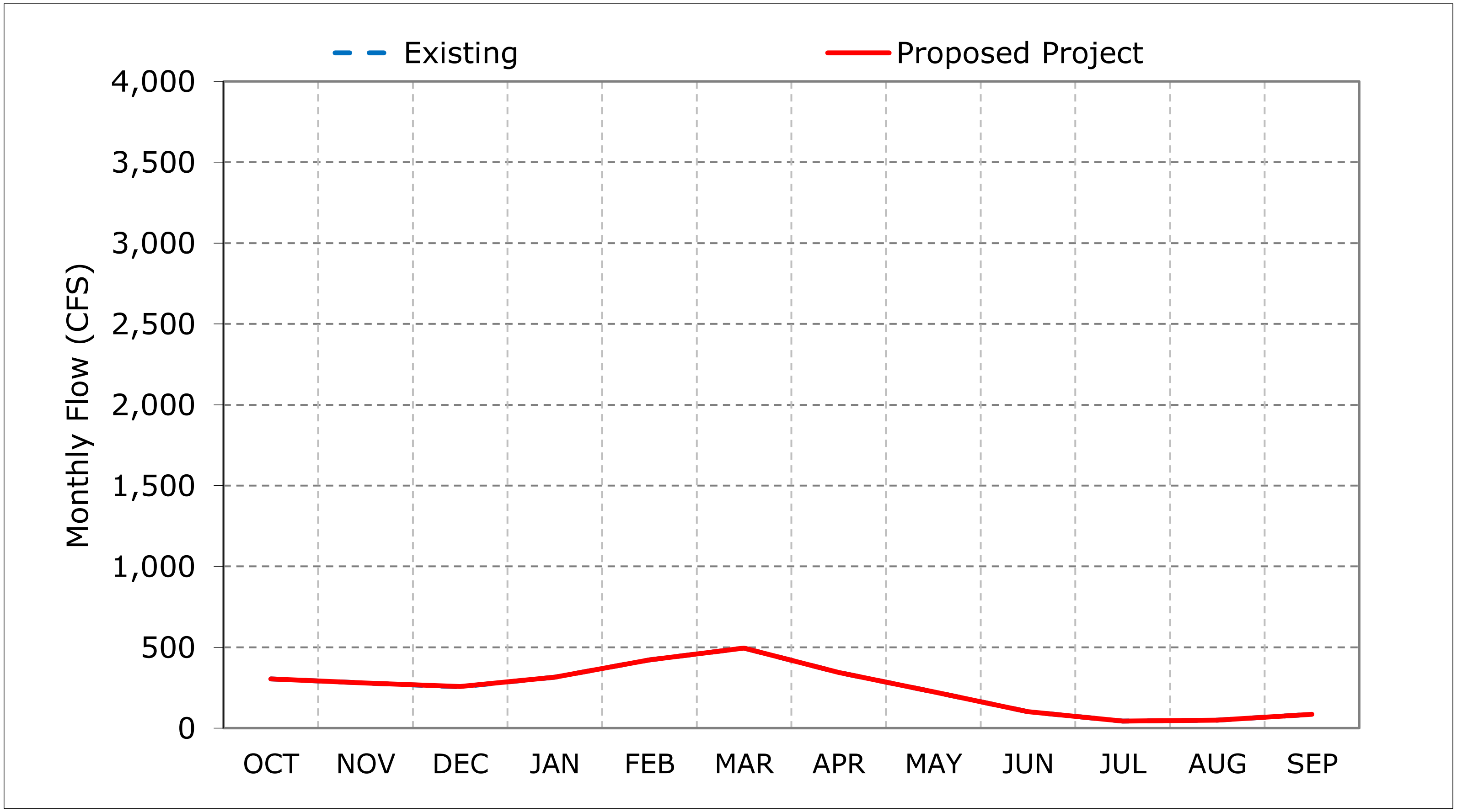
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 6-5. Mokelumne River below Consumnes, Dry Year Average Flow



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 6-6. Mokelumne River below Consumnes, Critical Year Average Flow



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 6-7. Mokelumne River below Consumnes, October

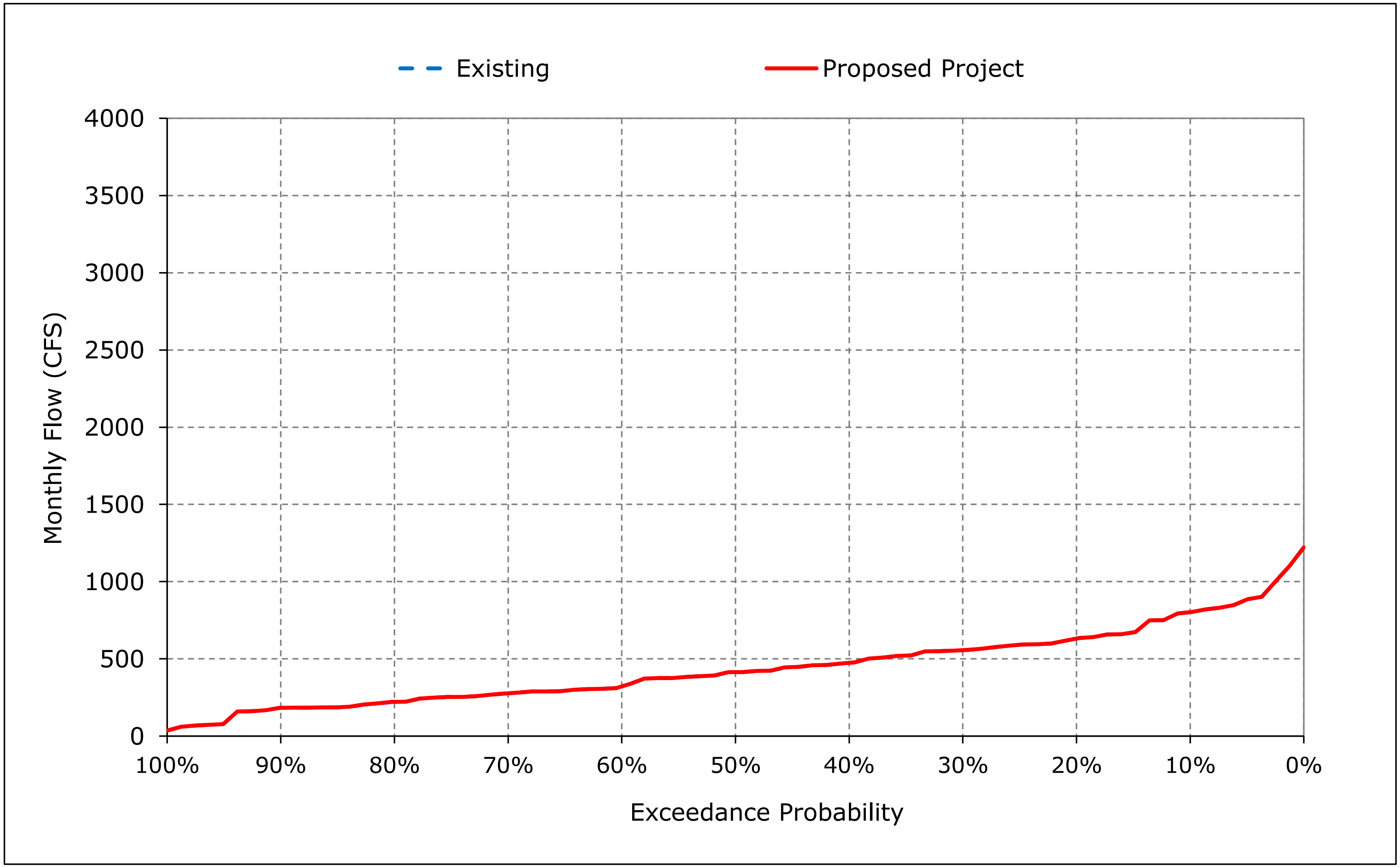


Figure 6-8. Mokelumne River below Consumnes, November

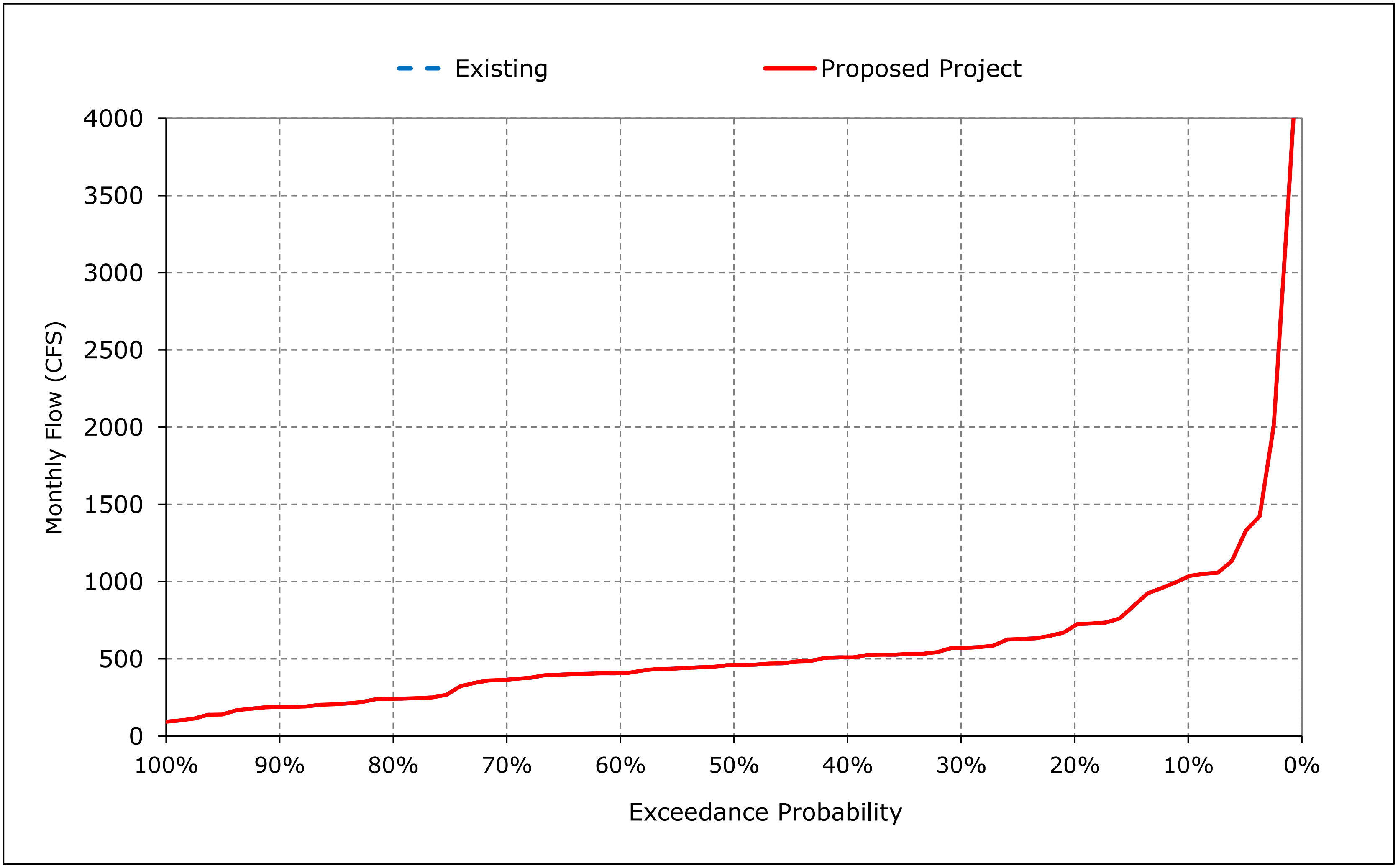


Figure 6-9. Mokelumne River below Consumnes, December

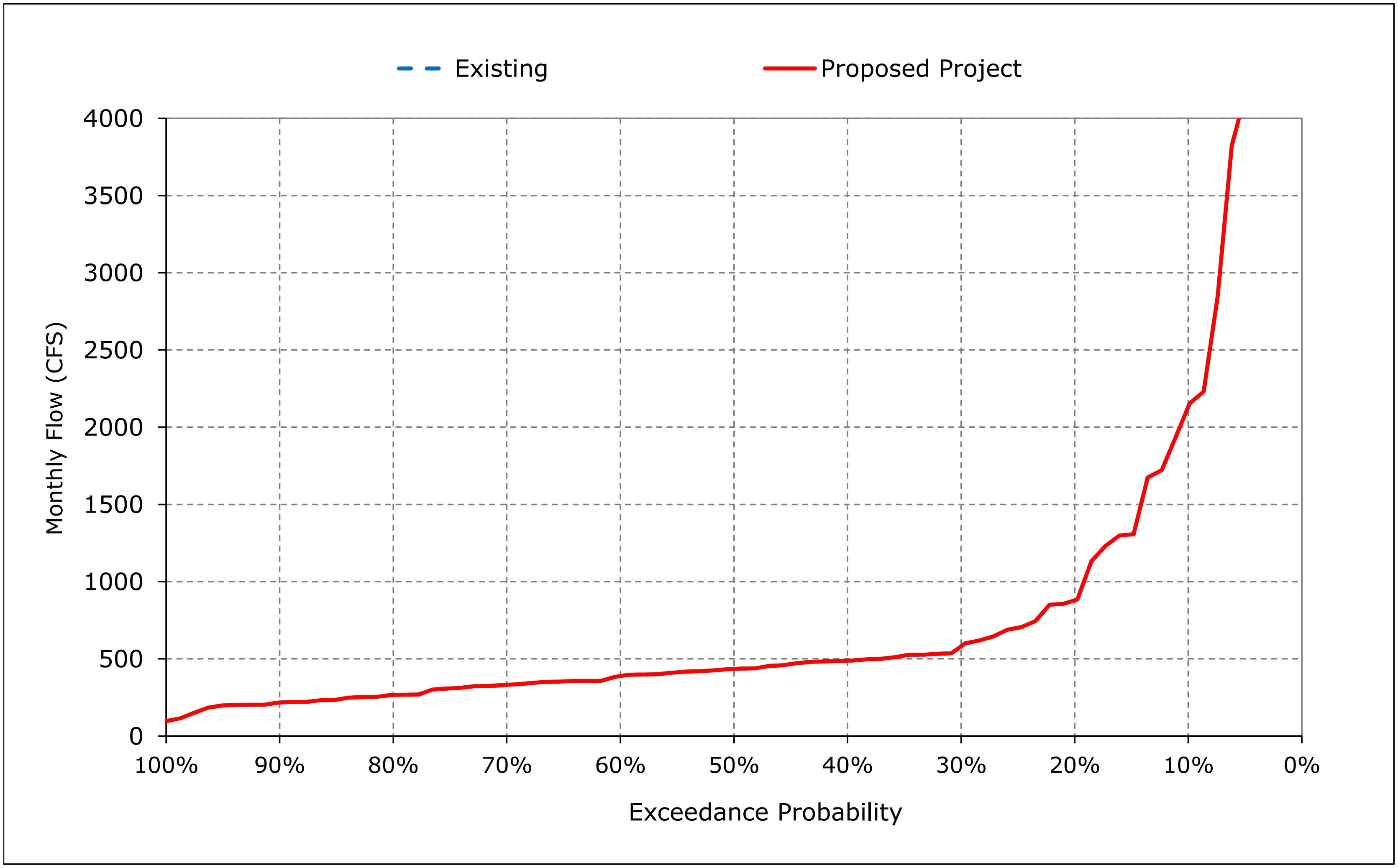


Figure 6-10. Mokelumne River below Consumnes, January

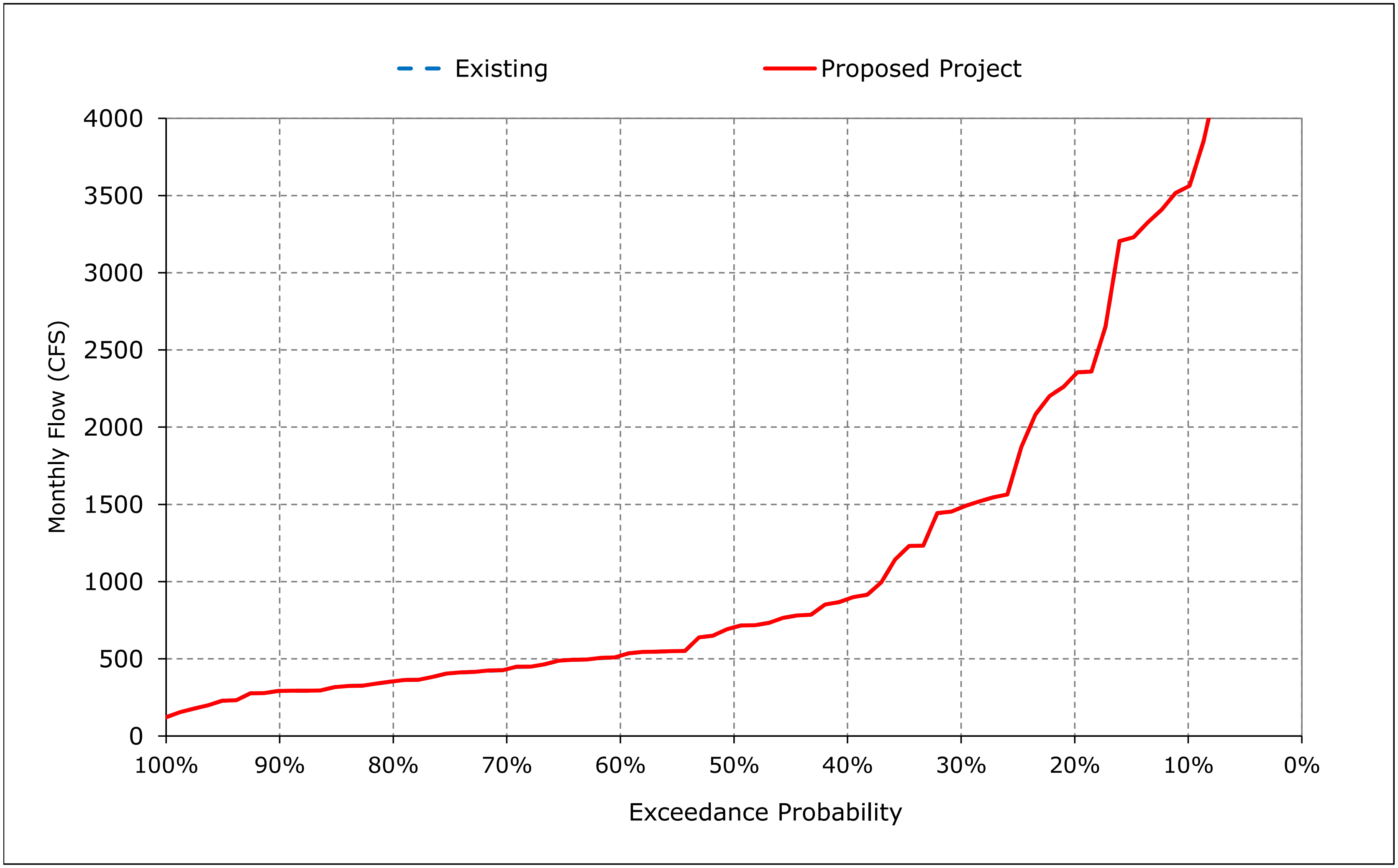


Figure 6-11. Mokelumne River below Consumnes, February

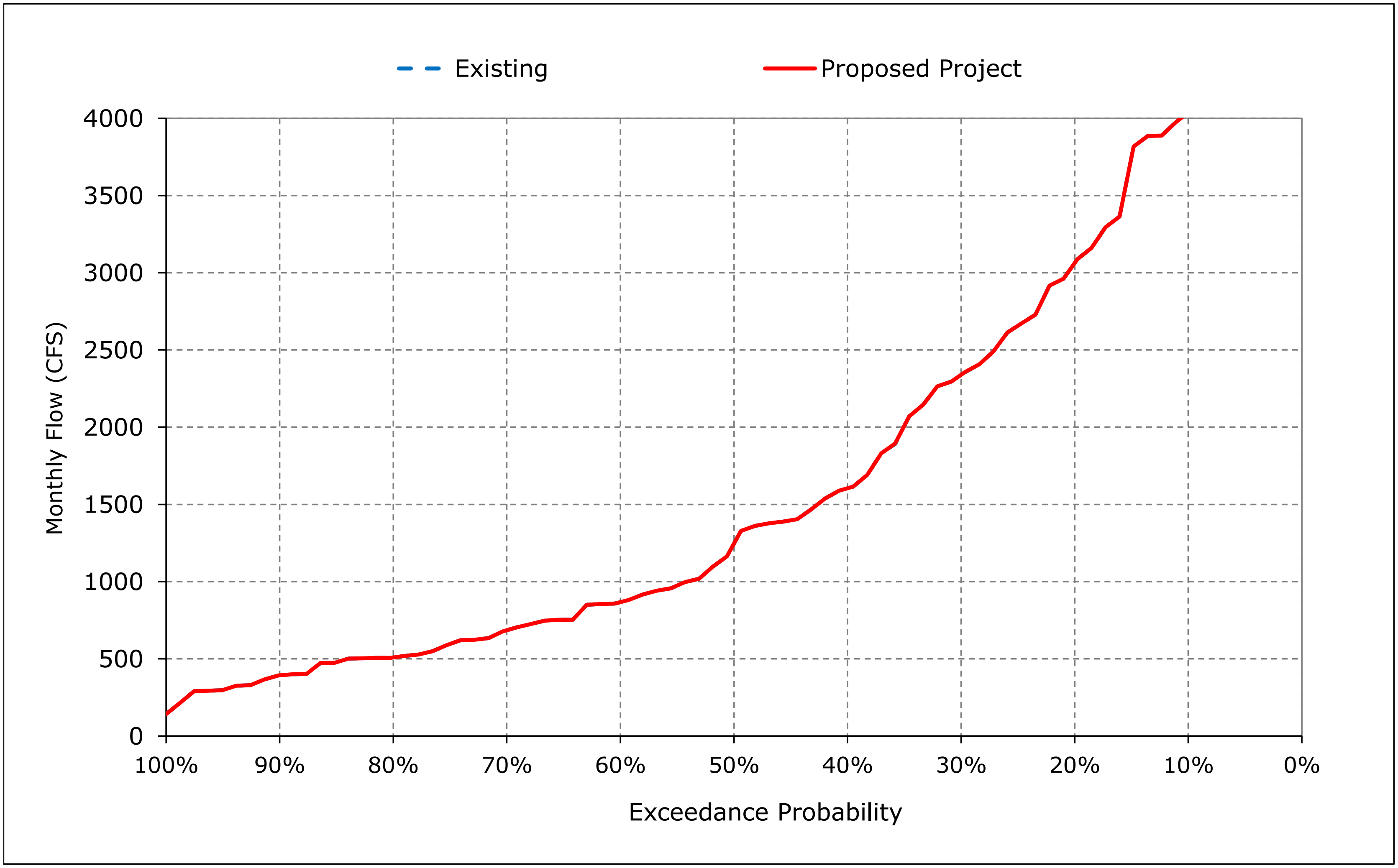


Figure 6-12. Mokelumne River below Consumnes, March

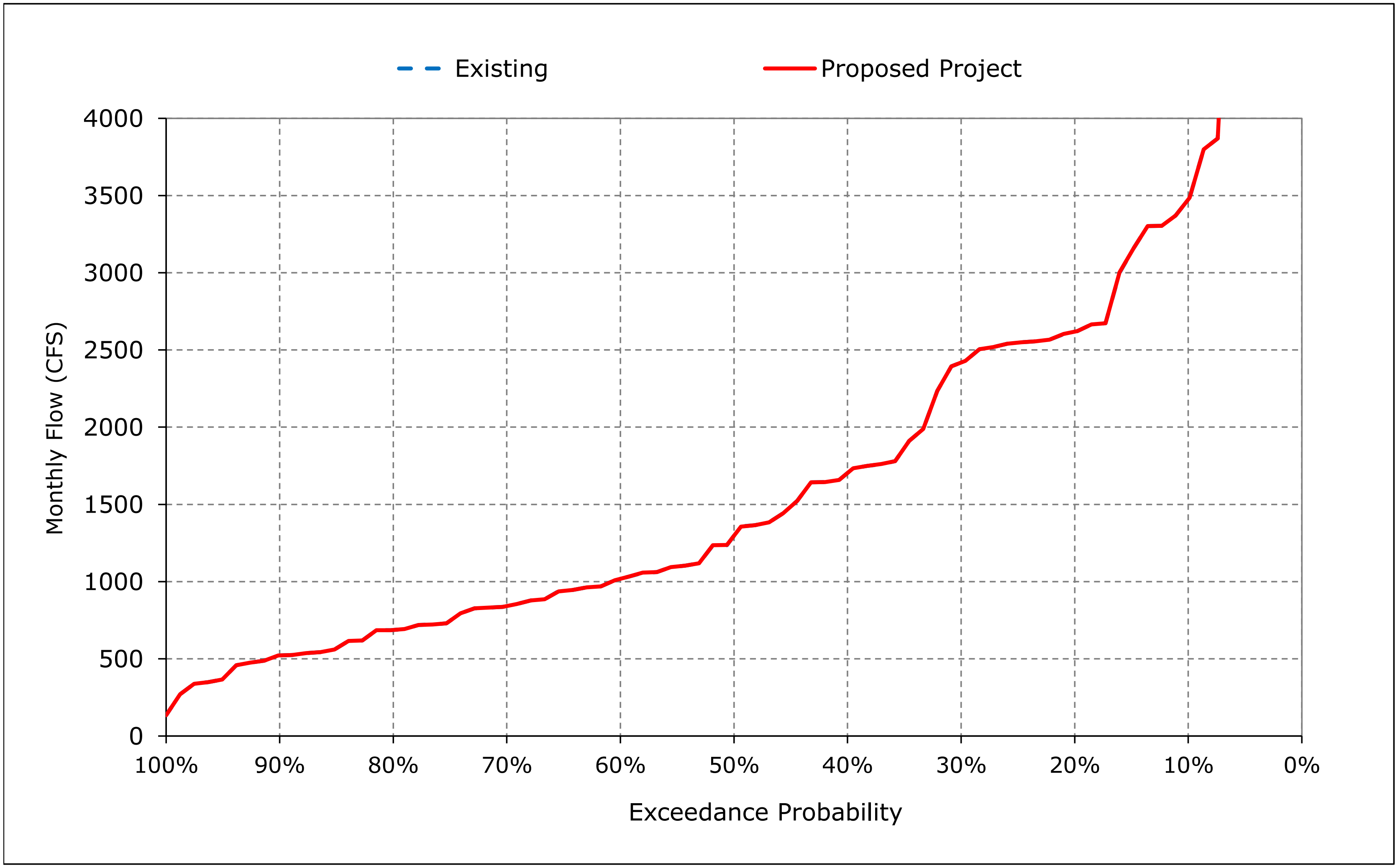


Figure 6-13. Mokelumne River below Consumnes, April

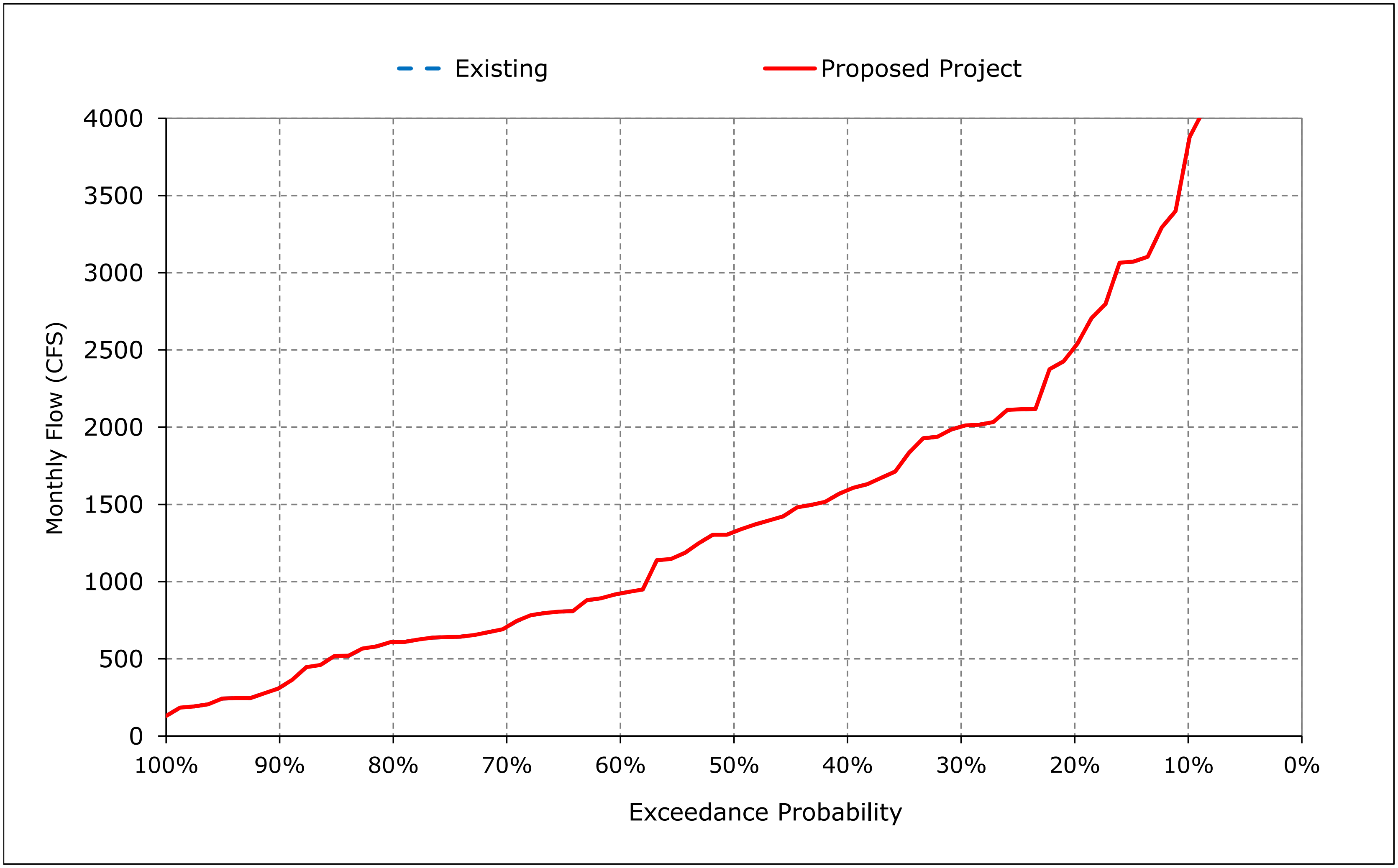


Figure 6-14. Mokelumne River below Consumnes, May

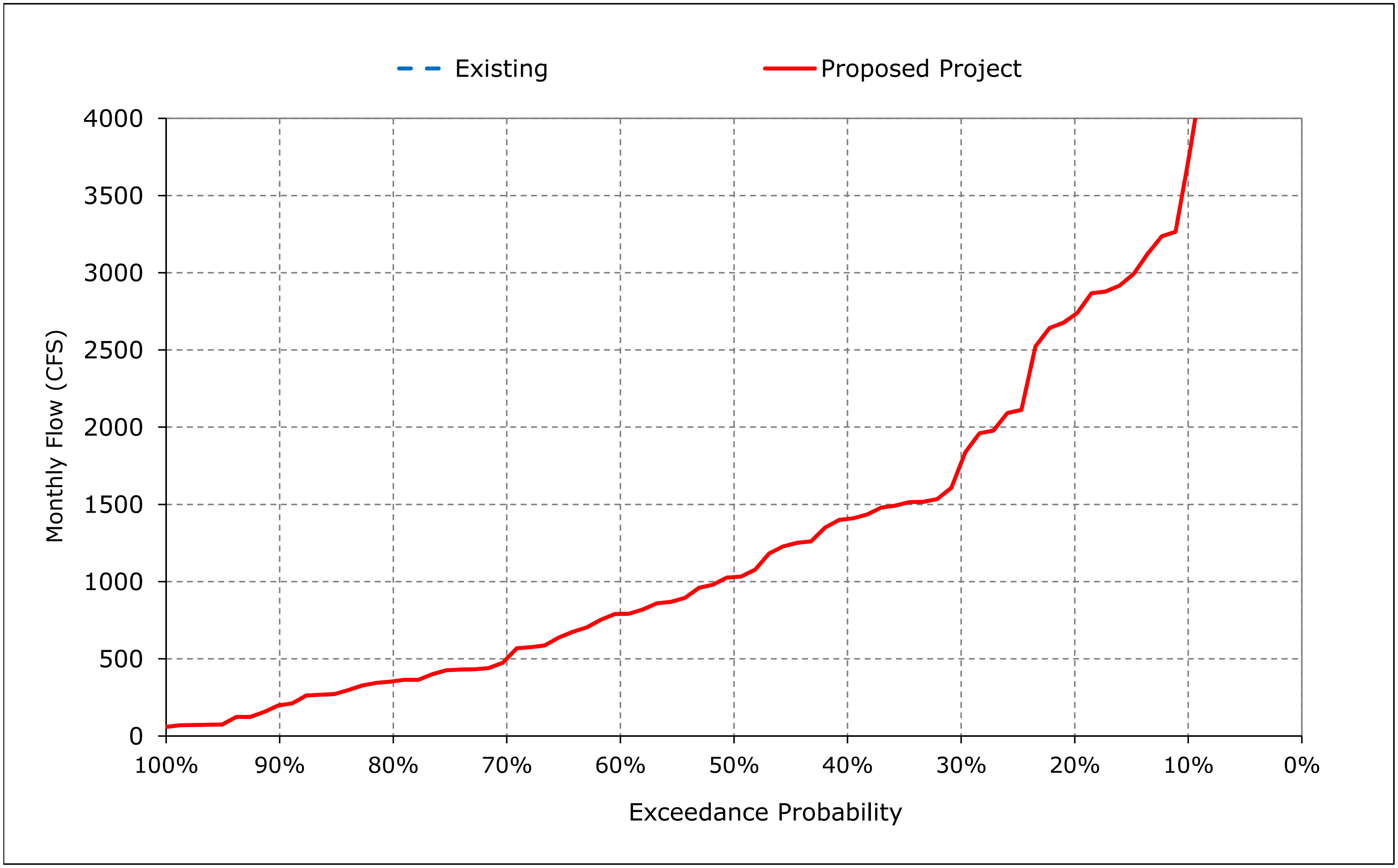


Figure 6-15. Mokelumne River below Consumnes, June

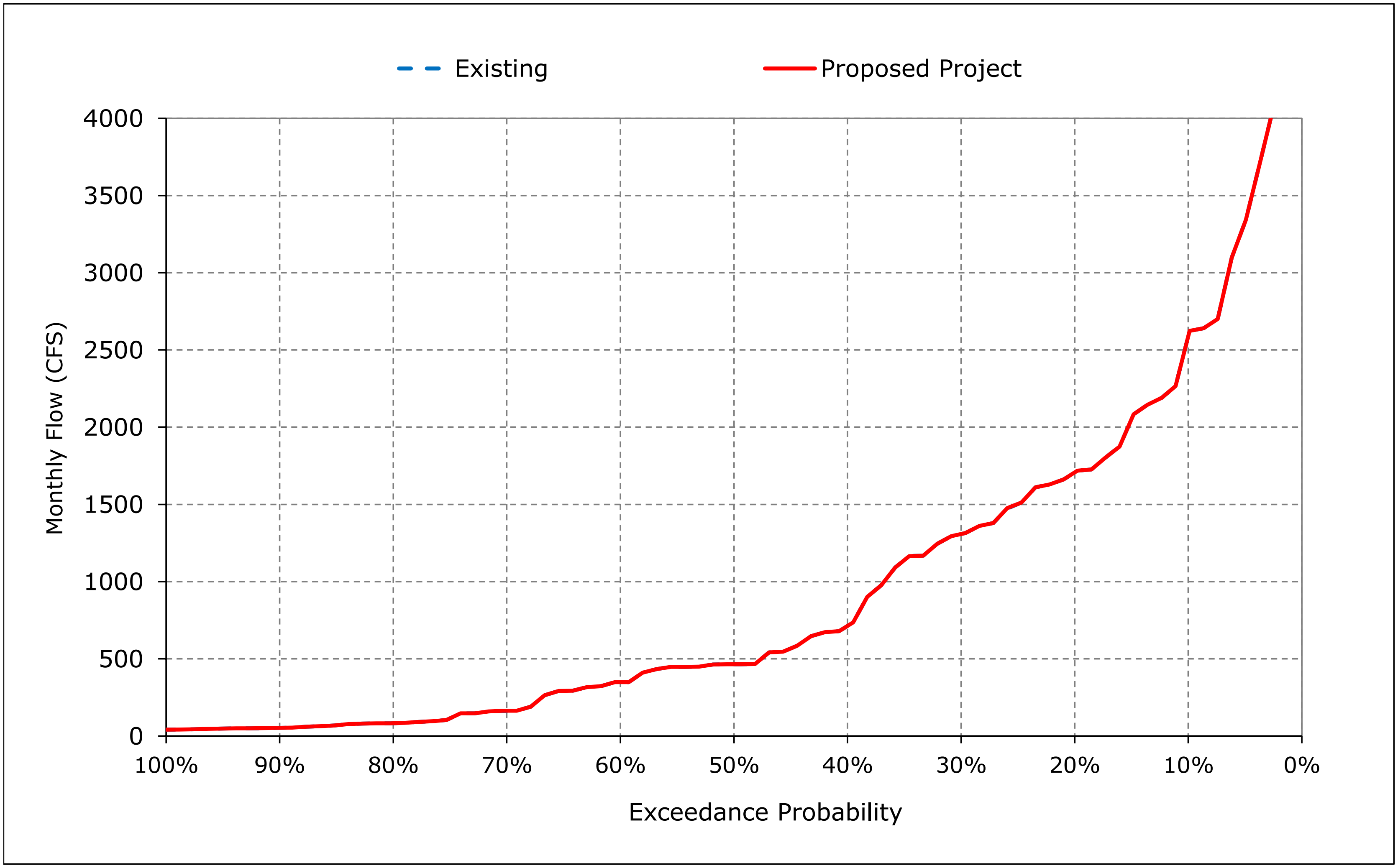


Figure 6-16. Mokelumne River below Consumnes, July

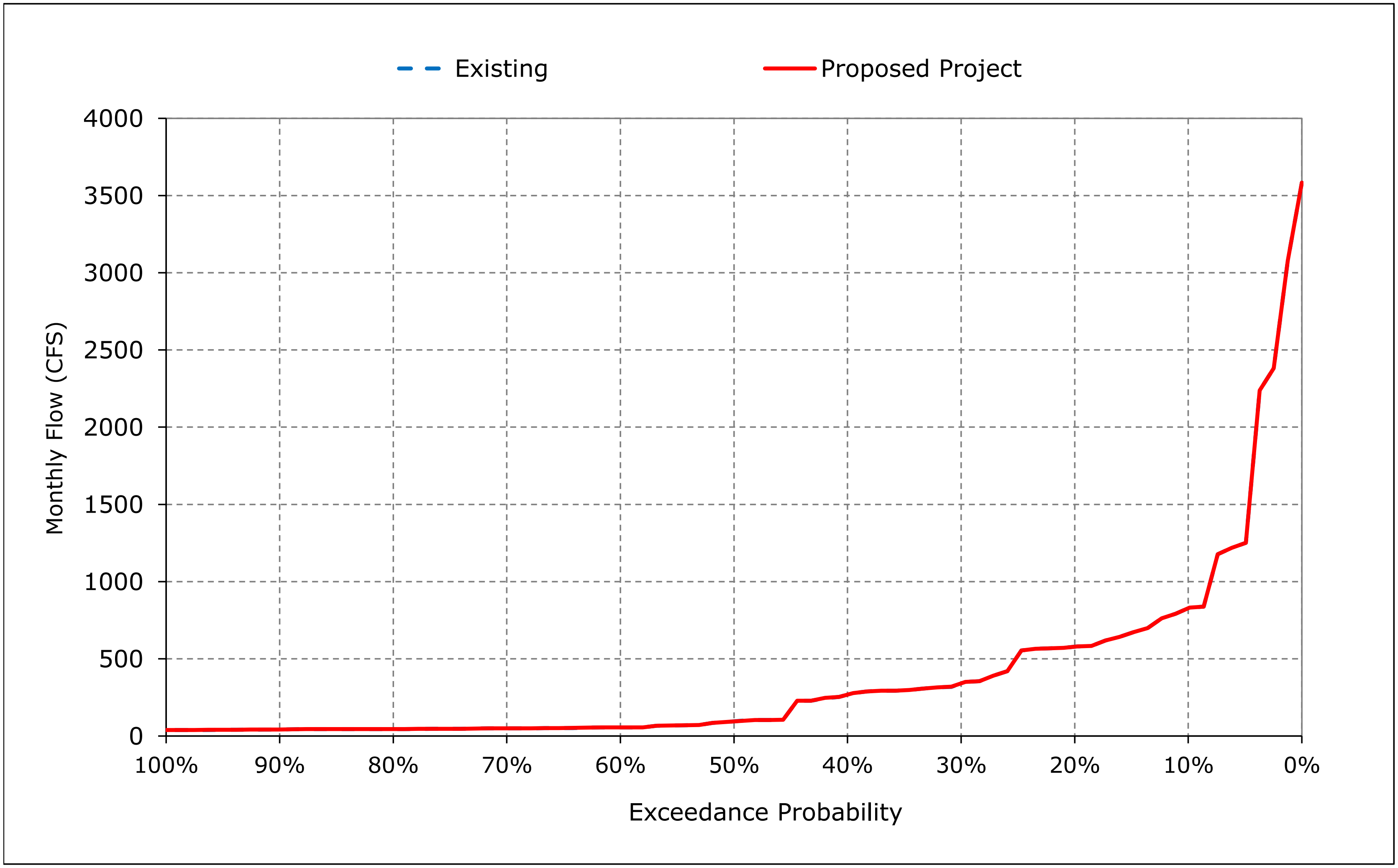


Figure 6-17. Mokelumne River below Consumnes, August

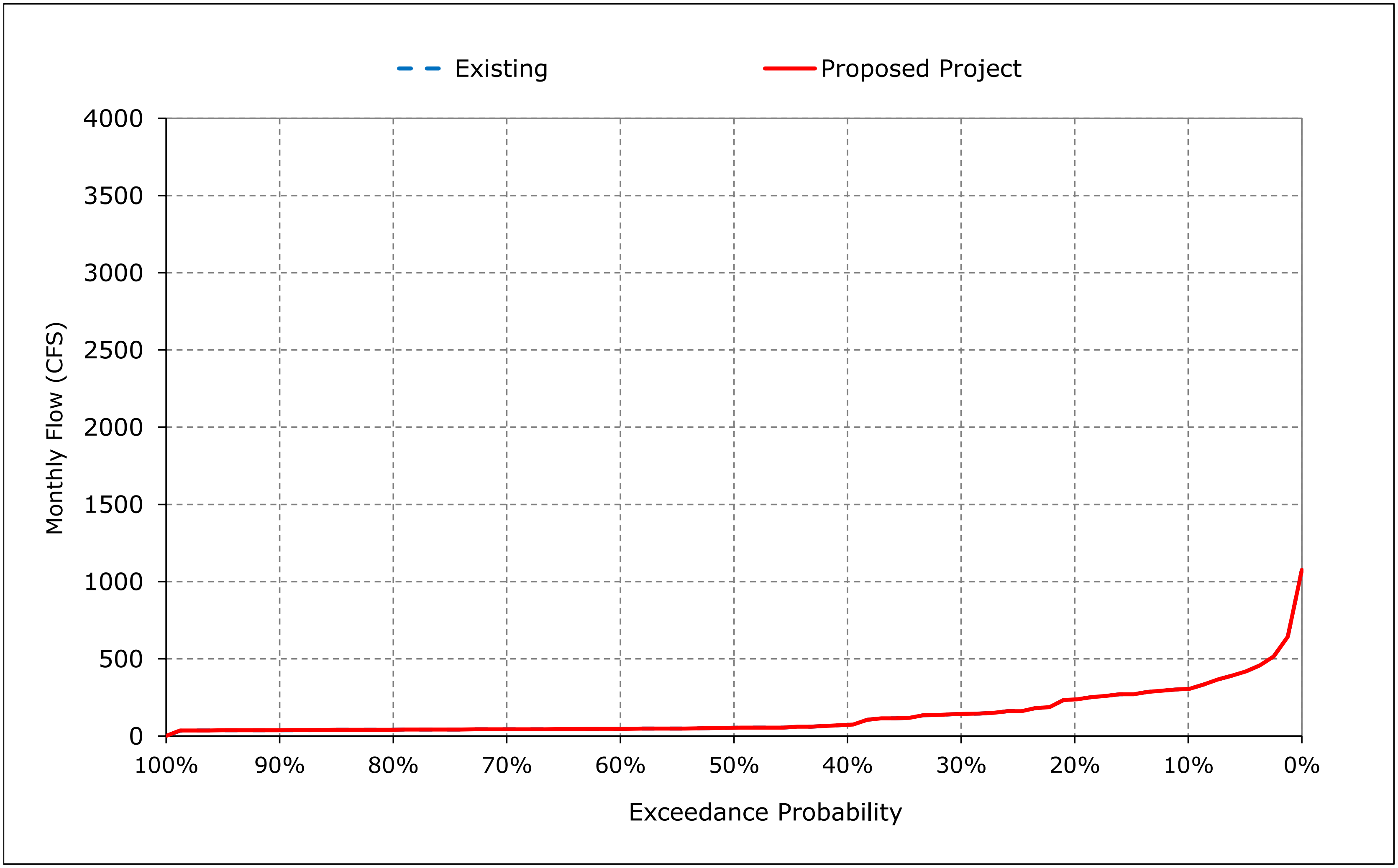


Figure 6-18. Mokelumne River below Consumnes, September

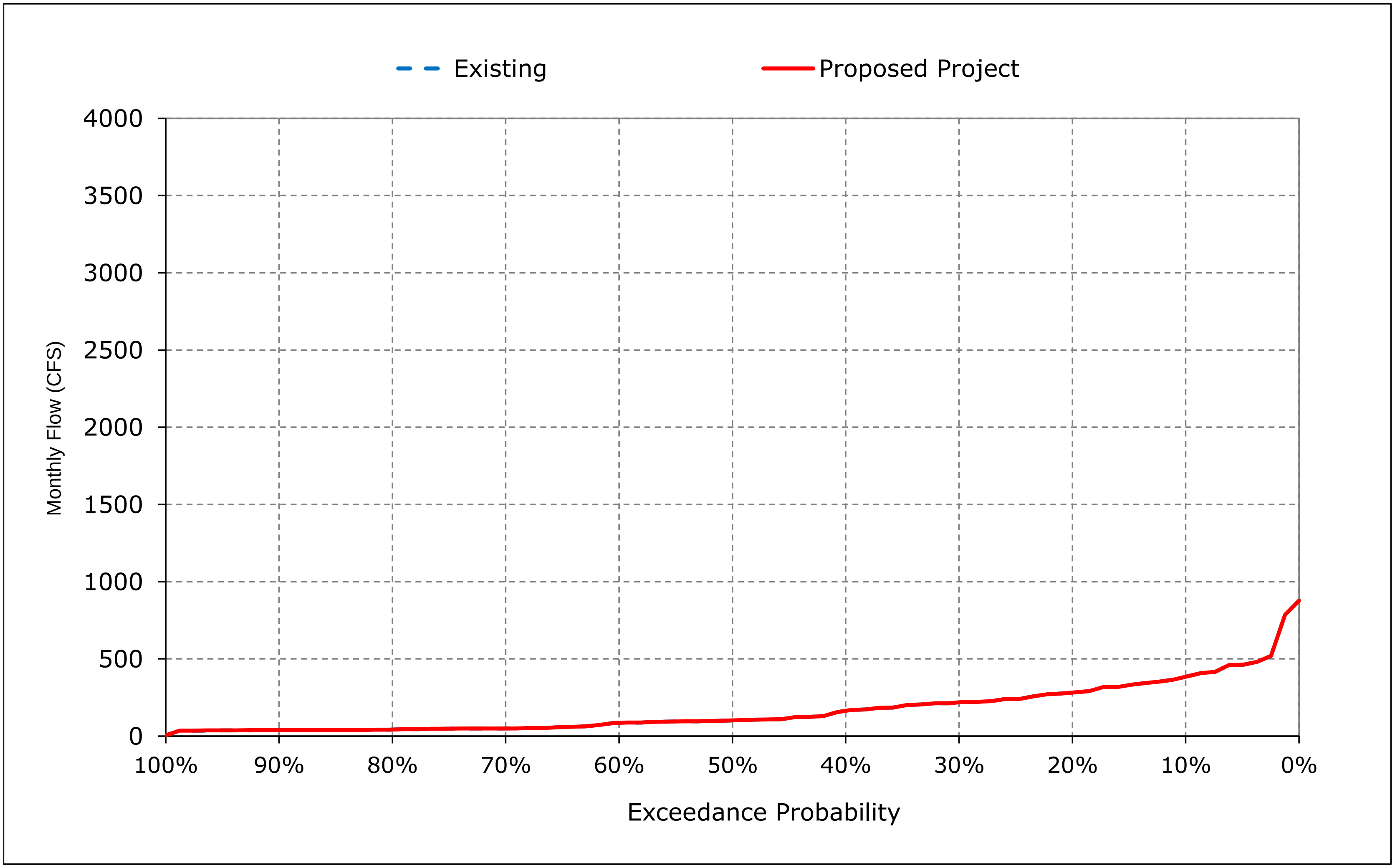


Table 7-1. Old and Middle River Flow, Monthly Flow (combined flows)

Existing

	Monthly Flow (CFS)											
Statistic	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Probability of Exceedance												
10%	-3,881	-3,777	-4,457	-3,645	-3,332	-1,406	2,480	2,164	-2,590	-3,012	-3,262	-3,631
20%	-4,680	-4,317	-5,290	-3,645	-4,464	-3,539	1,530	1,037	-4,475	-5,673	-4,219	-5,827
30%	-5,019	-5,410	-5,290	-4,516	-4,464	-4,288	1,103	488	-5,000	-7,848	-5,410	-6,363
40%	-5,299	-5,958	-5,290	-4,516	-4,464	-4,371	594	-1,530	-5,000	-8,435	-8,514	-7,721
50%	-5,929	-6,405	-5,616	-4,516	-4,474	-4,371	-1,385	-1,706	-5,000	-9,287	-9,802	-8,906
60%	-6,394	-6,805	-6,374	-5,000	-4,483	-4,371	-1,592	-1,767	-5,000	-9,669	-10,268	-9,620
70%	-6,761	-7,651	-7,242	-5,000	-4,984	-4,371	-1,636	-1,796	-5,000	-10,199	-10,450	-9,841
80%	-7,446	-8,620	-9,502	-5,000	-5,000	-4,371	-1,743	-1,833	-5,000	-10,673	-10,558	-9,950
90%	-8,256	-10,054	-9,701	-5,000	-5,000	-4,371	-1,928	-1,977	-5,000	-10,901	-10,815	-10,152
Long Term												
Full Simulation Period[a]	-6,004	-6,570	-6,394	-4,029	-4,014	-3,219	-43	-582	-4,532	-8,245	-7,927	-7,854
Water Year Types[b,c]												
Wet (32%)	-6,495	-7,433	-5,515	-2,766	-2,728	-1,815	1,945	812	-4,667	-8,739	-10,214	-9,567
Above Normal (15%)	-5,955	-6,478	-7,343	-4,274	-4,248	-3,761	104	-383	-4,967	-9,553	-10,592	-9,992
Below Normal (17%)	-6,003	-6,910	-7,000	-4,578	-4,649	-4,294	-415	-695	-4,973	-10,256	-9,703	-8,760
Dry (22%)	-5,844	-6,372	-7,004	-4,889	-4,709	-4,151	-1,586	-1,773	-4,727	-8,401	-4,339	-6,036
Critical (15%)	-5,232	-4,692	-5,727	-4,588	-4,787	-3,067	-1,748	-1,881	-2,998	-3,286	-3,621	-3,678

Proposed Project

	Monthly Flow (CFS)											
Statistic	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Probability of Exceedance												
10%	-3,159	-3,418	-4,037	-3,645	-2,977	-1,144	-838	-1,353	-2,588	-2,886	-3,402	-3,537
20%	-3,935	-4,497	-5,267	-3,645	-4,464	-3,258	-1,677	-1,792	-4,333	-4,885	-4,546	-5,432
30%	-4,264	-5,333	-5,290	-4,516	-4,464	-3,258	-1,888	-2,197	-5,000	-7,628	-5,633	-5,976
40%	-4,663	-6,337	-5,290	-4,516	-4,464	-3,258	-2,026	-2,571	-5,000	-8,136	-7,927	-6,740
50%	-6,059	-7,452	-5,320	-4,516	-4,466	-3,258	-2,352	-2,897	-5,000	-8,951	-9,532	-7,407
60%	-6,549	-8,886	-6,461	-5,000	-4,483	-3,258	-2,538	-3,241	-5,000	-9,552	-10,098	-8,662
70%	-6,933	-9,101	-7,976	-5,226	-5,000	-3,258	-2,926	-3,557	-5,000	-10,007	-10,441	-9,284
80%	-7,355	-9,253	-9,447	-5,226	-5,193	-3,258	-3,109	-3,760	-5,000	-10,414	-10,580	-9,507
90%	-8,244	-9,373	-9,699	-5,226	-5,250	-3,500	-3,260	-4,061	-5,000	-10,816	-10,844	-9,660
Long Term												
Full Simulation Period[a]	-5,655	-6,916	-6,413	-3,967	-3,901	-2,466	-1,948	-2,622	-4,491	-7,964	-7,929	-7,292
Water Year Types[b,c]												
Wet (32%)	-6,267	-7,818	-5,512	-2,373	-2,270	-955	-1,208	-2,388	-4,629	-8,548	-10,134	-8,733
Above Normal (15%)	-5,951	-6,950	-7,391	-4,331	-3,985	-2,755	-2,740	-3,585	-4,961	-9,713	-10,525	-9,339
Below Normal (17%)	-5,725	-7,415	-6,970	-4,707	-4,787	-3,238	-2,495	-3,268	-4,959	-9,485	-9,414	-8,182
Dry (22%)	-5,342	-6,276	-7,274	-5,061	-4,918	-3,289	-2,300	-2,548	-4,668	-7,739	-4,457	-5,653
Critical (15%)	-4,422	-5,307	-5,447	-4,553	-4,794	-3,316	-1,592	-1,522	-2,909	-3,512	-4,031	-3,545

Proposed Project minus Existing

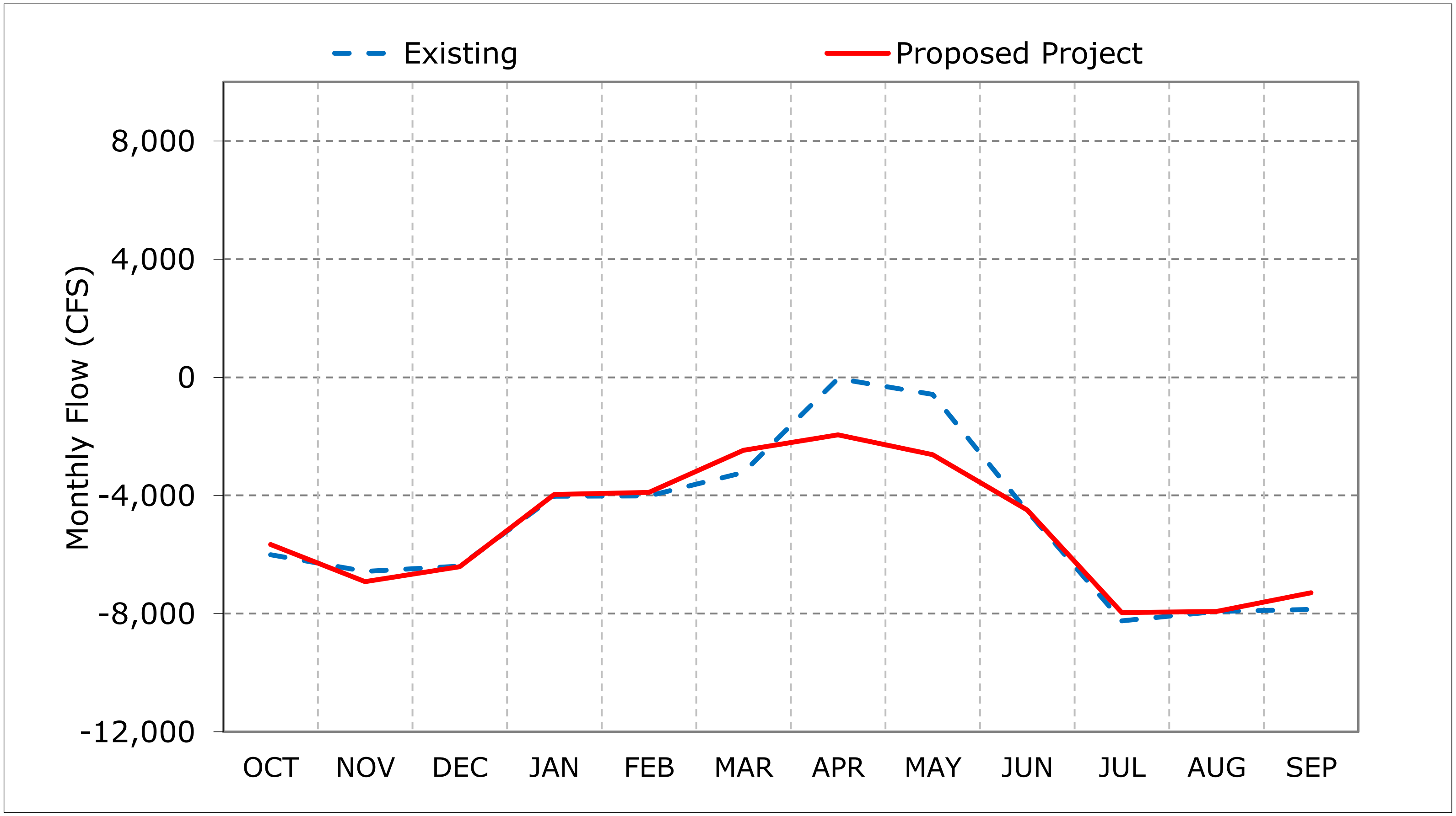
	Monthly Flow (CFS)											
Statistic	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Probability of Exceedance												
10%	722	358	420	0	354	262	**-3,318**	**-3,517**	2	126	**-141**	94
20%	745	**-180**	23	0	0	281	**-3,207**	**-2,830**	142	787	**-327**	395
30%	755	78	0	0	0	1,030	**-2,991**	**-2,685**	0	220	**-224**	387
40%	636	**-379**	0	0	0	1,113	**-2,620**	**-1,041**	0	300	587	981
50%	**-131**	**-1,046**	297	0	8	1,113	**-967**	**-1,191**	0	336	271	1,499
60%	**-155**	**-2,081**	**-87**	0	0	1,113	**-946**	**-1,475**	0	117	170	958
70%	**-172**	**-1,450**	**-734**	**-226**	**-16**	1,113	**-1,290**	**-1,762**	0	193	9	557
80%	91	**-633**	55	**-226**	**-193**	1,113	**-1,366**	**-1,928**	0	259	**-22**	443
90%	12	681	2	**-226**	**-250**	871	**-1,332**	**-2,084**	0	86	**-29**	492
Long Term												
Full Simulation Period[a]	349	**-346**	**-19**	61	113	753	**-1,905**	**-2,040**	41	281	**-2**	562
Water Year Types[b,c]												
Wet (32%)	228	**-385**	3	392	457	859	**-3,154**	**-3,200**	39	191	80	834
Above Normal (15%)	4	**-472**	**-48**	**-56**	262	1,005	**-2,844**	**-3,202**	6	**-159**	67	653
Below Normal (17%)	278	**-505**	30	**-129**	**-137**	1,056	**-2,080**	**-2,573**	13	772	289	579
Dry (22%)	503	96	**-270**	**-173**	**-209**	862	**-714**	**-775**	59	662	**-119**	383
Critical (15%)	810	**-615**	280	36	**-7**	**-250**	156	359	89	**-227**	**-411**	133

a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

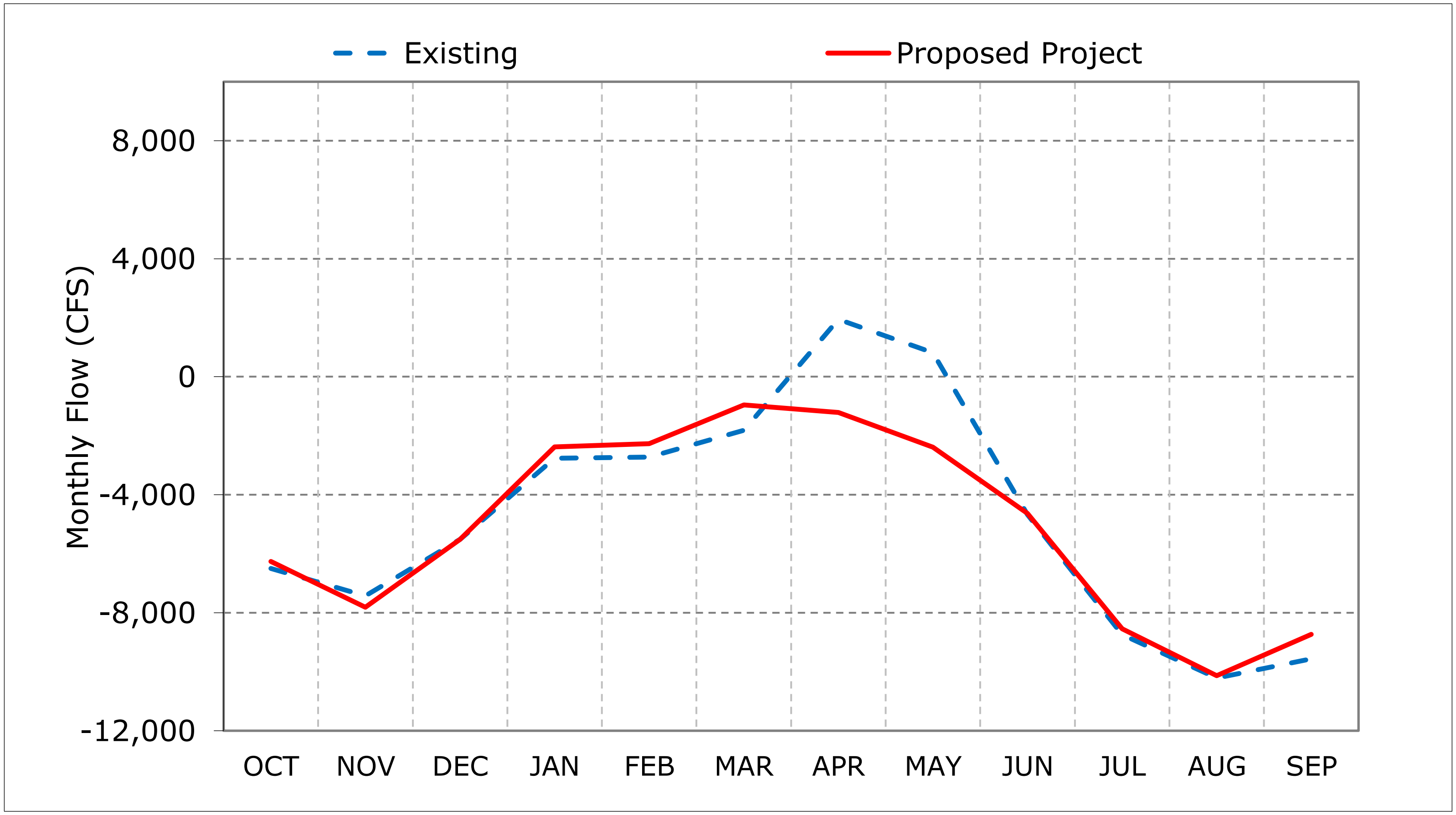
c These results are displayed with water year - year type sorting.

Figure 7-1. Old and Middle River Flow, Long-Term Average Flow



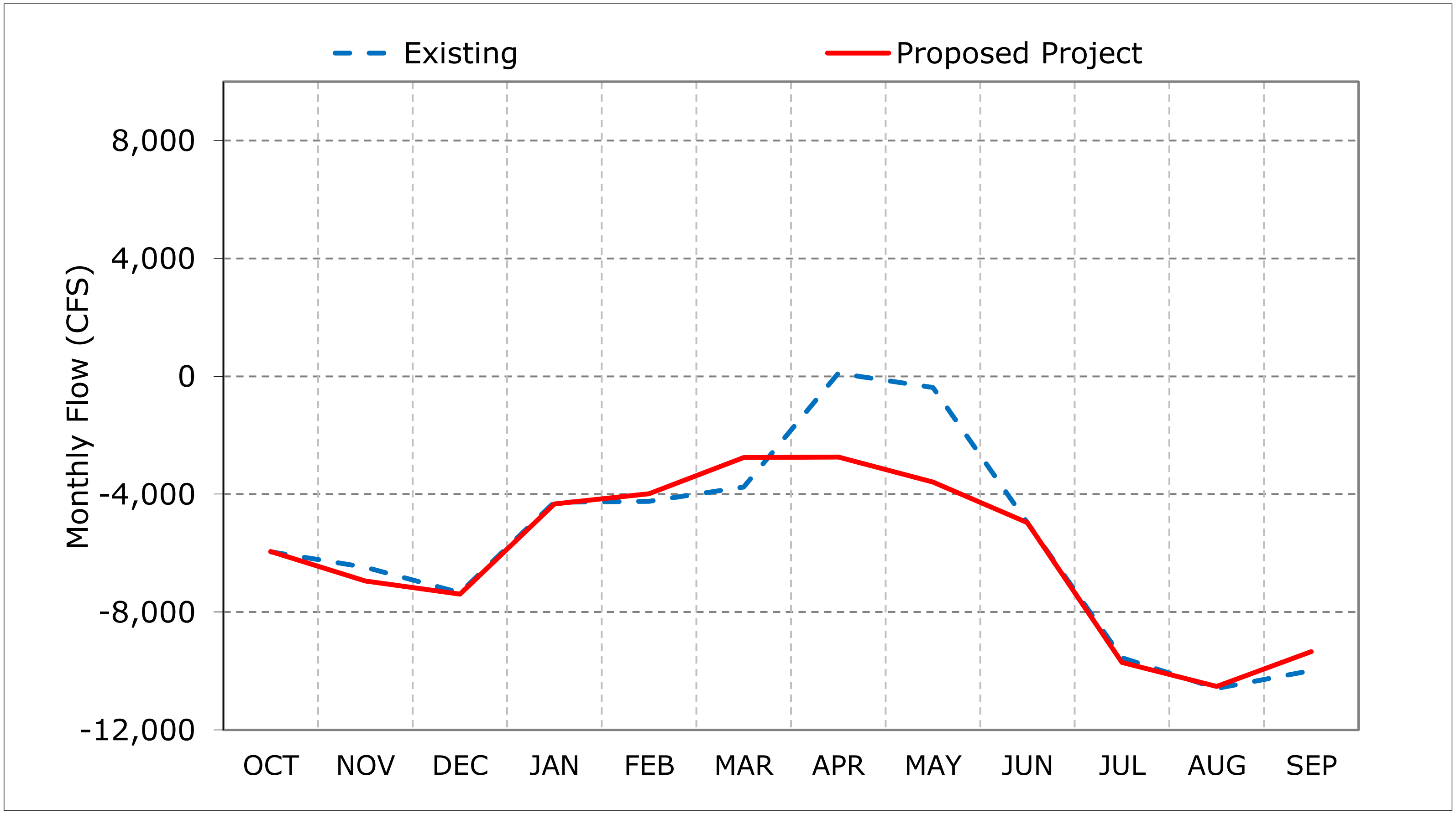
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 7-2. Old and Middle River Flow, Wet Year Average Flow



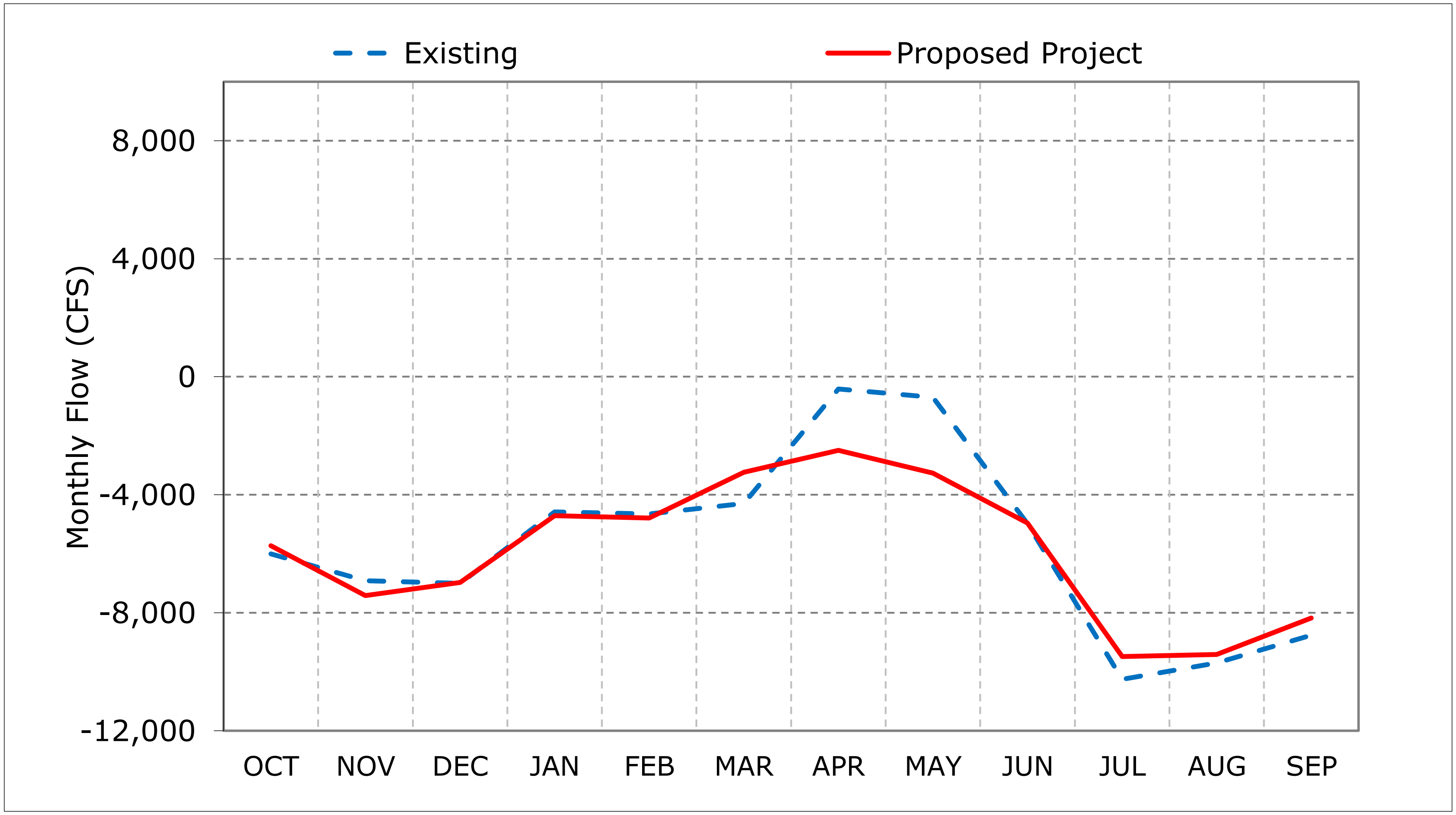
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 7-3. Old and Middle River Flow, Above Normal Year Average Flow



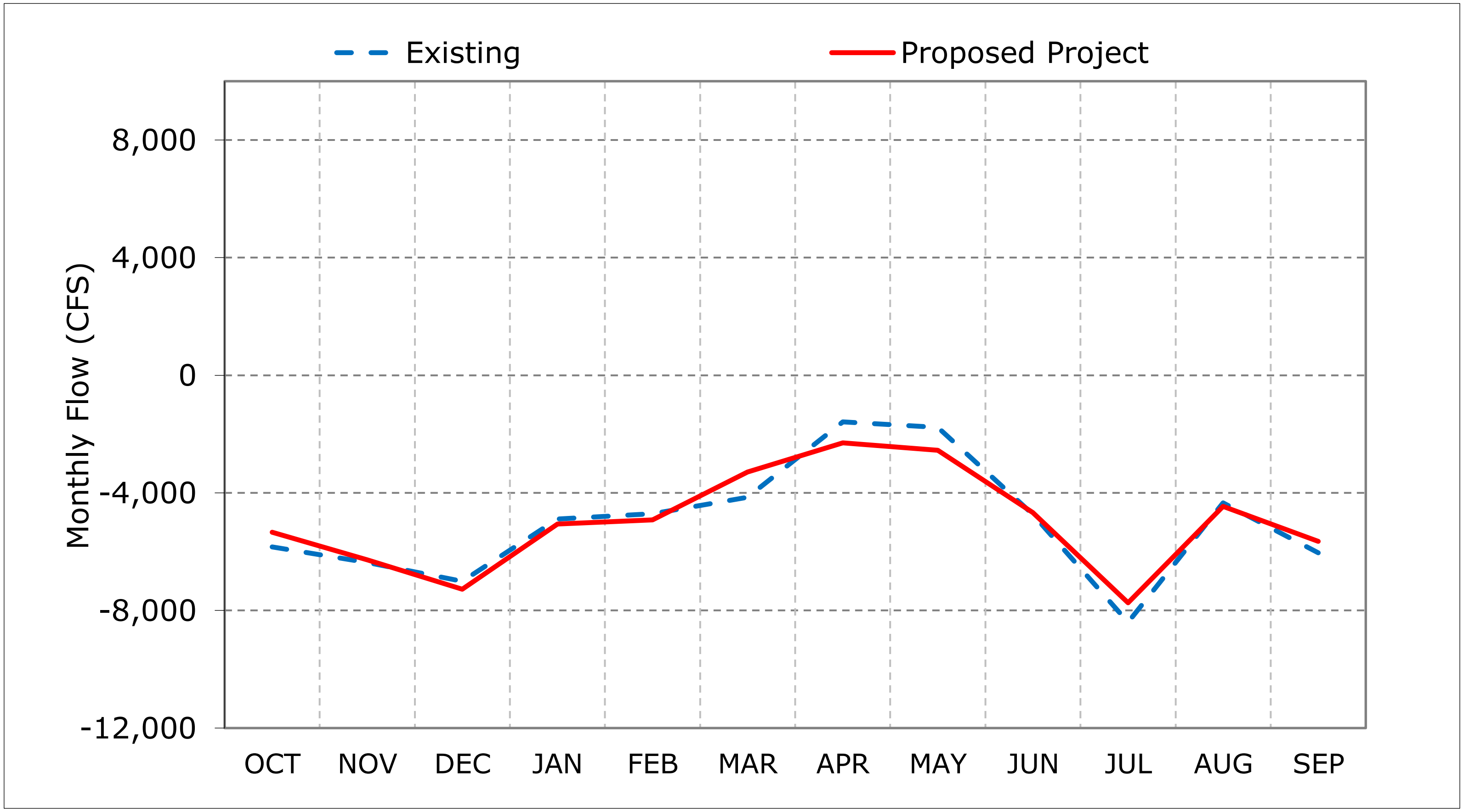
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 7-4. Old and Middle River Flow, Below Normal Year Average Flow



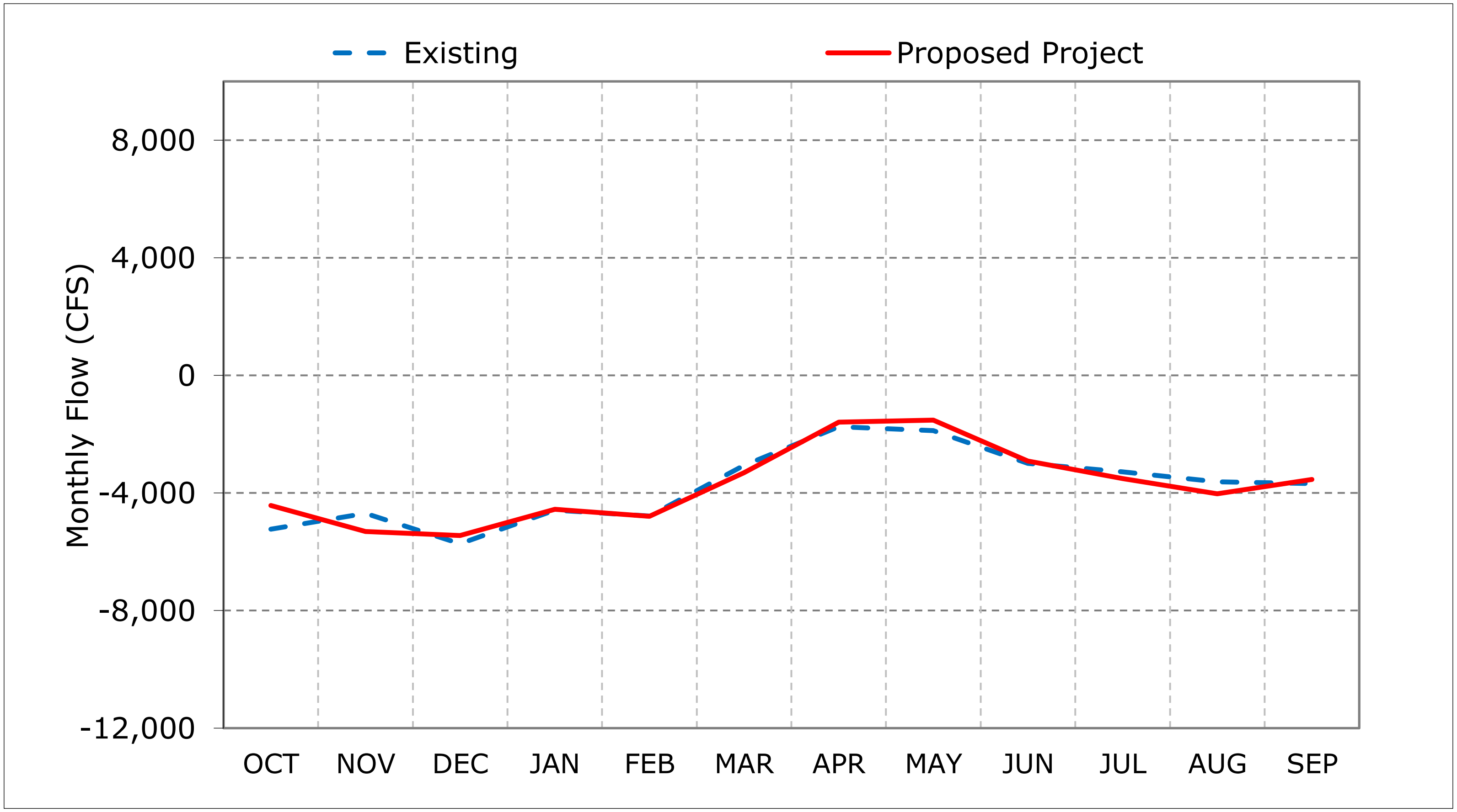
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 7-5. Old and Middle River Flow, Dry Year Average Flow



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 7-6. Old and Middle River Flow, Critical Year Average Flow



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 7-7. Old and Middle River Flow, October

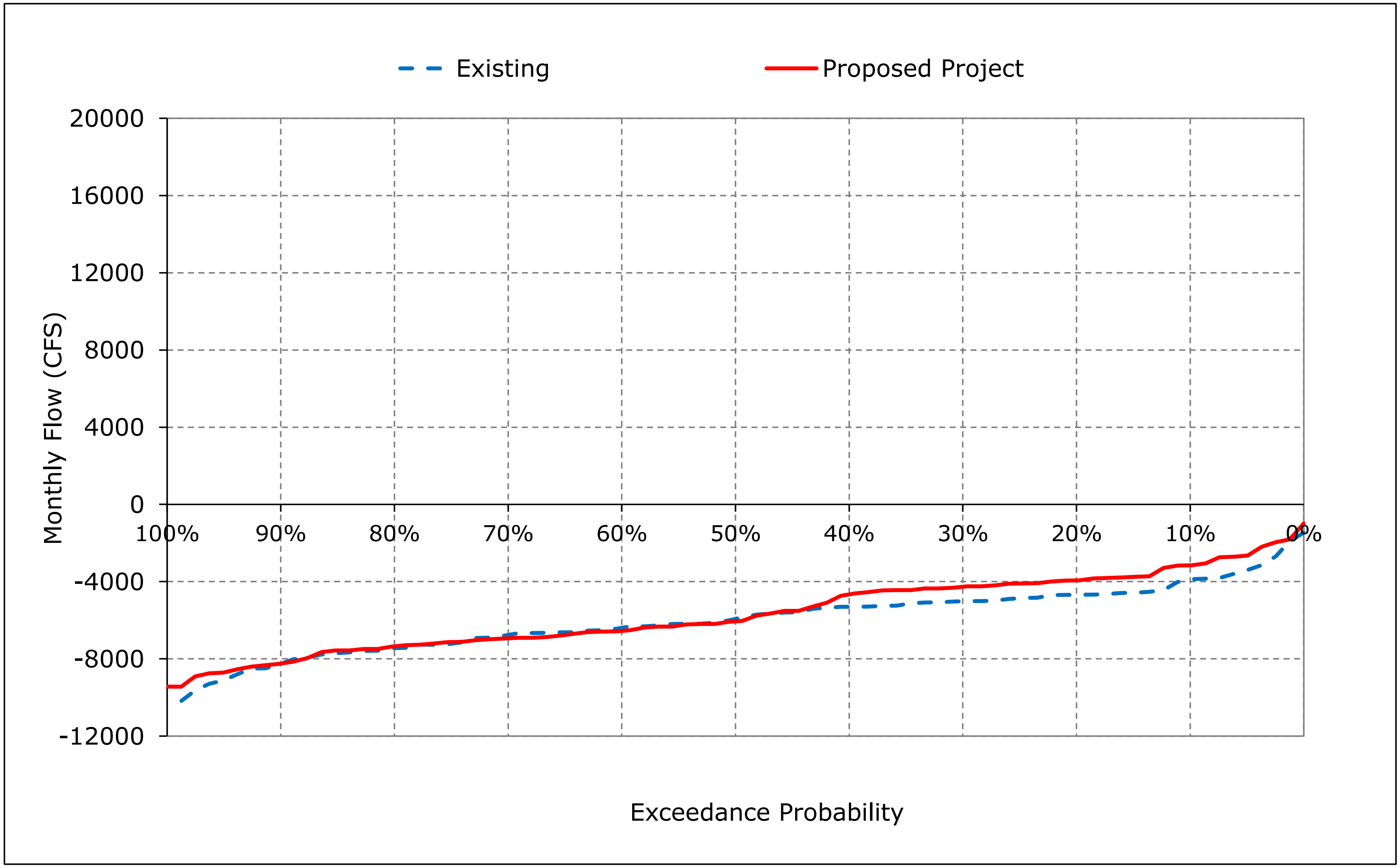


Figure 7-8. Old and Middle River Flow, November

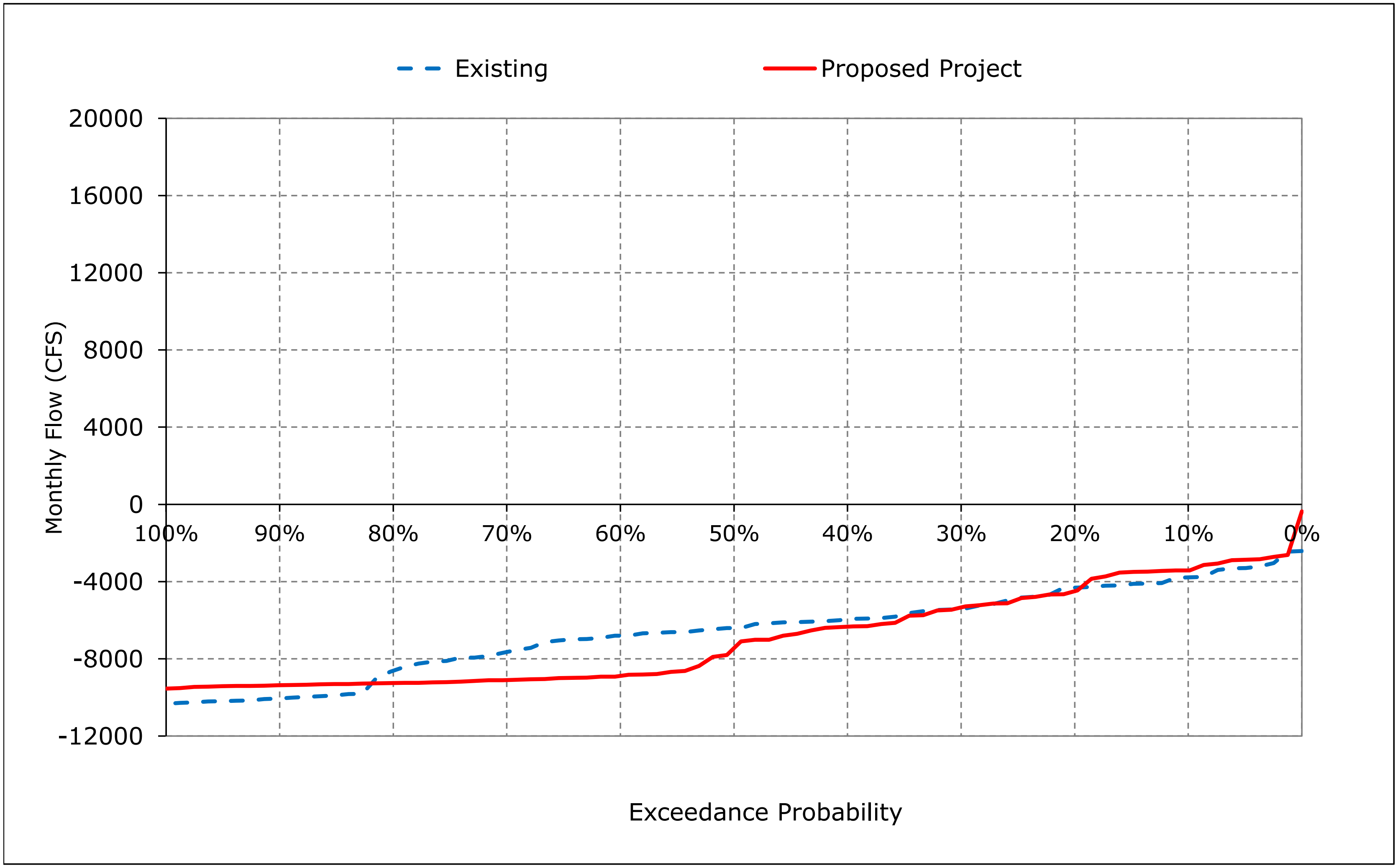


Figure 7-9. Old and Middle River Flow, December

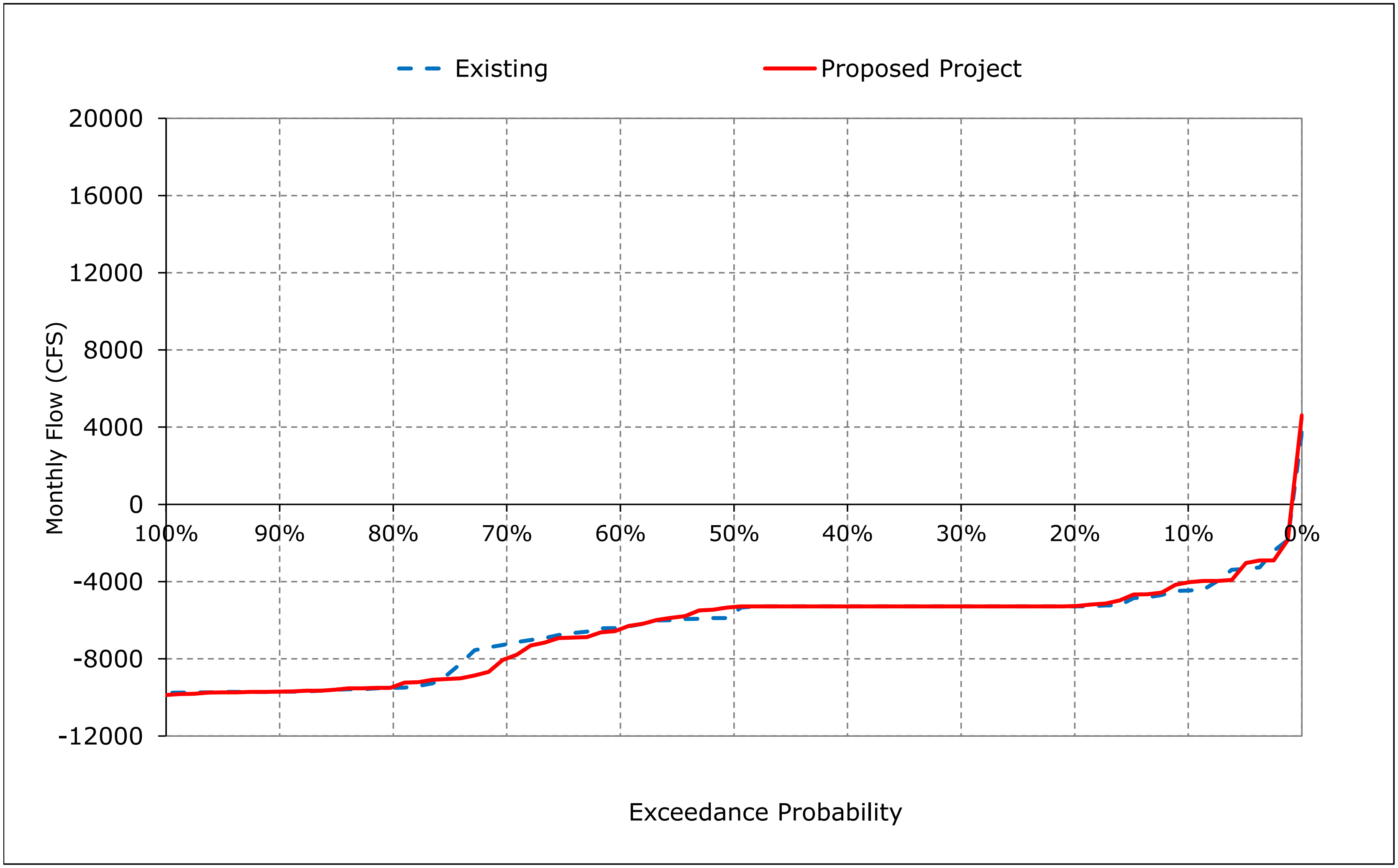


Figure 7-10. Old and Middle River Flow, January

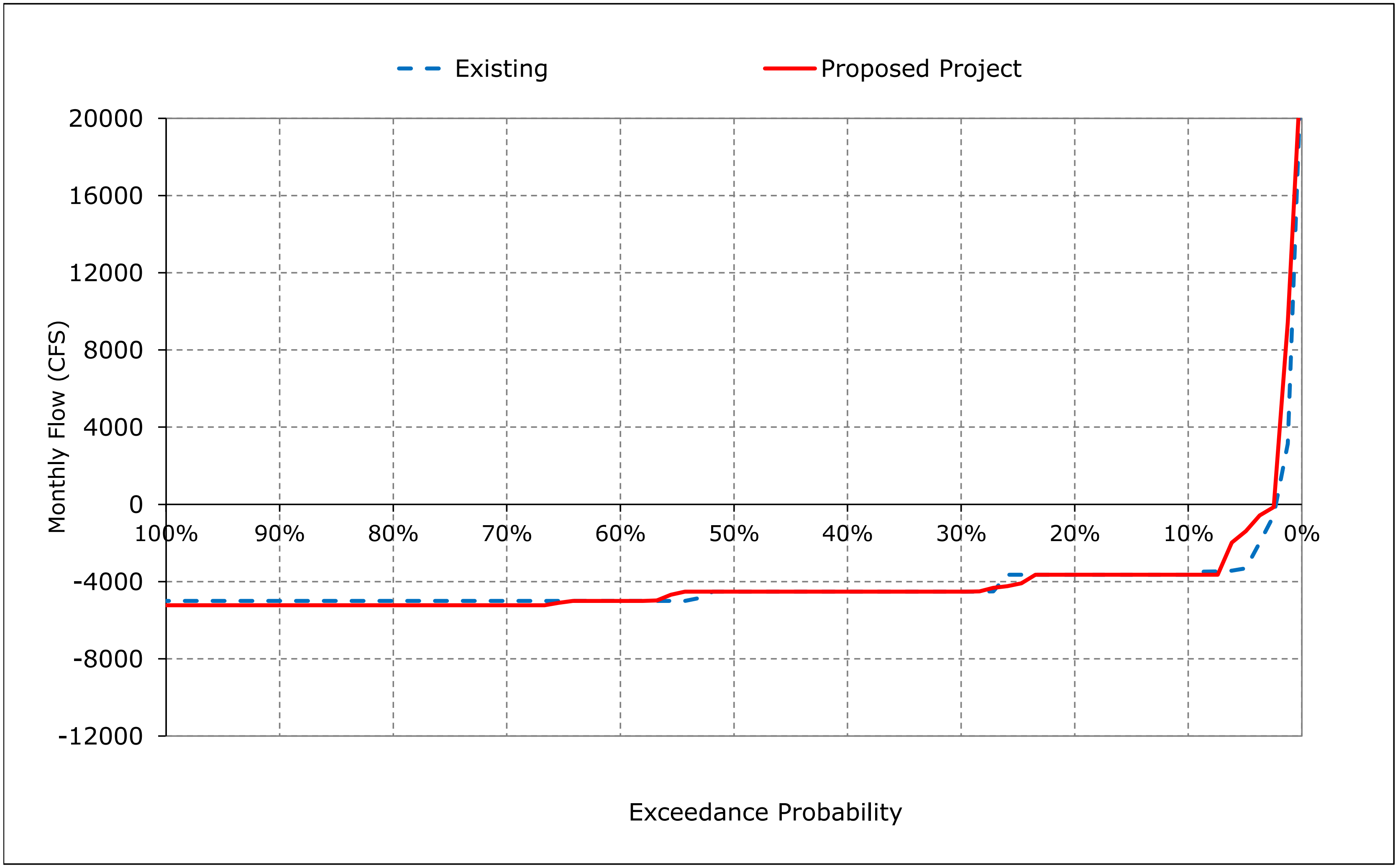


Figure 7-11. Old and Middle River Flow, February

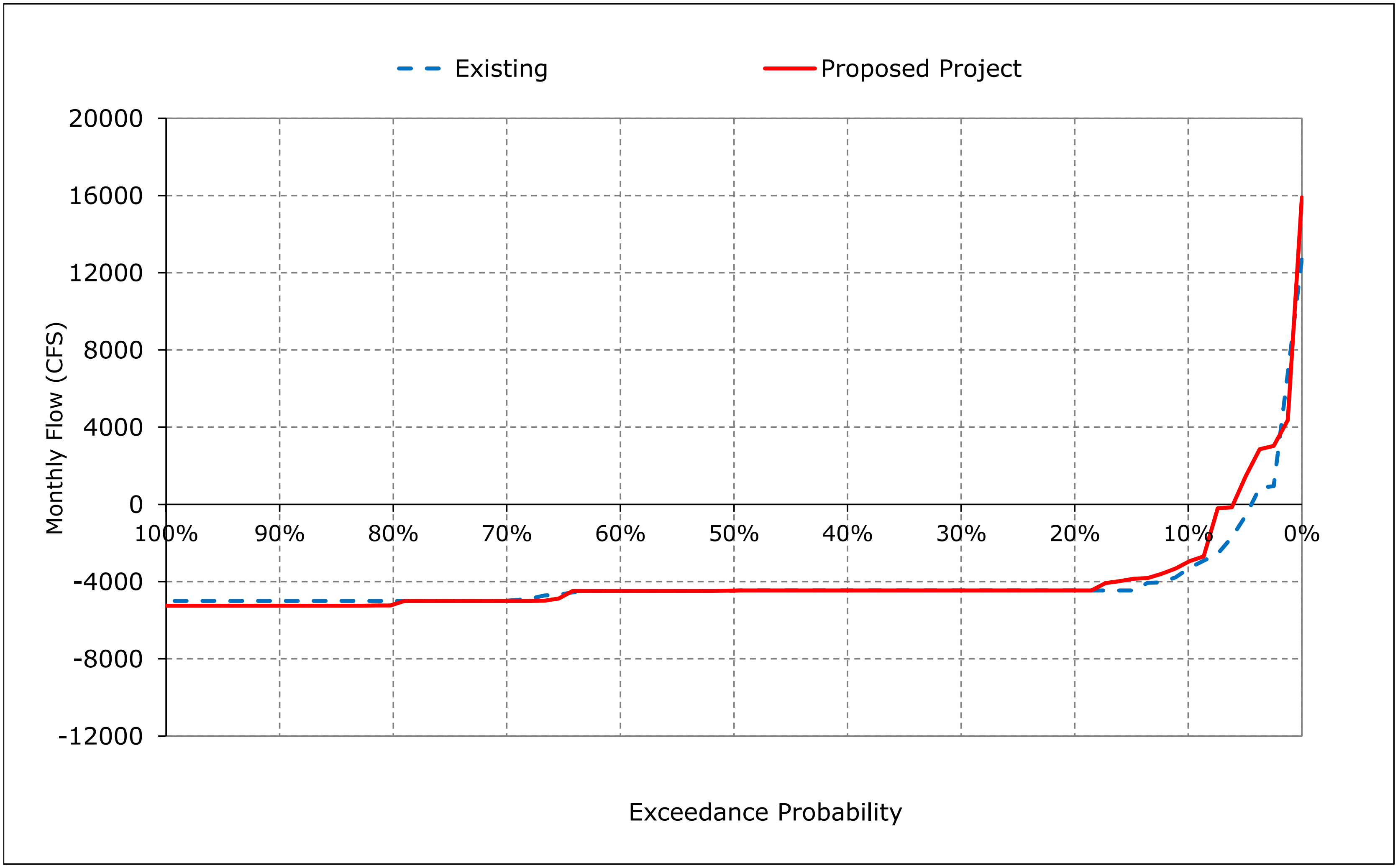


Figure 7-12. Old and Middle River Flow, March

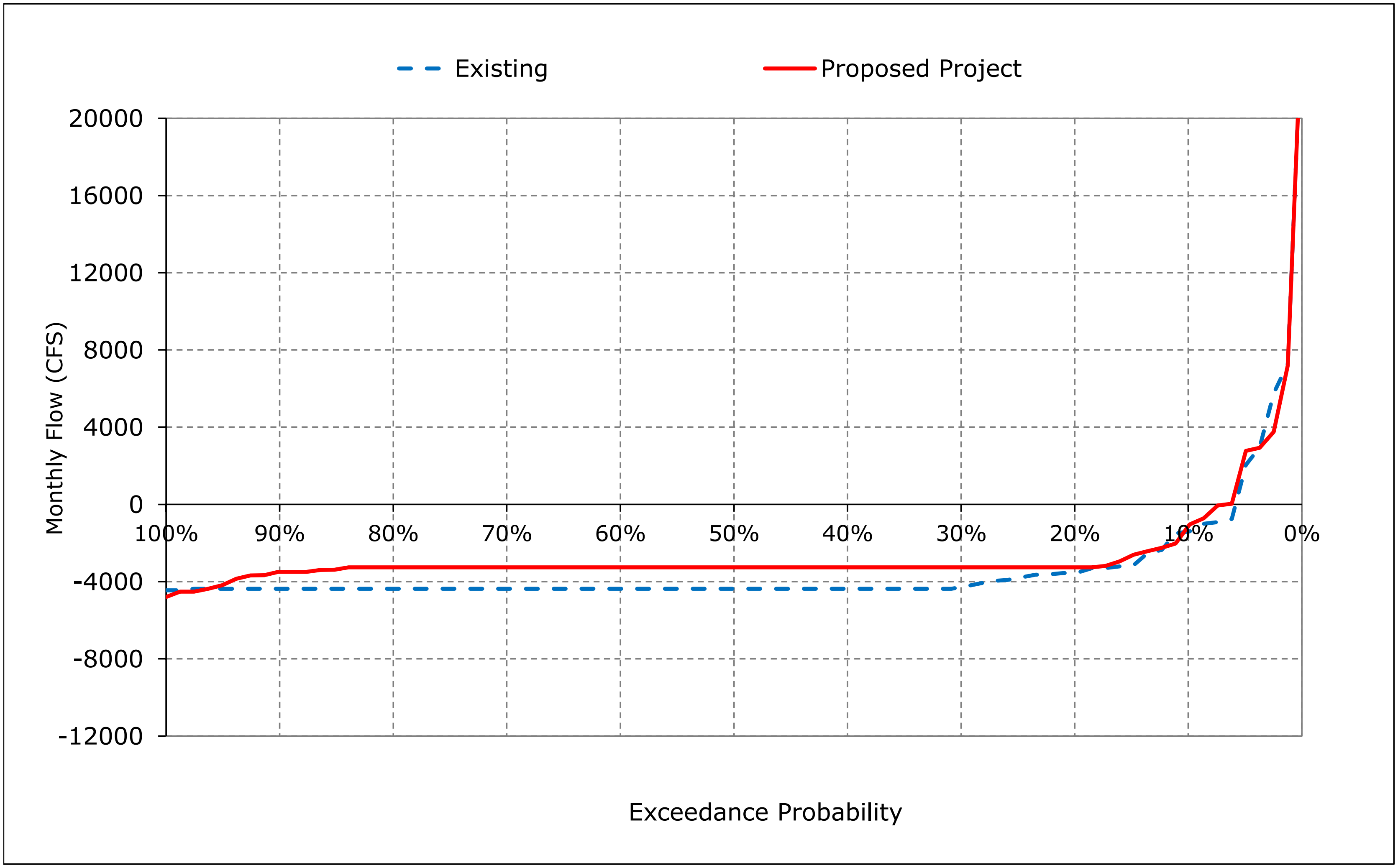


Figure 7-13. Old and Middle River Flow, April

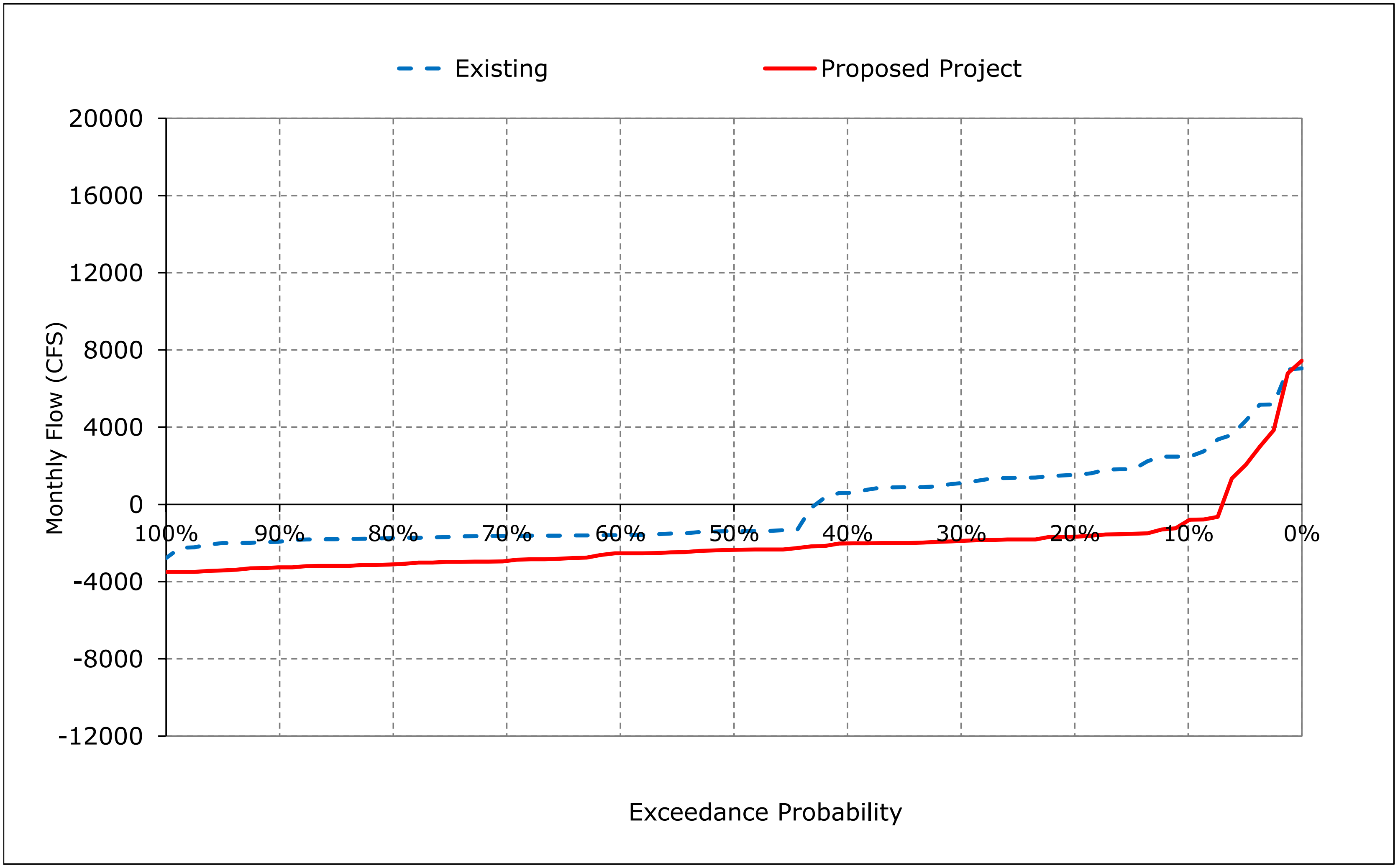


Figure 7-14. Old and Middle River Flow, May

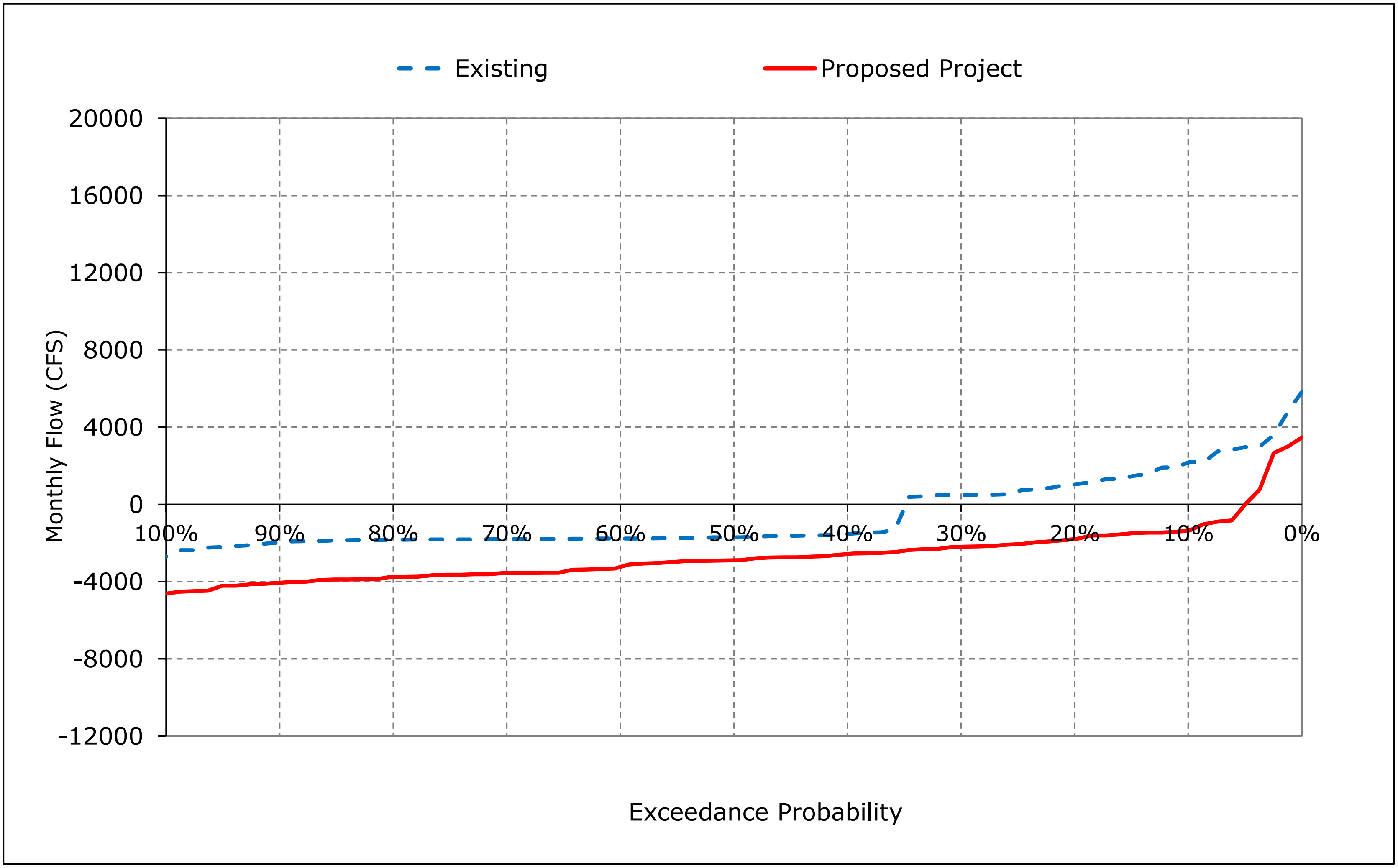


Figure 7-15. Old and Middle River Flow, June

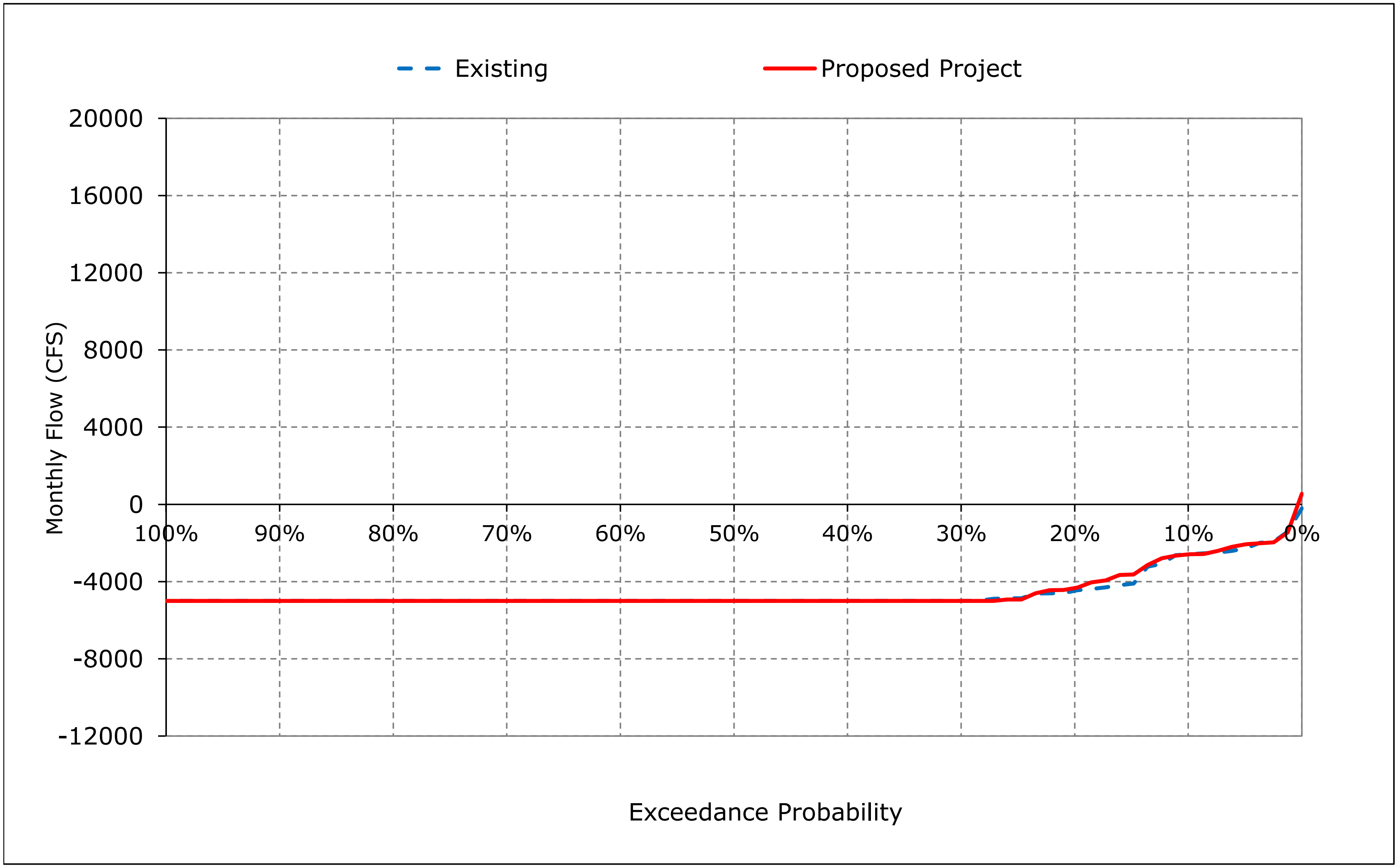


Figure 7-16. Old and Middle River Flow, July

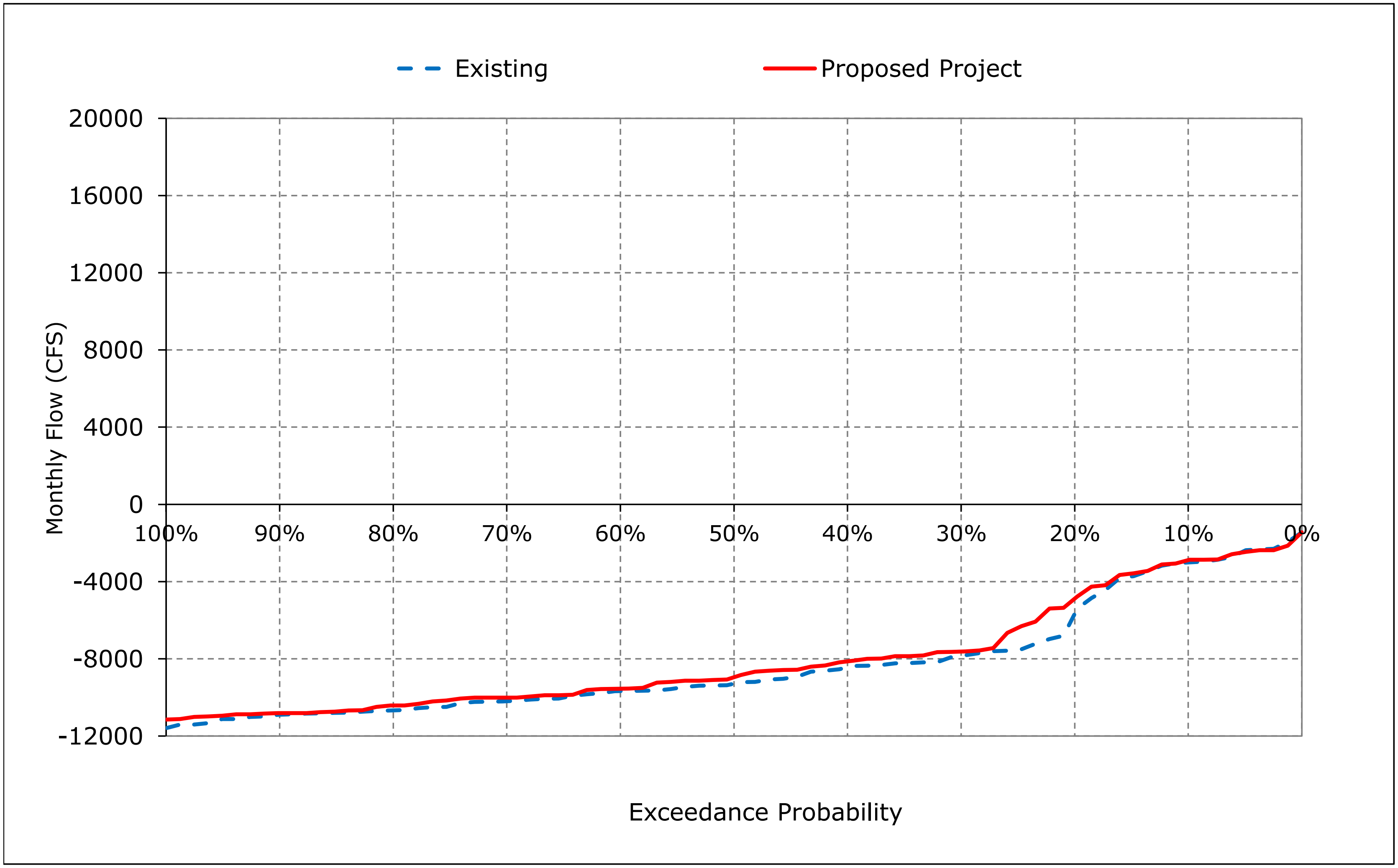


Figure 7-17. Old and Middle River Flow, August

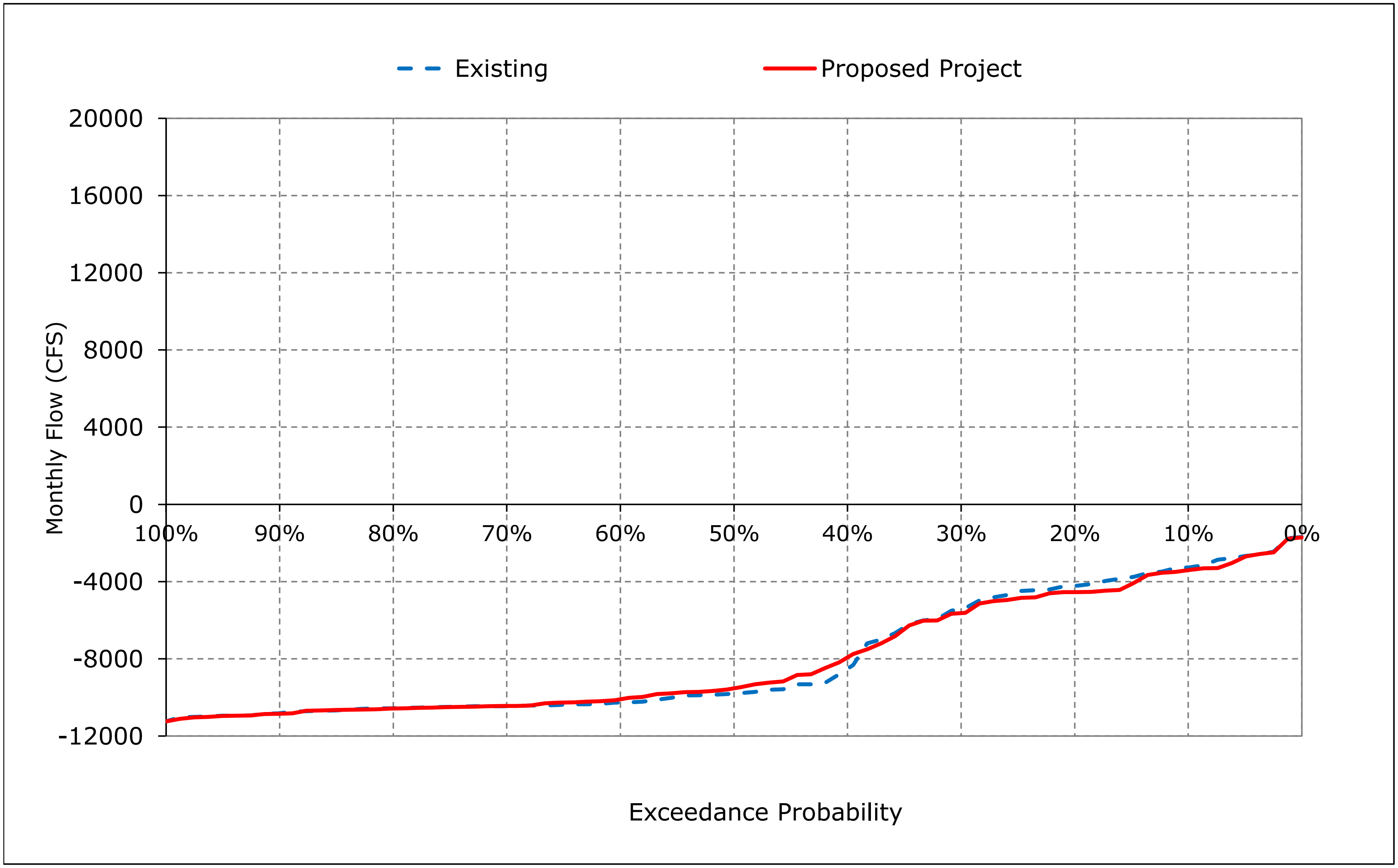


Figure 7-18. Old and Middle River Flow, September

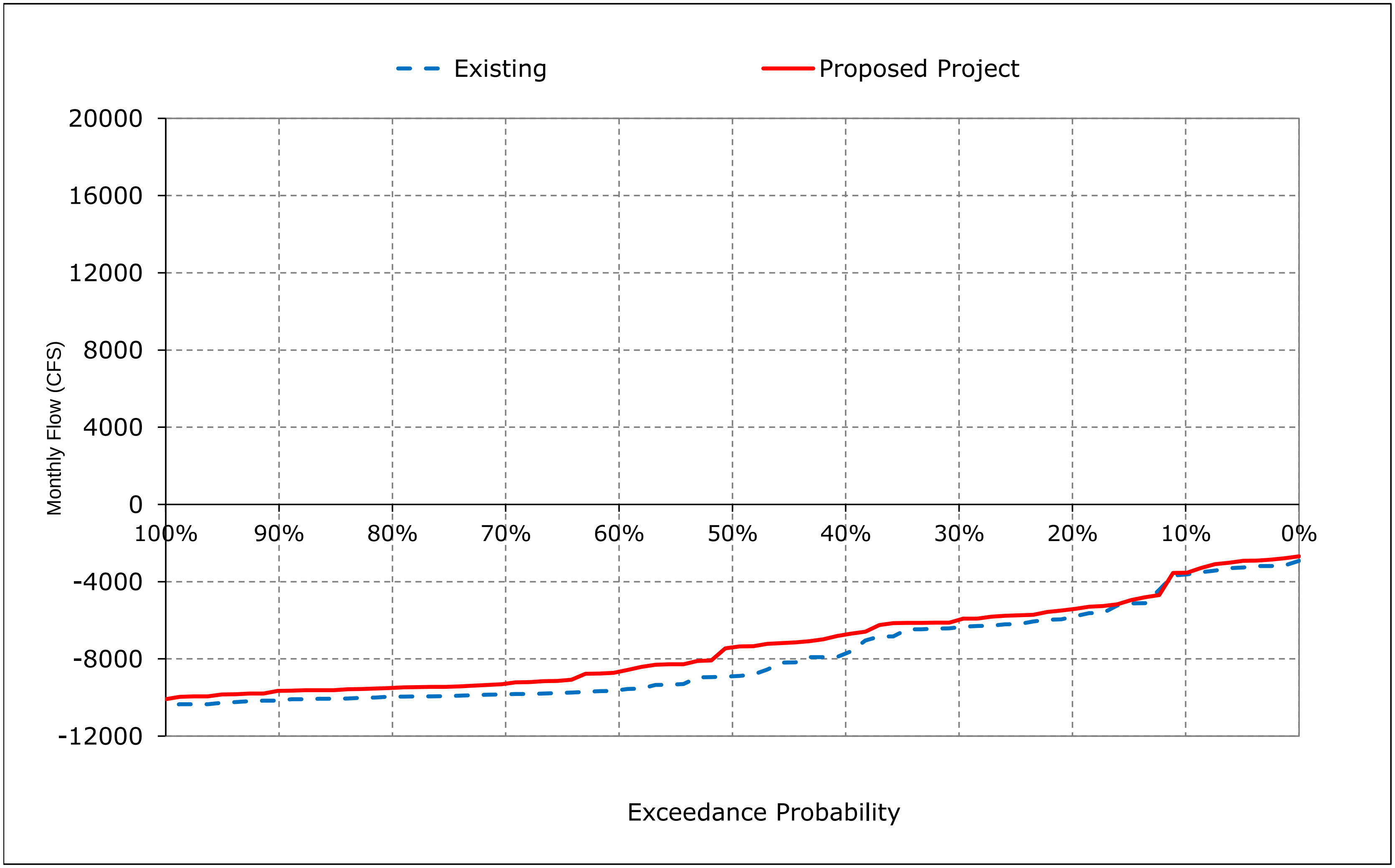


Table 8-1. Qwest, Monthly Flow

Existing

Statistic	Monthly Flow (CFS)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	1,101	1,598	7,499	14,692	18,541	18,228	20,508	16,658	7,874	362	245	35
20%	459	97	2,675	10,229	12,454	11,863	14,500	9,590	3,602	-285	-650	-1,012
30%	76	-77	-321	5,864	10,150	6,927	10,843	7,568	2,039	-1,323	-1,260	-1,568
40%	-10	-641	-1,310	3,159	7,473	5,169	8,593	6,449	1,054	-2,443	-2,321	-1,948
50%	-224	-923	-1,710	1,398	4,039	3,332	6,602	5,451	476	-2,799	-4,233	-2,266
60%	-371	-1,513	-2,422	261	1,931	2,051	4,740	3,606	51	-3,227	-4,588	-2,638
70%	-578	-1,990	-3,349	-189	730	1,470	3,805	2,374	-556	-3,787	-4,725	-3,631
80%	-1,237	-2,586	-4,822	-985	-18	684	2,559	1,691	-930	-4,236	-5,078	-4,095
90%	-1,696	-3,624	-5,504	-1,333	-908	-178	1,618	921	-1,123	-4,772	-5,296	-4,560
Long Term												
Full Simulation Period[a]	-375	-767	-53	5,395	7,422	7,194	8,963	6,858	2,054	-1,788	-3,008	-2,285
Water Year Types[b,c]												
Wet (32%)	-497	-233	4,357	13,707	15,795	15,802	16,456	13,289	6,129	542	-3,962	-3,120
Above Normal (15%)	-536	-877	-1,207	6,404	8,852	8,806	9,620	7,376	1,502	-2,434	-5,088	-1,665
Below Normal (17%)	-221	-1,429	-1,740	1,722	5,401	3,169	7,343	5,311	189	-4,172	-4,524	-3,501
Dry (22%)	-281	-1,341	-2,853	-309	1,266	1,312	3,890	2,496	-660	-3,778	-769	-1,874
Critical (15%)	-268	-182	-2,286	-781	-560	451	1,572	755	25	-425	-449	-295

Proposed Project

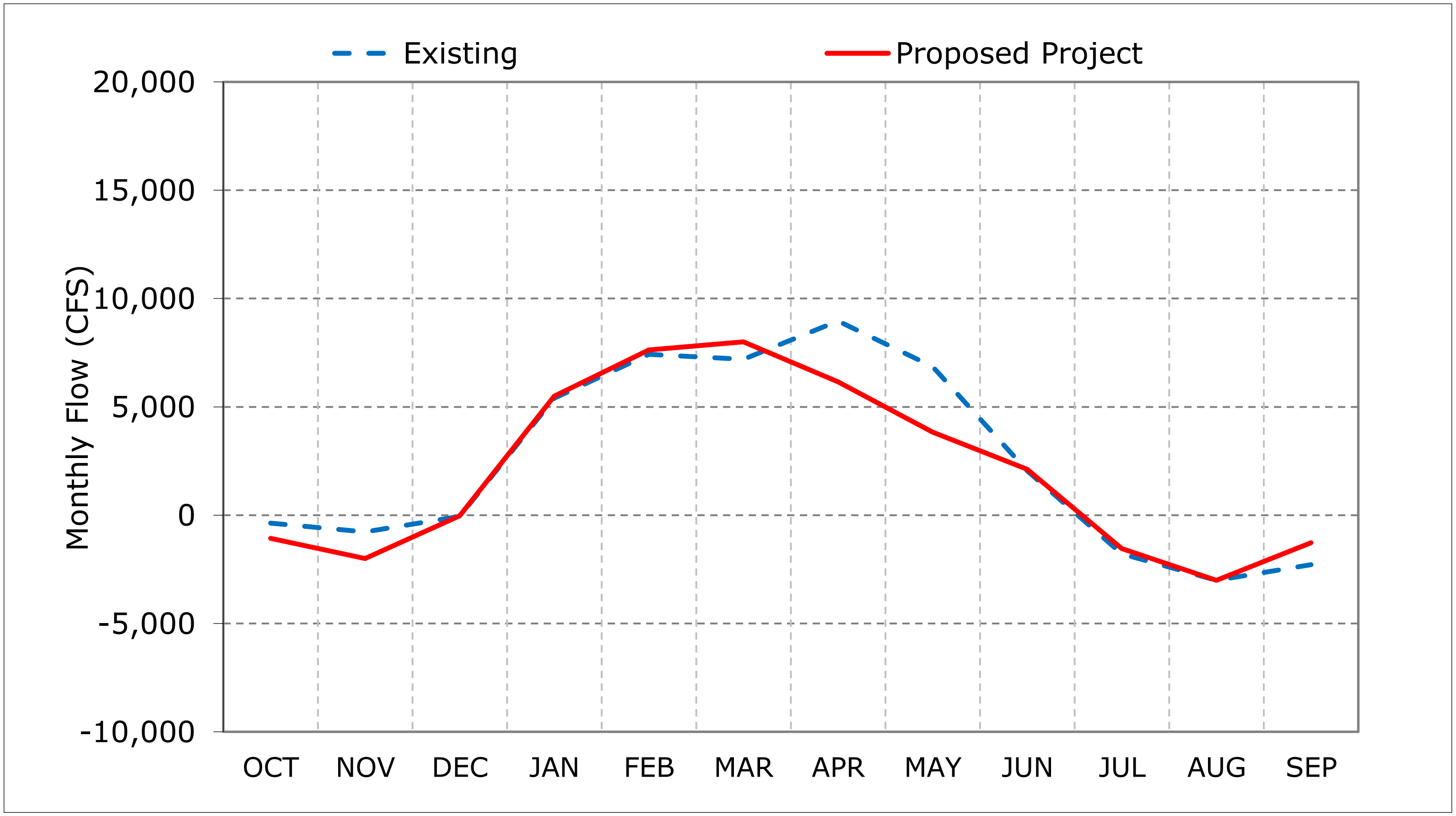
Statistic	Monthly Flow (CFS)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	485	60	7,406	14,759	19,661	18,842	14,629	10,860	7,870	362	-3	399
20%	66	-270	2,425	10,208	12,519	13,483	9,890	4,611	3,762	-104	-1,020	27
30%	-97	-1,185	-240	5,986	9,693	7,878	6,428	3,428	2,105	-1,053	-1,511	-588
40%	-309	-2,025	-1,146	3,492	7,430	6,540	4,573	2,225	1,187	-1,906	-2,476	-1,020
50%	-711	-2,389	-1,593	1,762	4,072	4,475	3,218	1,747	508	-2,622	-3,693	-1,491
60%	-1,306	-3,364	-2,365	132	1,825	2,886	2,086	1,086	11	-3,090	-4,271	-1,785
70%	-1,774	-3,628	-3,357	-653	575	1,911	1,772	650	-496	-3,428	-4,795	-1,981
80%	-2,216	-3,967	-4,945	-1,172	-401	1,302	1,321	264	-832	-3,999	-5,029	-2,266
90%	-3,033	-4,706	-5,426	-1,505	-1,033	-101	786	-36	-1,095	-4,290	-5,392	-3,078
Long Term												
Full Simulation Period[a]	-1,064	-2,007	-26	5,494	7,622	8,001	6,155	3,830	2,113	-1,540	-3,008	-1,268
Water Year Types[b,c]												
Wet (32%)	-1,362	-1,756	4,499	14,173	16,435	16,725	12,634	9,001	6,123	758	-3,870	-154
Above Normal (15%)	-1,489	-2,116	-1,245	6,427	9,208	9,991	5,917	3,228	1,626	-2,580	-5,036	-1,208
Below Normal (17%)	-1,067	-2,716	-1,691	1,736	5,440	4,290	4,354	1,905	337	-3,452	-4,306	-3,385
Dry (22%)	-772	-2,042	-3,154	-528	990	2,222	1,847	588	-615	-3,305	-890	-1,848
Critical (15%)	-430	-1,561	-1,979	-827	-564	106	914	339	72	-600	-778	-405

Proposed Project minus Existing

Statistic	Monthly Flow (CFS)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	**-615**	**-1,538**	**-94**	67	1,120	614	**-5,880**	**-5,799**	**-4**	0	**-248**	364
20%	**-393**	**-368**	**-251**	**-21**	65	1,619	**-4,610**	**-4,979**	160	182	**-370**	1,039
30%	**-173**	**-1,108**	80	122	**-458**	951	**-4,416**	**-4,140**	66	270	**-251**	980
40%	**-299**	**-1,383**	165	333	**-43**	1,371	**-4,020**	**-4,224**	132	536	**-154**	928
50%	**-488**	**-1,466**	117	364	33	1,143	**-3,384**	**-3,703**	32	177	540	776
60%	**-935**	**-1,851**	57	**-129**	**-105**	835	**-2,654**	**-2,520**	**-40**	136	318	853
70%	**-1,196**	**-1,637**	**-8**	**-465**	**-155**	441	**-2,033**	**-1,724**	60	360	**-69**	1,650
80%	**-980**	**-1,381**	**-122**	**-186**	**-383**	618	**-1,238**	**-1,428**	99	237	49	1,829
90%	**-1,337**	**-1,082**	78	**-172**	**-124**	77	**-832**	**-957**	29	482	**-96**	1,481
Long Term												
Full Simulation Period[a]	**-690**	**-1,240**	27	99	200	806	**-2,809**	**-3,028**	59	248	**0**	1,017
Water Year Types[b,c]												
Wet (32%)	**-865**	**-1,523**	142	467	639	923	**-3,822**	**-4,288**	**-6**	216	92	2,966
Above Normal (15%)	**-953**	**-1,239**	**-39**	23	356	1,185	**-3,703**	**-4,147**	124	**-145**	52	457
Below Normal (17%)	**-845**	**-1,287**	49	15	39	1,121	**-2,989**	**-3,406**	148	720	218	116
Dry (22%)	**-492**	**-701**	**-301**	**-219**	**-276**	910	**-2,042**	**-1,908**	46	473	**-121**	26
Critical (15%)	**-162**	**-1,378**	307	**-47**	**-3**	**-346**	**-658**	**-416**	47	**-175**	**-328**	**-110**

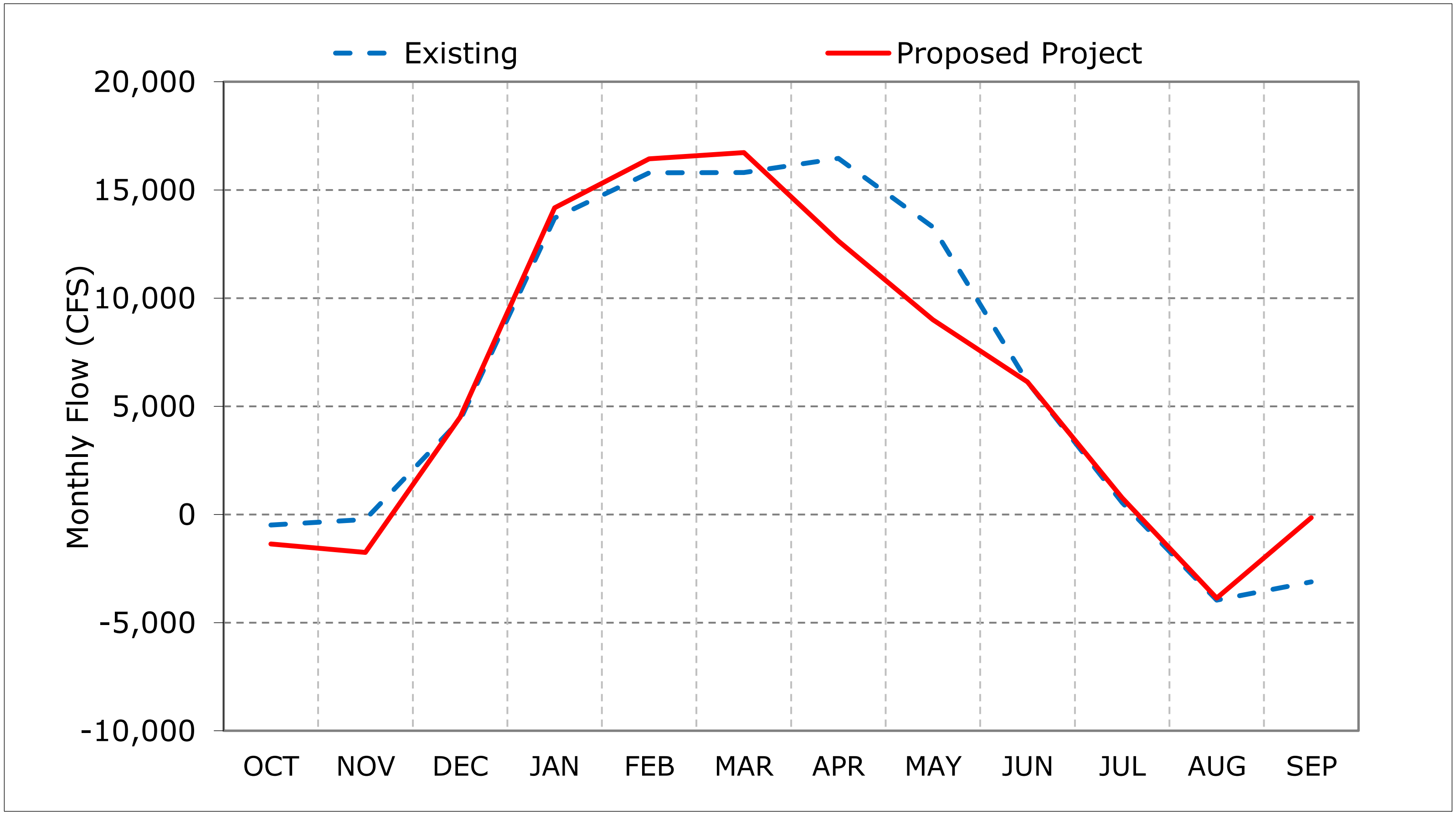
a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with water year - year type sorting.

Figure 8-1. Qwest, Long-Term Average Flow



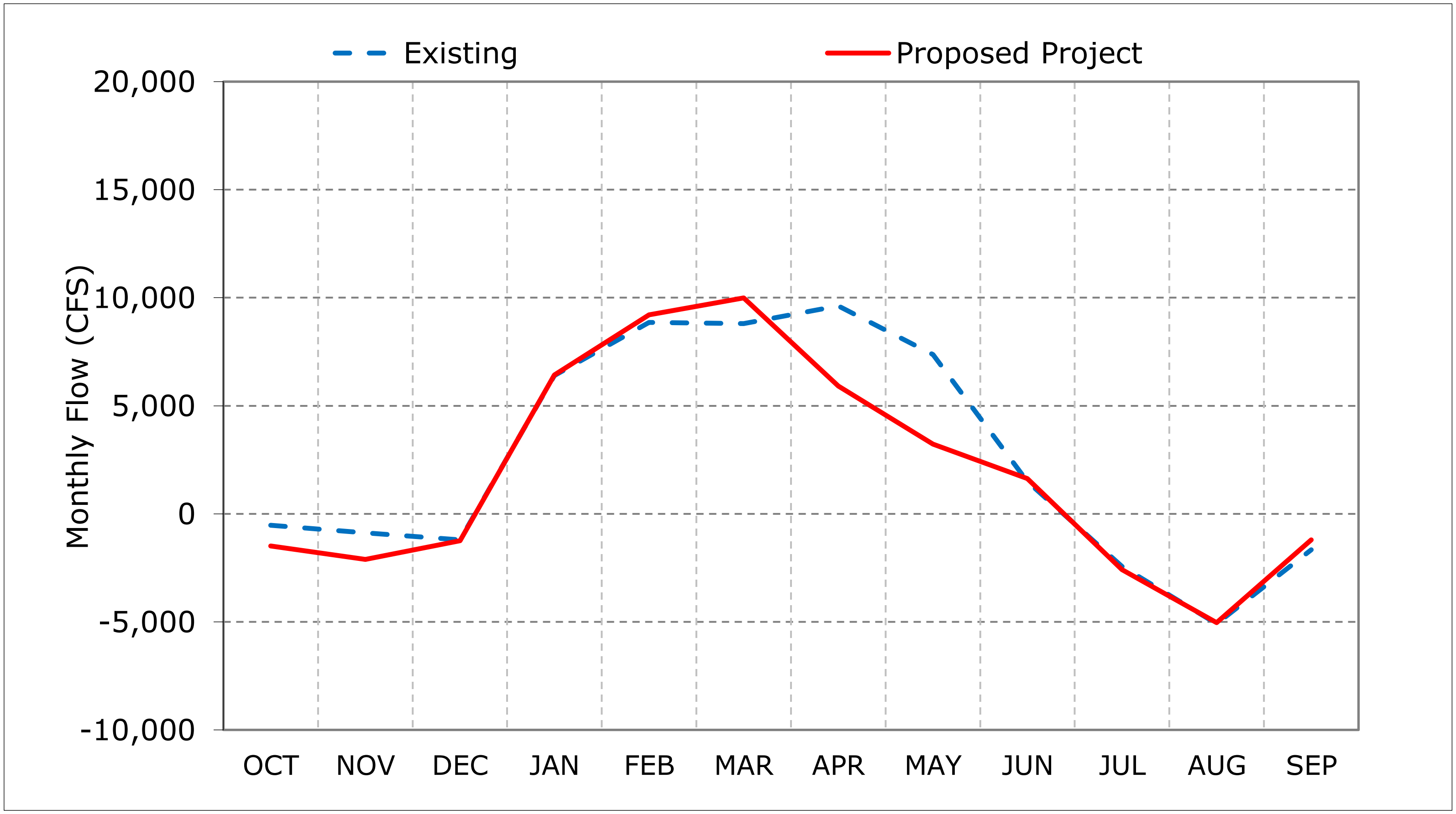
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 8-2. Qwest, Wet Year Average Flow



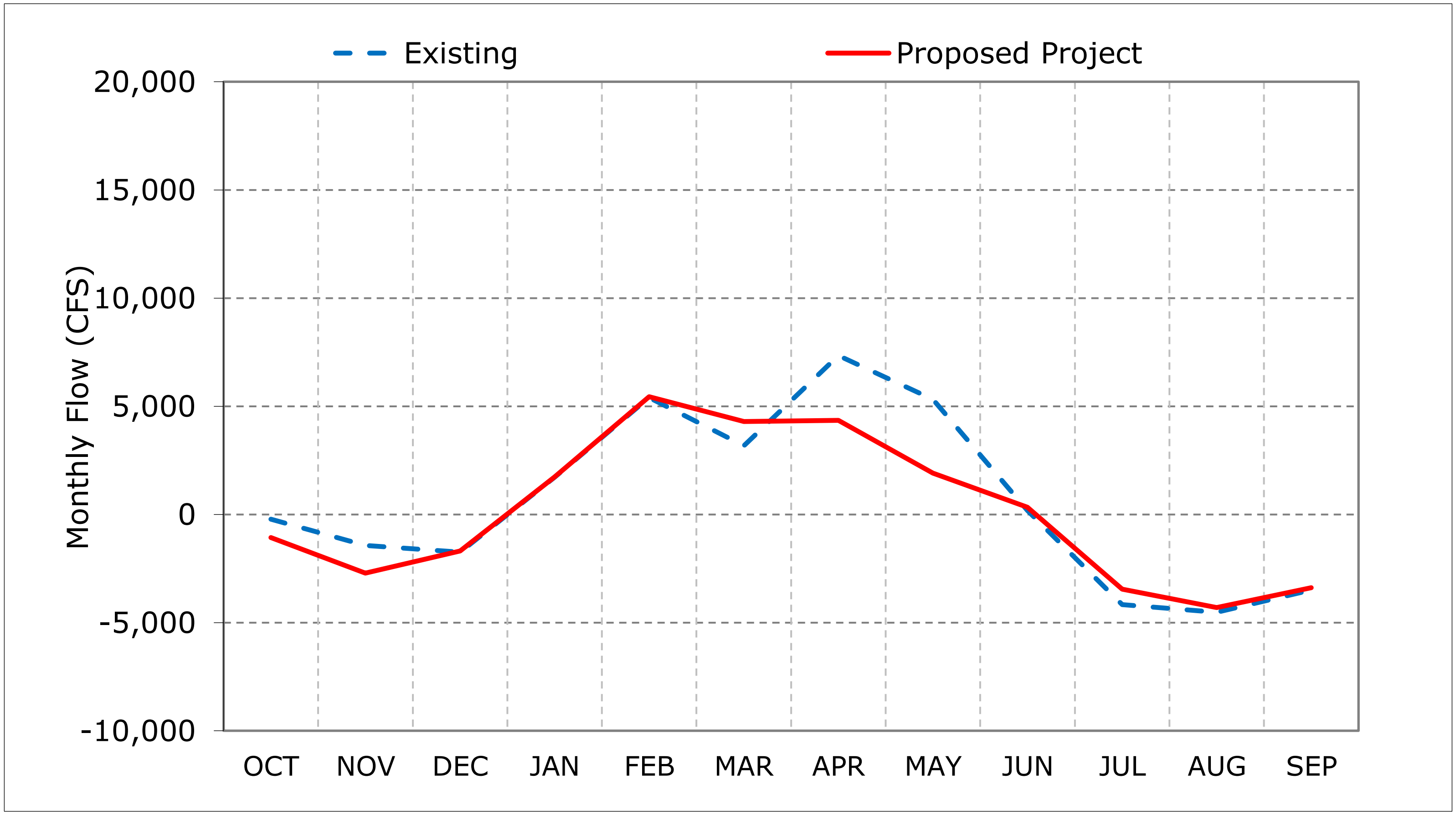
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 8-3. Qwest, Above Normal Year Average Flow



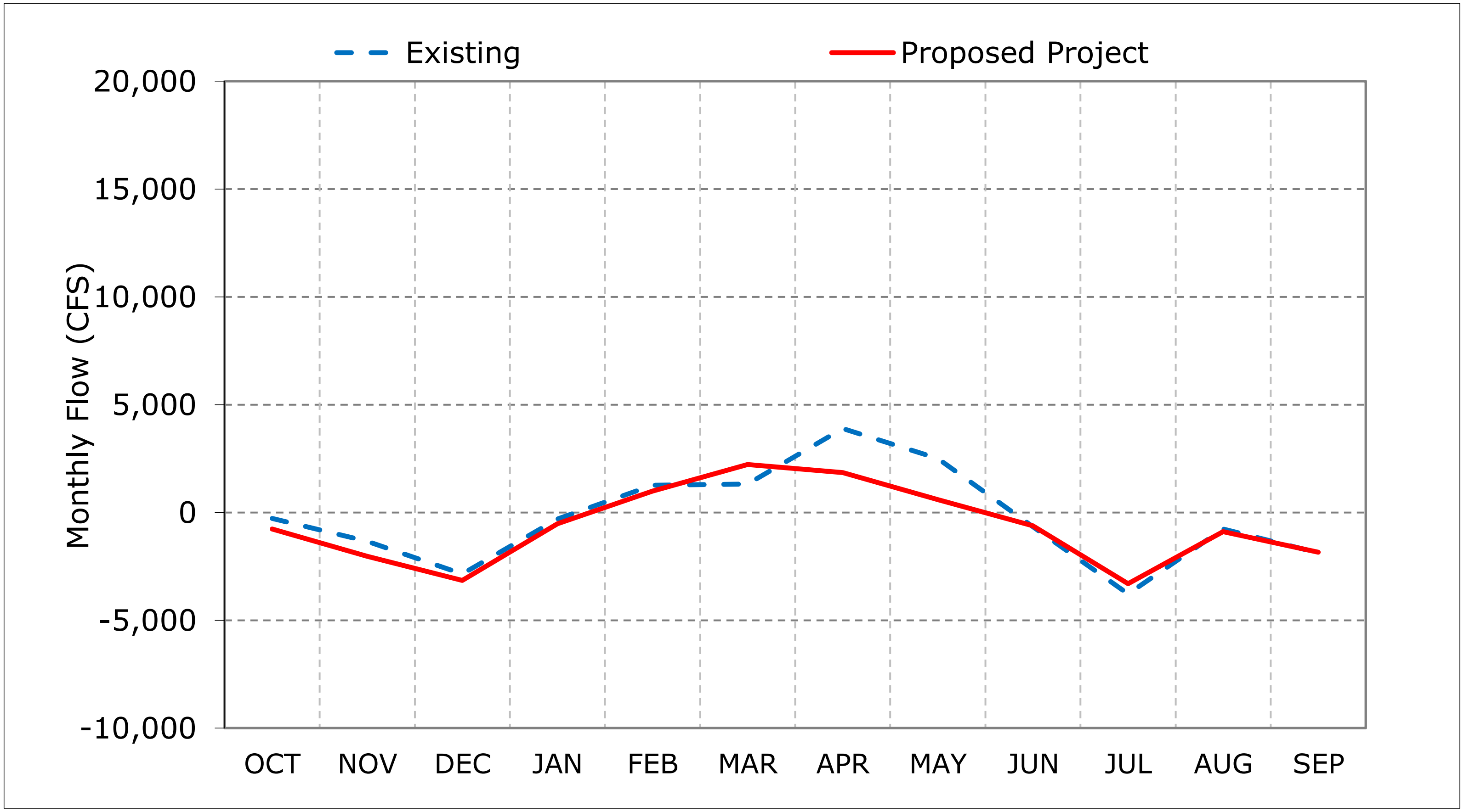
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 8-4. Qwest, Below Normal Year Average Flow



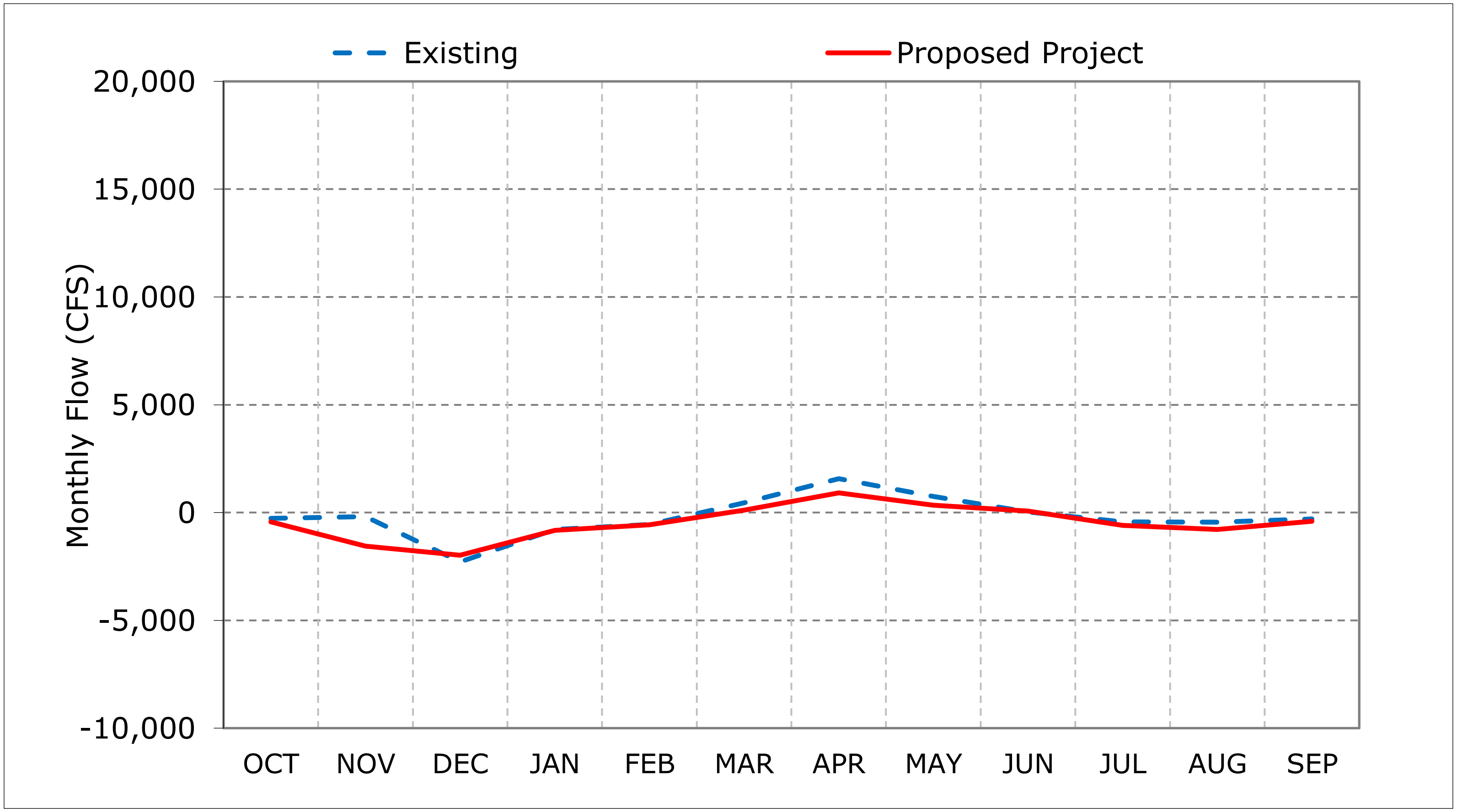
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 8-5. Qwest, Dry Year Average Flow



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 8-6. Qwest, Critical Year Average Flow



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 8-7. Qwest, October

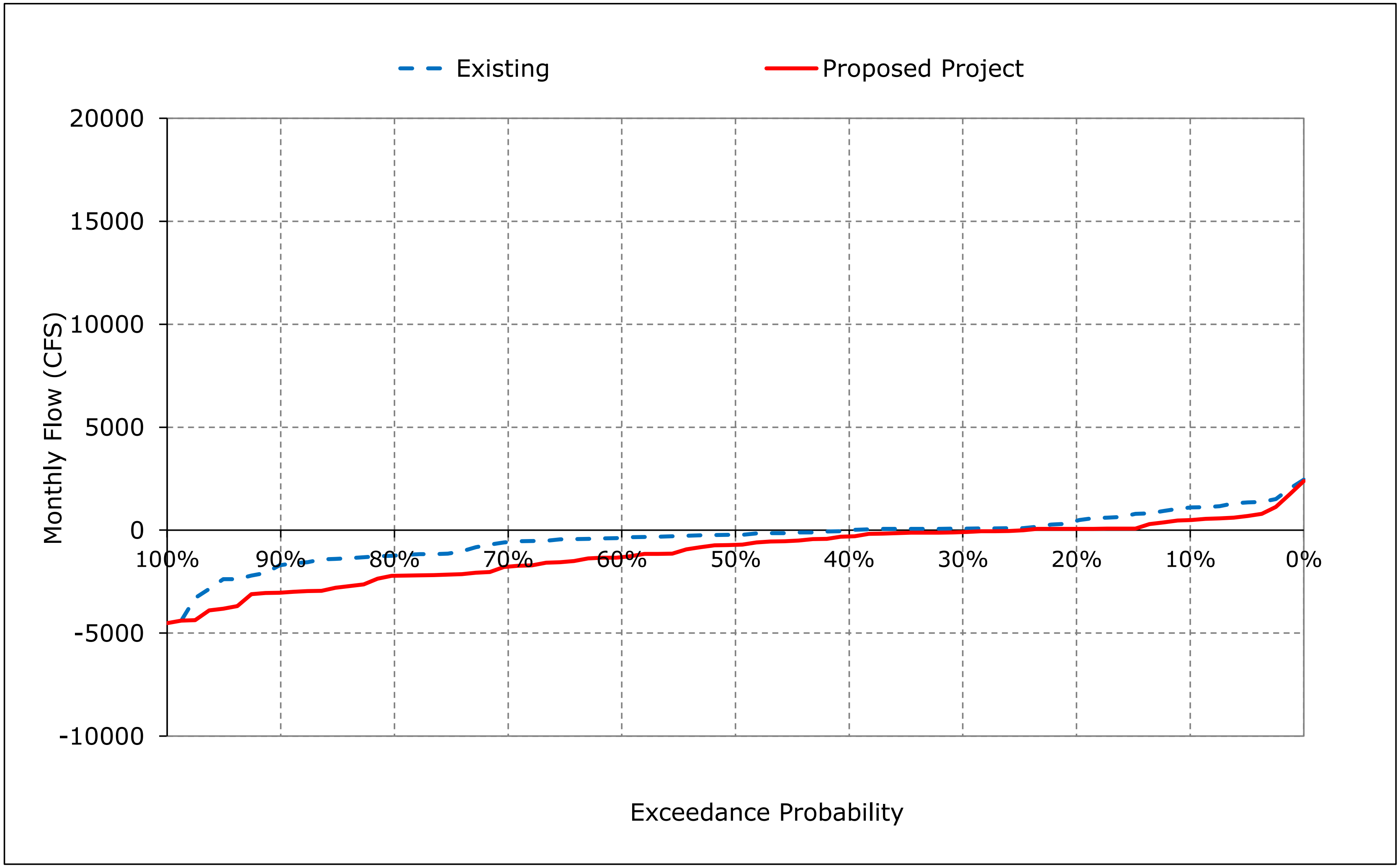


Figure 8-8. Qwest, November

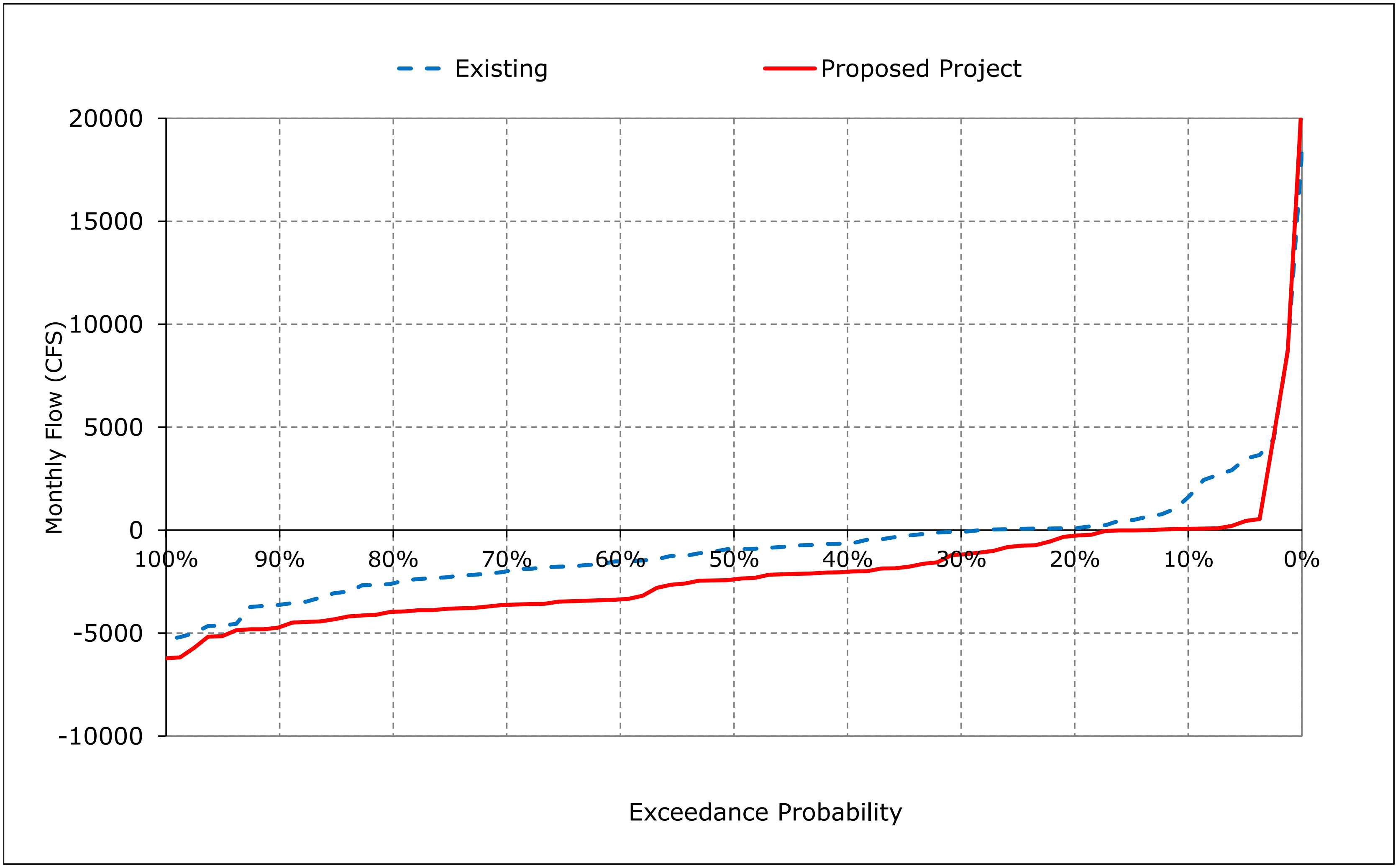


Figure 8-9. Qwest, December

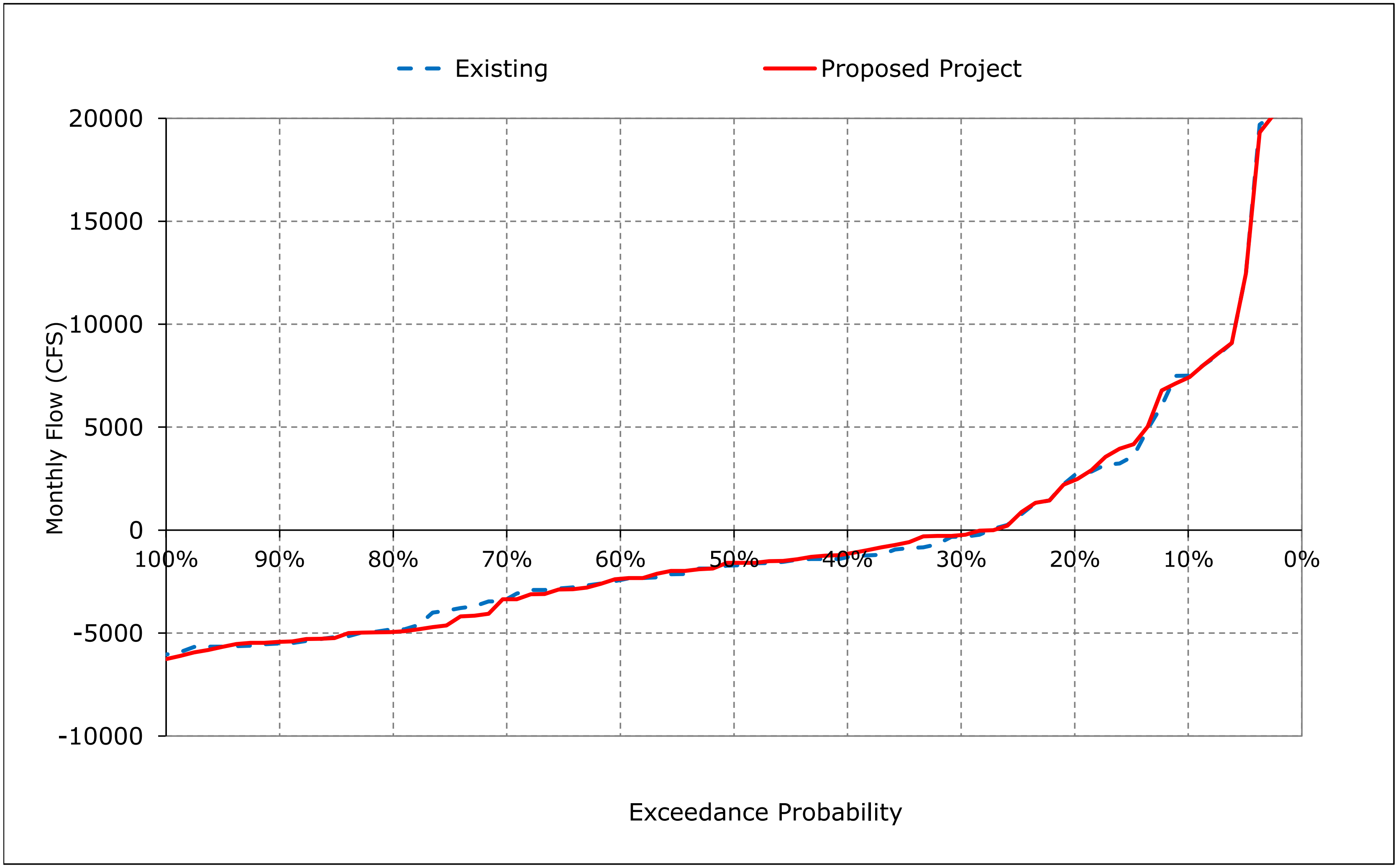


Figure 8-10. Qwest, January

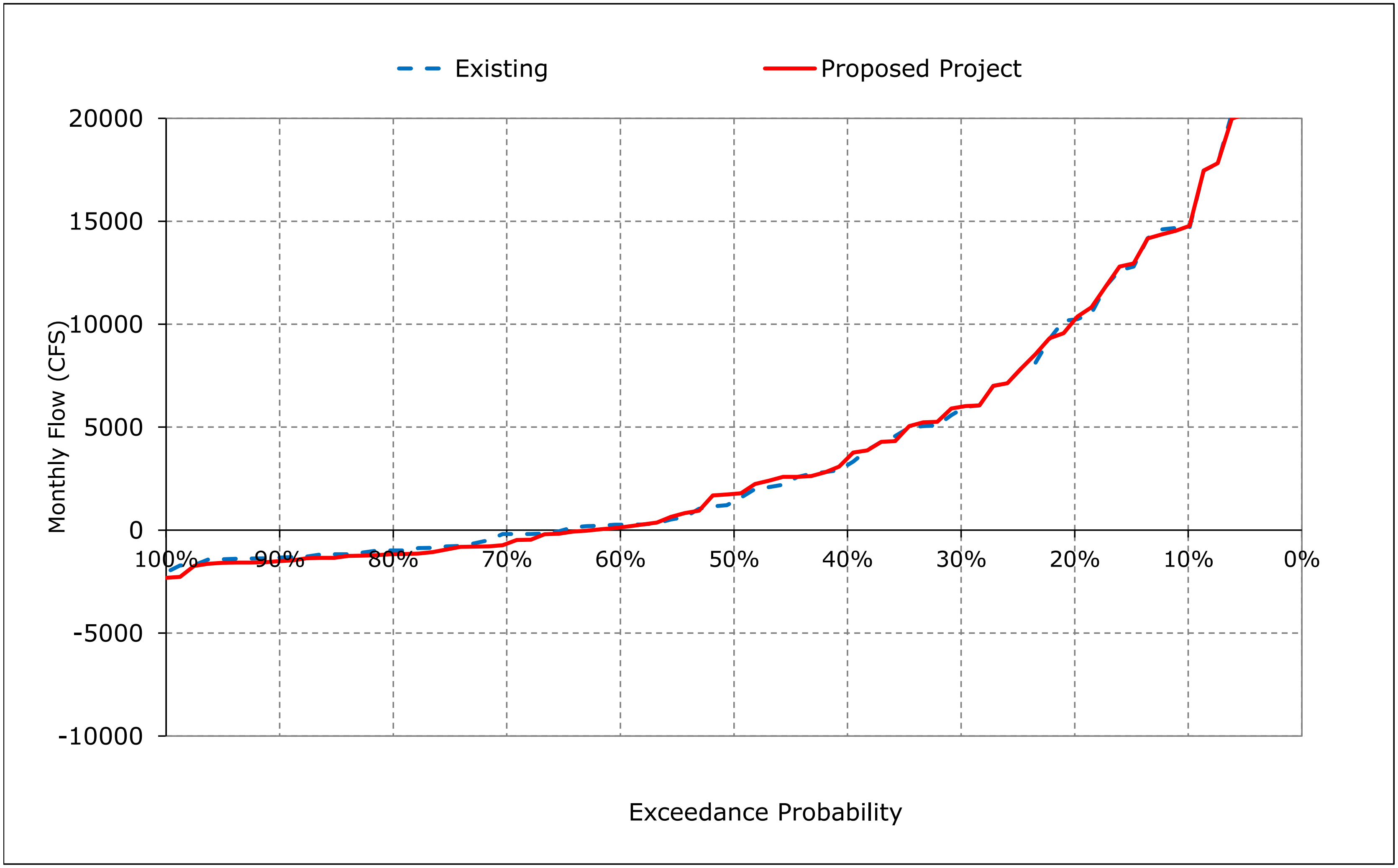


Figure 8-11. Qwest, February

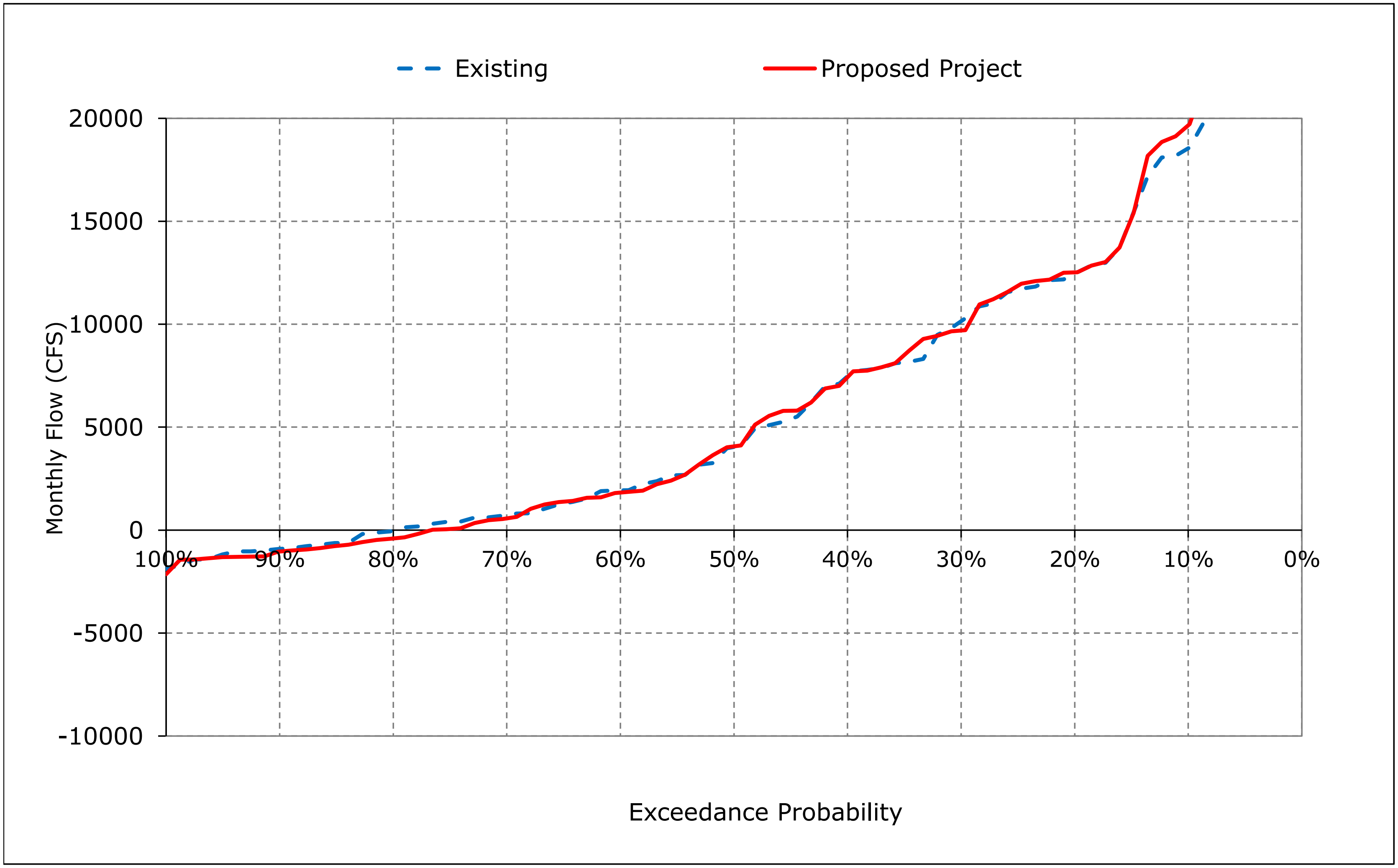


Figure 8-12. Qwest, March

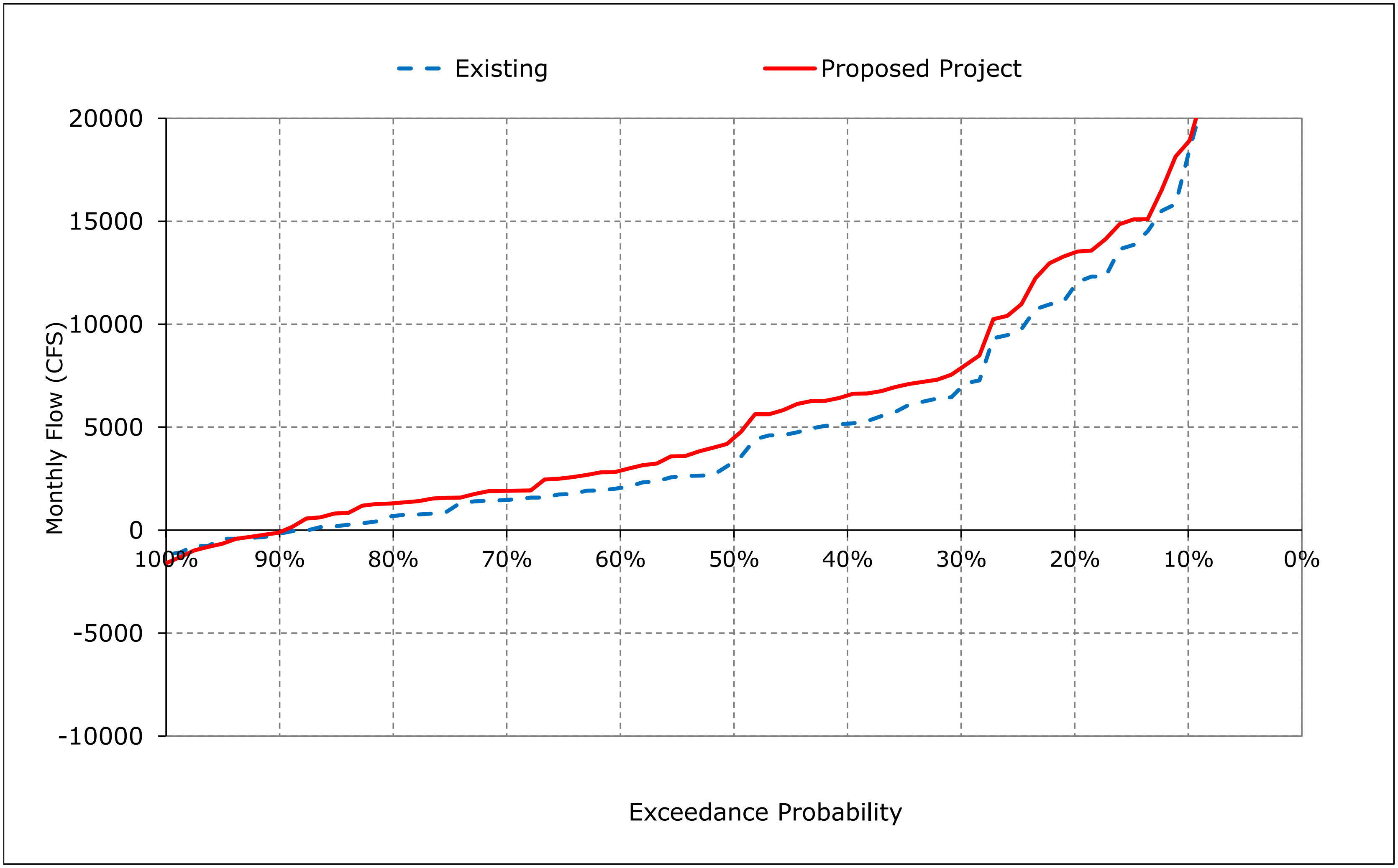


Figure 8-13. Qwest, April

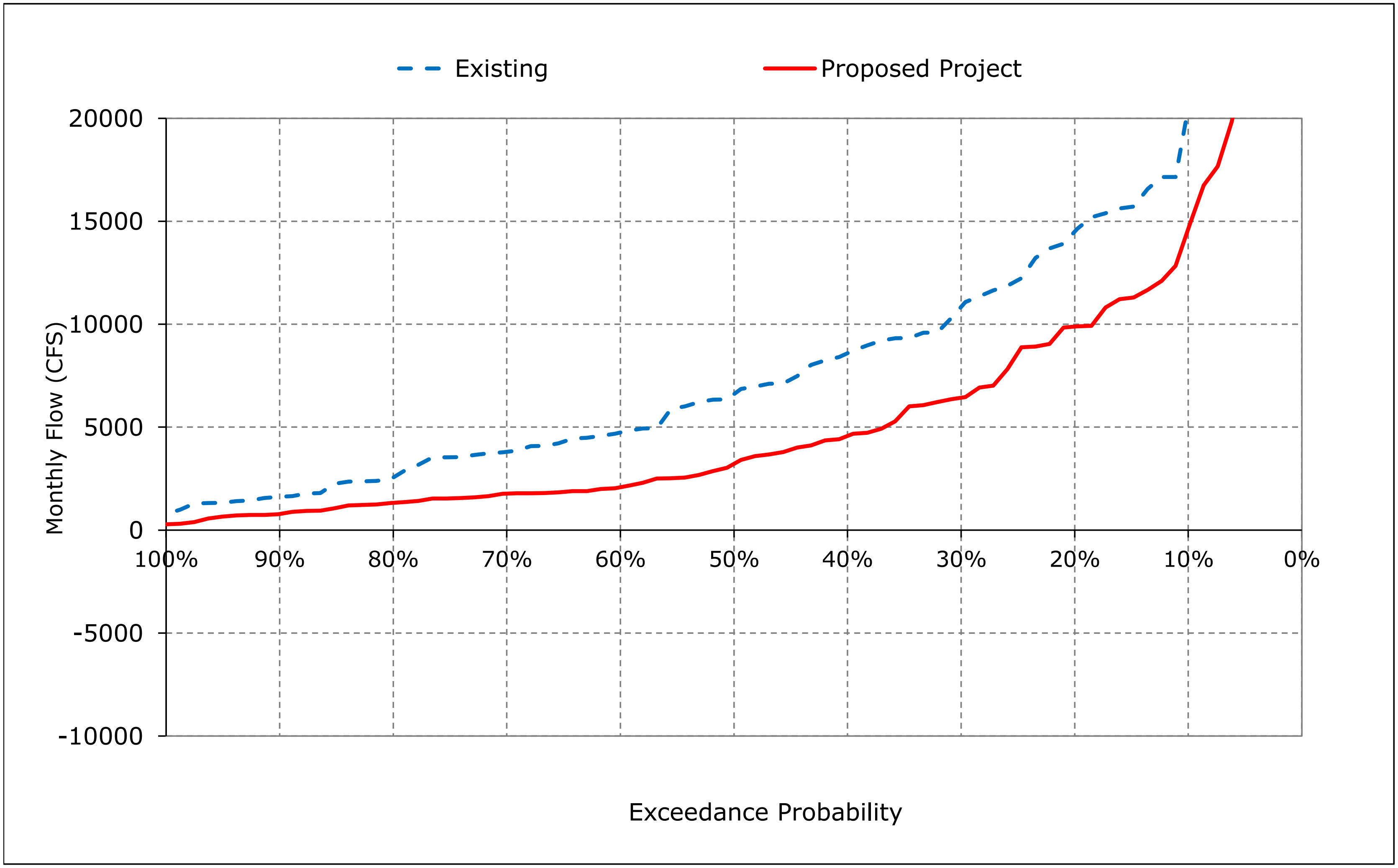


Figure 8-14. Qwest, May

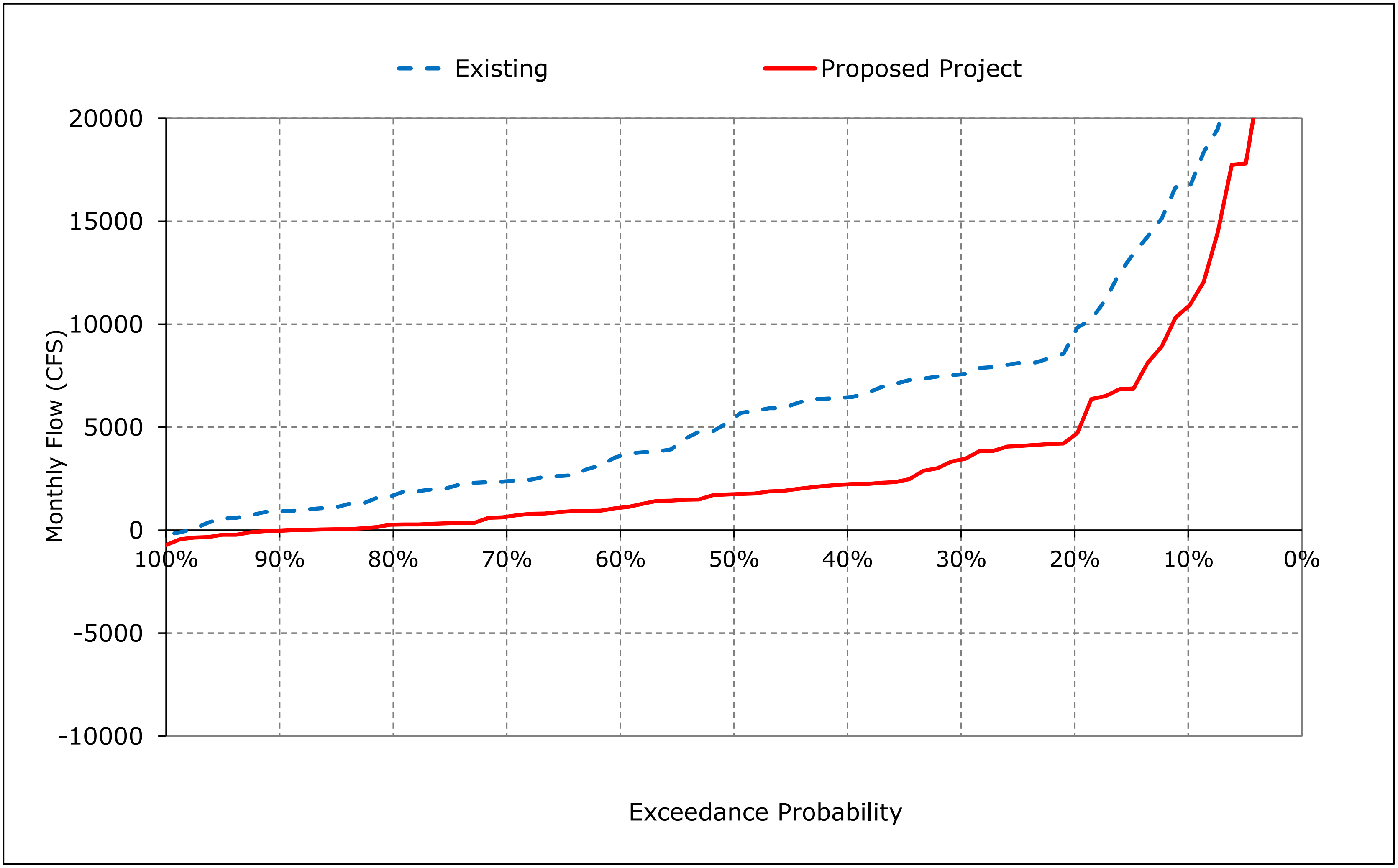


Figure 8-15. Qwest, June

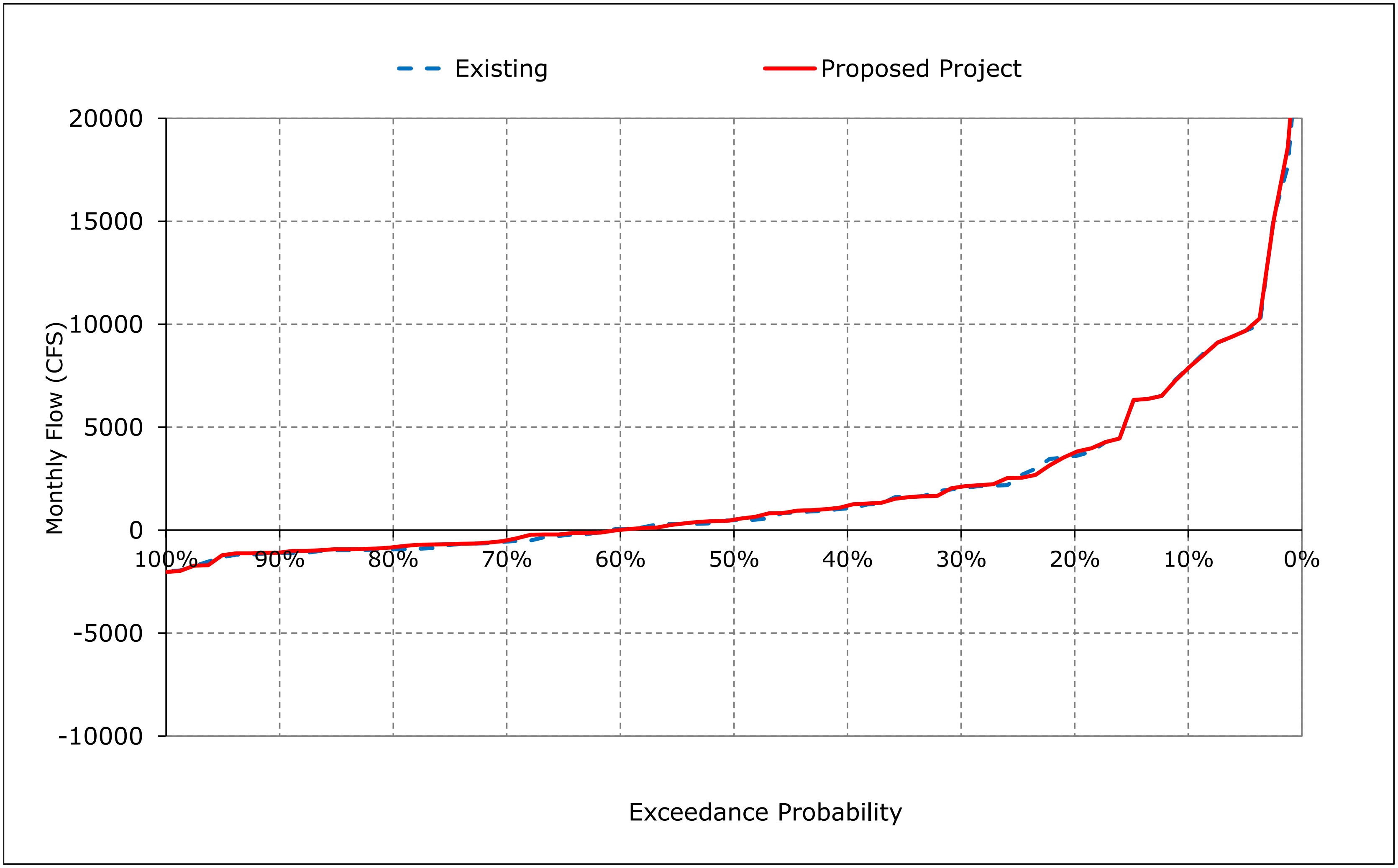


Figure 8-16. Qwest, July

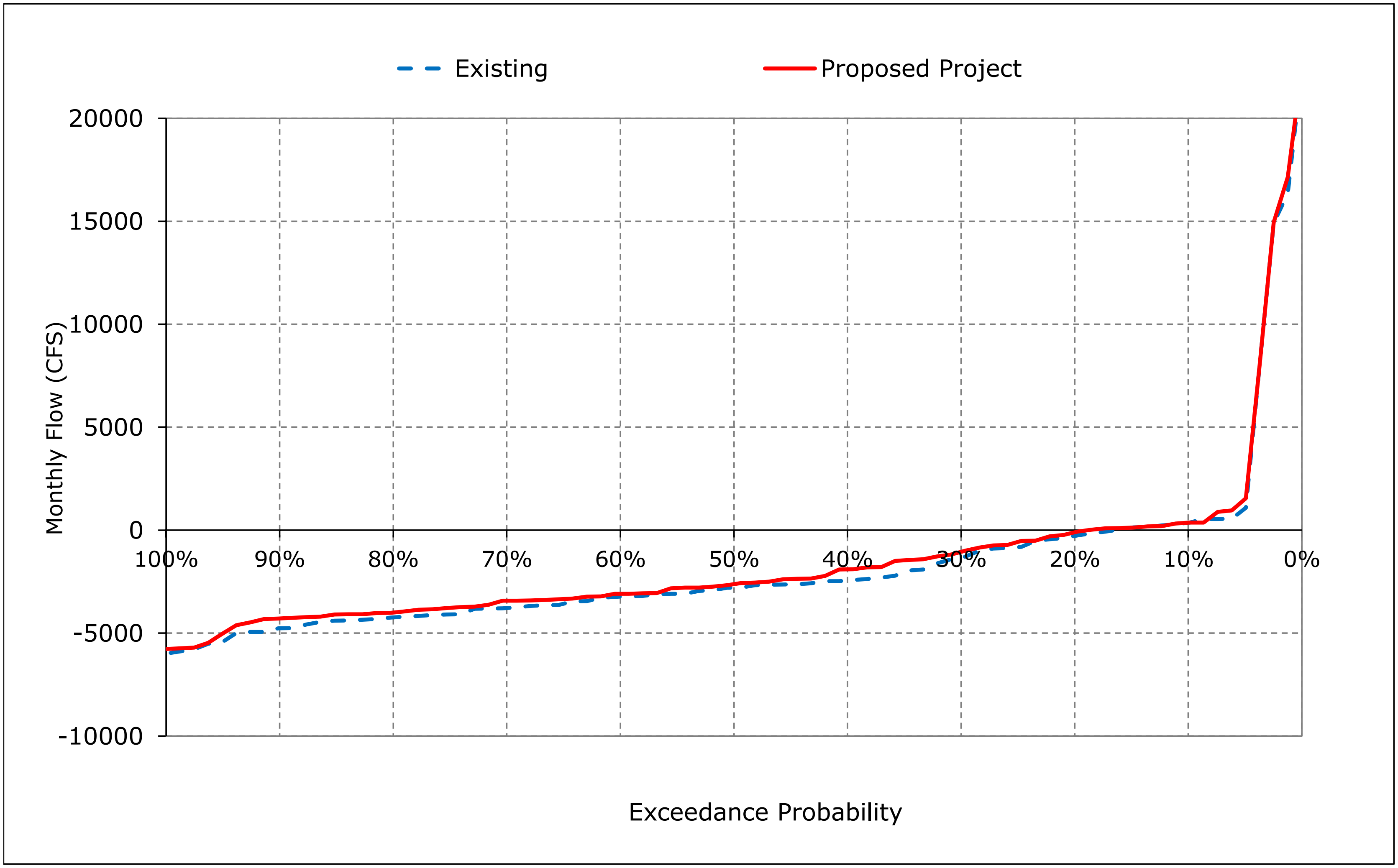


Figure 8-17. Qwest, August

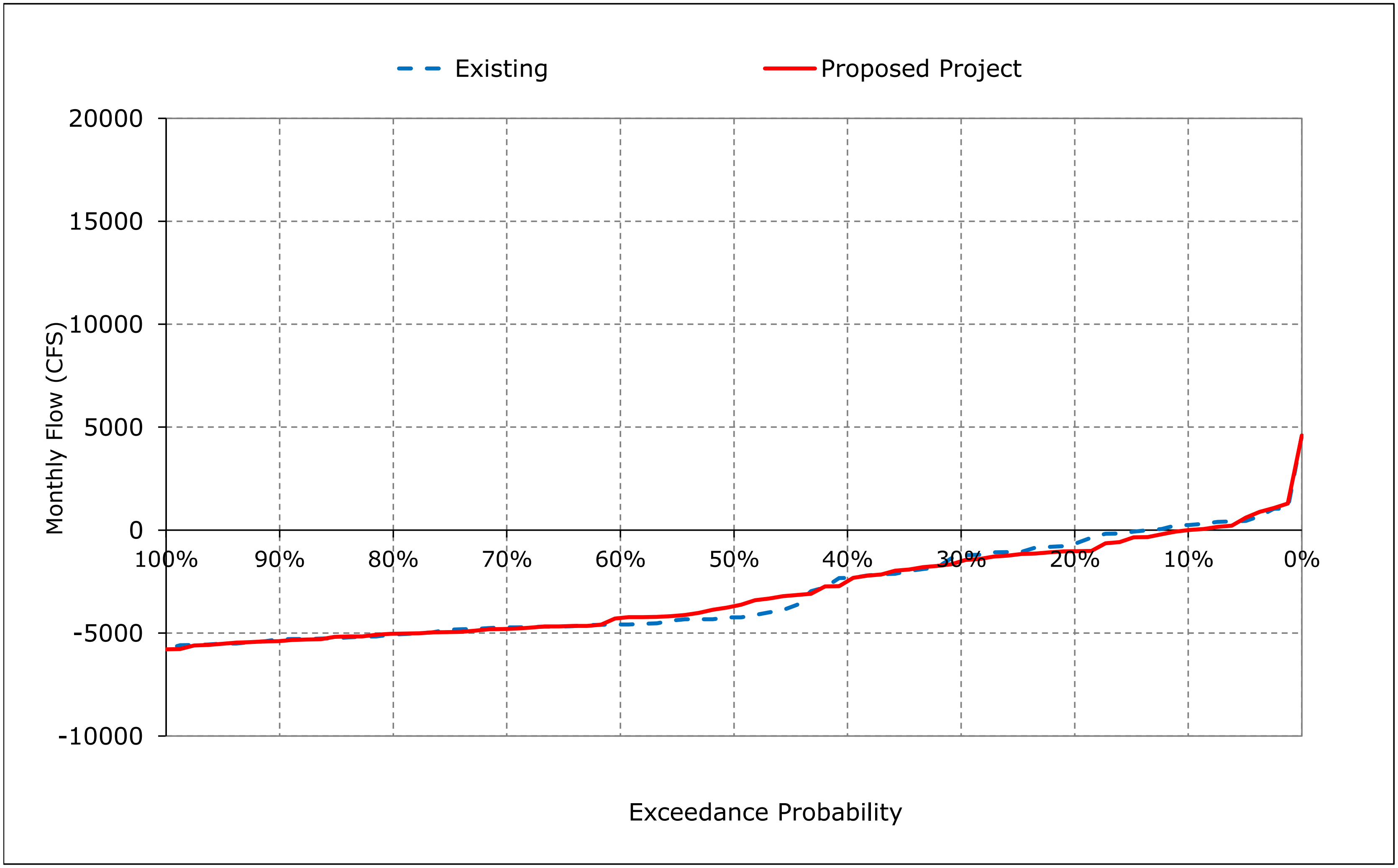


Figure 8-18. Qwest, September

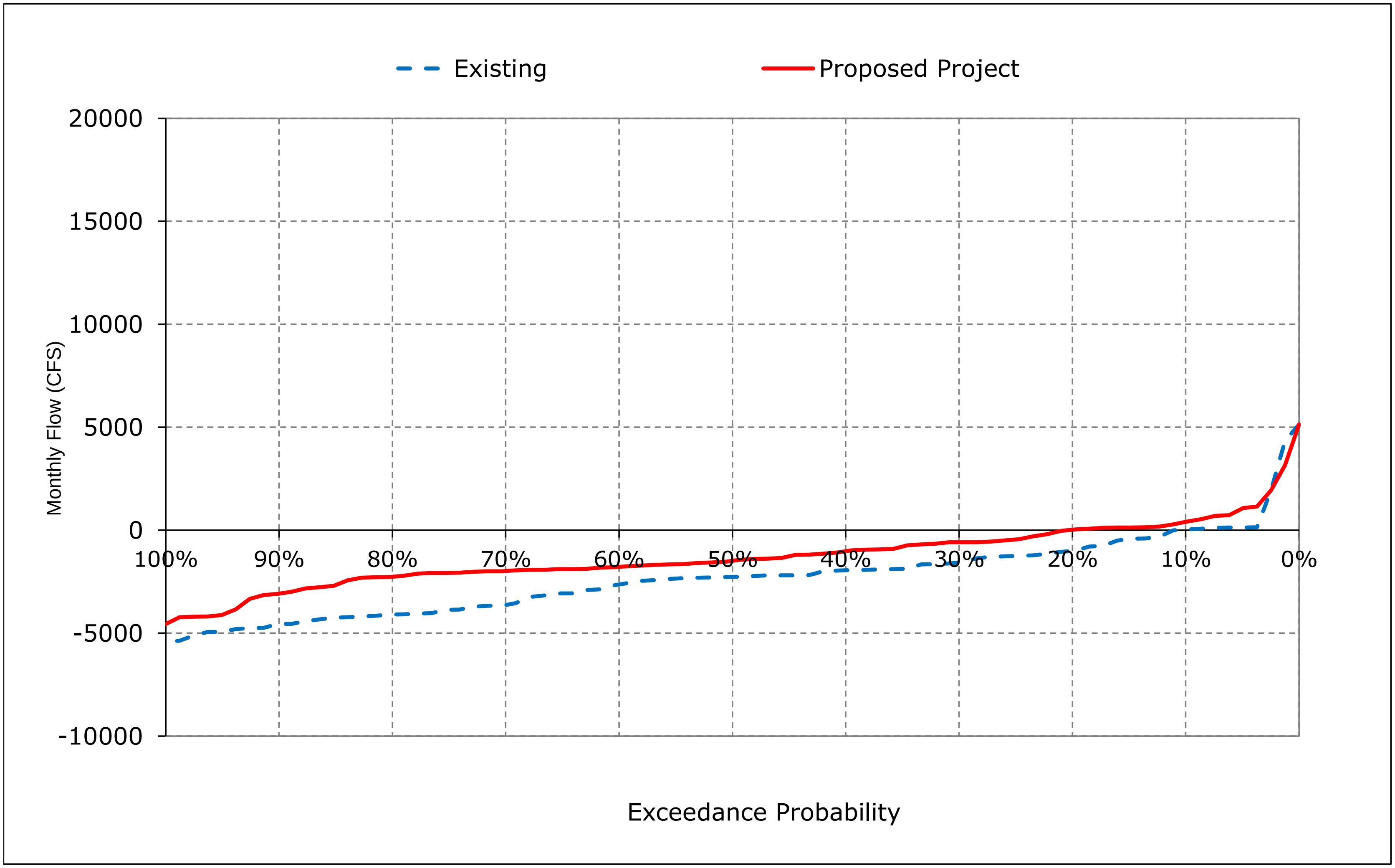


Table 9-1. Delta Outflow, Monthly Outflow

Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Outflow (CFS)											
Probability of Exceedance												
10%	8,281	16,003	64,924	99,529	128,573	86,962	73,320	51,194	29,470	11,514	4,216	20,133
20%	7,813	15,281	32,439	66,067	79,799	65,200	53,523	31,419	14,524	9,504	4,000	19,500
30%	7,453	13,889	15,815	47,484	60,558	43,763	31,053	21,380	10,193	8,268	4,000	15,953
40%	6,031	11,000	12,583	28,238	51,342	35,194	28,456	18,465	7,993	8,000	4,000	11,563
50%	4,712	10,156	9,684	19,147	35,758	25,841	22,248	15,195	7,243	8,000	4,000	4,203
60%	4,000	5,463	5,579	16,356	24,017	20,399	16,601	11,910	7,100	6,500	4,000	3,055
70%	4,000	4,500	4,932	11,933	16,765	16,301	13,467	9,446	7,037	5,000	3,998	3,000
80%	4,000	4,500	4,506	9,402	14,140	12,437	11,550	8,237	6,119	5,000	3,838	3,000
90%	4,000	4,500	4,500	8,081	10,146	9,076	9,541	6,979	5,034	4,000	3,500	3,000
Long Term												
Full Simulation Period[a]	5,997	11,472	21,026	41,339	52,691	42,631	31,618	21,916	12,394	8,075	4,216	9,630
Water Year Types[b,c]												
Wet (32%)	7,724	17,334	42,783	83,568	97,663	79,915	56,933	39,709	22,444	11,645	5,047	19,510
Above Normal (15%)	5,432	12,125	17,901	45,449	59,682	52,471	33,562	24,582	11,383	9,804	4,000	11,758
Below Normal (17%)	5,429	8,622	12,186	20,966	36,006	22,558	23,217	15,806	7,964	7,360	4,000	3,625
Dry (22%)	5,213	8,210	8,791	13,693	22,405	18,720	15,097	9,920	6,717	5,036	3,801	3,006
Critical (15%)	4,657	6,332	5,673	10,968	13,155	11,295	9,410	5,821	5,316	4,004	3,506	3,040

Proposed Project

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Outflow (CFS)											
Probability of Exceedance												
10%	6,859	14,685	64,939	100,311	129,486	90,940	67,887	44,418	29,473	11,562	4,284	13,594
20%	6,406	6,932	32,897	66,826	80,337	65,797	48,067	28,298	14,459	9,830	4,000	12,656
30%	6,250	5,186	19,037	47,311	64,736	45,962	27,983	17,016	10,628	8,581	4,000	12,500
40%	6,010	4,997	12,289	28,203	53,411	36,137	23,971	13,637	8,509	8,000	4,000	12,125
50%	5,250	4,865	9,331	22,286	36,075	27,590	17,845	12,246	7,700	8,000	4,000	4,199
60%	4,196	4,500	6,400	15,901	24,348	22,213	13,221	10,391	7,197	6,500	4,000	3,000
70%	4,000	4,500	5,161	11,690	17,941	17,235	11,321	8,791	7,100	5,000	3,933	3,000
80%	4,000	4,500	4,613	8,949	14,002	12,990	9,673	7,241	6,915	5,000	3,722	3,000
90%	4,000	3,976	4,500	7,950	10,082	9,117	8,442	6,546	4,956	4,000	3,500	3,000
Long Term												
Full Simulation Period[a]	5,693	8,486	21,802	41,945	53,614	43,855	28,870	19,239	12,669	8,188	4,213	7,784
Water Year Types[b,c]												
Wet (32%)	7,288	13,528	45,045	85,036	98,901	81,055	53,084	35,402	22,498	11,770	5,082	13,273
Above Normal (15%)	5,086	8,579	18,014	46,486	61,233	55,035	29,851	20,521	12,029	9,707	4,000	12,721
Below Normal (17%)	5,100	5,755	12,292	21,931	37,884	23,943	20,278	13,073	8,690	7,835	4,014	3,579
Dry (22%)	4,814	6,064	8,722	13,304	22,134	19,961	13,225	8,909	6,894	5,030	3,753	3,006
Critical (15%)	4,854	4,291	5,946	10,352	13,442	11,146	8,916	5,628	5,316	4,056	3,462	3,028

Proposed Project minus Existing

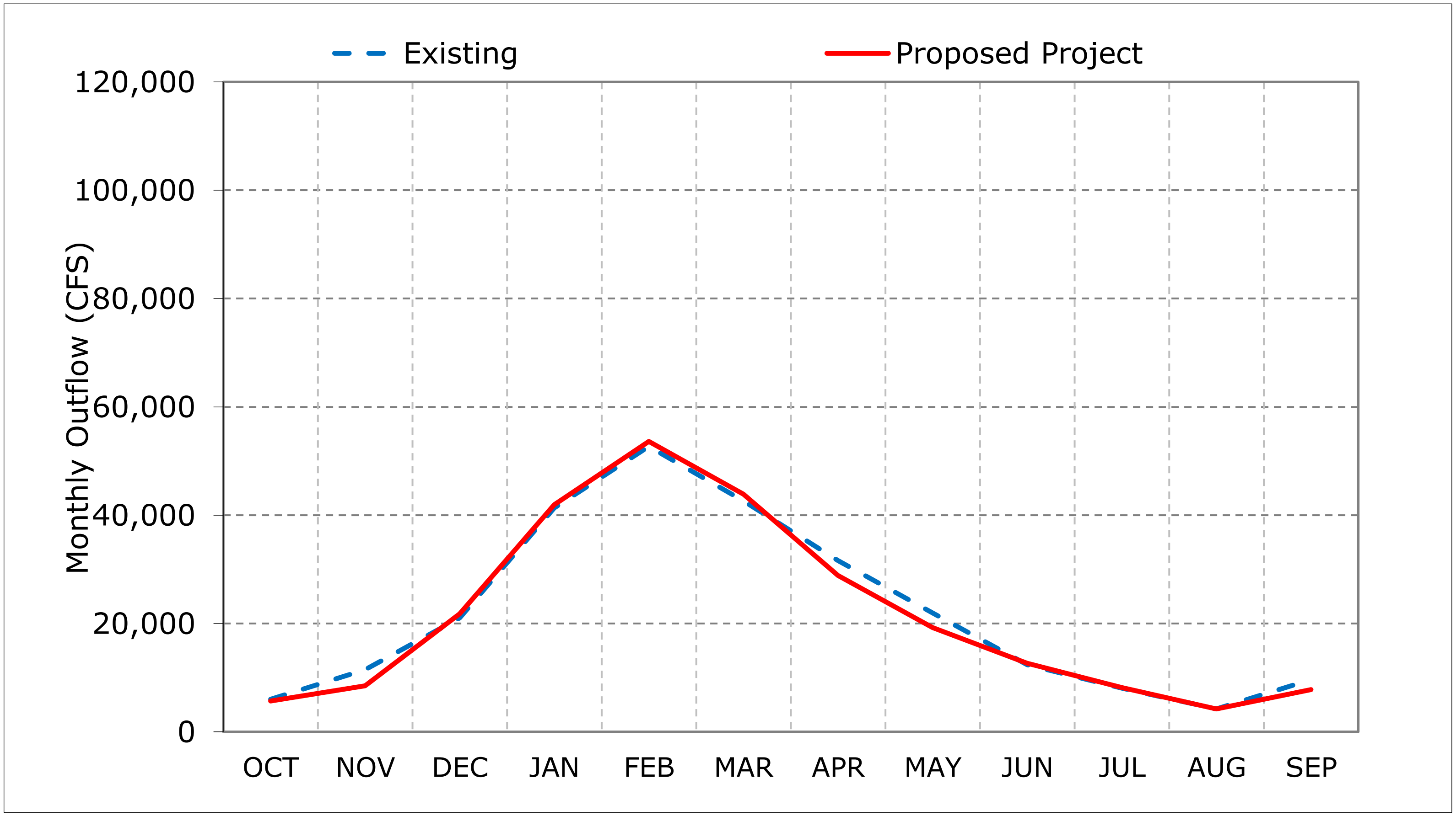
Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Outflow (CFS)											
Probability of Exceedance												
10%	**-1,422**	**-1,318**	14	782	913	3,978	**-5,433**	**-6,777**	3	48	68	**-6,539**
20%	**-1,406**	**-8,349**	458	760	538	597	**-5,456**	**-3,121**	**-65**	326	0	**-6,844**
30%	**-1,203**	**-8,703**	3,222	**-174**	4,177	2,199	**-3,070**	**-4,364**	435	313	0	**-3,453**
40%	**-21**	**-6,003**	**-294**	**-35**	2,069	944	**-4,485**	**-4,828**	516	0	0	563
50%	537	**-5,291**	**-353**	3,139	317	1,749	**-4,403**	**-2,949**	457	0	0	**-4**
60%	196	**-963**	821	**-454**	330	1,813	**-3,380**	**-1,520**	97	0	0	**-55**
70%	0	0	229	**-243**	1,176	935	**-2,146**	**-655**	63	0	**-65**	0
80%	0	0	107	**-453**	**-137**	553	**-1,877**	**-997**	796	0	**-116**	0
90%	0	**-524**	0	**-130**	**-64**	41	**-1,100**	**-433**	**-77**	0	0	0
Long Term												
Full Simulation Period[a]	**-304**	**-2,985**	776	607	923	1,224	**-2,749**	**-2,677**	274	113	**-3**	**-1,846**
Water Year Types[b,c]												
Wet (32%)	**-436**	**-3,806**	2,261	1,468	1,238	1,140	**-3,849**	**-4,307**	54	125	35	**-6,237**
Above Normal (15%)	**-346**	**-3,546**	113	1,038	1,550	2,564	**-3,711**	**-4,061**	646	**-97**	0	964
Below Normal (17%)	**-329**	**-2,868**	106	965	1,878	1,385	**-2,940**	**-2,733**	726	474	14	**-46**
Dry (22%)	**-399**	**-2,146**	**-70**	**-389**	**-270**	1,241	**-1,873**	**-1,011**	177	**-6**	**-48**	**-1**
Critical (15%)	196	**-2,041**	273	**-616**	286	**-149**	**-494**	**-194**	**0**	51	**-44**	**-11**

a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

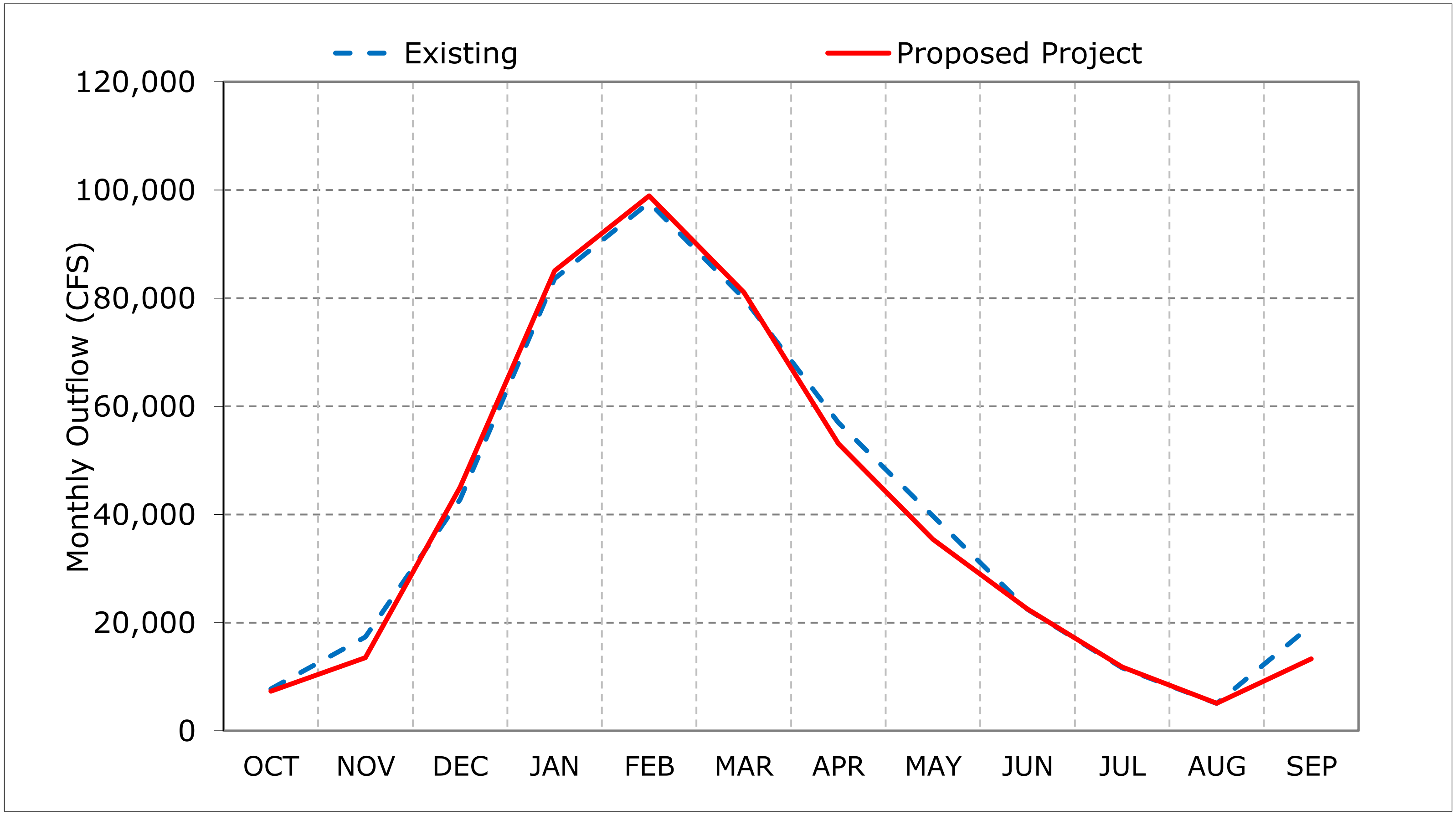
c These results are displayed with water year - year type sorting.

Figure 9-1. Delta Outflow, Long-Term Average Outflow



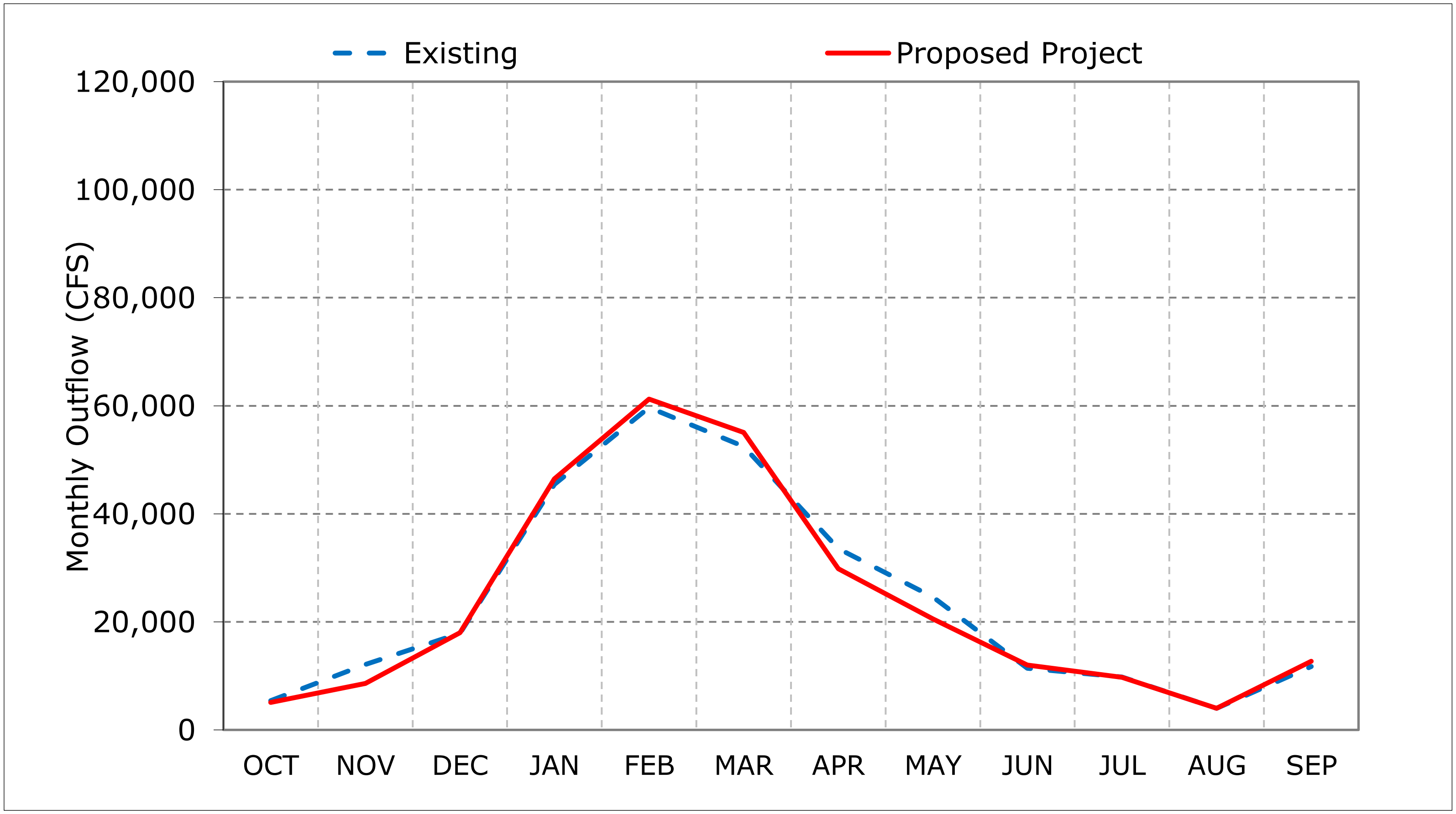
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 9-2. Delta Outflow, Wet Year Average Outflow



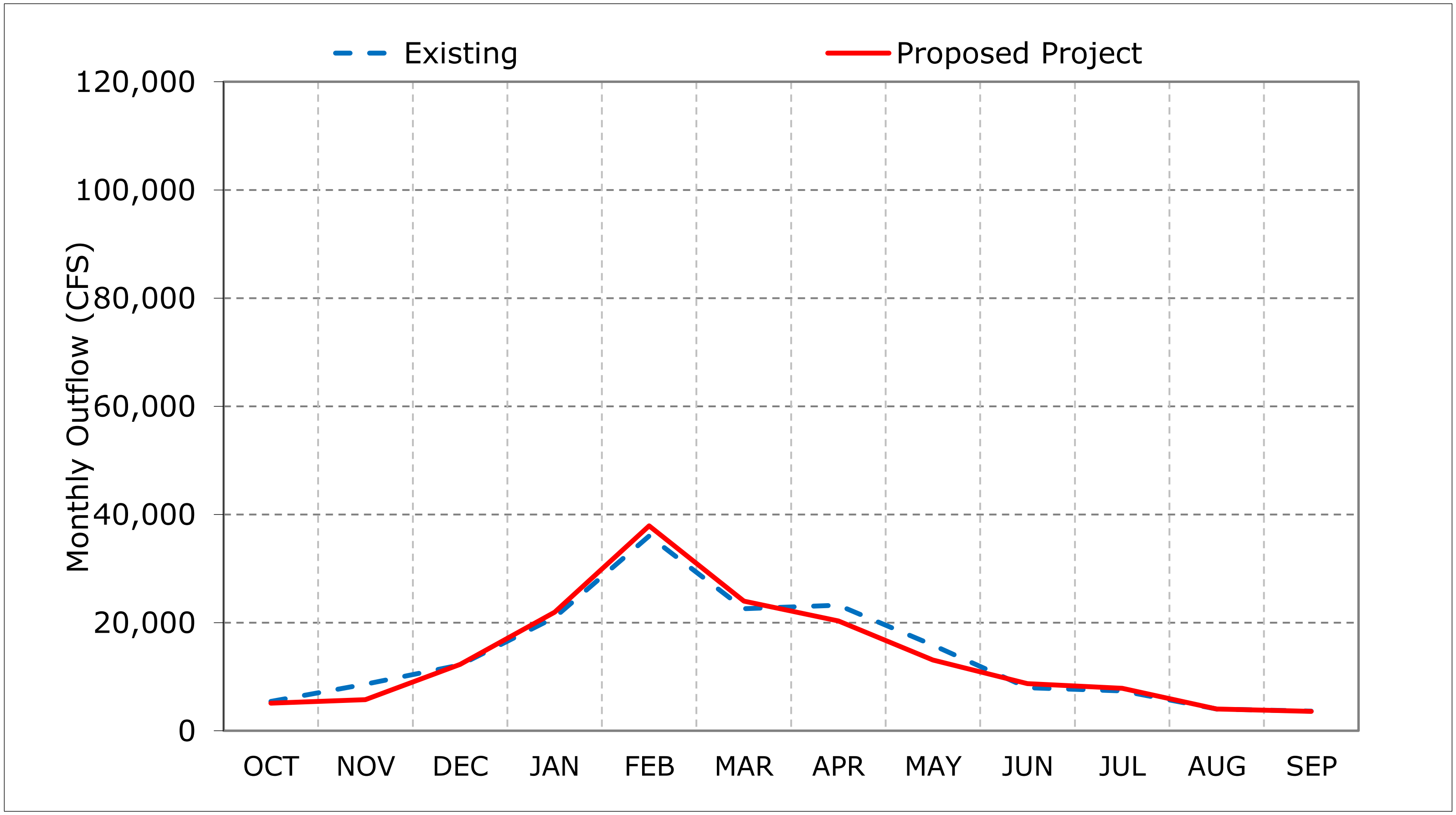
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 9-3. Delta Outflow, Above Normal Year Average Outflow



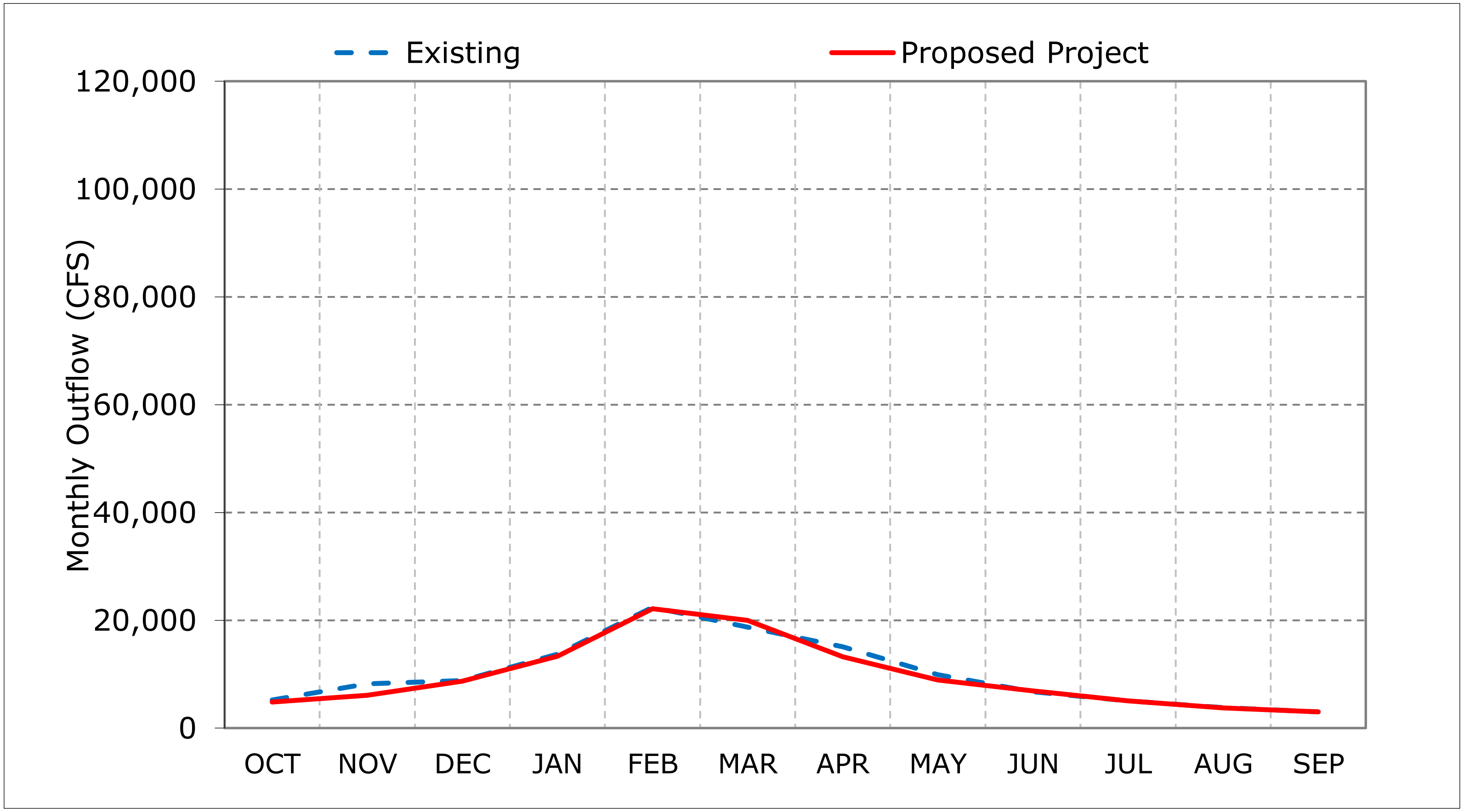
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 9-4. Delta Outflow, Below Normal Year Average Outflow



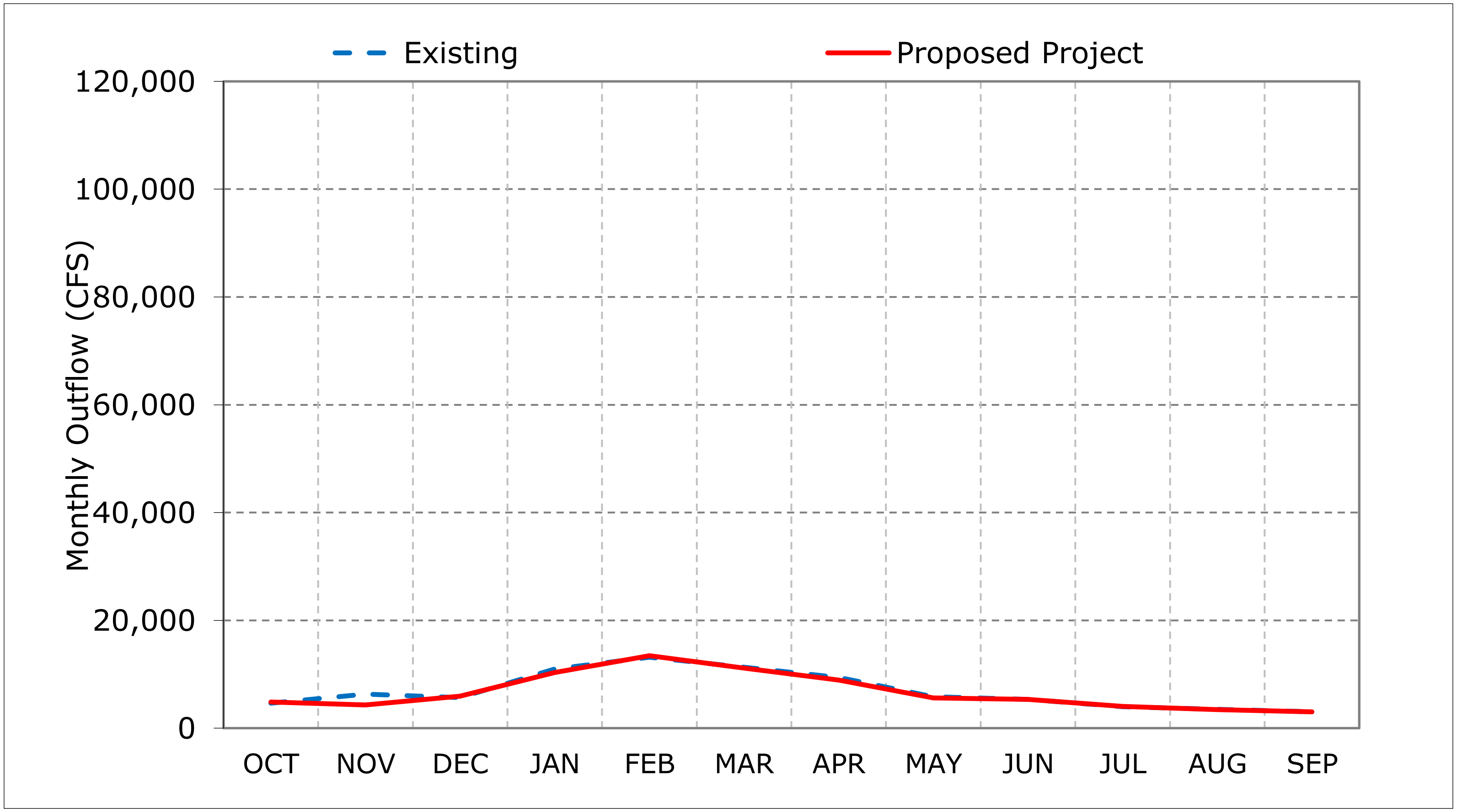
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 9-5. Delta Outflow, Dry Year Average Outflow



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 9-6. Delta Outflow, Critical Year Average Outflow



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 9-7. Delta Outflow, October

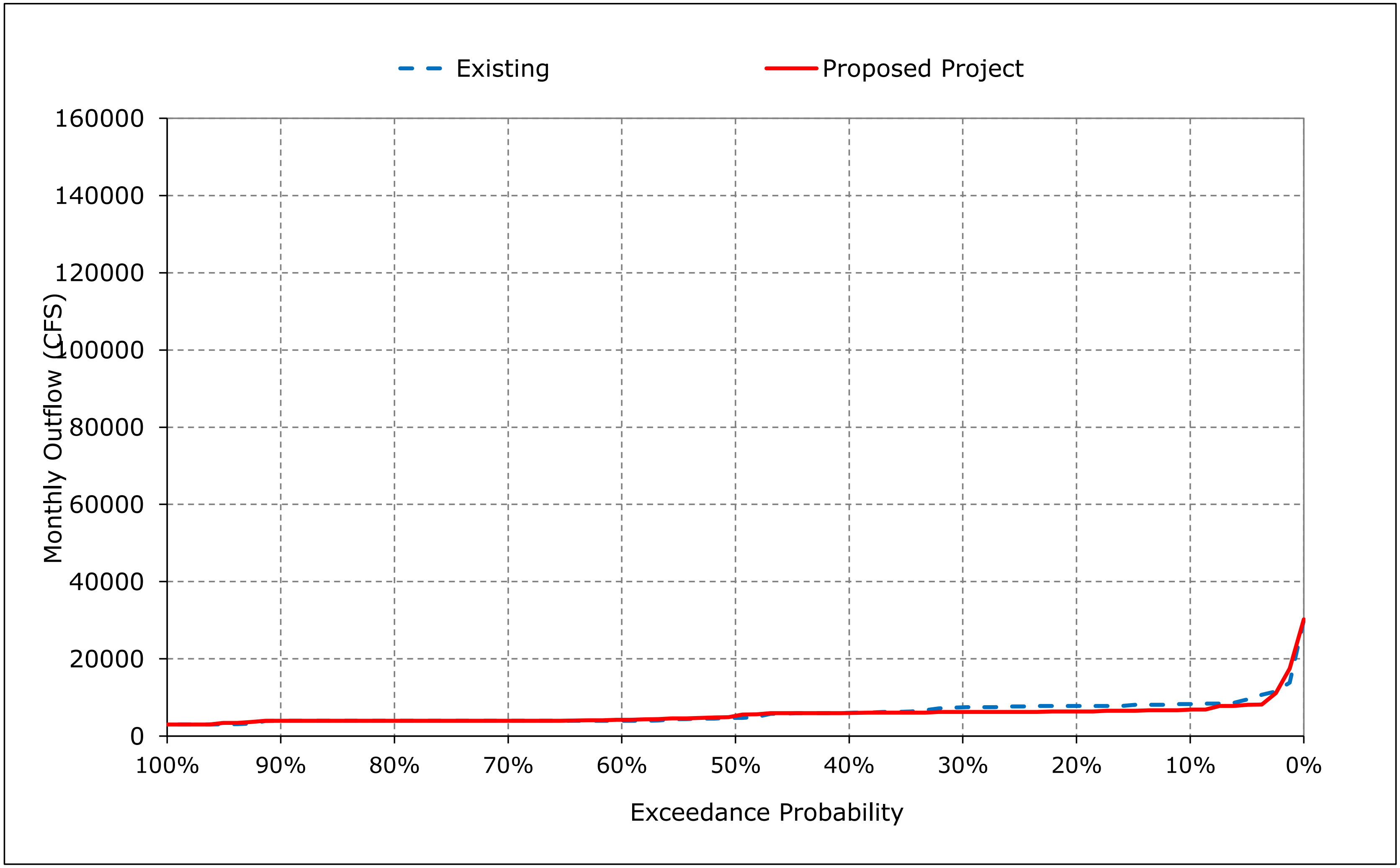


Figure 9-8. Delta Outflow, November

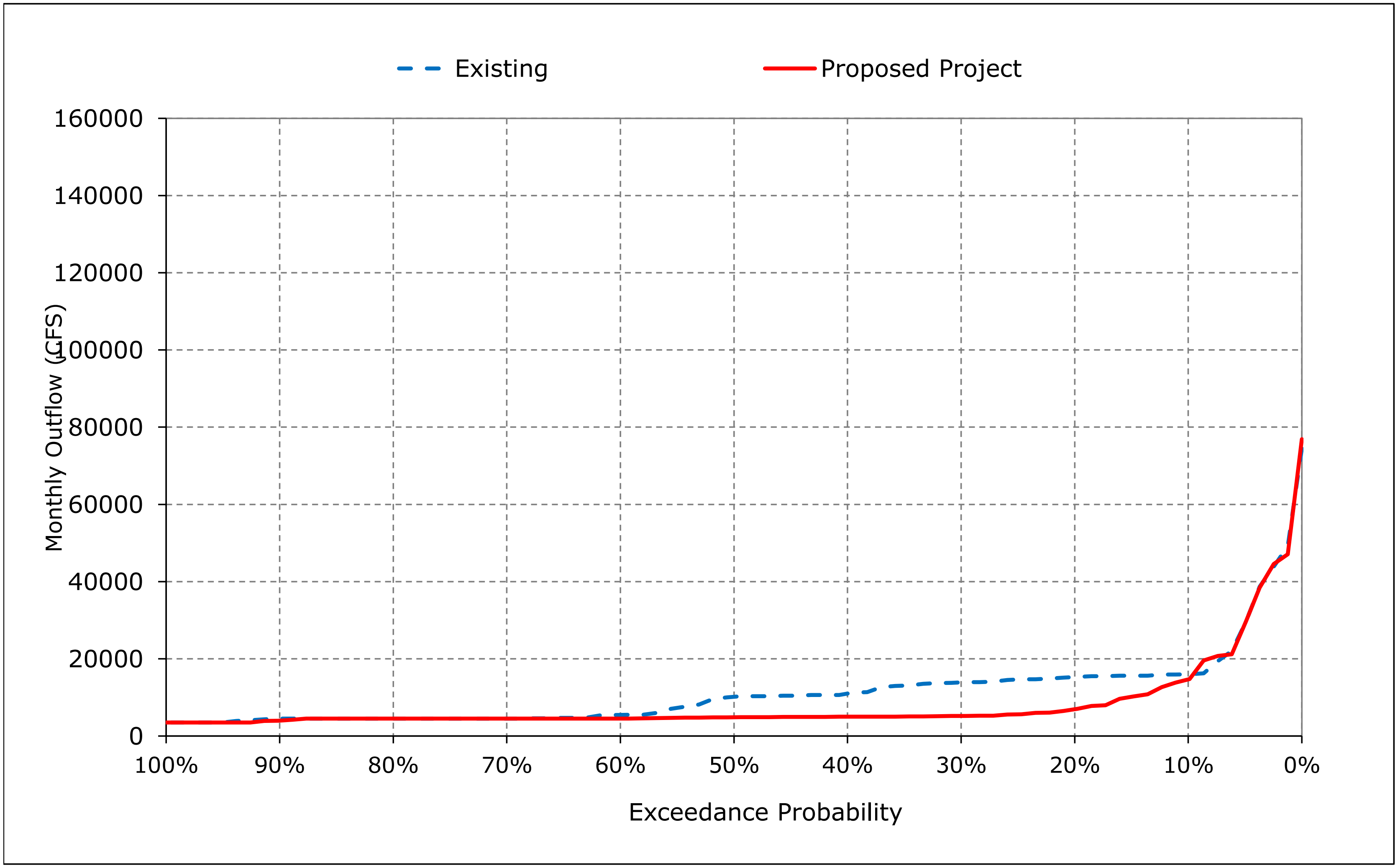


Figure 9-9. Delta Outflow, December

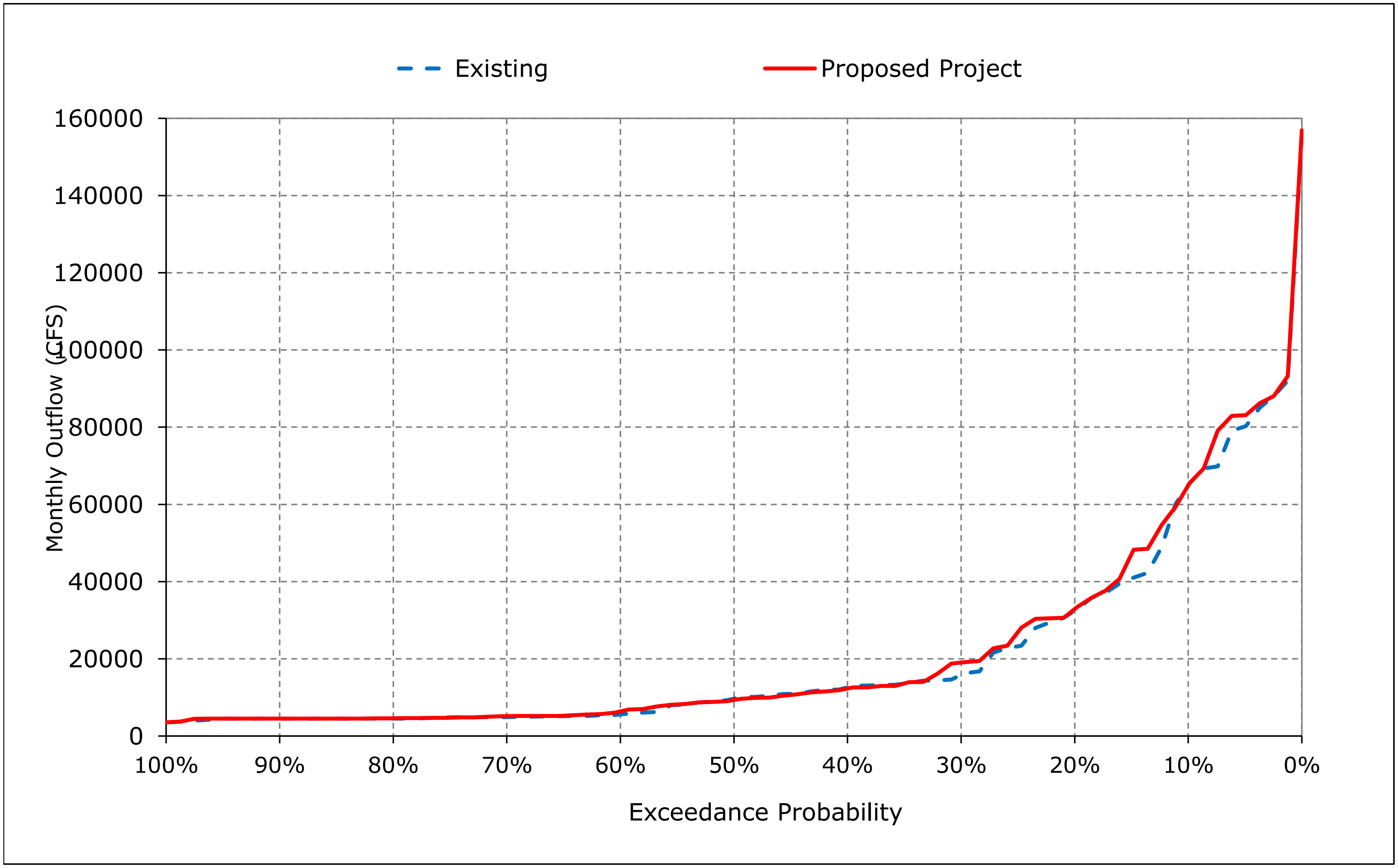


Figure 9-10. Delta Outflow, January

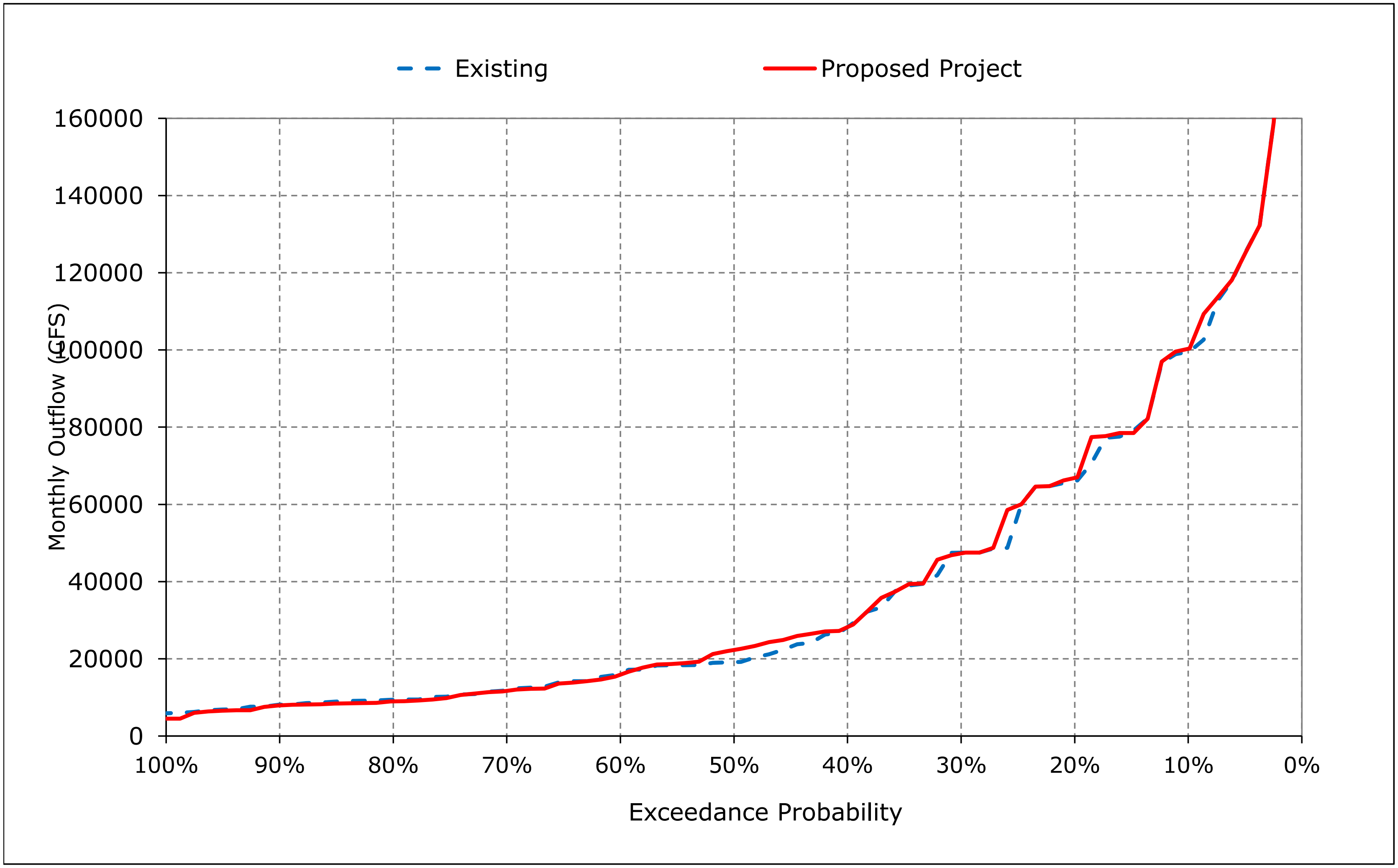


Figure 9-11. Delta Outflow, February

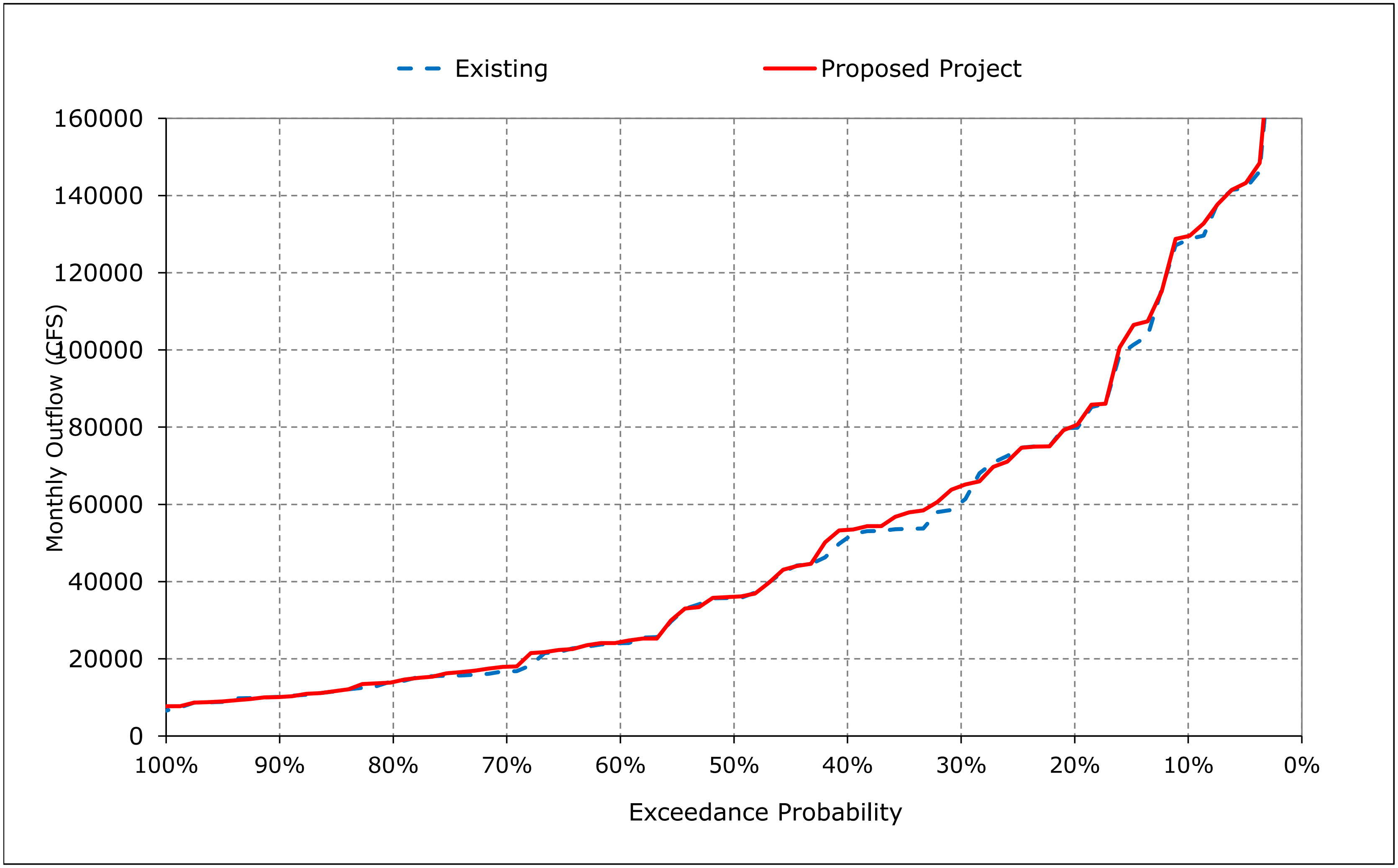


Figure 9-12. Delta Outflow, March

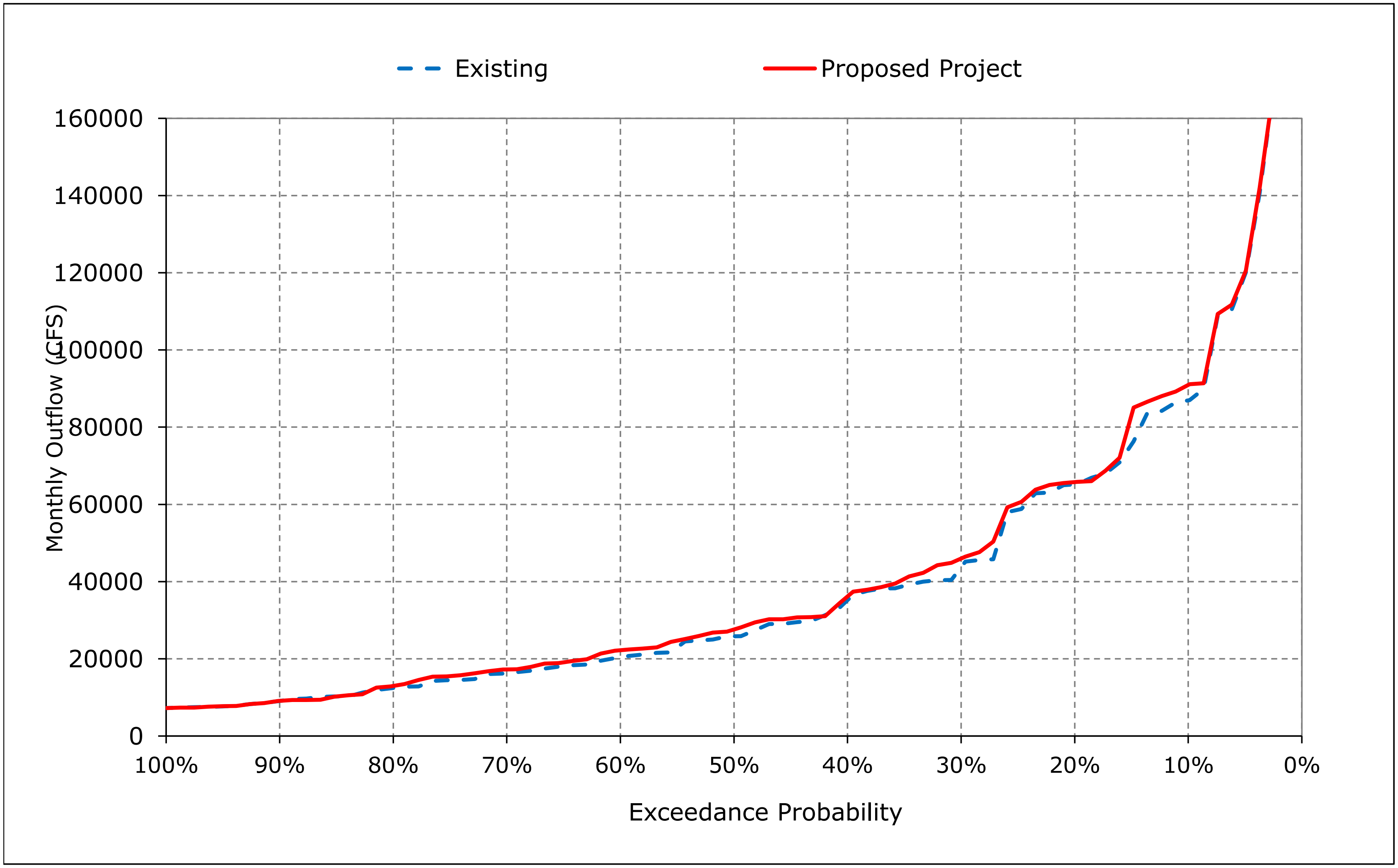


Figure 9-13. Delta Outflow, April

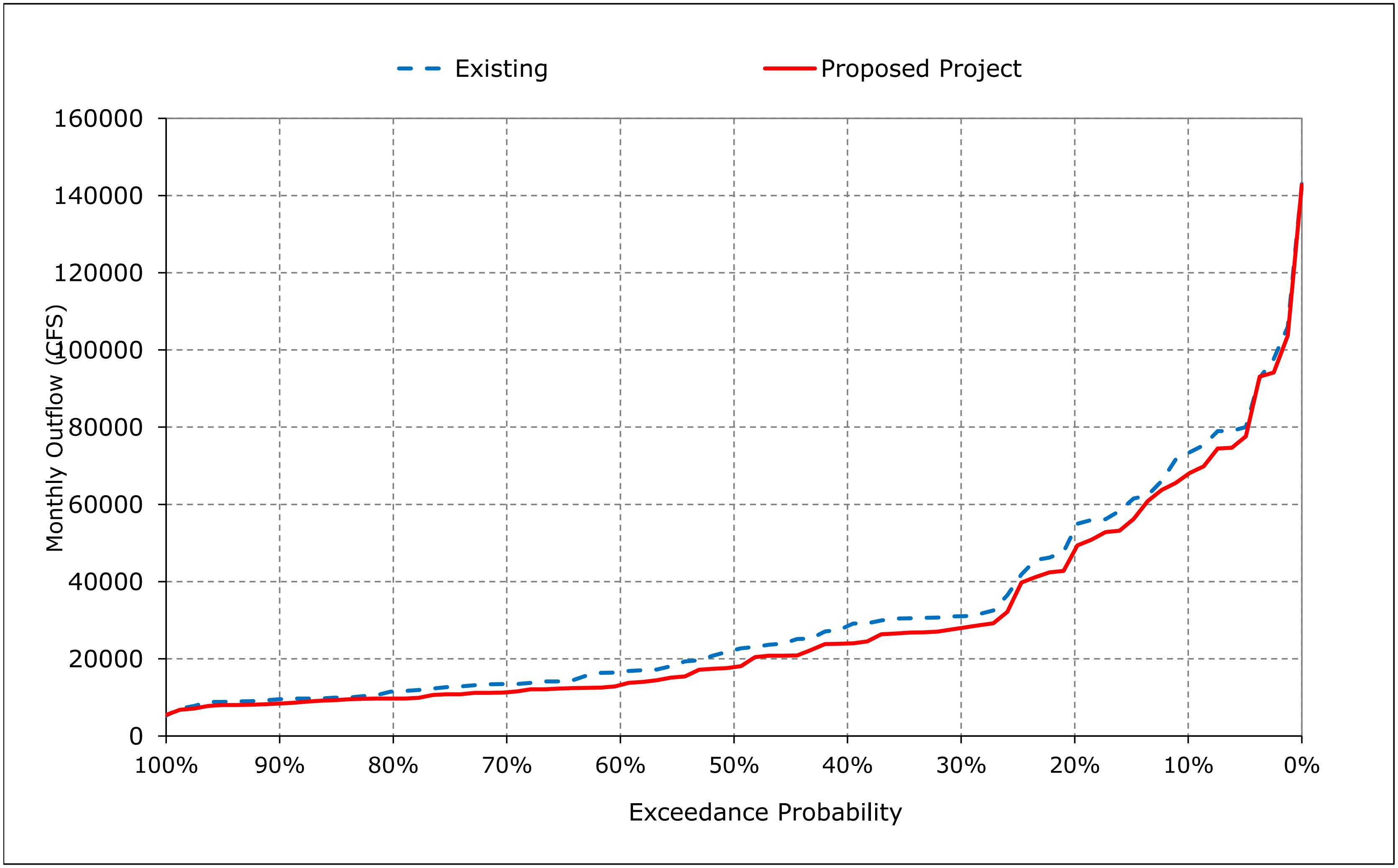


Figure 9-14. Delta Outflow, May

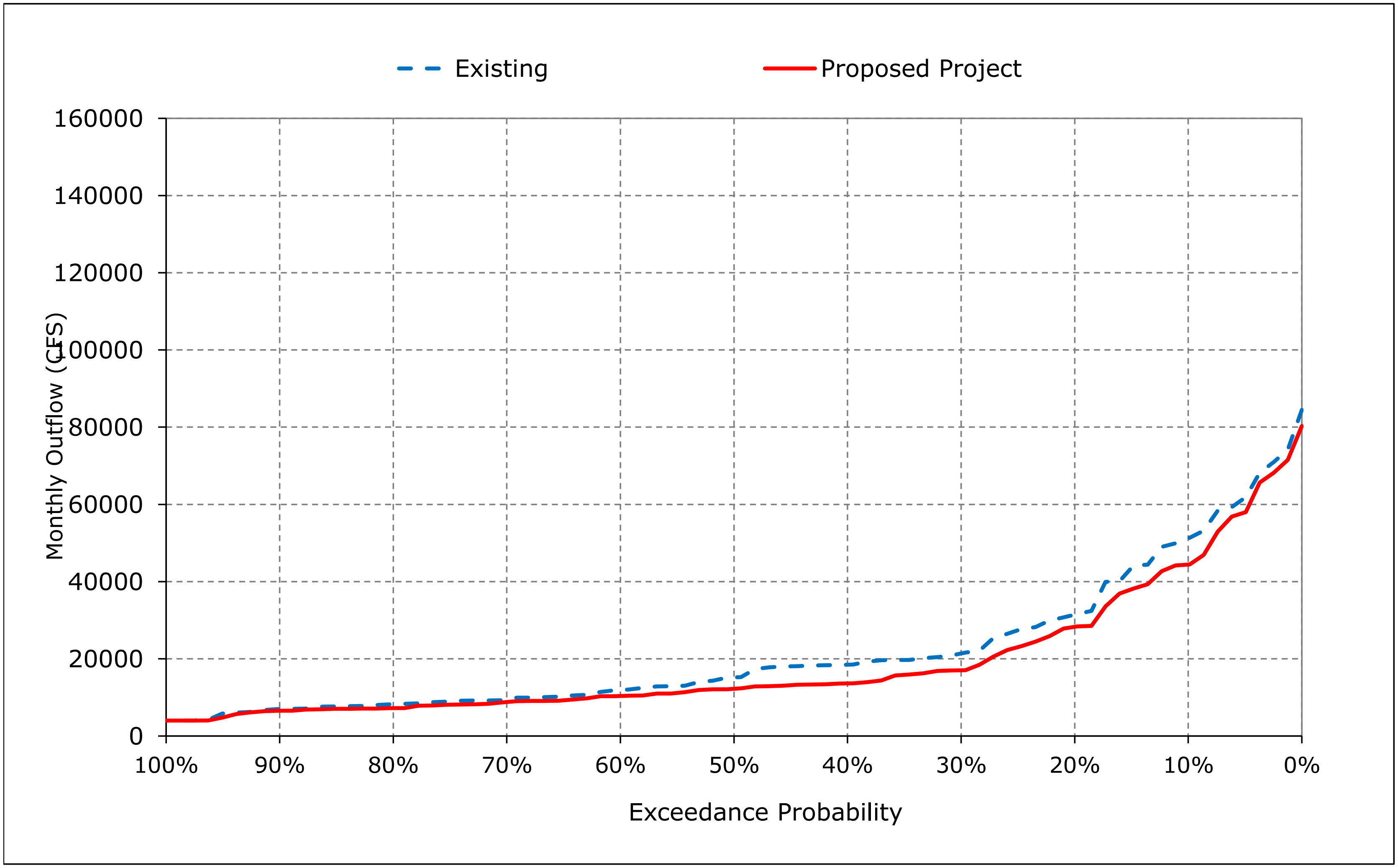


Figure 9-15. Delta Outflow, June

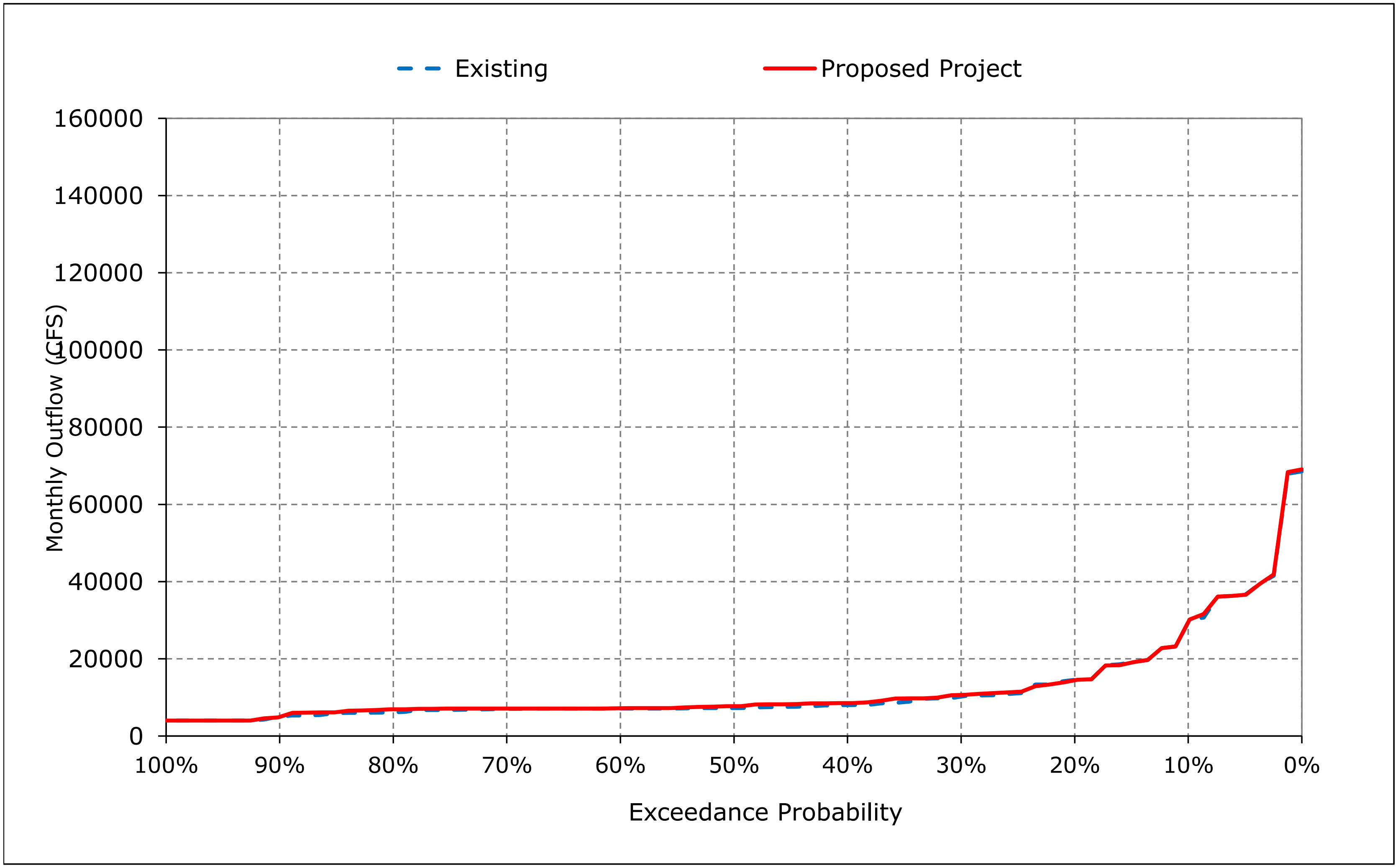


Figure 9-16. Delta Outflow, July

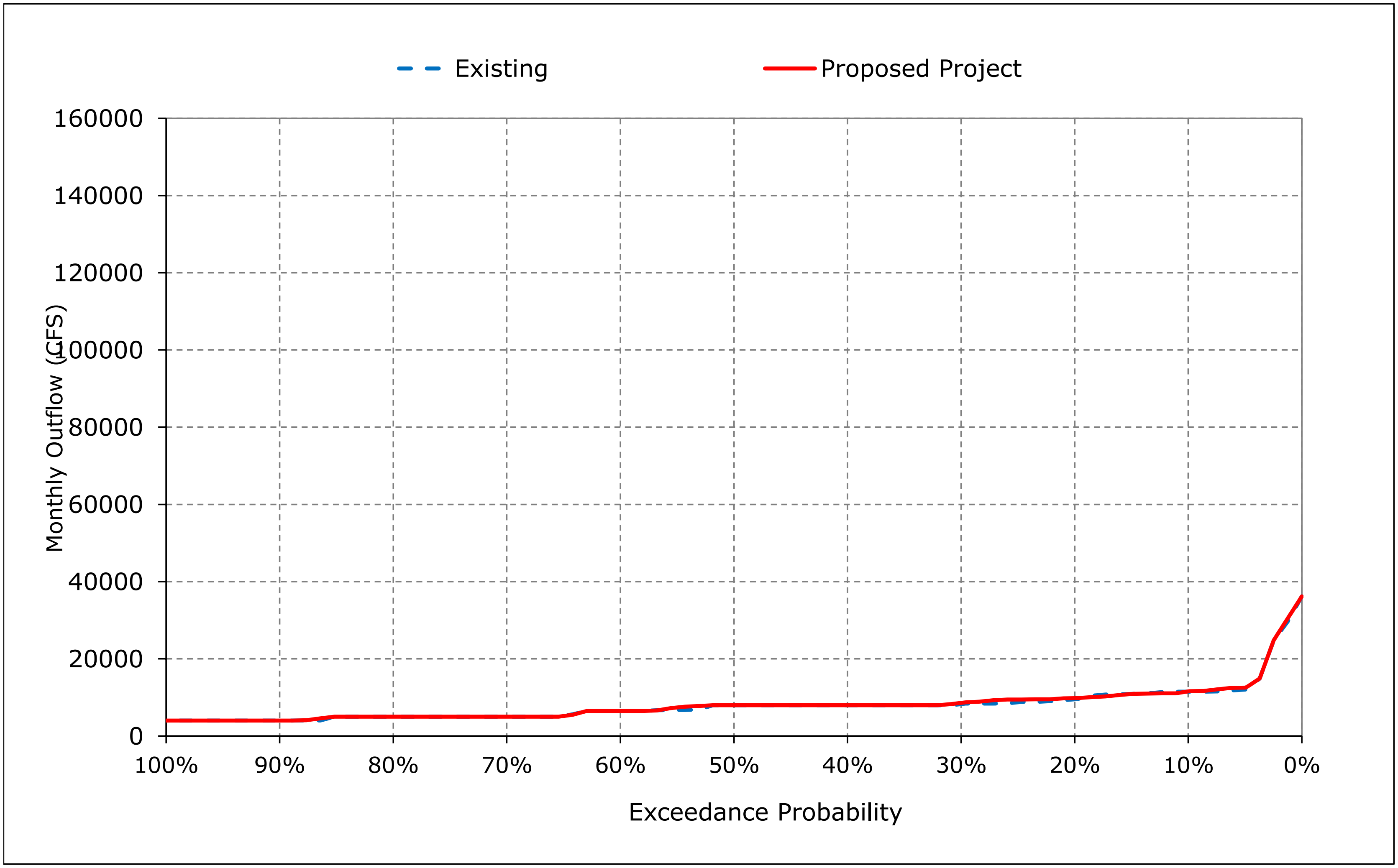


Figure 9-17. Delta Outflow, August

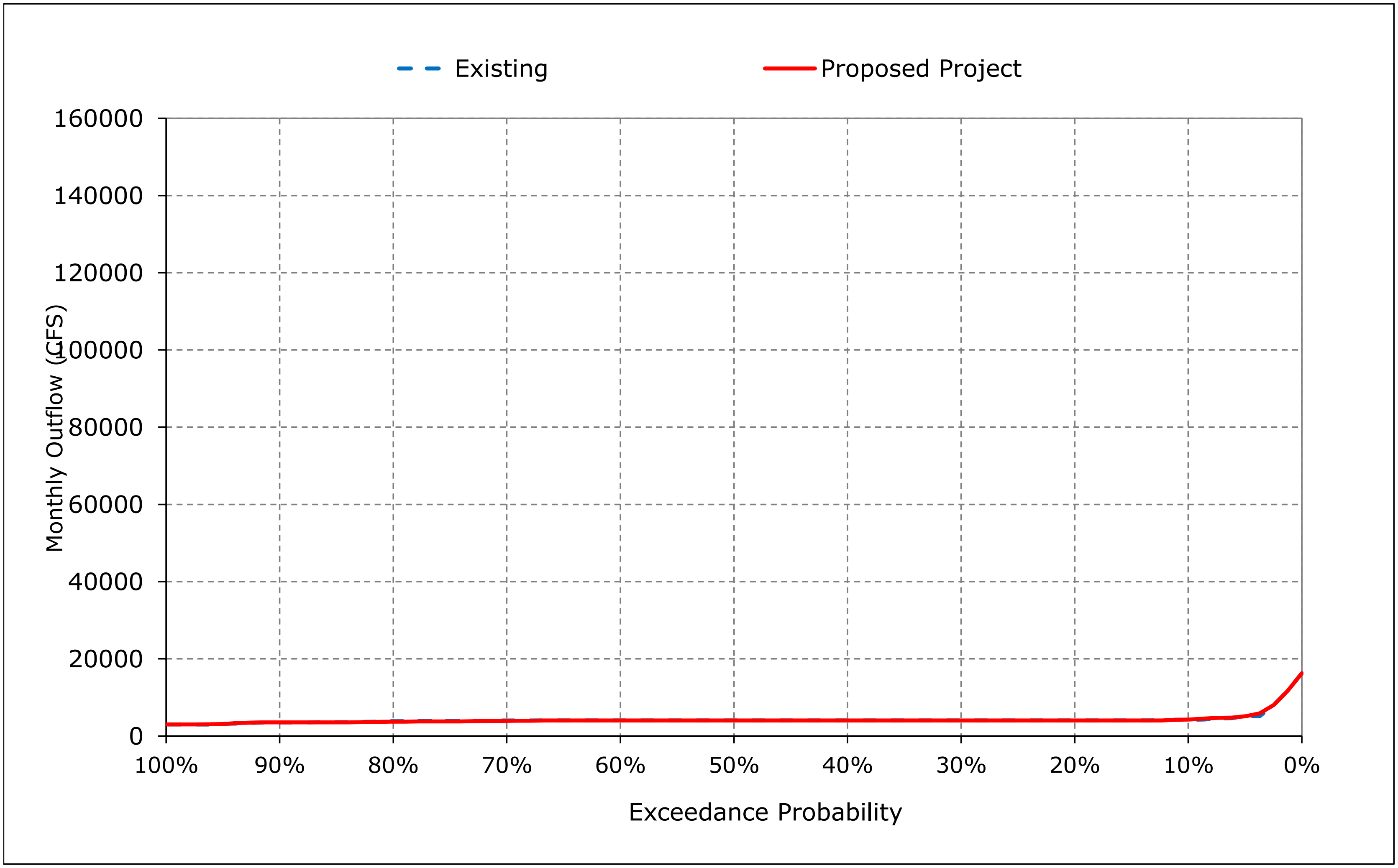
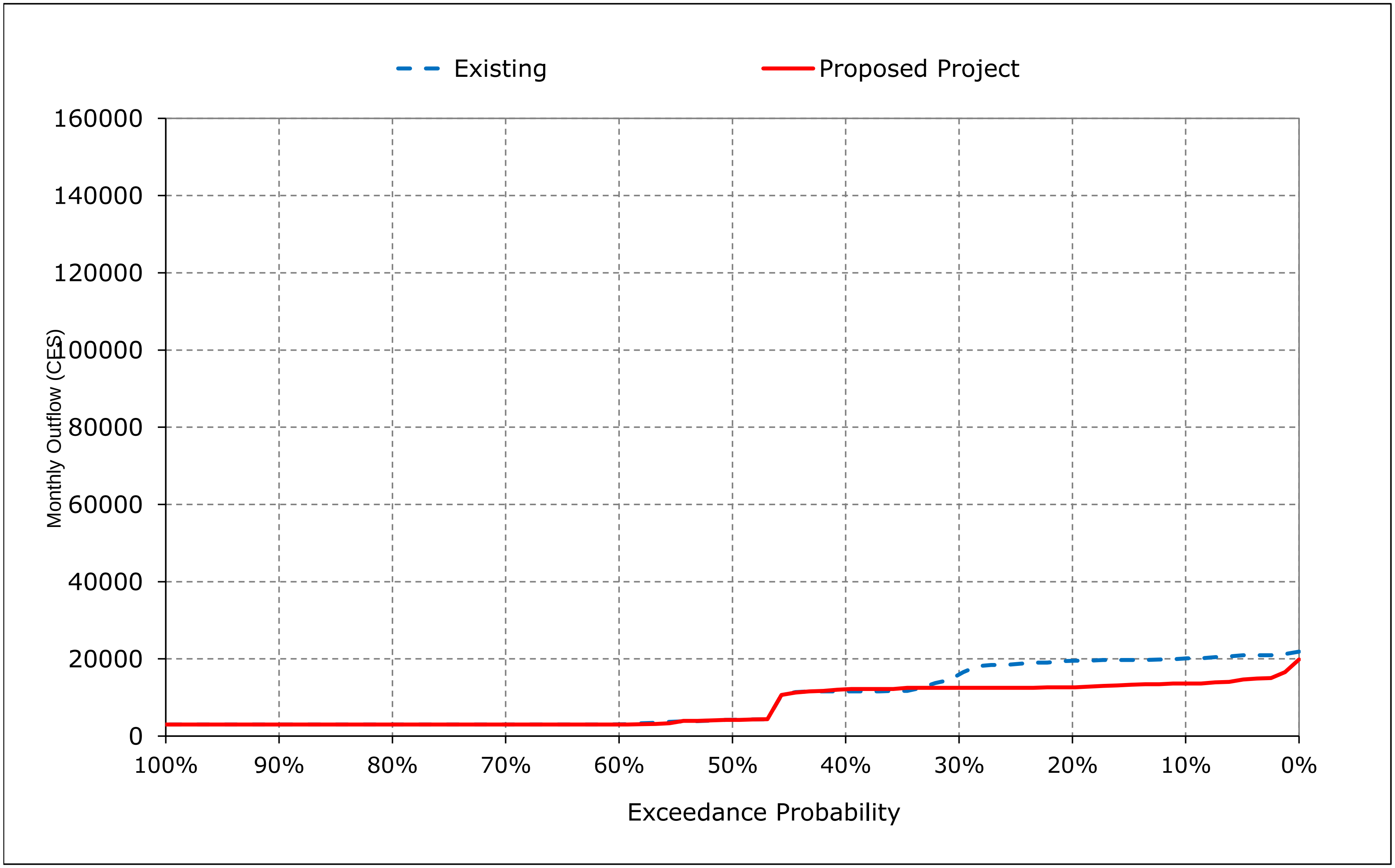


Figure 9-18. Delta Outflow, September



Appendix C – Modeling

Attachment 2-3 – Diversion Results (CalSim II)

The following results of the CalSim II model are included for diversions at key project locations for the following alternatives:

- Existing Conditions
- Proposed Project

Table 2-3.1. Diversion Results (CalSim II)

Title	Model Parameter	Table Numbers	Figure Numbers
North Bay Aqueduct Exports	D403B	1-1	1-1 to 1-18
DCC Flow	C401B_DXC	2-1	2-1 to 2-18
Total Delta Exports	TOTAL_EXP	3-1	3-1 to 3-18
SWP Banks PP Exports	D419_SWP	4-1	4-1 to 4-18
CVP Banks PP Exports	D419_CVP	5-1	5-1 to 5-18
Banks PP Exports	D419	6-1	6-1 to 6-18
Jones PP Exports	D418	7-1	7-1 to 7-18

Report formats

- Monthly tables comparing two scenarios (exceedance values, long-term average, and average by water year type)
- Monthly pattern charts (long-term average and average by water year type) including all scenarios
- Monthly exceedance charts (all months) including all scenarios

Table 1-1. North Bay Aqueduct, Monthly Diversion

Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Diversion (CFS)											
Probability of Exceedance												
10%	74	72	67	33	37	33	87	66	70	92	83	66
20%	54	70	65	33	37	33	87	64	70	90	63	66
30%	54	63	65	33	37	33	86	63	69	89	63	66
40%	54	38	64	33	37	33	85	57	64	64	63	66
50%	53	38	64	33	37	33	84	57	61	64	63	62
60%	53	38	63	33	37	33	84	57	61	60	63	62
70%	51	38	60	33	37	33	63	57	36	37	60	52
80%	46	36	60	33	36	33	63	53	36	37	60	52
90%	41	32	32	33	36	33	35	32	2	3	35	41
Long Term												
Full Simulation Period[a]	54	47	58	33	35	31	70	53	51	59	61	59
Water Year Types[b,c]												
Wet (32%)	54	51	63	33	37	33	86	57	68	73	63	66
Above Normal (15%)	57	48	58	33	37	33	86	61	70	86	63	66
Below Normal (17%)	54	43	58	33	32	33	84	65	62	81	60	62
Dry (22%)	53	49	57	33	35	32	59	57	38	37	75	52
Critical (15%)	55	42	50	33	34	17	21	15	2	5	35	44

Proposed Project

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Diversion (CFS)											
Probability of Exceedance												
10%	74	72	67	33	37	33	87	64	76	92	83	66
20%	58	70	65	33	37	33	87	64	70	90	63	66
30%	54	66	65	33	37	33	86	63	70	89	63	66
40%	54	49	64	33	37	33	85	57	64	64	63	66
50%	54	42	63	33	37	33	84	57	64	64	63	62
60%	53	39	63	33	37	33	84	57	61	60	61	62
70%	51	38	60	33	37	33	63	57	36	37	60	52
80%	51	38	60	33	36	33	63	53	36	37	50	52
90%	41	32	32	33	36	33	35	32	2	3	35	41
Long Term												
Full Simulation Period[a]	56	50	58	33	35	31	70	52	52	59	60	59
Water Year Types[b,c]												
Wet (32%)	54	56	63	33	37	33	86	57	68	74	64	66
Above Normal (15%)	62	48	58	33	37	33	86	61	68	86	65	66
Below Normal (17%)	54	49	56	33	32	33	84	63	70	81	60	62
Dry (22%)	53	52	55	33	35	32	57	57	39	37	70	52
Critical (15%)	58	39	53	31	34	20	21	13	2	8	32	44

Proposed Project minus Existing

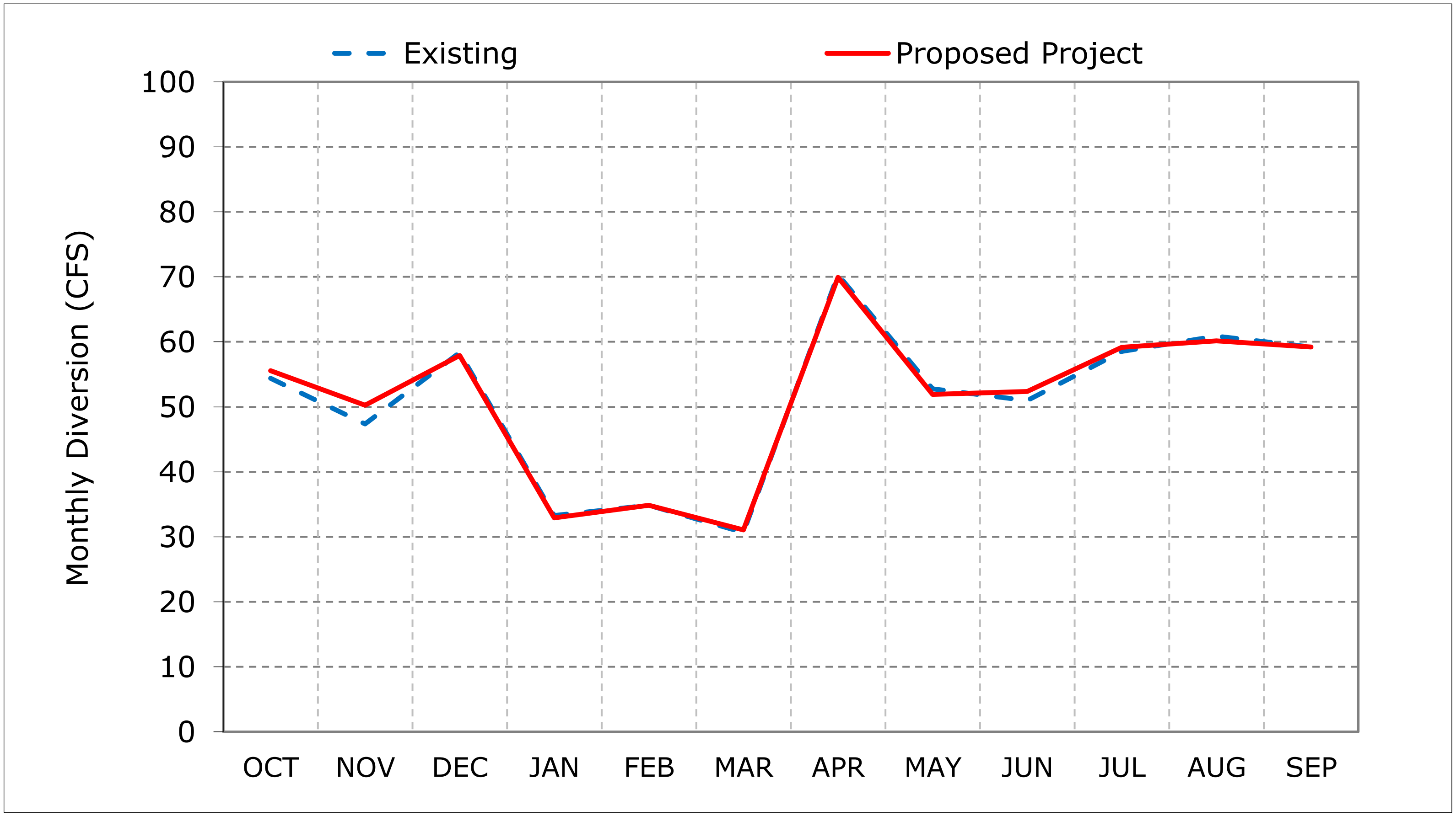
Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Diversion (CFS)											
Probability of Exceedance												
10%	0	0	0	0	0	0	0	**-2**	6	0	**0**	0
20%	4	0	**0**	0	0	0	0	0	0	0	**0**	0
30%	0	3	0	0	0	0	0	**0**	1	0	0	0
40%	0	10	**0**	0	0	0	0	**0**	0	0	0	0
50%	1	4	**-1**	0	0	0	0	0	3	0	**0**	0
60%	0	1	**0**	**0**	0	0	0	**0**	0	0	**-2**	0
70%	0	0	**0**	0	0	0	0	**0**	0	0	**0**	0
80%	5	1	0	0	0	0	0	0	0	0	**-9**	0
90%	0	0	**0**	0	0	0	0	**0**	0	0	0	0
Long Term												
Full Simulation Period[a]	1	3	**0**	**0**	0	0	**0**	**-1**	1	1	**-1**	0
Water Year Types[b,c]												
Wet (32%)	0	4	0	0	0	0	0	0	0	1	1	0
Above Normal (15%)	5	0	**-1**	0	0	0	0	**-1**	**-2**	0	3	0
Below Normal (17%)	0	6	**-2**	0	0	0	0	**-2**	8	0	0	0
Dry (22%)	0	3	**-2**	0	0	0	**-2**	0	1	0	**-4**	0
Critical (15%)	3	**-2**	3	**-3**	0	3	0	**-3**	0	3	**-3**	0

a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

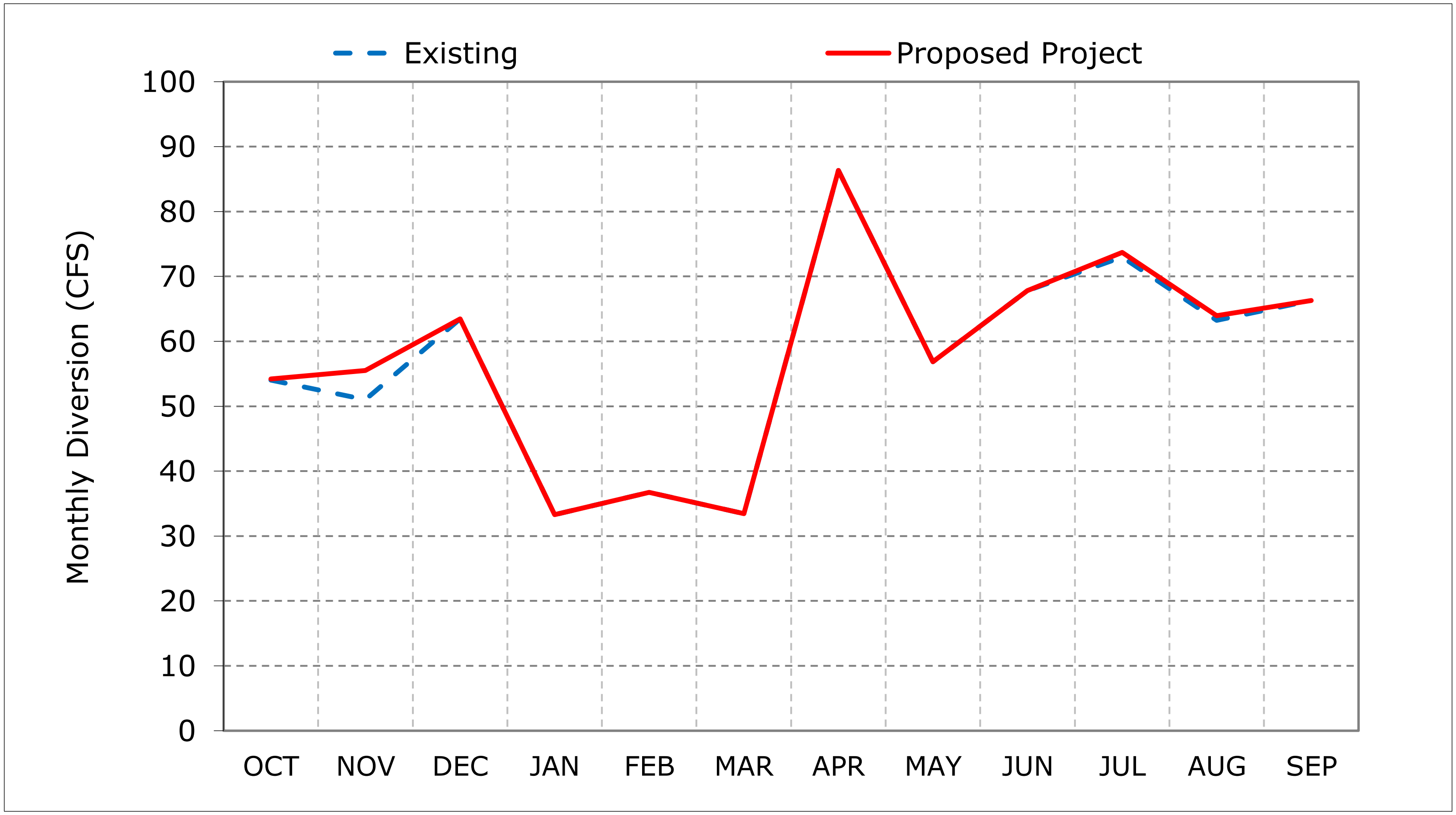
c These results are displayed with water year - year type sorting.

Figure 1-1. North Bay Aqueduct, Long-Term Average Diversion



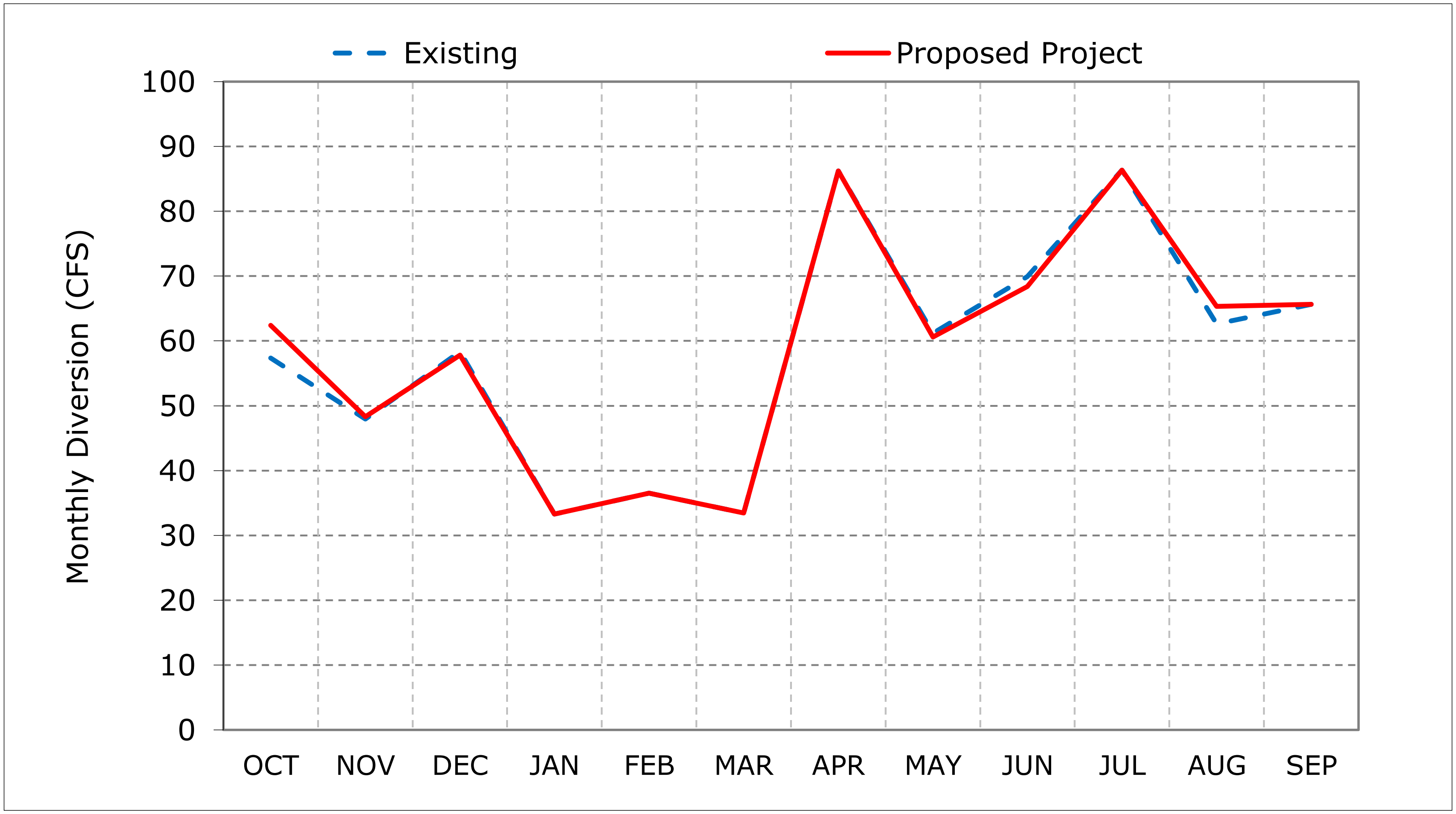
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 1-2. North Bay Aqueduct, Wet Year Average Diversion



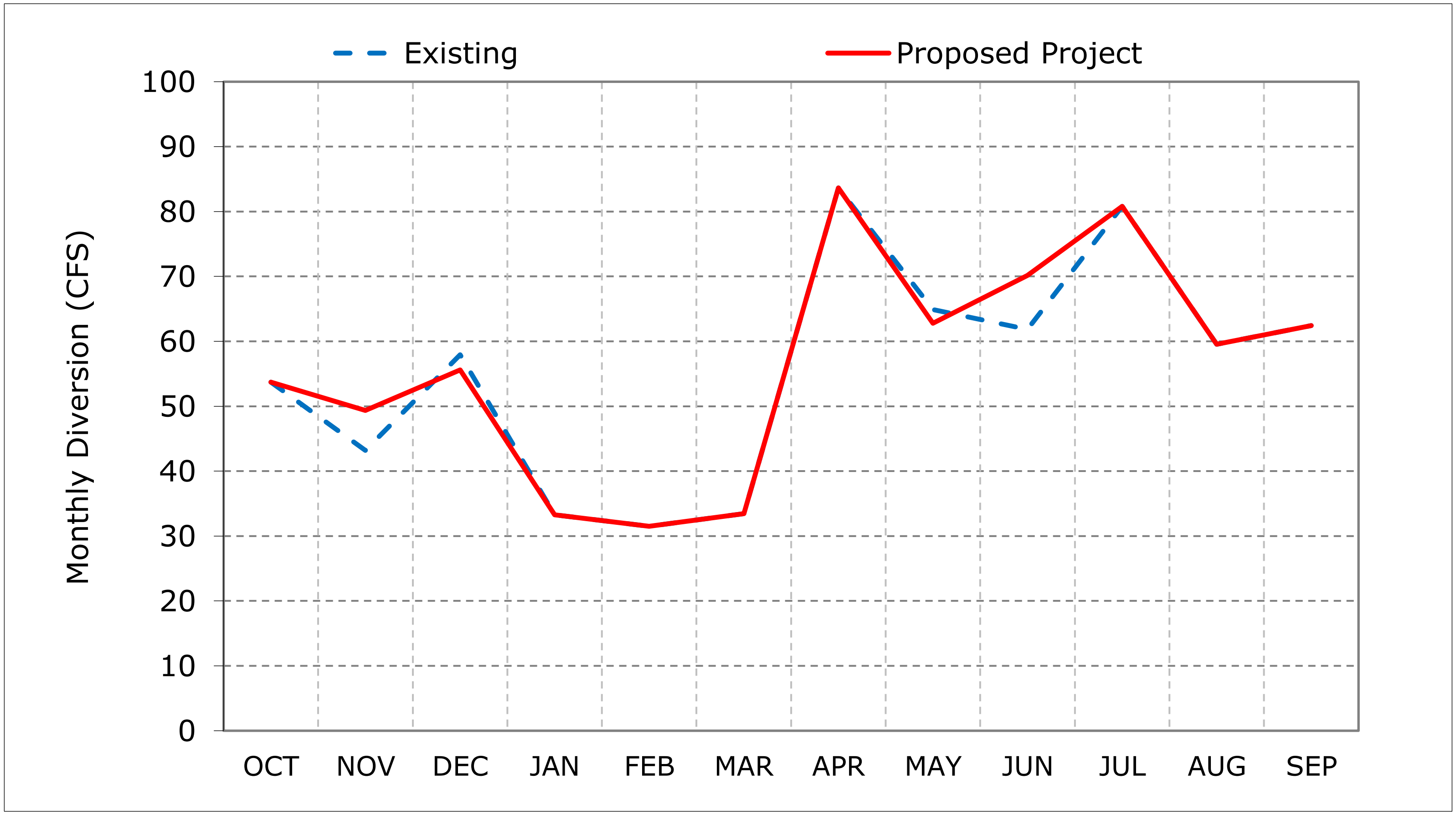
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 1-3. North Bay Aqueduct, Above Normal Year Average Diversion



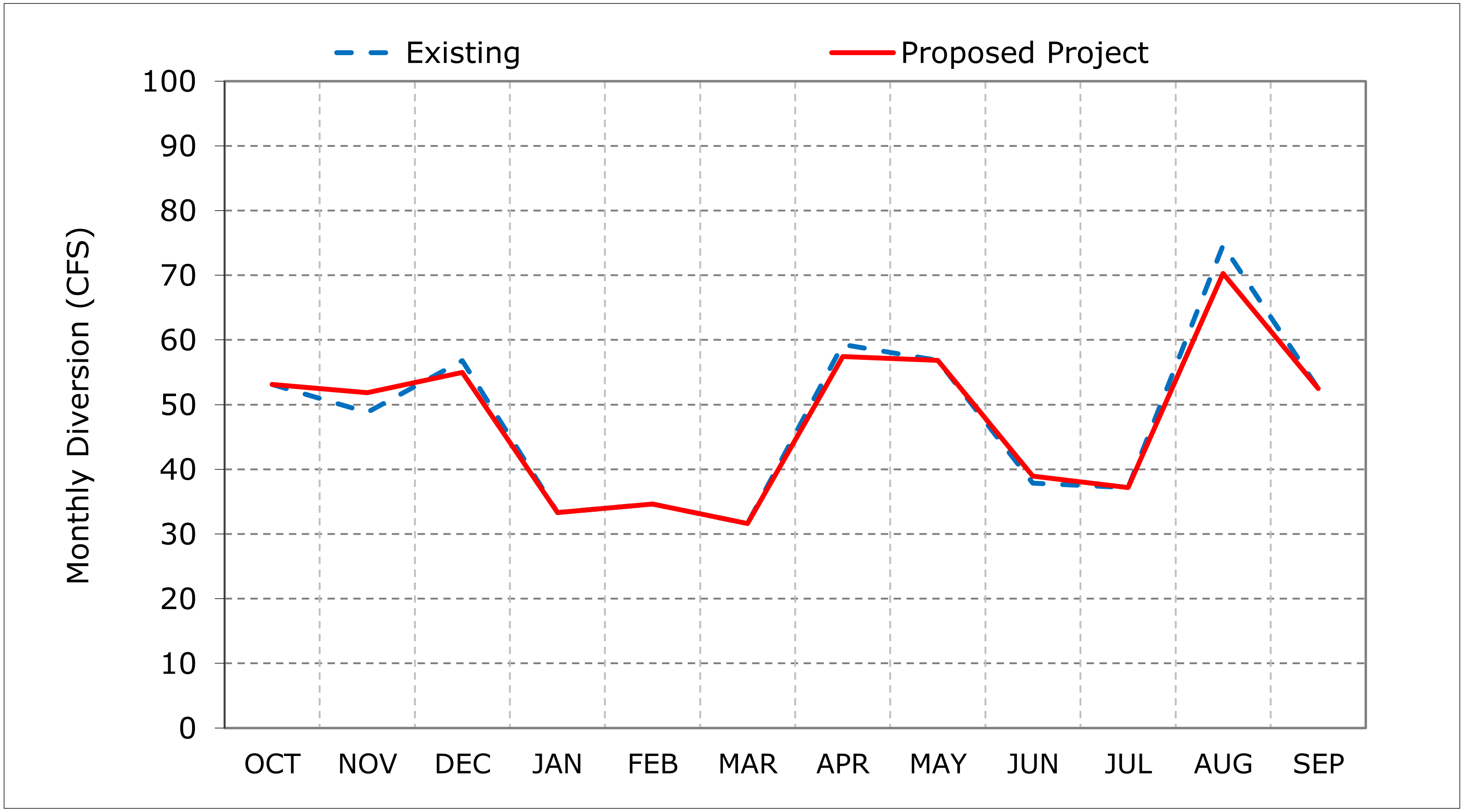
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 1-4. North Bay Aqueduct, Below Normal Year Average Diversion



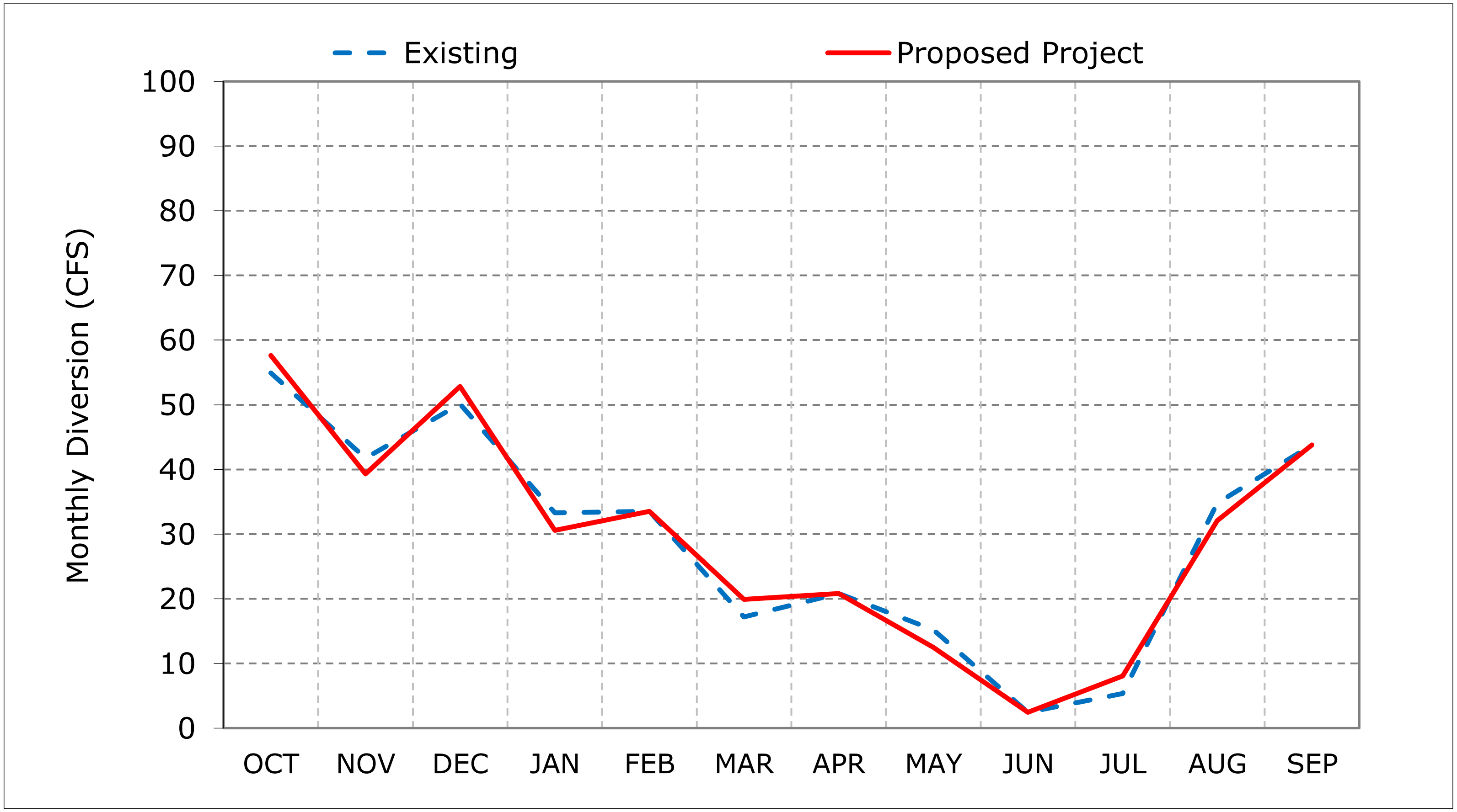
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 1-5. North Bay Aqueduct, Dry Year Average Diversion



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 1-6. North Bay Aqueduct, Critical Year Average Diversion



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 1-7. North Bay Aqueduct, October

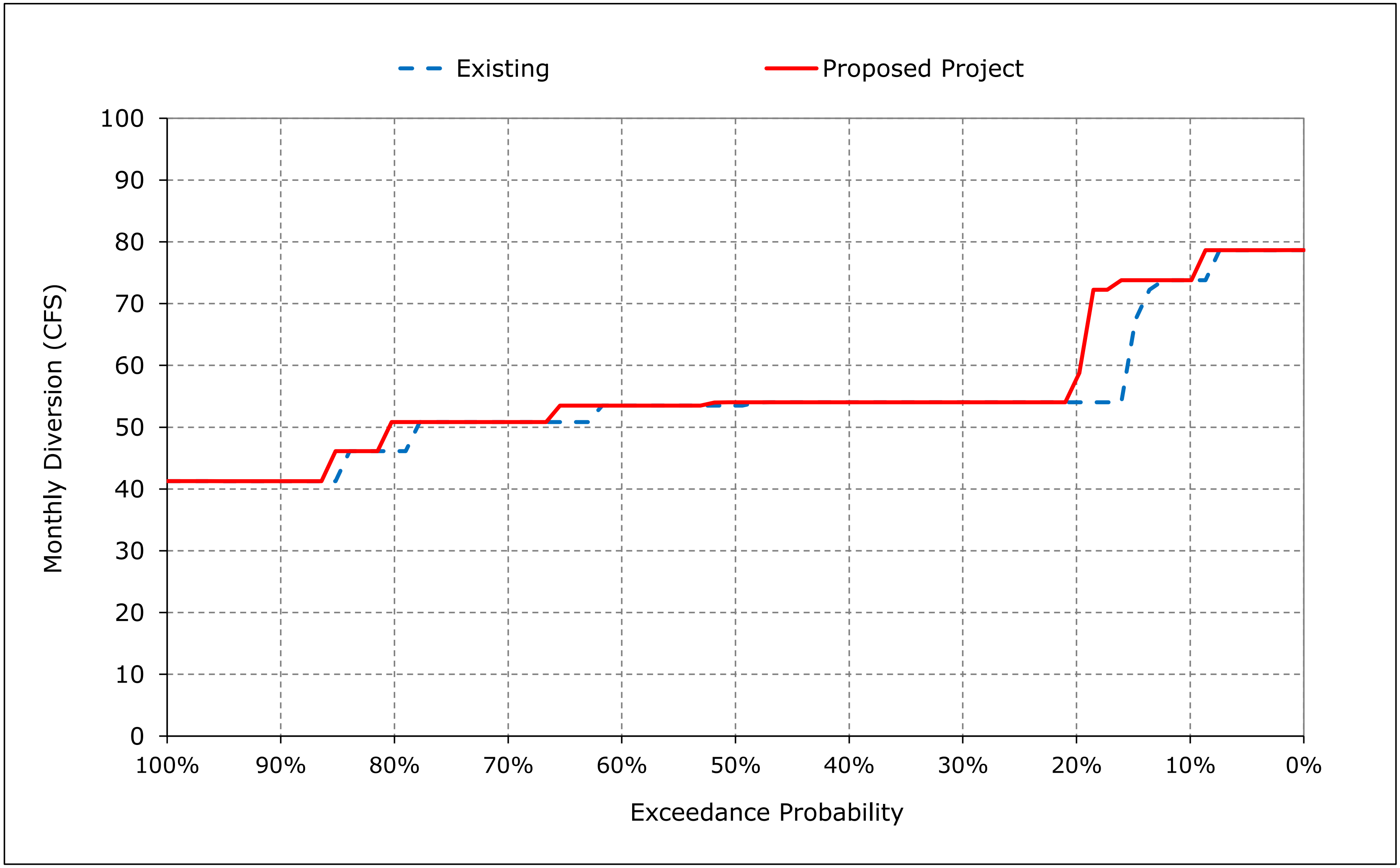


Figure 1-8. North Bay Aqueduct, November

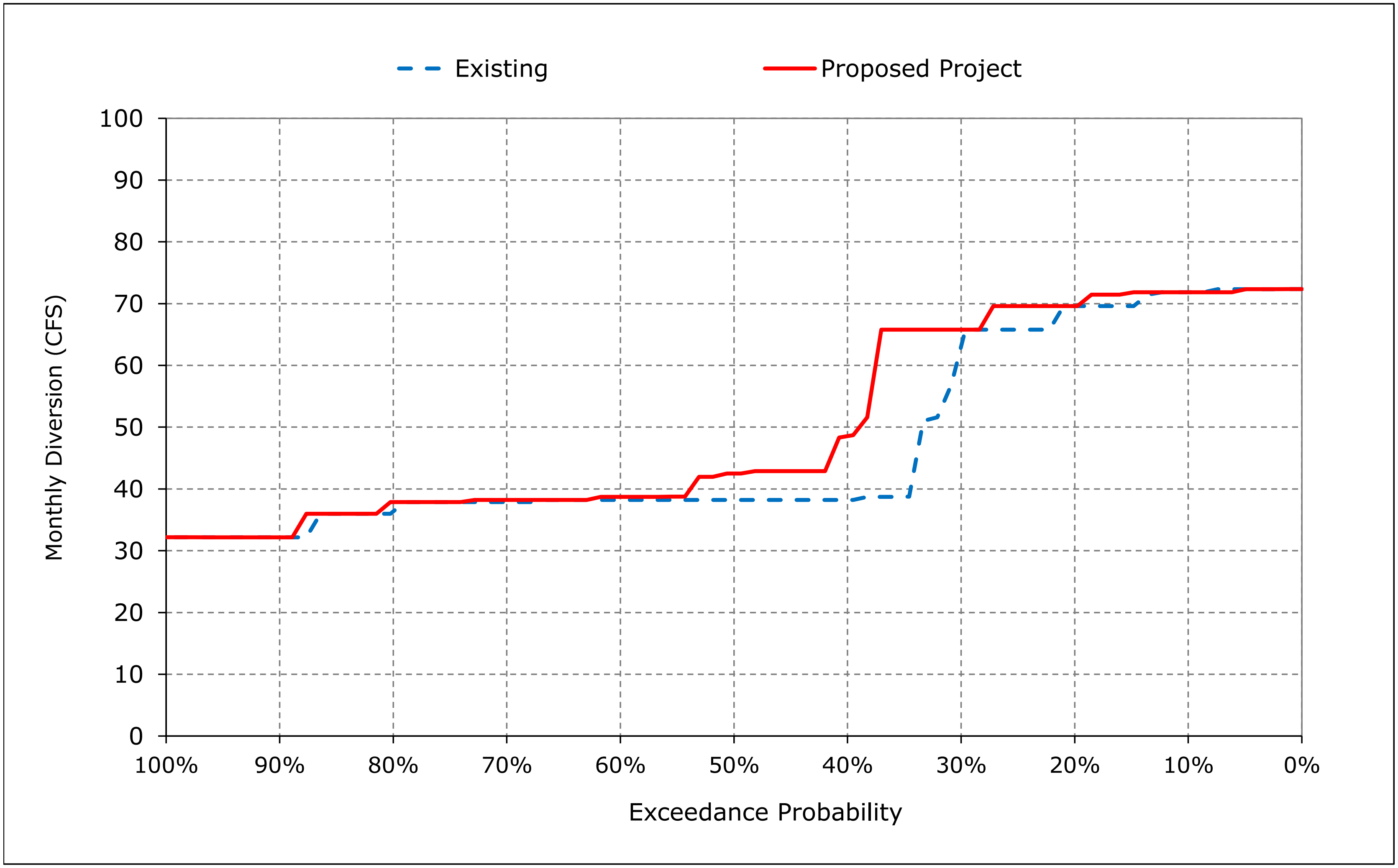


Figure 1-9. North Bay Aqueduct, December

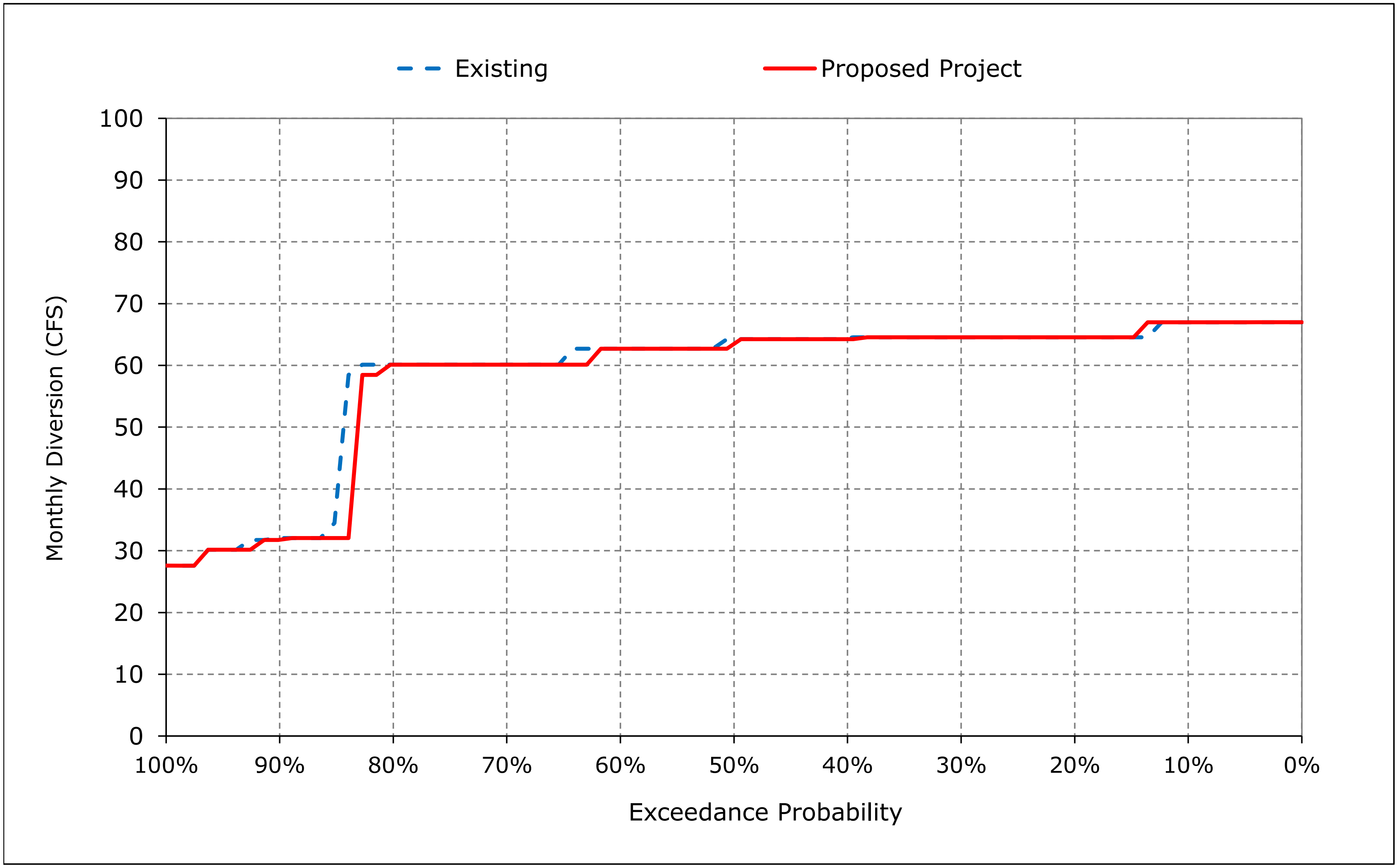


Figure 1-10. North Bay Aqueduct, January

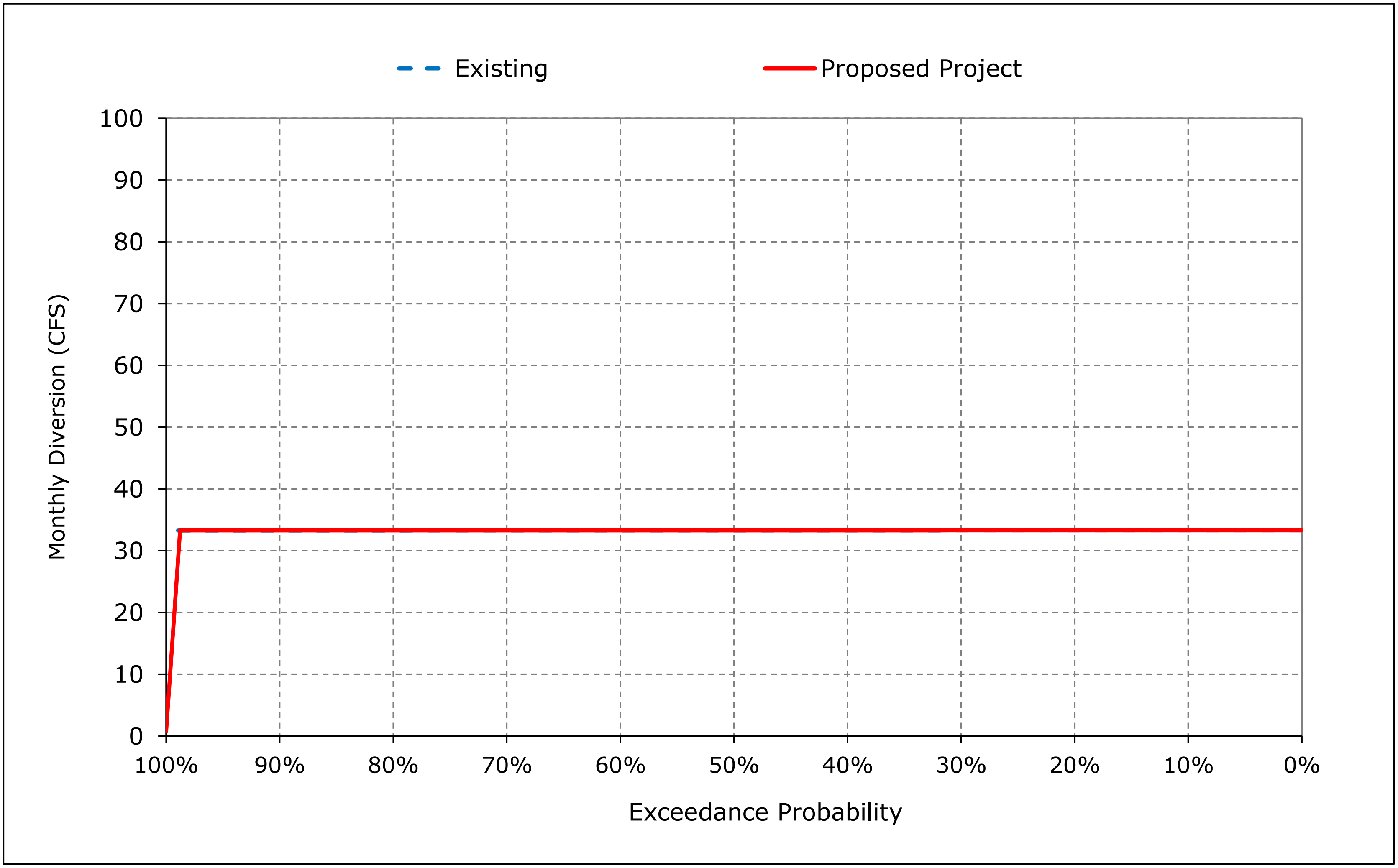


Figure 1-11. North Bay Aqueduct, February

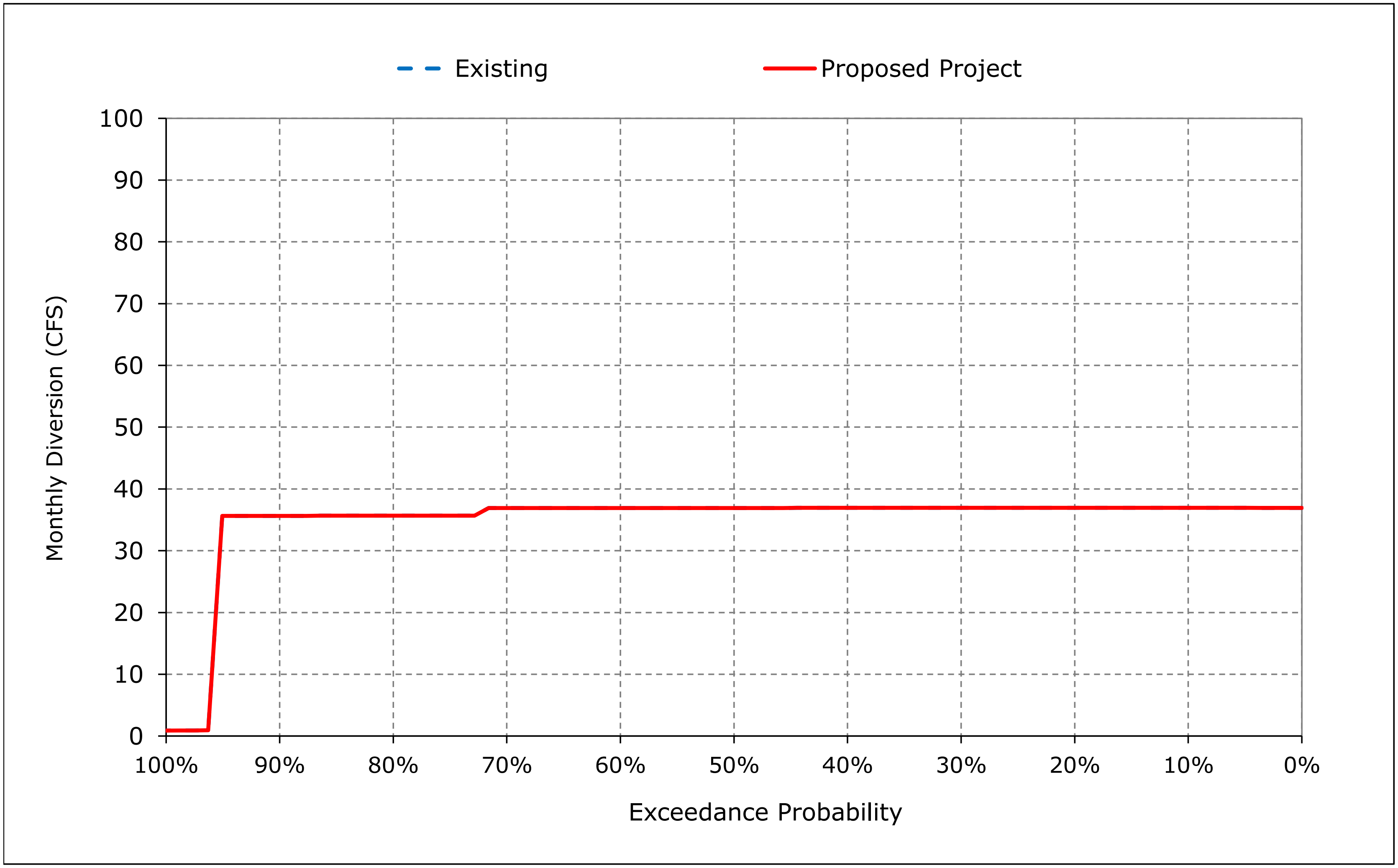


Figure 1-12. North Bay Aqueduct, March

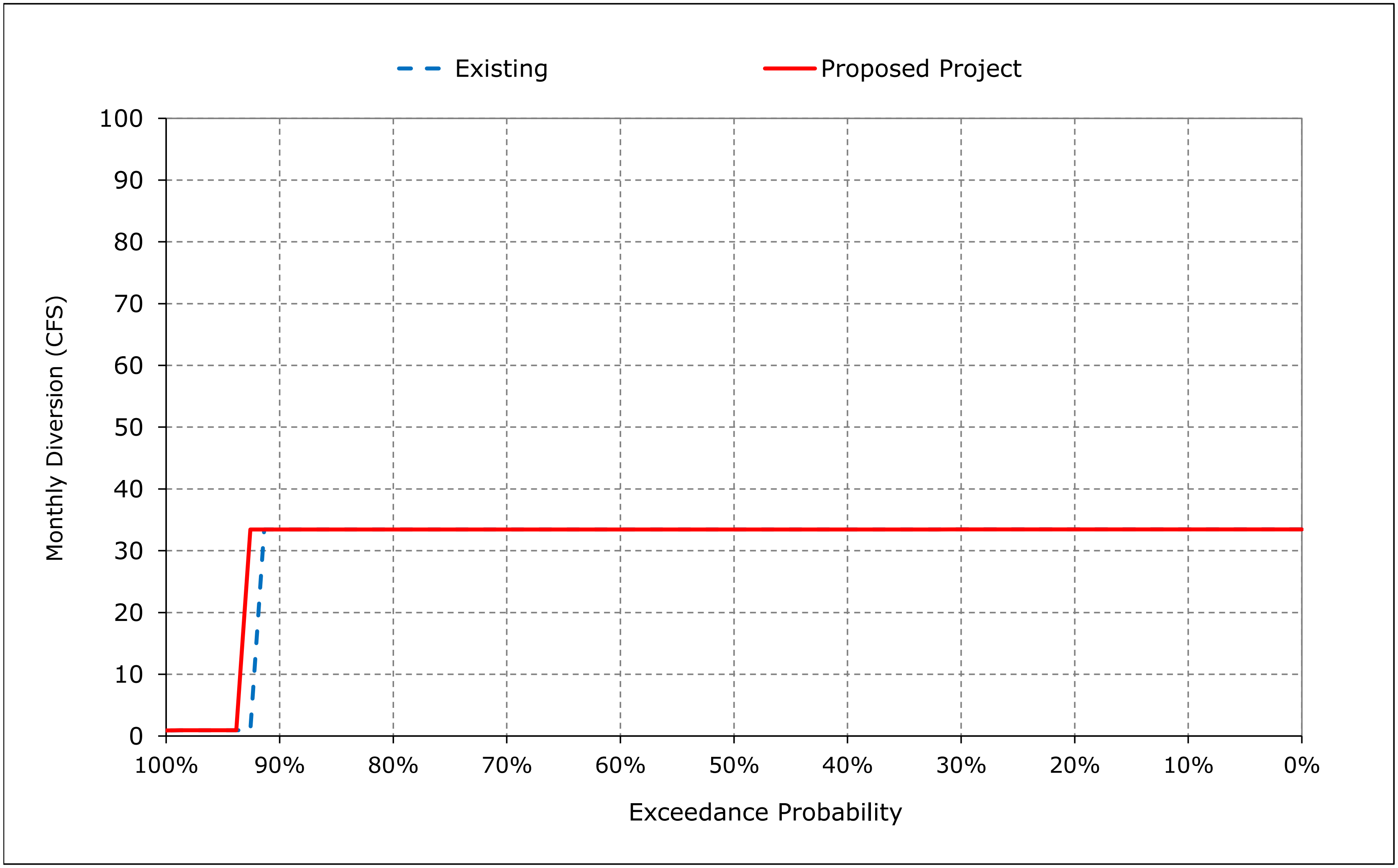


Figure 1-13. North Bay Aqueduct, April

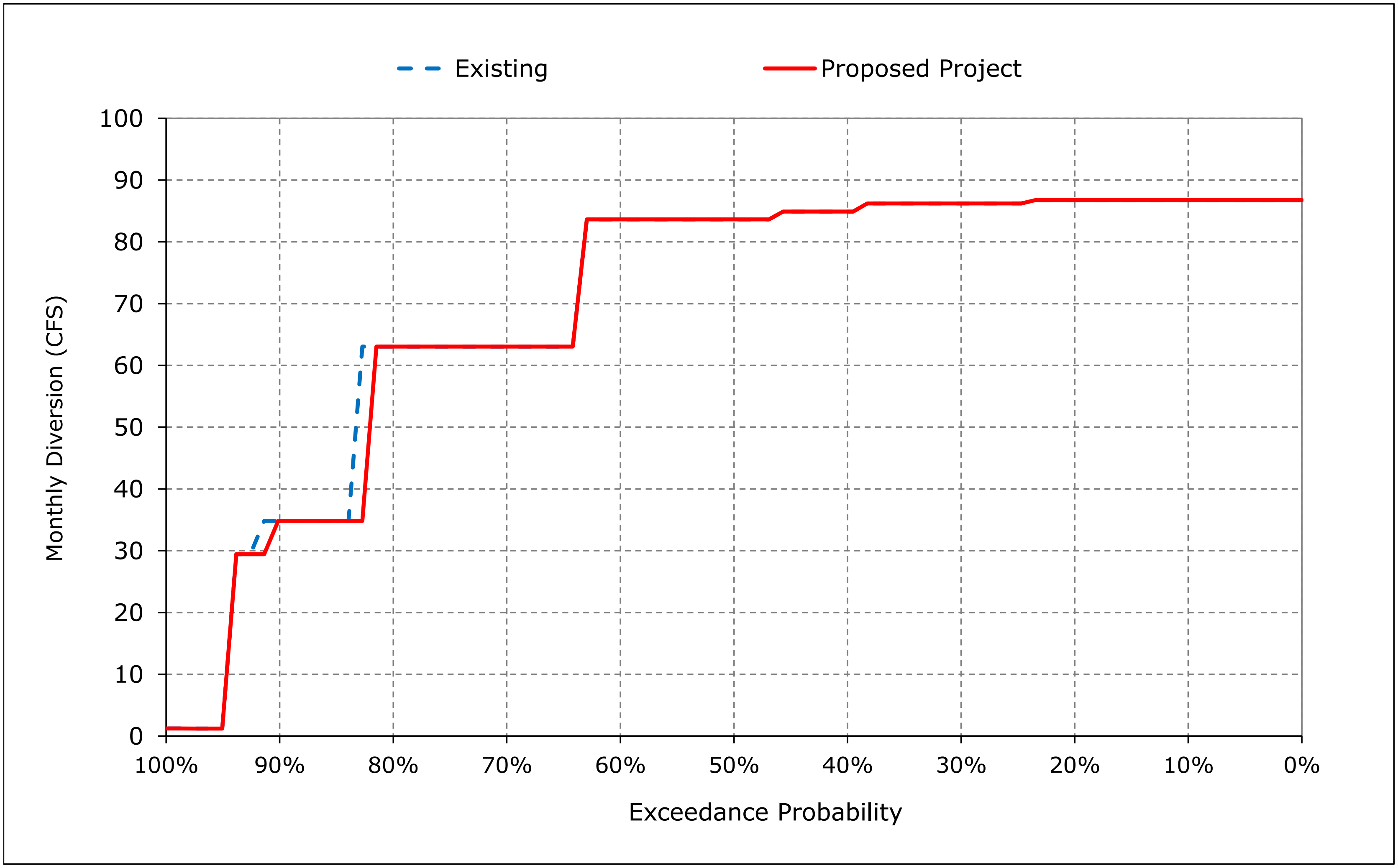


Figure 1-14. North Bay Aqueduct, May

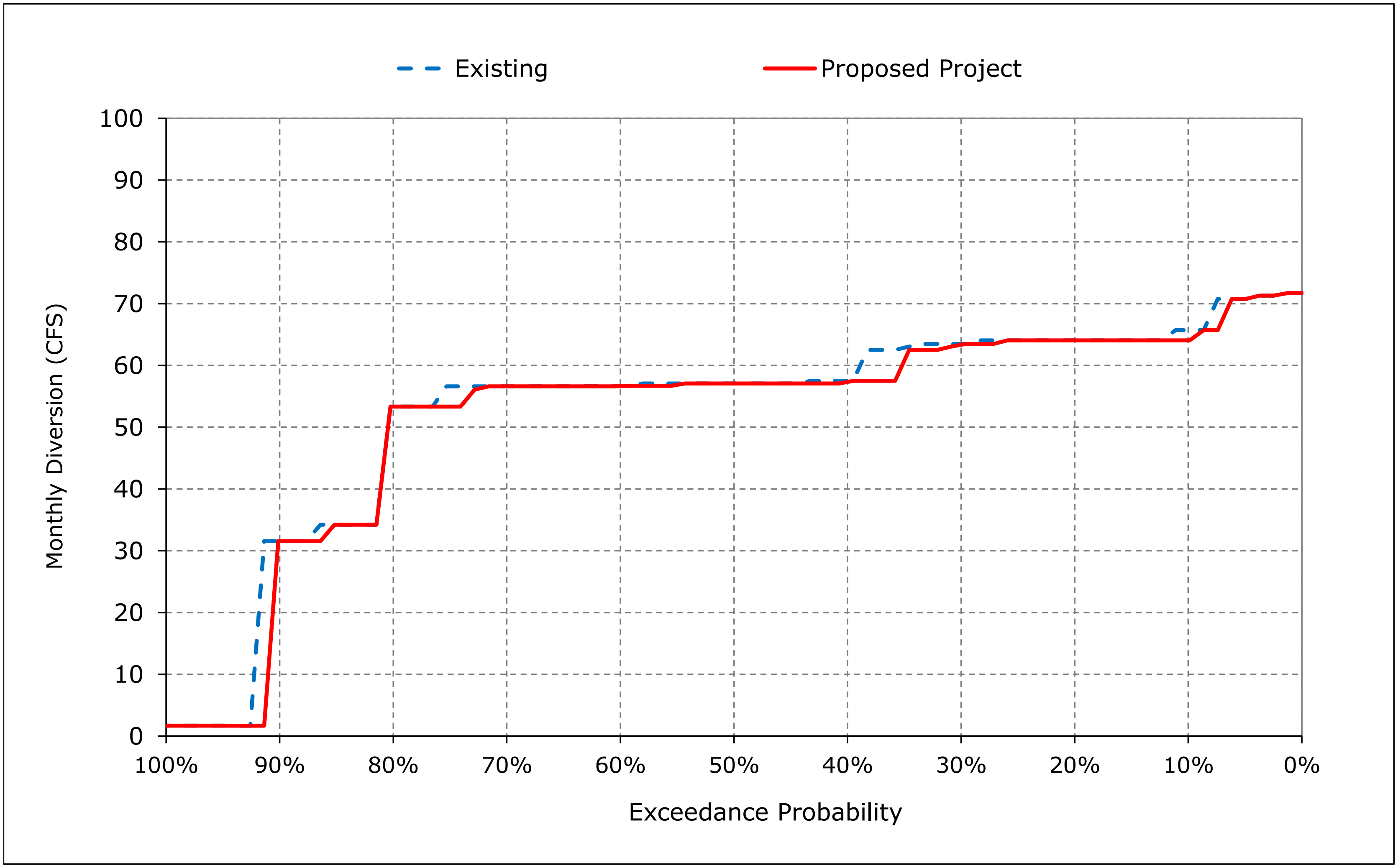


Figure 1-15. North Bay Aqueduct, June

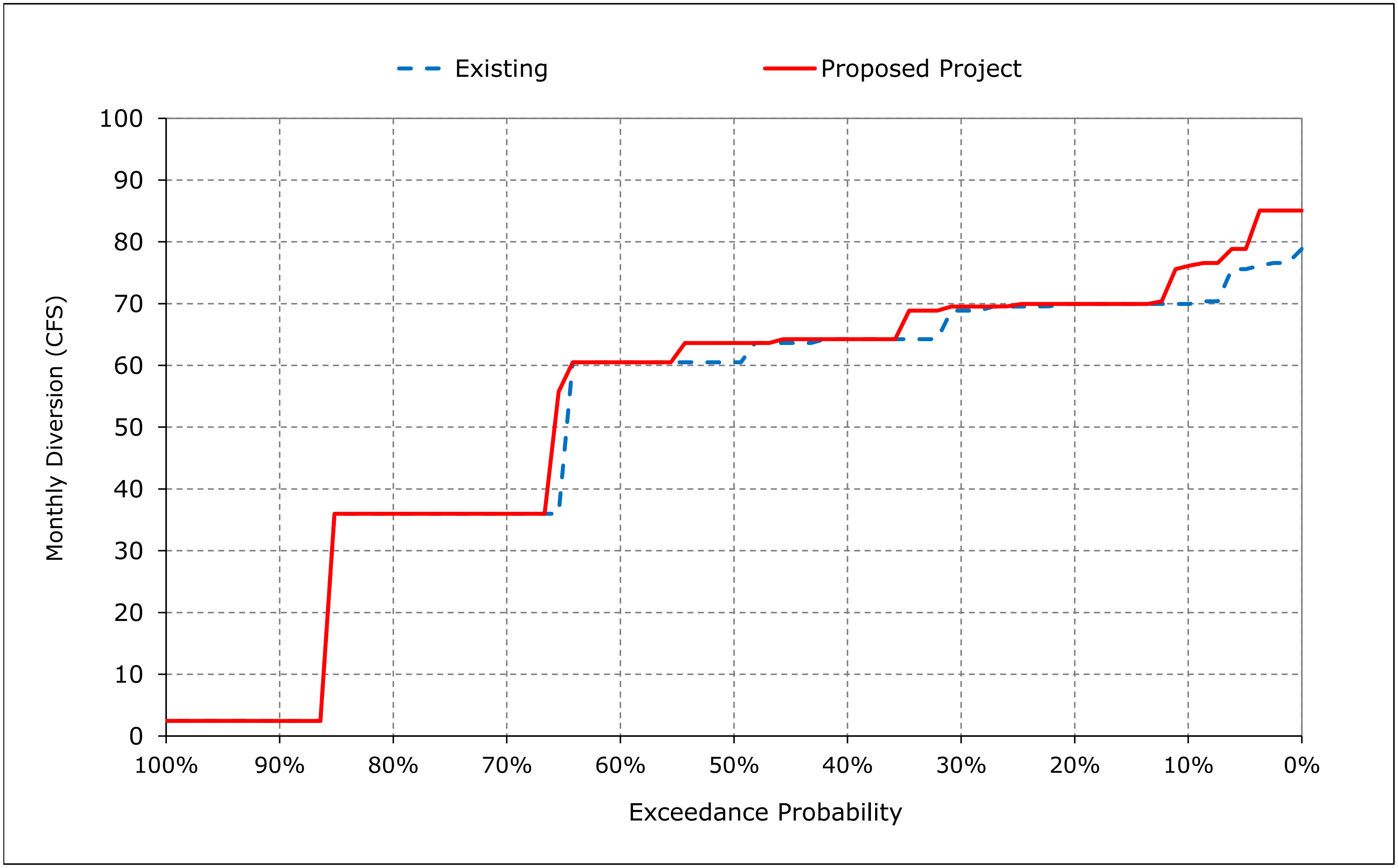


Figure 1-16. North Bay Aqueduct, July

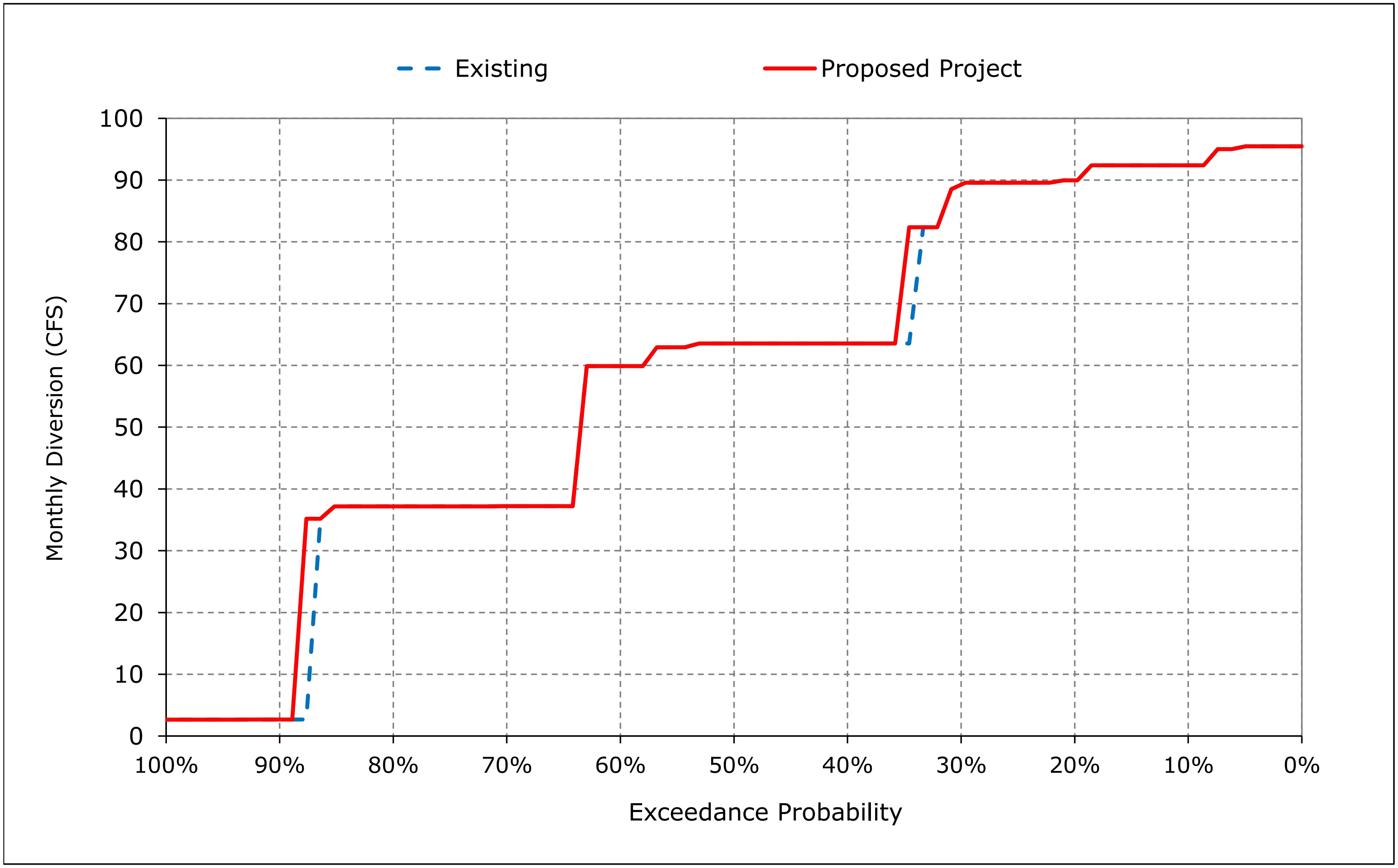


Figure 1-17. North Bay Aqueduct, August

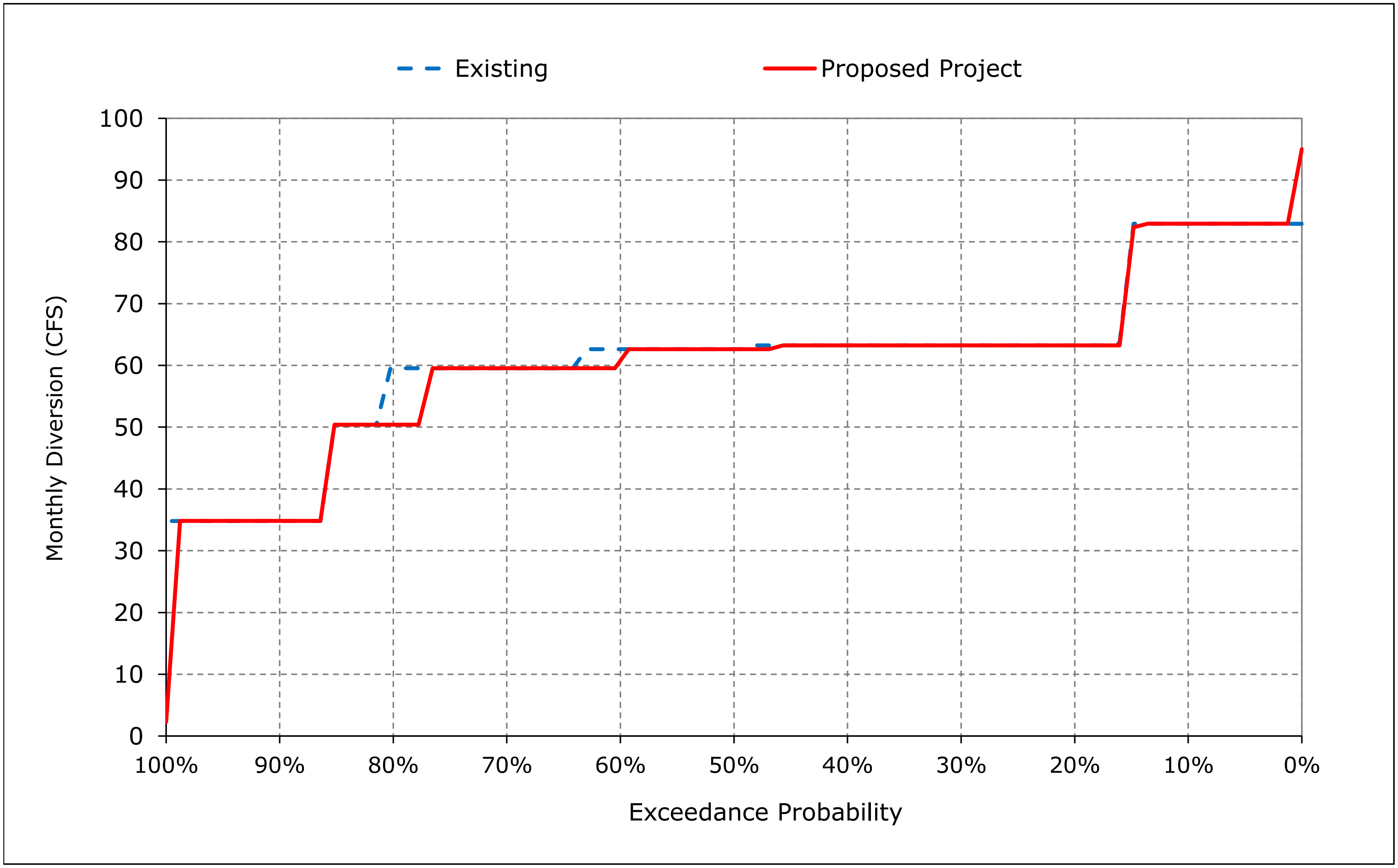


Figure 1-18. North Bay Aqueduct, September

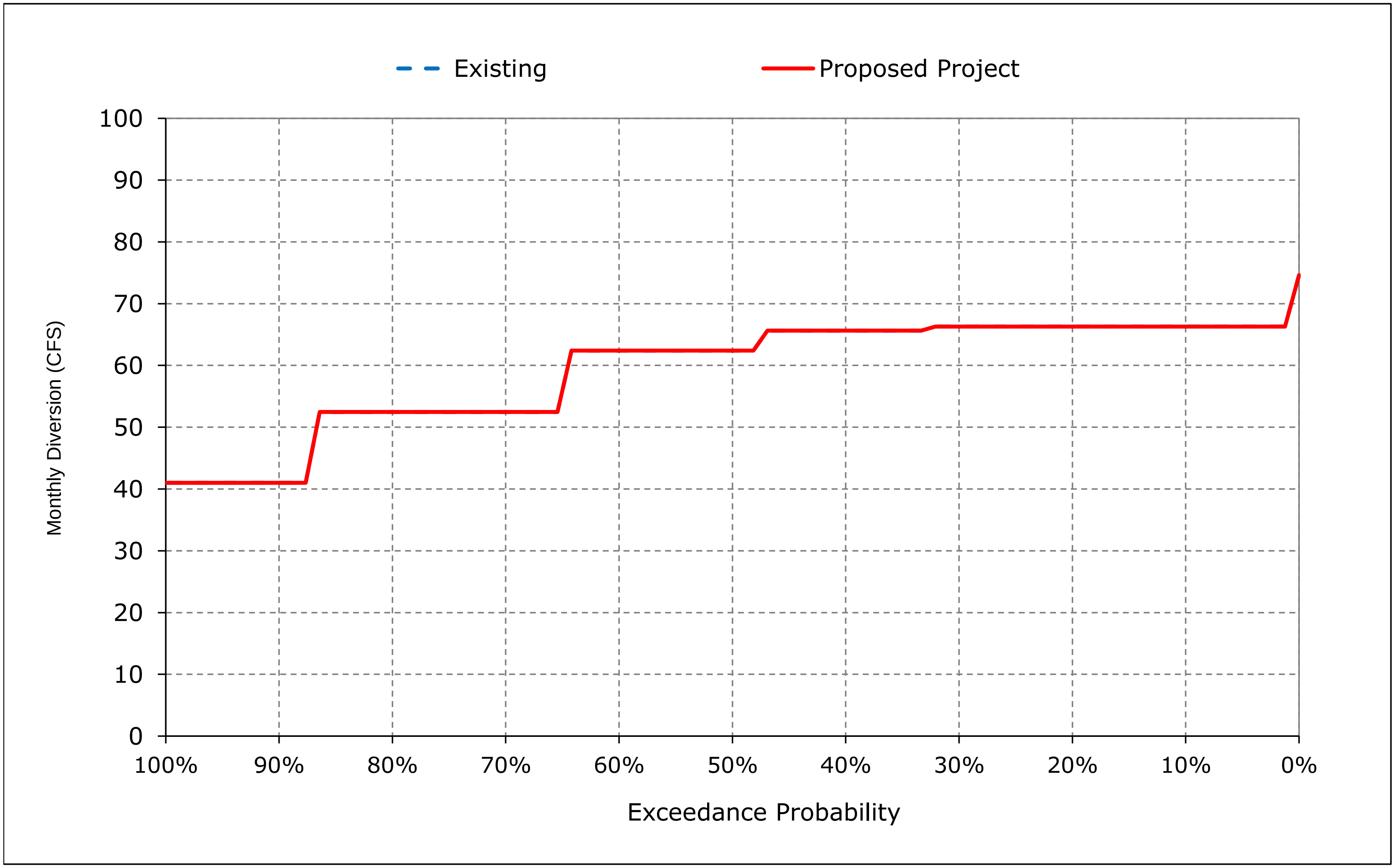


Table 2-1. DCC Flow, Monthly Flow

Existing

Statistic	Monthly Flow (CFS)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	2,148	1,277	922	0	0	0	0	0	3,039	4,572	3,153	4,268
20%	2,080	1,142	861	0	0	0	0	0	2,446	4,276	3,015	2,858
30%	1,881	1,008	776	0	0	0	0	0	2,368	4,013	2,970	2,314
40%	1,765	883	685	0	0	0	0	0	2,308	3,701	2,925	1,875
50%	1,613	797	485	0	0	0	0	0	2,230	3,553	2,885	1,789
60%	1,486	523	0	0	0	0	0	0	2,065	3,244	2,680	1,468
70%	1,446	30	0	0	0	0	0	0	1,944	3,049	1,947	1,213
80%	1,208	0	0	0	0	0	0	0	1,733	2,726	1,708	0
90%	1,157	0	0	0	0	0	0	0	130	1,907	1,527	0
Long Term												
Full Simulation Period[a]	1,596	645	436	0	0	0	0	0	2,061	3,402	2,526	1,828
Water Year Types[b,c]												
Wet (32%)	1,419	450	107	0	0	0	0	0	2,060	3,754	3,021	690
Above Normal (15%)	1,669	516	417	0	0	0	0	0	1,820	4,072	3,046	4,186
Below Normal (17%)	1,827	783	679	0	0	0	0	0	2,331	3,879	2,887	2,407
Dry (22%)	1,705	716	567	0	0	0	0	0	2,240	3,103	1,796	1,775
Critical (15%)	1,470	930	684	0	0	0	0	0	1,723	1,865	1,607	1,340

Proposed Project

Statistic	Monthly Flow (CFS)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	2,111	1,593	996	0	0	0	0	0	3,039	4,544	3,150	4,454
20%	1,935	1,461	830	0	0	0	0	0	2,486	4,397	3,035	4,332
30%	1,707	1,297	744	0	0	0	0	0	2,433	4,068	2,986	4,200
40%	1,592	1,113	645	0	0	0	0	0	2,380	3,643	2,931	3,948
50%	1,502	959	416	0	0	0	0	0	2,311	3,445	2,799	2,726
60%	1,424	832	0	0	0	0	0	0	2,176	3,137	2,562	2,047
70%	1,236	774	0	0	0	0	0	0	2,013	2,933	1,967	1,823
80%	1,186	190	0	0	0	0	0	0	1,745	2,566	1,762	1,741
90%	734	0	0	0	0	0	0	0	131	1,922	1,648	1,386
Long Term												
Full Simulation Period[a]	1,455	905	421	0	0	0	0	0	2,112	3,365	2,525	2,951
Water Year Types[b,c]												
Wet (32%)	1,321	763	82	0	0	0	0	0	2,074	3,729	3,005	4,185
Above Normal (15%)	1,536	828	407	0	0	0	0	0	1,943	4,086	3,033	4,328
Below Normal (17%)	1,582	1,063	684	0	0	0	0	0	2,467	3,810	2,831	2,362
Dry (22%)	1,633	935	537	0	0	0	0	0	2,271	2,969	1,815	1,767
Critical (15%)	1,246	1,058	685	0	0	0	0	0	1,712	1,928	1,686	1,365

Proposed Project minus Existing

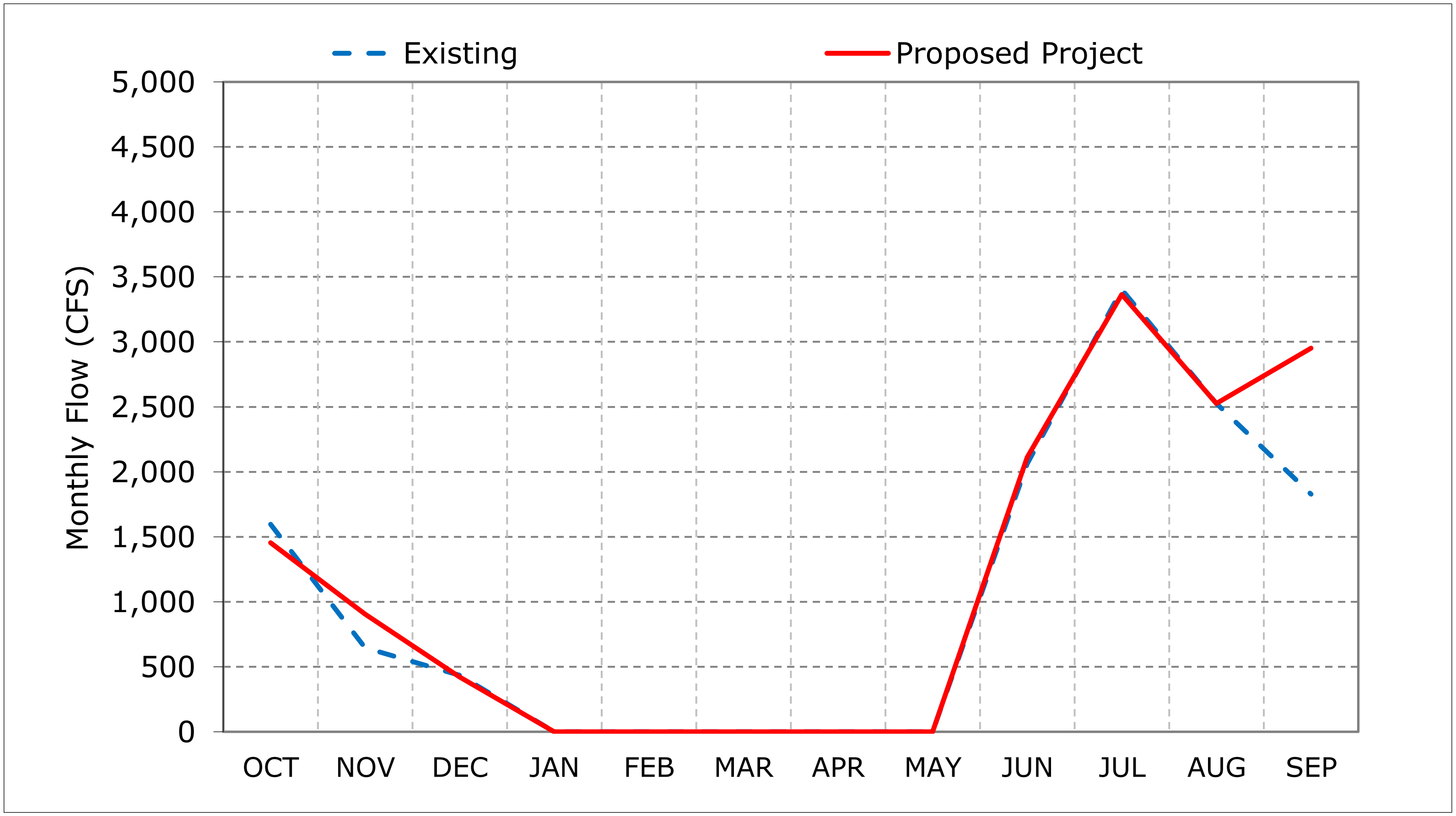
Statistic	Monthly Flow (CFS)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	-38	317	74	0	0	0	0	0	0	-28	-3	187
20%	-145	319	-31	0	0	0	0	0	41	121	21	1,474
30%	-174	289	-32	0	0	0	0	0	64	55	17	1,885
40%	-173	231	-39	0	0	0	0	0	72	-58	6	2,073
50%	-111	162	-70	0	0	0	0	0	81	-109	-86	936
60%	-62	309	0	0	0	0	0	0	111	-107	-118	580
70%	-210	744	0	0	0	0	0	0	69	-115	19	610
80%	-22	190	0	0	0	0	0	0	12	-160	54	1,741
90%	-423	0	0	0	0	0	0	0	2	14	120	1,386
Long Term												
Full Simulation Period[a]	-141	259	-15	0	0	0	0	0	51	-38	-1	1,123
Water Year Types[b,c]												
Wet (32%)	-98	313	-25	0	0	0	0	0	14	-25	-16	3,495
Above Normal (15%)	-134	311	-10	0	0	0	0	0	122	13	-14	142
Below Normal (17%)	-244	280	5	0	0	0	0	0	136	-69	-57	-45
Dry (22%)	-72	220	-30	0	0	0	0	0	31	-134	19	-8
Critical (15%)	-223	127	1	0	0	0	0	0	-11	64	79	25

a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

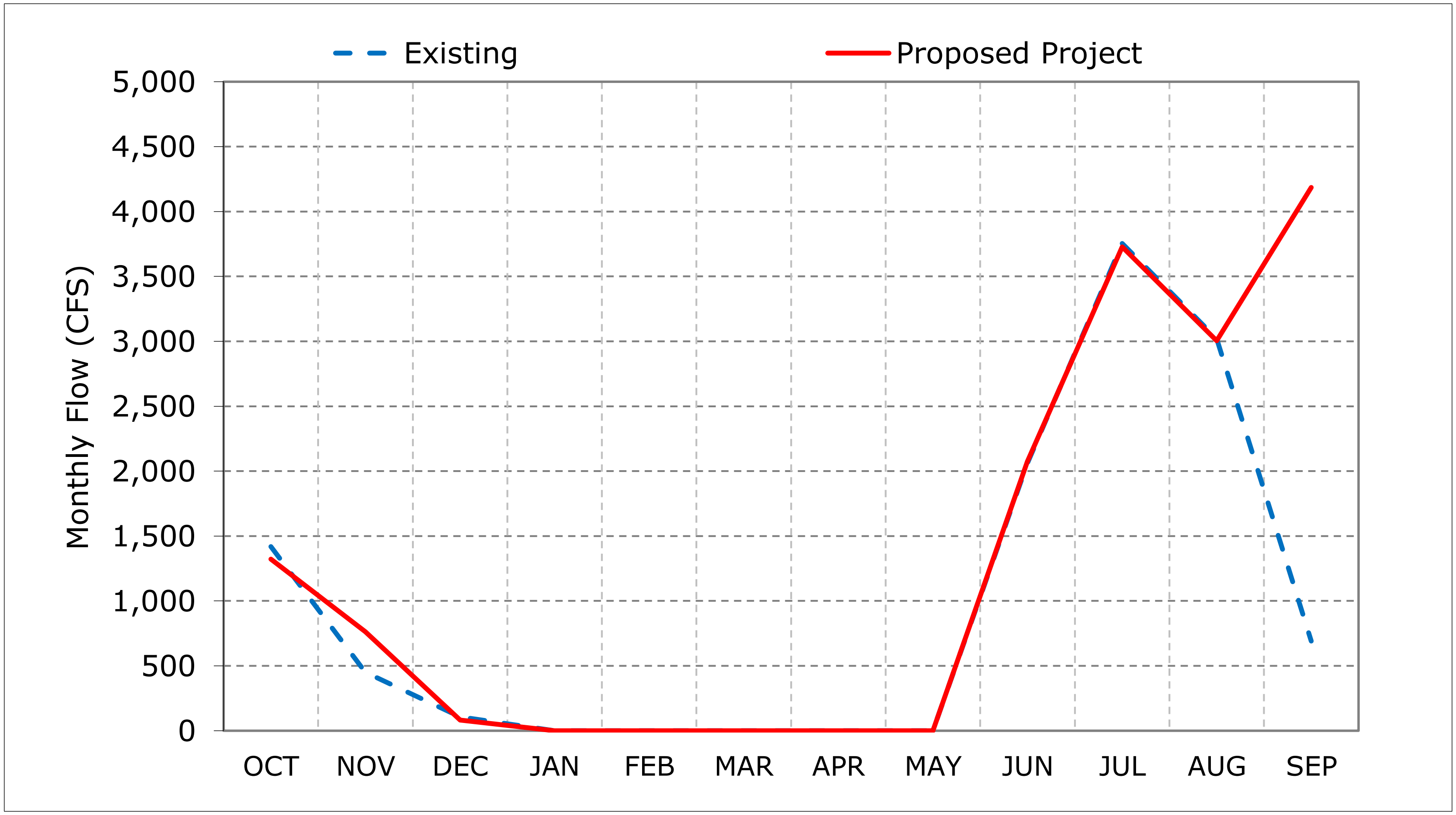
c These results are displayed with water year - year type sorting.

Figure 2-1. DCC Flow, Long-Term Average Flow



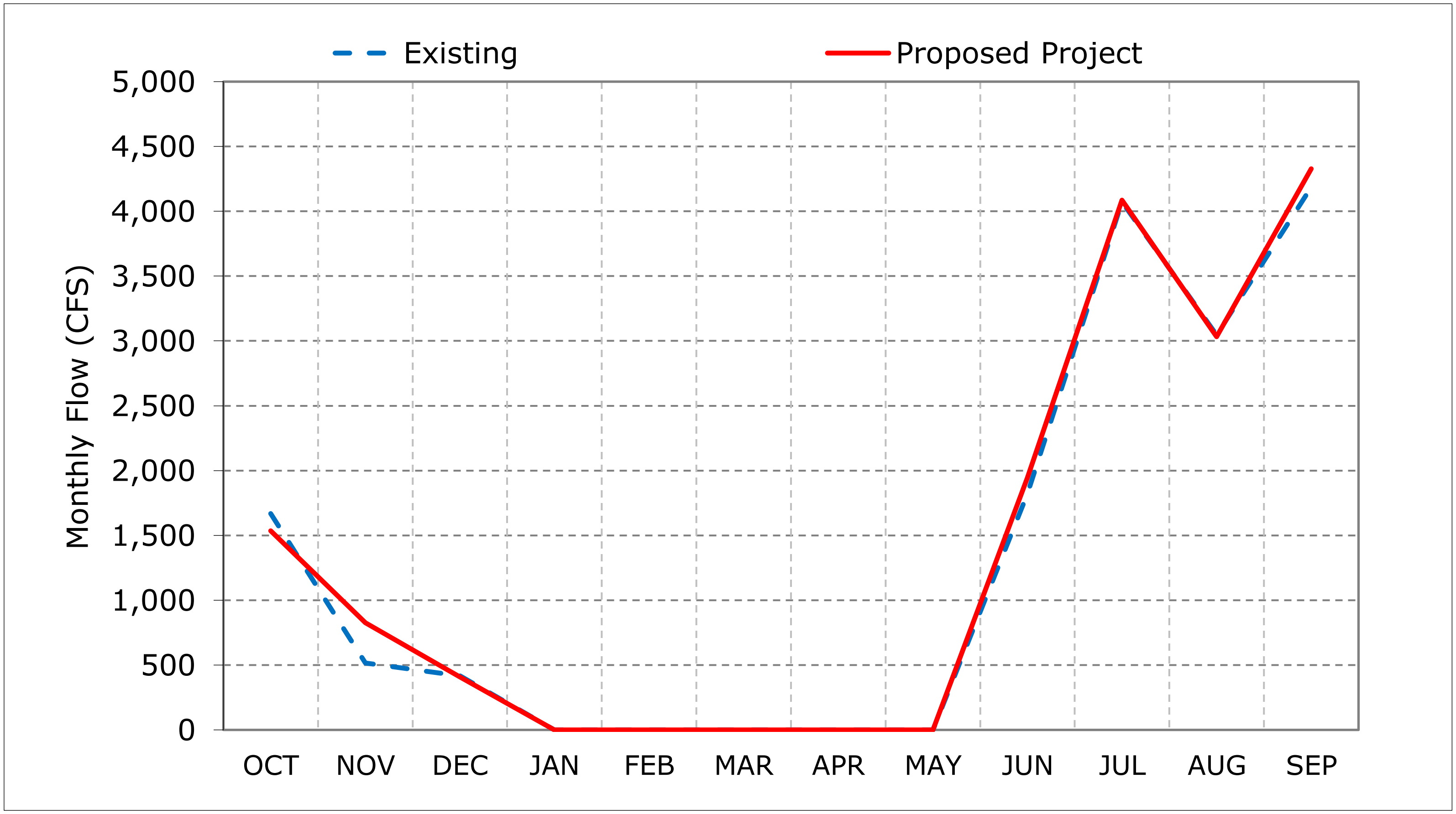
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 2-2. DCC Flow, Wet Year Average Flow



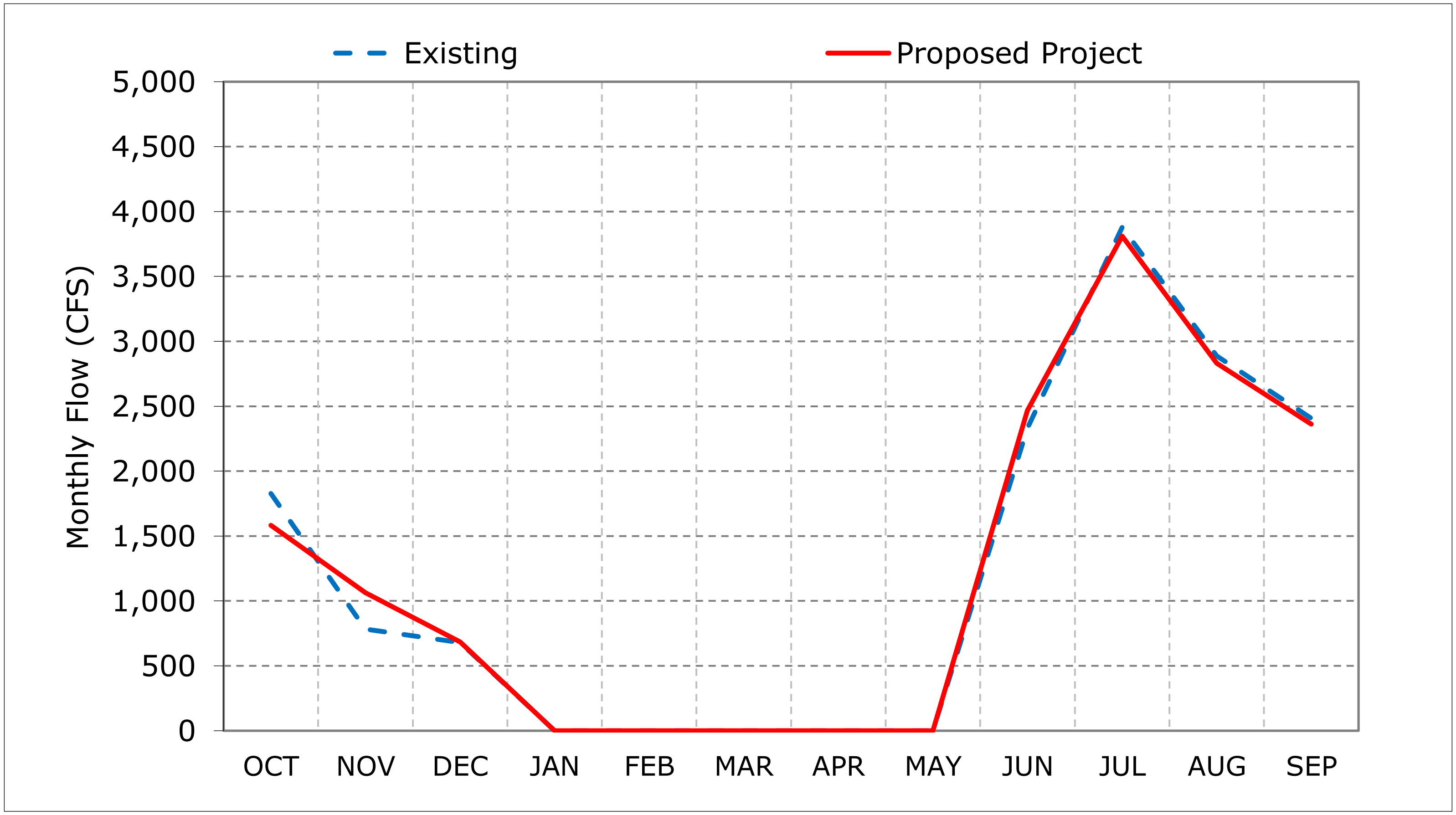
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 2-3. DCC Flow, Above Normal Year Average Flow



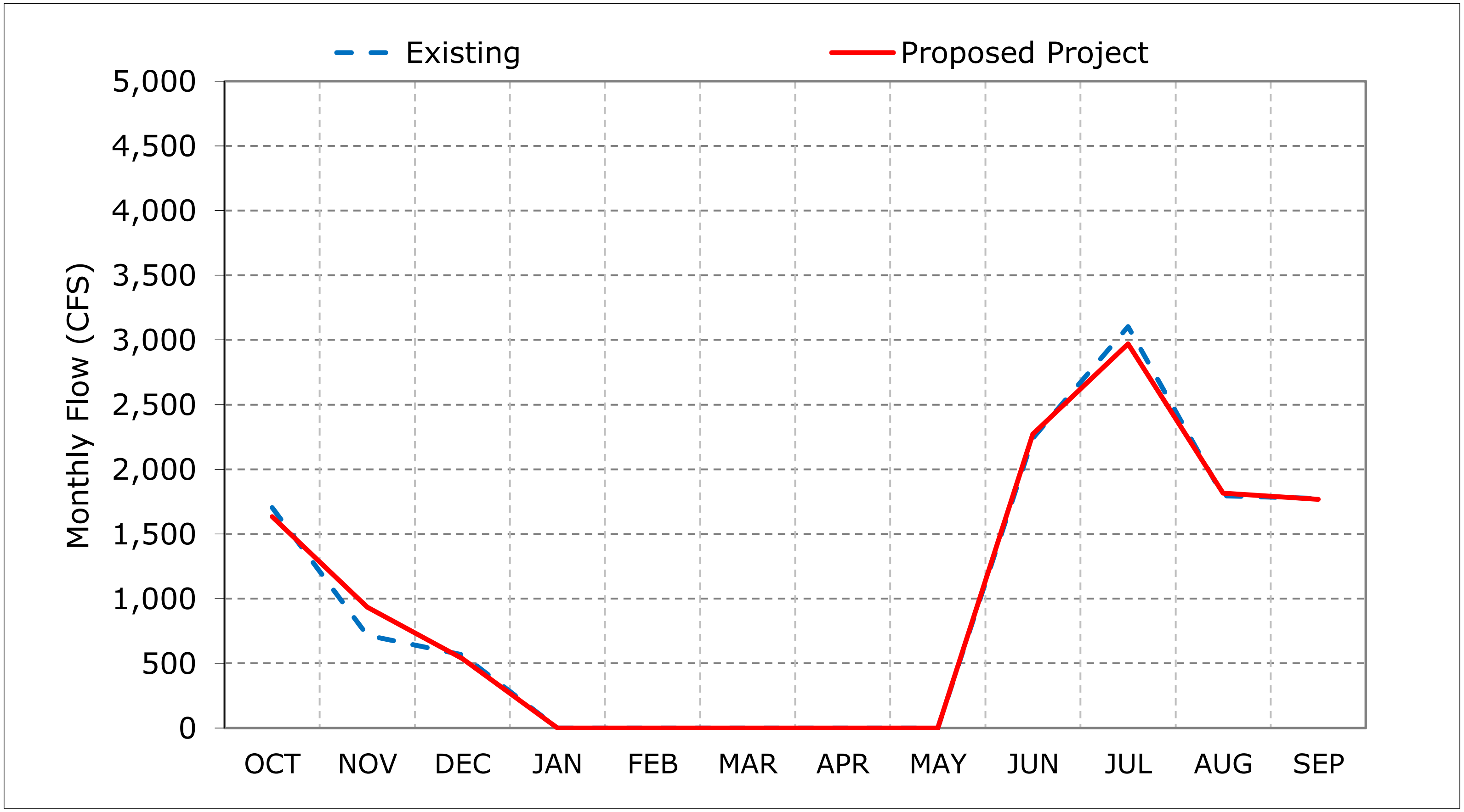
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 2-4. DCC Flow, Below Normal Year Average Flow



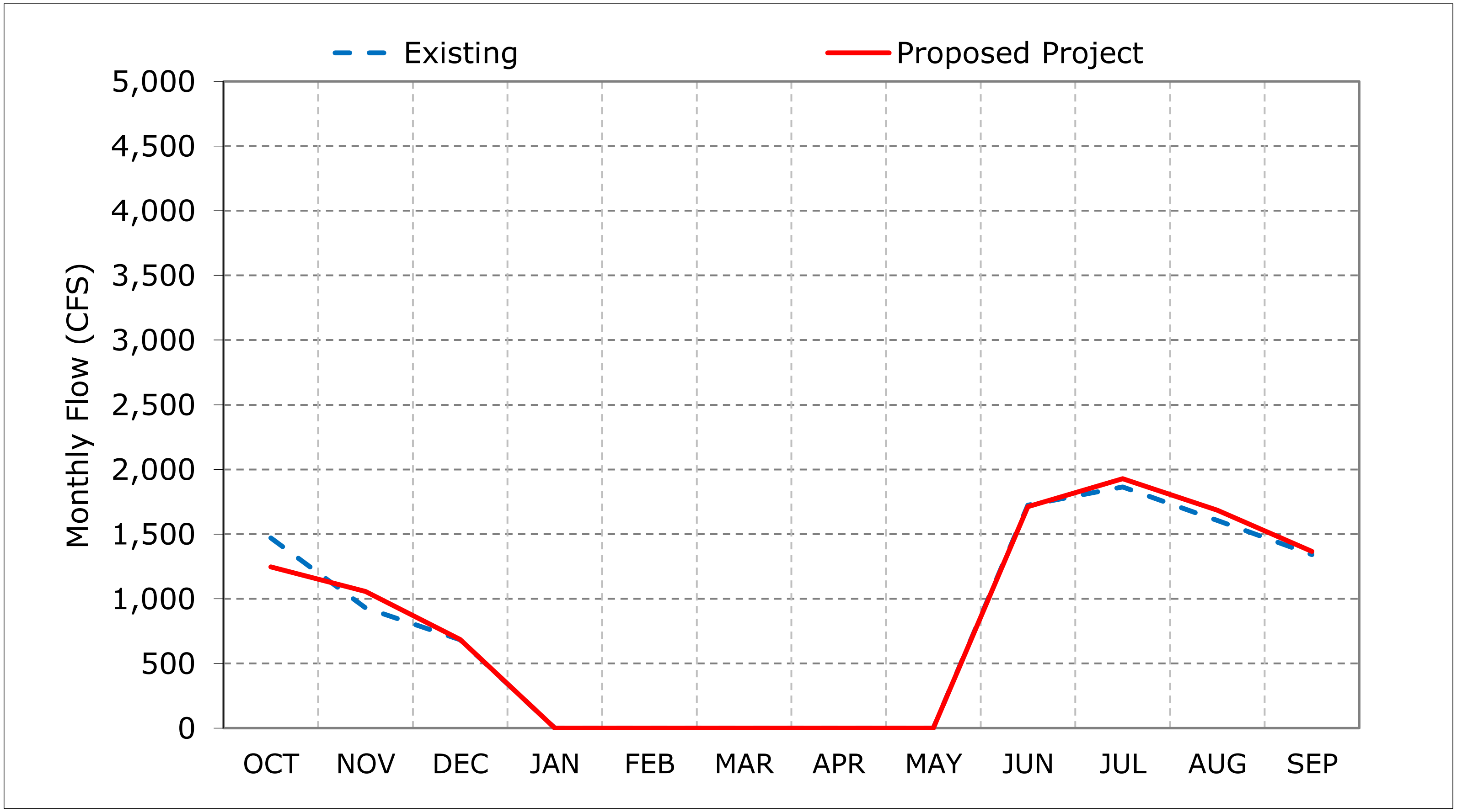
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 2-5. DCC Flow, Dry Year Average Flow



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 2-6. DCC Flow, Critical Year Average Flow



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164

*These results are displayed with water year - year type sorting.

Figure 2-7. DCC Flow, October

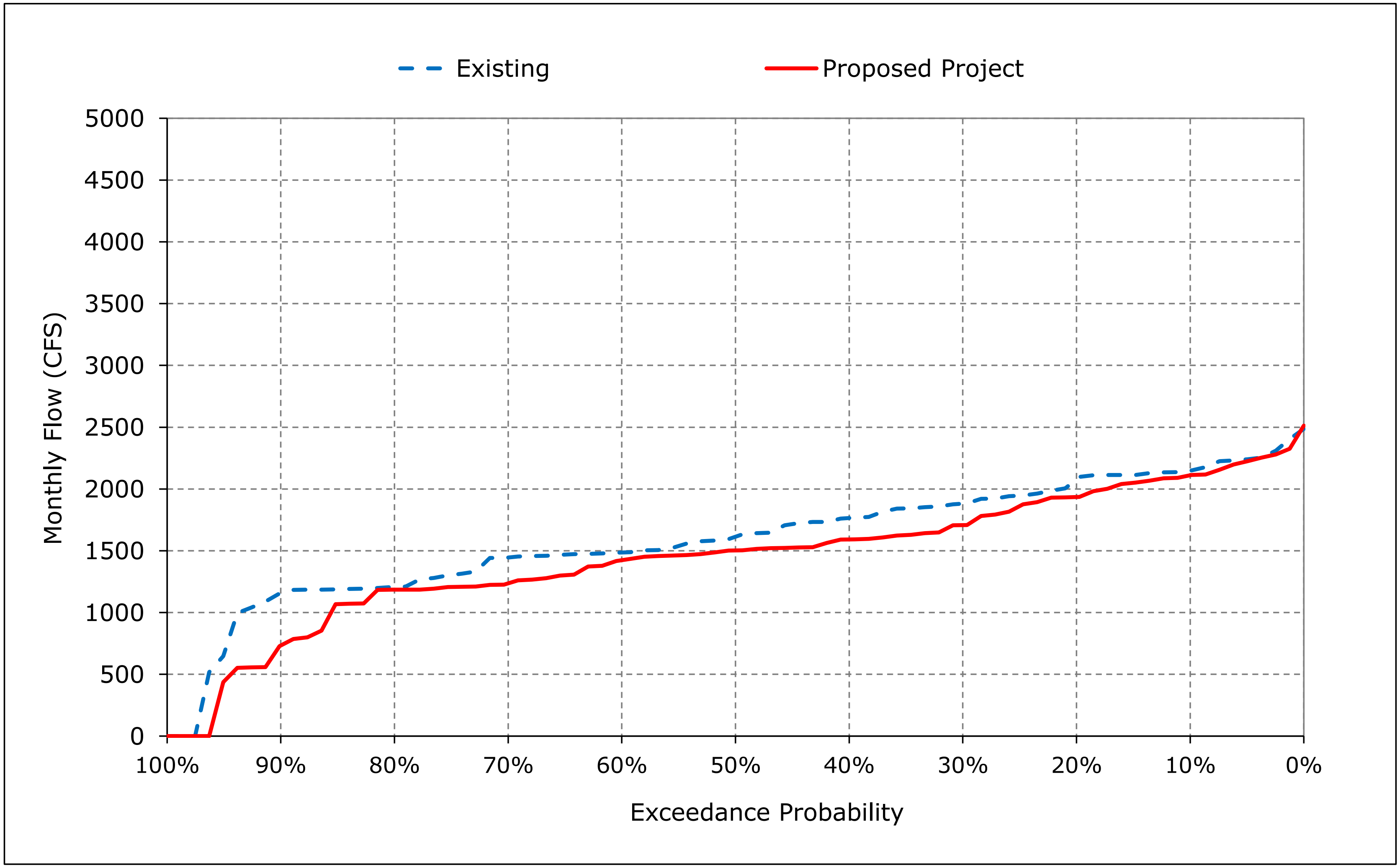


Figure 2-8. DCC Flow, November

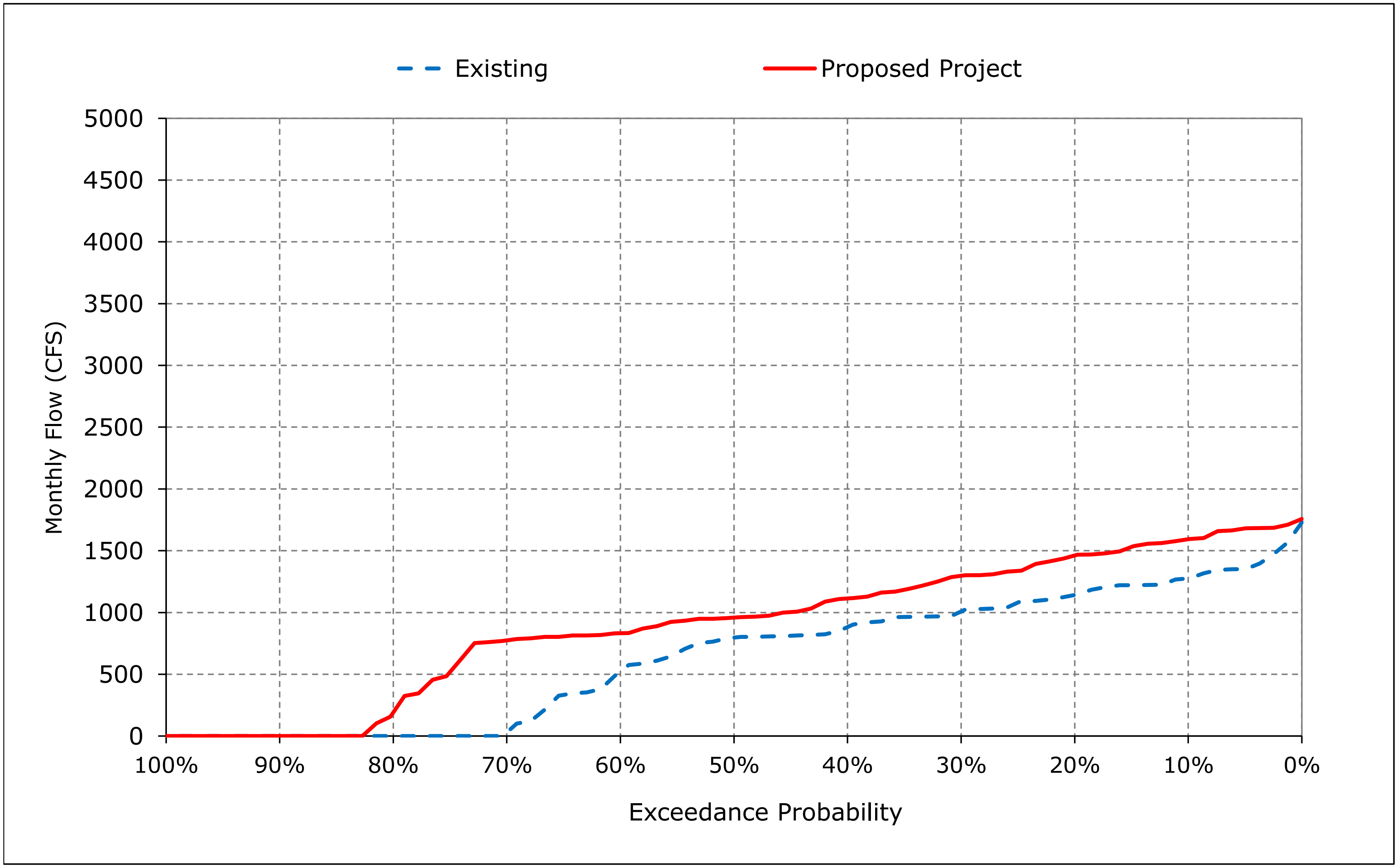


Figure 2-9. DCC Flow, December

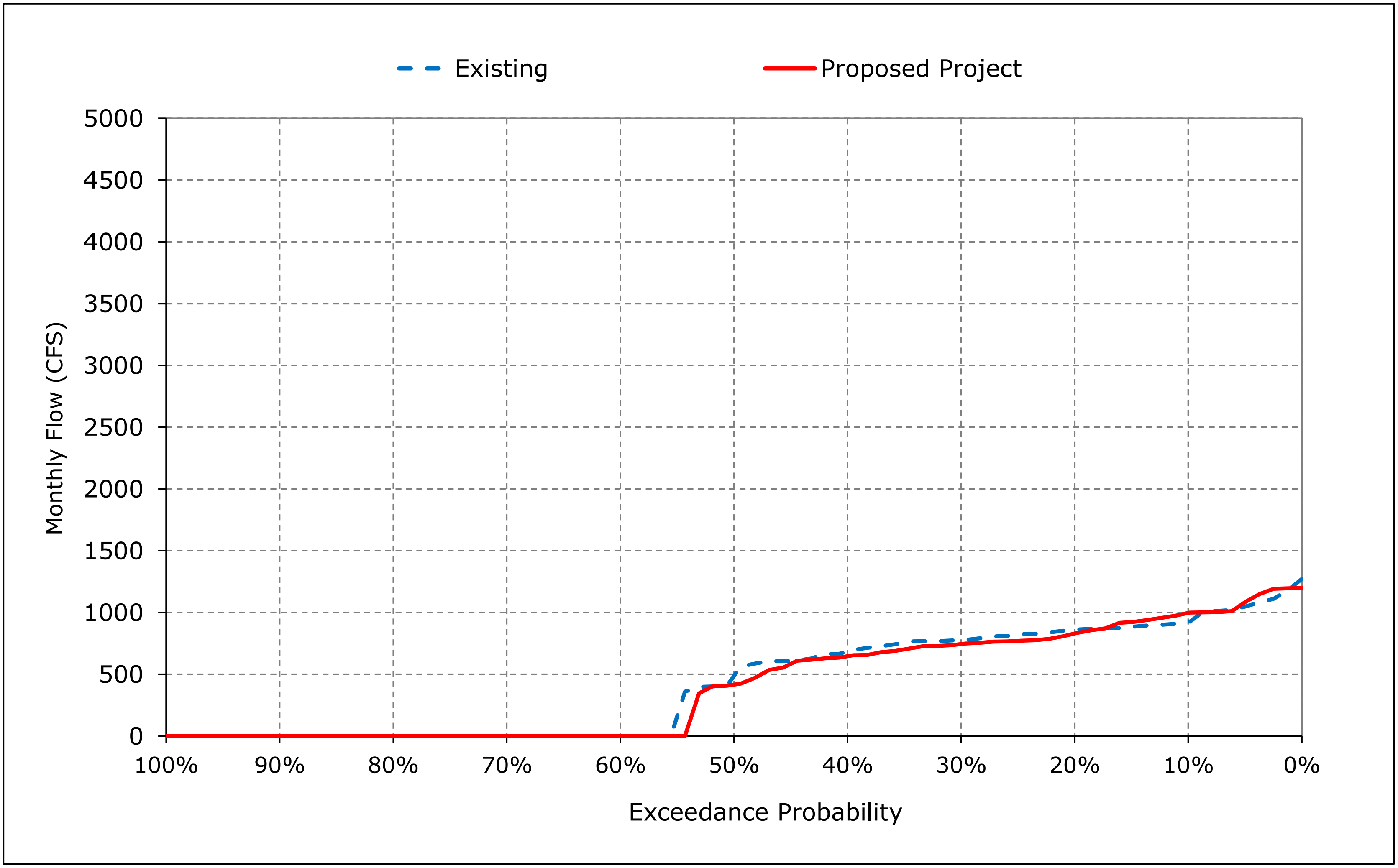


Figure 2-10. DCC Flow, January

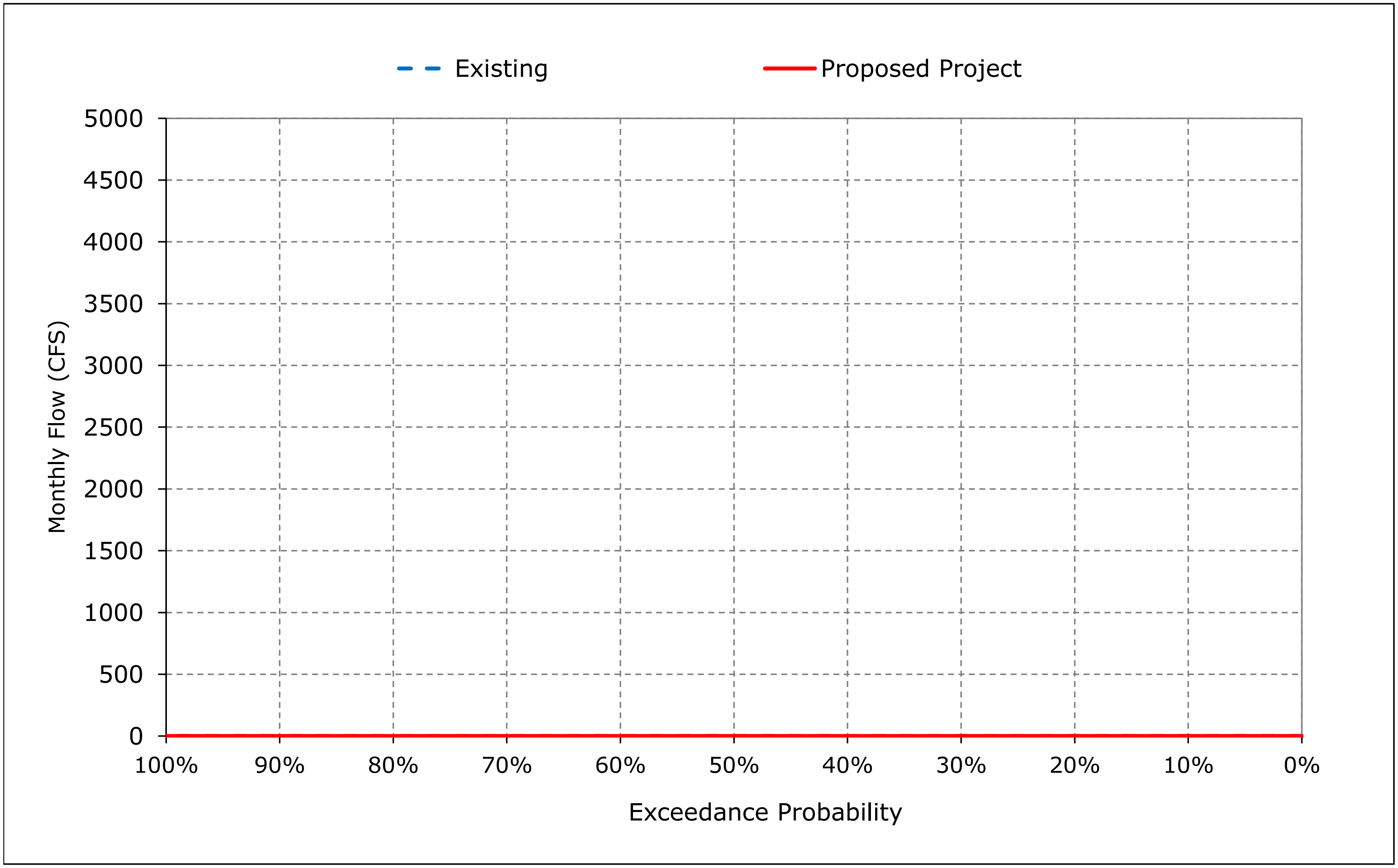


Figure 2-11. DCC Flow, February

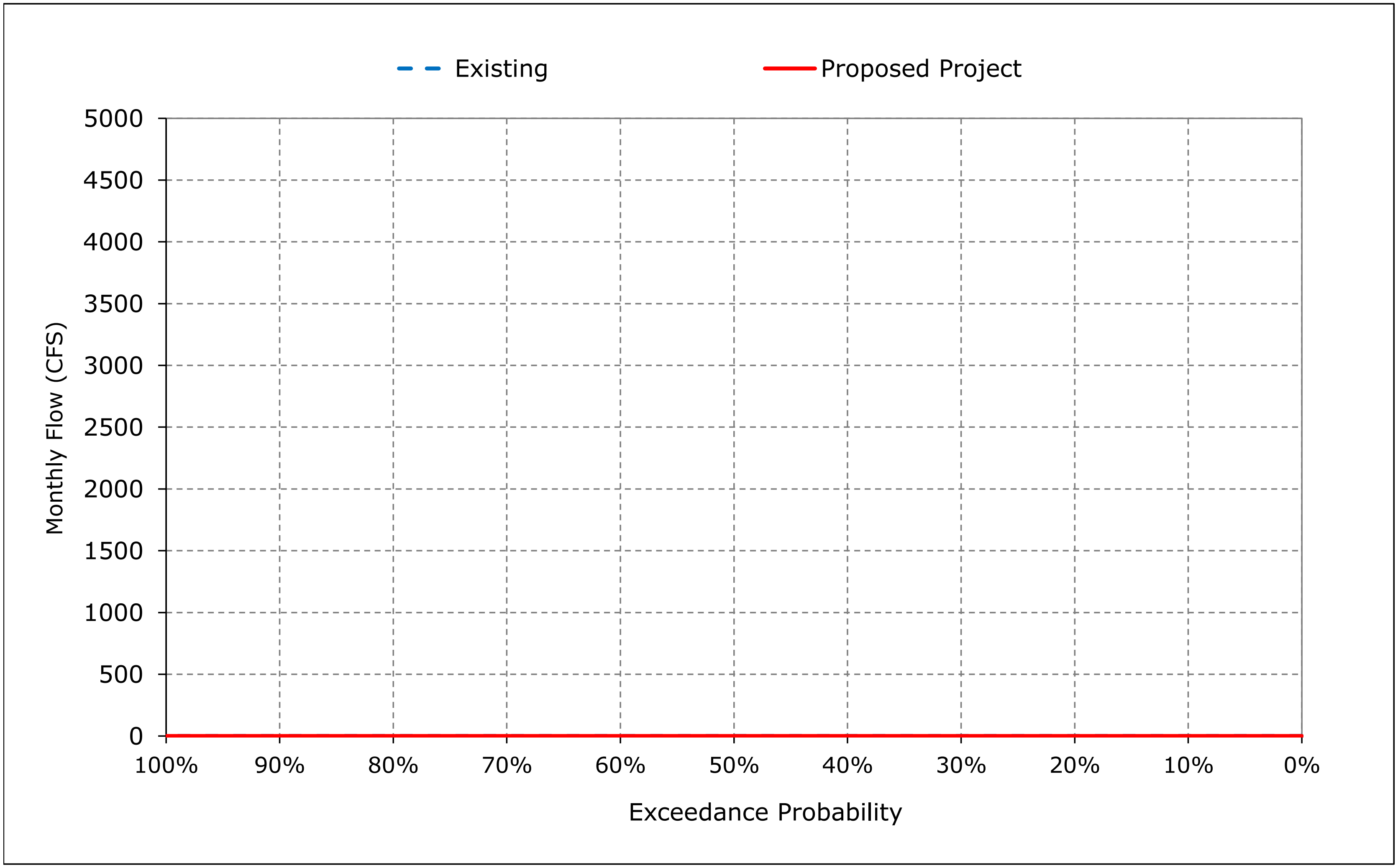


Figure 2-12. DCC Flow, March

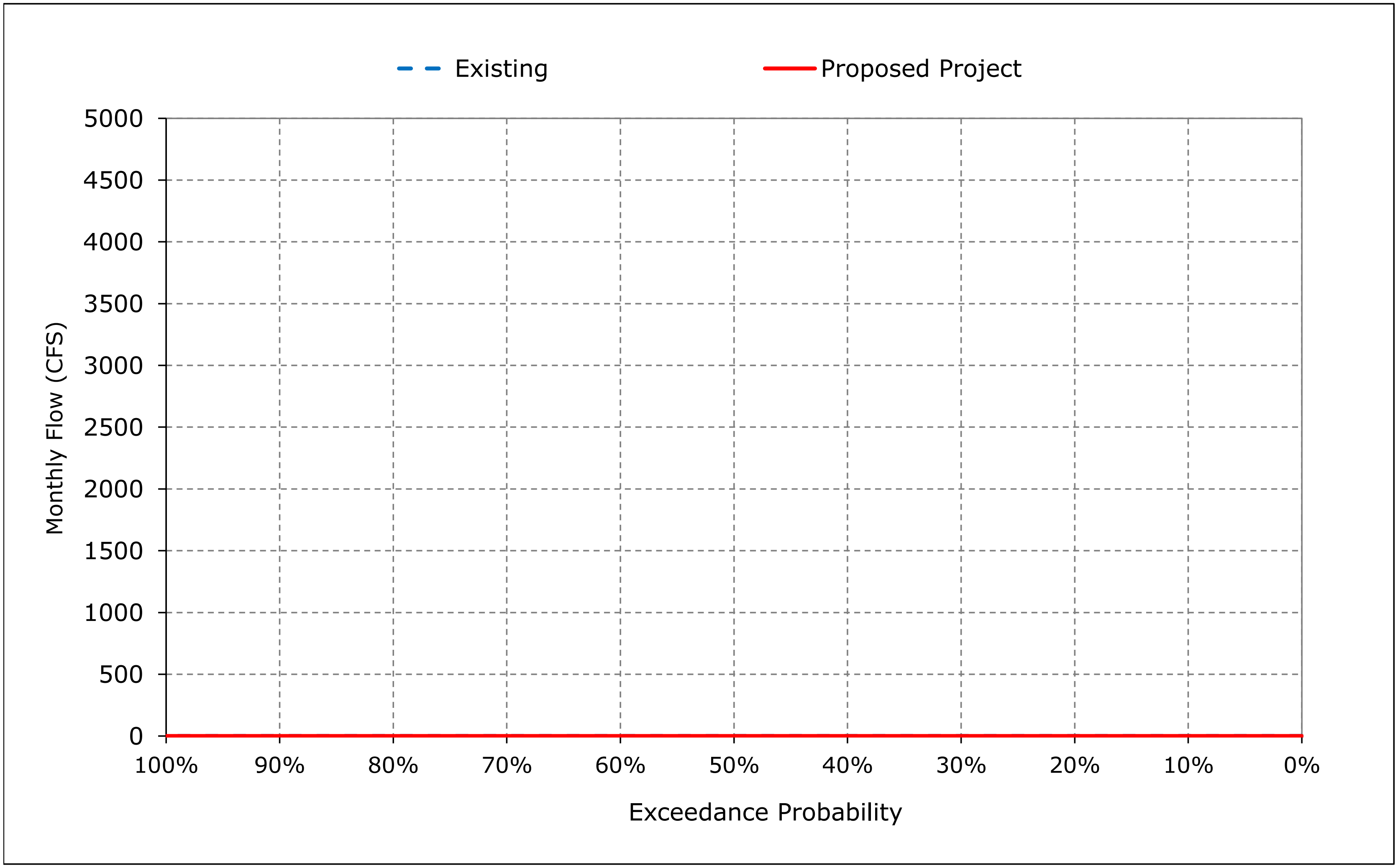


Figure 2-13. DCC Flow, April

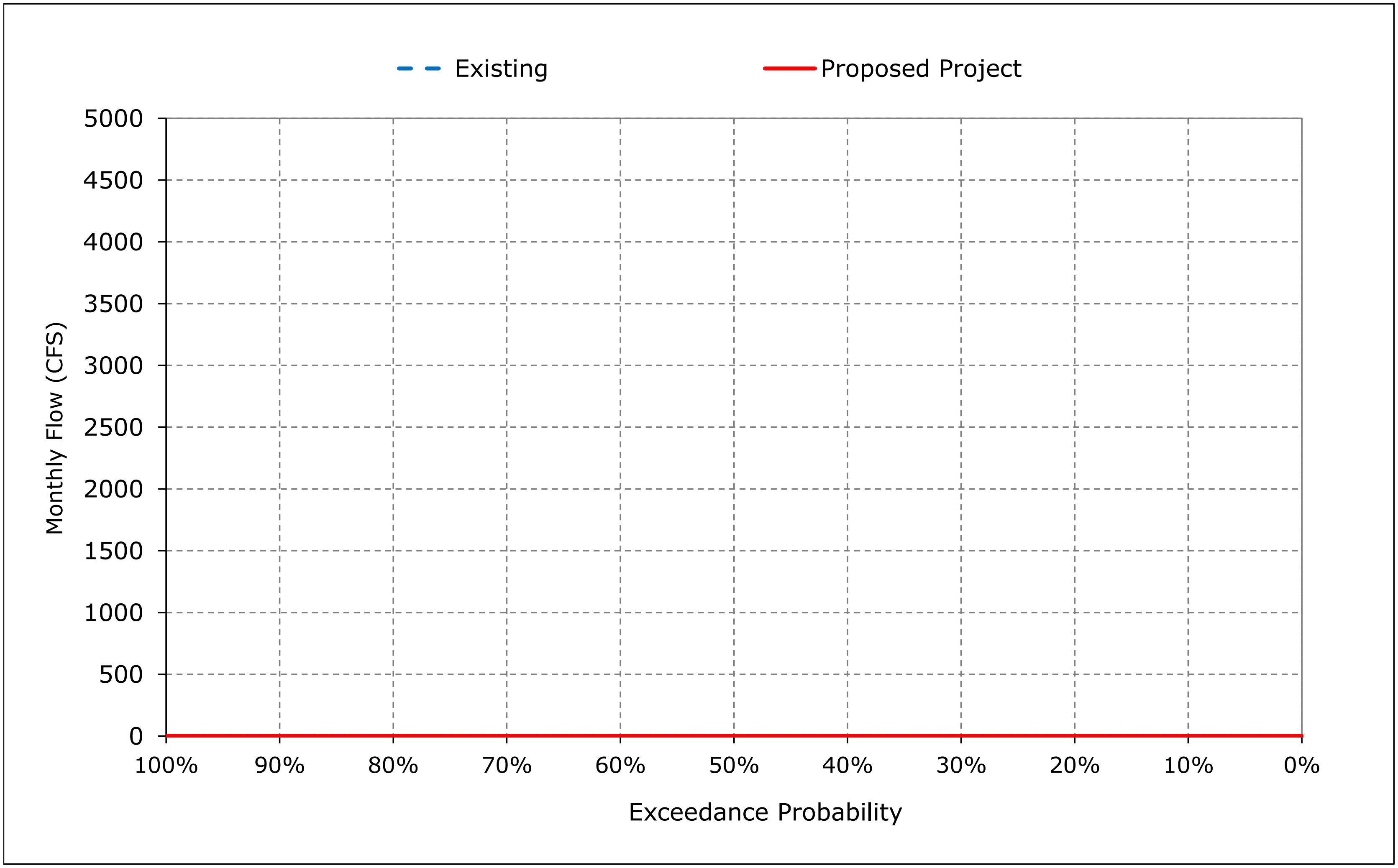


Figure 2-14. DCC Flow, May

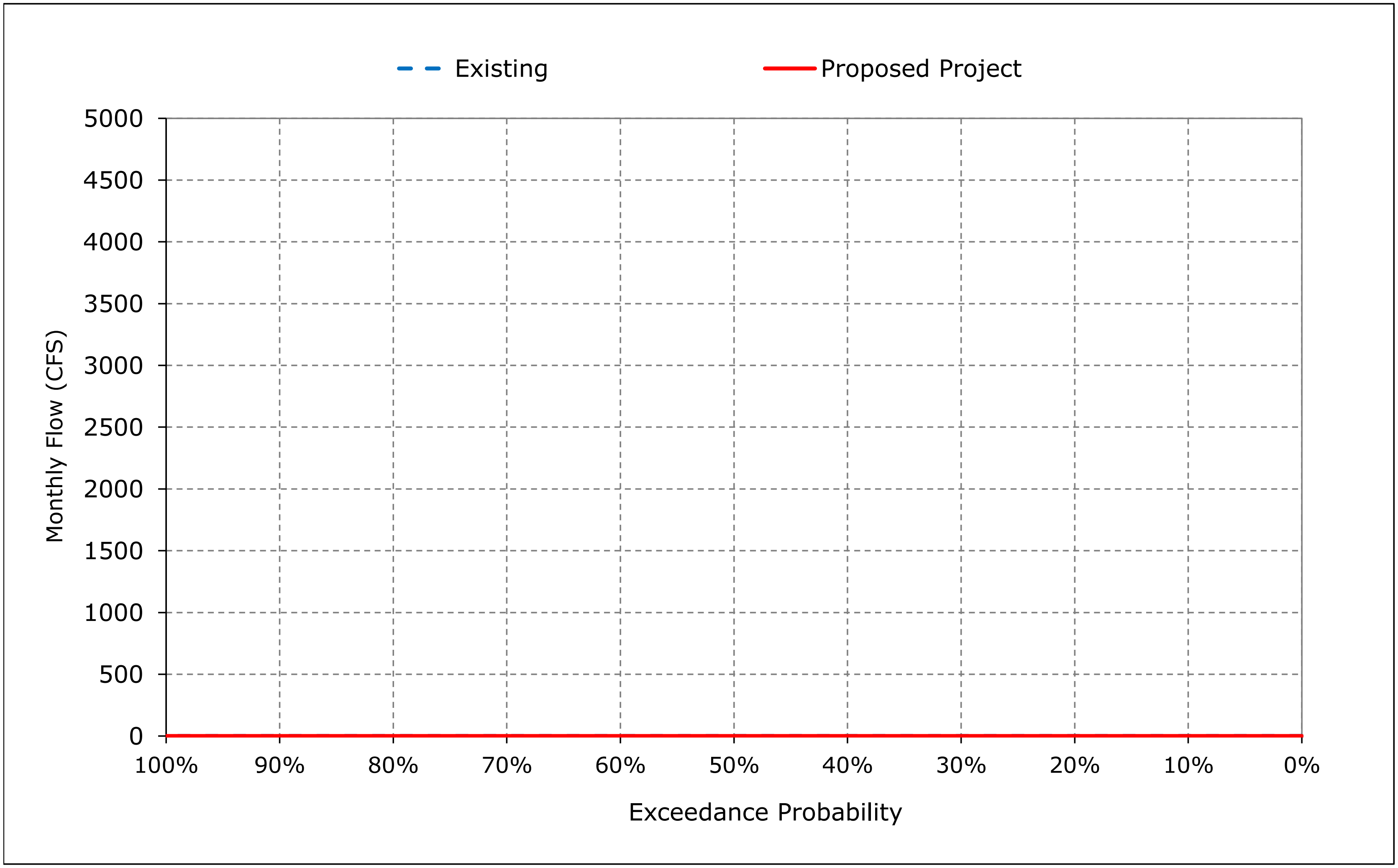


Figure 2-15. DCC Flow, June

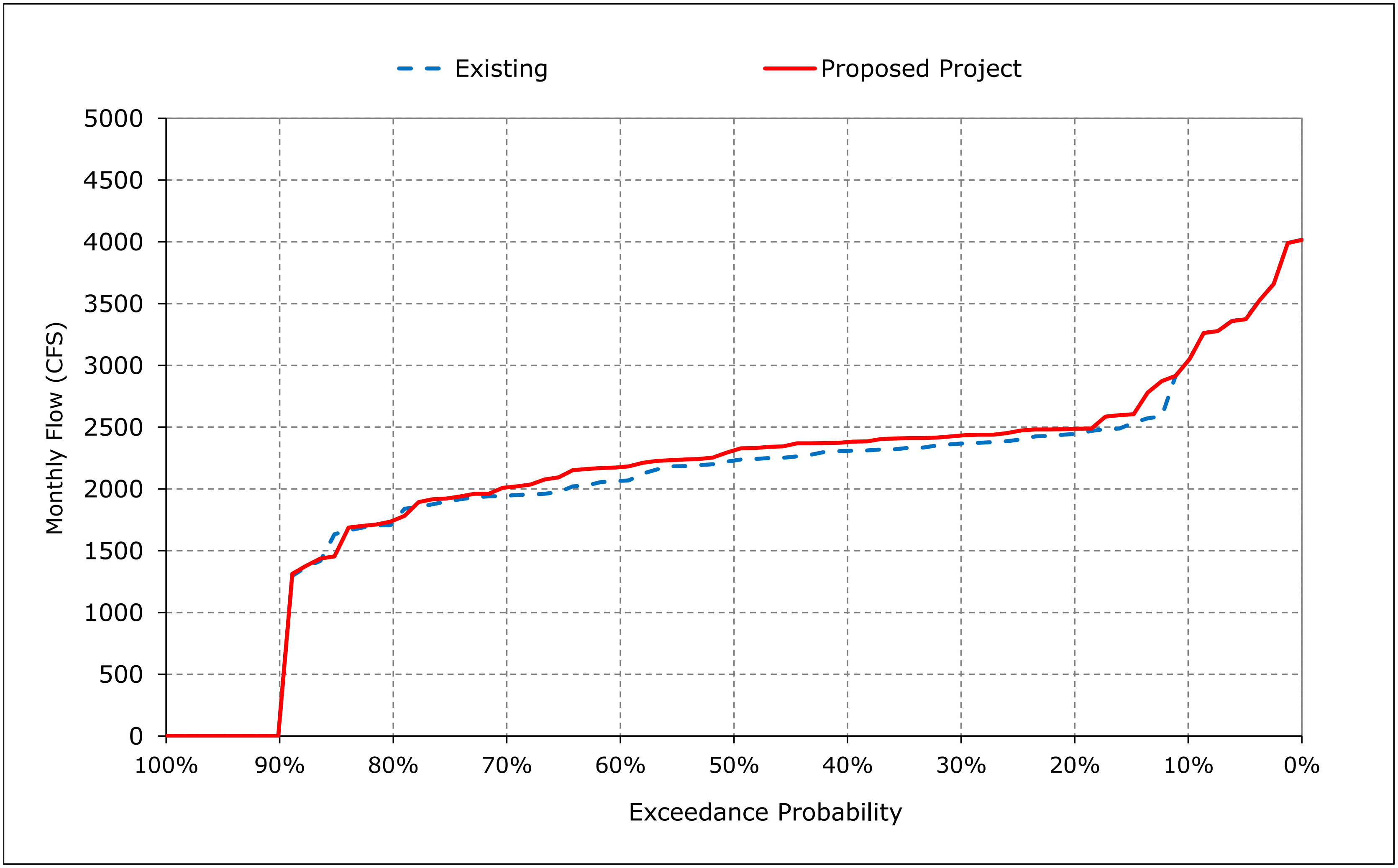


Figure 2-16. DCC Flow, July

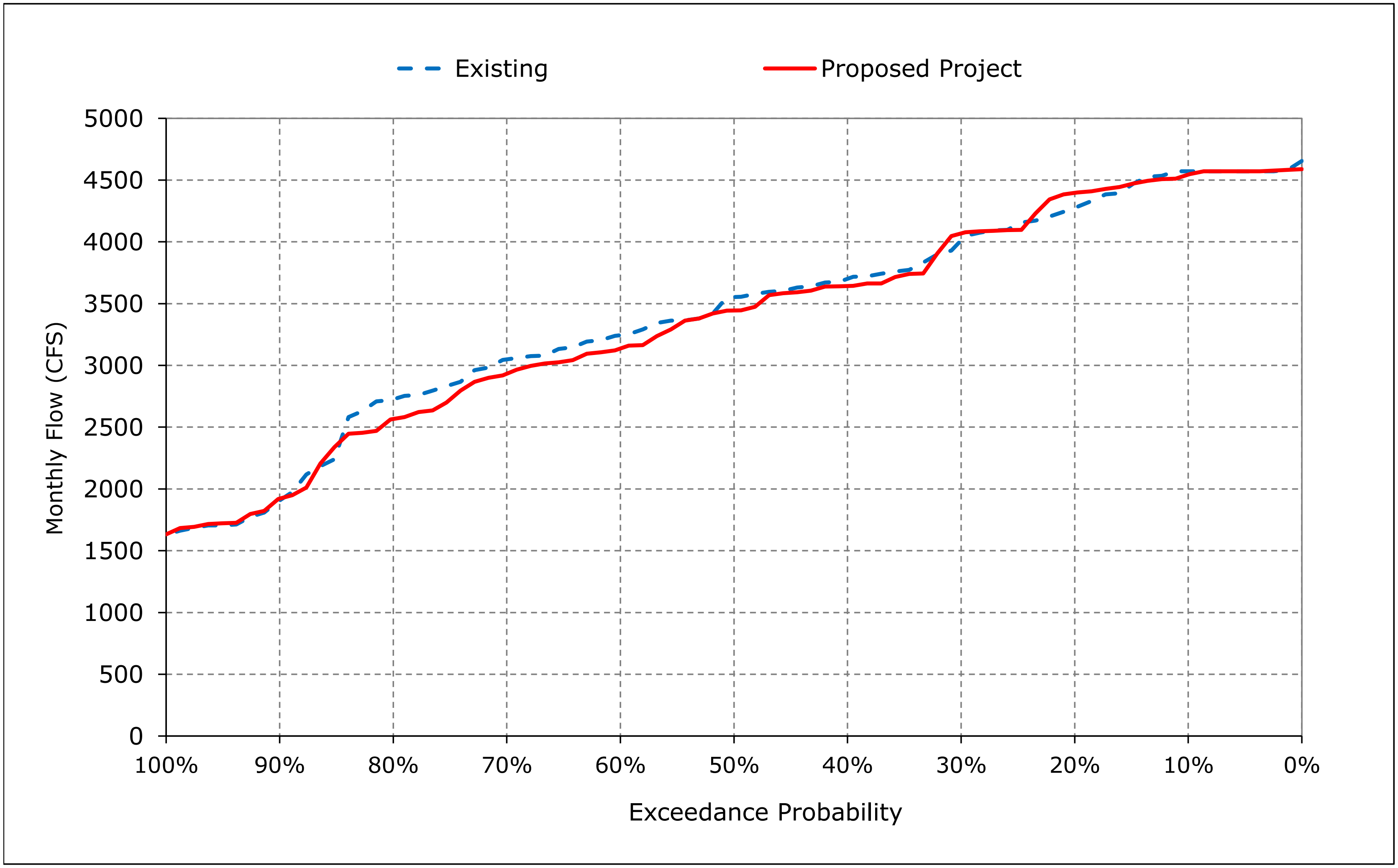


Figure 2-17. DCC Flow, August

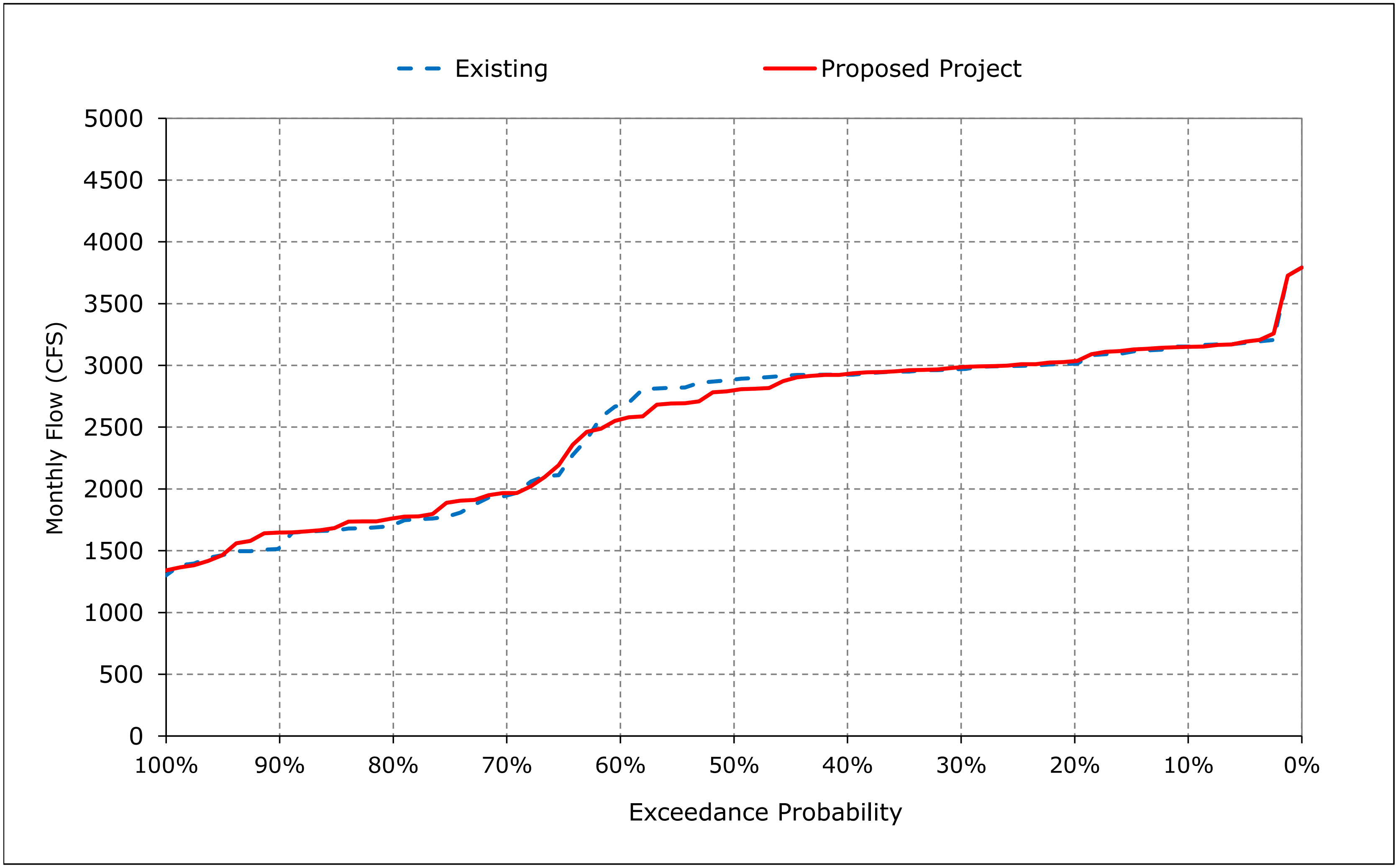


Figure 2-18. DCC Flow, September

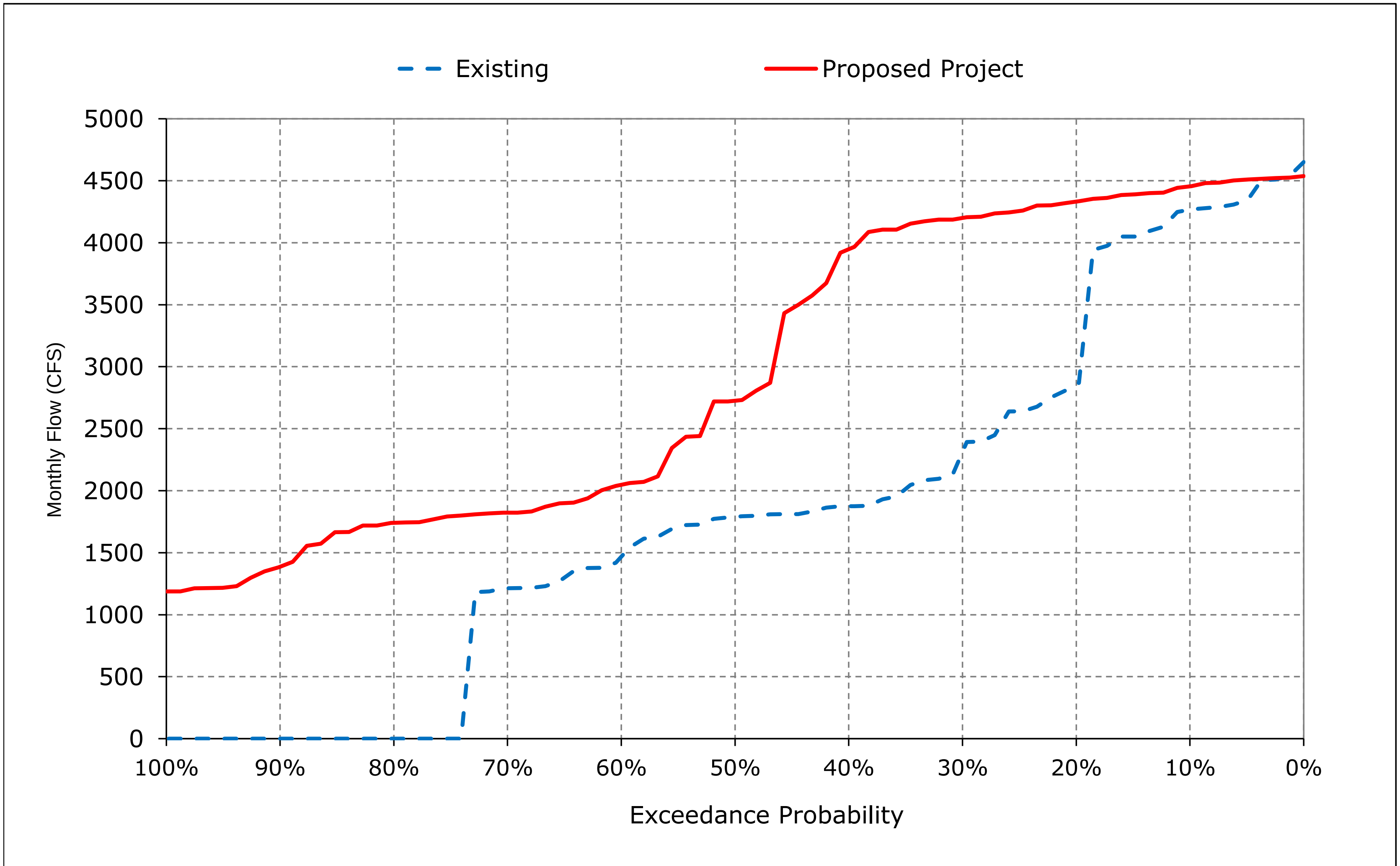


Table 3-1. Total Delta Exports, Monthly Delivery

Existing

Statistic	Monthly Delivery (CFS)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	9,505	11,280	11,672	10,061	12,003	10,316	3,006	2,765	8,910	11,483	11,629	11,280
20%	8,355	10,656	11,620	8,032	9,639	9,196	2,231	1,956	6,968	11,338	11,569	11,280
30%	7,633	8,681	10,027	7,159	8,359	8,719	1,970	1,698	5,734	11,280	11,363	11,206
40%	7,193	7,557	8,942	6,890	7,752	7,282	1,790	1,514	5,587	11,140	11,280	11,115
50%	6,672	7,183	8,016	6,749	7,108	6,587	1,625	1,500	5,319	10,475	10,858	10,419
60%	5,945	6,628	7,390	6,549	6,703	6,104	1,500	1,500	5,053	9,917	10,057	8,592
70%	5,628	6,008	7,197	6,453	6,576	5,823	1,500	1,500	4,907	8,976	5,344	7,062
80%	5,093	4,950	6,685	6,180	6,419	5,545	1,500	1,500	4,670	7,186	4,136	6,579
90%	4,332	4,216	5,939	5,204	6,063	4,720	1,500	1,500	2,900	2,468	3,201	3,927
Long Term												
Full Simulation Period[a]	6,738	7,386	8,593	7,274	8,058	7,232	2,053	2,013	5,677	9,053	8,537	8,885
Water Year Types[b,c]												
Wet (32%)	7,370	8,515	8,705	8,773	9,741	9,395	2,791	2,861	7,690	11,211	11,501	11,092
Above Normal (15%)	6,560	7,164	9,463	7,134	8,319	7,873	1,765	1,639	6,253	10,328	11,350	11,102
Below Normal (17%)	6,739	7,696	8,931	6,680	8,176	7,197	1,651	1,580	5,366	10,518	10,293	9,805
Dry (22%)	6,572	7,130	8,672	6,573	6,552	5,843	1,813	1,621	4,684	8,247	4,413	6,754
Critical (15%)	5,790	5,184	6,966	5,907	6,271	4,027	1,570	1,644	2,592	2,603	3,439	4,011

Proposed Project

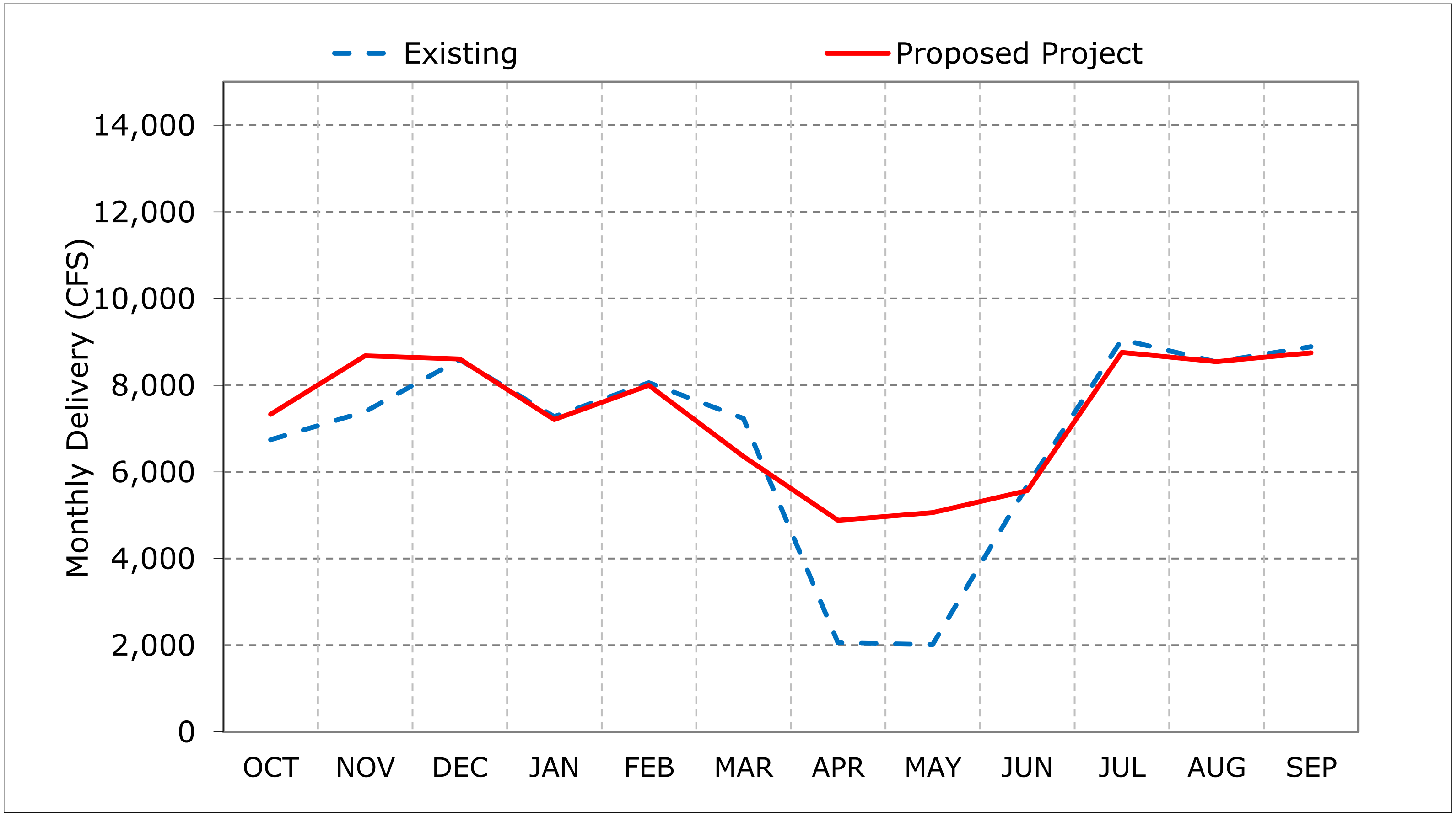
Statistic	Monthly Delivery (CFS)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	11,062	11,280	11,696	9,352	10,883	9,977	7,423	8,500	8,907	11,386	11,622	11,280
20%	9,229	11,280	11,627	8,004	9,226	7,874	6,315	7,417	6,925	11,280	11,531	11,280
30%	8,850	11,280	10,699	7,251	8,575	7,455	6,037	6,249	5,519	11,279	11,280	11,238
40%	8,362	10,980	9,039	7,093	7,875	6,172	5,542	5,686	5,372	10,675	11,258	10,925
50%	7,932	9,343	7,982	6,904	7,244	5,683	4,929	5,029	5,156	10,221	10,712	9,768
60%	6,427	8,271	7,347	6,738	6,737	5,348	4,347	4,211	5,019	9,560	8,870	8,316
70%	5,644	6,874	7,034	6,521	6,544	4,843	3,624	3,383	4,845	7,893	5,613	6,957
80%	5,100	5,798	6,634	6,108	6,294	4,611	2,923	2,762	4,603	6,037	4,632	6,434
90%	4,122	4,517	5,817	5,537	6,068	4,403	2,382	2,112	2,730	2,416	3,333	4,055
Long Term												
Full Simulation Period[a]	7,327	8,681	8,605	7,207	7,996	6,357	4,881	5,058	5,568	8,757	8,543	8,748
Water Year Types[b,c]												
Wet (32%)	8,188	10,049	8,678	8,346	9,476	8,453	6,606	7,027	7,588	11,047	11,441	10,828
Above Normal (15%)	7,437	8,489	9,515	7,195	8,096	6,752	5,702	5,966	6,162	10,504	11,280	10,886
Below Normal (17%)	7,418	9,123	8,898	6,824	8,279	5,951	4,931	5,258	5,259	9,684	9,981	9,618
Dry (22%)	6,973	7,871	8,962	6,761	6,745	4,824	3,643	3,495	4,560	7,520	4,532	6,702
Critical (15%)	5,777	6,609	6,660	5,868	6,236	4,191	2,121	1,996	2,472	2,823	3,869	4,156

Proposed Project minus Existing

Statistic	Monthly Delivery (CFS)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	1,556	0	24	**-708**	**-1,120**	**-339**	4,417	5,735	**-3**	**-97**	**-8**	0
20%	874	624	7	**-28**	**-413**	**-1,321**	4,084	5,461	**-43**	**-58**	**-38**	0
30%	1,217	2,599	671	92	216	**-1,264**	4,067	4,551	**-215**	**-1**	**-83**	32
40%	1,169	3,423	97	203	122	**-1,111**	3,752	4,172	**-216**	**-465**	**-22**	**-190**
50%	1,260	2,161	**-35**	155	136	**-904**	3,305	3,529	**-162**	**-255**	**-146**	**-652**
60%	482	1,643	**-43**	189	34	**-756**	2,847	2,711	**-33**	**-357**	**-1,187**	**-276**
70%	15	866	**-163**	69	**-32**	**-979**	2,124	1,883	**-62**	**-1,083**	269	**-105**
80%	7	848	**-51**	**-72**	**-125**	**-934**	1,423	1,262	**-67**	**-1,149**	495	**-145**
90%	**-210**	301	**-122**	333	5	**-317**	882	612	**-170**	**-52**	132	129
Long Term												
Full Simulation Period[a]	590	1,295	12	**-67**	**-62**	**-875**	2,828	3,045	**-109**	**-296**	6	**-138**
Water Year Types[b,c]												
Wet (32%)	818	1,534	**-27**	**-428**	**-265**	**-942**	3,815	4,166	**-102**	**-164**	**-60**	**-264**
Above Normal (15%)	876	1,325	53	61	**-222**	**-1,121**	3,937	4,327	**-91**	176	**-70**	**-217**
Below Normal (17%)	679	1,427	**-33**	144	103	**-1,246**	3,280	3,678	**-107**	**-834**	**-312**	**-186**
Dry (22%)	402	741	291	187	192	**-1,019**	1,830	1,874	**-125**	**-726**	118	**-52**
Critical (15%)	**-12**	1,425	**-307**	**-38**	**-34**	164	550	351	**-120**	220	430	145

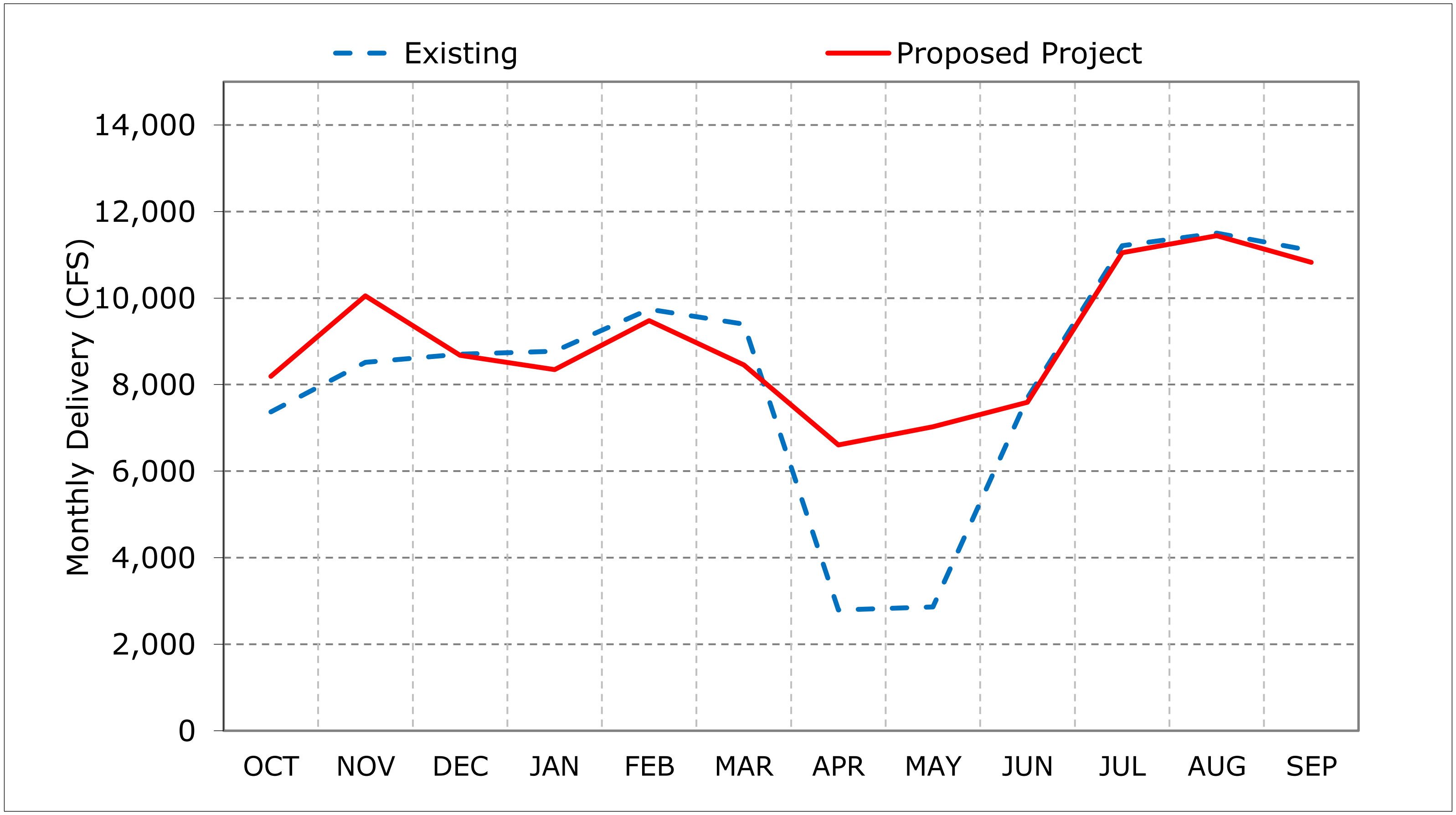
a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with water year - year type sorting.

Figure 3-1. Total Delta Exports, Long-Term Average Delivery



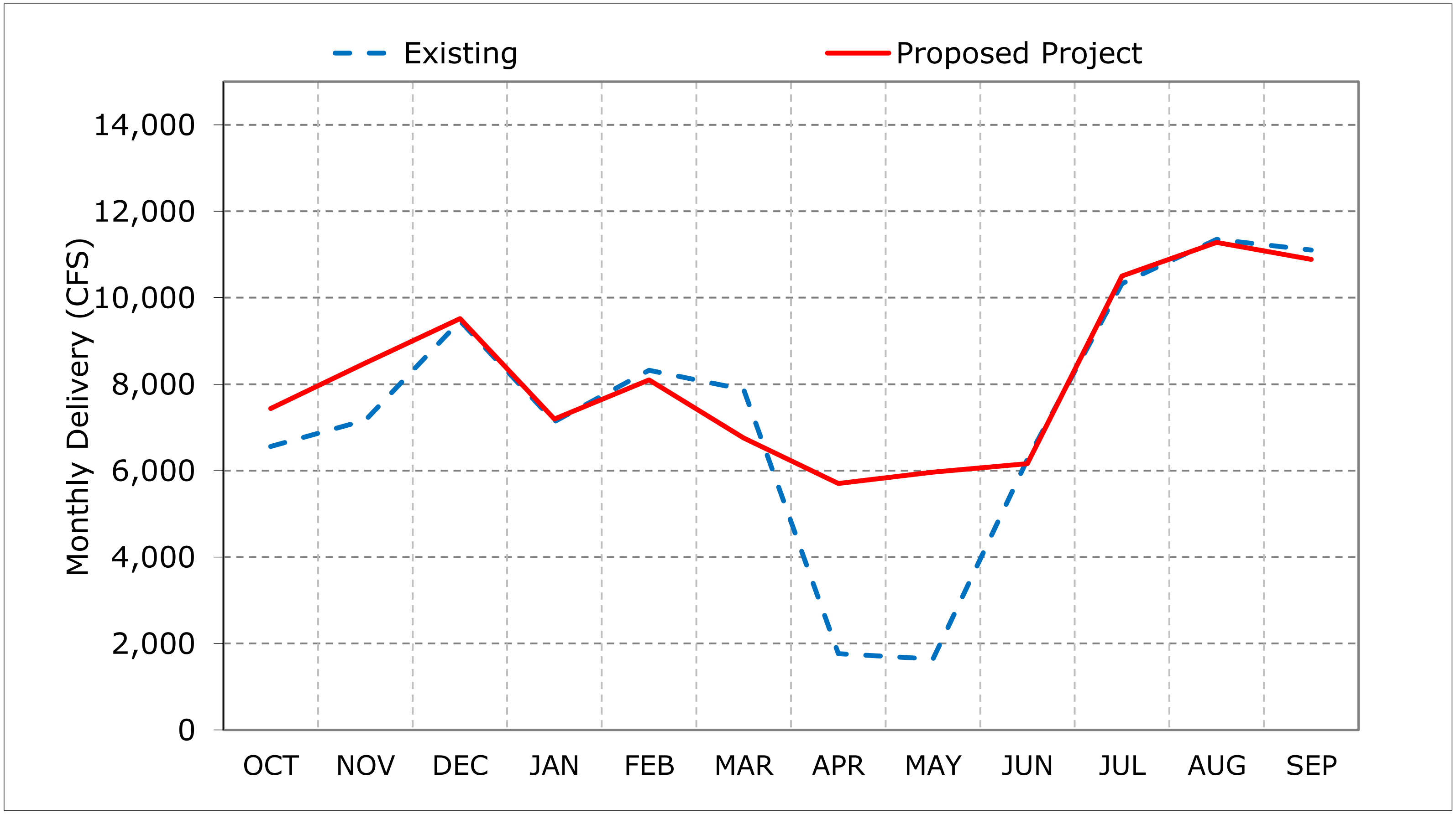
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 3-2. Total Delta Exports, Wet Year Average Delivery



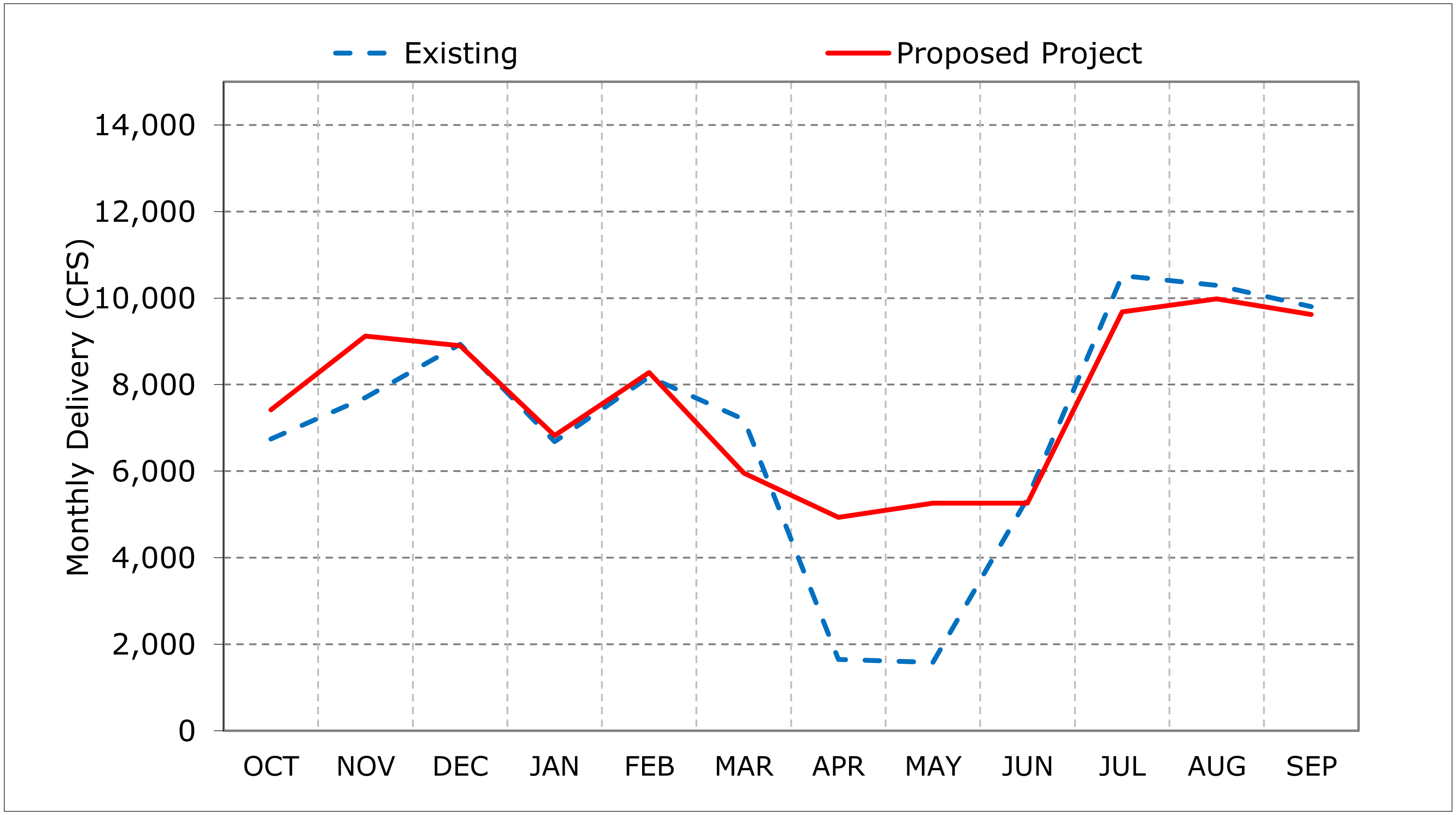
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 3-3. Total Delta Exports, Above Normal Year Average Delivery



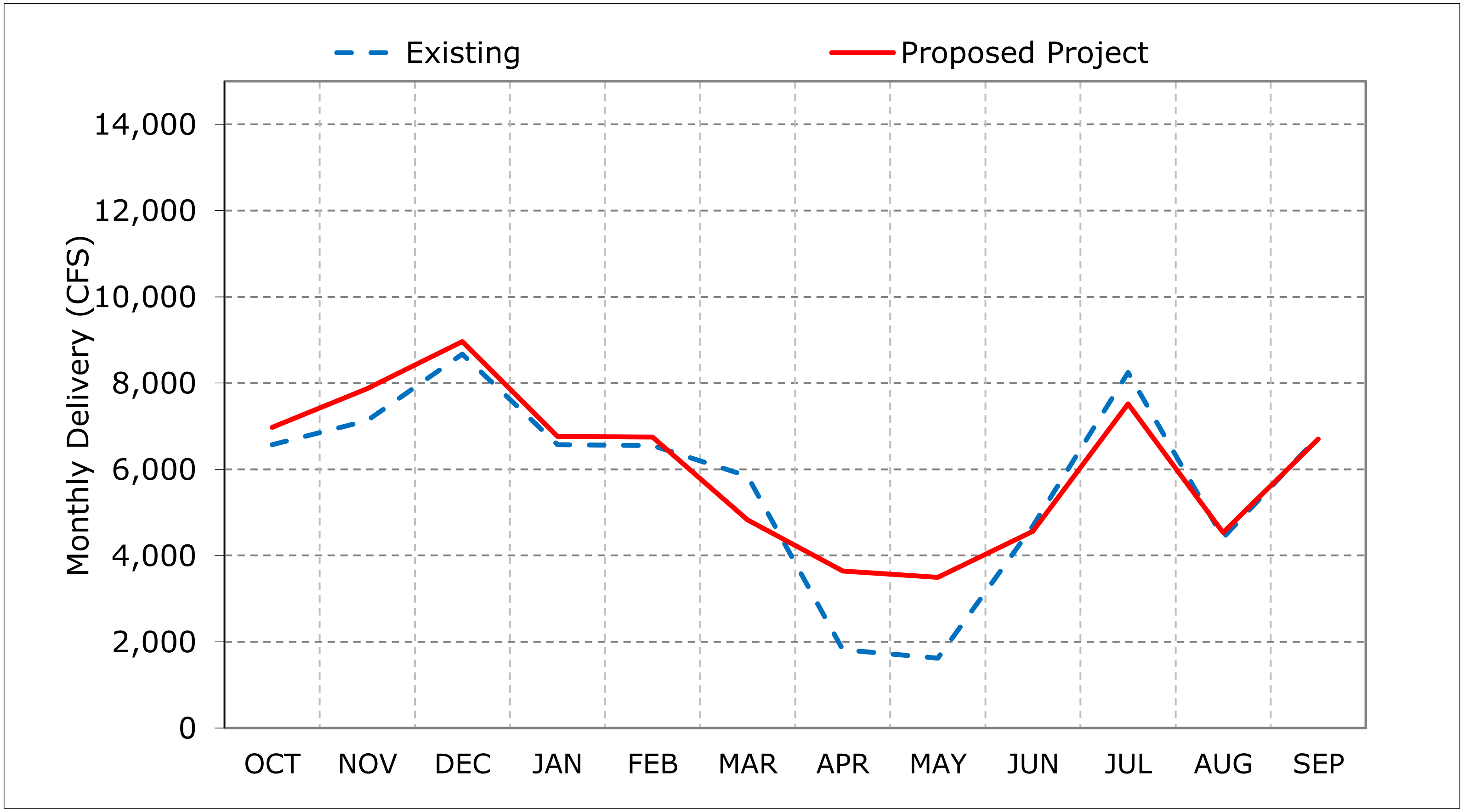
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 3-4. Total Delta Exports, Below Normal Year Average Delivery



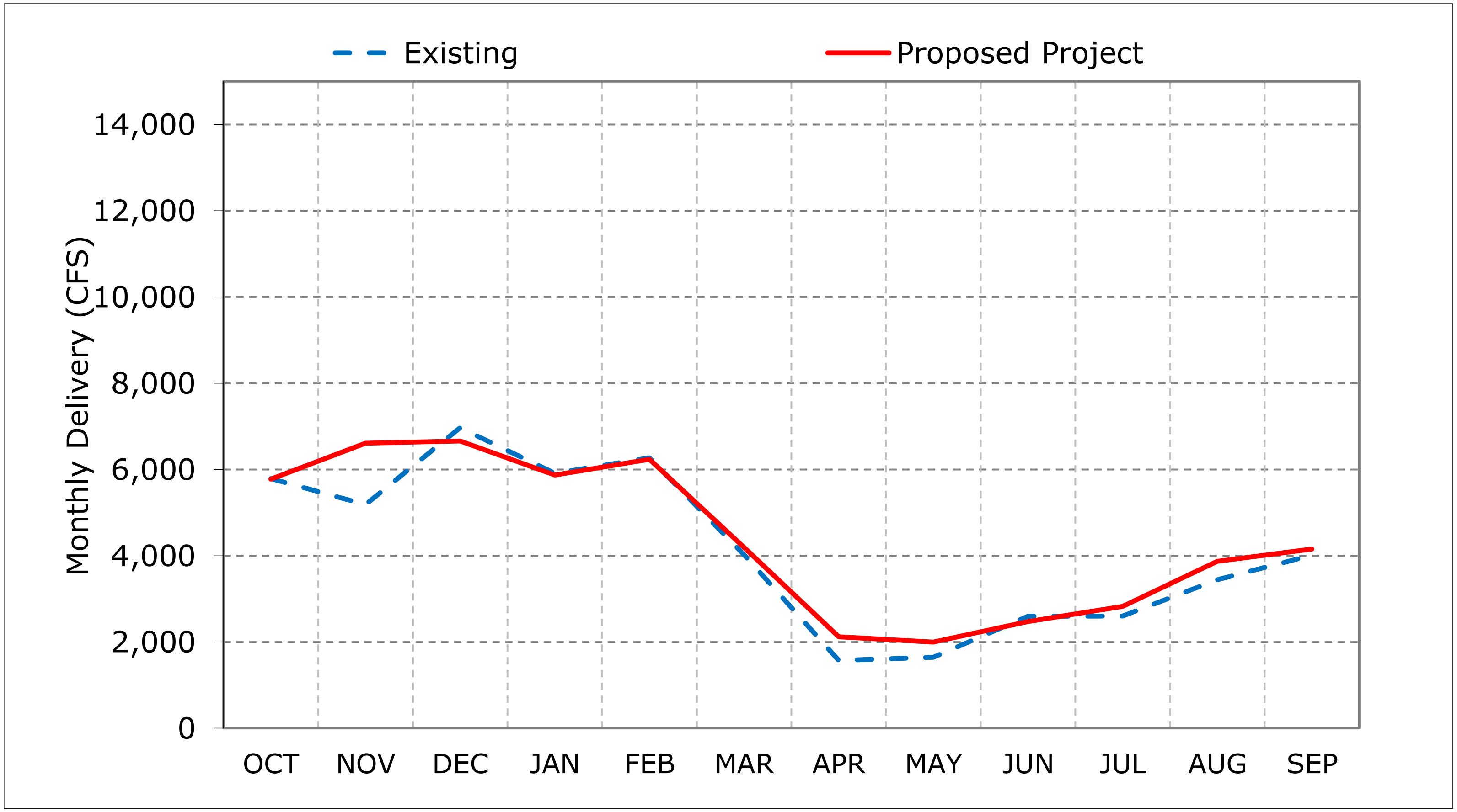
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 3-5. Total Delta Exports, Dry Year Average Delivery



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 3-6. Total Delta Exports, Critical Year Average Delivery



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 3-7. Total Delta Exports, October

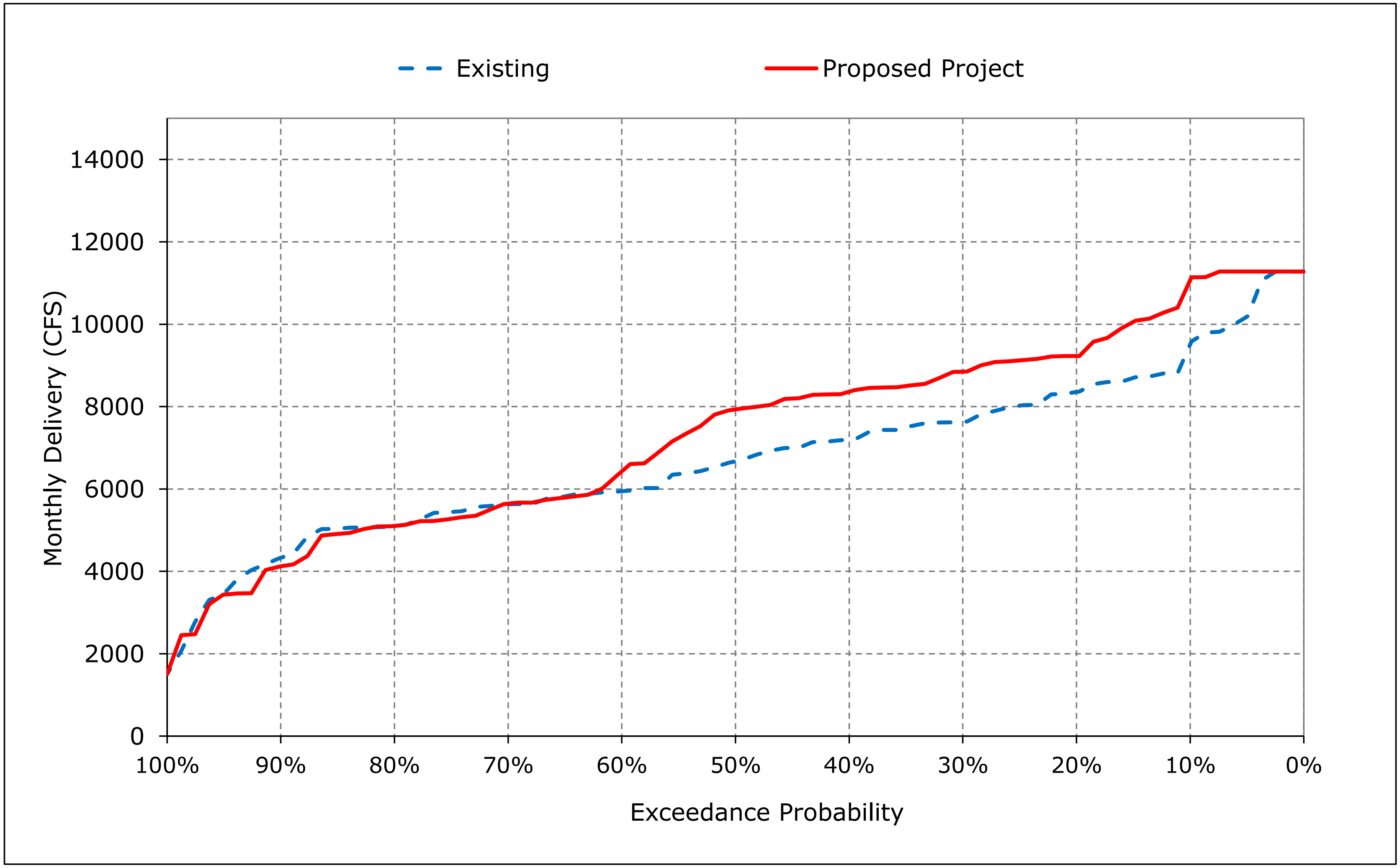


Figure 3-8. Total Delta Exports, November

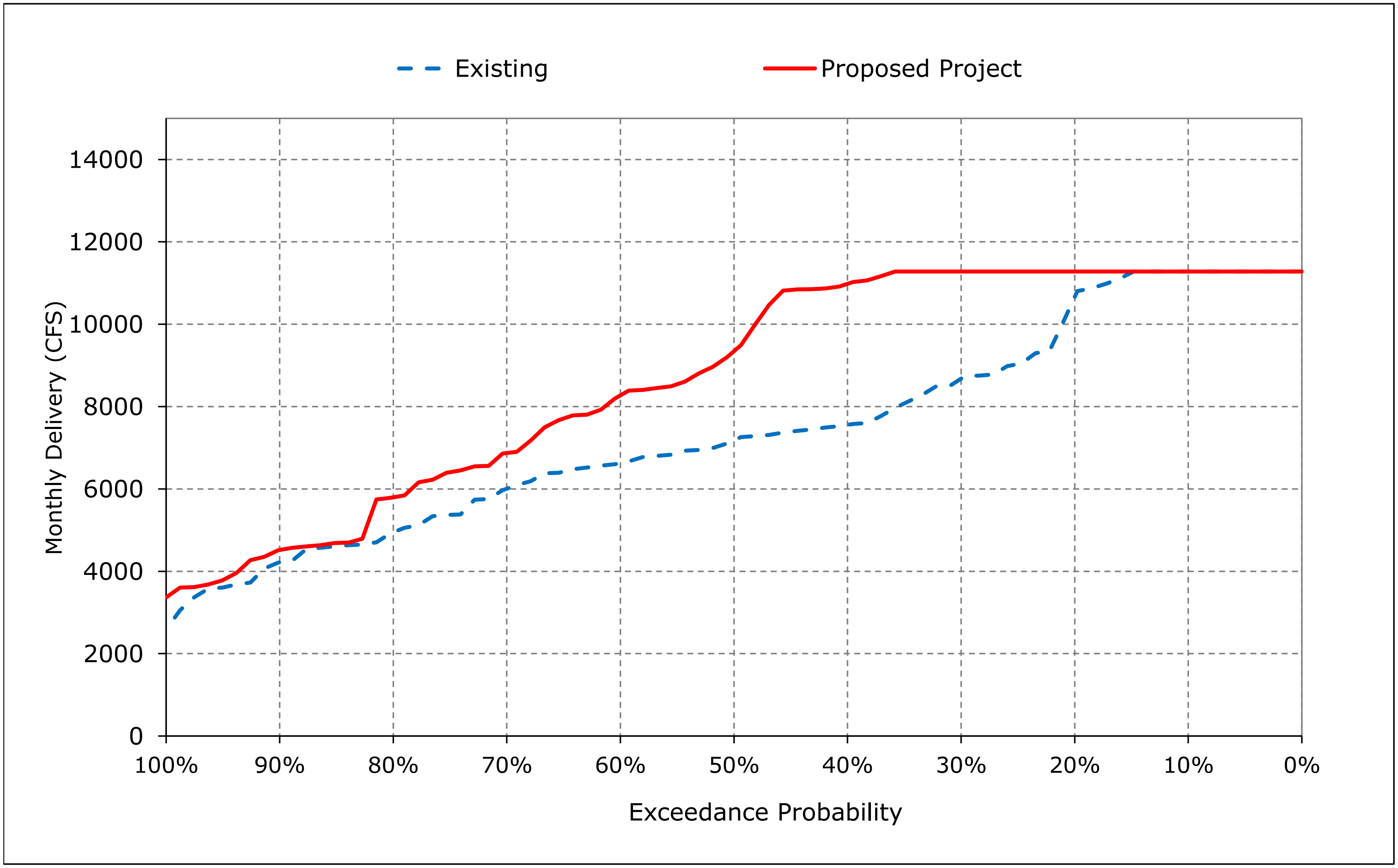


Figure 3-9. Total Delta Exports, December

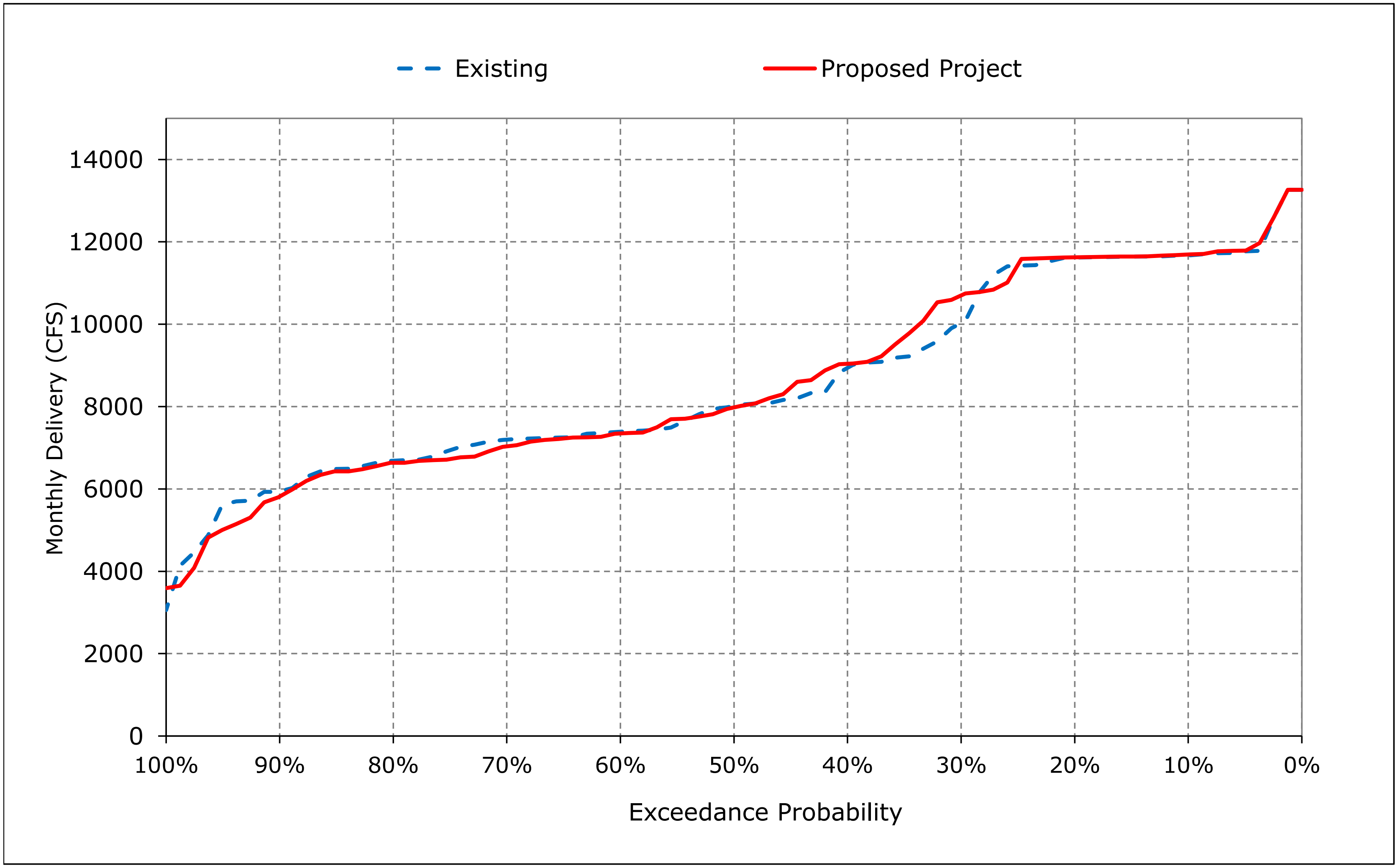


Figure 3-10. Total Delta Exports, January

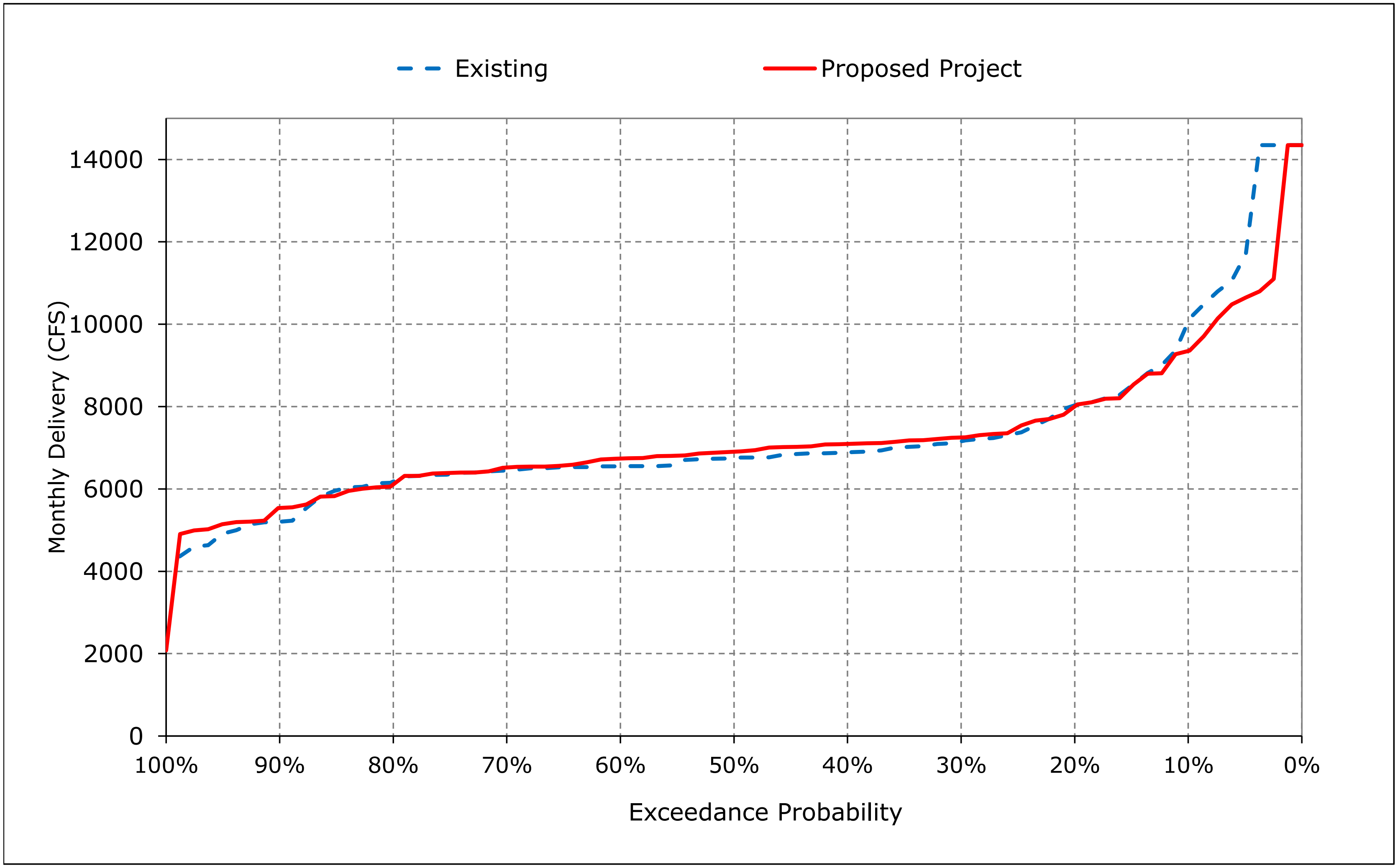


Figure 3-11. Total Delta Exports, February

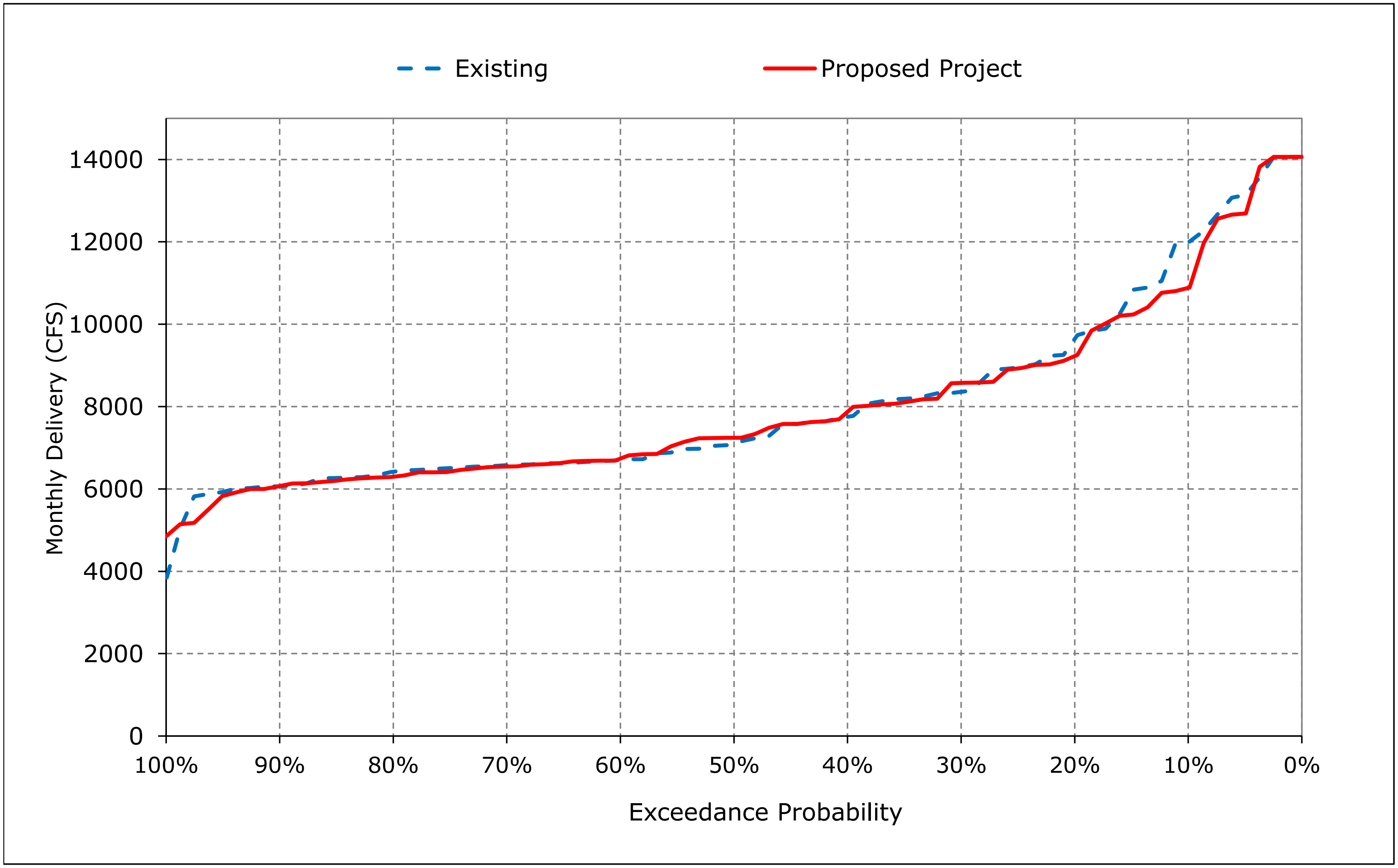


Figure 3-12. Total Delta Exports, March

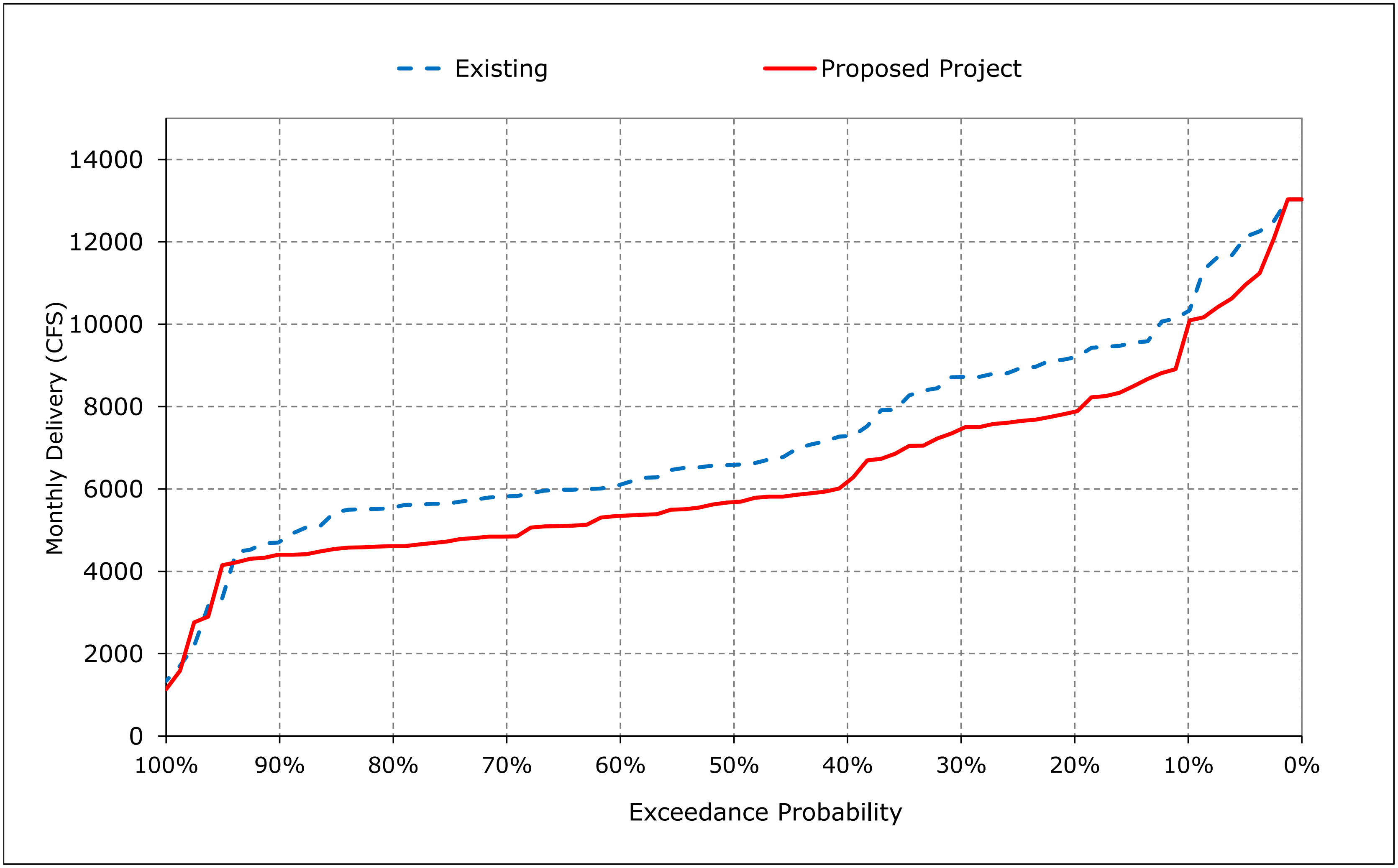


Figure 3-13. Total Delta Exports, April

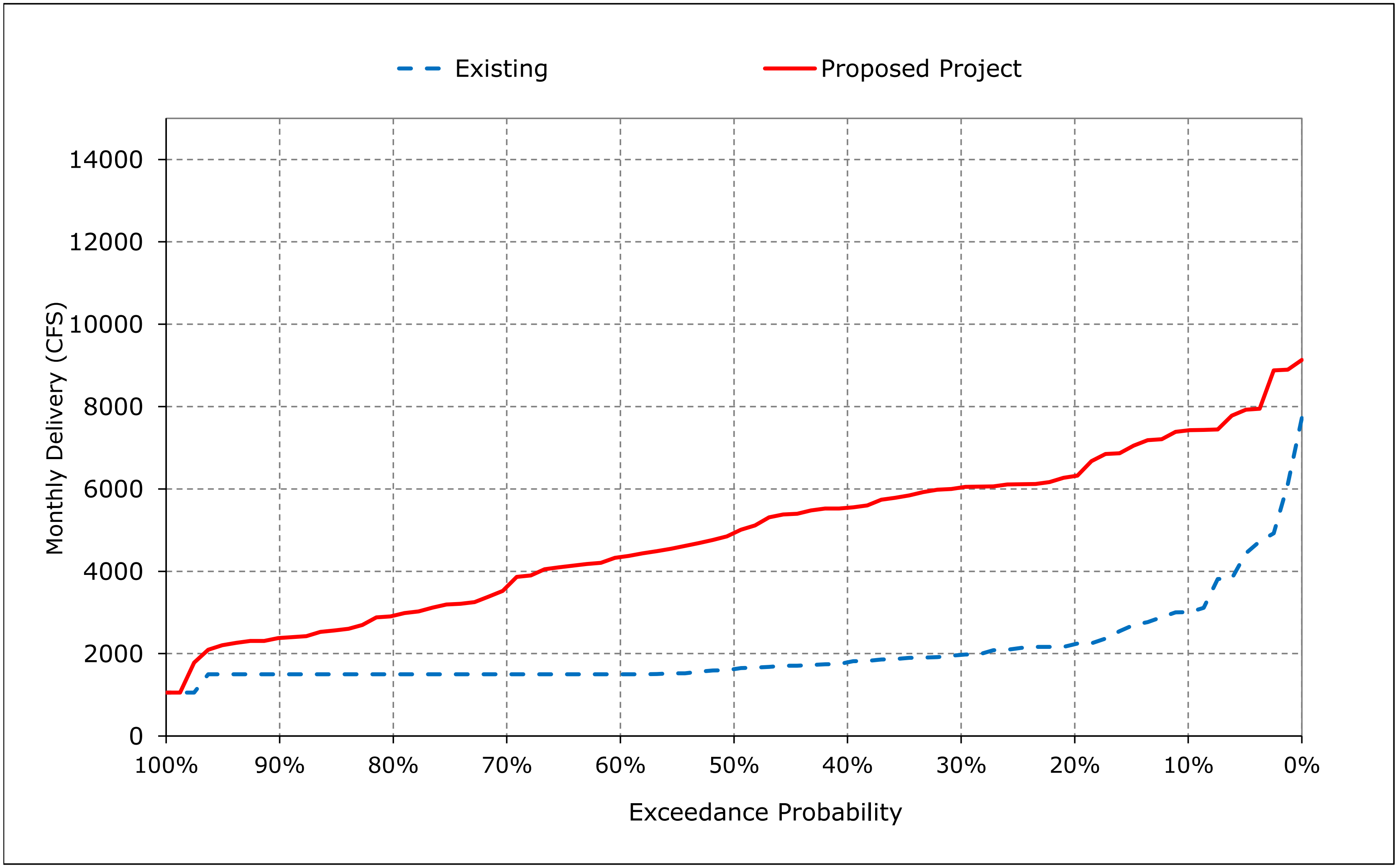


Figure 3-14. Total Delta Exports, May

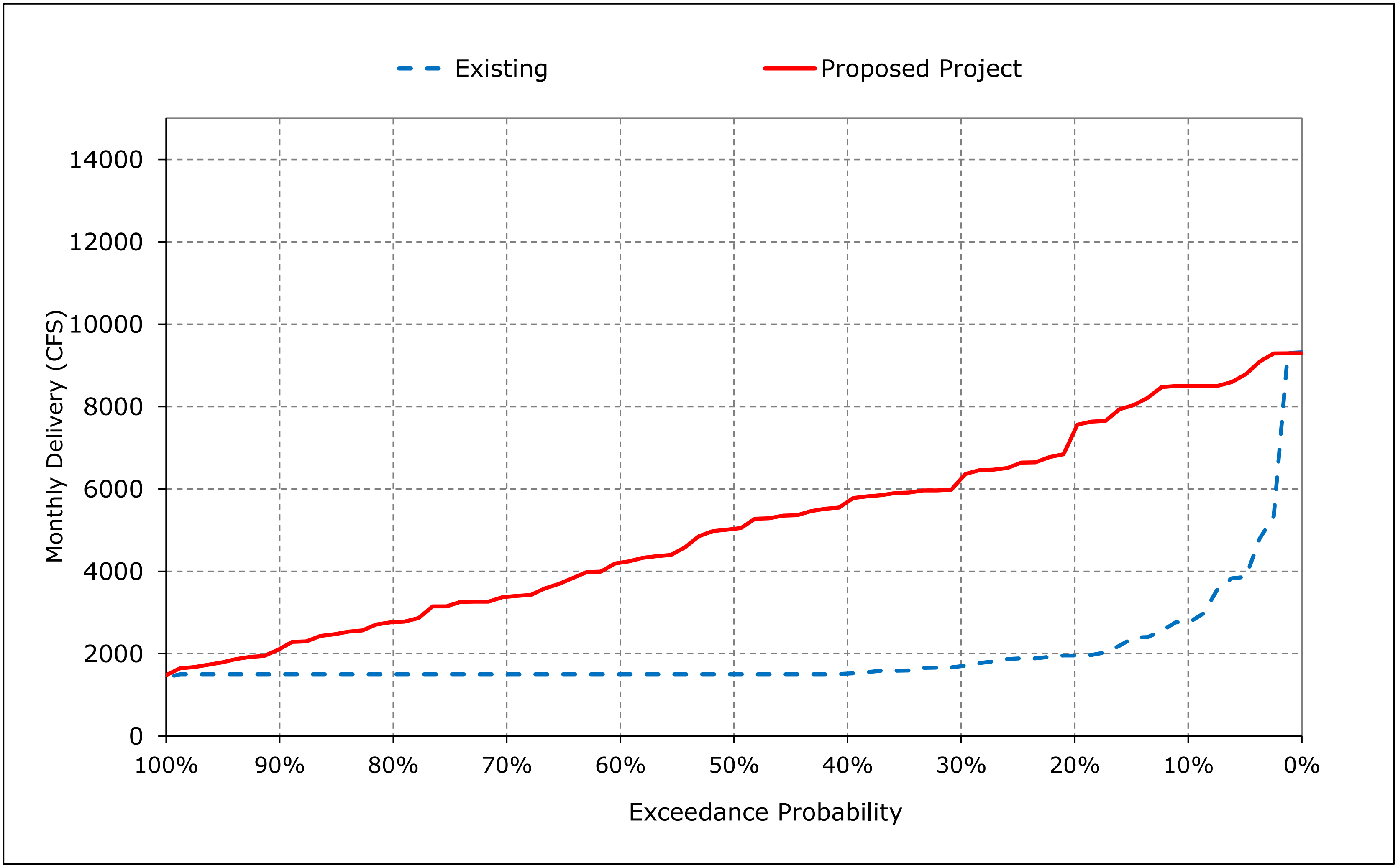


Figure 3-15. Total Delta Exports, June

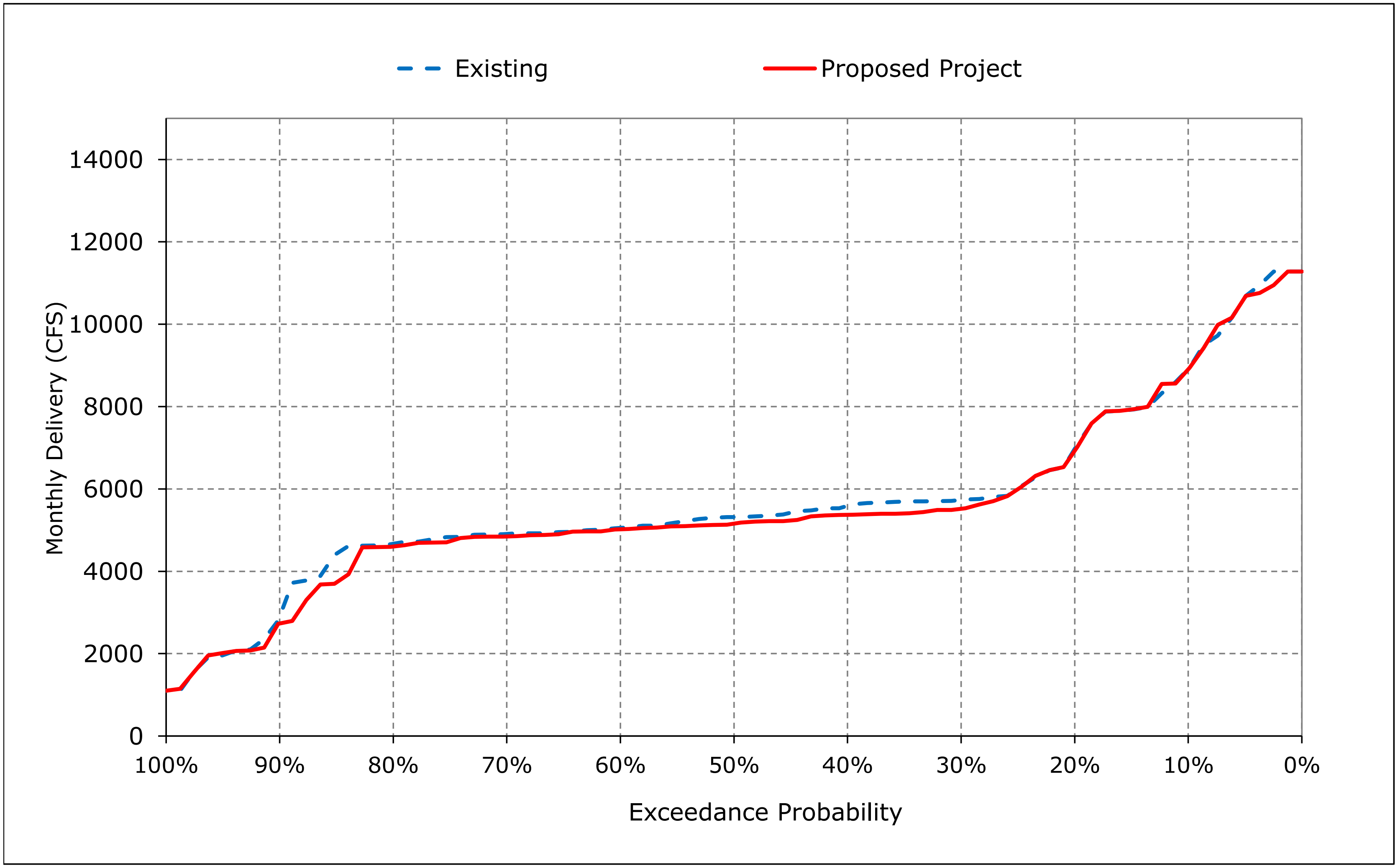


Figure 3-16. Total Delta Exports, July

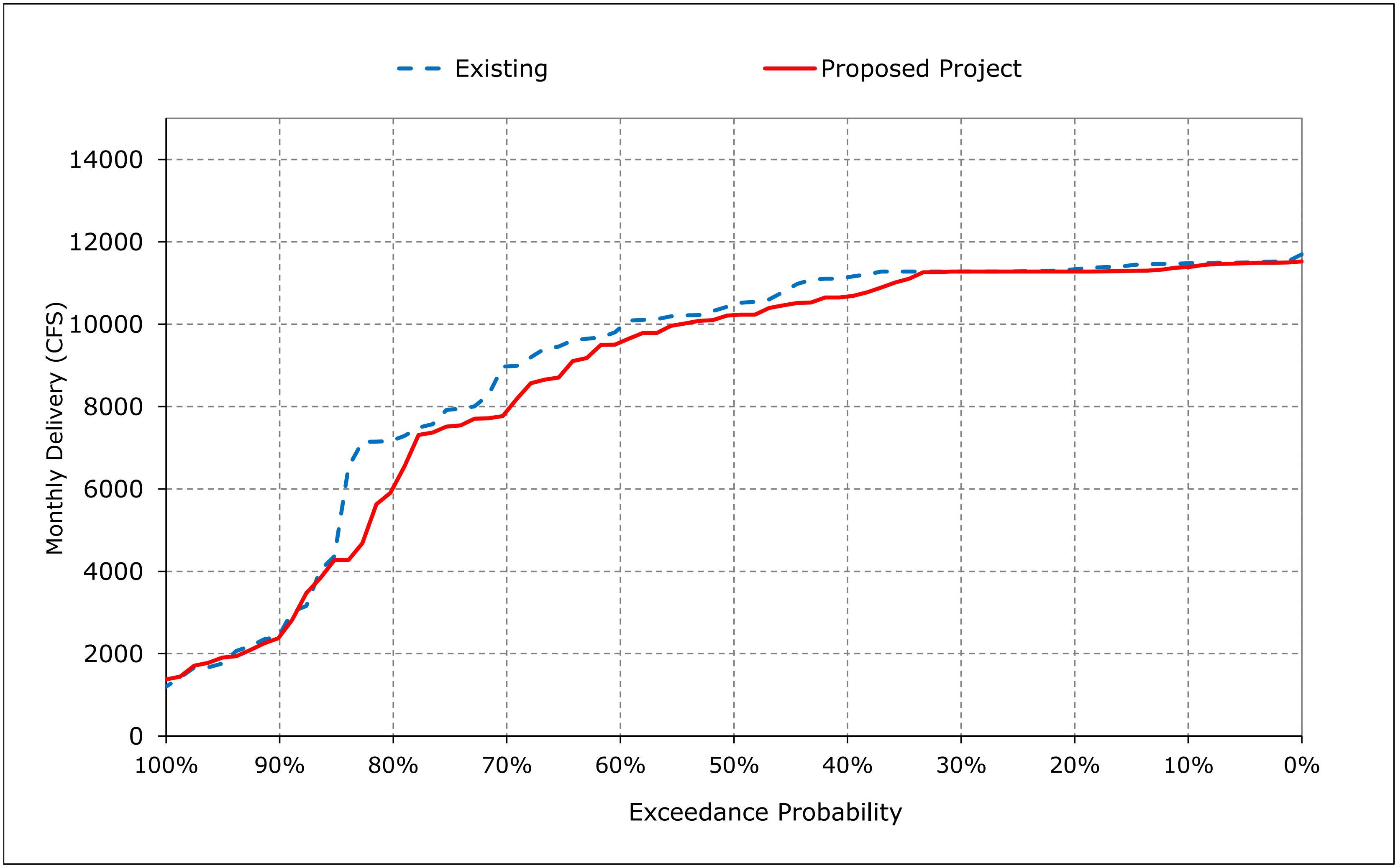


Figure 3-17. Total Delta Exports, August

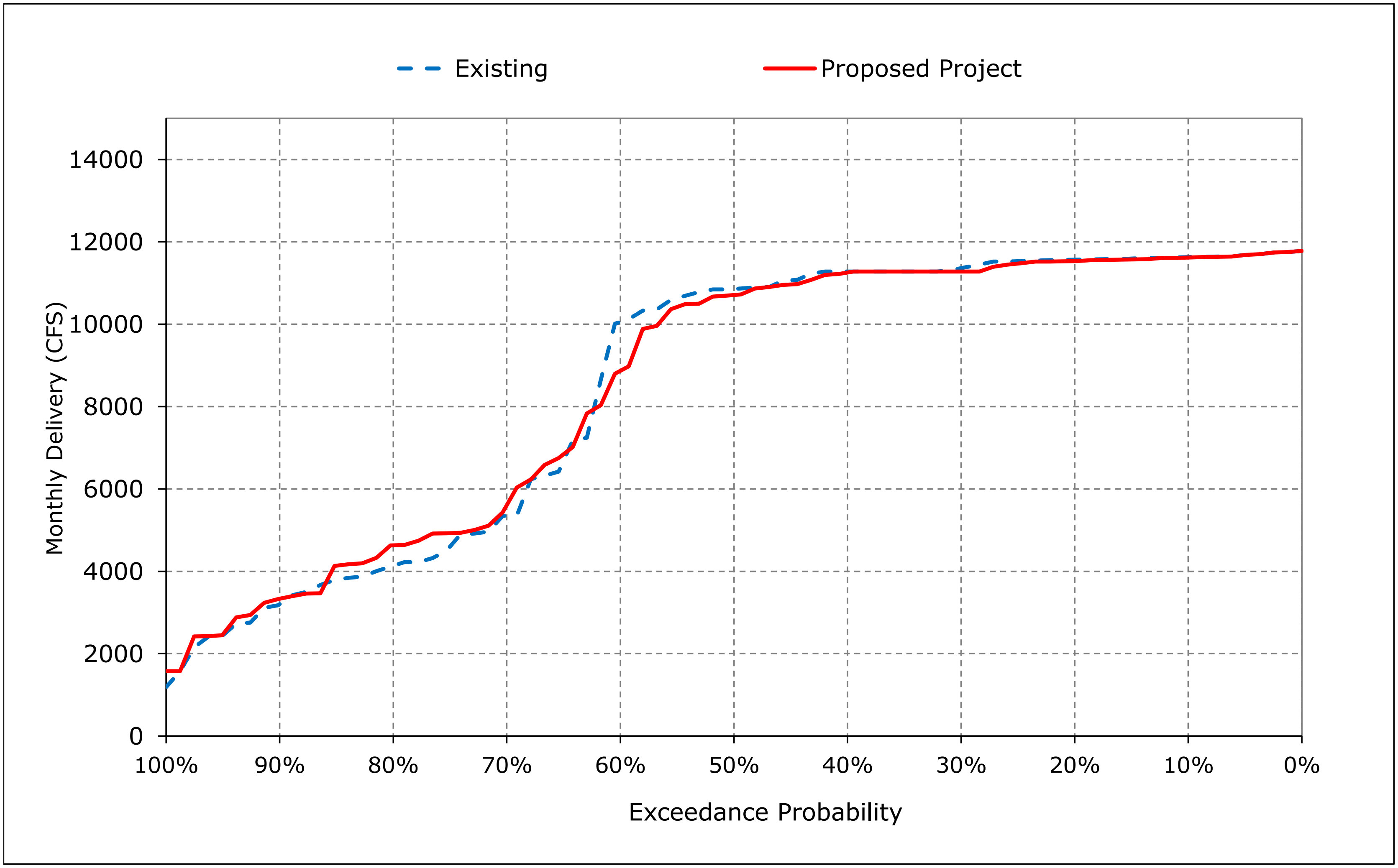


Figure 3-18. Total Delta Exports, September

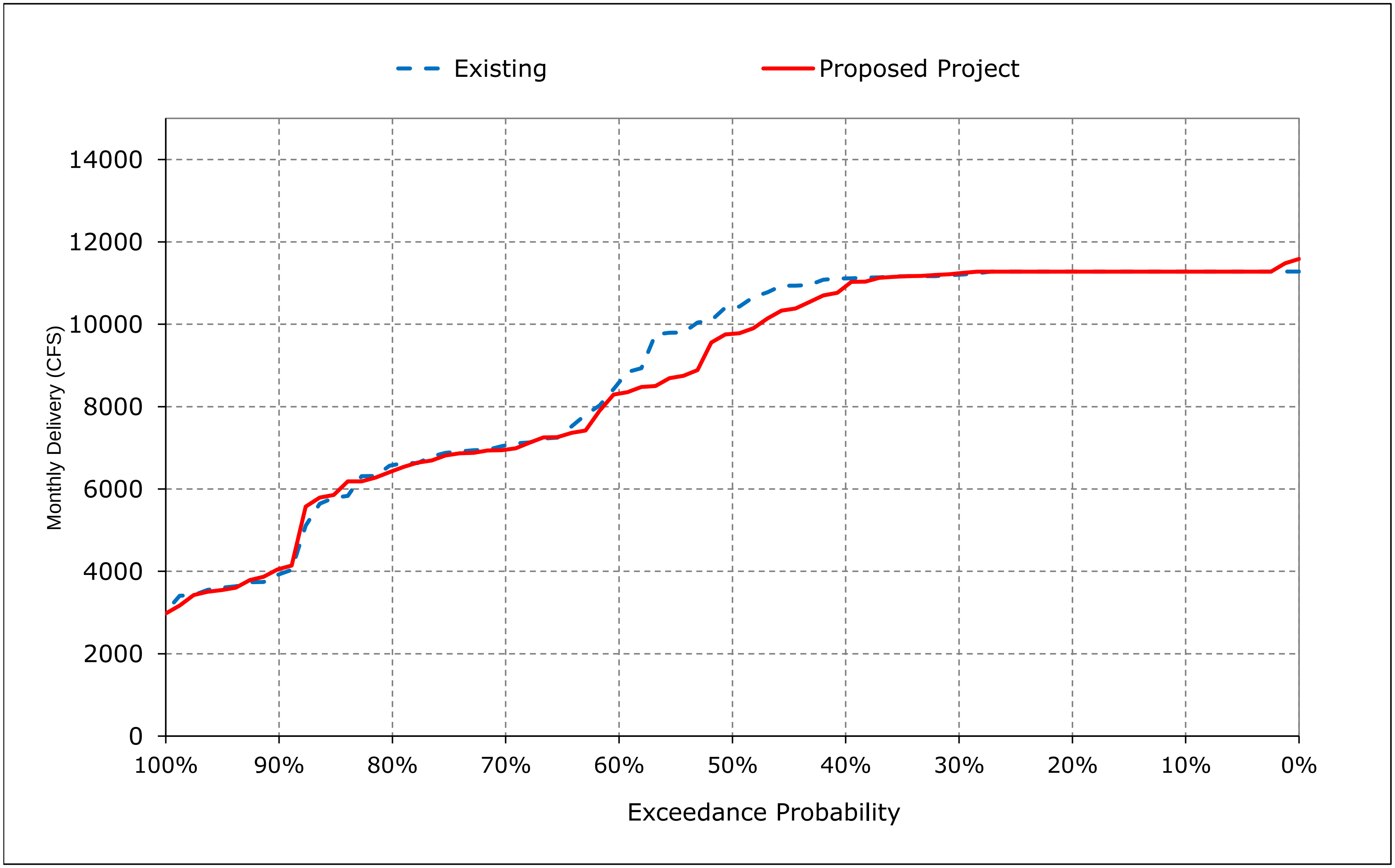


Table 4-1. SWP Banks PP Exports, Monthly Delivery

Existing

	Monthly Delivery (CFS)											
Statistic	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Probability of Exceedance												
10%	4,953	6,680	7,105	5,846	7,403	8,190	1,330	1,106	4,310	6,680	6,680	6,680
20%	4,110	5,508	7,043	3,432	5,331	5,223	935	766	3,083	6,680	6,680	6,680
30%	3,758	4,523	6,552	2,864	3,916	4,832	787	637	2,325	6,680	6,680	6,680
40%	3,419	3,519	4,565	2,770	3,313	3,773	712	600	2,119	6,680	6,680	6,680
50%	3,163	2,821	4,000	2,707	2,877	2,912	673	600	1,935	6,680	6,680	6,428
60%	2,882	2,225	3,485	2,621	2,689	2,634	606	600	1,848	6,626	6,680	3,197
70%	2,297	1,683	2,960	2,601	2,622	2,386	600	600	1,741	5,788	511	2,574
80%	1,813	1,337	2,774	2,485	2,559	2,249	600	600	1,635	2,943	300	2,416
90%	986	564	2,487	2,204	2,423	1,632	600	526	324	300	300	1,678
Long Term												
Full Simulation Period[a]	3,088	3,243	4,576	3,302	3,900	3,793	873	811	2,335	5,164	4,373	4,622
Water Year Types[b,c]												
Wet (32%)	3,680	4,067	4,520	4,574	5,340	5,783	1,264	1,270	3,555	6,602	6,680	6,617
Above Normal (15%)	3,044	2,865	5,335	3,151	4,114	3,956	706	656	2,482	6,411	6,680	6,680
Below Normal (17%)	3,114	3,394	4,908	2,768	3,839	3,682	672	632	2,049	6,676	6,404	4,657
Dry (22%)	2,775	3,074	4,599	2,692	2,683	2,383	695	628	1,687	4,089	515	2,581
Critical (15%)	2,289	1,911	3,514	2,234	2,464	1,566	692	454	852	650	483	1,264

Proposed Project

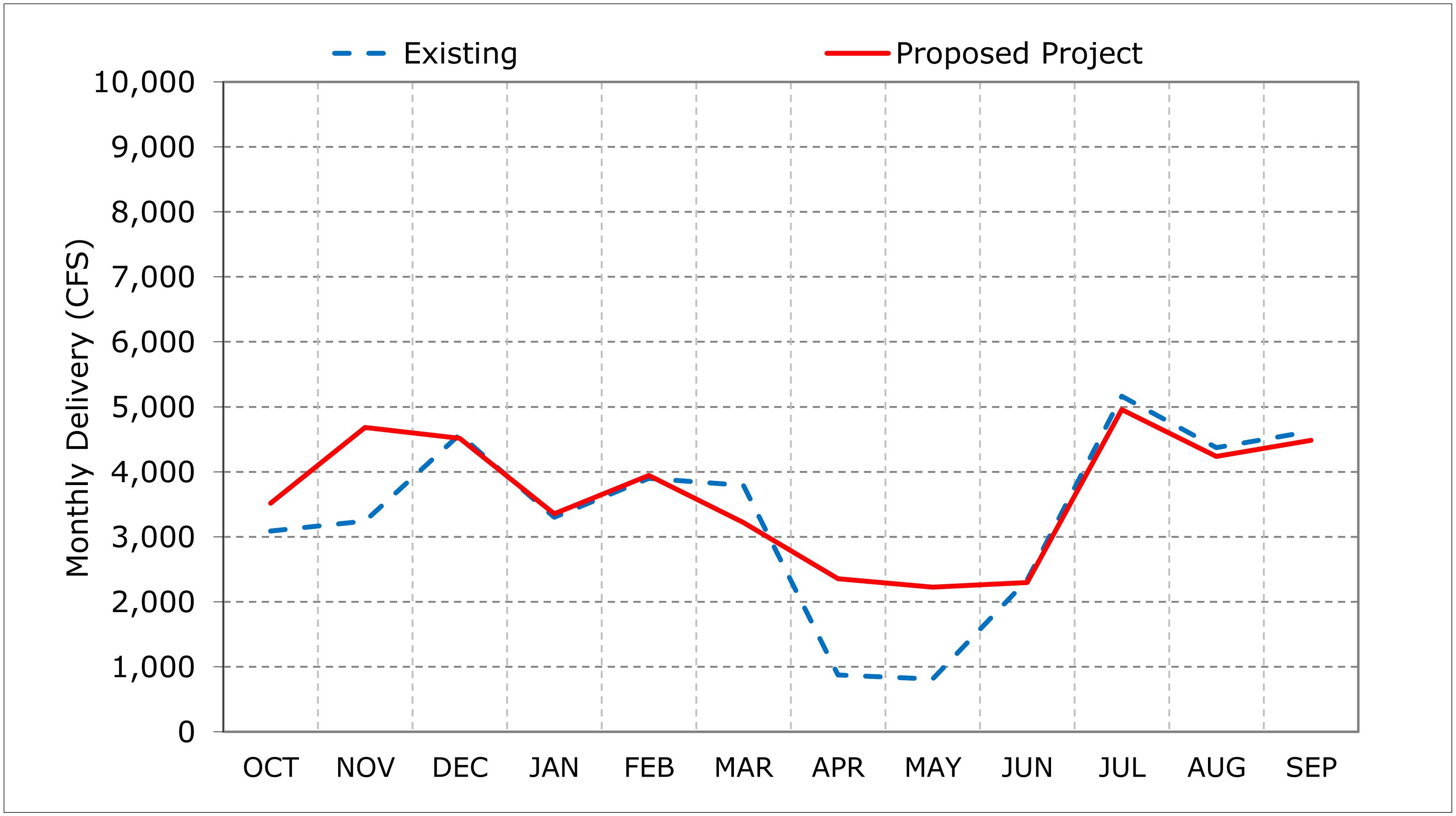
	Monthly Delivery (CFS)											
Statistic	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Probability of Exceedance												
10%	5,791	6,680	7,103	5,534	6,288	6,357	3,972	4,558	4,318	6,680	6,680	6,680
20%	5,062	6,680	7,040	3,861	5,596	4,169	3,189	3,539	3,243	6,680	6,680	6,680
30%	4,490	6,434	5,420	3,185	4,321	3,582	2,859	2,810	2,461	6,680	6,680	6,680
40%	3,961	5,531	4,831	2,914	3,517	3,065	2,523	2,390	2,003	6,680	6,680	6,680
50%	3,644	5,076	3,977	2,837	3,031	2,655	2,305	2,144	1,898	6,675	6,680	5,182
60%	3,095	4,095	3,476	2,748	2,874	2,243	1,999	1,602	1,795	6,239	3,915	3,157
70%	2,412	3,577	2,960	2,642	2,634	2,029	1,714	1,405	1,738	5,121	997	2,620
80%	1,933	2,899	2,817	2,526	2,518	1,821	1,453	904	1,644	1,395	300	2,455
90%	1,009	2,133	2,574	2,216	2,371	1,623	1,078	451	300	300	300	1,820
Long Term												
Full Simulation Period[a]	3,518	4,684	4,517	3,355	3,946	3,218	2,353	2,225	2,295	4,957	4,237	4,484
Water Year Types[b,c]												
Wet (32%)	4,245	5,995	4,558	4,352	5,403	4,945	3,241	3,393	3,449	6,490	6,382	6,318
Above Normal (15%)	3,646	4,424	5,264	3,184	3,934	3,092	2,669	2,702	2,477	6,473	6,378	6,555
Below Normal (17%)	3,483	4,784	4,900	2,946	3,974	3,046	2,515	2,221	2,023	6,175	6,050	4,372
Dry (22%)	3,100	4,043	4,759	2,931	2,801	1,965	1,636	1,334	1,666	3,537	694	2,599
Critical (15%)	2,484	2,949	2,870	2,480	2,486	1,678	999	559	870	831	646	1,400

Proposed Project minus Existing

	Monthly Delivery (CFS)											
Statistic	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Probability of Exceedance												
10%	838	0	-1	-312	-1,115	-1,834	2,642	3,452	8	0	0	0
20%	952	1,172	-3	429	265	-1,054	2,254	2,773	161	0	0	0
30%	732	1,910	-1,132	321	405	-1,250	2,072	2,173	137	0	0	0
40%	542	2,013	266	144	204	-707	1,810	1,790	-115	0	0	0
50%	480	2,255	-23	130	154	-257	1,632	1,544	-37	-5	0	-1,245
60%	213	1,870	-9	126	185	-391	1,393	1,002	-53	-387	-2,765	-40
70%	115	1,894	0	41	11	-356	1,114	805	-3	-667	486	46
80%	120	1,562	43	42	-42	-429	853	304	9	-1,547	0	38
90%	23	1,569	88	12	-52	-9	478	-76	-24	0	0	141
Long Term												
Full Simulation Period[a]	430	1,442	-59	53	46	-576	1,480	1,414	-41	-207	-136	-138
Water Year Types[b,c]												
Wet (32%)	565	1,929	38	-222	63	-837	1,977	2,123	-106	-111	-298	-300
Above Normal (15%)	601	1,559	-71	33	-180	-864	1,963	2,046	-5	62	-302	-125
Below Normal (17%)	369	1,390	-9	178	135	-636	1,844	1,590	-25	-501	-355	-285
Dry (22%)	326	969	160	239	118	-419	941	706	-21	-552	179	17
Critical (15%)	195	1,039	-644	246	23	112	306	105	18	181	164	136

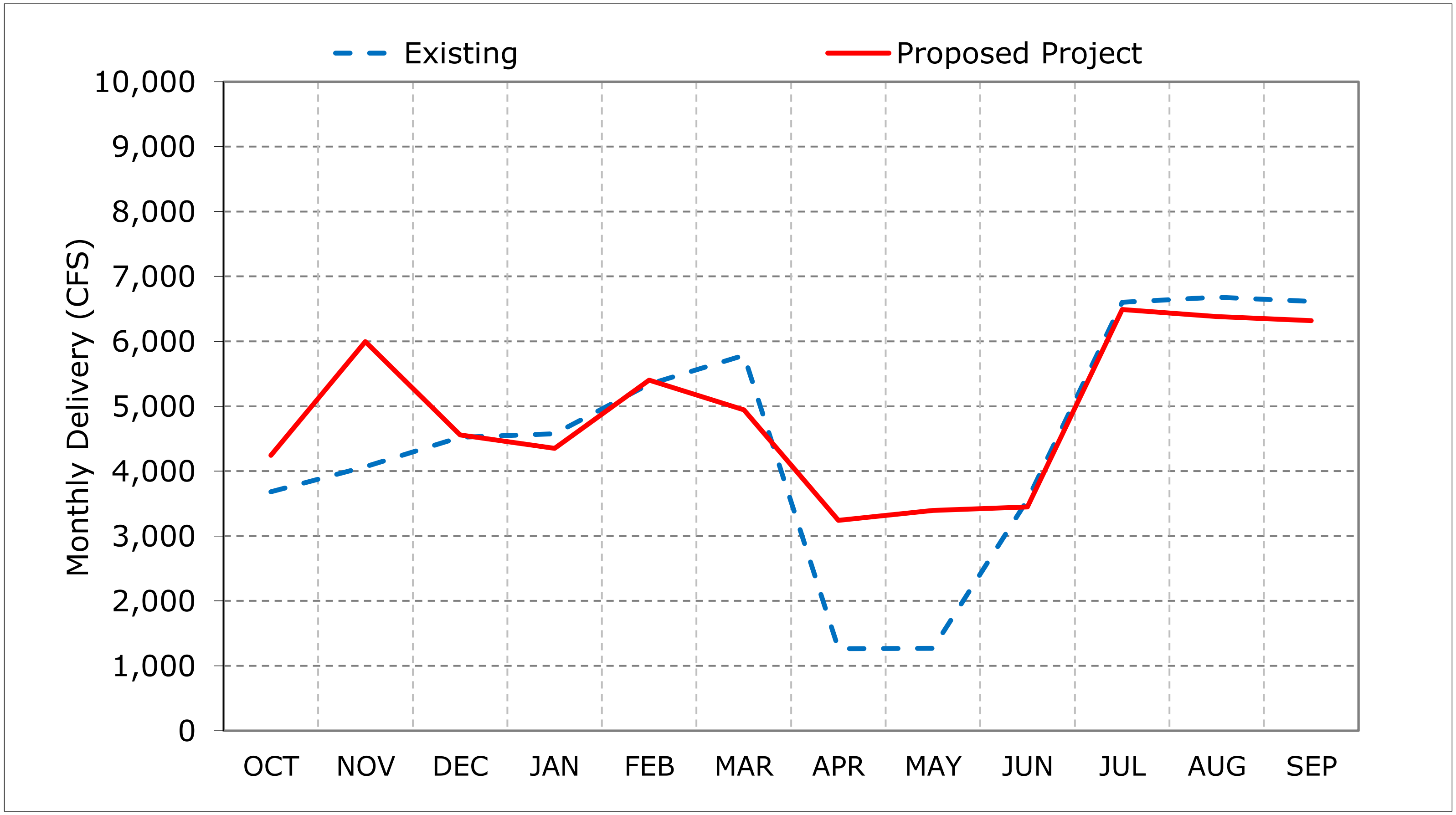
a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with water year - year type sorting.

Figure 4-1. SWP Banks PP Exports, Long-Term Average Delivery



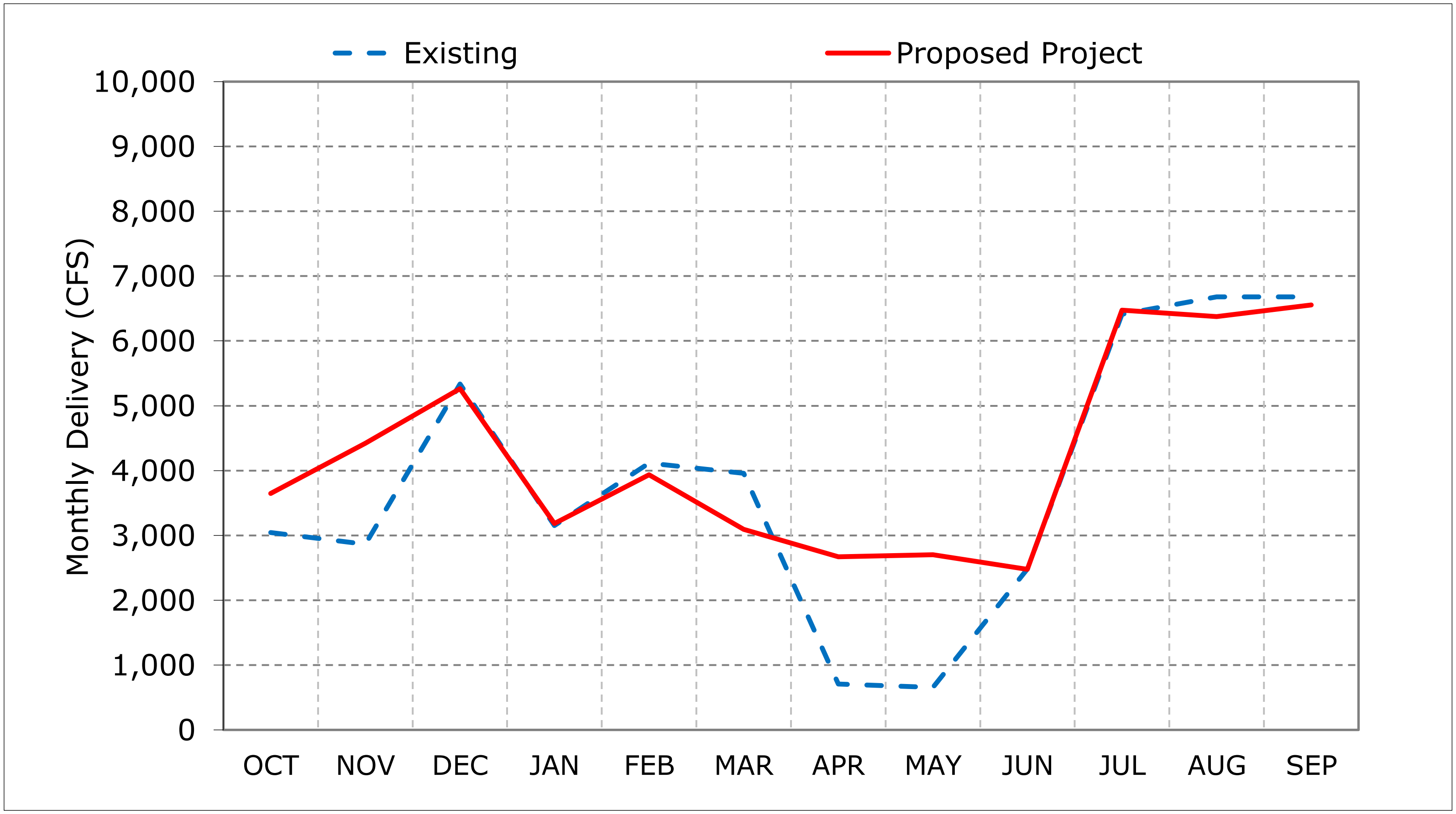
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 4-2. SWP Banks PP Exports, Wet Year Average Delivery



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

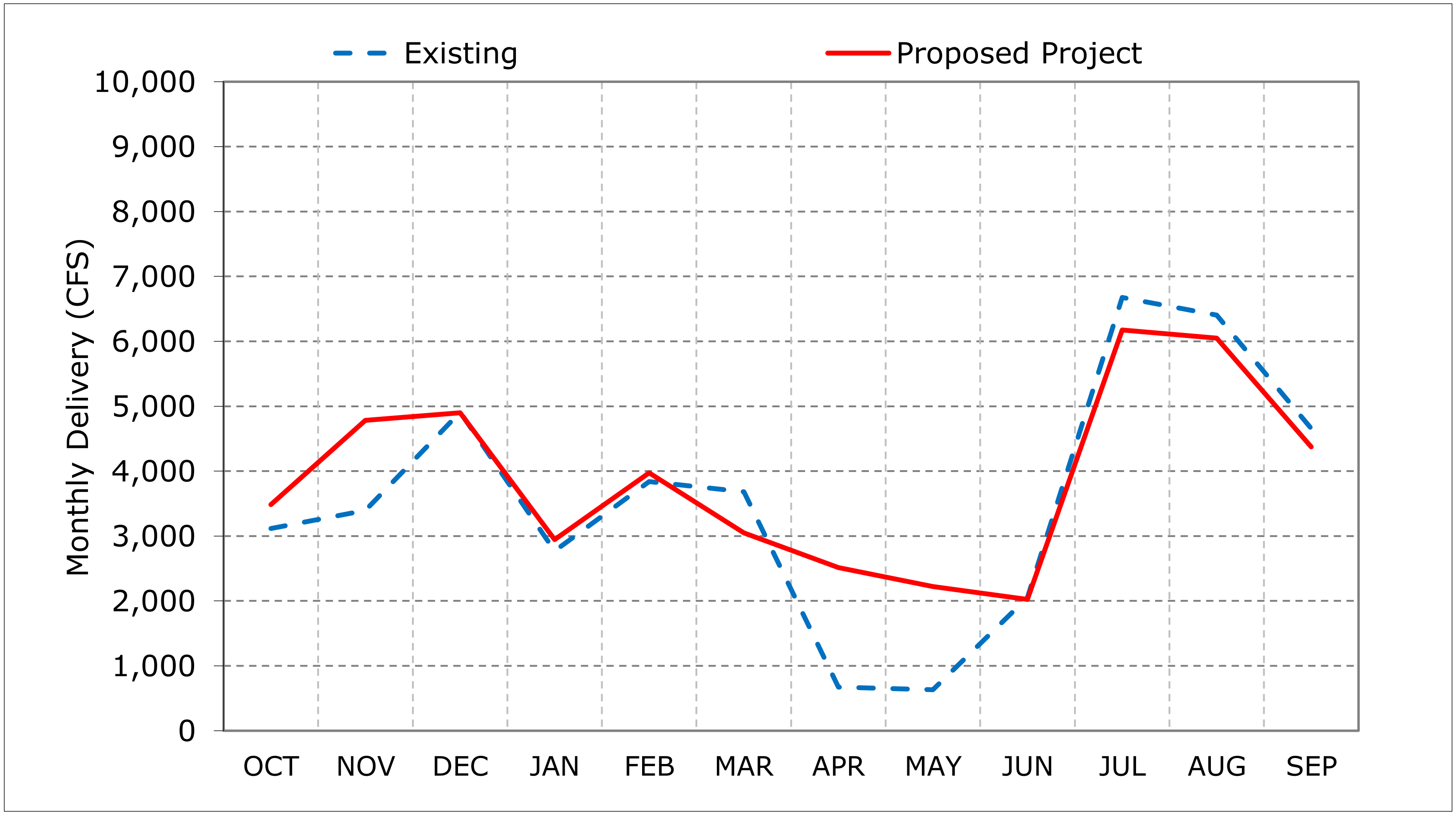
Figure 4-3. SWP Banks PP Exports, Above Normal Year Average Delivery



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164

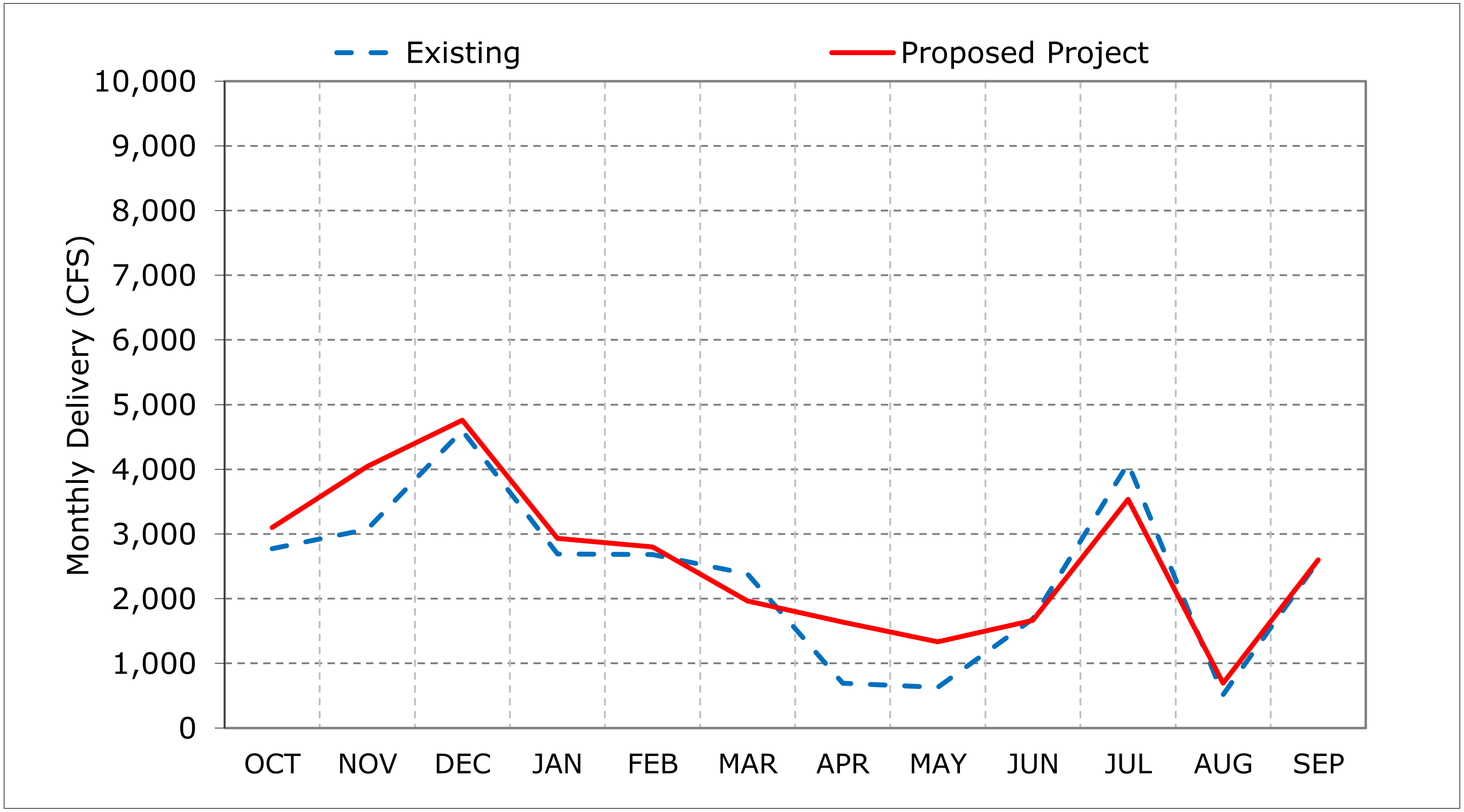
*These results are displayed with water year - year type sorting.

Figure 4-4. SWP Banks PP Exports, Below Normal Year Average Delivery



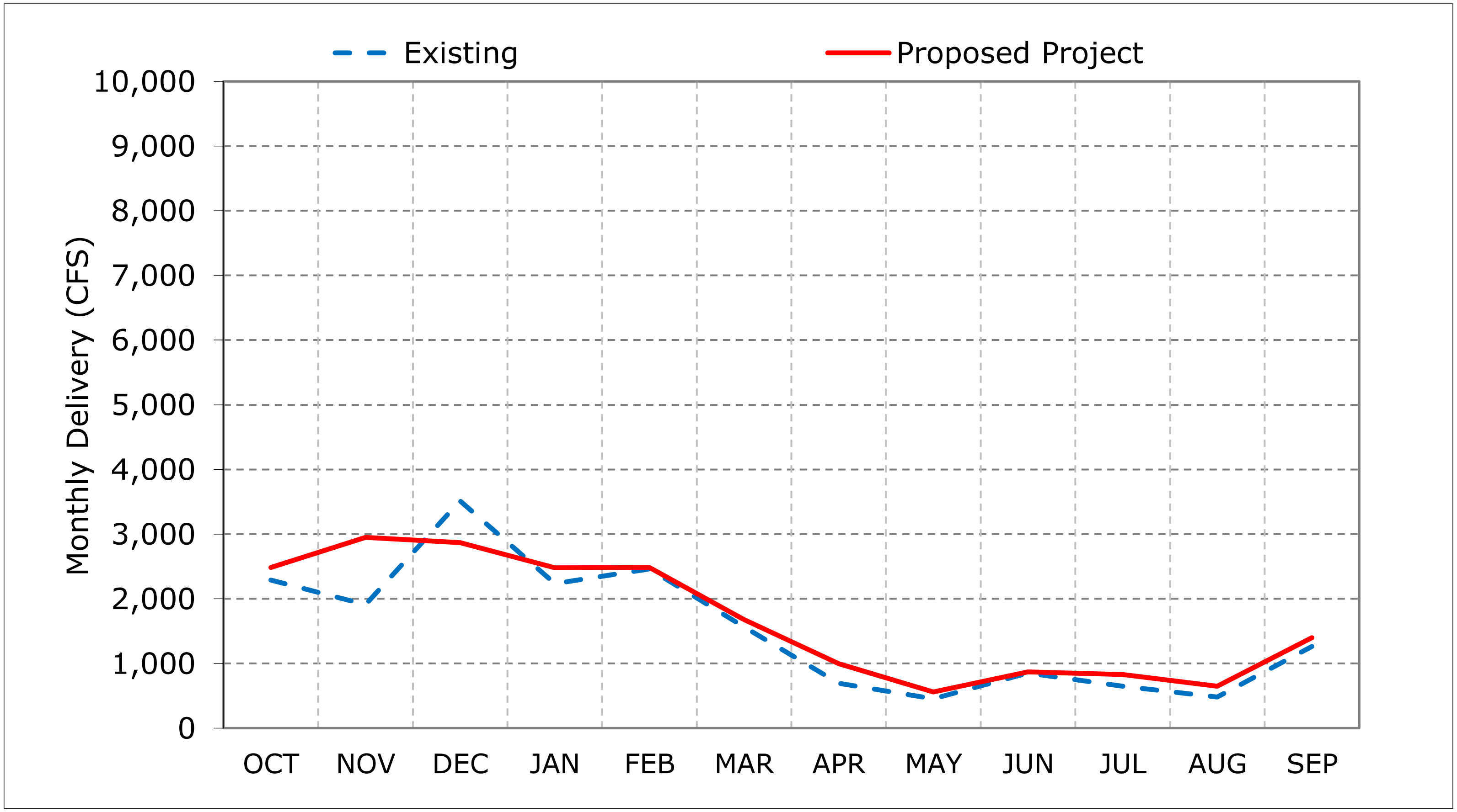
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 4-5. SWP Banks PP Exports, Dry Year Average Delivery



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 4-6. SWP Banks PP Exports, Critical Year Average Delivery



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 4-7. SWP Banks PP Exports, October

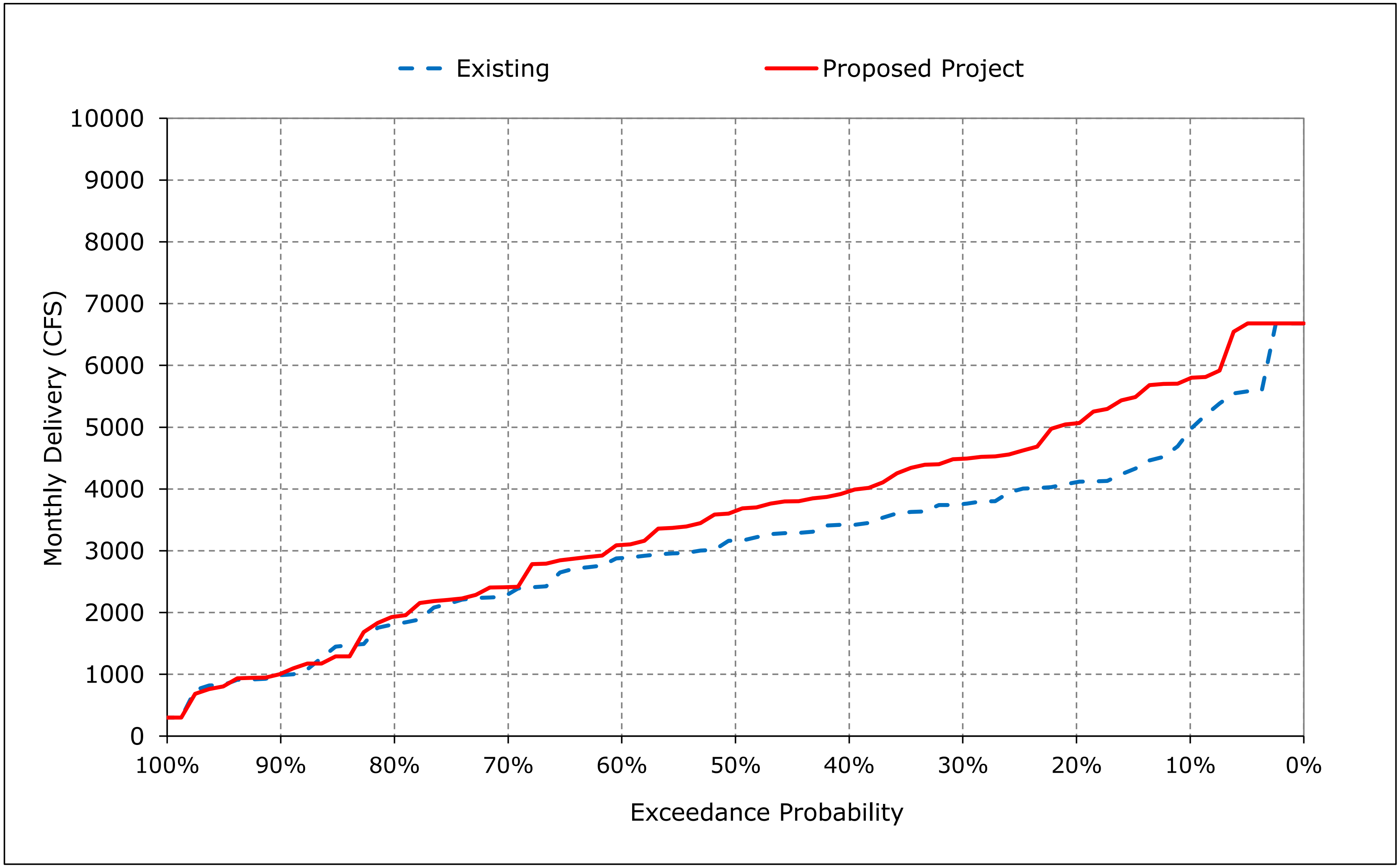


Figure 4-8. SWP Banks PP Exports, November

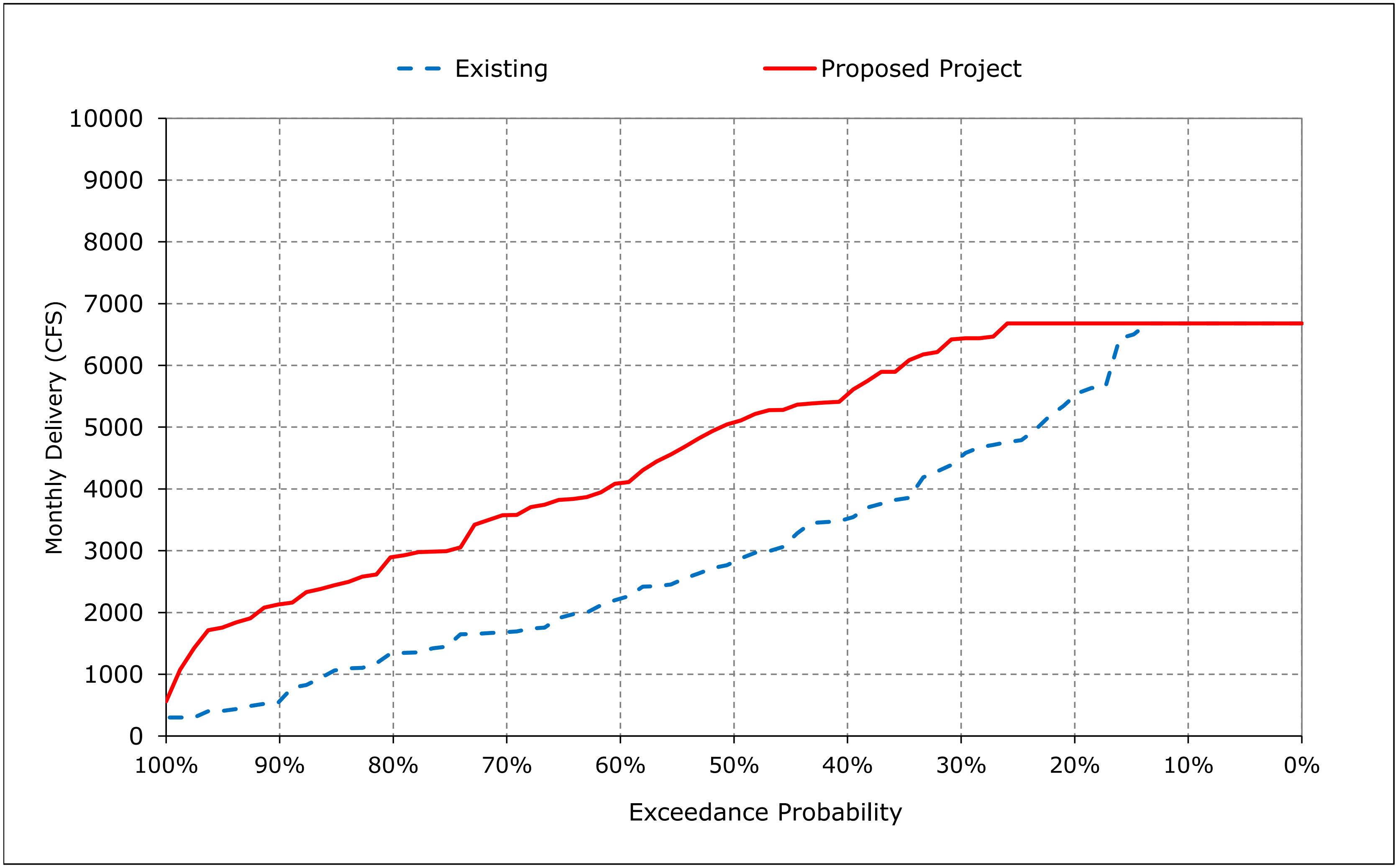


Figure 4-9. SWP Banks PP Exports, December

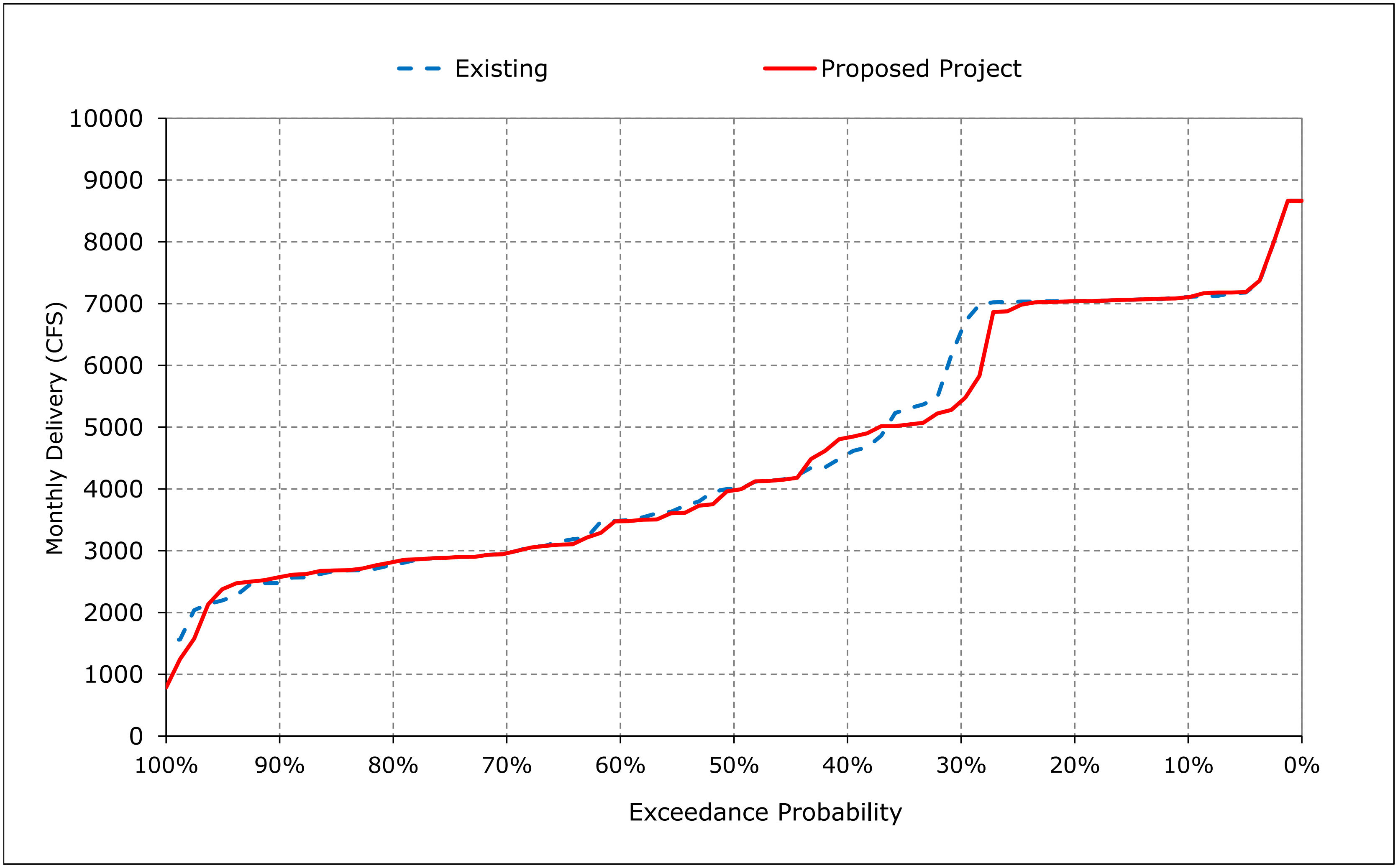


Figure 4-10. SWP Banks PP Exports, January

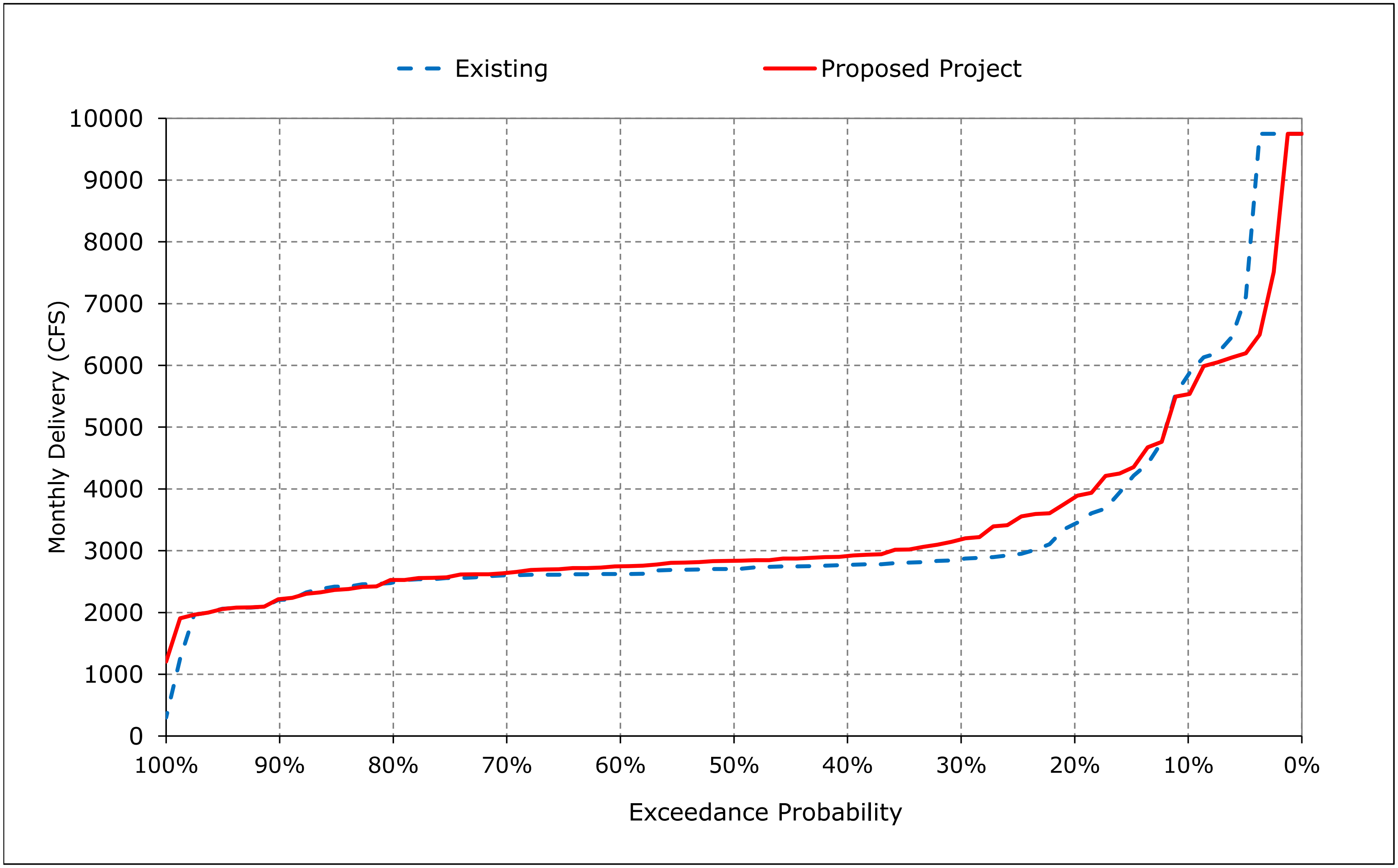


Figure 4-11. SWP Banks PP Exports, February

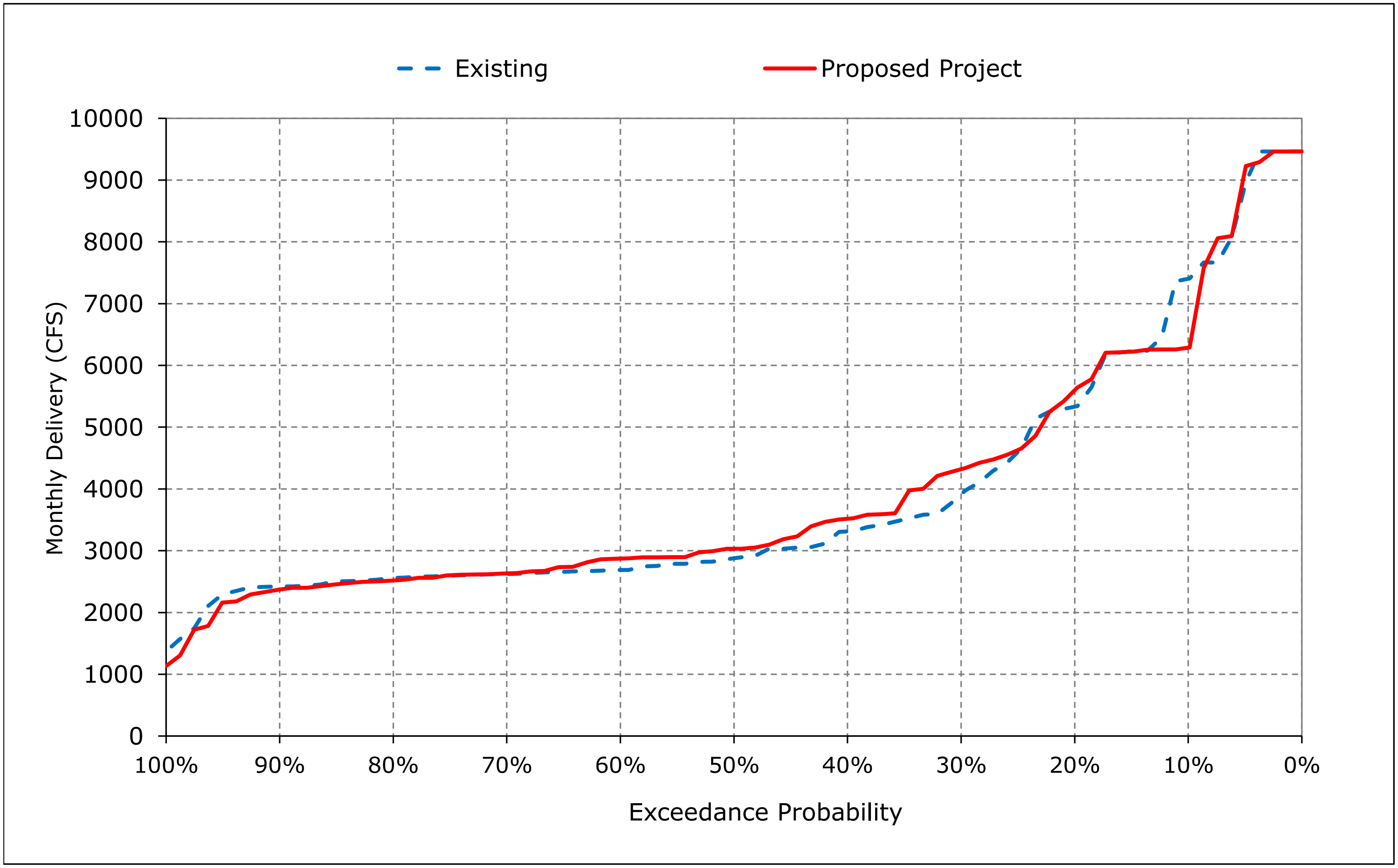


Figure 4-12. SWP Banks PP Exports, March

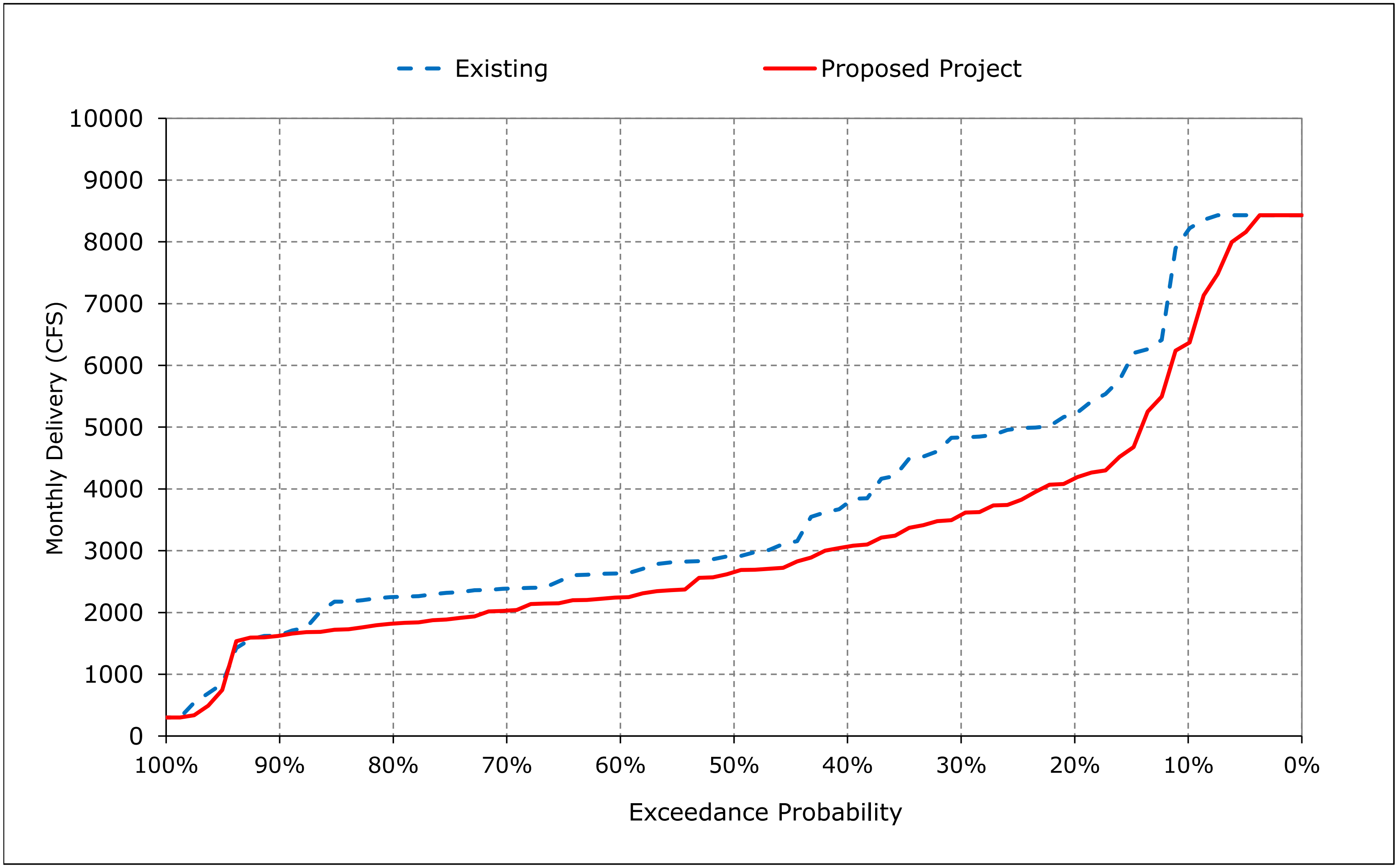


Figure 4-13. SWP Banks PP Exports, April

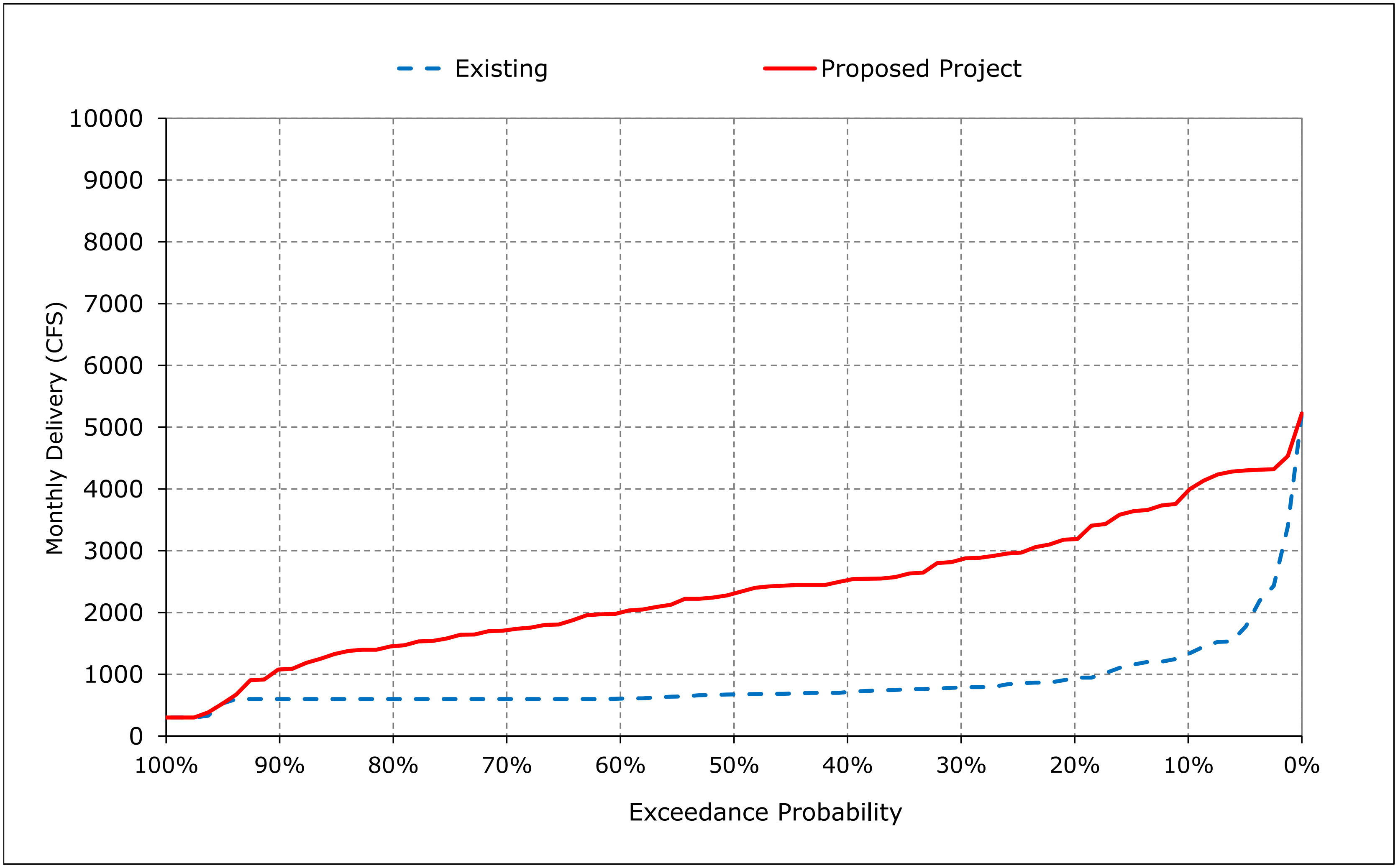


Figure 4-14. SWP Banks PP Exports, May

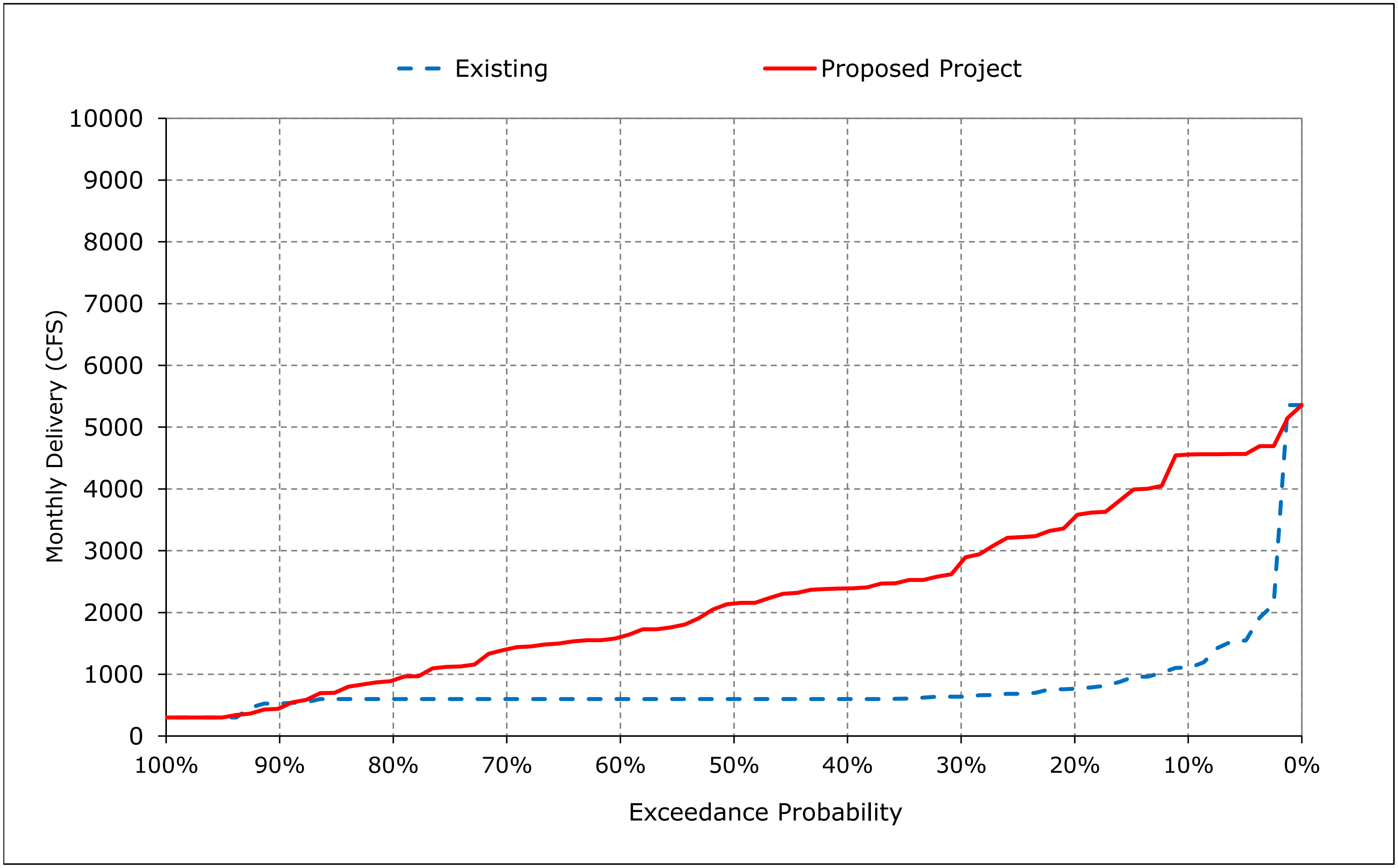


Figure 4-15. SWP Banks PP Exports, June

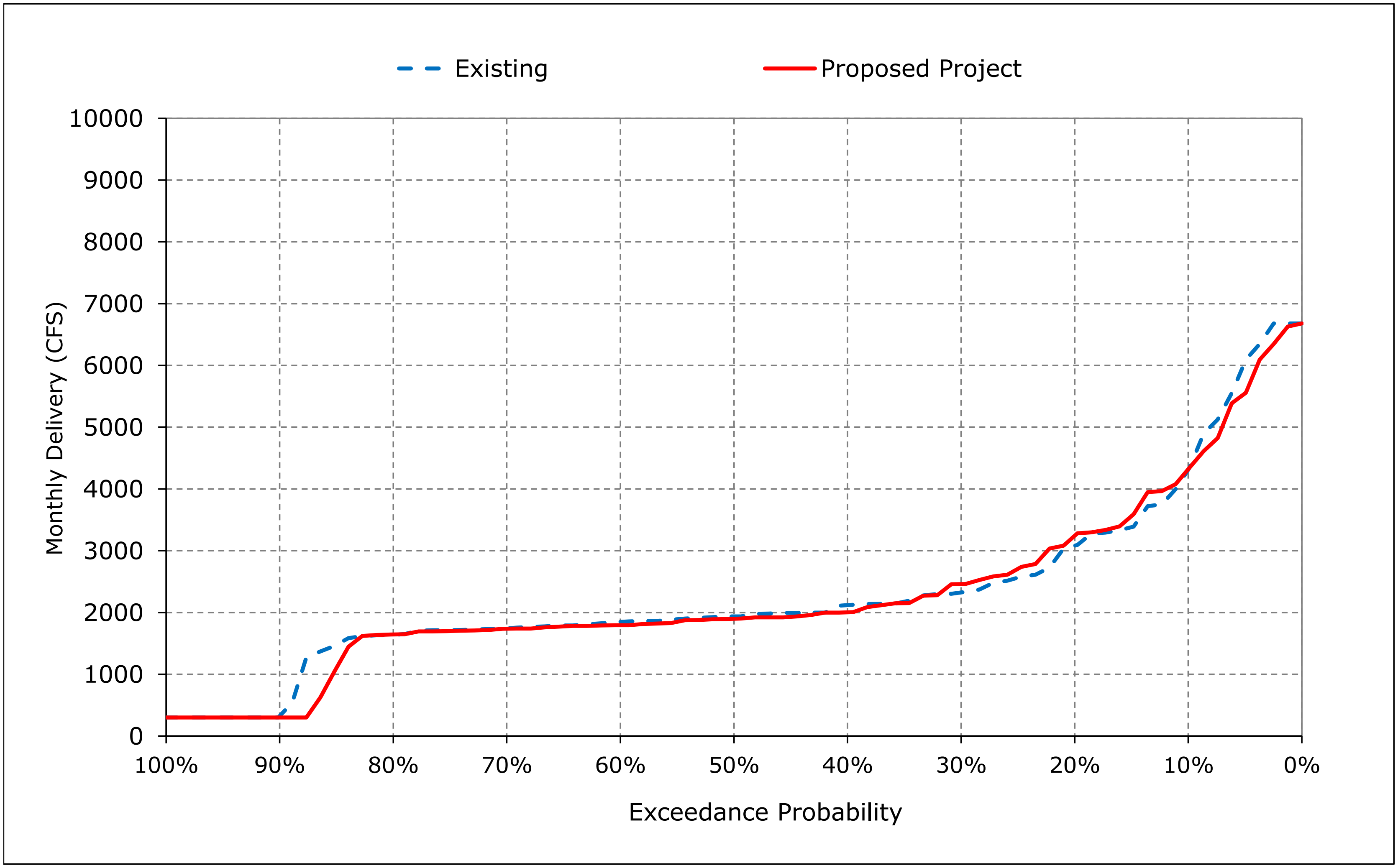


Figure 4-16. SWP Banks PP Exports, July

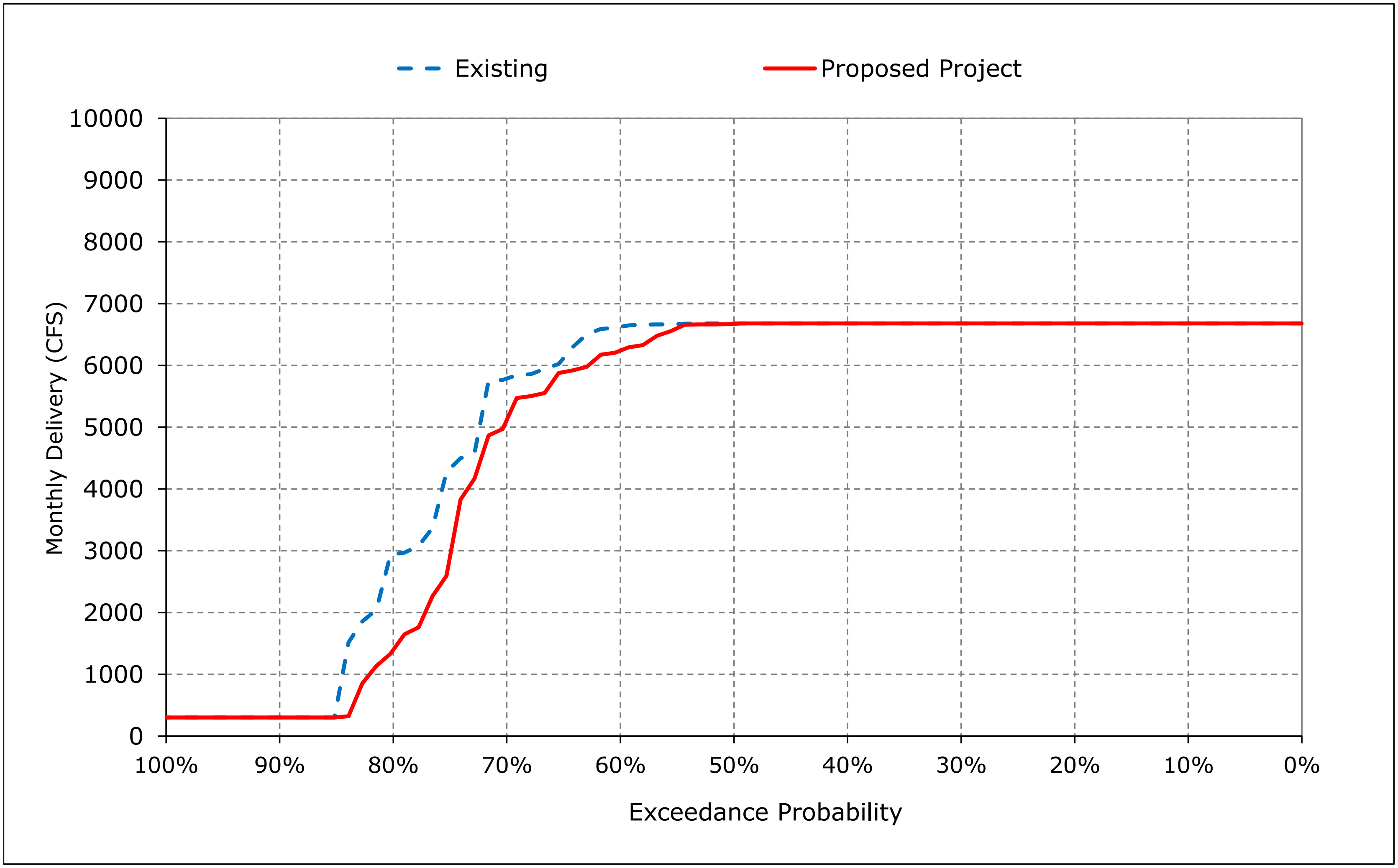


Figure 4-17. SWP Banks PP Exports, August

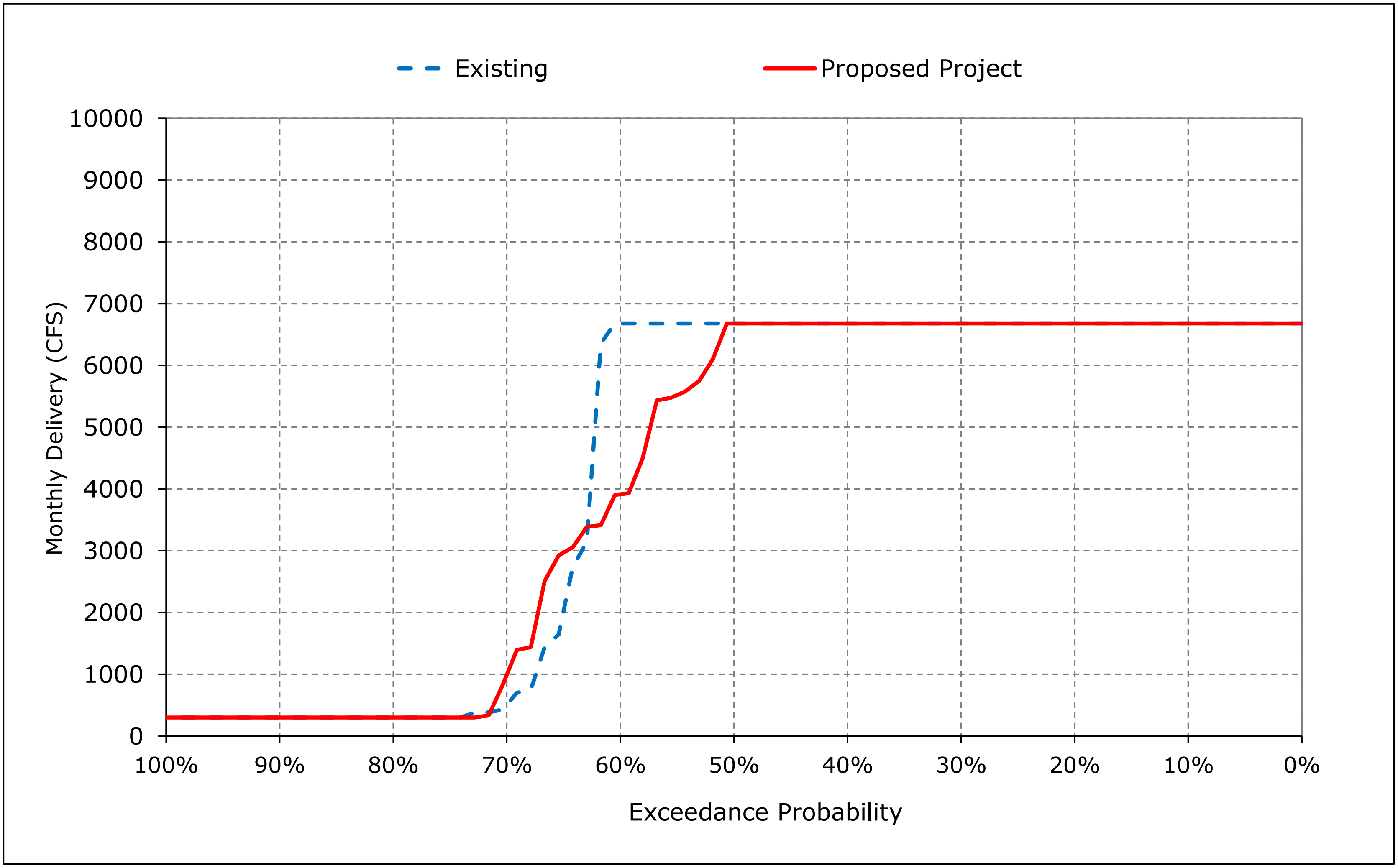


Figure 4-18. SWP Banks PP Exports, September

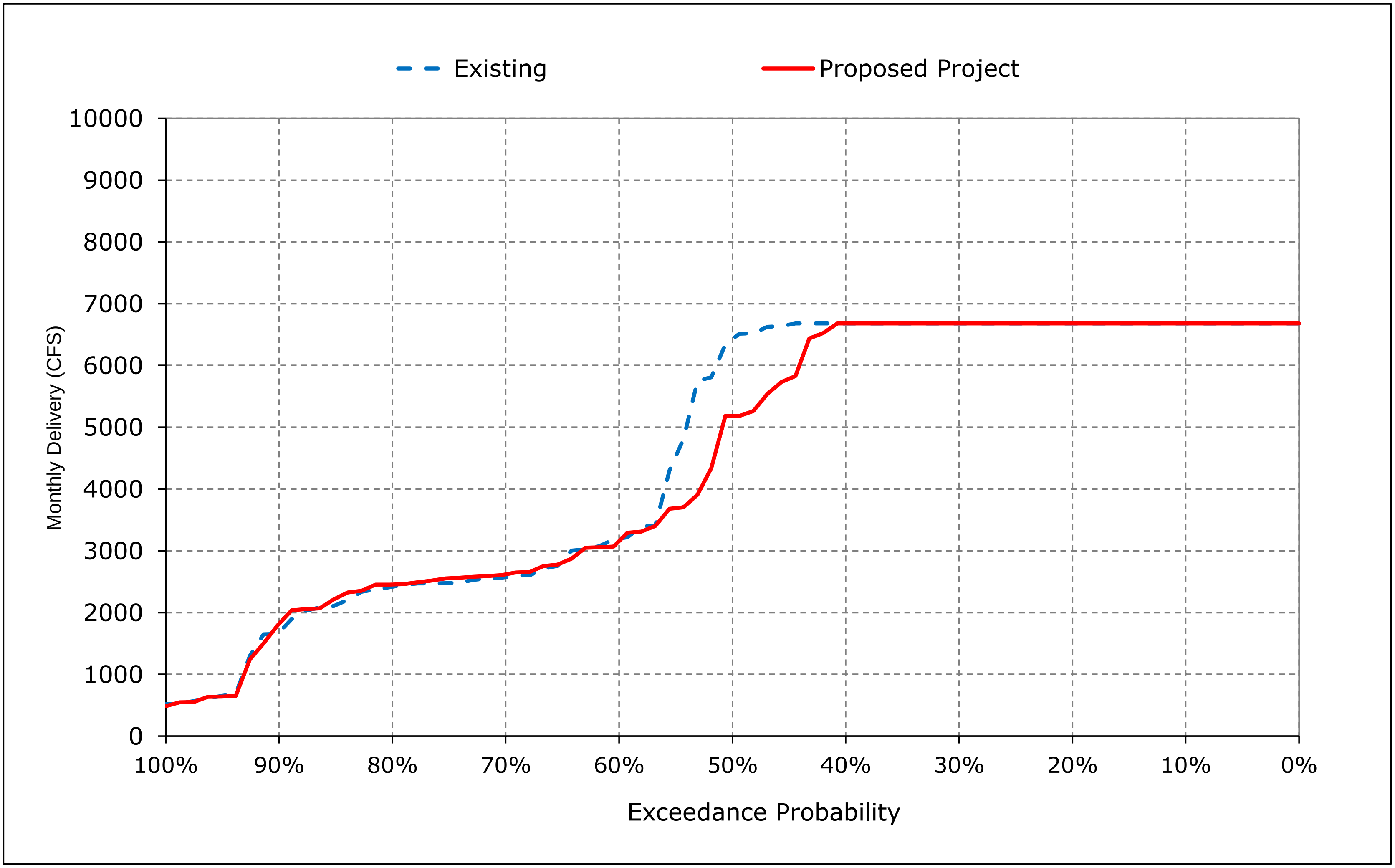


Table 5-1. CVP Banks PP Exports, Monthly Delivery

Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Delivery (CFS)											
Probability of Exceedance												
10%	0	1,875	0	0	0	0	0	0	0	915	293	0
20%	0	1,705	0	0	0	0	0	0	0	622	0	0
30%	0	1,454	0	0	0	0	0	0	0	76	0	0
40%	0	163	0	0	0	0	0	0	0	0	0	0
50%	0	0	0	0	0	0	0	0	0	0	0	0
60%	0	0	0	0	0	0	0	0	0	0	0	0
70%	0	0	0	0	0	0	0	0	0	0	0	0
80%	0	0	0	0	0	0	0	0	0	0	0	0
90%	0	0	0	0	0	0	0	0	0	0	0	0
Long Term												
Full Simulation Period[a]	69	660	19	0	41	10	0	0	0	224	95	103
Water Year Types[b,c]												
Wet (32%)	8	715	21	0	73	0	0	0	0	33	0	0
Above Normal (15%)	74	740	0	0	73	0	0	0	0	0	0	0
Below Normal (17%)	84	759	0	0	41	0	0	0	0	1	107	602
Dry (22%)	113	647	0	0	0	44	0	0	0	632	347	0
Critical (15%)	111	361	85	0	0	0	0	0	0	513	1	0

Proposed Project

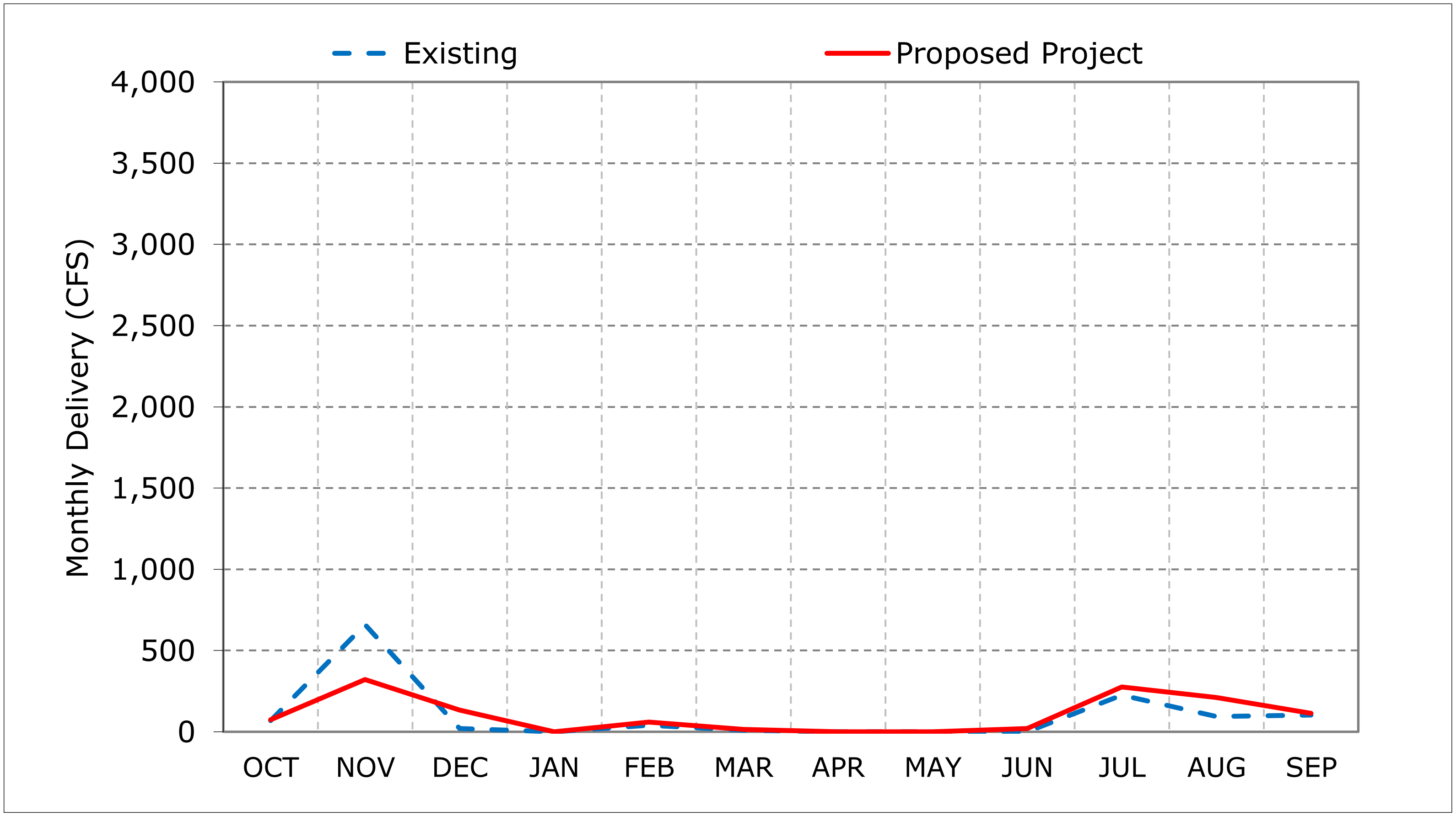
Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Delivery (CFS)											
Probability of Exceedance												
10%	0	1,297	211	0	0	0	0	0	0	1,074	975	14
20%	0	745	0	0	0	0	0	0	0	692	35	0
30%	0	91	0	0	0	0	0	0	0	235	0	0
40%	0	0	0	0	0	0	0	0	0	0	0	0
50%	0	0	0	0	0	0	0	0	0	0	0	0
60%	0	0	0	0	0	0	0	0	0	0	0	0
70%	0	0	0	0	0	0	0	0	0	0	0	0
80%	0	0	0	0	0	0	0	0	0	0	0	0
90%	0	0	0	0	0	0	0	0	0	0	0	0
Long Term												
Full Simulation Period[a]	74	322	134	0	60	15	0	0	20	276	212	114
Water Year Types[b,c]												
Wet (32%)	33	258	0	0	140	49	0	0	62	70	256	0
Above Normal (15%)	99	384	175	0	62	0	0	0	0	0	166	0
Below Normal (17%)	102	394	154	0	39	0	0	0	0	142	160	652
Dry (22%)	145	269	160	0	0	0	0	0	0	707	319	13
Critical (15%)	0	390	318	0	0	0	0	0	0	508	60	0

Proposed Project minus Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Delivery (CFS)											
Probability of Exceedance												
10%	0	**-579**	211	0	0	0	0	0	0	159	683	14
20%	0	**-960**	0	0	0	0	0	0	0	70	35	0
30%	0	**-1,363**	0	0	0	0	0	0	0	159	0	0
40%	0	**-163**	0	0	0	0	0	0	0	0	0	0
50%	0	0	0	0	0	0	0	0	0	0	0	0
60%	0	0	0	0	0	0	0	0	0	0	0	0
70%	0	0	0	0	0	0	0	0	0	0	0	0
80%	0	0	0	0	0	0	0	0	0	0	0	0
90%	0	0	0	0	0	0	0	0	0	0	0	0
Long Term												
Full Simulation Period[a]	6	**-338**	114	0	19	6	0	0	20	52	117	11
Water Year Types[b,c]												
Wet (32%)	25	**-456**	**-21**	0	67	49	0	0	62	37	256	0
Above Normal (15%)	25	**-357**	175	0	**-11**	0	0	0	0	0	166	0
Below Normal (17%)	18	**-365**	154	0	**-2**	0	0	0	0	140	52	50
Dry (22%)	32	**-378**	160	0	0	**-44**	0	0	0	75	**-28**	13
Critical (15%)	**-111**	29	232	0	0	0	0	0	0	**-5**	59	0

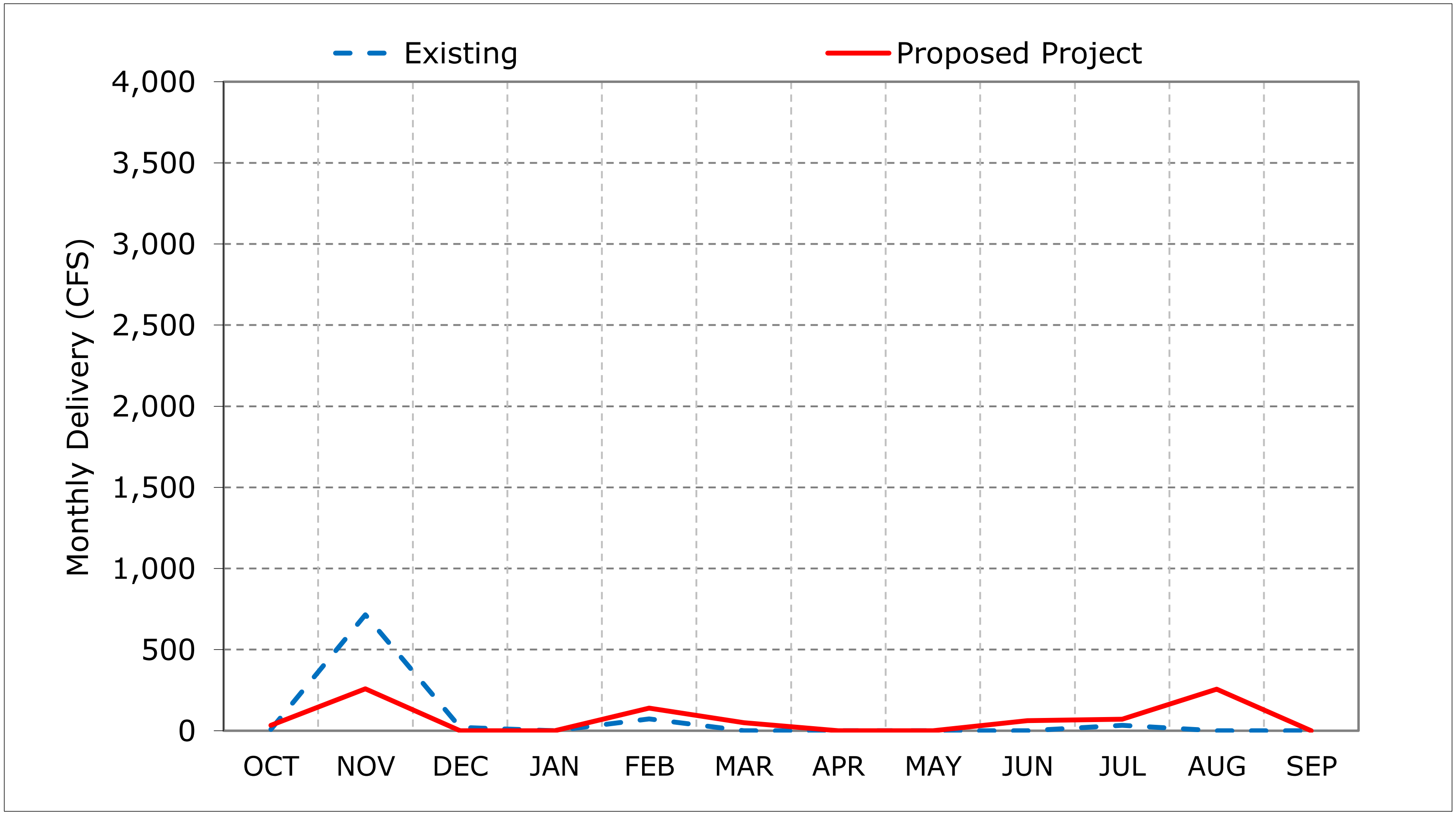
a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with water year - year type sorting.

Figure 5-1. CVP Banks PP Exports, Long-Term Average Delivery



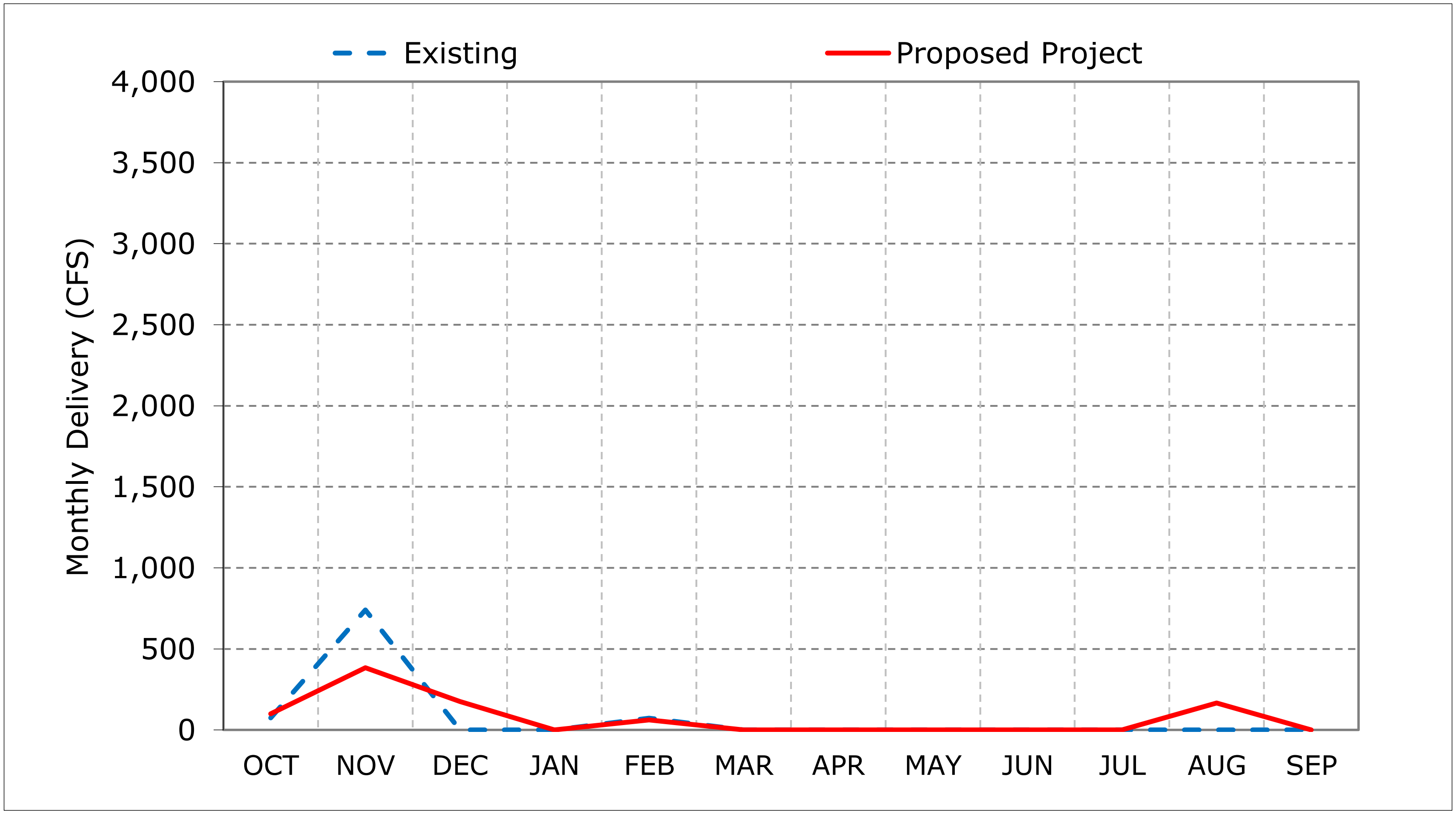
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 5-2. CVP Banks PP Exports, Wet Year Average Delivery



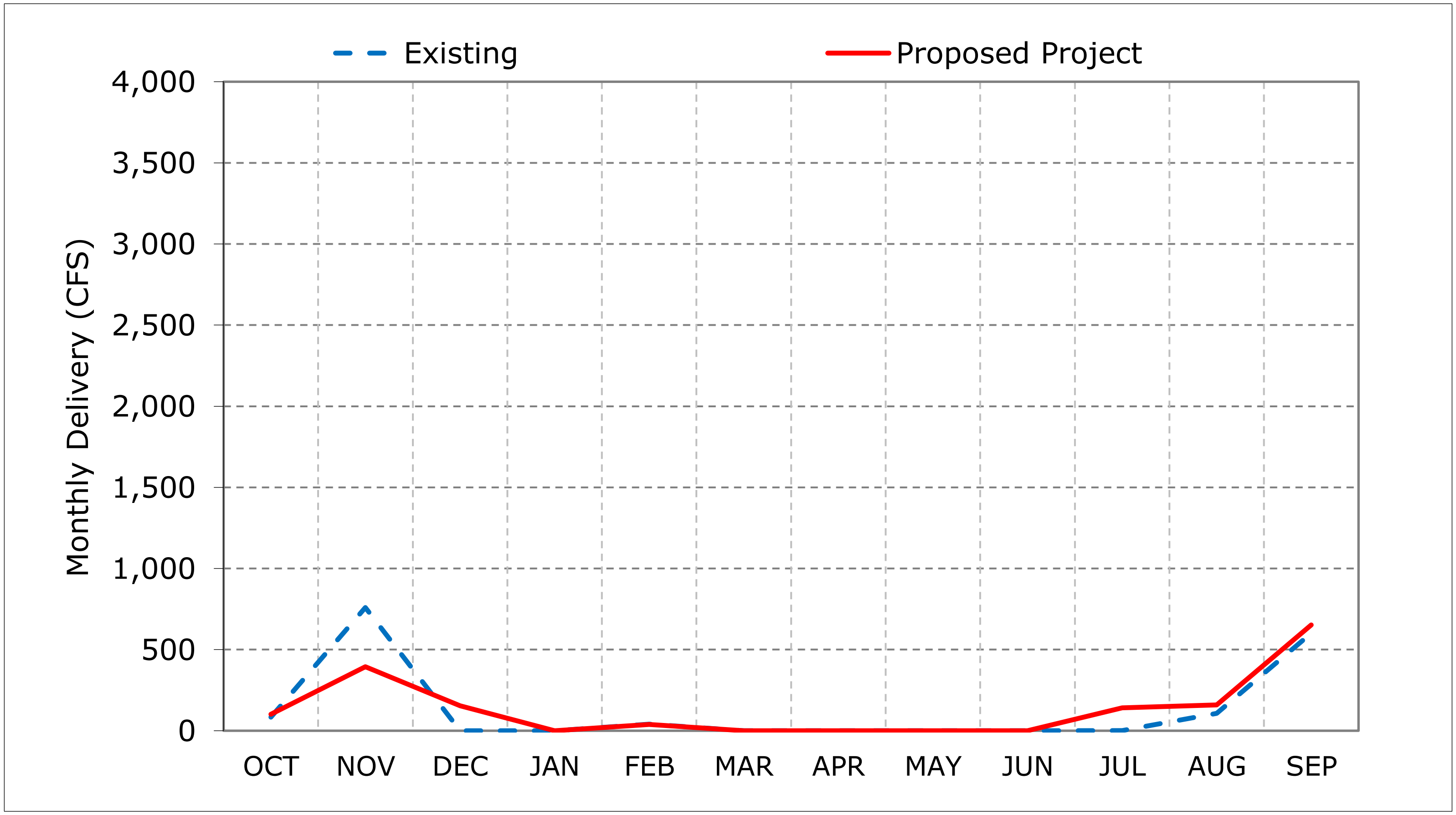
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 5-3. CVP Banks PP Exports, Above Normal Year Average Delivery



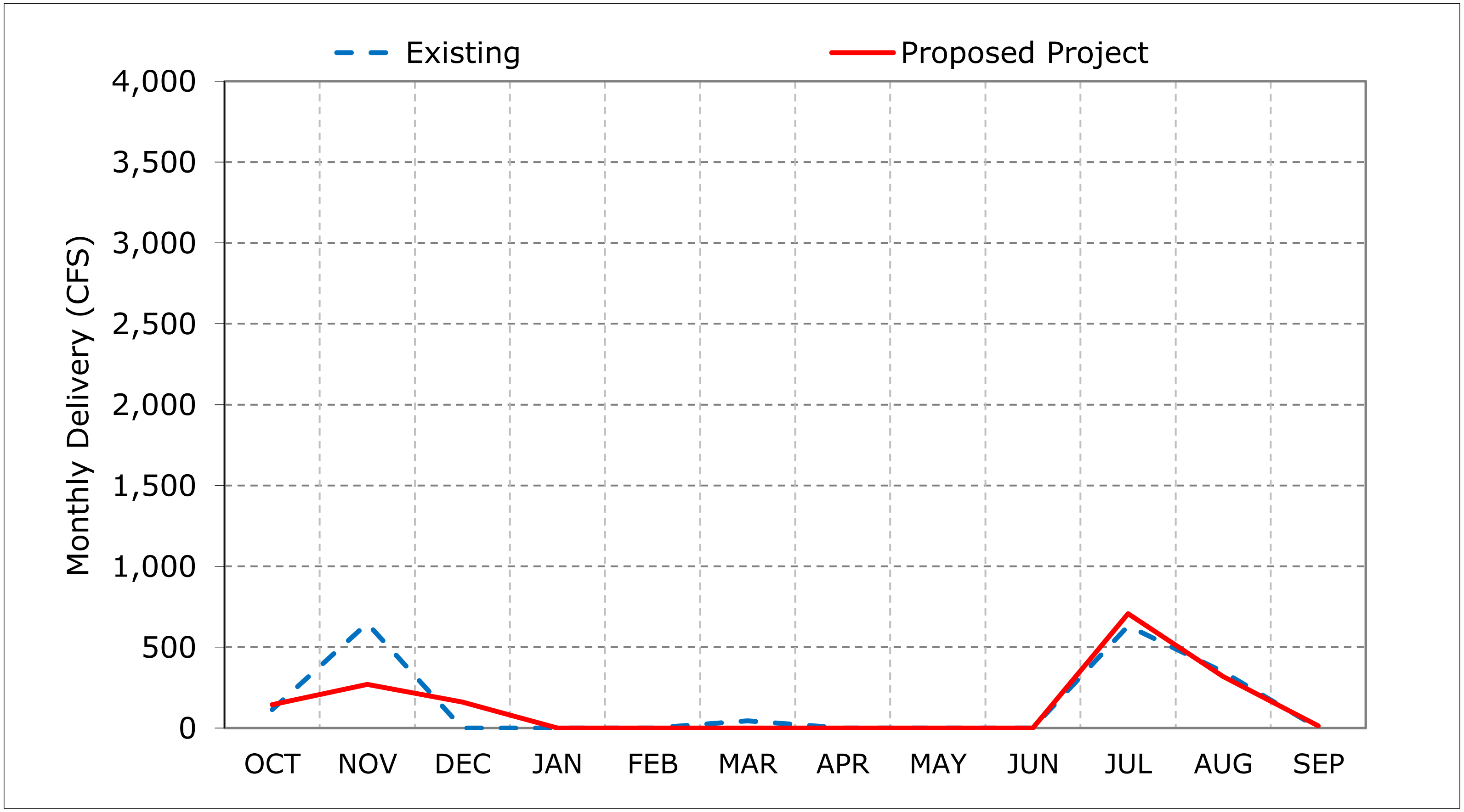
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 5-4. CVP Banks PP Exports, Below Normal Year Average Delivery



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

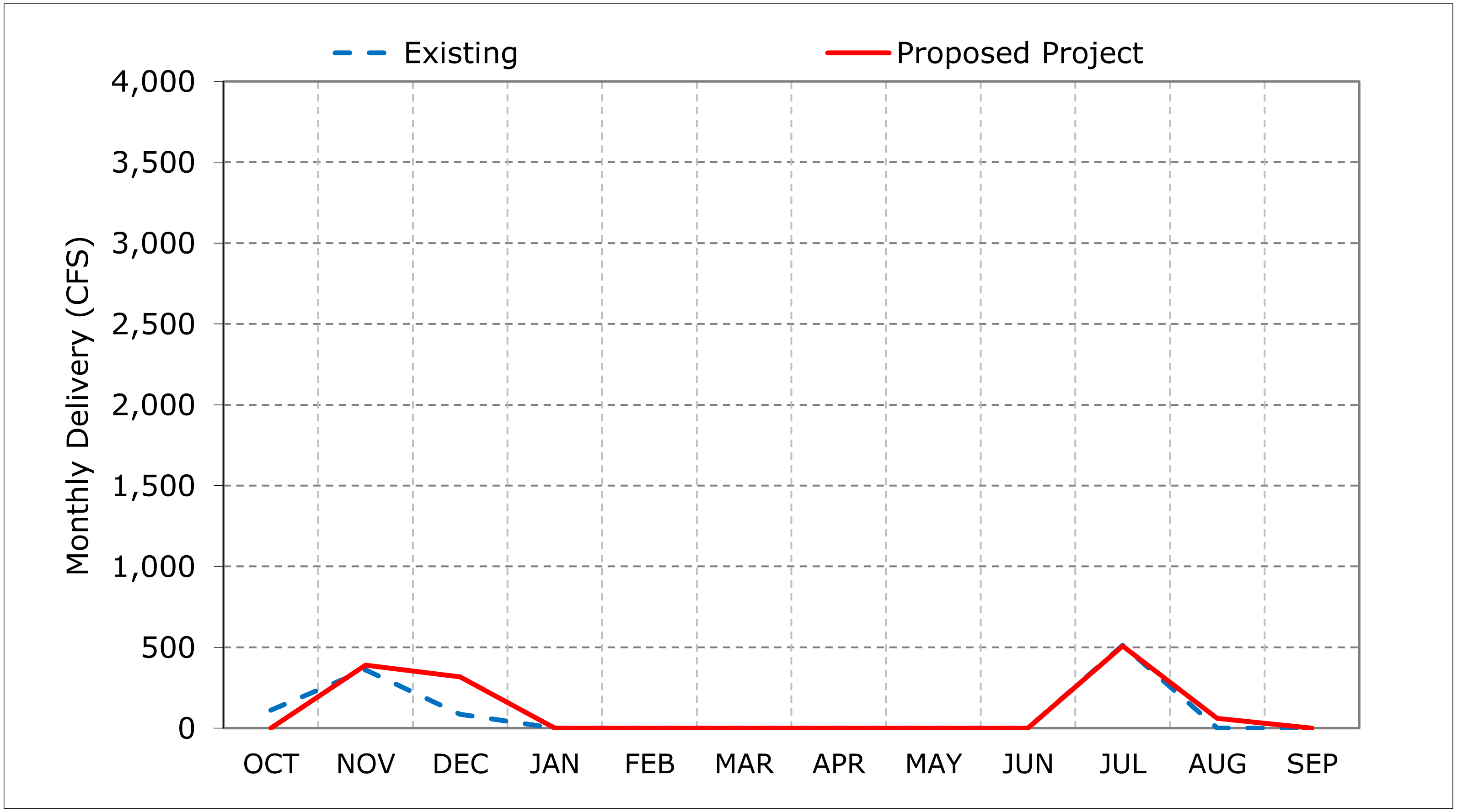
Figure 5-5. CVP Banks PP Exports, Dry Year Average Delivery



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164

*These results are displayed with water year - year type sorting.

Figure 5-6. CVP Banks PP Exports, Critical Year Average Delivery



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 5-7. CVP Banks PP Exports, October

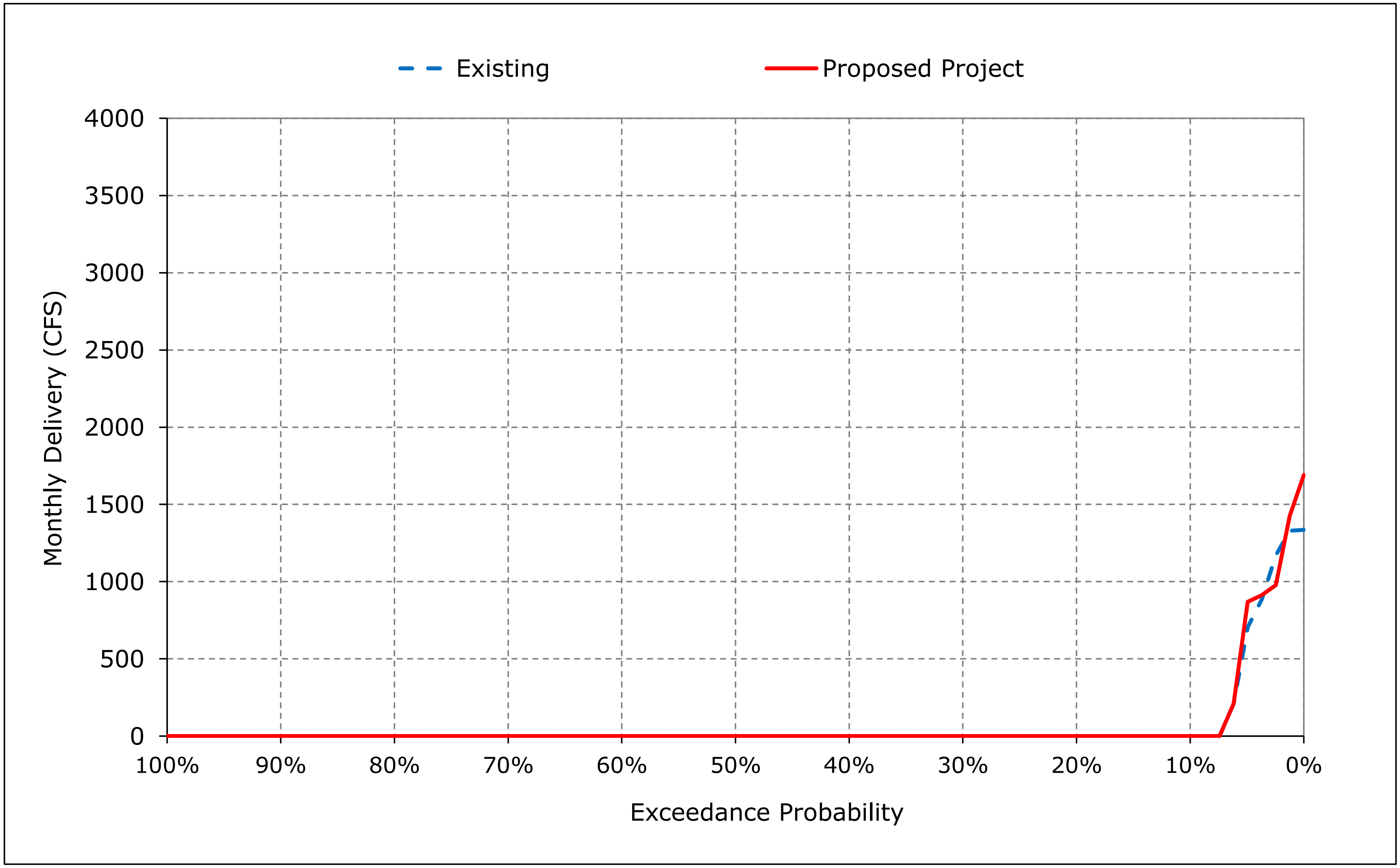


Figure 5-8. CVP Banks PP Exports, November

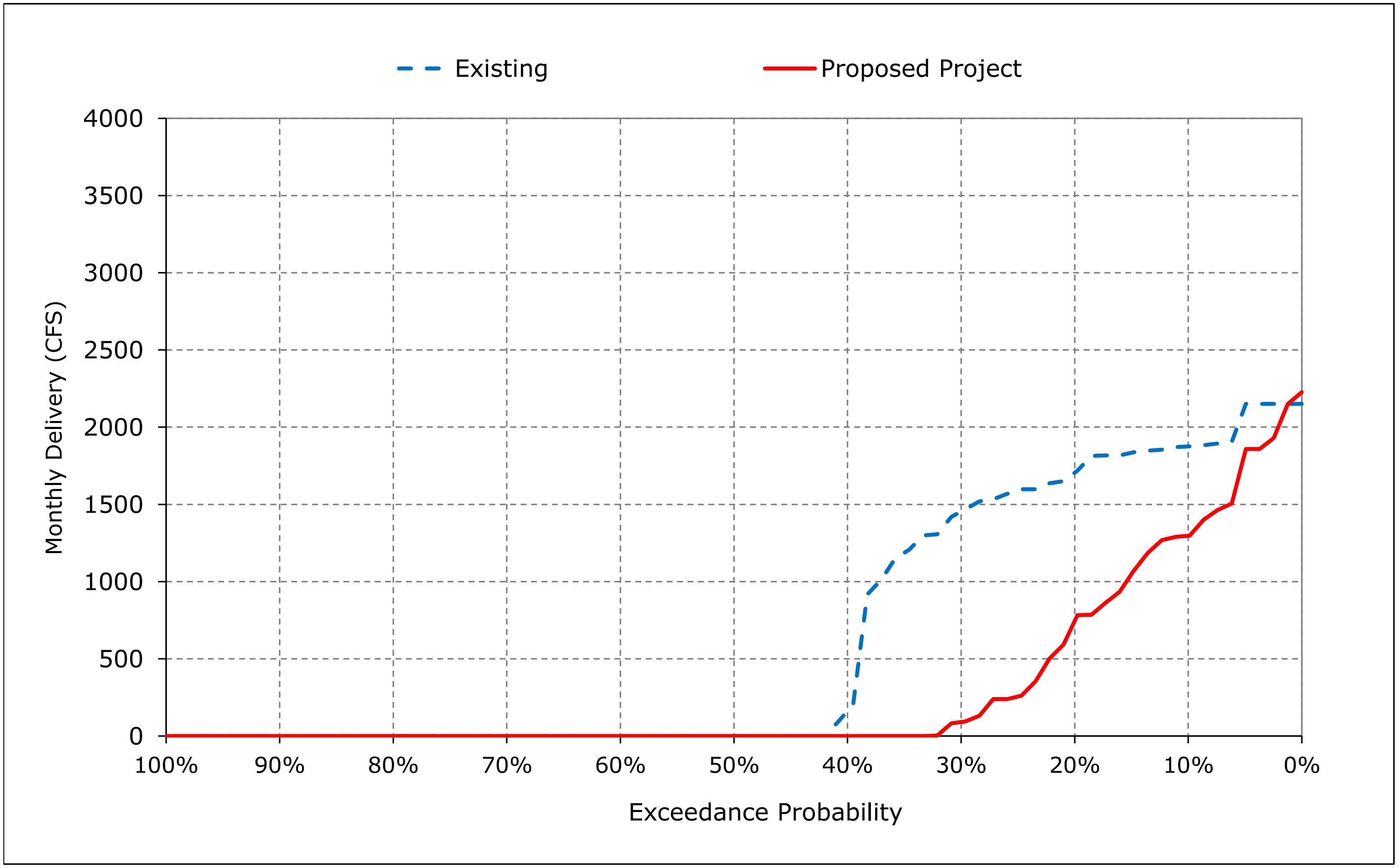


Figure 5-9. CVP Banks PP Exports, December

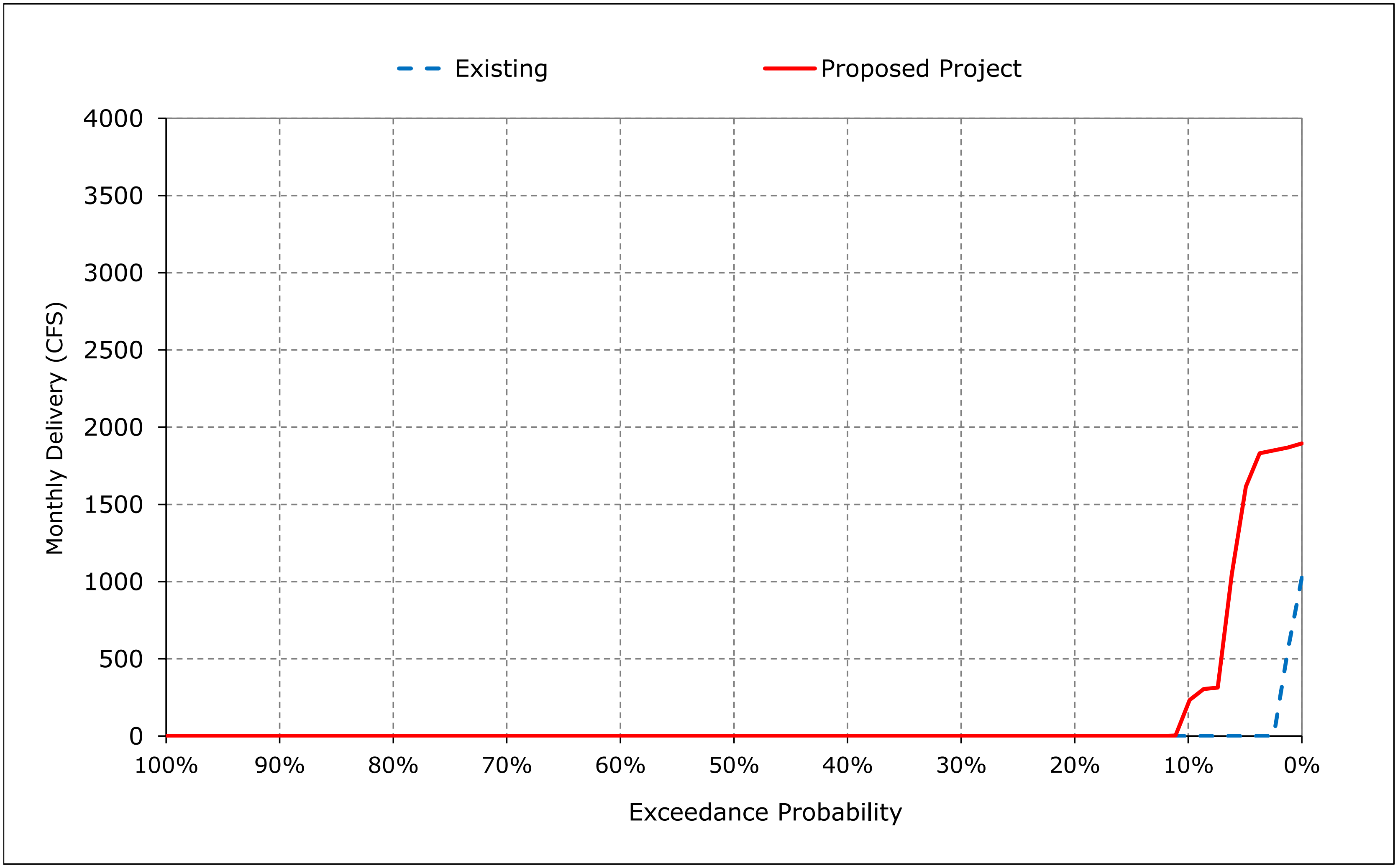


Figure 5-10. CVP Banks PP Exports, January

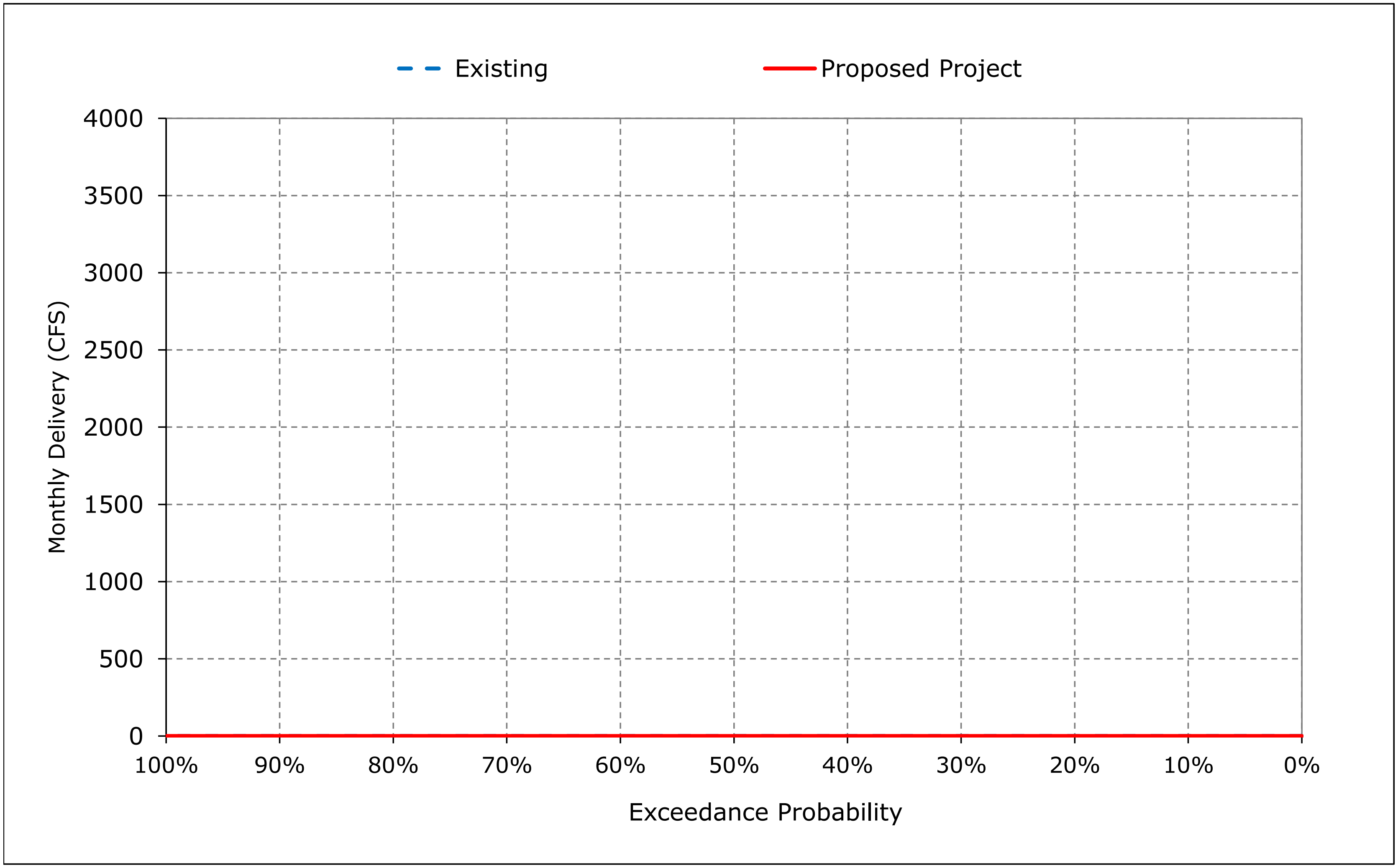


Figure 5-11. CVP Banks PP Exports, February

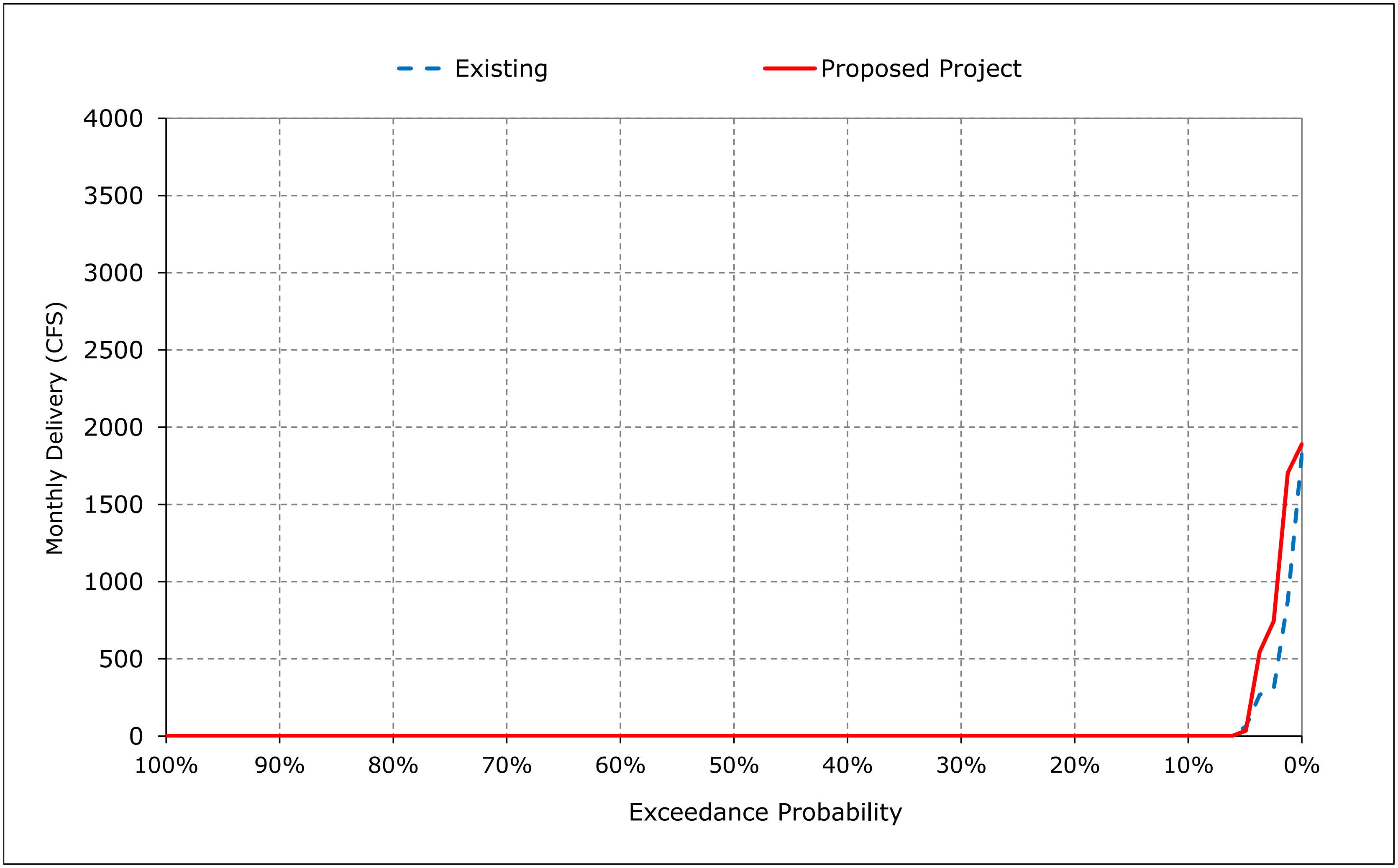


Figure 5-12. CVP Banks PP Exports, March

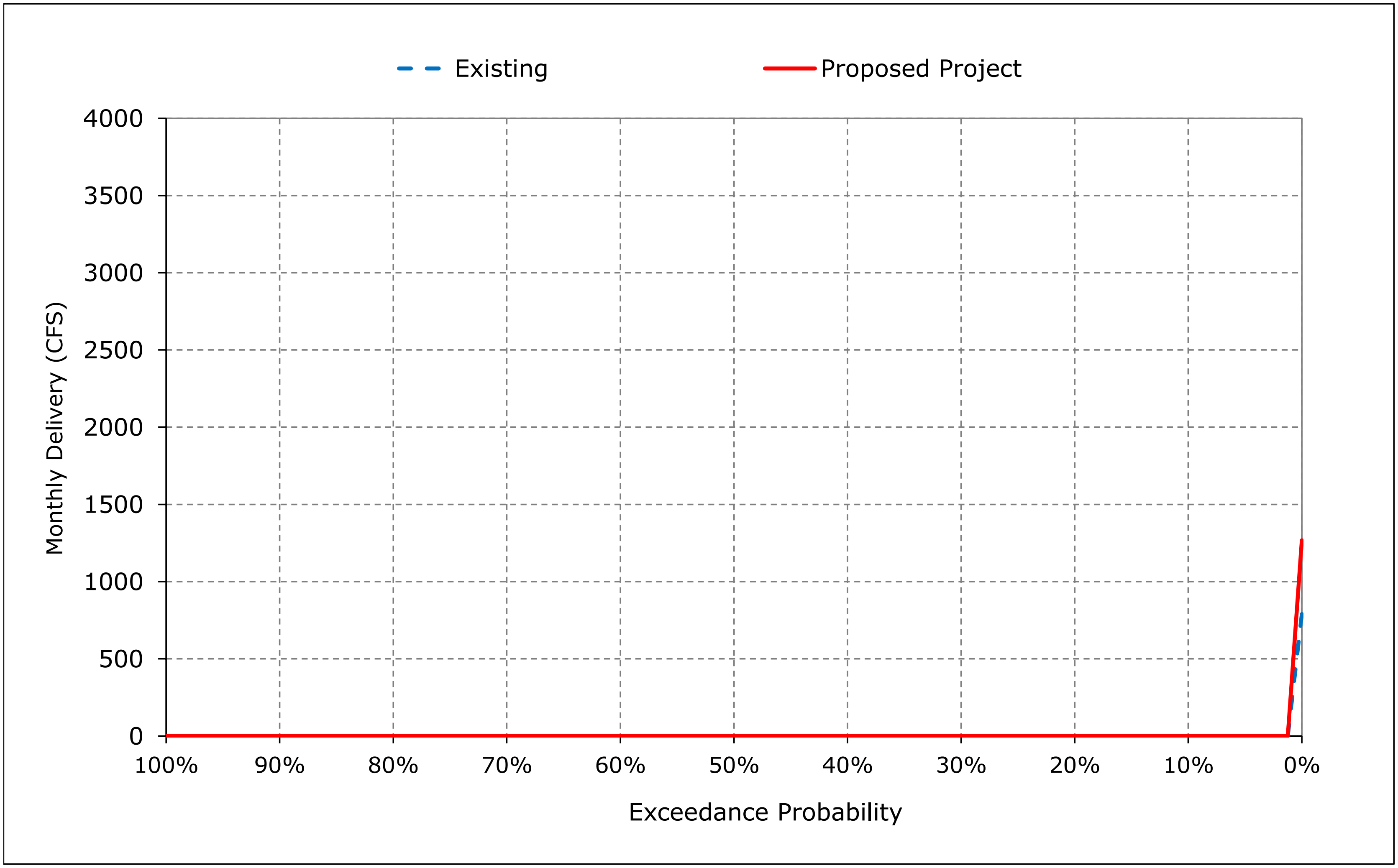


Figure 5-13. CVP Banks PP Exports, April

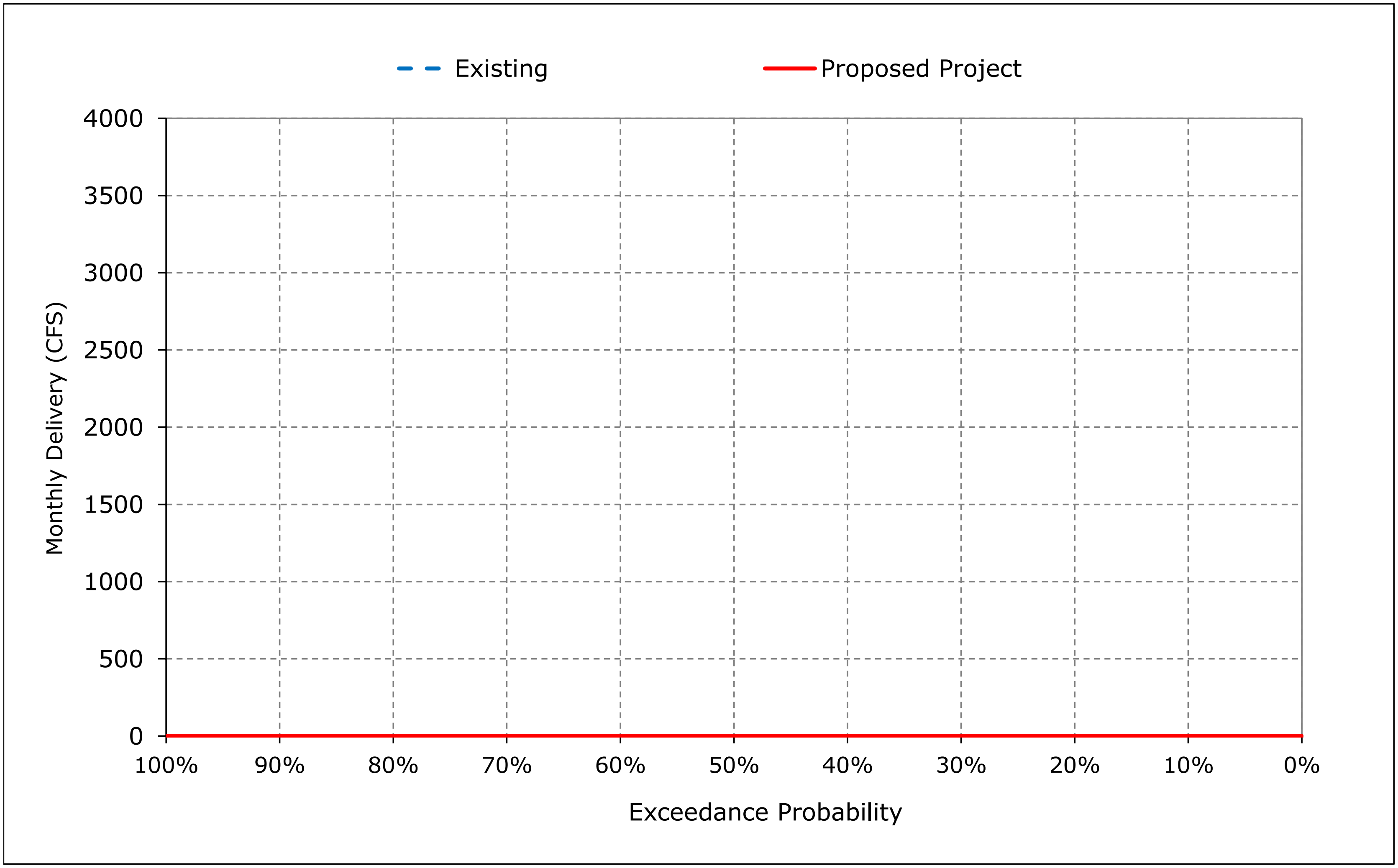


Figure 5-14. CVP Banks PP Exports, May

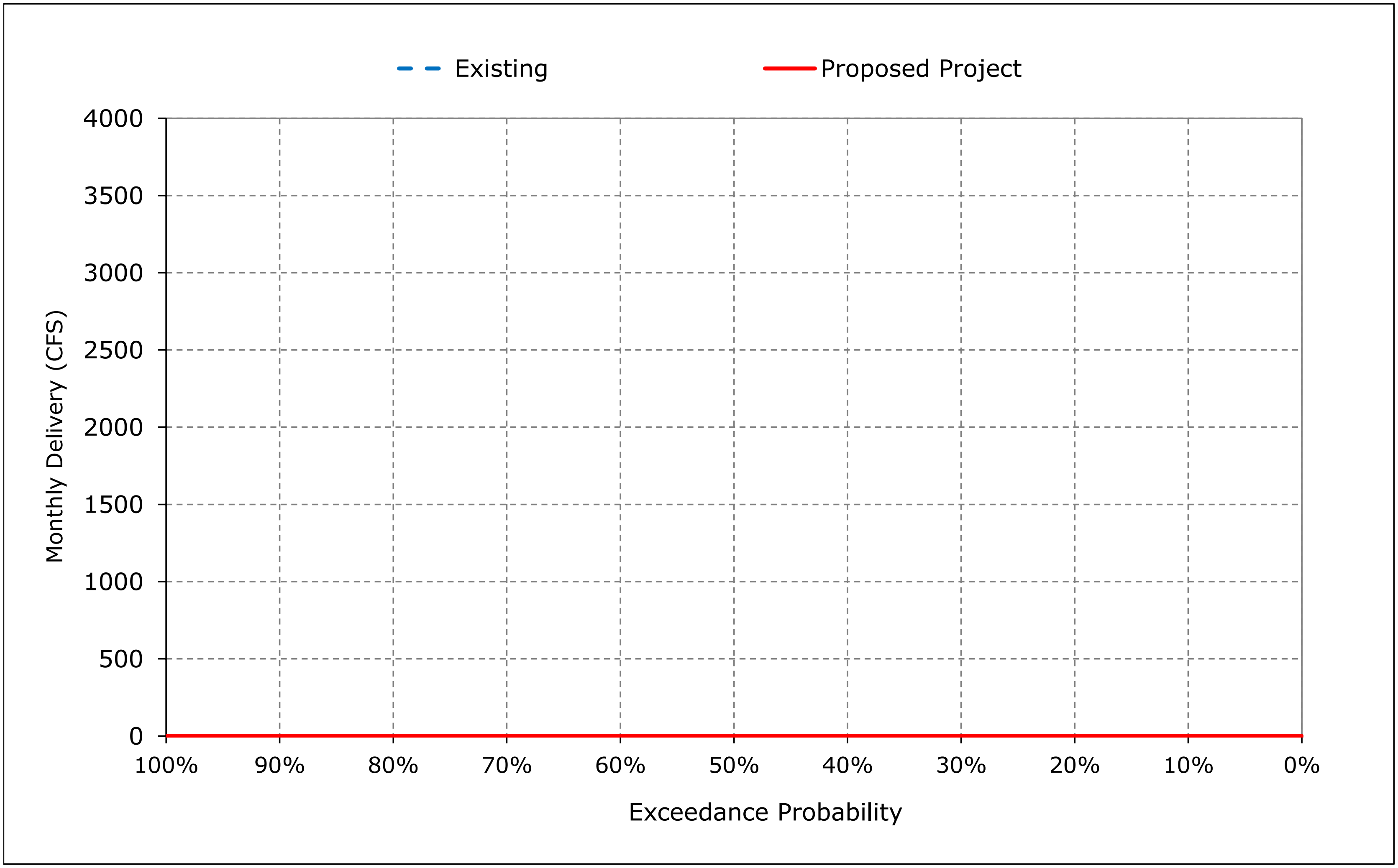


Figure 5-15. CVP Banks PP Exports, June

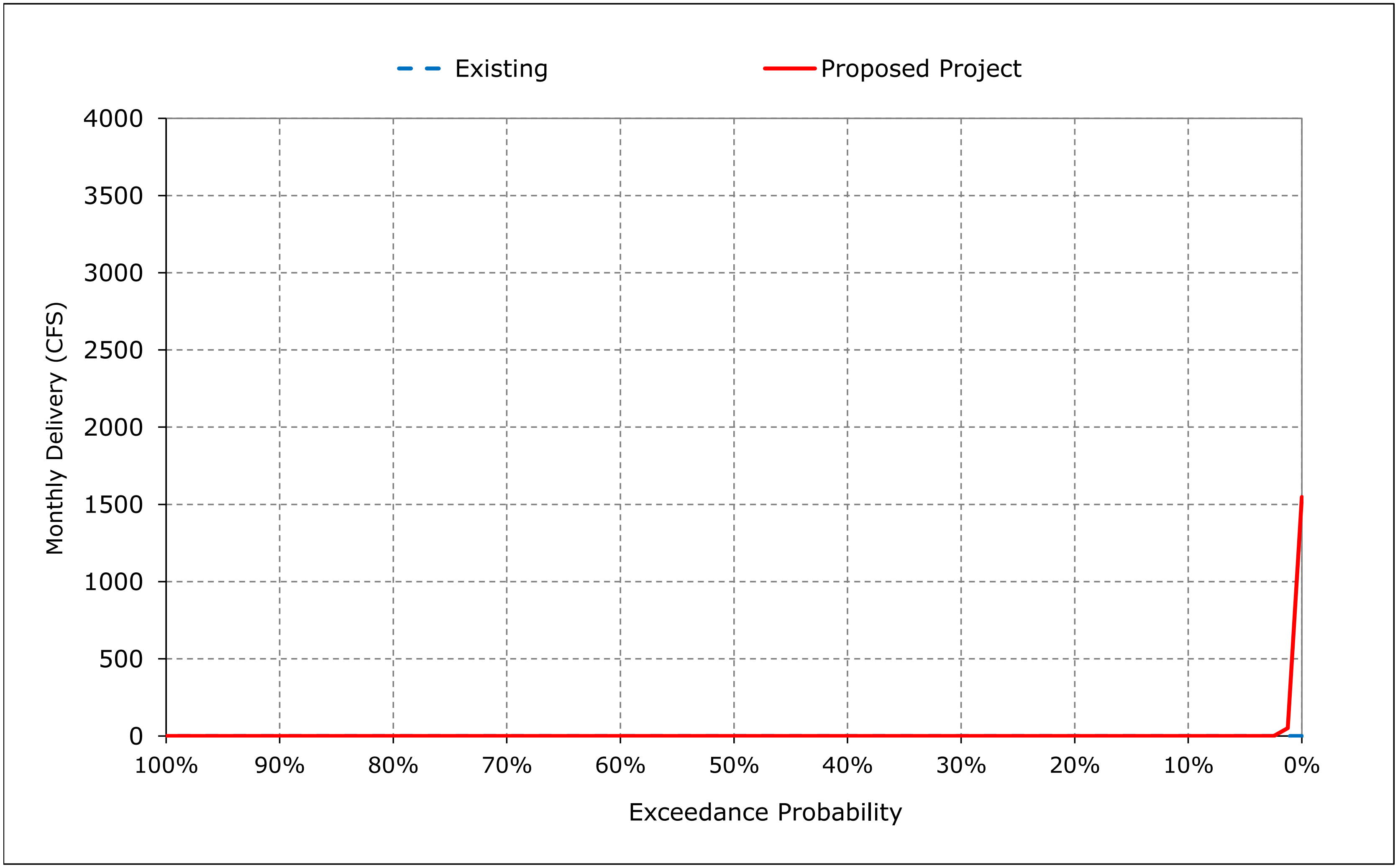


Figure 5-16. CVP Banks PP Exports, July

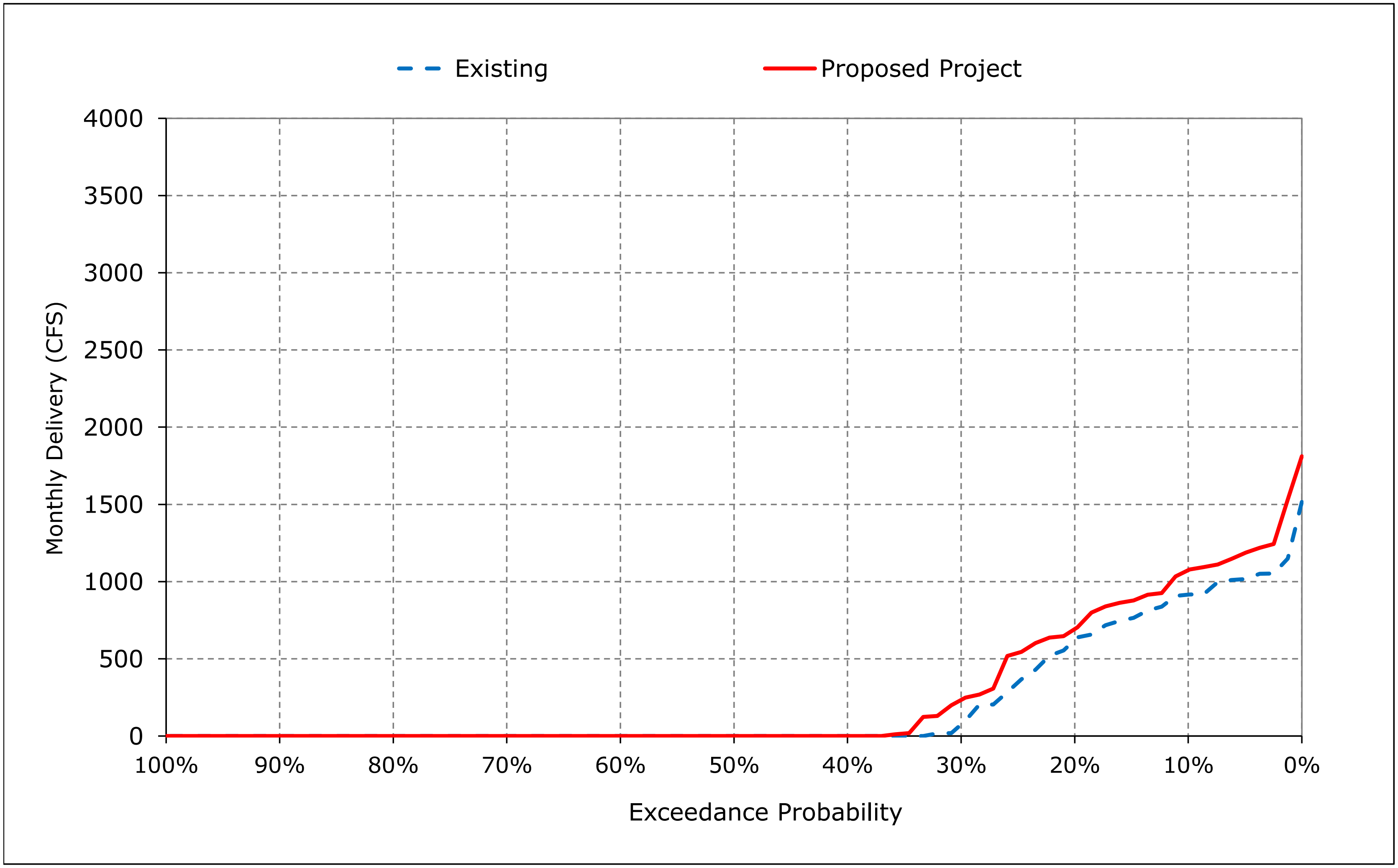


Figure 5-17. CVP Banks PP Exports, August

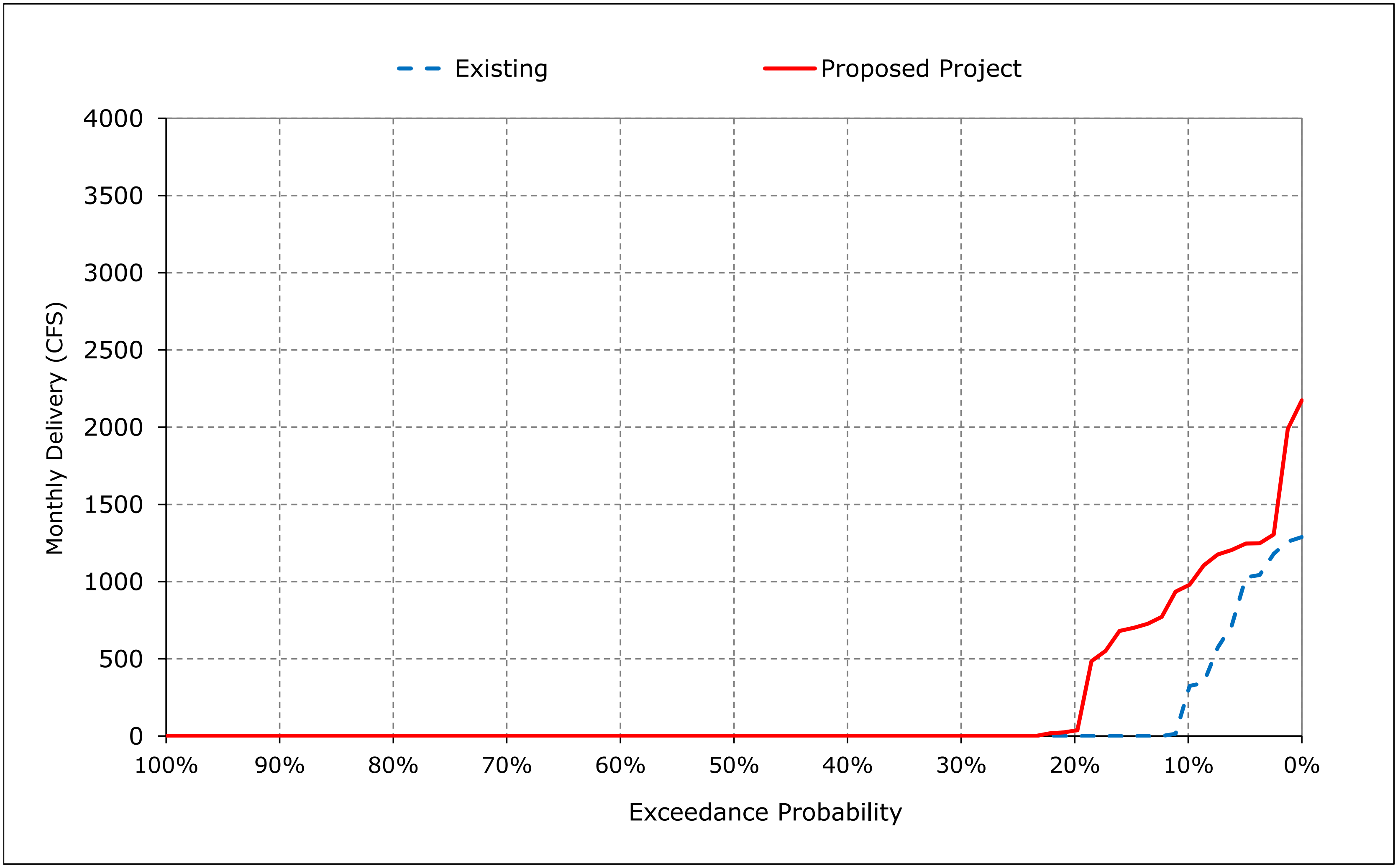


Figure 5-18. CVP Banks PP Exports, September

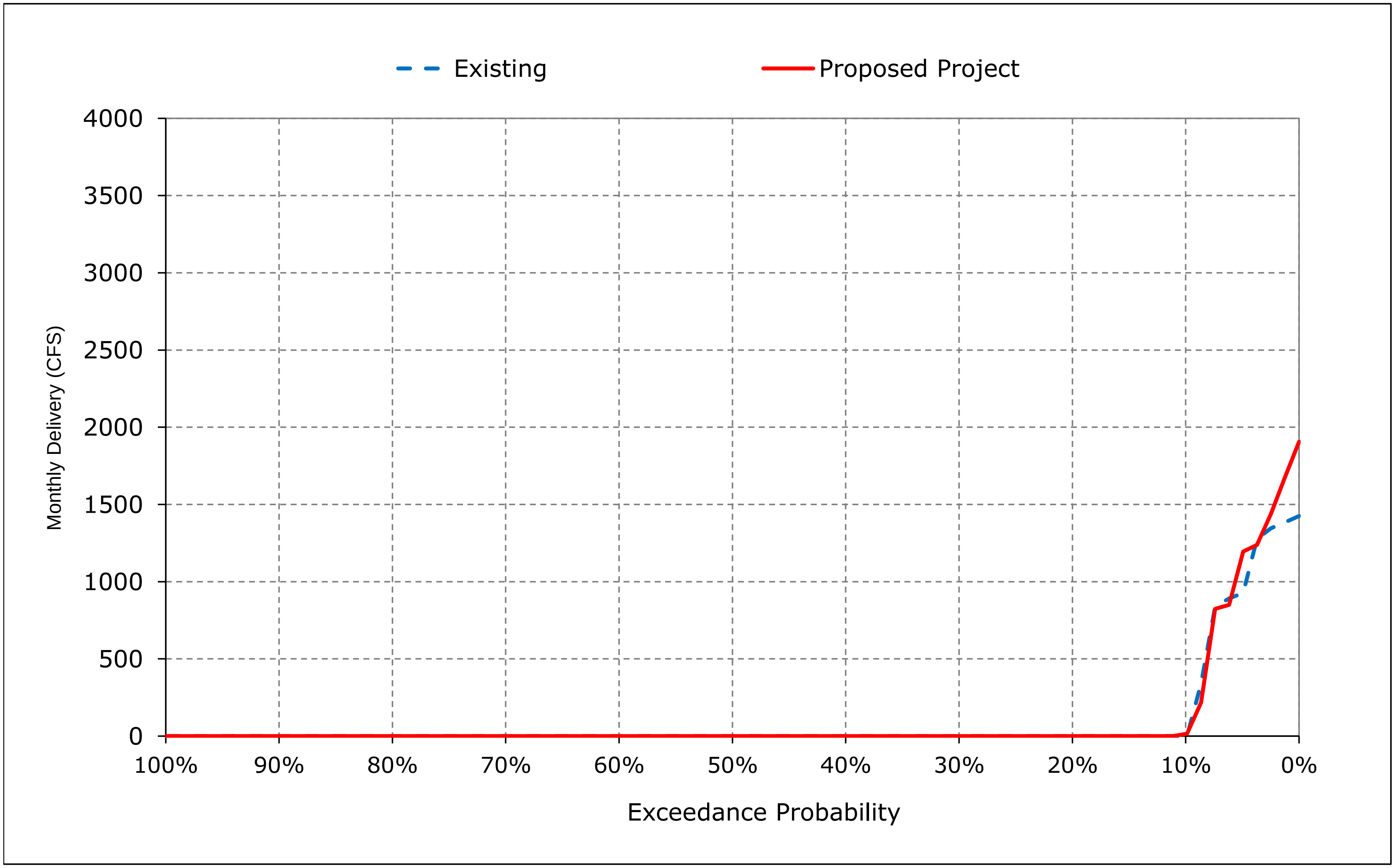


Table 6-1. Banks PP Exports, Monthly Delivery

Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Delivery (CFS)											
Probability of Exceedance												
10%	5,172	6,680	7,105	5,846	7,403	8,190	1,330	1,106	4,310	6,930	7,042	6,680
20%	4,189	6,460	7,043	3,432	5,331	5,223	935	766	3,083	6,903	7,008	6,680
30%	3,988	4,842	6,672	2,864	4,069	4,832	787	637	2,325	6,873	6,965	6,680
40%	3,576	4,299	4,565	2,770	3,356	3,773	712	600	2,119	6,782	6,930	6,680
50%	3,193	3,504	4,000	2,707	2,877	2,912	673	600	1,935	6,680	6,774	6,519
60%	2,882	3,106	3,487	2,621	2,689	2,634	606	600	1,848	6,680	6,680	4,063
70%	2,297	2,691	3,017	2,601	2,622	2,386	600	600	1,757	5,793	1,588	2,826
80%	1,813	2,277	2,819	2,485	2,559	2,249	600	600	1,663	4,160	628	2,543
90%	986	1,765	2,565	2,204	2,423	1,632	600	526	549	1,076	305	1,903
Long Term												
Full Simulation Period[a]	3,165	3,956	4,602	3,302	3,943	3,803	873	811	2,349	5,543	4,684	4,802
Water Year Types[b,c]												
Wet (32%)	3,688	4,850	4,542	4,574	5,413	5,783	1,264	1,270	3,555	6,722	6,901	6,617
Above Normal (15%)	3,152	3,621	5,362	3,151	4,187	3,956	706	656	2,482	6,513	6,990	6,680
Below Normal (17%)	3,198	4,171	4,908	2,768	3,891	3,682	672	632	2,049	6,892	6,775	5,404
Dry (22%)	2,902	3,799	4,607	2,692	2,683	2,427	695	628	1,721	4,996	1,105	2,748
Critical (15%)	2,400	2,341	3,610	2,234	2,464	1,566	692	454	894	1,268	503	1,372

Proposed Project

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Delivery (CFS)											
Probability of Exceedance												
10%	6,481	6,680	7,110	5,534	7,795	6,357	3,972	4,558	4,318	6,935	7,038	6,680
20%	5,257	6,680	7,048	3,861	5,633	4,169	3,189	3,539	3,243	6,903	6,977	6,680
30%	4,549	6,680	6,994	3,214	4,321	3,582	2,859	2,810	2,461	6,868	6,945	6,680
40%	4,070	6,680	5,049	2,914	3,517	3,065	2,523	2,390	2,003	6,692	6,902	6,680
50%	3,725	6,057	4,047	2,837	3,031	2,655	2,305	2,144	1,898	6,680	6,680	5,283
60%	3,095	5,079	3,476	2,748	2,874	2,243	1,999	1,602	1,795	6,612	5,567	3,888
70%	2,412	3,730	2,960	2,642	2,634	2,029	1,714	1,405	1,738	5,518	1,586	2,820
80%	1,933	2,979	2,817	2,526	2,518	1,821	1,453	904	1,656	3,077	594	2,519
90%	1,009	2,171	2,574	2,216	2,371	1,623	1,078	451	404	1,144	332	1,820
Long Term												
Full Simulation Period[a]	3,609	5,022	4,665	3,357	4,006	3,233	2,353	2,225	2,326	5,388	4,666	4,655
Water Year Types[b,c]												
Wet (32%)	4,279	6,280	4,558	4,358	5,543	4,994	3,241	3,393	3,511	6,648	6,841	6,337
Above Normal (15%)	3,833	4,808	5,458	3,184	3,996	3,092	2,669	2,702	2,477	6,611	6,854	6,555
Below Normal (17%)	3,585	5,194	5,066	2,946	4,013	3,046	2,515	2,221	2,023	6,501	6,514	5,119
Dry (22%)	3,259	4,327	4,941	2,931	2,801	1,965	1,636	1,334	1,692	4,522	1,244	2,710
Critical (15%)	2,484	3,354	3,221	2,480	2,486	1,678	999	559	911	1,433	746	1,483

Proposed Project minus Existing

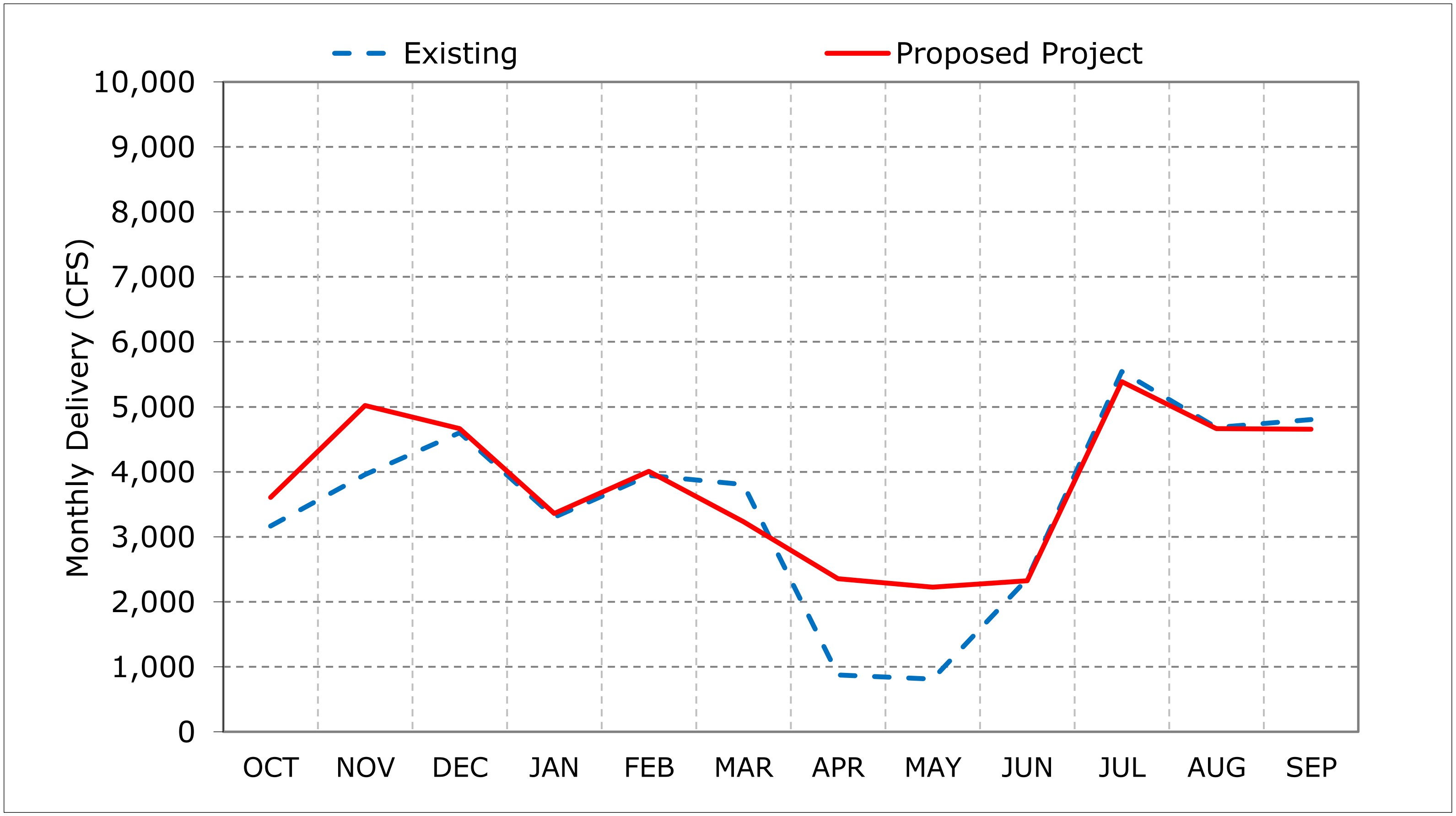
Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Delivery (CFS)											
Probability of Exceedance												
10%	1,309	0	5	**-312**	393	**-1,834**	2,642	3,452	8	6	**-5**	0
20%	1,068	220	5	429	302	**-1,054**	2,254	2,773	161	0	**-31**	0
30%	560	1,838	323	350	252	**-1,250**	2,072	2,173	137	**-6**	**-20**	0
40%	494	2,381	484	144	161	**-707**	1,810	1,790	**-115**	**-91**	**-28**	0
50%	532	2,553	47	130	154	**-257**	1,632	1,544	**-37**	0	**-94**	**-1,236**
60%	213	1,973	**-11**	126	185	**-391**	1,393	1,002	**-54**	**-68**	**-1,113**	**-175**
70%	115	1,039	**-56**	41	11	**-356**	1,114	805	**-20**	**-275**	**-2**	**-6**
80%	120	702	**-1**	42	**-42**	**-429**	853	304	**-8**	**-1,083**	**-35**	**-24**
90%	23	406	9	12	**-52**	**-9**	478	**-76**	**-145**	68	26	**-83**
Long Term												
Full Simulation Period[a]	444	1,066	63	55	63	**-570**	1,480	1,414	**-23**	**-156**	**-18**	**-148**
Water Year Types[b,c]												
Wet (32%)	591	1,430	16	**-216**	130	**-789**	1,977	2,123	**-44**	**-74**	**-60**	**-280**
Above Normal (15%)	682	1,186	96	33	**-190**	**-864**	1,963	2,046	**-5**	98	**-136**	**-125**
Below Normal (17%)	387	1,023	158	178	122	**-636**	1,844	1,590	**-25**	**-391**	**-262**	**-285**
Dry (22%)	357	528	334	239	118	**-462**	941	706	**-29**	**-474**	139	**-38**
Critical (15%)	84	1,013	**-389**	246	23	112	306	105	18	165	243	111

a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

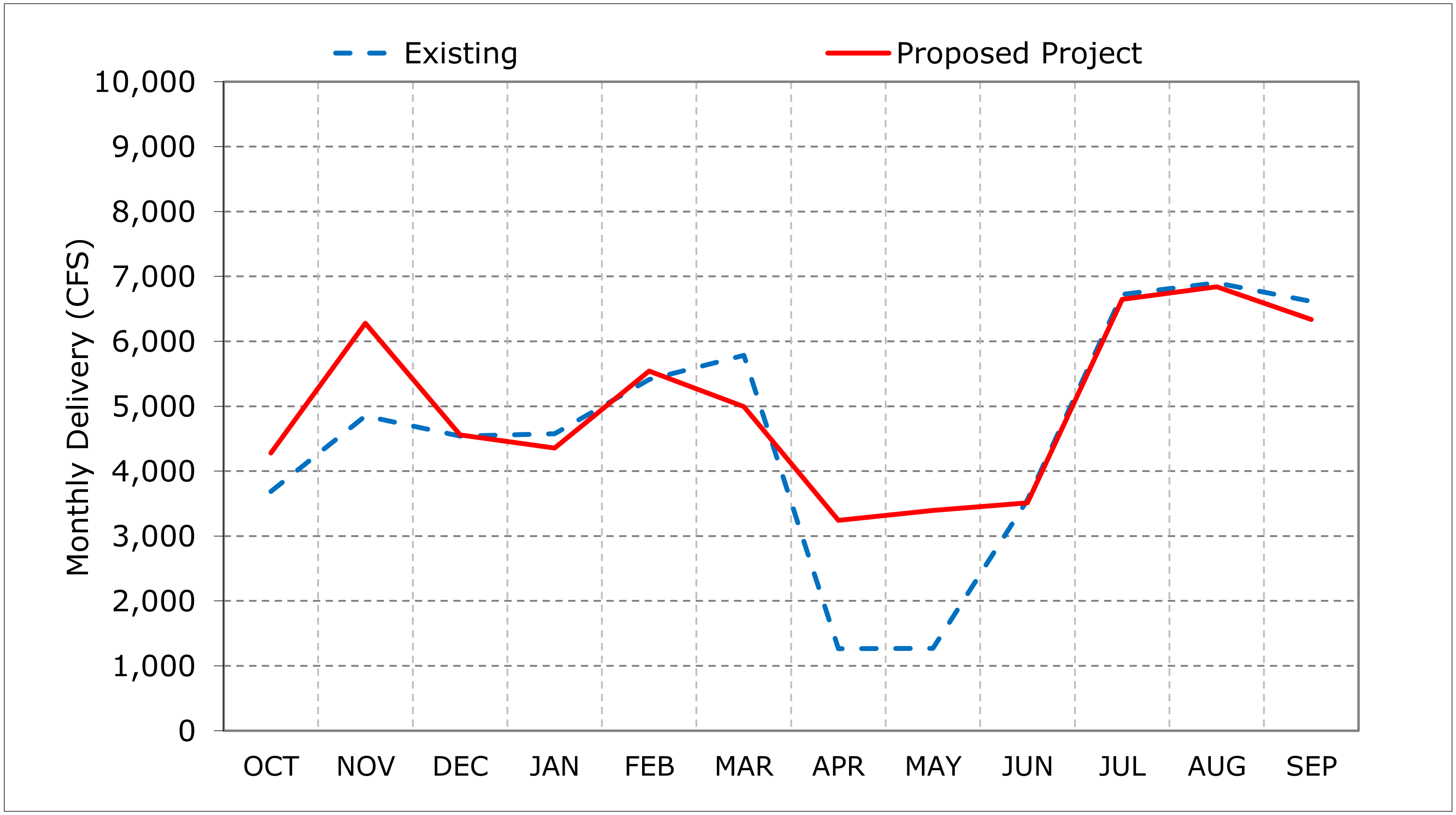
c These results are displayed with water year - year type sorting.

Figure 6-1. Banks PP Exports, Long-Term Average Delivery



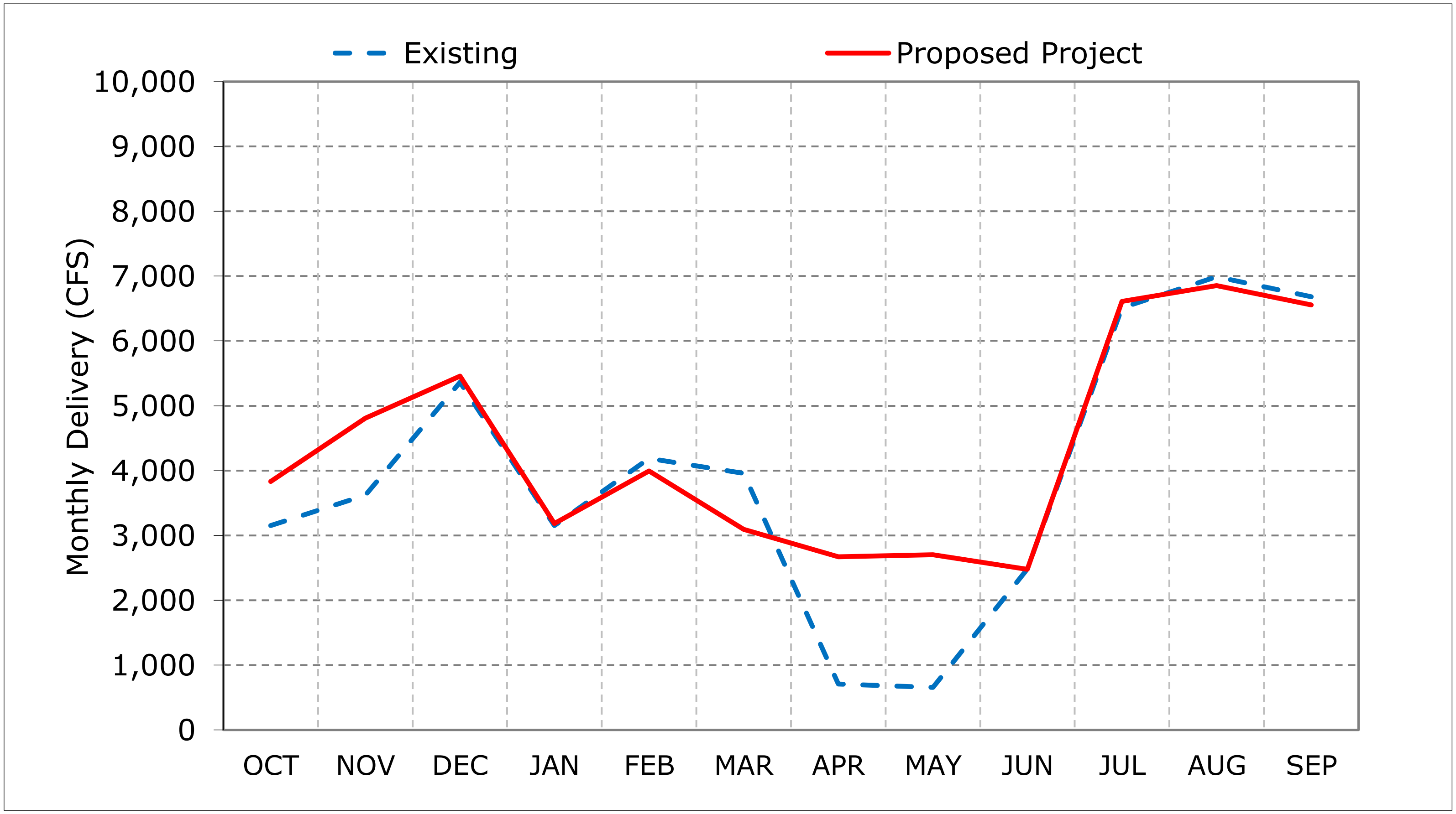
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 6-2. Banks PP Exports, Wet Year Average Delivery



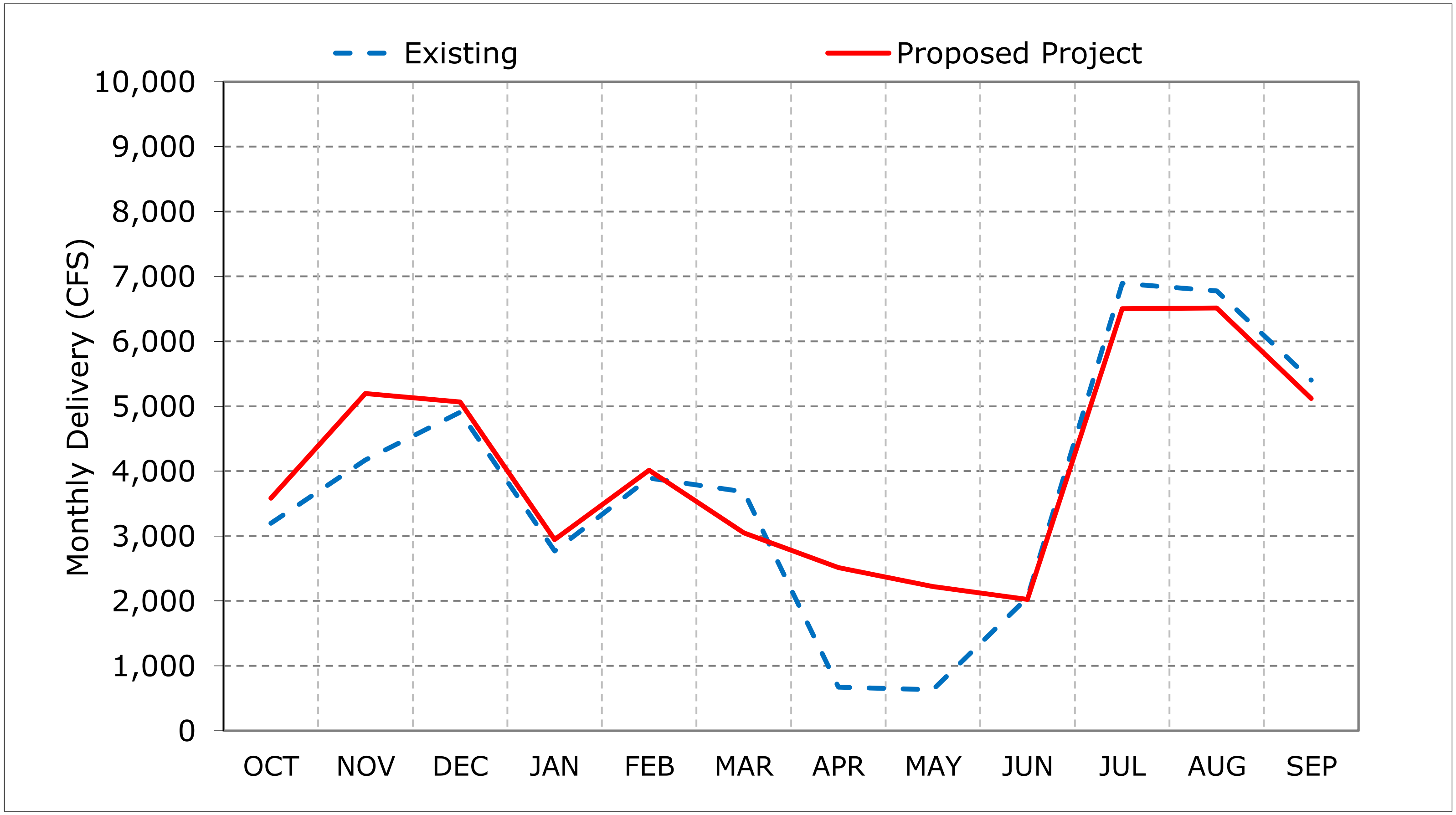
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 6-3. Banks PP Exports, Above Normal Year Average Delivery



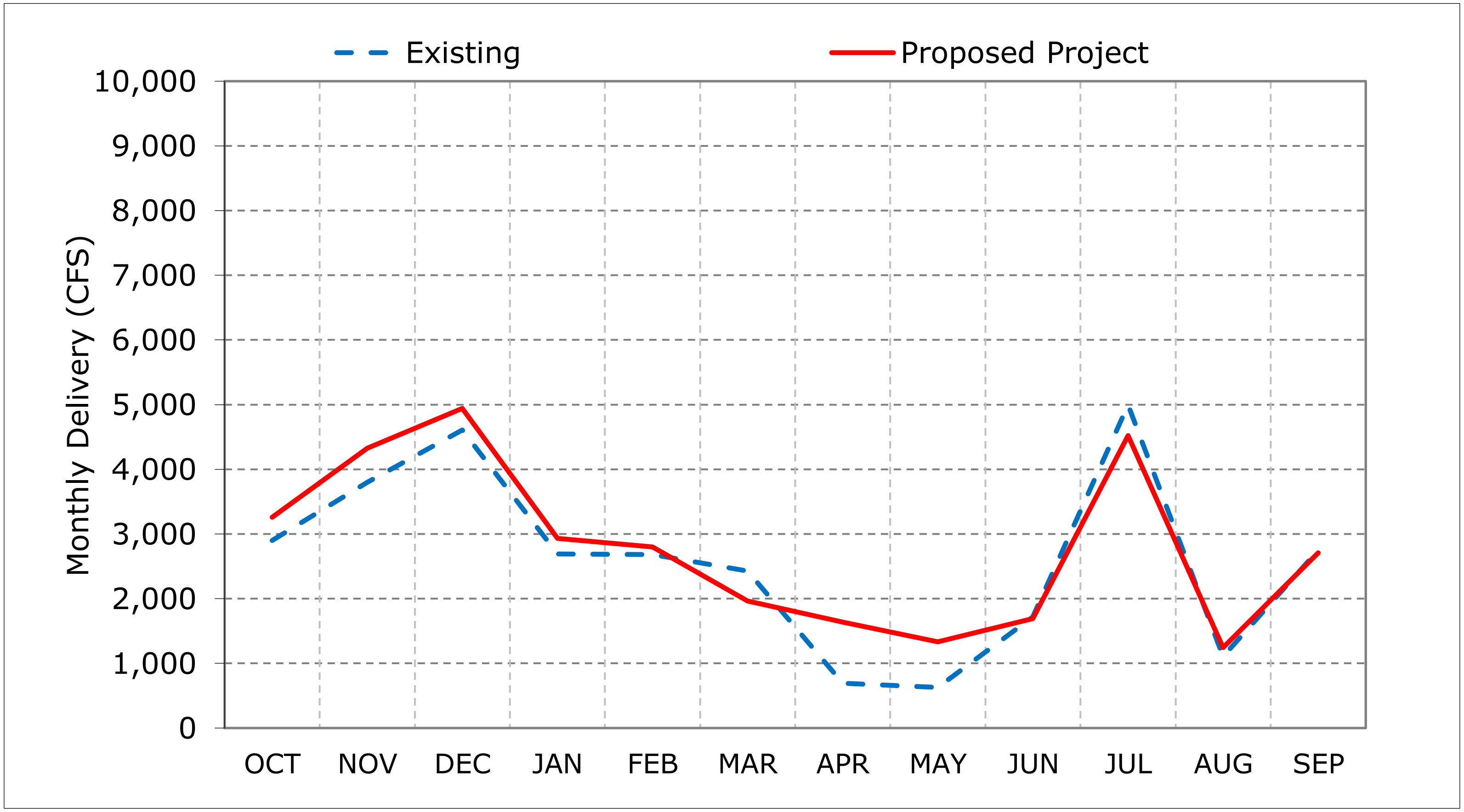
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 6-4. Banks PP Exports, Below Normal Year Average Delivery



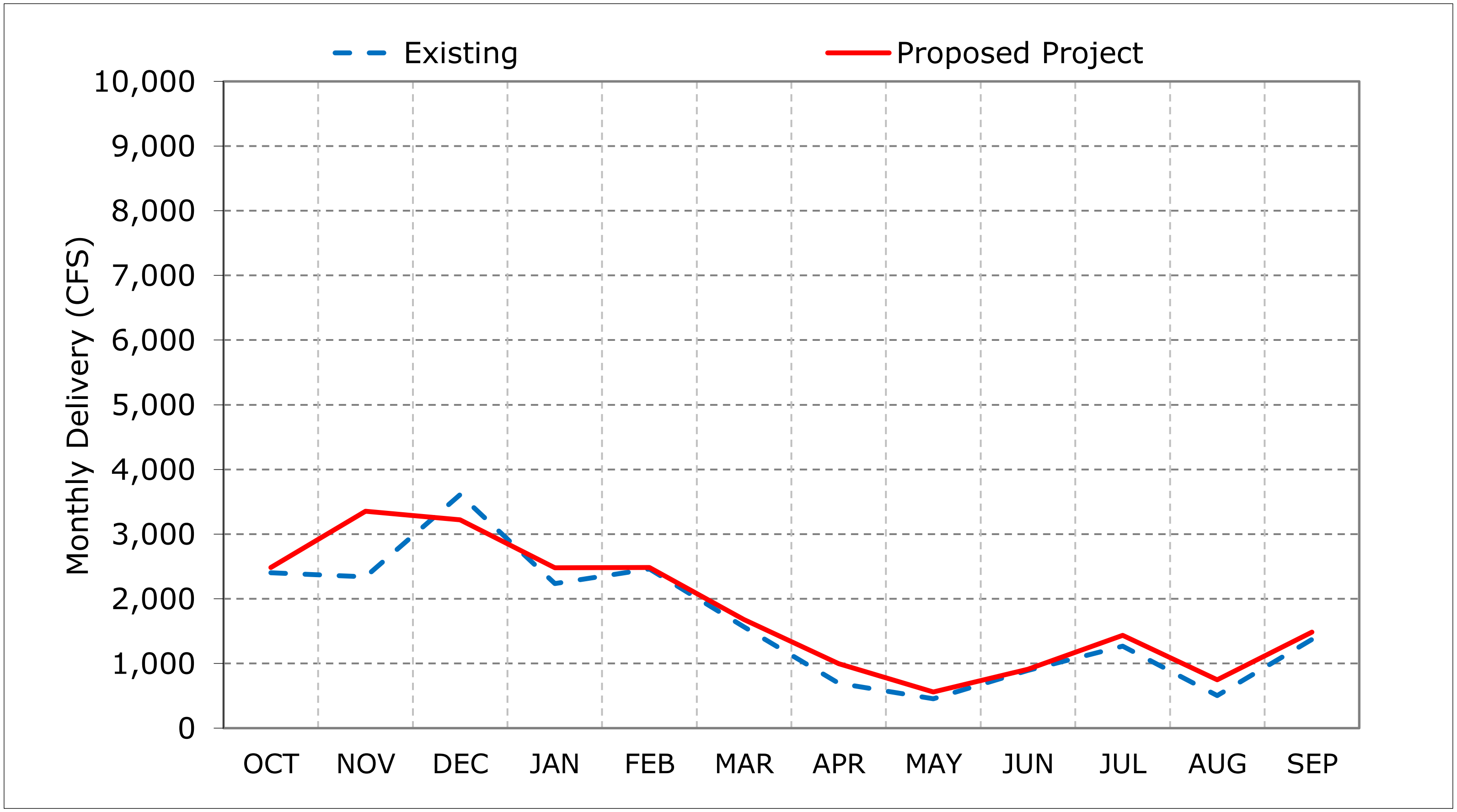
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 6-5. Banks PP Exports, Dry Year Average Delivery



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 6-6. Banks PP Exports, Critical Year Average Delivery



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 6-7. Banks PP Exports, October

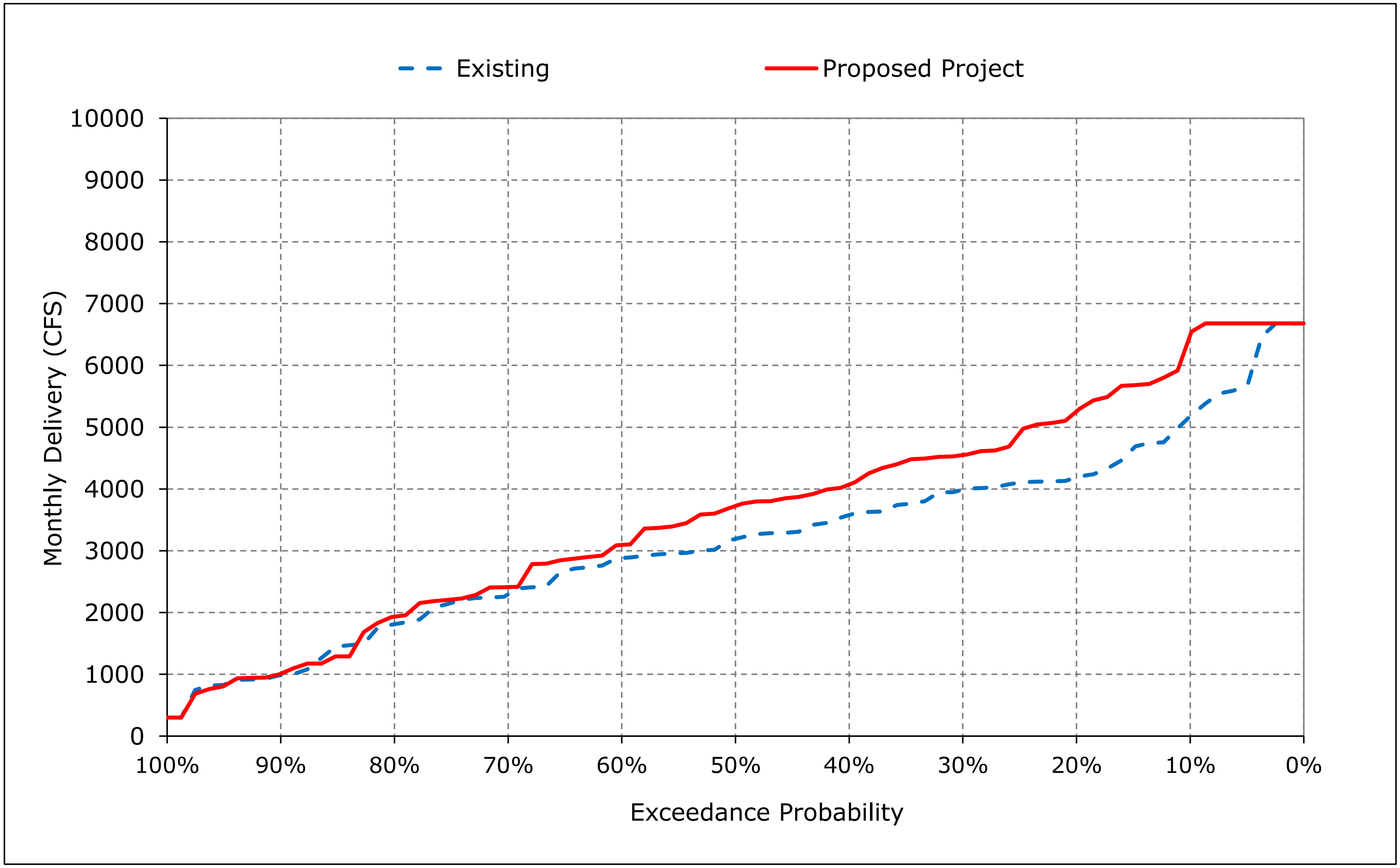


Figure 6-8. Banks PP Exports, November

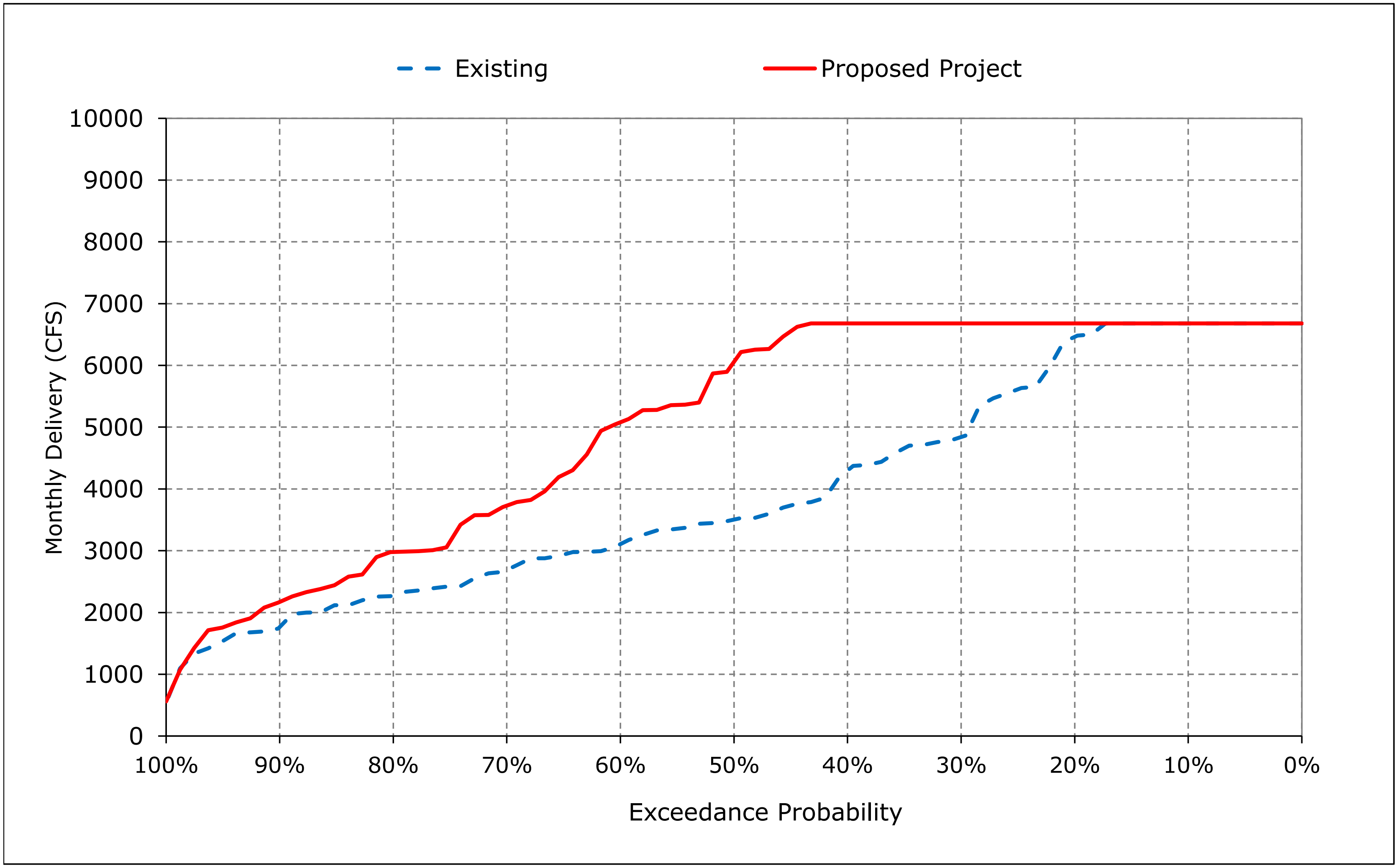


Figure 6-9. Banks PP Exports, December

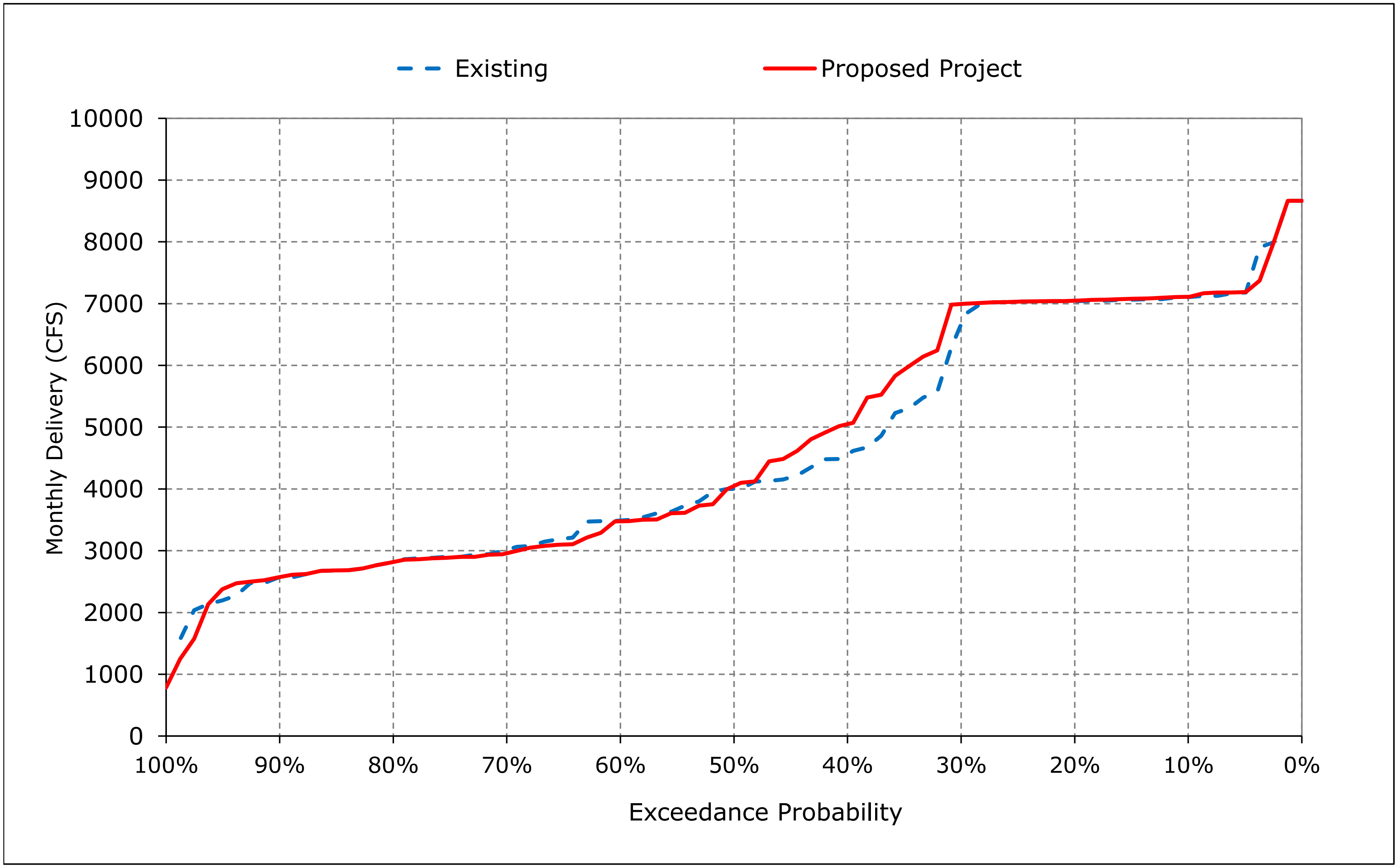


Figure 6-10. Banks PP Exports, January

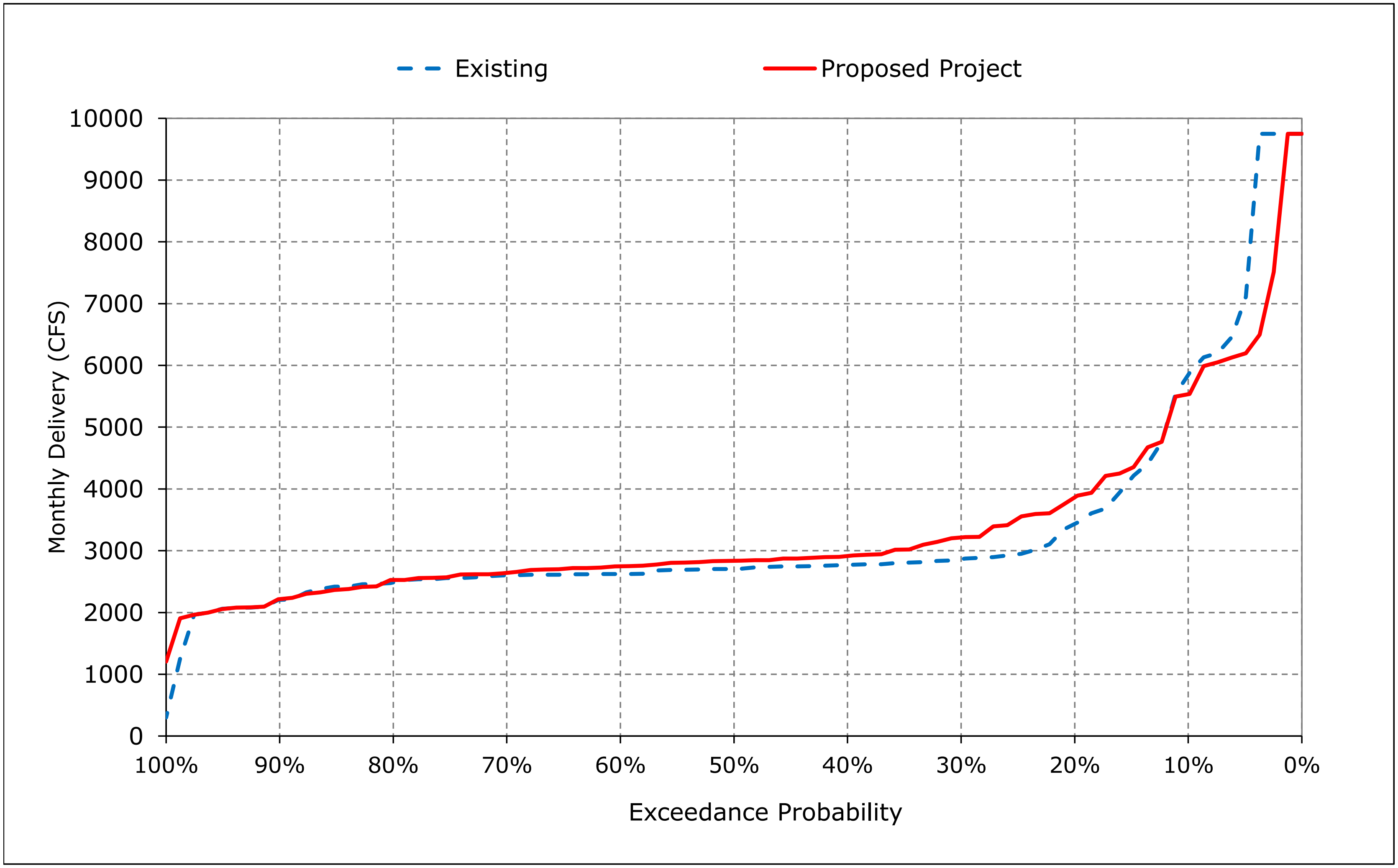


Figure 6-11. Banks PP Exports, February

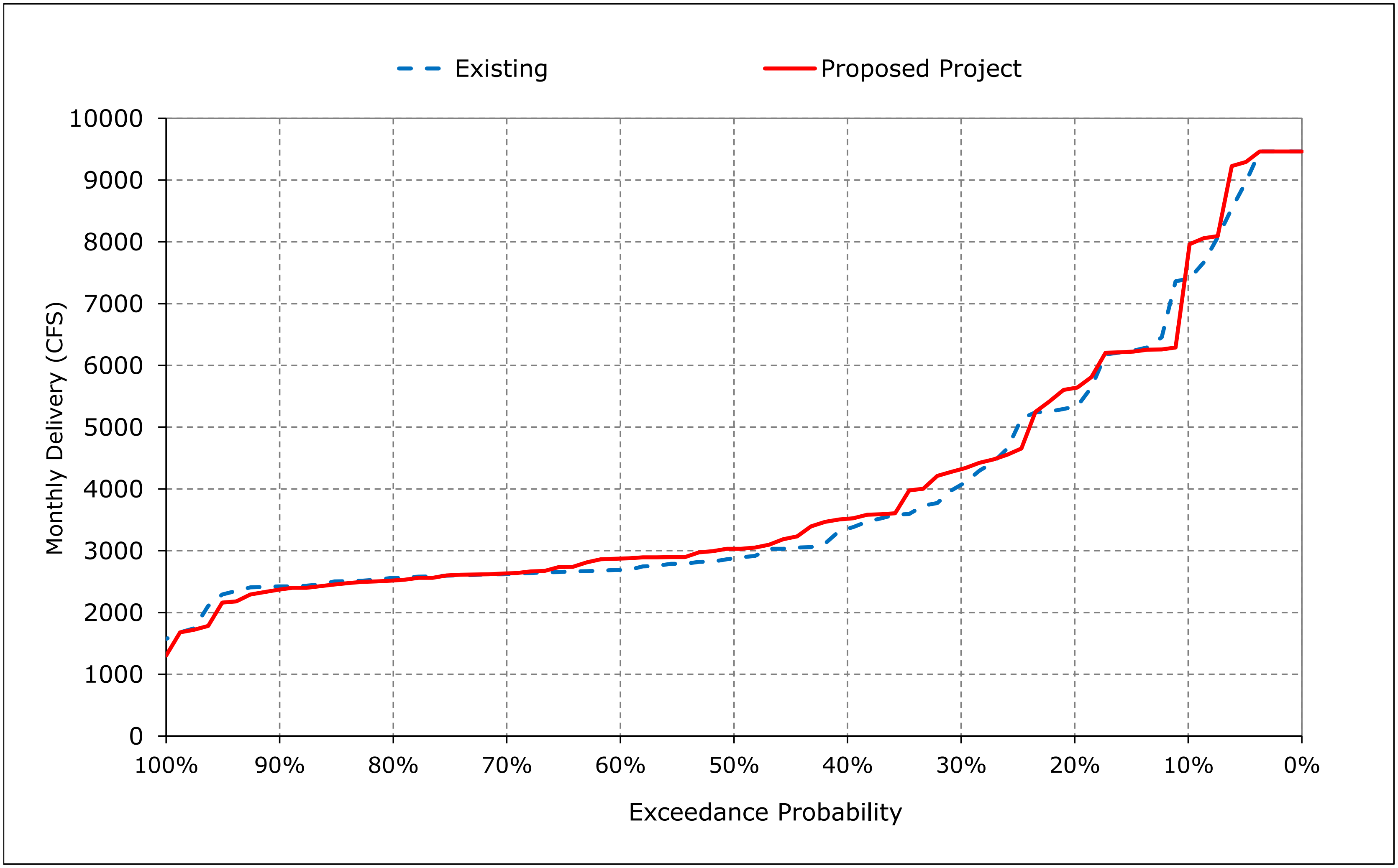


Figure 6-12. Banks PP Exports, March

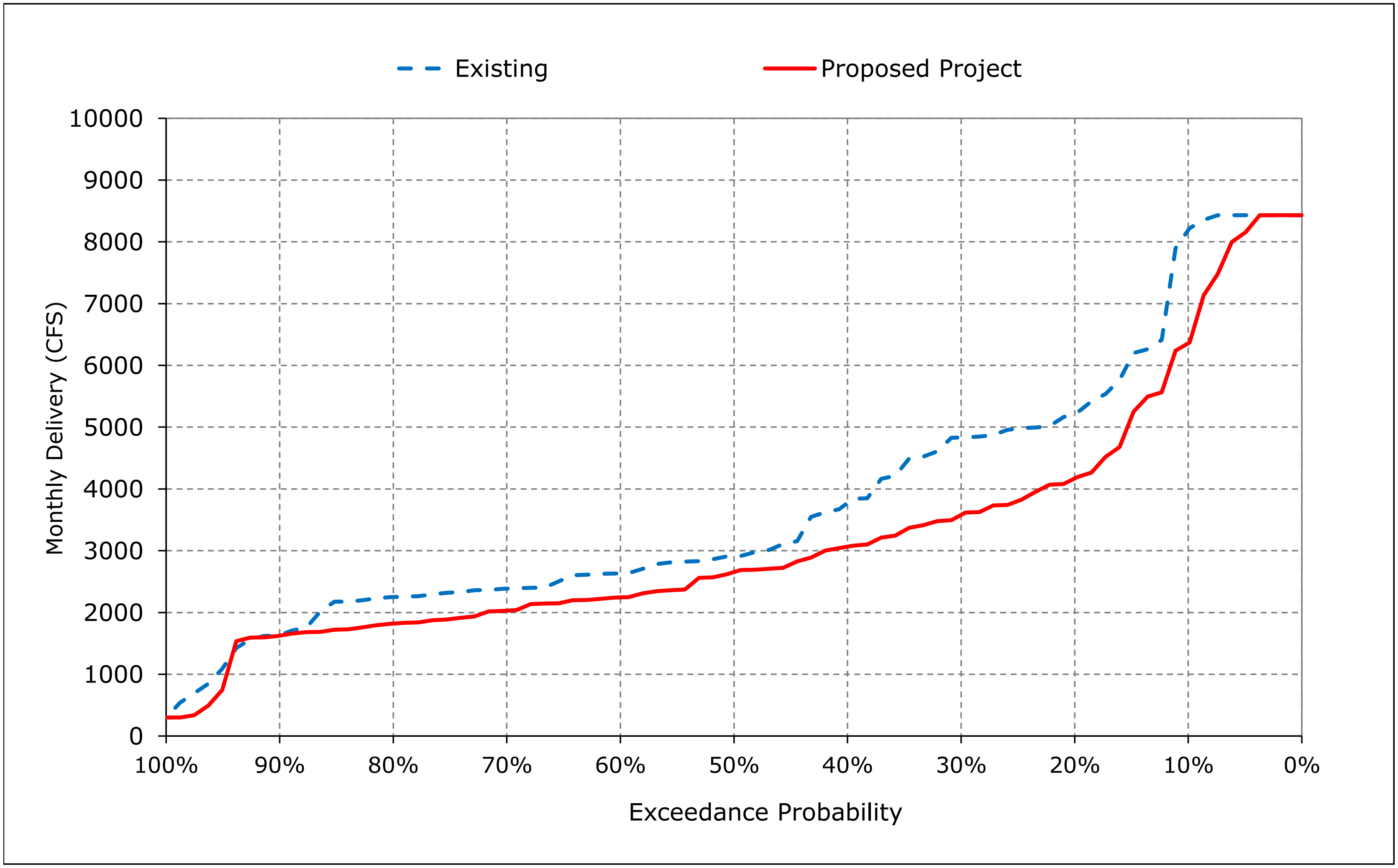


Figure 6-13. Banks PP Exports, April

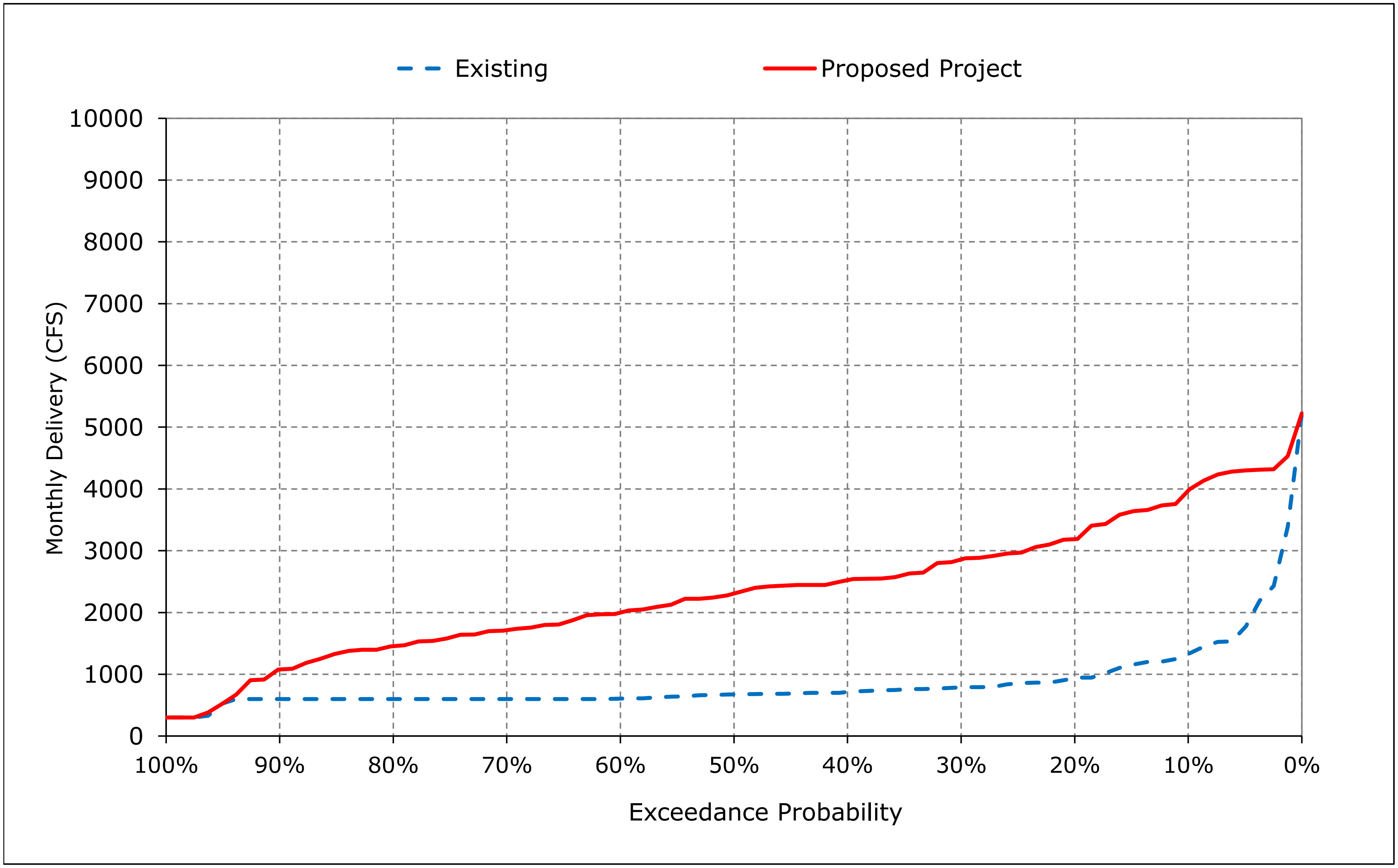


Figure 6-14. Banks PP Exports, May

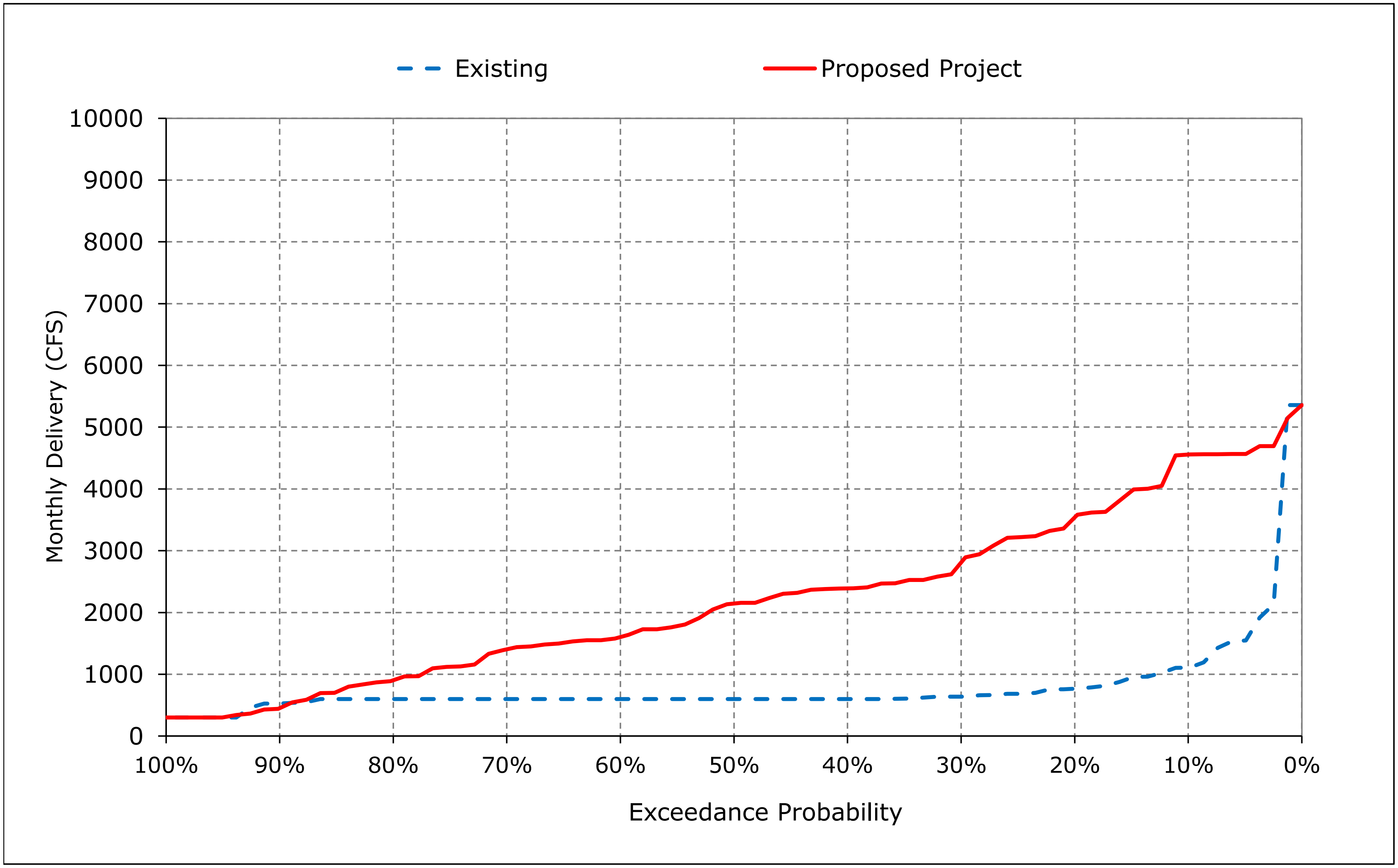


Figure 6-15. Banks PP Exports, June

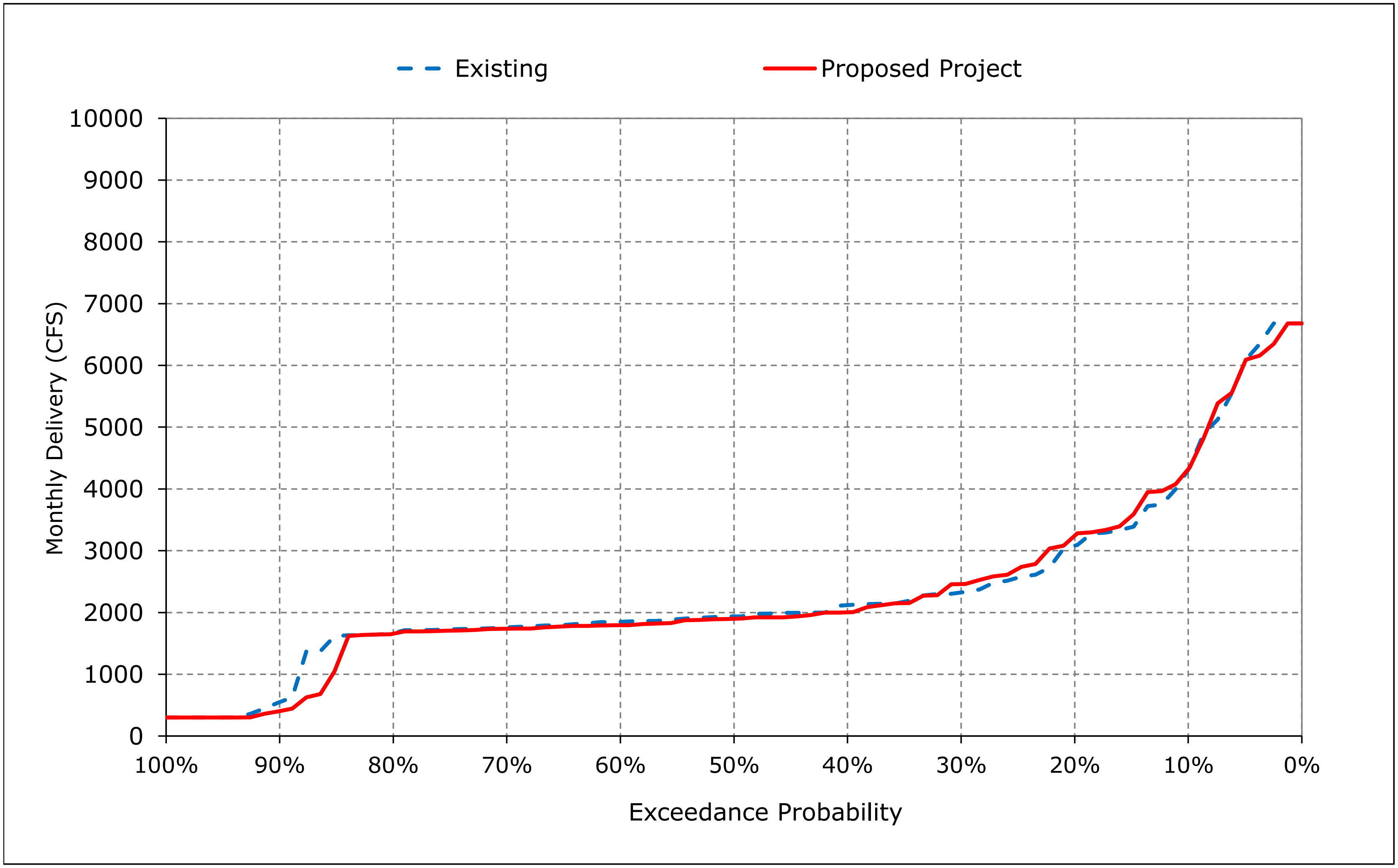


Figure 6-16. Banks PP Exports, July

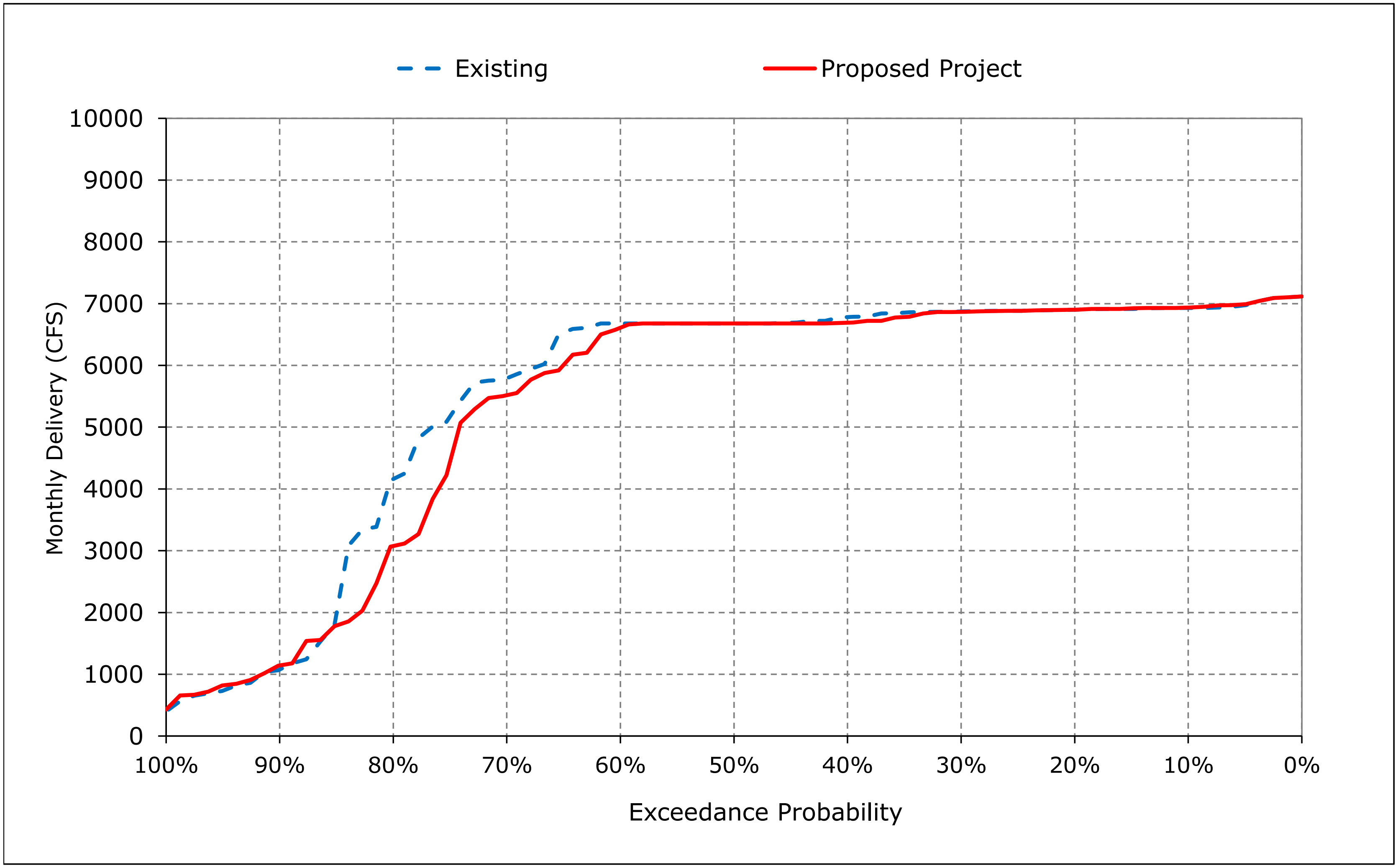


Figure 6-17. Banks PP Exports, August

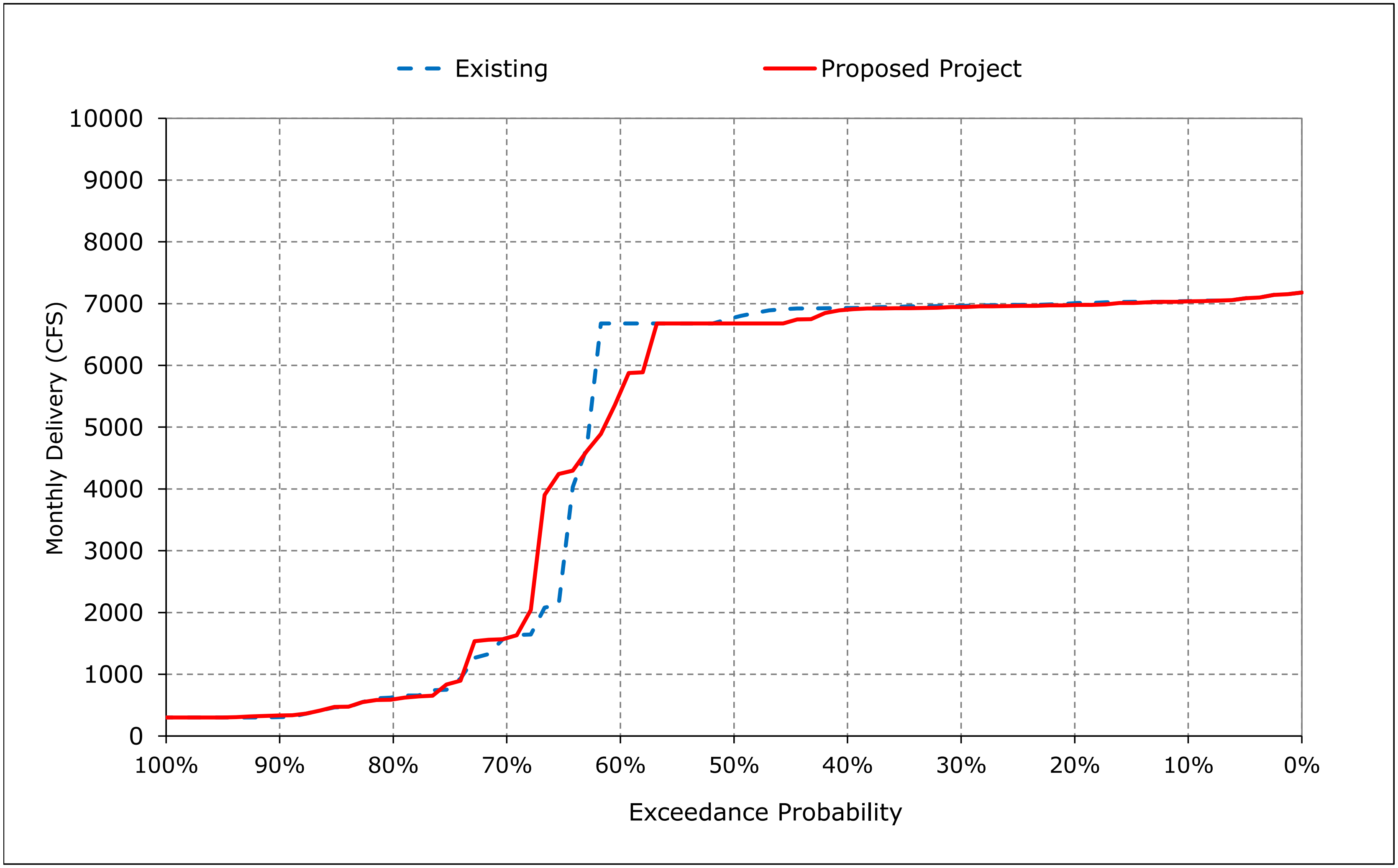


Figure 6-18. Banks PP Exports, September

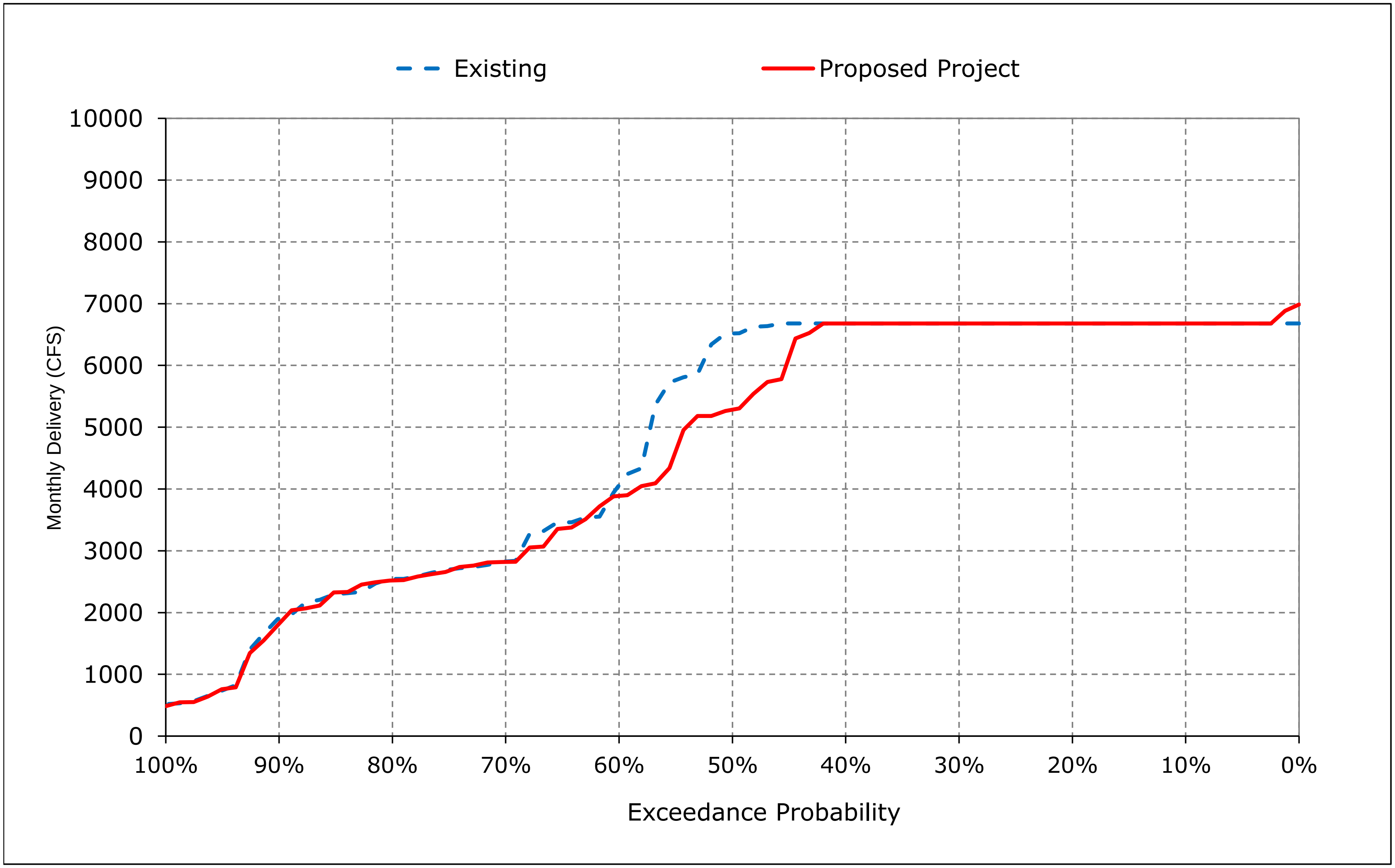


Table 7-1. Jones PP Exports, Monthly Delivery

Existing

	Monthly Delivery (CFS)											
Statistic	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Probability of Exceedance												
10%	4,600	4,600	4,600	4,600	4,600	4,600	1,804	1,659	4,600	4,600	4,600	4,600
20%	4,393	4,600	4,600	4,600	4,600	4,371	1,341	1,346	4,433	4,600	4,600	4,600
30%	4,114	4,579	4,600	4,287	4,600	4,031	1,165	1,172	3,703	4,600	4,600	4,600
40%	3,631	4,201	4,411	4,134	4,386	3,809	1,043	975	3,491	4,397	4,600	4,524
50%	3,499	3,913	4,327	4,049	4,184	3,534	948	900	3,408	3,972	4,241	4,443
60%	3,337	3,333	4,174	3,929	3,986	3,377	900	900	3,237	3,465	3,919	4,293
70%	3,189	2,639	3,987	3,864	3,896	3,115	900	900	3,179	3,235	3,650	3,979
80%	3,064	2,063	3,614	3,685	3,762	2,552	900	900	2,728	2,110	3,198	3,544
90%	2,878	1,760	2,571	3,122	3,607	1,913	820	900	1,820	1,385	2,175	3,088
Long Term												
Full Simulation Period[a]	3,573	3,430	3,990	3,972	4,115	3,429	1,180	1,202	3,328	3,510	3,853	4,083
Water Year Types[b,c]												
Wet (32%)	3,683	3,665	4,164	4,199	4,328	3,612	1,527	1,591	4,135	4,489	4,600	4,475
Above Normal (15%)	3,409	3,543	4,101	3,983	4,132	3,917	1,059	984	3,771	3,815	4,360	4,422
Below Normal (17%)	3,541	3,525	4,023	3,912	4,285	3,515	980	948	3,317	3,625	3,518	4,401
Dry (22%)	3,670	3,331	4,064	3,881	3,870	3,416	1,118	992	2,963	3,251	3,308	4,006
Critical (15%)	3,389	2,843	3,357	3,673	3,807	2,461	878	1,190	1,698	1,335	2,936	2,639

Proposed Project

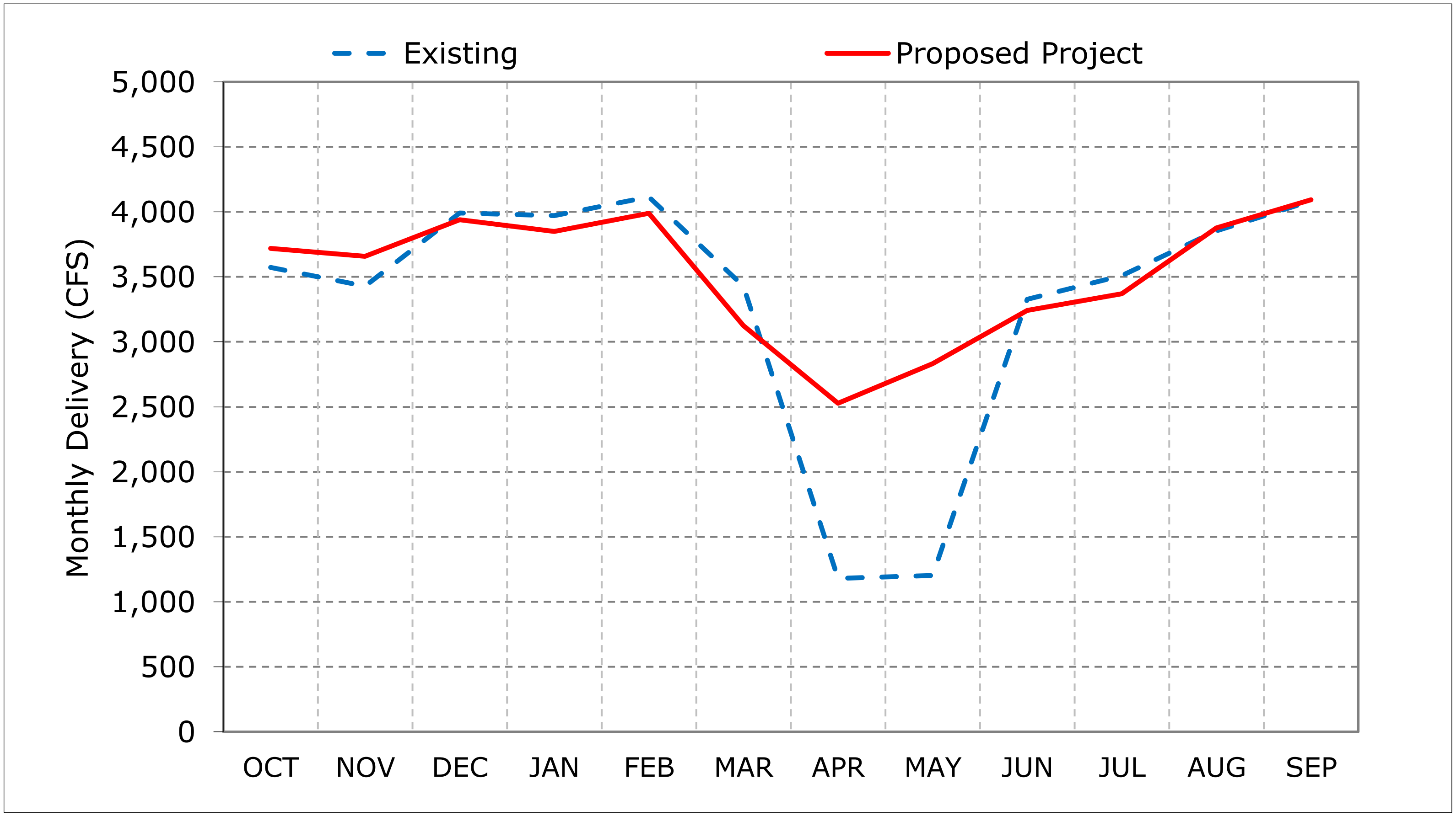
	Monthly Delivery (CFS)											
Statistic	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Probability of Exceedance												
10%	4,600	4,600	4,600	4,600	4,600	4,600	3,781	3,942	4,600	4,600	4,600	4,600
20%	4,600	4,600	4,600	4,479	4,600	4,139	3,501	3,901	4,430	4,600	4,600	4,600
30%	4,600	4,600	4,600	4,297	4,600	3,560	3,143	3,459	3,568	4,600	4,600	4,600
40%	4,400	4,600	4,509	4,209	4,390	3,274	2,733	3,241	3,410	4,174	4,600	4,600
50%	3,765	4,243	4,321	4,079	4,107	3,027	2,511	2,879	3,300	3,816	4,348	4,584
60%	3,439	3,929	4,214	3,924	3,935	2,819	2,114	2,581	3,201	3,309	3,950	4,480
70%	3,166	3,127	3,929	3,636	3,761	2,701	1,877	2,309	3,057	2,852	3,737	3,923
80%	2,966	2,430	3,354	3,250	3,587	2,423	1,599	1,673	2,554	1,897	3,082	3,449
90%	2,790	1,860	2,490	2,949	3,032	1,879	1,258	1,435	1,685	1,235	2,515	3,033
Long Term												
Full Simulation Period[a]	3,719	3,659	3,940	3,850	3,990	3,124	2,528	2,833	3,242	3,370	3,877	4,093
Water Year Types[b,c]												
Wet (32%)	3,909	3,770	4,120	3,988	3,933	3,459	3,364	3,634	4,078	4,399	4,600	4,491
Above Normal (15%)	3,603	3,682	4,057	4,011	4,100	3,660	3,033	3,264	3,685	3,893	4,427	4,330
Below Normal (17%)	3,833	3,929	3,832	3,878	4,266	2,905	2,416	3,037	3,235	3,182	3,468	4,499
Dry (22%)	3,715	3,544	4,021	3,829	3,943	2,860	2,007	2,161	2,867	2,999	3,288	3,992
Critical (15%)	3,293	3,255	3,439	3,389	3,750	2,513	1,122	1,436	1,561	1,390	3,123	2,673

Proposed Project minus Existing

	Monthly Delivery (CFS)											
Statistic	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Probability of Exceedance												
10%	0	0	0	0	0	0	1,978	2,283	0	0	0	0
20%	207	0	0	-121	0	-232	2,159	2,555	-4	0	0	0
30%	486	21	0	10	0	-471	1,978	2,286	-134	0	0	0
40%	769	399	98	76	4	-536	1,689	2,266	-81	-223	0	76
50%	266	330	-6	30	-77	-507	1,562	1,979	-108	-156	107	141
60%	102	597	40	-6	-51	-558	1,214	1,681	-36	-157	30	186
70%	-23	488	-58	-228	-135	-414	977	1,409	-122	-384	87	-55
80%	-98	367	-260	-435	-175	-128	699	773	-174	-213	-116	-95
90%	-88	100	-80	-174	-576	-34	438	535	-135	-149	340	-55
Long Term												
Full Simulation Period[a]	146	230	-50	-122	-125	-305	1,347	1,631	-86	-140	24	10
Water Year Types[b,c]												
Wet (32%)	227	105	-44	-211	-395	-153	1,837	2,043	-58	-90	0	16
Above Normal (15%)	195	139	-44	28	-32	-257	1,974	2,281	-86	78	67	-92
Below Normal (17%)	292	404	-191	-34	-19	-610	1,436	2,089	-82	-443	-50	99
Dry (22%)	44	213	-44	-52	74	-556	889	1,168	-96	-252	-20	-14
Critical (15%)	-96	412	82	-284	-57	52	244	246	-137	55	187	34

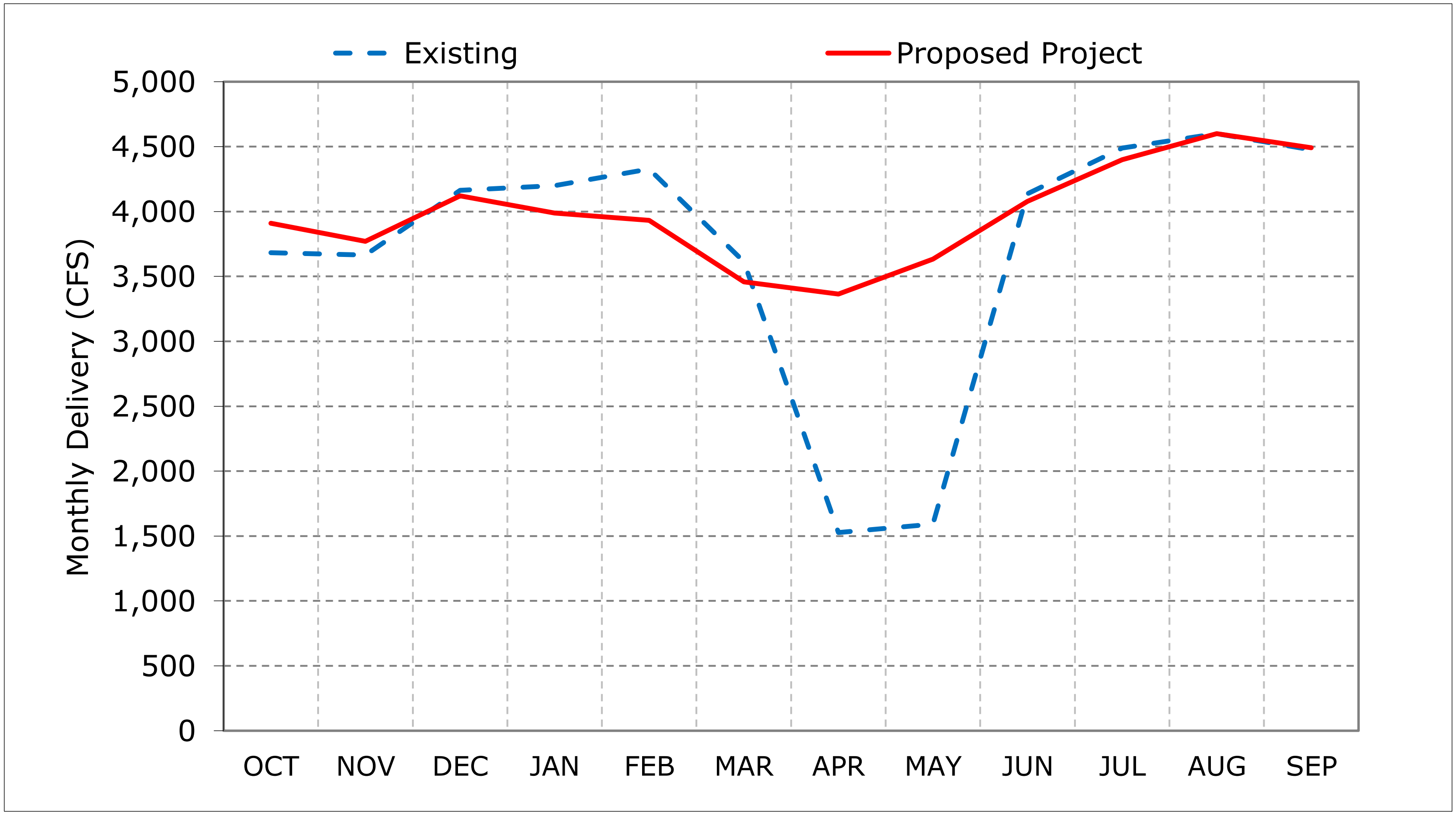
a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with water year - year type sorting.

Figure 7-1. Jones PP Exports, Long-Term Average Delivery



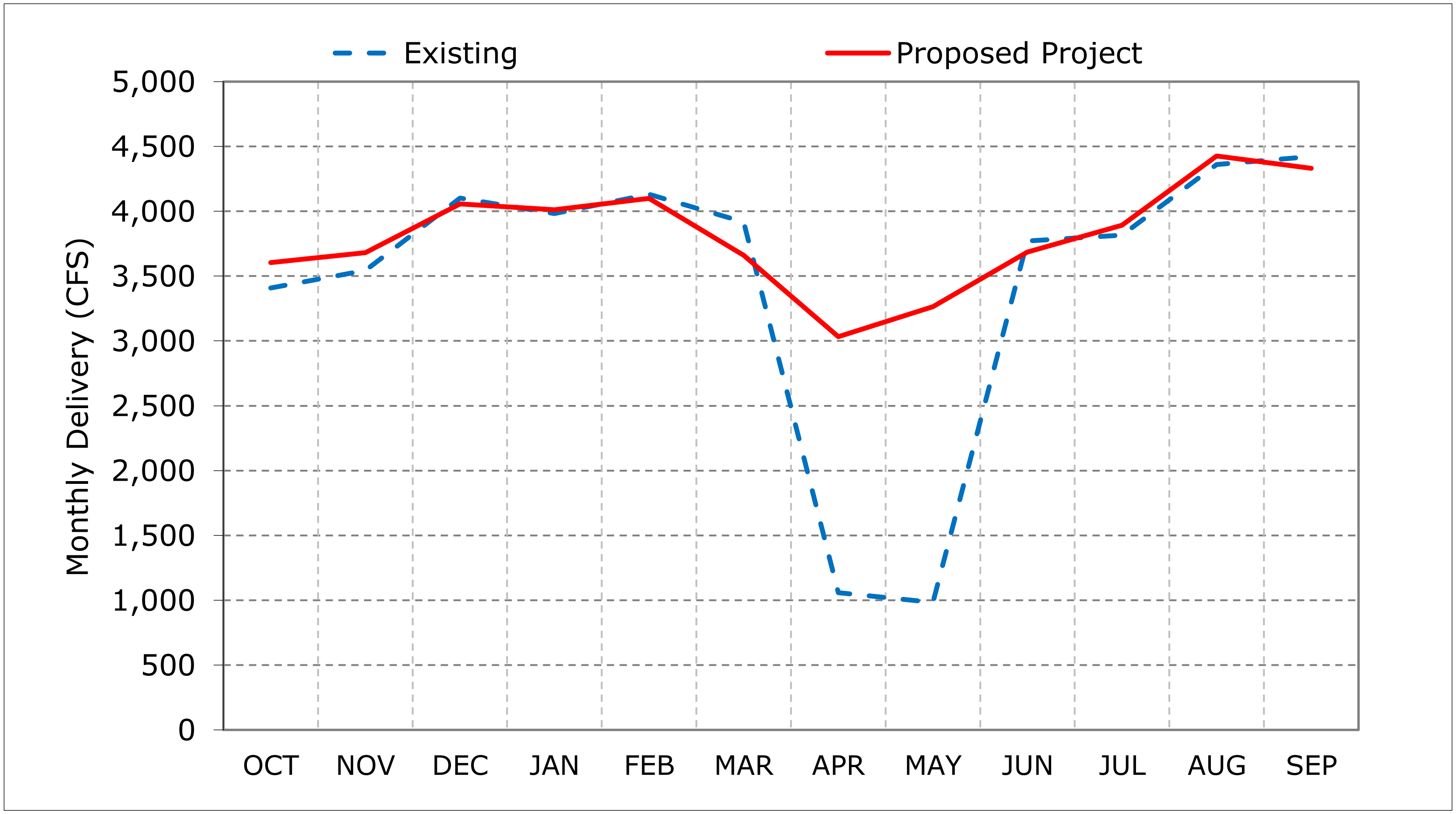
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 7-2. Jones PP Exports, Wet Year Average Delivery



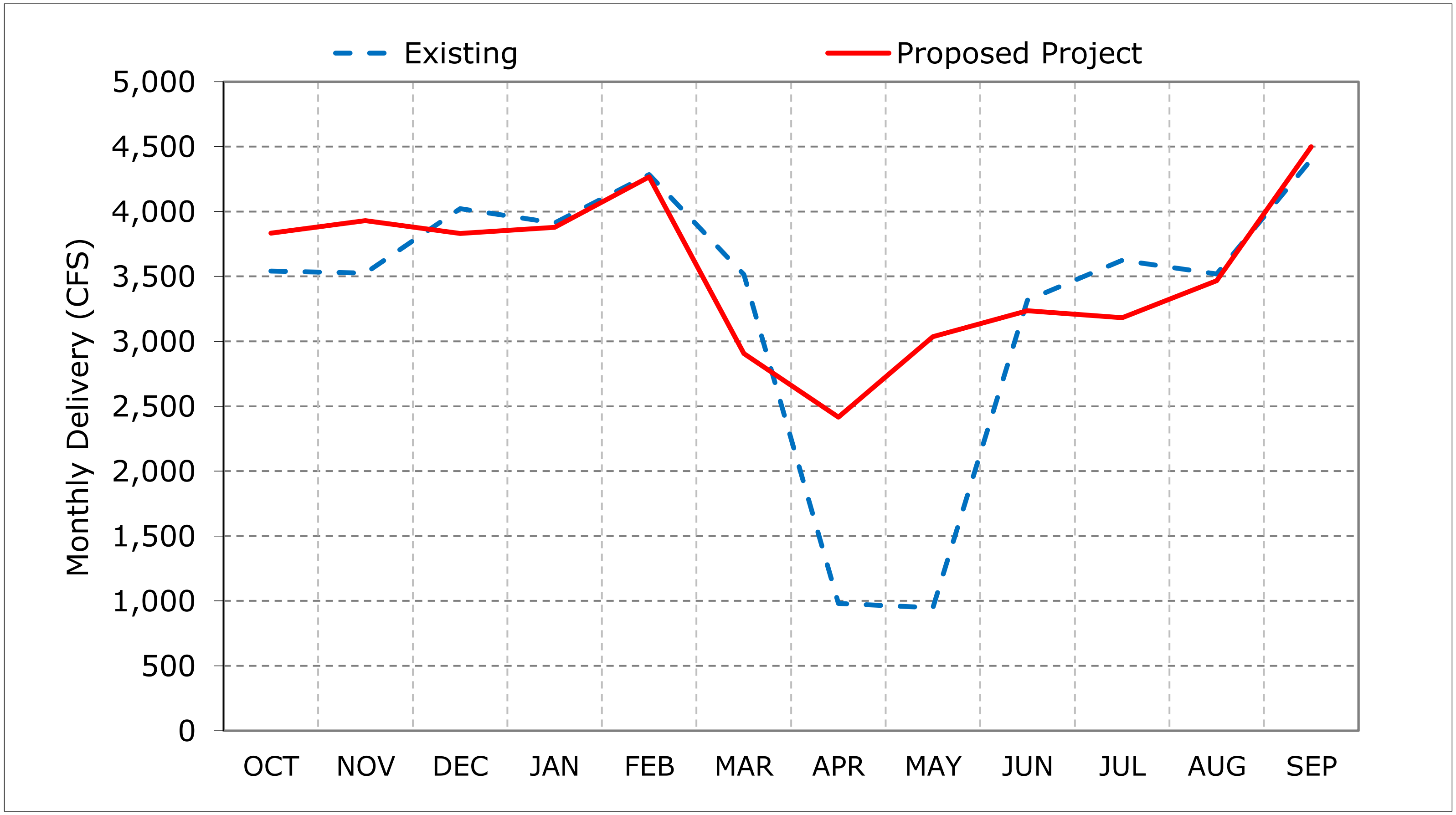
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 7-3. Jones PP Exports, Above Normal Year Average Delivery



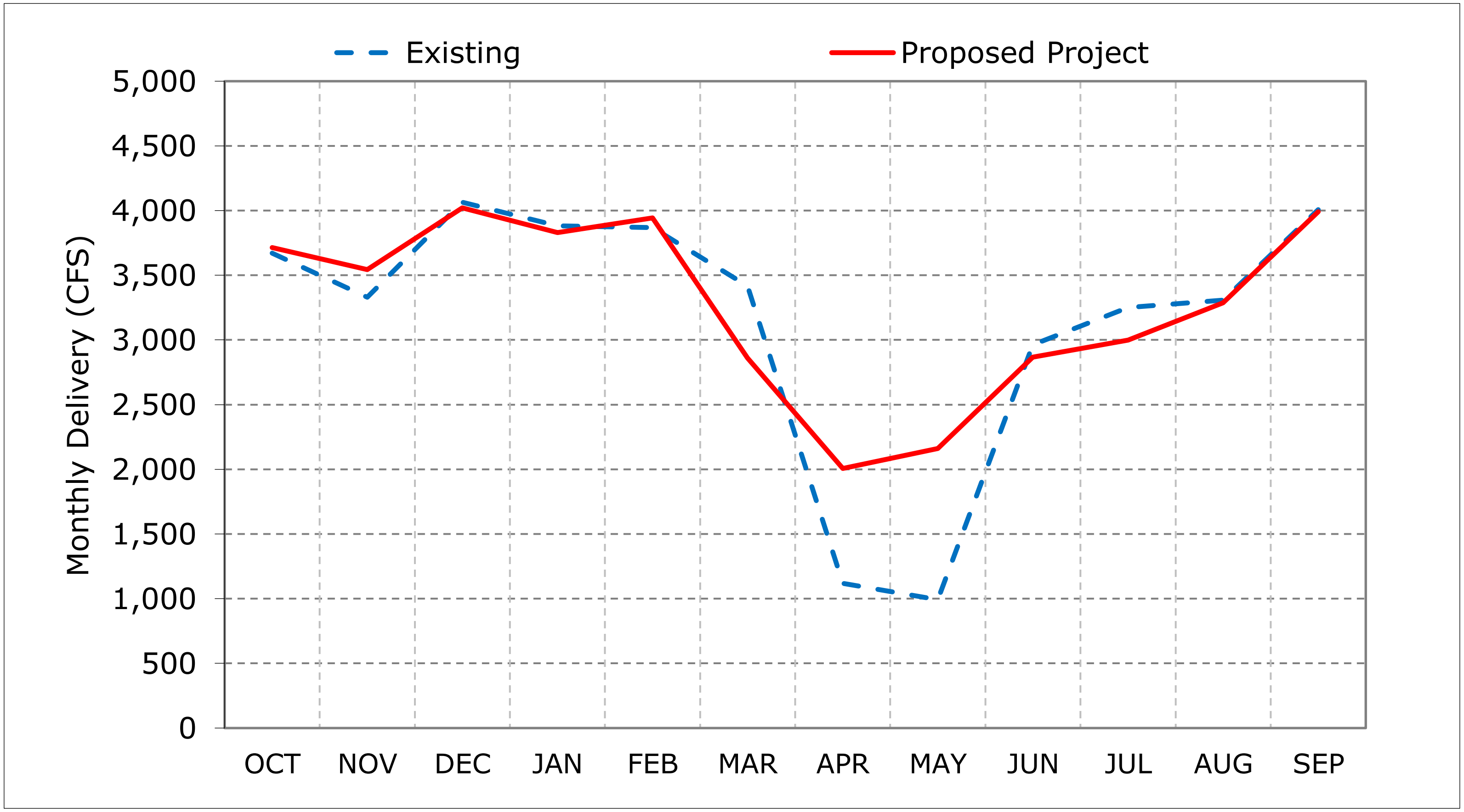
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 7-4. Jones PP Exports, Below Normal Year Average Delivery



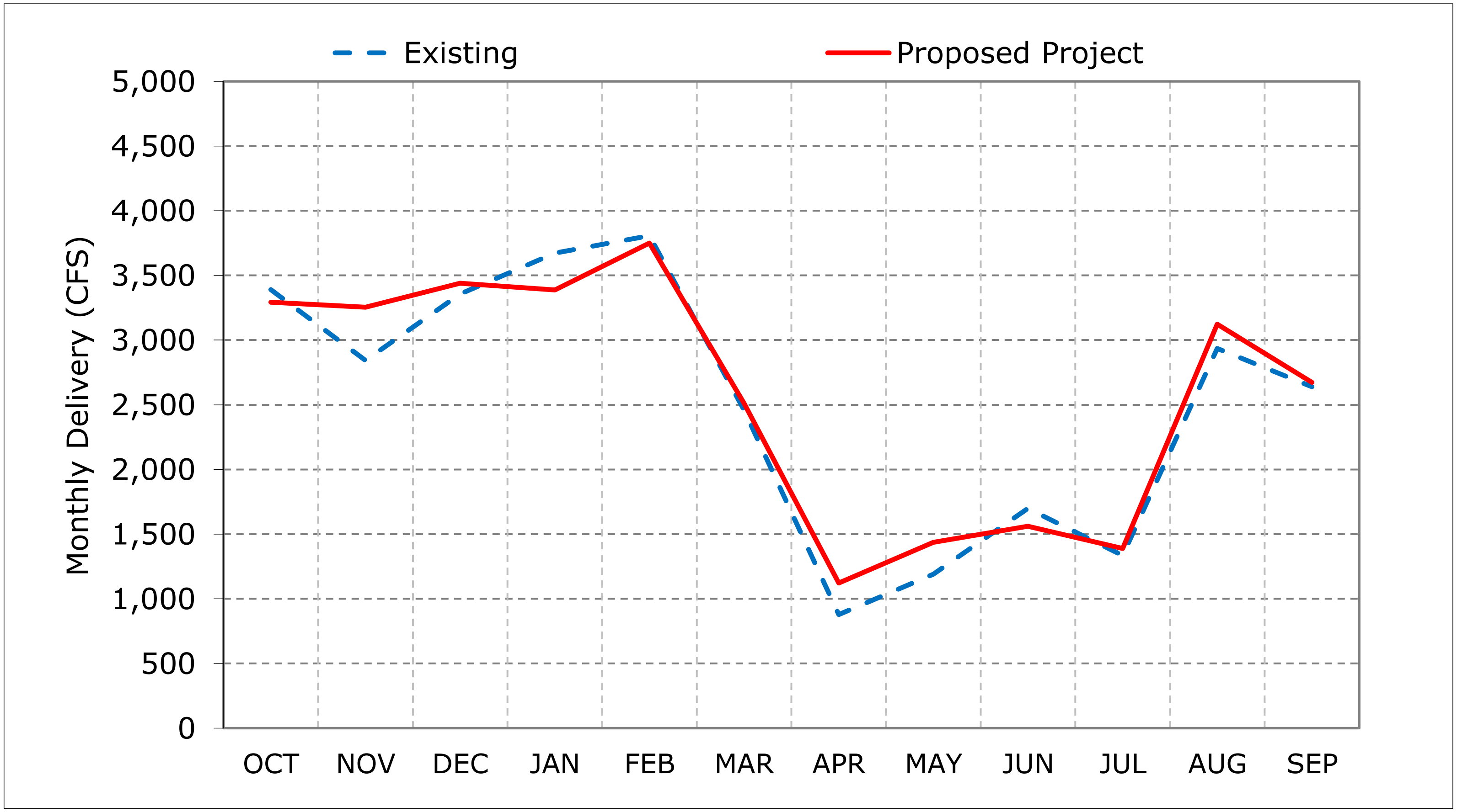
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 7-5. Jones PP Exports, Dry Year Average Delivery



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 7-6. Jones PP Exports, Critical Year Average Delivery



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 7-7. Jones PP Exports, October

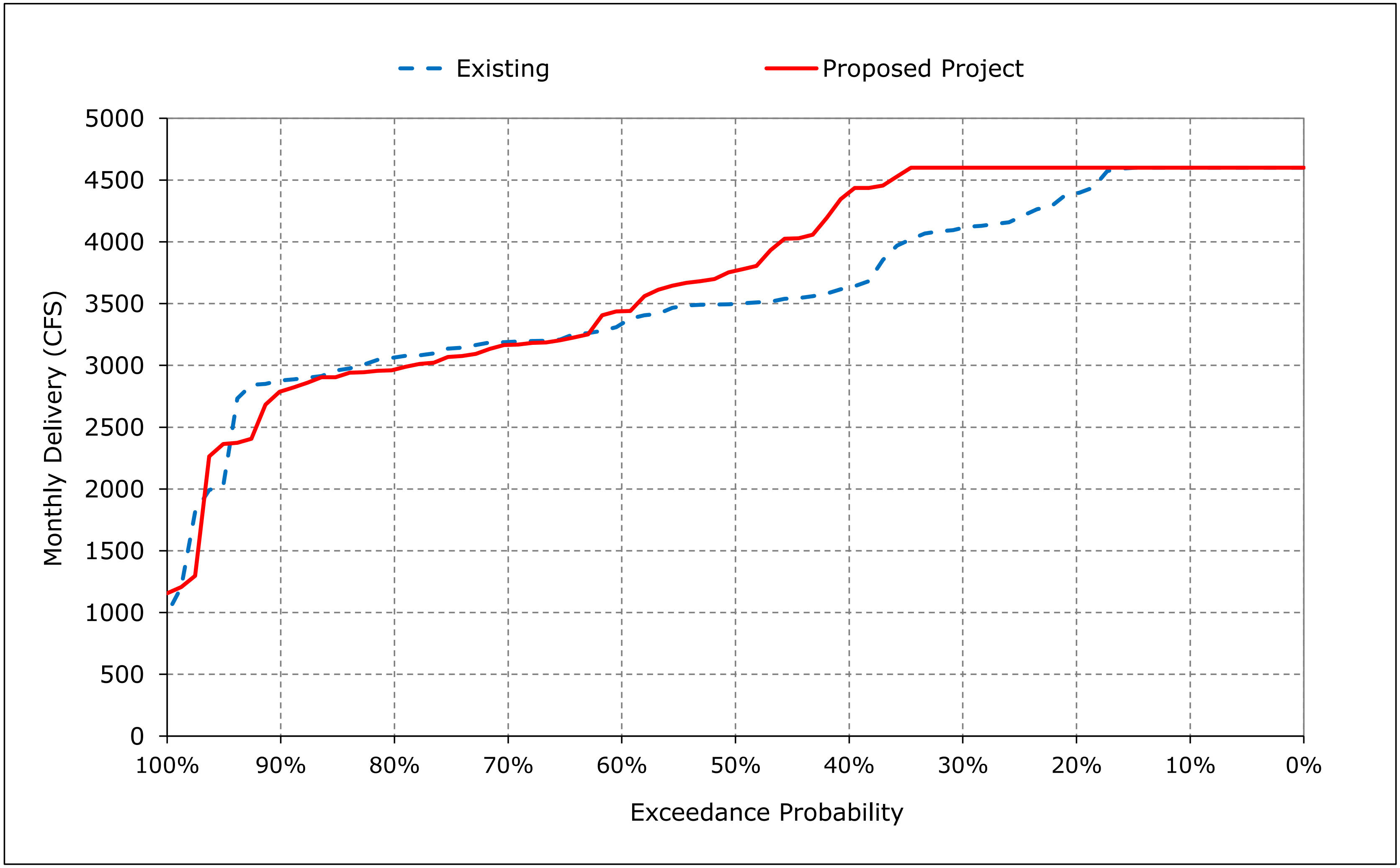


Figure 7-8. Jones PP Exports, November

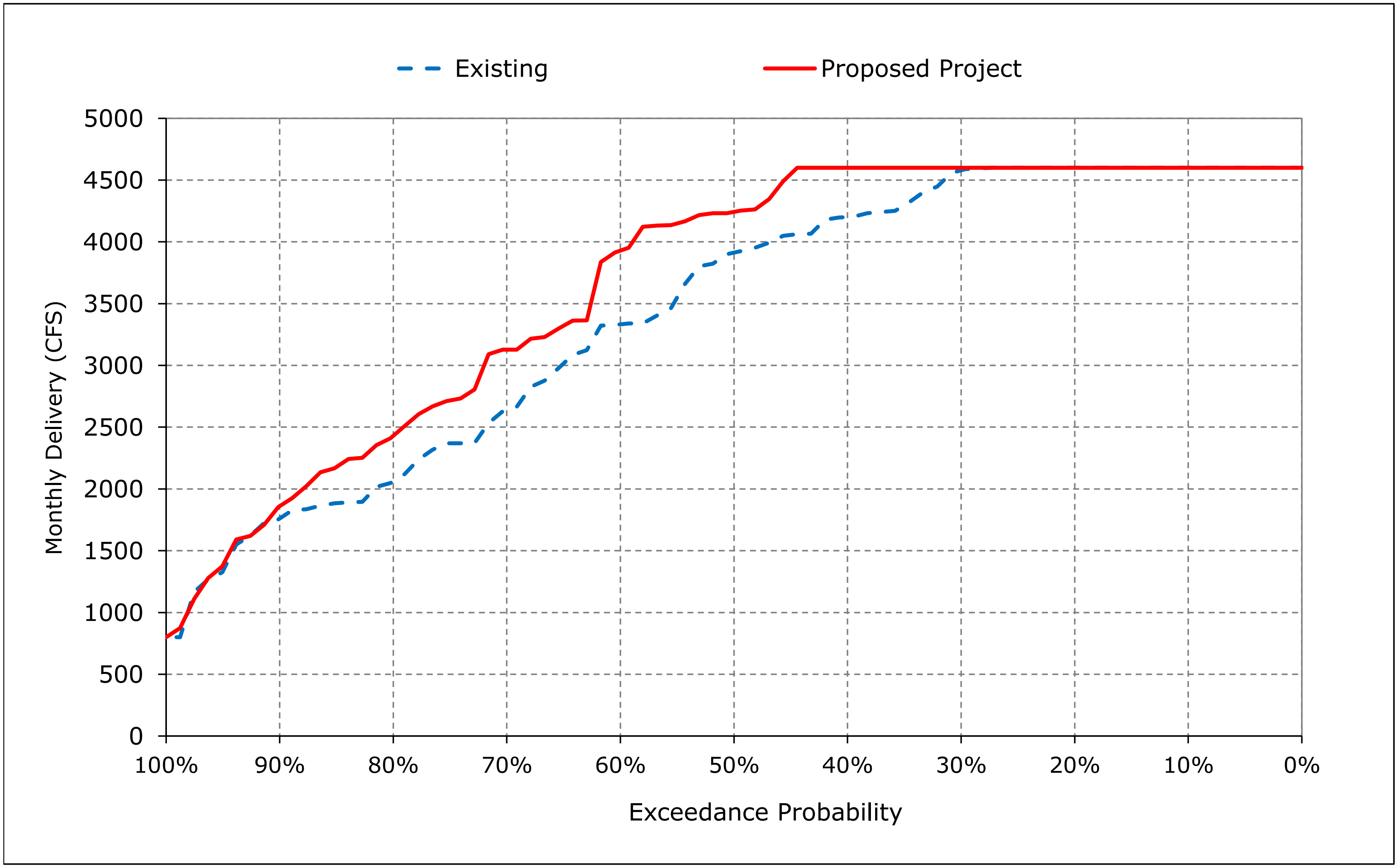


Figure 7-9. Jones PP Exports, December

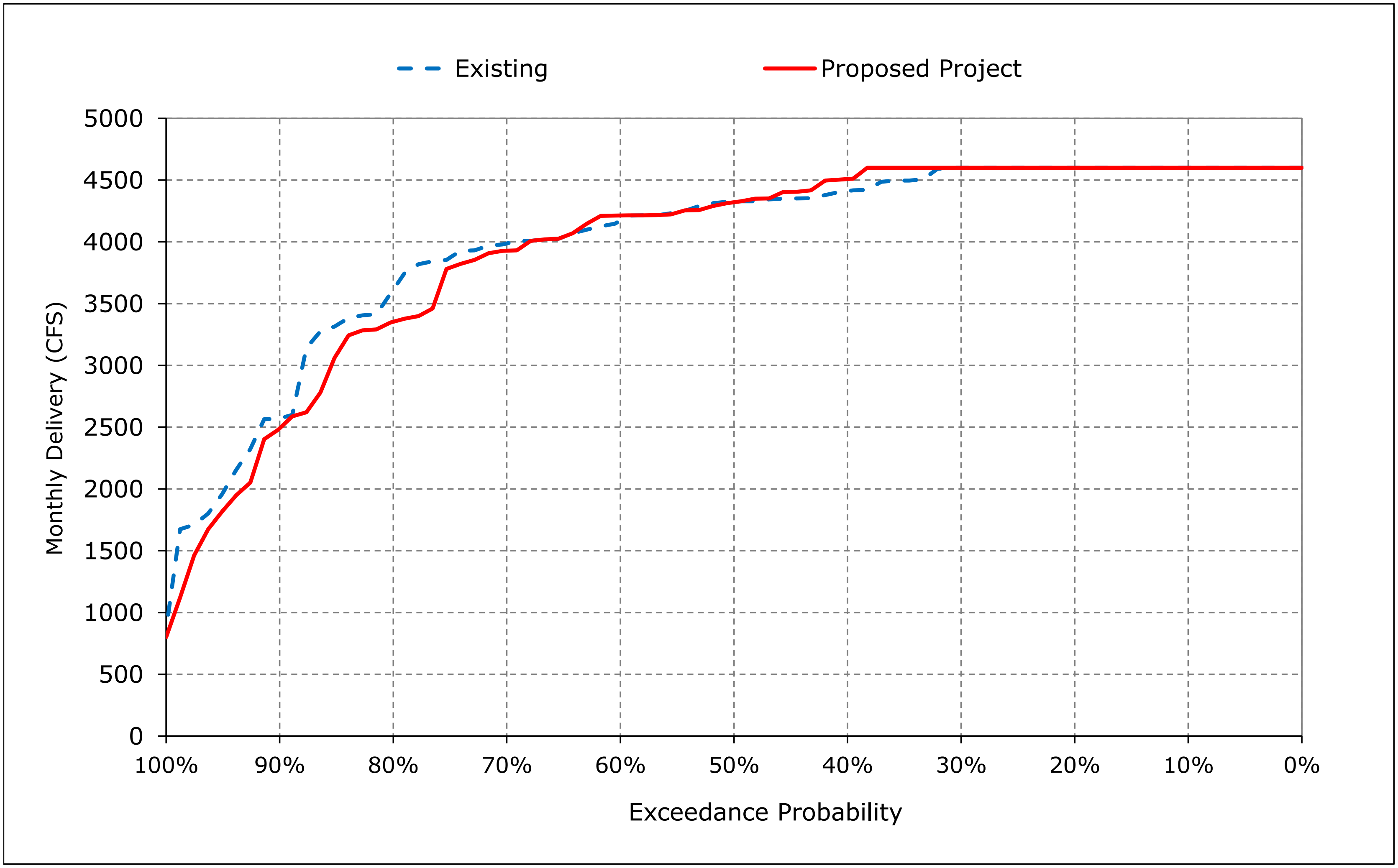


Figure 7-10. Jones PP Exports, January

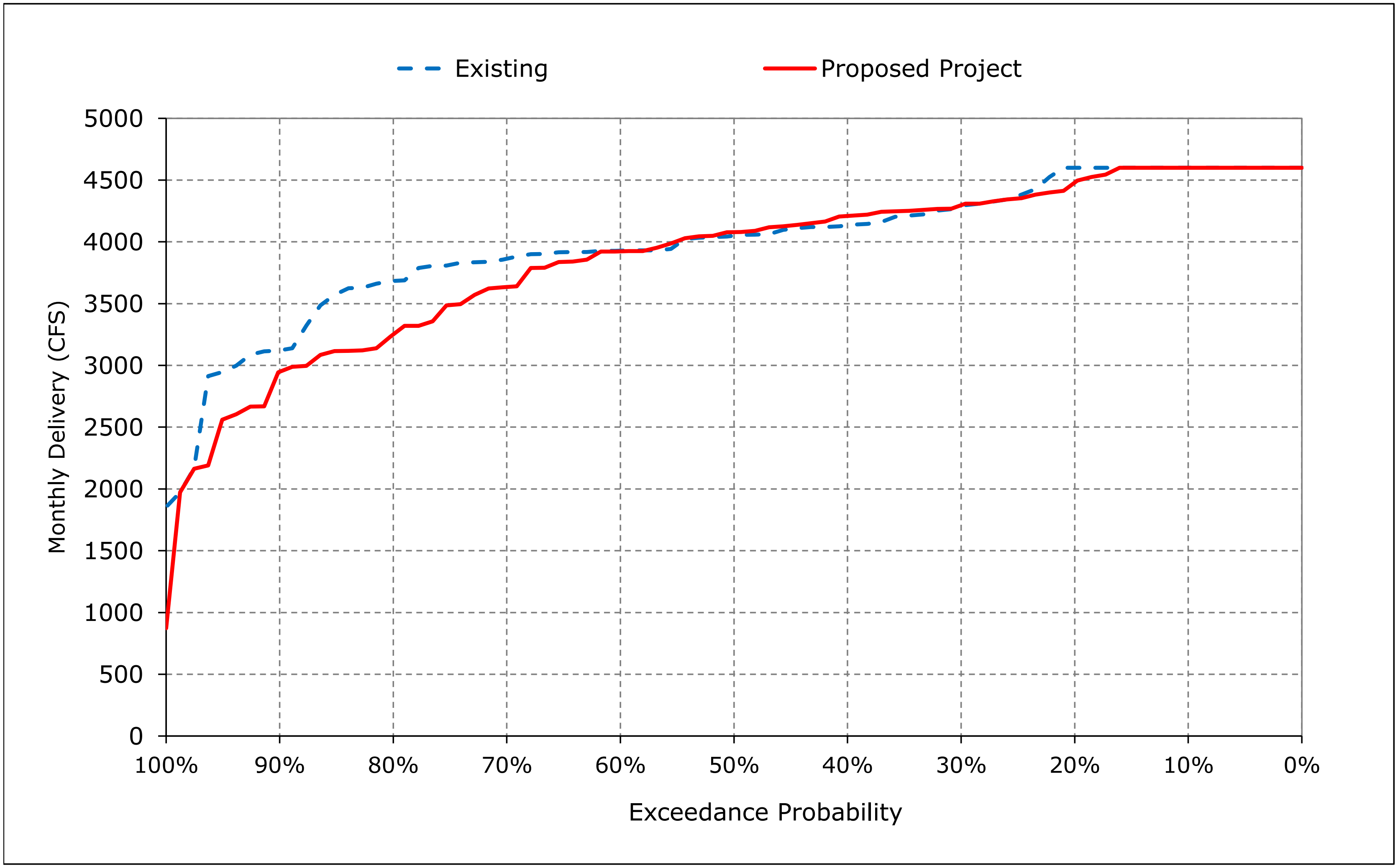


Figure 7-11. Jones PP Exports, February

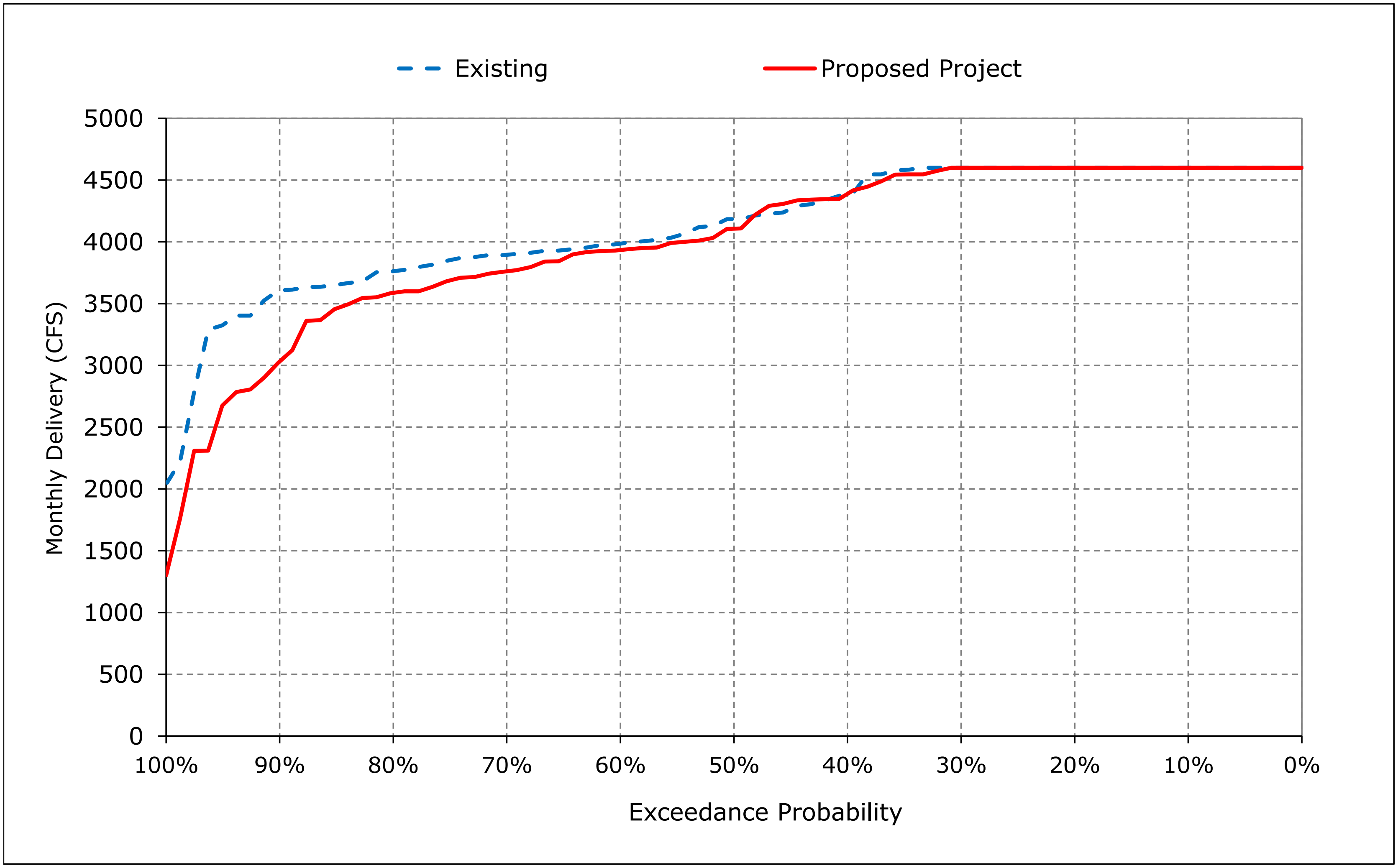


Figure 7-12. Jones PP Exports, March

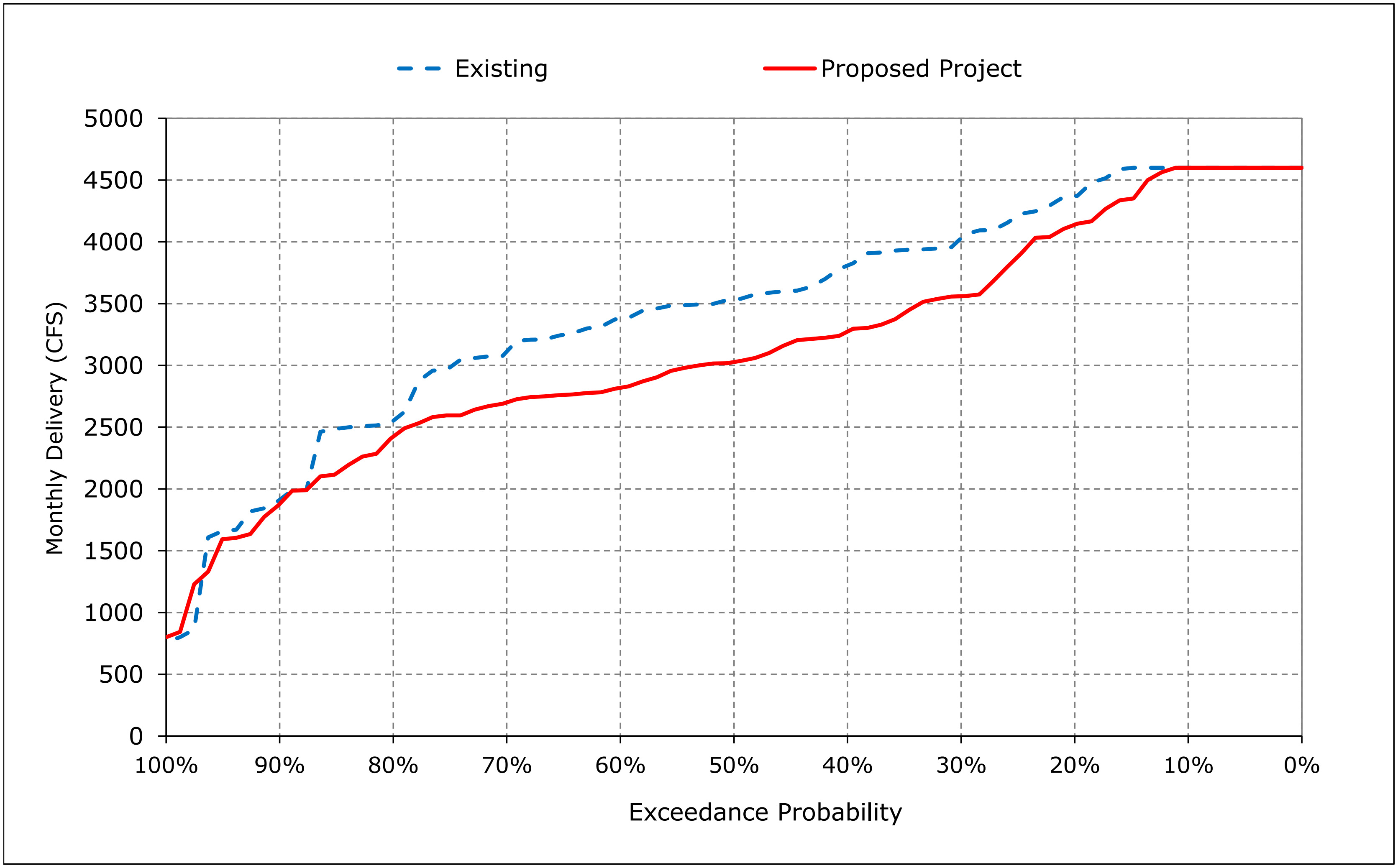


Figure 7-13. Jones PP Exports, April

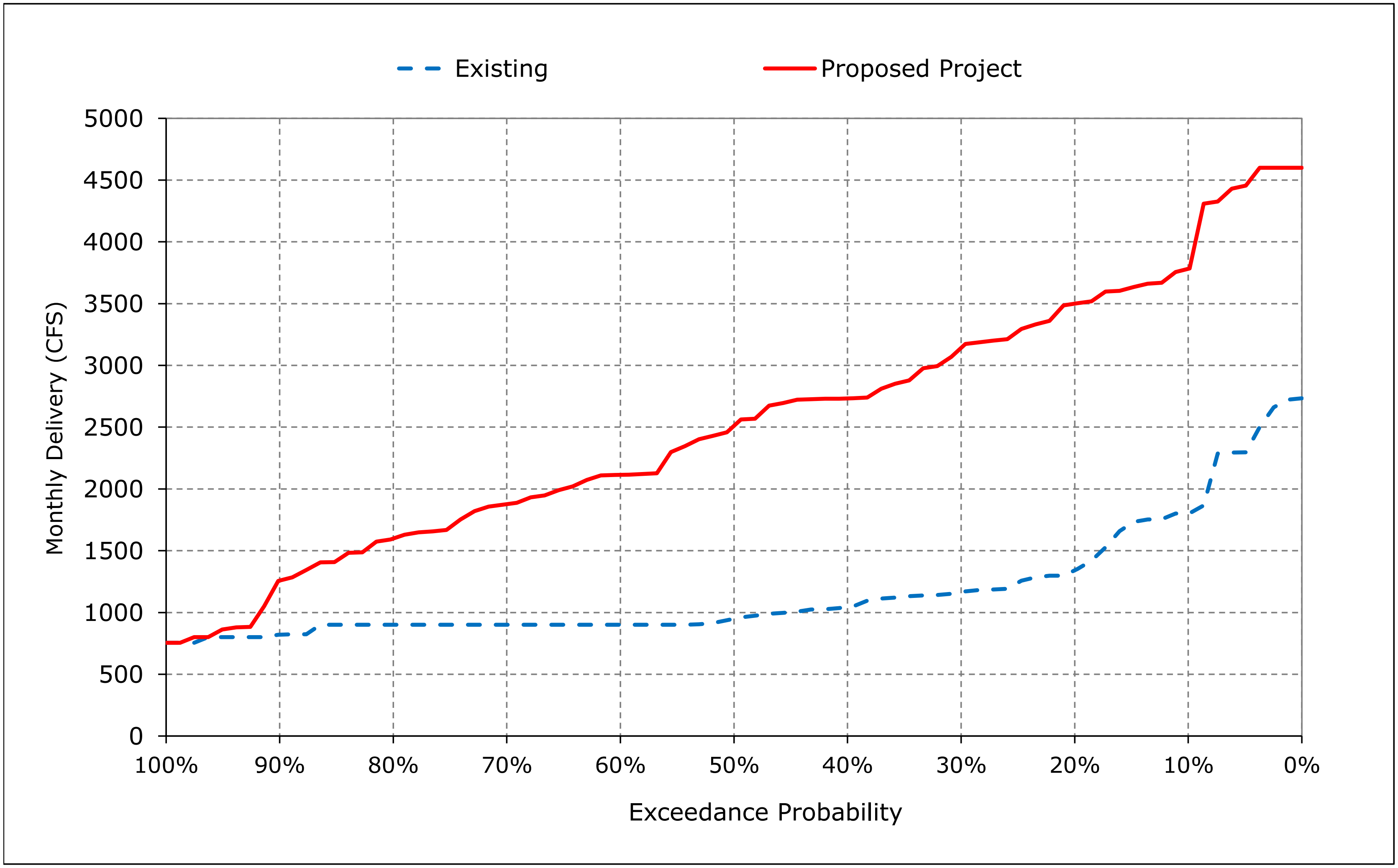


Figure 7-14. Jones PP Exports, May

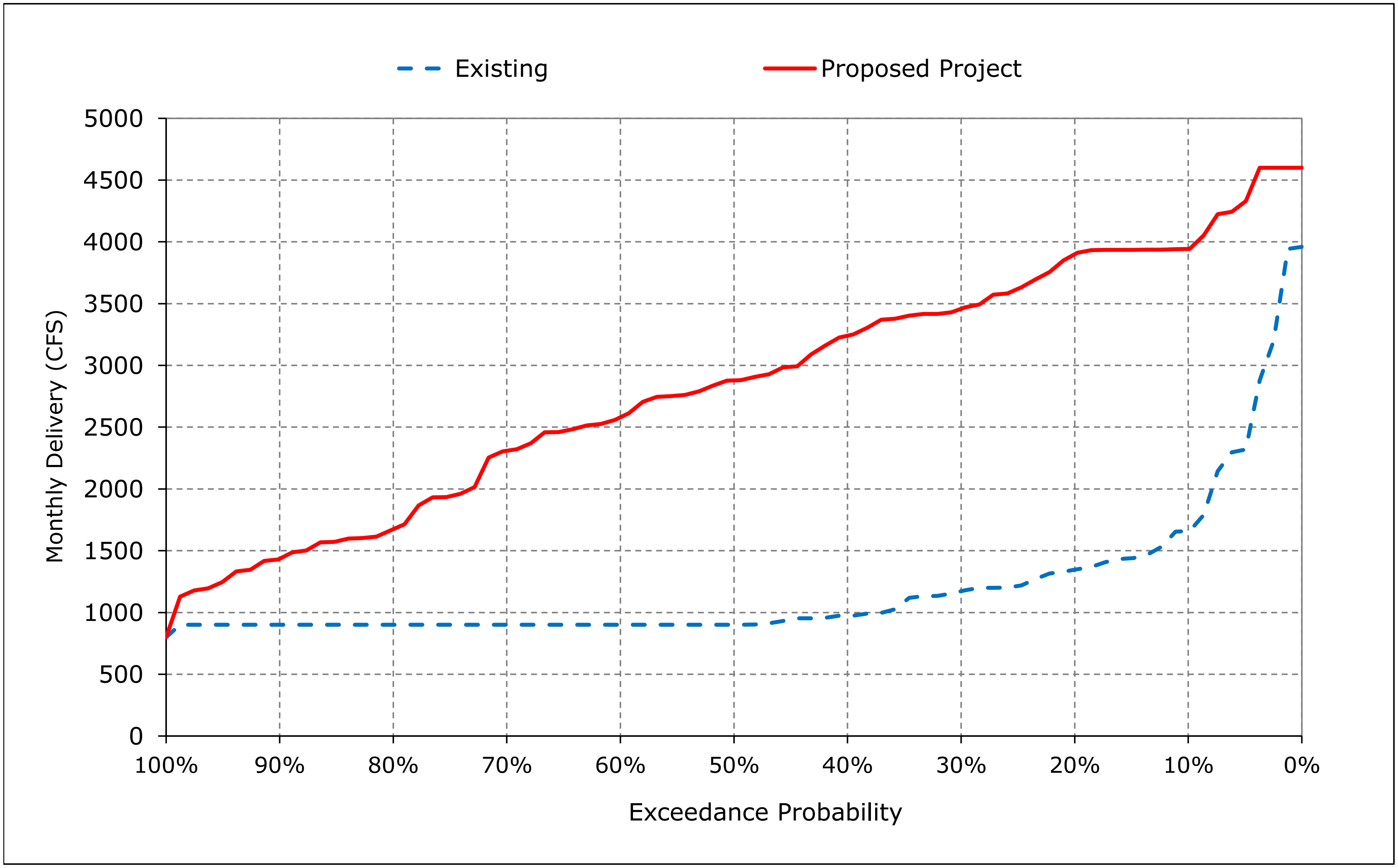


Figure 7-15. Jones PP Exports, June

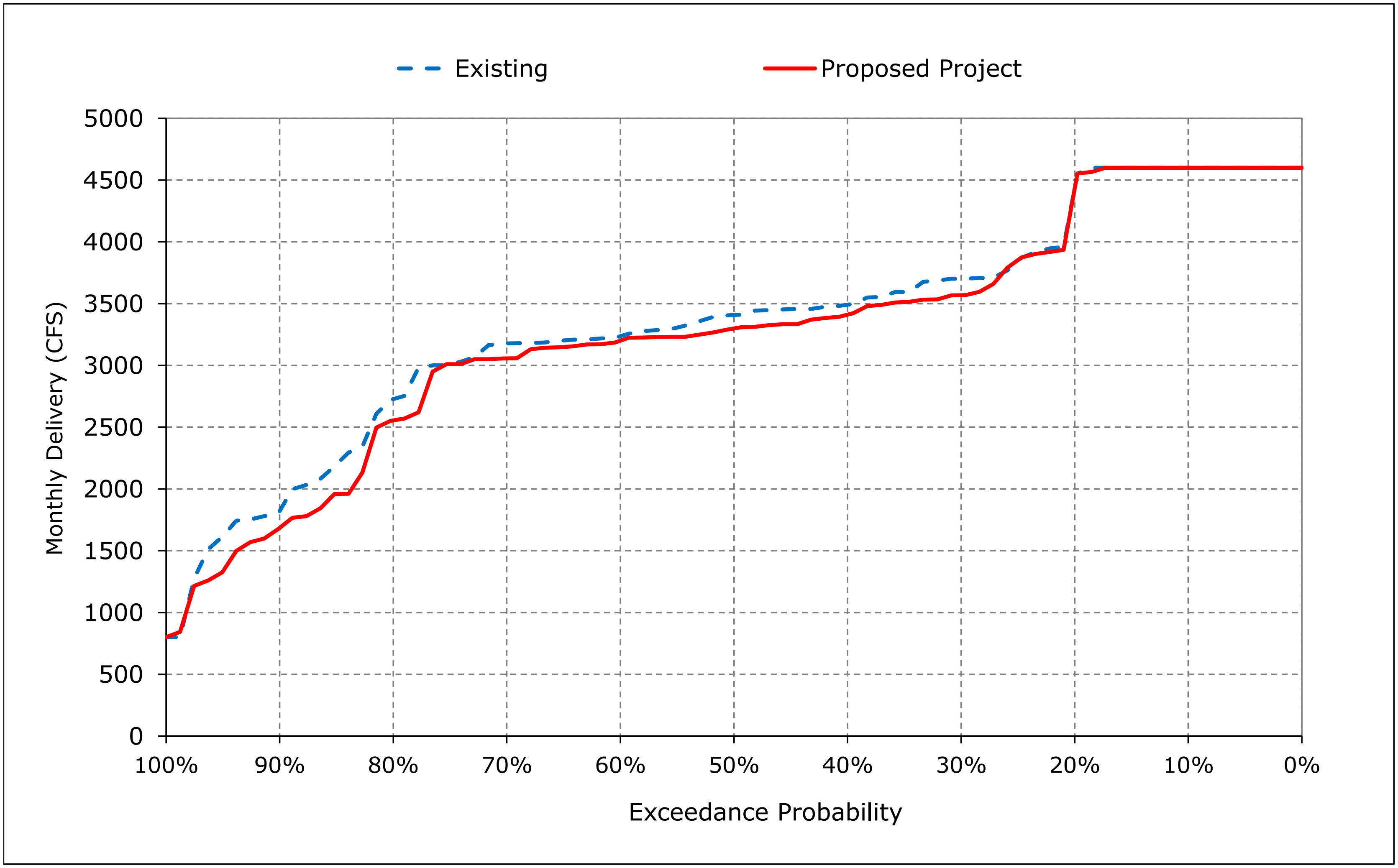


Figure 7-16. Jones PP Exports, July

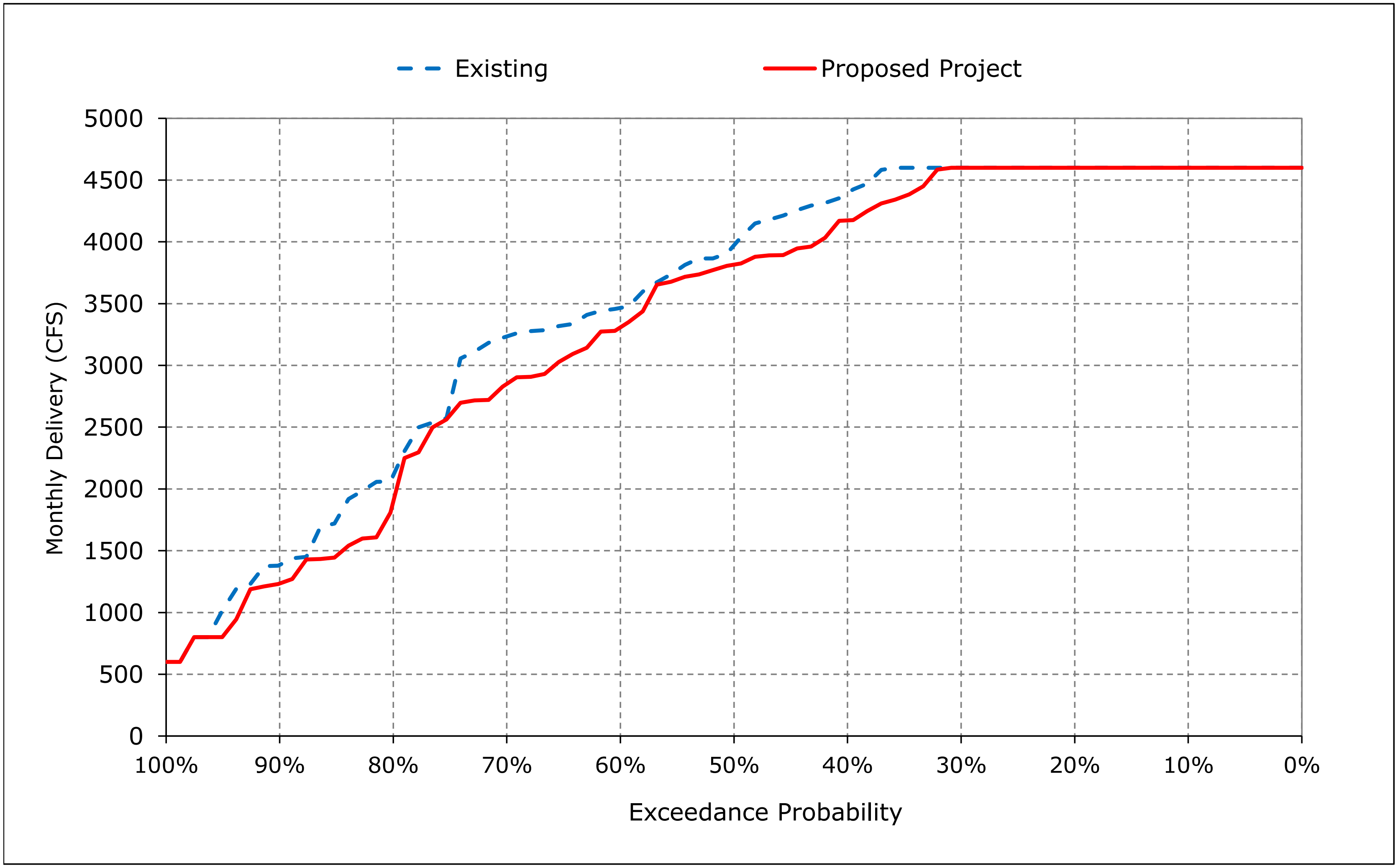


Figure 7-17. Jones PP Exports, August

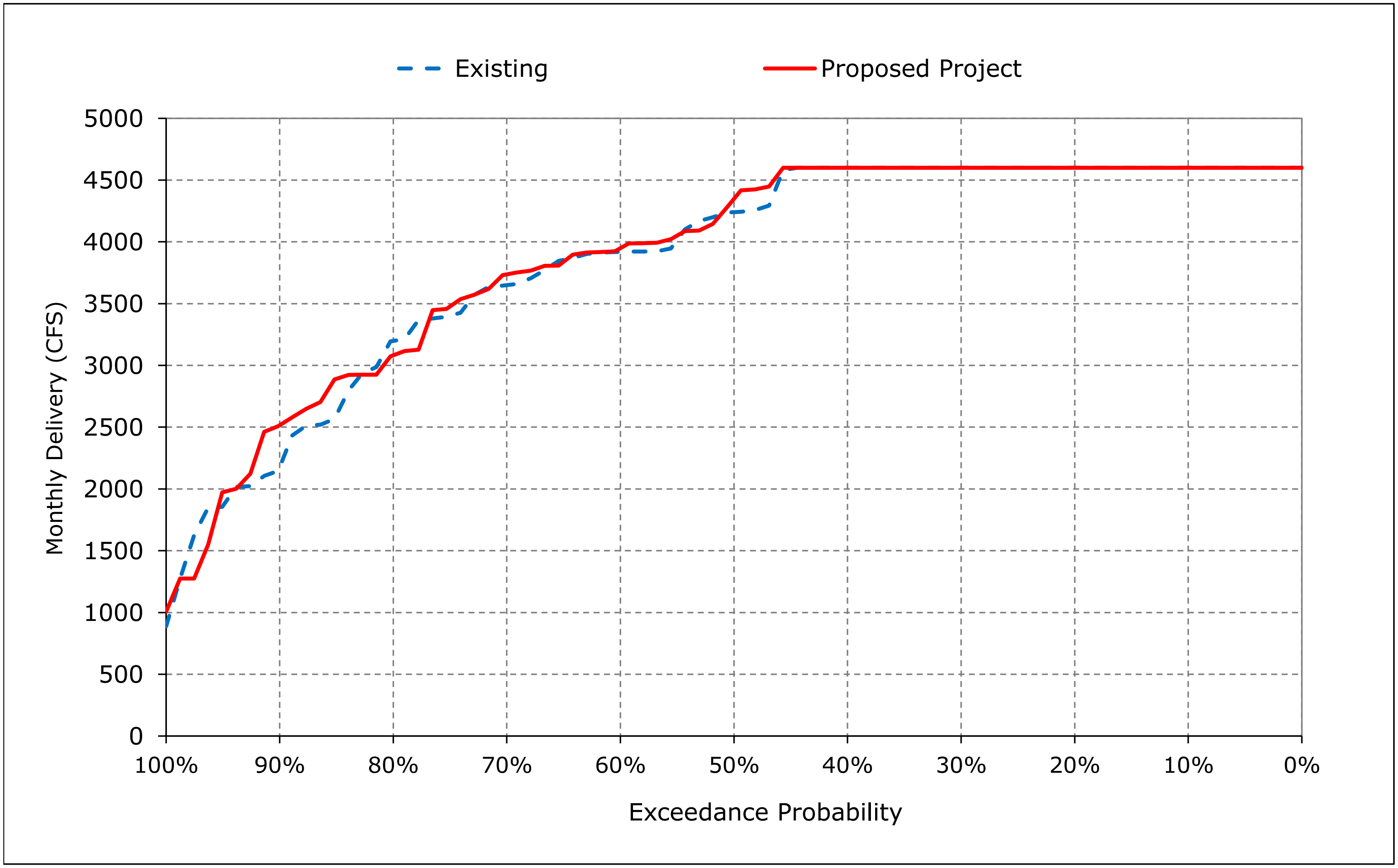
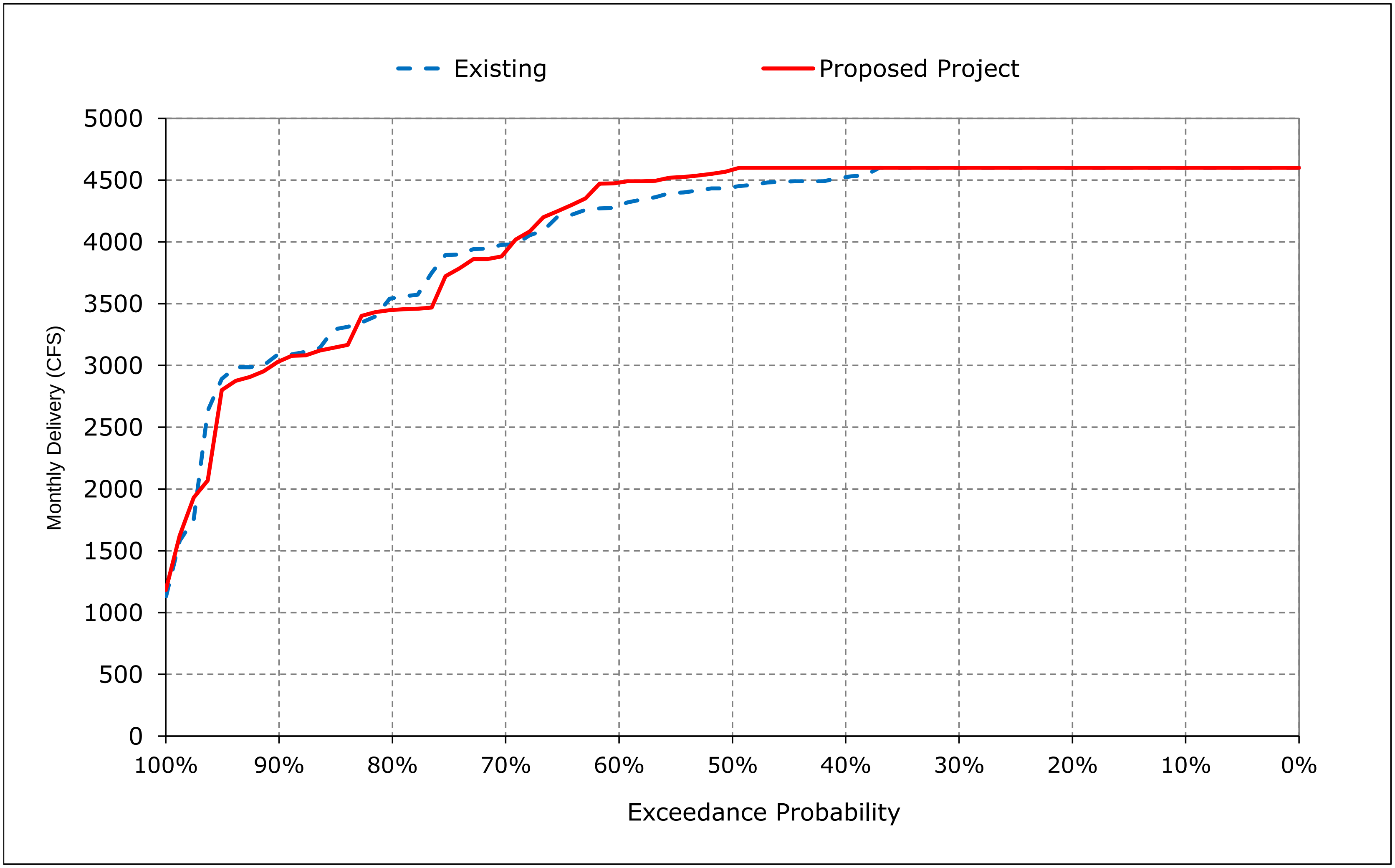


Figure 7-18. Jones PP Exports, September



Appendix C – Modeling

Attachment 2-4 – Water Supply Results (CalSim II)

The following water supply results of the CalSim II model are included for the following alternatives:

- Existing Conditions
- Proposed Project

Table 2-4.1. Water Supply Results (CalSim II)

Title	Model Parameter	Table Numbers	Figure Numbers
CalSim II Water Supply Summary Report	NA	1-1 to 1-8	1-1 to 1-9
Total Delta Exports	TOTAL_EXP	-	2-1

Note: "-" indicates blank cell

Report formats

- Tables comparing water supply of two scenarios (water supply by region and type, and water supply by type)
- Annual exceedance charts including all scenarios

Table 1-1. CALSIM II Water Summary Report, by Region and Type, Long-Term Average and Dry and Critical Year Averages

				Proposed Project	Existing	Proposed Project minus Existing
Water Supply Reliability						
Sacramento River Hydrologic Region						
CVP Settlement	Contract Delivery (annual average)	(TAF/year)	Long Term Dry and Critical	1,600 1,576	1,610 1,585	-10 -9
CVP Refuge Level 2	Contract Delivery (annual average)	(TAF/year)	Long Term Dry and Critical	163 144	159 140	4 3
CVP M&I	Contract Delivery (annual average)	(TAF/year)	Long Term Dry and Critical	227 201	225 199	2 3
CVP Ag	Contract Delivery (annual average - does not include Settlement	(TAF/year)	Long Term Dry and Critical	280 190	275 181	5 9
SWP FRSA	Contract Delivery (annual average)	(TAF/year)	Long Term Dry and Critical	952 908	952 908	0 0
SWP M&I	Contract Delivery (annual average)	(TAF/year)	Long Term Dry and Critical	31 22	30 20	1 2
San Joaquin River Hydrologic Region (not including Friant-Kern and Madera Canal water users)						
CVP Exchange	Contract Delivery (annual average)	(TAF/year)	Long Term Dry and Critical	852 814	852 814	0 0
CVP Refuge Level 2	Contract Delivery (annual average)	(TAF/year)	Long Term Dry and Critical	261 249	261 249	0 0
CVP M&I	Contract Delivery (annual average)	(TAF/year)	Long Term Dry and Critical	18 15	17 15	1 0
CVP Ag	Contract Delivery (annual average; does not include Exchange	(TAF/year)	Long Term Dry and Critical	404 243	352 226	52 17
SWP Ag	Contract Delivery (including Article 21) (annual average)	(TAF/year)	Long Term Dry and Critical	4 2	3 2	0 0
San Francisco Bay Hydrologic Region						
CVP M&I	Contract Delivery (annual average)	(TAF/year)	Long Term Dry and Critical	263 284	259 281	5 2
CVP Ag	Contract Delivery (annual average)	(TAF/year)	Long Term Dry and Critical	50 30	44 28	6 2
SWP M&I	Contract Delivery (including Article 21, includes transfers to SWP contractors) (annual average)	(TAF/year)	Long Term Dry and Critical	215 138	202 125	13 13
Central Coast Hydrologic Region						
SWP M&I	Contract Delivery (annual average)	(TAF/year)	Long Term Dry and Critical	43 24	40 22	3 2
Tulare Lake Hydrologic Region (not including Friant-Kern Canal water users)						
CVP Refuge Level 2	Contract Delivery (annual average)	(TAF/year)	Long Term Dry and Critical	12 11	12 11	0 0
CVP Ag	Contract Delivery (annual average - includes Cross Valley Canal)	(TAF/year)	Long Term Dry and Critical	820 509	728 474	91 35
SWP M&I	Contract Delivery (annual average)	(TAF/year)	Long Term Dry and Critical	83 47	77 42	6 4
SWP Ag	Contract Delivery (including Article 21) (annual average)	(TAF/year)	Long Term Dry and Critical	639 342	585 310	54 31
South Lahontan Hydrologic Region						
SWP M&I	Contract Delivery (including Article 21) (annual average)	(TAF/year)	Long Term Dry and Critical	281 175	260 155	21 20
South Coast Hydrologic Region						
SWP M&I	Contract Delivery (including Article 21, includes transfers to SWP contractors) (annual average)	(TAF/year)	Long Term Dry and Critical	1,363 884	1,242 763	121 121
SWP Ag	Contract Delivery (including Article 21) (annual average)	(TAF/year)	Long Term Dry and Critical	8 4	7 4	1 0
Total For All Regions						
Total Supplies	Contract Delivery (CVP, SWP and other) (annual average)	(TAF/year)	Long Term Dry and Critical	8,568 6,812	8,193 6,556	375 255

Notes:

1. Long Term is the average quantity for the period of Oct 1921 - Sep 2003.
2. Dry and Critical Years Average is the average quantity for the combination of the SWRCB D-1641 40-30-30 Dry and Critical years for the period of Oct 192

Table 1-2. CALSIM II Water Supply Summary Report, by Type, Long-Term Average and Dry and Critical Year Averages

					Proposed Project	Existing	Proposed Project minus Existing
Water Supply Reliability							
North of Delta							
	CVP Ag	Contract Delivery (annual average; does not include Exchange	(TAF/year)	Long Term Dry and Critical	280 190	275 181	5 9
	CVP M&I	Contract Delivery (annual average)	(TAF/year)	Long Term Dry and Critical	379 388	376 386	2 3
	SWP Ag	Contract Delivery (including Article 21) (annual average)	(TAF/year)	Long Term Dry and Critical	0 0	0 0	0 0
	SWP M&I	Contract Delivery (including Article 21, includes transfers to SWP contractors) (annual average)	(TAF/year)	Long Term Dry and Critical	102 70	101 68	1 2
Total CVP North of Delta							
	Total CVP Ag and M&I NOD	Contract Delivery (CVP) (annual average)	(TAF/year)	Long Term Dry and Critical	658 578	651 567	7 11
Total SWP North of Delta							
	Total SWP Ag and M&I NOD	Contract Delivery (SWP) (annual average)	(TAF/year)	Long Term Dry and Critical	102 70	101 68	1 2
Total North of Delta							
	Total North of Delta Ag and M&I Deliveries	Contract Delivery (CVP, SWP and other) (annual average)	(TAF/year)	Long Term Dry and Critical	761 648	752 635	9 13
South of Delta							
	CVP Ag	Contract Delivery (annual average; does not include Exchange	(TAF/year)	Long Term Dry and Critical	1,273 782	1,124 729	149 53
	CVP M&I	Contract Delivery (annual average)	(TAF/year)	Long Term Dry and Critical	130 112	124 109	5 3
	SWP Ag	Contract Delivery (including Article 21) (annual average)	(TAF/year)	Long Term Dry and Critical	650 348	596 316	55 32
	SWP M&I	Contract Delivery (including Article 21, includes transfers to SWP contractors) (annual average)	(TAF/year)	Long Term Dry and Critical	1,914 1,220	1,750 1,060	163 160
Total CVP South of Delta							
	Total CVP Ag and M&I SOD	Contract Delivery (CVP) (annual average)	(TAF/year)	Long Term Dry and Critical	1,403 894	1,248 838	155 56
Total SWP South of Delta							
	Total SWP Ag and M&I SOD	Contract Delivery (SWP) (annual average)	(TAF/year)	Long Term Dry and Critical	2,564 1,568	2,346 1,377	218 192
Total South of Delta							
	Total South of Delta Ag and M&I Deliveries	Contract Delivery (CVP, SWP and other) (annual average)	(TAF/year)	Long Term Dry and Critical	3,967 2,462	3,594 2,215	373 248

Notes:
1. Long Term is the average quantity for the period of Oct 1921 - Sep 2003.
2. Dry and Critical Years Average is the average quantity for the combination of the SWRCB D-1641 40-30-30 Dry and Critical years for the period of Oct 192

Figure 1-1. CVP North of Delta Agricultural Water Service Contract Deliveries, Annual (Mar-Feb)

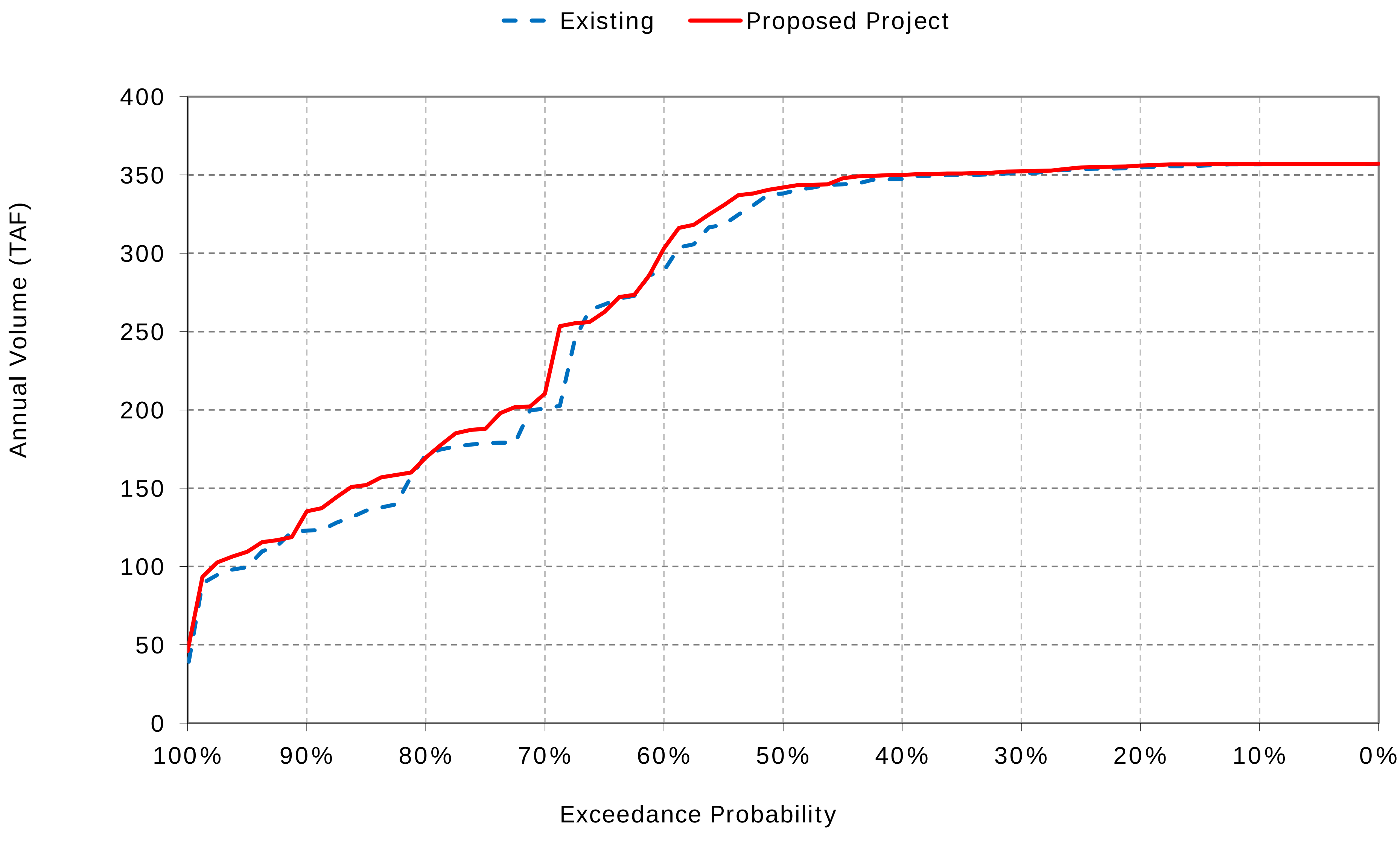


Figure 1-2. CVP South of Delta Agricultural Water Service Contract Deliveries, Annual (Mar-Feb)

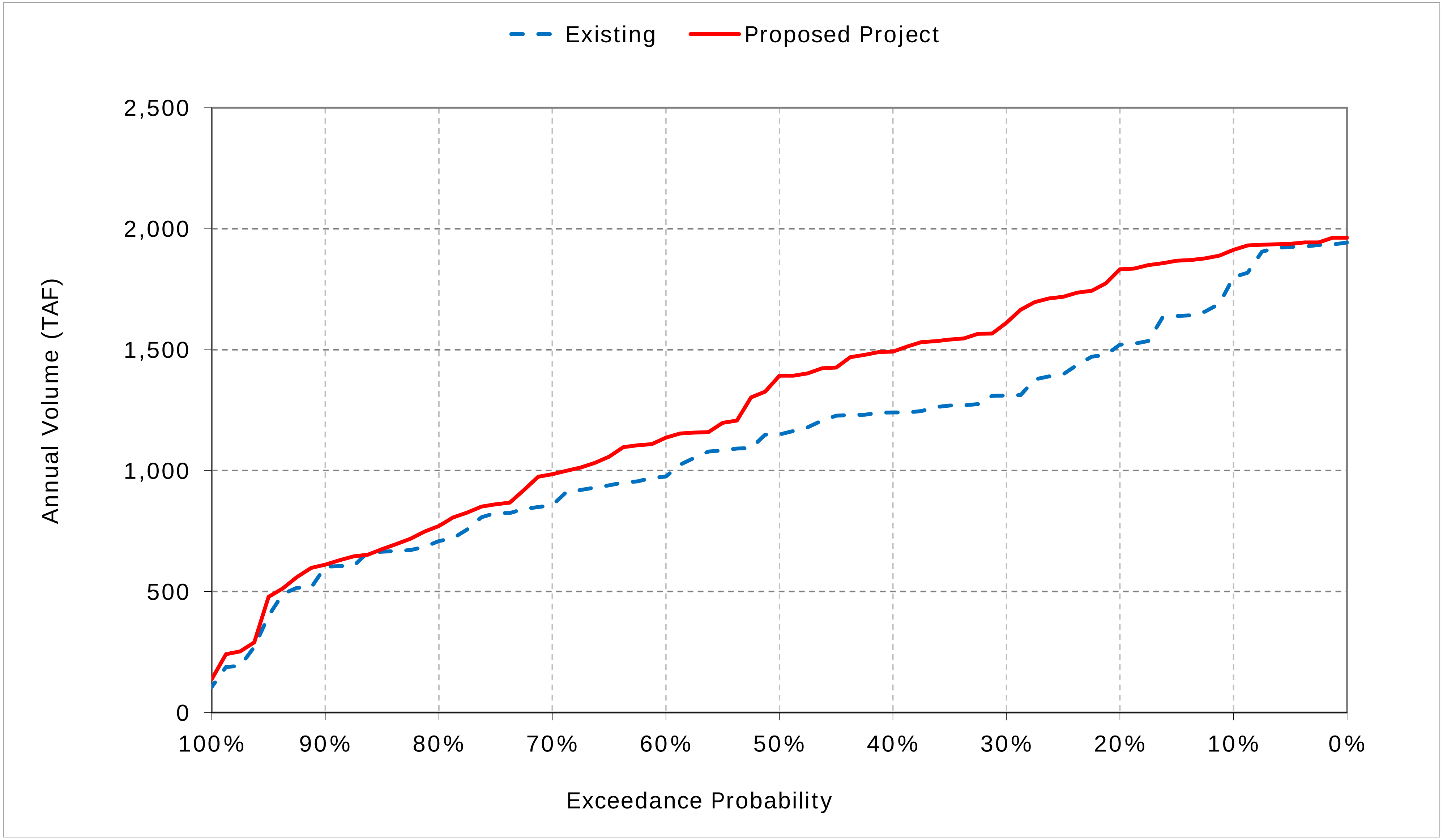


Figure 1-3. CVP North of Delta M&I Water Service Contract Deliveries, Annual (Mar-Feb)

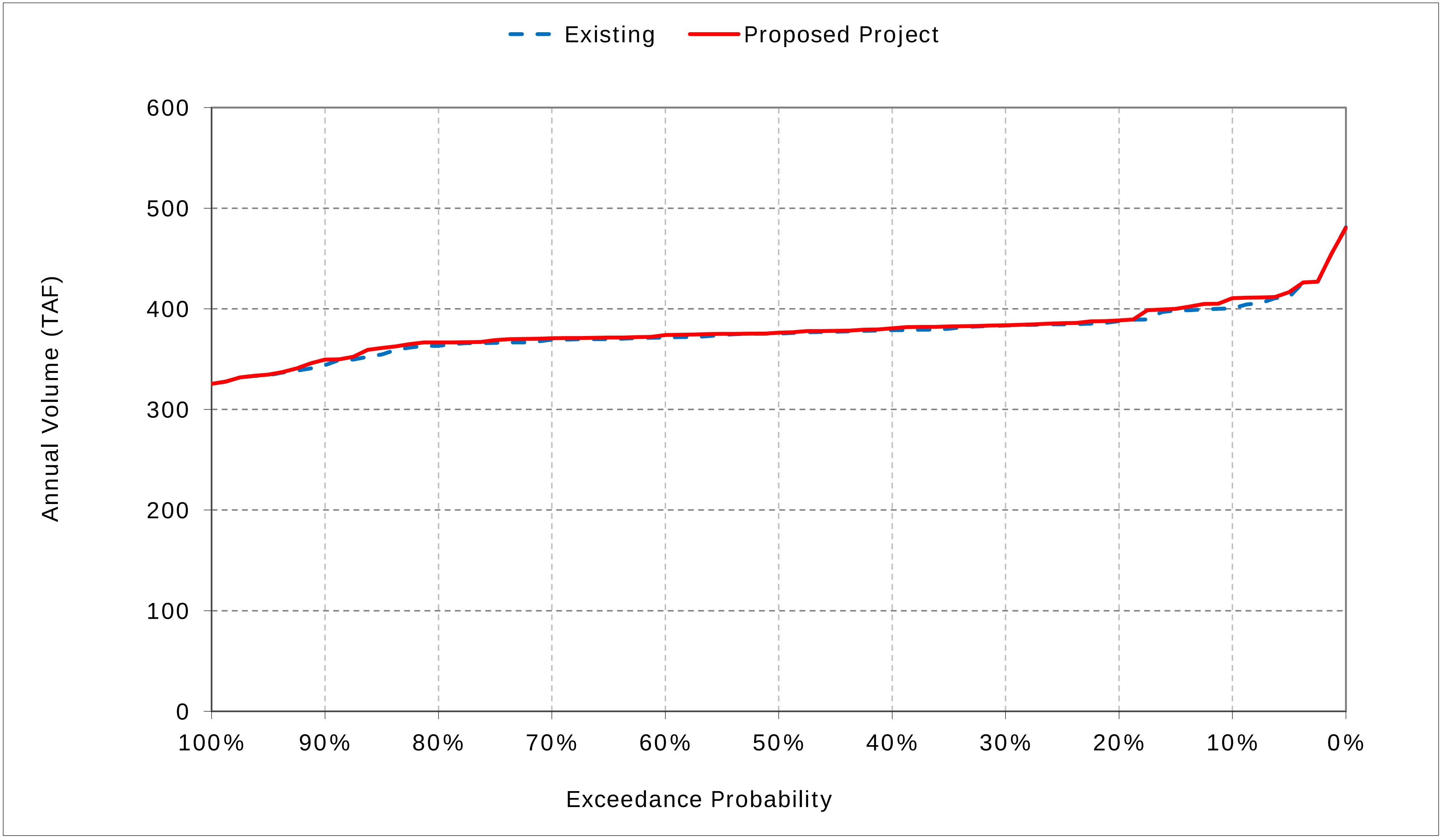


Figure 1-4. CVP South of Delta M&I Water Service Contract Deliveries, Annual (Mar-Feb)

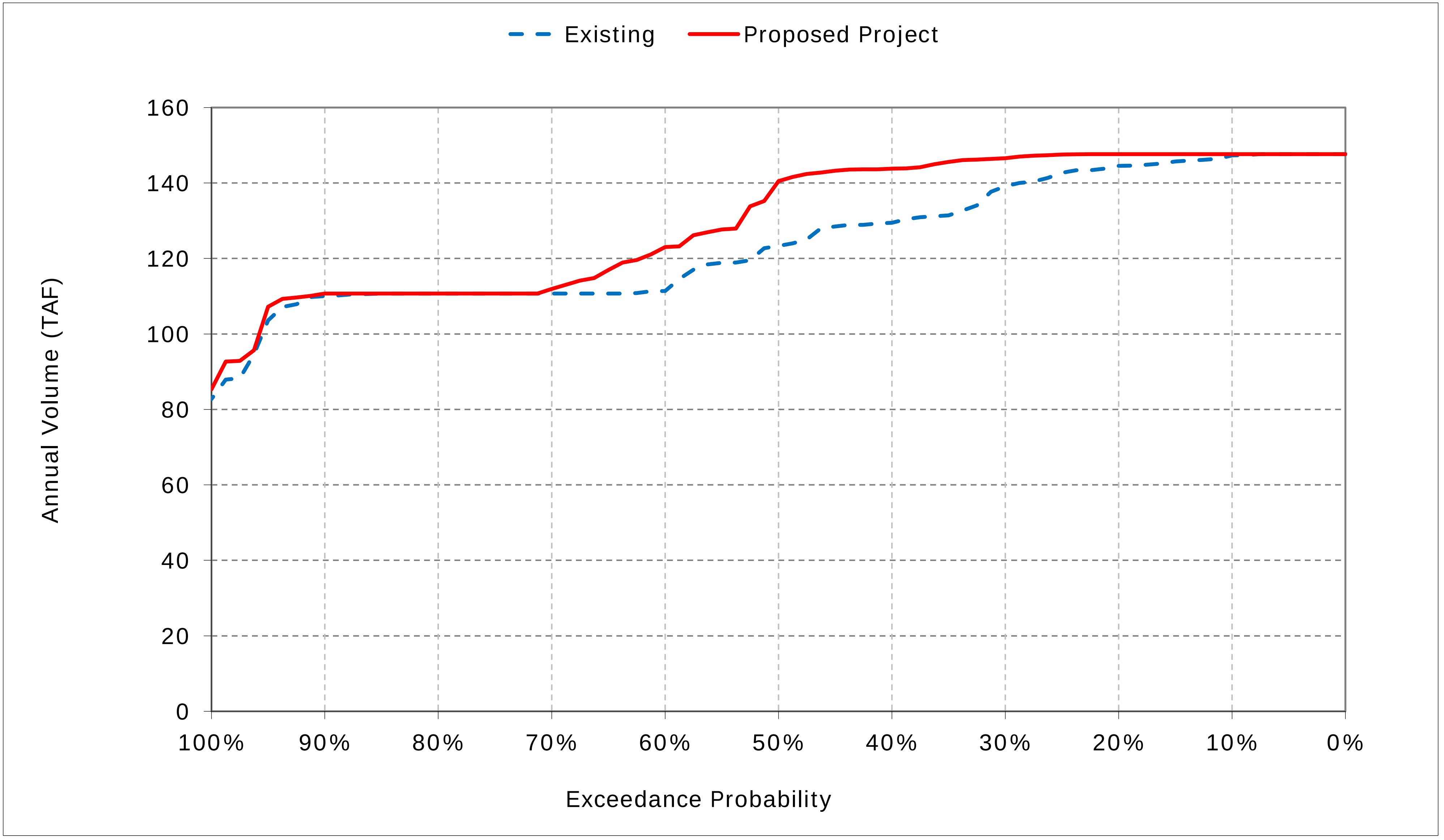


Figure 1-5. Total SWP Deliveries, Annual (Jan-Dec)

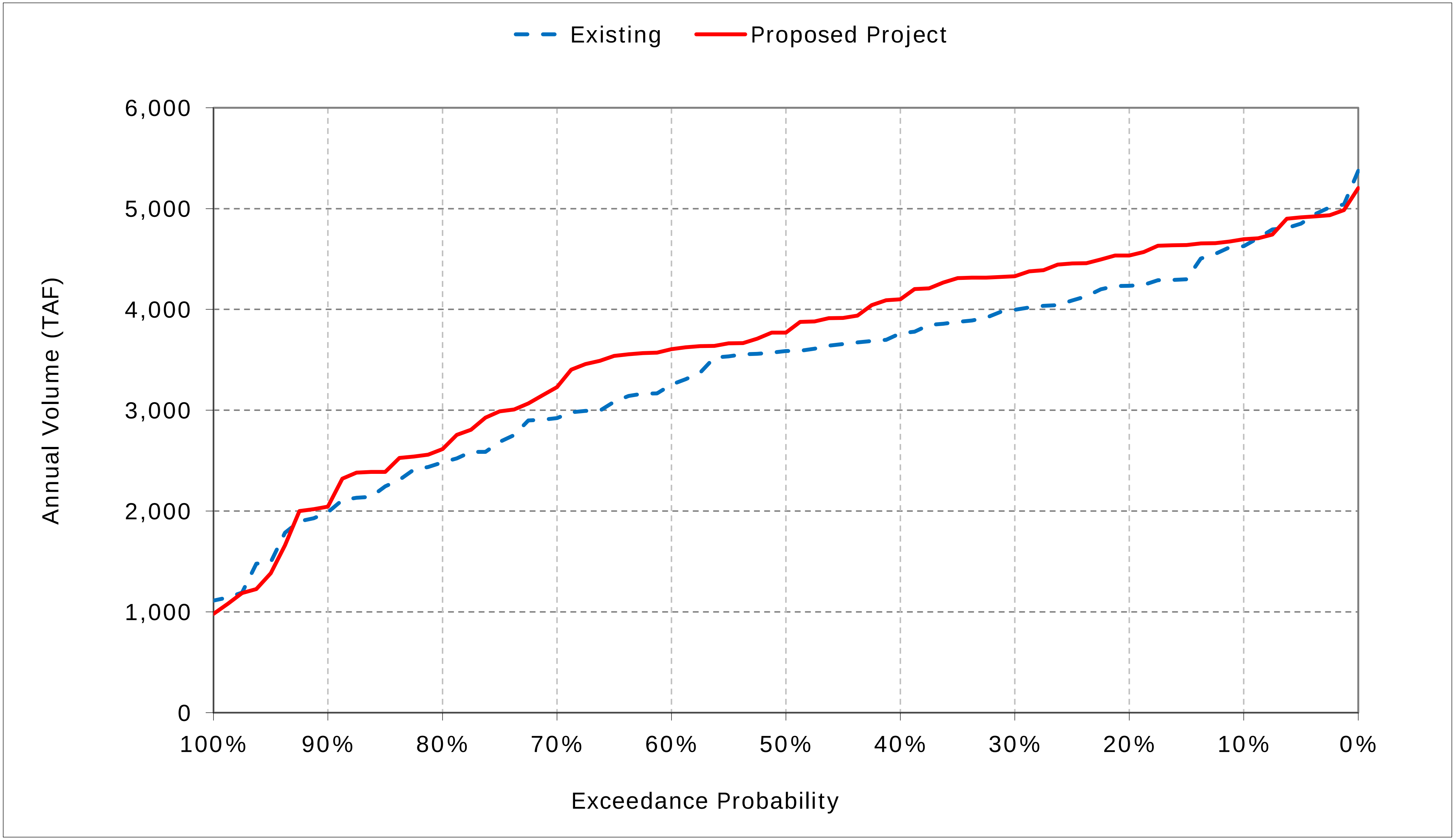


Figure 1-6. Total SWP South of Delta Deliveries including Article 21 and 56, Annual (Jan-Dec)

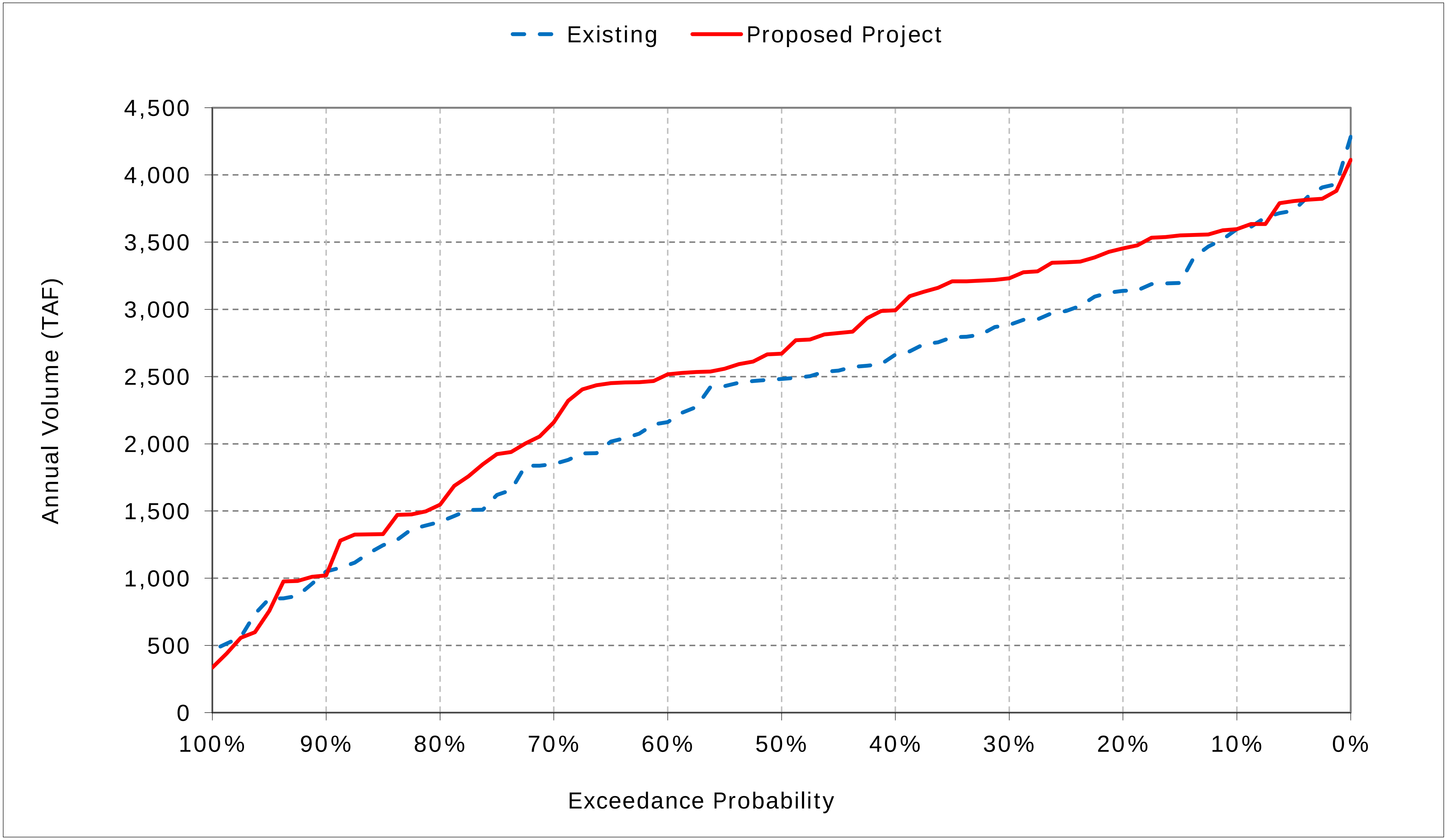


Figure 1-7. SWP Table A Deliveries with Article 56, Annual (Jan-Dec)

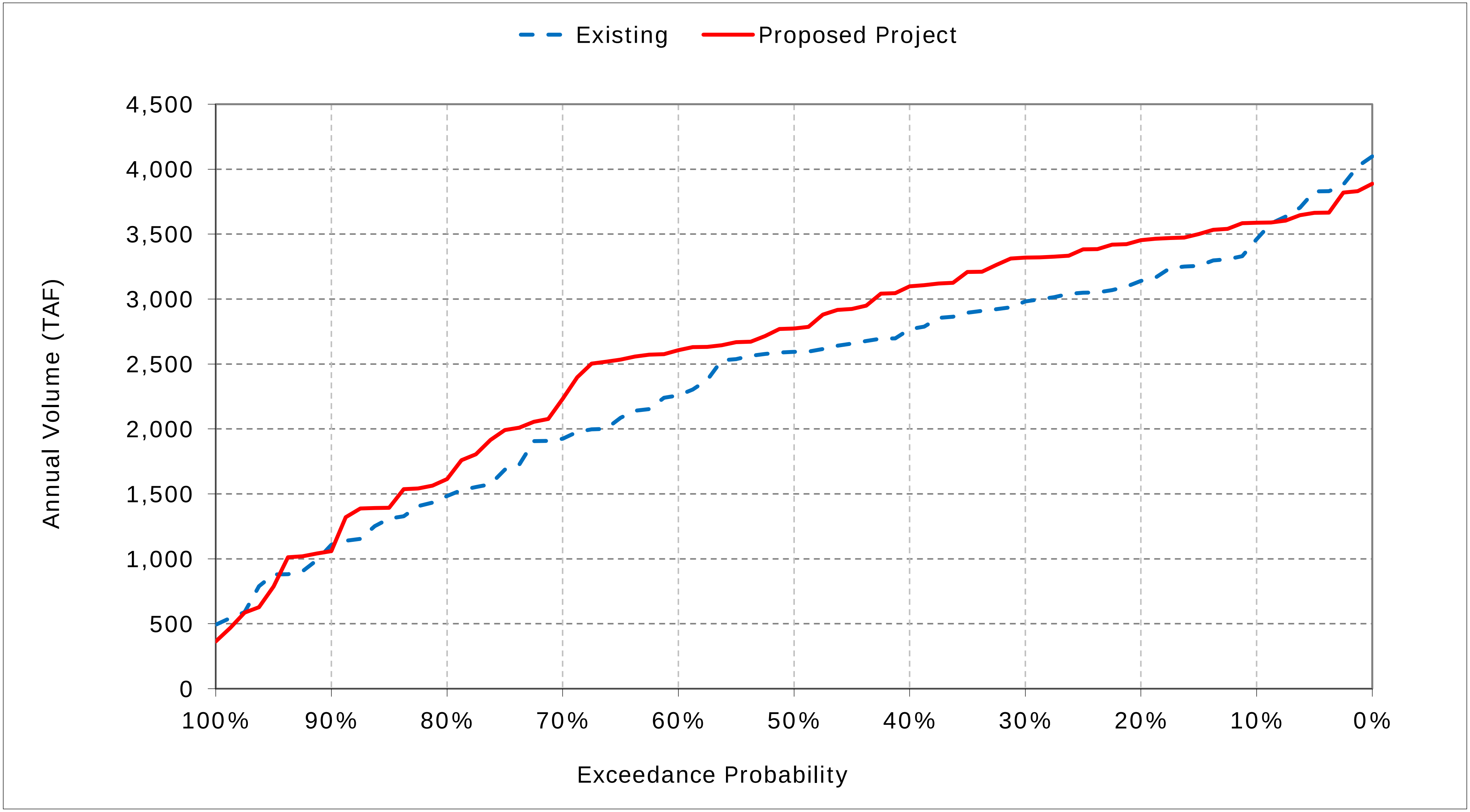


Figure 1-8. SWP South of Delta Table A Deliveries with Article 56, Annual (Jan-Dec)

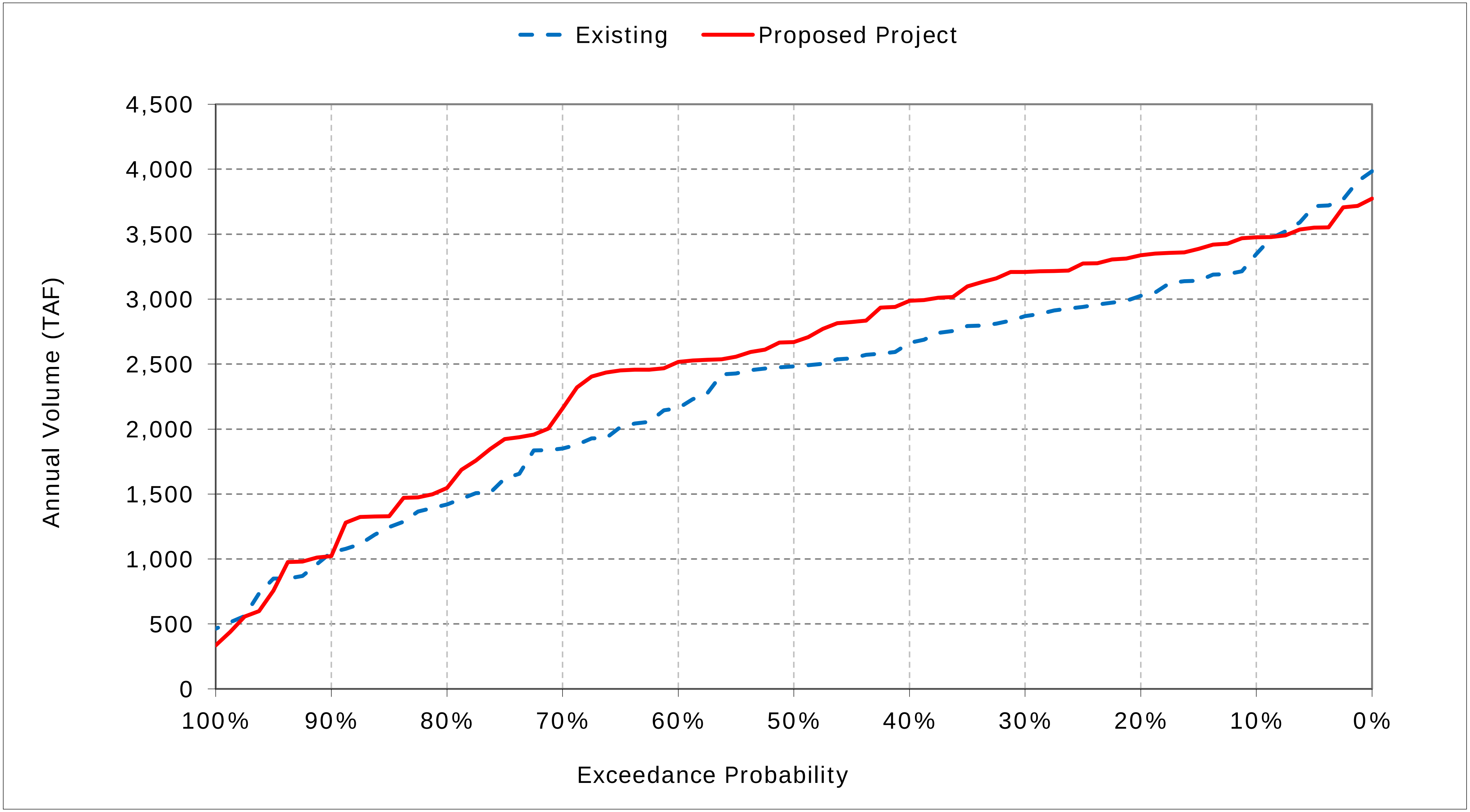


Figure 1-9. SWP Article 21 Deliveries, Annual (Jan-Dec)

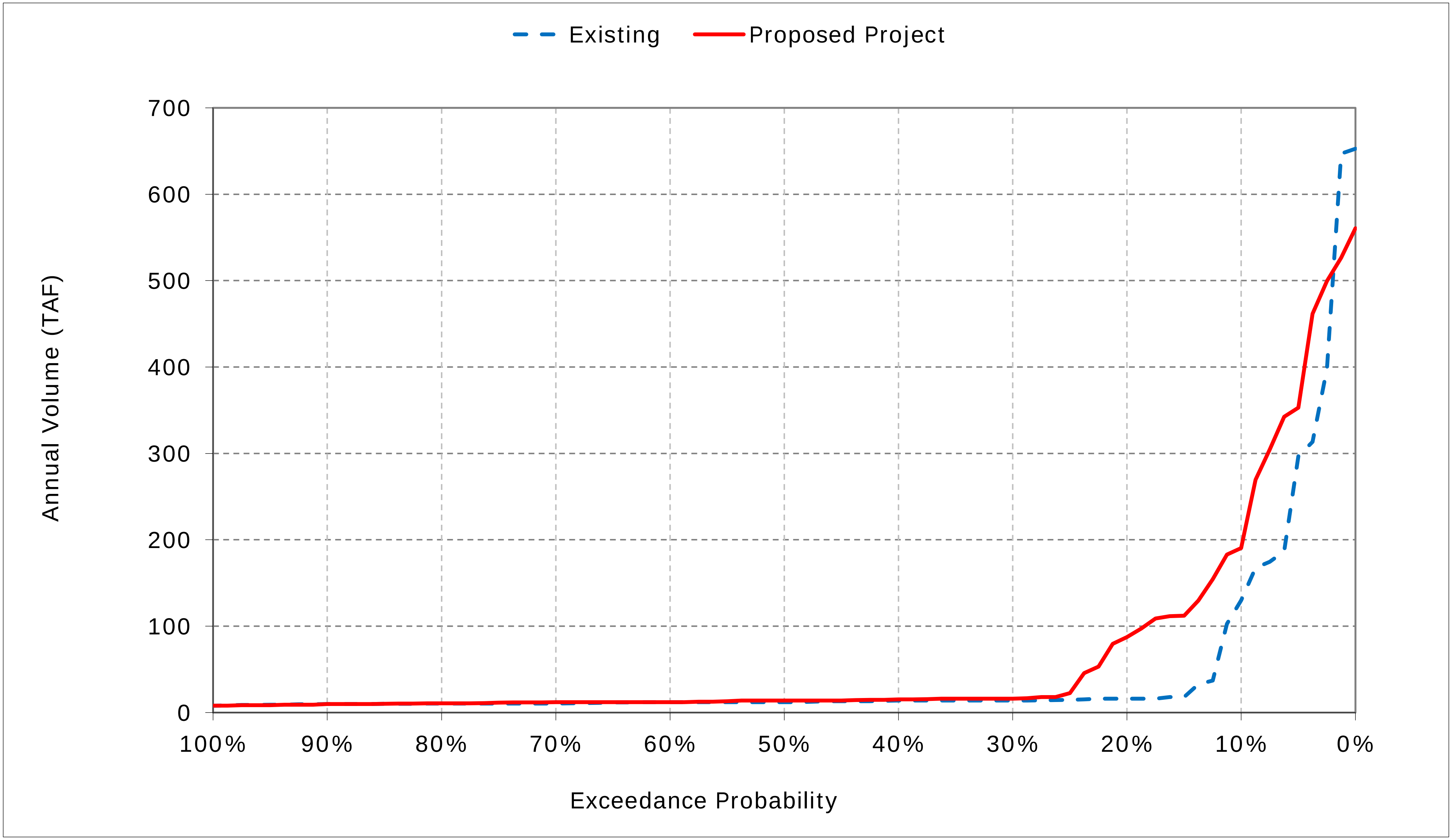
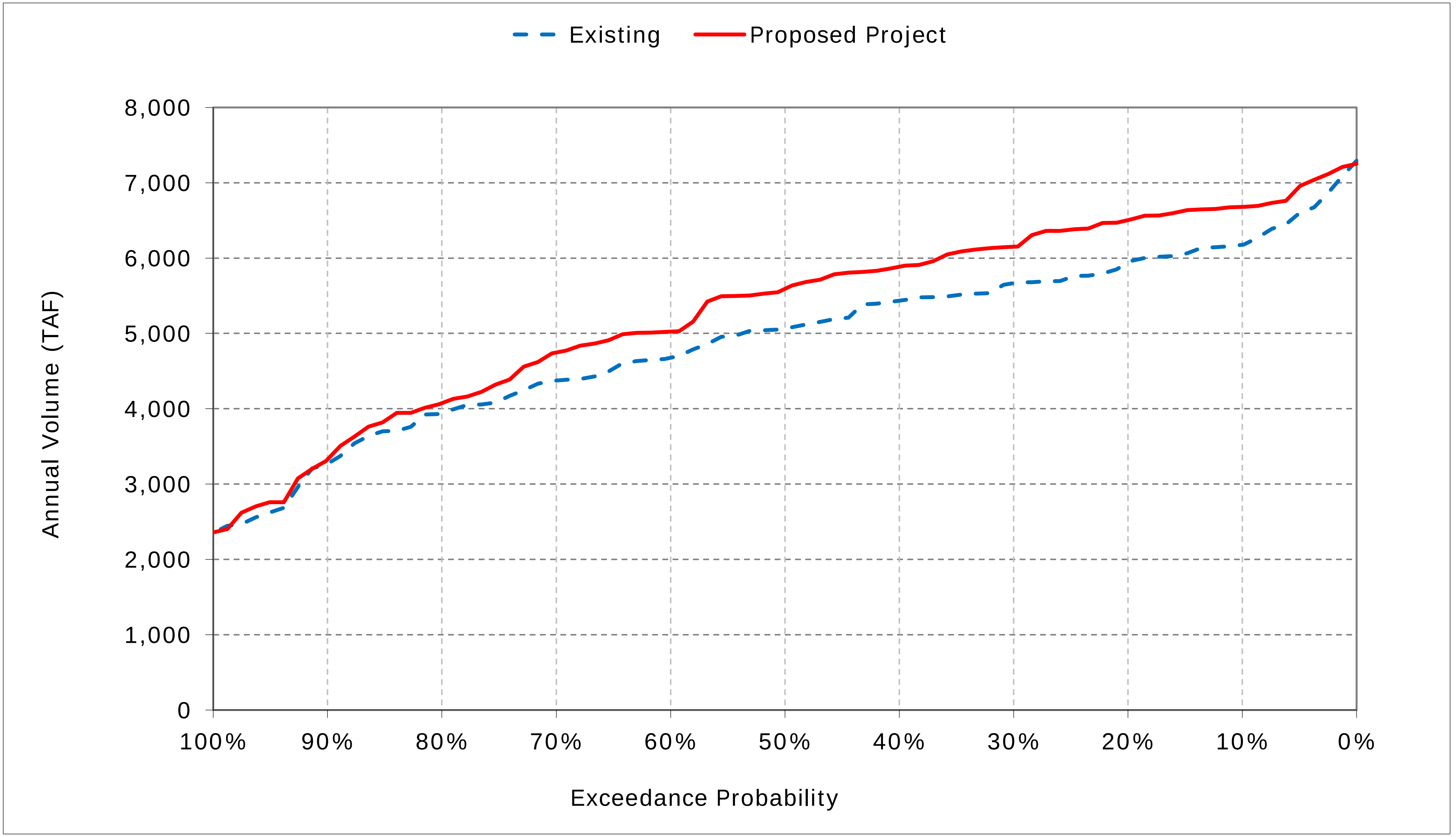


Figure 2-1. Total Delta Exports, Annual (Oct-Sep)



Appendix C – Modeling

Attachment 2-5 – X2 Position Results (CalSim II)

The following results of the CalSim II model are included for Delta X2 conditions for the following alternatives:

- Existing Conditions
- Proposed Project

Table 2-5.1. X2 Position Results (CalSim II)

Title	Model Parameter	Table Numbers	Figure Numbers
X2	X2_PRV_MOD	1-1	1-1 to 1-18

Report formats

- Monthly tables comparing two scenarios (exceedance values, long-term average, and average by water year type)
- Monthly pattern charts (long-term average and average by water year type) including all scenarios
- Monthly exceedance charts (all months) including all scenarios

Table 1-1. X2 Position, Monthly Position

Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Position (KM)											
Probability of Exceedance												
10%	92.8	91.8	90.7	84.5	78.2	77.3	78.1	80.9	83.4	86.4	90.3	92.3
20%	92.1	91.3	88.6	82.9	72.2	71.8	72.2	78.1	81.7	85.1	88.2	91.1
30%	91.7	90.9	84.0	79.8	67.4	65.1	67.8	75.1	81.0	84.5	87.7	90.6
40%	91.0	90.4	82.0	73.4	63.3	63.6	66.4	71.0	80.4	82.4	86.3	89.8
50%	89.9	81.1	80.1	71.5	58.9	60.3	62.4	66.9	77.0	80.9	85.7	88.5
60%	81.0	80.9	78.8	65.4	53.8	57.3	60.0	64.5	75.3	79.9	85.0	81.0
70%	74.0	75.4	71.5	55.4	51.0	54.0	57.9	62.0	72.2	78.6	84.6	74.1
80%	74.0	74.0	63.5	50.3	48.2	49.9	53.2	58.7	66.5	77.1	83.7	74.0
90%	74.0	73.3	52.5	48.4	47.7	48.1	49.1	53.1	59.7	73.9	82.4	74.0
Long Term												
Full Simulation Period[a]	84.1	82.4	76.3	67.9	60.7	60.9	63.2	67.7	74.9	80.5	85.6	83.9
Water Year Types[b,c]												
Wet (32%)	80.7	76.7	63.8	53.9	50.2	51.8	54.1	57.9	65.5	74.4	82.7	73.6
Above Normal (15%)	83.6	80.9	76.6	62.5	54.7	53.8	58.2	62.5	73.0	78.2	83.6	74.3
Below Normal (17%)	85.3	84.9	81.5	72.7	61.0	63.5	63.9	68.5	76.9	81.6	85.4	89.1
Dry (22%)	85.3	85.4	82.7	78.1	69.3	67.2	69.8	74.8	80.8	84.9	87.9	90.8
Critical (15%)	88.9	88.6	87.7	82.7	76.3	75.4	77.5	82.7	86.2	88.2	90.5	92.5

Proposed Project

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Position (KM)											
Probability of Exceedance												
10%	92.5	91.9	90.6	86.4	77.6	77.4	78.6	81.3	83.4	86.4	90.3	92.6
20%	92.1	91.4	88.8	84.1	71.7	71.1	73.7	79.6	82.8	85.2	88.4	91.3
30%	91.6	90.8	88.0	80.8	67.6	64.4	69.4	77.2	81.6	84.6	87.9	90.9
40%	91.1	90.3	87.3	74.6	63.9	62.8	67.5	73.3	81.0	81.4	85.8	89.7
50%	89.7	86.7	84.8	71.0	58.8	59.7	64.1	69.5	77.9	80.3	85.4	88.6
60%	80.1	86.4	81.0	64.7	53.5	56.7	61.1	67.4	76.6	79.6	84.7	80.1
70%	80.0	86.2	73.2	55.0	51.1	53.6	58.8	63.7	73.4	78.3	84.2	80.0
80%	80.0	84.7	64.7	50.1	48.2	49.3	54.2	59.8	66.9	77.1	83.4	80.0
90%	79.9	73.2	52.6	48.2	47.7	48.0	49.5	54.3	59.8	73.7	82.4	80.0
Long Term												
Full Simulation Period[a]	85.6	85.7	78.1	68.2	60.8	60.6	64.2	69.5	75.6	80.3	85.5	85.6
Water Year Types[b,c]												
Wet (32%)	82.6	81.0	65.0	53.8	50.1	51.6	54.9	59.6	66.3	74.3	82.5	79.0
Above Normal (15%)	85.4	84.9	79.4	62.6	54.3	53.3	59.2	64.7	73.9	77.9	83.5	73.3
Below Normal (17%)	86.8	88.1	83.7	72.5	60.5	62.8	65.2	71.1	77.6	80.8	85.0	89.1
Dry (22%)	86.7	88.1	84.7	79.1	69.9	66.6	70.8	76.4	81.5	84.9	88.1	91.0
Critical (15%)	89.0	90.5	89.0	83.5	77.0	75.6	78.0	83.3	86.4	88.3	90.6	92.6

Proposed Project minus Existing

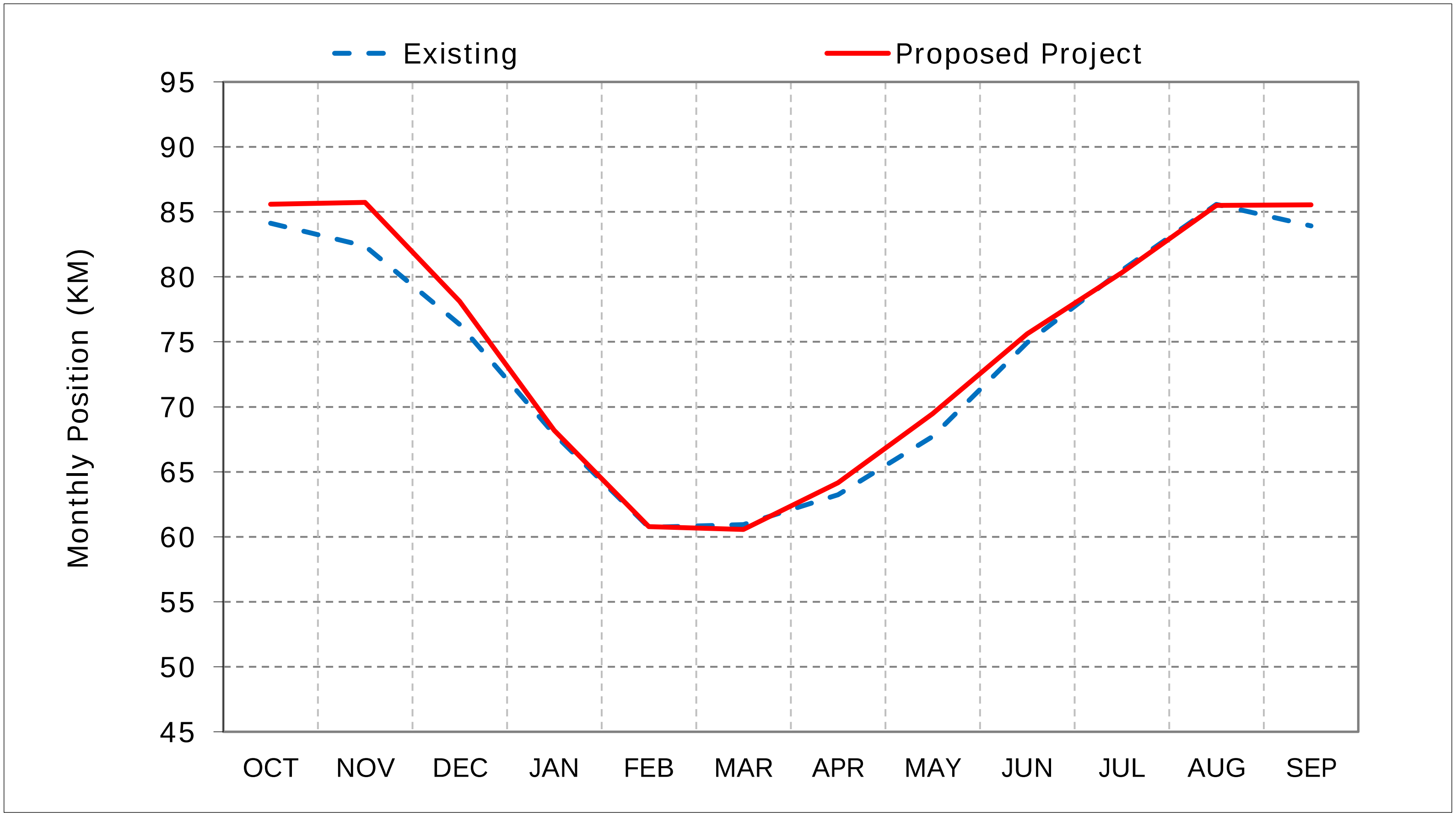
Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Position (KM)											
Probability of Exceedance												
10%	-0.3	0.1	-0.1	1.9	-0.5	0.1	0.5	0.3	0.0	0.0	-0.1	0.3
20%	0.0	0.1	0.1	1.1	-0.5	-0.7	1.5	1.5	1.2	0.0	0.2	0.2
30%	-0.1	-0.1	4.0	1.0	0.2	-0.7	1.6	2.1	0.6	0.1	0.2	0.2
40%	0.0	-0.2	5.3	1.1	0.6	-0.8	1.1	2.3	0.5	-0.9	-0.4	-0.1
50%	-0.2	5.6	4.6	-0.5	-0.1	-0.6	1.7	2.6	0.9	-0.6	-0.3	0.1
60%	-0.9	5.5	2.2	-0.6	-0.3	-0.5	1.1	2.9	1.4	-0.4	-0.3	-0.9
70%	6.0	10.7	1.7	-0.4	0.1	-0.4	0.9	1.8	1.2	-0.2	-0.4	5.9
80%	6.0	10.7	1.2	-0.1	0.0	-0.6	0.9	1.1	0.4	0.1	-0.3	6.0
90%	6.0	-0.1	0.1	-0.2	-0.1	-0.1	0.4	1.2	0.1	-0.1	0.0	6.0
Long Term												
Full Simulation Period[a]	1.5	3.4	1.8	0.3	0.1	-0.4	0.9	1.8	0.7	-0.2	-0.1	1.6
Water Year Types[b,c]												
Wet (32%)	1.9	4.3	1.2	-0.1	-0.1	-0.3	0.9	1.7	0.8	-0.1	-0.2	5.3
Above Normal (15%)	1.9	4.0	2.8	0.1	-0.4	-0.5	1.0	2.3	0.9	-0.3	-0.1	-0.9
Below Normal (17%)	1.6	3.2	2.1	-0.1	-0.5	-0.7	1.2	2.6	0.7	-0.8	-0.4	0.0
Dry (22%)	1.5	2.7	2.0	1.0	0.6	-0.6	1.0	1.6	0.6	0.0	0.2	0.2
Critical (15%)	0.1	1.9	1.3	0.8	0.7	0.2	0.6	0.6	0.3	0.1	0.1	0.1

a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

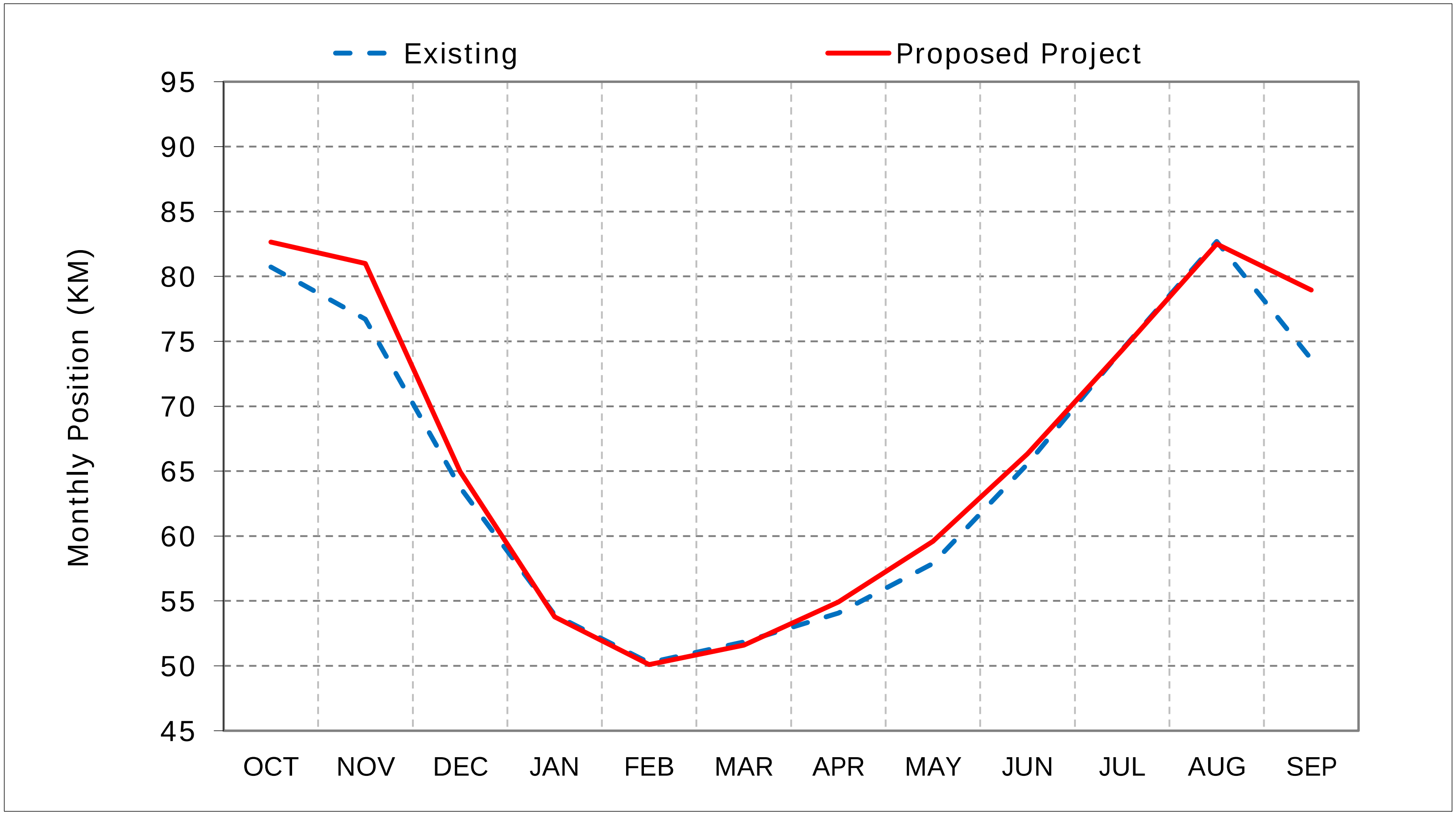
c These results are displayed with water year - year type sorting.

Figure 1-1. X2 Position, Long-Term Average Position



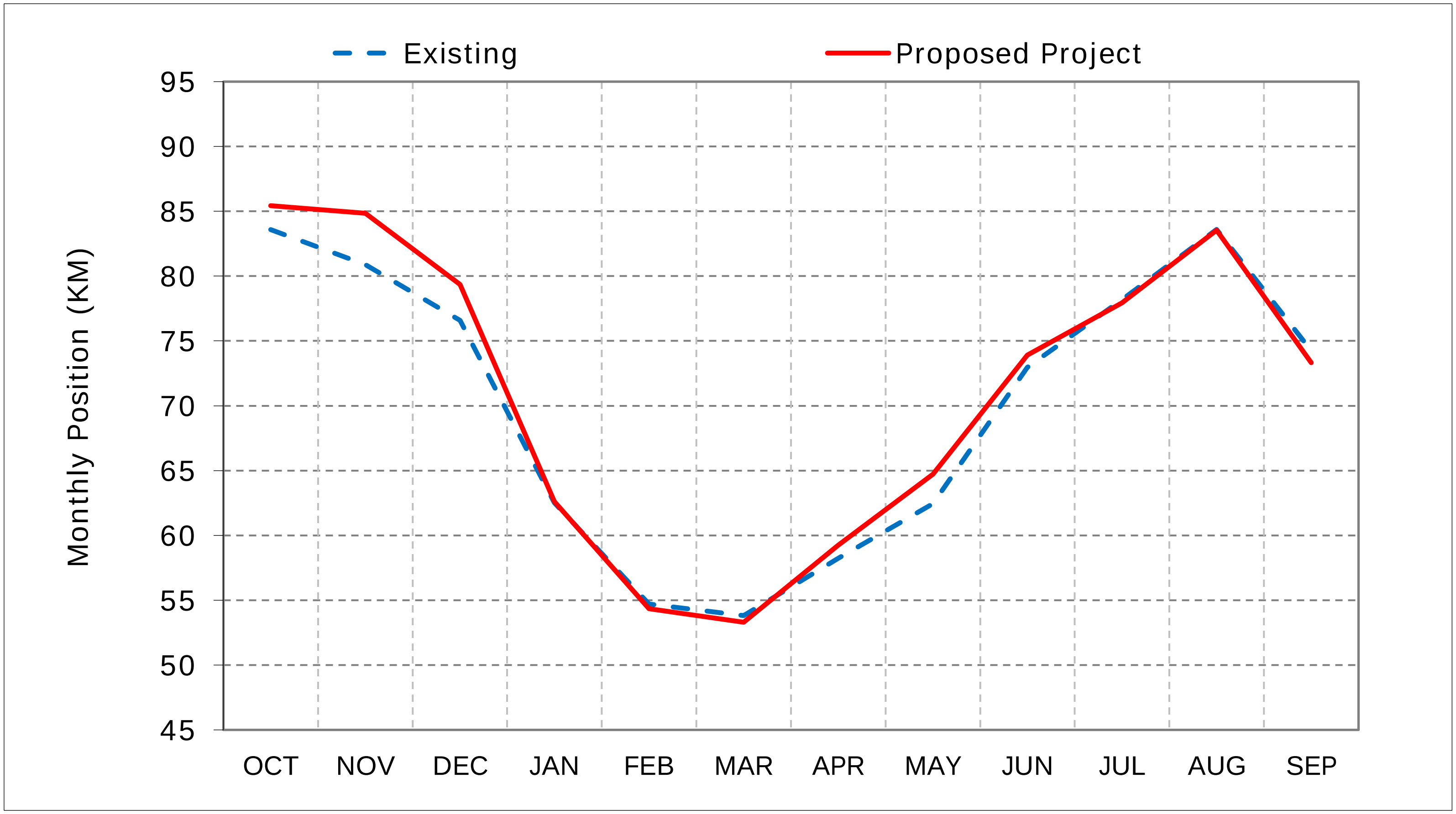
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 1-2. X2 Position, Wet Year Average Position



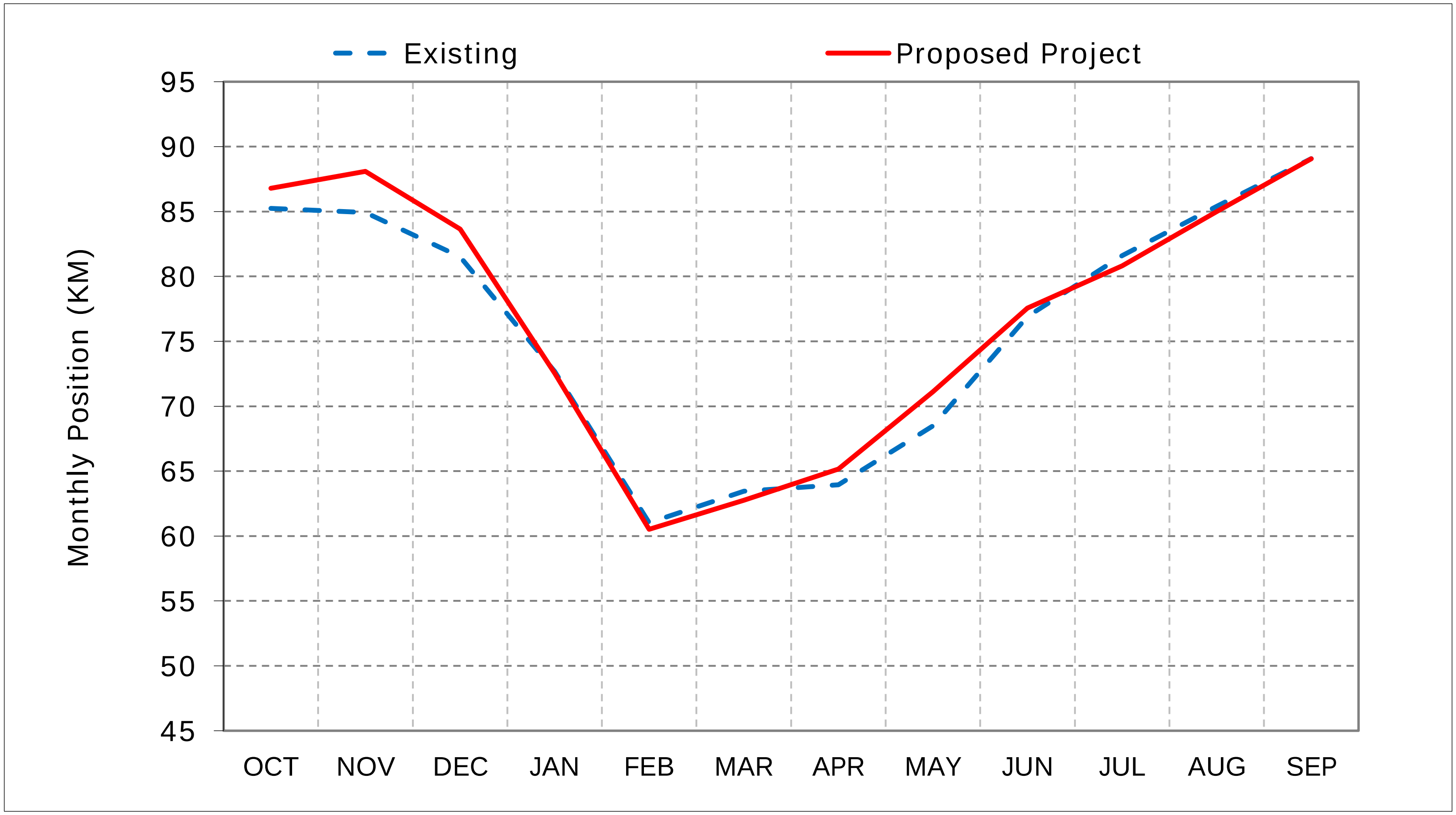
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 1-3. X2 Position, Above Normal Year Average Position



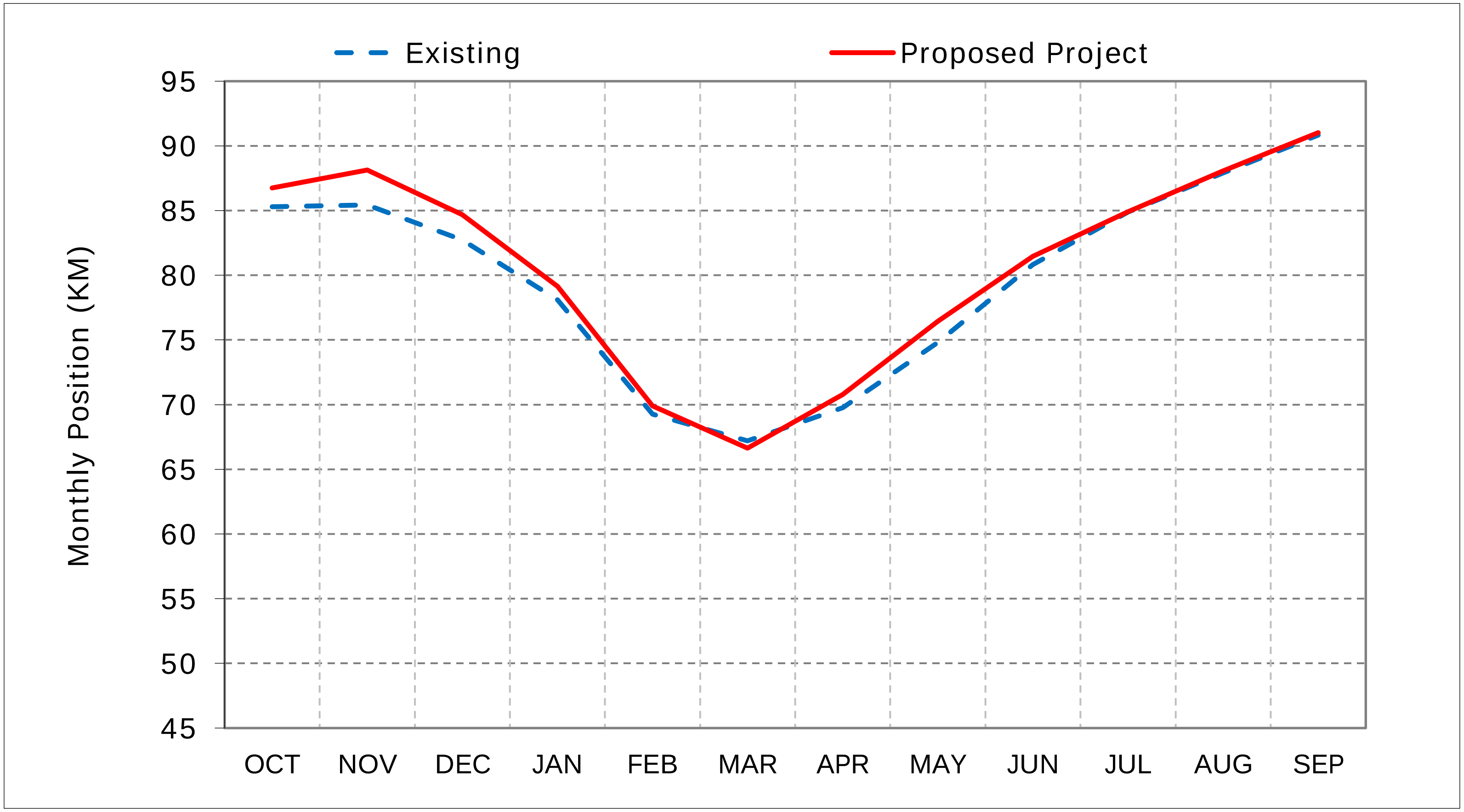
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 1-4. X2 Position, Below Normal Year Average Position



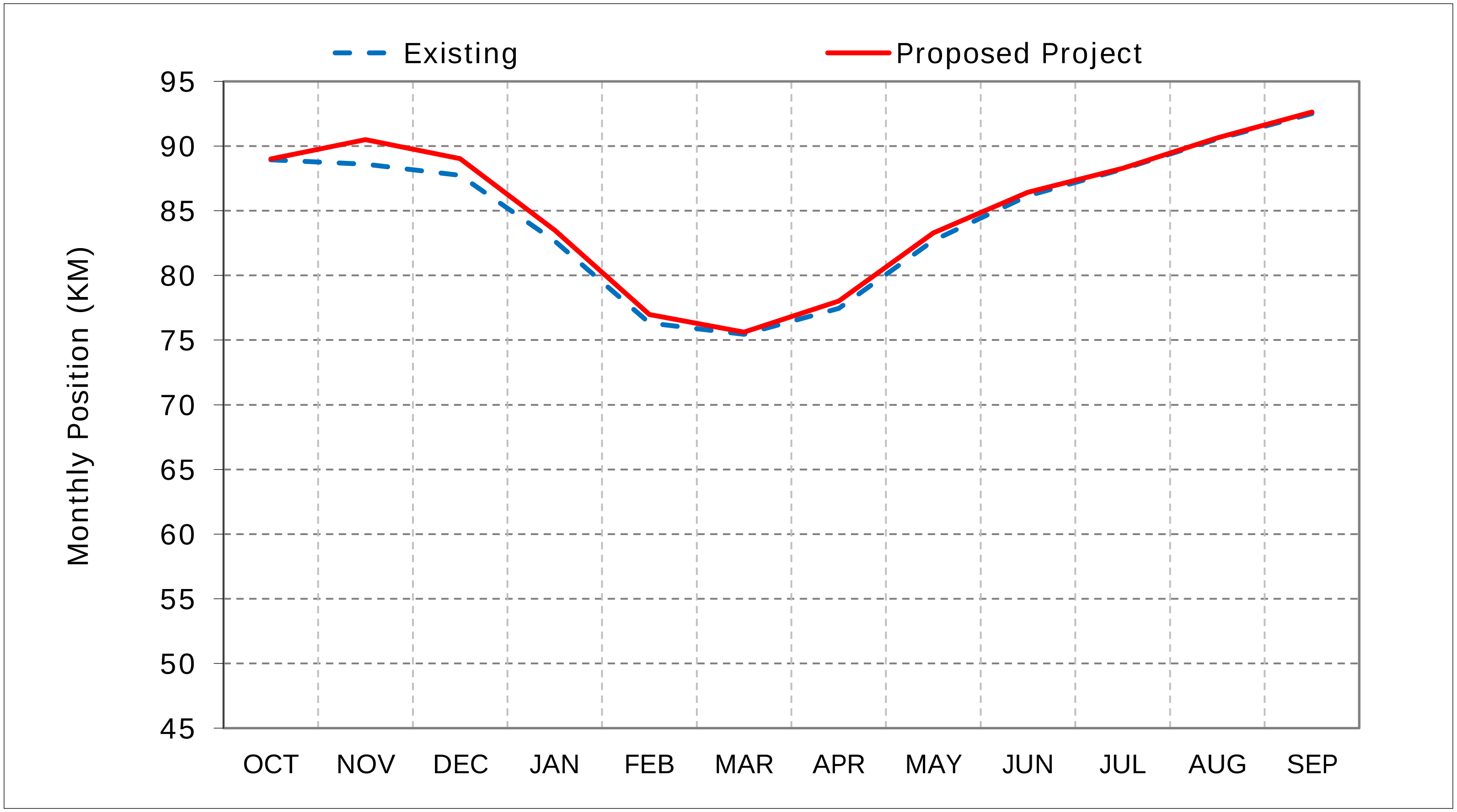
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 1-5. X2 Position, Dry Year Average Position



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 1-6. X2 Position, Critical Year Average Position



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 1-7. X2 Position, October

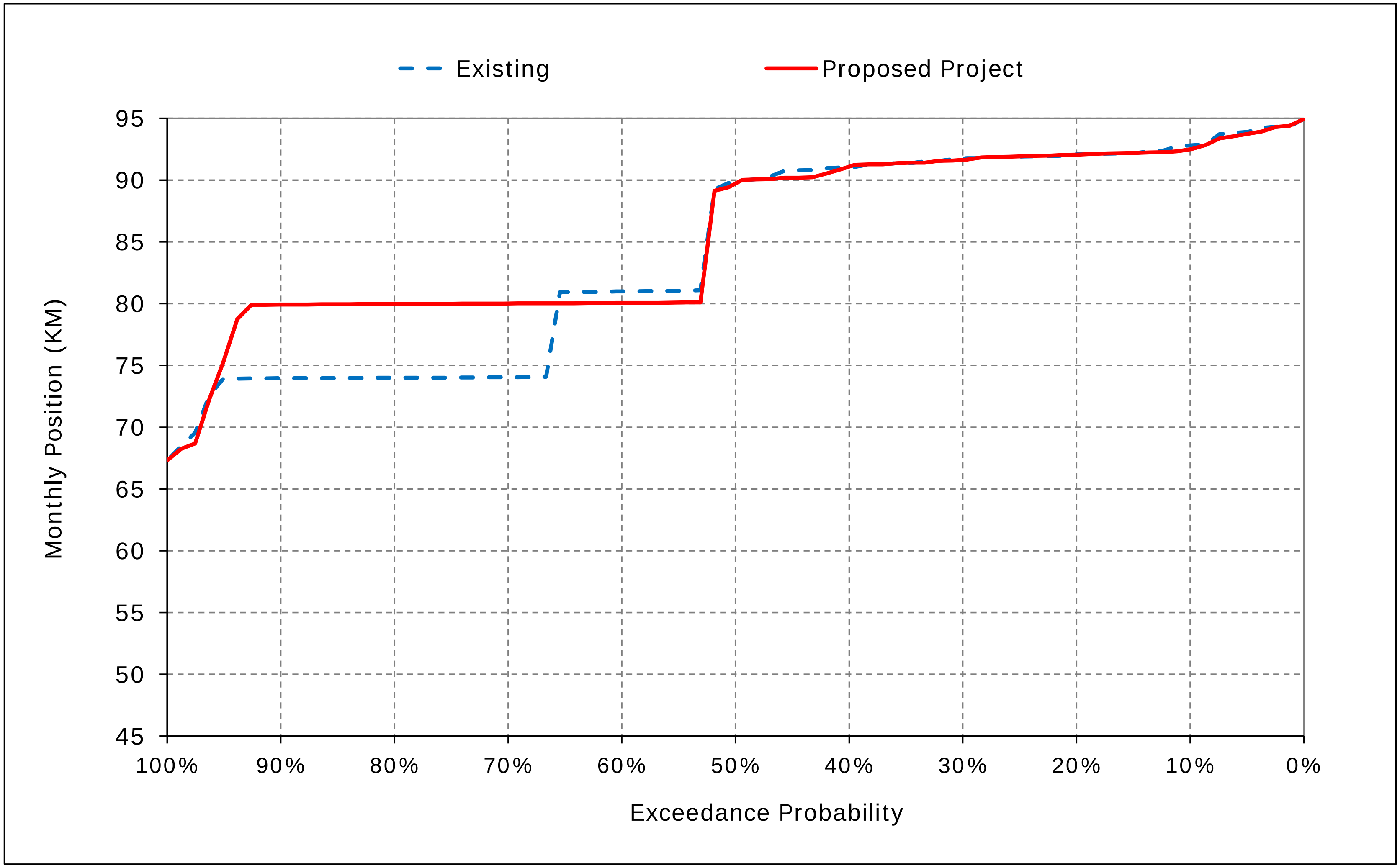


Figure 1-8. X2 Position, November

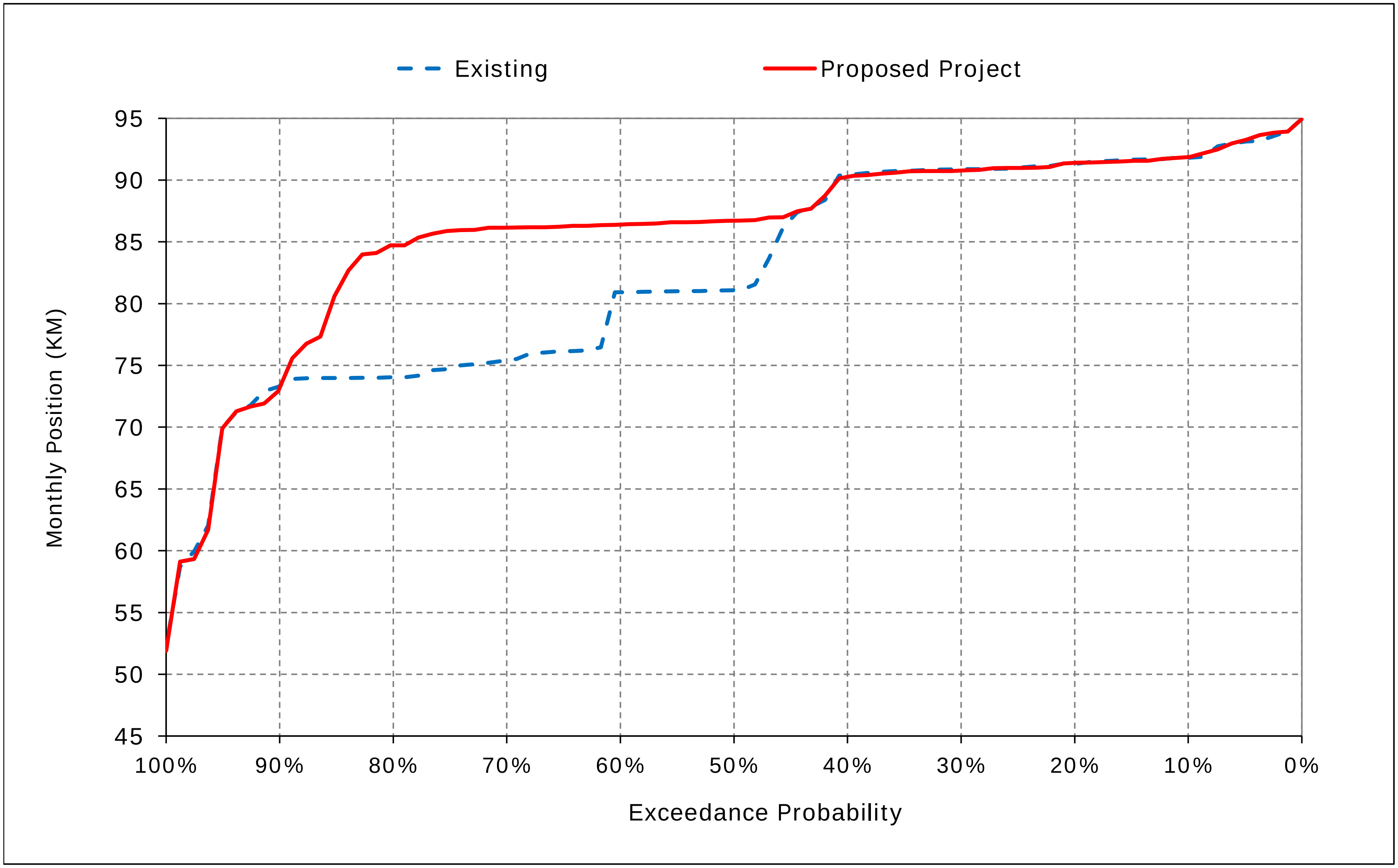


Figure 1-9. X2 Position, December

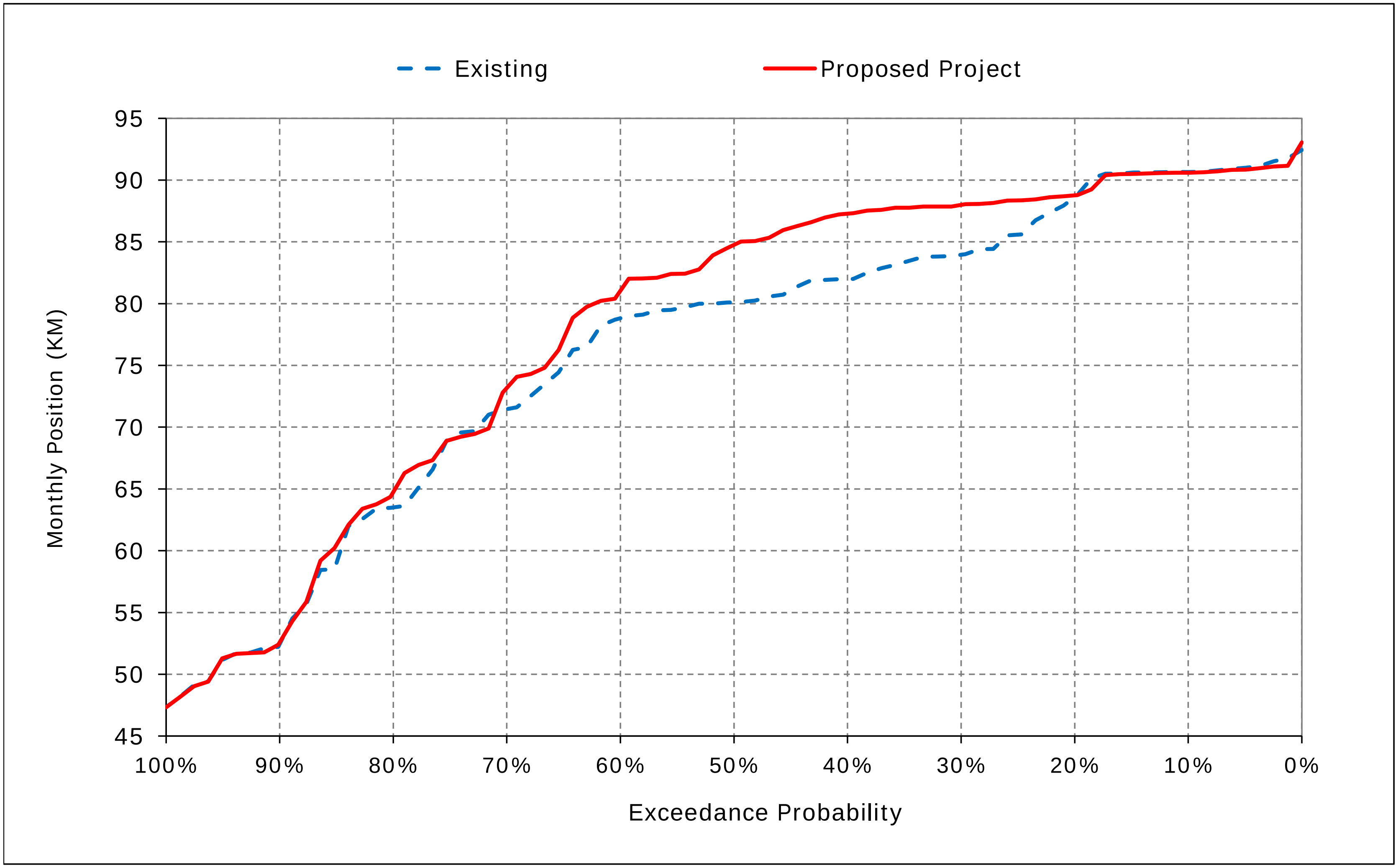


Figure 1-10. X2 Position, January

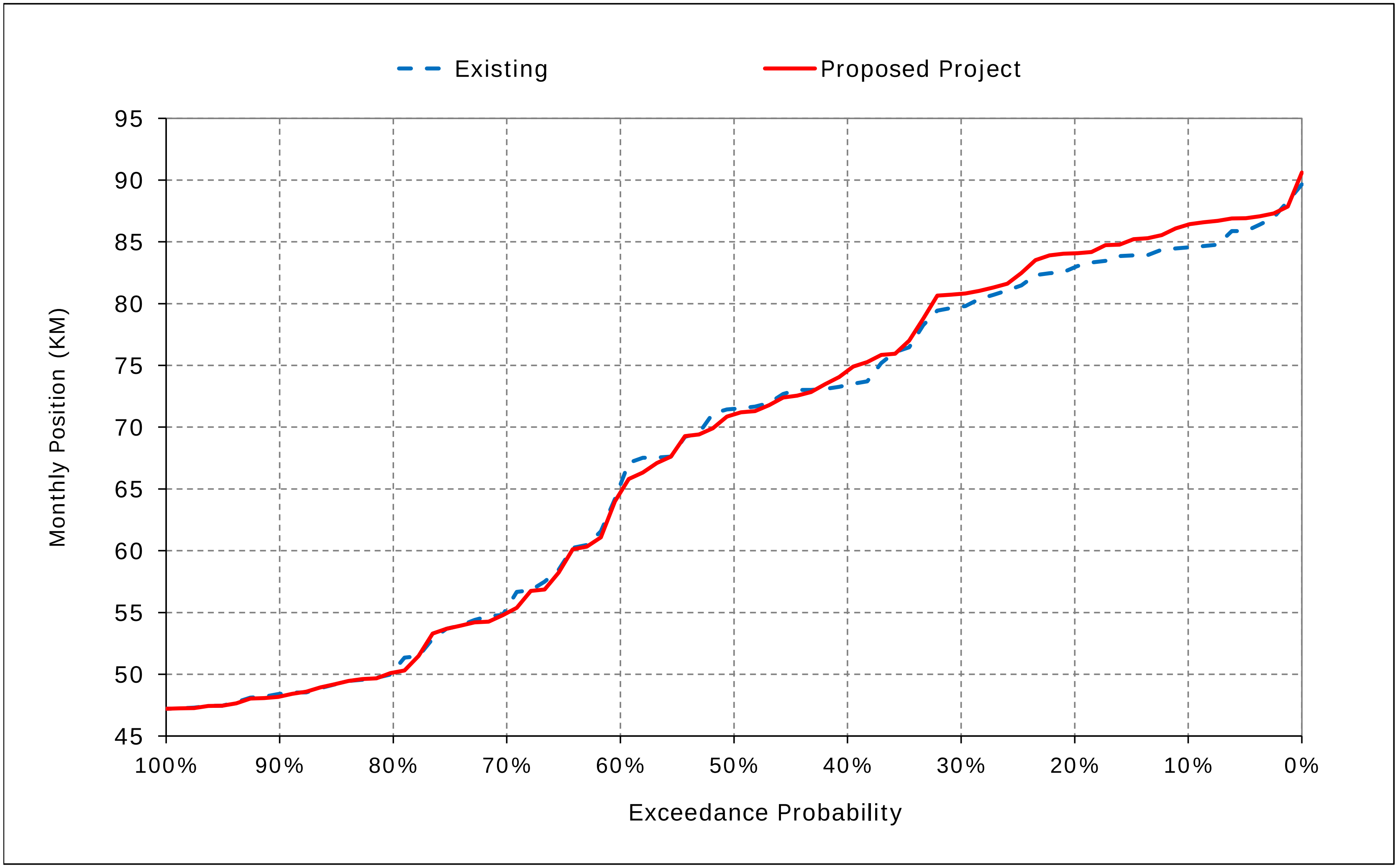


Figure 1-11. X2 Position, February

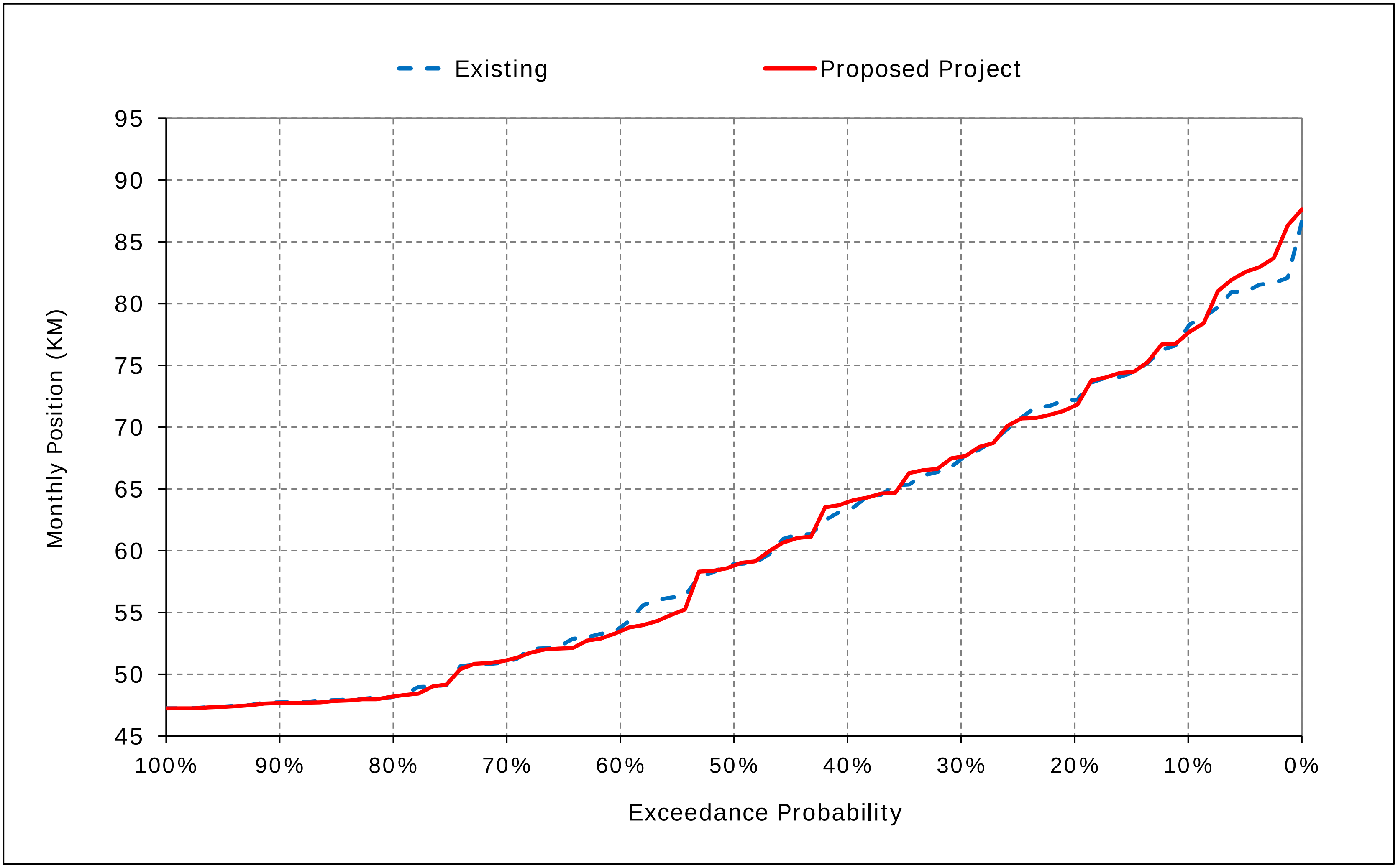


Figure 1-12. X2 Position, March

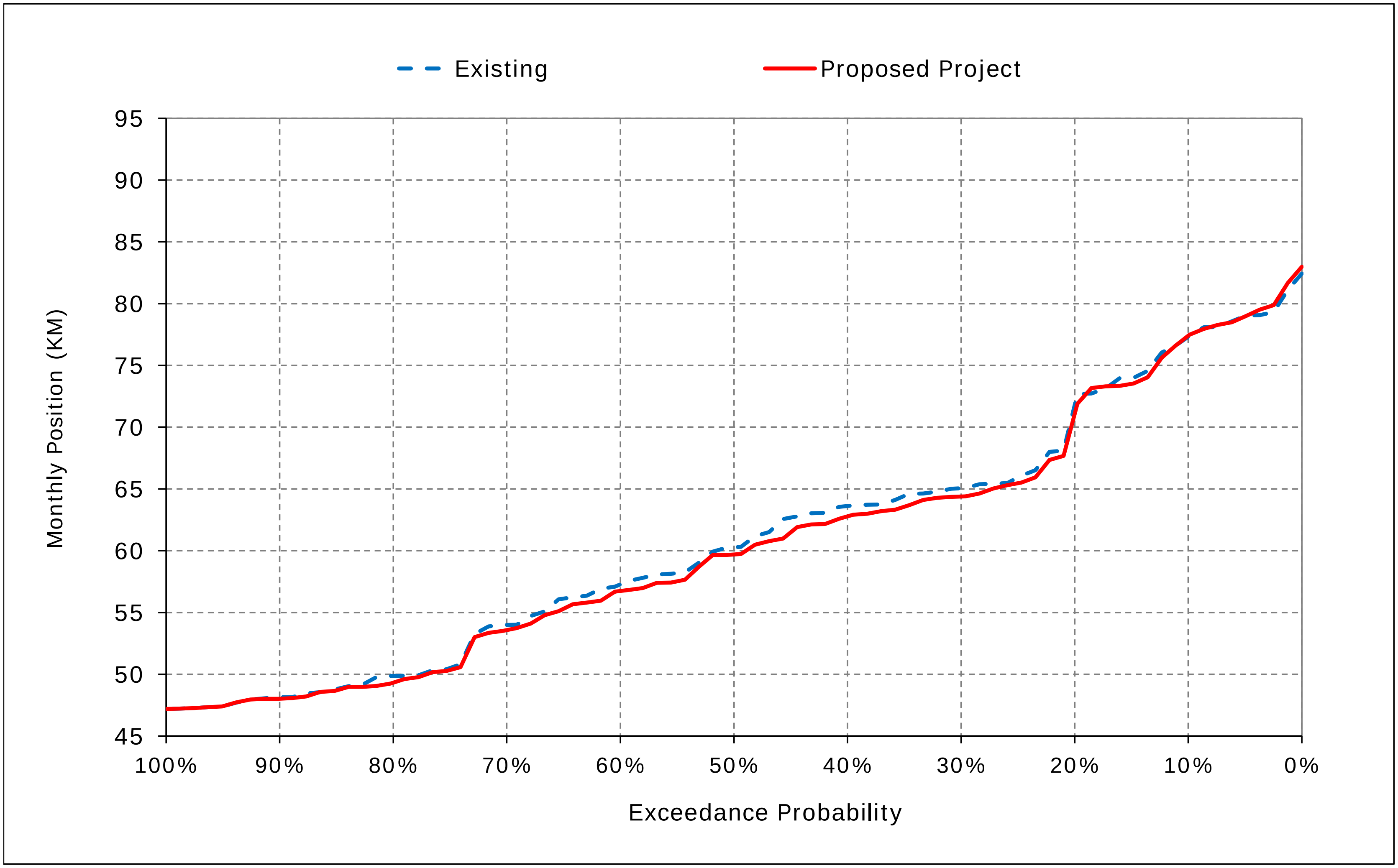


Figure 1-13. X2 Position, April

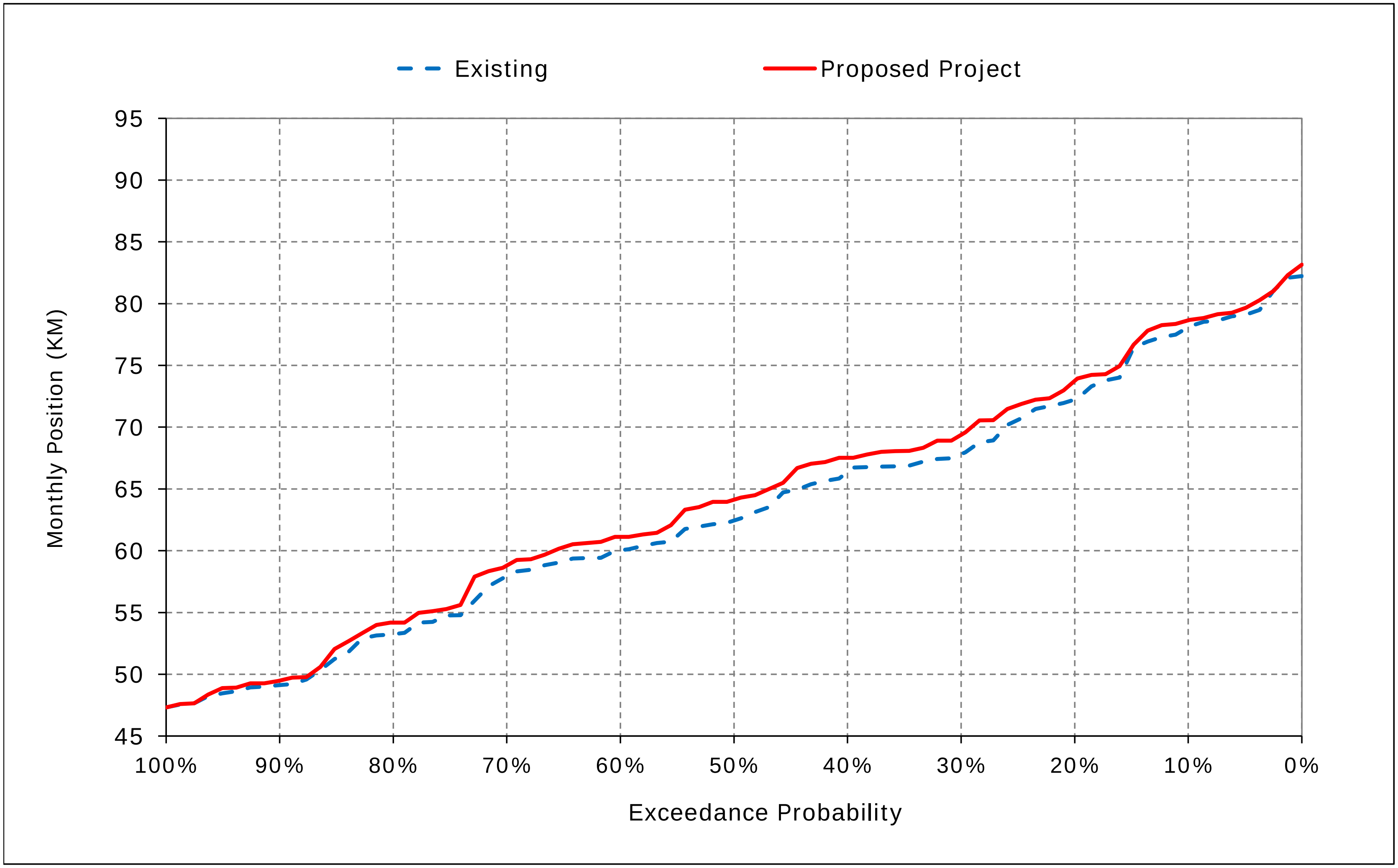


Figure 1-14. X2 Position, May

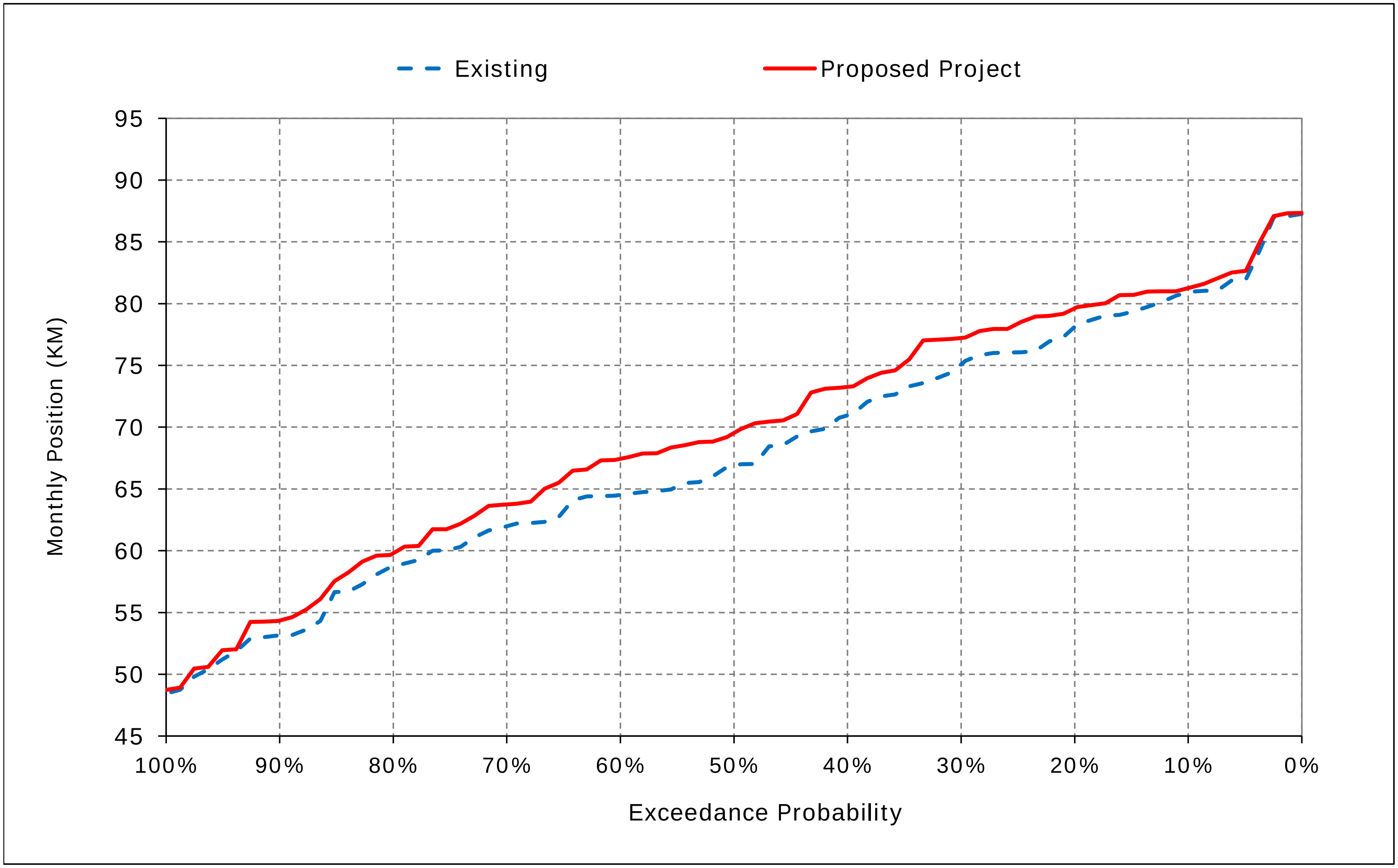


Figure 1-15. X2 Position, June

Figure 1-16. X2 Position, July

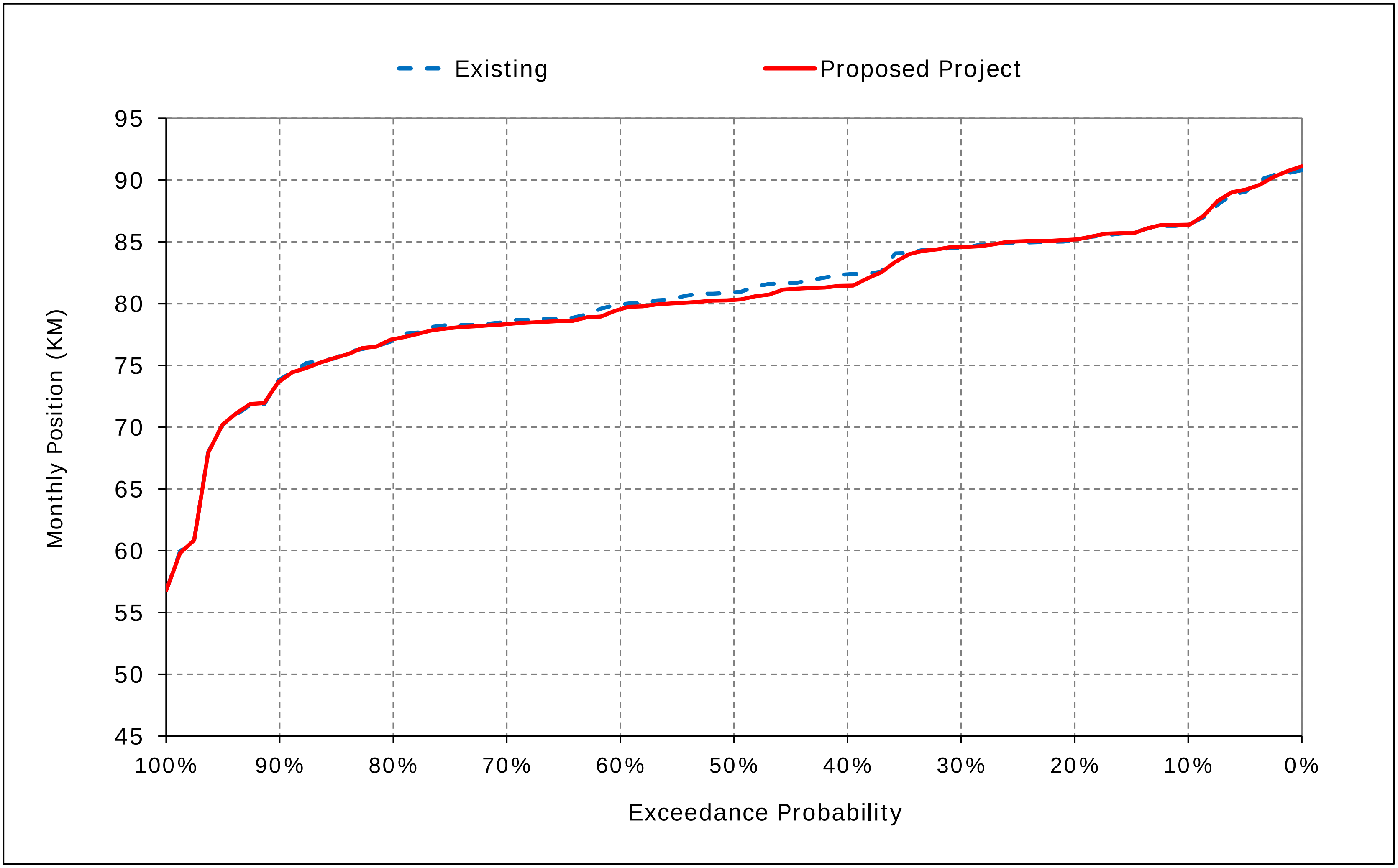


Figure 1-17. X2 Position, August

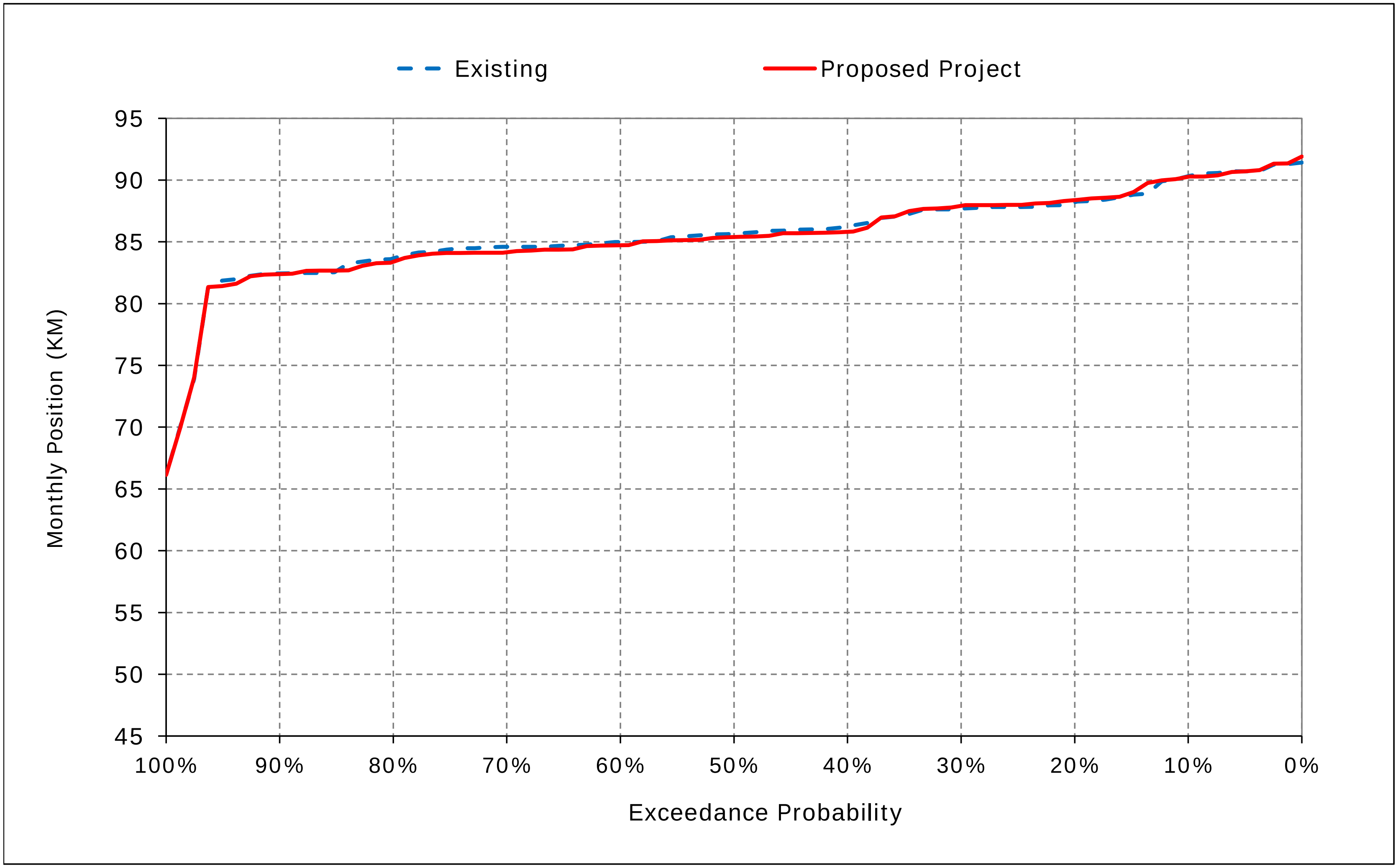
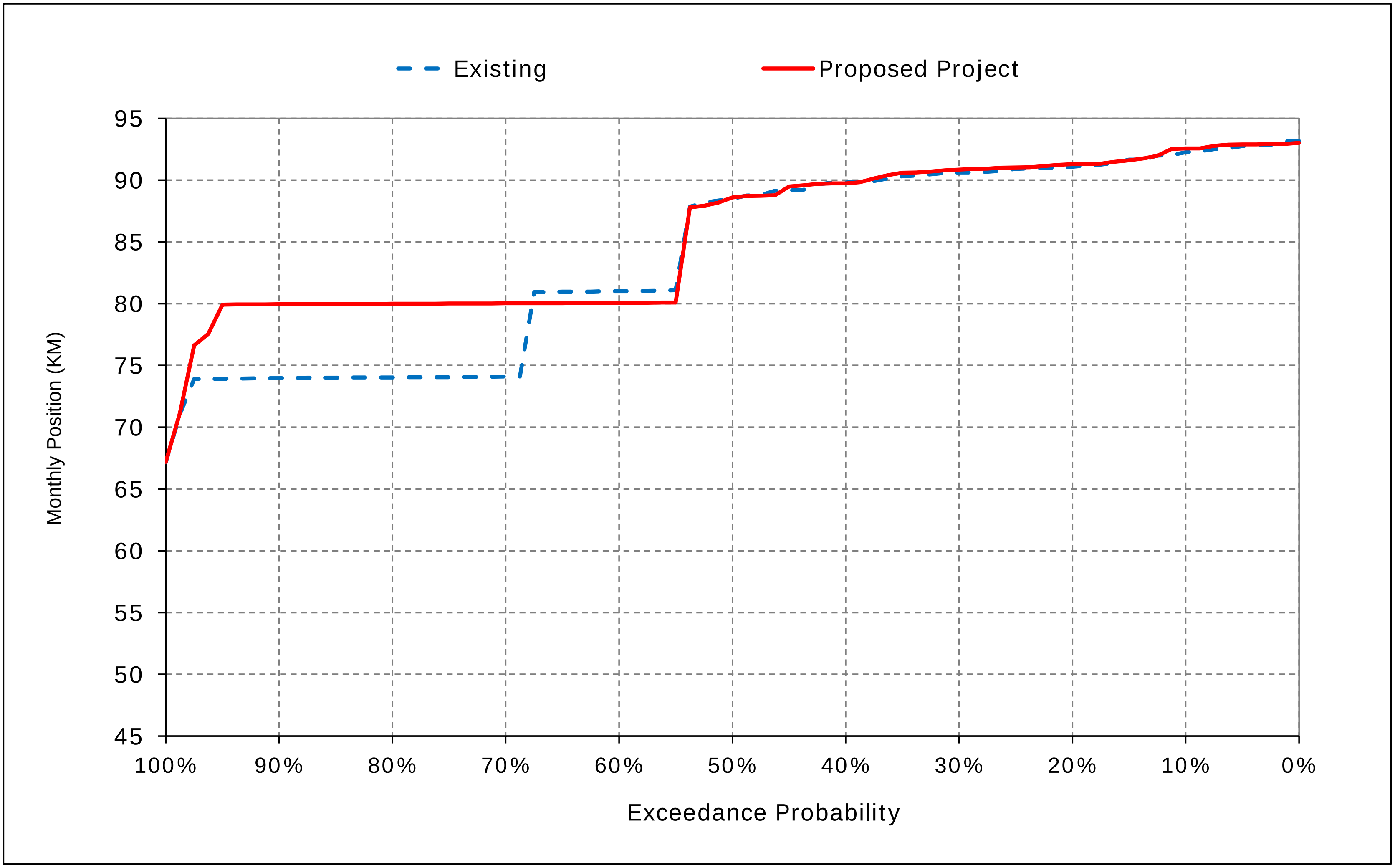


Figure 1-18. X2 Position, September



Appendix C – Modeling

Attachment 2-6 – Water Surface Elevation Results (DSM2-HYDRO)

The following results of the DSM2-HYDRO model are included for Delta water surface elevation conditions for the following alternatives:

- Existing Conditions
- Proposed Project

Table 2-6.1. Water Surface Elevation Results (DSM2-HYDRO)

Title	Model Parameter	Table Numbers	Figure Numbers
Sacramento River at Freeport Water Surface Elevation	RSAC155	1-1 to 1-2	NA
Sacramento River downstream of Steamboat Slough Water Surface Elevation	SAC_DS_STMBTSL	2-1 to 2-2	NA
Sacramento River at Rio Vista Water Surface Elevation	RSAC101	3-1 to 3-2	NA
San Joaquin River at Jersey Point Water Surface Elevation	RSAN018	4-1 to 4-2	NA
San Joaquin River at Prisoners Point Water Surface Elevation	RSAN037	5-1 to 5-2	NA
Old River at Tracy Boulevard Water Surface Elevation	ROLD059	6-1 to 6-2	NA

Report formats

- Monthly tables comparing two scenarios (exceedance values, long-term average, and average by water year type)

Table 1-1-1. Sacramento River at Freeport, Monthly Averaged Daily Maximum Elevation

Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Averaged Daily Maximum Elevation (FEET)											
Probability of Exceedance												
10%	3.8	5.6	5.9	7.5	15.0	12.0	10.8	5.7	4.7	5.3	4.6	6.5
20%	3.6	4.8	5.0	6.9	12.0	8.9	6.7	4.3	4.5	5.0	4.5	4.3
30%	3.6	4.0	4.6	6.0	9.0	7.5	6.1	4.3	4.4	4.9	4.3	4.0
40%	3.5	3.7	4.3	5.5	6.0	6.5	6.0	4.2	4.4	4.7	4.1	3.8
50%	3.5	3.7	3.9	5.1	5.0	4.8	5.6	4.0	4.2	4.6	4.0	3.8
60%	3.4	3.6	3.8	4.9	4.7	4.0	4.2	3.8	4.1	4.5	3.9	3.7
70%	3.3	3.4	3.8	4.3	4.5	3.8	3.7	3.8	3.9	4.2	3.9	3.6
80%	3.3	3.3	3.7	4.0	4.4	3.4	3.6	3.6	3.8	4.0	3.8	3.5
90%	3.2	3.3	3.7	3.9	4.2	3.3	3.4	3.4	3.8	3.9	3.7	3.5
Long Term												
Full Simulation Period[a]	3.5	4.1	4.9	5.5	7.7	6.6	6.0	4.6	4.4	4.6	4.1	4.3
Water Year Types[b]												
Wet (32%)	3.5	3.7	4.0	4.5	4.6	4.6	3.6	3.6	4.0	4.2	3.9	3.6
Above Normal (16%)	3.2	4.3	4.4	5.8	14.3	7.3	8.7	5.1	4.4	5.0	4.2	5.6
Below Normal (13%)	3.5	3.6	3.8	4.9	9.5	4.7	5.4	3.7	4.2	4.5	3.7	3.5
Dry (24%)	3.5	3.9	4.4	6.2	7.3	7.3	5.0	4.0	4.2	4.9	4.3	4.4
Critical (15%)	3.5	4.6	6.3	5.6	7.6	7.7	7.7	5.9	5.0	4.6	4.2	4.5

Proposed Project

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Averaged Daily Maximum Elevation (FEET)											
Probability of Exceedance												
10%	3.9	4.8	6.0	7.6	15.0	12.6	10.8	5.7	4.8	5.3	4.6	5.8
20%	3.7	4.0	5.1	6.8	11.5	8.8	6.7	4.3	4.5	5.0	4.5	4.3
30%	3.6	3.8	4.6	5.9	9.0	7.5	6.2	4.3	4.4	4.7	4.3	4.0
40%	3.6	3.6	4.3	5.6	6.1	6.5	6.0	4.2	4.4	4.6	4.0	3.8
50%	3.5	3.6	4.0	5.1	5.1	4.7	5.6	4.1	4.2	4.4	4.0	3.7
60%	3.5	3.5	3.9	4.8	4.8	4.0	4.2	3.8	4.1	4.3	3.9	3.7
70%	3.3	3.4	3.8	4.2	4.7	3.8	3.7	3.8	3.9	4.1	3.9	3.7
80%	3.3	3.3	3.7	4.0	4.5	3.6	3.6	3.6	3.9	4.0	3.8	3.5
90%	3.2	3.3	3.7	3.9	4.3	3.4	3.4	3.4	3.8	3.9	3.7	3.5
Long Term												
Full Simulation Period[a]	3.5	3.9	4.9	5.4	7.7	6.7	6.0	4.6	4.5	4.6	4.1	4.1
Water Year Types[b]												
Wet (32%)	3.5	3.6	4.0	4.5	4.6	4.6	3.6	3.5	4.0	4.2	3.9	3.6
Above Normal (16%)	3.2	4.2	4.4	5.8	14.1	7.3	8.7	5.1	4.4	4.9	4.3	4.8
Below Normal (13%)	3.5	3.5	3.9	4.8	9.5	4.5	5.4	4.2	4.1	4.5	3.7	3.4
Dry (24%)	3.5	3.5	4.4	6.1	7.3	7.6	5.0	4.0	4.3	4.8	4.3	4.4
Critical (15%)	3.6	4.4	6.3	5.6	7.7	7.7	7.8	5.9	5.1	4.5	4.1	4.1

Proposed Project minus Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Averaged Daily Maximum Elevation (FEET)											
Probability of Exceedance												
10%	0.1	-0.9	0.1	0.0	0.0	0.6	0.0	0.0	0.1	0.0	0.0	-0.7
20%	0.1	-0.8	0.1	0.0	-0.5	0.0	0.0	0.0	0.1	0.0	0.0	0.1
30%	0.0	-0.2	0.0	0.0	0.0	0.0	0.1	0.0	0.0	-0.2	-0.1	-0.1
40%	0.0	-0.1	-0.1	0.1	0.1	0.0	0.0	0.0	0.0	-0.1	-0.1	0.0
50%	0.0	0.0	0.1	-0.1	0.1	-0.1	0.0	0.2	0.0	-0.2	0.0	0.0
60%	0.0	0.0	0.0	-0.1	0.1	0.0	0.0	0.0	0.0	-0.2	0.0	0.0
70%	0.0	0.0	0.0	-0.1	0.2	0.0	0.0	0.0	0.0	-0.2	0.0	0.0
80%	0.0	0.0	0.0	0.0	0.2	0.2	0.1	0.0	0.0	0.0	0.0	0.0
90%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Long Term												
Full Simulation Period[a]	0.0	-0.2	0.0	0.0	0.0	0.1	0.0	0.0	0.0	-0.1	0.0	-0.2
Water Year Types[b]												
Wet (32%)	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Above Normal (16%)	0.0	-0.1	0.0	0.0	-0.2	0.0	0.0	0.0	0.0	-0.1	0.0	-0.9
Below Normal (13%)	0.0	0.0	0.0	-0.1	0.0	-0.2	0.0	0.5	-0.1	0.0	0.0	0.0
Dry (24%)	0.0	-0.4	0.0	0.0	0.1	0.3	0.0	0.0	0.0	-0.1	0.0	0.1
Critical (15%)	0.1	-0.3	0.1	0.0	0.1	0.0	0.1	0.0	0.1	-0.1	0.0	-0.4

a Based on the 16-year simulation period

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999) at Early Long-Term

c The Elevations are based on National Geodetic Vertical Datum of 1929 (NGVD 29)

Table 1-2-1. Sacramento River at Freeport, Monthly Averaged Daily Minimum Elevation

Existing

Statistic	Monthly Averaged Daily Minimum Elevation (FEET)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	2.1	4.7	5.0	6.8	14.6	11.5	10.4	4.7	3.3	4.1	3.2	5.7
20%	1.8	3.7	4.0	6.0	11.5	8.4	5.9	2.9	2.8	3.8	3.0	2.8
30%	1.6	2.3	3.2	5.2	8.5	6.9	5.5	2.7	2.8	3.5	2.8	2.4
40%	1.5	1.9	2.8	4.4	5.2	5.7	5.2	2.7	2.7	3.2	2.3	1.9
50%	1.4	1.7	2.1	4.1	4.0	3.7	4.7	2.3	2.5	3.0	1.7	1.8
60%	1.3	1.3	1.9	3.6	3.7	2.7	2.7	1.9	2.1	2.9	1.7	1.6
70%	1.1	1.2	1.8	2.7	3.3	2.3	2.1	1.8	2.0	2.2	1.6	1.3
80%	1.0	0.9	1.7	2.5	3.1	2.1	1.9	1.5	1.9	1.6	1.6	1.2
90%	0.9	0.9	1.6	2.3	2.8	1.9	1.6	1.2	1.6	1.6	1.4	1.1
Long Term												
Full Simulation Period[a]	1.5	2.3	3.3	4.3	6.8	5.6	4.9	3.0	2.7	2.9	2.2	2.5
Water Year Types[b]												
Wet (32%)	1.4	1.5	2.1	3.0	3.4	3.2	1.9	1.4	2.0	2.0	1.5	1.3
Above Normal (16%)	1.1	2.8	3.1	4.6	13.9	6.5	8.2	3.9	2.7	3.7	2.5	4.4
Below Normal (13%)	1.5	1.7	1.7	3.6	9.0	3.6	4.5	1.9	2.5	3.0	1.4	1.4
Dry (24%)	1.4	1.9	2.9	5.3	6.3	6.3	3.7	2.3	2.5	3.3	2.4	2.7
Critical (15%)	1.7	3.2	4.9	4.5	6.7	6.9	6.9	4.6	3.5	3.1	2.5	2.9

Proposed Project

Statistic	Monthly Averaged Daily Minimum Elevation (FEET)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	2.3	3.5	5.1	6.8	14.6	12.1	10.4	4.7	3.4	4.2	3.2	4.9
20%	2.1	2.5	3.9	6.0	11.0	8.4	5.8	2.9	3.1	3.7	2.9	2.9
30%	1.8	2.2	3.2	5.1	8.5	6.9	5.5	2.8	2.8	3.2	2.8	2.3
40%	1.5	1.7	2.7	4.6	5.2	5.8	5.3	2.8	2.7	3.1	2.2	1.9
50%	1.4	1.5	2.2	4.0	4.1	3.6	4.7	2.6	2.5	2.9	1.7	1.8
60%	1.3	1.3	2.0	3.5	3.8	2.7	2.7	2.0	2.3	2.6	1.6	1.6
70%	1.1	1.2	1.8	2.6	3.6	2.4	2.1	1.7	2.0	1.8	1.6	1.3
80%	1.0	0.9	1.7	2.4	3.3	2.4	2.0	1.6	1.9	1.6	1.5	1.2
90%	0.9	0.9	1.6	2.3	2.8	1.9	1.6	1.2	1.6	1.6	1.3	1.1
Long Term												
Full Simulation Period[a]	1.5	2.0	3.3	4.3	6.9	5.7	4.9	3.0	2.7	2.8	2.1	2.3
Water Year Types[b]												
Wet (32%)	1.5	1.4	2.1	3.0	3.4	3.3	2.0	1.4	2.0	2.0	1.5	1.3
Above Normal (16%)	1.1	2.6	3.1	4.6	13.6	6.5	8.2	3.9	2.8	3.6	2.5	3.4
Below Normal (13%)	1.5	1.6	1.7	3.5	9.0	3.3	4.5	2.8	2.4	3.1	1.3	1.4
Dry (24%)	1.4	1.4	2.8	5.2	6.4	6.6	3.7	2.3	2.6	3.1	2.4	2.7
Critical (15%)	1.8	2.8	5.0	4.5	6.8	6.9	7.0	4.6	3.6	2.9	2.4	2.5

Proposed Project minus Existing

Statistic	Monthly Averaged Daily Minimum Elevation (FEET)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	0.2	-1.2	0.1	0.0	0.0	0.6	0.0	0.0	0.0	0.1	0.0	-0.8
20%	0.4	-1.3	-0.1	0.0	-0.5	0.0	0.0	0.0	0.3	-0.1	-0.1	0.1
30%	0.1	-0.2	0.0	-0.1	0.0	0.0	0.1	0.0	0.0	-0.3	-0.1	-0.2
40%	0.0	-0.2	-0.1	0.2	0.1	0.0	0.1	0.1	0.0	-0.1	-0.1	-0.1
50%	0.0	-0.1	0.1	-0.1	0.2	-0.2	0.0	0.3	0.0	-0.2	0.1	0.0
60%	0.0	0.0	0.1	-0.1	0.1	0.0	0.0	0.0	0.2	-0.4	0.0	0.0
70%	0.0	0.0	0.0	-0.1	0.2	0.0	0.0	0.0	0.0	-0.4	0.0	0.0
80%	0.0	0.0	0.1	-0.1	0.2	0.3	0.1	0.1	0.0	0.0	-0.1	0.0
90%	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	-0.1	0.0
Long Term												
Full Simulation Period[a]	0.1	-0.3	0.0	0.0	0.1	0.1	0.0	0.1	0.1	-0.1	0.0	-0.2
Water Year Types[b]												
Wet (32%)	0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Above Normal (16%)	0.0	-0.2	0.0	0.0	-0.2	0.0	0.0	0.0	0.0	-0.1	0.1	-1.0
Below Normal (13%)	0.0	-0.1	0.1	-0.1	0.0	-0.3	0.0	0.8	-0.1	0.0	-0.1	0.0
Dry (24%)	0.0	-0.5	-0.1	-0.1	0.1	0.3	0.0	0.0	0.1	-0.2	0.0	0.1
Critical (15%)	0.1	-0.4	0.1	0.0	0.1	0.0	0.1	0.0	0.1	-0.2	-0.1	-0.5

a Based on the 16-year simulation period
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999) at Early Long-Term
c The Elevations are based on National Geodetic Vertical Datum of 1929 (NGVD 29)

Table 2-1-1. Sacramento River d/s of Steamboat Slough, Monthly Averaged Daily Maximum Elevation

Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Averaged Daily Maximum Elevation (FEET)											
Probability of Exceedance												
10%	3.3	4.1	4.2	4.9	9.1	7.1	6.4	4.1	3.9	4.1	3.9	4.3
20%	3.2	3.6	3.8	4.6	7.1	5.5	4.3	3.8	3.8	4.1	3.8	3.7
30%	3.2	3.4	3.8	4.2	5.6	4.7	4.1	3.7	3.8	4.0	3.7	3.6
40%	3.2	3.4	3.7	4.1	4.2	4.3	4.0	3.6	3.7	4.0	3.6	3.5
50%	3.2	3.3	3.5	4.0	3.9	3.7	3.9	3.5	3.7	3.9	3.6	3.4
60%	3.1	3.2	3.5	3.8	3.8	3.4	3.5	3.4	3.7	3.9	3.5	3.3
70%	3.0	3.1	3.4	3.7	3.7	3.3	3.3	3.4	3.5	3.7	3.5	3.3
80%	2.9	3.0	3.3	3.6	3.6	3.0	3.2	3.2	3.5	3.6	3.5	3.2
90%	2.9	2.9	3.3	3.5	3.6	3.0	3.1	3.1	3.5	3.6	3.3	3.1
Long Term												
Full Simulation Period[a]	3.1	3.4	3.9	4.1	5.2	4.5	4.2	3.7	3.8	3.9	3.6	3.5
Water Year Types[b]												
Wet (32%)	3.1	3.2	3.5	3.8	3.7	3.6	3.2	3.2	3.6	3.7	3.5	3.3
Above Normal (16%)	2.9	3.4	3.5	4.1	8.6	4.7	5.3	3.9	3.7	4.0	3.6	4.1
Below Normal (13%)	3.1	3.2	3.5	4.0	5.8	3.7	4.0	3.3	3.7	3.8	3.3	3.1
Dry (24%)	3.1	3.3	3.7	4.3	5.1	4.9	3.7	3.6	3.7	4.0	3.7	3.6
Critical (15%)	3.2	3.6	4.5	4.1	5.2	5.1	5.0	4.3	4.0	3.9	3.6	3.6

Proposed Project

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Averaged Daily Maximum Elevation (FEET)											
Probability of Exceedance												
10%	3.4	3.8	4.2	4.9	9.1	7.5	6.4	4.1	4.0	4.1	3.9	3.9
20%	3.2	3.4	3.8	4.6	6.9	5.4	4.3	3.8	3.8	4.0	3.8	3.7
30%	3.2	3.3	3.8	4.2	5.6	4.7	4.1	3.7	3.8	4.0	3.7	3.5
40%	3.2	3.3	3.7	4.0	4.2	4.3	4.0	3.6	3.7	3.9	3.6	3.5
50%	3.2	3.3	3.6	4.0	3.9	3.7	3.9	3.6	3.7	3.8	3.6	3.4
60%	3.1	3.2	3.5	3.8	3.8	3.4	3.5	3.5	3.6	3.8	3.5	3.3
70%	3.0	3.1	3.4	3.7	3.7	3.3	3.3	3.4	3.5	3.7	3.5	3.3
80%	2.9	3.0	3.3	3.6	3.6	3.1	3.3	3.2	3.5	3.6	3.5	3.2
90%	2.9	2.9	3.3	3.5	3.6	3.0	3.1	3.1	3.5	3.6	3.3	3.1
Long Term												
Full Simulation Period[a]	3.1	3.3	3.9	4.1	5.2	4.6	4.2	3.7	3.8	3.8	3.6	3.4
Water Year Types[b]												
Wet (32%)	3.2	3.2	3.5	3.8	3.7	3.6	3.2	3.2	3.6	3.7	3.5	3.3
Above Normal (16%)	2.9	3.4	3.5	4.1	8.5	4.7	5.3	3.9	3.8	3.9	3.7	3.6
Below Normal (13%)	3.1	3.2	3.5	4.0	5.9	3.6	4.0	3.5	3.6	3.8	3.3	3.1
Dry (24%)	3.1	3.1	3.7	4.3	5.1	5.1	3.7	3.6	3.8	3.9	3.7	3.6
Critical (15%)	3.2	3.5	4.6	4.1	5.2	5.1	5.0	4.3	4.0	3.8	3.6	3.4

Proposed Project minus Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Averaged Daily Maximum Elevation (FEET)											
Probability of Exceedance												
10%	0.0	-0.3	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	-0.4
20%	0.0	-0.2	0.0	0.0	-0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30%	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0
40%	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0
50%	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0
60%	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0
70%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
90%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Long Term												
Full Simulation Period[a]	0.0	-0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	-0.1
Water Year Types[b]												
Wet (32%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Above Normal (16%)	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	-0.4
Below Normal (13%)	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.2	0.0	0.0	0.0	0.0
Dry (24%)	0.0	-0.1	0.0	0.0	0.0	0.2	0.0	0.0	0.0	-0.1	0.0	0.0
Critical (15%)	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.2

a Based on the 16-year simulation period
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999) at Early Long-Term
c The Elevations are based on National Geodetic Vertical Datum of 1929 (NGVD 29)

Table 2-2-1. Sacramento River d/s of Steamboat Slough, Monthly Averaged Daily Minimum Elevation

Existing

Statistic	Monthly Averaged Daily Minimum Elevation (FEET)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	0.6	2.0	2.2	3.2	8.4	6.2	5.4	2.0	1.1	1.4	1.0	2.4
20%	0.5	1.4	1.6	2.8	6.2	4.3	2.7	1.1	0.9	1.2	1.0	0.9
30%	0.4	0.7	1.2	2.3	4.3	3.3	2.4	1.1	0.8	1.2	0.9	0.8
40%	0.3	0.5	1.0	1.9	2.3	2.7	2.3	1.0	0.8	1.0	0.7	0.6
50%	0.3	0.4	0.6	1.7	1.7	1.6	2.1	0.8	0.7	0.9	0.5	0.5
60%	0.3	0.3	0.5	1.5	1.5	0.9	1.0	0.6	0.5	0.9	0.5	0.5
70%	0.1	0.1	0.5	1.0	1.4	0.8	0.7	0.5	0.5	0.6	0.4	0.3
80%	0.1	0.0	0.4	0.9	1.2	0.6	0.5	0.3	0.5	0.4	0.4	0.3
90%	0.0	-0.1	0.3	0.8	1.1	0.5	0.4	0.2	0.3	0.4	0.3	0.2
Long Term												
Full Simulation Period[a]	0.3	0.7	1.3	1.9	3.5	2.7	2.2	1.2	0.8	0.9	0.6	0.9
Water Year Types[b]												
Wet (32%)	0.3	0.3	0.6	1.2	1.3	1.3	0.6	0.3	0.5	0.5	0.4	0.3
Above Normal (16%)	0.1	1.0	1.1	2.0	7.8	3.1	4.1	1.7	0.9	1.2	0.7	1.9
Below Normal (13%)	0.4	0.4	0.5	1.5	4.6	1.6	2.0	0.6	0.7	0.9	0.3	0.3
Dry (24%)	0.3	0.5	1.0	2.3	3.2	3.1	1.5	0.8	0.7	1.0	0.8	0.9
Critical (15%)	0.4	1.2	2.3	2.0	3.4	3.5	3.4	2.1	1.3	1.0	0.8	1.1

Proposed Project

Statistic	Monthly Averaged Daily Minimum Elevation (FEET)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	0.7	1.4	2.2	3.2	8.4	6.6	5.4	2.0	1.1	1.4	1.0	1.8
20%	0.6	0.7	1.6	2.8	5.9	4.2	2.6	1.1	1.0	1.2	1.0	1.0
30%	0.4	0.6	1.2	2.3	4.3	3.3	2.5	1.1	0.8	1.0	0.9	0.7
40%	0.4	0.5	0.9	2.0	2.4	2.7	2.3	1.0	0.8	0.9	0.7	0.6
50%	0.3	0.3	0.6	1.6	1.7	1.5	2.1	1.0	0.7	0.9	0.5	0.5
60%	0.3	0.3	0.6	1.5	1.5	0.9	1.0	0.6	0.6	0.8	0.4	0.5
70%	0.1	0.1	0.5	1.0	1.5	0.8	0.7	0.5	0.6	0.5	0.4	0.3
80%	0.1	0.0	0.5	0.9	1.4	0.7	0.6	0.4	0.4	0.4	0.4	0.3
90%	0.0	-0.1	0.3	0.8	1.1	0.5	0.4	0.3	0.3	0.4	0.3	0.2
Long Term												
Full Simulation Period[a]	0.3	0.6	1.3	1.8	3.5	2.7	2.2	1.2	0.9	0.9	0.6	0.7
Water Year Types[b]												
Wet (32%)	0.3	0.3	0.6	1.2	1.3	1.3	0.6	0.3	0.5	0.5	0.4	0.3
Above Normal (16%)	0.1	0.9	1.1	2.0	7.7	3.1	4.1	1.6	0.9	1.1	0.8	1.1
Below Normal (13%)	0.4	0.3	0.6	1.5	4.6	1.4	2.0	1.0	0.6	0.9	0.3	0.3
Dry (24%)	0.3	0.2	1.0	2.3	3.2	3.3	1.5	0.8	0.7	1.0	0.7	0.9
Critical (15%)	0.5	1.0	2.3	2.0	3.5	3.5	3.5	2.1	1.4	0.9	0.7	0.8

Proposed Project minus Existing

Statistic	Monthly Averaged Daily Minimum Elevation (FEET)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	0.0	-0.6	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	-0.7
20%	0.1	-0.7	0.0	0.0	-0.3	0.0	0.0	0.0	0.1	-0.1	0.0	0.0
30%	0.1	-0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0	-0.1	0.0	-0.1
40%	0.1	0.0	-0.1	0.1	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0
50%	0.0	0.0	0.0	0.0	0.1	-0.1	0.0	0.2	0.0	-0.1	0.0	0.0
60%	0.0	0.0	0.1	-0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
70%	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	-0.2	0.0	0.0
80%	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0
90%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Long Term												
Full Simulation Period[a]	0.0	-0.2	0.0	0.0	0.0	0.1	0.0	0.0	0.0	-0.1	0.0	-0.2
Water Year Types[b]												
Wet (32%)	0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Above Normal (16%)	0.0	-0.1	0.0	0.0	-0.2	0.0	0.0	0.0	0.0	0.0	0.0	-0.8
Below Normal (13%)	0.0	0.0	0.0	0.0	0.0	-0.2	0.0	0.4	-0.1	0.0	0.0	0.0
Dry (24%)	0.0	-0.3	0.0	0.0	0.1	0.2	0.0	0.0	0.0	-0.1	0.0	0.0
Critical (15%)	0.0	-0.2	0.0	0.0	0.1	0.0	0.0	0.0	0.1	-0.1	0.0	-0.3

a Based on the 16-year simulation period

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999) at Early Long-Term

c The Elevations are based on National Geodetic Vertical Datum of 1929 (NGVD 29)

Table 3-1-1. Sacramento River at Rio Vista, Monthly Averaged Daily Maximum Elevation

Existing

Statistic	Monthly Averaged Daily Maximum Elevation (FEET)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	3.3	3.4	3.5	3.6	4.0	3.5	3.4	3.5	3.6	3.7	3.6	3.5
20%	3.2	3.3	3.4	3.5	3.7	3.4	3.3	3.4	3.6	3.7	3.6	3.4
30%	3.2	3.3	3.4	3.5	3.6	3.3	3.2	3.4	3.6	3.7	3.6	3.4
40%	3.1	3.2	3.4	3.5	3.5	3.2	3.1	3.3	3.6	3.7	3.5	3.3
50%	3.1	3.2	3.4	3.4	3.4	3.1	3.1	3.3	3.5	3.7	3.5	3.3
60%	3.1	3.2	3.3	3.4	3.4	3.0	3.1	3.3	3.5	3.6	3.5	3.3
70%	3.1	3.1	3.3	3.3	3.3	3.0	3.0	3.2	3.5	3.6	3.5	3.3
80%	3.0	3.1	3.2	3.3	3.1	2.9	3.0	3.1	3.5	3.6	3.5	3.3
90%	3.0	3.0	3.1	3.2	3.1	2.7	2.9	3.0	3.4	3.5	3.4	3.2
Long Term												
Full Simulation Period[a]	3.1	3.2	3.4	3.4	3.5	3.1	3.1	3.3	3.5	3.6	3.5	3.3
Water Year Types[b]												
Wet (32%)	3.2	3.2	3.3	3.4	3.2	3.0	3.0	3.2	3.5	3.7	3.5	3.4
Above Normal (16%)	3.0	3.1	3.1	3.2	3.8	3.1	3.2	3.3	3.5	3.6	3.5	3.4
Below Normal (13%)	3.2	3.2	3.5	3.5	3.7	3.2	3.3	3.1	3.5	3.5	3.5	3.1
Dry (24%)	3.1	3.2	3.4	3.4	3.5	3.2	3.1	3.4	3.5	3.7	3.6	3.4
Critical (15%)	3.1	3.2	3.4	3.4	3.4	3.2	3.2	3.4	3.5	3.6	3.4	3.3

Proposed Project

Statistic	Monthly Averaged Daily Maximum Elevation (FEET)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	3.3	3.4	3.5	3.6	4.0	3.5	3.4	3.5	3.6	3.7	3.6	3.5
20%	3.2	3.3	3.4	3.5	3.7	3.4	3.3	3.4	3.6	3.7	3.6	3.4
30%	3.2	3.3	3.4	3.5	3.6	3.3	3.2	3.4	3.6	3.7	3.6	3.4
40%	3.1	3.2	3.4	3.5	3.5	3.2	3.1	3.3	3.6	3.7	3.5	3.3
50%	3.1	3.2	3.4	3.4	3.4	3.1	3.1	3.3	3.5	3.7	3.5	3.3
60%	3.1	3.1	3.3	3.4	3.4	3.0	3.1	3.2	3.5	3.6	3.5	3.3
70%	3.1	3.1	3.3	3.3	3.3	3.0	3.0	3.2	3.5	3.6	3.5	3.3
80%	3.0	3.1	3.2	3.2	3.1	2.9	3.0	3.2	3.5	3.6	3.4	3.3
90%	3.0	3.0	3.1	3.2	3.1	2.7	2.9	3.0	3.4	3.5	3.4	3.2
Long Term												
Full Simulation Period[a]	3.1	3.2	3.4	3.4	3.5	3.1	3.1	3.3	3.5	3.6	3.5	3.3
Water Year Types[b]												
Wet (32%)	3.2	3.2	3.3	3.4	3.2	3.0	3.0	3.2	3.5	3.7	3.5	3.4
Above Normal (16%)	3.0	3.1	3.1	3.2	3.8	3.1	3.2	3.3	3.5	3.6	3.5	3.3
Below Normal (13%)	3.2	3.2	3.5	3.5	3.7	3.2	3.3	3.2	3.5	3.5	3.4	3.1
Dry (24%)	3.1	3.1	3.4	3.4	3.5	3.2	3.1	3.4	3.5	3.7	3.6	3.4
Critical (15%)	3.1	3.2	3.4	3.4	3.4	3.2	3.2	3.4	3.5	3.6	3.4	3.2

Proposed Project minus Existing

Statistic	Monthly Averaged Daily Maximum Elevation (FEET)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
40%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
60%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
70%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
90%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Long Term												
Full Simulation Period[a]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Water Year Types[b]												
Wet (32%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Above Normal (16%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1
Below Normal (13%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dry (24%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Critical (15%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

a Based on the 16-year simulation period

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999) at Early Long-Term

c The Elevations are based on National Geodetic Vertical Datum of 1929 (NGVD 29)

Table 3-2-1. Sacramento River at Rio Vista, Monthly Averaged Daily Minimum Elevation

Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Averaged Daily Minimum Elevation (FEET)											
Probability of Exceedance												
10%	-0.8	-0.9	-0.9	-0.8	0.3	-0.4	-0.5	-0.8	-0.9	-0.8	-0.7	-0.6
20%	-0.8	-0.9	-1.0	-0.9	-0.2	-0.6	-0.7	-0.9	-0.9	-0.8	-0.7	-0.6
30%	-0.9	-1.0	-1.1	-0.9	-0.4	-0.7	-0.8	-0.9	-1.0	-0.9	-0.8	-0.7
40%	-0.9	-1.1	-1.1	-1.0	-0.8	-0.8	-0.9	-1.1	-1.0	-0.9	-0.8	-0.8
50%	-1.0	-1.1	-1.2	-1.0	-0.8	-0.8	-1.0	-1.1	-1.0	-0.9	-0.8	-0.8
60%	-1.0	-1.2	-1.2	-1.1	-0.9	-0.9	-1.0	-1.1	-1.0	-0.9	-0.8	-0.8
70%	-1.1	-1.3	-1.2	-1.1	-0.9	-1.1	-1.1	-1.1	-1.0	-0.9	-0.9	-0.8
80%	-1.1	-1.3	-1.2	-1.1	-0.9	-1.2	-1.1	-1.2	-1.1	-1.0	-0.9	-0.8
90%	-1.1	-1.3	-1.3	-1.2	-1.1	-1.2	-1.2	-1.2	-1.1	-1.0	-0.9	-0.9
Long Term												
Full Simulation Period[a]	-1.0	-1.1	-1.1	-1.0	-0.6	-0.8	-0.9	-1.0	-1.0	-0.9	-0.8	-0.8
Water Year Types[b]												
Wet (32%)	-1.0	-1.2	-1.2	-1.1	-1.0	-1.1	-1.1	-1.2	-1.1	-0.9	-0.9	-0.8
Above Normal (16%)	-1.1	-1.1	-1.3	-1.1	0.2	-0.8	-0.7	-1.0	-0.9	-0.9	-0.8	-0.7
Below Normal (13%)	-0.8	-1.1	-1.0	-0.9	-0.3	-0.7	-0.7	-1.2	-1.0	-1.0	-0.9	-1.0
Dry (24%)	-1.0	-1.2	-1.1	-1.1	-0.7	-0.8	-1.0	-1.0	-1.0	-0.9	-0.8	-0.7
Critical (15%)	-0.9	-1.0	-0.9	-1.0	-0.5	-0.5	-0.7	-0.9	-0.9	-0.8	-0.8	-0.7

Proposed Project

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Averaged Daily Minimum Elevation (FEET)											
Probability of Exceedance												
10%	-0.8	-0.9	-0.9	-0.8	0.3	-0.3	-0.6	-0.9	-0.9	-0.8	-0.7	-0.6
20%	-0.8	-1.0	-1.0	-0.9	-0.2	-0.6	-0.7	-0.9	-0.9	-0.8	-0.7	-0.7
30%	-0.9	-1.0	-1.1	-0.9	-0.4	-0.7	-0.8	-0.9	-1.0	-0.9	-0.8	-0.7
40%	-0.9	-1.1	-1.1	-1.0	-0.8	-0.8	-0.9	-1.1	-1.0	-0.9	-0.8	-0.8
50%	-1.0	-1.1	-1.2	-1.1	-0.8	-0.8	-1.0	-1.1	-1.0	-0.9	-0.8	-0.8
60%	-1.0	-1.2	-1.2	-1.1	-0.9	-1.0	-1.1	-1.1	-1.0	-0.9	-0.8	-0.8
70%	-1.1	-1.3	-1.2	-1.1	-0.9	-1.1	-1.1	-1.1	-1.0	-0.9	-0.9	-0.8
80%	-1.1	-1.3	-1.2	-1.1	-0.9	-1.2	-1.1	-1.2	-1.1	-1.0	-0.9	-0.8
90%	-1.1	-1.3	-1.3	-1.2	-1.1	-1.2	-1.2	-1.2	-1.1	-1.0	-0.9	-0.9
Long Term												
Full Simulation Period[a]	-1.0	-1.1	-1.1	-1.0	-0.6	-0.8	-0.9	-1.0	-1.0	-0.9	-0.8	-0.8
Water Year Types[b]												
Wet (32%)	-1.0	-1.2	-1.2	-1.1	-1.0	-1.1	-1.1	-1.2	-1.1	-0.9	-0.9	-0.8
Above Normal (16%)	-1.1	-1.2	-1.3	-1.1	0.2	-0.8	-0.8	-1.0	-0.9	-0.9	-0.8	-0.8
Below Normal (13%)	-0.8	-1.1	-1.0	-0.9	-0.3	-0.7	-0.7	-1.1	-1.0	-1.0	-0.9	-1.0
Dry (24%)	-1.0	-1.2	-1.1	-1.1	-0.7	-0.8	-1.0	-1.0	-1.0	-0.9	-0.8	-0.7
Critical (15%)	-0.9	-1.0	-0.9	-1.0	-0.5	-0.5	-0.7	-0.9	-0.9	-0.8	-0.8	-0.7

Proposed Project minus Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Averaged Daily Minimum Elevation (FEET)											
Probability of Exceedance												
10%	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
20%	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1
30%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
40%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
60%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
70%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
90%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Long Term												
Full Simulation Period[a]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Water Year Types[b]												
Wet (32%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Above Normal (16%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Below Normal (13%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dry (24%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Critical (15%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

a Based on the 16-year simulation period

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999) at Early Long-Term

c The Elevations are based on National Geodetic Vertical Datum of 1929 (NGVD 29)

Table 4-1-1. San Joaquin River at Jersey Point, Monthly Averaged Daily Maximum Elevation

Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Averaged Daily Maximum Elevation (FEET)											
Probability of Exceedance												
10%	3.0	3.0	3.1	3.2	3.5	3.0	2.9	3.2	3.3	3.4	3.3	3.2
20%	2.9	2.9	3.1	3.1	3.2	3.0	2.8	3.1	3.3	3.4	3.3	3.1
30%	2.9	2.9	3.0	3.1	3.2	2.9	2.8	3.1	3.3	3.4	3.2	3.0
40%	2.8	2.9	3.0	3.0	3.1	2.8	2.8	3.0	3.2	3.3	3.2	3.0
50%	2.8	2.8	3.0	3.0	3.0	2.7	2.8	3.0	3.2	3.3	3.2	3.0
60%	2.8	2.8	3.0	3.0	3.0	2.7	2.7	2.8	3.1	3.3	3.2	3.0
70%	2.8	2.8	2.9	2.9	2.9	2.6	2.7	2.8	3.1	3.3	3.1	2.9
80%	2.7	2.8	2.9	2.9	2.8	2.6	2.7	2.8	3.1	3.2	3.1	2.9
90%	2.7	2.7	2.8	2.8	2.7	2.4	2.6	2.7	3.1	3.1	3.0	2.9
Long Term												
Full Simulation Period[a]	2.8	2.8	3.0	3.0	3.0	2.7	2.8	2.9	3.2	3.3	3.2	3.0
Water Year Types[b]												
Wet (32%)	2.9	2.9	3.0	3.1	2.9	2.7	2.7	2.9	3.2	3.4	3.2	3.1
Above Normal (16%)	2.6	2.7	2.7	2.8	3.3	2.7	2.8	2.9	3.2	3.2	3.2	3.0
Below Normal (13%)	2.9	2.8	3.1	3.1	3.2	2.8	2.9	2.8	3.1	3.1	3.1	2.8
Dry (24%)	2.8	2.8	3.0	3.0	3.1	2.8	2.7	3.0	3.2	3.3	3.3	3.1
Critical (15%)	2.8	2.9	3.0	3.0	3.0	2.8	2.8	3.0	3.2	3.3	3.1	2.9

Proposed Project

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Averaged Daily Maximum Elevation (FEET)											
Probability of Exceedance												
10%	3.0	3.0	3.1	3.2	3.5	3.1	2.9	3.1	3.3	3.4	3.3	3.2
20%	2.9	2.9	3.1	3.1	3.2	3.0	2.8	3.1	3.3	3.4	3.3	3.1
30%	2.9	2.9	3.0	3.1	3.1	2.9	2.8	3.1	3.3	3.4	3.2	3.0
40%	2.8	2.9	3.0	3.0	3.1	2.8	2.8	3.0	3.2	3.3	3.2	3.0
50%	2.8	2.8	3.0	3.0	3.0	2.7	2.7	3.0	3.2	3.3	3.2	3.0
60%	2.8	2.8	3.0	3.0	3.0	2.7	2.7	2.8	3.2	3.3	3.2	3.0
70%	2.8	2.8	2.9	2.9	2.9	2.6	2.7	2.8	3.1	3.3	3.1	2.9
80%	2.7	2.8	2.9	2.9	2.8	2.6	2.7	2.8	3.1	3.2	3.1	2.9
90%	2.7	2.6	2.8	2.8	2.7	2.4	2.6	2.7	3.1	3.1	3.0	2.8
Long Term												
Full Simulation Period[a]	2.8	2.8	3.0	3.0	3.0	2.7	2.7	2.9	3.2	3.3	3.2	3.0
Water Year Types[b]												
Wet (32%)	2.9	2.9	3.0	3.1	2.9	2.7	2.7	2.9	3.2	3.4	3.2	3.1
Above Normal (16%)	2.6	2.7	2.7	2.8	3.3	2.7	2.8	2.9	3.2	3.2	3.2	3.0
Below Normal (13%)	2.9	2.8	3.1	3.1	3.2	2.8	2.9	2.8	3.1	3.1	3.1	2.8
Dry (24%)	2.8	2.8	3.0	3.0	3.1	2.8	2.7	3.0	3.2	3.3	3.3	3.1
Critical (15%)	2.8	2.9	3.0	3.0	3.0	2.8	2.8	3.0	3.2	3.3	3.1	2.9

Proposed Project minus Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Averaged Daily Maximum Elevation (FEET)											
Probability of Exceedance												
10%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
40%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
60%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
70%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
90%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Long Term												
Full Simulation Period[a]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Water Year Types[b]												
Wet (32%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Above Normal (16%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Below Normal (13%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dry (24%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Critical (15%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

a Based on the 16-year simulation period

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999) at Early Long-Term

c The Elevations are based on National Geodetic Vertical Datum of 1929 (NGVD 29)

Table 4-2-1. San Joaquin River at Jersey Point, Monthly Averaged Daily Minimum Elevation

Existing

Statistic	Monthly Averaged Daily Minimum Elevation (FEET)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	-0.5	-0.6	-0.6	-0.5	0.2	-0.2	-0.3	-0.5	-0.5	-0.4	-0.3	-0.3
20%	-0.5	-0.6	-0.7	-0.6	-0.1	-0.3	-0.4	-0.5	-0.5	-0.5	-0.4	-0.3
30%	-0.5	-0.7	-0.7	-0.6	-0.2	-0.4	-0.5	-0.5	-0.6	-0.5	-0.4	-0.4
40%	-0.6	-0.7	-0.7	-0.7	-0.5	-0.5	-0.5	-0.7	-0.6	-0.5	-0.4	-0.4
50%	-0.6	-0.8	-0.8	-0.7	-0.5	-0.6	-0.7	-0.7	-0.6	-0.5	-0.5	-0.4
60%	-0.6	-0.8	-0.8	-0.7	-0.6	-0.7	-0.7	-0.7	-0.6	-0.6	-0.5	-0.4
70%	-0.7	-0.9	-0.9	-0.7	-0.6	-0.8	-0.7	-0.8	-0.7	-0.6	-0.5	-0.5
80%	-0.7	-0.9	-0.9	-0.8	-0.6	-0.8	-0.8	-0.8	-0.7	-0.6	-0.5	-0.5
90%	-0.7	-0.9	-0.9	-0.8	-0.7	-0.8	-0.8	-0.9	-0.7	-0.6	-0.5	-0.5
Long Term												
Full Simulation Period[a]	-0.6	-0.8	-0.7	-0.7	-0.4	-0.5	-0.6	-0.7	-0.6	-0.5	-0.4	-0.4
Water Year Types[b]												
Wet (32%)	-0.6	-0.8	-0.8	-0.7	-0.7	-0.7	-0.8	-0.8	-0.7	-0.5	-0.5	-0.4
Above Normal (16%)	-0.7	-0.8	-0.9	-0.8	0.0	-0.6	-0.5	-0.6	-0.5	-0.6	-0.5	-0.4
Below Normal (13%)	-0.4	-0.7	-0.6	-0.5	-0.1	-0.3	-0.3	-0.8	-0.7	-0.6	-0.5	-0.6
Dry (24%)	-0.7	-0.8	-0.8	-0.7	-0.4	-0.5	-0.7	-0.6	-0.6	-0.6	-0.4	-0.4
Critical (15%)	-0.5	-0.7	-0.6	-0.6	-0.3	-0.3	-0.4	-0.5	-0.5	-0.5	-0.4	-0.4

Proposed Project

Statistic	Monthly Averaged Daily Minimum Elevation (FEET)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	-0.5	-0.6	-0.6	-0.5	0.2	-0.2	-0.3	-0.5	-0.5	-0.4	-0.3	-0.3
20%	-0.5	-0.6	-0.7	-0.6	-0.1	-0.3	-0.4	-0.5	-0.5	-0.5	-0.4	-0.3
30%	-0.5	-0.7	-0.7	-0.6	-0.2	-0.4	-0.5	-0.6	-0.6	-0.5	-0.4	-0.4
40%	-0.6	-0.7	-0.8	-0.7	-0.5	-0.5	-0.6	-0.7	-0.6	-0.5	-0.4	-0.4
50%	-0.6	-0.8	-0.8	-0.7	-0.5	-0.6	-0.7	-0.7	-0.6	-0.5	-0.5	-0.4
60%	-0.6	-0.8	-0.8	-0.7	-0.6	-0.7	-0.7	-0.7	-0.6	-0.6	-0.5	-0.4
70%	-0.7	-0.9	-0.9	-0.7	-0.6	-0.8	-0.7	-0.8	-0.7	-0.6	-0.5	-0.5
80%	-0.7	-0.9	-0.9	-0.8	-0.6	-0.8	-0.8	-0.8	-0.7	-0.6	-0.5	-0.5
90%	-0.7	-0.9	-0.9	-0.8	-0.7	-0.8	-0.8	-0.8	-0.7	-0.6	-0.5	-0.5
Long Term												
Full Simulation Period[a]	-0.6	-0.8	-0.7	-0.7	-0.4	-0.5	-0.6	-0.7	-0.6	-0.5	-0.4	-0.4
Water Year Types[b]												
Wet (32%)	-0.6	-0.8	-0.8	-0.7	-0.7	-0.7	-0.8	-0.8	-0.7	-0.5	-0.5	-0.4
Above Normal (16%)	-0.7	-0.8	-0.9	-0.8	0.0	-0.5	-0.5	-0.6	-0.5	-0.6	-0.5	-0.4
Below Normal (13%)	-0.4	-0.7	-0.6	-0.5	-0.1	-0.3	-0.4	-0.8	-0.7	-0.6	-0.5	-0.6
Dry (24%)	-0.7	-0.9	-0.8	-0.7	-0.4	-0.5	-0.7	-0.6	-0.6	-0.5	-0.4	-0.4
Critical (15%)	-0.5	-0.7	-0.6	-0.6	-0.3	-0.3	-0.5	-0.6	-0.5	-0.5	-0.4	-0.4

Proposed Project minus Existing

Statistic	Monthly Averaged Daily Minimum Elevation (FEET)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
20%	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0
30%	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0
40%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
60%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
70%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
90%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Long Term												
Full Simulation Period[a]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Water Year Types[b]												
Wet (32%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Above Normal (16%)	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0
Below Normal (13%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dry (24%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Critical (15%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

a Based on the 16-year simulation period

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999) at Early Long-Term

c The Elevations are based on National Geodetic Vertical Datum of 1929 (NGVD 29)

Table 5-1-1. San Joaquin River at Prisoners Point, Monthly Averaged Daily Maximum Elevation

Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Averaged Daily Maximum Elevation (FEET)											
Probability of Exceedance												
10%	3.1	3.1	3.2	3.3	3.7	3.2	3.1	3.3	3.4	3.5	3.4	3.3
20%	3.1	3.0	3.2	3.2	3.4	3.1	3.0	3.2	3.4	3.5	3.4	3.2
30%	3.0	3.0	3.1	3.2	3.3	3.0	3.0	3.2	3.4	3.5	3.4	3.2
40%	2.9	3.0	3.1	3.1	3.2	2.9	2.9	3.2	3.4	3.5	3.3	3.1
50%	2.9	2.9	3.1	3.1	3.2	2.8	2.9	3.1	3.3	3.4	3.3	3.1
60%	2.9	2.9	3.1	3.1	3.1	2.8	2.8	3.0	3.3	3.4	3.3	3.1
70%	2.9	2.9	3.0	3.0	3.0	2.7	2.8	2.9	3.2	3.4	3.3	3.1
80%	2.8	2.9	3.0	3.0	2.9	2.7	2.8	2.9	3.2	3.3	3.2	3.0
90%	2.8	2.8	2.9	2.9	2.8	2.5	2.7	2.8	3.2	3.2	3.1	3.0
Long Term												
Full Simulation Period[a]	2.9	2.9	3.1	3.1	3.2	2.9	2.9	3.1	3.3	3.4	3.3	3.1
Water Year Types[b]												
Wet (32%)	3.0	3.0	3.1	3.2	3.0	2.8	2.8	3.0	3.3	3.5	3.3	3.2
Above Normal (16%)	2.8	2.8	2.8	2.9	3.4	2.8	2.9	3.0	3.3	3.3	3.3	3.1
Below Normal (13%)	3.0	2.9	3.2	3.2	3.4	2.9	3.1	2.9	3.2	3.2	3.2	2.9
Dry (24%)	2.9	2.9	3.1	3.1	3.3	2.9	2.9	3.1	3.3	3.4	3.4	3.2
Critical (15%)	2.9	3.0	3.2	3.1	3.2	2.9	2.9	3.1	3.3	3.4	3.2	3.0

Proposed Project

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Averaged Daily Maximum Elevation (FEET)											
Probability of Exceedance												
10%	3.1	3.1	3.2	3.3	3.7	3.2	3.1	3.2	3.4	3.5	3.4	3.3
20%	3.1	3.0	3.2	3.2	3.4	3.1	3.0	3.2	3.4	3.5	3.4	3.2
30%	3.0	3.0	3.1	3.2	3.3	3.0	2.9	3.1	3.4	3.5	3.4	3.2
40%	2.9	3.0	3.1	3.1	3.2	2.9	2.9	3.1	3.3	3.5	3.3	3.1
50%	2.9	2.9	3.1	3.1	3.2	2.8	2.9	3.1	3.3	3.5	3.3	3.1
60%	2.9	2.9	3.1	3.1	3.1	2.8	2.8	2.9	3.3	3.4	3.3	3.1
70%	2.9	2.9	3.0	3.0	3.0	2.8	2.8	2.9	3.2	3.4	3.3	3.1
80%	2.8	2.9	3.0	3.0	2.9	2.7	2.8	2.9	3.2	3.3	3.2	3.0
90%	2.8	2.8	2.9	2.9	2.8	2.5	2.7	2.8	3.2	3.2	3.1	3.0
Long Term												
Full Simulation Period[a]	2.9	2.9	3.1	3.1	3.2	2.9	2.9	3.0	3.3	3.4	3.3	3.1
Water Year Types[b]												
Wet (32%)	3.0	3.0	3.1	3.2	3.0	2.8	2.8	3.0	3.3	3.5	3.3	3.2
Above Normal (16%)	2.8	2.8	2.8	2.9	3.4	2.8	2.9	3.0	3.3	3.3	3.3	3.1
Below Normal (13%)	3.0	2.9	3.2	3.2	3.4	2.9	3.0	2.9	3.2	3.2	3.2	2.9
Dry (24%)	2.9	2.9	3.1	3.1	3.3	3.0	2.9	3.1	3.3	3.4	3.4	3.2
Critical (15%)	2.9	3.0	3.2	3.1	3.2	2.9	2.9	3.1	3.3	3.4	3.2	3.0

Proposed Project minus Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Averaged Daily Maximum Elevation (FEET)											
Probability of Exceedance												
10%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
40%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
60%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
70%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
90%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Long Term												
Full Simulation Period[a]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Water Year Types[b]												
Wet (32%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Above Normal (16%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Below Normal (13%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dry (24%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Critical (15%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

a Based on the 16-year simulation period

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999) at Early Long-Term

c The Elevations are based on National Geodetic Vertical Datum of 1929 (NGVD 29)

Table 5-2-1. San Joaquin River at Prisoners Point, Monthly Averaged Daily Minimum Elevation

Existing

Statistic	Monthly Averaged Daily Minimum Elevation (FEET)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	-0.6	-0.7	-0.6	-0.6	0.1	-0.3	-0.3	-0.5	-0.6	-0.5	-0.5	-0.4
20%	-0.6	-0.7	-0.8	-0.6	-0.2	-0.4	-0.4	-0.6	-0.6	-0.6	-0.5	-0.4
30%	-0.6	-0.8	-0.8	-0.7	-0.3	-0.5	-0.5	-0.6	-0.7	-0.6	-0.5	-0.5
40%	-0.6	-0.8	-0.8	-0.7	-0.6	-0.5	-0.6	-0.7	-0.7	-0.6	-0.5	-0.5
50%	-0.7	-0.9	-0.9	-0.8	-0.6	-0.6	-0.7	-0.8	-0.7	-0.6	-0.5	-0.5
60%	-0.7	-0.9	-0.9	-0.8	-0.7	-0.7	-0.7	-0.8	-0.7	-0.6	-0.5	-0.5
70%	-0.7	-0.9	-0.9	-0.8	-0.7	-0.9	-0.8	-0.8	-0.7	-0.6	-0.6	-0.6
80%	-0.8	-1.0	-0.9	-0.9	-0.7	-0.9	-0.8	-0.8	-0.7	-0.7	-0.6	-0.6
90%	-0.8	-1.0	-1.0	-0.9	-0.8	-0.9	-0.9	-0.9	-0.8	-0.7	-0.6	-0.6
Long Term												
Full Simulation Period[a]	-0.7	-0.9	-0.8	-0.7	-0.4	-0.6	-0.6	-0.7	-0.7	-0.6	-0.5	-0.5
Water Year Types[b]												
Wet (32%)	-0.7	-0.9	-0.9	-0.8	-0.8	-0.8	-0.8	-0.9	-0.7	-0.6	-0.6	-0.5
Above Normal (16%)	-0.8	-0.9	-1.0	-0.9	0.0	-0.6	-0.5	-0.6	-0.6	-0.7	-0.6	-0.5
Below Normal (13%)	-0.5	-0.8	-0.7	-0.6	-0.2	-0.4	-0.4	-0.8	-0.7	-0.7	-0.5	-0.7
Dry (24%)	-0.7	-0.9	-0.9	-0.8	-0.4	-0.6	-0.7	-0.7	-0.7	-0.6	-0.5	-0.5
Critical (15%)	-0.6	-0.8	-0.7	-0.7	-0.4	-0.4	-0.5	-0.6	-0.6	-0.6	-0.5	-0.5

Proposed Project

Statistic	Monthly Averaged Daily Minimum Elevation (FEET)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	-0.6	-0.7	-0.6	-0.6	0.1	-0.2	-0.4	-0.6	-0.6	-0.5	-0.4	-0.4
20%	-0.6	-0.7	-0.8	-0.6	-0.2	-0.4	-0.5	-0.6	-0.6	-0.5	-0.5	-0.4
30%	-0.6	-0.8	-0.8	-0.7	-0.3	-0.5	-0.6	-0.6	-0.7	-0.6	-0.5	-0.5
40%	-0.6	-0.8	-0.8	-0.7	-0.6	-0.5	-0.6	-0.7	-0.7	-0.6	-0.5	-0.5
50%	-0.7	-0.9	-0.9	-0.8	-0.6	-0.6	-0.7	-0.8	-0.7	-0.6	-0.5	-0.5
60%	-0.7	-0.9	-0.9	-0.8	-0.7	-0.7	-0.7	-0.8	-0.7	-0.6	-0.5	-0.5
70%	-0.8	-1.0	-0.9	-0.8	-0.7	-0.9	-0.8	-0.9	-0.7	-0.6	-0.6	-0.5
80%	-0.8	-1.0	-0.9	-0.9	-0.7	-0.9	-0.8	-0.9	-0.7	-0.6	-0.6	-0.6
90%	-0.8	-1.0	-1.0	-0.9	-0.8	-0.9	-0.9	-0.9	-0.8	-0.7	-0.6	-0.6
Long Term												
Full Simulation Period[a]	-0.7	-0.9	-0.8	-0.8	-0.4	-0.6	-0.7	-0.7	-0.7	-0.6	-0.5	-0.5
Water Year Types[b]												
Wet (32%)	-0.7	-0.9	-0.9	-0.8	-0.8	-0.8	-0.8	-0.9	-0.7	-0.6	-0.6	-0.5
Above Normal (16%)	-0.8	-0.9	-1.0	-0.9	0.0	-0.6	-0.6	-0.7	-0.6	-0.7	-0.6	-0.5
Below Normal (13%)	-0.5	-0.8	-0.7	-0.6	-0.2	-0.4	-0.5	-0.9	-0.7	-0.7	-0.5	-0.7
Dry (24%)	-0.7	-0.9	-0.9	-0.8	-0.4	-0.6	-0.7	-0.7	-0.7	-0.6	-0.5	-0.5
Critical (15%)	-0.6	-0.8	-0.7	-0.7	-0.4	-0.4	-0.5	-0.6	-0.6	-0.5	-0.5	-0.5

Proposed Project minus Existing

Statistic	Monthly Averaged Daily Minimum Elevation (FEET)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	0.0	0.0	0.0	0.0	0.0	0.1	0.0	-0.1	0.0	0.0	0.0	0.0
20%	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0
30%	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	-0.1	0.0	0.0	0.0	0.0
40%	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0
50%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
60%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
70%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
90%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Long Term												
Full Simulation Period[a]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Water Year Types[b]												
Wet (32%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Above Normal (16%)	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	-0.1	0.0	0.0	0.0	0.0
Below Normal (13%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dry (24%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Critical (15%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

a Based on the 16-year simulation period

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999) at Early Long-Term

c The Elevations are based on National Geodetic Vertical Datum of 1929 (NGVD 29)

Table 6-1-1. Old River at Tracy Blvd, Monthly Averaged Daily Maximum Elevation

Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Averaged Daily Maximum Elevation (FEET)											
Probability of Exceedance												
10%	2.4	2.4	2.8	2.8	3.6	3.1	3.3	3.2	2.8	2.8	2.7	2.7
20%	2.4	2.3	2.8	2.8	3.3	2.8	3.2	3.1	2.8	2.7	2.7	2.6
30%	2.4	2.3	2.6	2.7	2.9	2.7	3.1	2.8	2.7	2.6	2.6	2.6
40%	2.3	2.3	2.5	2.7	2.7	2.5	3.0	2.8	2.7	2.6	2.6	2.4
50%	2.3	2.2	2.4	2.6	2.7	2.5	2.8	2.7	2.7	2.5	2.5	2.4
60%	2.2	2.2	2.4	2.5	2.6	2.4	2.6	2.6	2.7	2.4	2.5	2.3
70%	2.2	2.1	2.3	2.5	2.5	2.3	2.5	2.4	2.6	2.3	2.5	2.3
80%	2.2	2.1	2.3	2.5	2.5	2.3	2.5	2.4	2.5	2.3	2.5	2.3
90%	2.2	2.0	2.2	2.4	2.2	2.2	2.4	2.3	2.4	2.1	2.3	2.2
Long Term												
Full Simulation Period[a]	2.3	2.2	2.5	2.6	2.9	2.7	2.8	2.8	2.7	2.5	2.5	2.4
Water Year Types[b]												
Wet (32%)	2.4	2.4	2.5	2.7	2.4	2.4	2.5	2.5	2.6	2.6	2.7	2.6
Above Normal (16%)	2.2	2.1	2.2	2.4	3.0	2.3	3.1	2.8	2.7	2.2	2.4	2.3
Below Normal (13%)	2.4	2.1	2.8	2.7	3.0	2.4	3.0	2.4	2.2	2.0	2.6	2.3
Dry (24%)	2.3	2.3	2.4	2.6	2.9	2.7	2.7	2.7	2.7	2.4	2.5	2.4
Critical (15%)	2.2	2.1	2.6	2.6	3.1	3.2	3.1	3.1	2.8	2.7	2.5	2.3

Proposed Project

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Averaged Daily Maximum Elevation (FEET)											
Probability of Exceedance												
10%	2.7	2.6	2.8	2.8	3.5	3.3	3.1	2.9	2.8	2.8	2.8	2.8
20%	2.6	2.6	2.7	2.7	3.3	2.8	2.9	2.8	2.7	2.8	2.7	2.8
30%	2.5	2.5	2.6	2.7	2.9	2.8	2.7	2.7	2.7	2.7	2.6	2.7
40%	2.5	2.5	2.5	2.7	2.7	2.7	2.7	2.7	2.7	2.6	2.6	2.5
50%	2.5	2.4	2.4	2.6	2.7	2.5	2.6	2.6	2.7	2.5	2.5	2.5
60%	2.5	2.4	2.3	2.5	2.6	2.4	2.6	2.5	2.6	2.4	2.5	2.5
70%	2.5	2.4	2.3	2.5	2.5	2.4	2.6	2.4	2.6	2.3	2.5	2.4
80%	2.4	2.3	2.3	2.5	2.4	2.4	2.6	2.3	2.4	2.3	2.5	2.4
90%	2.4	2.2	2.2	2.4	2.2	2.1	2.5	2.3	2.4	2.1	2.3	2.3
Long Term												
Full Simulation Period[a]	2.5	2.4	2.5	2.6	2.9	2.7	2.7	2.7	2.7	2.6	2.6	2.5
Water Year Types[b]												
Wet (32%)	2.6	2.5	2.5	2.7	2.4	2.4	2.6	2.6	2.6	2.6	2.7	2.7
Above Normal (16%)	2.4	2.3	2.2	2.3	3.0	2.4	2.6	2.5	2.7	2.2	2.4	2.4
Below Normal (13%)	2.6	2.4	2.7	2.7	3.0	2.7	2.7	2.3	2.2	2.0	2.7	2.4
Dry (24%)	2.5	2.5	2.4	2.6	2.9	2.7	2.7	2.6	2.7	2.5	2.6	2.6
Critical (15%)	2.5	2.4	2.6	2.6	3.1	3.2	3.0	2.9	2.8	2.7	2.5	2.5

Proposed Project minus Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Averaged Daily Maximum Elevation (FEET)											
Probability of Exceedance												
10%	0.3	0.2	0.0	0.0	0.0	0.2	-0.2	-0.2	0.0	0.1	0.0	0.1
20%	0.2	0.2	0.0	0.0	0.0	0.0	-0.3	-0.3	0.0	0.1	0.0	0.1
30%	0.2	0.2	0.0	0.0	0.0	0.1	-0.4	-0.2	0.0	0.1	0.0	0.1
40%	0.2	0.3	0.0	0.0	0.0	0.1	-0.4	-0.1	0.0	0.0	-0.1	0.1
50%	0.2	0.2	0.0	0.0	0.0	0.0	-0.2	-0.1	0.0	0.0	0.0	0.1
60%	0.3	0.2	-0.1	0.0	0.0	0.1	0.0	-0.1	0.0	0.0	0.0	0.1
70%	0.2	0.2	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.1
80%	0.2	0.3	0.0	0.0	0.0	0.1	0.1	-0.1	0.0	0.1	0.0	0.1
90%	0.2	0.2	0.0	0.0	0.0	-0.1	0.1	0.0	0.0	0.0	0.0	0.1
Long Term												
Full Simulation Period[a]	0.2	0.2	0.0	0.0	0.0	0.1	-0.1	-0.1	0.0	0.0	0.0	0.1
Water Year Types[b]												
Wet (32%)	0.2	0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.1
Above Normal (16%)	0.2	0.3	0.0	0.0	0.0	0.1	-0.5	-0.3	0.0	0.0	-0.1	0.1
Below Normal (13%)	0.2	0.3	0.0	0.0	0.0	0.3	-0.3	-0.1	0.0	0.0	0.0	0.1
Dry (24%)	0.2	0.2	0.0	0.0	0.0	0.1	0.0	-0.1	0.0	0.1	0.0	0.1
Critical (15%)	0.3	0.3	0.0	0.0	0.0	0.0	-0.1	-0.2	0.0	0.0	0.0	0.1

a Based on the 16-year simulation period

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999) at Early Long-Term

c The Elevations are based on National Geodetic Vertical Datum of 1929 (NGVD 29)

Table 6-2-1. Old River at Tracy Blvd, Monthly Averaged Daily Minimum Elevation

Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Averaged Daily Minimum Elevation (FEET)											
Probability of Exceedance												
10%	1.5	1.4	-0.2	-0.2	1.1	0.4	0.4	0.6	1.7	1.5	1.6	1.5
20%	1.4	1.3	-0.5	-0.4	0.3	0.0	0.4	0.3	1.7	1.5	1.6	1.5
30%	1.4	1.3	-0.6	-0.4	-0.1	-0.3	0.3	0.0	1.6	1.4	1.5	1.5
40%	1.4	1.3	-0.6	-0.5	-0.1	-0.4	0.1	-0.1	1.5	1.2	1.4	1.5
50%	1.4	1.3	-0.7	-0.5	-0.3	-0.4	-0.2	-0.3	1.2	1.2	1.4	1.4
60%	1.3	1.3	-0.7	-0.6	-0.4	-0.4	-0.5	-0.4	1.2	1.2	1.3	1.4
70%	1.3	1.2	-0.7	-0.6	-0.4	-0.5	-0.6	-0.4	1.1	1.2	1.3	1.4
80%	1.3	1.2	-0.7	-0.6	-0.5	-0.6	-0.7	-0.4	1.1	1.1	1.3	1.4
90%	1.3	1.2	-0.8	-0.7	-0.6	-0.7	-0.7	-0.5	1.1	1.1	1.3	1.4
Long Term												
Full Simulation Period[a]	1.4	1.3	-0.5	-0.5	0.1	0.0	-0.1	0.0	1.4	1.4	1.4	1.4
Water Year Types[b]												
Wet (32%)	1.4	1.3	-0.6	-0.6	-0.6	-0.6	-0.7	-0.4	1.2	1.2	1.3	1.4
Above Normal (16%)	1.3	1.2	-0.7	-0.7	0.1	-0.5	0.2	0.0	1.6	1.2	1.4	1.4
Below Normal (13%)	1.5	1.3	-0.3	-0.4	-0.1	-0.4	0.1	-0.4	1.0	1.0	1.3	1.4
Dry (24%)	1.4	1.3	-0.7	-0.6	0.0	-0.2	-0.3	-0.1	1.4	1.3	1.4	1.4
Critical (15%)	1.4	1.3	-0.4	-0.3	0.6	0.8	0.5	0.6	1.5	1.7	1.5	1.5

Proposed Project

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Averaged Daily Minimum Elevation (FEET)											
Probability of Exceedance												
10%	1.7	1.5	-0.3	-0.2	1.1	0.6	0.4	0.4	1.6	1.6	1.6	1.7
20%	1.7	1.5	-0.4	-0.4	0.3	0.1	0.2	0.1	1.5	1.5	1.6	1.6
30%	1.6	1.5	-0.6	-0.5	-0.1	-0.3	0.1	0.0	1.5	1.4	1.5	1.6
40%	1.6	1.4	-0.6	-0.5	-0.1	-0.3	-0.1	-0.1	1.4	1.2	1.4	1.5
50%	1.6	1.4	-0.7	-0.6	-0.3	-0.4	-0.2	-0.2	1.2	1.2	1.4	1.5
60%	1.5	1.4	-0.7	-0.6	-0.4	-0.5	-0.3	-0.3	1.2	1.2	1.3	1.4
70%	1.5	1.4	-0.7	-0.6	-0.5	-0.5	-0.5	-0.3	1.1	1.1	1.3	1.4
80%	1.4	1.3	-0.7	-0.6	-0.5	-0.6	-0.6	-0.4	1.1	1.1	1.3	1.4
90%	1.4	1.3	-0.7	-0.7	-0.6	-0.7	-0.6	-0.4	1.0	1.1	1.2	1.4
Long Term												
Full Simulation Period[a]	1.5	1.4	-0.6	-0.5	0.1	0.0	-0.1	0.0	1.3	1.4	1.4	1.5
Water Year Types[b]												
Wet (32%)	1.5	1.4	-0.6	-0.6	-0.6	-0.6	-0.6	-0.4	1.1	1.2	1.3	1.5
Above Normal (16%)	1.4	1.4	-0.7	-0.7	0.1	-0.4	0.0	0.0	1.5	1.2	1.4	1.5
Below Normal (13%)	1.6	1.4	-0.4	-0.4	-0.1	-0.4	-0.1	-0.4	1.0	1.0	1.4	1.4
Dry (24%)	1.5	1.4	-0.7	-0.6	0.0	-0.2	-0.2	-0.1	1.3	1.3	1.4	1.5
Critical (15%)	1.6	1.4	-0.4	-0.3	0.6	0.8	0.4	0.6	1.4	1.7	1.5	1.6

Proposed Project minus Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Averaged Daily Minimum Elevation (FEET)											
Probability of Exceedance												
10%	0.2	0.2	0.0	0.0	0.0	0.2	-0.1	-0.1	-0.1	0.1	0.0	0.1
20%	0.2	0.2	0.0	0.0	0.0	0.1	-0.2	-0.2	-0.2	0.0	0.0	0.1
30%	0.2	0.2	0.0	0.0	0.0	0.0	-0.2	0.0	-0.2	0.0	0.0	0.1
40%	0.2	0.1	0.0	0.0	0.0	0.1	-0.2	0.0	0.0	0.0	0.0	0.1
50%	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1
60%	0.2	0.1	0.0	0.0	0.0	-0.1	0.2	0.1	0.0	0.0	0.0	0.1
70%	0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.1
80%	0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1
90%	0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
Long Term												
Full Simulation Period[a]	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.1
Water Year Types[b]												
Wet (32%)	0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
Above Normal (16%)	0.1	0.1	0.0	0.0	0.0	0.1	-0.3	-0.1	-0.1	0.0	0.0	0.1
Below Normal (13%)	0.2	0.2	0.0	0.0	0.0	0.0	-0.2	0.0	0.0	0.0	0.0	0.1
Dry (24%)	0.2	0.1	0.0	0.0	0.0	0.0	0.1	0.0	-0.1	0.0	0.0	0.1
Critical (15%)	0.2	0.2	0.0	0.0	0.0	0.0	-0.1	0.0	-0.1	0.0	0.0	0.1

a Based on the 16-year simulation period
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999) at Early Long-Term
c The Elevations are based on National Geodetic Vertical Datum of 1929 (NGVD 29)

Appendix C – Modeling

Attachment 2-7 – Salinity Results (DSM2-QUAL)

The following results of the DSM2-QUAL model are included for Delta salinity conditions for the following alternatives:

- Existing Conditions
- Proposed Project

Table 2-7.1. Salinity Results (DSM2-QUAL)

Title	Model Parameter	Table Numbers	Figure Numbers
Sacramento River downstream of Steamboat Slough Salinity	SAC_DS_STMBTSL	1-1	1-1 to 1-18
Cache Slough at Ryer Island Salinity	CACHE_RYER	2-1	2-1 to 2-18
Sacramento River downstream of Georgiana Slough Salinity	RSAC123	3-1	3-1 to 3-18
Sacramento River at Rio Vista Salinity	RSAC101	4-1	4-1 to 4-18
Sacramento River at Emmaton Salinity	RSAC092	5-1	5-1 to 5-18
Sacramento River at Collinsville Salinity	RSAC081	6-1	6-1 to 6-18
Sacramento River at Mallard Slough Salinity	RSAC075	7-1	7-1 to 7-18
Chipps Island North Channel Salinity	CHIPS_N_437	8-1	8-1 to 8-18
Chipps Island South Channel Salinity	CHIPS_S_442	9-1	9-1 to 9-18
Sacramento River at Port Chicago Salinity	RSAC064	10-1	10-1 to 10-18
San Joaquin River at Antioch Salinity	RSAN007	11-1	11-1 to 11-18
San Joaquin River at Jersey Point Salinity	RSAN018	12-1	12-1 to 12-18
San Joaquin River at San Andreas Salinity	RSAN032	13-1	13-1 to 13-18
San Joaquin River at Prisoners Point Salinity	RSAN037	14-1	14-1 to 14-18
Old River at Rock Slough Salinity	ROLD024	15-1	15-1 to 15-18
Banks Pumping Plant South Delta Exports Salinity	CLIFTON_COURT	16-1	16-1 to 16-18
Jones Pumping Plant South Delta Exports Salinity	CHDMC006	17-1	17-1 to 17-18
Old River at Highway 4	ROLD034	18-1	18-1 to 18-18
Victoria Canal	CHVCT000	19-1	19-1 to 19-18

Title	Model Parameter	Table Numbers	Figure Numbers
Montezuma Slough at Hunter Cut	SLMZU003	20-1	20-1 to 20-18
Montezuma Slough at Beldons Landing	SLMZU011	21-1	21-1 to 21-18
Montezuma Slough at National Steel	SLMZU025	22-1	22-1 to 22-18
Suisun Bay near Ryer	RYC	24-1	24-1 to 24-18
Goodyear Slough Outfall at Naval Fleet	GYS	25-1	25-1 to 25-18

Report formats

- Monthly tables comparing two scenarios (exceedance values, long-term average, and average by water year type)
- Monthly pattern charts (long-term average and average by water year type) including all scenarios
- Monthly exceedance charts (all months) including all scenarios

Table 1-1. Sacramento River downstream of Steamboat Slough Salinity, Monthly EC

Existing

Statistic	Monthly EC (UMHOS/CM)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	176	177	179	181	179	177	176	176	176	176	176	176
20%	176	176	178	180	178	176	176	176	176	176	176	176
30%	176	176	177	179	177	176	176	176	176	176	176	176
40%	176	176	177	178	177	176	176	176	176	175	176	176
50%	176	176	176	178	177	176	176	176	176	175	176	175
60%	176	176	176	178	176	176	176	176	176	175	176	175
70%	176	175	176	177	176	176	175	175	176	175	176	175
80%	175	175	175	177	176	176	175	175	176	175	175	175
90%	175	175	175	177	176	175	175	175	175	175	175	175
Long Term												
Full Simulation Period[a]	176	176	177	178	177	176	176	176	176	176	176	176
Water Year Types[b]												
Wet (32%)	176	176	177	178	176	176	175	175	176	175	176	175
Above Normal (15%)	176	176	177	178	177	176	176	175	176	175	175	175
Below Normal (17%)	176	176	177	179	177	176	176	176	176	175	176	176
Dry (22%)	176	176	177	179	177	176	176	176	176	176	176	176
Critical (15%)	176	176	176	178	177	176	176	176	176	176	176	176

Proposed Project

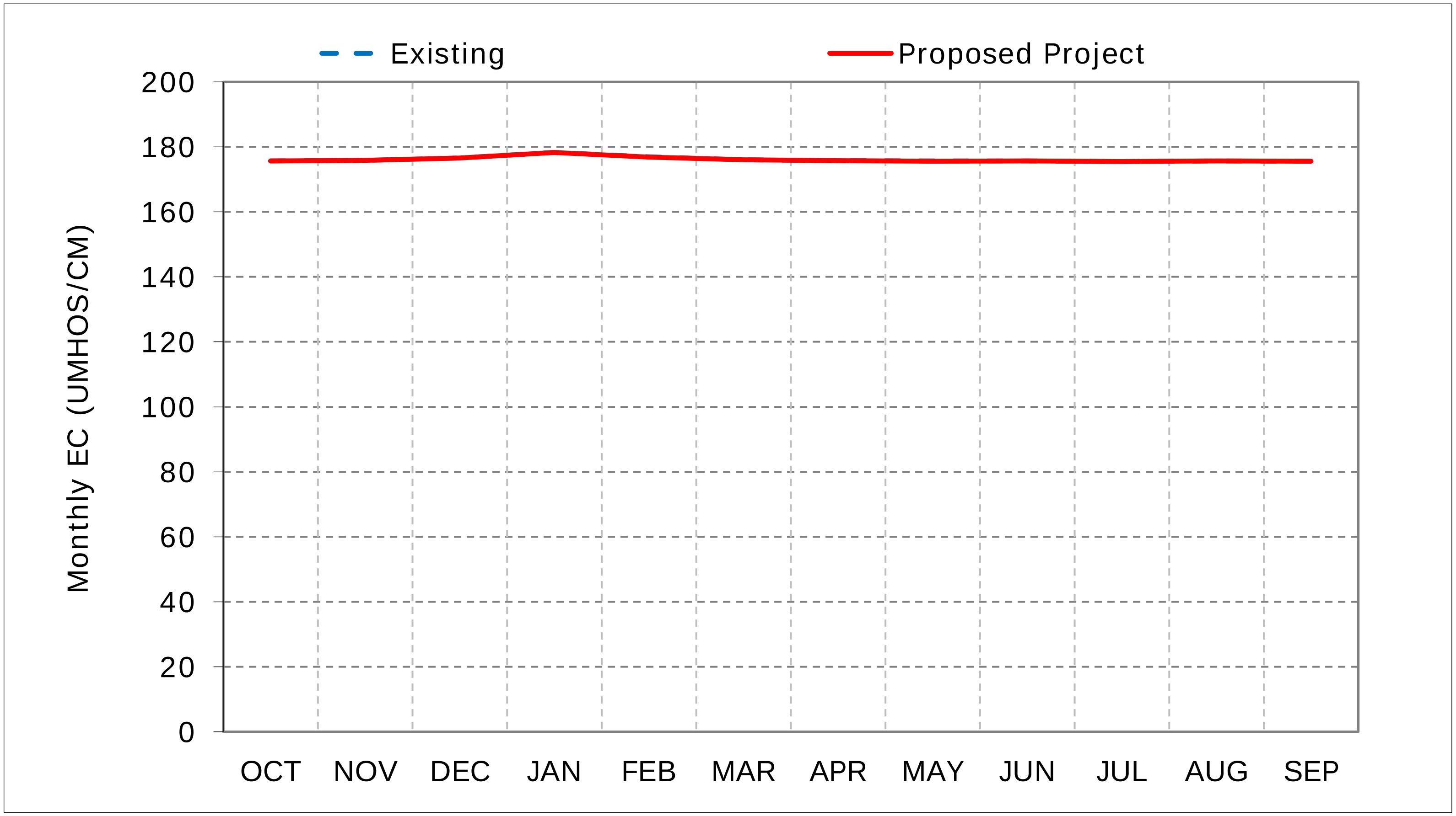
Statistic	Monthly EC (UMHOS/CM)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	176	177	178	181	179	177	176	176	176	176	176	176
20%	176	176	177	180	178	176	176	176	176	176	176	176
30%	176	176	177	179	177	176	176	176	176	176	176	176
40%	176	176	177	178	177	176	176	176	176	175	176	176
50%	176	176	176	178	177	176	176	176	176	175	176	175
60%	176	176	176	178	176	176	176	176	176	175	176	175
70%	176	175	176	177	176	176	175	175	176	175	176	175
80%	175	175	176	177	176	176	175	175	176	175	176	175
90%	175	175	175	177	176	175	175	175	175	175	175	175
Long Term												
Full Simulation Period[a]	176	176	177	178	177	176	176	176	176	176	176	176
Water Year Types[b]												
Wet (32%)	176	176	177	178	176	176	175	175	176	175	176	175
Above Normal (15%)	176	176	177	178	177	176	176	175	176	175	176	175
Below Normal (17%)	176	176	177	179	177	176	176	176	176	175	176	176
Dry (22%)	176	176	177	179	177	176	176	176	176	176	176	176
Critical (15%)	176	176	176	179	177	176	176	176	176	176	176	176

Proposed Project minus Existing

Statistic	Monthly EC (UMHOS/CM)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	0	0	0	0	0	0	0	0	0	0	0	0
20%	0	0	0	0	0	0	0	0	0	0	0	0
30%	0	0	0	0	0	0	0	0	0	0	0	0
40%	0	0	0	0	0	0	0	0	0	0	0	0
50%	0	0	0	0	0	0	0	0	0	0	0	0
60%	0	0	0	0	0	0	0	0	0	0	0	0
70%	0	0	0	0	0	0	0	0	0	0	0	0
80%	0	0	0	0	0	0	0	0	0	0	0	0
90%	0	0	0	0	0	0	0	0	0	0	0	0
Long Term												
Full Simulation Period[a]	0	0	0	0	0	0	0	0	0	0	0	0
Water Year Types[b]												
Wet (32%)	0	0	0	0	0	0	0	0	0	0	0	0
Above Normal (15%)	0	0	0	0	0	0	0	0	0	0	0	0
Below Normal (17%)	0	0	0	0	0	0	0	0	0	0	0	0
Dry (22%)	0	0	0	0	0	0	0	0	0	0	0	0
Critical (15%)	0	0	0	0	0	0	0	0	0	0	0	0

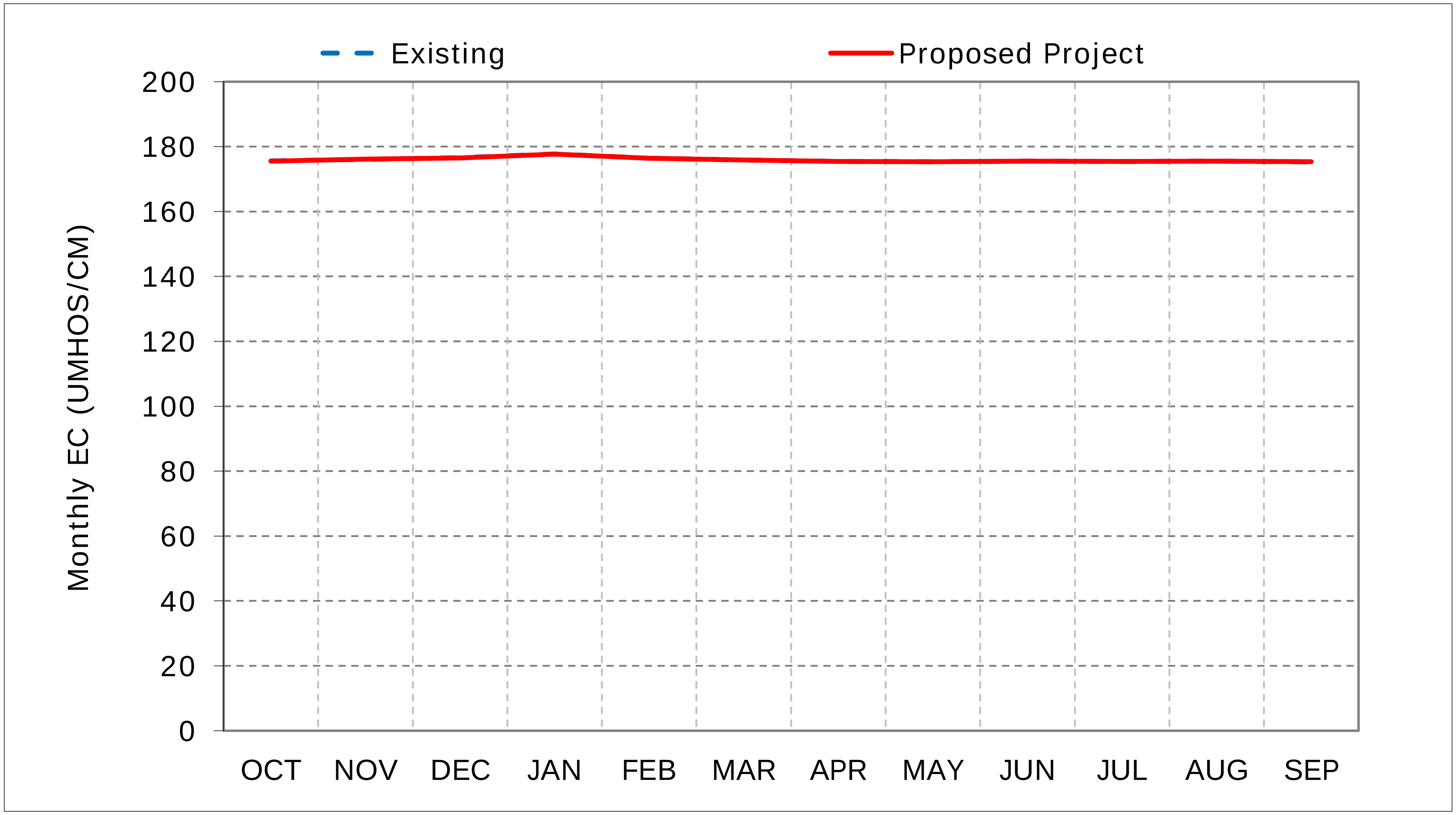
a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with water year - year type sorting.
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 1-1. Sacramento River downstream of Steamboat Slough Salinity, Long-Ter



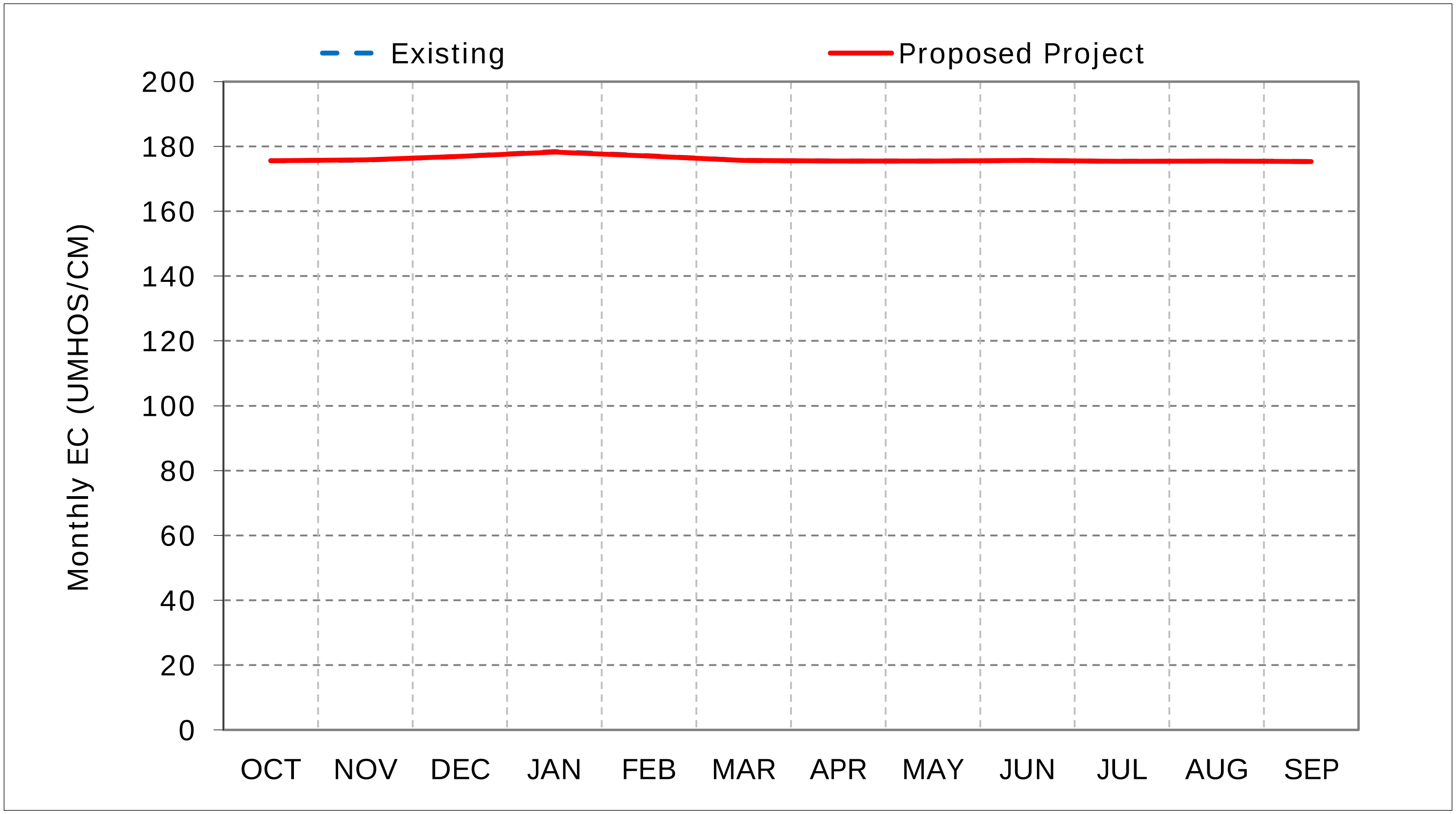
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 1-2. Sacramento River downstream of Steamboat Slough Salinity, Wet Year



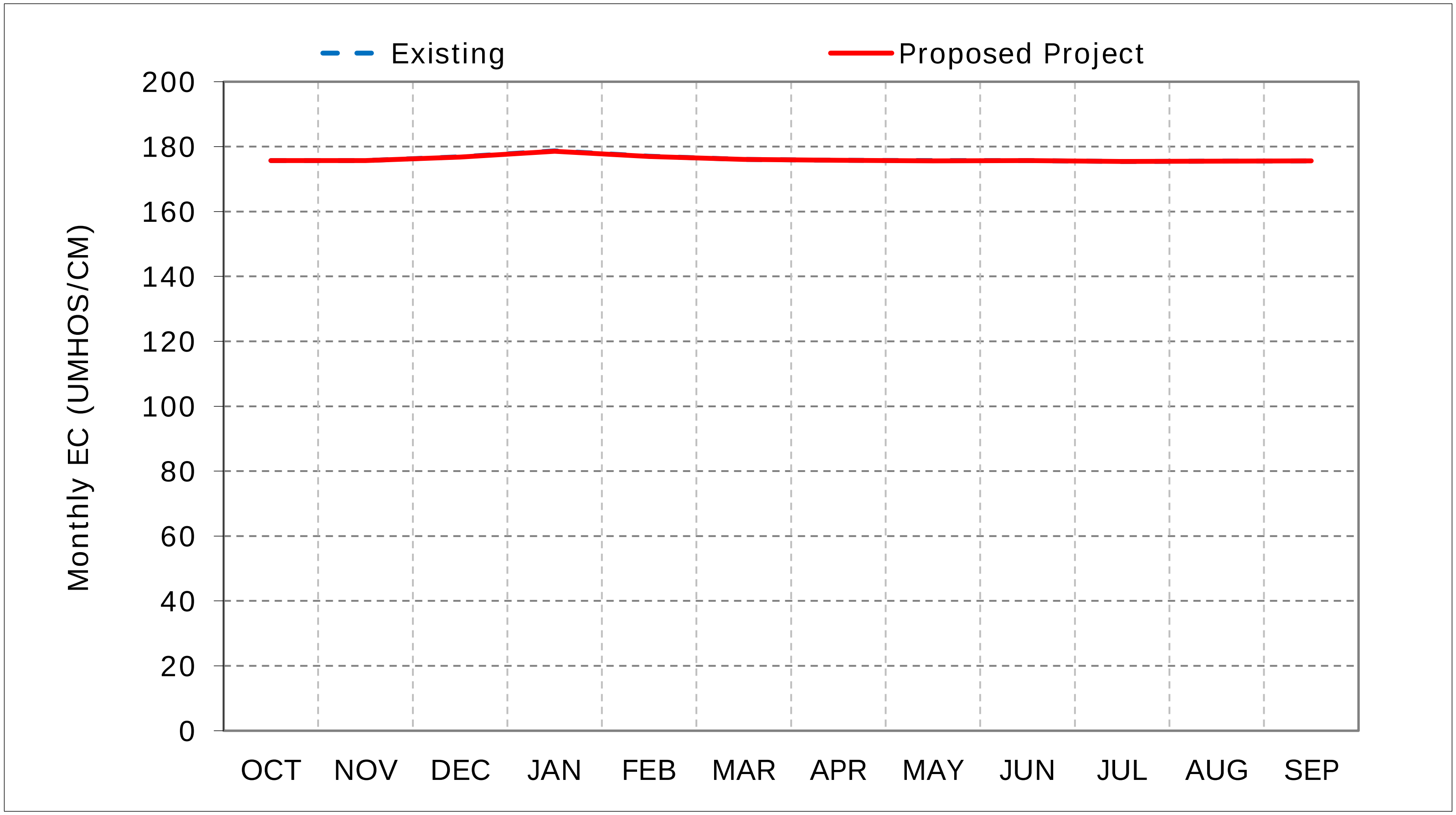
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 1-3. Sacramento River downstream of Steamboat Slough Salinity, Above N



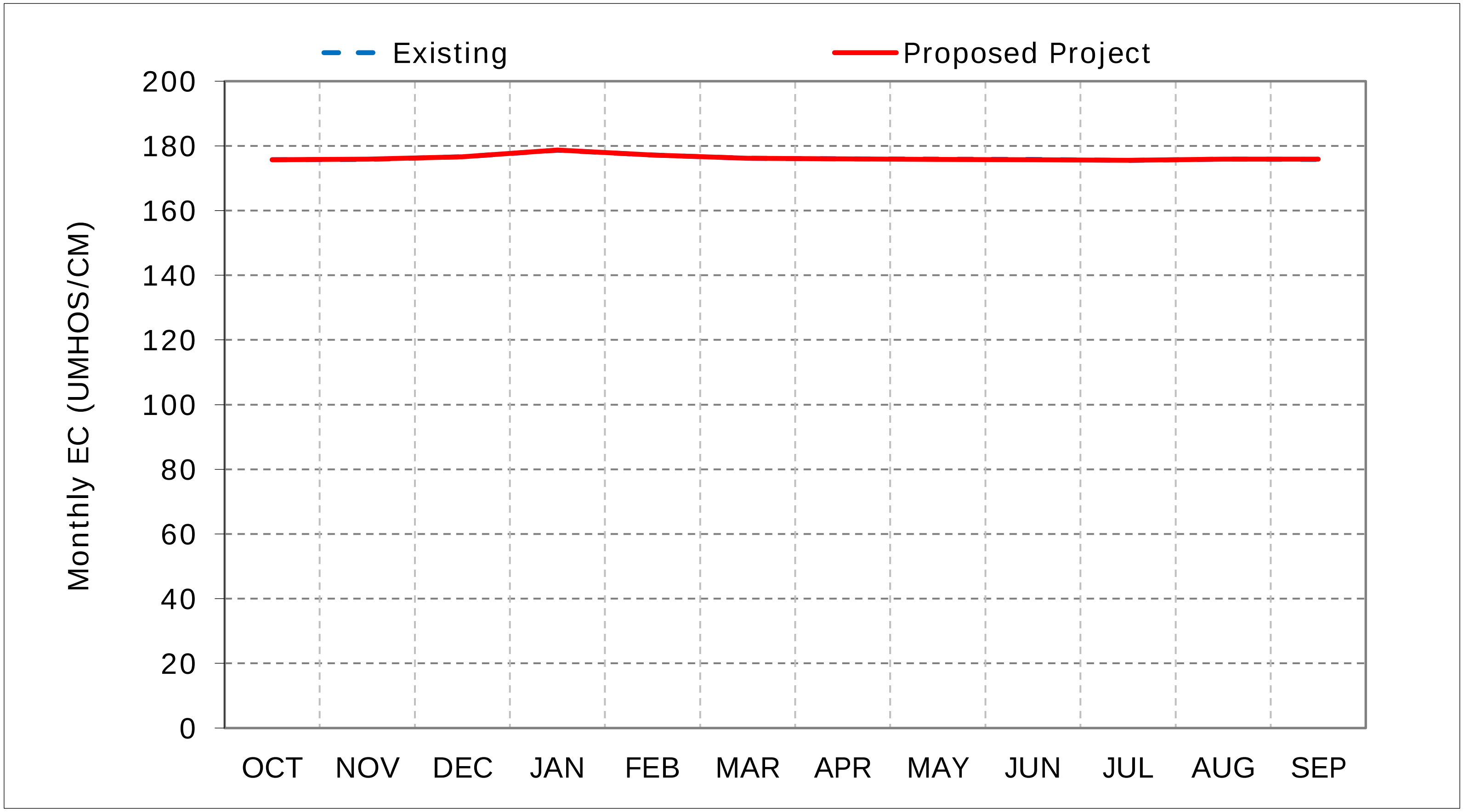
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 1-4. Sacramento River downstream of Steamboat Slough Salinity, Below N



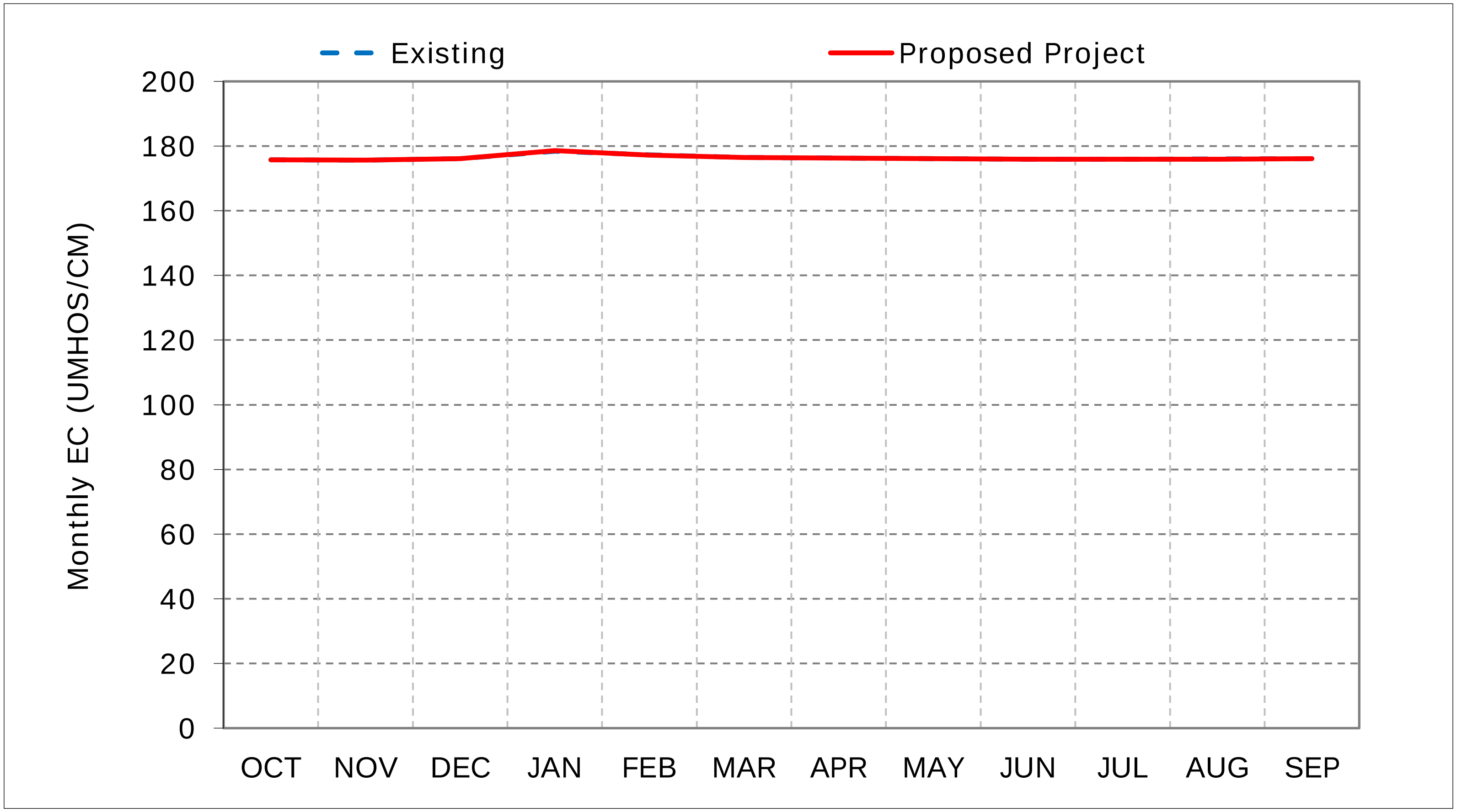
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 1-5. Sacramento River downstream of Steamboat Slough Salinity, Dry Year



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 1-6. Sacramento River downstream of Steamboat Slough Salinity, Critical Y



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 1-7. Sacramento River downstream of Steamboat Slough Salinity, January EC

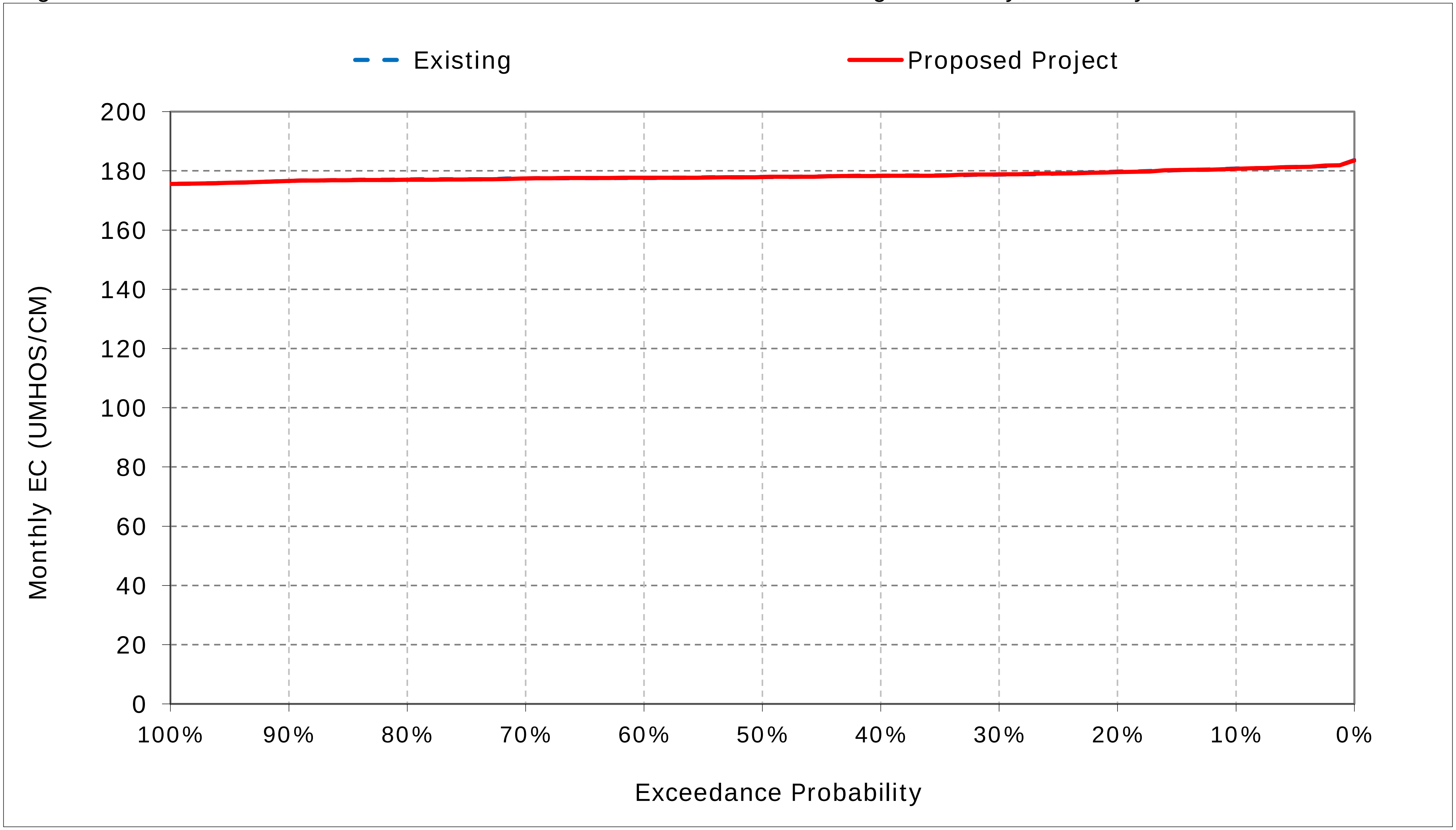


Figure 1-8. Sacramento River downstream of Steamboat Slough Salinity, February EC

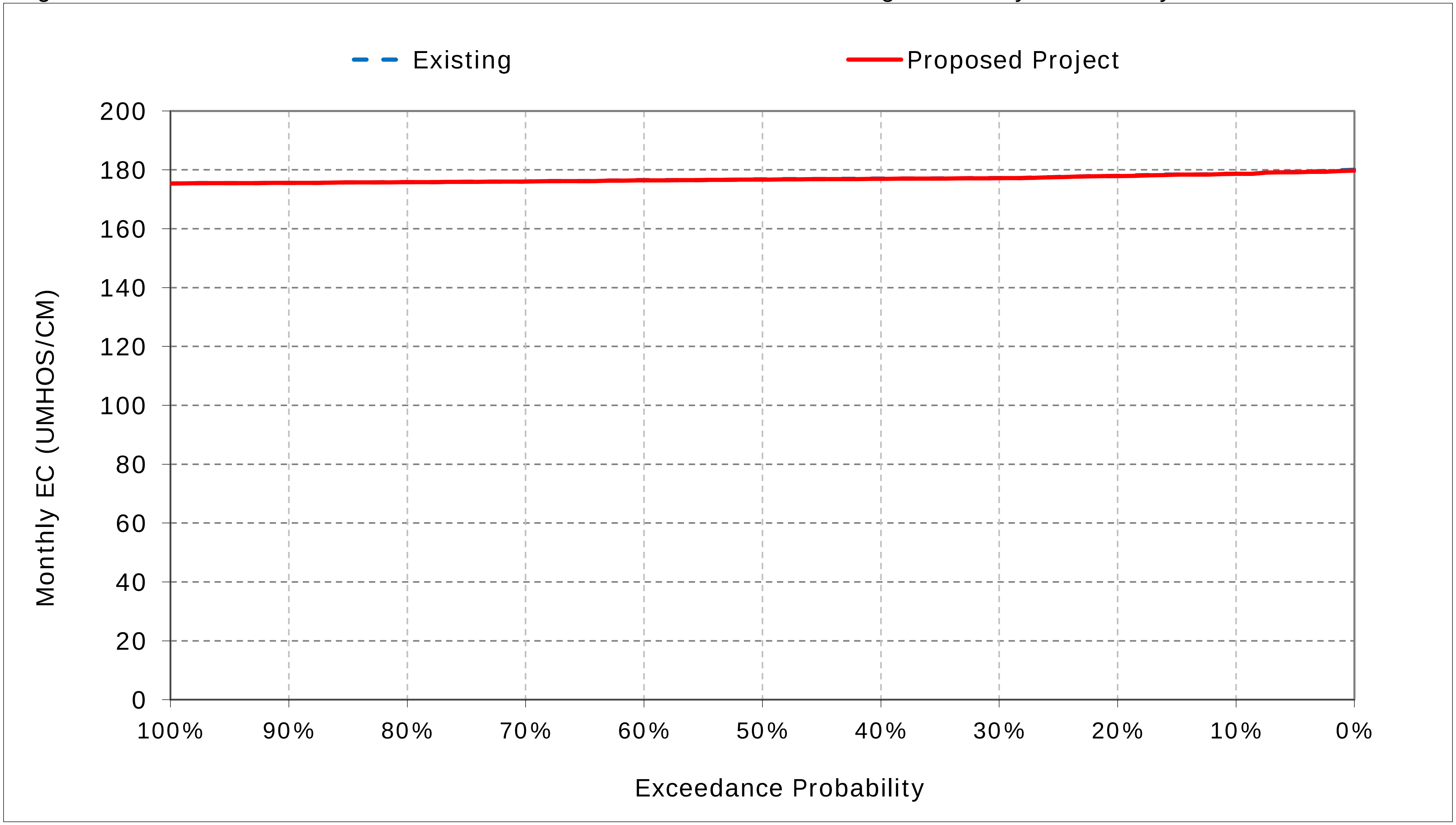


Figure 1-9. Sacramento River downstream of Steamboat Slough Salinity, March EC

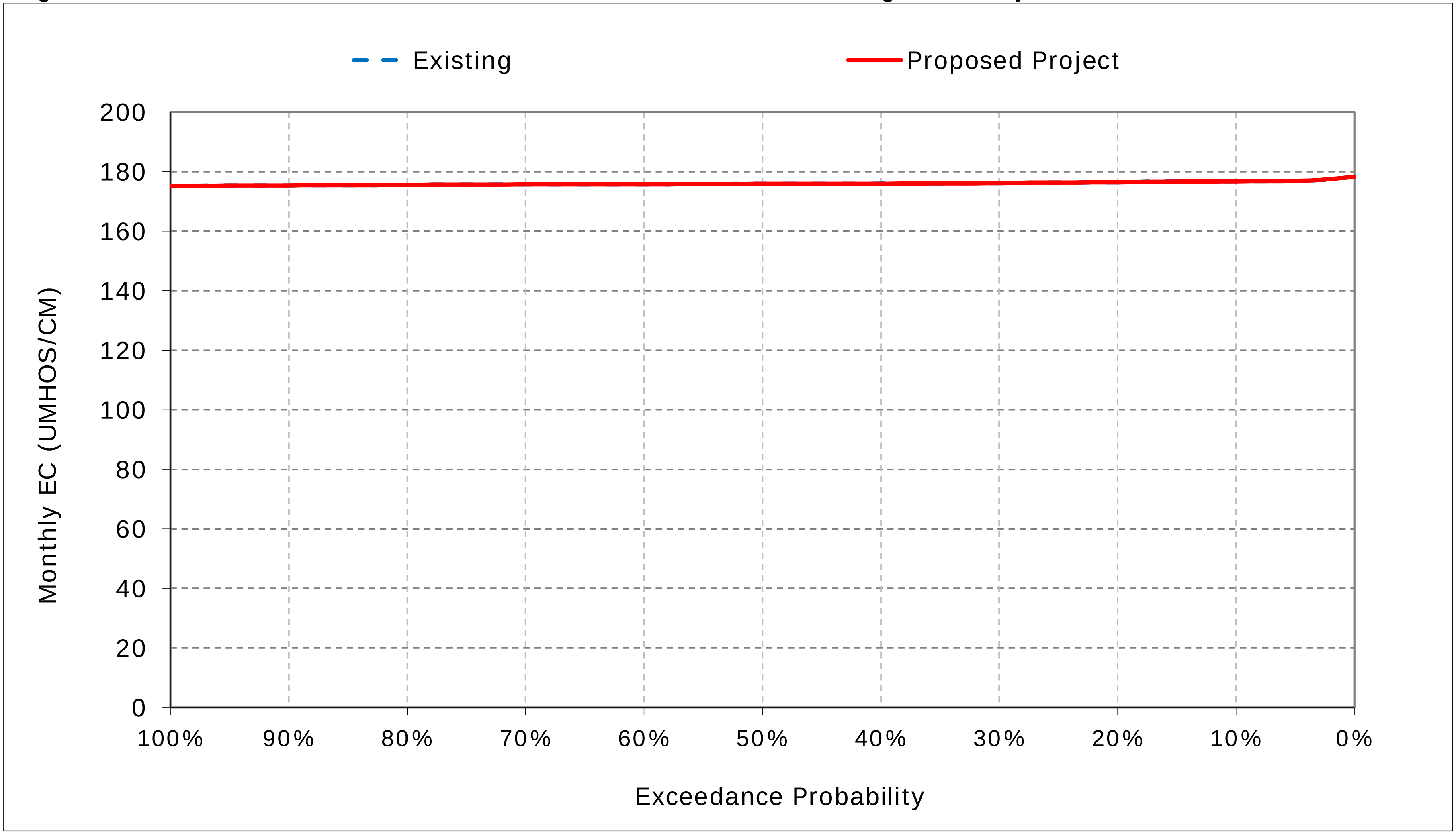


Figure 1-10. Sacramento River downstream of Steamboat Slough Salinity, April EC

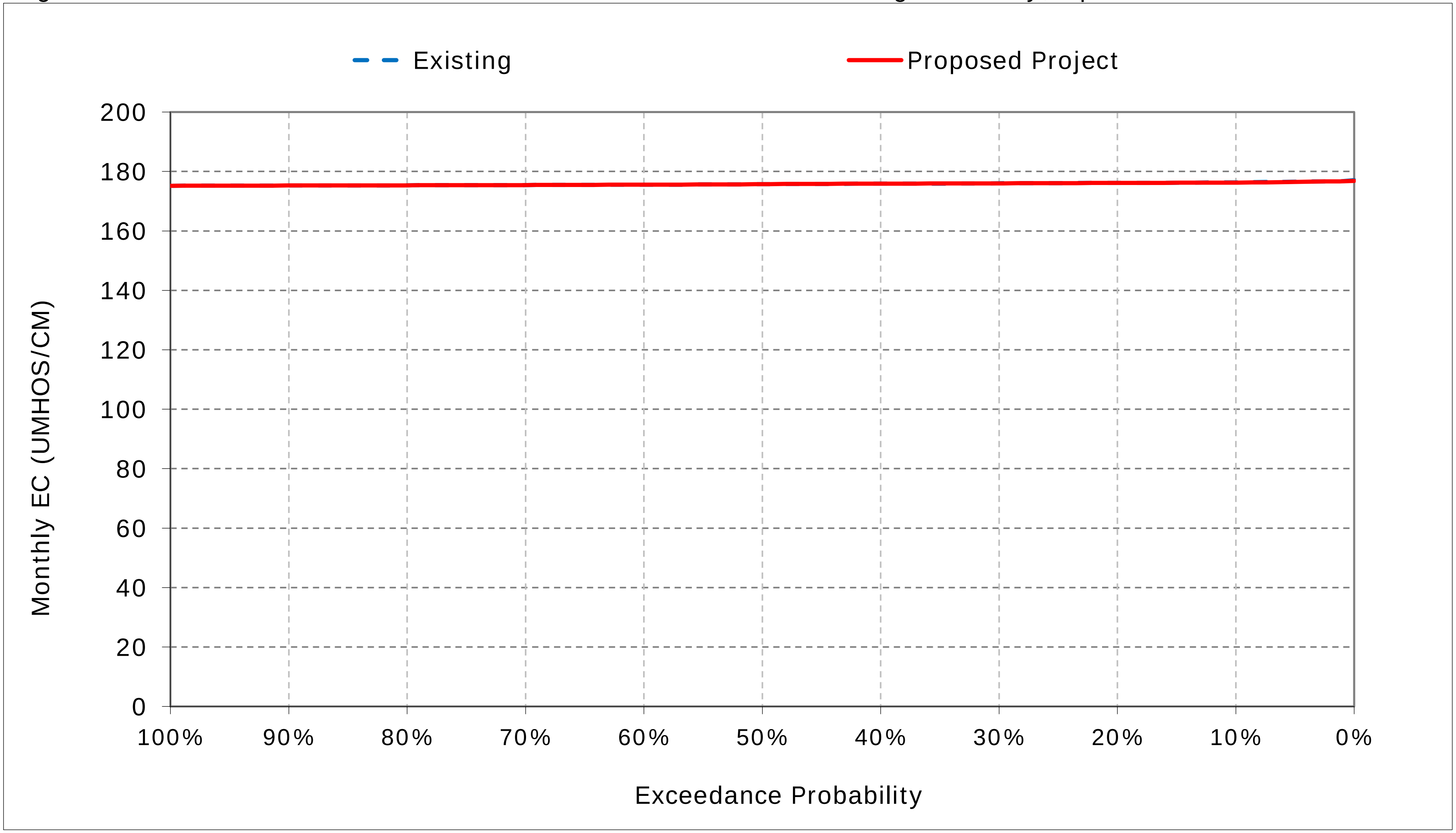


Figure 1-11. Sacramento River downstream of Steamboat Slough Salinity, May EC

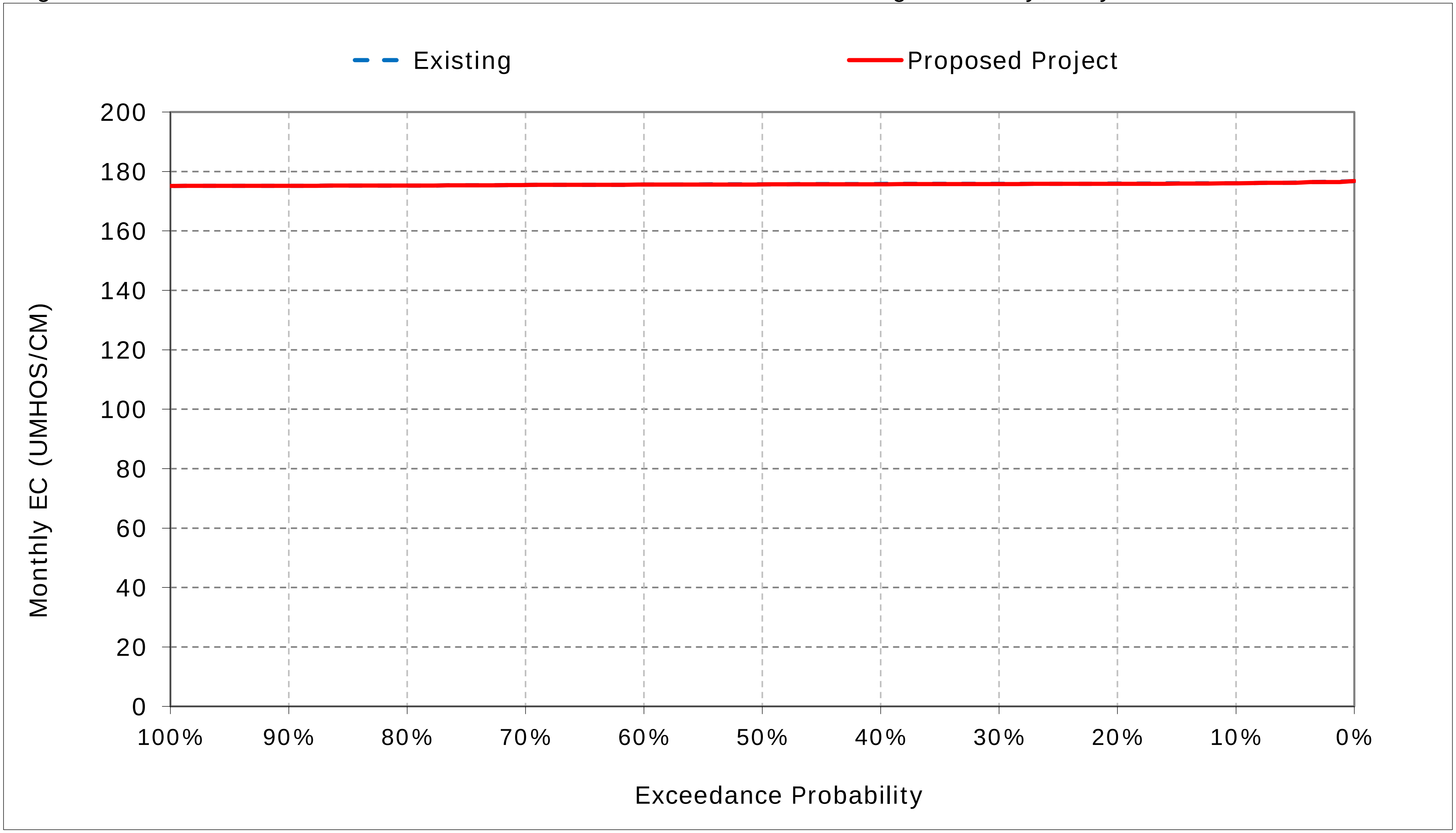


Figure 1-12. Sacramento River downstream of Steamboat Slough Salinity, June EC

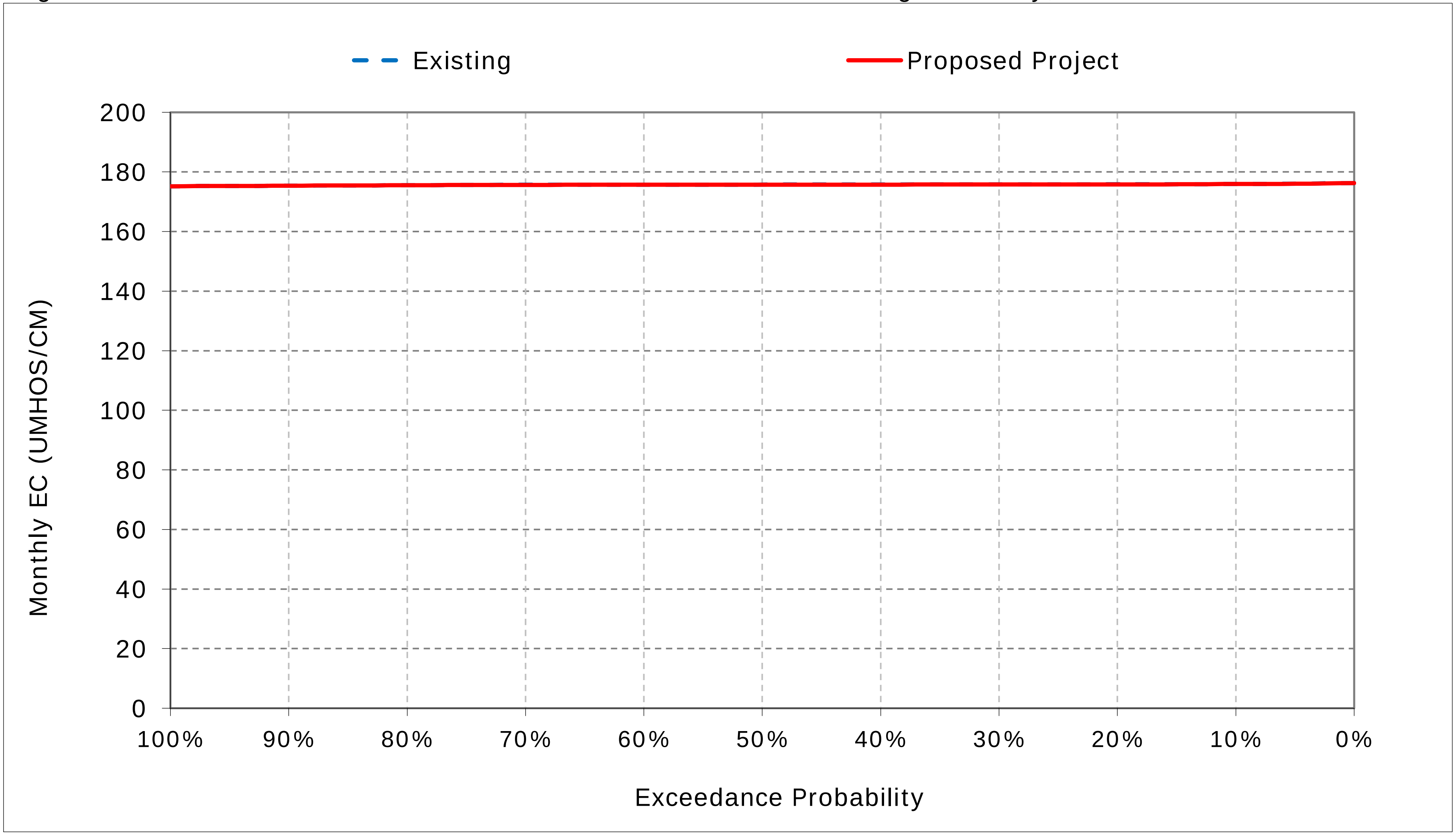


Figure 1-13. Sacramento River downstream of Steamboat Slough Salinity, July EC

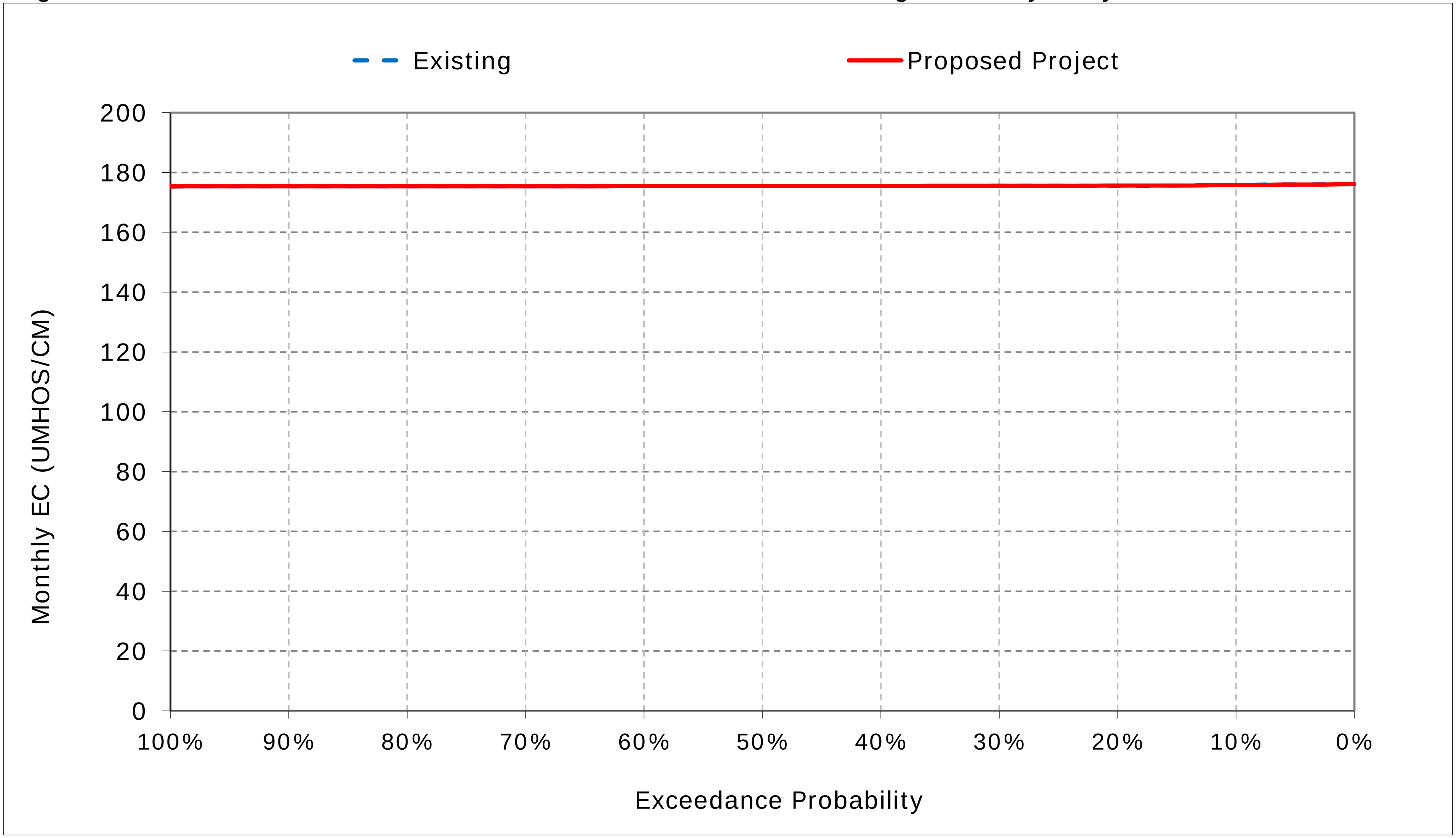


Figure 1-14. Sacramento River downstream of Steamboat Slough Salinity, August EC

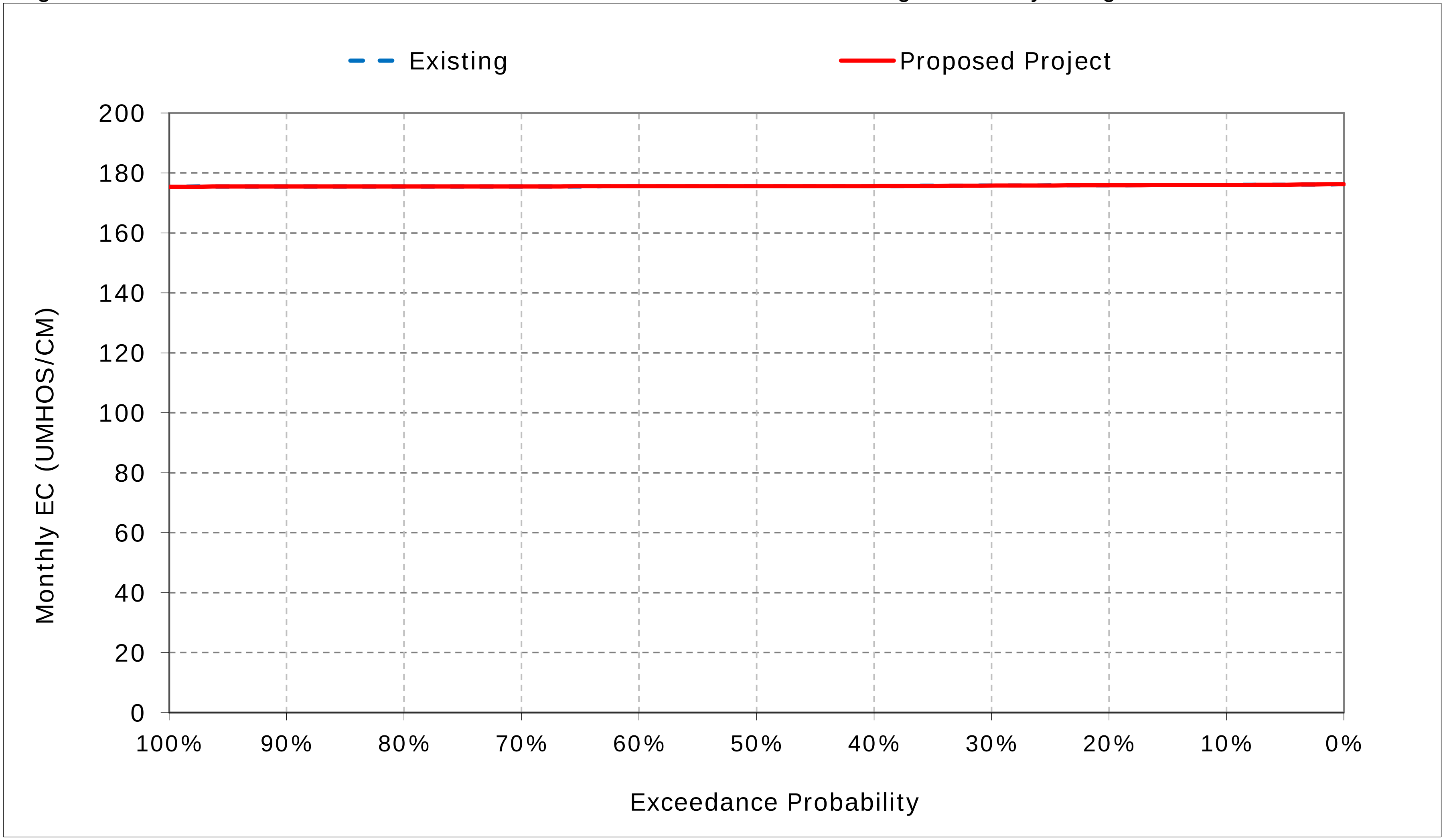


Figure 1-15. Sacramento River downstream of Steamboat Slough Salinity, September EC

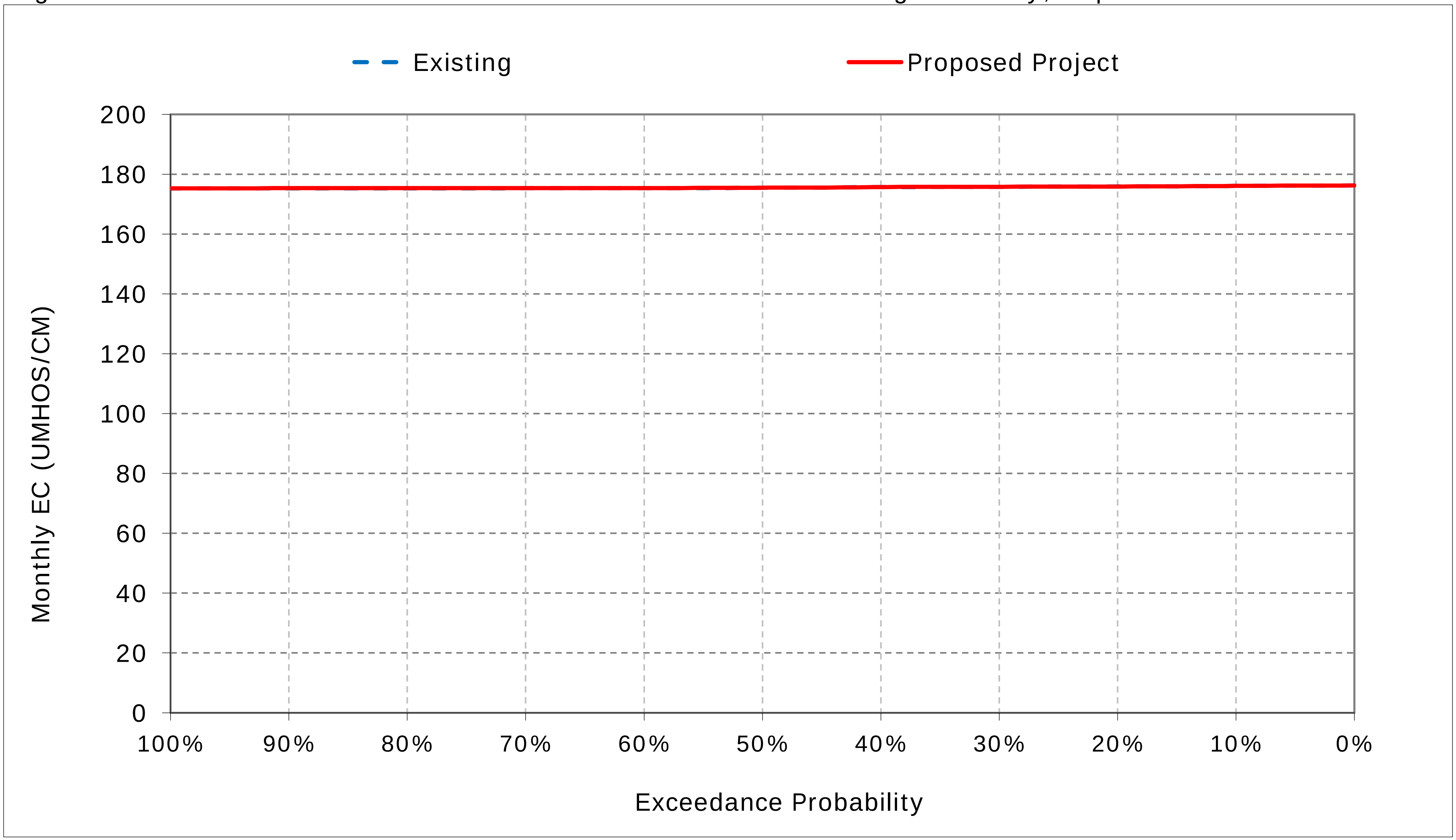


Figure 1-16. Sacramento River downstream of Steamboat Slough Salinity, October EC

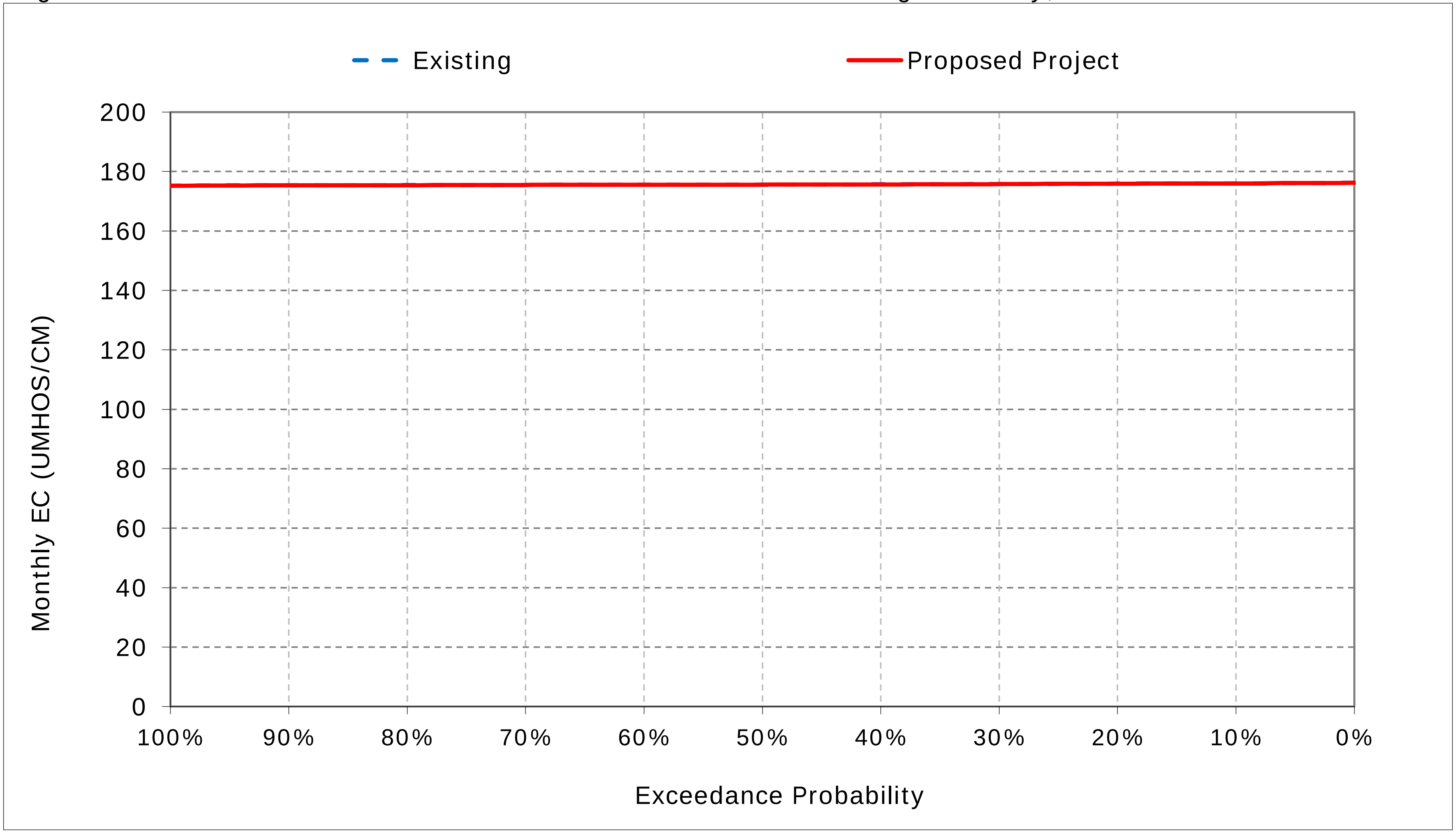


Figure 1-17. Sacramento River downstream of Steamboat Slough Salinity, November EC

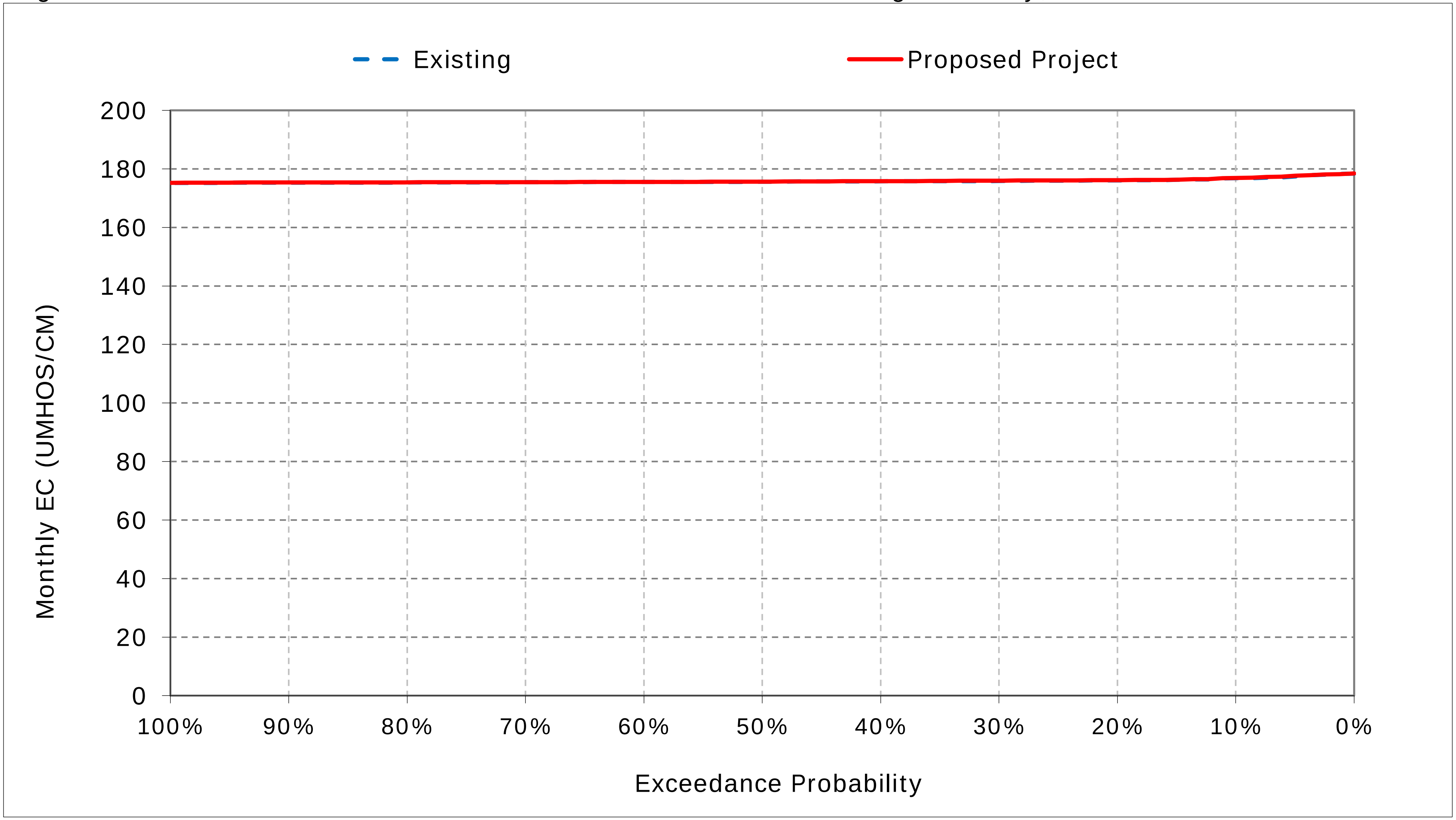


Figure 1-18. Sacramento River downstream of Steamboat Slough Salinity, December EC

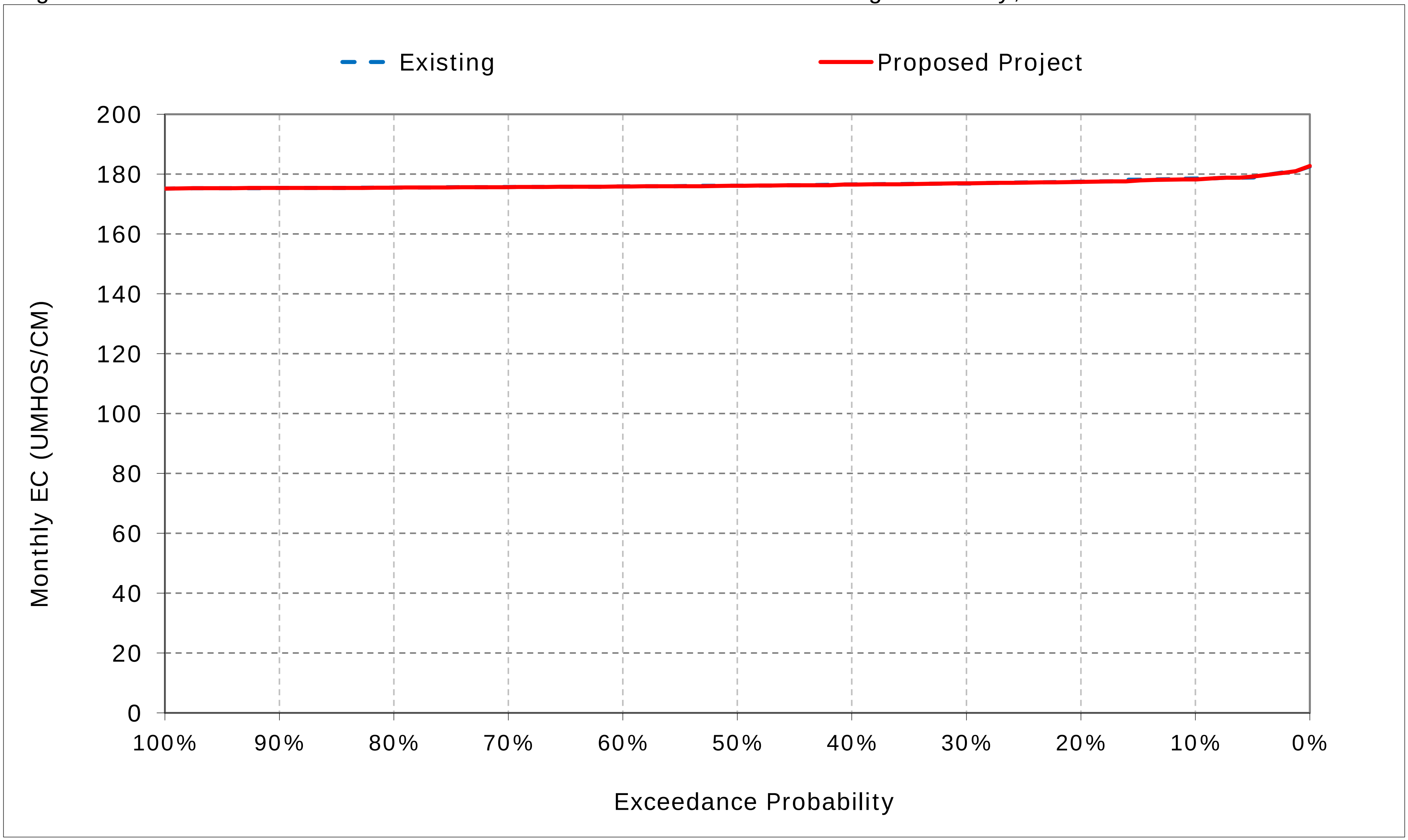


Table 2-1. Cache Slough at Ryer Island Salinity, Monthly EC

Existing

Statistic	Monthly EC (UMHOS/CM)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	189	190	191	203	201	194	187	184	184	185	186	187
20%	185	186	188	197	197	192	186	183	183	181	184	183
30%	184	184	186	193	192	190	185	183	182	181	183	182
40%	183	183	185	191	189	186	184	182	182	180	181	181
50%	181	181	184	190	188	185	183	182	182	180	180	180
60%	180	180	182	189	187	184	183	181	181	180	180	179
70%	180	180	181	187	185	183	182	180	181	180	180	179
80%	180	179	180	186	184	182	181	179	180	179	180	178
90%	179	179	180	184	182	181	180	178	179	179	179	178
Long Term												
Full Simulation Period[a]	183	183	185	192	190	187	184	181	182	181	182	181
Water Year Types[b]												
Wet (32%)	181	181	183	190	184	183	182	180	180	180	180	178
Above Normal (15%)	183	183	185	194	192	185	182	180	181	180	180	179
Below Normal (17%)	183	182	186	193	193	189	184	182	181	180	180	180
Dry (22%)	184	185	185	193	193	188	185	183	182	181	184	183
Critical (15%)	185	187	186	191	193	190	186	184	185	186	186	188

Proposed Project

Statistic	Monthly EC (UMHOS/CM)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	188	190	191	202	200	194	187	184	184	185	185	187
20%	185	186	188	197	197	192	186	183	182	181	184	183
30%	184	184	186	193	192	190	185	182	182	181	182	182
40%	182	183	185	191	188	186	184	182	182	180	181	181
50%	181	182	184	190	187	185	183	181	181	180	180	180
60%	180	181	182	188	187	184	182	181	181	180	180	179
70%	180	181	181	187	185	183	182	180	181	180	180	179
80%	180	180	180	186	184	182	181	179	180	179	179	179
90%	179	179	180	183	182	180	180	178	179	179	179	179
Long Term												
Full Simulation Period[a]	183	184	185	192	190	187	183	181	181	181	181	181
Water Year Types[b]												
Wet (32%)	181	182	183	189	184	183	182	180	180	180	180	179
Above Normal (15%)	182	184	185	193	192	185	182	180	181	180	180	179
Below Normal (17%)	183	182	186	192	192	189	184	181	181	180	180	181
Dry (22%)	184	185	186	193	193	188	185	182	182	181	184	183
Critical (15%)	185	187	187	191	193	190	186	184	186	186	185	188

Proposed Project minus Existing

Statistic	Monthly EC (UMHOS/CM)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	0	0	0	-1	-1	0	0	-1	0	0	0	0
20%	0	0	0	0	0	0	0	0	0	0	0	0
30%	0	0	0	0	0	0	0	0	0	0	0	0
40%	0	0	0	0	-1	0	0	0	0	0	0	0
50%	0	1	0	0	-1	0	0	0	0	0	0	0
60%	0	1	0	0	0	0	0	0	0	0	0	0
70%	0	1	0	0	0	0	0	0	0	0	0	0
80%	0	1	0	0	0	0	0	0	0	0	0	1
90%	0	1	0	-1	0	-1	0	0	0	0	0	1
Long Term												
Full Simulation Period[a]	0	0	0	0	0	0	0	0	0	0	0	0
Water Year Types[b]												
Wet (32%)	0	1	0	0	0	0	0	0	0	0	0	1
Above Normal (15%)	0	0	0	0	-1	0	0	0	0	0	0	0
Below Normal (17%)	0	0	0	0	-1	0	0	0	0	0	0	0
Dry (22%)	0	0	0	0	0	0	0	-1	0	0	0	0
Critical (15%)	0	0	0	1	0	0	0	0	0	0	-1	0

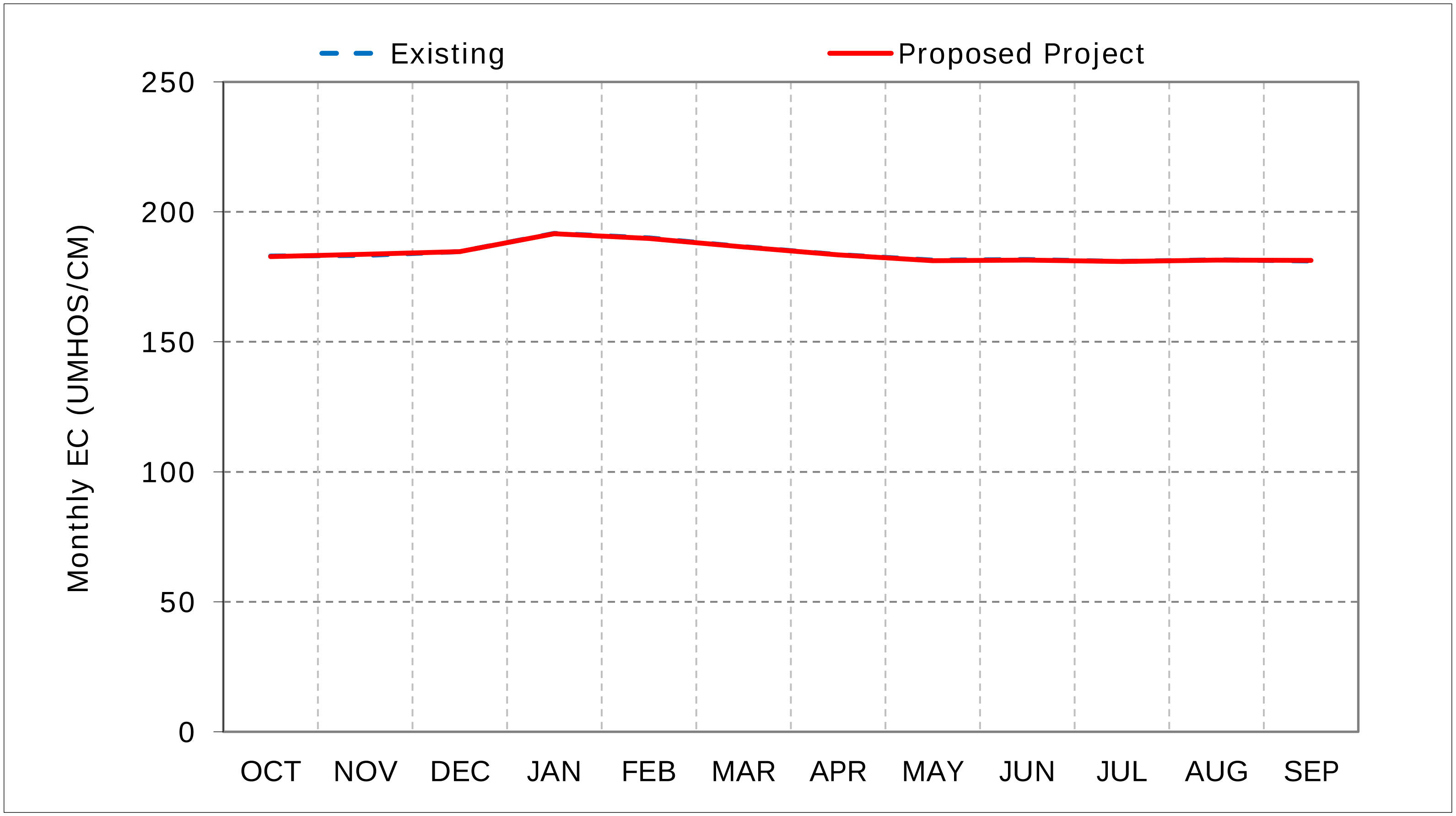
a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

c These results are displayed with water year - year type sorting.

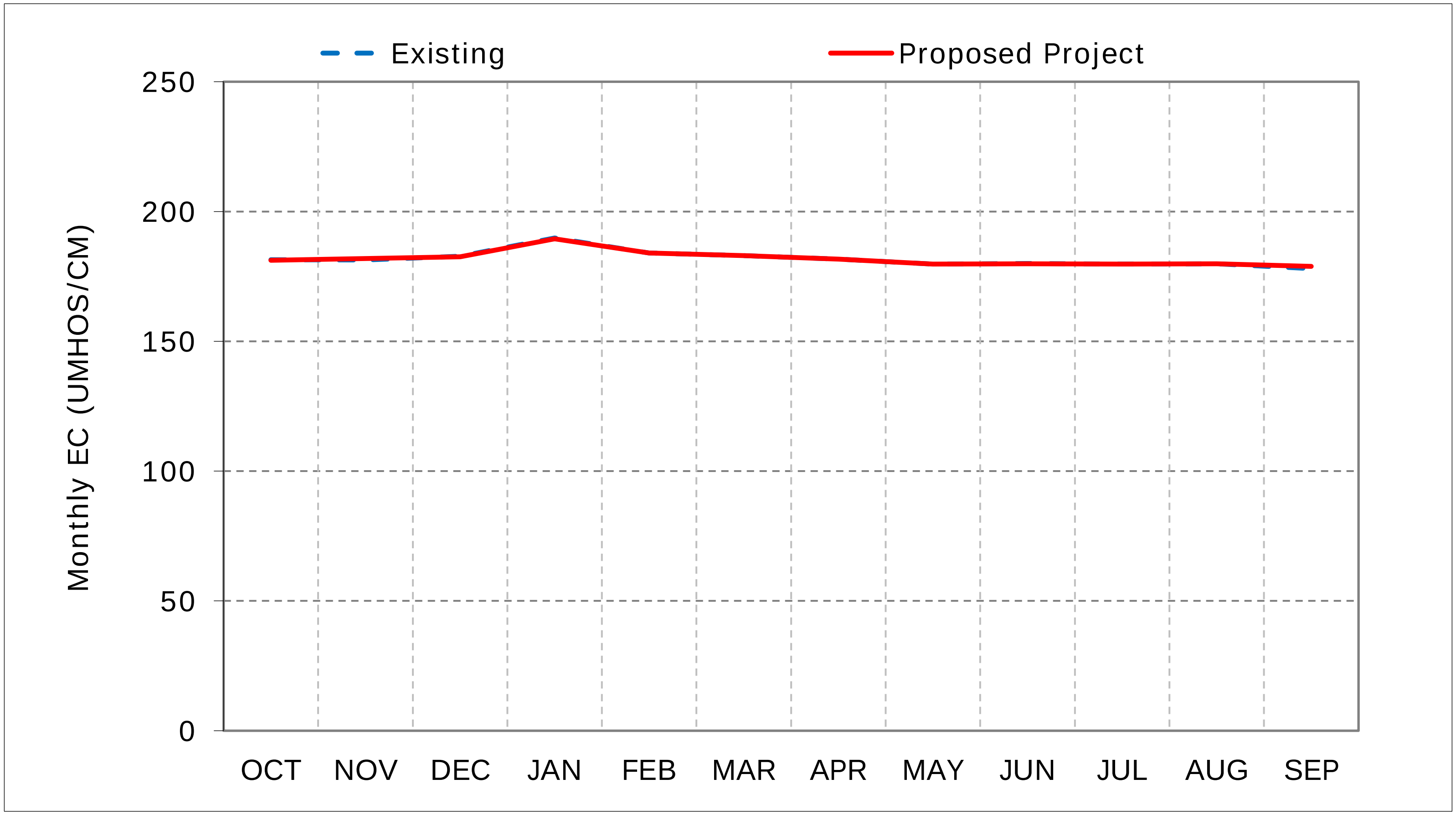
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 2-1. Cache Slough at Ryer Island Salinity, Long-Term Average EC



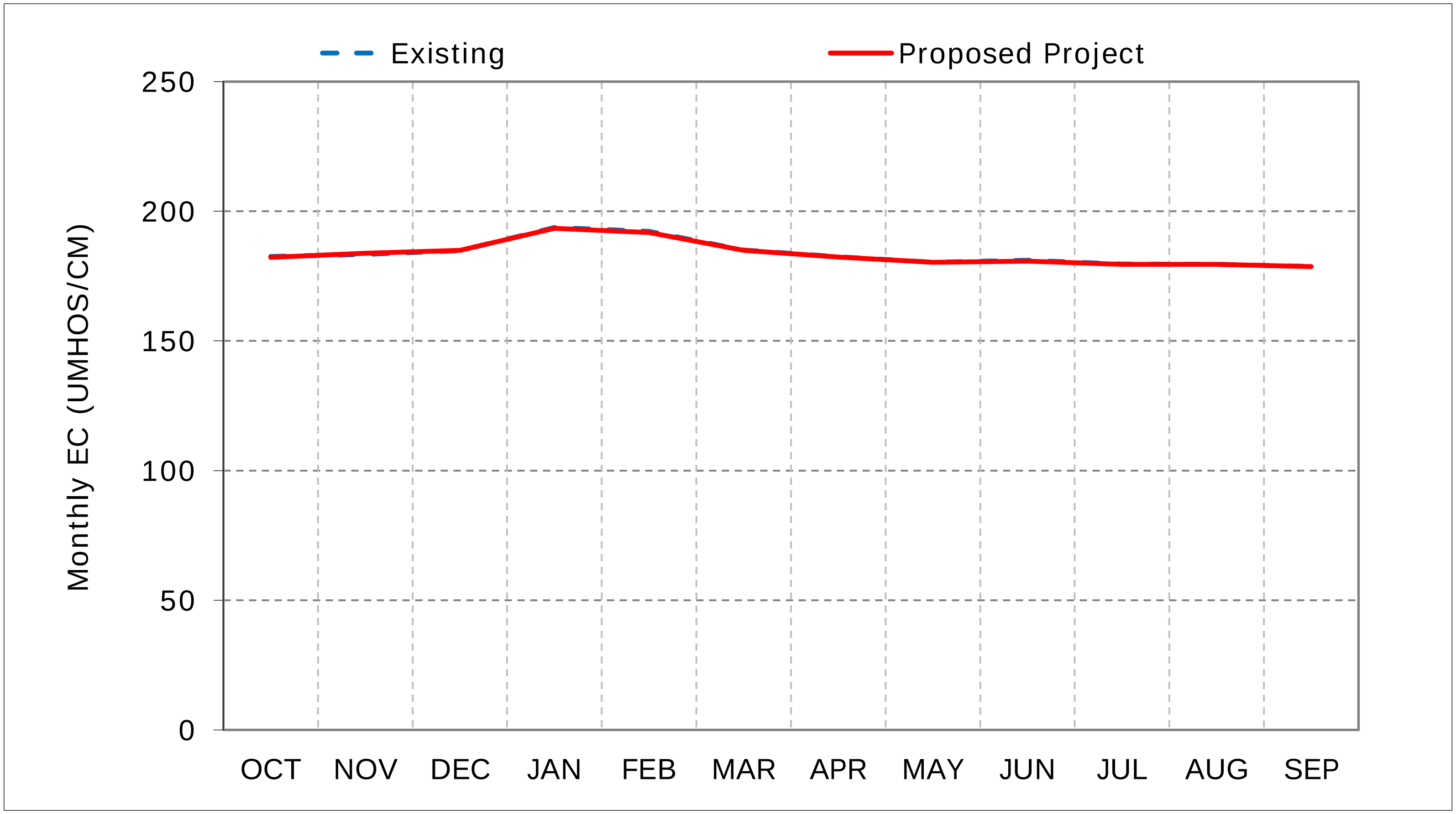
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 2-2. Cache Slough at Ryer Island Salinity, Wet Year Average EC



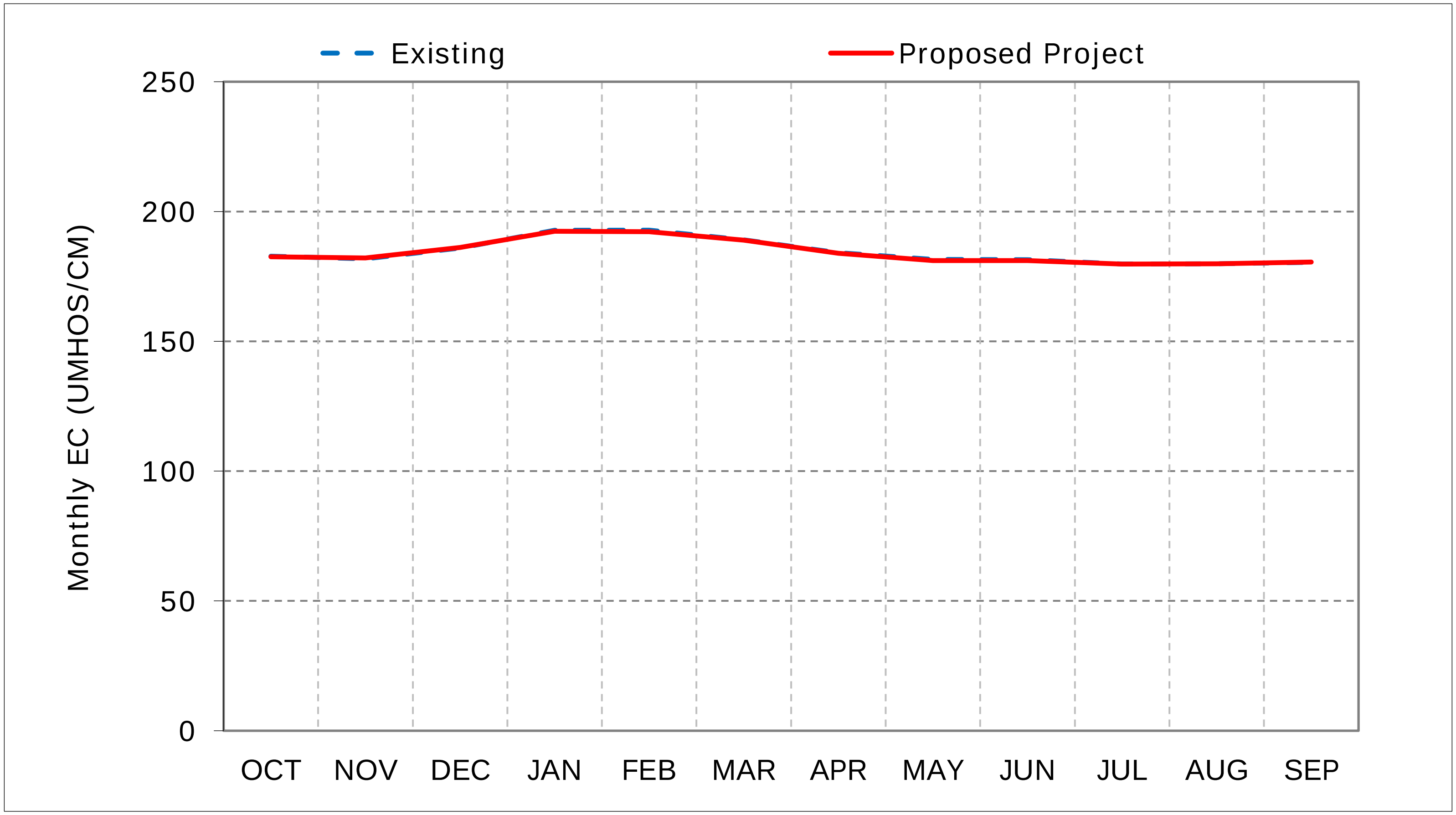
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 2-3. Cache Slough at Ryer Island Salinity, Above Normal Year Average EC



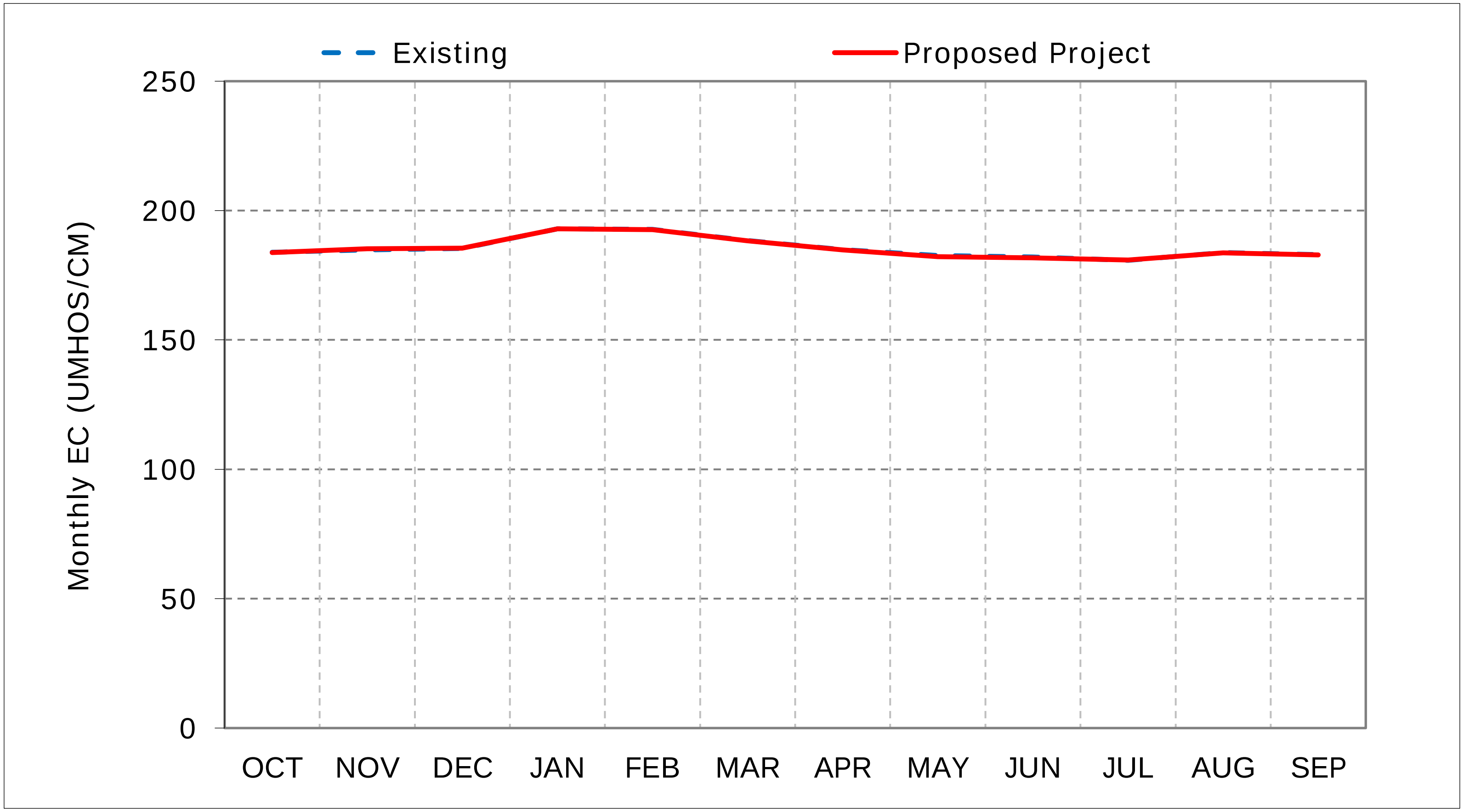
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 2-4. Cache Slough at Ryer Island Salinity, Below Normal Year Average EC



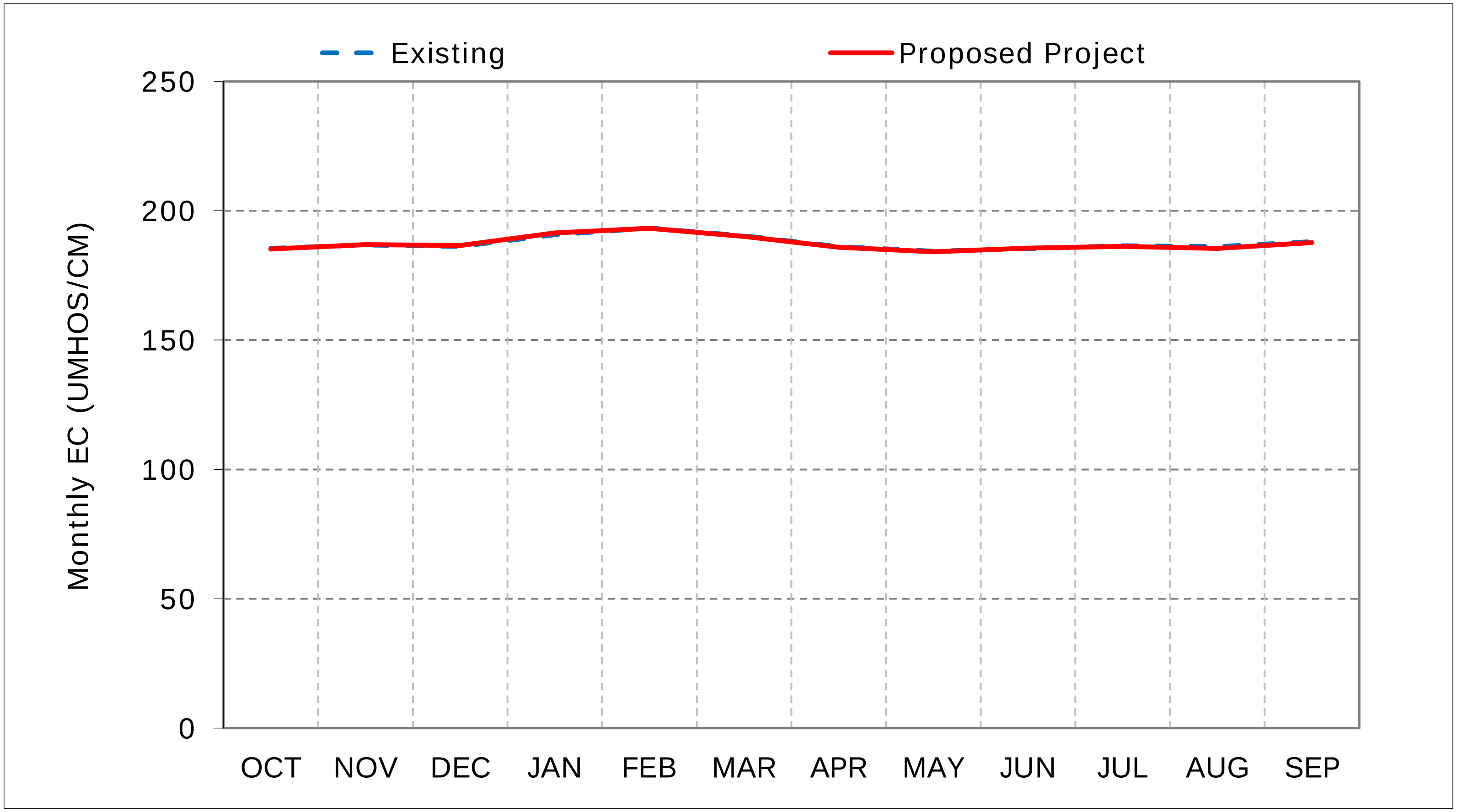
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 2-5. Cache Slough at Ryer Island Salinity, Dry Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 2-6. Cache Slough at Ryer Island Salinity, Critical Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 2-7. Cache Slough at Ryer Island Salinity, January EC

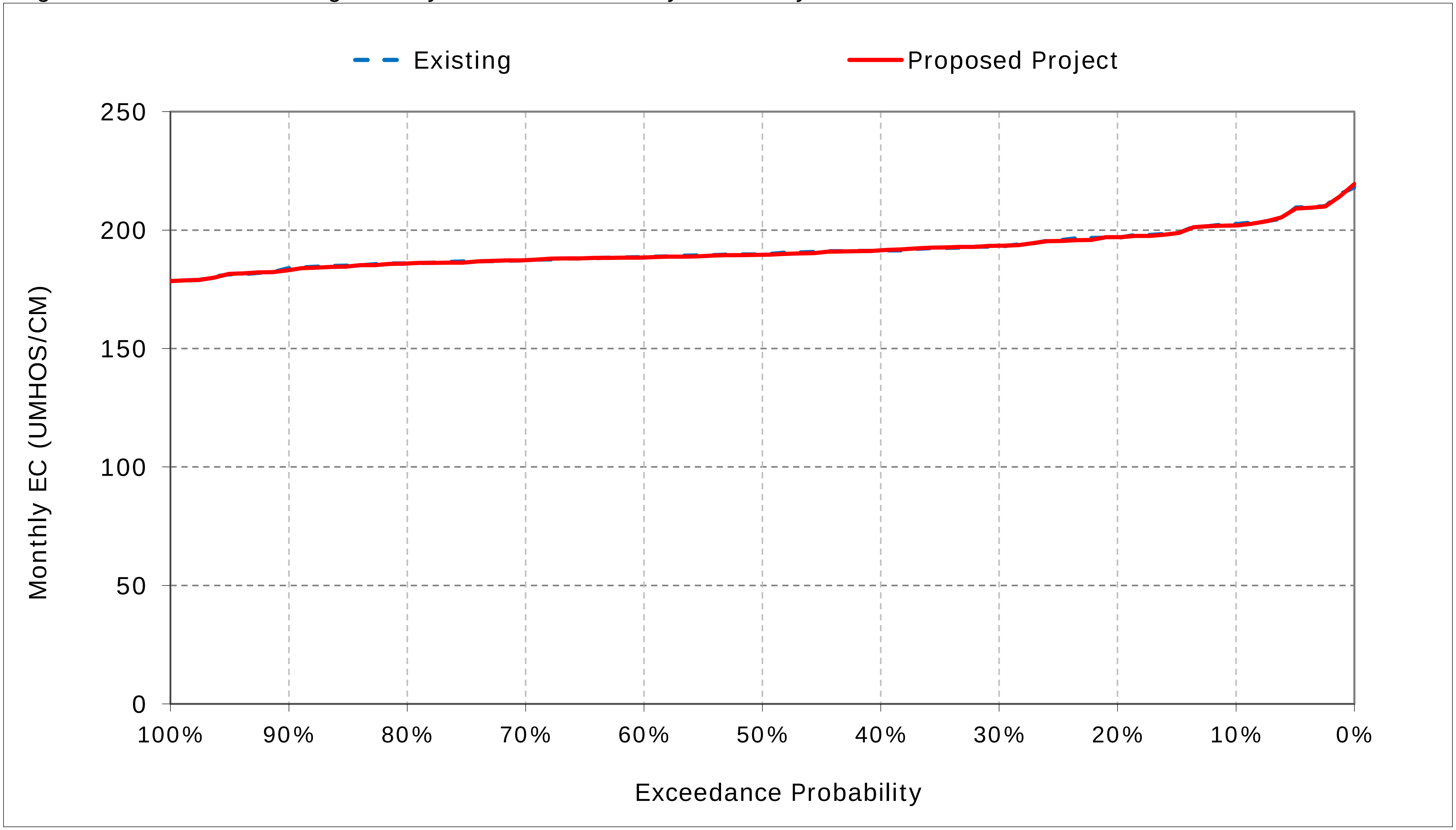


Figure 2-8. Cache Slough at Ryer Island Salinity, February EC

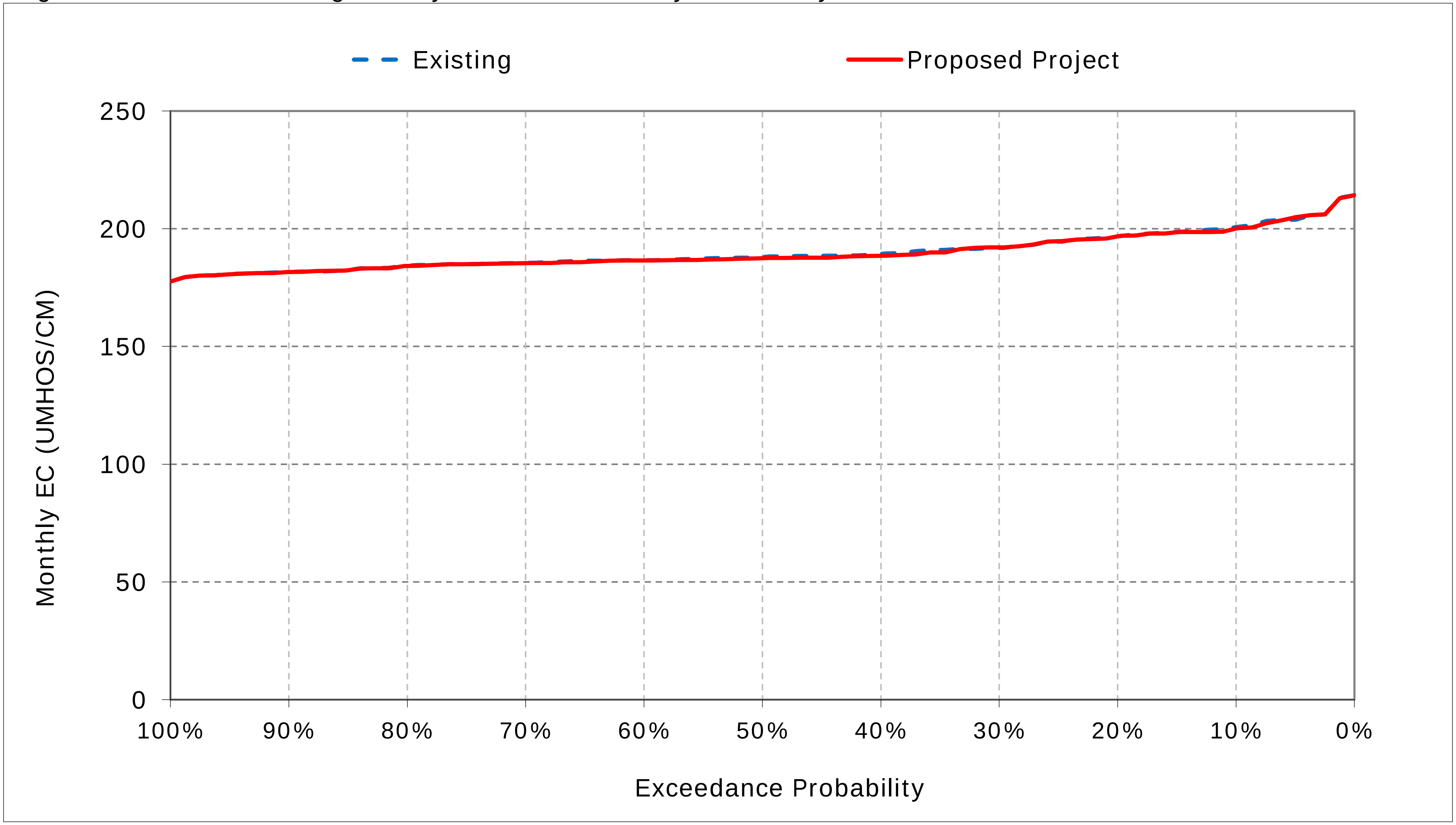


Figure 2-9. Cache Slough at Ryer Island Salinity, March EC

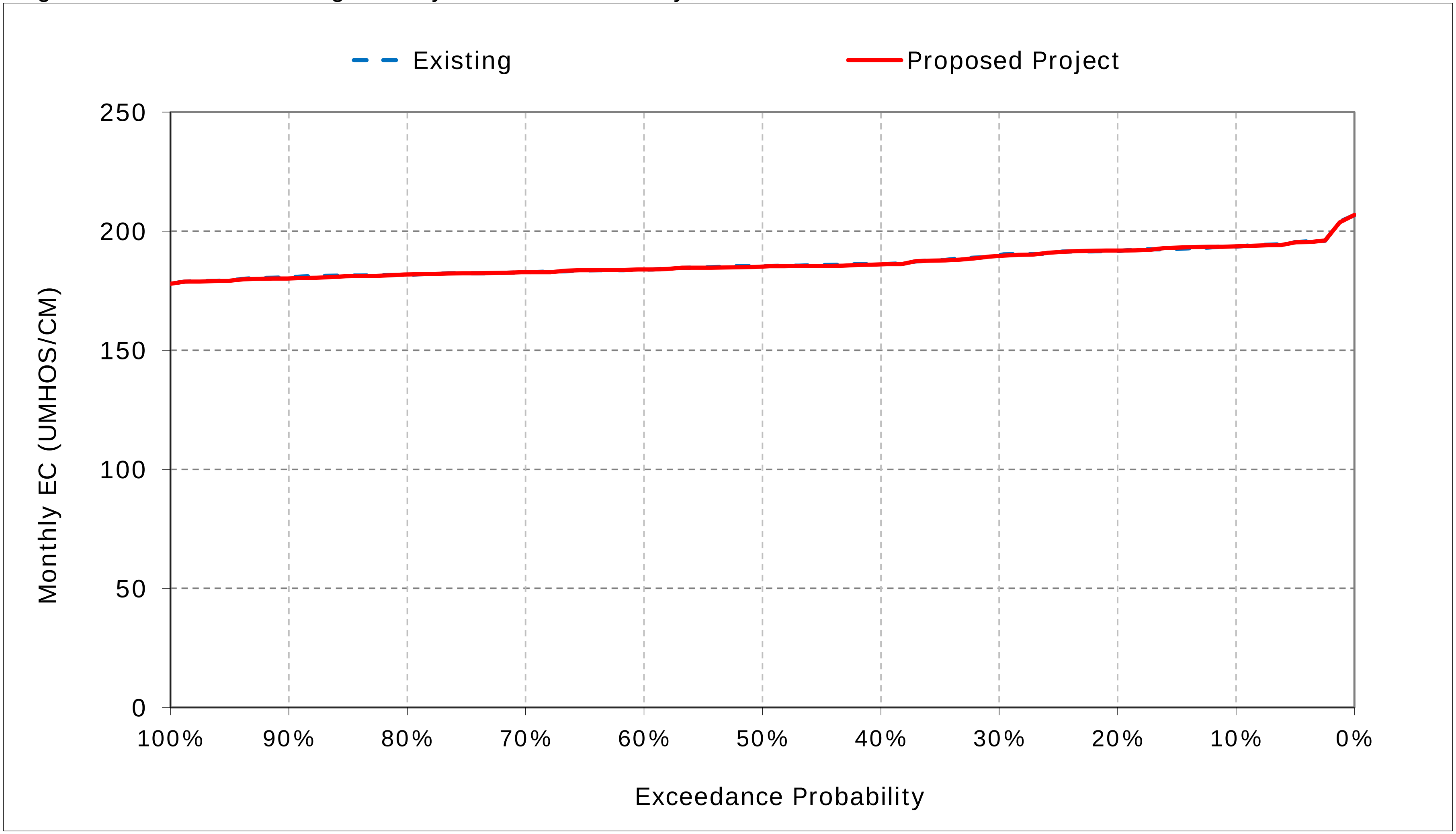


Figure 2-10. Cache Slough at Ryer Island Salinity, April EC

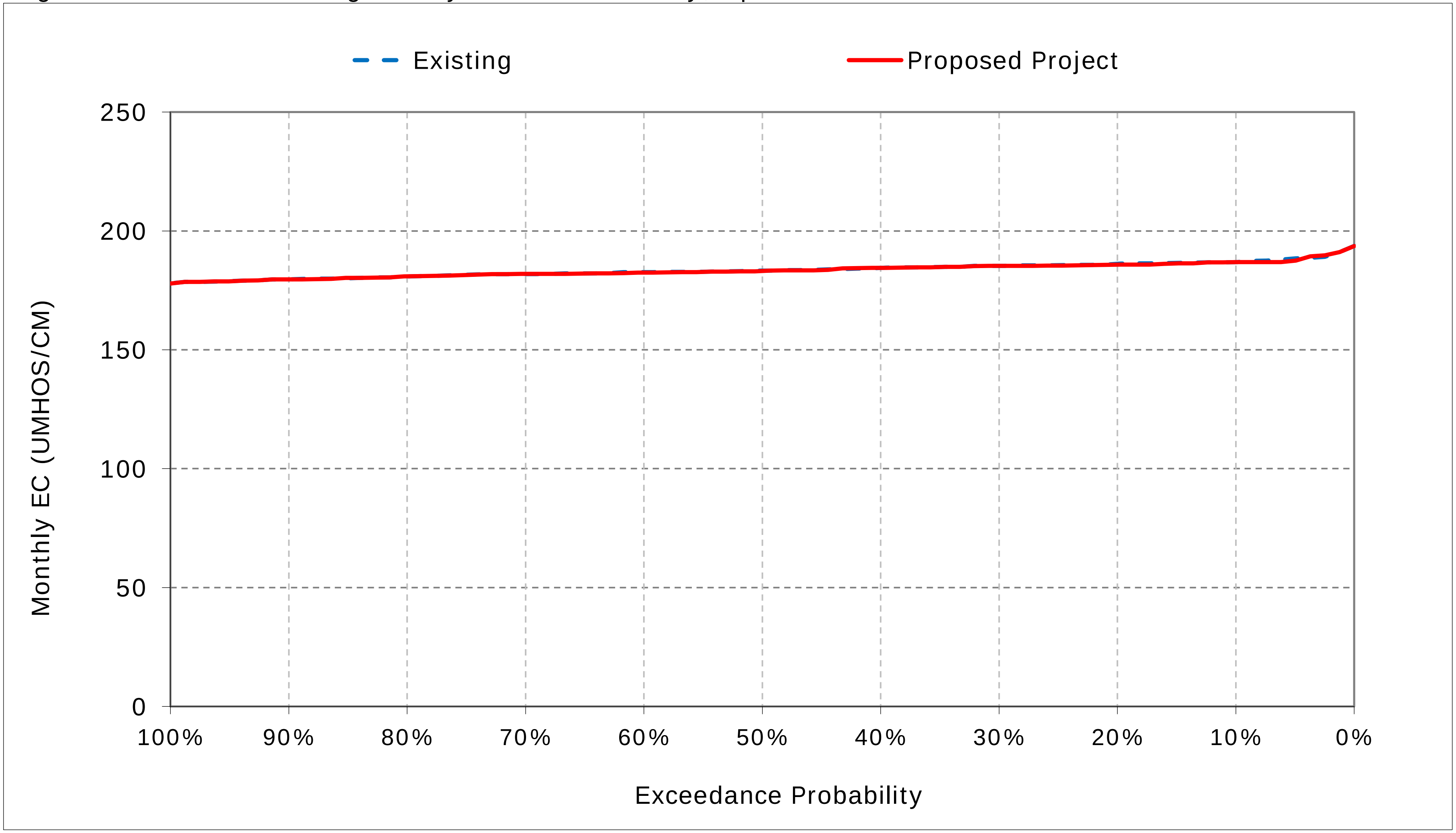


Figure 2-11. Cache Slough at Ryer Island Salinity, May EC

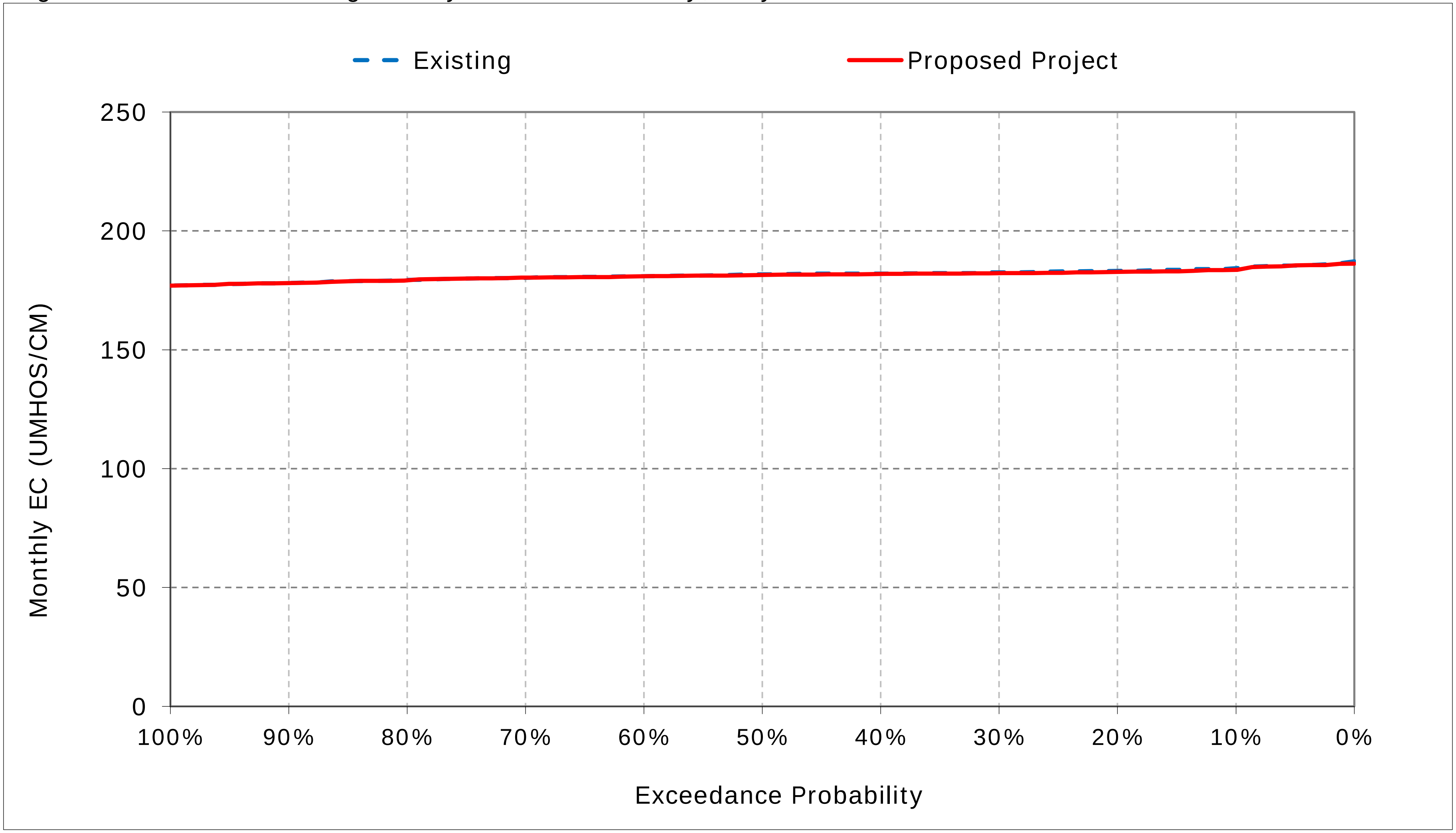


Figure 2-12. Cache Slough at Ryer Island Salinity, June EC

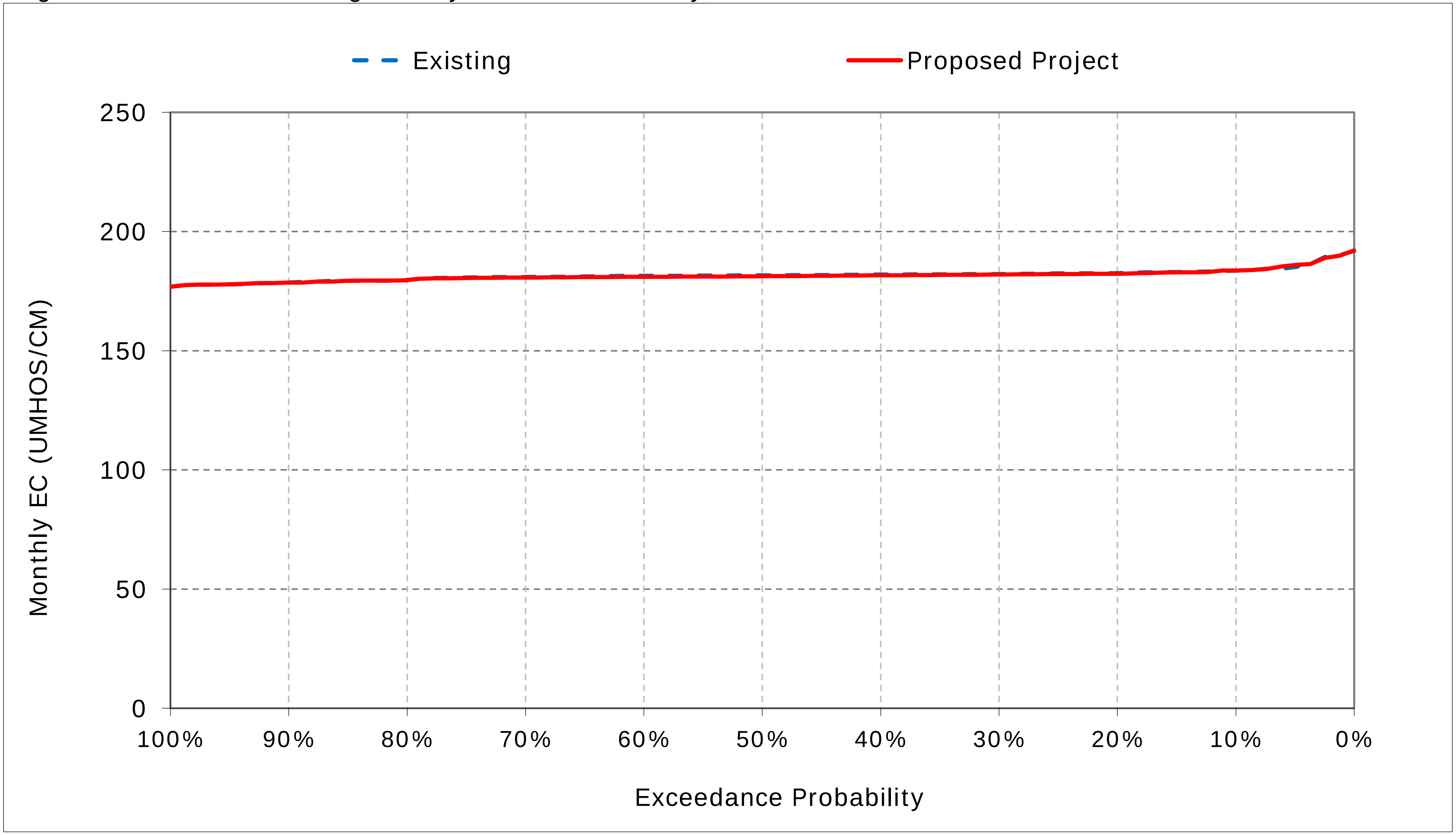


Figure 2-13. Cache Slough at Ryer Island Salinity, July EC

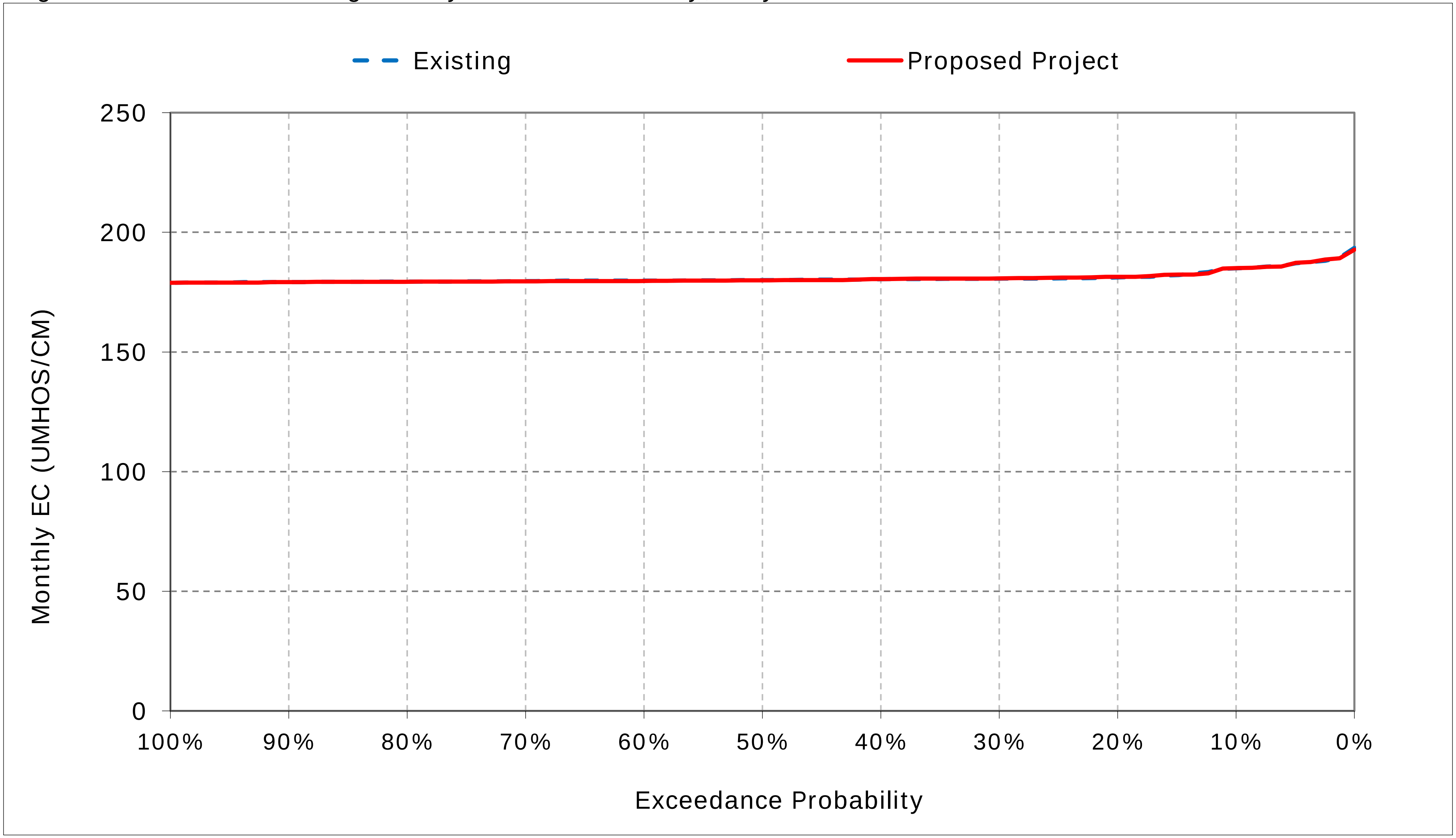


Figure 2-14. Cache Slough at Ryer Island Salinity, August EC

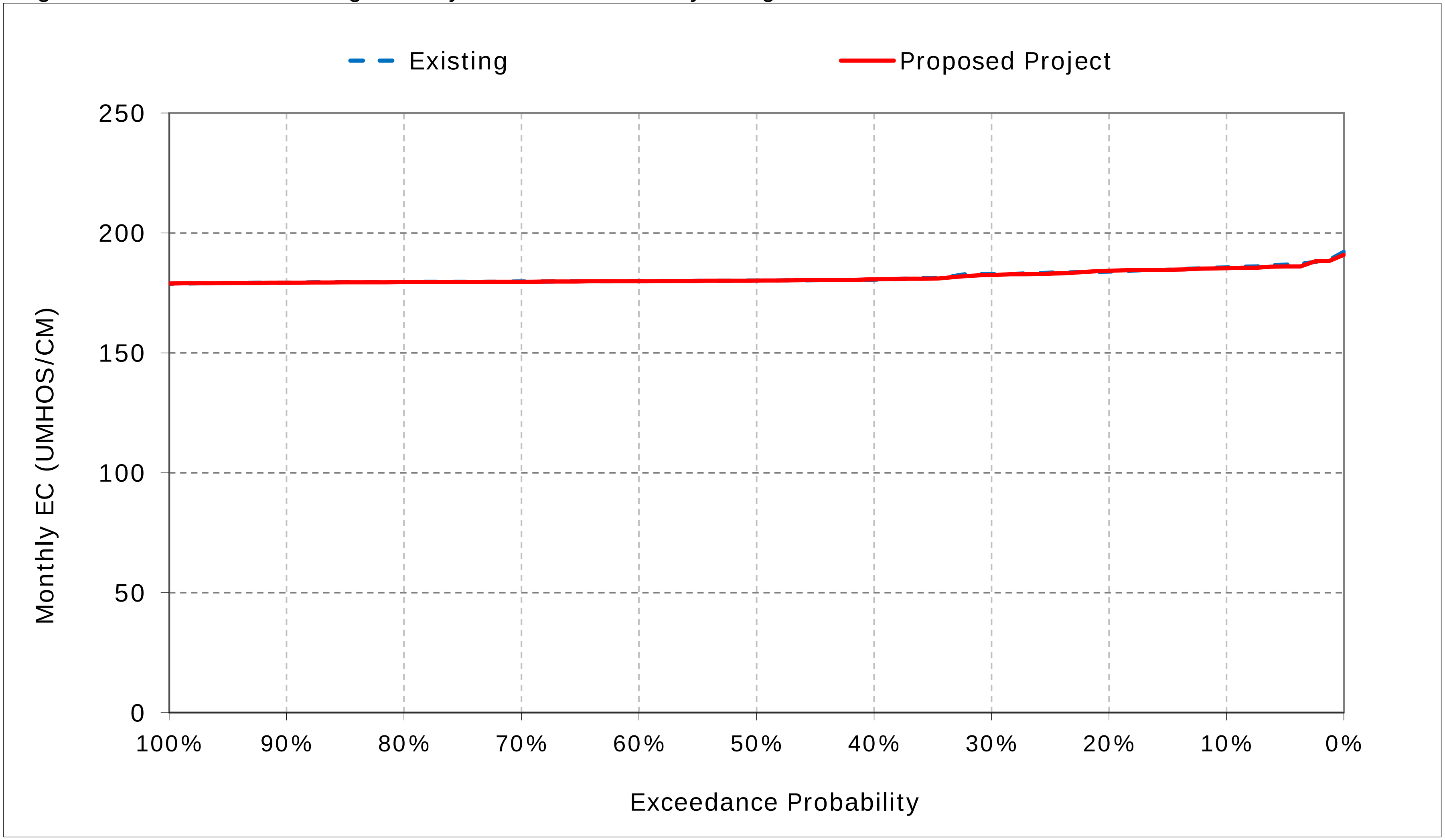


Figure 2-15. Cache Slough at Ryer Island Salinity, September EC

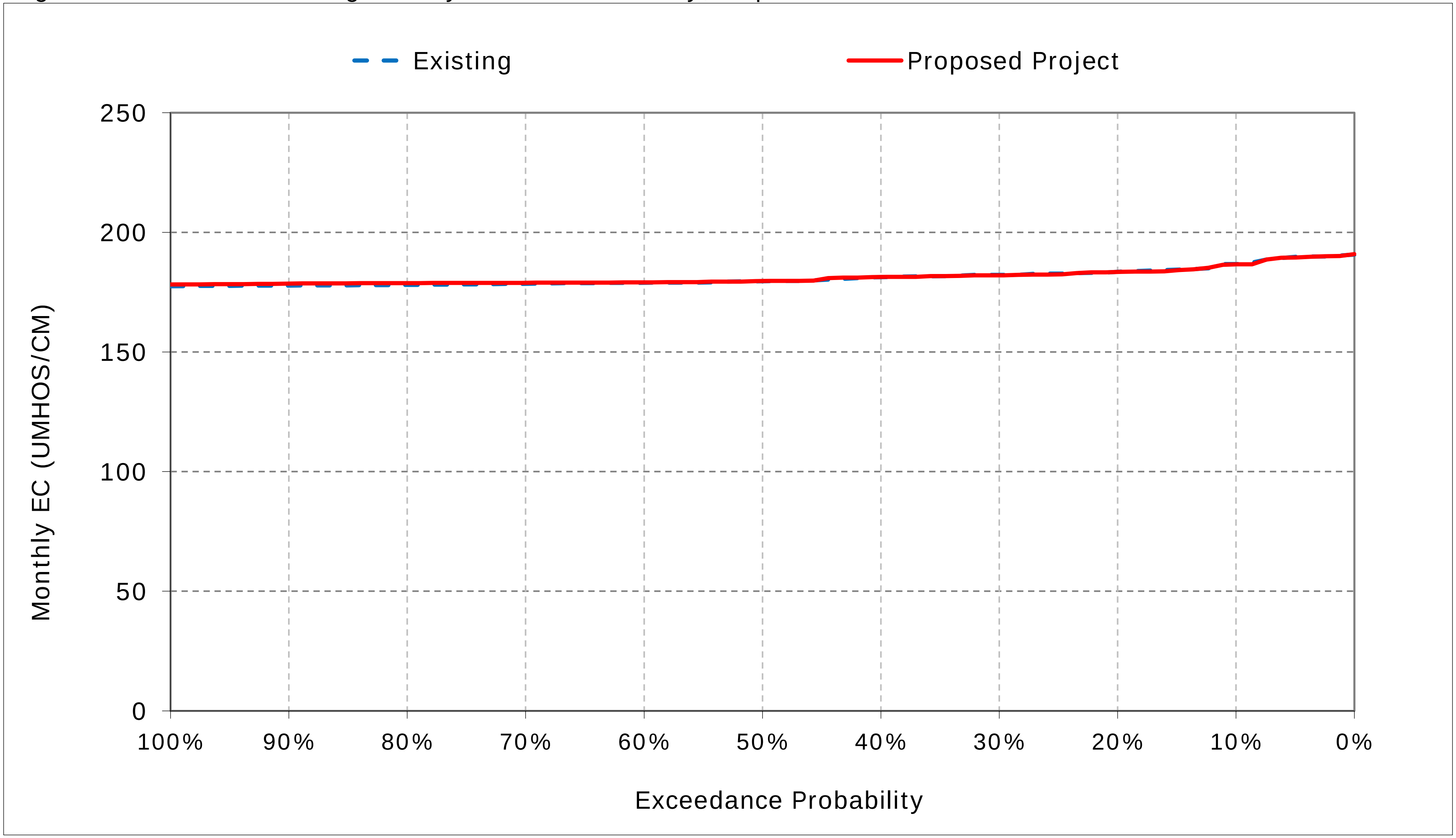


Figure 2-16. Cache Slough at Ryer Island Salinity, October EC

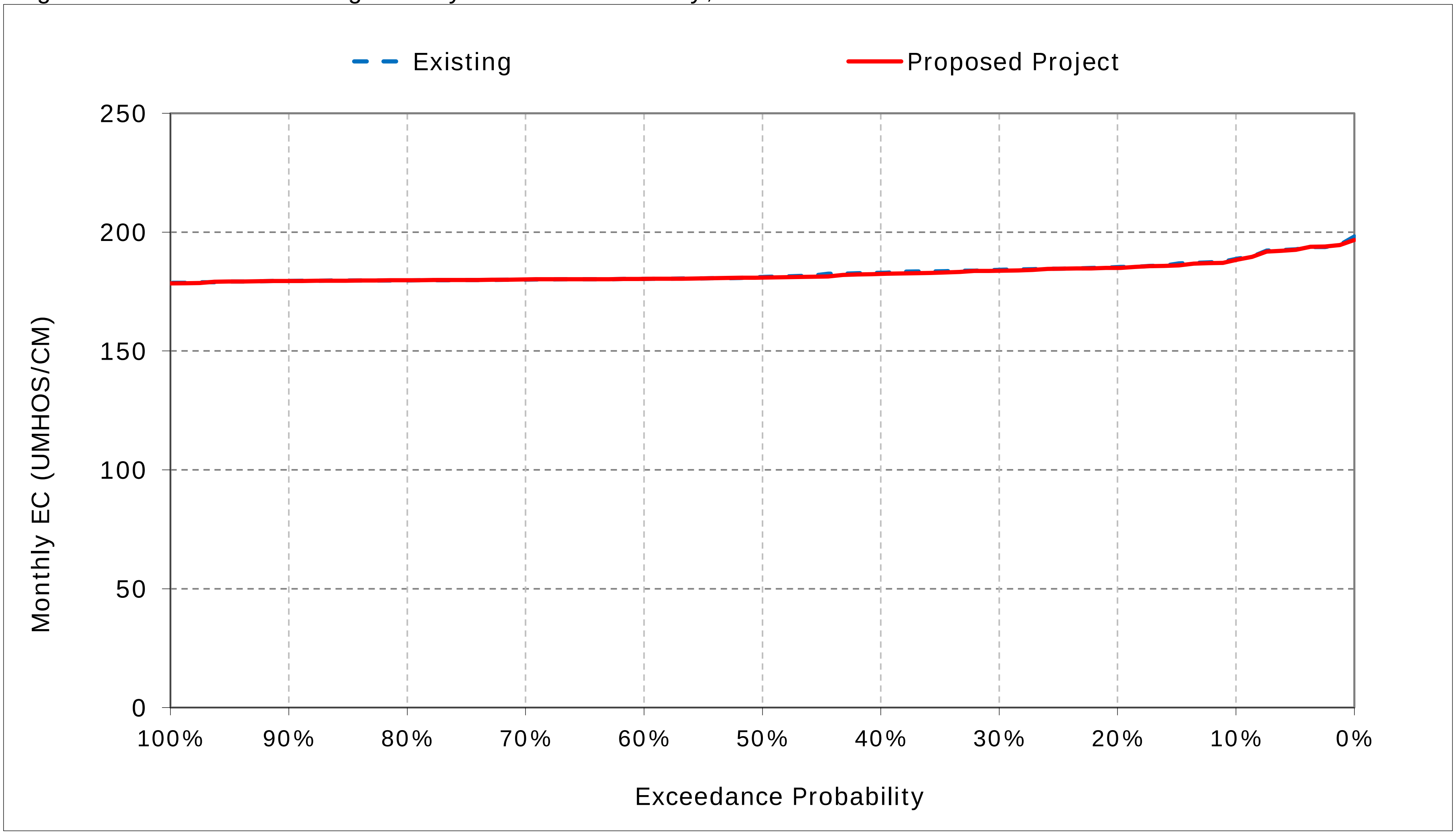


Figure 2-17. Cache Slough at Ryer Island Salinity, November EC

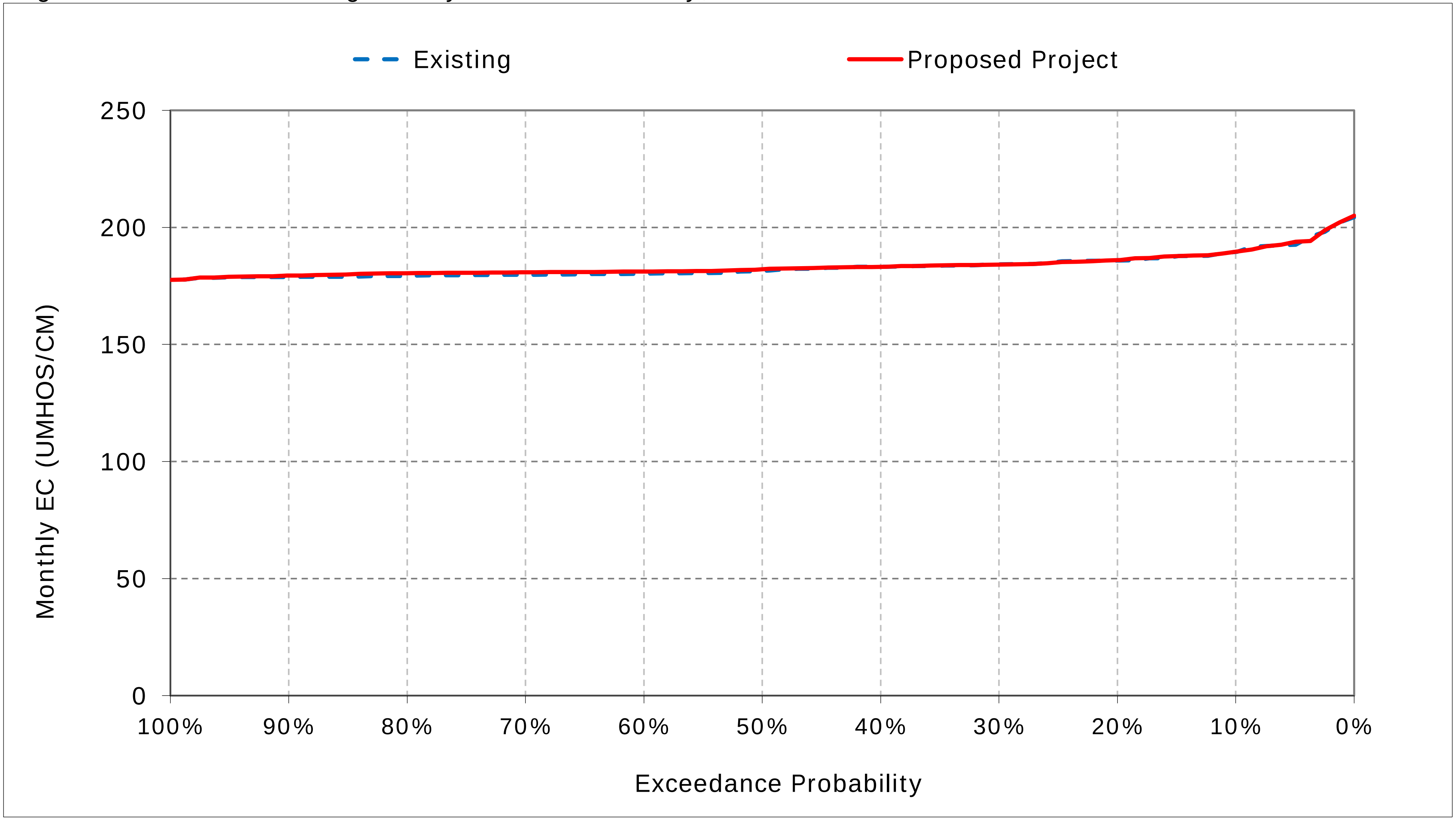


Figure 2-18. Cache Slough at Ryer Island Salinity, December EC

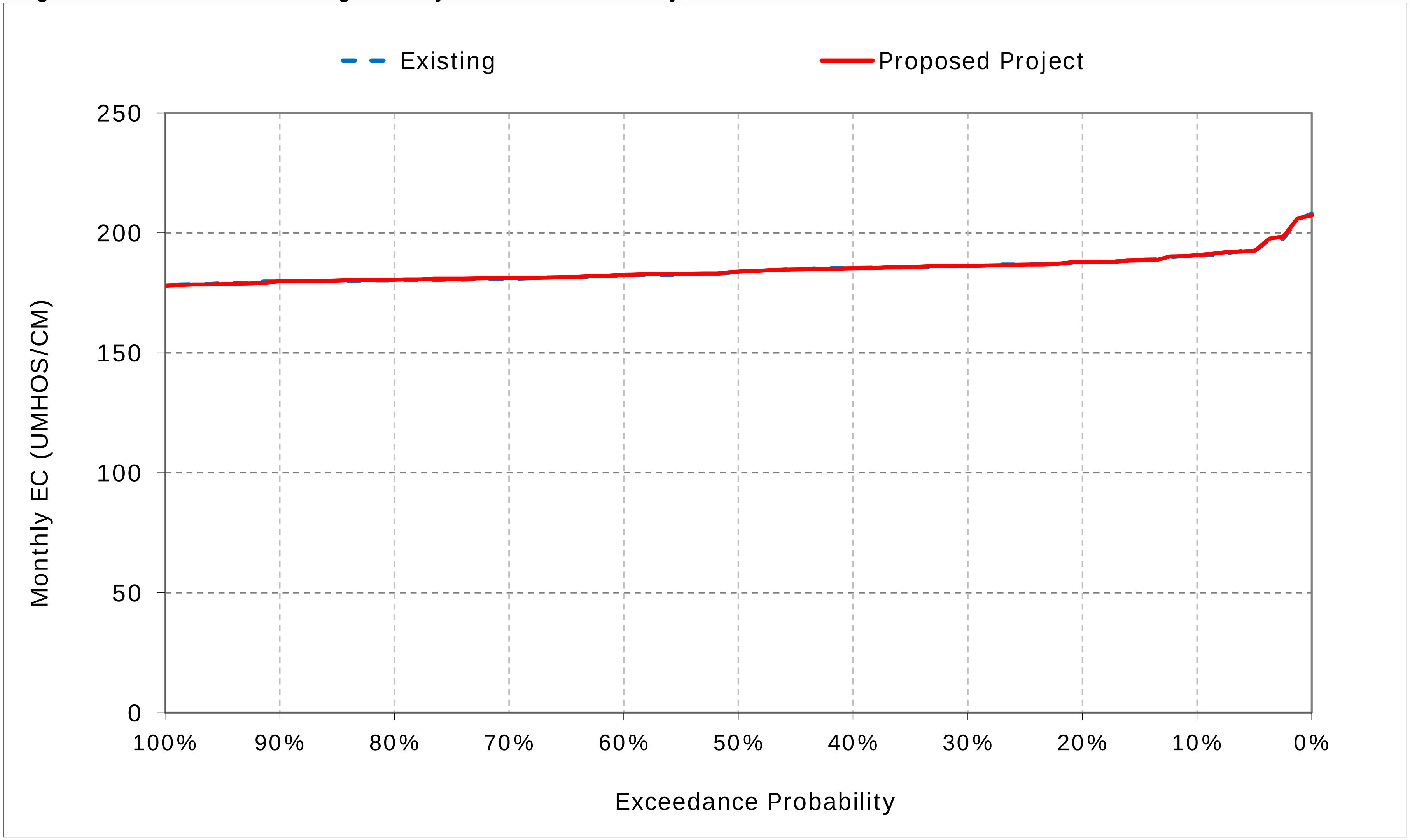


Table 3-1. Sacramento River downstream of Georgiana Slough Salinity, Monthly EC

Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	176	177	179	181	179	177	176	176	176	176	176	176
20%	176	176	178	180	178	177	176	176	176	176	176	176
30%	176	176	177	179	177	176	176	176	176	176	176	176
40%	176	176	177	179	177	176	176	176	176	176	176	176
50%	176	176	176	178	177	176	176	176	176	175	176	176
60%	176	176	176	178	177	176	176	176	176	175	176	175
70%	176	175	176	178	176	176	176	175	176	175	176	175
80%	176	175	176	177	176	176	175	175	176	175	176	175
90%	175	175	175	177	176	175	175	175	175	175	176	175
Long Term												
Full Simulation Period[a]	176	176	177	179	177	176	176	176	176	176	176	176
Water Year Types[b]												
Wet (32%)	176	176	177	178	177	176	176	175	176	175	176	175
Above Normal (15%)	176	176	177	179	177	176	176	176	176	175	176	175
Below Normal (17%)	176	176	177	179	177	176	176	176	176	175	176	176
Dry (22%)	176	176	177	179	177	176	176	176	176	176	176	176
Critical (15%)	176	176	176	179	177	177	176	176	176	176	176	176

Proposed Project

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	176	177	178	181	179	177	176	176	176	176	176	176
20%	176	176	178	180	178	177	176	176	176	176	176	176
30%	176	176	177	179	177	176	176	176	176	176	176	176
40%	176	176	177	179	177	176	176	176	176	176	176	176
50%	176	176	176	178	177	176	176	176	176	176	176	176
60%	176	176	176	178	177	176	176	176	176	175	176	175
70%	176	176	176	178	176	176	176	175	176	175	176	175
80%	175	175	176	177	176	176	175	175	176	175	176	175
90%	175	175	175	177	176	175	175	175	175	175	176	175
Long Term												
Full Simulation Period[a]	176	176	177	178	177	176	176	176	176	176	176	176
Water Year Types[b]												
Wet (32%)	176	176	177	178	177	176	176	175	176	175	176	175
Above Normal (15%)	176	176	177	178	177	176	176	176	176	175	176	175
Below Normal (17%)	176	176	177	179	177	176	176	176	176	175	176	176
Dry (22%)	176	176	177	179	177	176	176	176	176	176	176	176
Critical (15%)	176	176	176	179	177	177	176	176	176	176	176	176

Proposed Project minus Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	0	0	0	0	0	0	0	0	0	0	0	0
20%	0	0	0	0	0	0	0	0	0	0	0	0
30%	0	0	0	0	0	0	0	0	0	0	0	0
40%	0	0	0	0	0	0	0	0	0	0	0	0
50%	0	0	0	0	0	0	0	0	0	0	0	0
60%	0	0	0	0	0	0	0	0	0	0	0	0
70%	0	0	0	0	0	0	0	0	0	0	0	0
80%	0	0	0	0	0	0	0	0	0	0	0	0
90%	0	0	0	0	0	0	0	0	0	0	0	0
Long Term												
Full Simulation Period[a]	0	0	0	0	0	0	0	0	0	0	0	0
Water Year Types[b]												
Wet (32%)	0	0	0	0	0	0	0	0	0	0	0	0
Above Normal (15%)	0	0	0	0	0	0	0	0	0	0	0	0
Below Normal (17%)	0	0	0	0	0	0	0	0	0	0	0	0
Dry (22%)	0	0	0	0	0	0	0	0	0	0	0	0
Critical (15%)	0	0	0	0	0	0	0	0	0	0	0	0

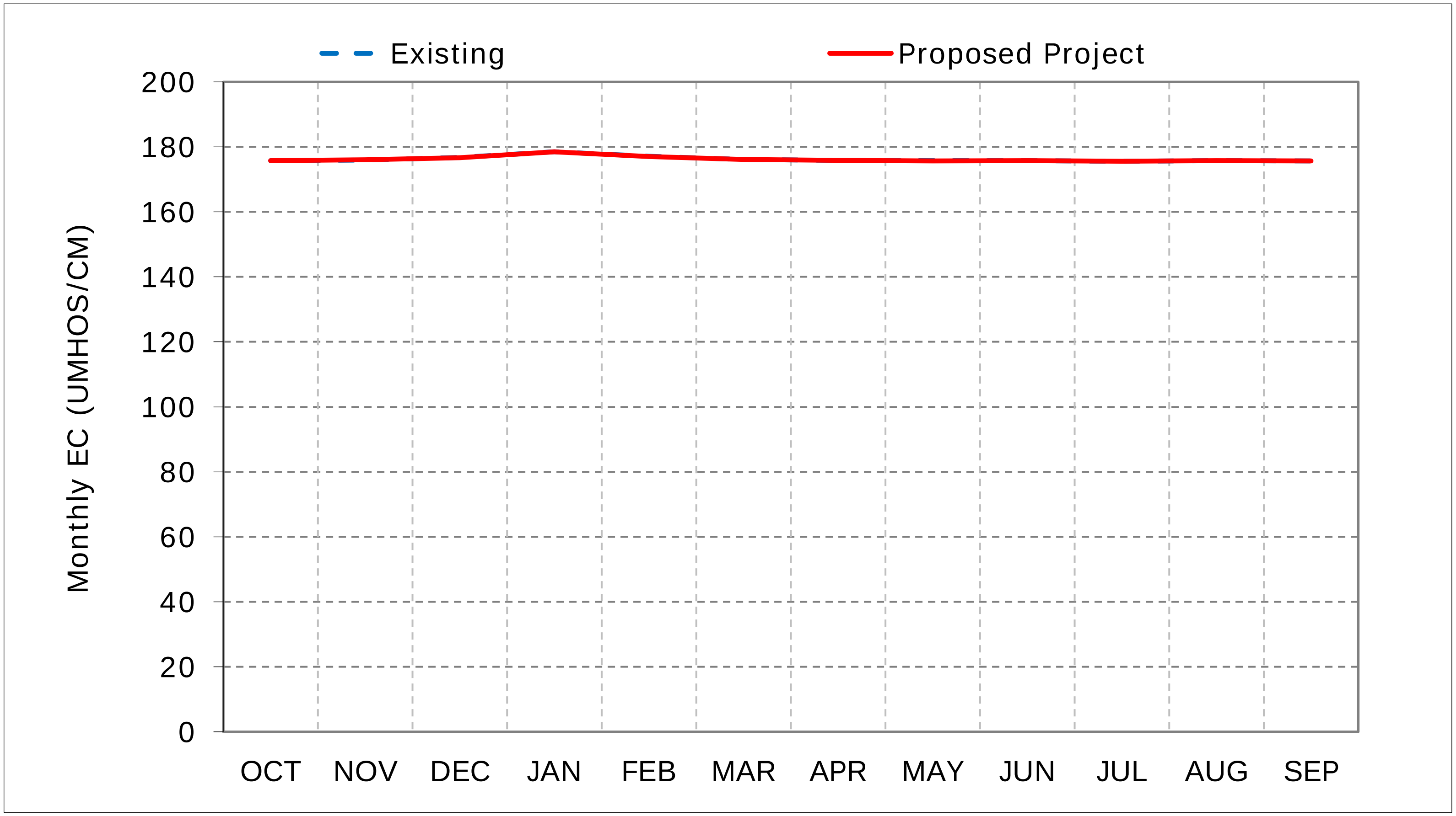
a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

c These results are displayed with water year - year type sorting.

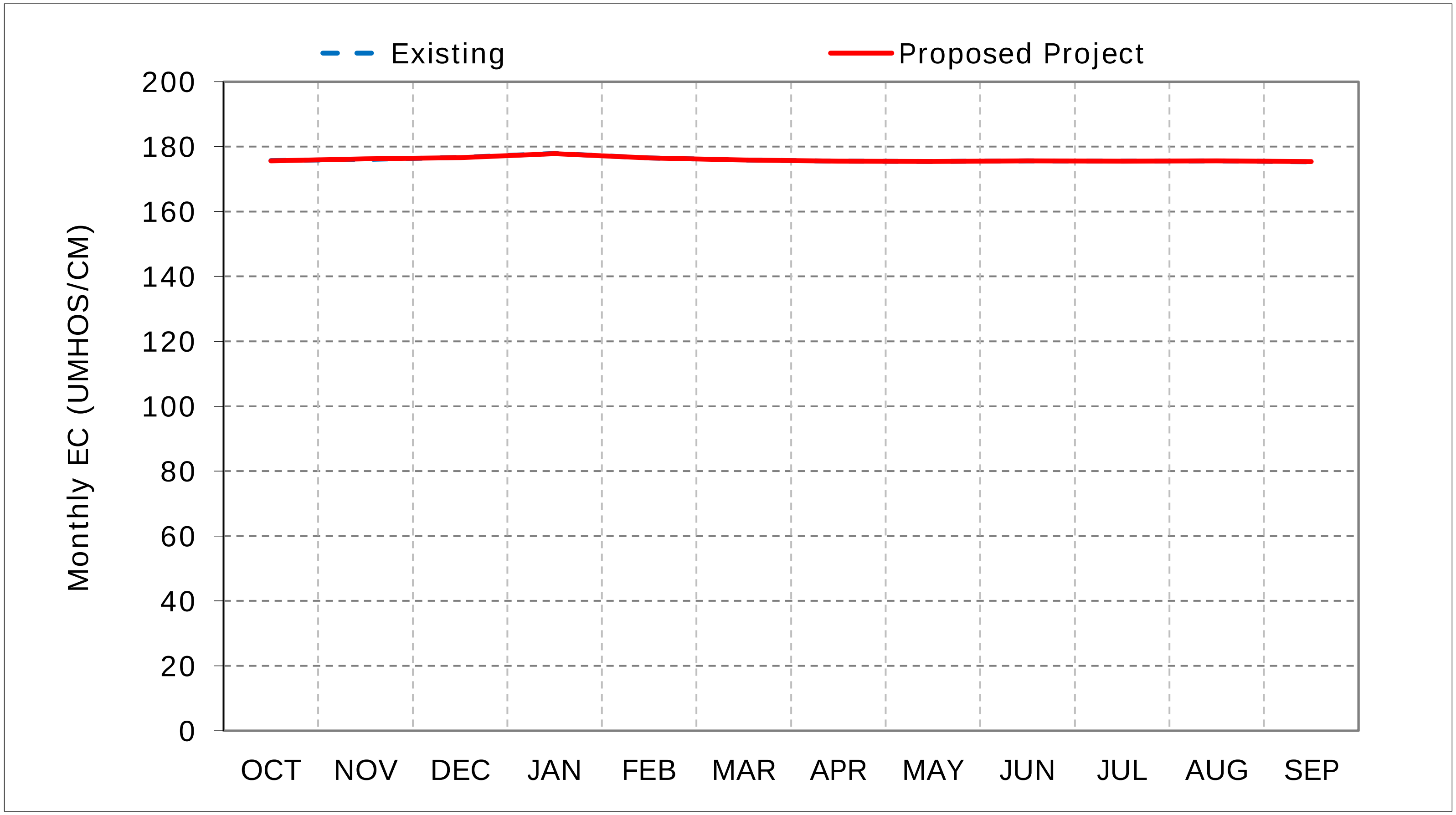
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 3-1. Sacramento River downstream of Georgiana Slough Salinity, Long-Ter



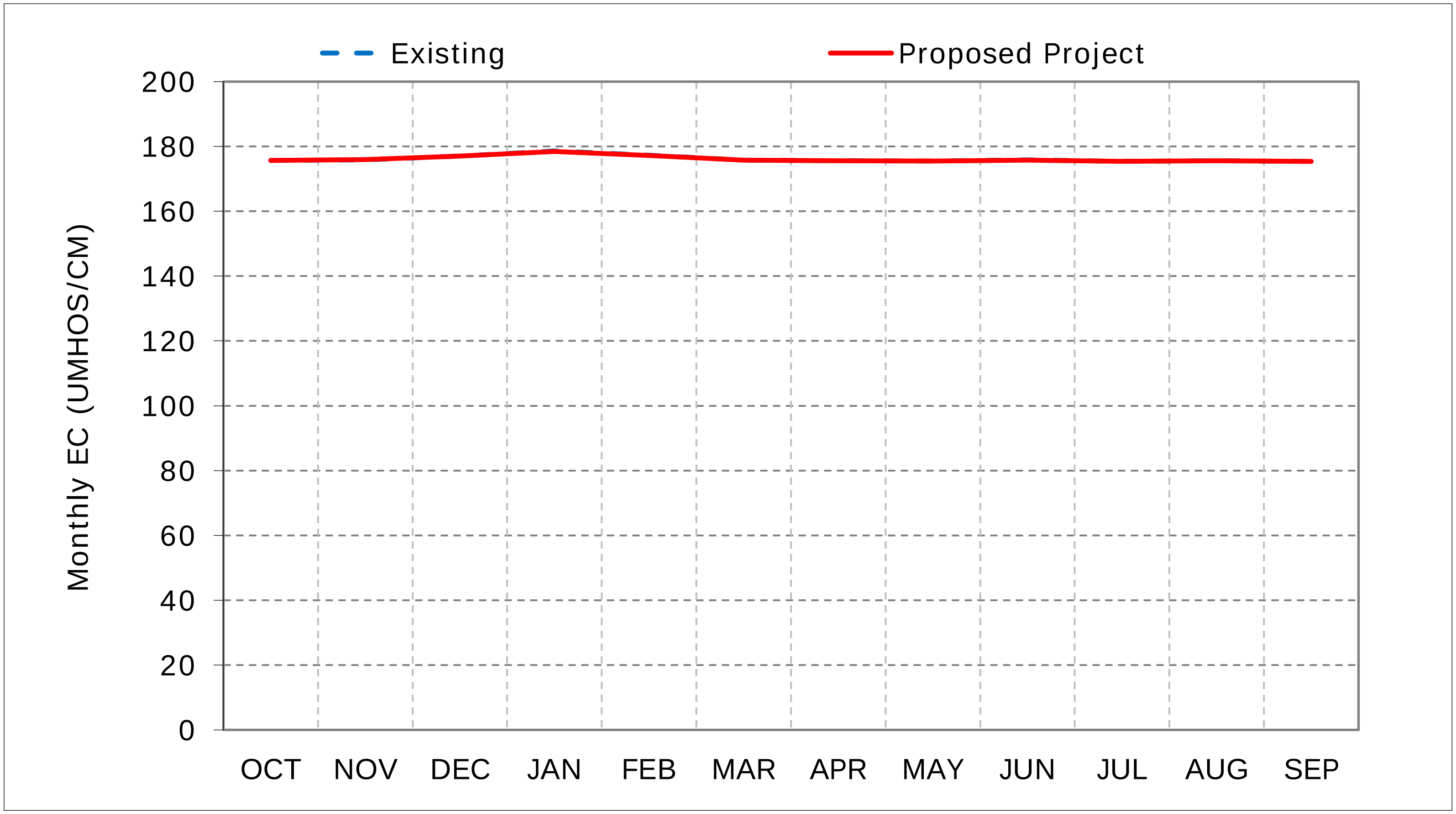
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 3-2. Sacramento River downstream of Georgiana Slough Salinity, Wet Year



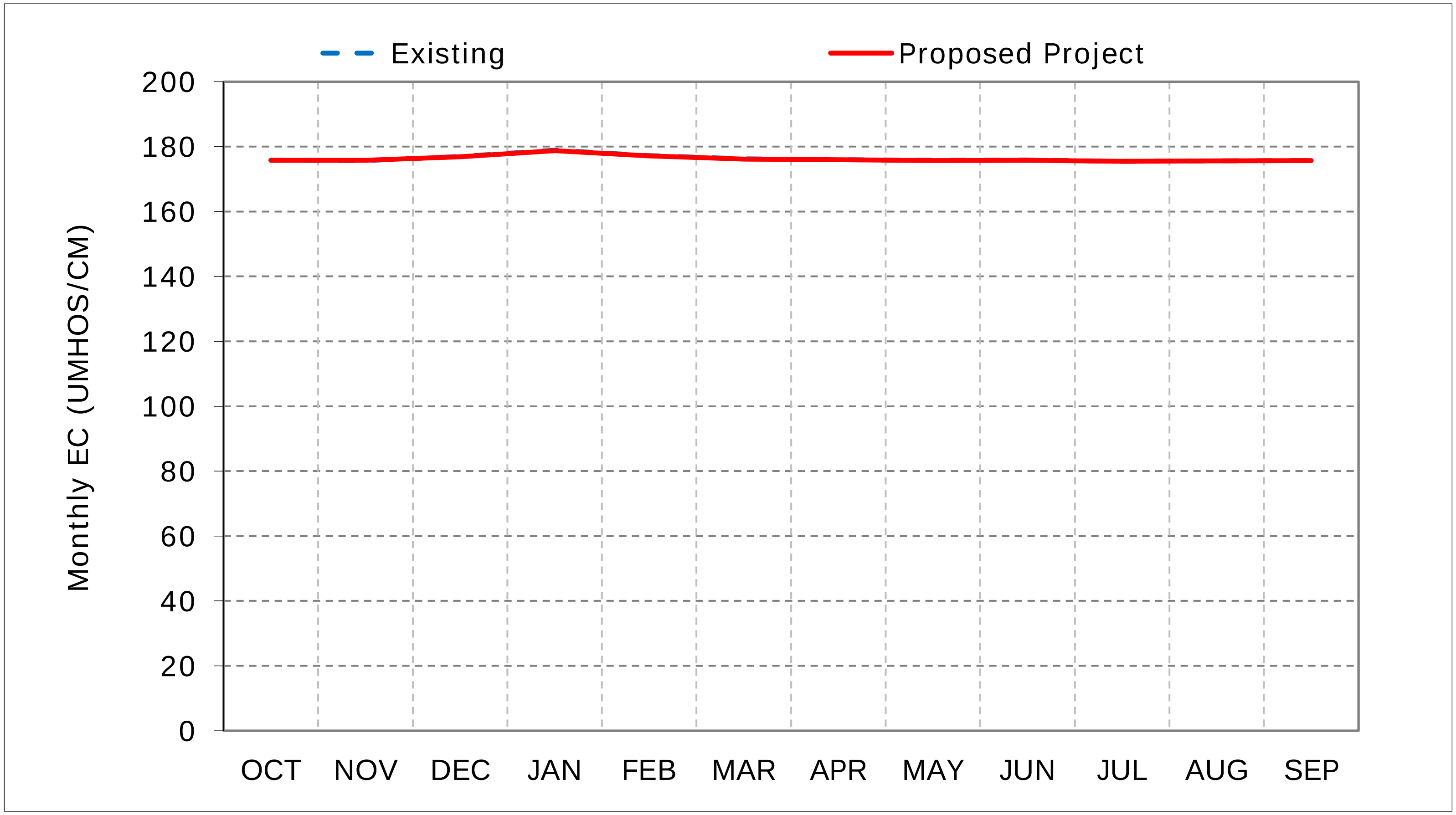
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 3-3. Sacramento River downstream of Georgiana Slough Salinity, Above No



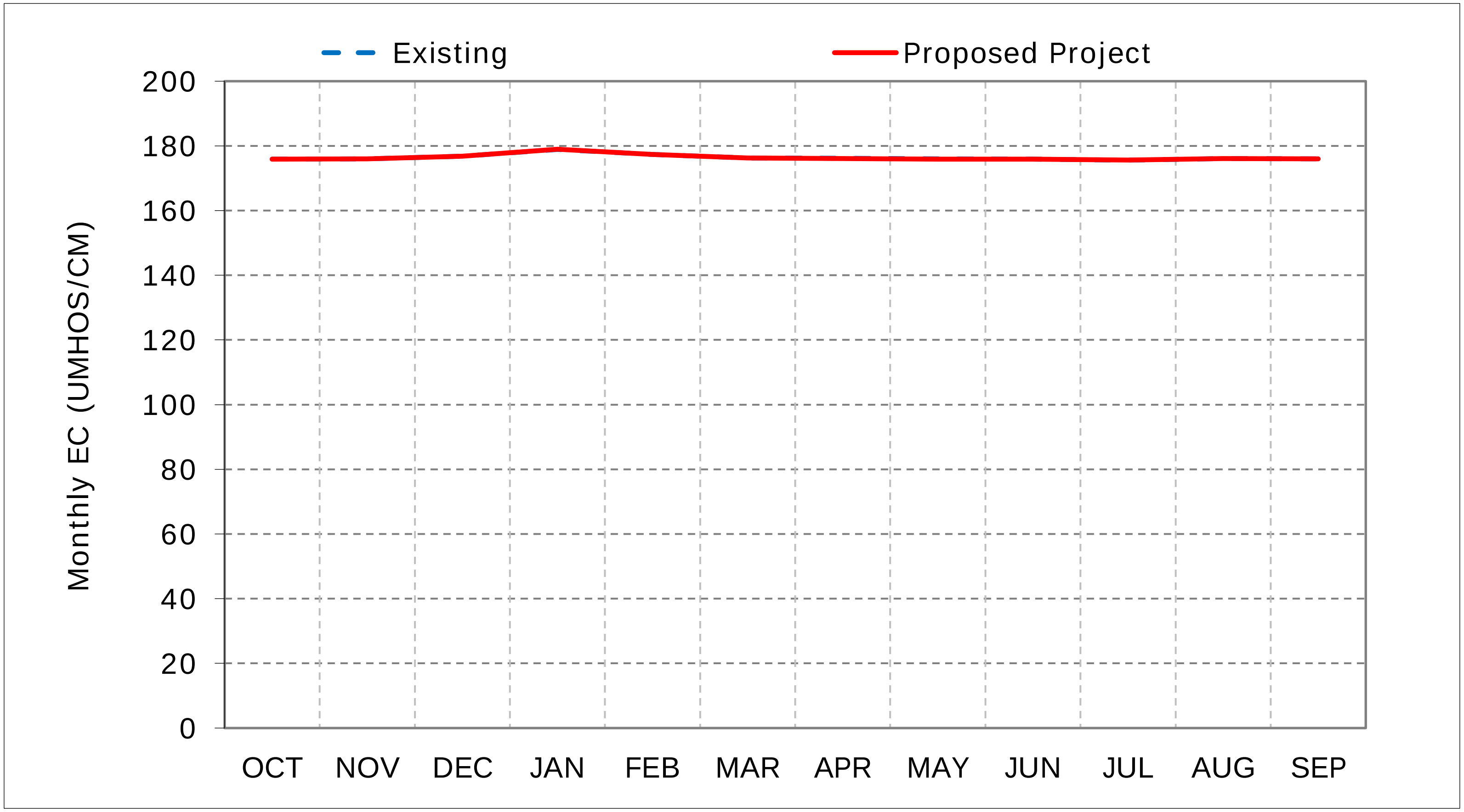
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 3-4. Sacramento River downstream of Georgiana Slough Salinity, Below No



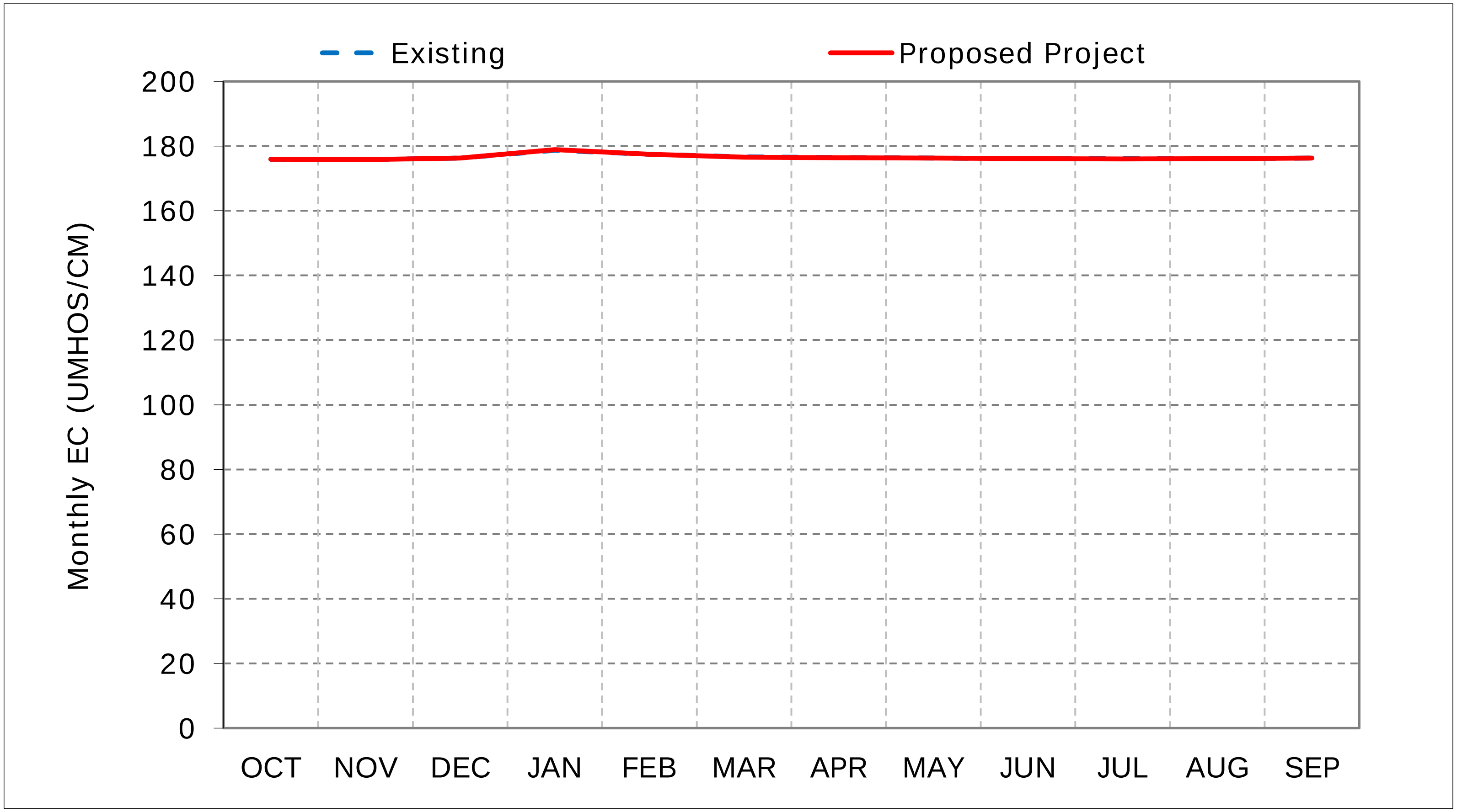
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 3-5. Sacramento River downstream of Georgiana Slough Salinity, Dry Year



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 3-6. Sacramento River downstream of Georgiana Slough Salinity, Critical Y



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 3-7. Sacramento River downstream of Georgiana Slough Salinity, January EC

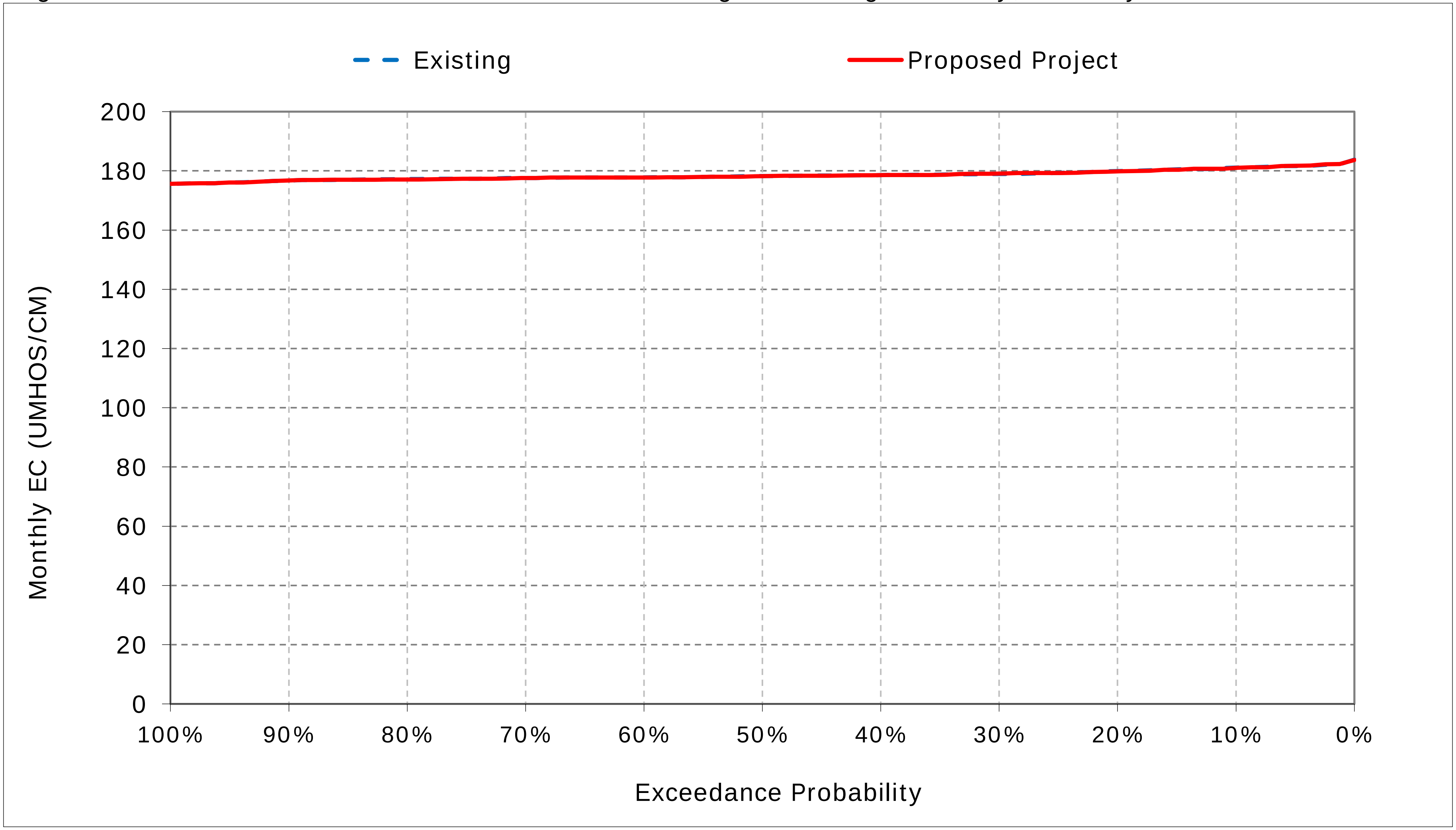


Figure 3-8. Sacramento River downstream of Georgiana Slough Salinity, February EC

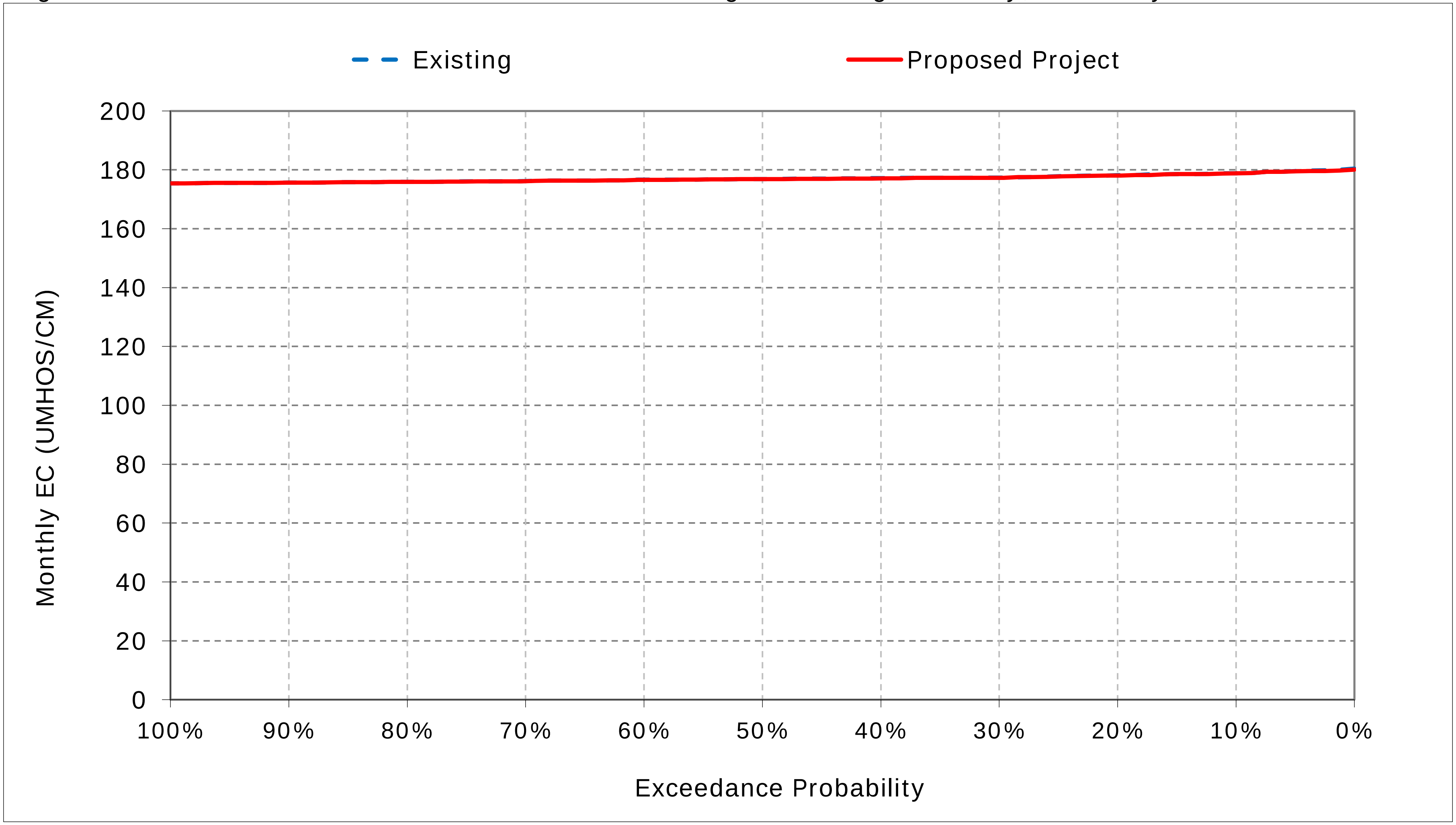


Figure 3-9. Sacramento River downstream of Georgiana Slough Salinity, March EC

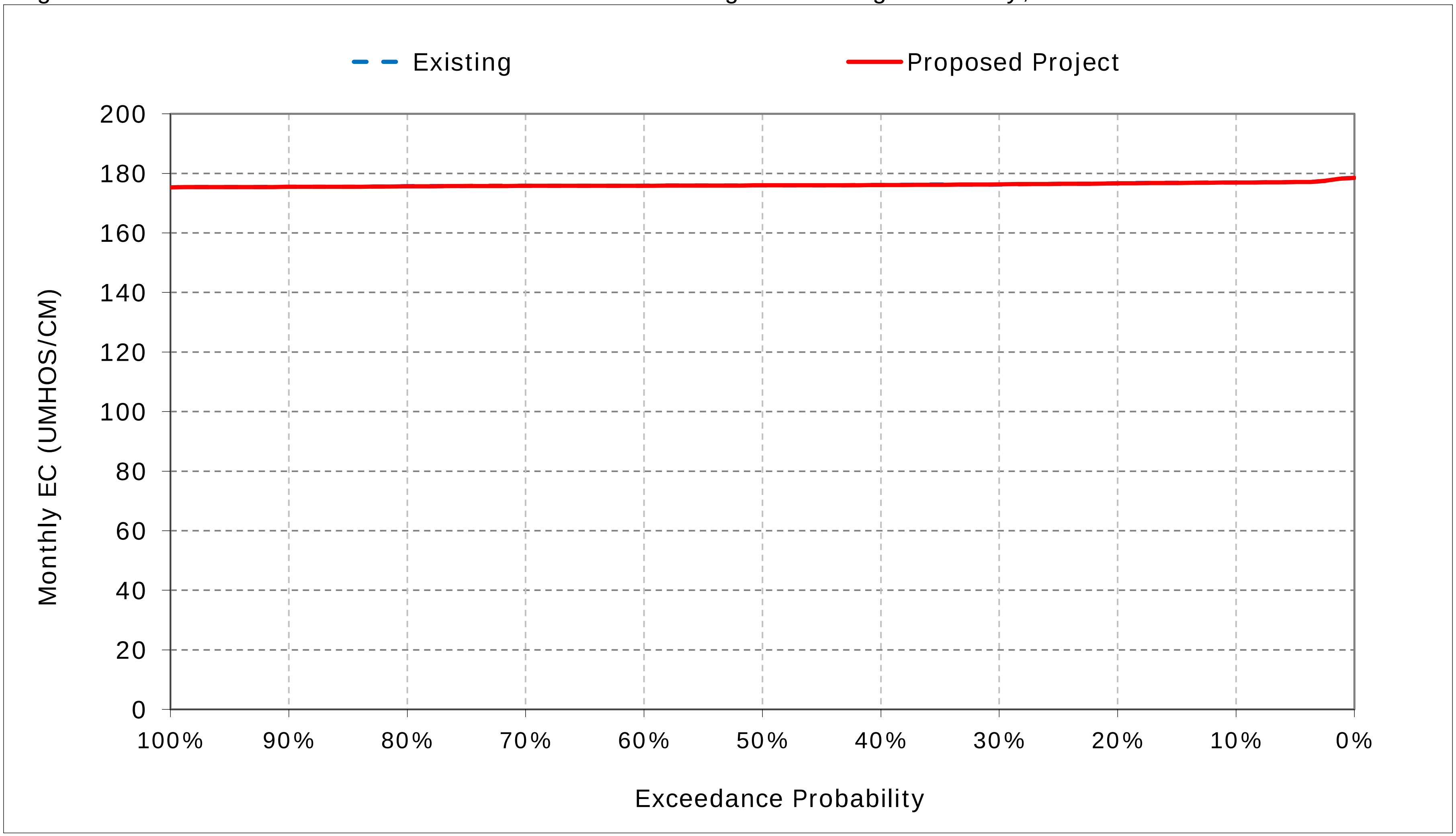


Figure 3-10. Sacramento River downstream of Georgiana Slough Salinity, April EC

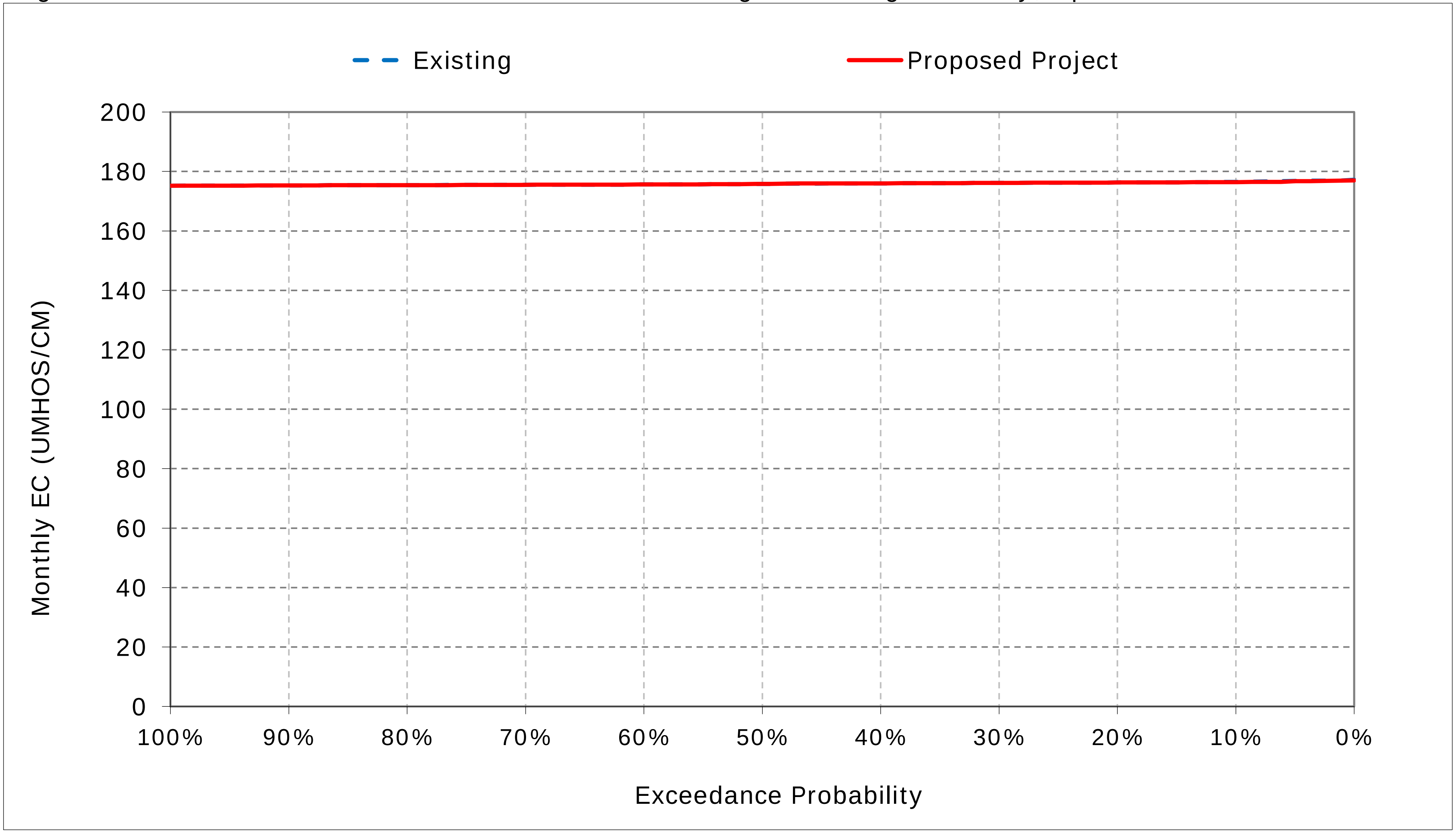


Figure 3-11. Sacramento River downstream of Georgiana Slough Salinity, May EC

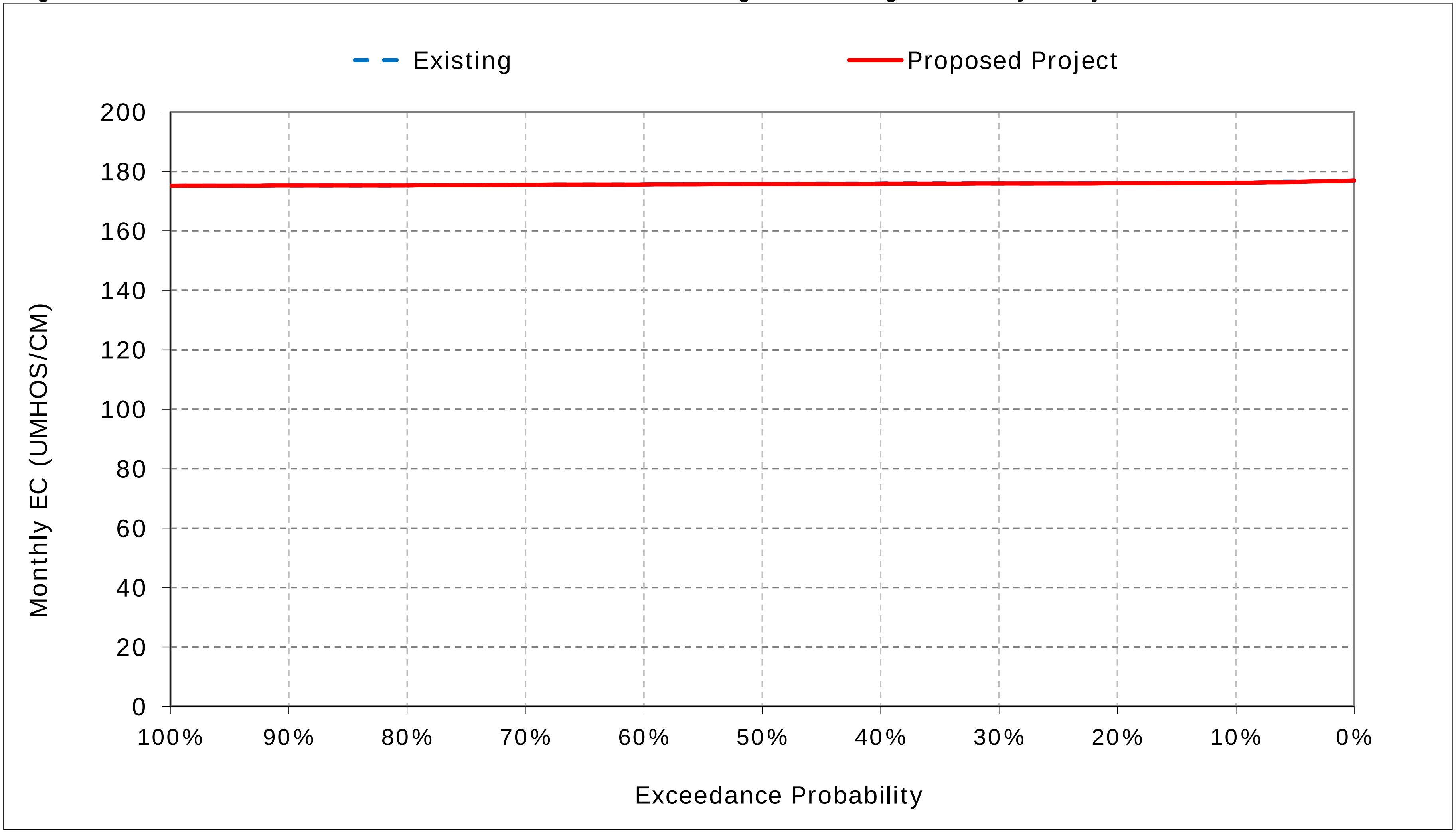


Figure 3-12. Sacramento River downstream of Georgiana Slough Salinity, June EC

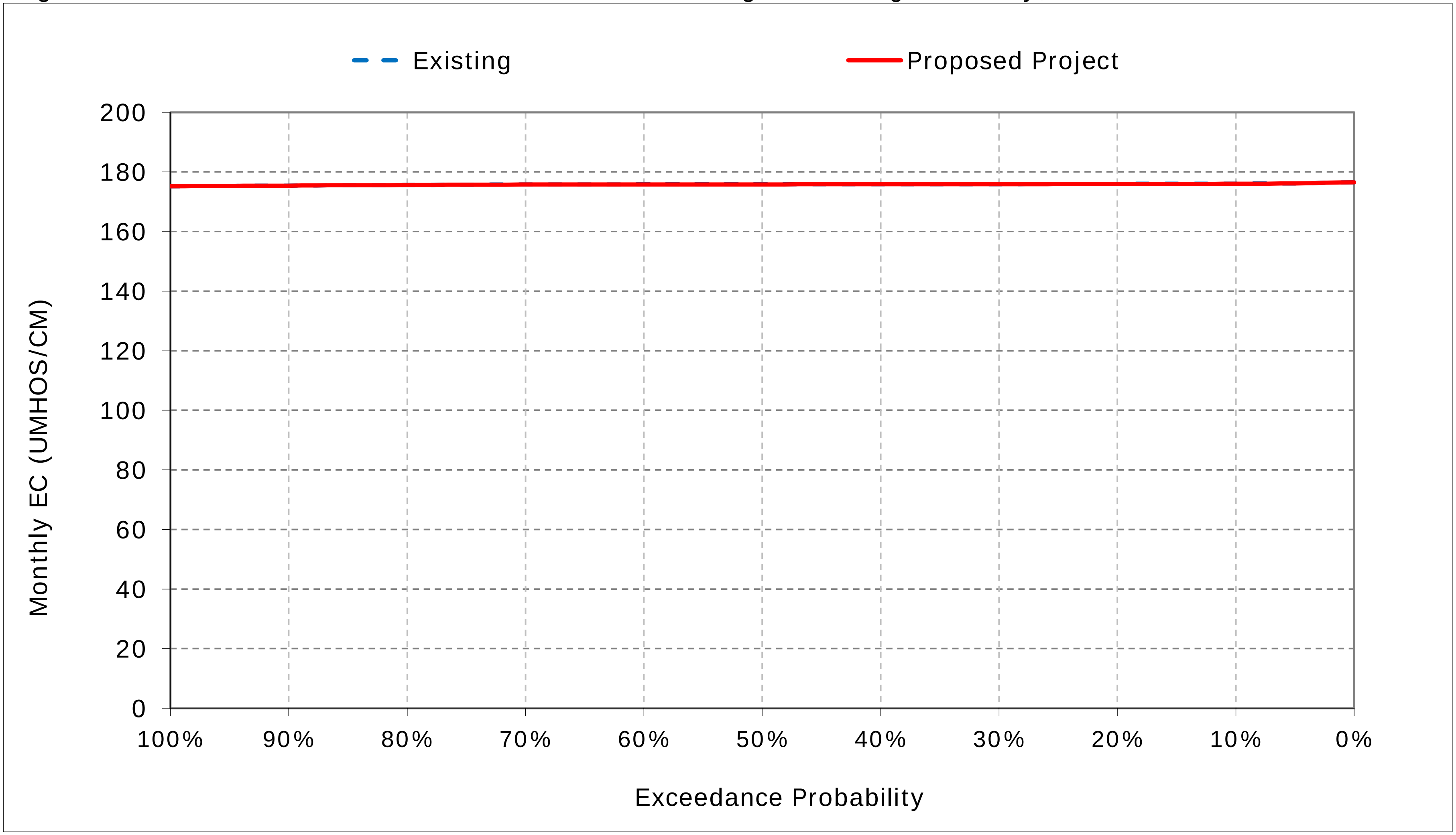


Figure 3-13. Sacramento River downstream of Georgiana Slough Salinity, July EC

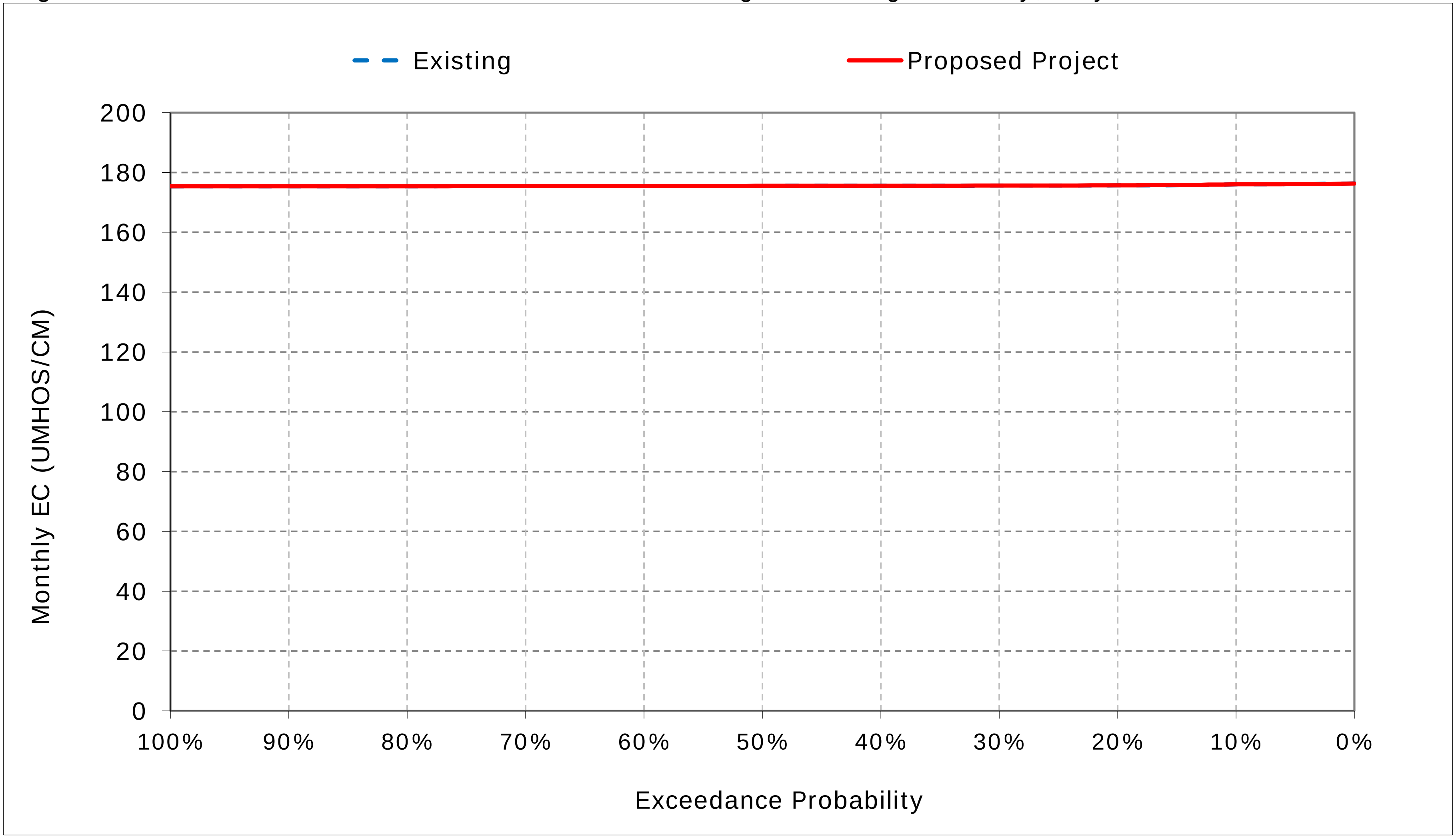


Figure 3-14. Sacramento River downstream of Georgiana Slough Salinity, August EC

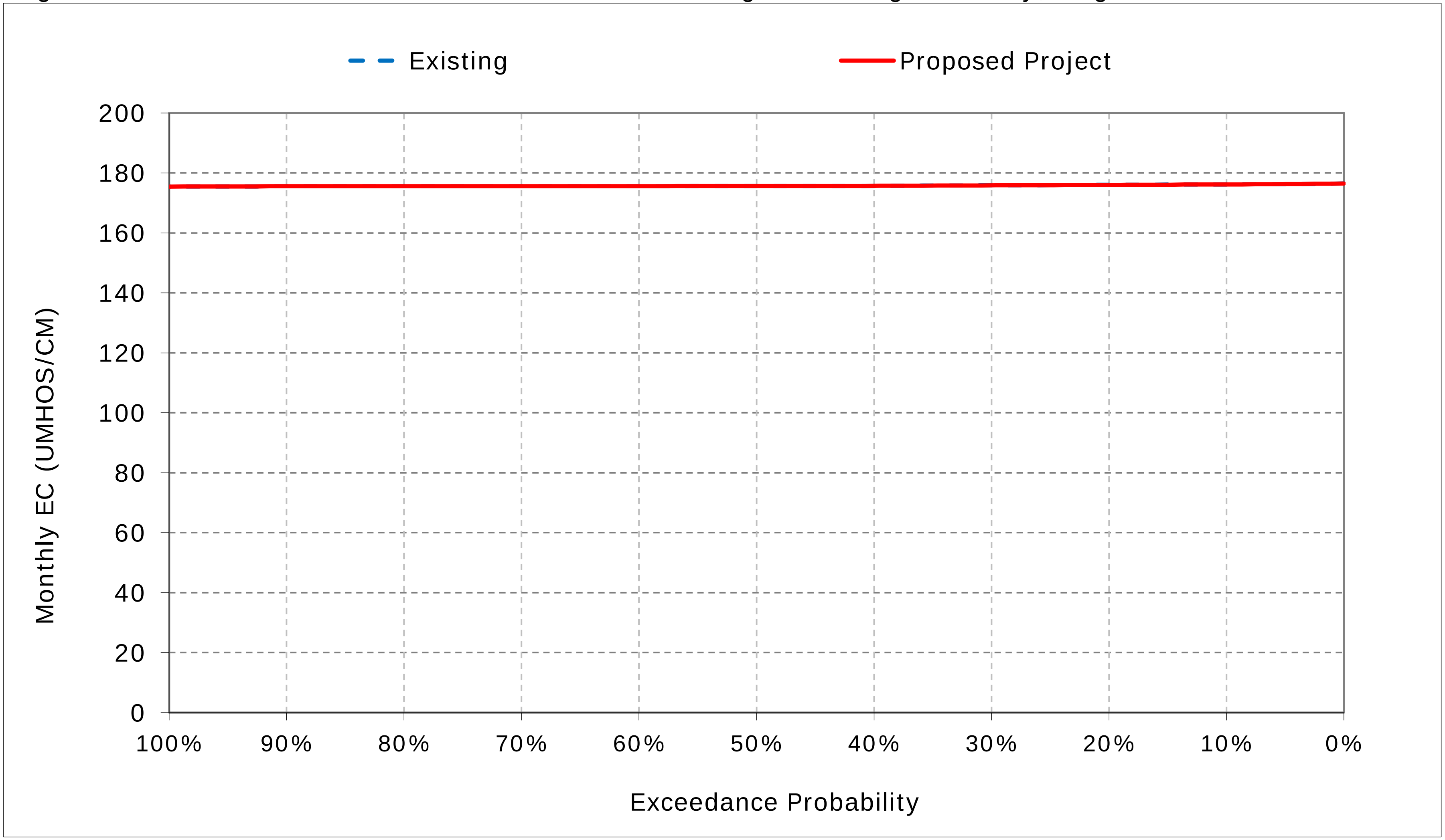


Figure 3-15. Sacramento River downstream of Georgiana Slough Salinity, September EC

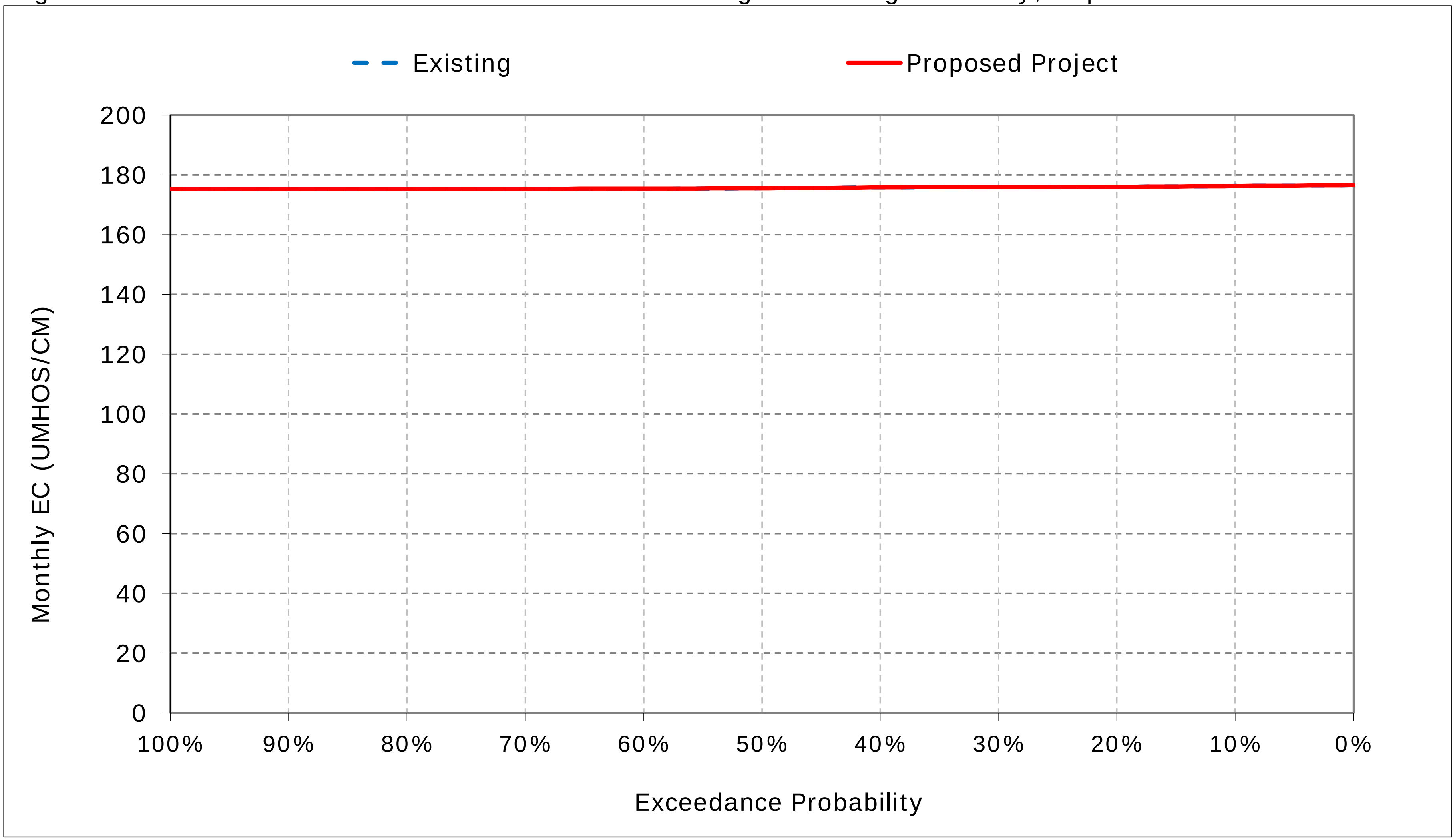


Figure 3-16. Sacramento River downstream of Georgiana Slough Salinity, October EC

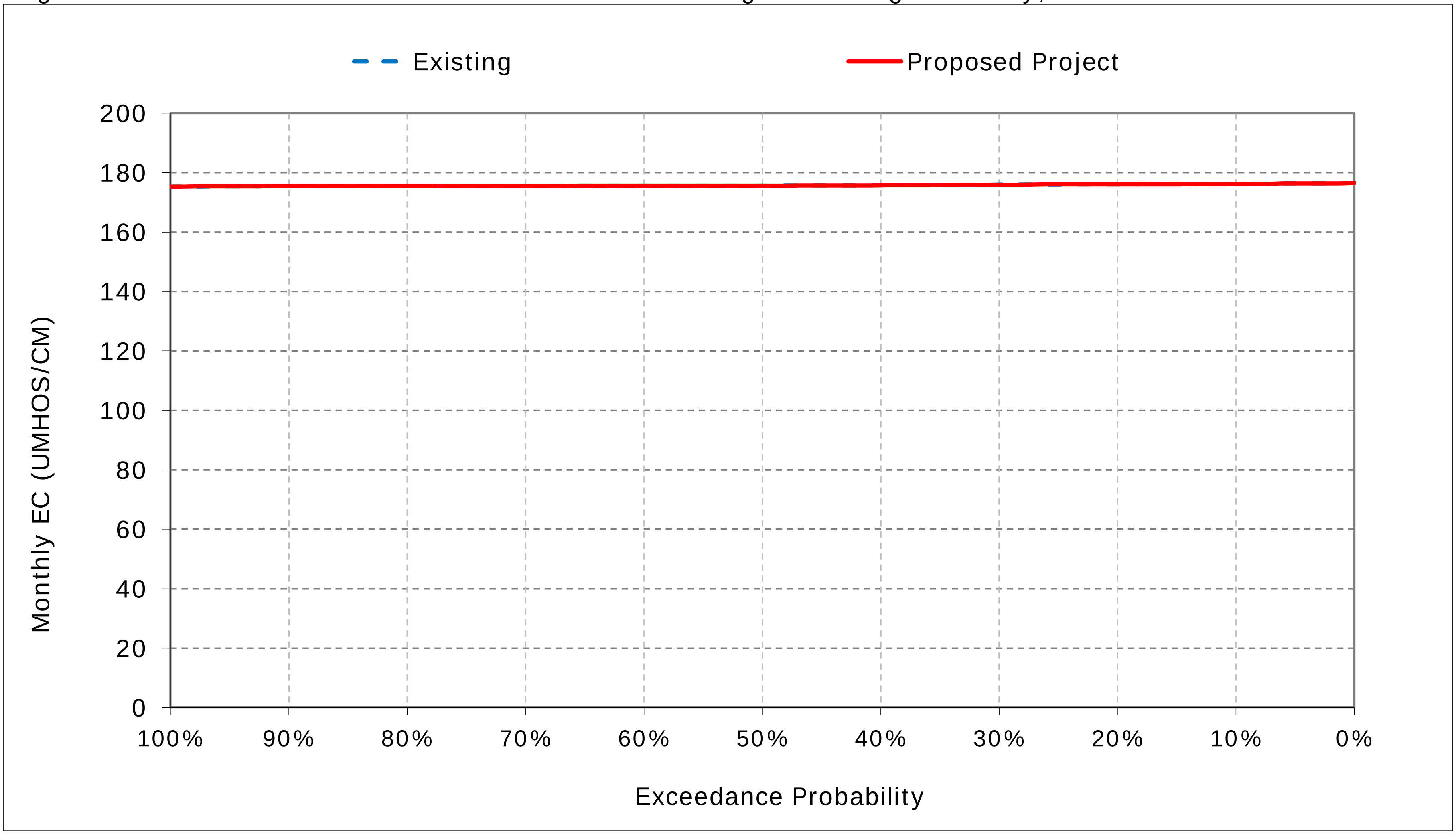


Figure 3-17. Sacramento River downstream of Georgiana Slough Salinity, November EC

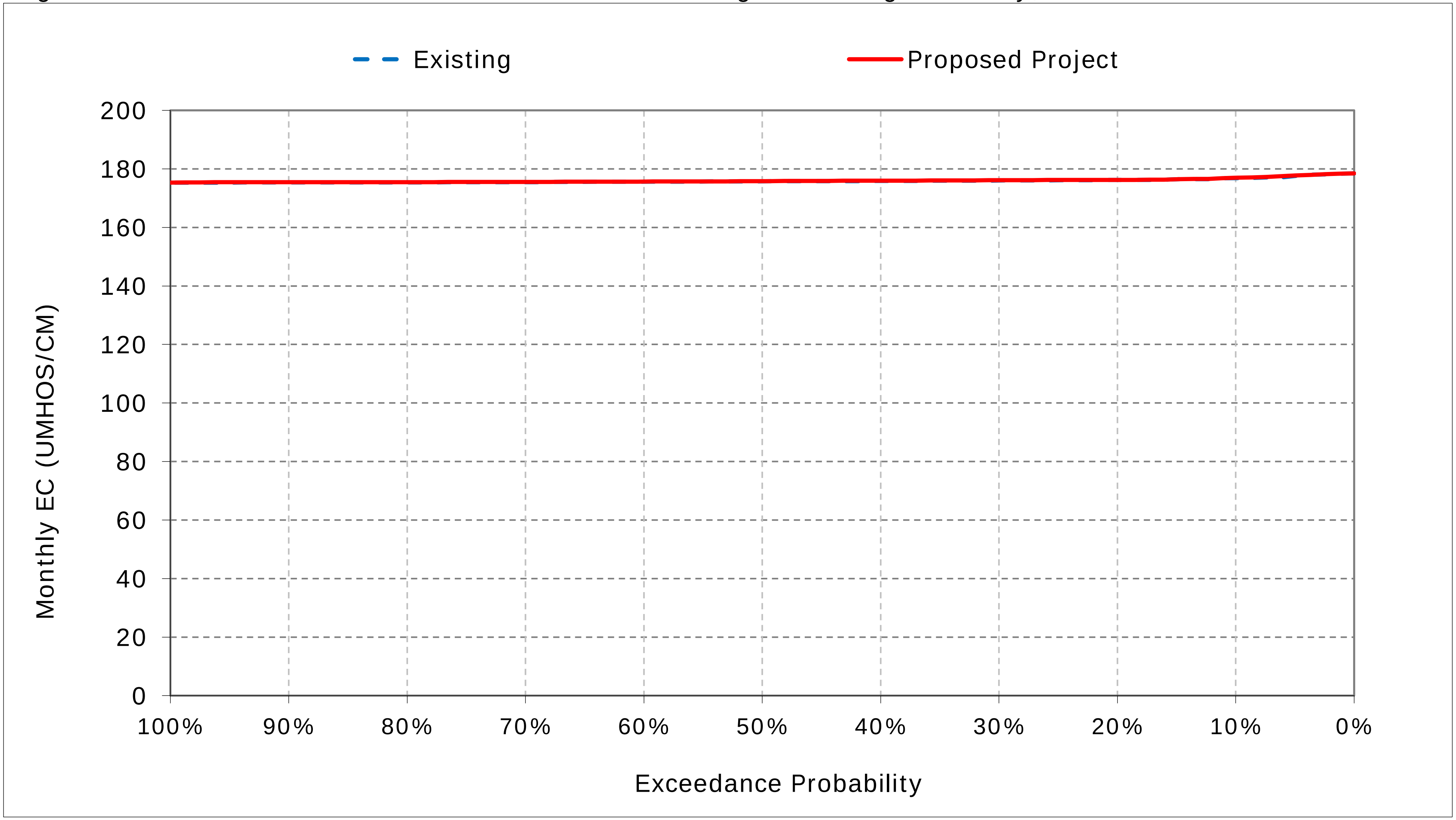


Figure 3-18. Sacramento River downstream of Georgiana Slough Salinity, December EC

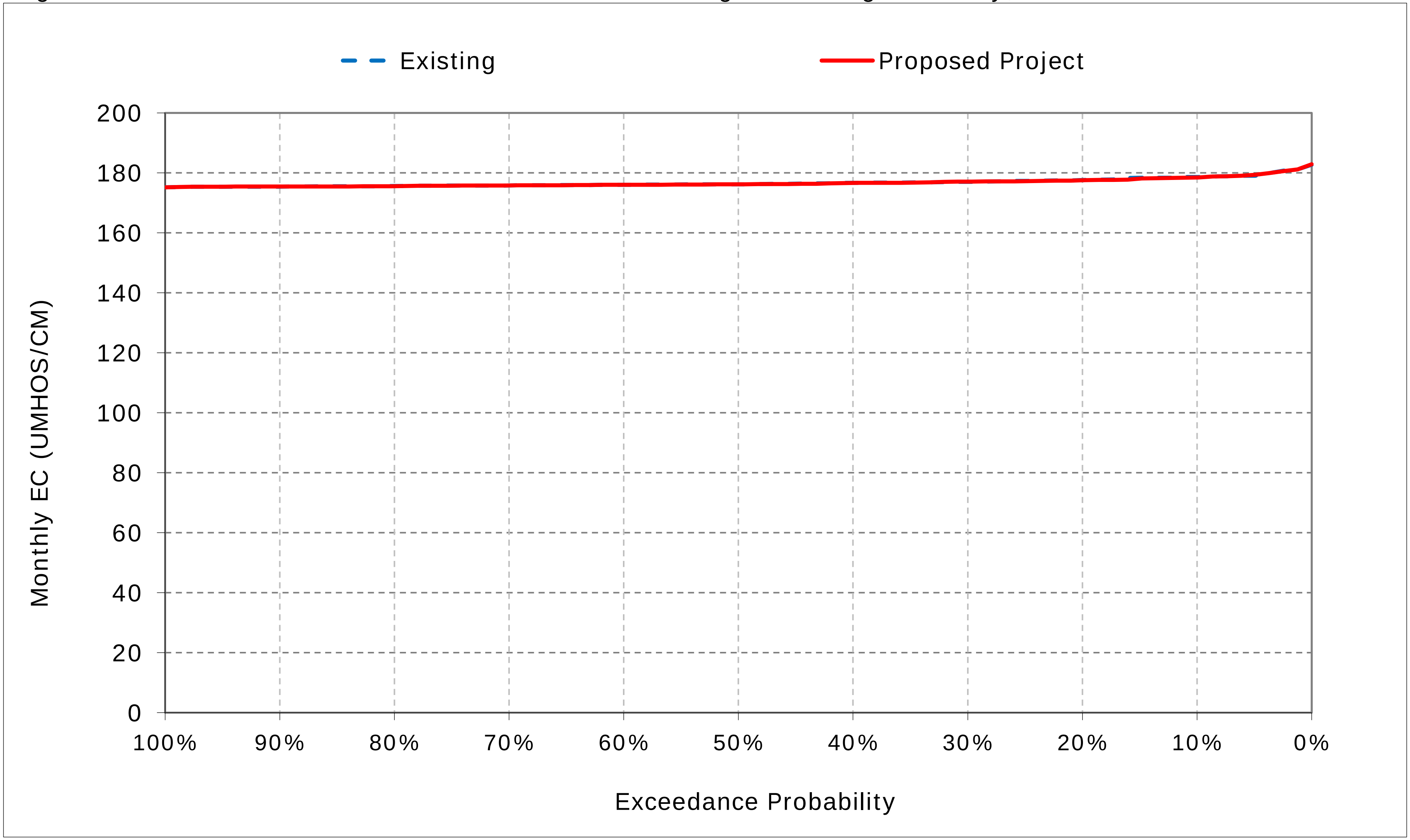


Table 4-1. Sacramento River at Rio Vista Salinity, Monthly EC

Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	491	422	367	244	201	195	191	198	215	278	369	457
20%	420	359	295	227	196	189	188	192	199	233	329	387
30%	401	337	234	213	193	187	186	188	195	221	314	371
40%	371	300	217	204	191	185	184	186	192	198	240	330
50%	322	201	204	198	186	183	183	184	190	194	233	282
60%	198	189	198	194	184	182	181	183	187	186	226	195
70%	188	182	187	190	183	180	180	181	184	185	221	183
80%	186	181	185	185	182	180	179	178	180	184	215	180
90%	185	180	180	181	180	179	178	177	178	182	212	180
Long Term												
Full Simulation Period[a]	311	274	239	207	190	185	184	189	200	216	267	291
Water Year Types[b]												
Wet (32%)	264	217	190	188	182	181	180	179	182	183	213	180
Above Normal (15%)	317	277	221	197	188	181	181	181	187	185	218	194
Below Normal (17%)	311	264	263	206	189	186	184	185	190	196	236	309
Dry (22%)	331	308	246	218	194	187	186	189	197	225	321	376
Critical (15%)	379	358	323	242	204	195	194	220	271	330	387	480

Proposed Project

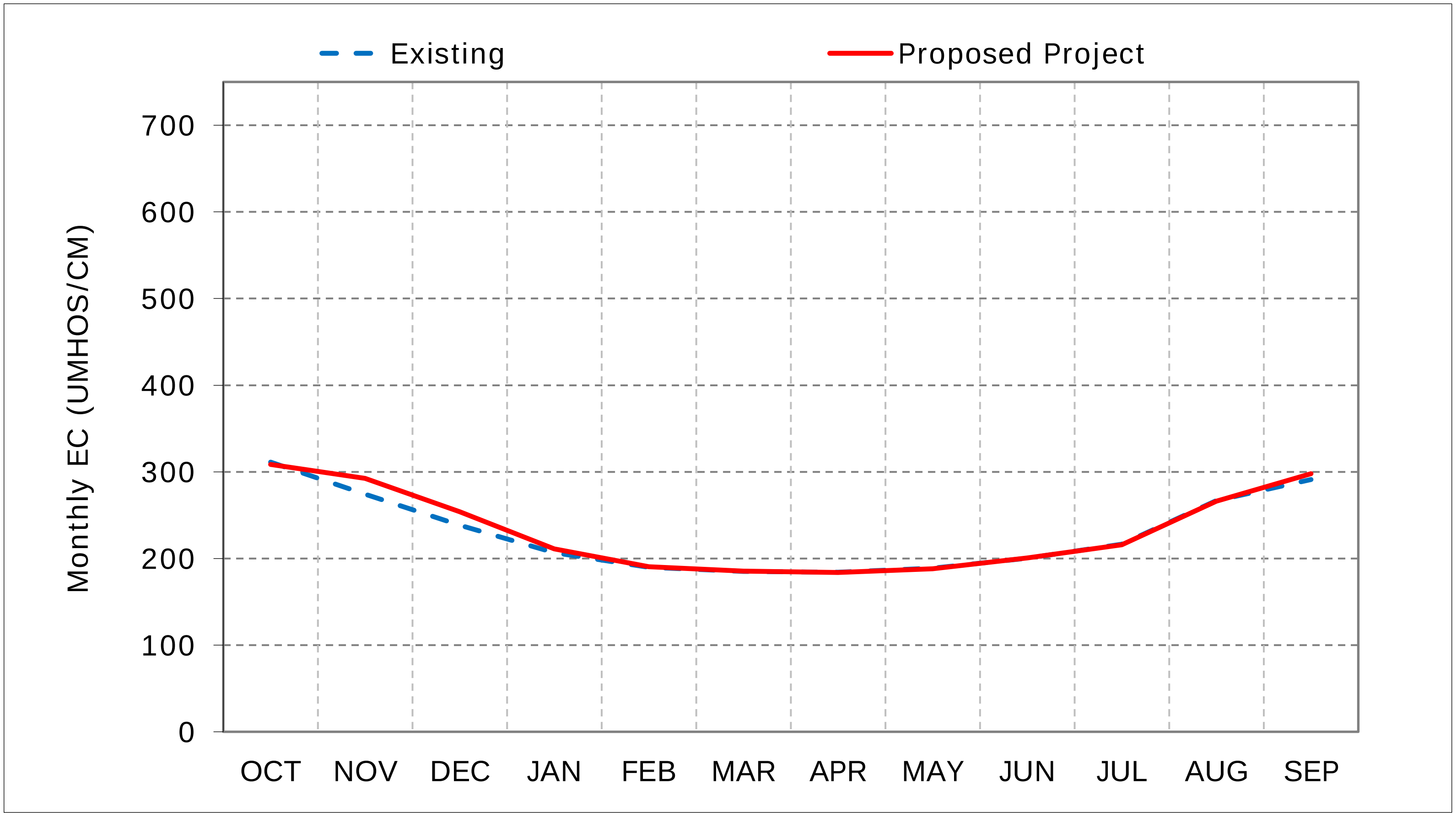
Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	468	420	365	261	201	196	191	199	217	277	370	446
20%	422	361	309	236	196	189	188	190	202	234	327	385
30%	397	339	279	218	193	187	185	187	197	221	311	373
40%	353	303	261	203	190	185	184	183	192	196	249	355
50%	310	243	234	199	186	183	182	182	187	191	237	297
60%	195	237	216	193	184	182	181	181	185	186	224	195
70%	193	232	191	190	183	180	180	179	182	185	219	193
80%	192	220	185	184	182	180	179	178	180	184	215	190
90%	189	187	180	181	180	179	178	177	178	182	211	187
Long Term												
Full Simulation Period[a]	309	292	254	211	190	185	184	188	201	216	266	298
Water Year Types[b]												
Wet (32%)	262	238	195	188	182	181	180	179	181	183	211	190
Above Normal (15%)	309	296	243	200	187	181	181	180	184	185	219	192
Below Normal (17%)	310	280	284	207	189	185	183	183	188	194	241	327
Dry (22%)	330	326	267	227	195	187	186	188	198	226	319	380
Critical (15%)	375	369	338	253	208	196	194	222	277	328	380	482

Proposed Project minus Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	-23	-2	-2	17	0	1	1	0	2	-2	2	-11
20%	1	2	14	9	0	0	0	-2	3	1	-2	-2
30%	-5	2	44	5	0	0	0	-1	2	0	-3	2
40%	-18	3	45	0	0	0	0	-3	-1	-2	9	25
50%	-12	43	31	1	0	0	0	-2	-3	-3	5	15
60%	-3	48	18	-1	0	0	-1	-2	-2	0	-2	0
70%	5	50	3	0	0	0	0	-1	-2	0	-2	10
80%	5	39	0	-1	0	0	0	0	0	0	0	10
90%	4	6	-1	0	0	0	0	0	0	0	-1	8
Long Term												
Full Simulation Period[a]	-3	18	15	4	1	0	0	-1	0	-1	-1	7
Water Year Types[b]												
Wet (32%)	-2	22	5	0	0	0	0	0	0	0	-2	10
Above Normal (15%)	-8	19	22	3	-1	0	0	-1	-2	0	1	-3
Below Normal (17%)	-1	17	21	1	-1	0	0	-2	-2	-2	6	18
Dry (22%)	-1	18	22	9	1	0	-1	-1	1	1	-2	3
Critical (15%)	-4	11	15	11	4	1	0	2	6	-2	-7	1

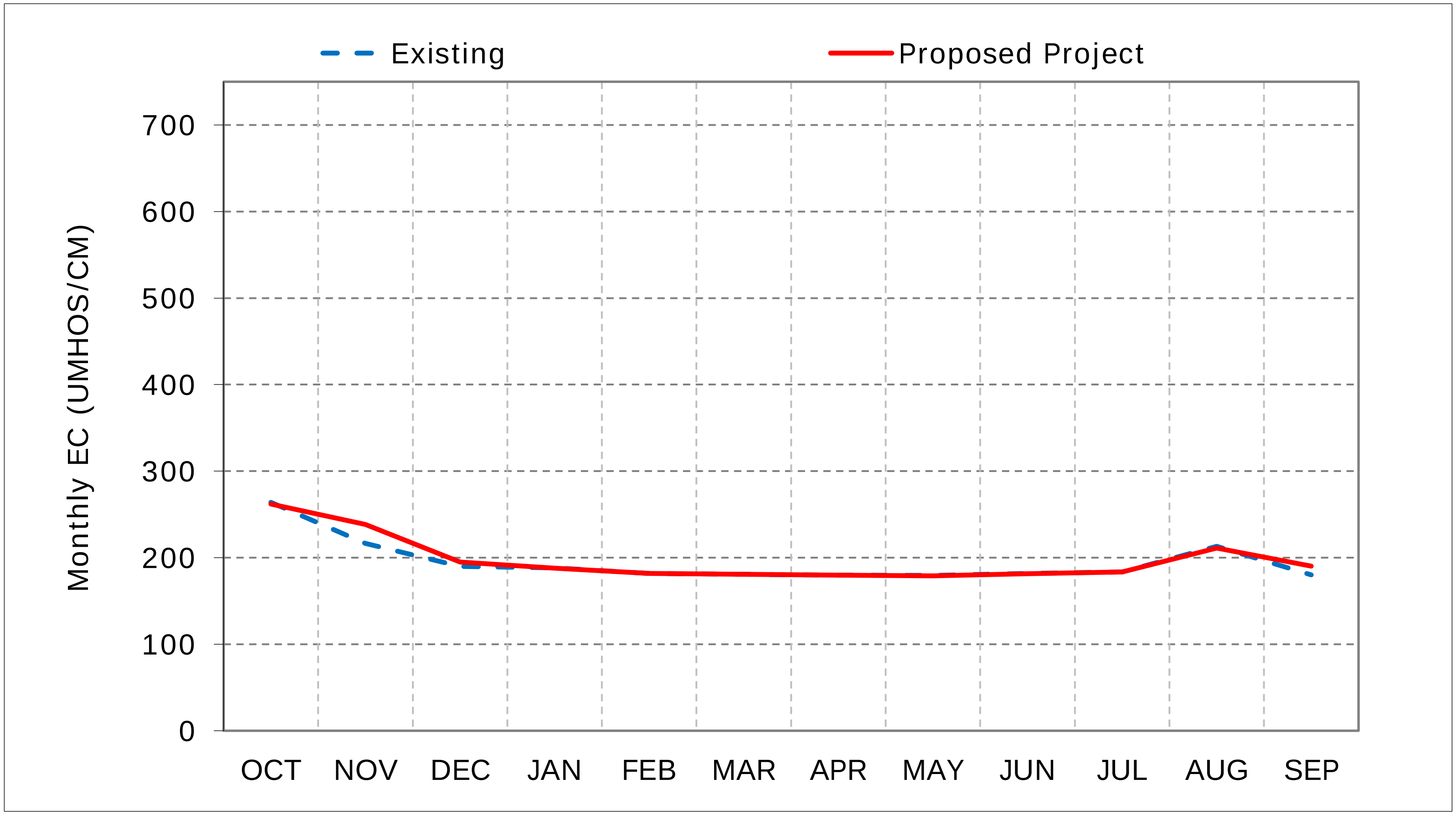
a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with water year - year type sorting.
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 4-1. Sacramento River at Rio Vista Salinity, Long-Term Average EC



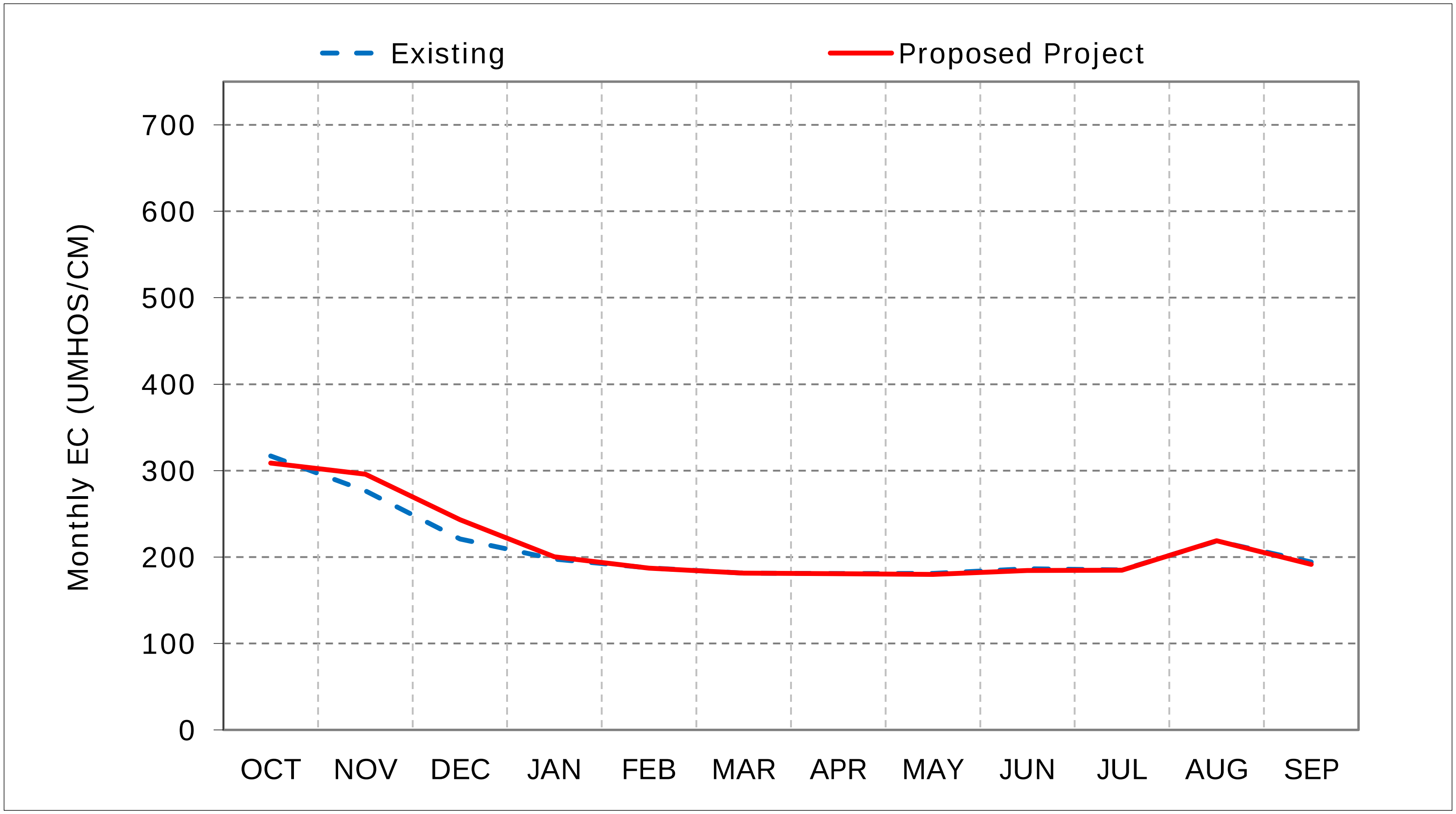
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 4-2. Sacramento River at Rio Vista Salinity, Wet Year Average EC



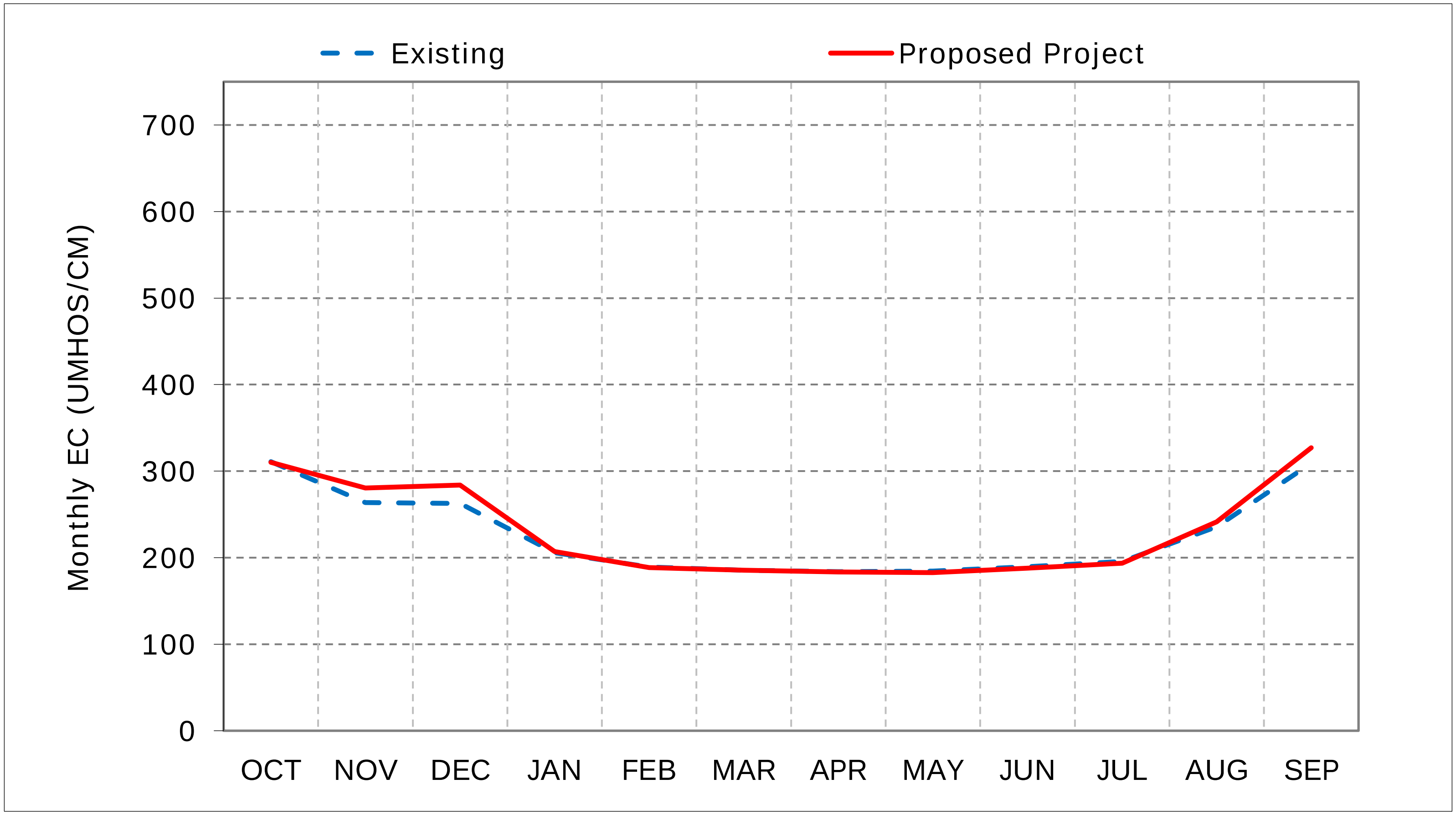
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 4-3. Sacramento River at Rio Vista Salinity, Above Normal Year Average EC



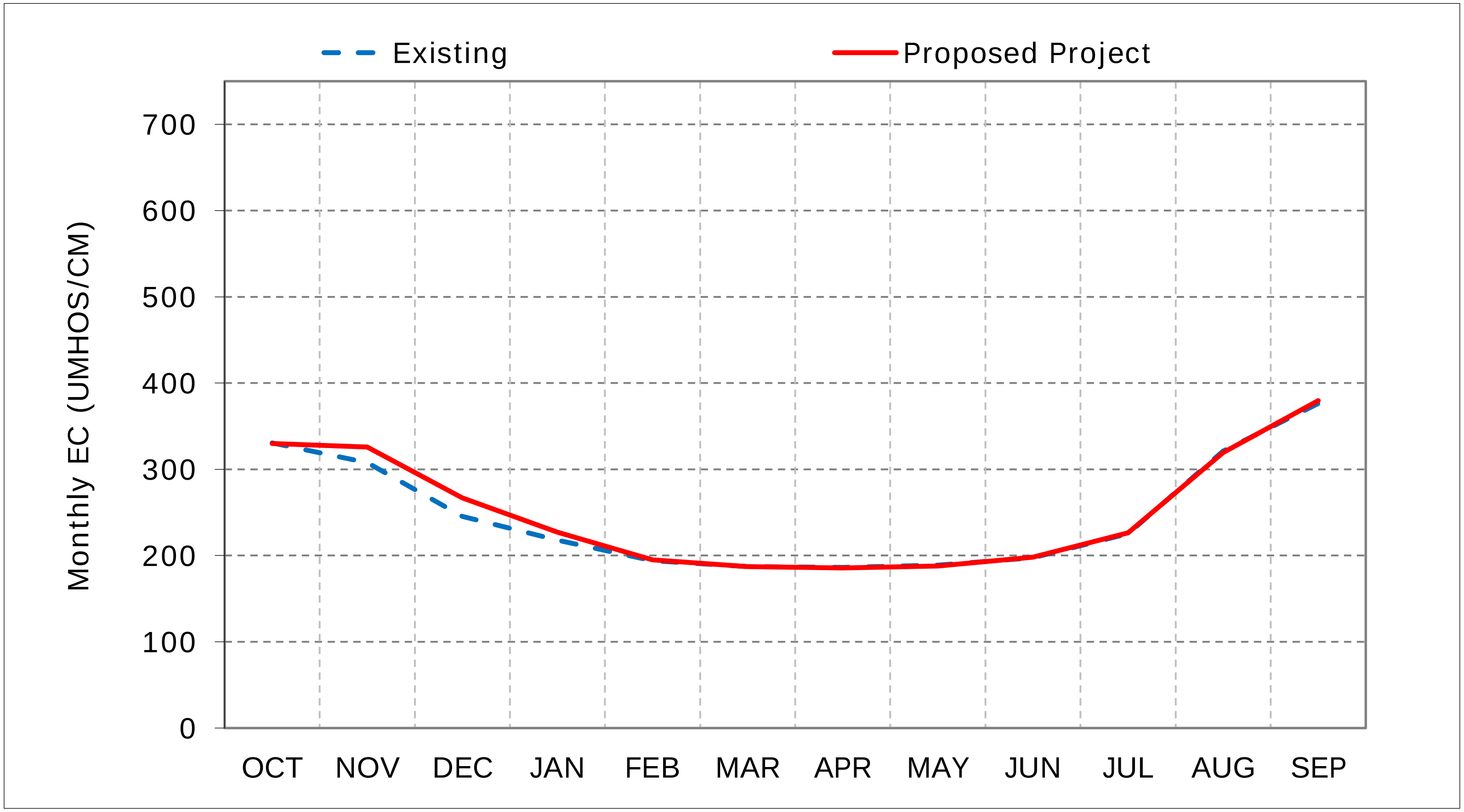
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 4-4. Sacramento River at Rio Vista Salinity, Below Normal Year Average EC



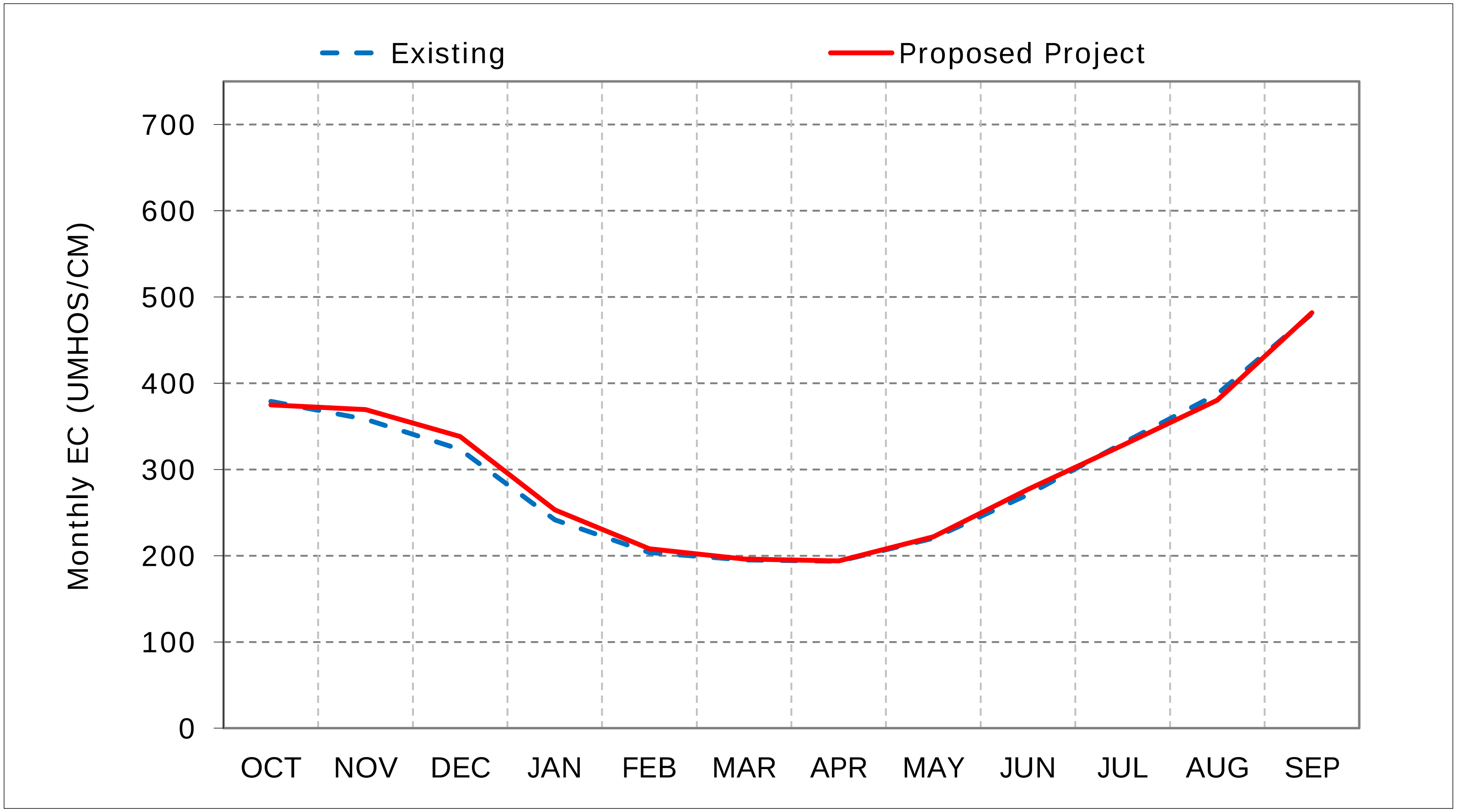
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 4-5. Sacramento River at Rio Vista Salinity, Dry Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 4-6. Sacramento River at Rio Vista Salinity, Critical Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 4-7. Sacramento River at Rio Vista Salinity, January EC

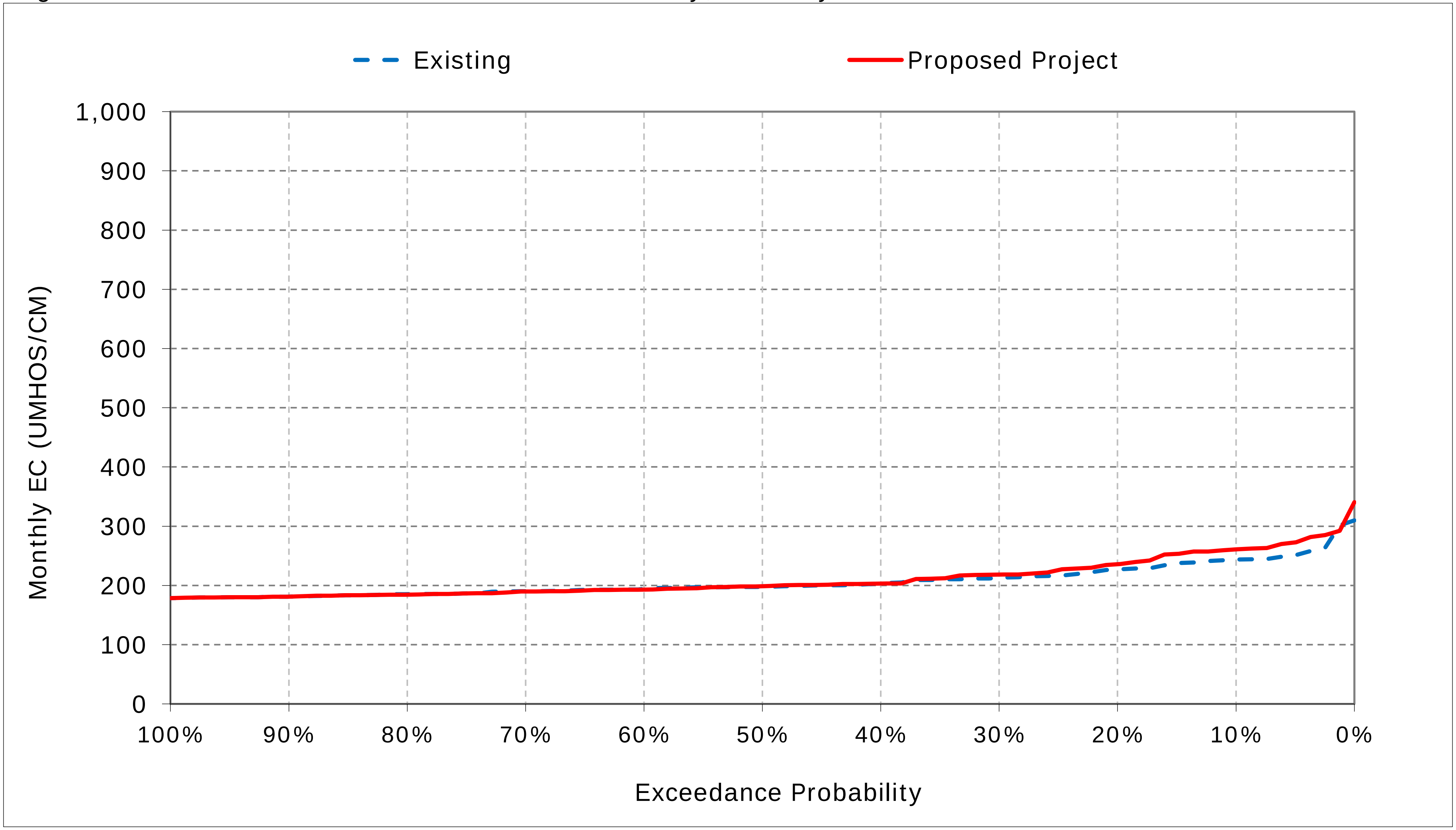


Figure 4-8. Sacramento River at Rio Vista Salinity, February EC

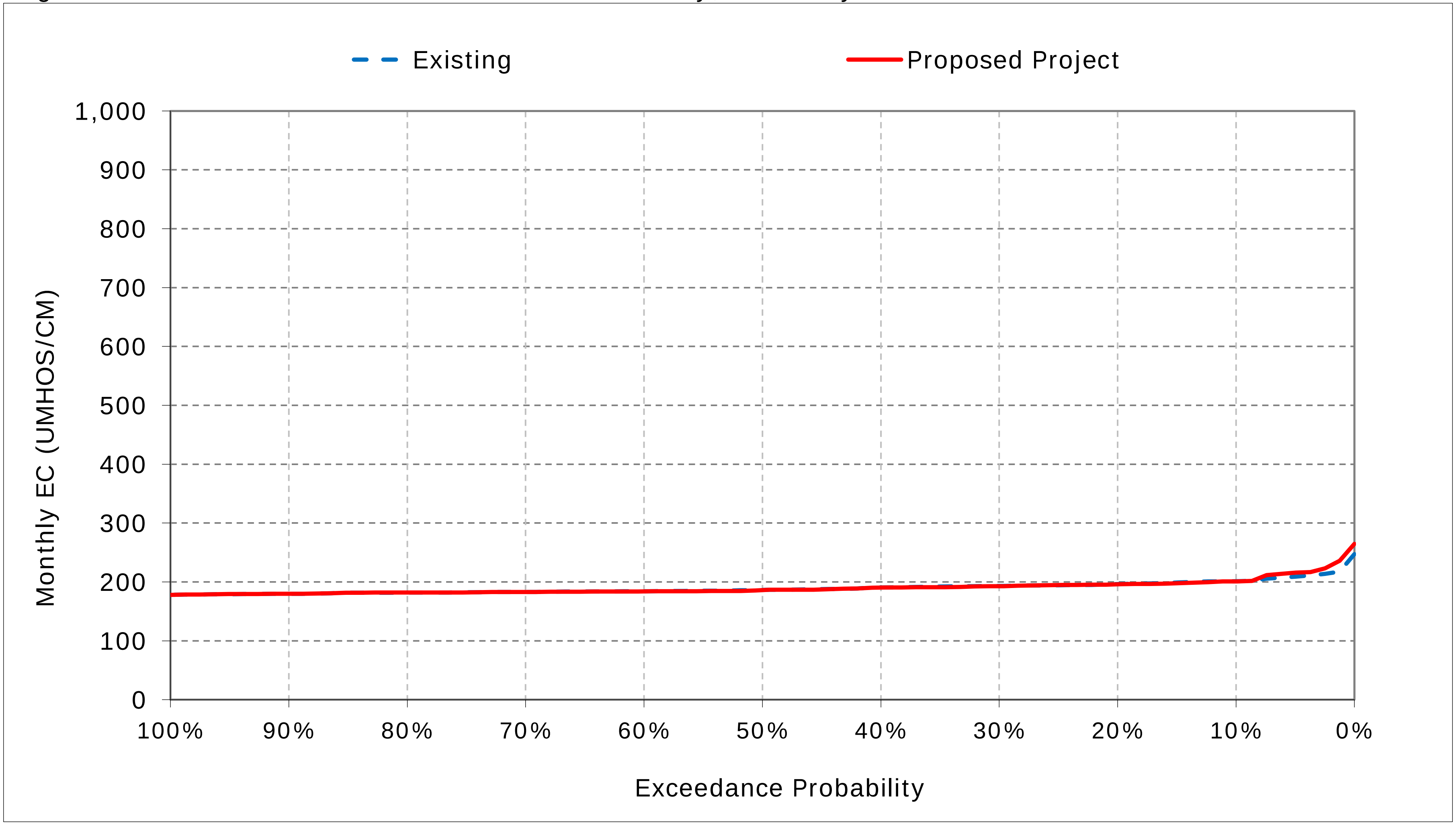


Figure 4-9. Sacramento River at Rio Vista Salinity, March EC

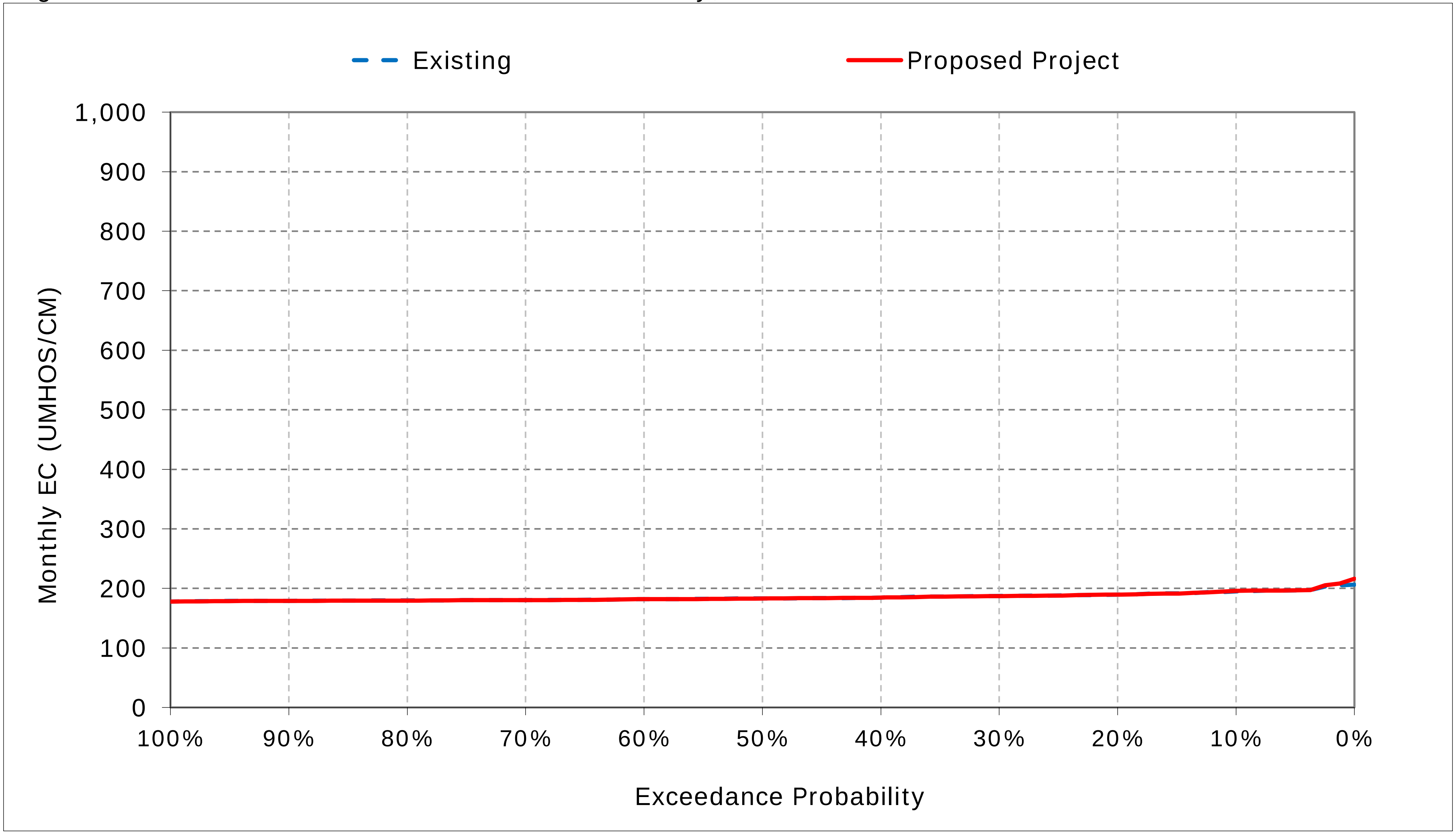


Figure 4-10. Sacramento River at Rio Vista Salinity, April EC

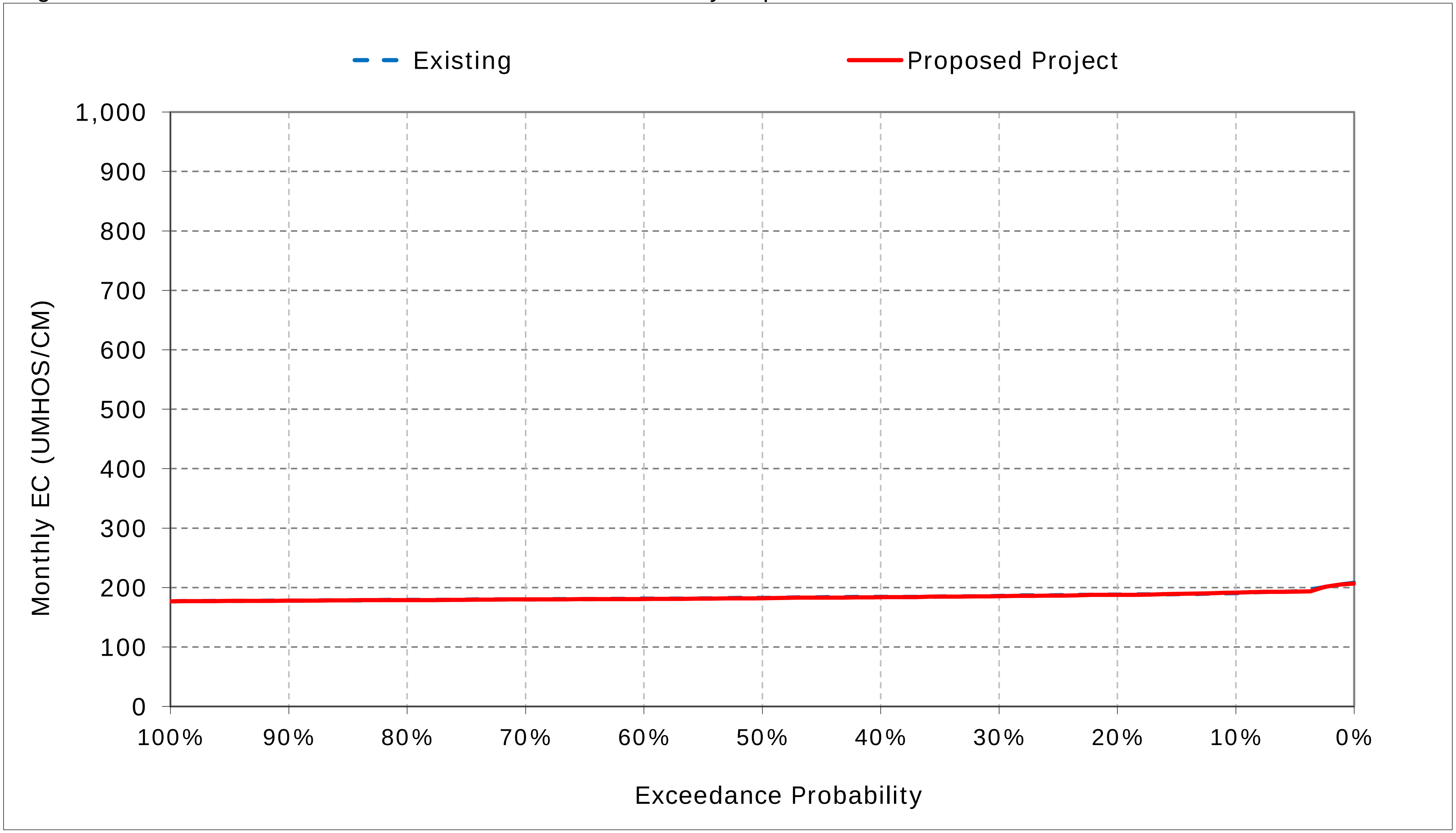


Figure 4-11. Sacramento River at Rio Vista Salinity, May EC

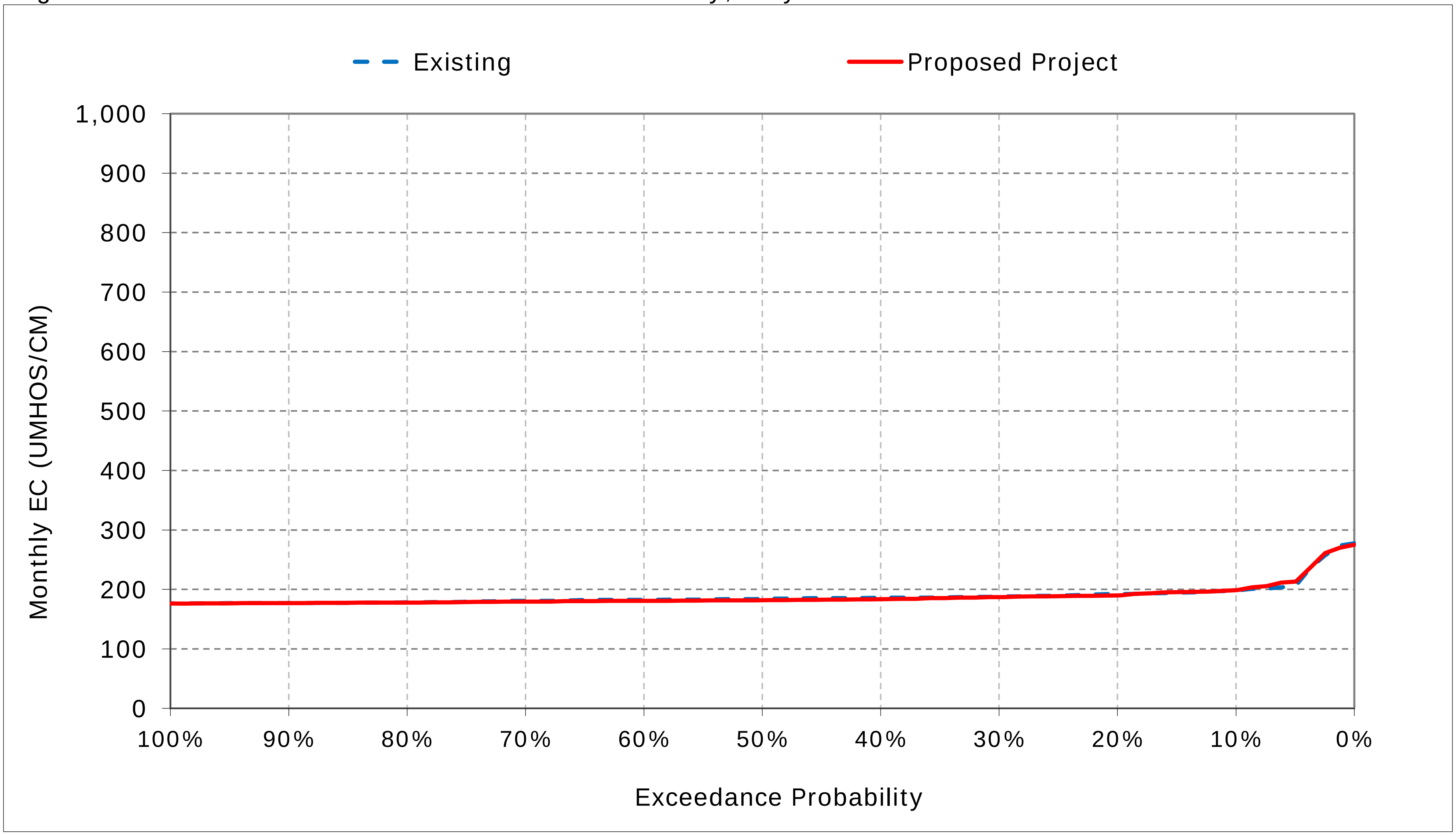


Figure 4-12. Sacramento River at Rio Vista Salinity, June EC

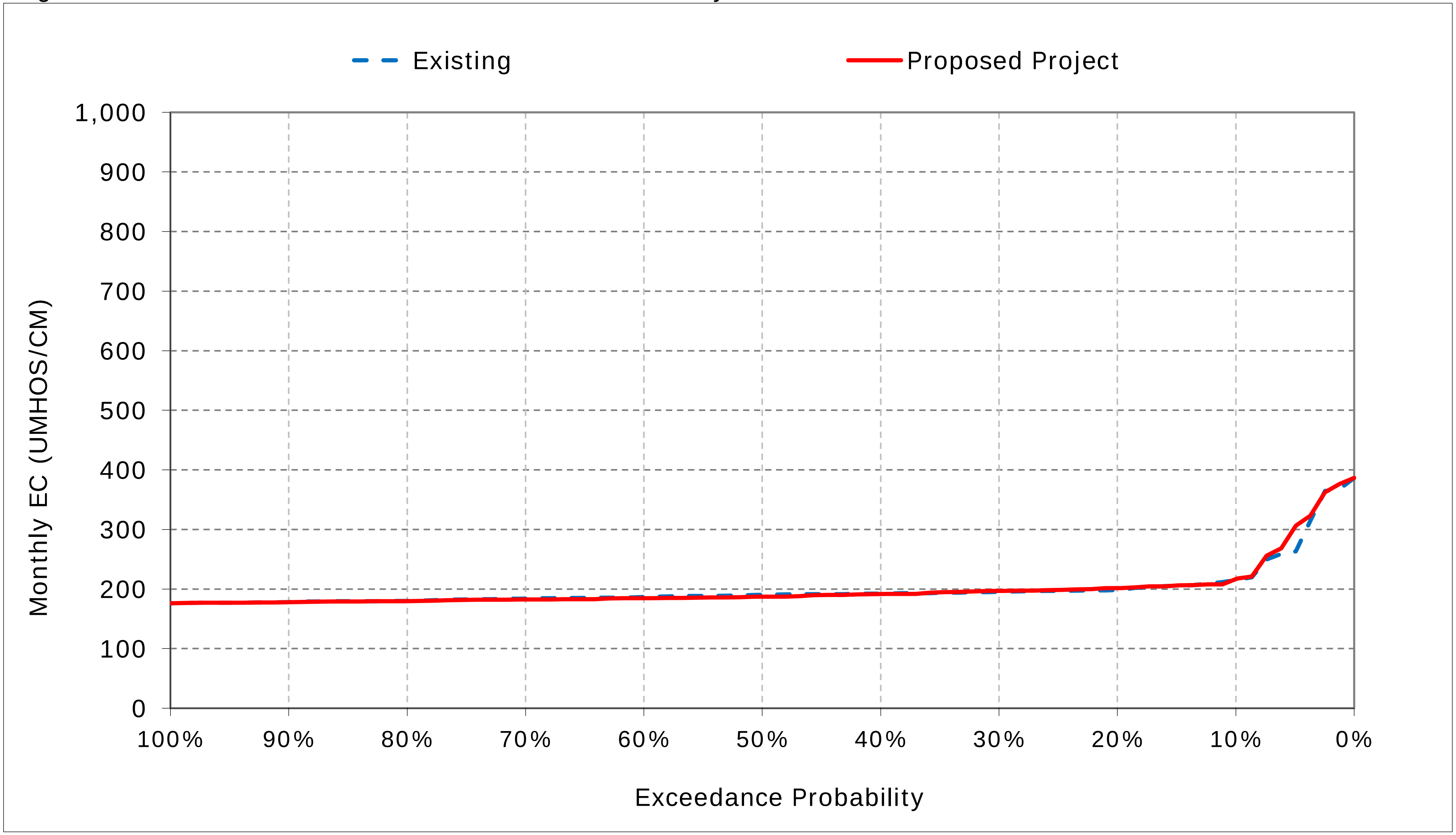


Figure 4-13. Sacramento River at Rio Vista Salinity, July EC

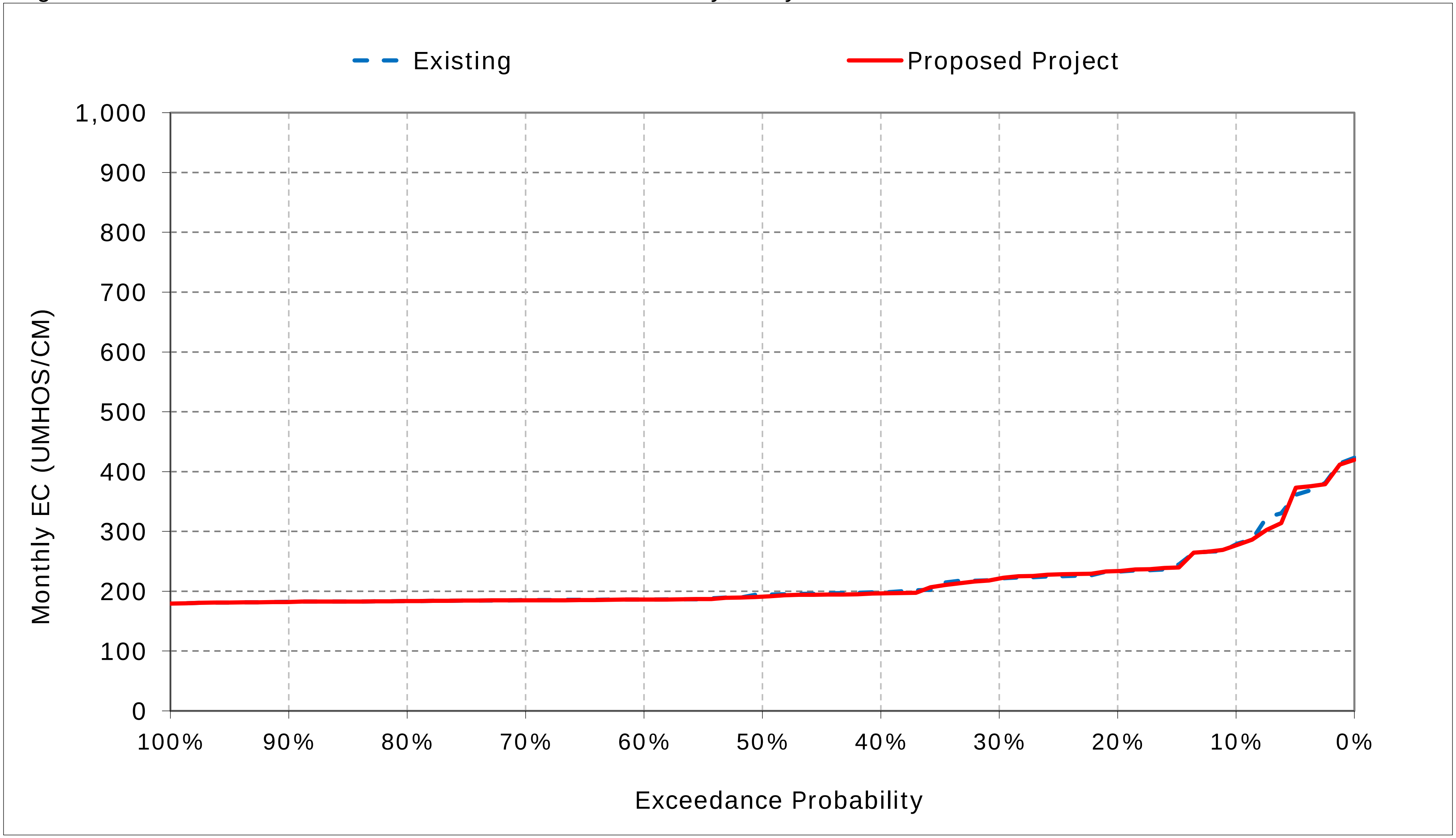


Figure 4-14. Sacramento River at Rio Vista Salinity, August EC

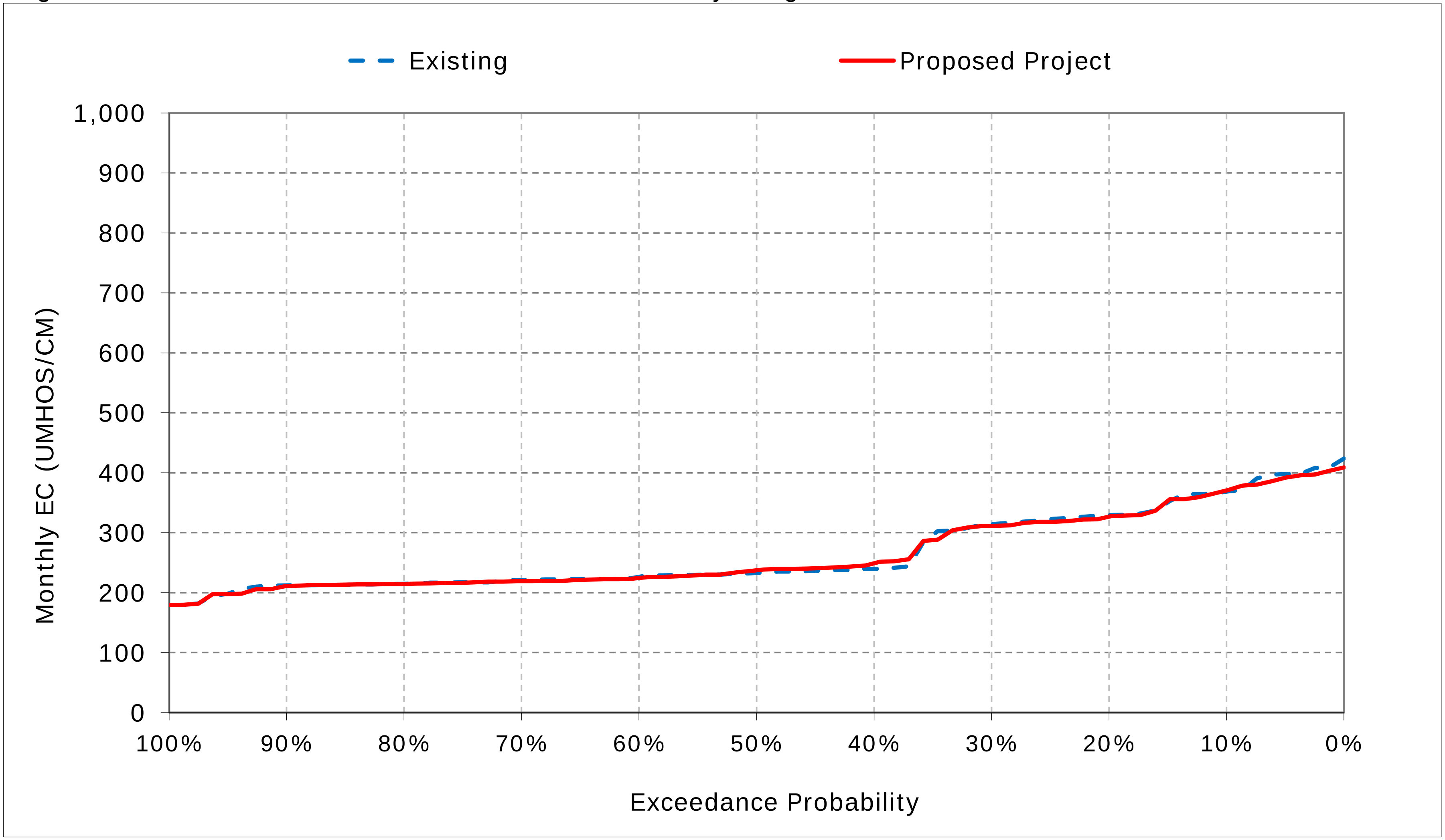


Figure 4-15. Sacramento River at Rio Vista Salinity, September EC

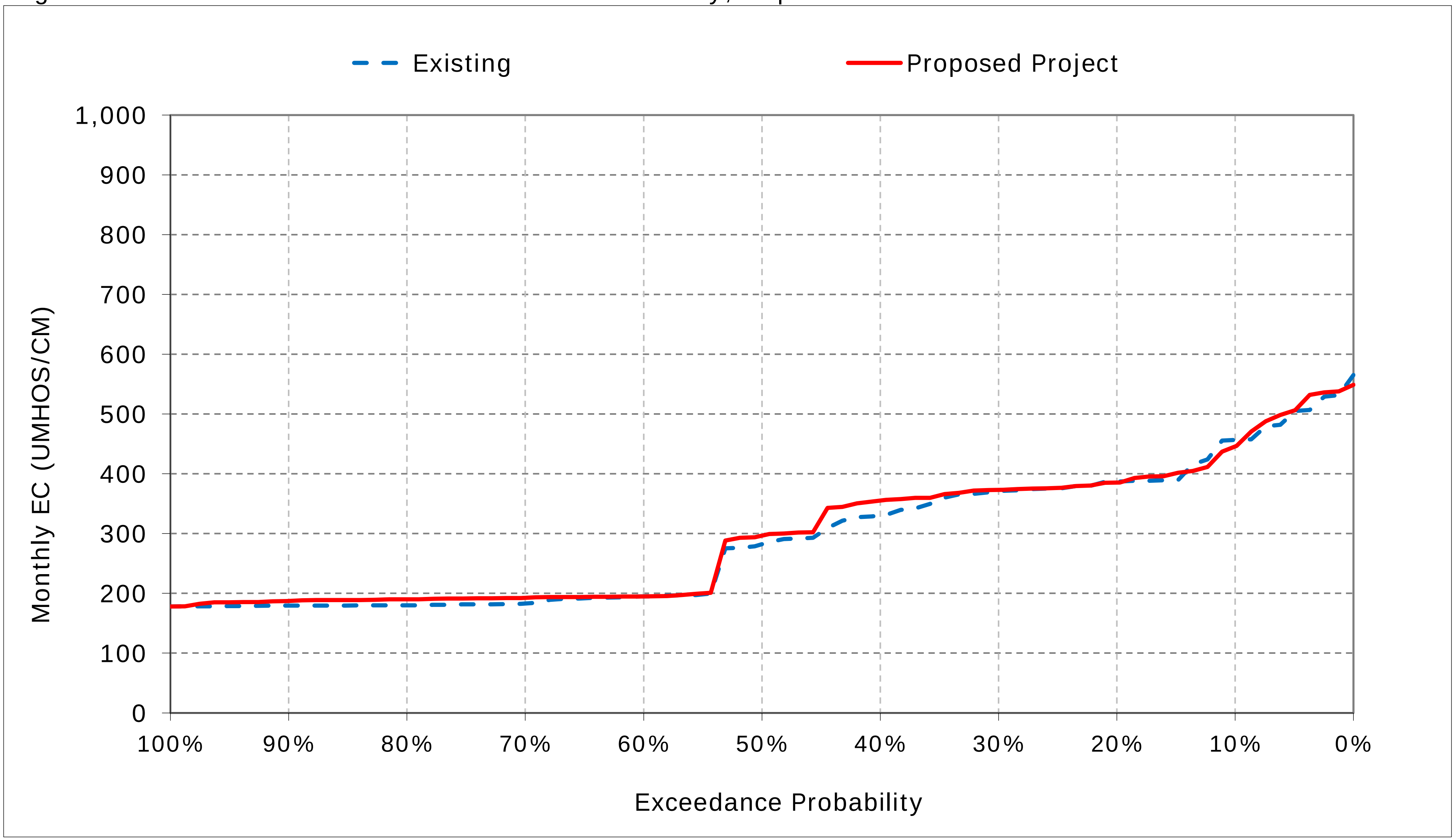


Figure 4-16. Sacramento River at Rio Vista Salinity, October EC

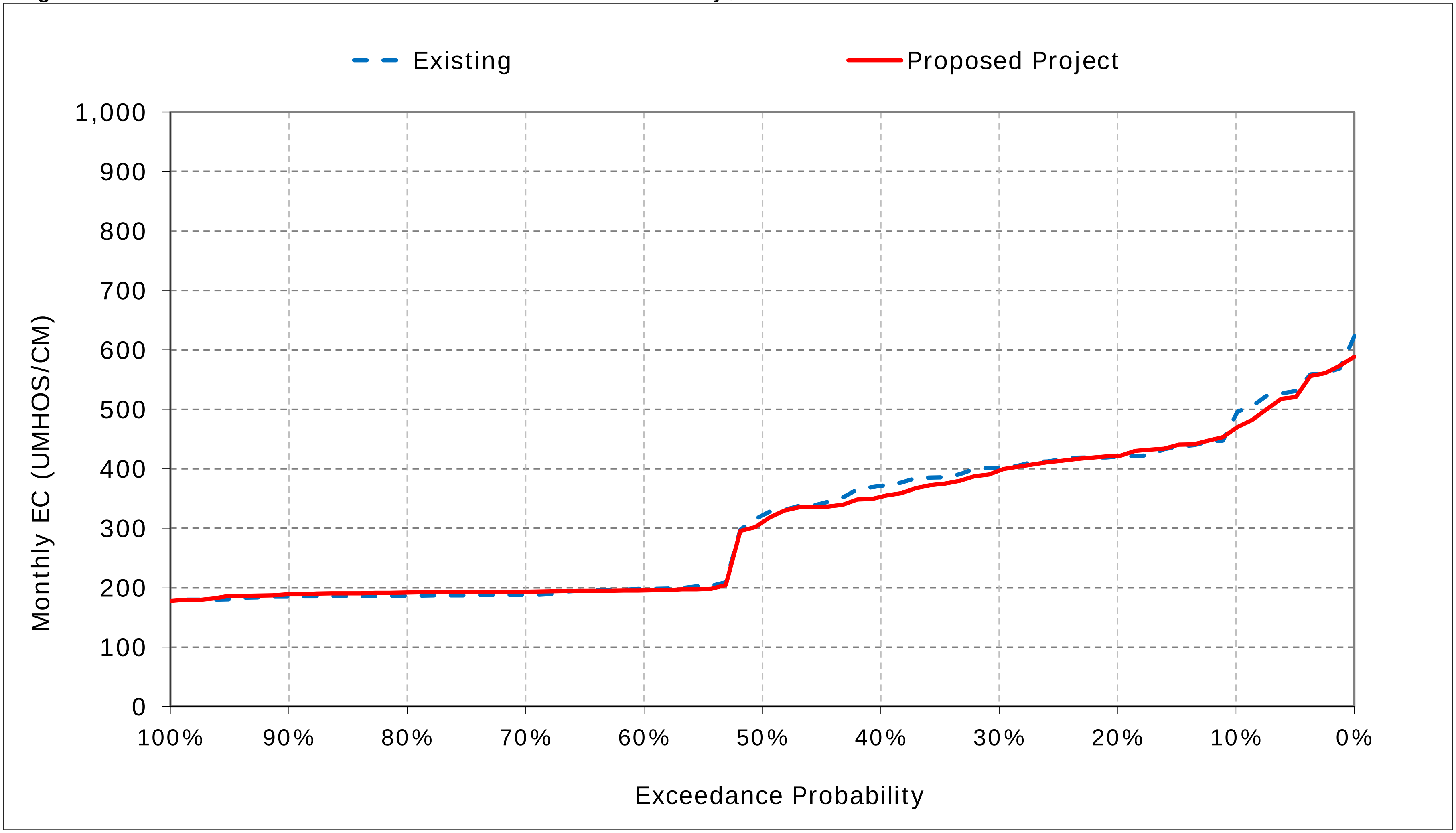


Figure 4-17. Sacramento River at Rio Vista Salinity, November EC

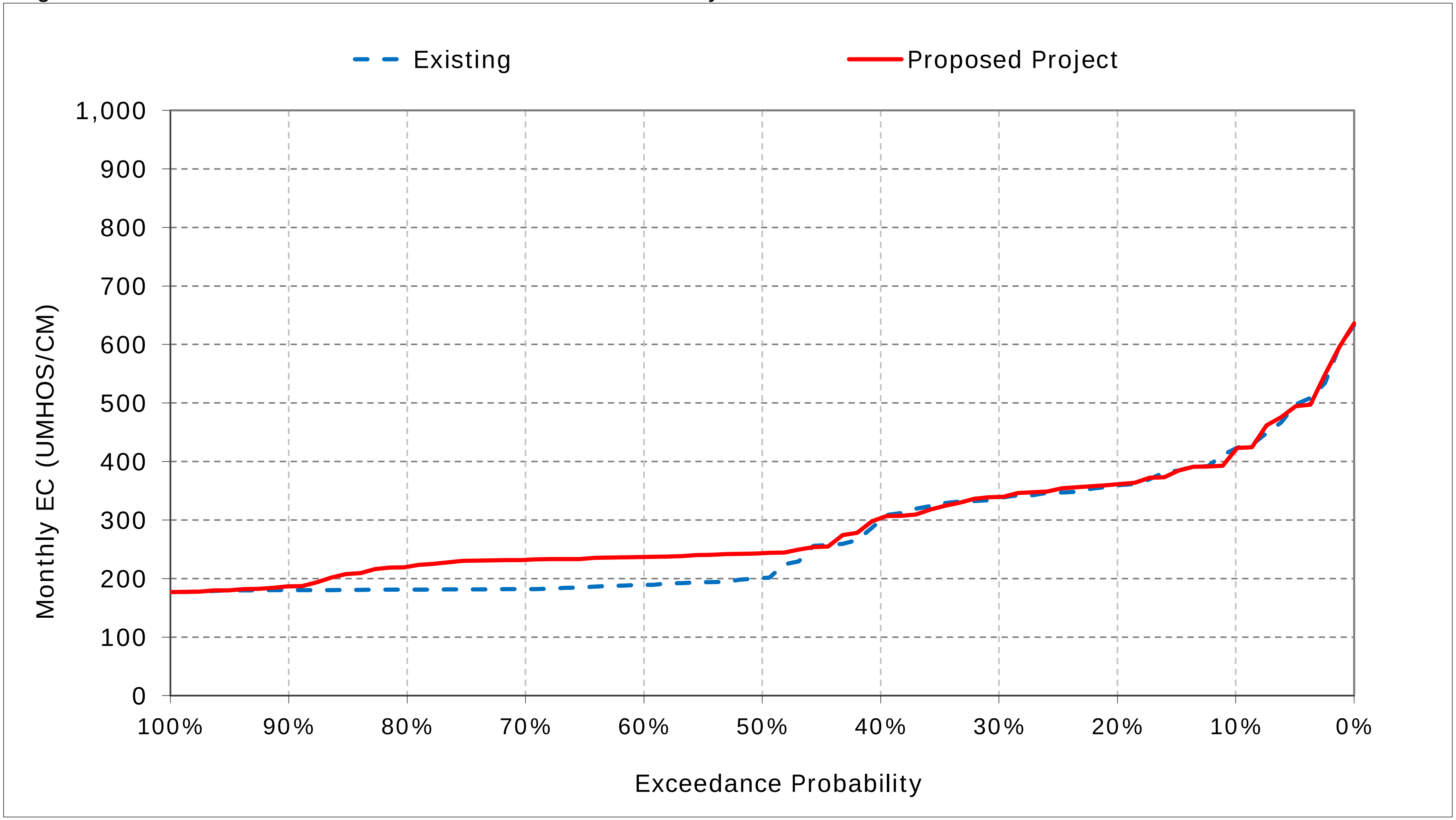


Figure 4-18. Sacramento River at Rio Vista Salinity, December EC

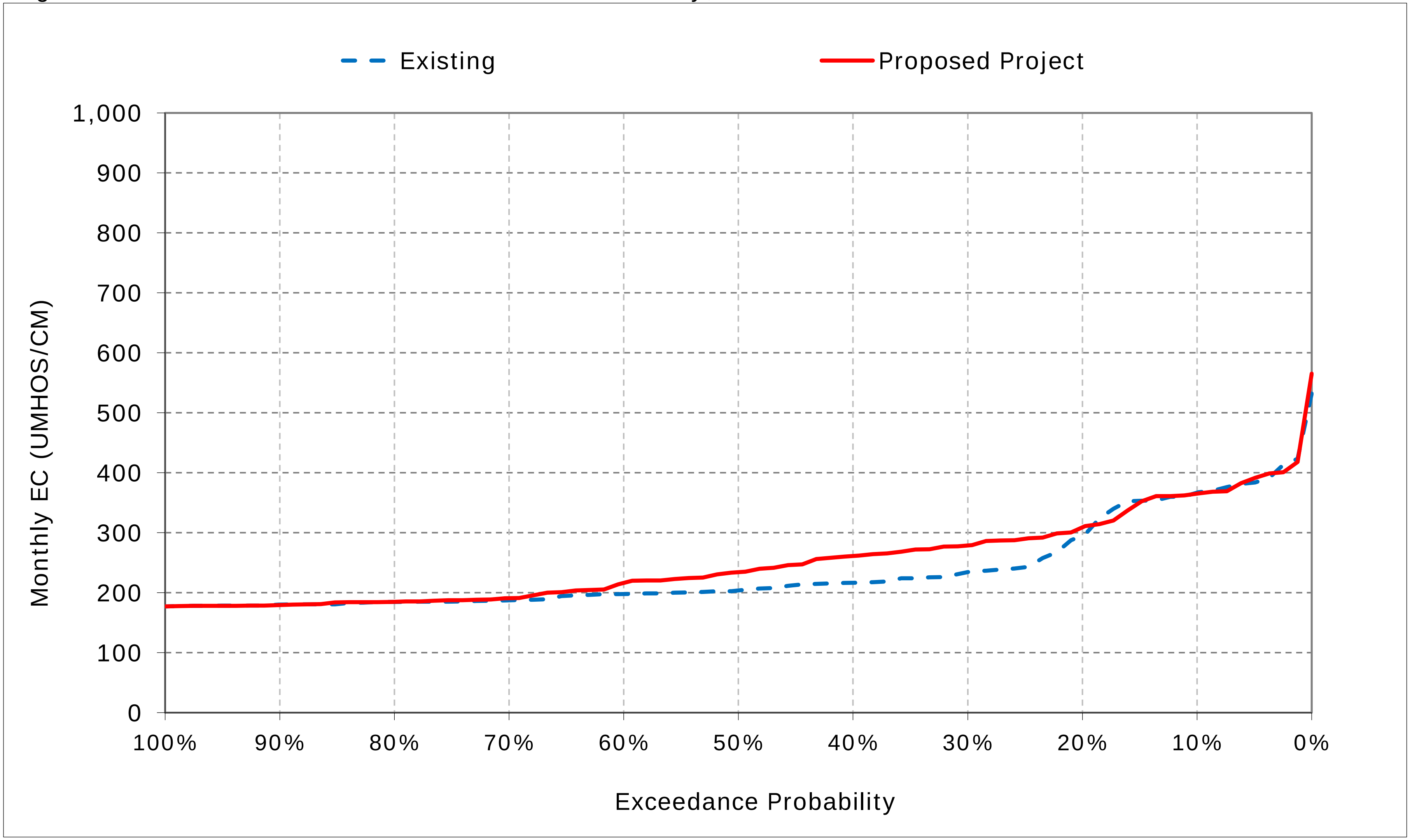


Table 5-1. Sacramento River at Emmaton Salinity, Monthly EC

Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	3,495	2,968	2,416	934	343	312	348	559	832	1,536	2,564	3,311
20%	3,015	2,476	1,573	736	252	238	247	399	595	1,007	2,001	2,732
30%	2,933	2,366	878	518	226	197	207	304	555	814	1,887	2,644
40%	2,724	1,968	712	352	206	193	198	232	461	535	1,085	2,188
50%	2,082	539	533	288	195	189	193	206	391	442	957	1,544
60%	644	426	493	227	190	187	189	198	300	348	912	472
70%	385	275	252	196	185	183	186	192	253	317	840	321
80%	342	247	211	188	183	181	182	183	194	293	796	302
90%	314	238	182	182	182	181	181	180	182	266	731	278
Long Term												
Full Simulation Period[a]	1,787	1,370	891	448	249	222	234	323	514	712	1,345	1,561
Water Year Types[b]												
Wet (32%)	1,273	710	302	209	184	183	185	190	230	281	748	283
Above Normal (15%)	1,870	1,412	735	301	199	184	188	195	316	328	809	464
Below Normal (17%)	1,848	1,367	1,153	437	211	199	206	235	390	485	1,020	1,843
Dry (22%)	1,958	1,695	1,017	590	285	233	240	326	562	901	1,951	2,694
Critical (15%)	2,492	2,273	1,828	913	432	353	408	839	1,398	2,011	2,644	3,399

Proposed Project

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	3,471	2,889	2,408	1,126	344	315	388	588	851	1,517	2,470	3,171
20%	3,051	2,554	1,627	844	262	230	267	428	651	1,065	2,004	2,775
30%	2,909	2,336	1,423	578	227	196	216	372	584	838	1,938	2,639
40%	2,452	1,938	1,191	378	205	193	199	251	475	525	1,315	2,409
50%	1,894	1,228	873	300	196	189	191	211	375	429	1,046	1,672
60%	615	1,086	602	221	189	187	186	197	302	338	907	461
70%	556	1,023	316	196	185	183	183	187	247	314	818	444
80%	492	837	246	189	183	181	182	180	192	288	777	413
90%	413	340	188	182	182	181	180	178	181	267	704	376
Long Term												
Full Simulation Period[a]	1,785	1,630	1,051	495	260	223	239	341	530	714	1,356	1,630
Water Year Types[b]												
Wet (32%)	1,293	1,034	371	209	184	183	184	195	240	282	727	398
Above Normal (15%)	1,822	1,661	966	338	196	185	187	197	304	320	818	426
Below Normal (17%)	1,859	1,607	1,372	456	209	199	212	251	386	486	1,151	2,027
Dry (22%)	1,985	1,967	1,233	682	300	233	250	365	593	929	1,956	2,719
Critical (15%)	2,430	2,409	1,959	1,037	486	363	422	874	1,456	1,988	2,597	3,403

Proposed Project minus Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	-23	-79	-8	192	1	2	40	29	20	-19	-94	-140
20%	36	79	54	108	10	-8	20	29	56	58	3	43
30%	-24	-31	545	61	1	-1	9	69	29	23	51	-5
40%	-273	-30	479	26	-1	0	1	19	14	-10	230	221
50%	-188	689	339	13	1	0	-2	5	-16	-14	89	128
60%	-29	660	109	-6	-1	1	-3	-2	1	-10	-5	-11
70%	171	748	64	1	0	0	-2	-5	-6	-3	-22	122
80%	150	590	35	1	0	0	-1	-4	-2	-4	-19	111
90%	98	102	6	0	0	0	-1	-2	-2	2	-27	99
Long Term												
Full Simulation Period[a]	-2	260	160	47	11	2	5	18	16	2	11	69
Water Year Types[b]												
Wet (32%)	20	323	69	0	0	0	0	5	10	1	-21	115
Above Normal (15%)	-49	249	232	37	-3	0	-1	1	-12	-8	10	-38
Below Normal (17%)	11	240	218	19	-2	0	7	16	-4	2	131	183
Dry (22%)	27	273	216	92	16	0	10	39	31	28	6	26
Critical (15%)	-62	136	130	124	55	10	13	35	58	-22	-47	4

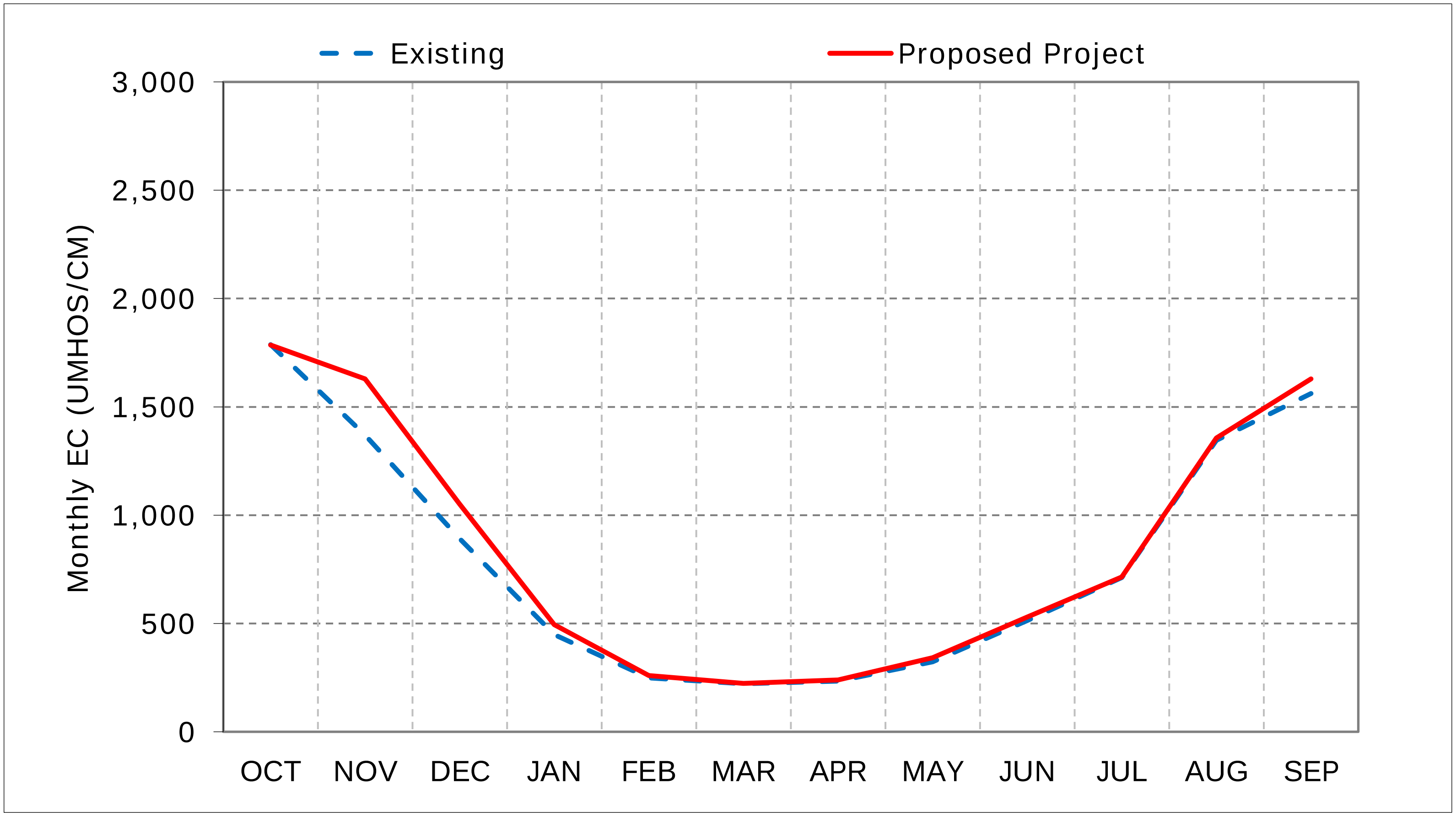
a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

c These results are displayed with water year - year type sorting.

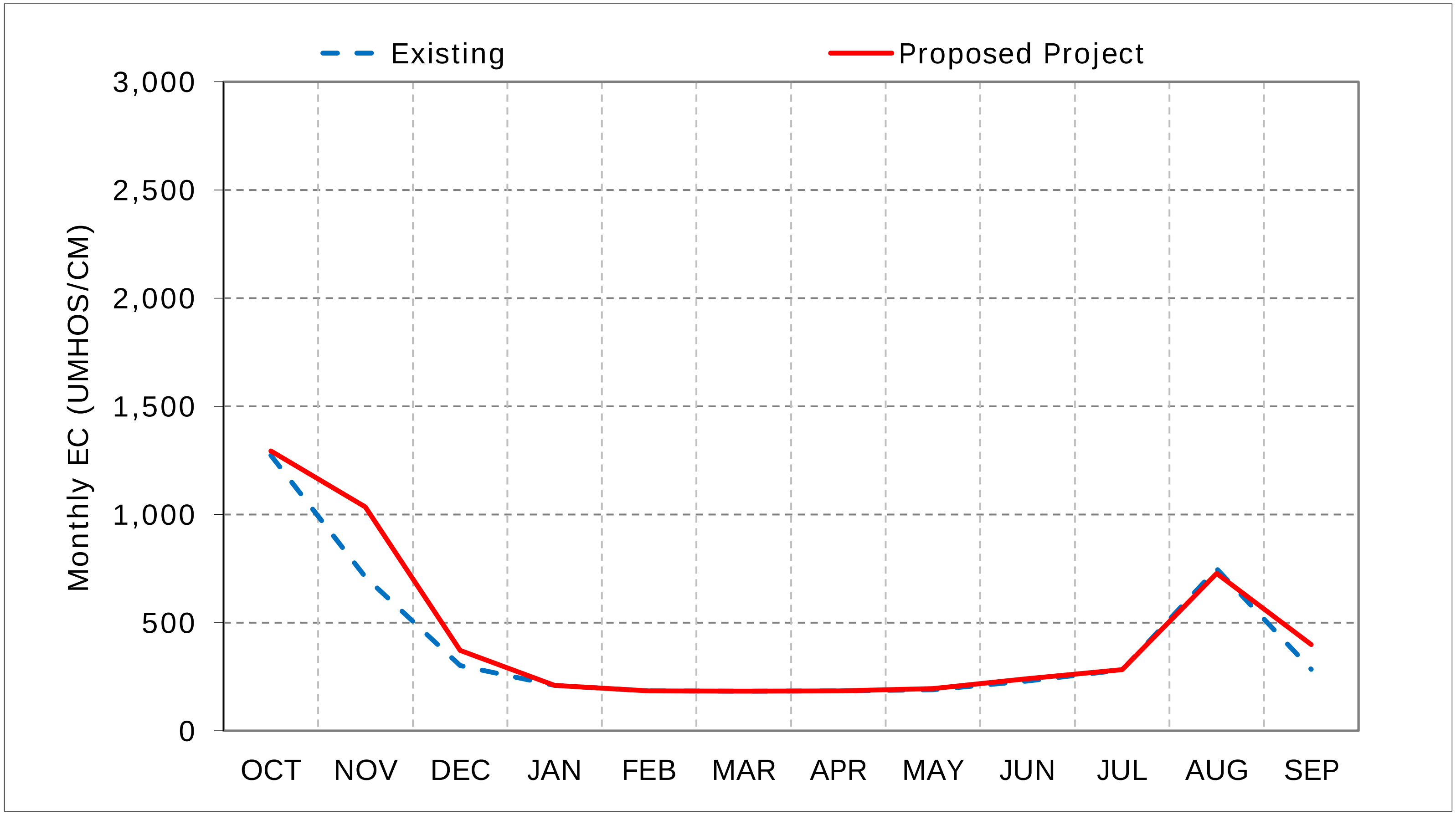
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 5-1. Sacramento River at Emmaton Salinity, Long-Term Average EC



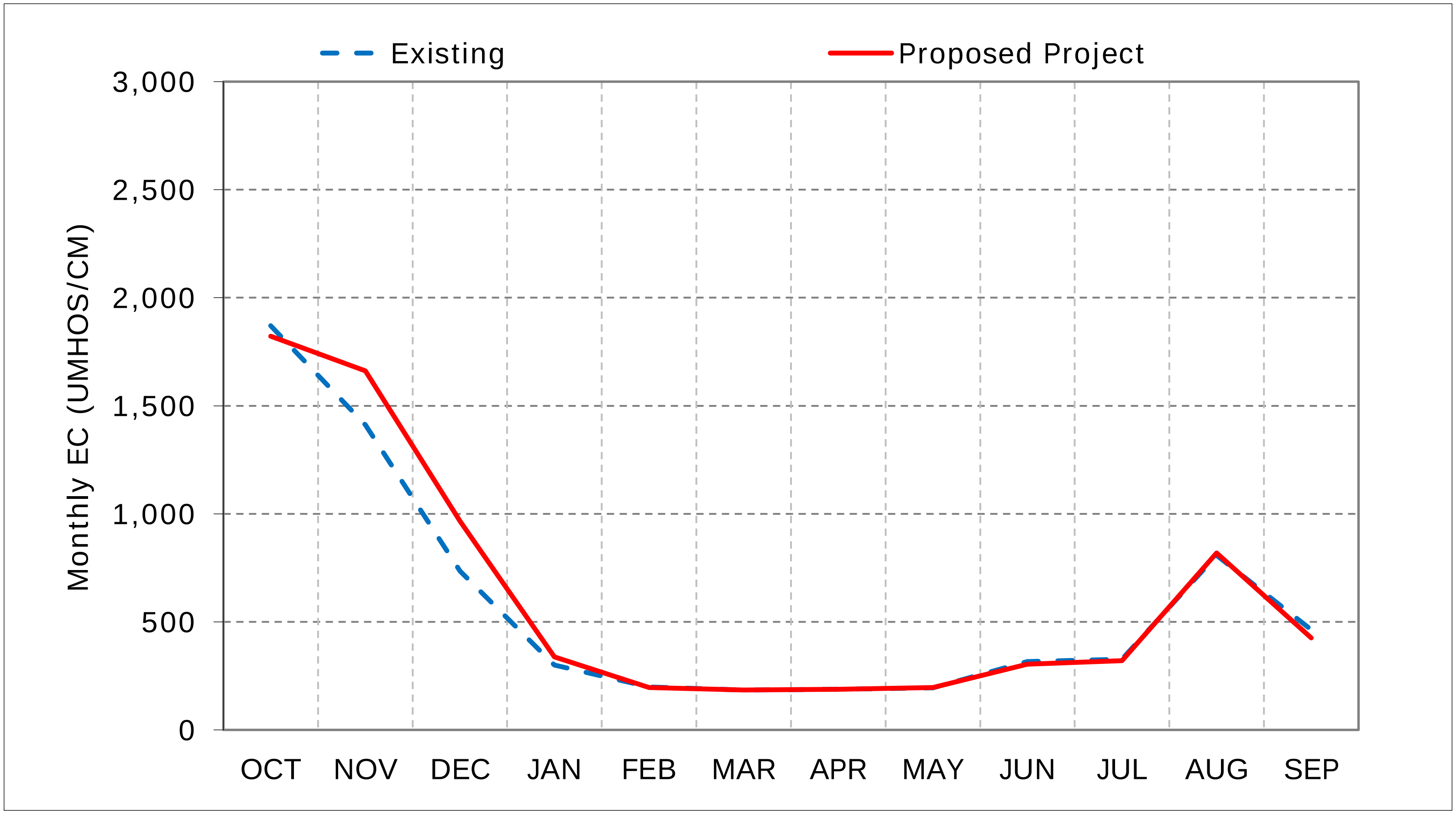
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 5-2. Sacramento River at Emmaton Salinity, Wet Year Average EC



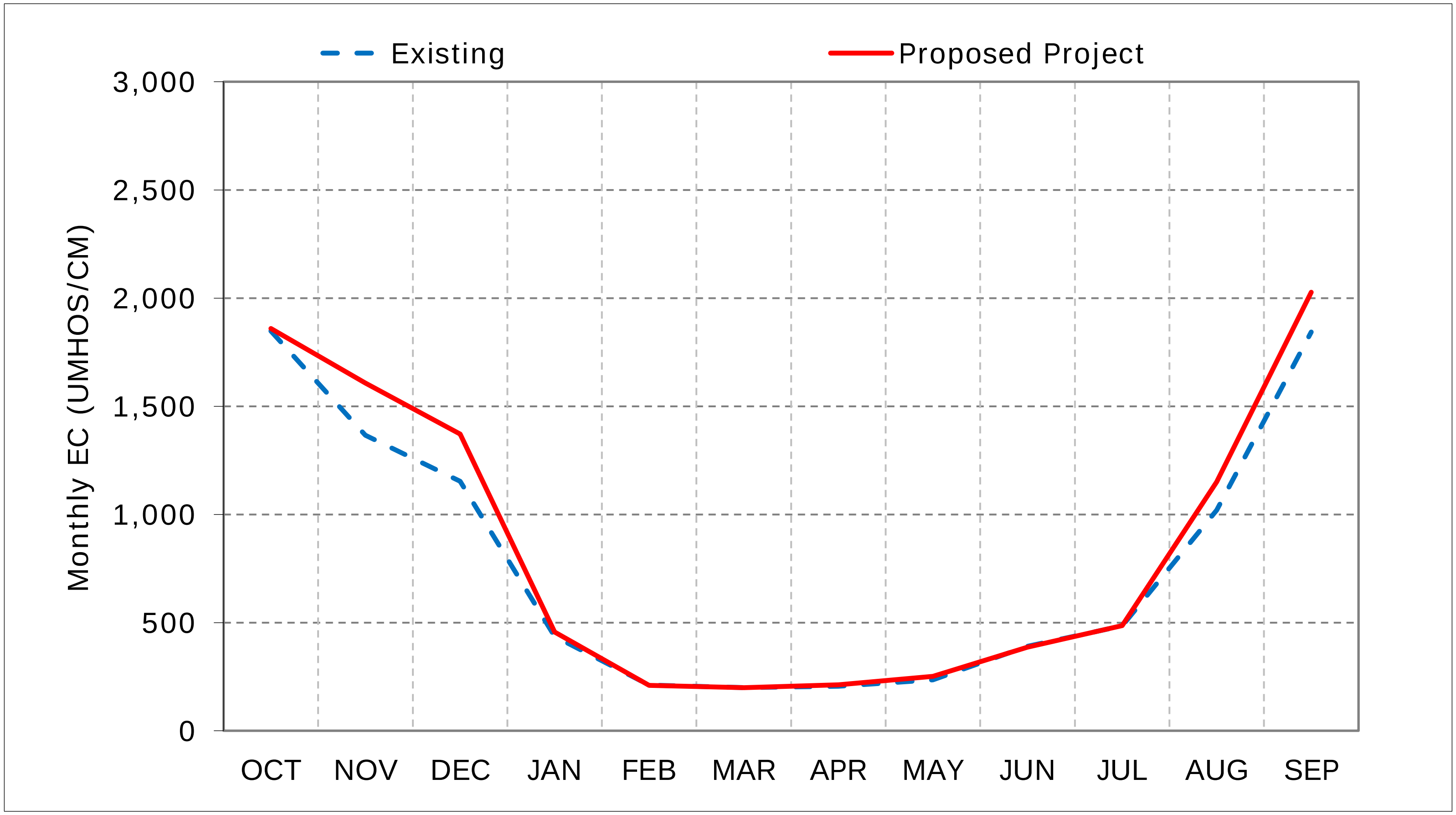
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 5-3. Sacramento River at Emmaton Salinity, Above Normal Year Average EC



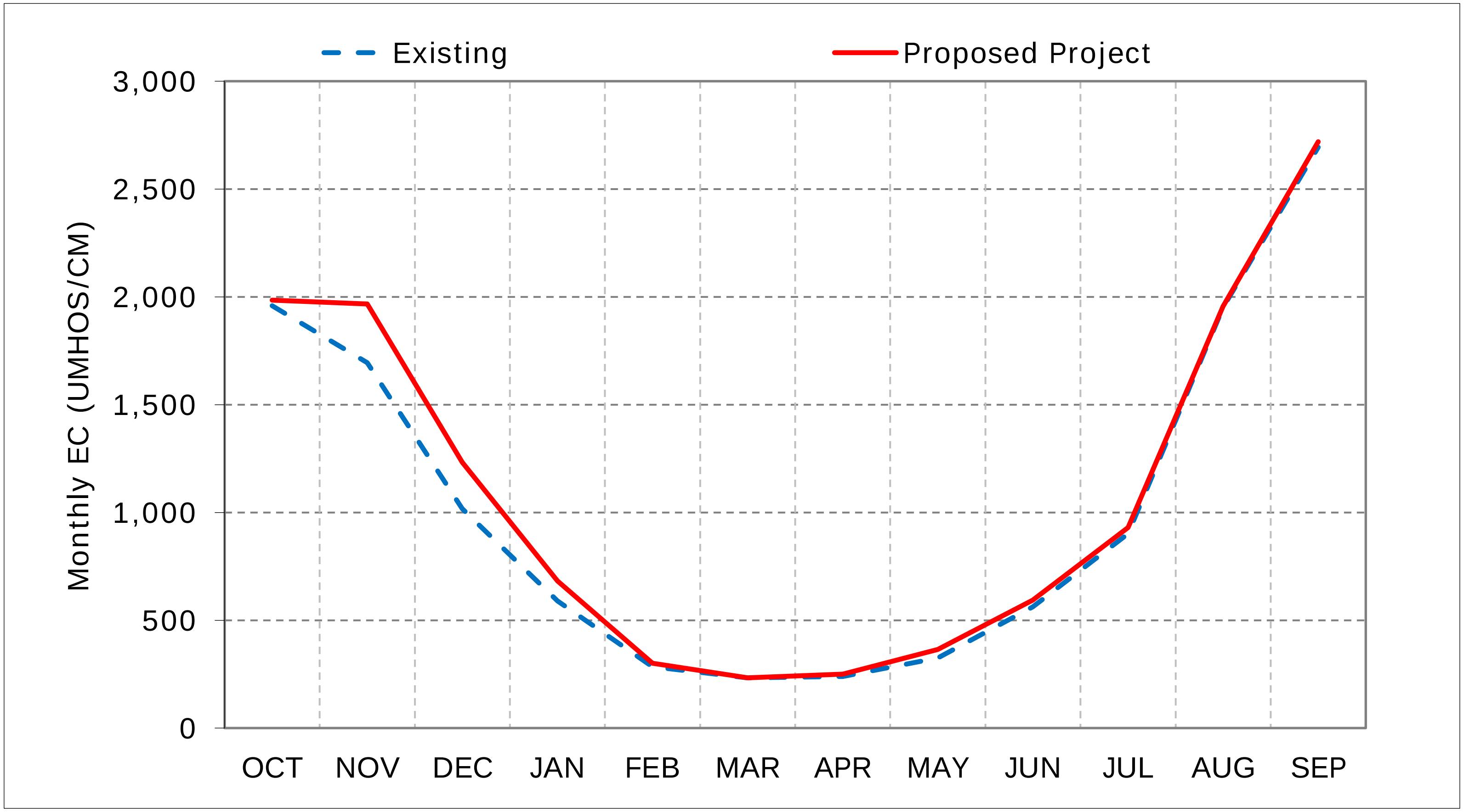
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 5-4. Sacramento River at Emmaton Salinity, Below Normal Year Average EC



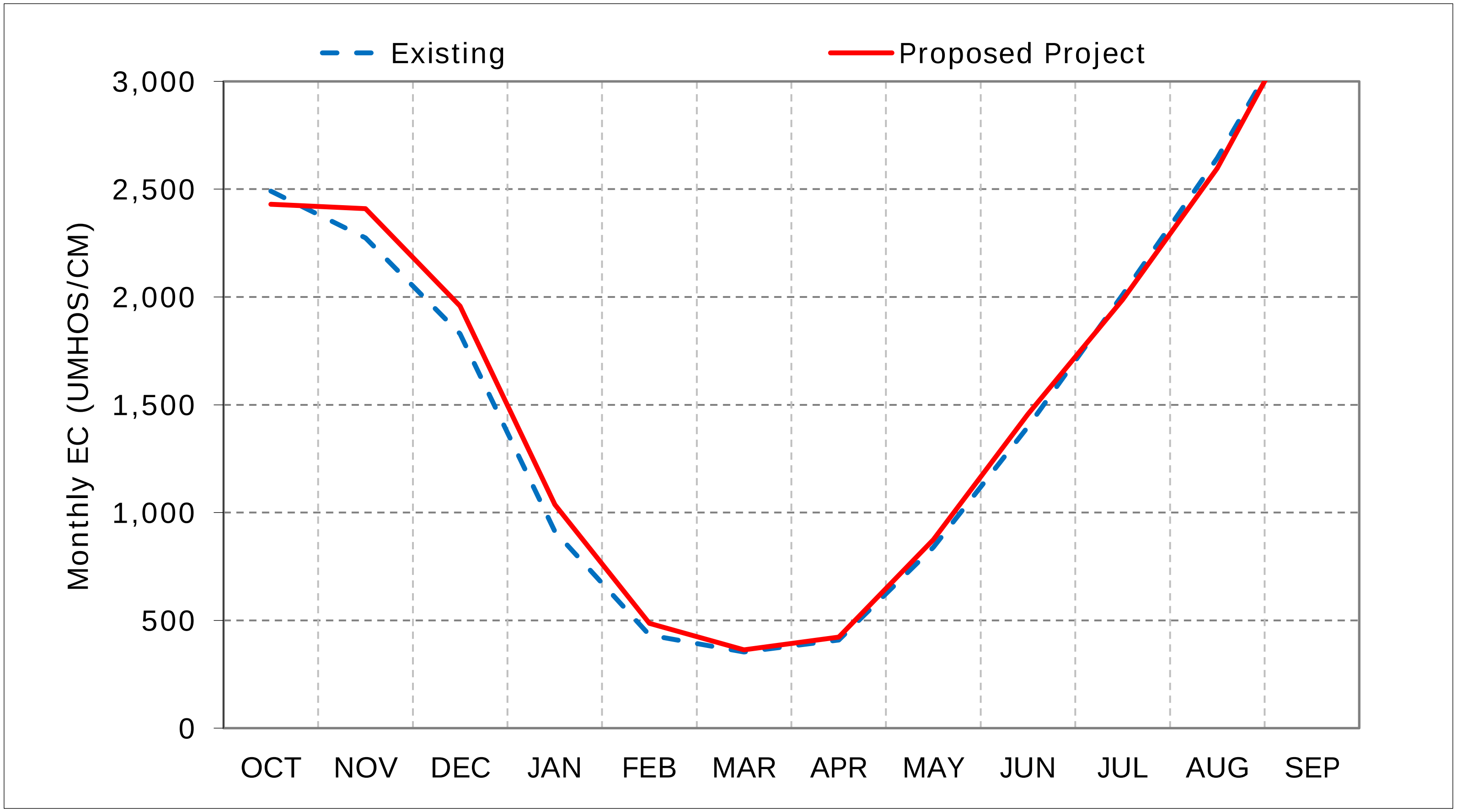
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 5-5. Sacramento River at Emmaton Salinity, Dry Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 5-6. Sacramento River at Emmaton Salinity, Critical Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 5-7. Sacramento River at Emmaton Salinity, January EC

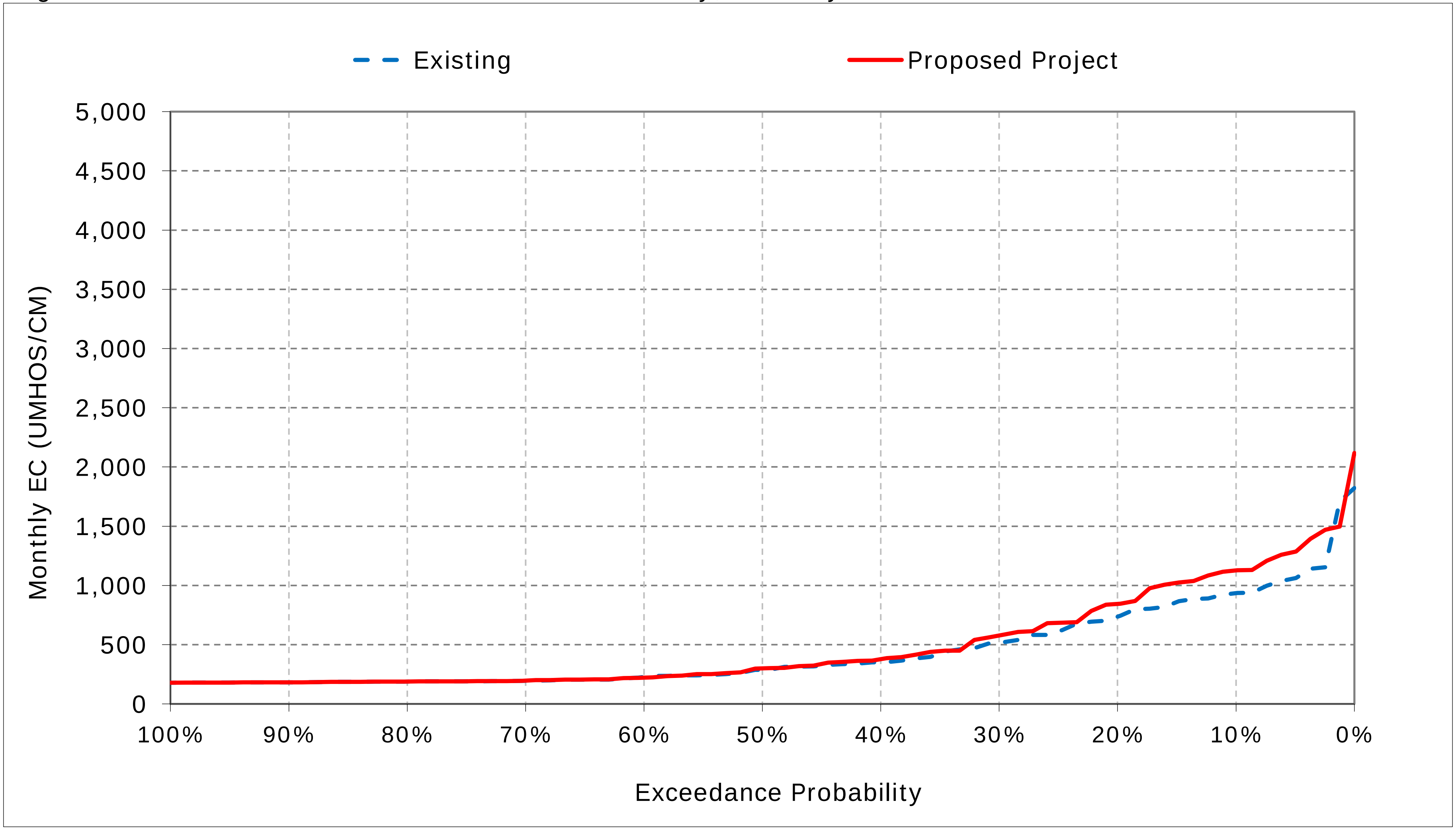


Figure 5-8. Sacramento River at Emmaton Salinity, February EC

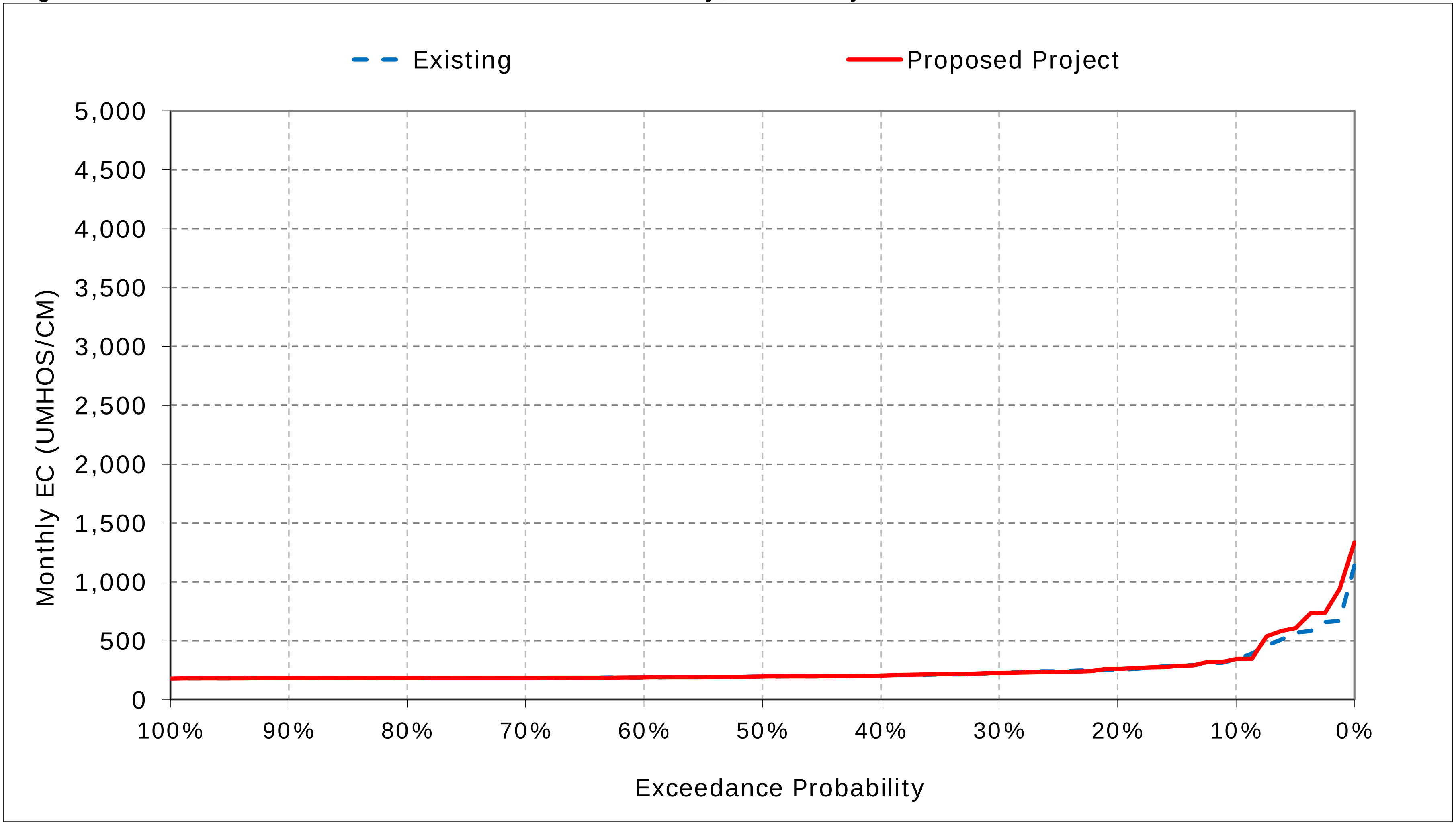


Figure 5-9. Sacramento River at Emmaton Salinity, March EC

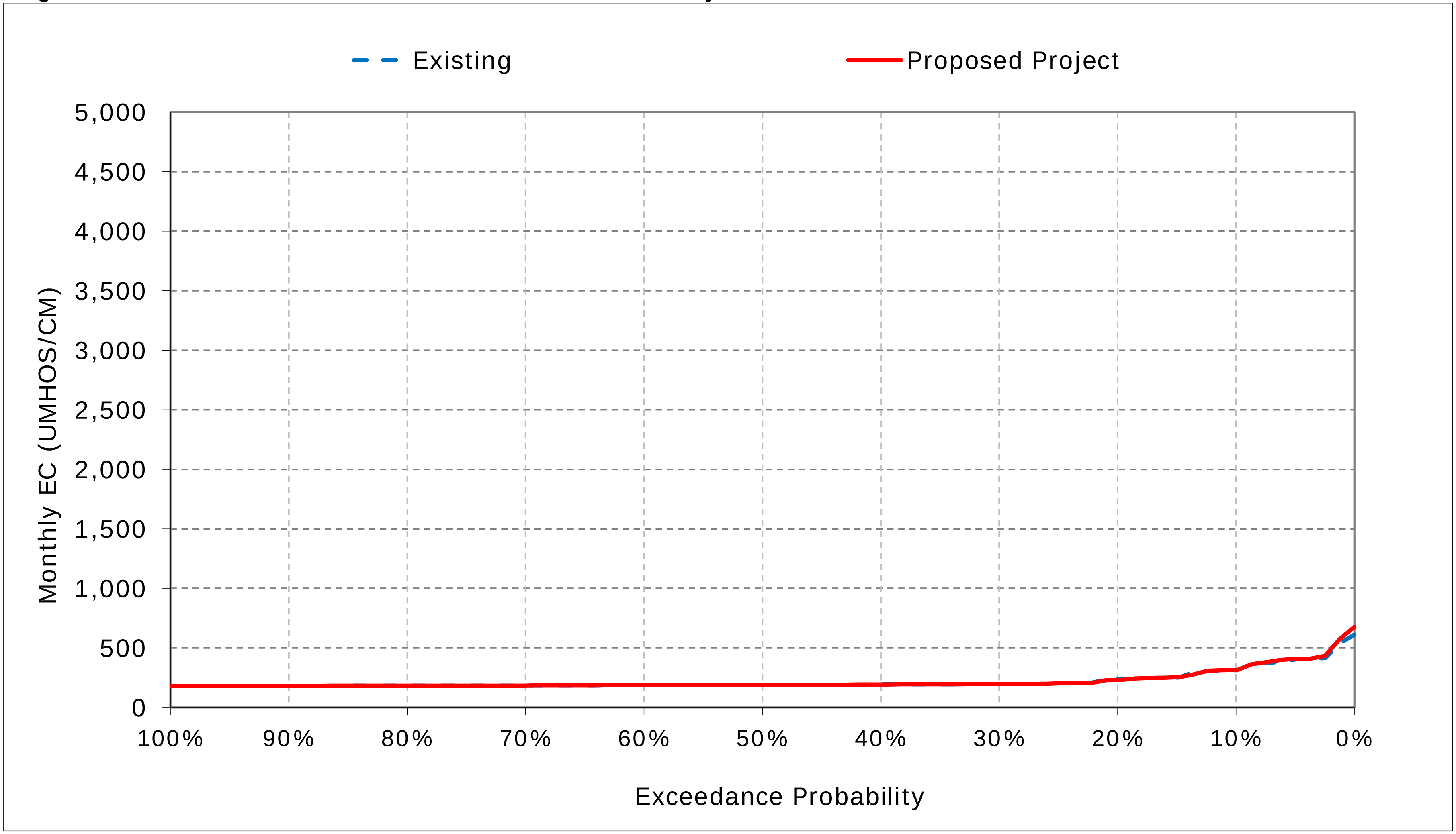


Figure 5-10. Sacramento River at Emmaton Salinity, April EC

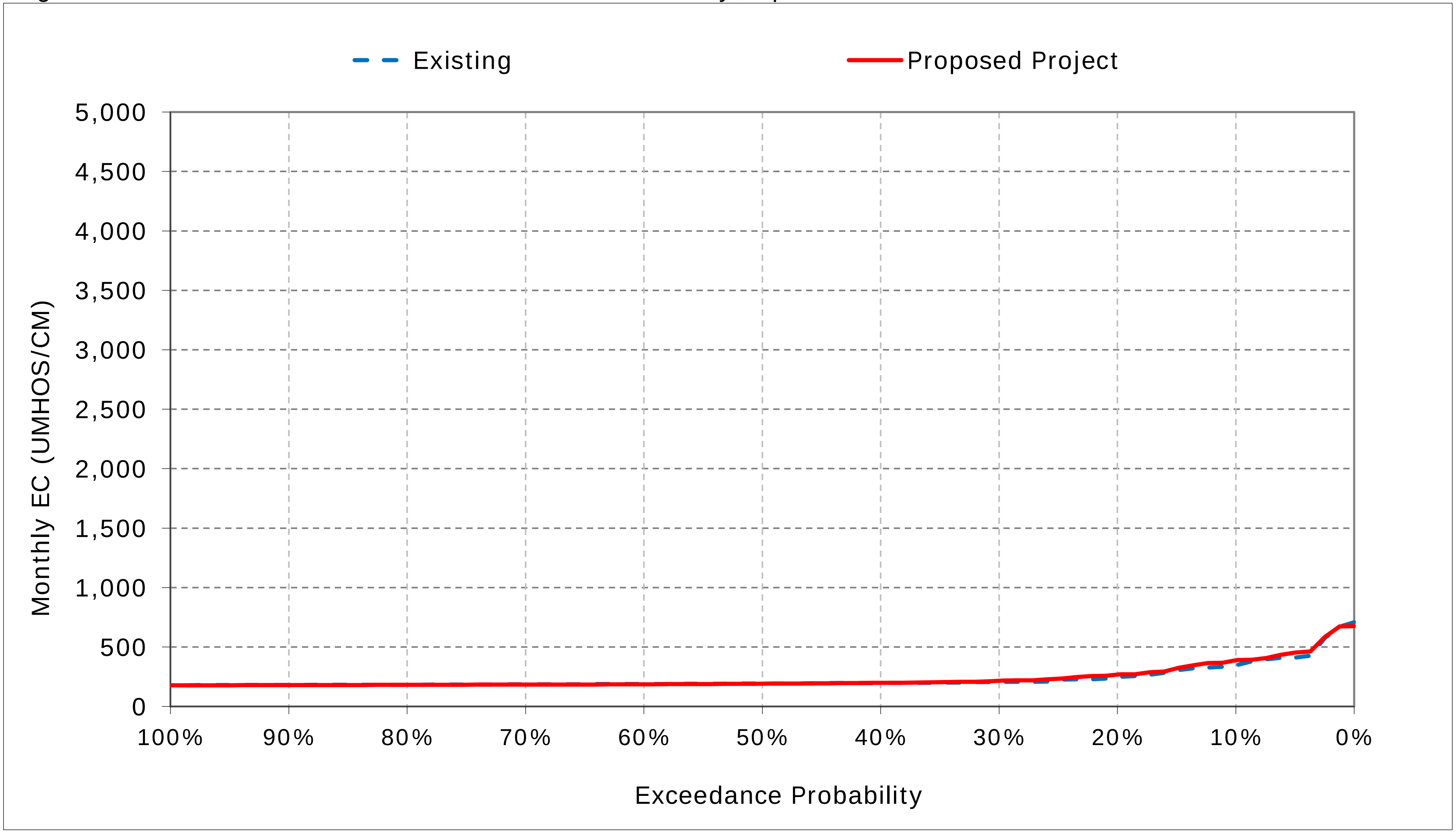


Figure 5-11. Sacramento River at Emmaton Salinity, May EC

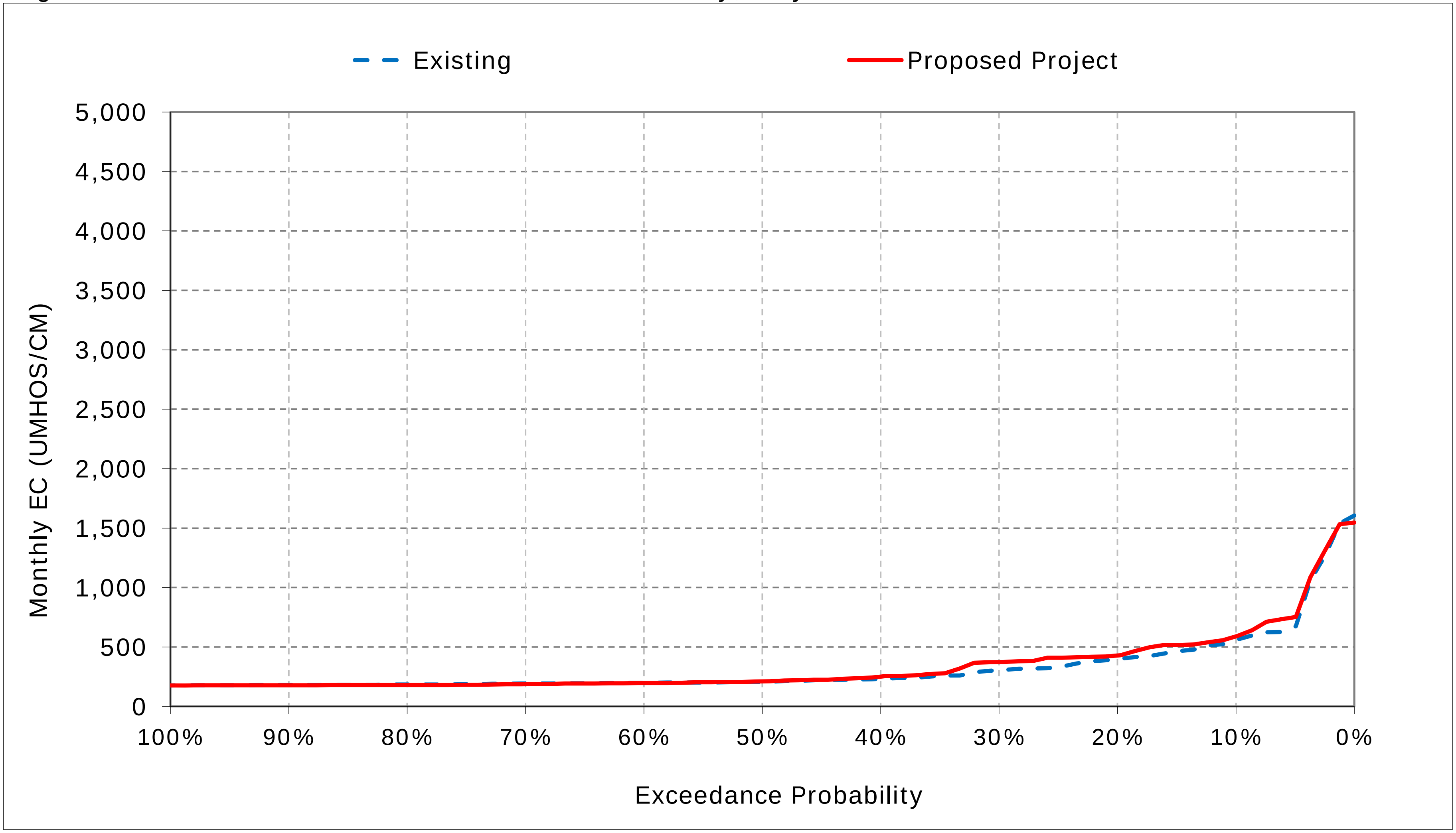


Figure 5-12. Sacramento River at Emmaton Salinity, June EC

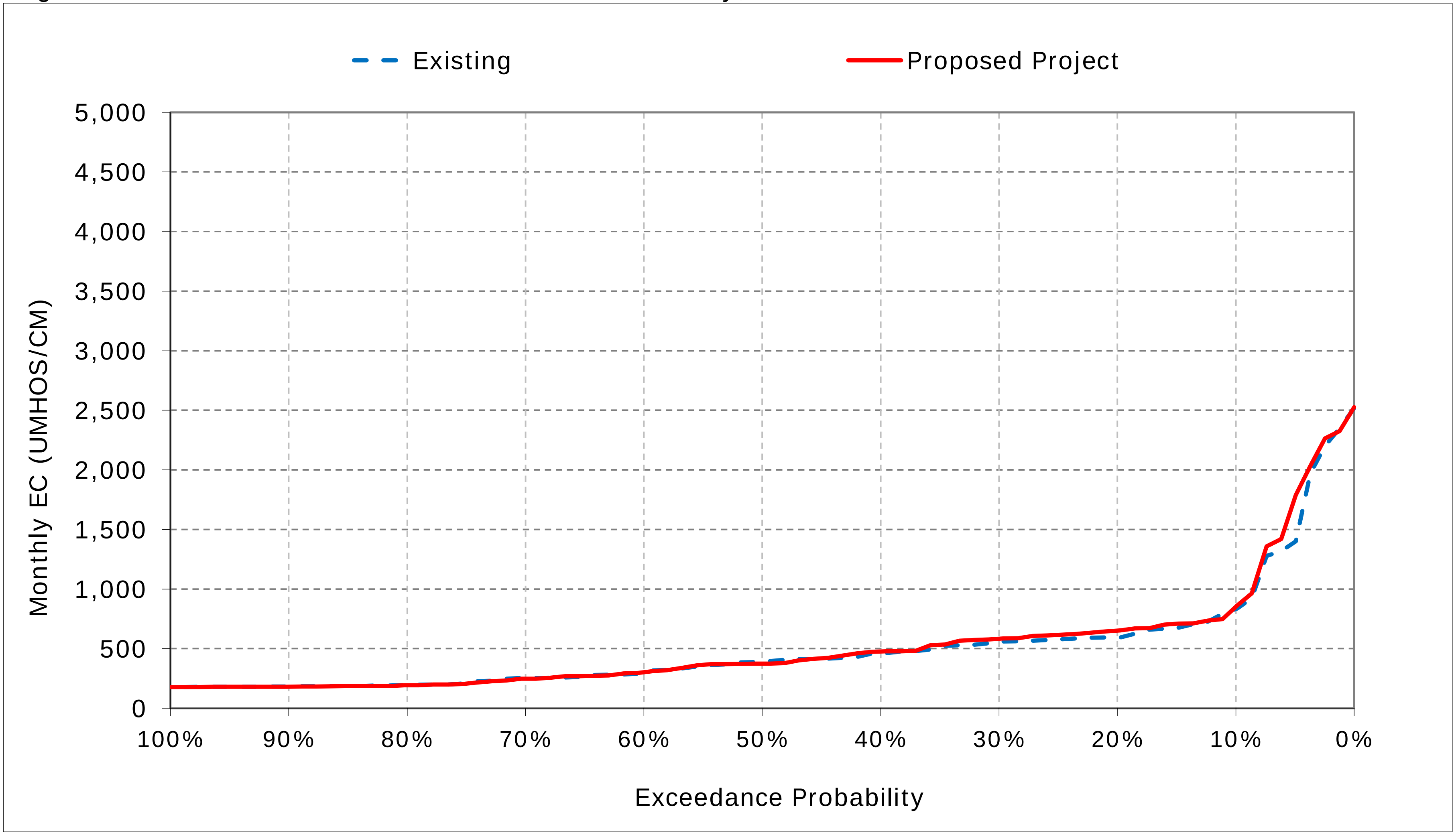


Figure 5-13. Sacramento River at Emmaton Salinity, July EC

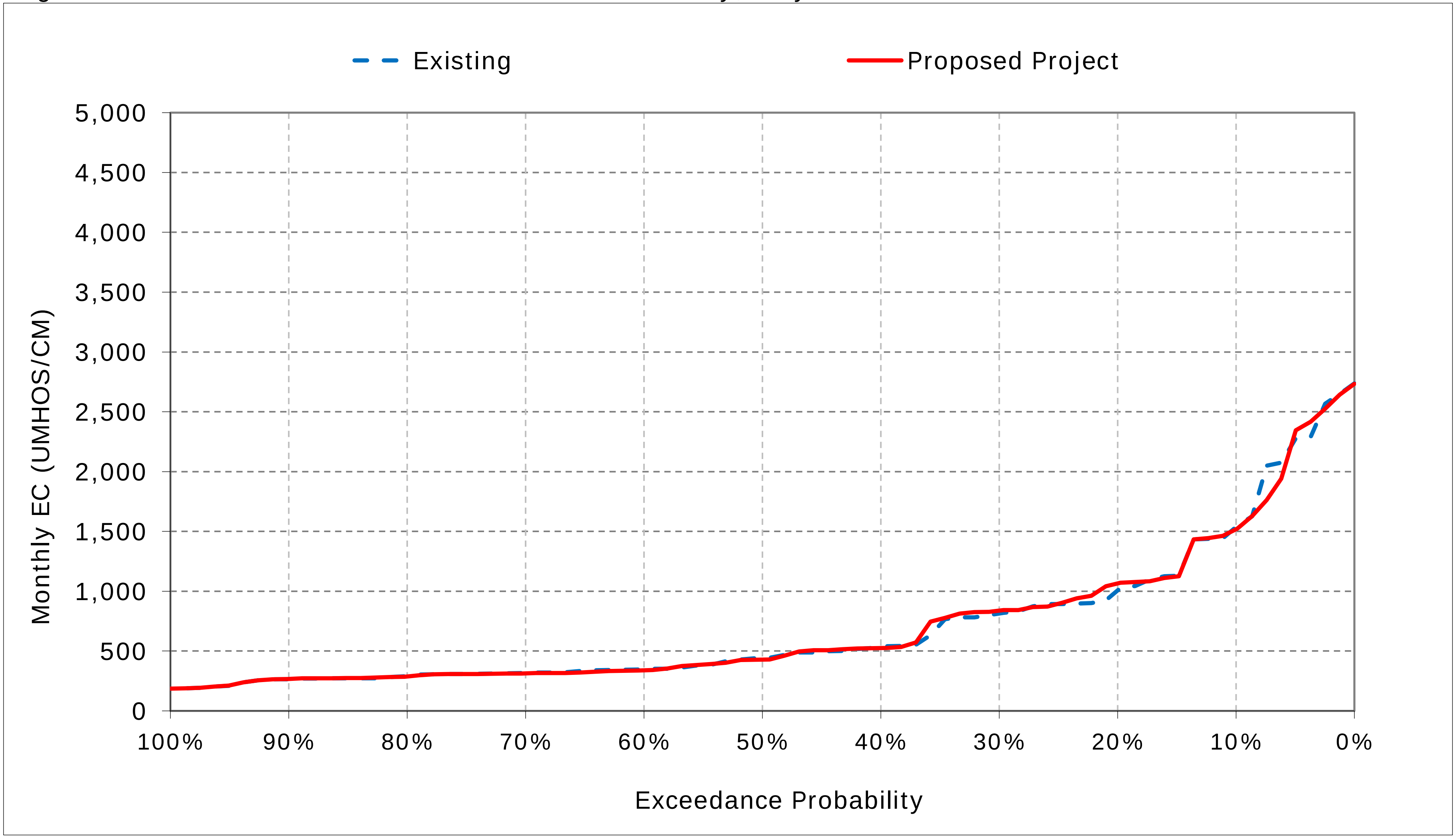


Figure 5-14. Sacramento River at Emmaton Salinity, August EC

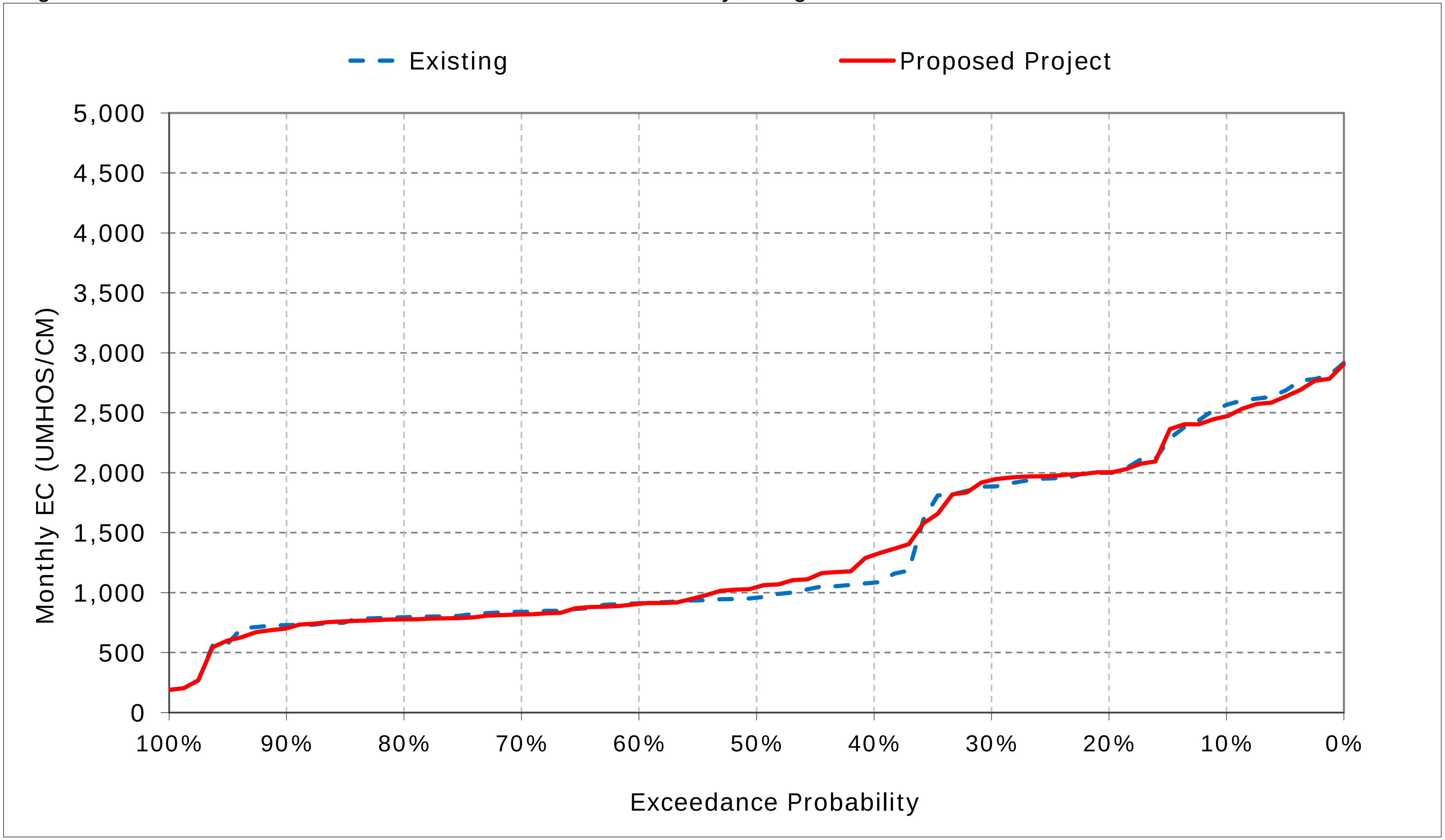


Figure 5-15. Sacramento River at Emmaton Salinity, September EC

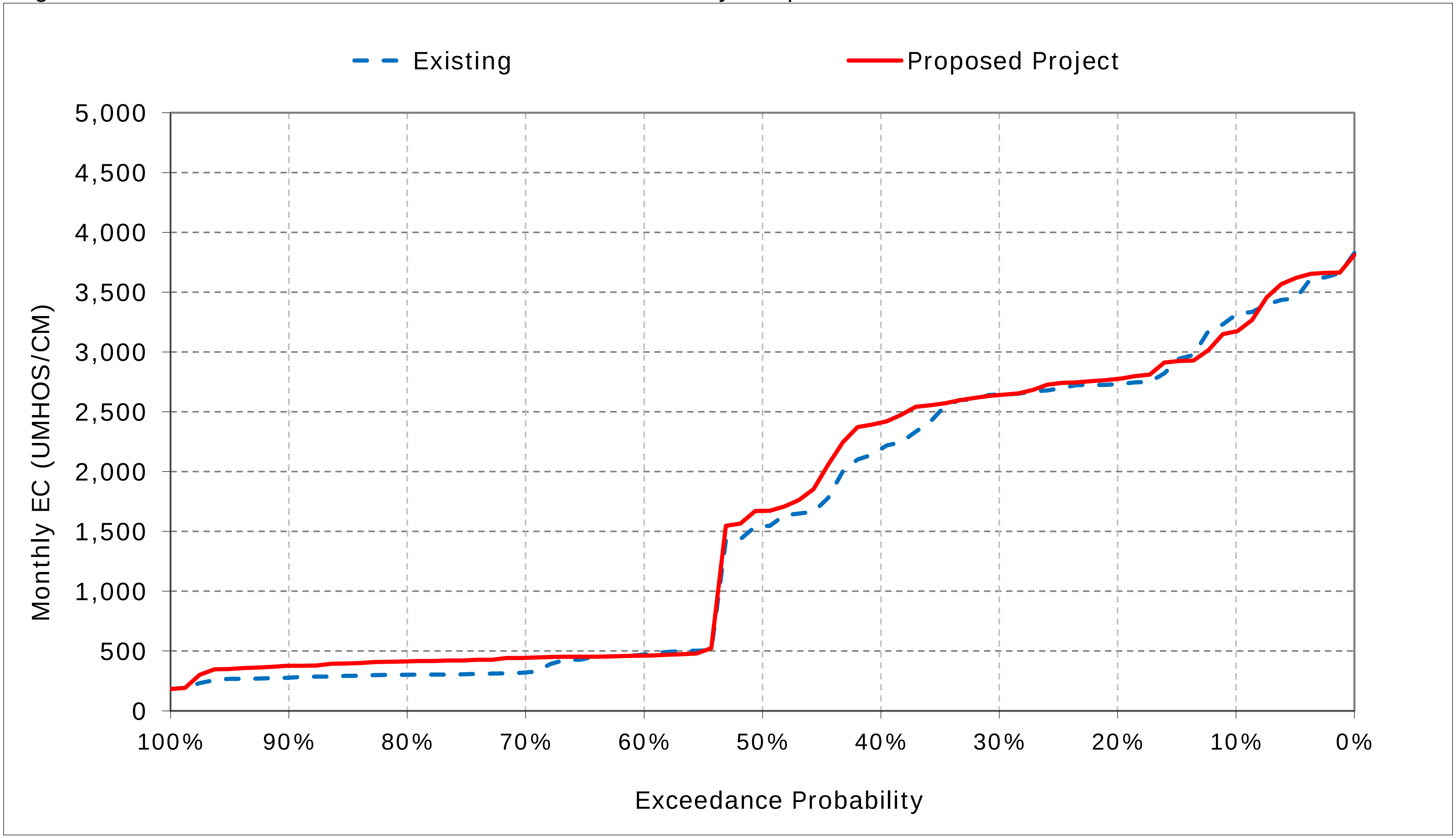


Figure 5-16. Sacramento River at Emmaton Salinity, October EC

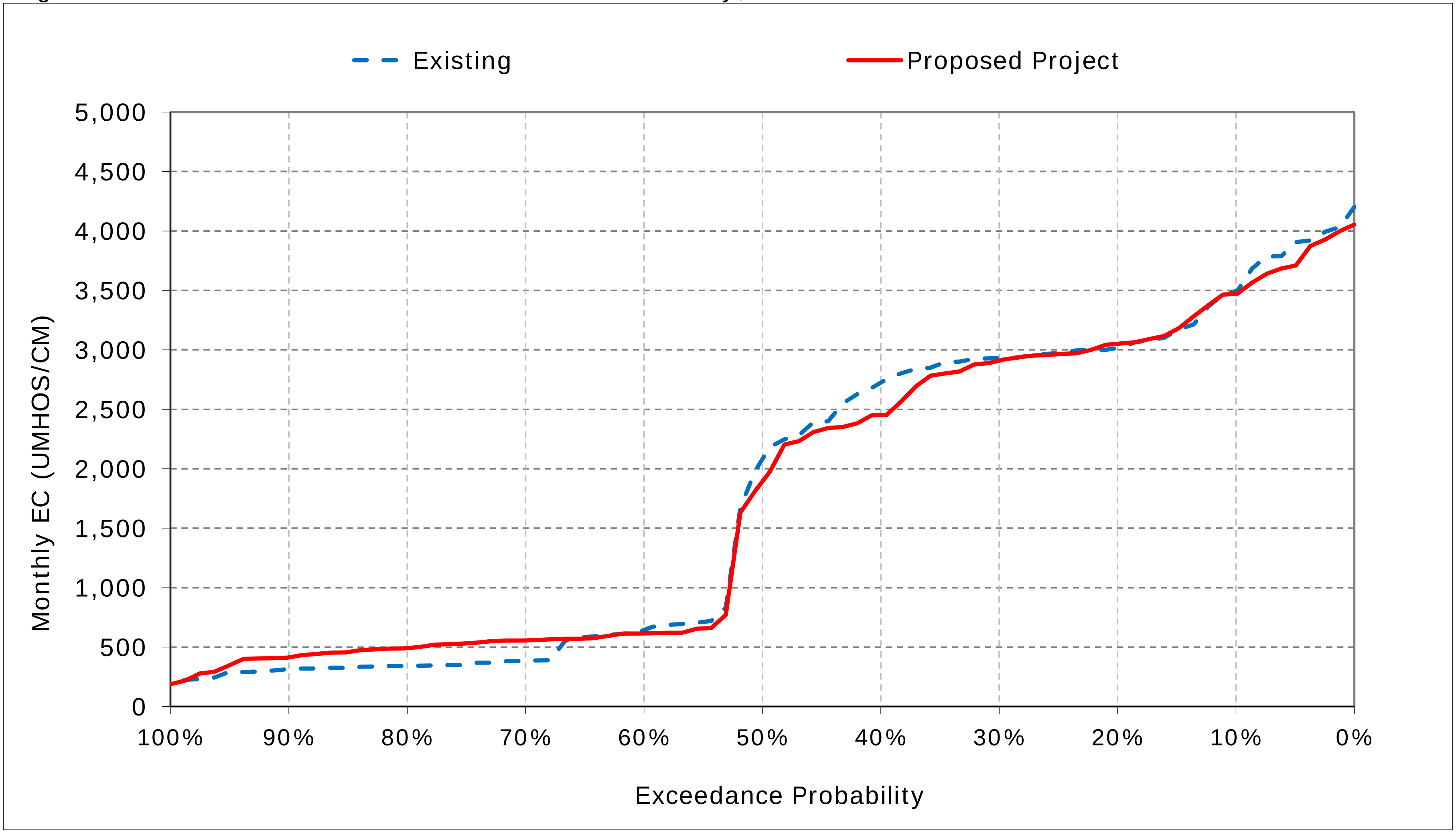


Figure 5-17. Sacramento River at Emmaton Salinity, November EC

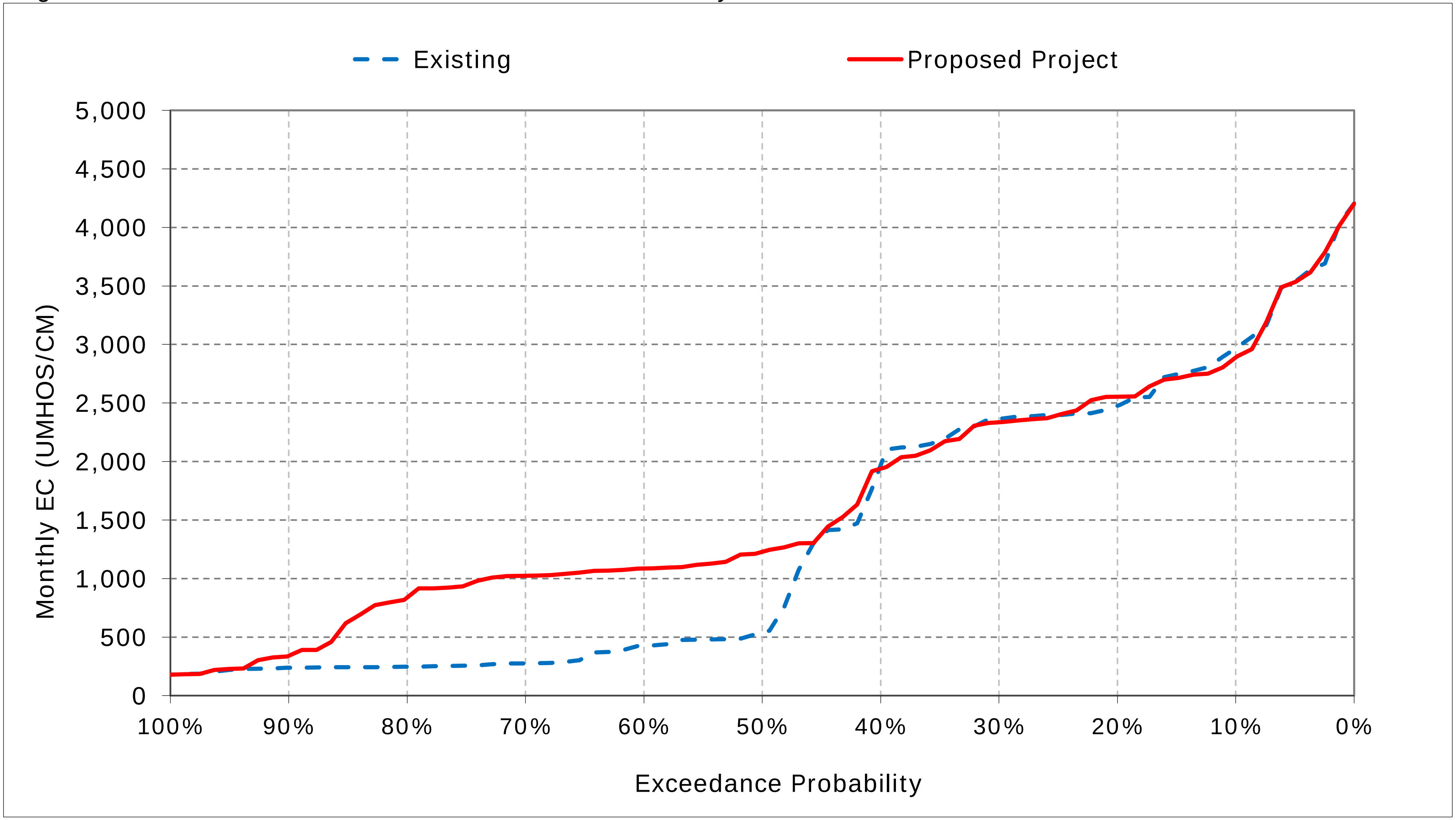


Figure 5-18. Sacramento River at Emmaton Salinity, December EC

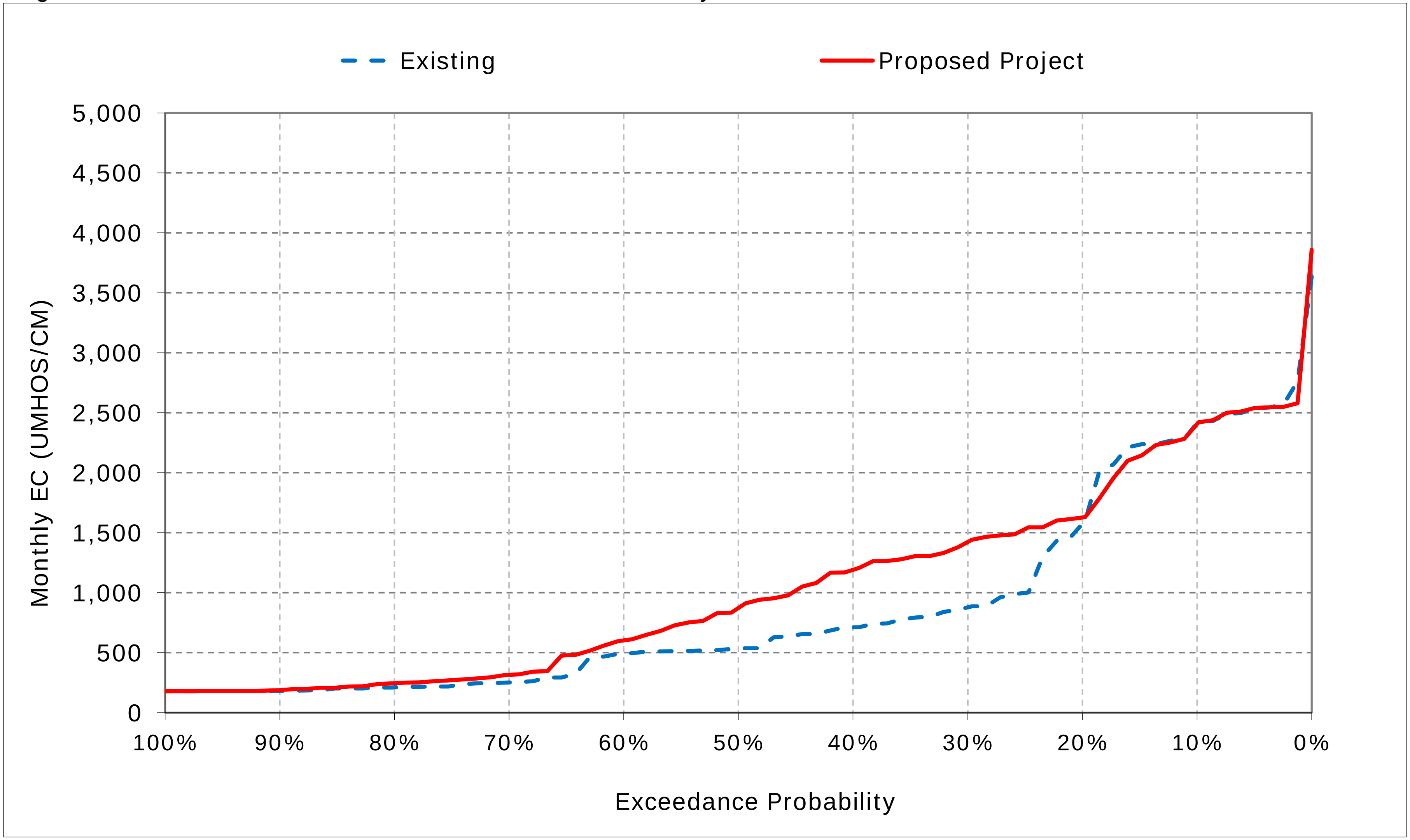


Table 6-1. Sacramento River at Collinsville Salinity, Monthly EC

Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	10,576	9,848	9,110	5,105	2,153	1,842	2,026	3,079	4,154	6,137	8,347	9,582
20%	9,842	9,273	7,373	4,259	1,341	965	1,027	2,112	3,307	5,010	7,170	8,936
30%	9,646	9,043	4,970	3,105	672	409	536	1,575	3,161	4,557	6,921	8,738
40%	9,323	8,431	4,102	1,656	393	313	407	851	2,547	3,240	5,285	7,855
50%	8,256	3,431	3,308	1,242	307	241	282	507	2,124	2,813	4,844	6,723
60%	3,721	2,939	3,073	649	215	209	221	349	1,490	2,140	4,720	2,769
70%	1,999	1,622	1,015	236	200	193	205	258	1,082	1,957	4,400	1,435
80%	1,856	1,375	518	205	192	189	195	200	468	1,696	4,159	1,261
90%	1,734	1,254	228	189	188	187	188	188	202	1,244	3,922	1,150
Long Term												
Full Simulation Period[a]	6,225	5,334	3,898	2,034	825	598	694	1,198	2,287	3,353	5,506	5,364
Water Year Types[b]												
Wet (32%)	4,702	3,187	1,148	404	202	200	220	295	726	1,457	3,869	1,153
Above Normal (15%)	6,525	5,298	3,716	1,157	344	206	239	342	1,446	1,943	4,256	2,698
Below Normal (17%)	6,541	5,825	5,091	2,147	511	414	447	787	2,047	3,006	5,064	7,241
Dry (22%)	6,655	6,322	4,797	3,160	1,238	759	877	1,623	3,094	4,725	7,025	8,834
Critical (15%)	8,210	7,970	7,294	4,624	2,401	1,826	2,188	3,854	5,577	7,217	8,538	9,762

Proposed Project

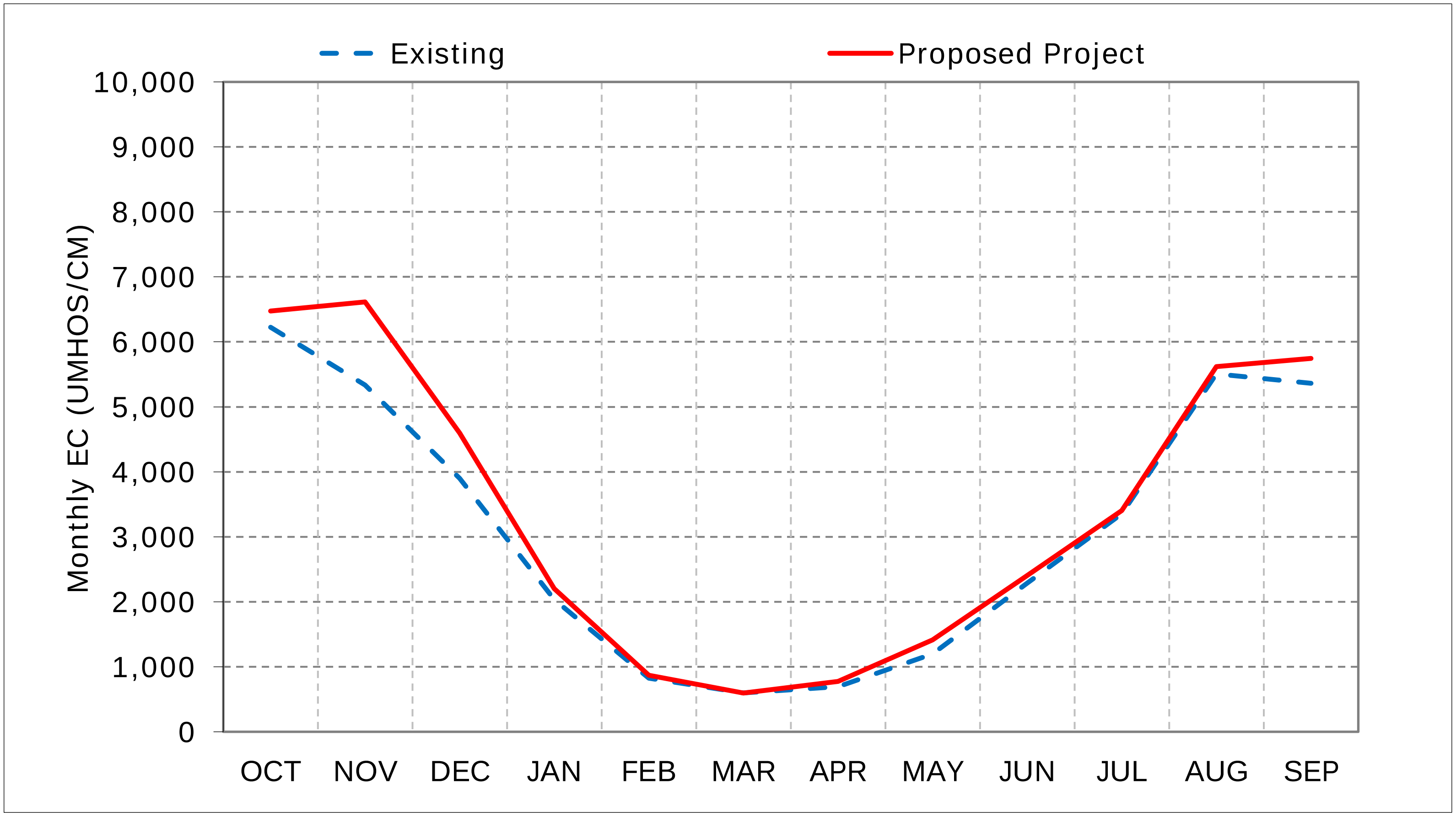
Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	10,439	9,621	9,107	5,883	2,047	1,861	2,202	3,282	4,219	6,086	8,218	9,547
20%	9,793	9,299	7,403	4,723	1,312	896	1,291	2,579	3,594	5,118	7,184	8,992
30%	9,615	9,068	6,897	3,477	690	366	719	2,184	3,262	4,508	6,964	8,759
40%	8,944	8,377	6,353	1,821	378	289	513	1,187	2,832	3,513	6,273	8,297
50%	7,945	6,073	5,110	1,210	314	229	343	753	2,148	2,980	5,421	6,850
60%	3,501	5,702	3,633	590	215	206	229	547	1,722	2,104	4,669	2,638
70%	3,281	5,530	1,351	240	199	194	209	332	1,261	1,929	4,375	2,518
80%	3,097	4,846	855	201	193	189	191	199	484	1,721	4,096	2,358
90%	2,779	2,000	297	189	188	187	186	183	201	1,248	3,877	2,114
Long Term												
Full Simulation Period[a]	6,476	6,615	4,596	2,202	868	596	775	1,413	2,405	3,404	5,618	5,744
Water Year Types[b]												
Wet (32%)	5,073	4,815	1,527	399	199	198	244	400	834	1,462	3,785	2,222
Above Normal (15%)	6,786	6,662	4,783	1,266	285	203	275	508	1,497	1,905	4,284	2,443
Below Normal (17%)	6,811	7,029	5,973	2,194	489	395	554	1,084	2,123	3,246	5,806	7,611
Dry (22%)	6,954	7,488	5,682	3,544	1,343	737	1,021	1,983	3,283	4,794	7,073	8,879
Critical (15%)	8,096	8,673	7,822	5,044	2,628	1,874	2,315	4,040	5,727	7,211	8,519	9,796

Proposed Project minus Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	-138	-228	-3	778	-106	20	176	203	65	-51	-129	-35
20%	-48	26	29	464	-29	-68	264	467	287	108	14	57
30%	-31	24	1,928	372	18	-43	183	610	101	-49	43	21
40%	-379	-54	2,251	165	-14	-23	105	336	285	273	988	442
50%	-311	2,642	1,802	-32	7	-13	61	246	25	167	577	127
60%	-219	2,764	561	-59	0	-4	7	198	232	-36	-51	-131
70%	1,282	3,909	336	5	-1	1	3	74	179	-28	-25	1,083
80%	1,241	3,471	337	-4	0	0	-4	-1	16	25	-63	1,097
90%	1,046	746	70	0	1	1	-2	-5	-1	4	-46	965
Long Term												
Full Simulation Period[a]	251	1,280	699	168	43	-2	81	215	118	51	112	380
Water Year Types[b]												
Wet (32%)	371	1,628	379	-5	-3	-2	24	104	108	5	-84	1,069
Above Normal (15%)	261	1,364	1,067	109	-58	-3	36	166	51	-39	28	-255
Below Normal (17%)	270	1,204	882	47	-22	-19	107	297	76	240	742	370
Dry (22%)	299	1,166	885	384	105	-22	145	360	189	69	49	45
Critical (15%)	-114	703	528	420	227	48	126	186	151	-6	-19	33

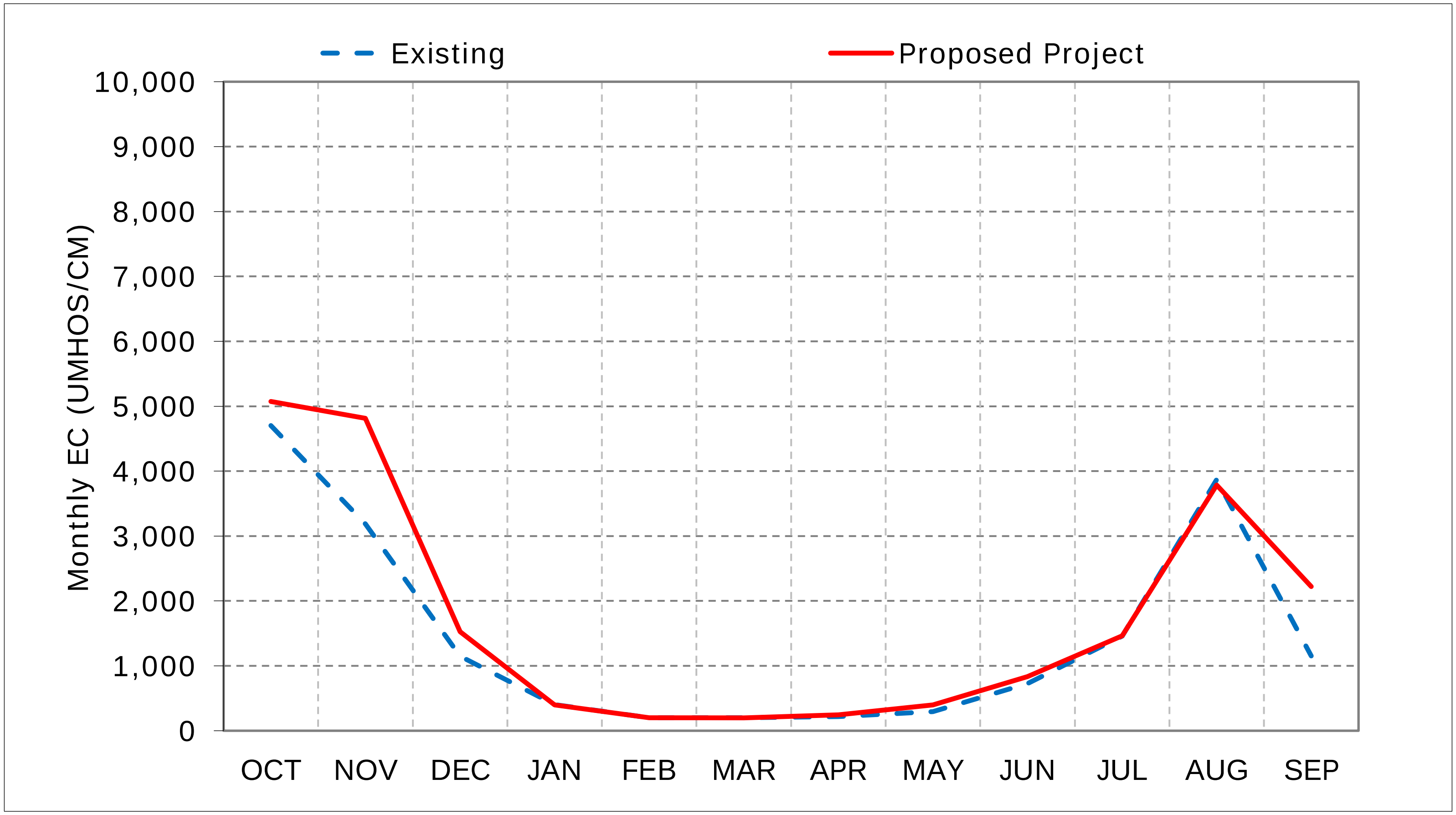
a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with water year - year type sorting.
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 6-1. Sacramento River at Collinsville Salinity, Long-Term Average EC



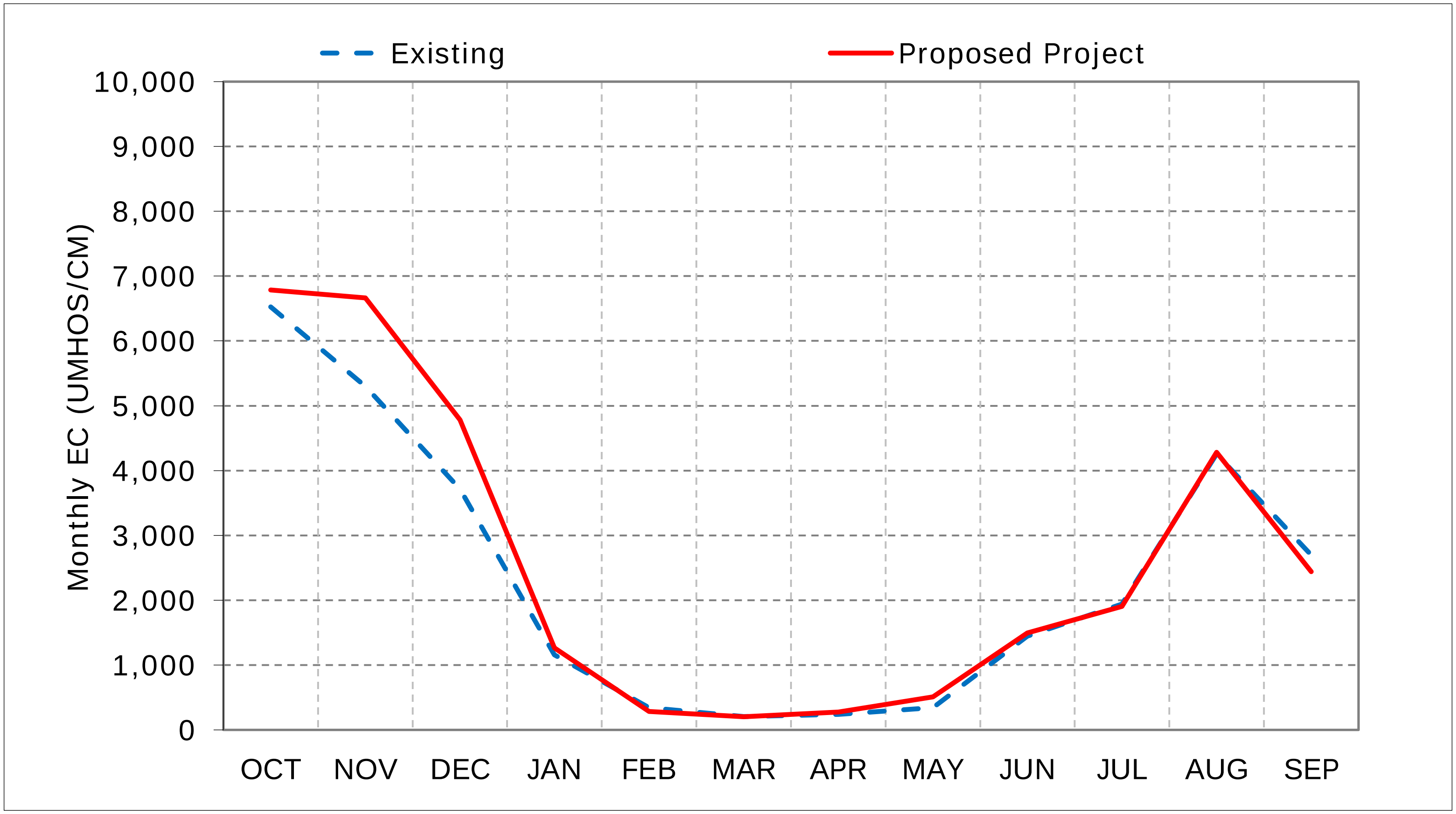
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 6-2. Sacramento River at Collinsville Salinity, Wet Year Average EC



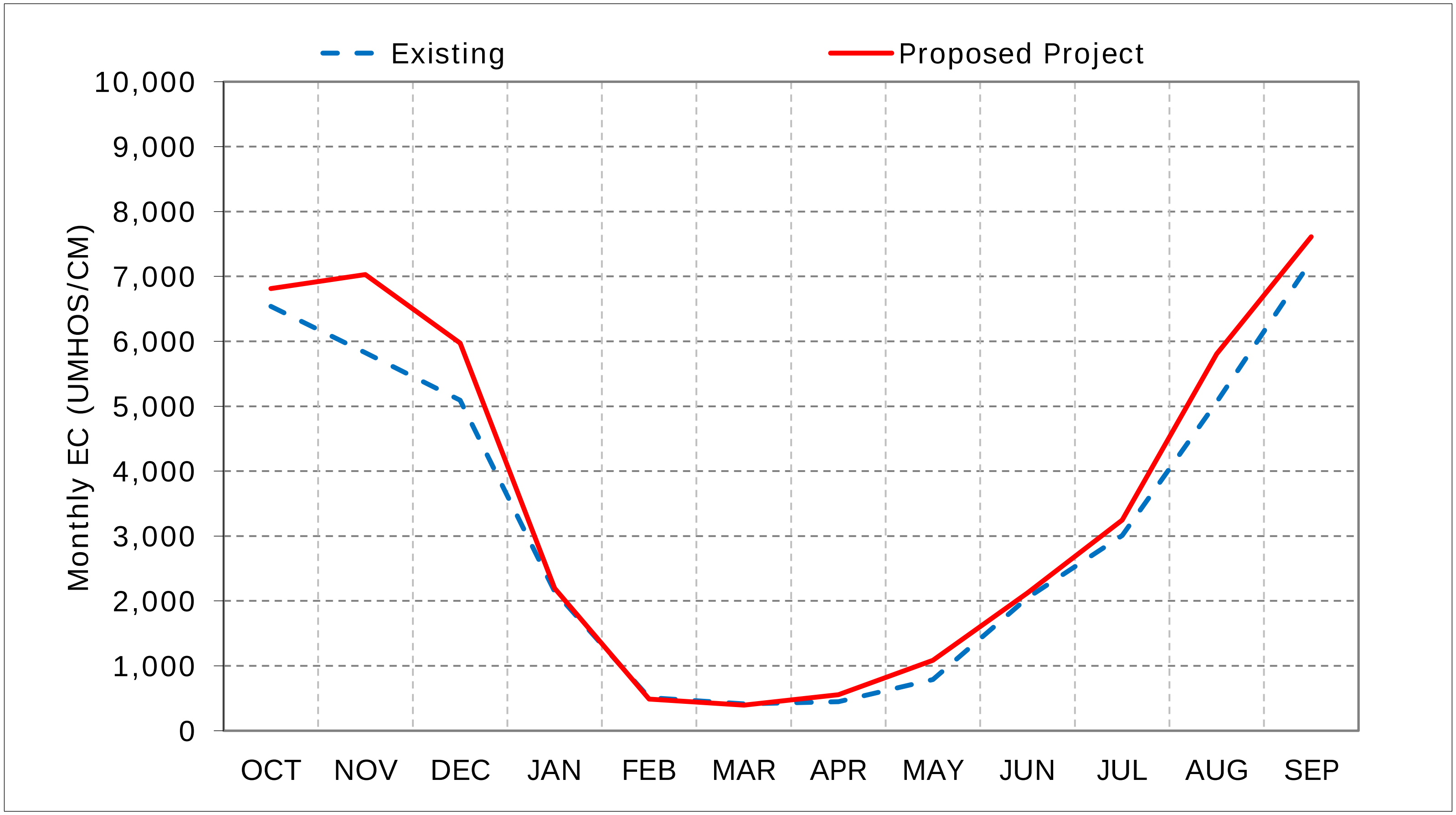
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 6-3. Sacramento River at Collinsville Salinity, Above Normal Year Average E



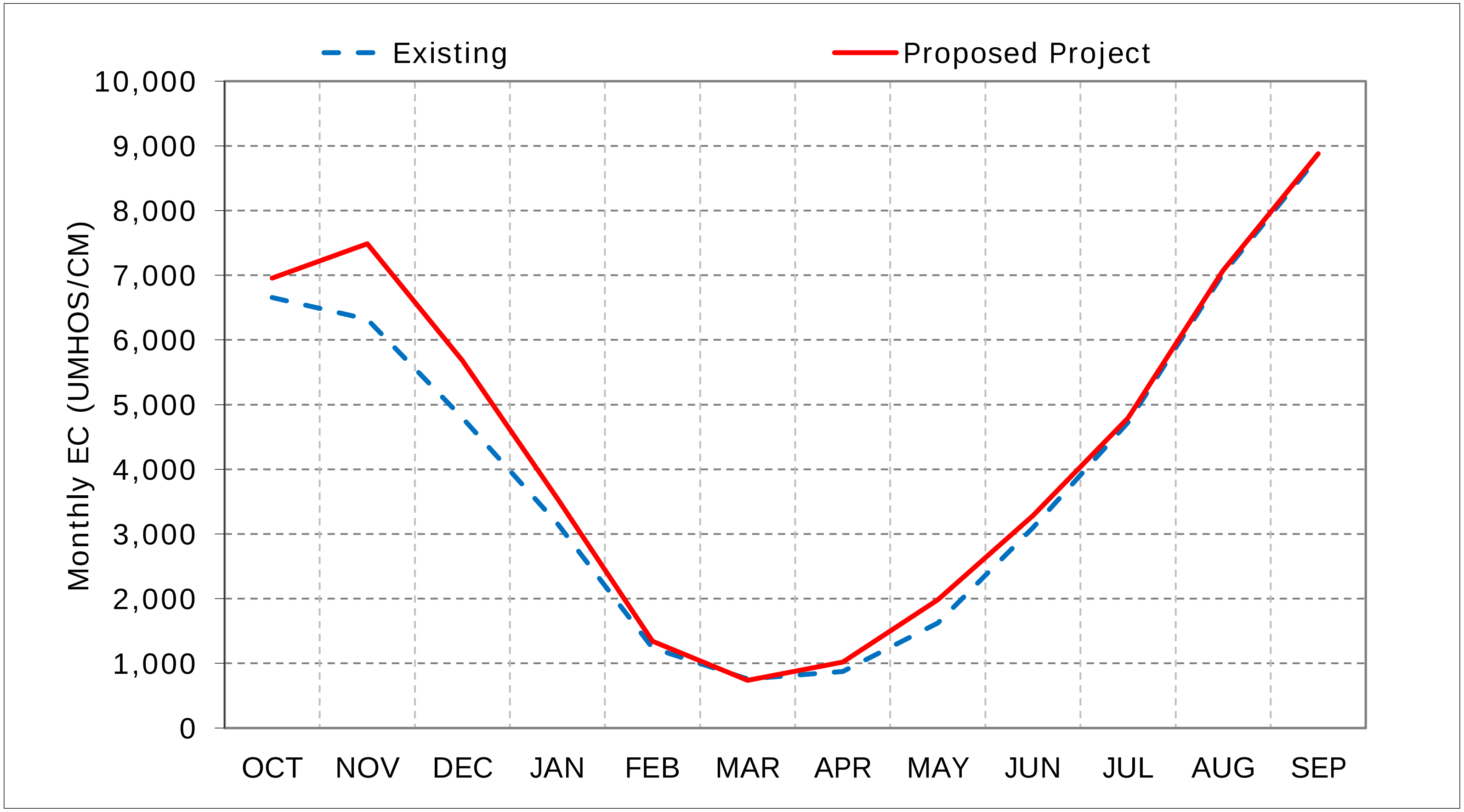
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 6-4. Sacramento River at Collinsville Salinity, Below Normal Year Average E



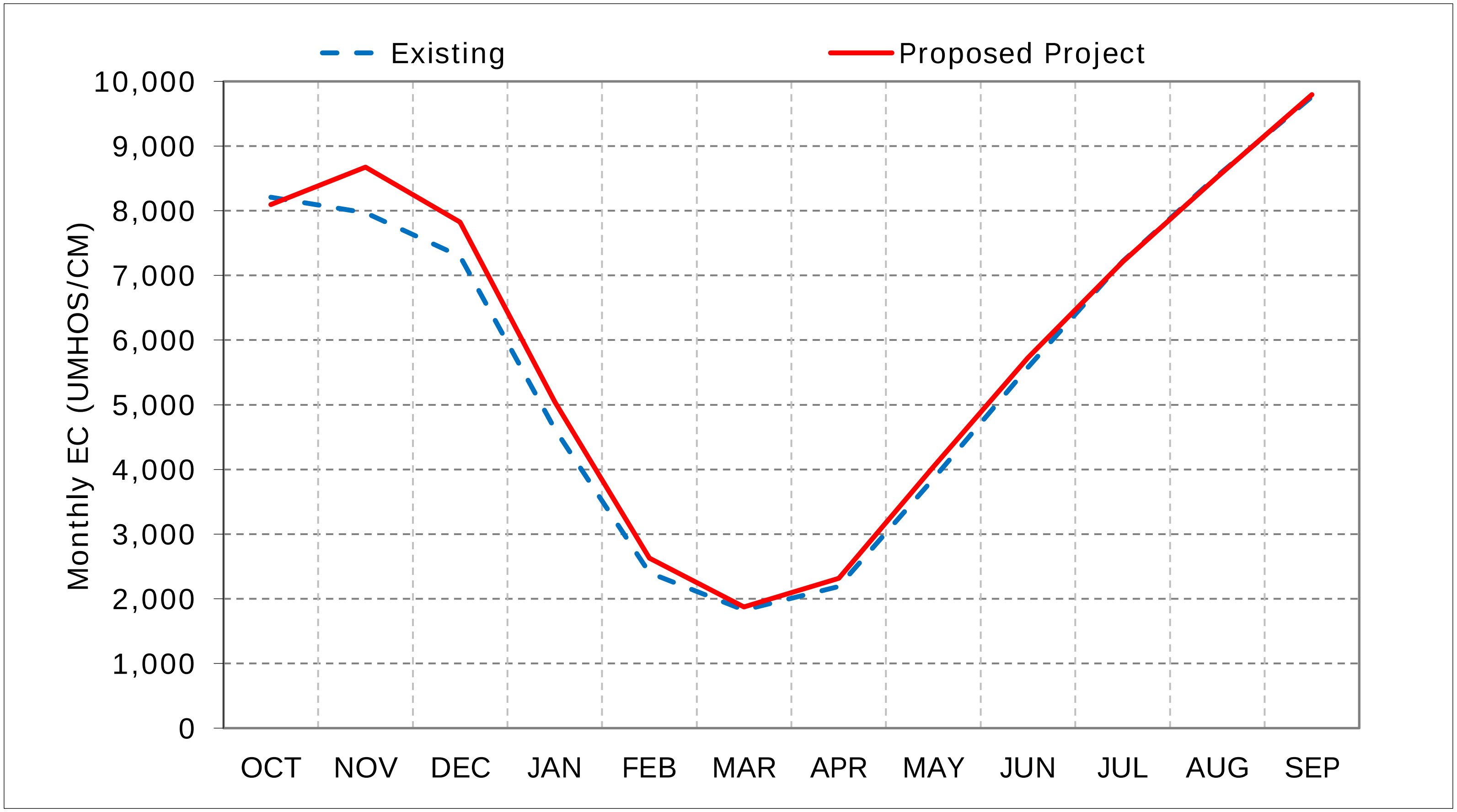
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 6-5. Sacramento River at Collinsville Salinity, Dry Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 6-6. Sacramento River at Collinsville Salinity, Critical Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 6-7. Sacramento River at Collinsville Salinity, January EC

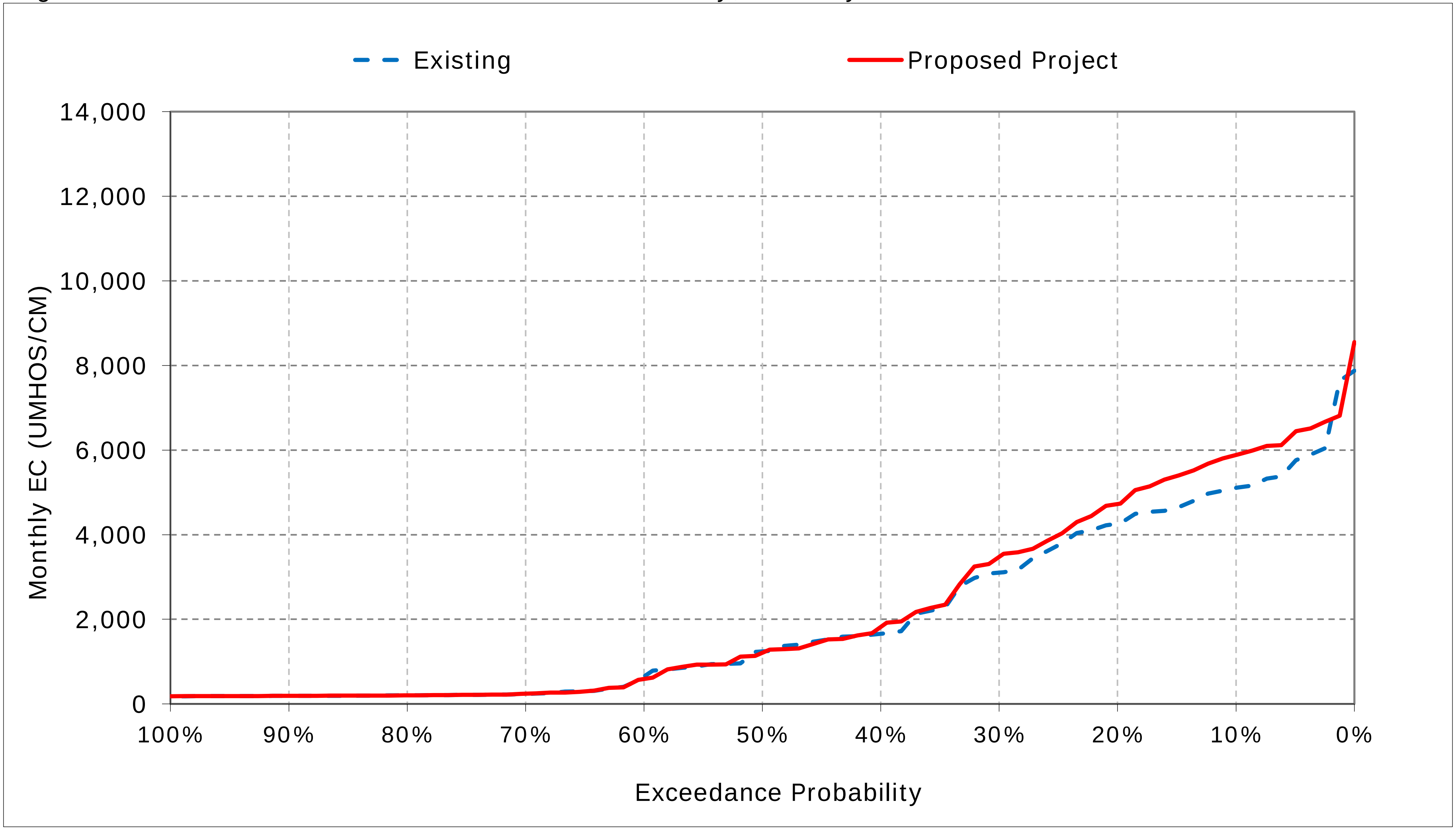


Figure 6-8. Sacramento River at Collinsville Salinity, February EC

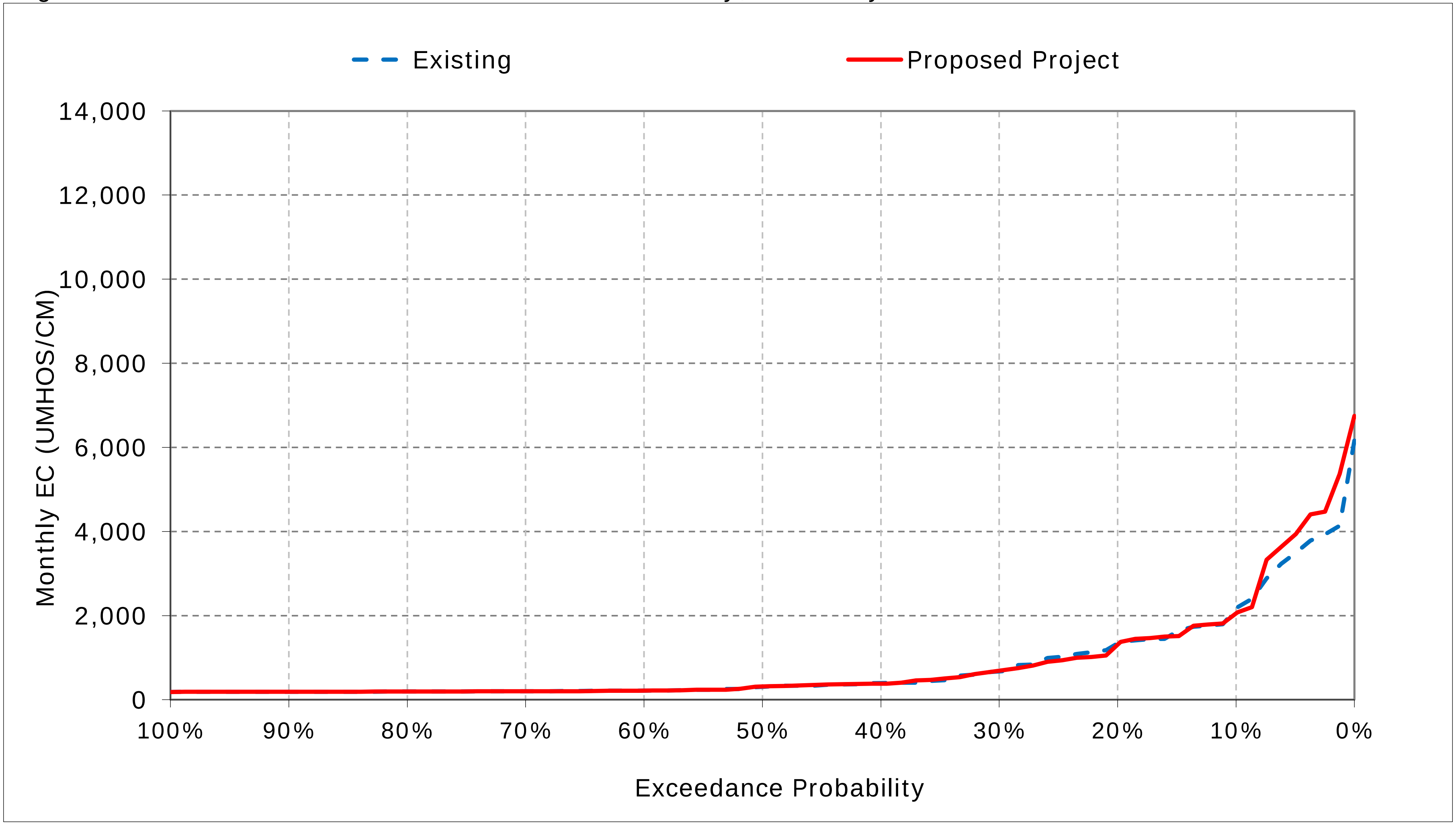


Figure 6-9. Sacramento River at Collinsville Salinity, March EC

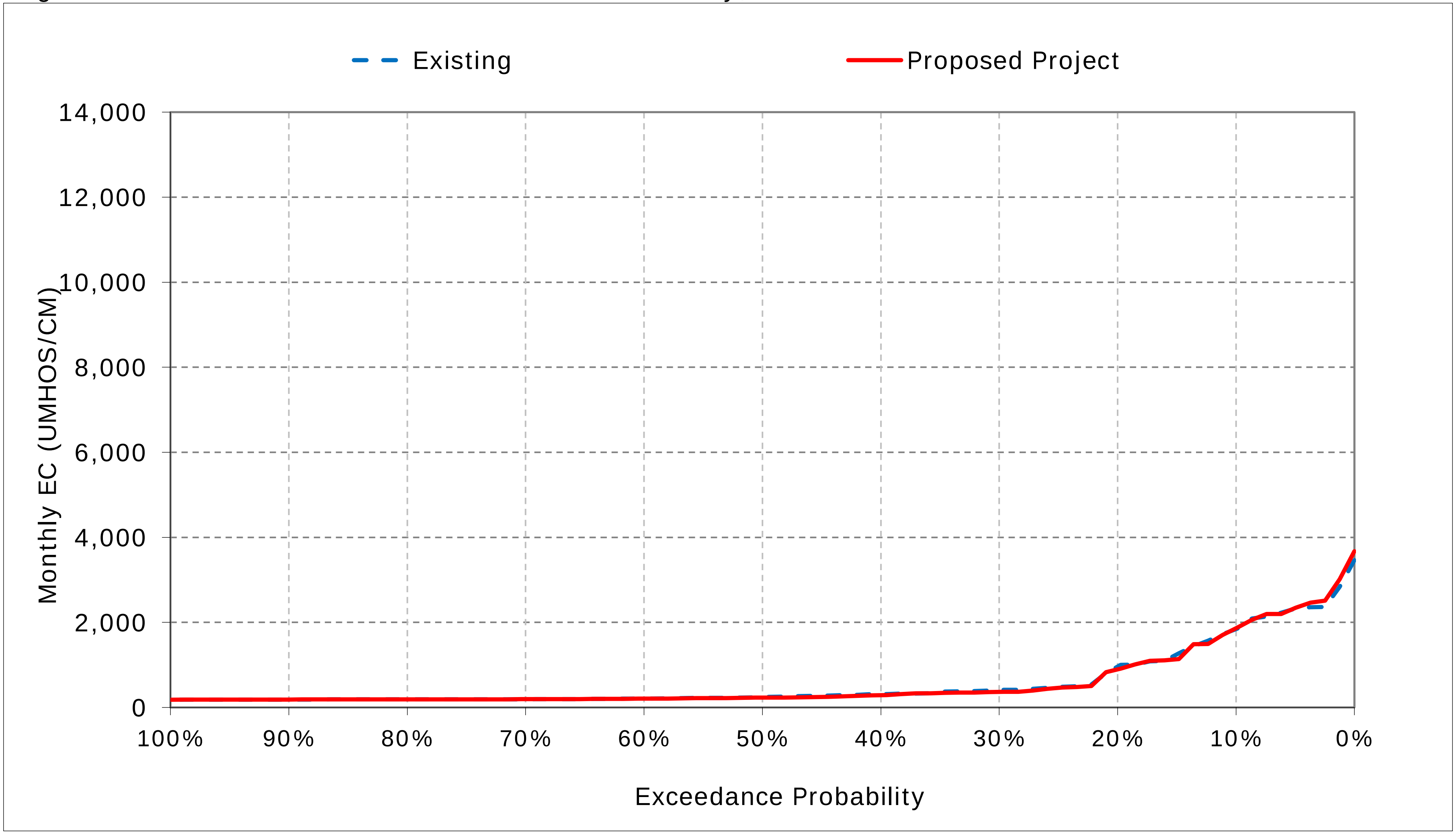


Figure 6-10. Sacramento River at Collinsville Salinity, April EC

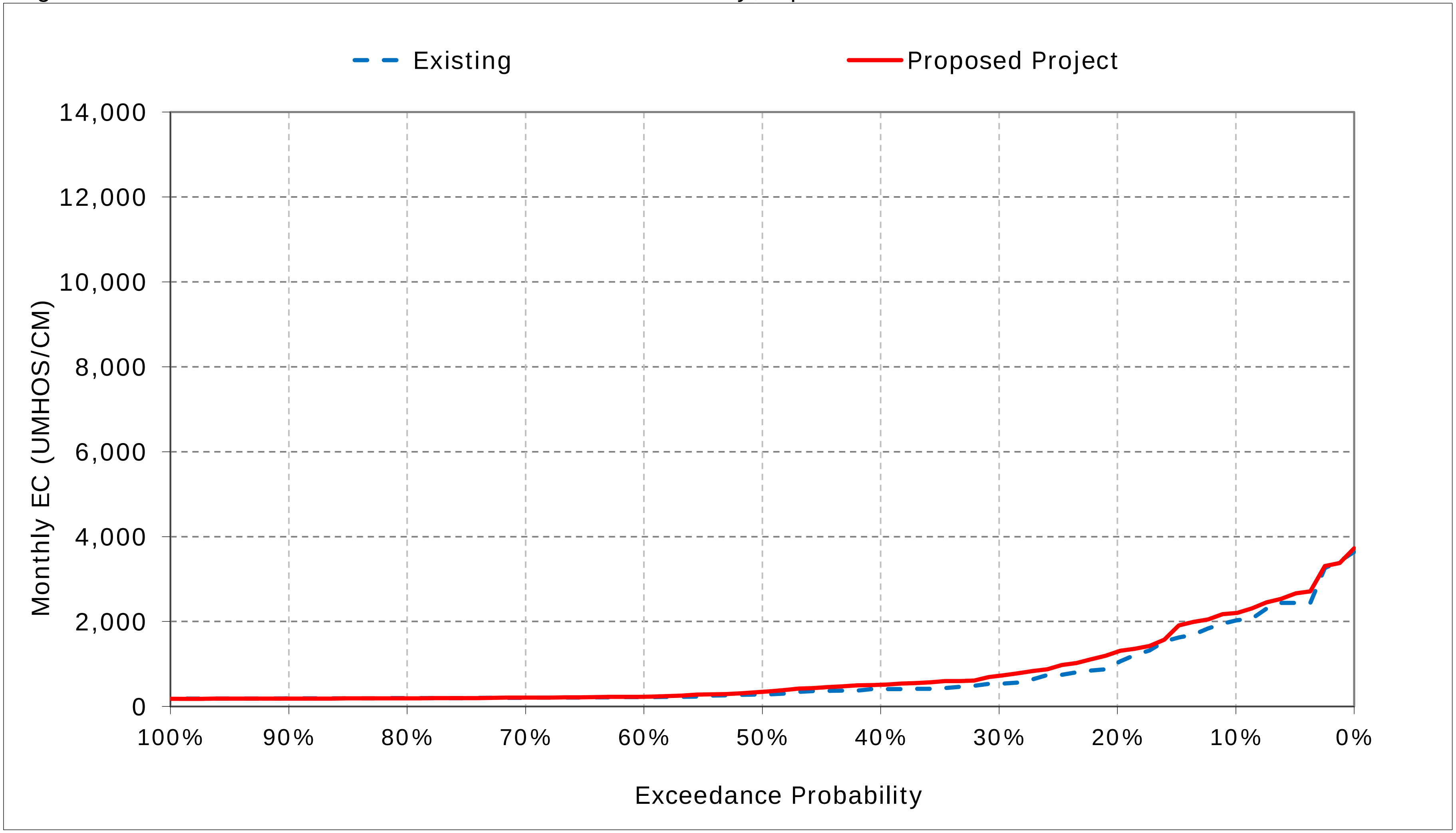


Figure 6-11. Sacramento River at Collinsville Salinity, May EC

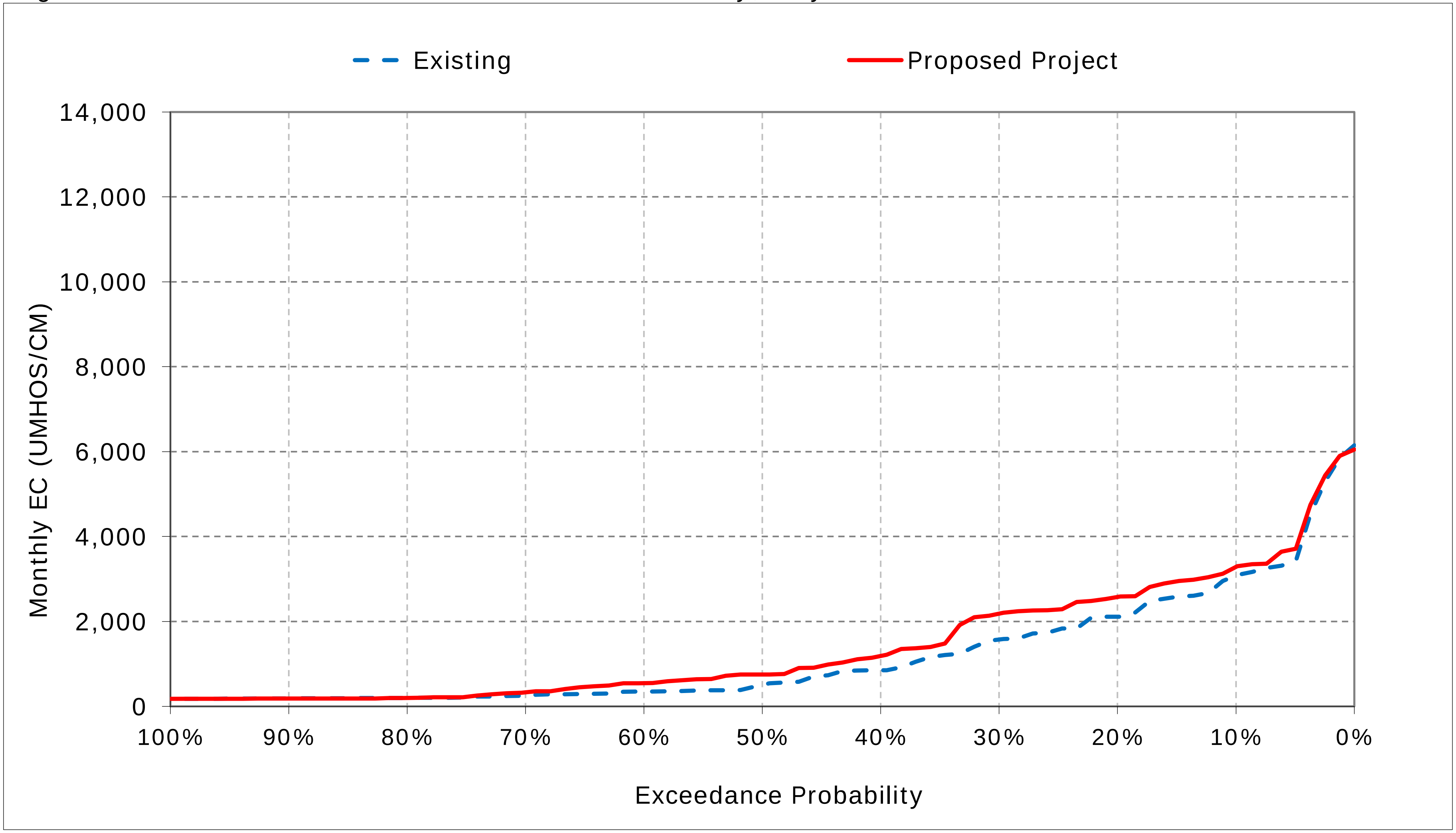


Figure 6-12. Sacramento River at Collinsville Salinity, June EC

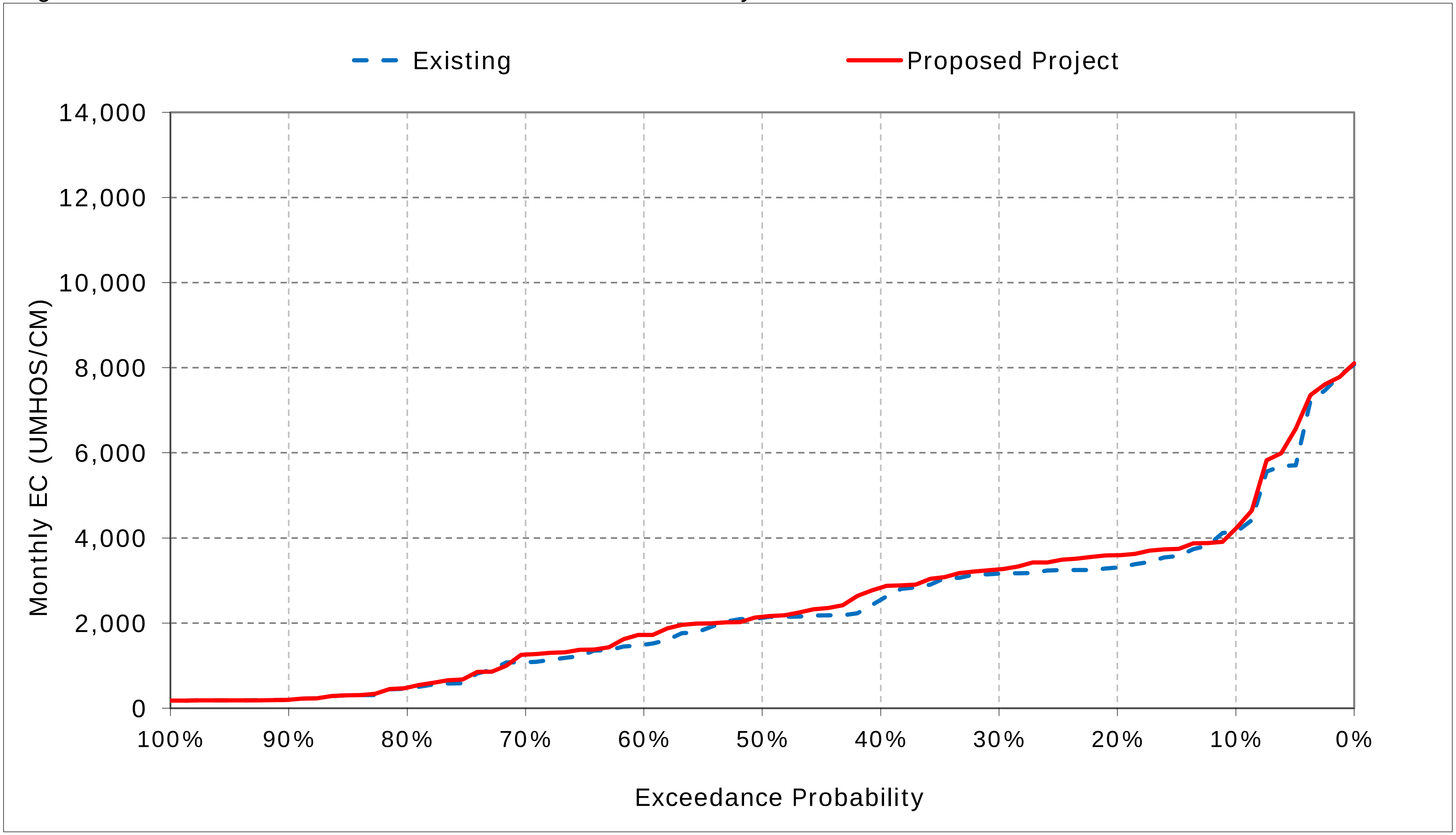


Figure 6-13. Sacramento River at Collinsville Salinity, July EC

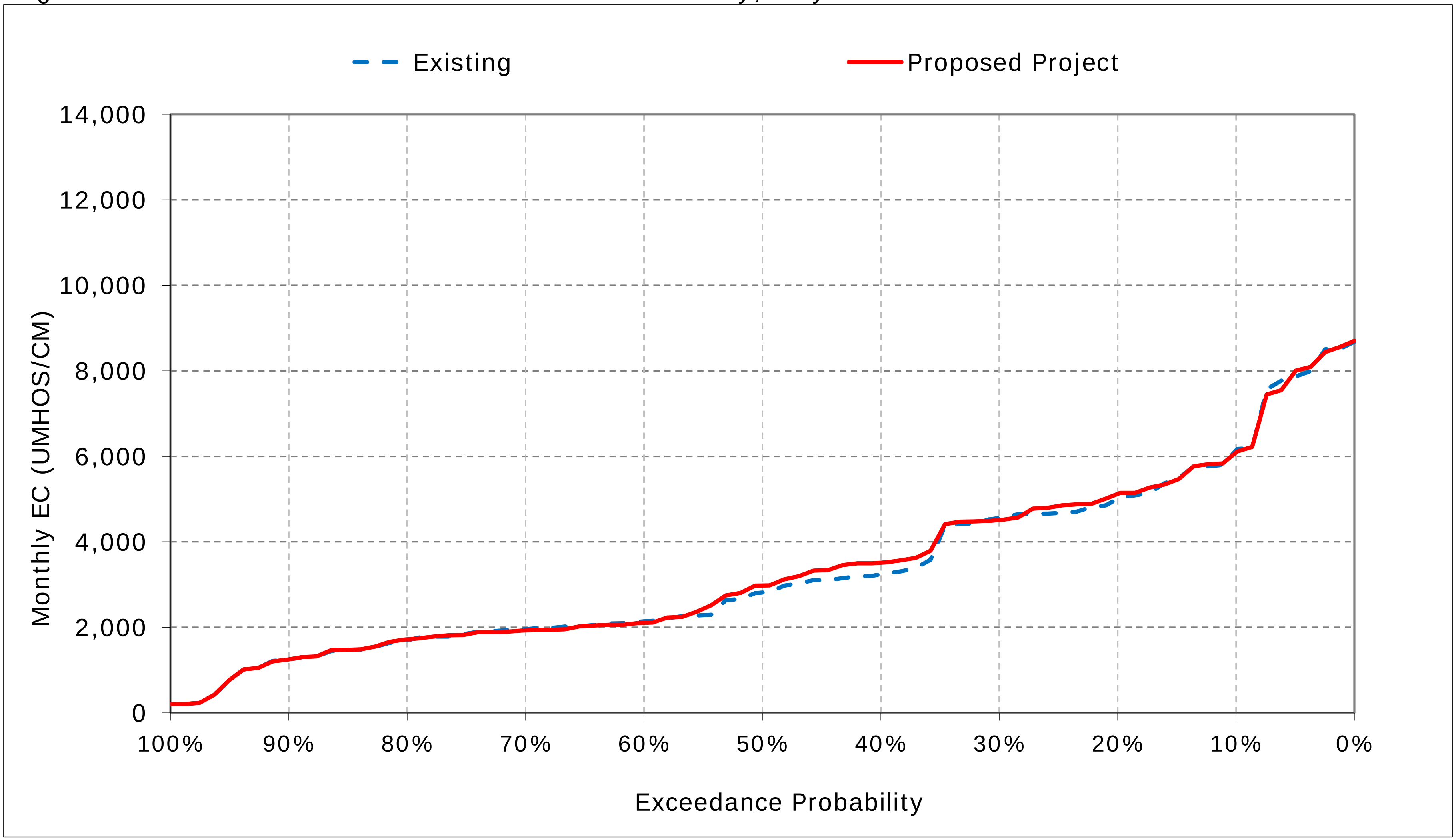


Figure 6-14. Sacramento River at Collinsville Salinity, August EC

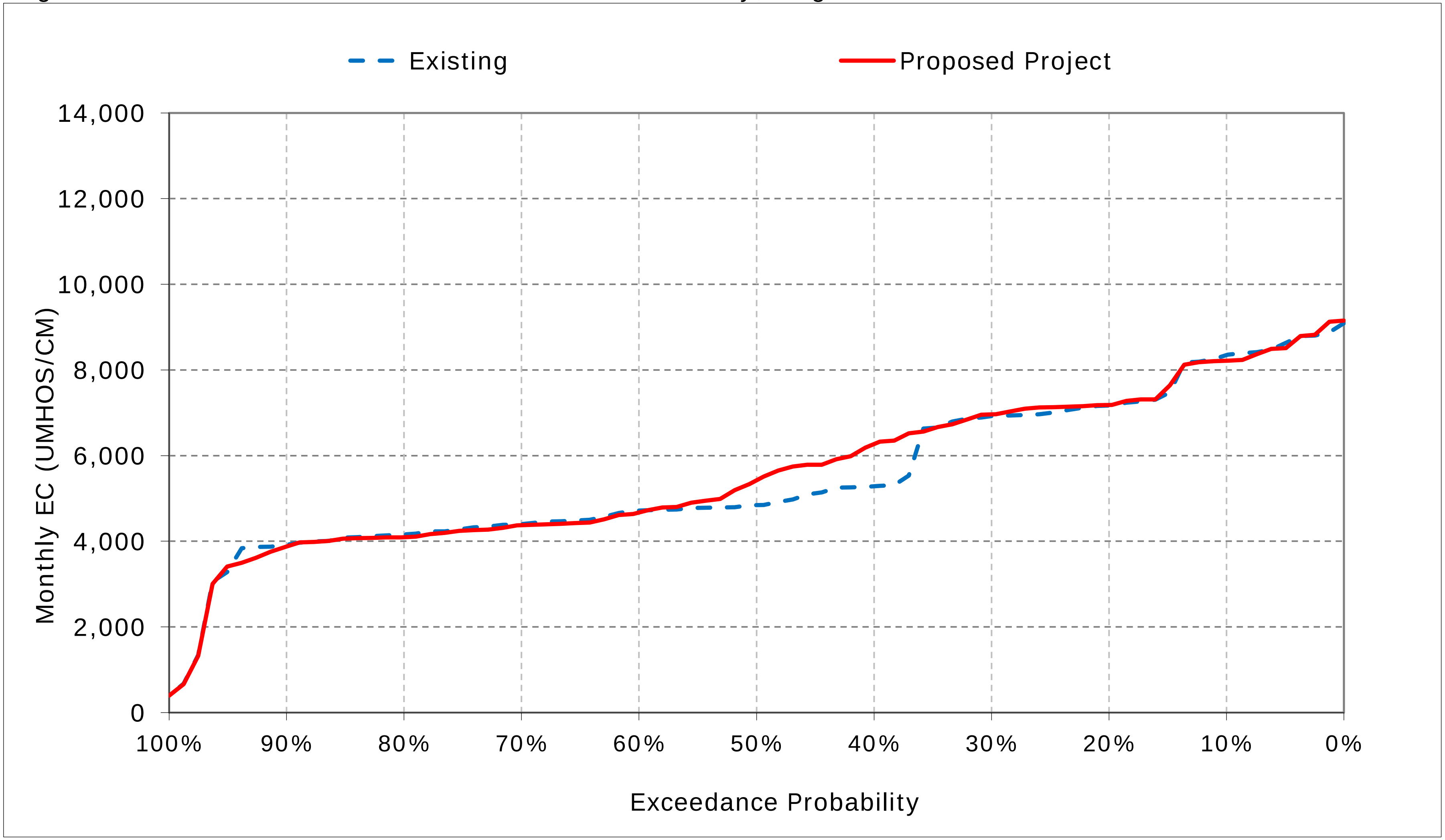


Figure 6-15. Sacramento River at Collinsville Salinity, September EC

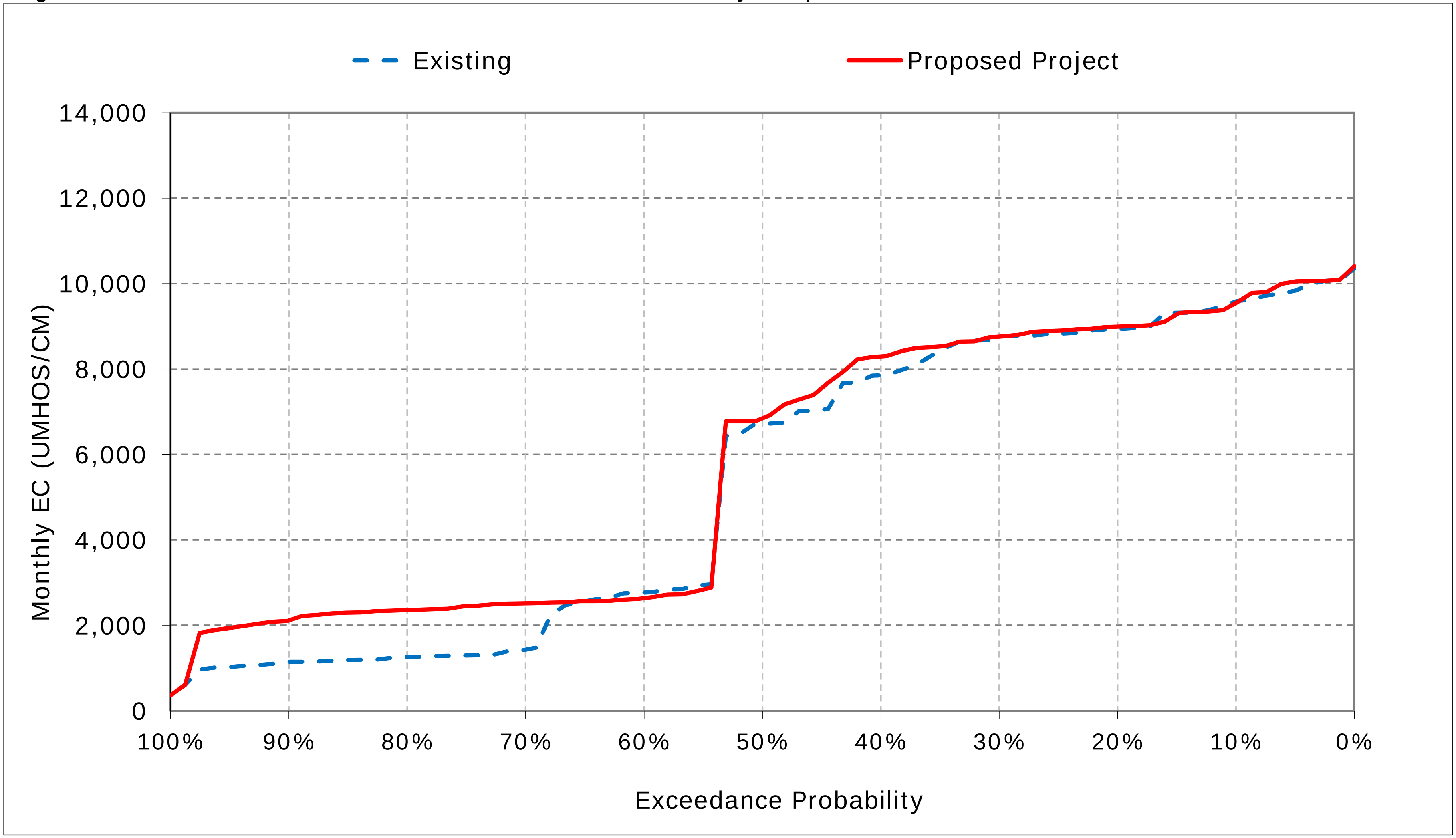


Figure 6-16. Sacramento River at Collinsville Salinity, October EC

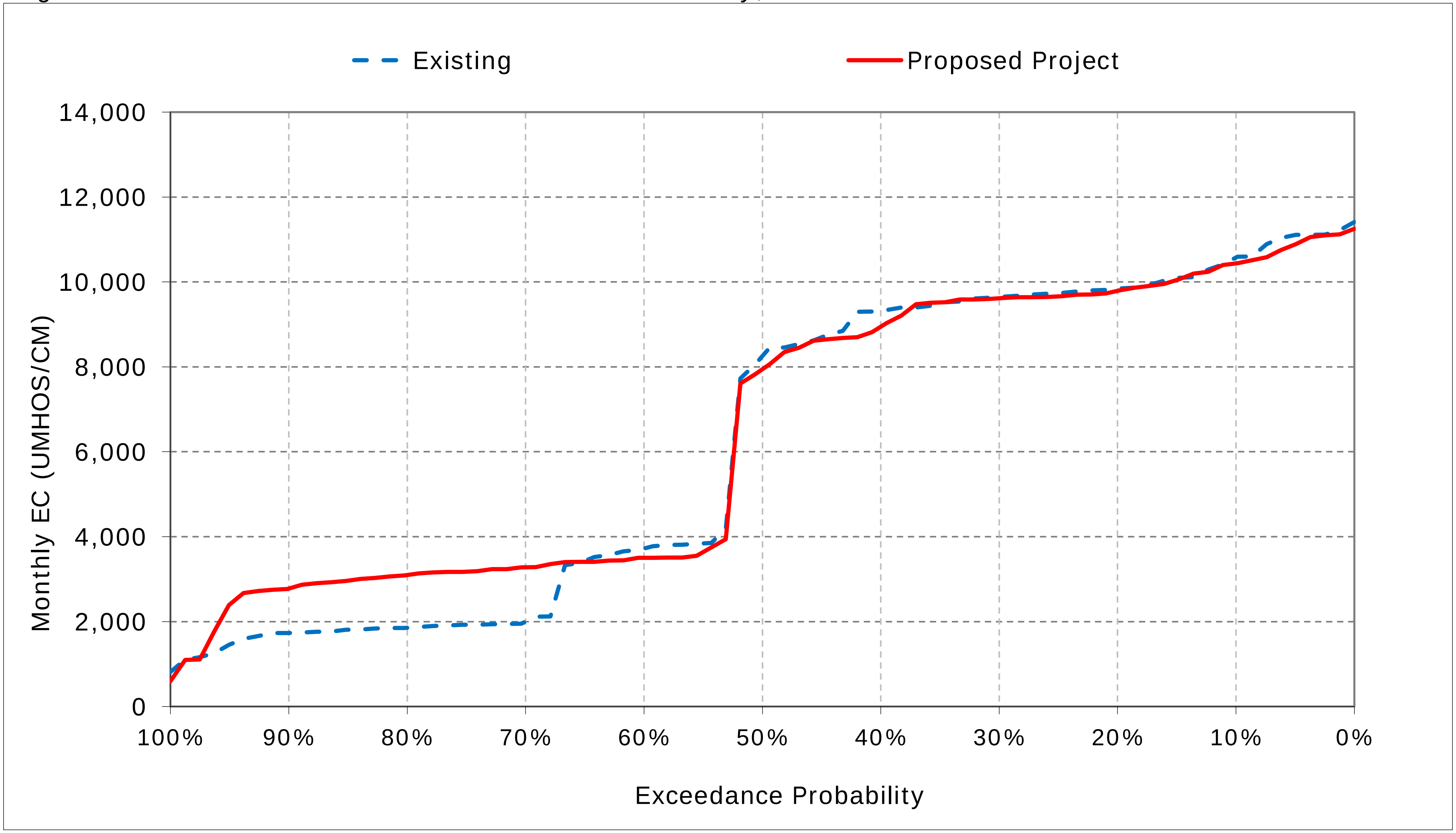


Figure 6-17. Sacramento River at Collinsville Salinity, November EC

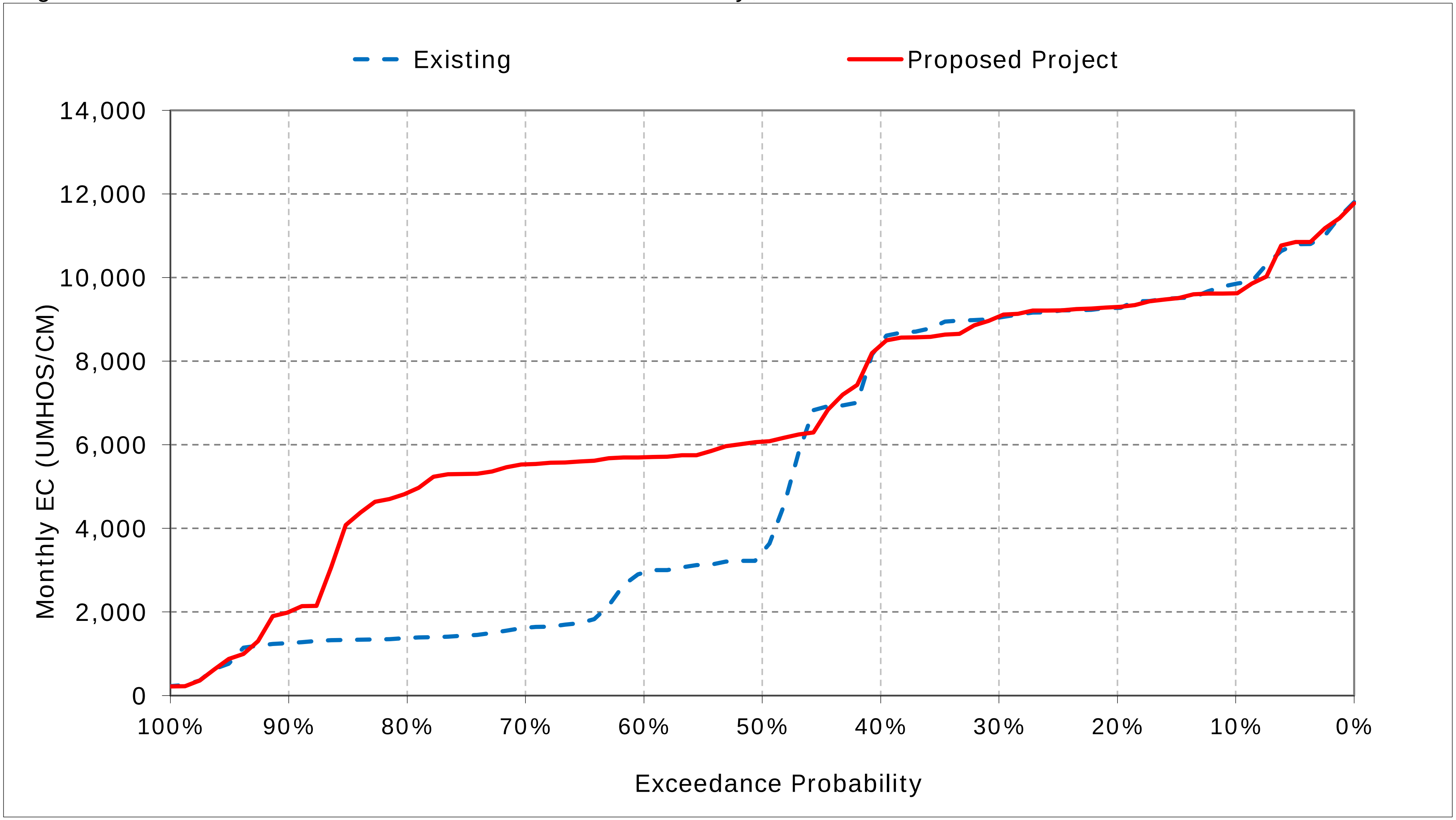


Figure 6-18. Sacramento River at Collinsville Salinity, December EC

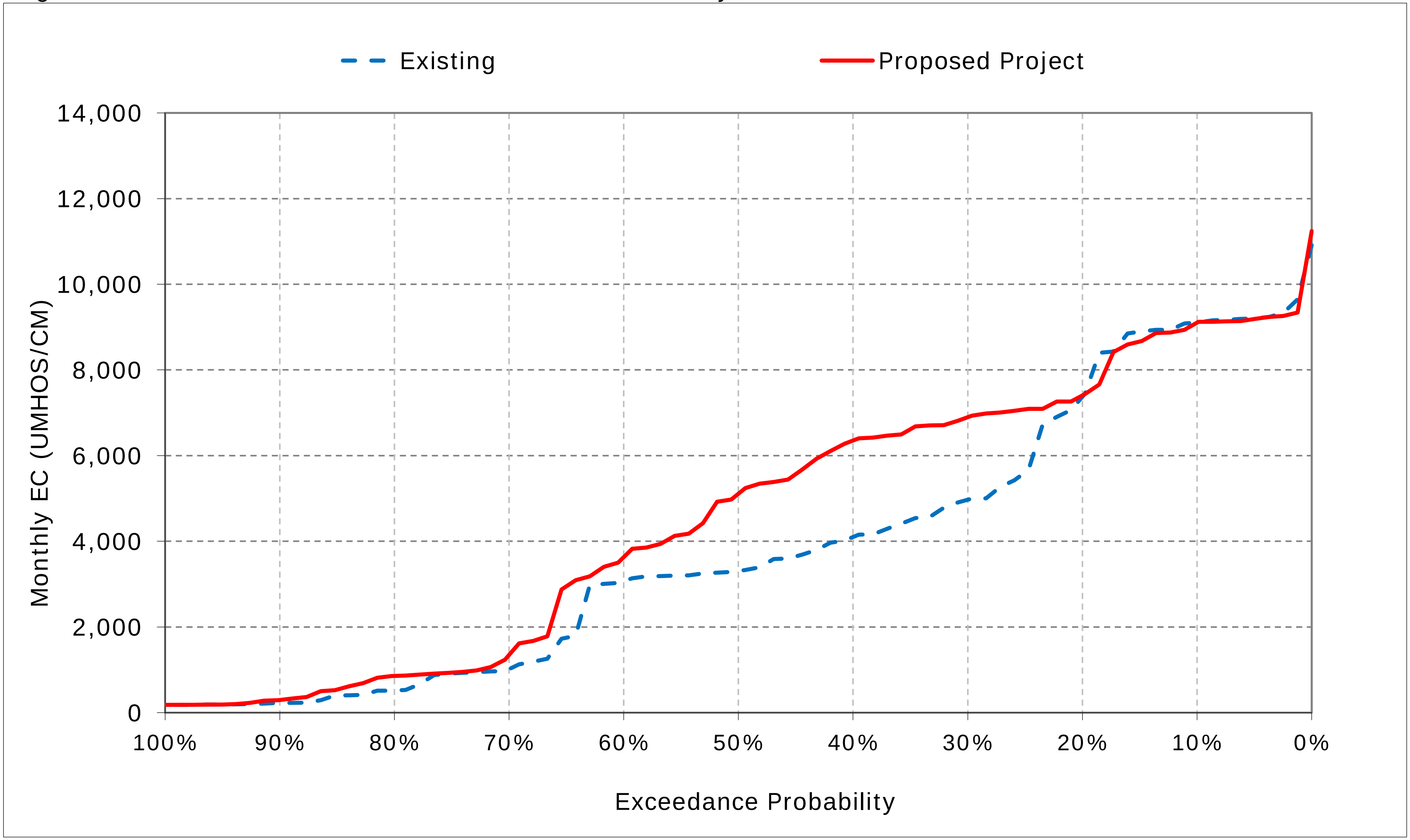


Table 7-1. Sacramento River at Mallard Slough Salinity, Monthly EC

Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	14,262	13,585	12,936	8,639	4,597	4,012	4,293	5,596	7,222	9,482	11,982	13,224
20%	13,605	13,227	11,331	7,673	2,924	2,247	2,342	4,309	6,033	8,280	10,695	12,609
30%	13,388	12,855	8,414	5,940	1,630	956	1,284	3,384	5,771	7,879	10,412	12,378
40%	13,120	12,345	7,099	3,495	809	700	1,005	2,083	4,919	6,131	8,722	11,515
50%	11,995	6,547	6,098	2,570	524	423	620	1,253	4,066	5,622	8,129	10,390
60%	6,582	5,724	5,568	1,463	286	274	361	814	3,217	4,474	7,926	5,456
70%	3,923	3,483	2,369	359	220	207	271	503	2,397	4,191	7,475	3,107
80%	3,688	3,152	1,073	220	202	199	207	270	1,164	3,700	7,186	2,793
90%	3,532	2,842	366	195	193	193	194	194	276	2,619	6,877	2,535
Long Term												
Full Simulation Period[a]	9,174	8,173	6,269	3,607	1,579	1,187	1,403	2,289	4,126	5,905	8,730	8,173
Water Year Types[b]												
Wet (32%)	7,268	5,420	2,138	668	239	254	318	527	1,492	3,090	6,675	2,582
Above Normal (15%)	9,562	8,069	6,277	2,184	595	270	393	736	2,907	4,100	7,318	5,343
Below Normal (17%)	9,602	8,995	7,981	3,998	1,044	902	977	1,745	4,029	5,789	8,430	10,918
Dry (22%)	9,695	9,431	7,836	5,709	2,550	1,656	1,989	3,398	5,703	8,040	10,550	12,495
Critical (15%)	11,632	11,396	10,864	7,790	4,638	3,754	4,381	6,633	8,800	10,742	12,212	13,430

Proposed Project

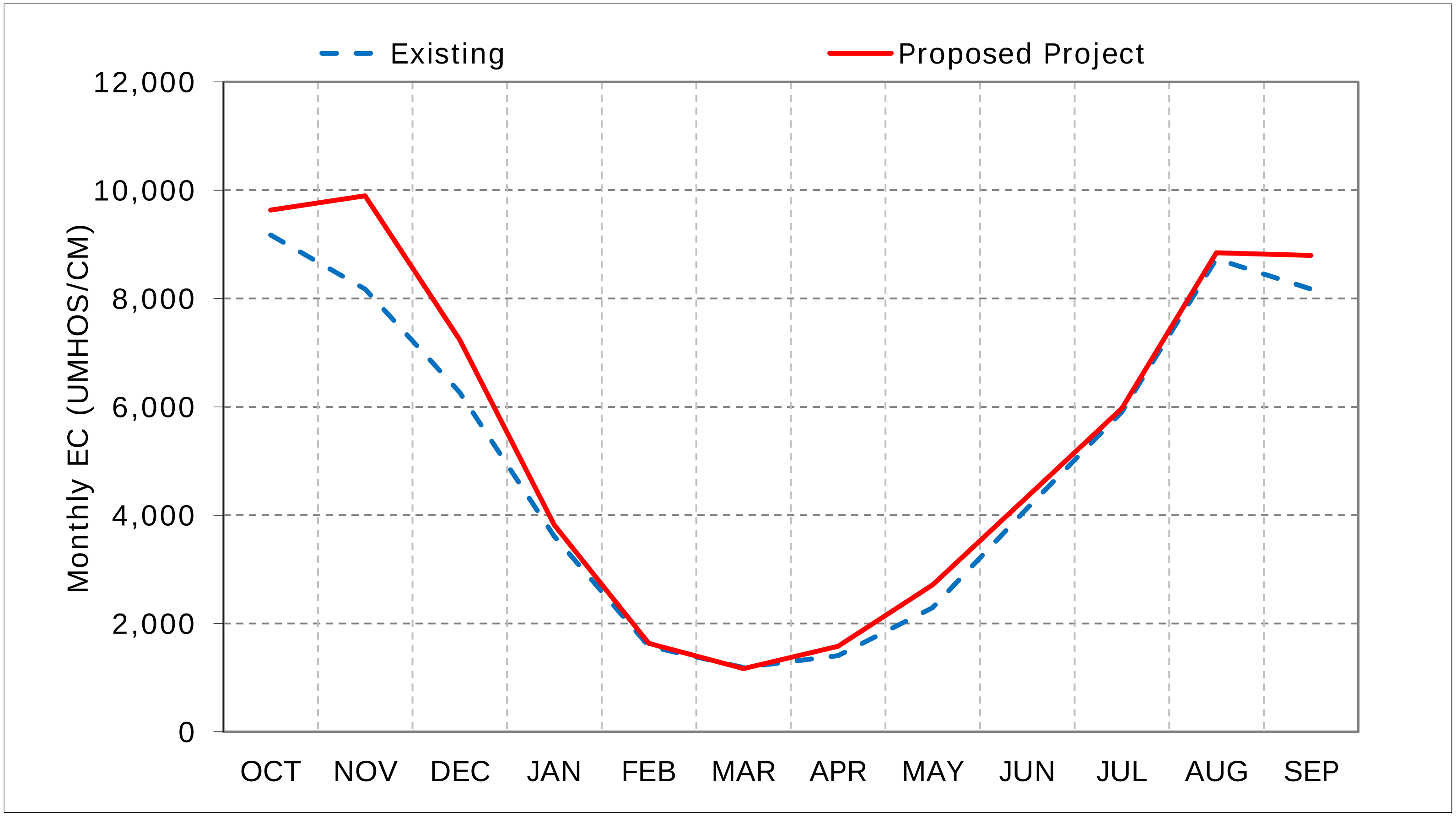
Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	14,167	13,475	12,852	9,668	4,399	4,044	4,553	5,852	7,281	9,478	11,896	13,216
20%	13,526	13,199	11,287	8,238	2,774	2,127	2,831	5,042	6,493	8,387	10,732	12,663
30%	13,333	12,839	10,716	6,425	1,558	829	1,773	4,310	5,961	7,815	10,452	12,433
40%	12,771	12,181	10,045	3,735	881	647	1,280	2,708	5,425	6,457	9,678	11,923
50%	11,774	9,464	8,812	2,603	509	374	802	1,842	4,266	5,757	8,735	10,520
60%	6,200	9,080	6,833	1,379	248	246	424	1,373	3,708	4,427	7,864	5,219
70%	5,974	8,875	2,870	366	218	207	303	761	2,691	4,152	7,433	5,051
80%	5,690	8,159	1,730	218	203	197	206	325	1,226	3,734	7,136	4,805
90%	5,367	3,977	454	197	193	192	190	192	277	2,624	6,832	4,429
Long Term												
Full Simulation Period[a]	9,634	9,897	7,242	3,821	1,633	1,166	1,576	2,711	4,339	5,969	8,845	8,794
Water Year Types[b]												
Wet (32%)	7,895	7,635	2,722	662	233	245	391	771	1,700	3,100	6,568	4,511
Above Normal (15%)	10,105	9,984	7,765	2,299	469	254	506	1,178	3,072	4,049	7,353	4,932
Below Normal (17%)	10,089	10,632	9,169	4,033	992	834	1,223	2,377	4,216	6,083	9,202	11,231
Dry (22%)	10,196	10,915	9,025	6,243	2,728	1,587	2,267	4,007	5,997	8,113	10,610	12,543
Critical (15%)	11,558	12,330	11,589	8,312	4,938	3,830	4,591	6,897	8,978	10,758	12,208	13,469

Proposed Project minus Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	-95	-109	-84	1,029	-198	31	260	256	59	-4	-86	-8
20%	-79	-28	-44	565	-149	-120	489	733	460	108	37	54
30%	-55	-17	2,302	485	-72	-127	489	927	190	-64	40	55
40%	-349	-163	2,946	240	72	-53	275	625	506	326	955	408
50%	-221	2,917	2,714	33	-15	-50	181	590	199	135	606	130
60%	-381	3,356	1,265	-84	-39	-27	63	558	491	-47	-63	-238
70%	2,051	5,392	500	8	-2	0	33	258	294	-39	-42	1,944
80%	2,002	5,007	657	-2	1	-1	-1	54	62	35	-50	2,012
90%	1,835	1,135	89	2	0	0	-4	-2	1	5	-45	1,894
Long Term												
Full Simulation Period[a]	461	1,724	973	214	54	-21	174	422	212	64	115	621
Water Year Types[b]												
Wet (32%)	627	2,215	584	-7	-6	-9	74	244	208	11	-108	1,929
Above Normal (15%)	543	1,914	1,488	115	-125	-16	113	442	165	-52	35	-411
Below Normal (17%)	487	1,637	1,188	35	-52	-68	246	632	187	294	772	313
Dry (22%)	501	1,483	1,188	533	178	-69	278	608	294	74	61	49
Critical (15%)	-75	934	725	522	300	76	210	264	178	15	-4	38

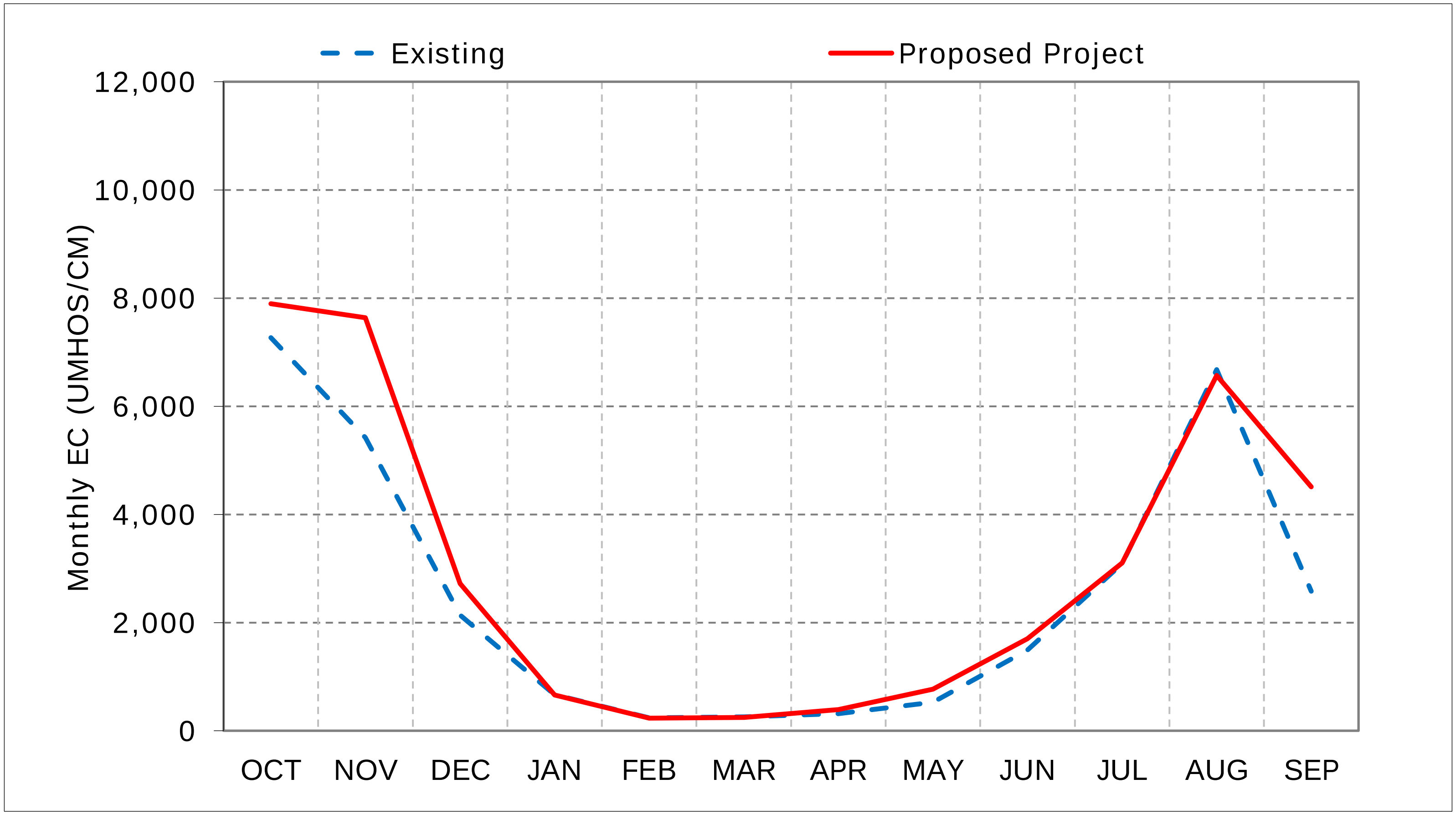
a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with water year - year type sorting.
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 7-1. Sacramento River at Mallard Slough Salinity, Long-Term Average EC



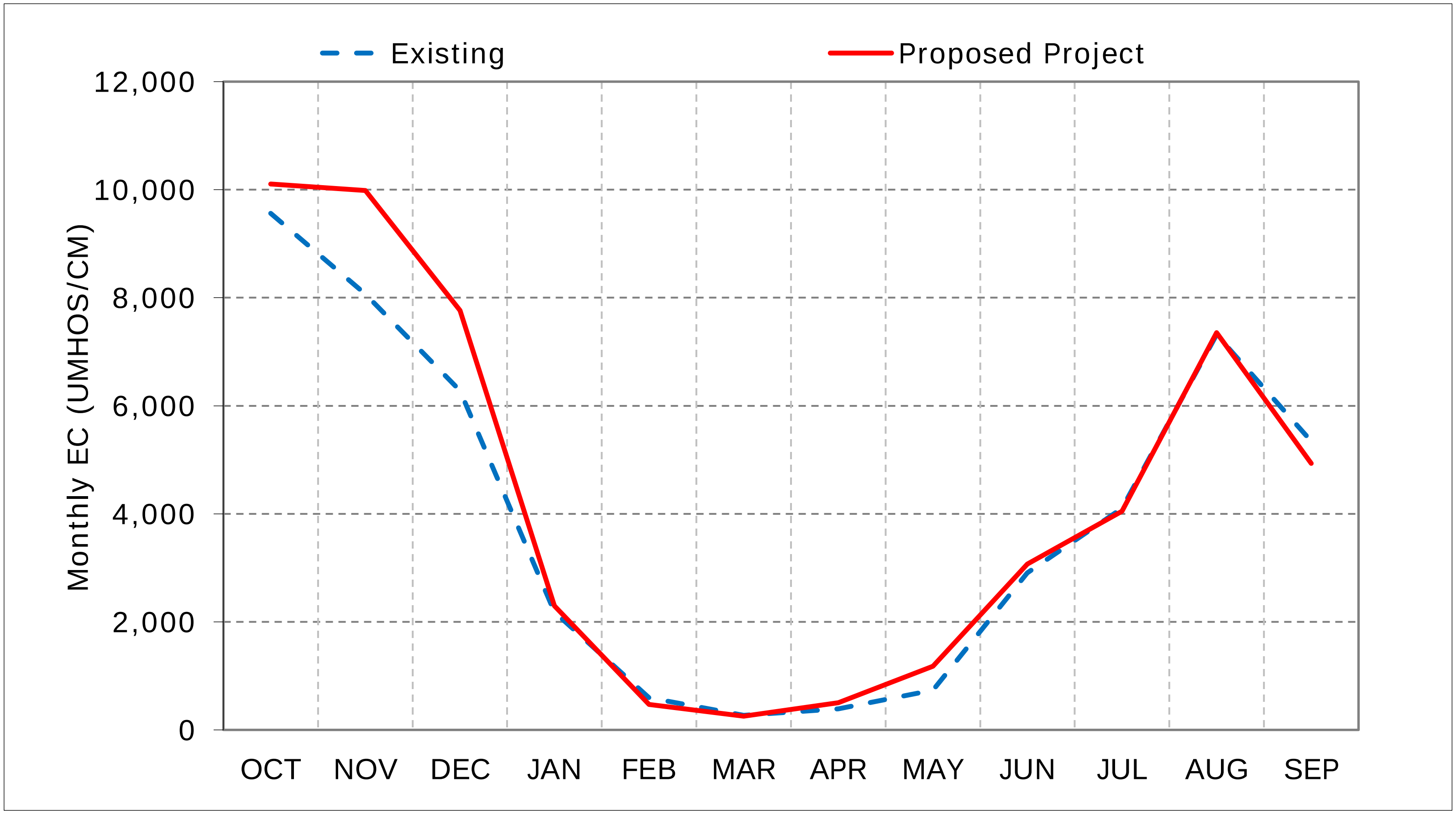
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 7-2. Sacramento River at Mallard Slough Salinity, Wet Year Average EC



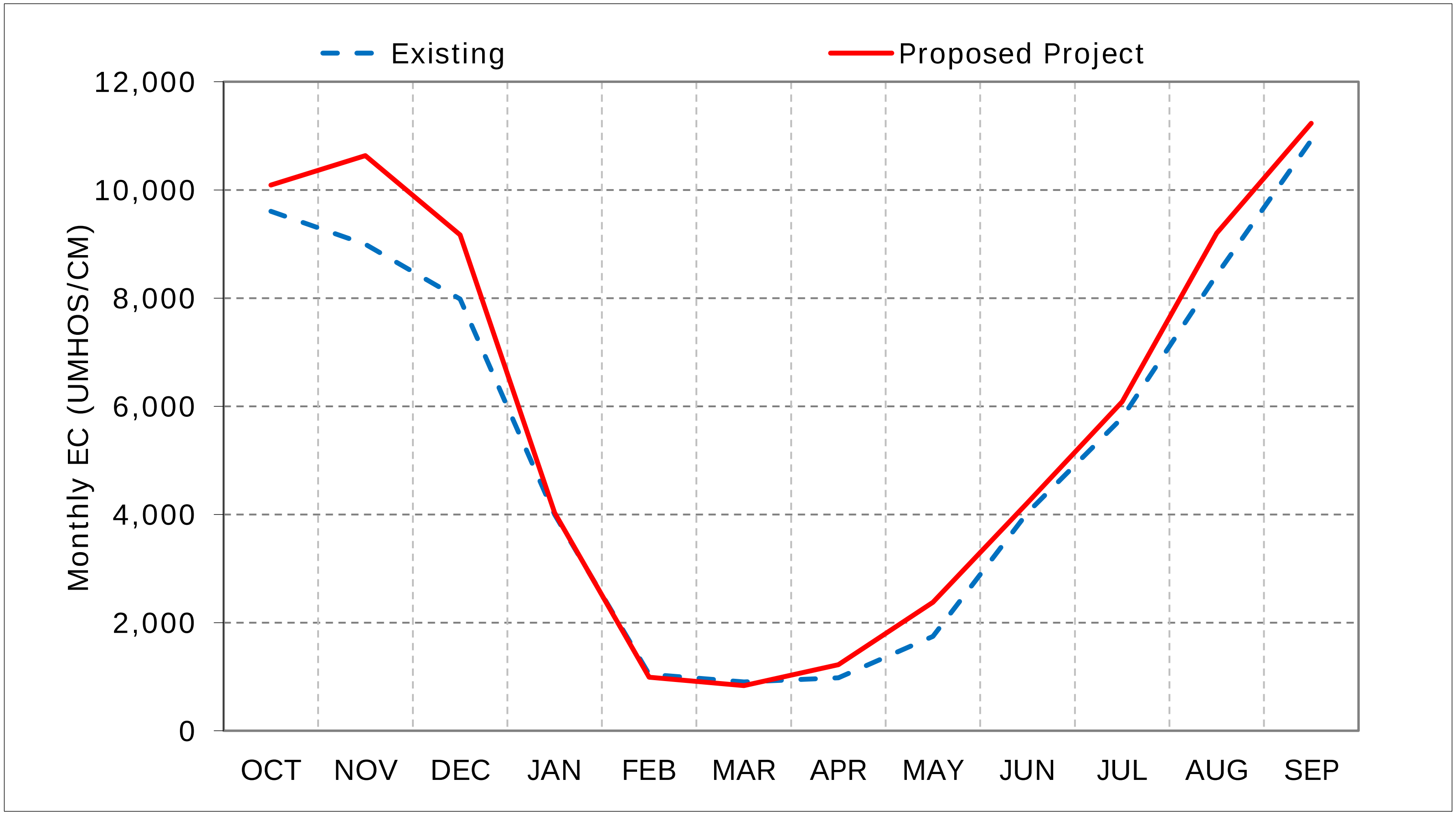
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 7-3. Sacramento River at Mallard Slough Salinity, Above Normal Year Avera



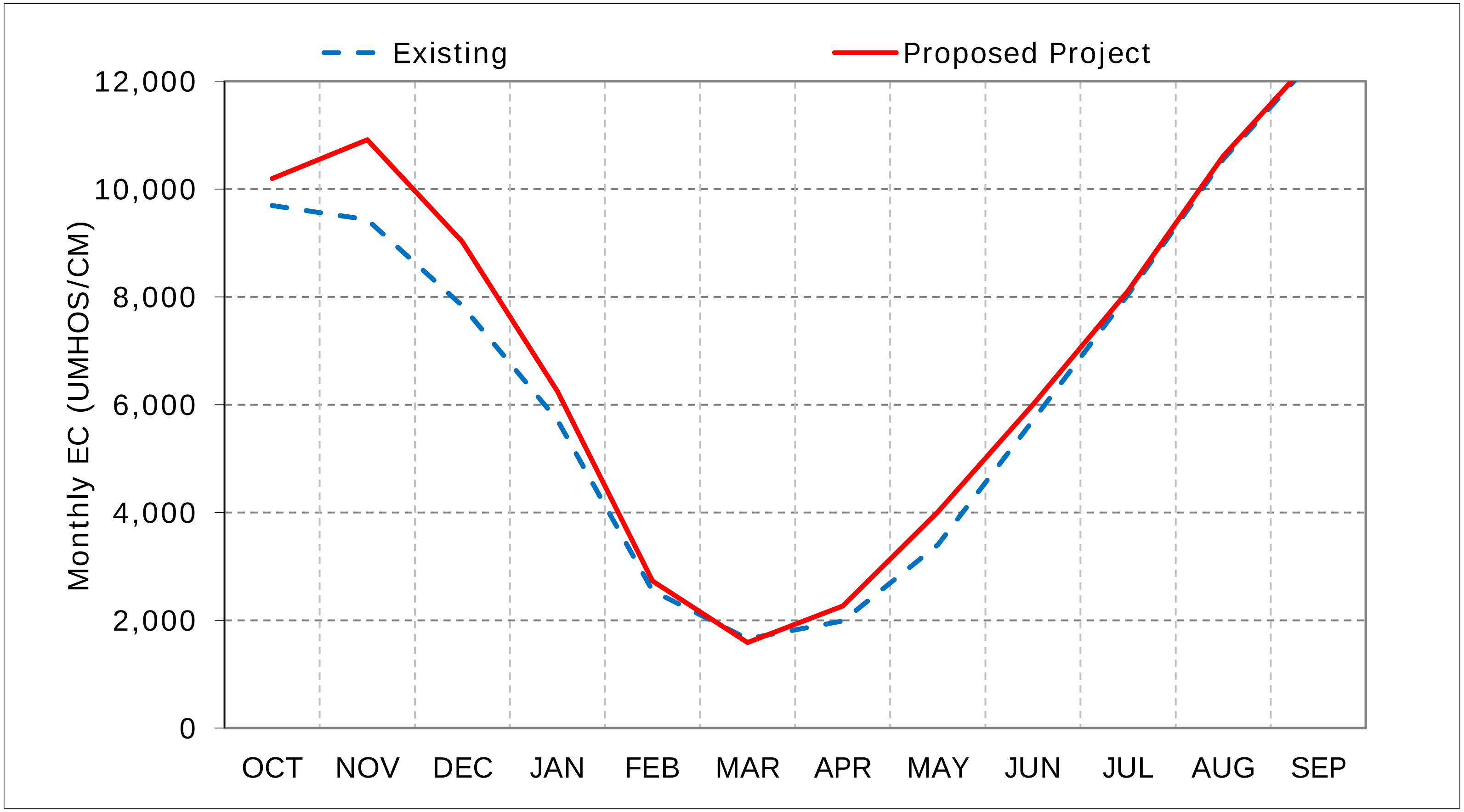
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 7-4. Sacramento River at Mallard Slough Salinity, Below Normal Year Avera



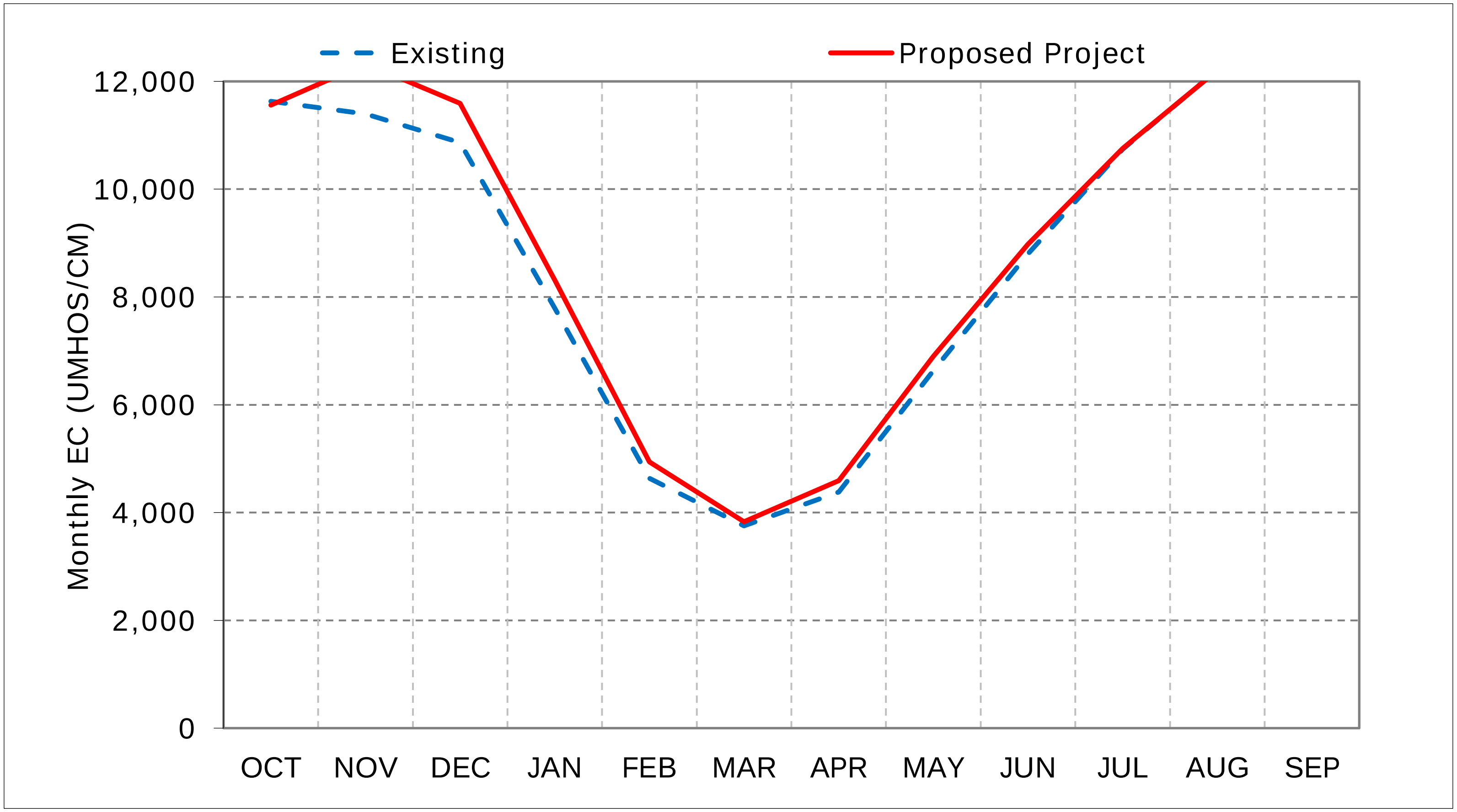
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 7-5. Sacramento River at Mallard Slough Salinity, Dry Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 7-6. Sacramento River at Mallard Slough Salinity, Critical Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 7-7. Sacramento River at Mallard Slough Salinity, January EC

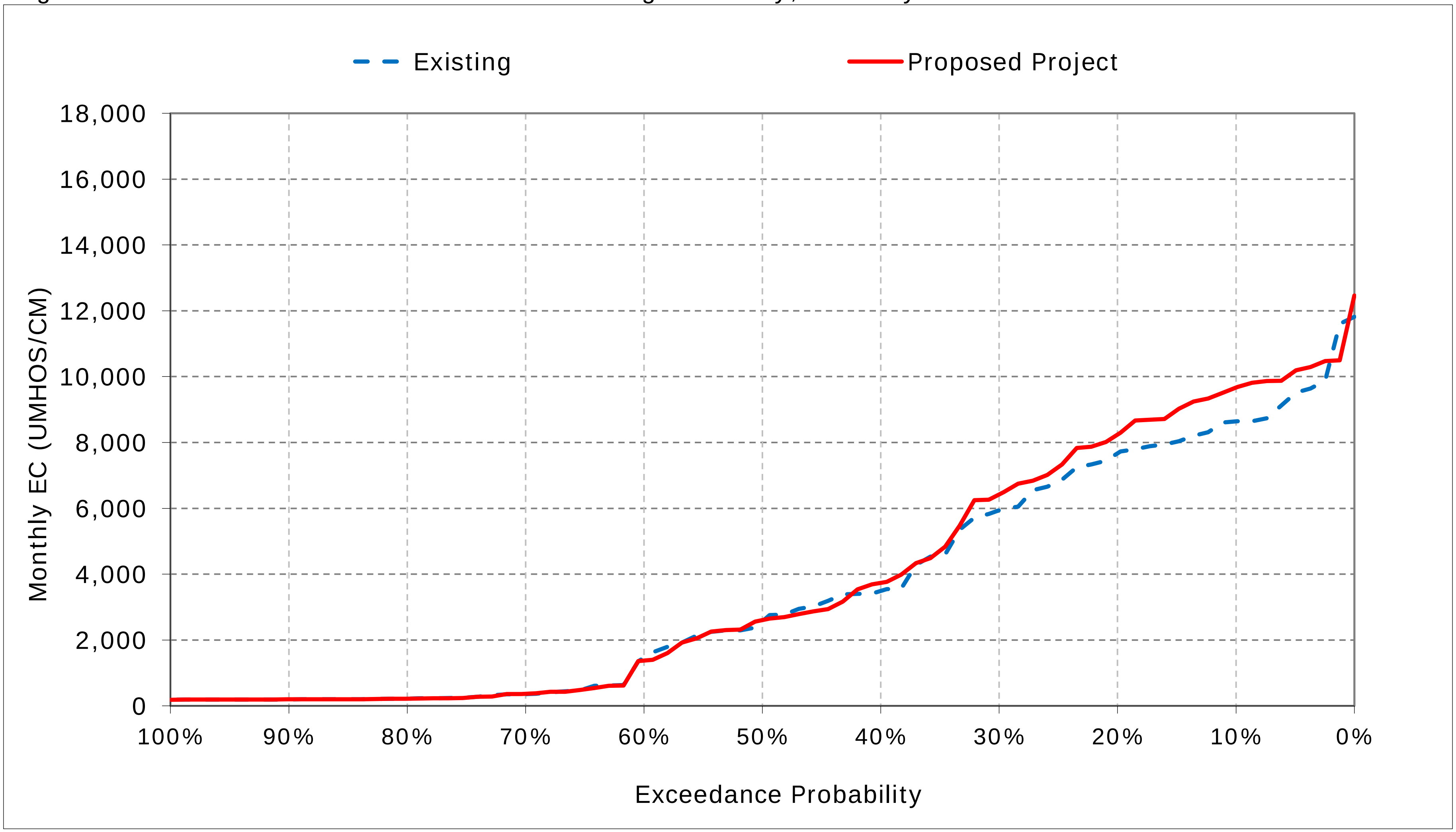


Figure 7-8. Sacramento River at Mallard Slough Salinity, February EC

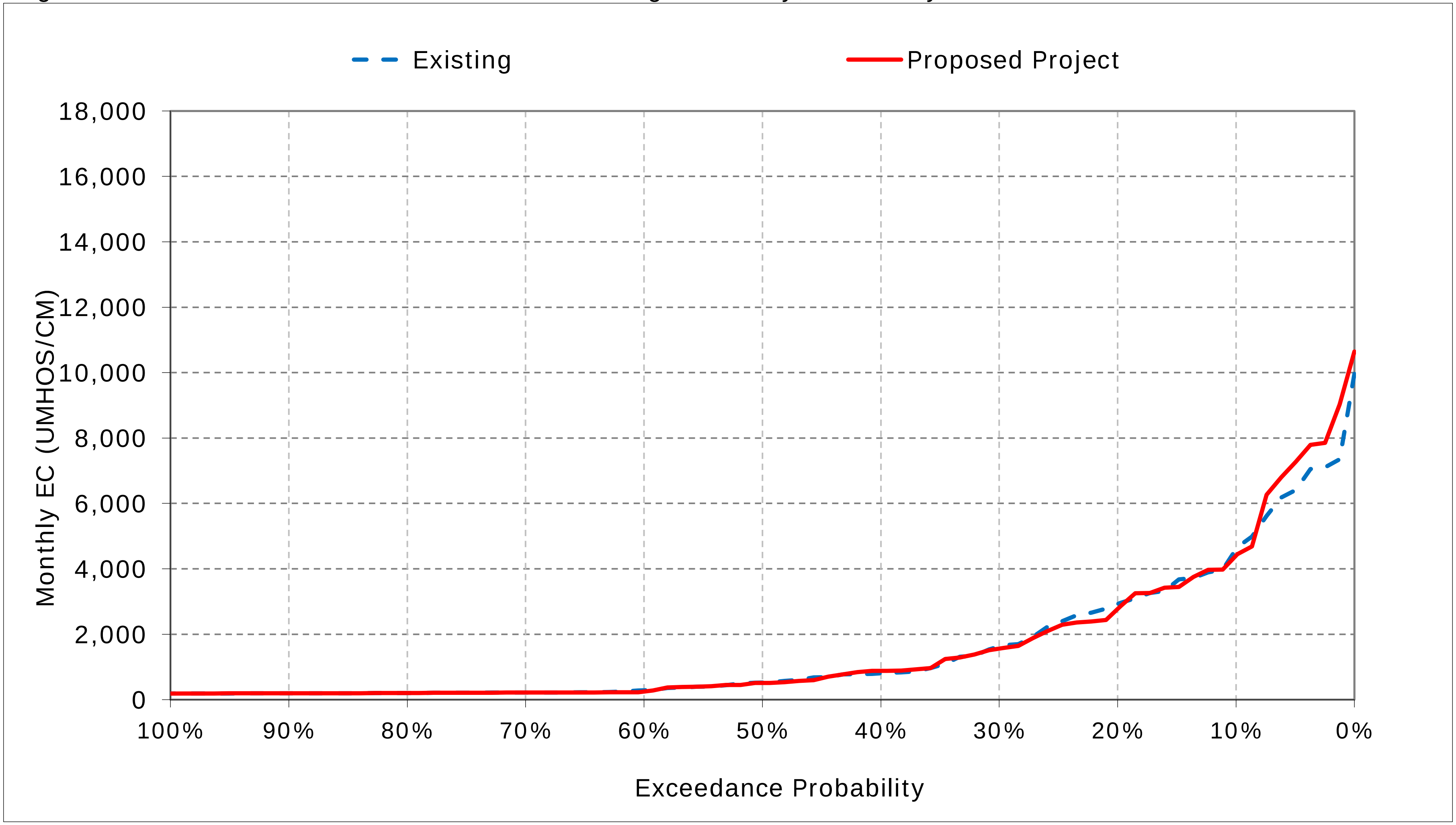


Figure 7-9. Sacramento River at Mallard Slough Salinity, March EC

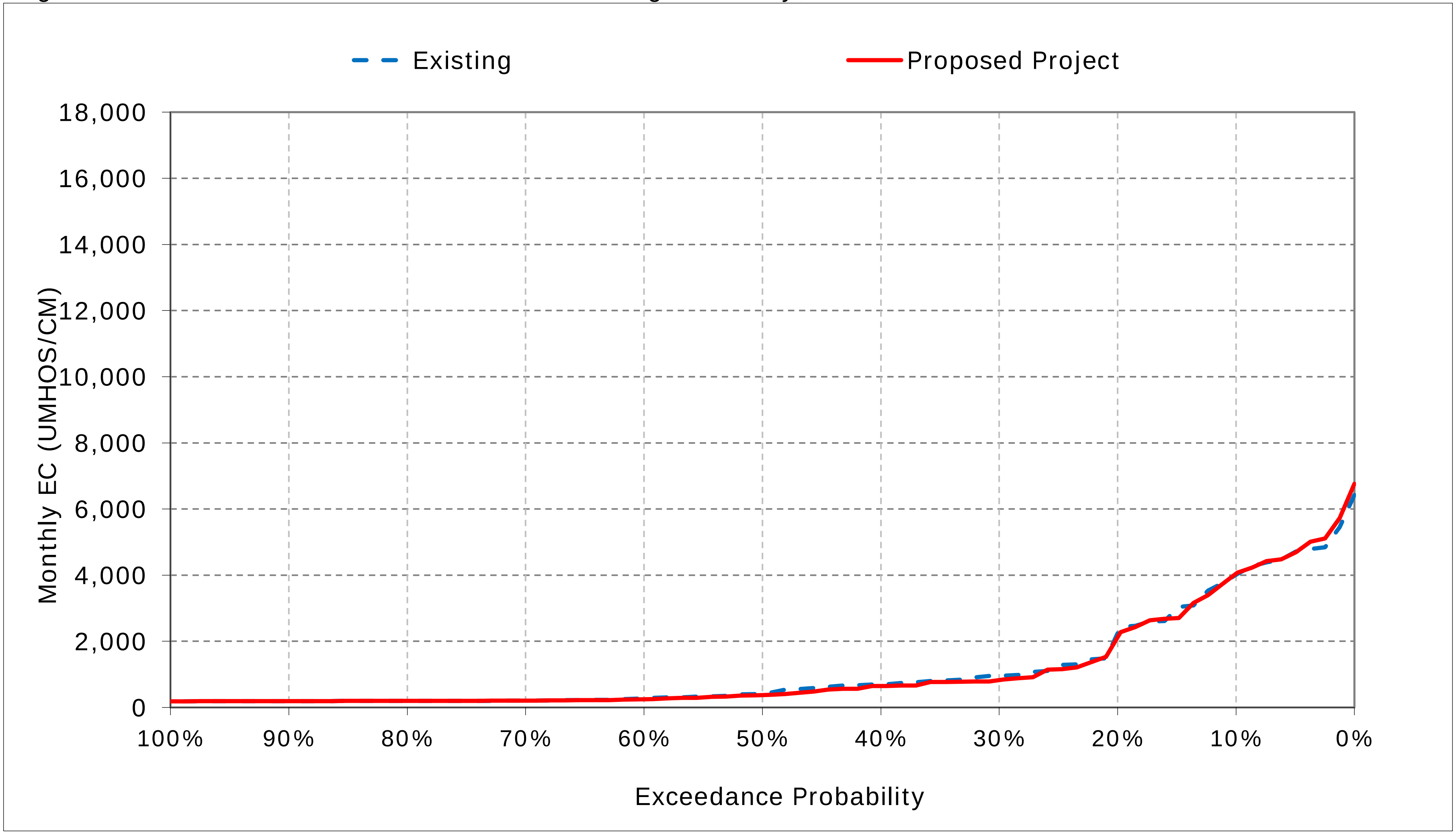


Figure 7-10. Sacramento River at Mallard Slough Salinity, April EC

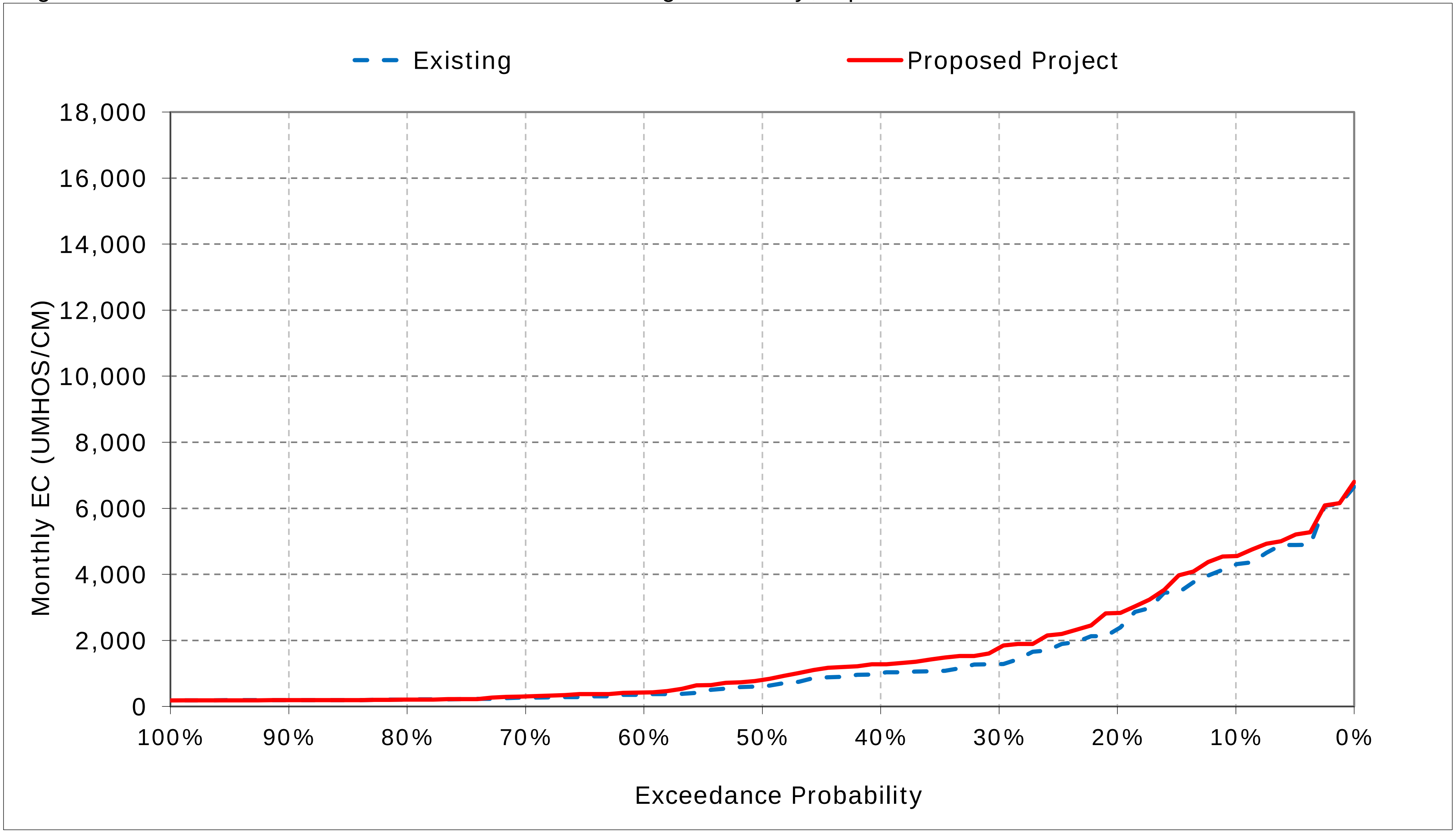


Figure 7-11. Sacramento River at Mallard Slough Salinity, May EC

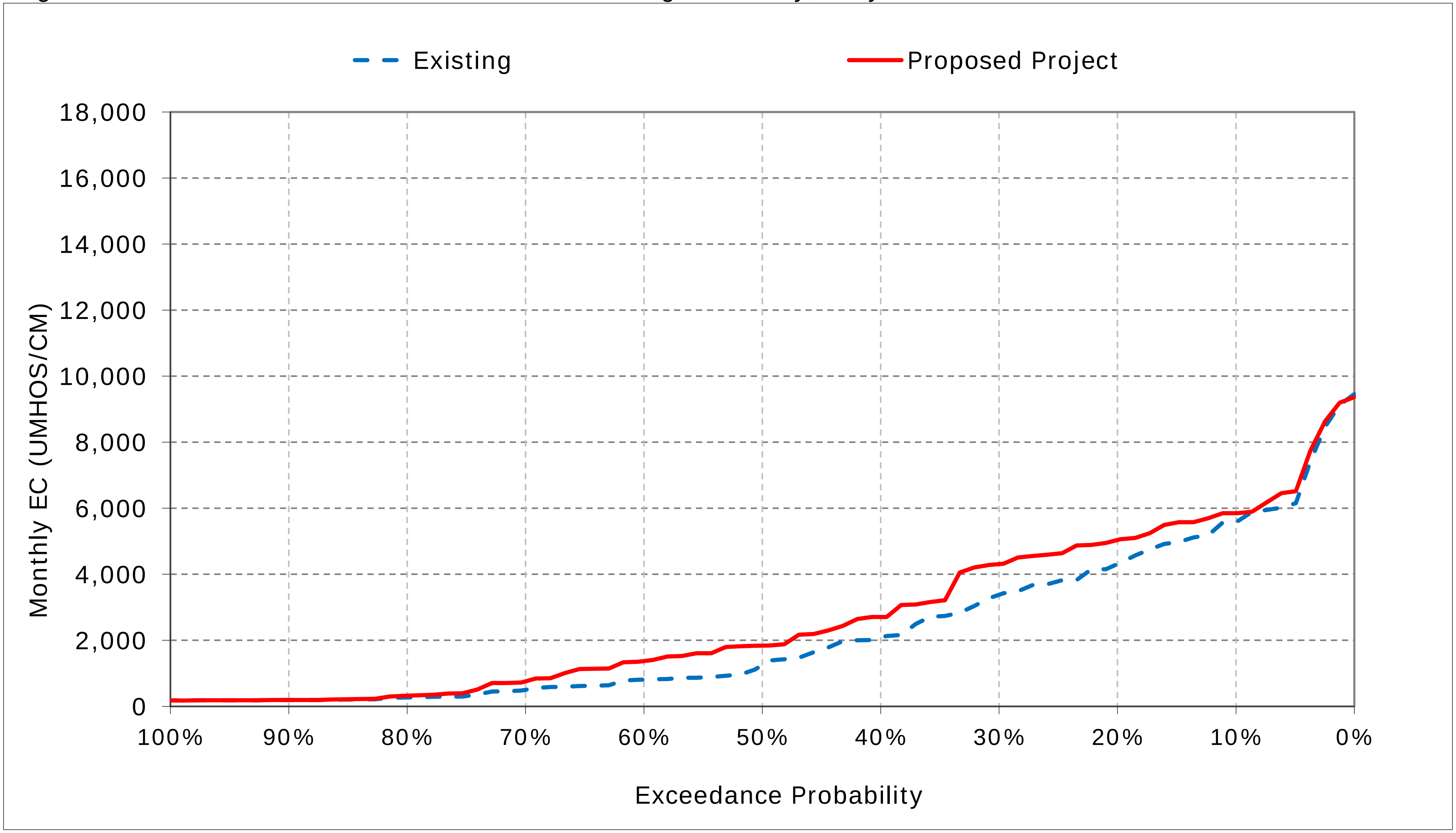


Figure 7-12. Sacramento River at Mallard Slough Salinity, June EC

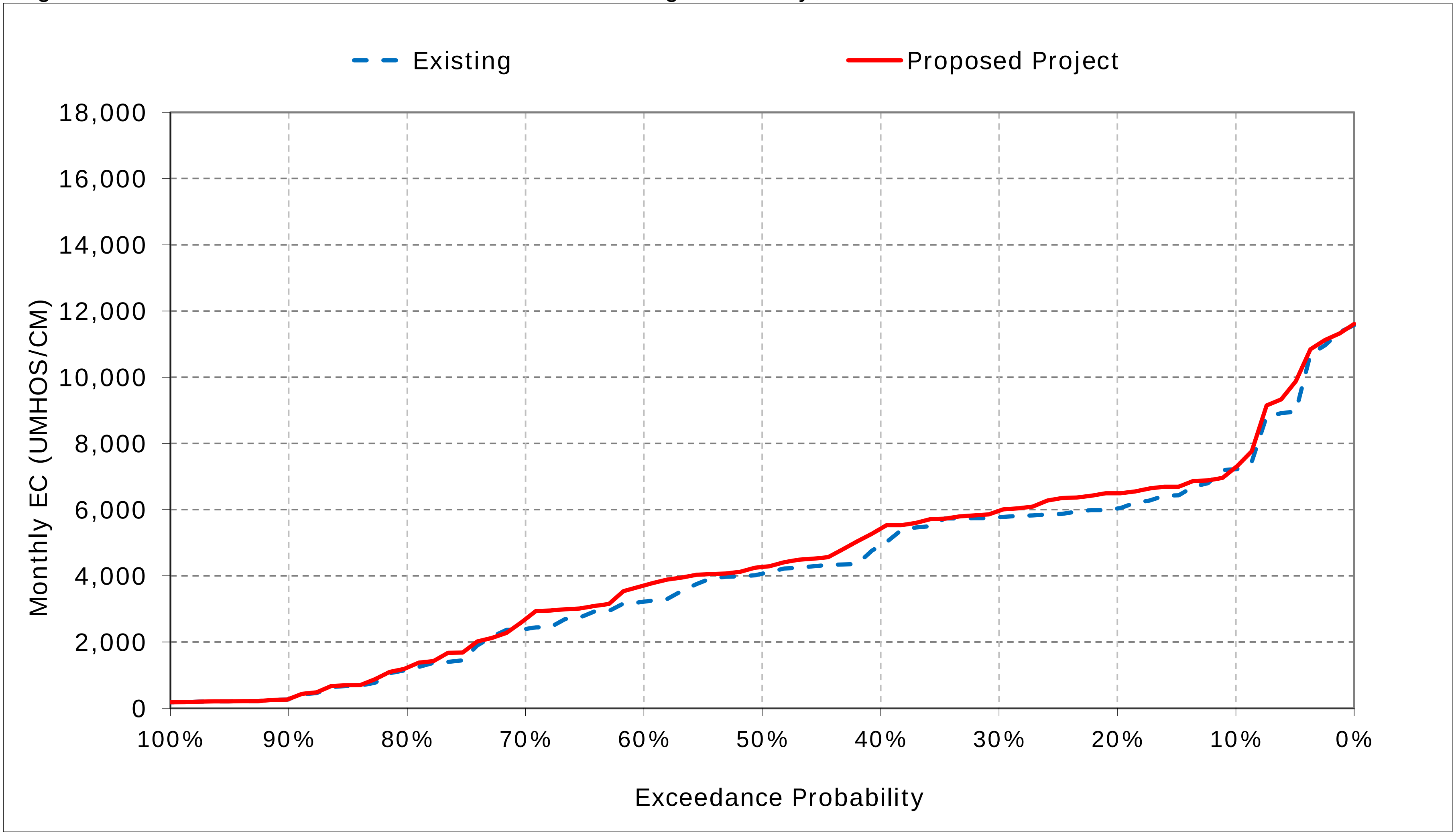


Figure 7-13. Sacramento River at Mallard Slough Salinity, July EC

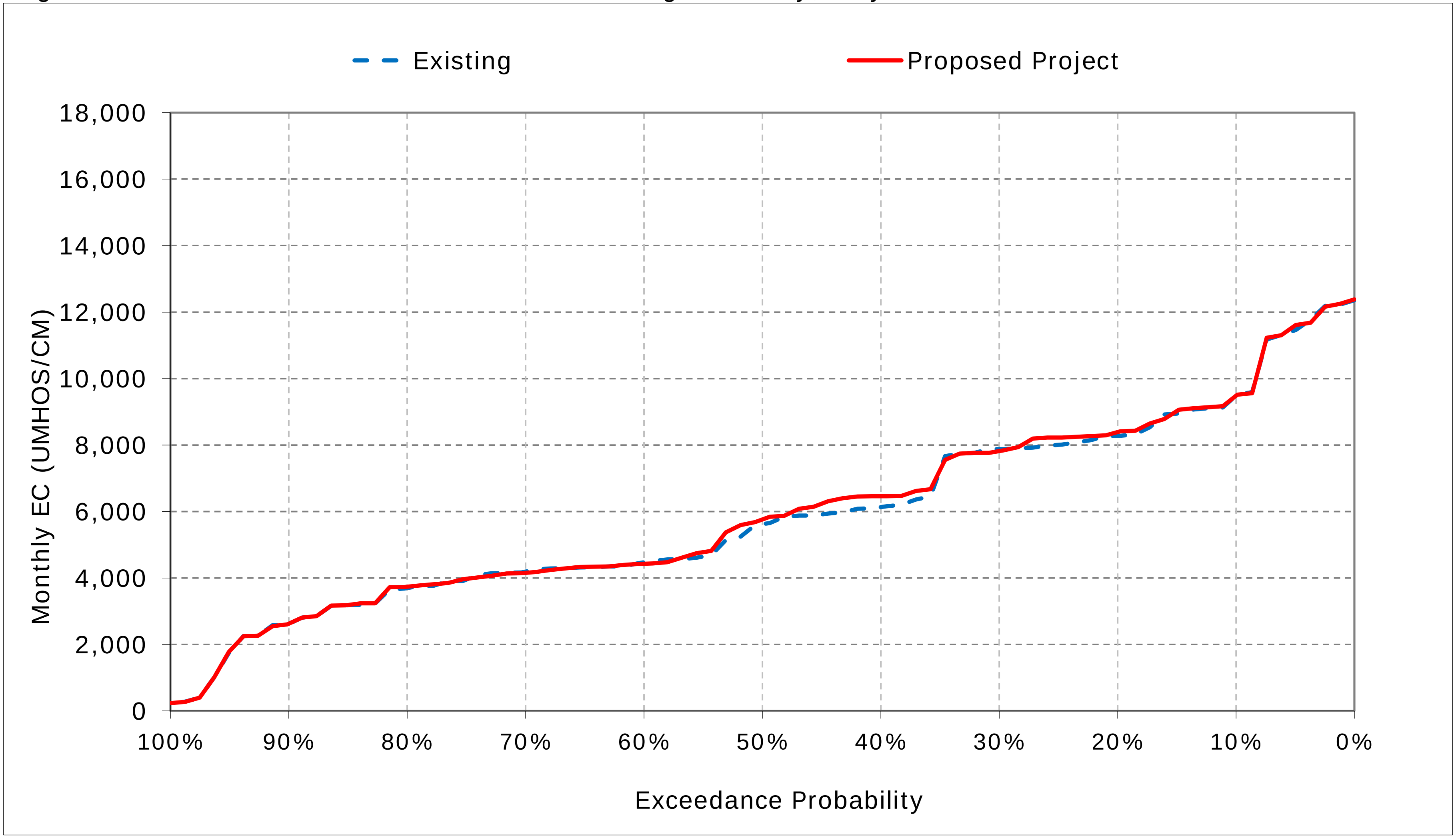


Figure 7-14. Sacramento River at Mallard Slough Salinity, August EC

Figure 7-15. Sacramento River at Mallard Slough Salinity, September EC

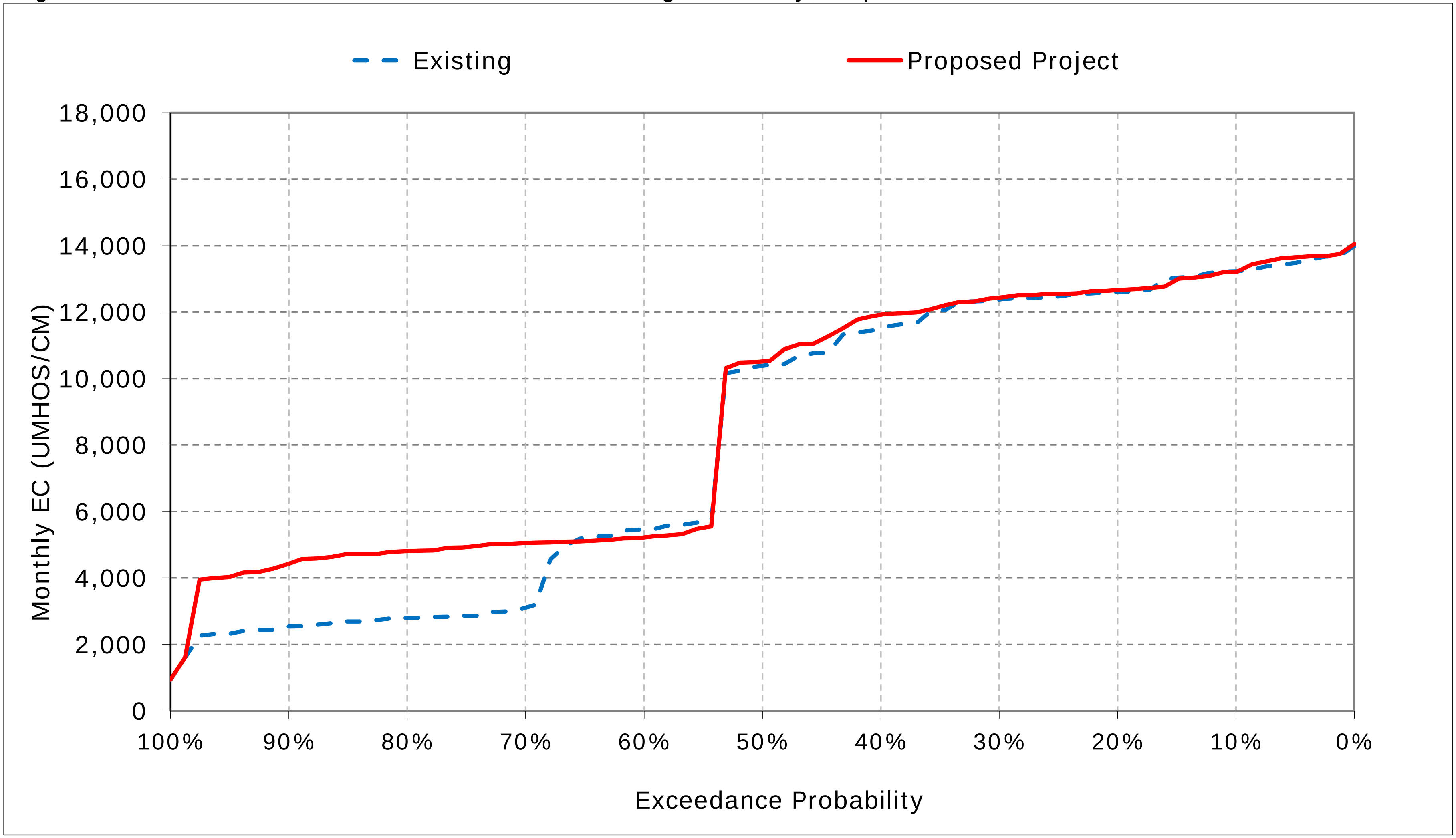


Figure 7-16. Sacramento River at Mallard Slough Salinity, October EC

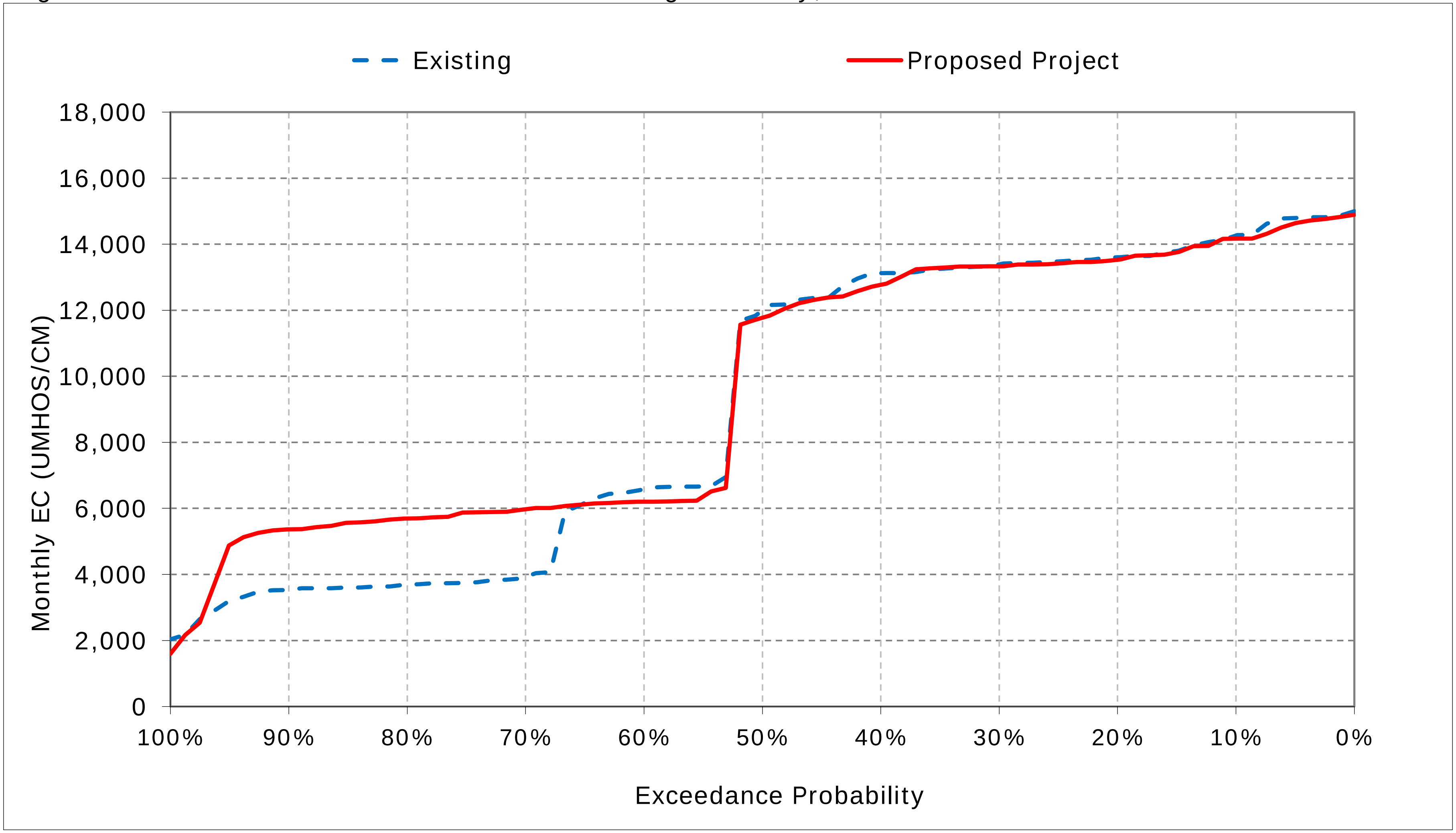


Figure 7-17. Sacramento River at Mallard Slough Salinity, November EC

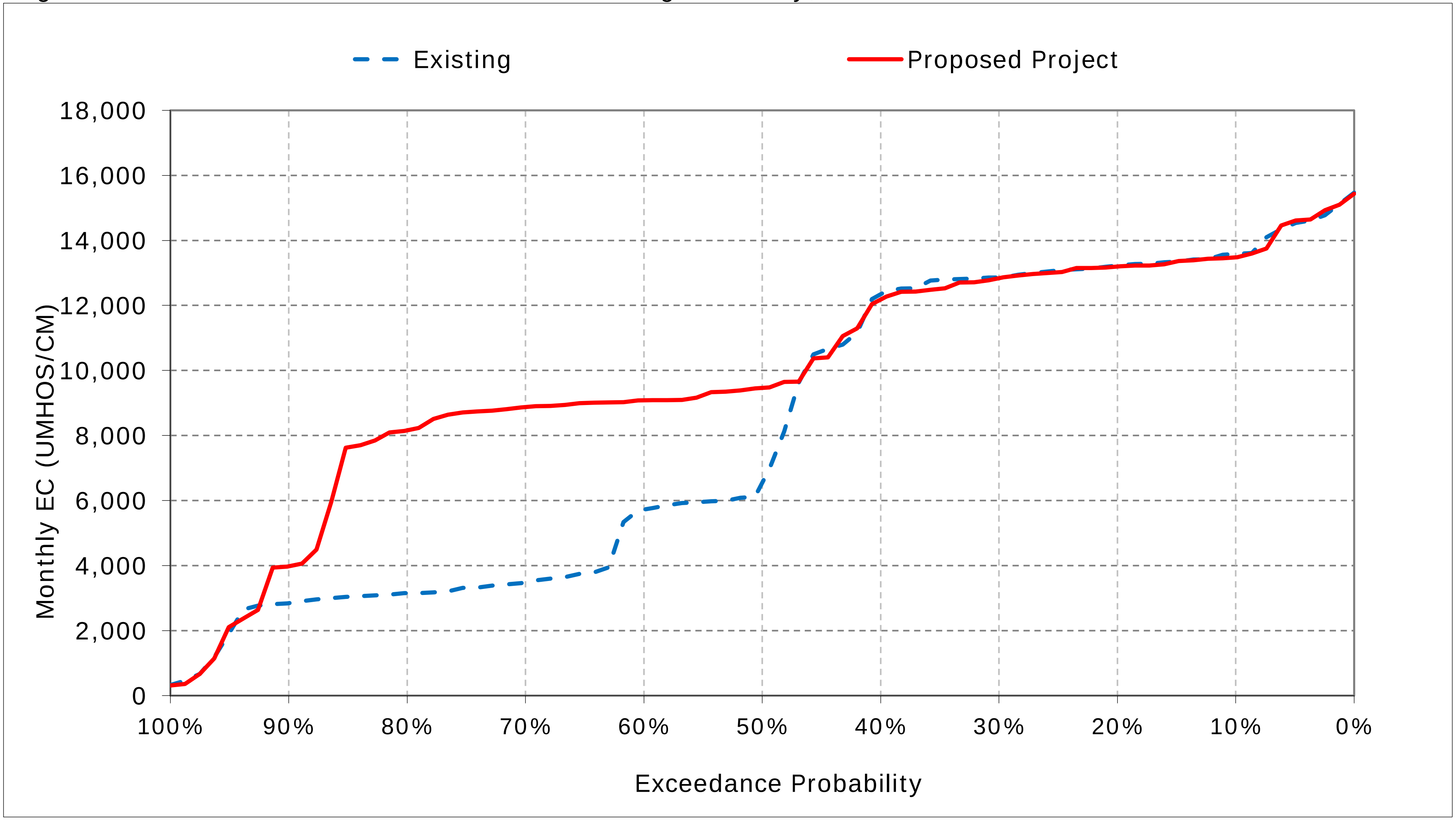


Figure 7-18. Sacramento River at Mallard Slough Salinity, December EC

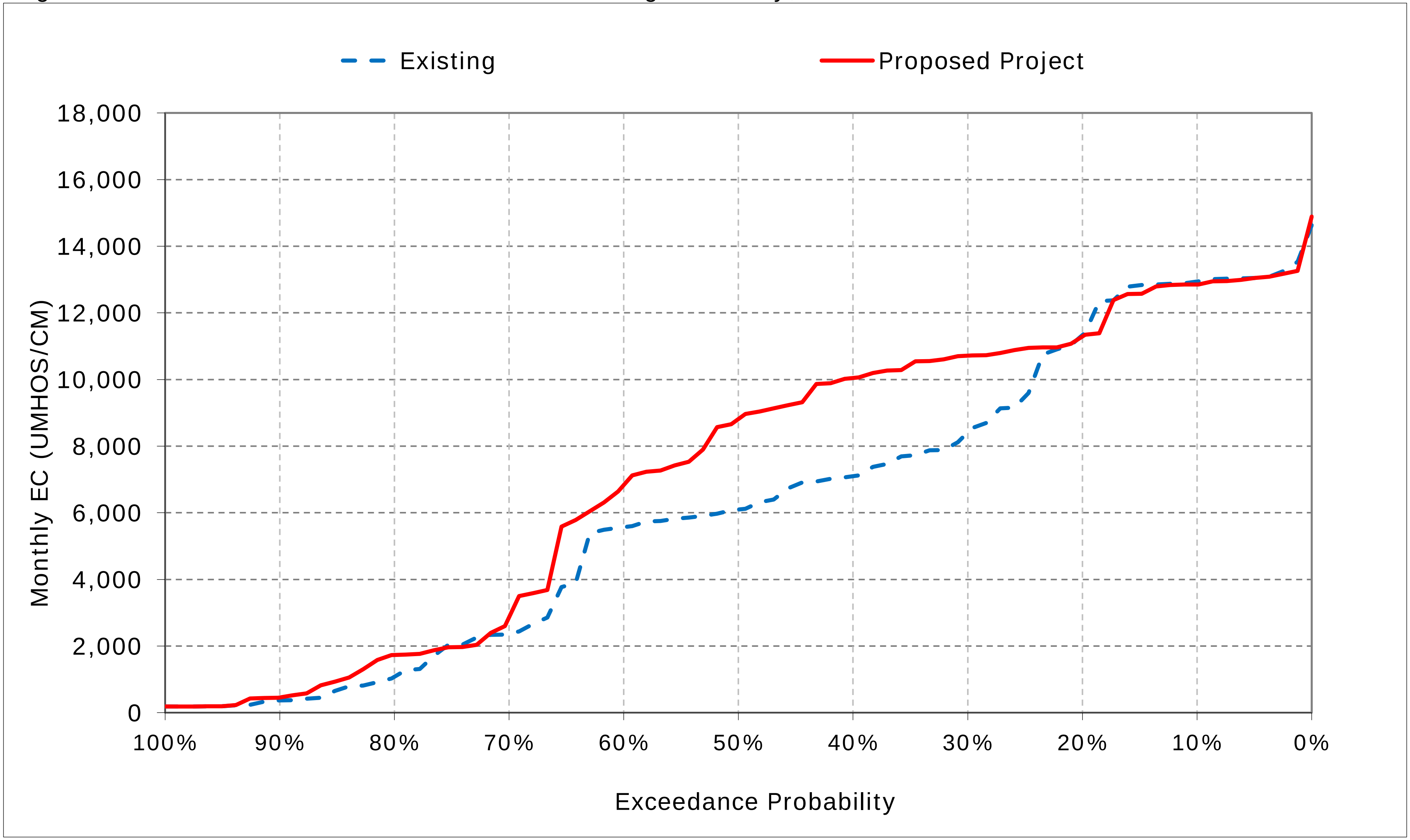


Table 8-1. Chipps Island North Channel Salinity, Monthly EC

Existing

Statistic	Monthly EC (UMHOS/CM)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	15,139	14,489	13,877	9,532	5,409	4,772	5,053	6,361	8,135	10,388	12,932	14,201
20%	14,525	14,158	12,320	8,644	3,435	2,748	2,823	5,030	6,871	9,219	11,638	13,565
30%	14,305	13,845	9,373	6,782	1,972	1,203	1,605	3,990	6,566	8,803	11,372	13,321
40%	14,060	13,301	8,053	4,143	1,005	902	1,261	2,549	5,667	6,999	9,694	12,485
50%	12,935	7,466	6,810	3,056	635	523	799	1,562	4,672	6,498	9,035	11,383
60%	7,398	6,550	6,264	1,784	321	316	446	1,033	3,816	5,231	8,836	6,341
70%	4,524	4,091	2,848	434	222	214	304	625	2,841	4,928	8,368	3,730
80%	4,248	3,742	1,294	227	203	200	215	317	1,451	4,385	8,047	3,386
90%	4,118	3,425	450	197	194	192	194	198	321	3,086	7,737	3,074
Long Term												
Full Simulation Period[a]	9,960	8,946	6,919	4,087	1,838	1,408	1,666	2,659	4,697	6,669	9,627	8,996
Water Year Types[b]												
Wet (32%)	7,986	6,081	2,461	761	253	280	364	625	1,765	3,635	7,485	3,140
Above Normal (15%)	10,362	8,828	6,983	2,528	692	305	468	909	3,388	4,812	8,193	6,219
Below Normal (17%)	10,414	9,840	8,741	4,591	1,252	1,113	1,204	2,106	4,665	6,641	9,377	11,904
Dry (22%)	10,498	10,257	8,668	6,472	3,009	2,003	2,412	3,999	6,494	8,973	11,500	13,449
Critical (15%)	12,501	12,262	11,767	8,686	5,345	4,410	5,103	7,452	9,701	11,681	13,181	14,387

Proposed Project

Statistic	Monthly EC (UMHOS/CM)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	15,070	14,400	13,806	10,696	5,193	4,805	5,348	6,648	8,162	10,405	12,917	14,179
20%	14,457	14,127	12,193	9,232	3,267	2,606	3,415	5,836	7,368	9,305	11,690	13,612
30%	14,274	13,789	11,685	7,293	1,920	1,052	2,167	4,977	6,750	8,756	11,404	13,393
40%	13,717	13,105	10,971	4,412	1,101	812	1,597	3,259	6,222	7,297	10,559	12,833
50%	12,744	10,308	9,824	3,117	595	464	1,012	2,258	4,933	6,563	9,587	11,497
60%	6,979	9,948	7,769	1,710	270	277	533	1,711	4,384	5,183	8,769	6,083
70%	6,758	9,727	3,471	435	220	212	361	961	3,171	4,900	8,314	5,901
80%	6,446	9,036	2,023	222	205	200	216	404	1,531	4,429	8,002	5,648
90%	6,121	4,658	537	197	194	193	190	199	327	3,091	7,695	5,237
Long Term												
Full Simulation Period[a]	10,473	10,735	7,950	4,308	1,894	1,380	1,867	3,142	4,939	6,731	9,730	9,678
Water Year Types[b]												
Wet (32%)	8,674	8,385	3,099	754	246	268	456	916	2,003	3,648	7,374	5,294
Above Normal (15%)	10,975	10,832	8,556	2,642	550	282	610	1,442	3,594	4,757	8,228	5,776
Below Normal (17%)	10,954	11,543	9,990	4,621	1,190	1,024	1,494	2,838	4,891	6,907	10,080	12,183
Dry (22%)	11,048	11,778	9,912	7,036	3,207	1,917	2,724	4,668	6,816	9,048	11,562	13,498
Critical (15%)	12,442	13,222	12,534	9,219	5,661	4,493	5,331	7,732	9,883	11,702	13,181	14,426

Proposed Project minus Existing

Statistic	Monthly EC (UMHOS/CM)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	-70	-89	-71	1,164	-216	34	295	288	28	17	-15	-22
20%	-68	-31	-127	588	-167	-142	592	806	497	85	52	47
30%	-31	-56	2,311	511	-52	-151	562	986	184	-47	32	73
40%	-344	-196	2,918	269	96	-90	336	710	556	298	864	348
50%	-191	2,843	3,014	61	-40	-59	212	697	261	66	552	114
60%	-419	3,399	1,505	-74	-52	-39	87	678	569	-48	-67	-259
70%	2,233	5,636	623	1	-2	-2	57	336	330	-28	-54	2,171
80%	2,198	5,293	729	-5	2	0	1	88	80	44	-45	2,262
90%	2,003	1,233	87	0	0	1	-3	1	7	5	-43	2,163
Long Term												
Full Simulation Period[a]	512	1,789	1,031	221	56	-29	201	483	242	61	104	682
Water Year Types[b]												
Wet (32%)	689	2,304	638	-7	-7	-12	92	291	238	13	-111	2,154
Above Normal (15%)	614	2,004	1,573	113	-143	-23	142	533	206	-55	36	-443
Below Normal (17%)	540	1,702	1,249	30	-62	-88	290	732	226	267	702	279
Dry (22%)	549	1,521	1,244	564	199	-85	311	669	322	75	62	49
Critical (15%)	-59	960	767	533	316	83	228	280	182	21	0	39

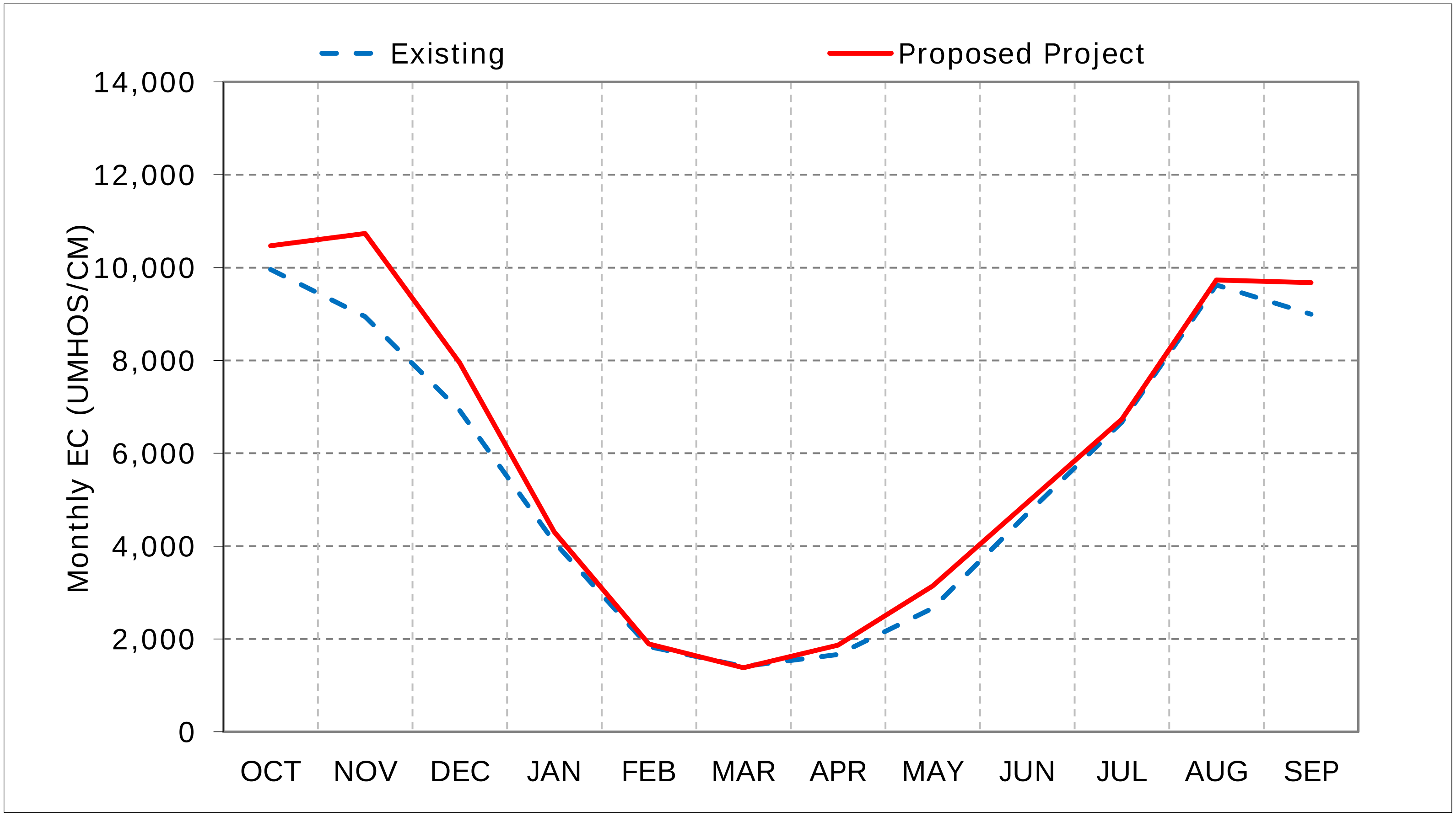
a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

c These results are displayed with water year - year type sorting.

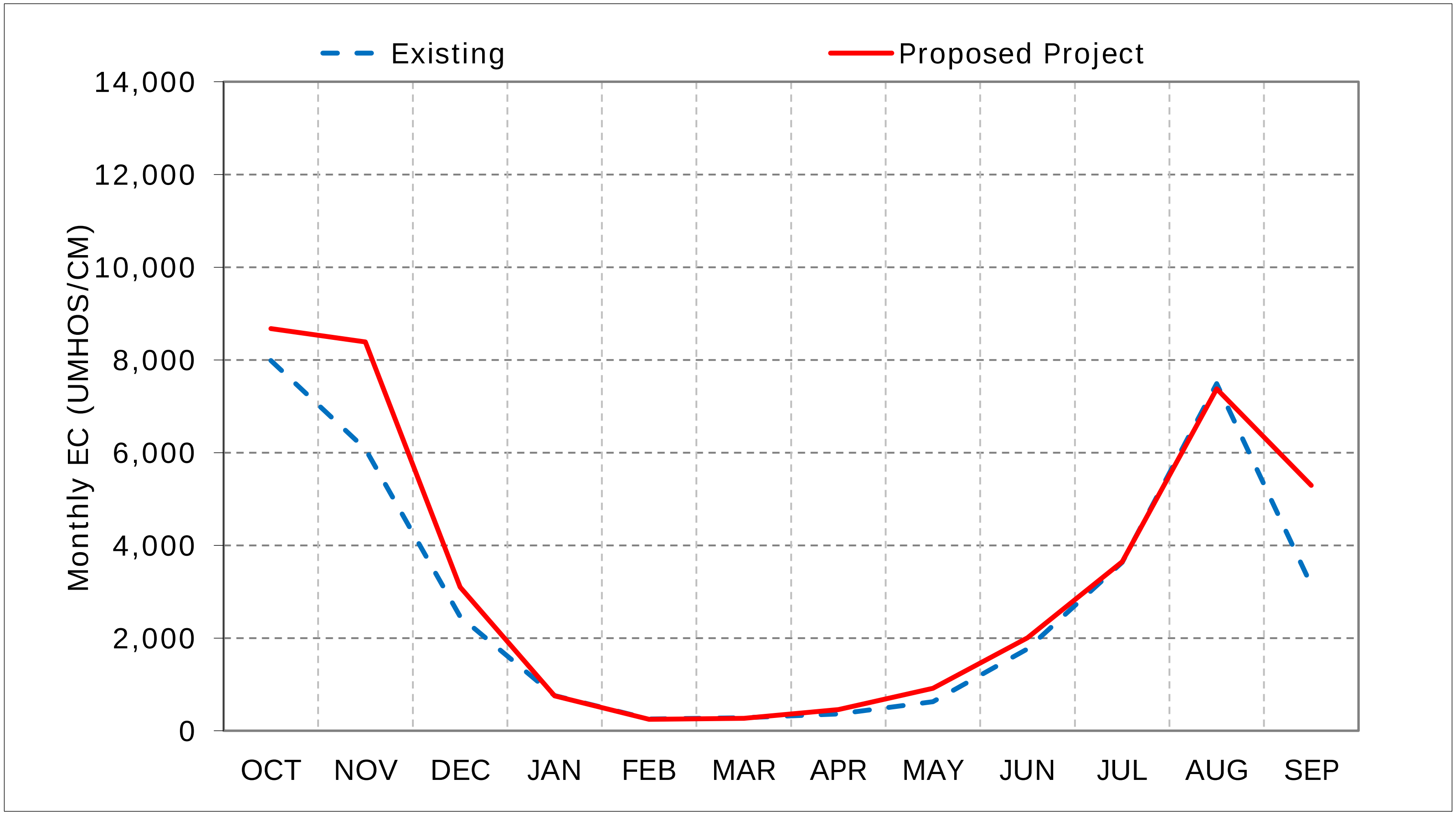
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 8-1. Chipps Island North Channel Salinity, Long-Term Average EC



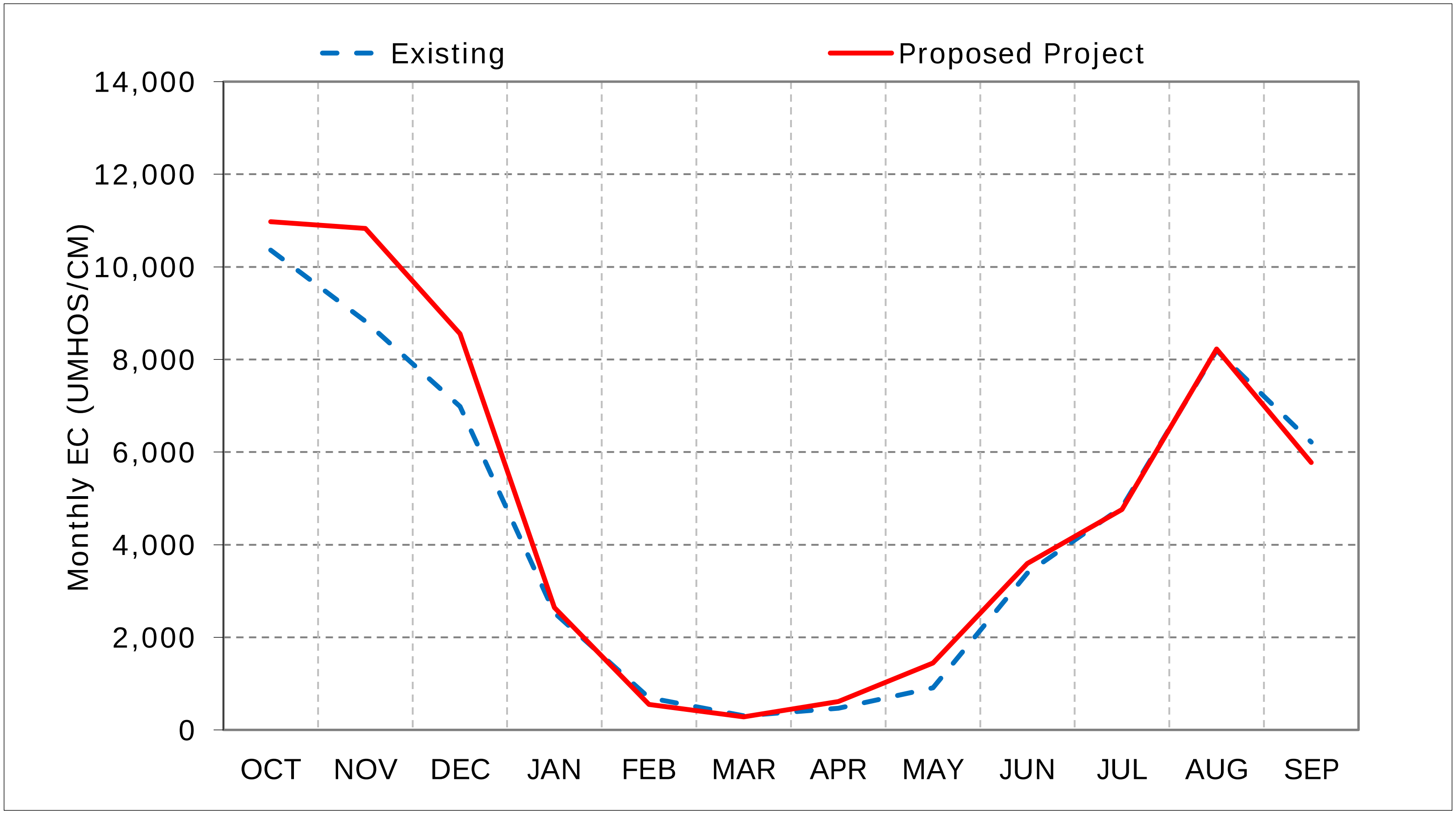
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 8-2. Chipps Island North Channel Salinity, Wet Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

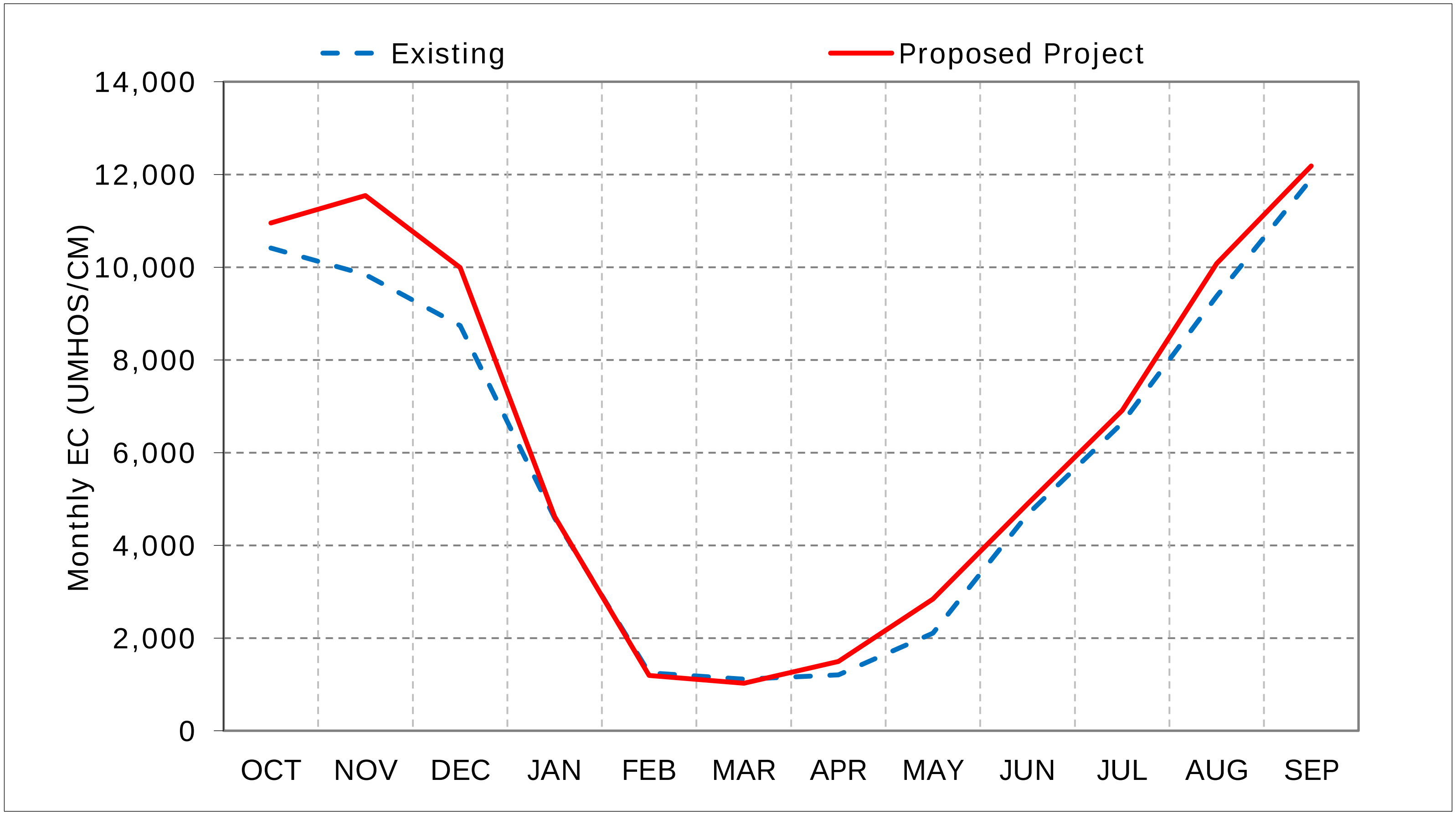
Figure 8-3. Chipps Island North Channel Salinity, Above Normal Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

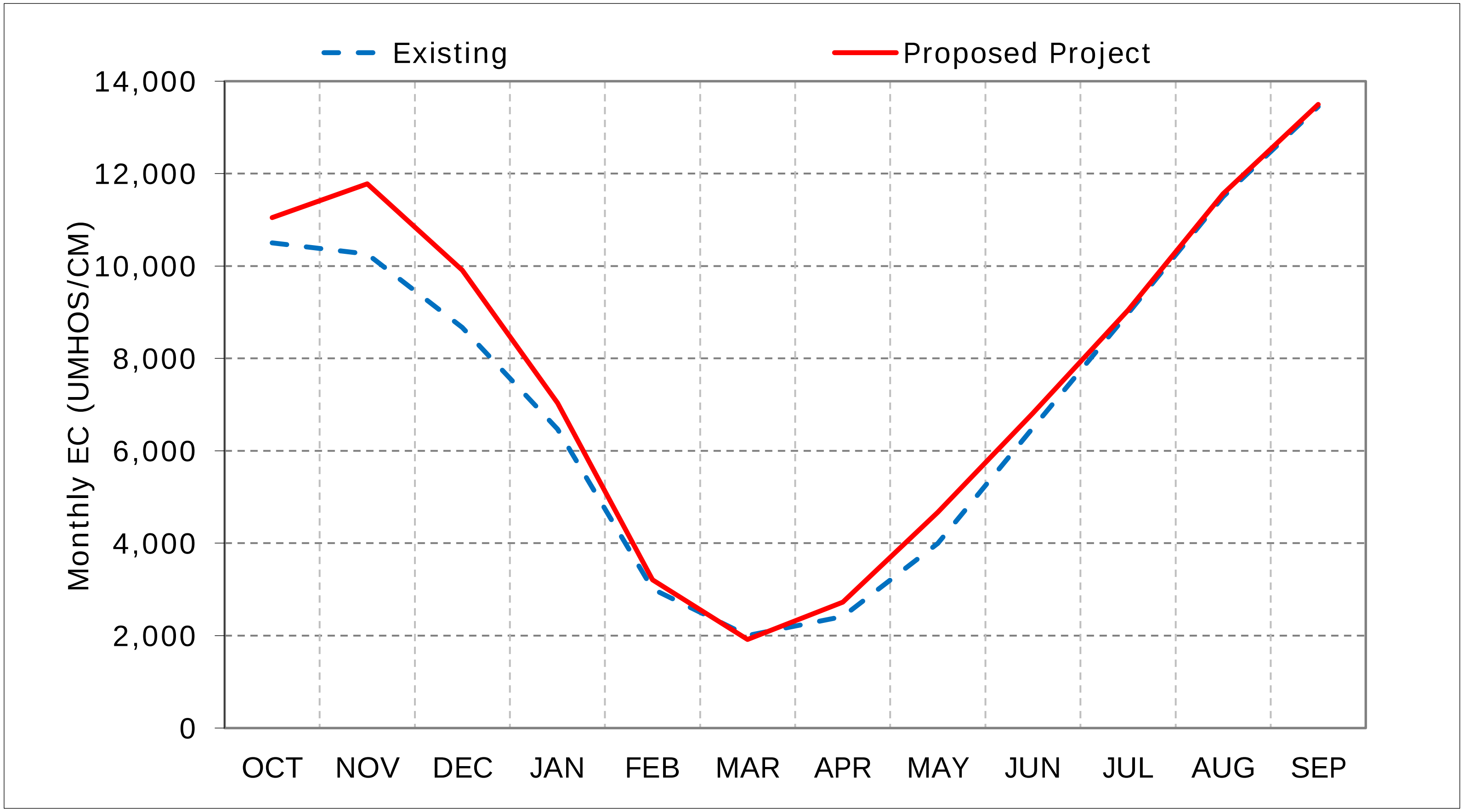
*These results are displayed with water year - year type sorting.

Figure 8-4. Chipps Island North Channel Salinity, Below Normal Year Average EC



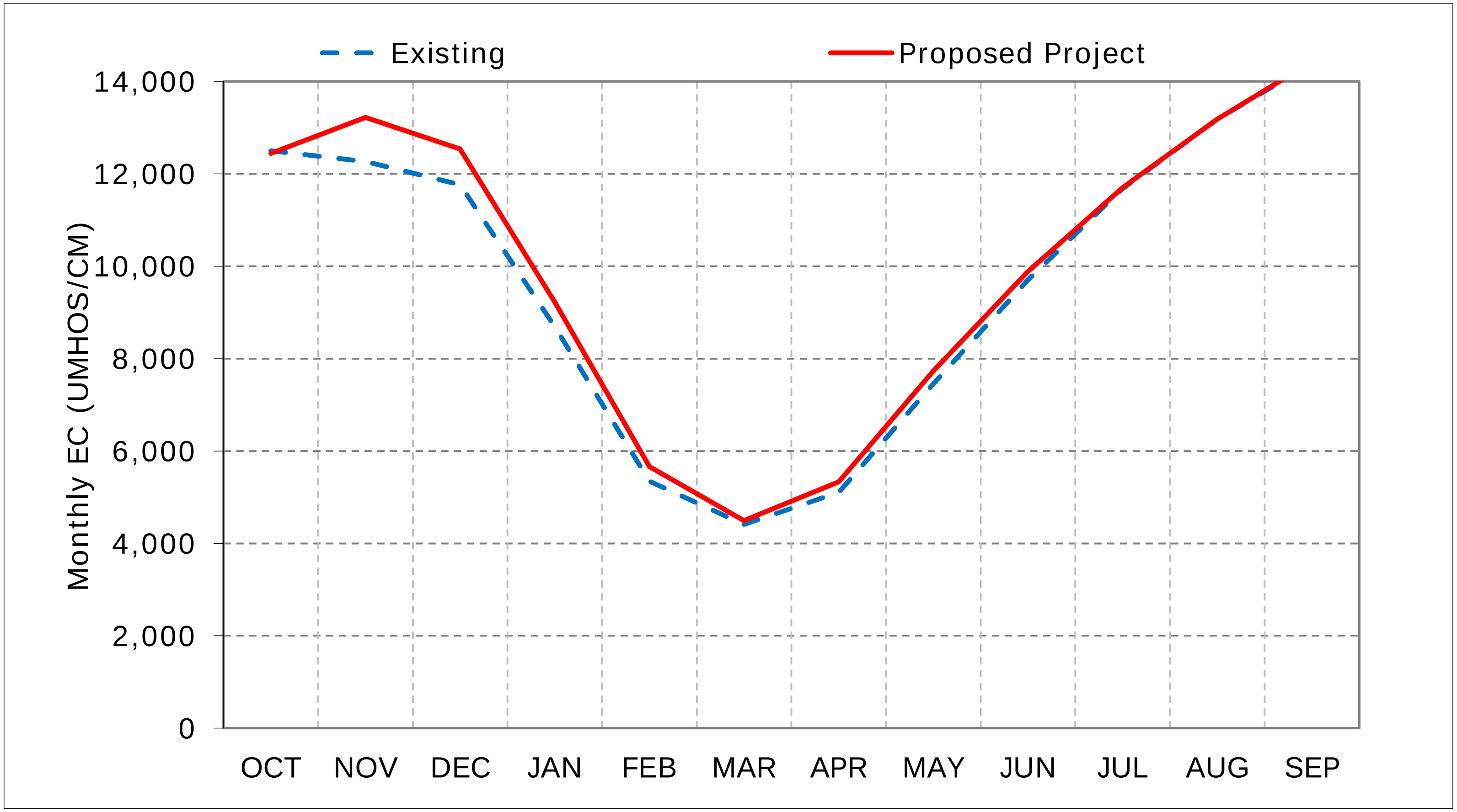
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 8-5. Chipps Island North Channel Salinity, Dry Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 8-6. Chipps Island North Channel Salinity, Critical Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 8-7. Chipps Island North Channel Salinity, January EC

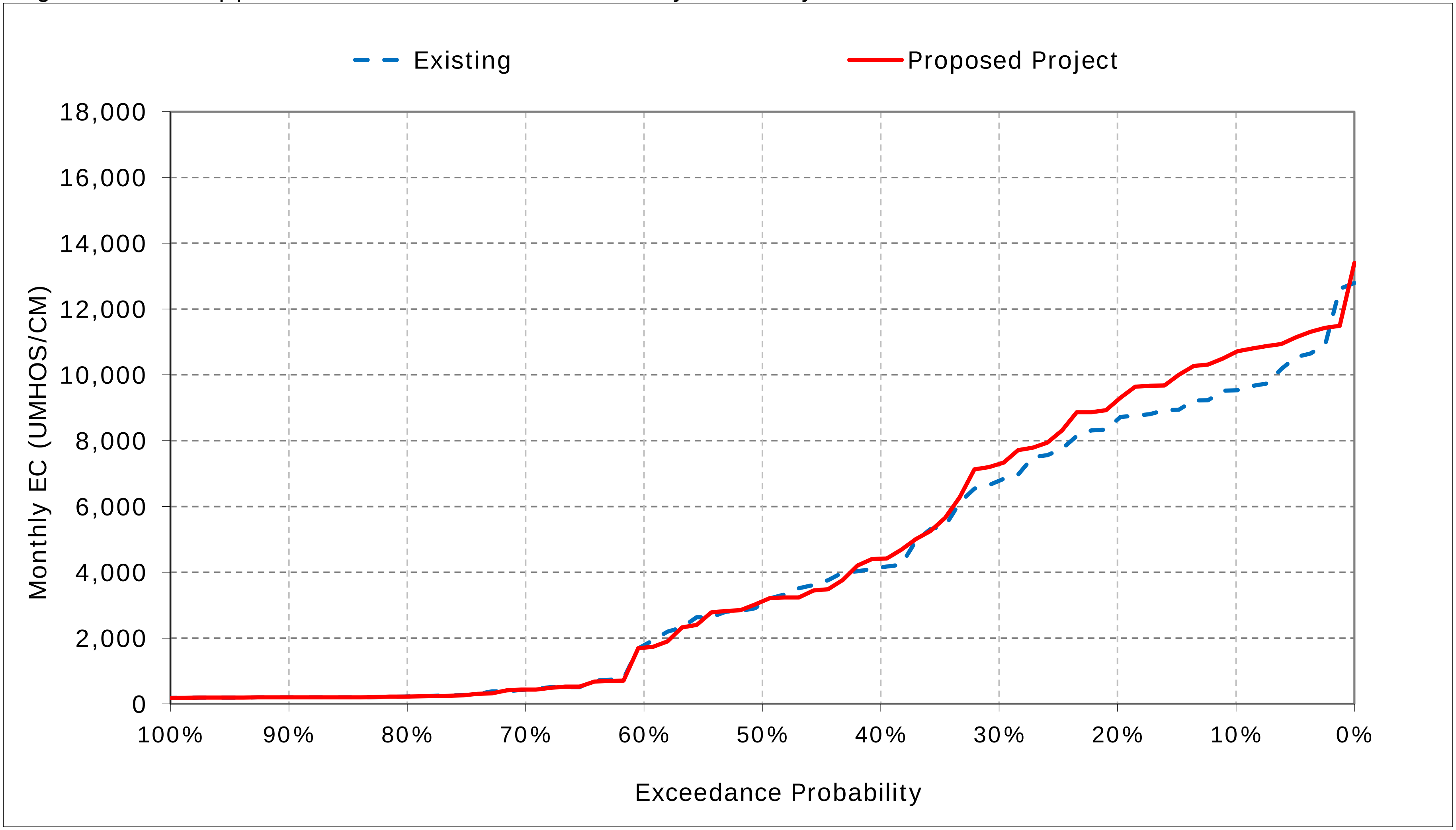


Figure 8-8. Chipps Island North Channel Salinity, February EC

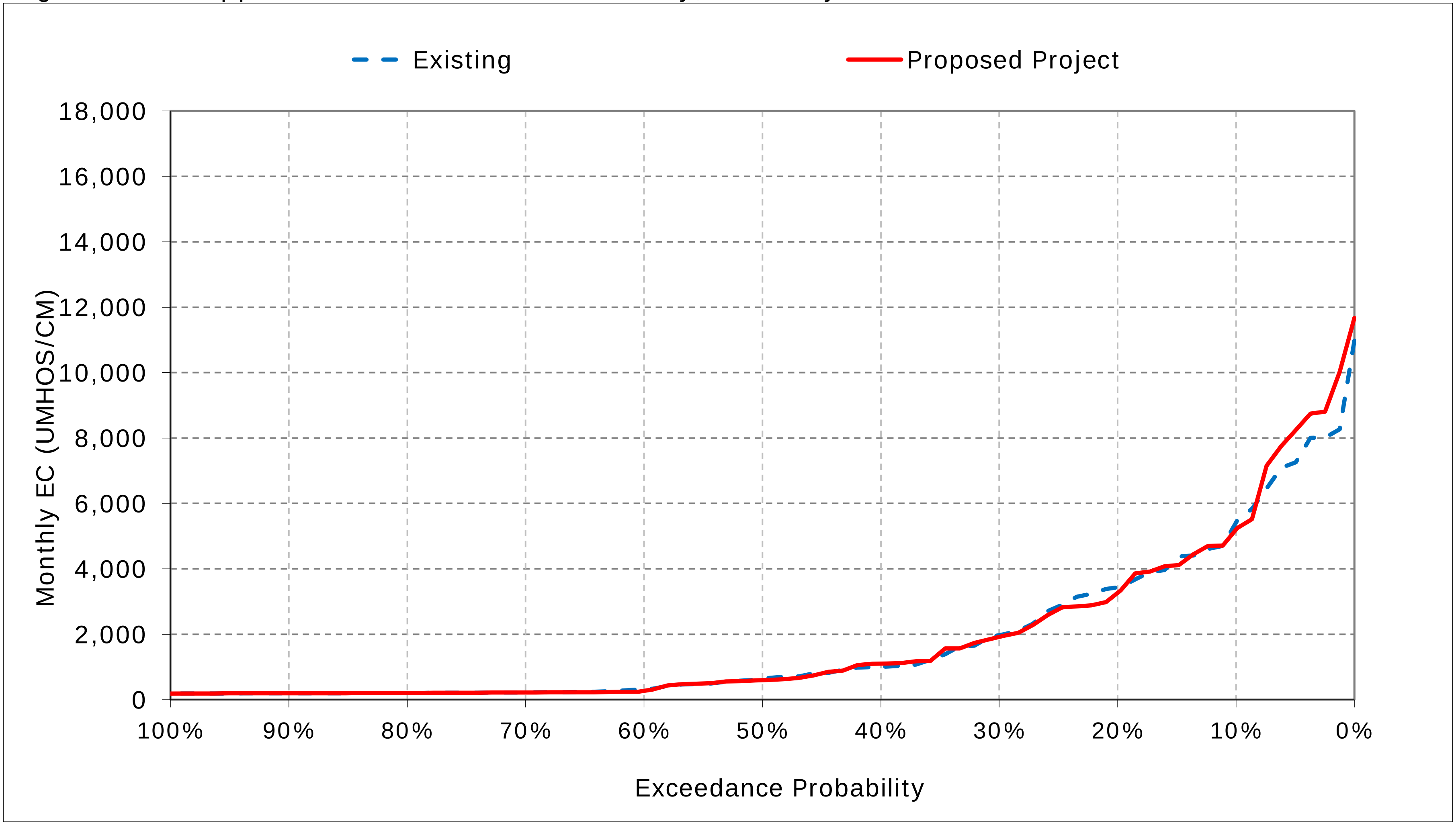


Figure 8-9. Chipps Island North Channel Salinity, March EC

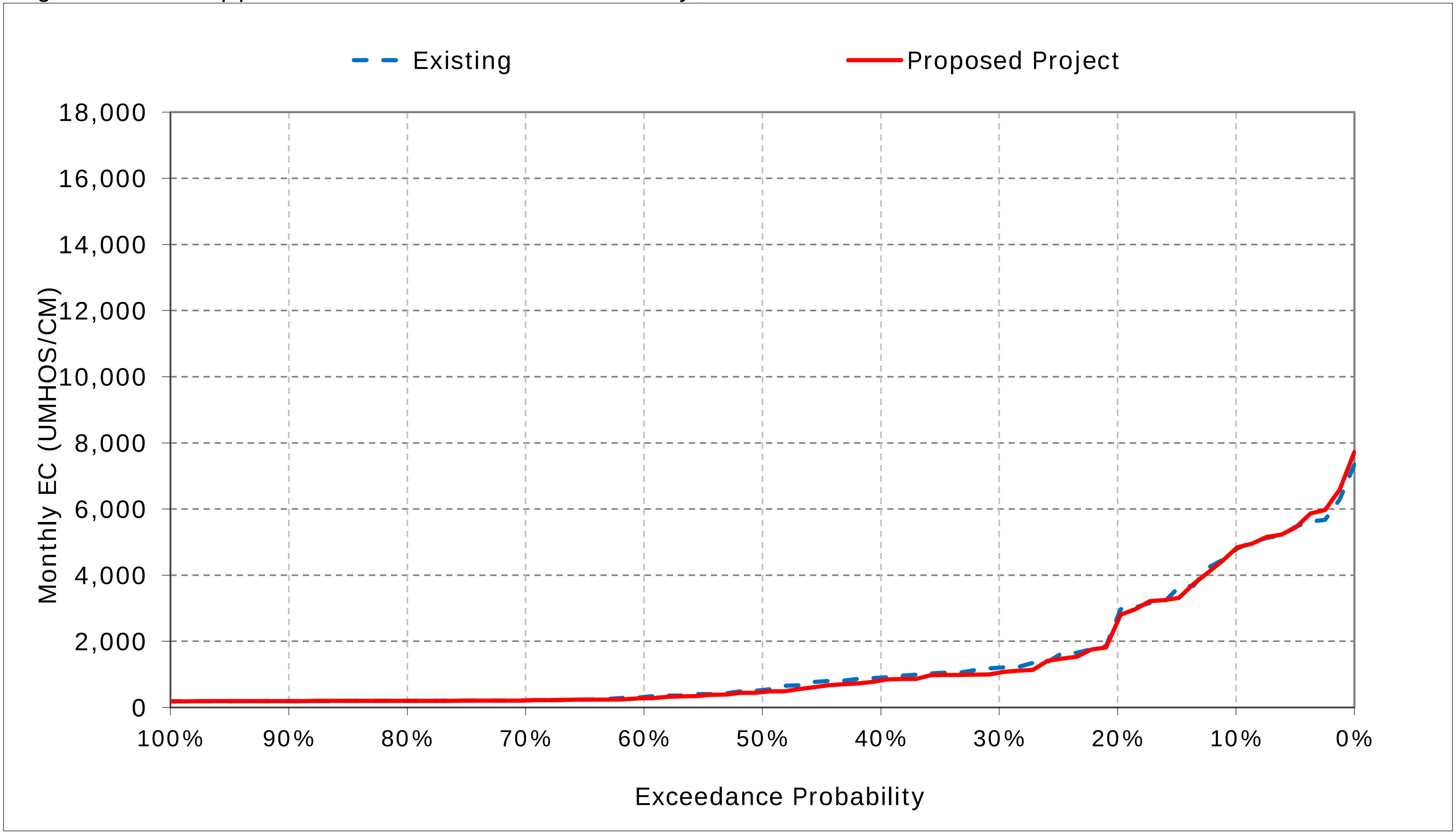


Figure 8-10. Chipps Island North Channel Salinity, April EC

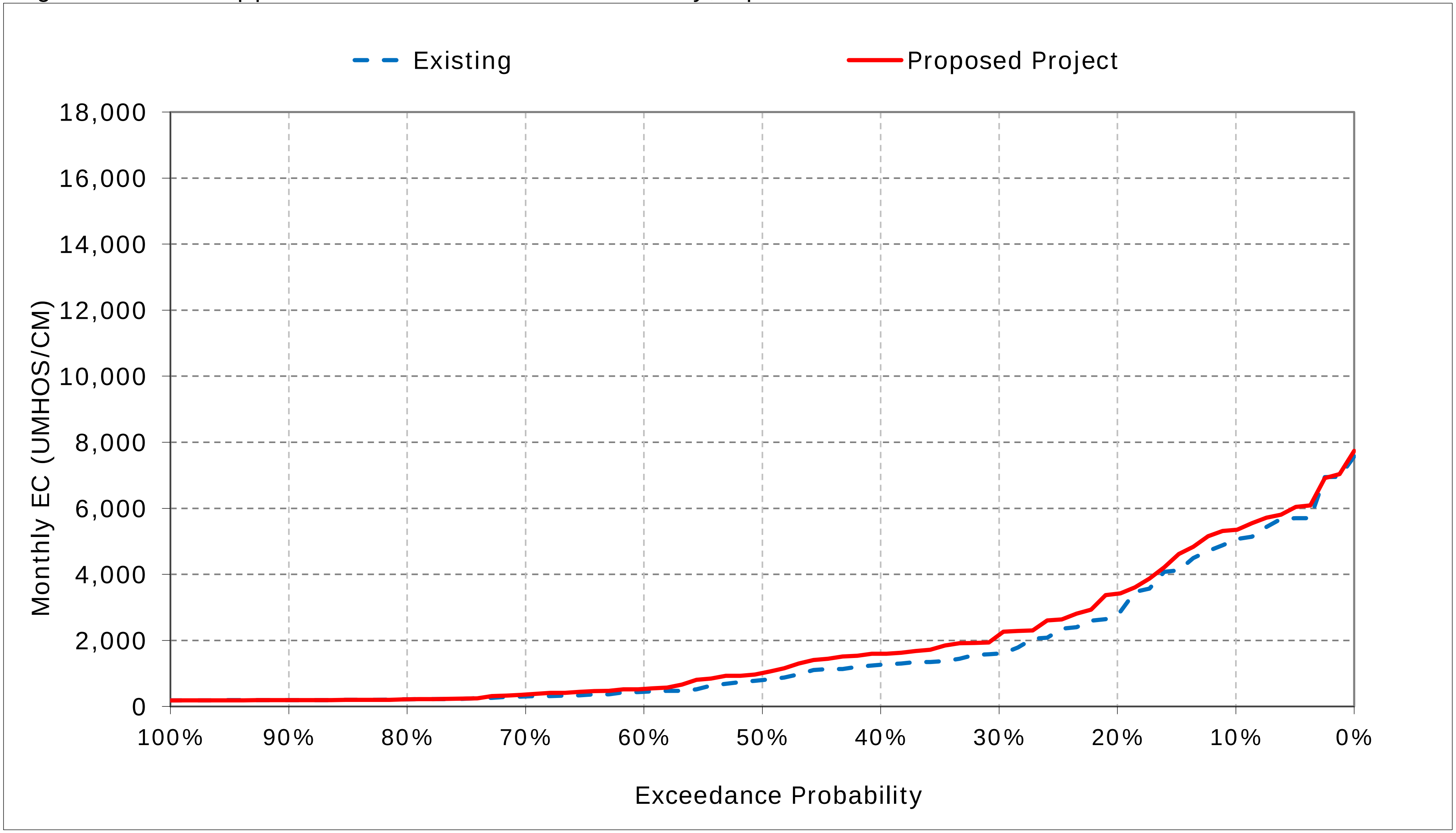


Figure 8-11. Chipps Island North Channel Salinity, May EC

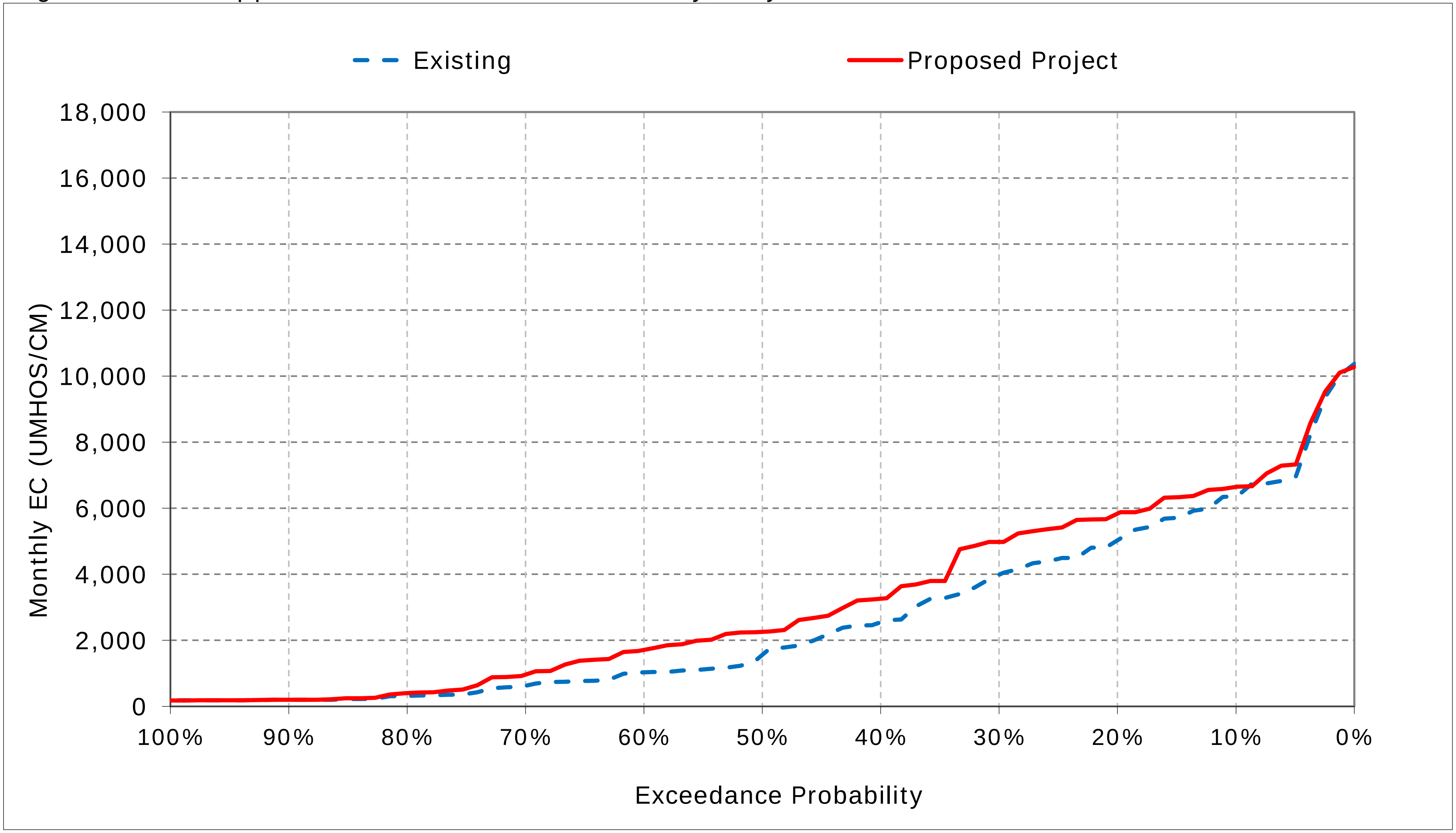


Figure 8-12. Chipps Island North Channel Salinity, June EC

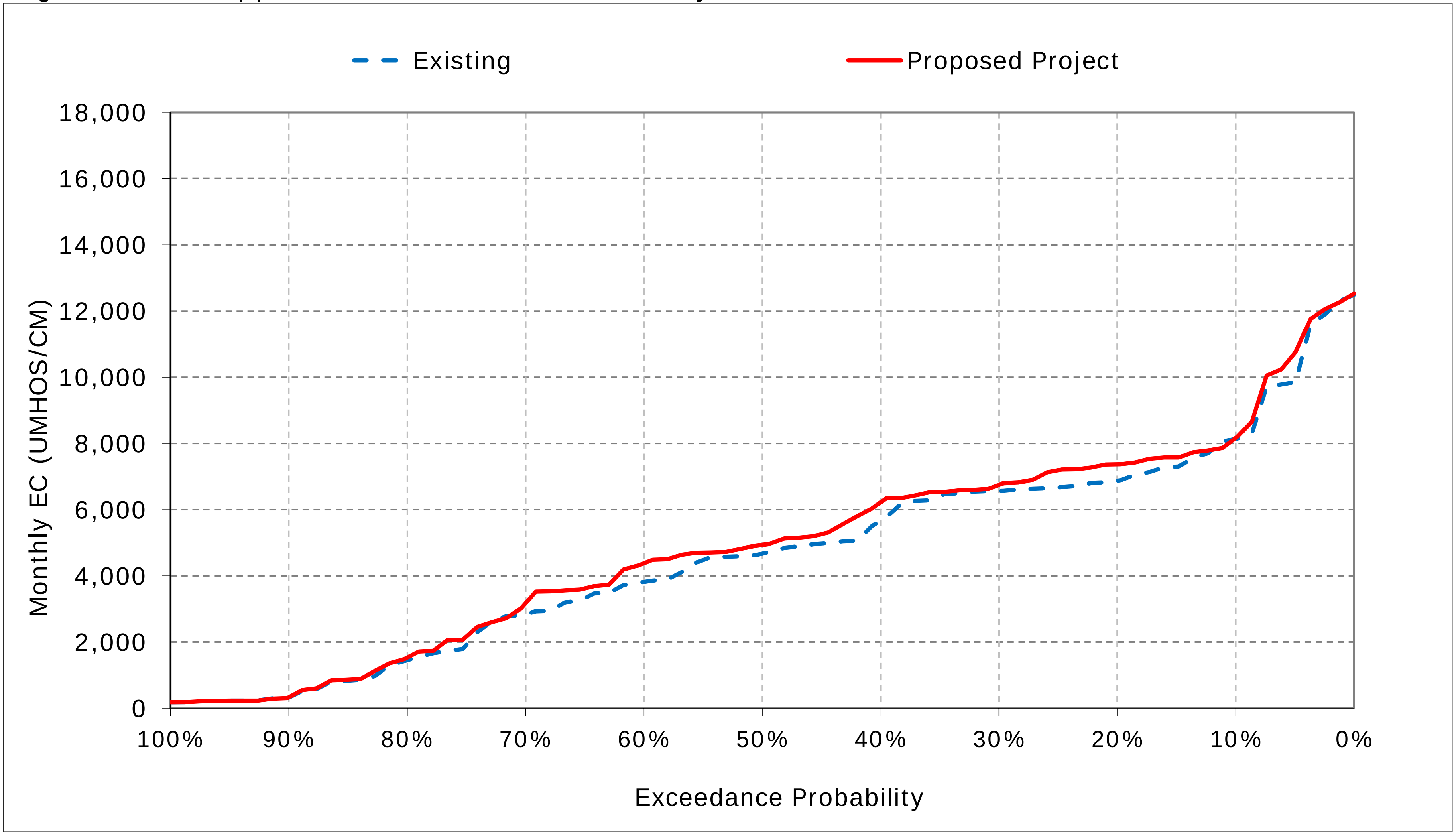


Figure 8-13. Chipps Island North Channel Salinity, July EC

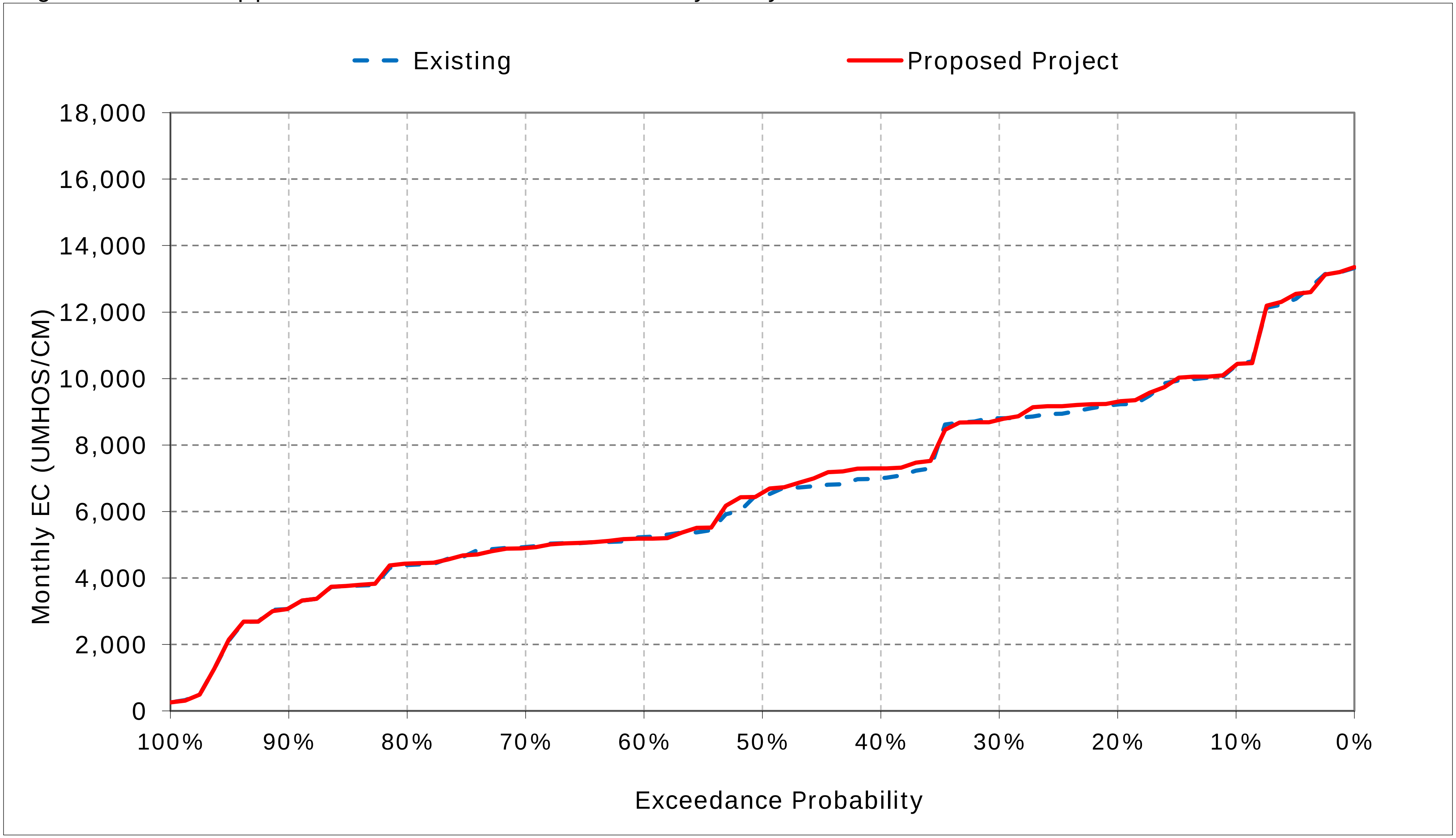


Figure 8-14. Chipps Island North Channel Salinity, August EC

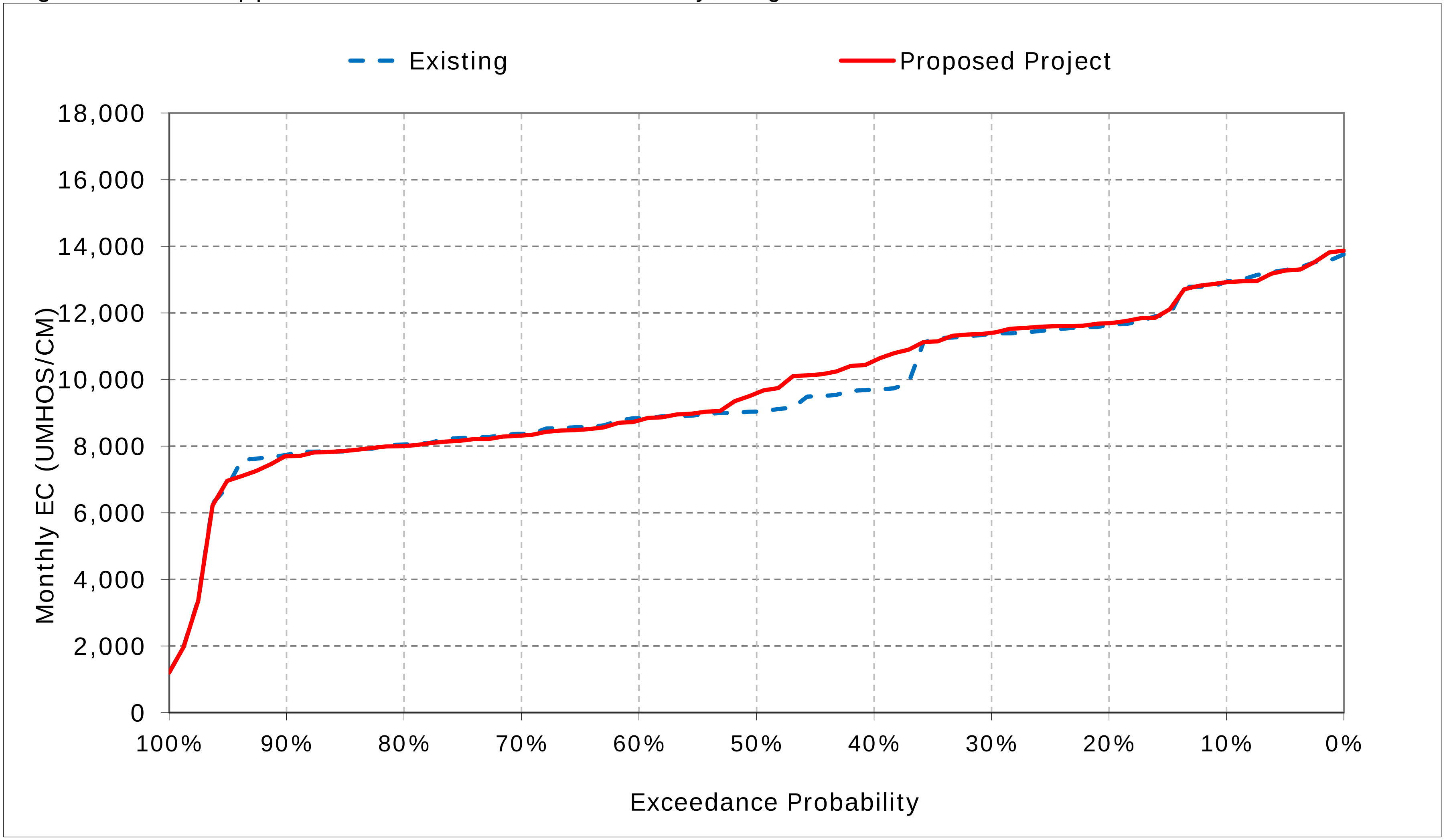


Figure 8-15. Chipps Island North Channel Salinity, September EC

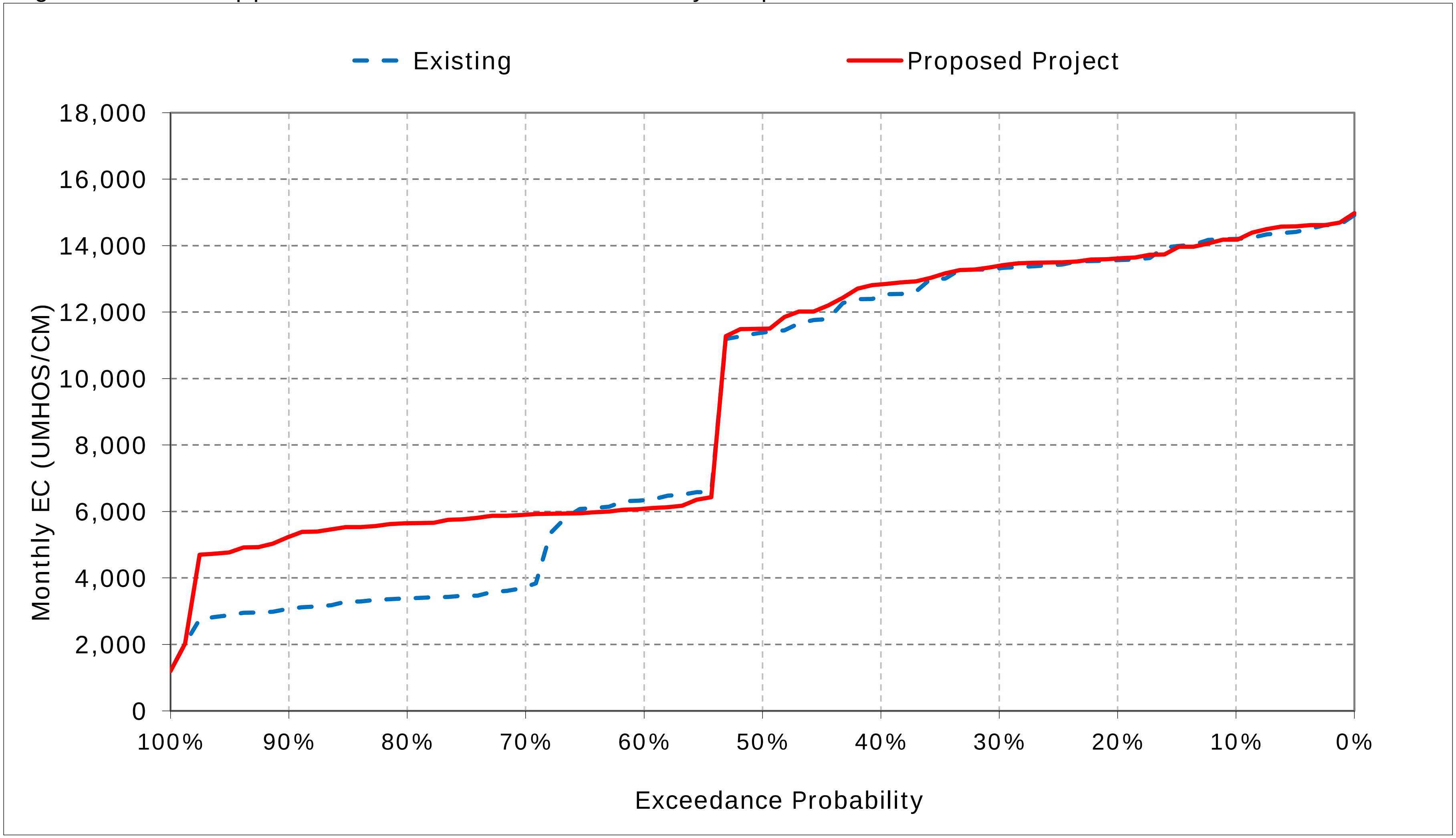


Figure 8-16. Chipps Island North Channel Salinity, October EC

Figure 8-17. Chipps Island North Channel Salinity, November EC

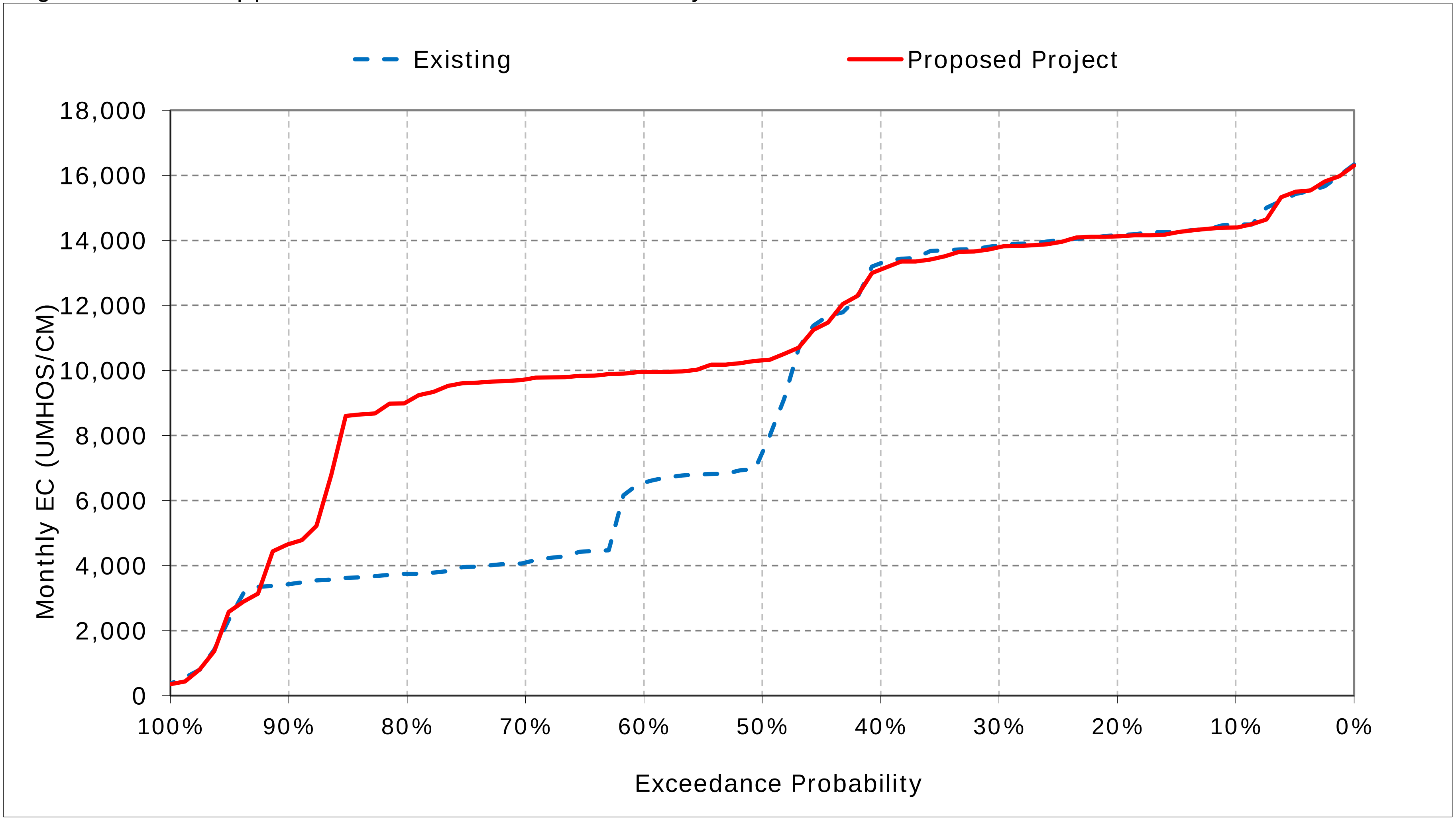


Figure 8-18. Chipps Island North Channel Salinity, December EC

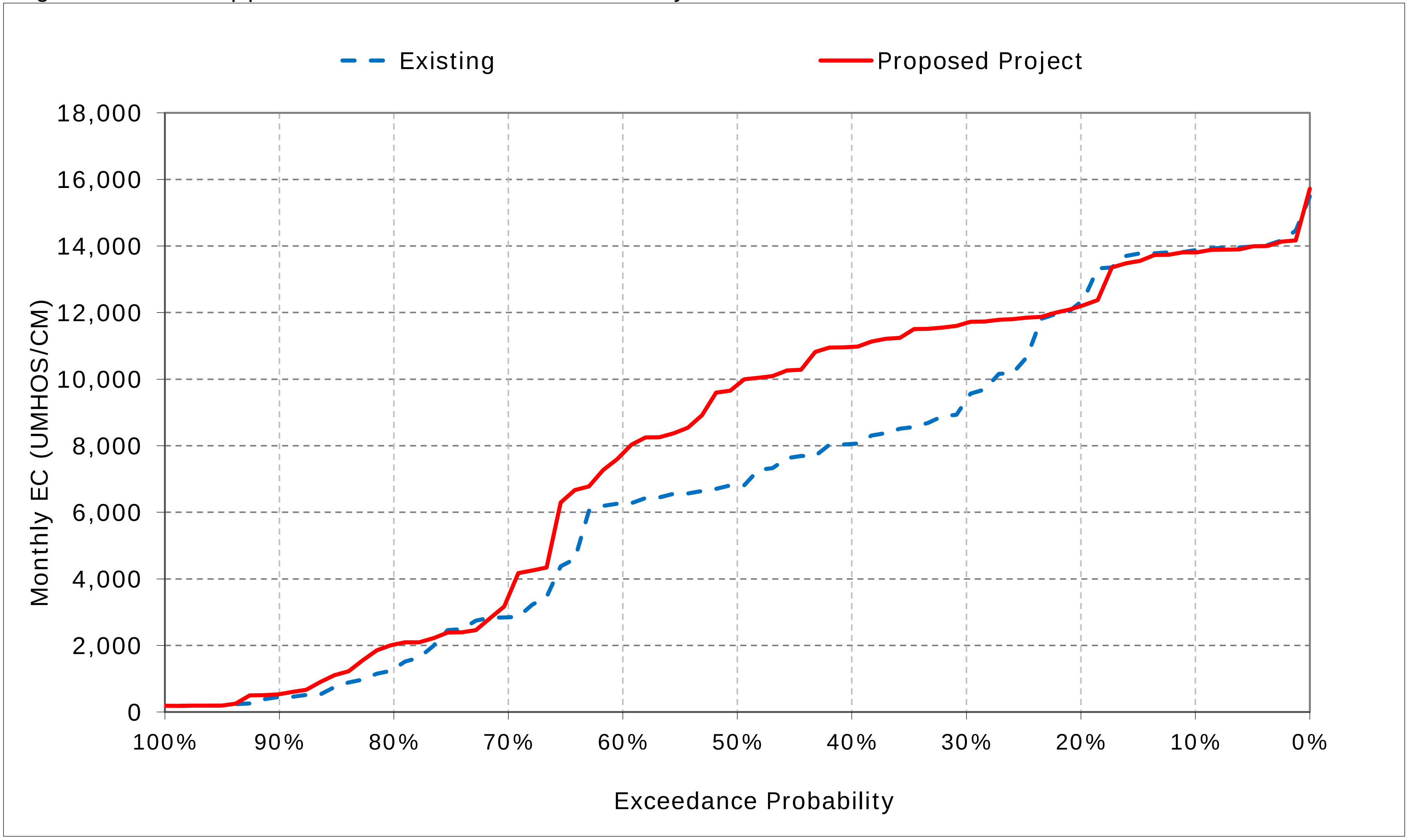


Table 9-1. Chipps Island South Channel Salinity, Monthly EC

Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	13,978	13,281	12,537	8,210	4,174	3,630	3,937	5,048	6,637	8,894	11,521	12,903
20%	13,320	12,805	10,920	7,295	2,547	2,037	1,966	3,919	5,526	7,692	10,241	12,247
30%	13,059	12,586	7,941	5,657	1,420	798	1,039	2,897	5,203	7,284	9,931	12,001
40%	12,865	11,999	6,732	3,264	795	605	808	1,734	4,277	5,564	8,261	11,115
50%	11,653	6,265	5,558	2,491	589	363	557	980	3,568	5,114	7,589	9,980
60%	6,184	5,367	5,069	1,335	295	244	307	646	2,720	4,060	7,427	5,219
70%	3,557	3,197	2,145	339	219	203	239	387	2,007	3,715	6,995	3,003
80%	3,334	2,863	1,040	216	201	196	205	238	897	3,268	6,690	2,663
90%	3,161	2,617	355	196	192	191	192	193	232	2,248	6,353	2,473
Long Term												
Full Simulation Period[a]	8,840	7,881	5,965	3,432	1,483	1,073	1,242	2,017	3,701	5,422	8,251	7,901
Water Year Types[b]												
Wet (32%)	6,948	5,172	2,013	631	240	236	282	448	1,259	2,703	6,196	2,473
Above Normal (15%)	9,230	7,827	5,961	2,122	564	251	336	595	2,502	3,646	6,818	5,100
Below Normal (17%)	9,261	8,675	7,599	3,803	972	781	836	1,470	3,527	5,266	7,910	10,521
Dry (22%)	9,348	9,098	7,430	5,383	2,376	1,474	1,734	2,962	5,139	7,459	10,075	12,122
Critical (15%)	11,294	11,051	10,428	7,453	4,354	3,446	3,964	6,062	8,235	10,217	11,797	13,075

Proposed Project

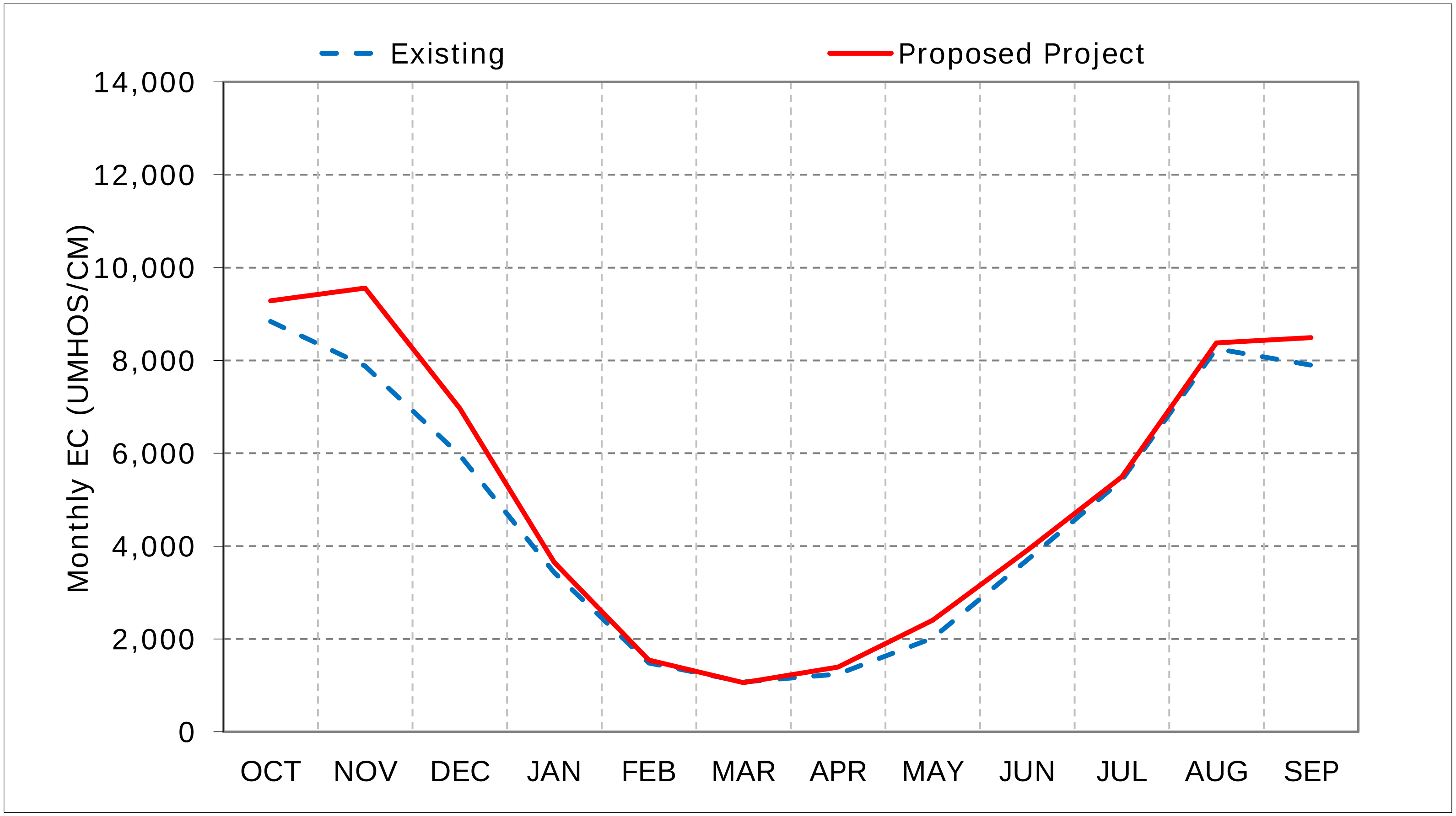
Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	13,914	13,142	12,458	9,361	4,157	3,658	4,141	5,232	6,727	8,834	11,506	12,877
20%	13,210	12,827	10,831	7,924	2,416	1,914	2,454	4,565	5,956	7,829	10,256	12,305
30%	13,042	12,504	10,368	6,055	1,509	728	1,454	3,837	5,355	7,258	9,968	12,060
40%	12,425	11,822	9,593	3,535	777	536	1,028	2,261	4,818	5,950	9,289	11,514
50%	11,422	9,081	8,412	2,438	617	333	663	1,480	3,761	5,297	8,243	10,131
60%	5,783	8,604	6,501	1,225	270	232	362	1,127	3,223	3,969	7,369	4,987
70%	5,517	8,426	2,623	336	217	205	261	584	2,231	3,715	6,945	4,772
80%	5,277	7,794	1,673	219	201	195	201	268	946	3,336	6,636	4,597
90%	4,950	3,727	612	197	193	192	190	188	234	2,255	6,234	4,347
Long Term												
Full Simulation Period[a]	9,288	9,559	6,973	3,651	1,543	1,058	1,392	2,399	3,910	5,492	8,376	8,491
Water Year Types[b]												
Wet (32%)	7,561	7,329	2,653	629	233	230	340	657	1,455	2,715	6,086	4,278
Above Normal (15%)	9,757	9,678	7,477	2,255	450	236	425	970	2,660	3,588	6,851	4,703
Below Normal (17%)	9,734	10,274	8,815	3,857	927	726	1,045	2,036	3,716	5,596	8,752	10,872
Dry (22%)	9,833	10,551	8,644	5,912	2,557	1,421	1,977	3,537	5,434	7,532	10,137	12,171
Critical (15%)	11,220	11,949	11,177	7,964	4,674	3,517	4,162	6,320	8,417	10,232	11,786	13,112

Proposed Project minus Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	-64	-139	-79	1,151	-17	29	205	184	90	-60	-16	-26
20%	-111	22	-89	629	-131	-123	488	646	429	137	16	58
30%	-18	-83	2,427	398	90	-71	415	941	152	-27	36	59
40%	-440	-176	2,861	271	-17	-69	220	527	540	385	1,029	399
50%	-232	2,816	2,853	-53	28	-31	106	500	193	183	654	151
60%	-400	3,238	1,431	-110	-25	-12	55	481	503	-91	-58	-232
70%	1,960	5,229	479	-3	-2	2	22	197	224	0	-50	1,769
80%	1,942	4,931	633	3	0	-1	-4	30	49	68	-55	1,933
90%	1,789	1,110	258	0	1	1	-2	-5	2	6	-119	1,874
Long Term												
Full Simulation Period[a]	448	1,678	1,008	219	60	-15	150	382	209	70	126	590
Water Year Types[b]												
Wet (32%)	613	2,157	640	-2	-7	-6	58	209	196	12	-110	1,805
Above Normal (15%)	527	1,852	1,515	133	-114	-15	89	374	158	-58	33	-398
Below Normal (17%)	473	1,599	1,216	54	-44	-55	209	565	189	330	842	351
Dry (22%)	485	1,453	1,214	528	181	-53	243	575	295	74	62	50
Critical (15%)	-74	898	749	511	320	72	198	258	182	14	-11	37

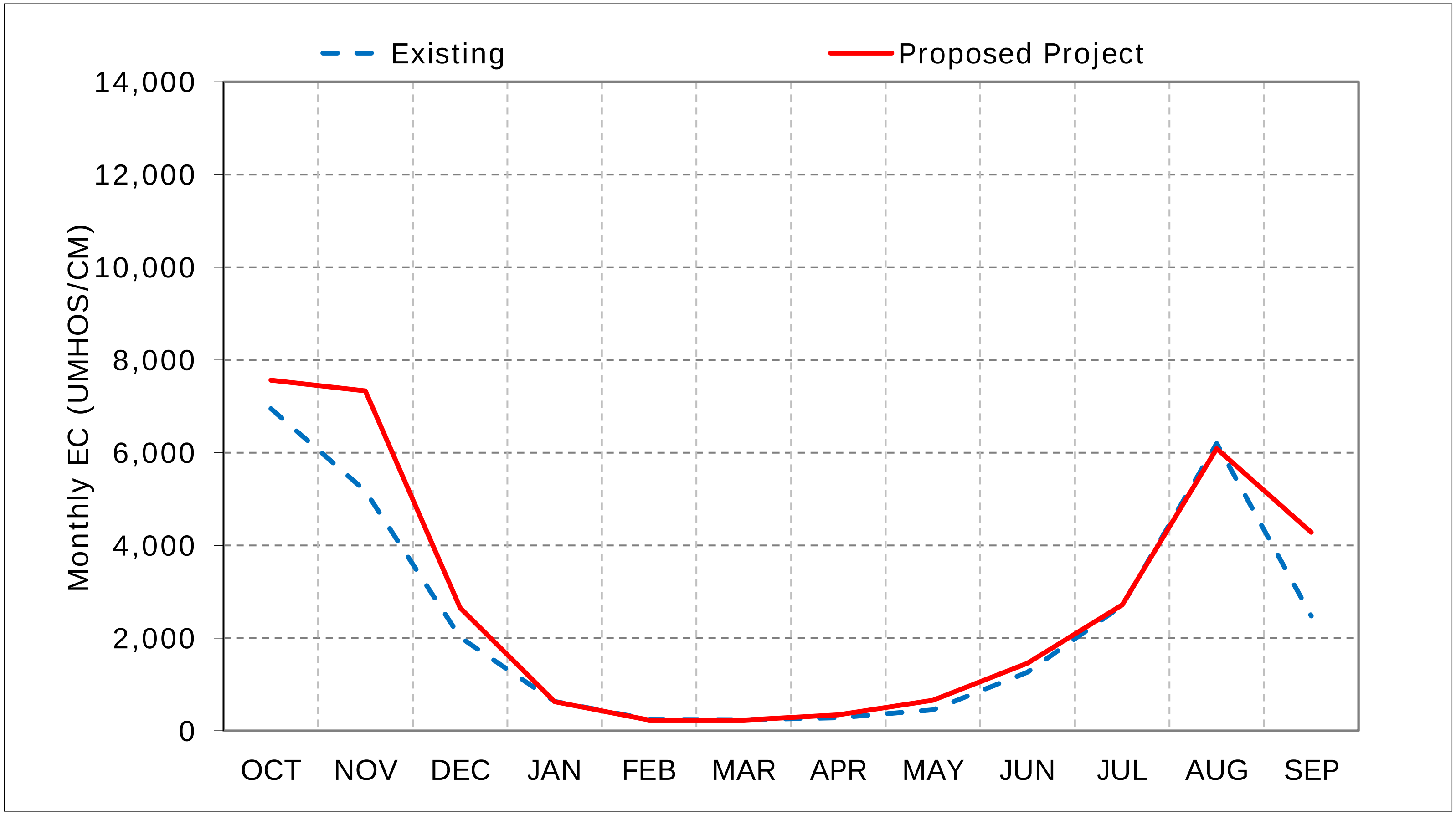
a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with water year - year type sorting.
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 9-1. Chipps Island South Channel Salinity, Long-Term Average EC



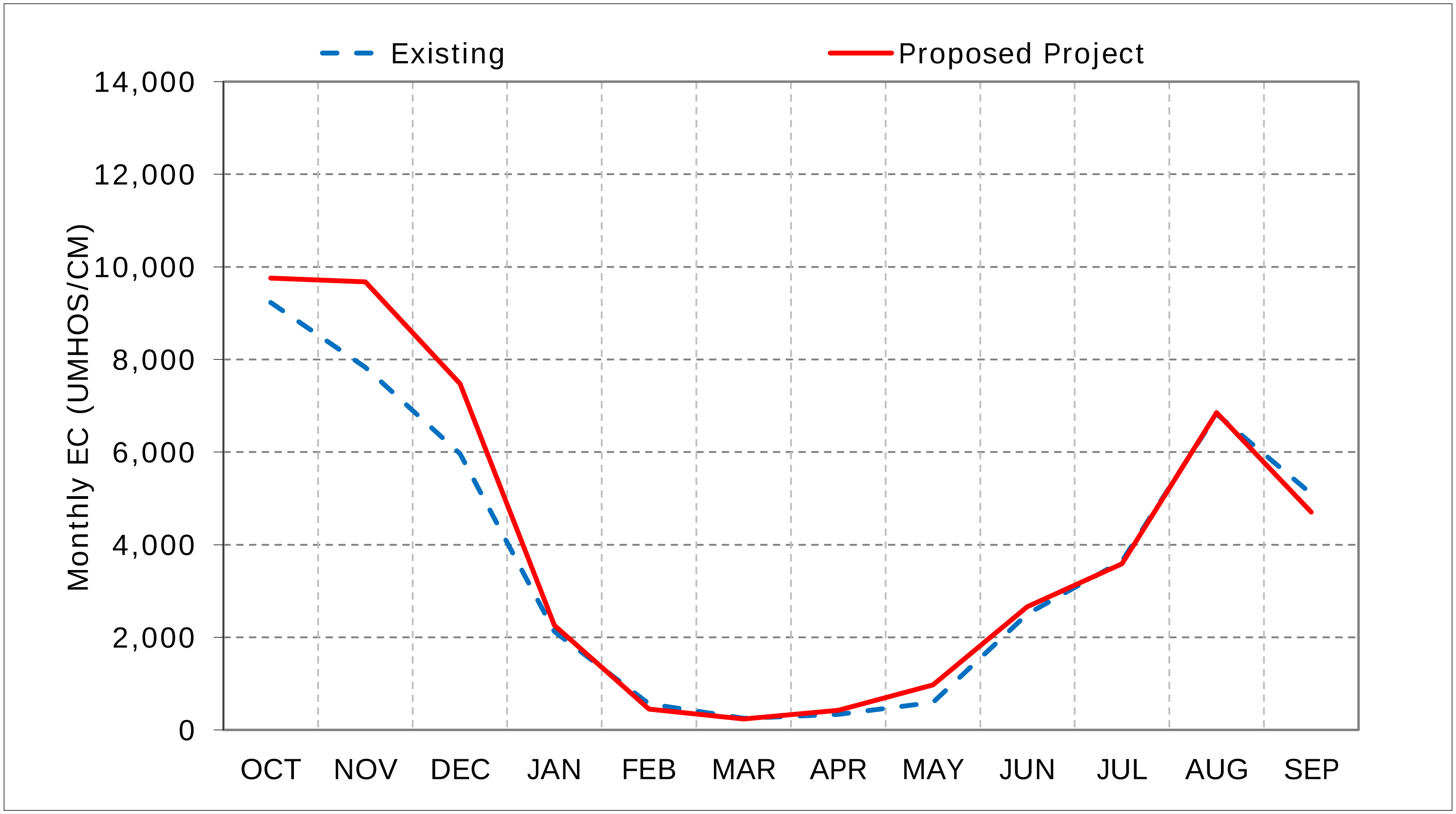
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 9-2. Chipps Island South Channel Salinity, Wet Year Average EC



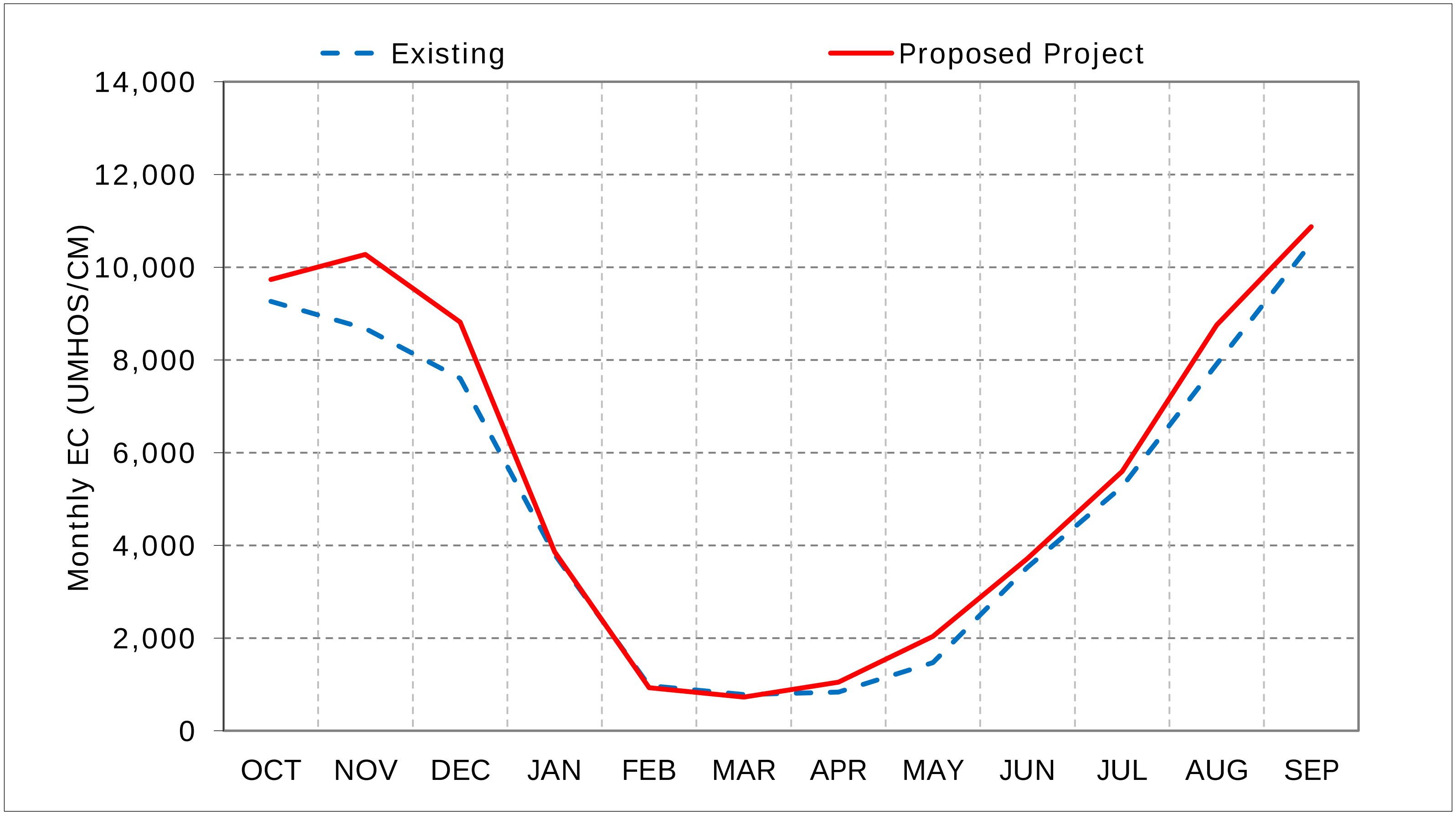
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 9-3. Chipps Island South Channel Salinity, Above Normal Year Average EC



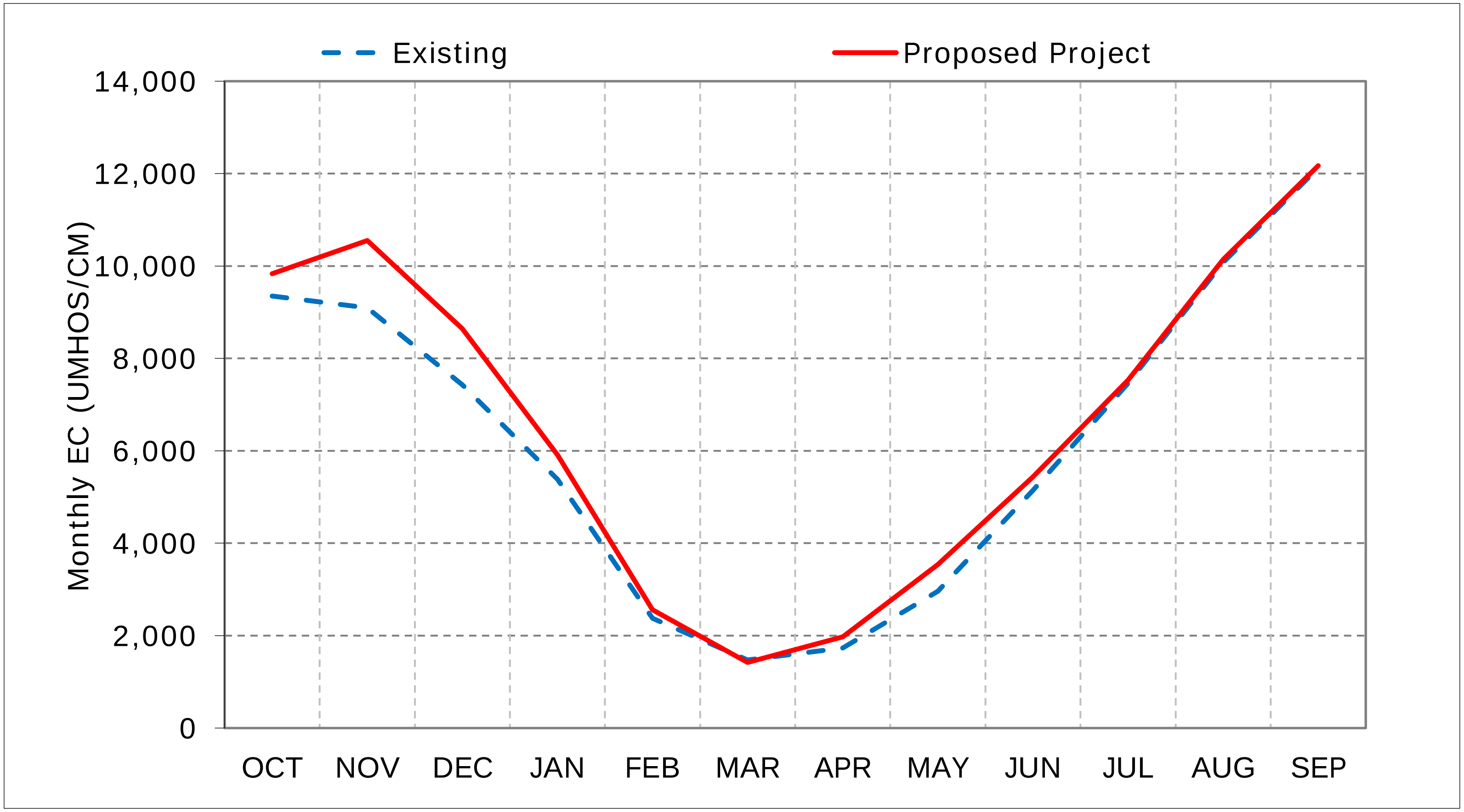
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 9-4. Chipps Island South Channel Salinity, Below Normal Year Average EC



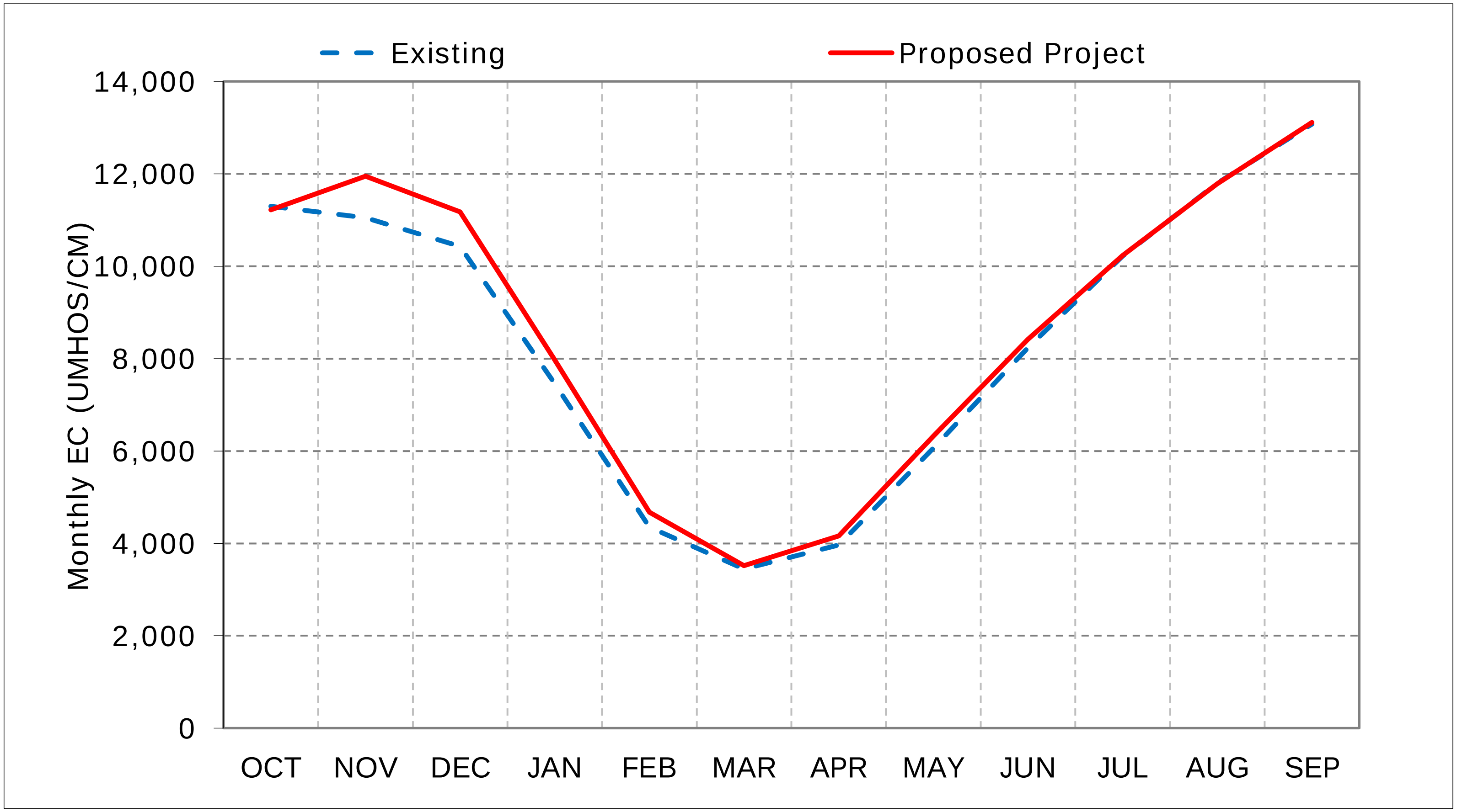
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 9-5. Chipps Island South Channel Salinity, Dry Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 9-6. Chipps Island South Channel Salinity, Critical Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 9-7. Chipps Island South Channel Salinity, January EC

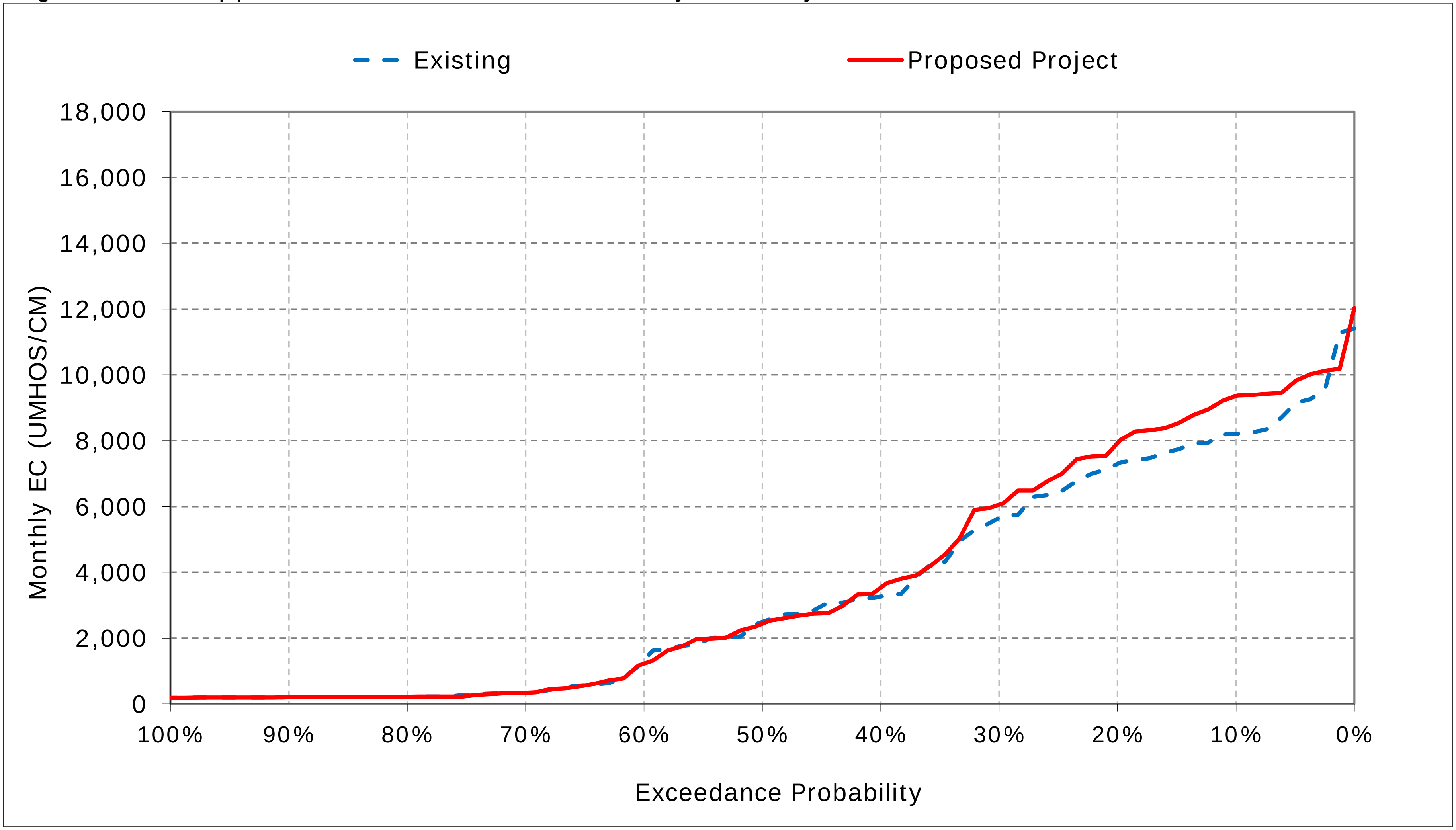


Figure 9-8. Chipps Island South Channel Salinity, February EC

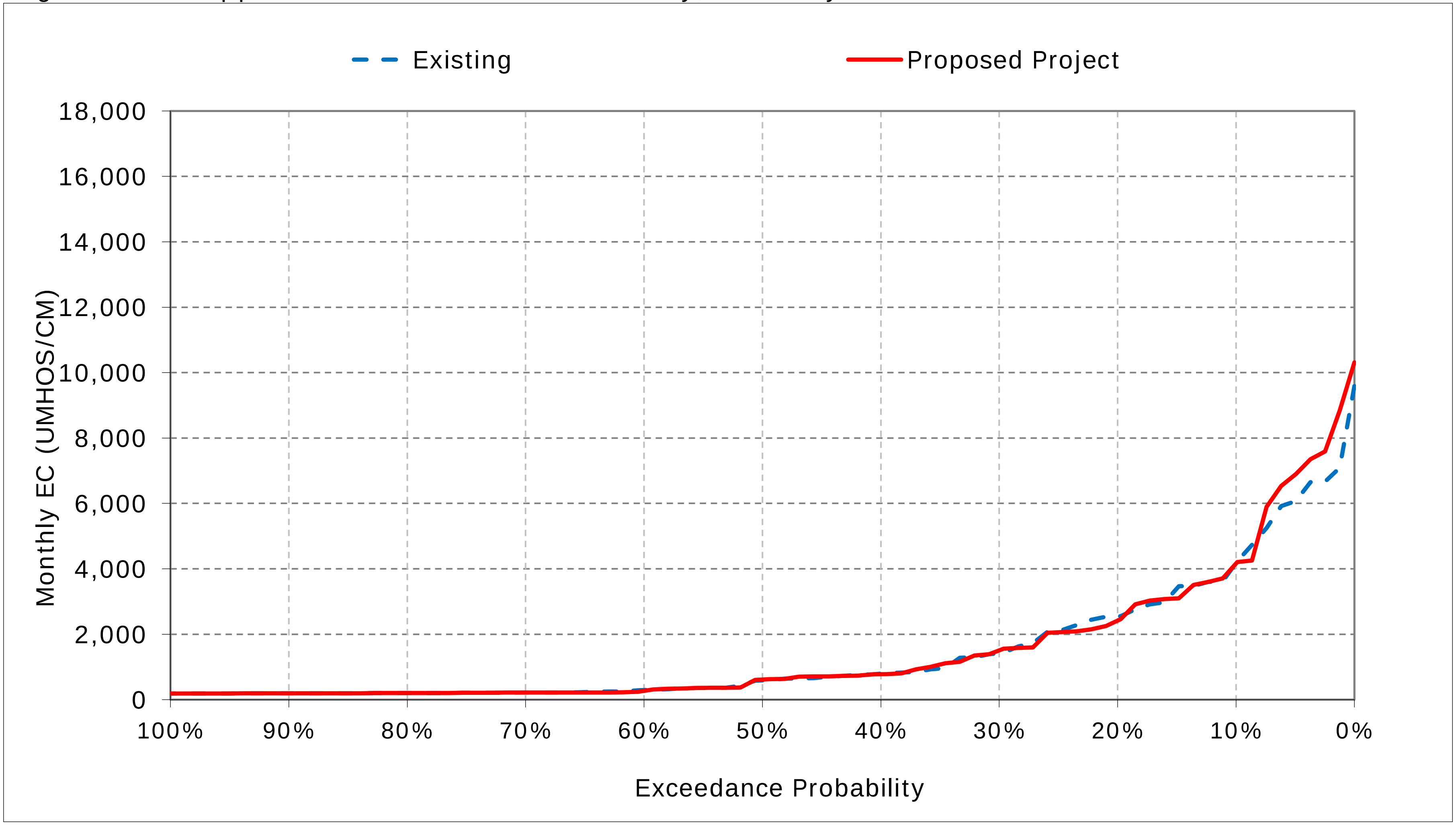


Figure 9-9. Chipps Island South Channel Salinity, March EC

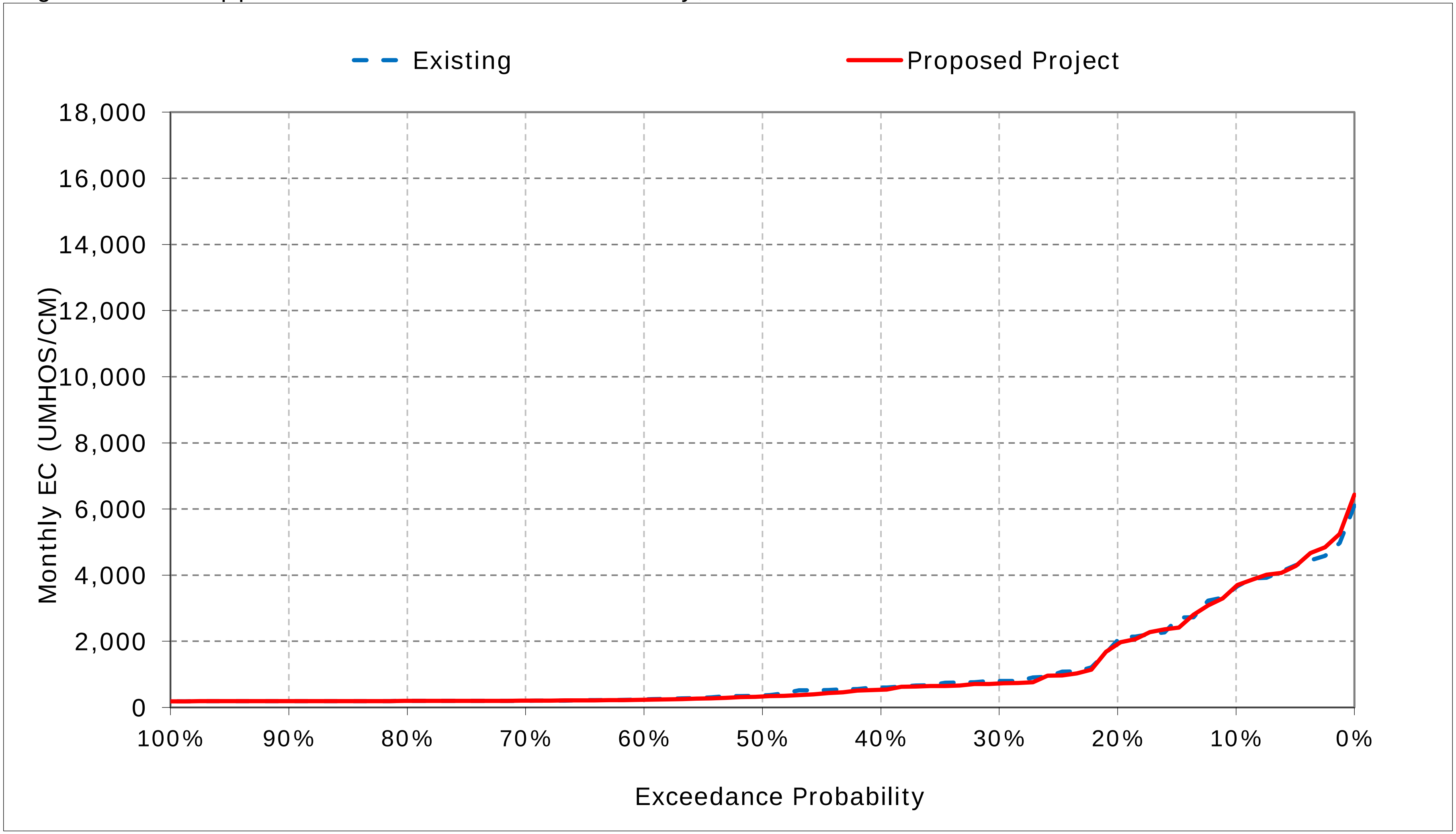


Figure 9-10. Chipps Island South Channel Salinity, April EC

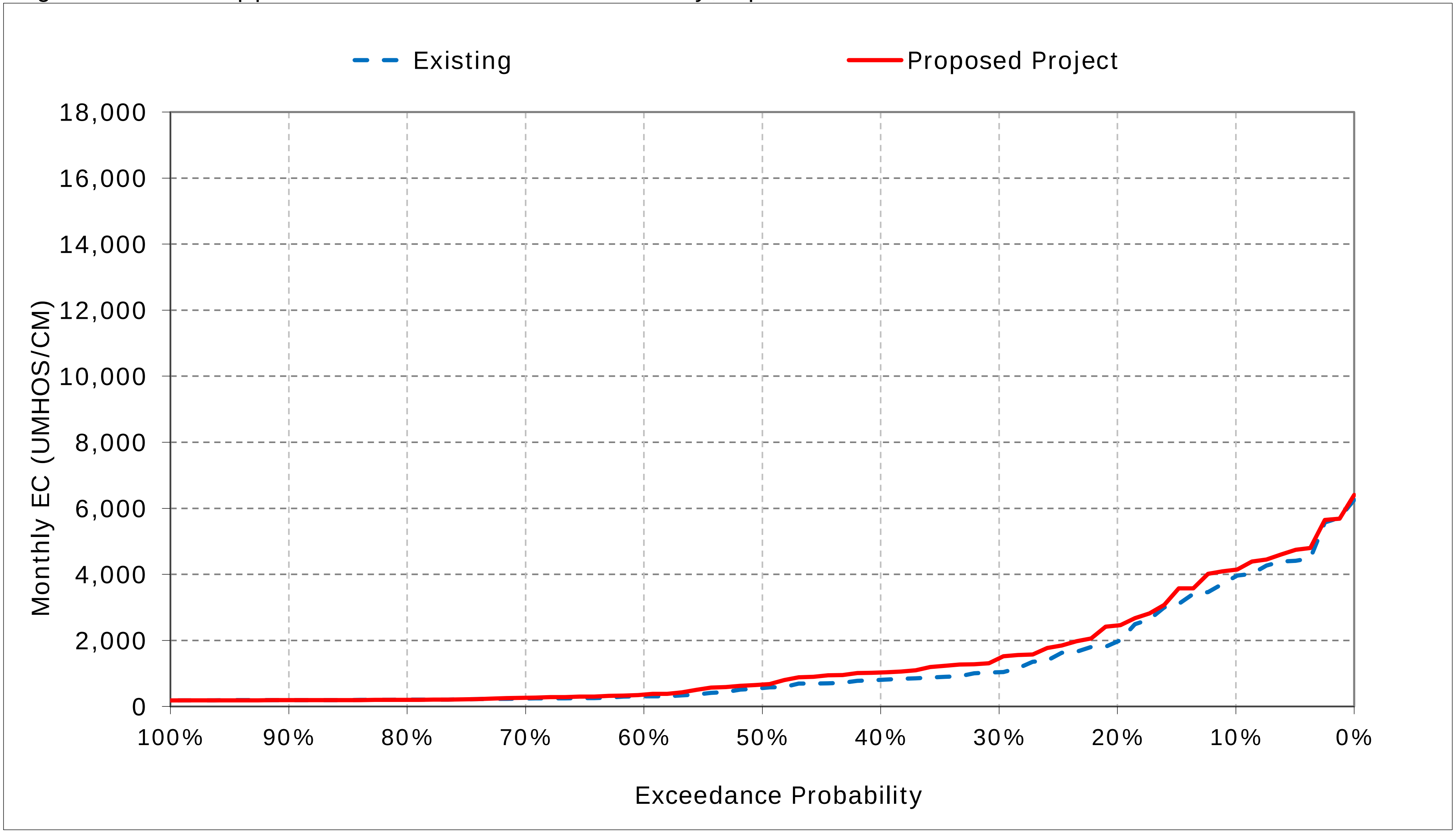


Figure 9-11. Chipps Island South Channel Salinity, May EC

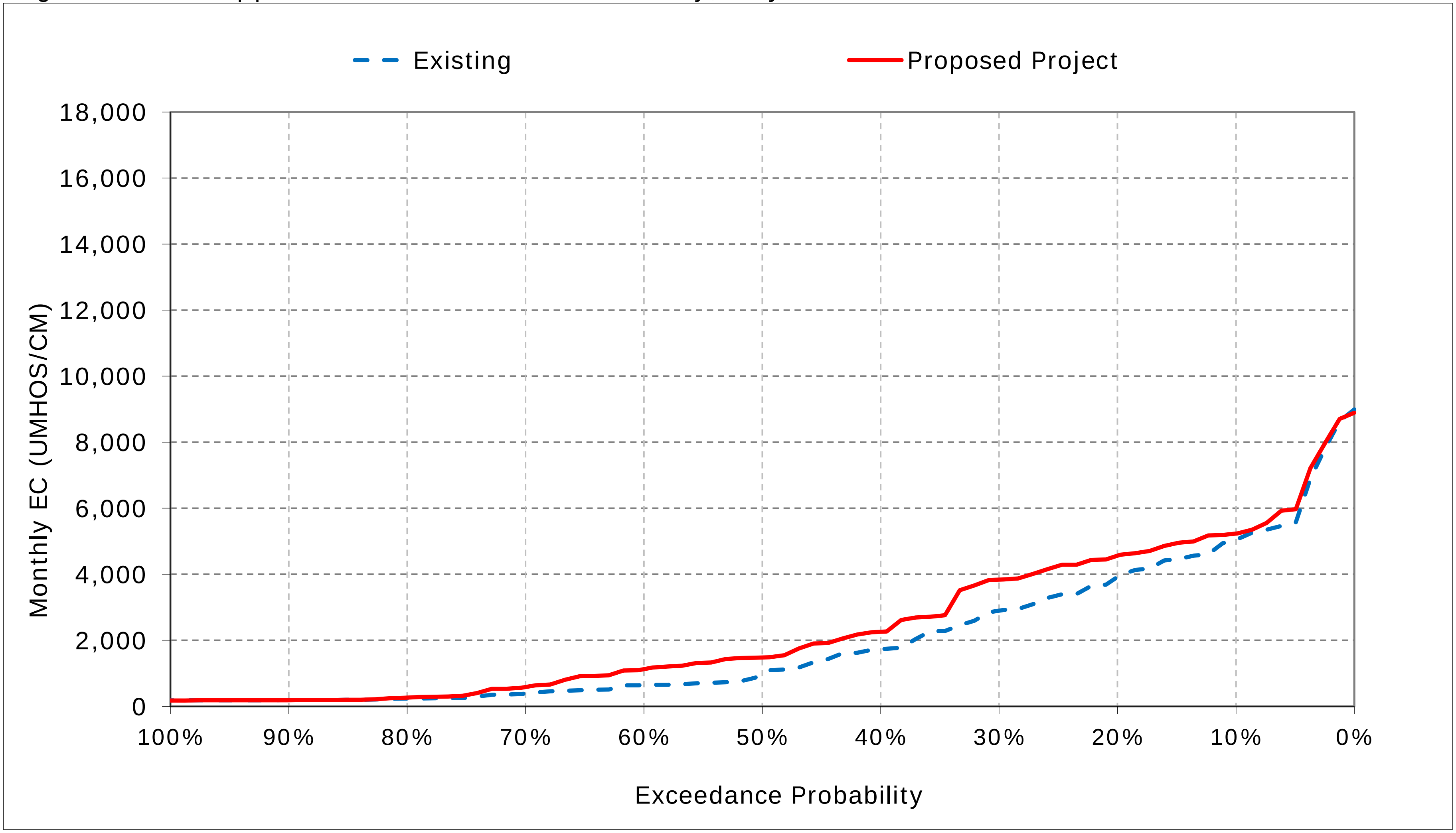


Figure 9-12. Chipps Island South Channel Salinity, June EC

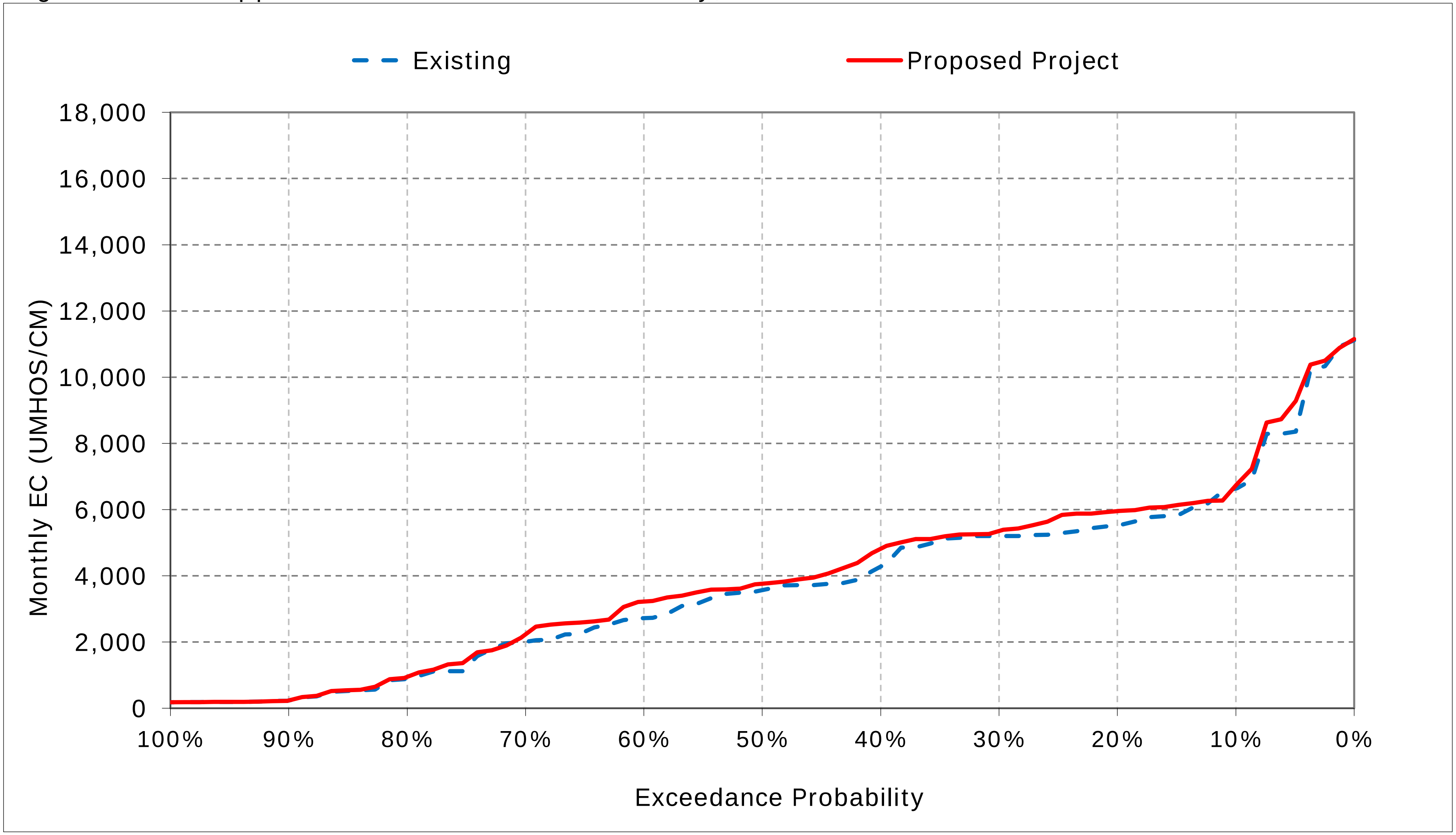


Figure 9-13. Chipps Island South Channel Salinity, July EC

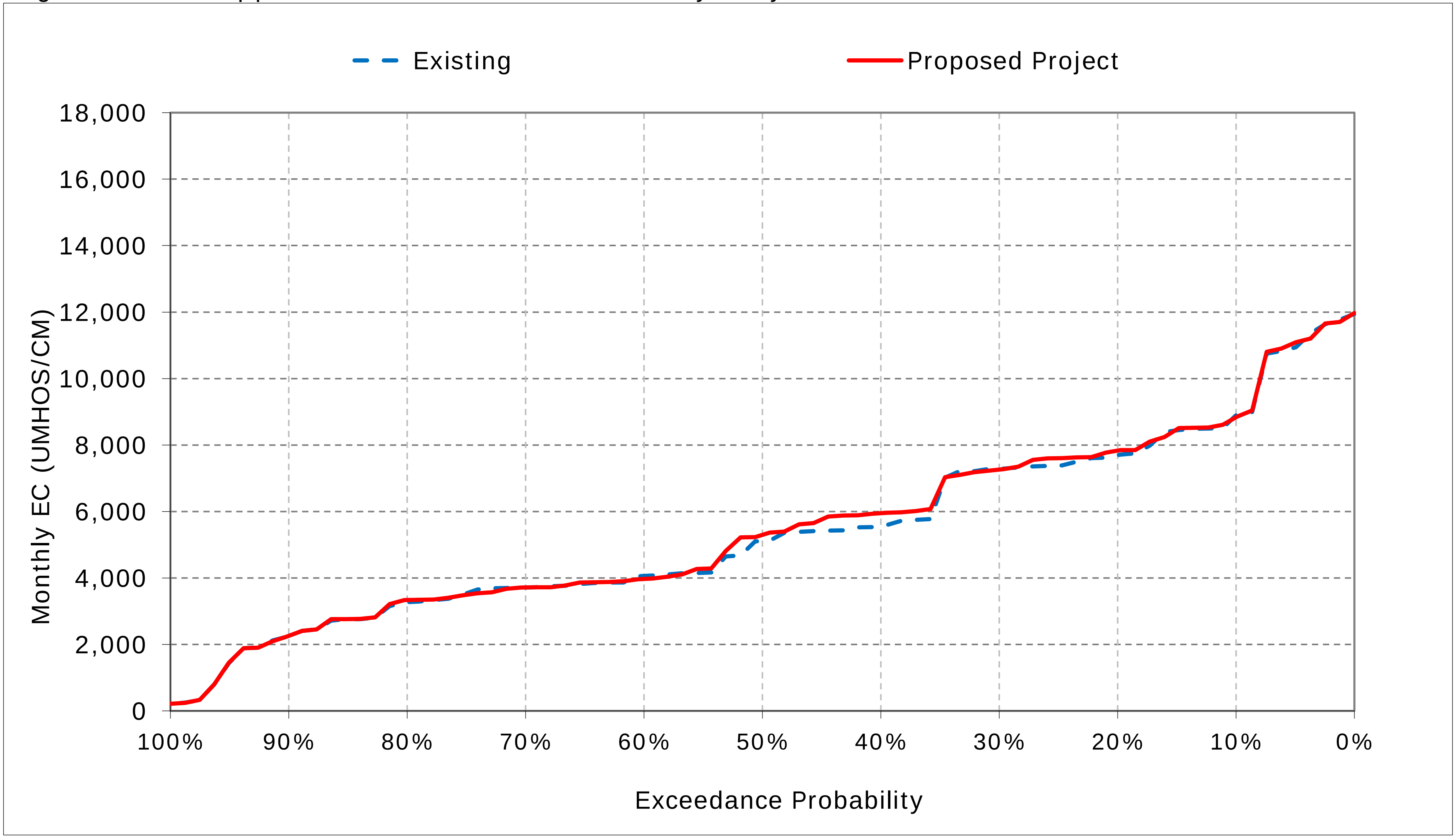


Figure 9-14. Chipps Island South Channel Salinity, August EC

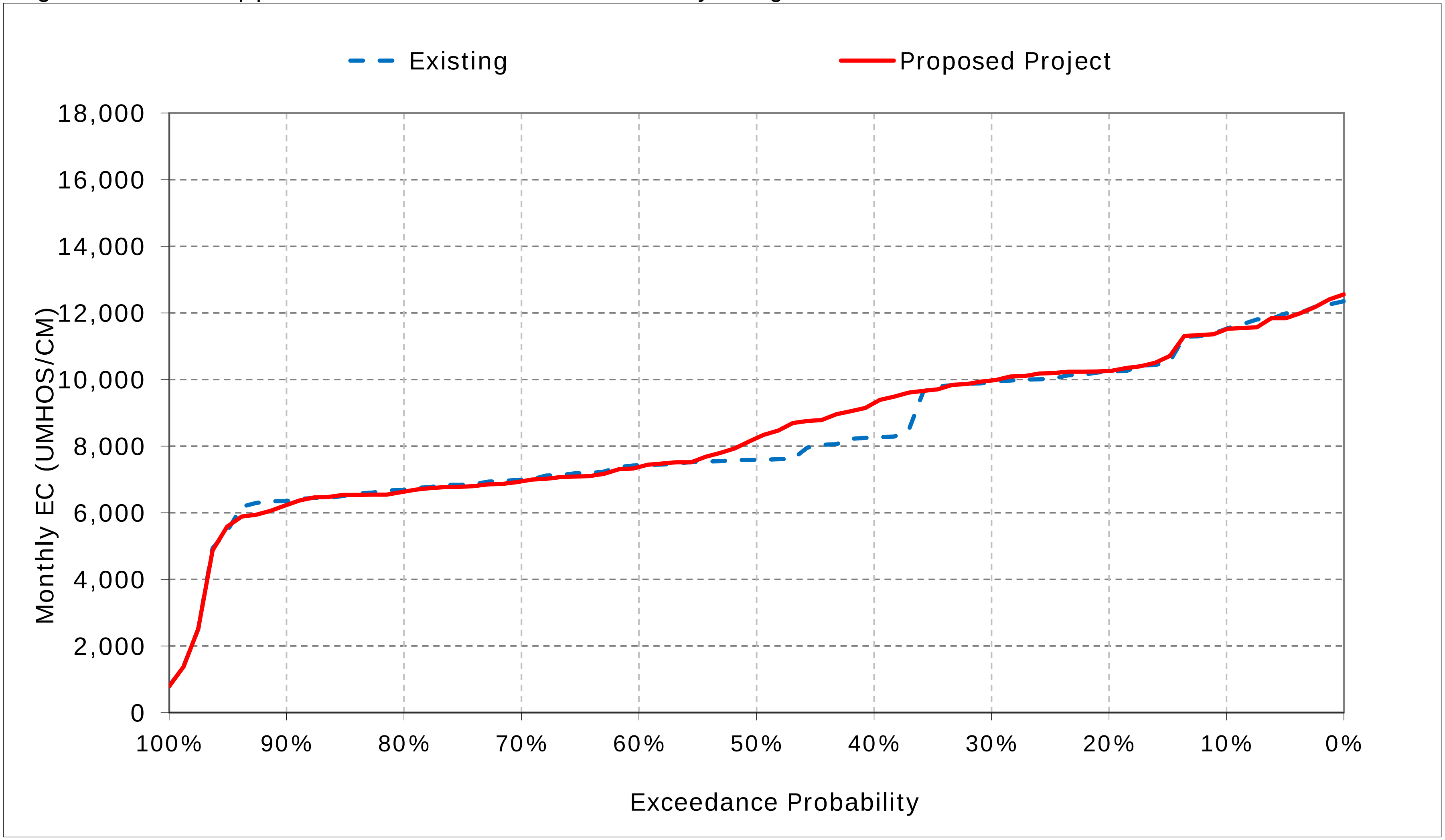


Figure 9-15. Chipps Island South Channel Salinity, September EC

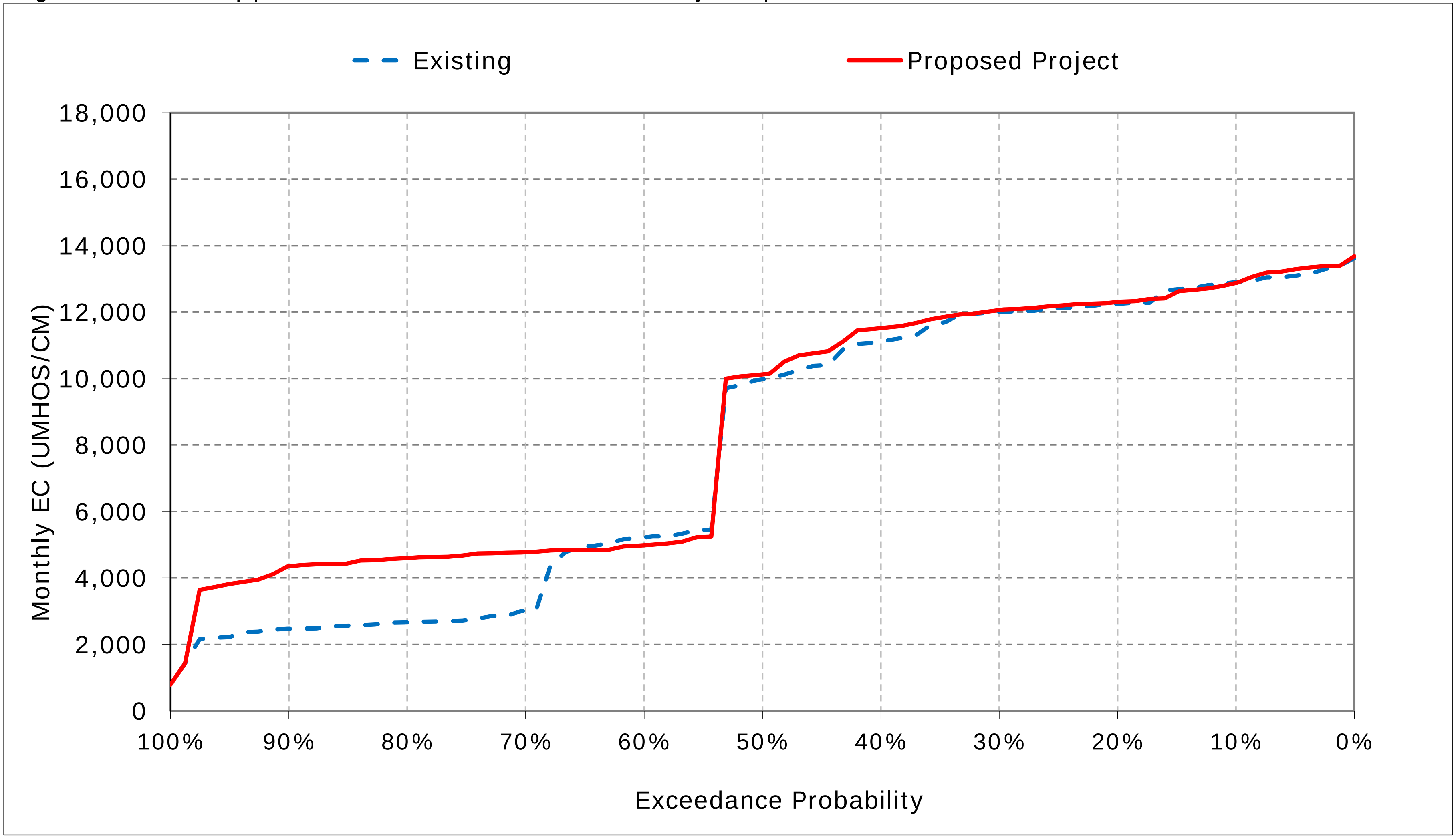


Figure 9-16. Chipps Island South Channel Salinity, October EC

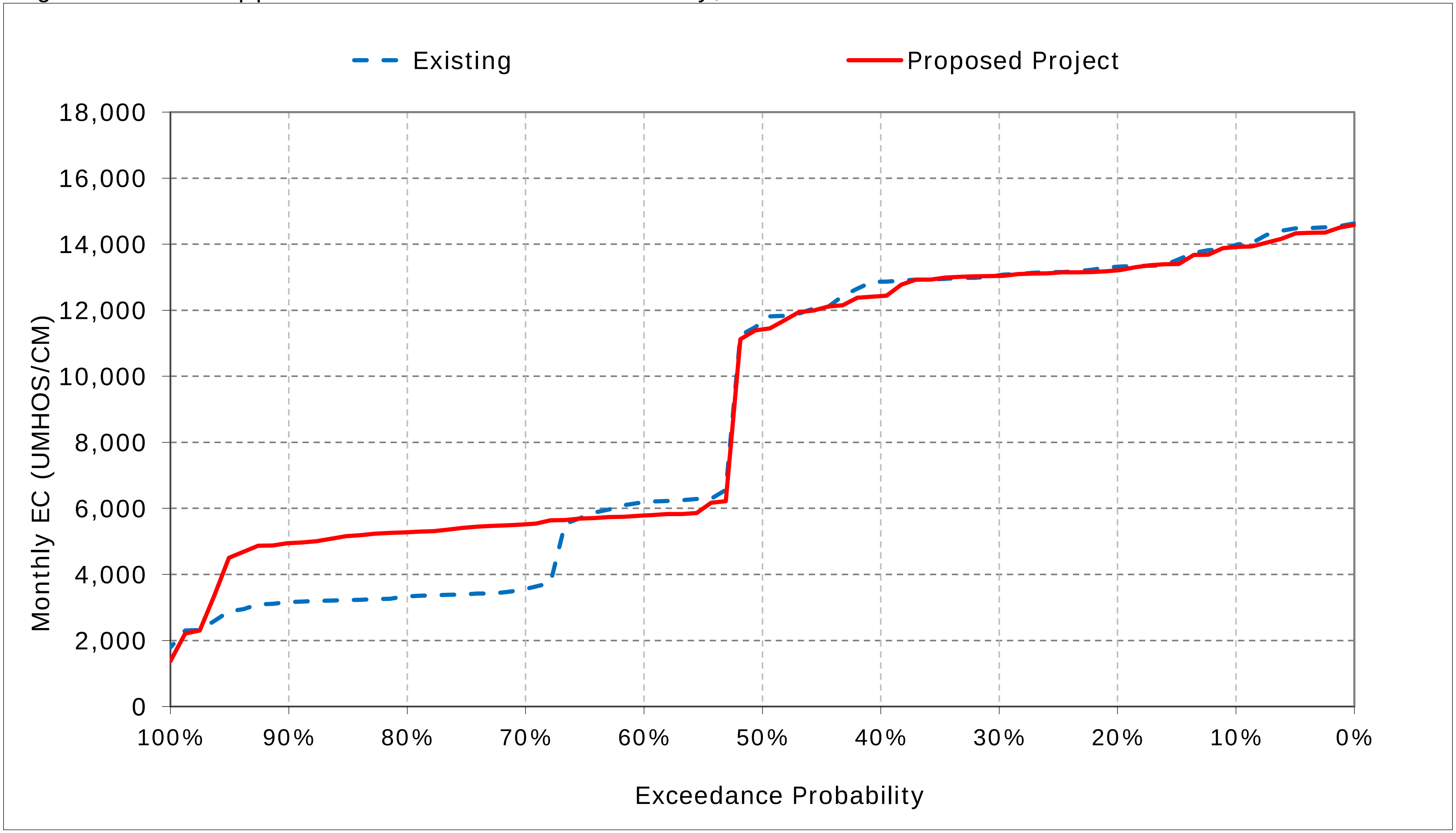


Figure 9-17. Chipps Island South Channel Salinity, November EC

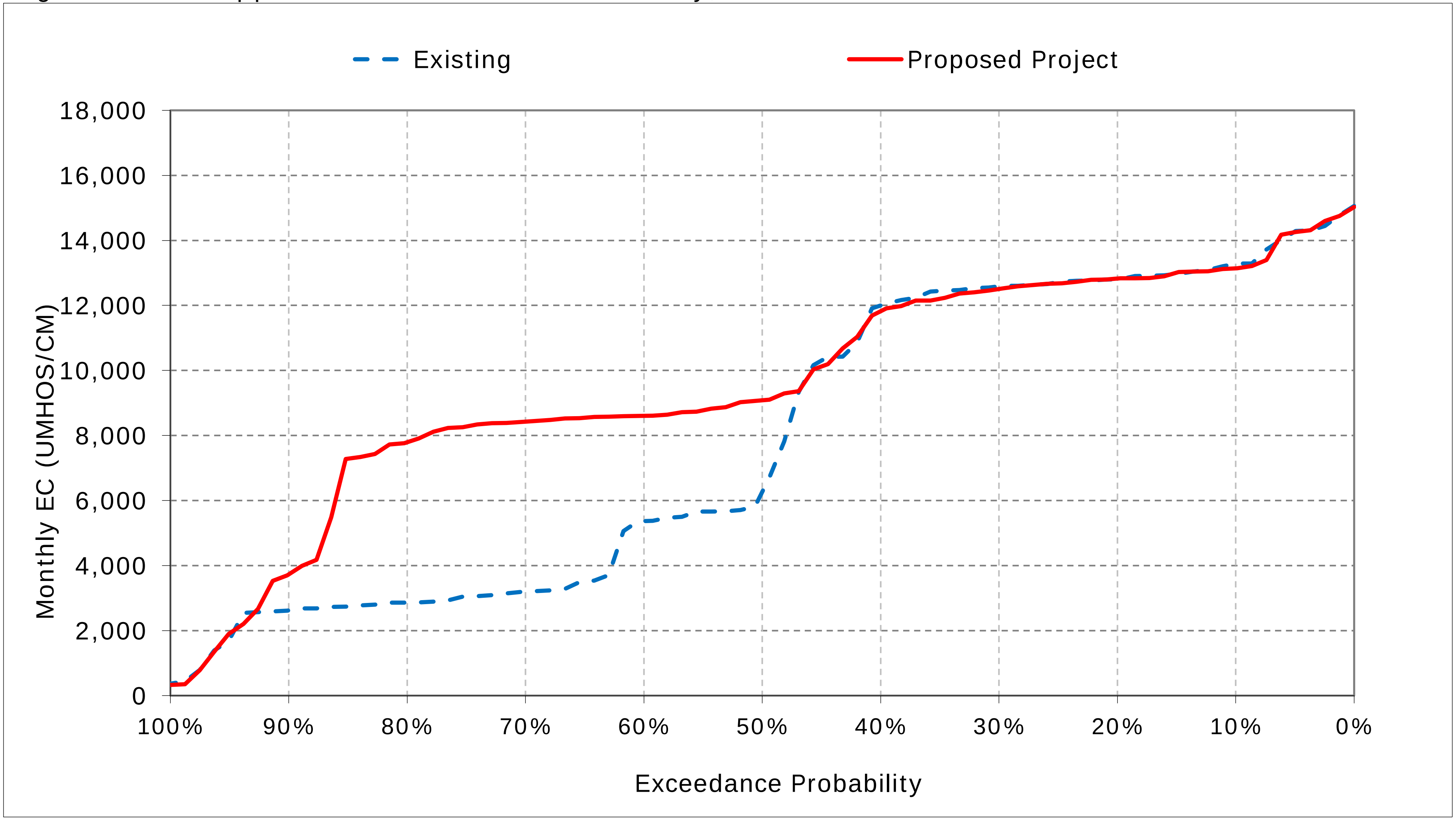


Figure 9-18. Chipps Island South Channel Salinity, December EC

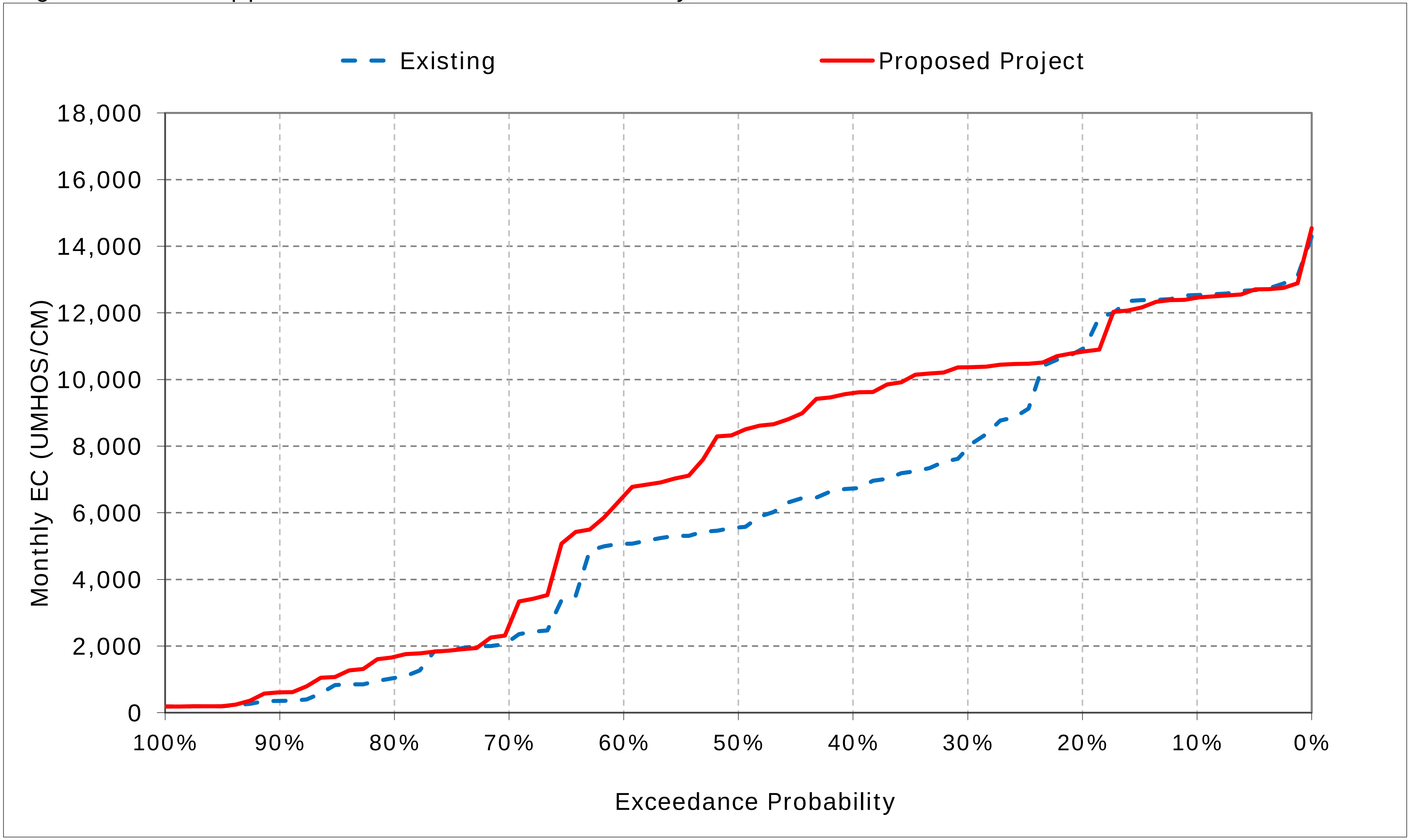


Table 10-1. Sacramento River at Port Chicago Salinity, Monthly EC

Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	18,857	18,301	17,944	14,027	10,103	9,246	9,508	11,032	12,944	14,993	17,328	18,408
20%	18,400	18,165	16,789	13,182	7,217	6,495	6,436	9,365	11,577	13,939	16,159	17,802
30%	18,221	17,817	14,104	11,188	4,890	3,578	4,510	8,038	11,116	13,675	15,975	17,592
40%	17,970	17,430	12,867	8,181	3,174	3,172	3,785	5,955	10,199	11,892	14,473	16,800
50%	17,153	12,186	11,009	6,774	1,756	1,883	2,627	4,393	8,819	11,353	13,884	16,050
60%	11,800	10,970	10,426	4,299	841	1,177	1,714	3,296	7,874	9,842	13,497	11,219
70%	8,403	8,017	6,384	1,127	341	539	1,041	2,304	6,353	9,483	13,064	7,842
80%	8,112	7,581	3,290	417	223	231	430	1,171	4,138	8,677	12,744	7,338
90%	7,934	7,173	1,022	227	205	201	219	337	1,237	6,634	12,410	6,785
Long Term												
Full Simulation Period[a]	13,892	12,807	10,348	6,775	3,582	3,140	3,701	5,288	8,305	11,058	14,210	13,231
Water Year Types[b]												
Wet (32%)	11,865	9,727	4,560	1,509	462	663	946	1,654	4,040	7,375	11,990	6,980
Above Normal (15%)	14,288	12,609	10,702	4,607	1,512	812	1,482	2,737	6,817	9,286	12,891	11,049
Below Normal (17%)	14,379	13,928	12,606	8,063	2,946	3,101	3,357	5,013	8,800	11,464	14,189	16,435
Dry (22%)	14,459	14,253	12,965	10,586	6,057	4,745	5,613	7,981	11,081	13,821	16,074	17,695
Critical (15%)	16,472	16,198	15,972	13,130	9,441	8,475	9,421	11,992	14,294	16,194	17,566	18,520

Proposed Project

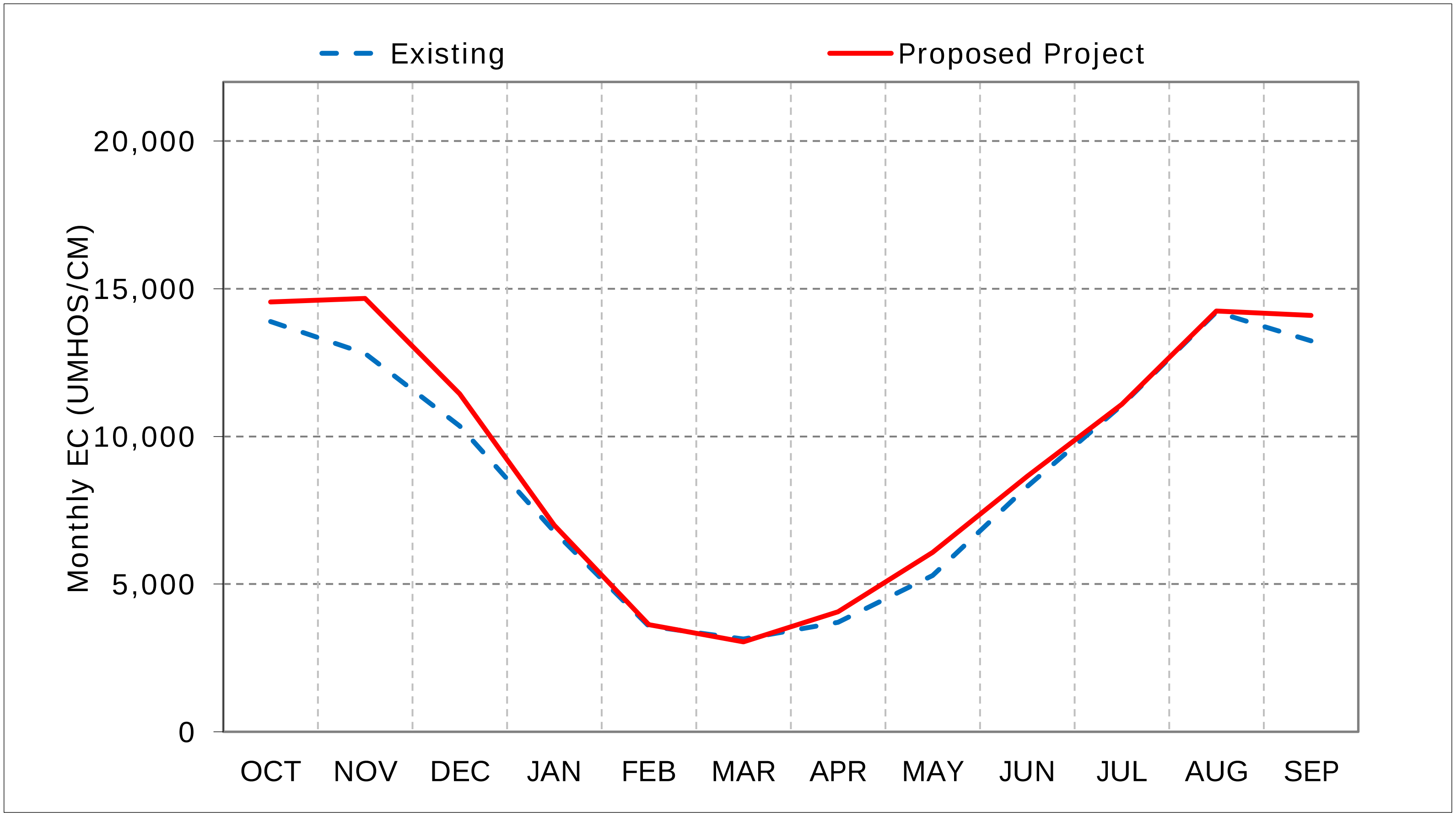
Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	18,807	18,364	17,930	15,275	9,733	9,189	9,988	11,273	12,972	15,024	17,357	18,381
20%	18,405	18,122	16,529	14,037	6,813	6,374	7,403	10,357	12,141	14,132	16,249	17,837
30%	18,208	17,757	15,920	11,990	4,783	3,379	5,337	9,248	11,297	13,652	16,010	17,655
40%	17,806	17,203	15,464	8,671	3,283	2,839	4,433	7,278	10,866	11,916	14,852	17,013
50%	16,991	14,487	14,493	6,707	1,740	1,688	3,260	5,648	9,276	11,117	14,028	16,078
60%	11,336	14,200	12,571	4,163	641	981	1,943	4,608	8,564	9,821	13,451	10,855
70%	11,175	13,963	7,579	990	343	471	1,381	3,248	6,684	9,531	13,012	10,665
80%	10,827	13,519	4,094	400	222	232	507	1,556	4,307	8,733	12,790	10,439
90%	10,471	8,783	1,270	220	206	199	217	443	1,292	6,638	12,283	9,904
Long Term												
Full Simulation Period[a]	14,553	14,670	11,441	6,990	3,628	3,043	4,065	6,071	8,644	11,081	14,242	14,098
Water Year Types[b]												
Wet (32%)	12,723	12,151	5,319	1,484	444	619	1,180	2,252	4,405	7,395	11,882	9,851
Above Normal (15%)	15,103	14,760	12,346	4,689	1,303	721	1,847	3,793	7,182	9,230	12,924	10,538
Below Normal (17%)	15,073	15,716	13,907	8,052	2,808	2,859	3,903	6,213	9,156	11,489	14,463	16,535
Dry (22%)	15,145	15,761	14,213	11,207	6,330	4,546	6,074	8,844	11,463	13,893	16,132	17,739
Critical (15%)	16,472	17,181	16,768	13,658	9,751	8,581	9,705	12,299	14,468	16,227	17,577	18,556

Proposed Project minus Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	-50	63	-15	1,248	-369	-57	480	242	28	32	30	-27
20%	5	-43	-259	855	-403	-121	967	992	564	193	90	35
30%	-13	-59	1,816	802	-107	-198	827	1,210	182	-24	35	64
40%	-164	-227	2,597	490	108	-333	648	1,323	667	23	379	213
50%	-162	2,301	3,484	-67	-16	-196	634	1,255	457	-236	144	29
60%	-464	3,230	2,145	-136	-199	-196	229	1,312	691	-21	-47	-364
70%	2,772	5,946	1,195	-137	2	-68	340	944	331	48	-52	2,823
80%	2,715	5,937	804	-17	0	2	77	385	169	56	46	3,101
90%	2,536	1,610	248	-7	1	-2	-2	105	55	5	-127	3,119
Long Term												
Full Simulation Period[a]	660	1,863	1,094	215	46	-97	364	783	339	23	32	867
Water Year Types[b]												
Wet (32%)	858	2,424	758	-25	-17	-44	234	598	365	19	-107	2,870
Above Normal (15%)	815	2,151	1,644	82	-210	-91	365	1,056	365	-56	33	-511
Below Normal (17%)	694	1,788	1,301	-12	-138	-242	545	1,200	356	25	273	100
Dry (22%)	686	1,507	1,249	621	273	-199	461	863	381	72	58	44
Critical (15%)	0	983	795	527	311	106	284	307	174	32	11	36

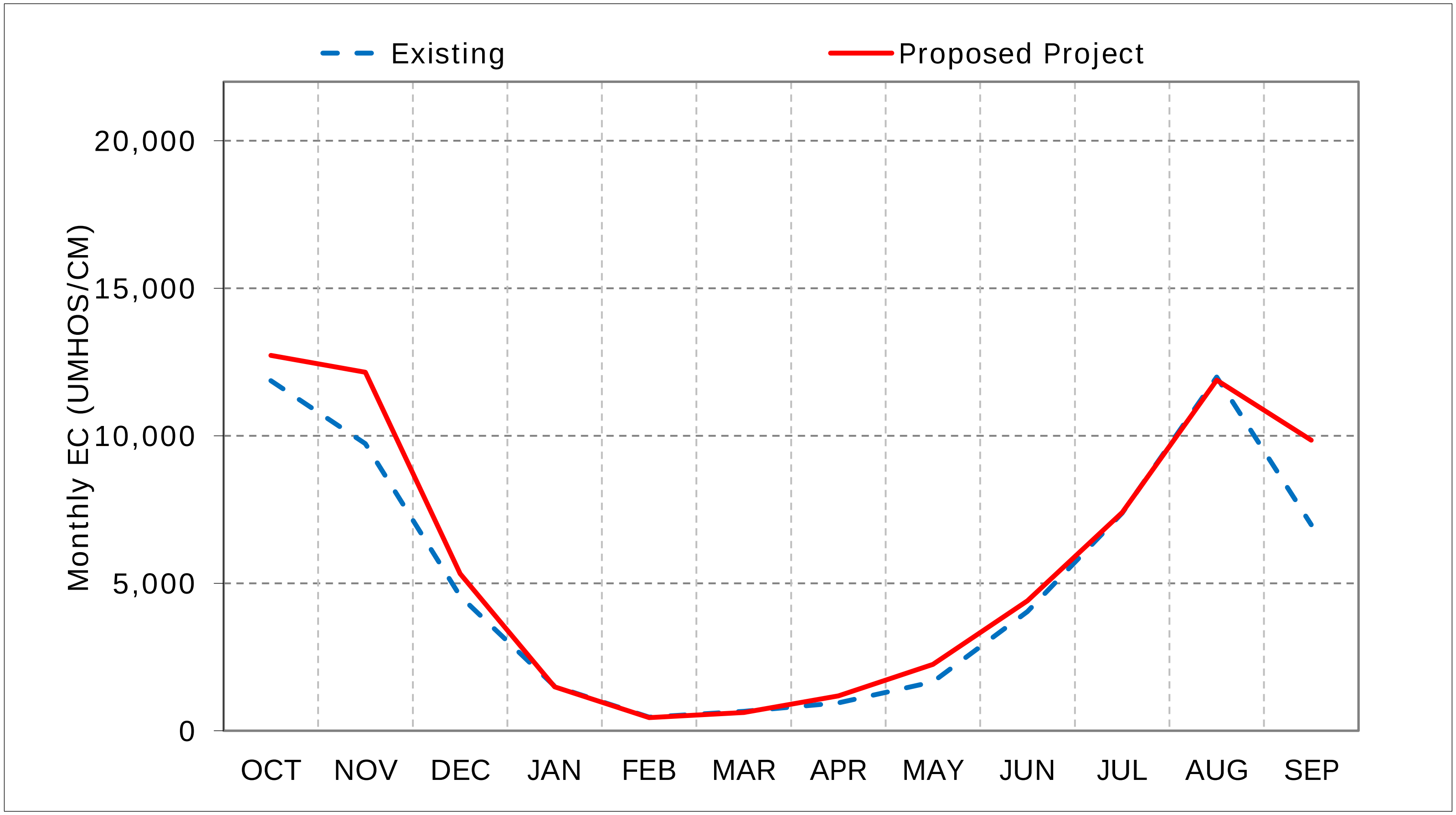
a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with water year - year type sorting.
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 10-1. Sacramento River at Port Chicago Salinity, Long-Term Average EC



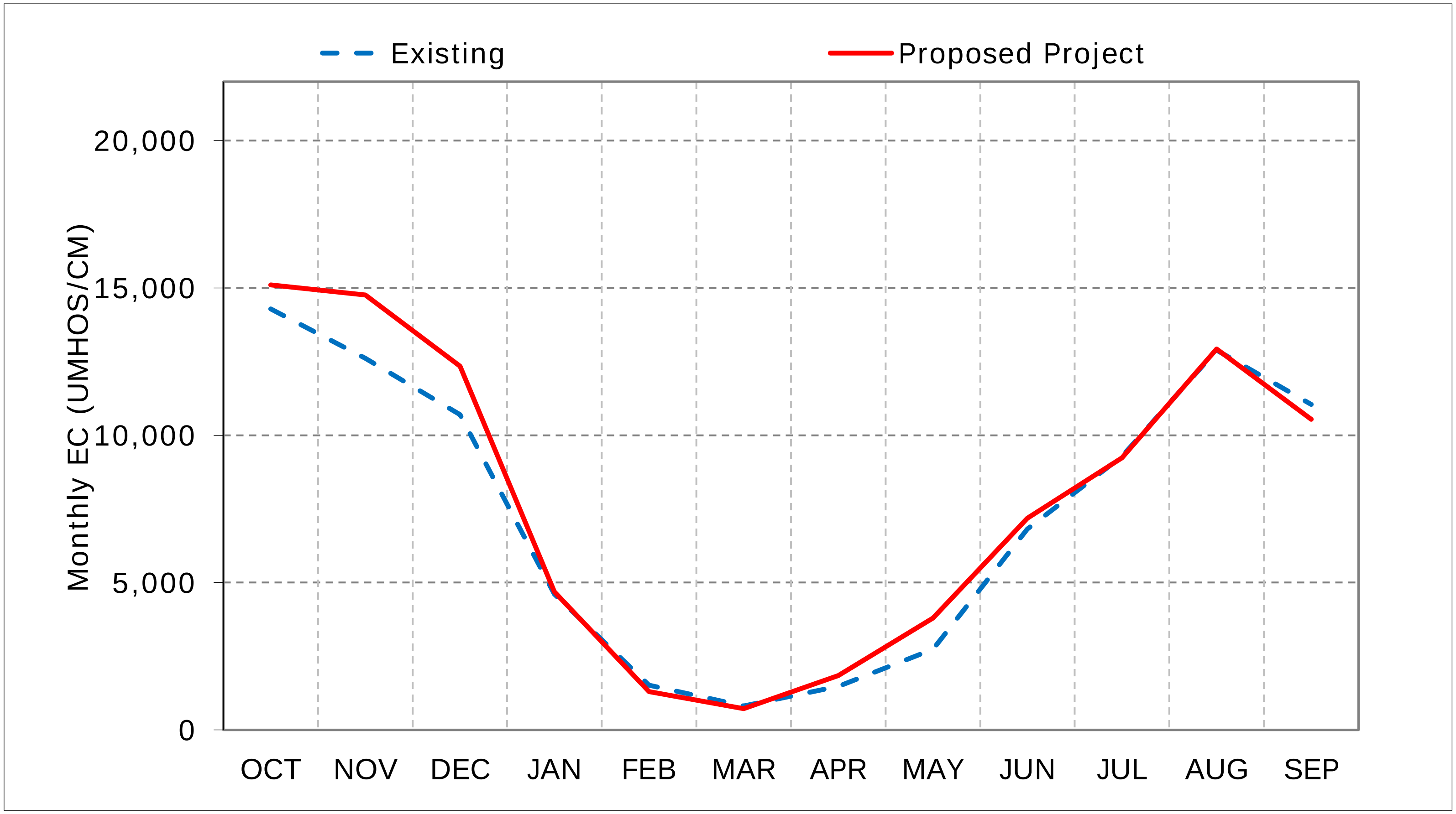
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 10-2. Sacramento River at Port Chicago Salinity, Wet Year Average EC



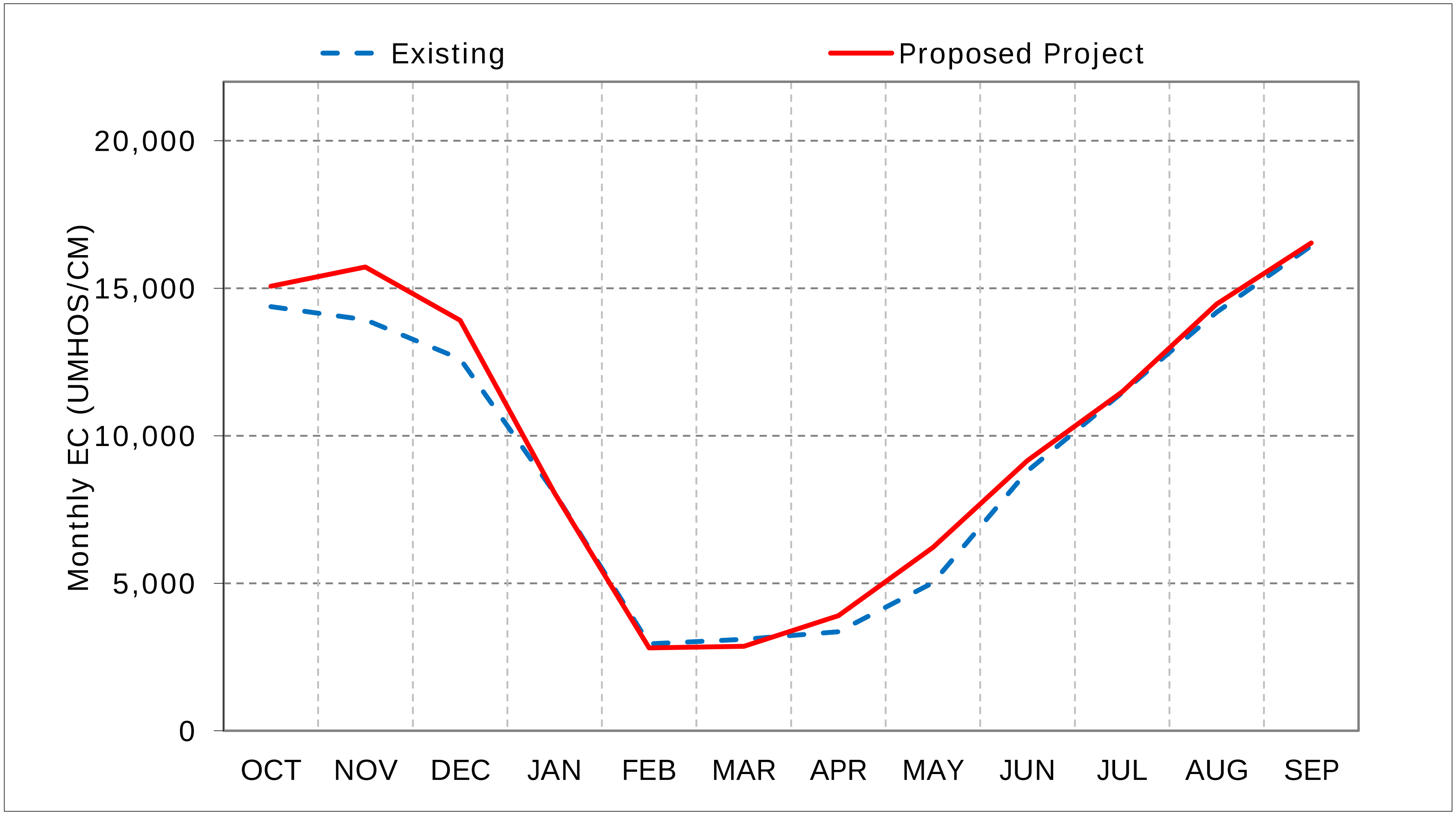
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 10-3. Sacramento River at Port Chicago Salinity, Above Normal Year Averag



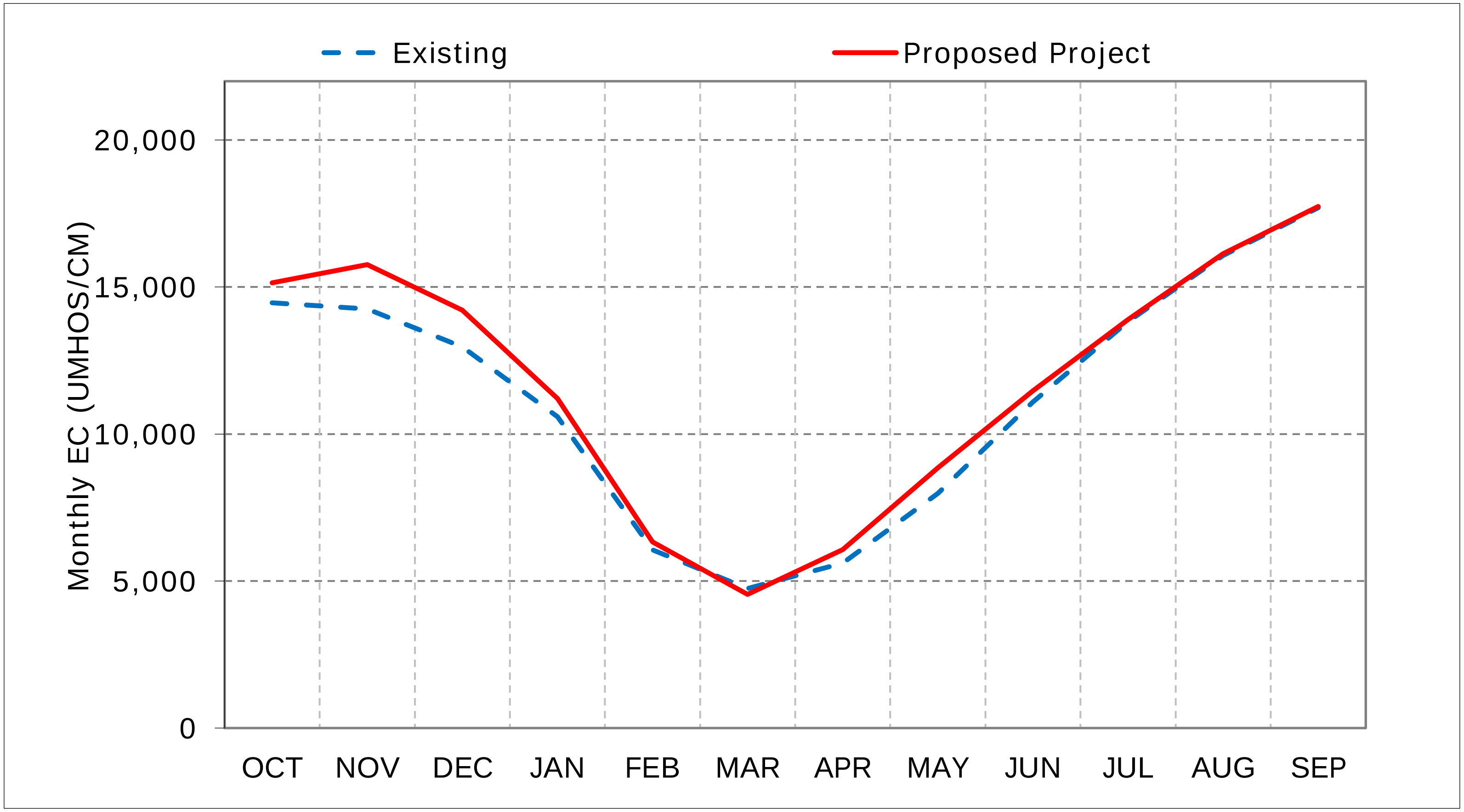
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 10-4. Sacramento River at Port Chicago Salinity, Below Normal Year Averag



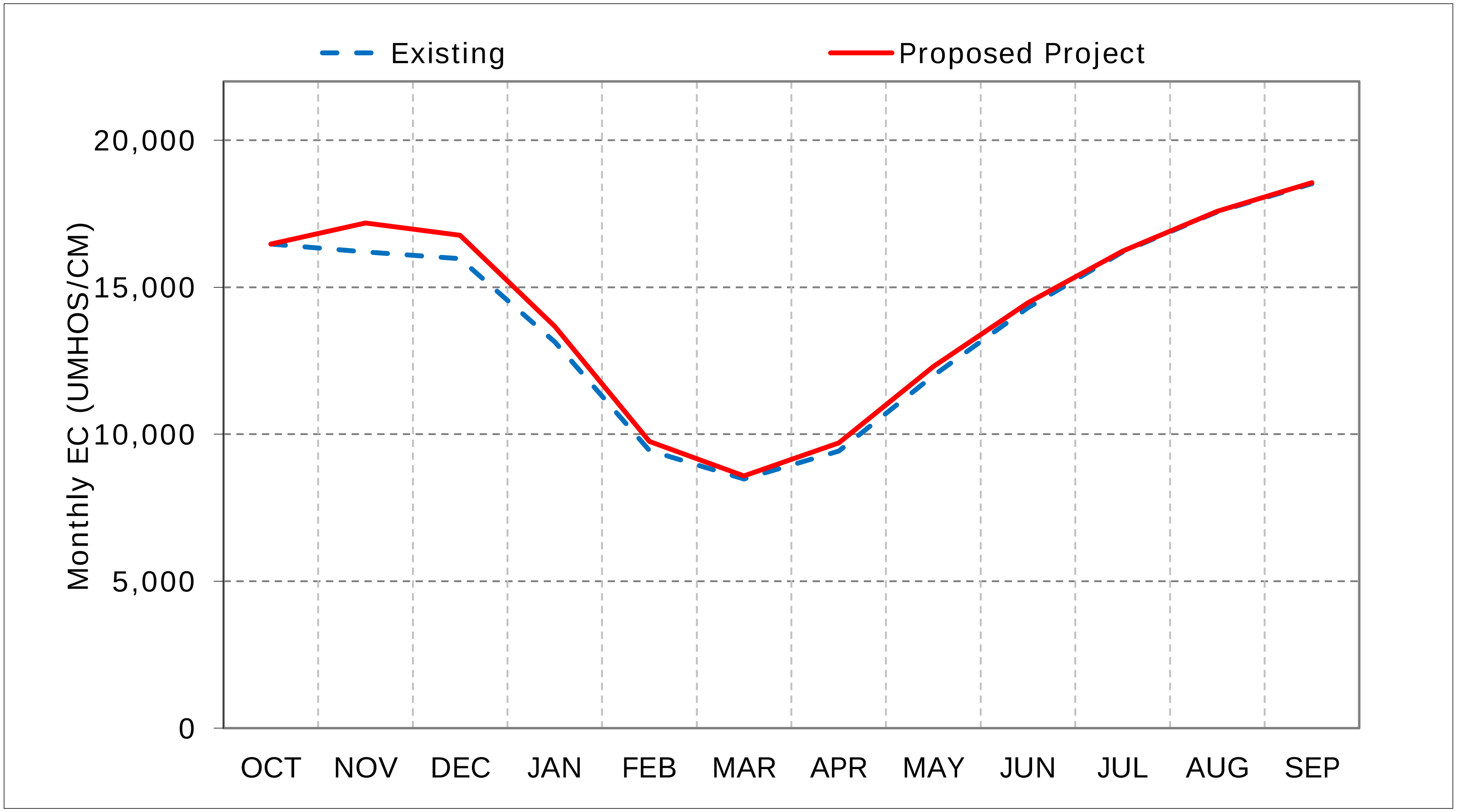
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 10-5. Sacramento River at Port Chicago Salinity, Dry Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 10-6. Sacramento River at Port Chicago Salinity, Critical Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 10-7. Sacramento River at Port Chicago Salinity, January EC

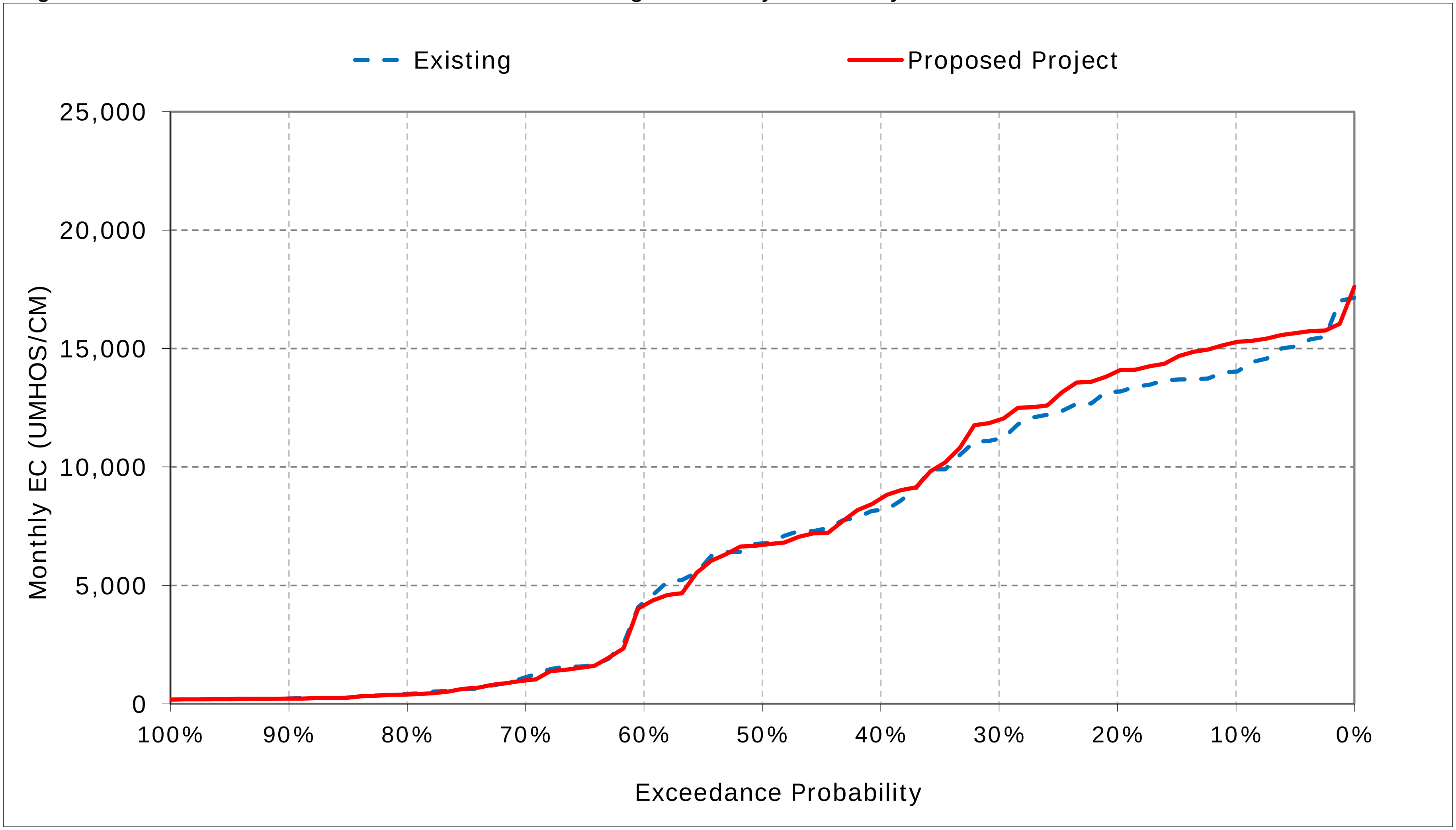


Figure 10-8. Sacramento River at Port Chicago Salinity, February EC

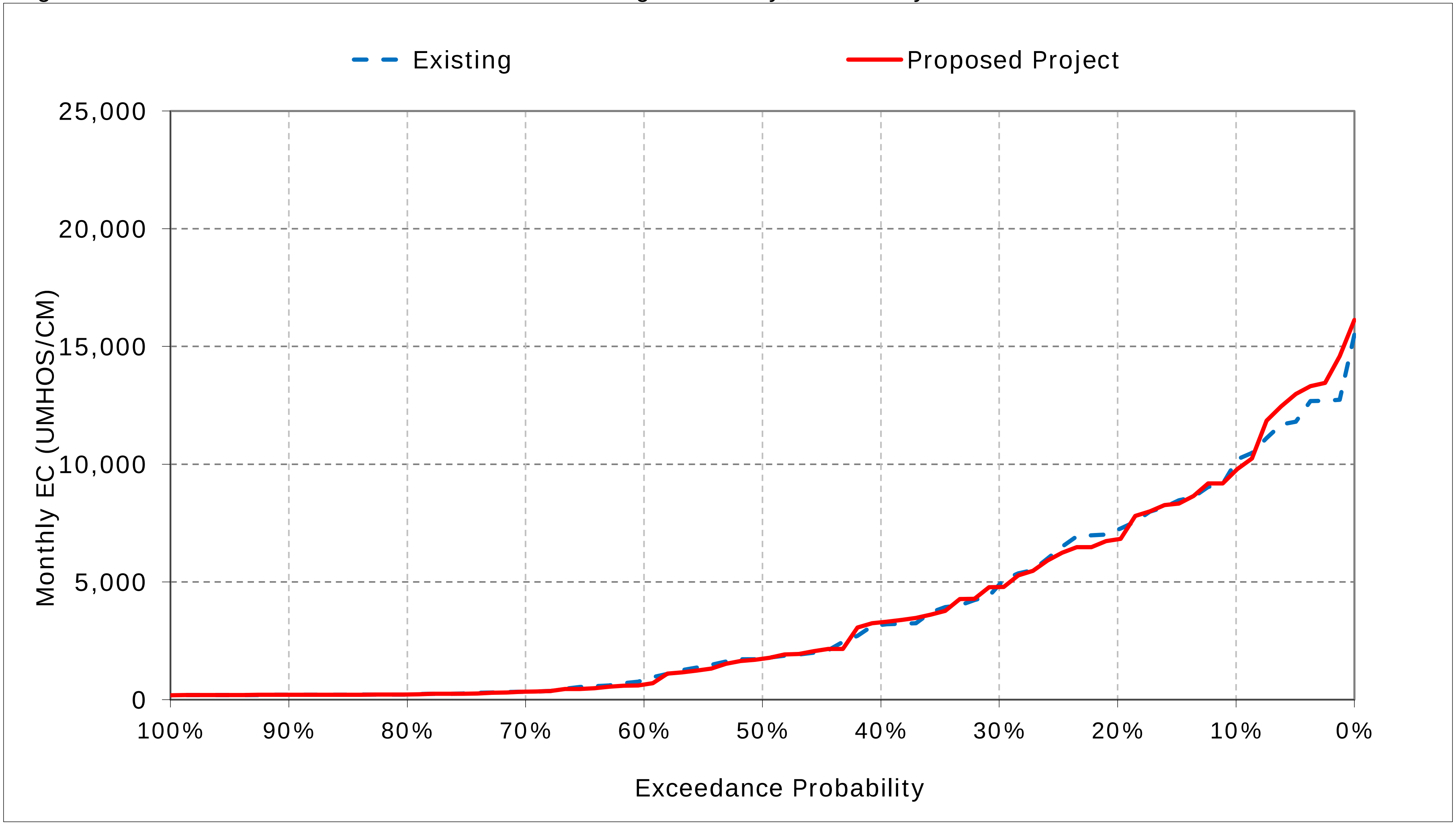


Figure 10-9. Sacramento River at Port Chicago Salinity, March EC

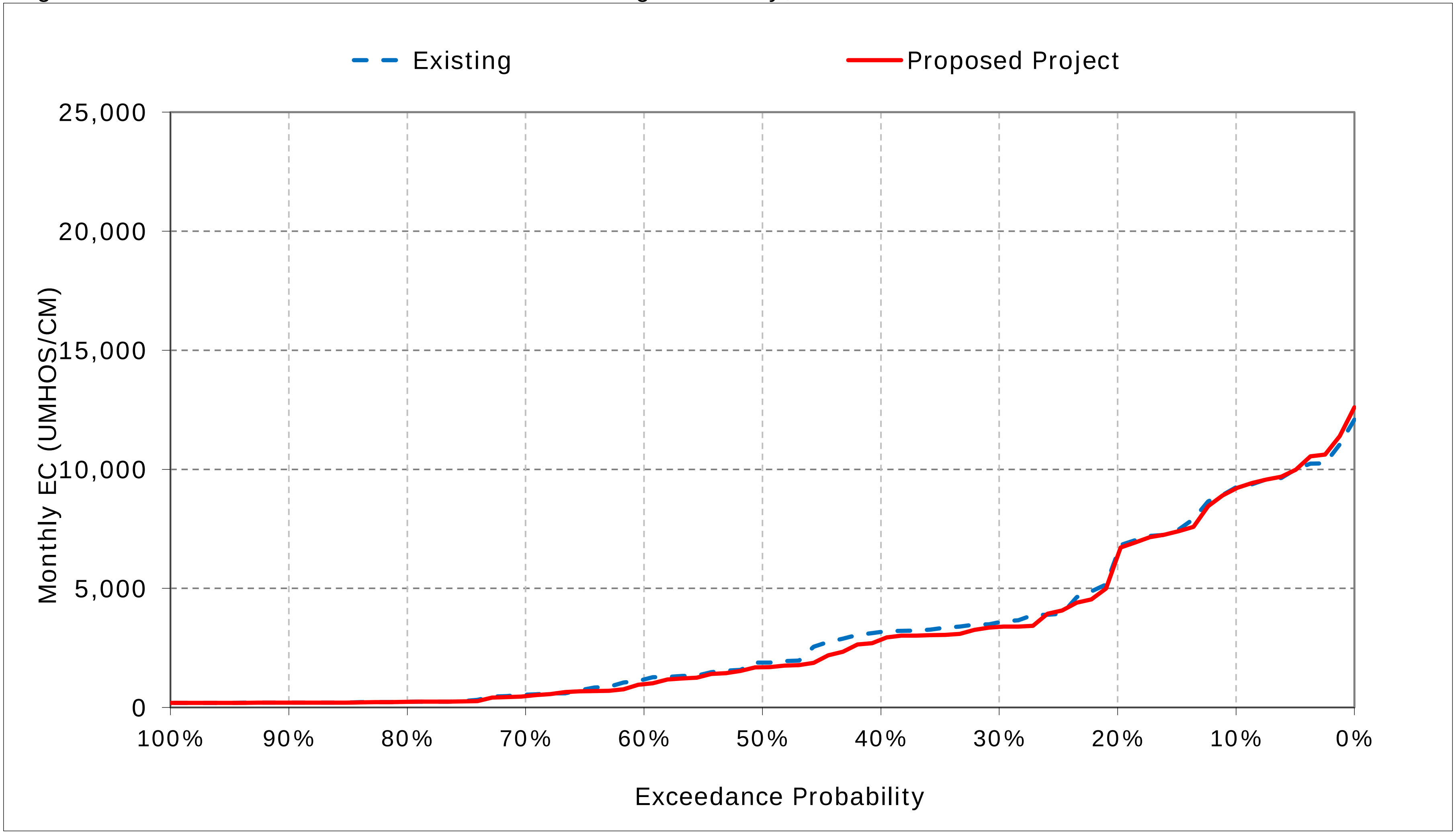


Figure 10-10. Sacramento River at Port Chicago Salinity, April EC

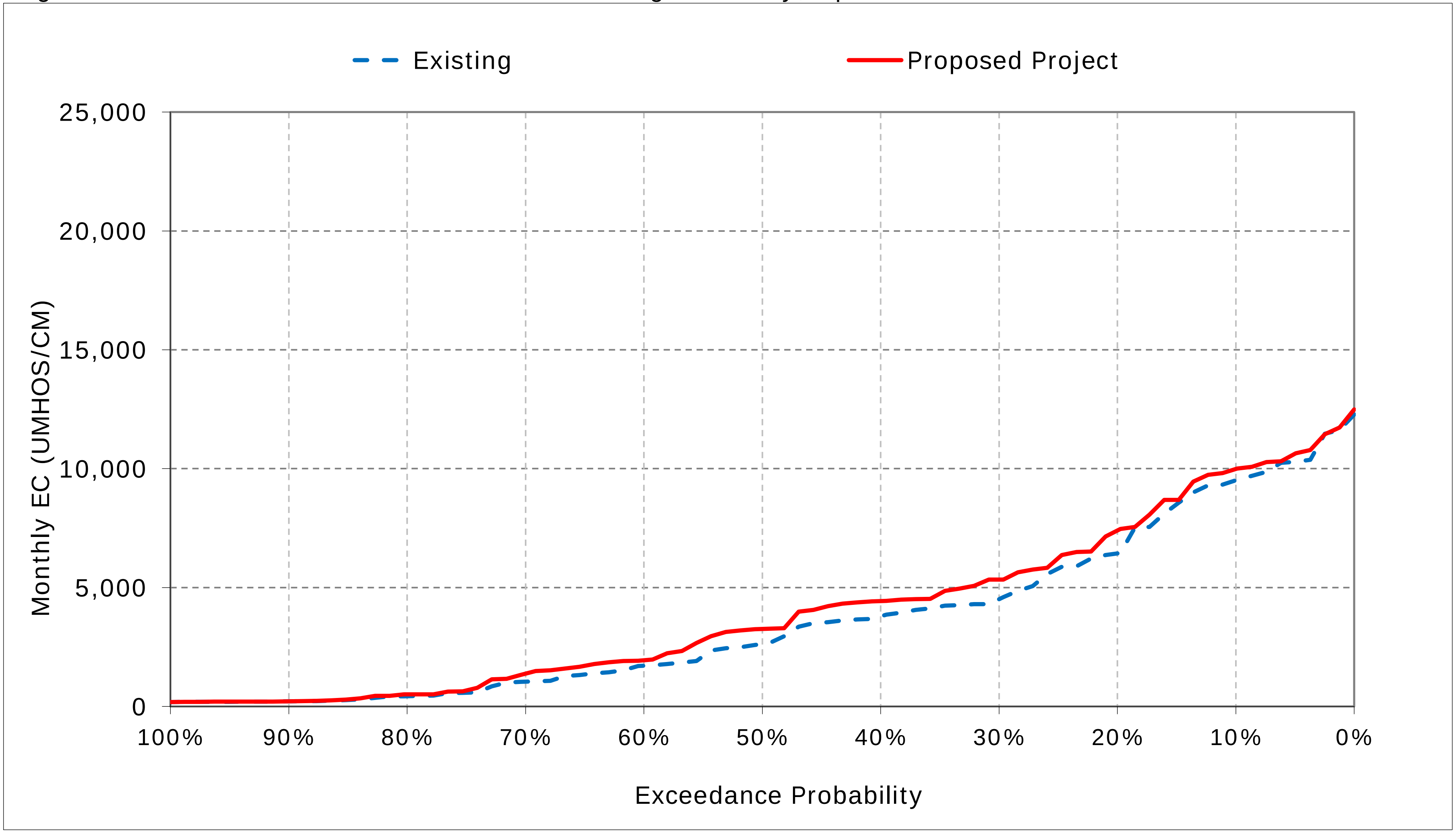


Figure 10-11. Sacramento River at Port Chicago Salinity, May EC

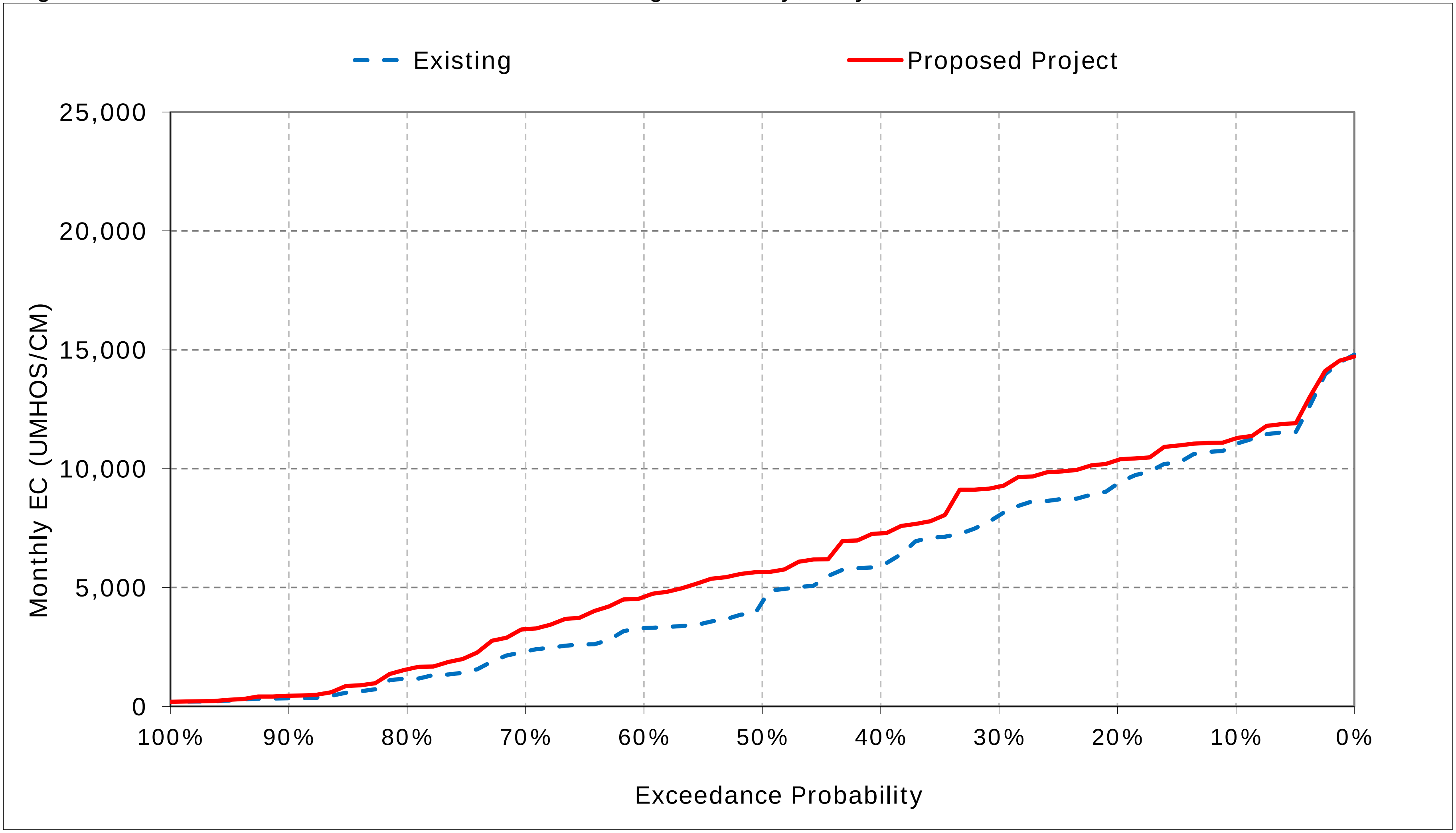


Figure 10-12. Sacramento River at Port Chicago Salinity, June EC

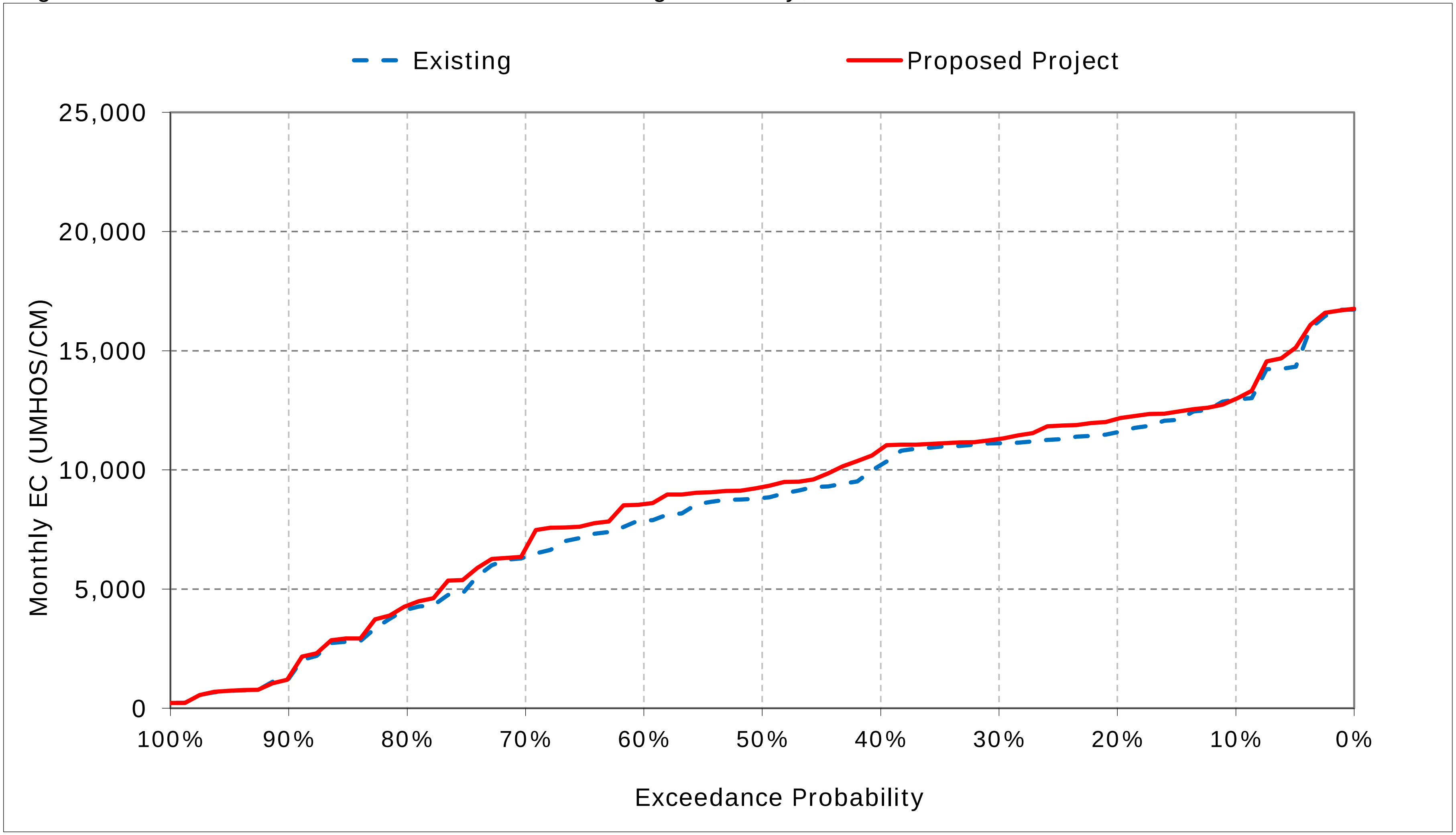


Figure 10-13. Sacramento River at Port Chicago Salinity, July EC

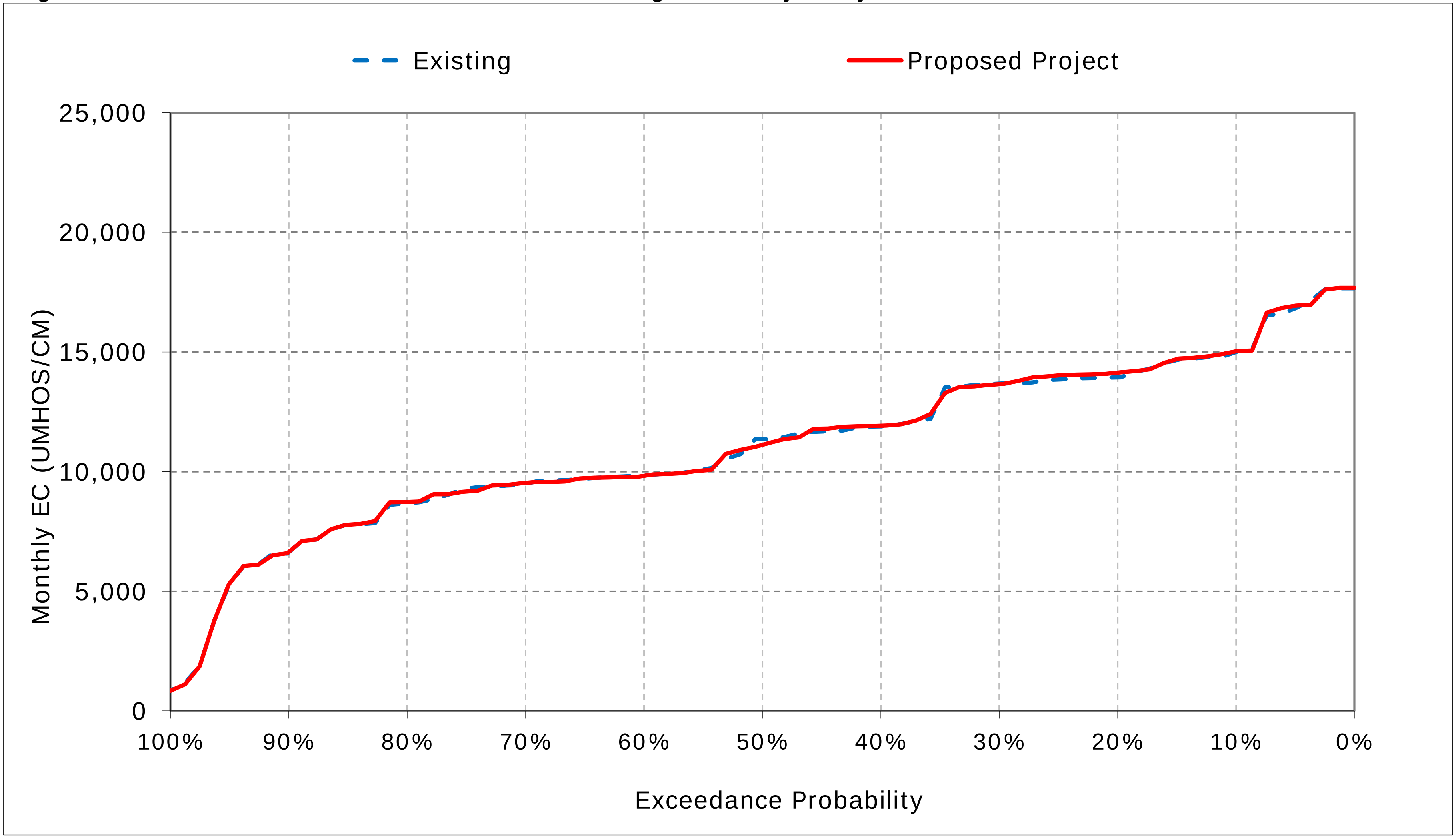


Figure 10-14. Sacramento River at Port Chicago Salinity, August EC

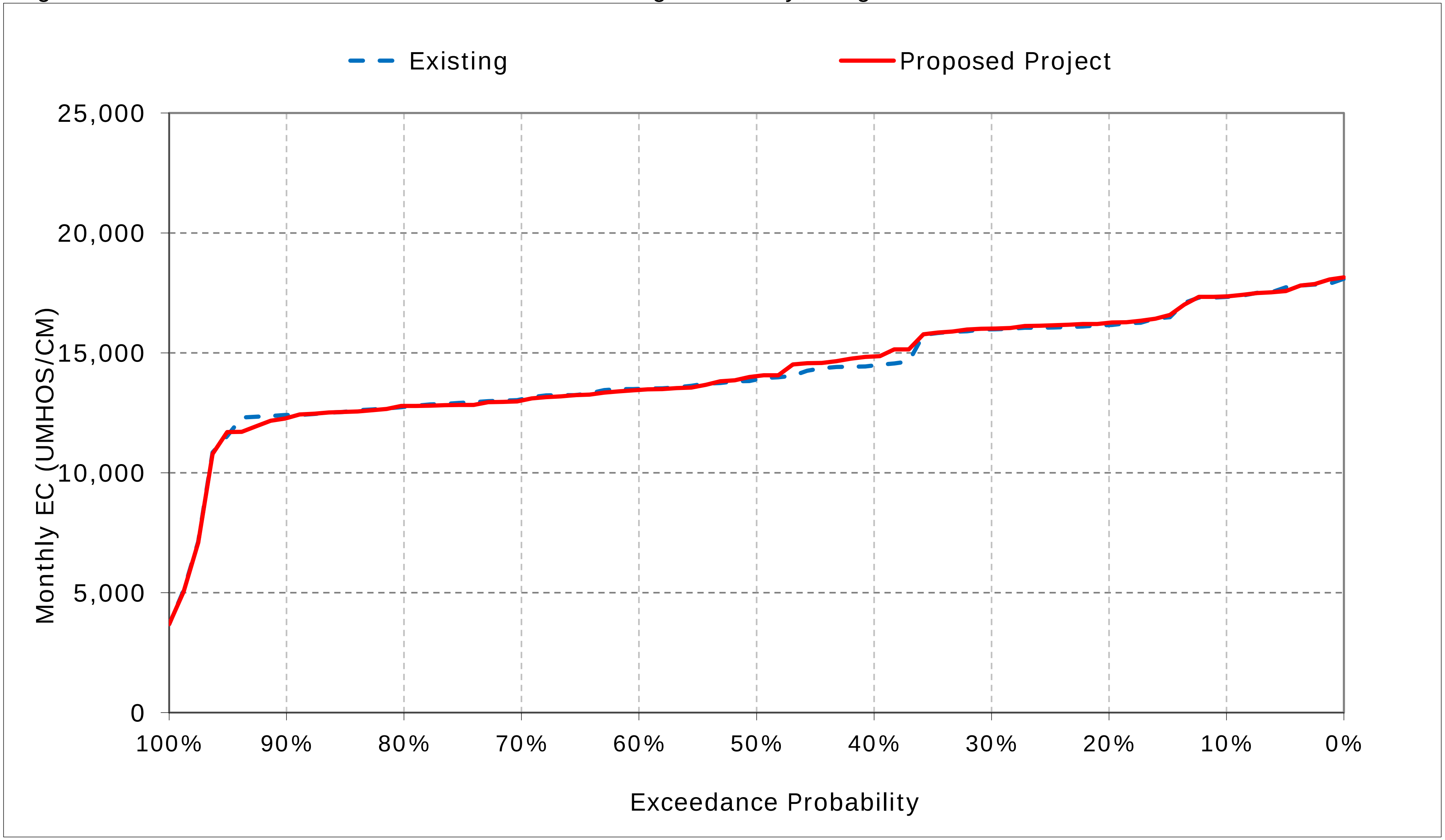


Figure 10-15. Sacramento River at Port Chicago Salinity, September EC

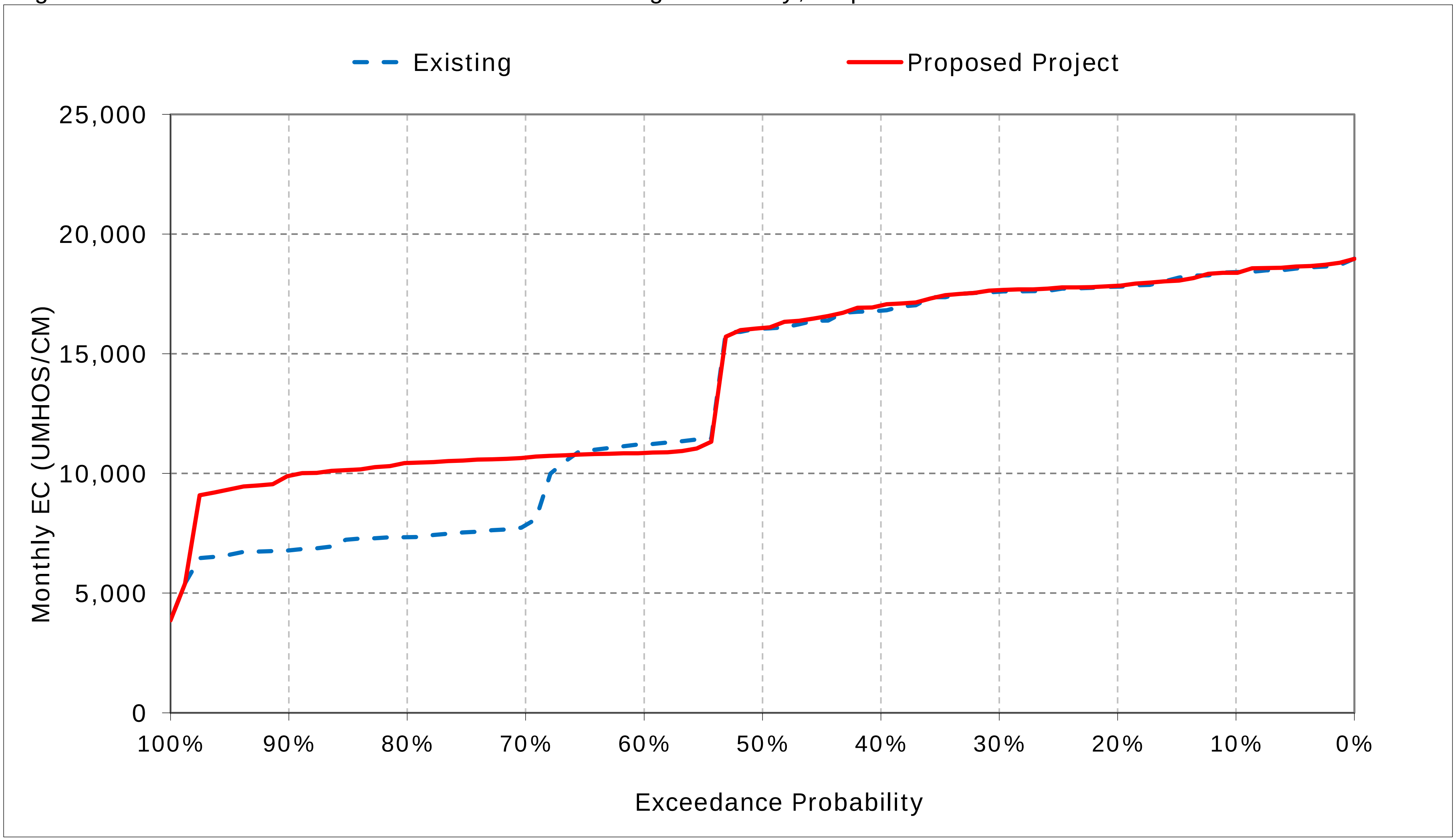


Figure 10-16. Sacramento River at Port Chicago Salinity, October EC

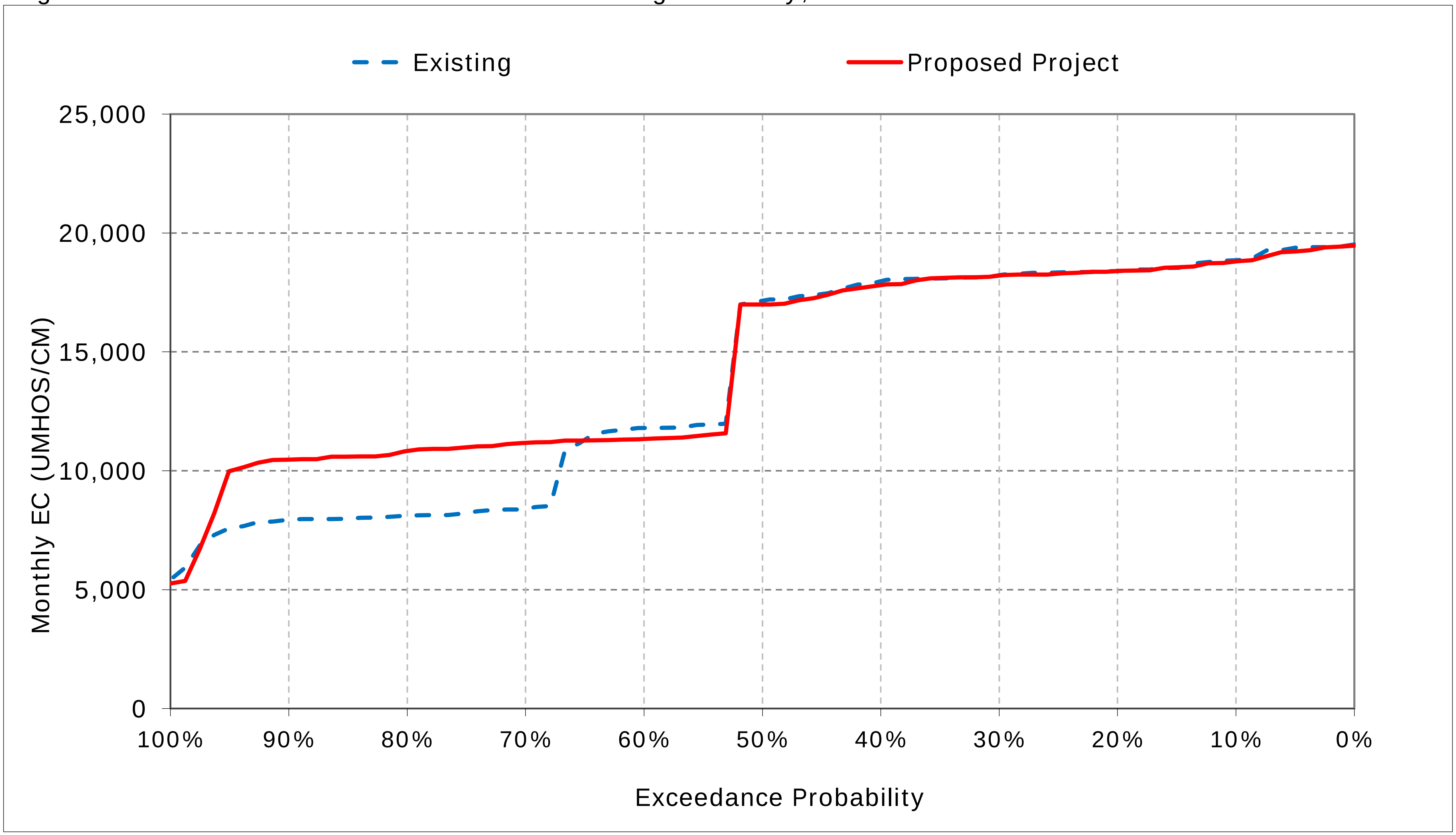


Figure 10-17. Sacramento River at Port Chicago Salinity, November EC

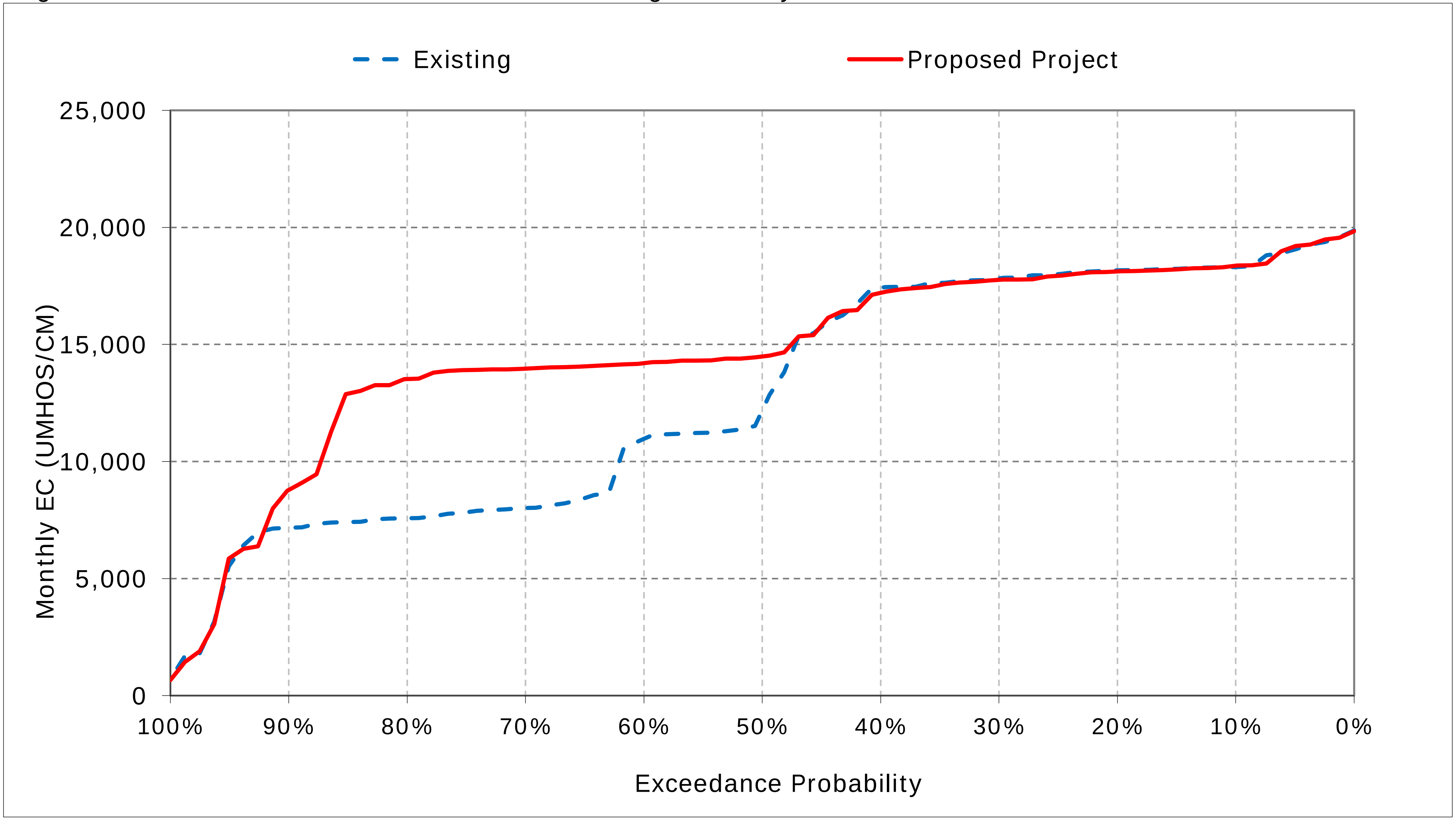


Figure 10-18. Sacramento River at Port Chicago Salinity, December EC

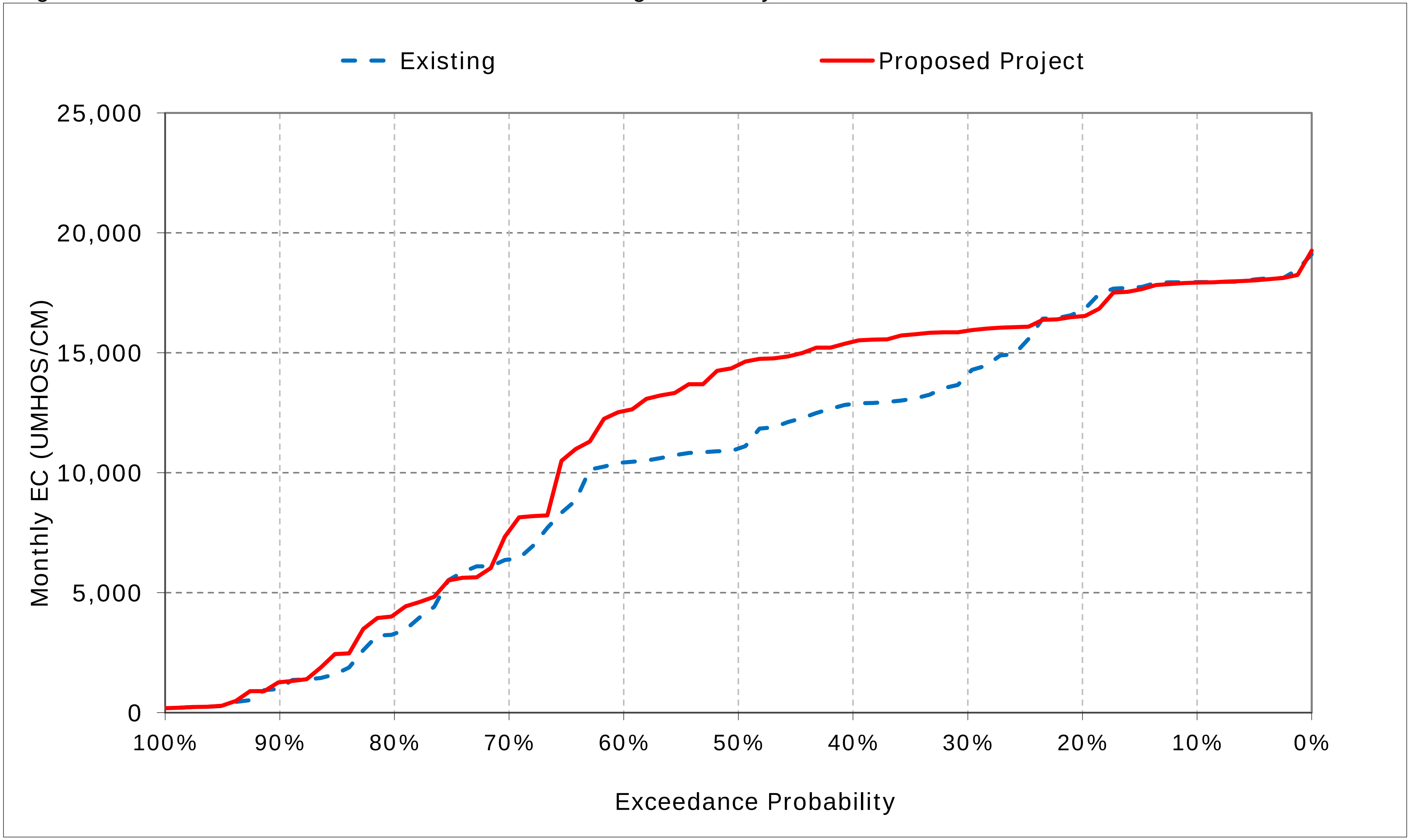


Table 11-1. San Joaquin River at Antioch Salinity, Monthly EC

Existing

Statistic	Monthly EC (UMHOS/CM)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	7,250	6,676	6,398	3,358	1,223	1,035	961	1,609	2,307	3,749	5,519	6,896
20%	6,792	6,518	5,164	2,829	758	498	505	1,020	1,833	3,160	4,834	6,480
30%	6,690	6,190	3,327	2,078	520	294	297	720	1,708	2,987	4,528	6,264
40%	6,284	5,969	2,785	1,274	370	260	262	422	1,303	2,013	3,709	5,800
50%	5,773	2,464	2,170	1,002	283	239	244	291	1,087	1,813	3,305	4,925
60%	2,050	1,730	1,872	491	255	229	227	252	689	1,232	3,199	2,032
70%	1,128	914	751	260	243	222	219	232	525	1,151	2,996	1,321
80%	952	798	486	235	225	216	213	216	270	955	2,779	1,199
90%	846	731	228	220	213	199	208	204	205	659	2,565	1,144
Long Term												
Full Simulation Period[a]	4,134	3,633	2,705	1,426	595	407	417	667	1,286	2,113	3,696	3,952
Water Year Types[b]												
Wet (32%)	3,066	2,178	843	354	240	220	220	236	408	827	2,568	1,081
Above Normal (15%)	4,383	3,637	2,584	908	319	223	224	251	755	1,128	2,849	2,005
Below Normal (17%)	4,353	3,978	3,531	1,536	399	296	293	422	1,065	1,884	3,469	5,337
Dry (22%)	4,420	4,312	3,284	2,079	808	464	454	785	1,686	3,078	4,668	6,380
Critical (15%)	5,515	5,357	5,024	3,155	1,547	1,040	1,123	2,128	3,379	4,706	5,797	6,863

Proposed Project

Statistic	Monthly EC (UMHOS/CM)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	7,178	6,644	6,230	4,058	1,249	1,047	1,110	1,754	2,368	3,799	5,530	6,973
20%	6,813	6,497	5,224	3,210	817	501	621	1,359	1,994	3,261	4,845	6,491
30%	6,621	6,139	5,010	2,234	538	284	376	1,112	1,786	2,980	4,623	6,268
40%	6,284	5,751	4,557	1,467	375	256	297	555	1,471	2,099	4,135	6,009
50%	5,636	4,014	3,616	1,024	296	241	244	372	1,065	1,800	3,675	5,149
60%	1,956	3,811	2,553	510	262	228	222	305	803	1,231	3,158	1,933
70%	1,802	3,730	1,140	271	242	219	212	228	593	1,124	2,954	1,849
80%	1,753	3,309	758	242	225	215	206	196	266	969	2,731	1,798
90%	1,622	1,396	364	220	214	201	201	192	199	659	2,502	1,571
Long Term												
Full Simulation Period[a]	4,301	4,564	3,319	1,577	645	413	457	785	1,355	2,125	3,776	4,170
Water Year Types[b]												
Wet (32%)	3,331	3,353	1,244	366	239	221	221	271	457	826	2,491	1,591
Above Normal (15%)	4,551	4,615	3,476	1,061	307	225	228	298	760	1,095	2,867	1,835
Below Normal (17%)	4,546	4,860	4,270	1,631	397	290	337	568	1,100	1,949	3,962	5,712
Dry (22%)	4,602	5,148	4,045	2,388	910	461	535	1,022	1,816	3,092	4,713	6,418
Critical (15%)	5,413	5,912	5,461	3,437	1,754	1,088	1,222	2,280	3,498	4,725	5,845	6,925

Proposed Project minus Existing

Statistic	Monthly EC (UMHOS/CM)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	-72	-32	-168	700	27	12	148	146	61	50	10	77
20%	21	-20	60	381	60	2	116	338	161	101	11	11
30%	-69	-52	1,683	156	18	-10	80	392	78	-7	95	5
40%	0	-217	1,773	193	5	-3	35	133	167	86	426	209
50%	-136	1,550	1,446	23	13	3	0	81	-22	-12	370	224
60%	-94	2,080	681	19	7	-1	-6	53	114	-2	-40	-99
70%	674	2,816	389	11	-1	-3	-7	-4	68	-28	-41	528
80%	801	2,510	272	7	1	0	-8	-20	-4	14	-48	599
90%	777	665	136	0	1	2	-7	-12	-5	0	-63	426
Long Term												
Full Simulation Period[a]	167	931	615	151	50	6	41	117	68	12	79	218
Water Year Types[b]												
Wet (32%)	265	1,175	401	12	-1	1	1	35	49	0	-77	510
Above Normal (15%)	168	978	892	153	-12	2	4	47	5	-33	18	-170
Below Normal (17%)	193	882	738	95	-2	-6	44	146	35	65	494	375
Dry (22%)	182	836	761	309	102	-3	80	238	130	14	45	38
Critical (15%)	-102	555	437	282	207	48	99	152	119	19	48	62

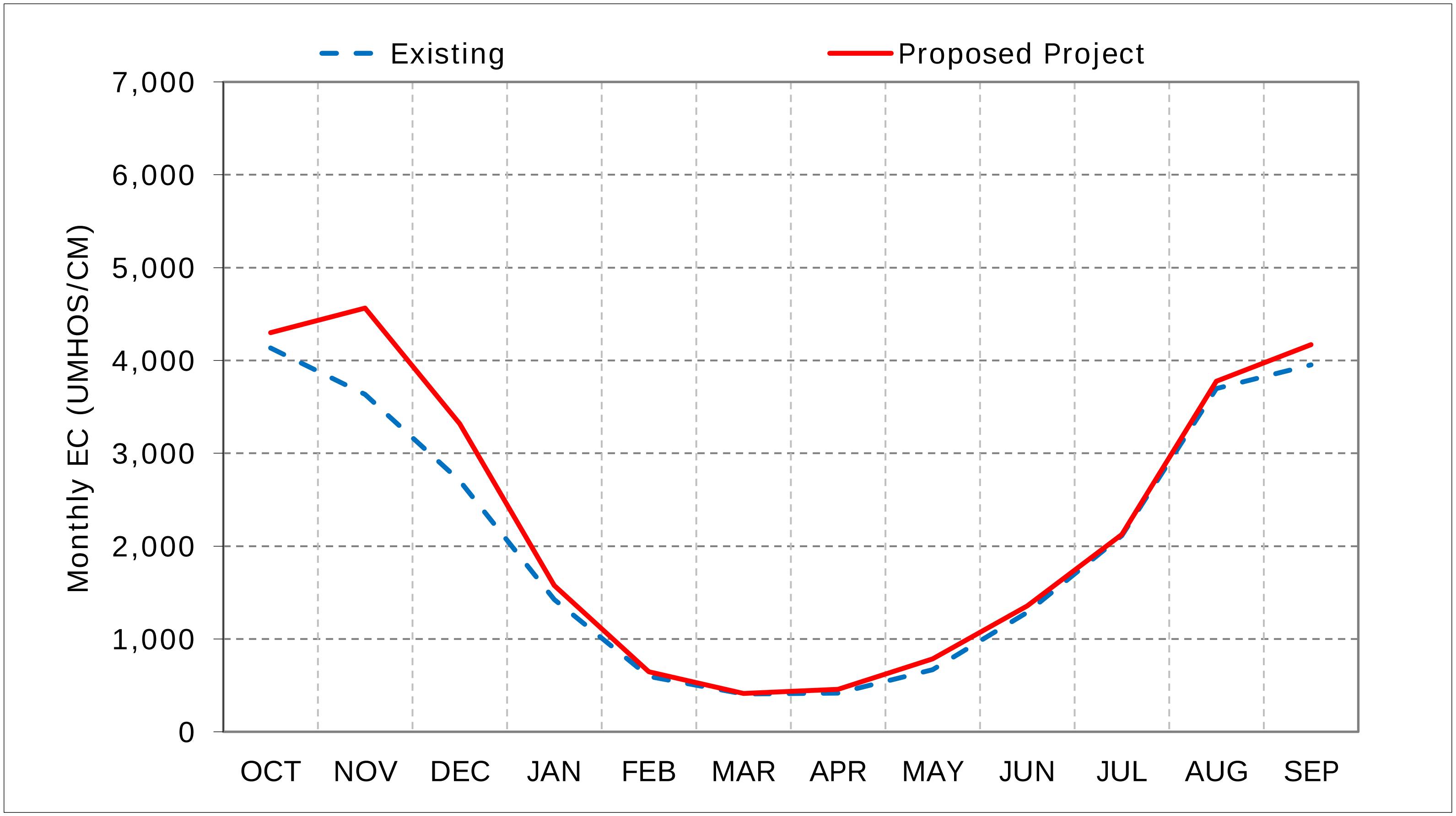
a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

c These results are displayed with water year - year type sorting.

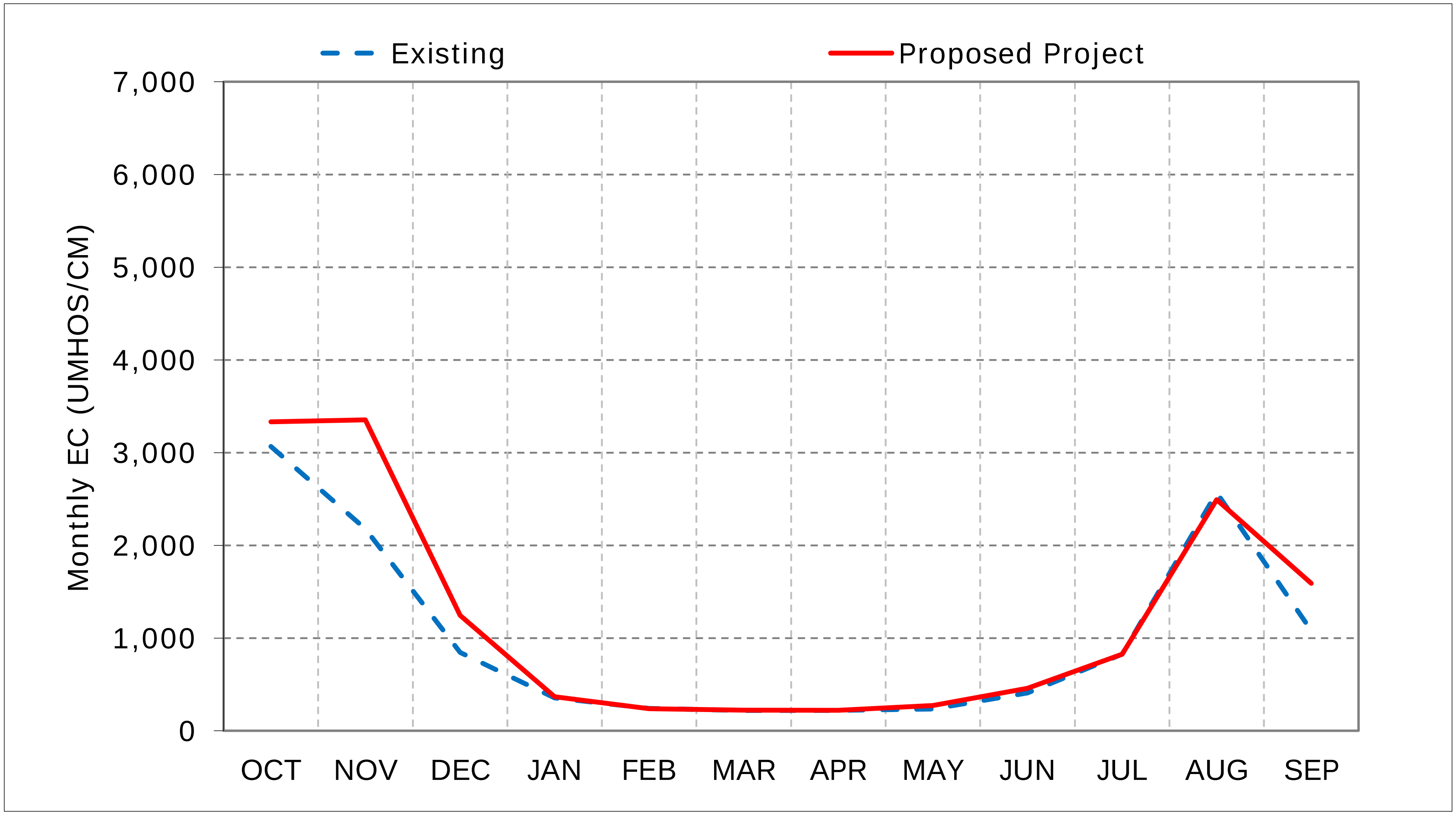
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 11-1. San Joaquin River at Antioch Salinity, Long-Term Average EC



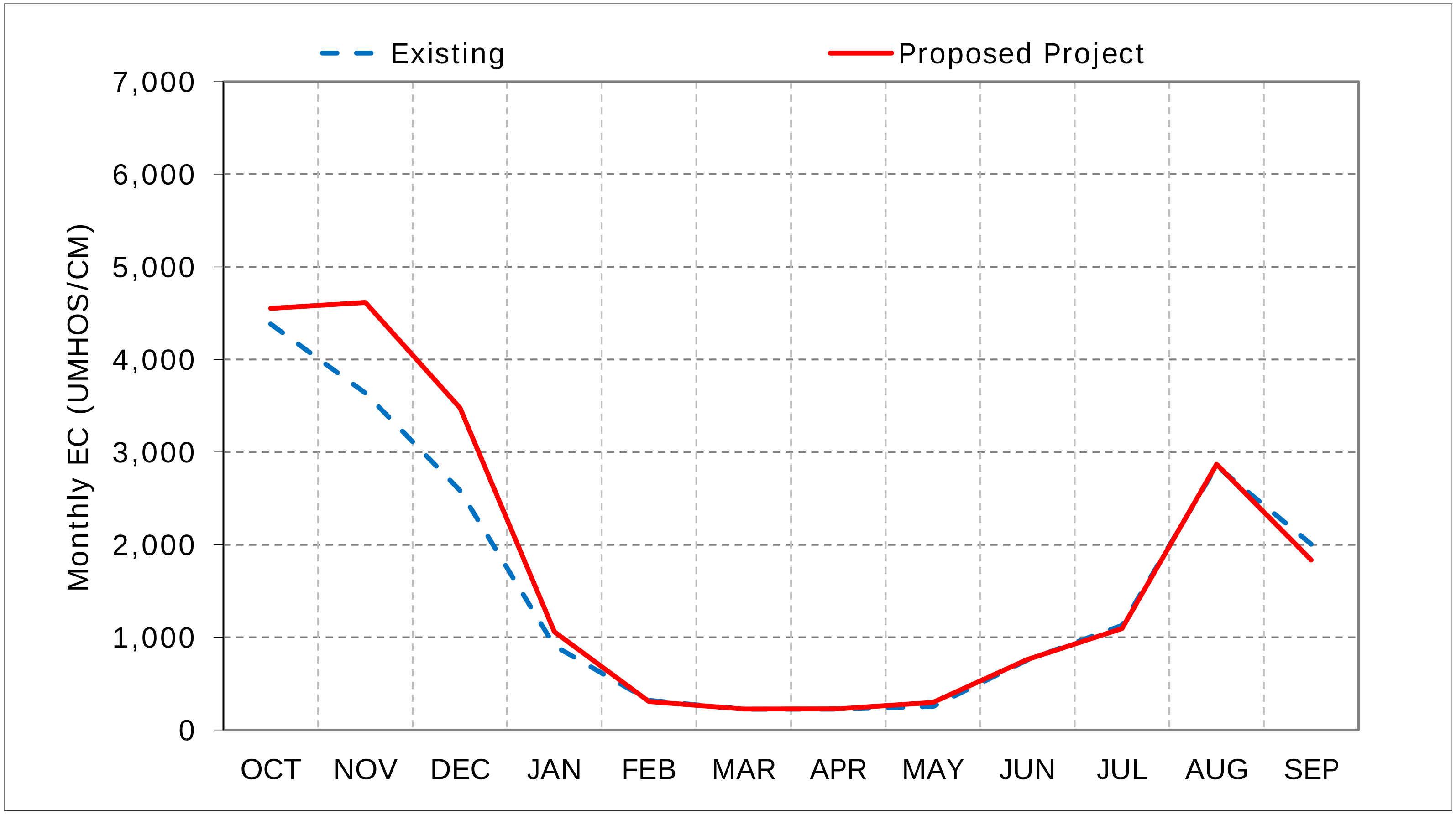
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 11-2. San Joaquin River at Antioch Salinity, Wet Year Average EC



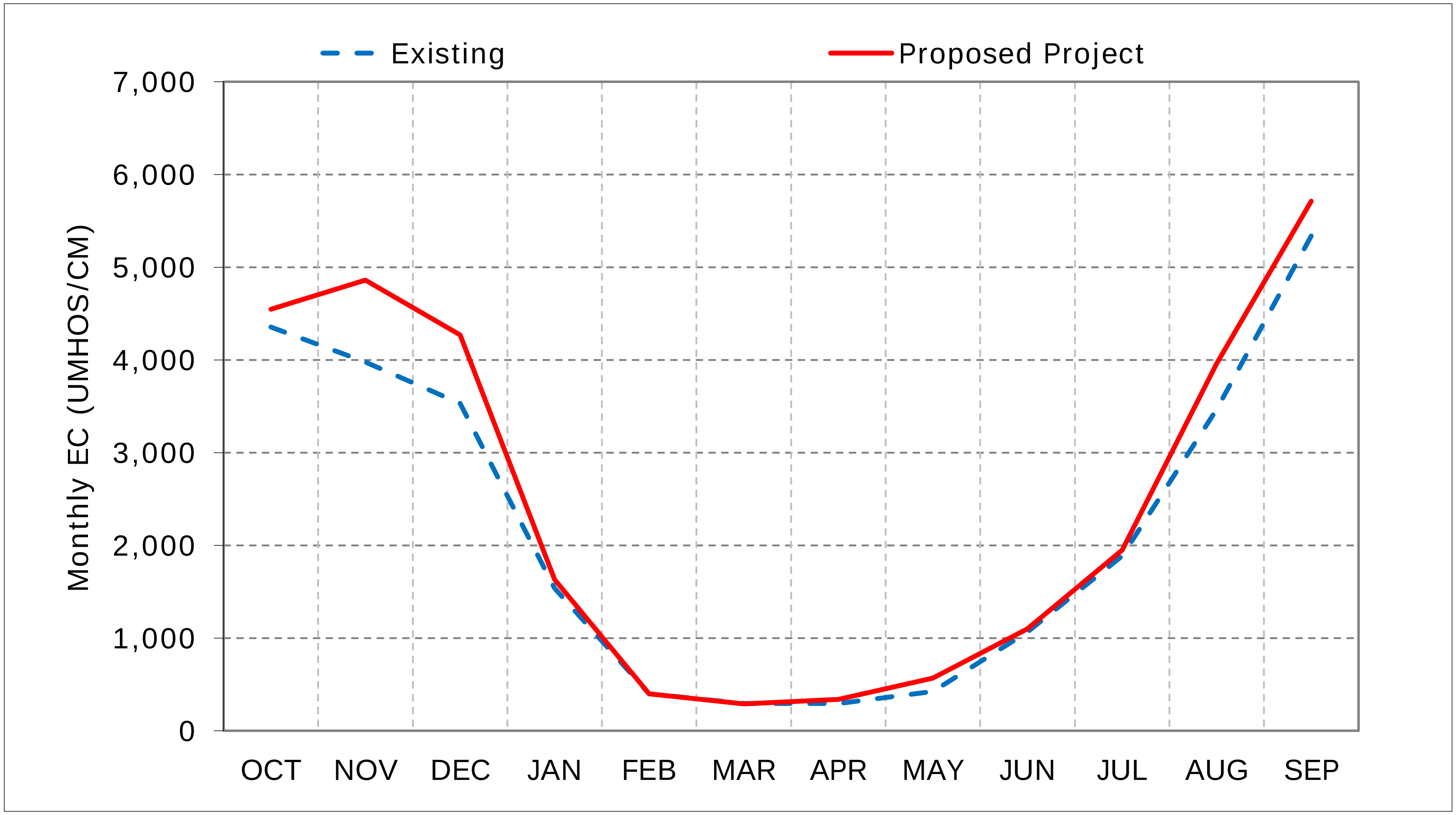
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 11-3. San Joaquin River at Antioch Salinity, Above Normal Year Average EC



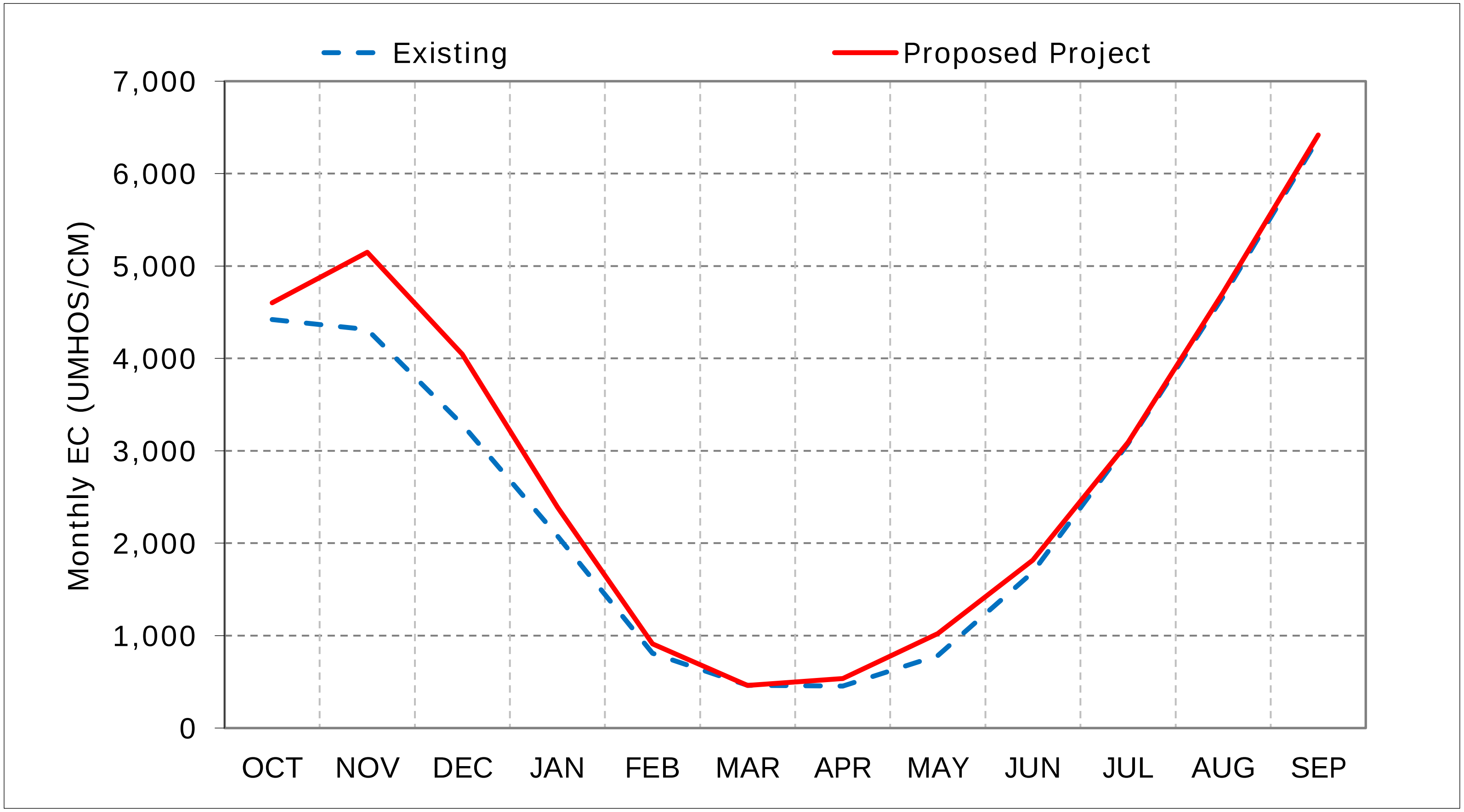
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 11-4. San Joaquin River at Antioch Salinity, Below Normal Year Average EC



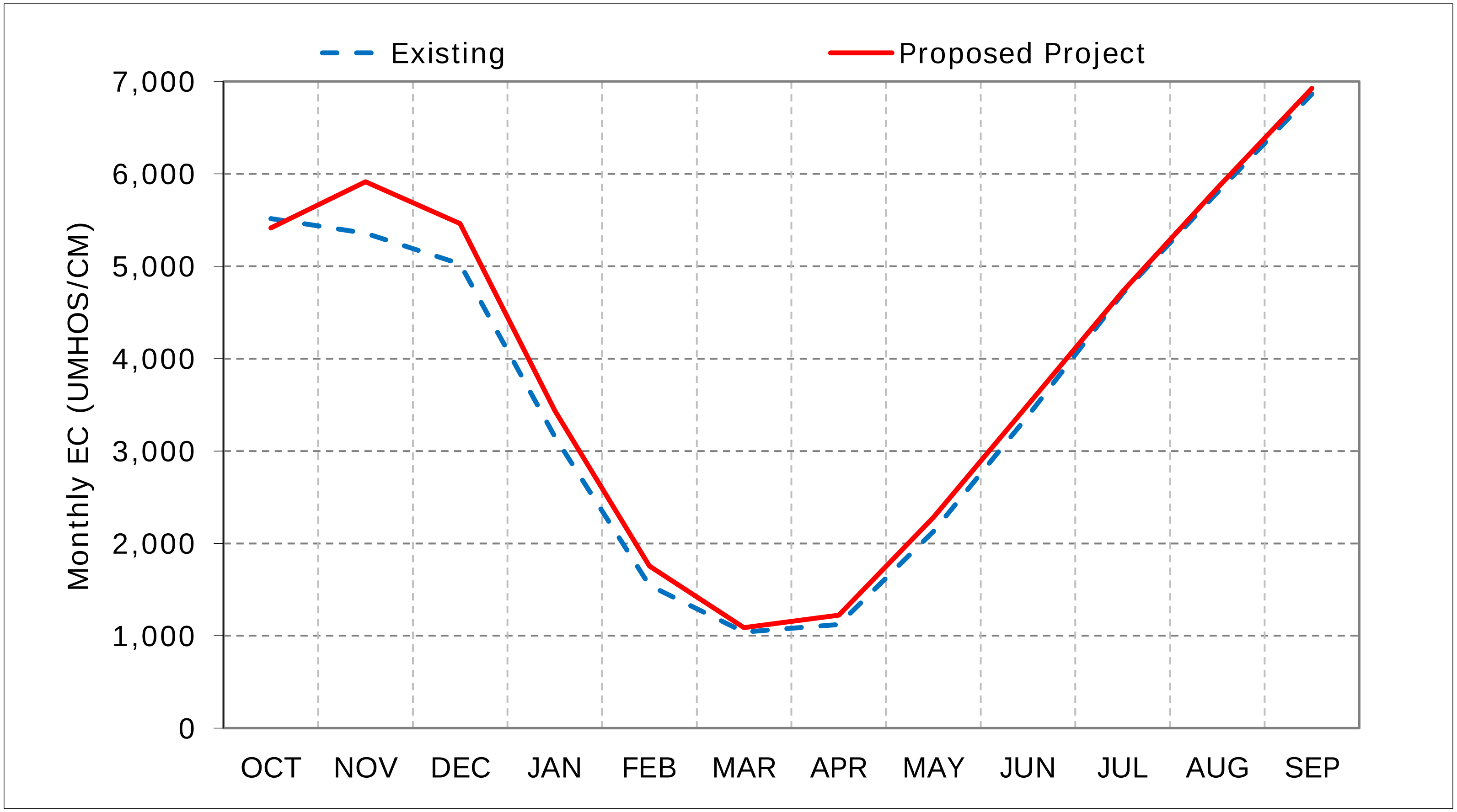
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 11-5. San Joaquin River at Antioch Salinity, Dry Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 11-6. San Joaquin River at Antioch Salinity, Critical Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 11-7. San Joaquin River at Antioch Salinity, January EC

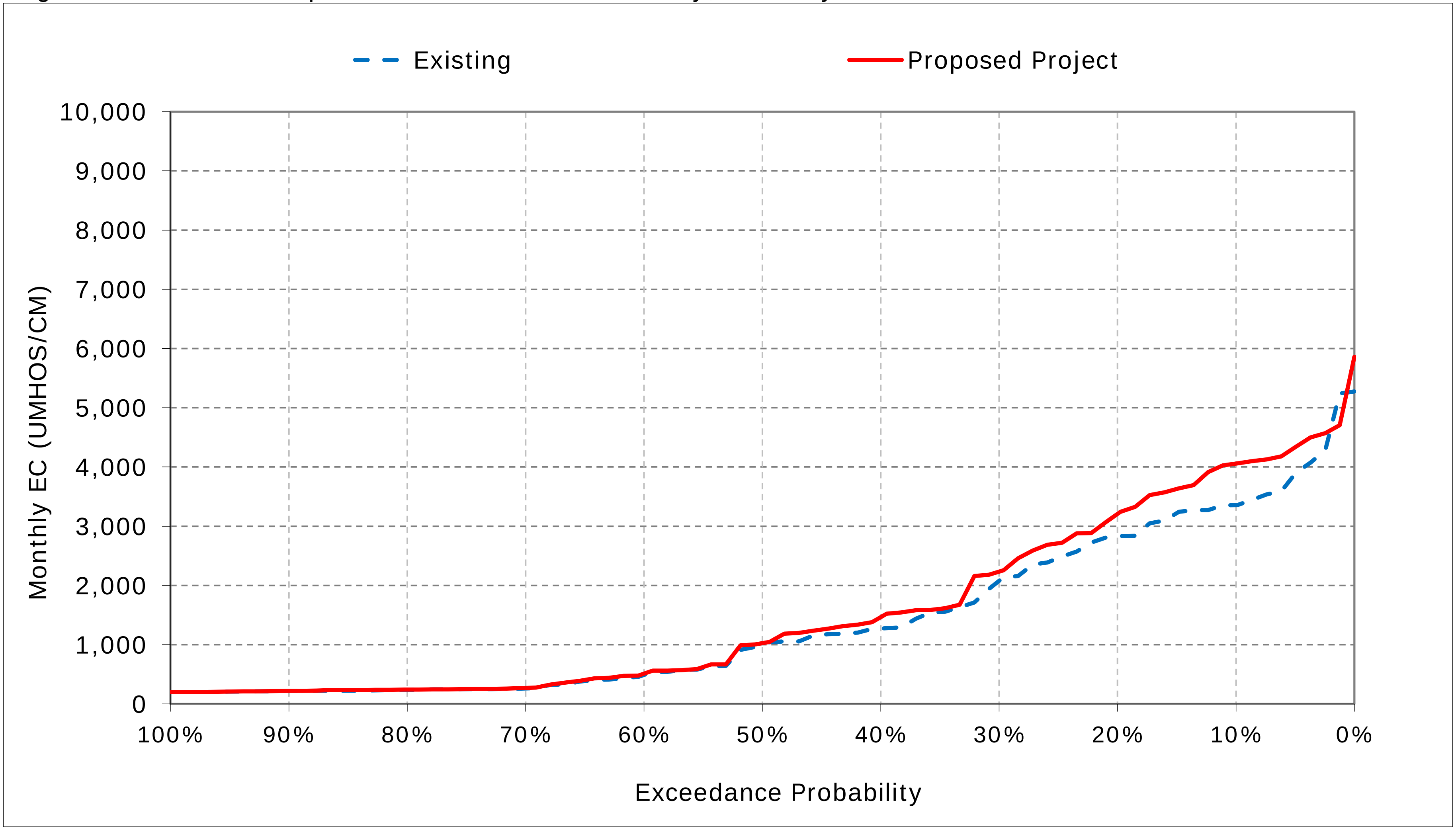


Figure 11-8. San Joaquin River at Antioch Salinity, February EC

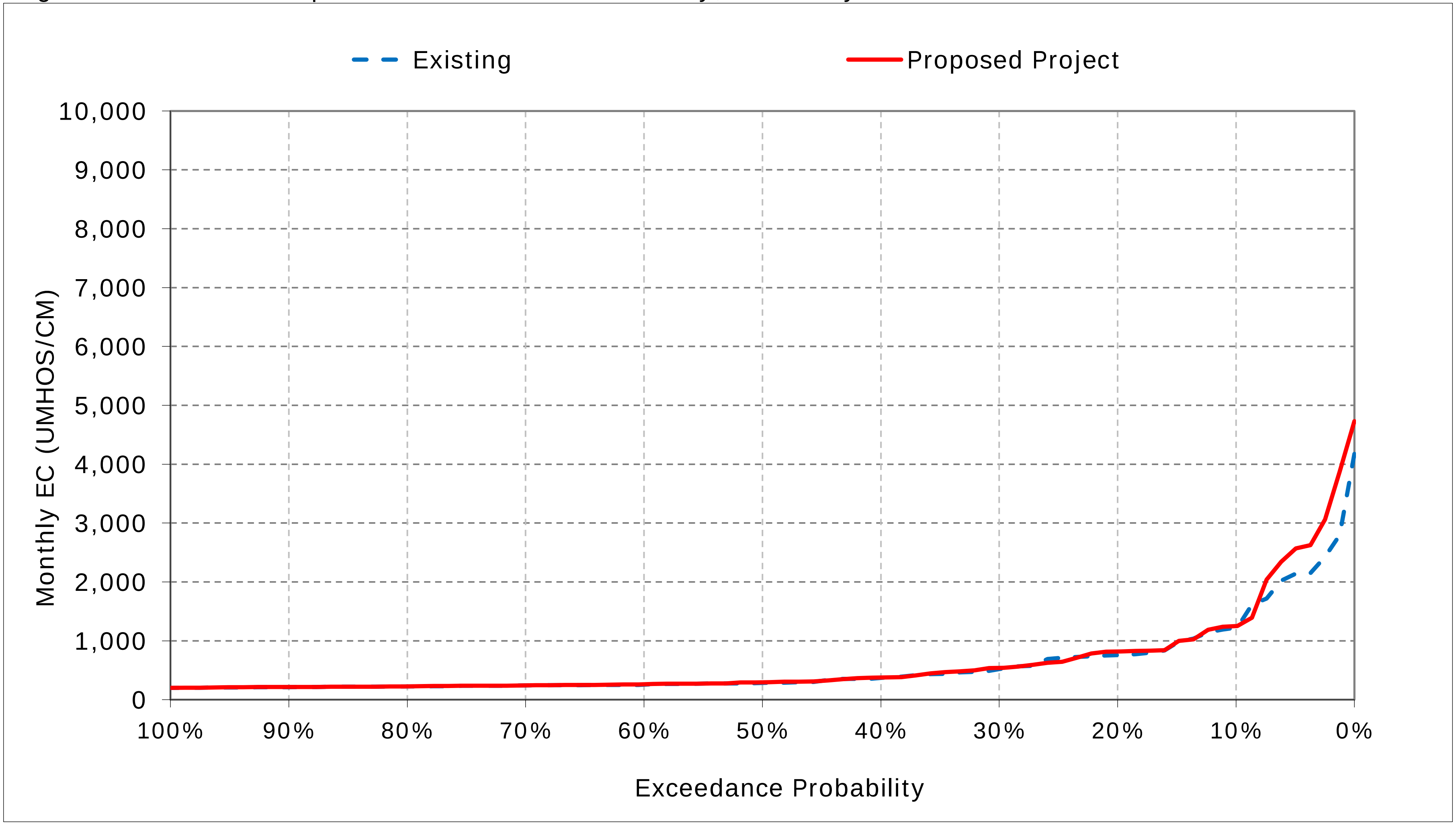


Figure 11-9. San Joaquin River at Antioch Salinity, March EC

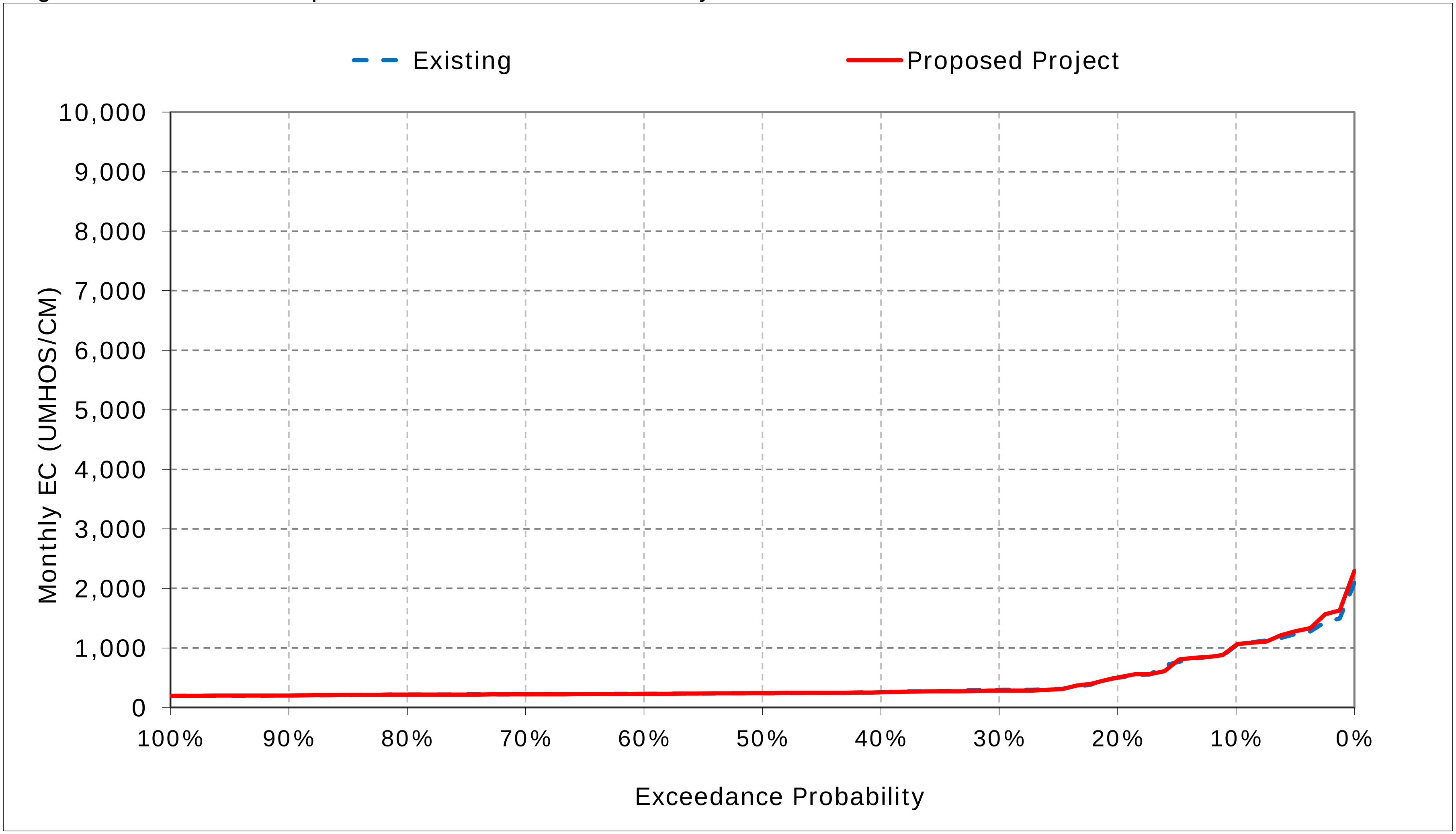


Figure 11-10. San Joaquin River at Antioch Salinity, April EC

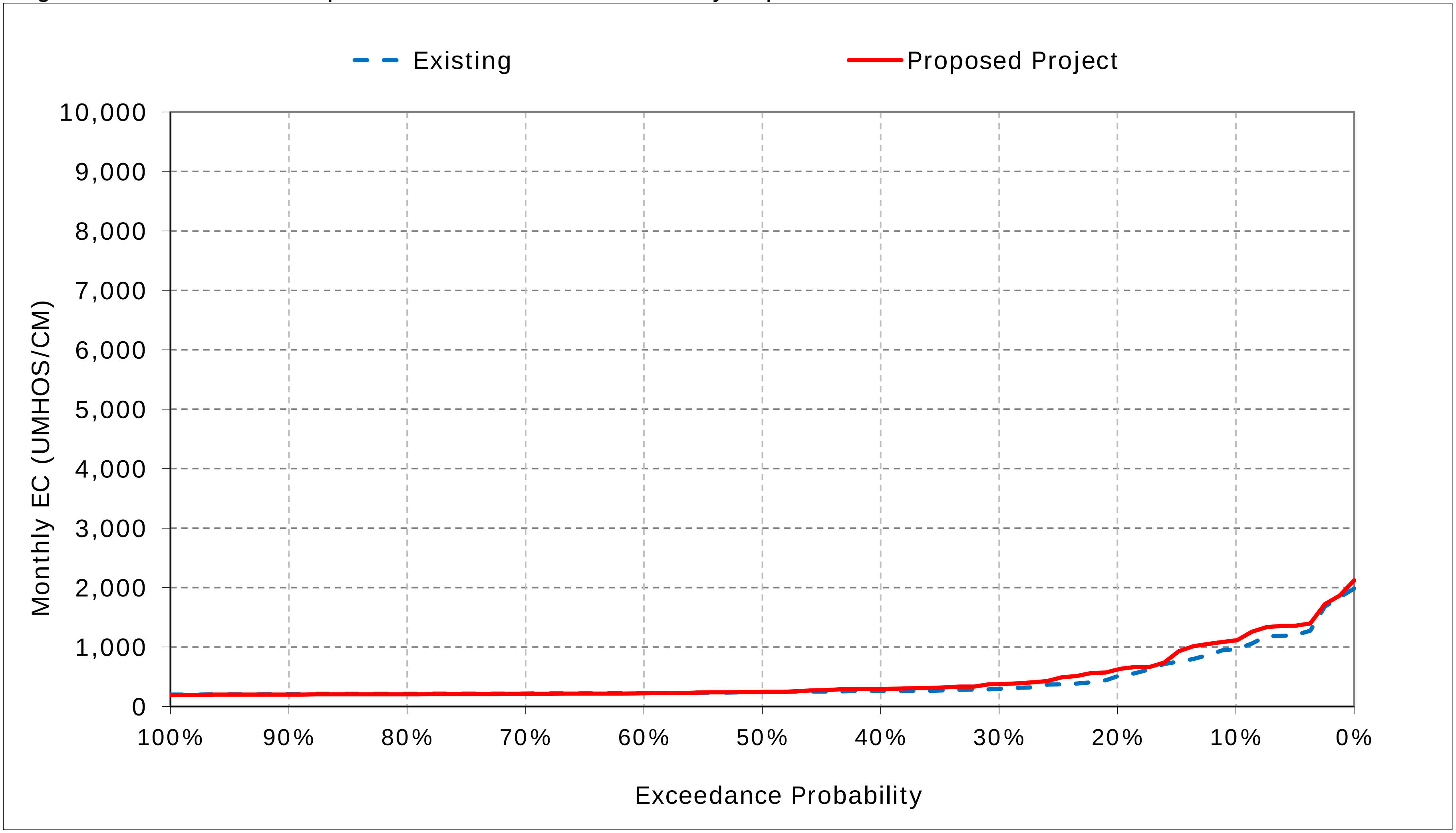


Figure 11-11. San Joaquin River at Antioch Salinity, May EC

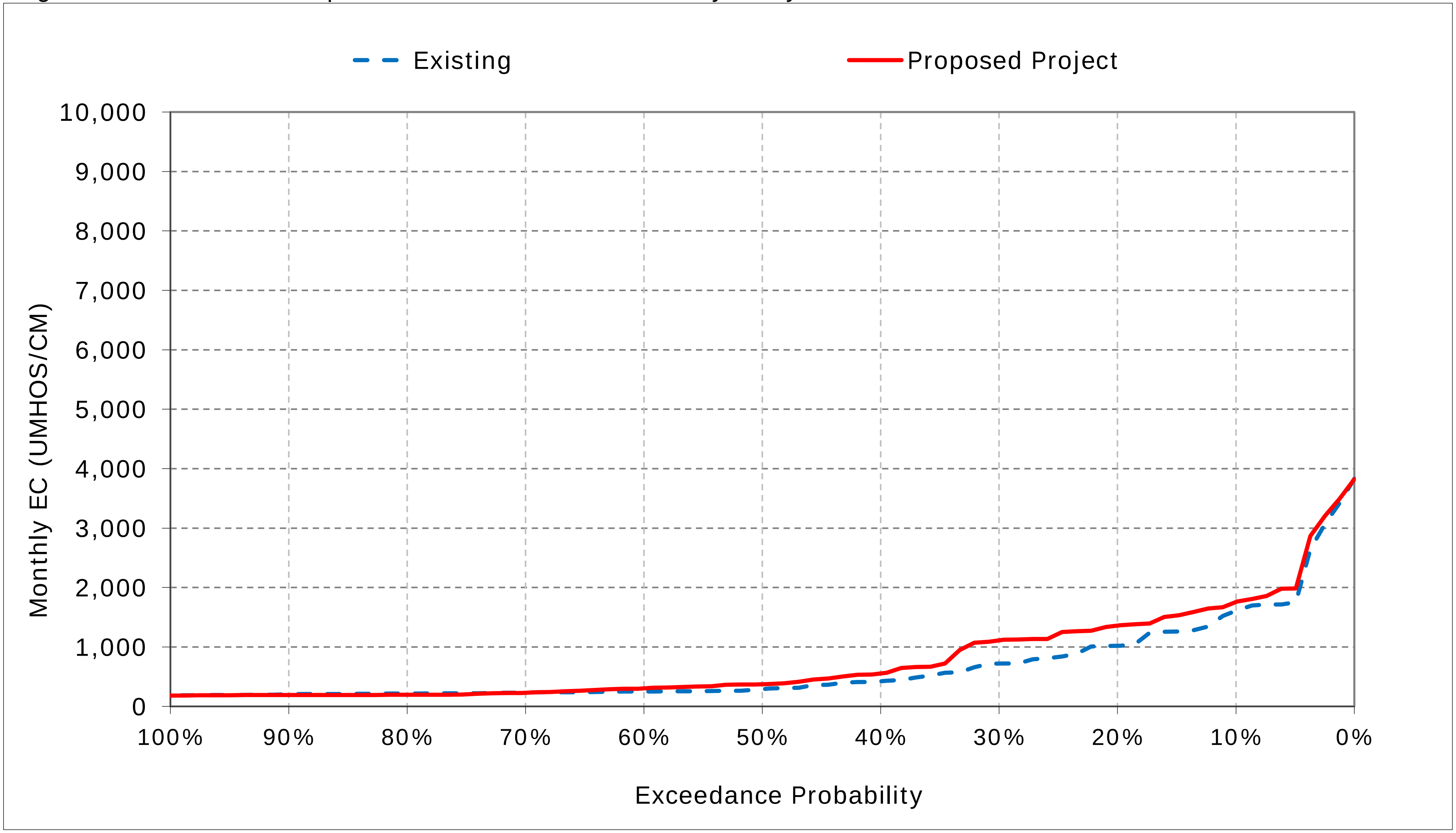


Figure 11-12. San Joaquin River at Antioch Salinity, June EC

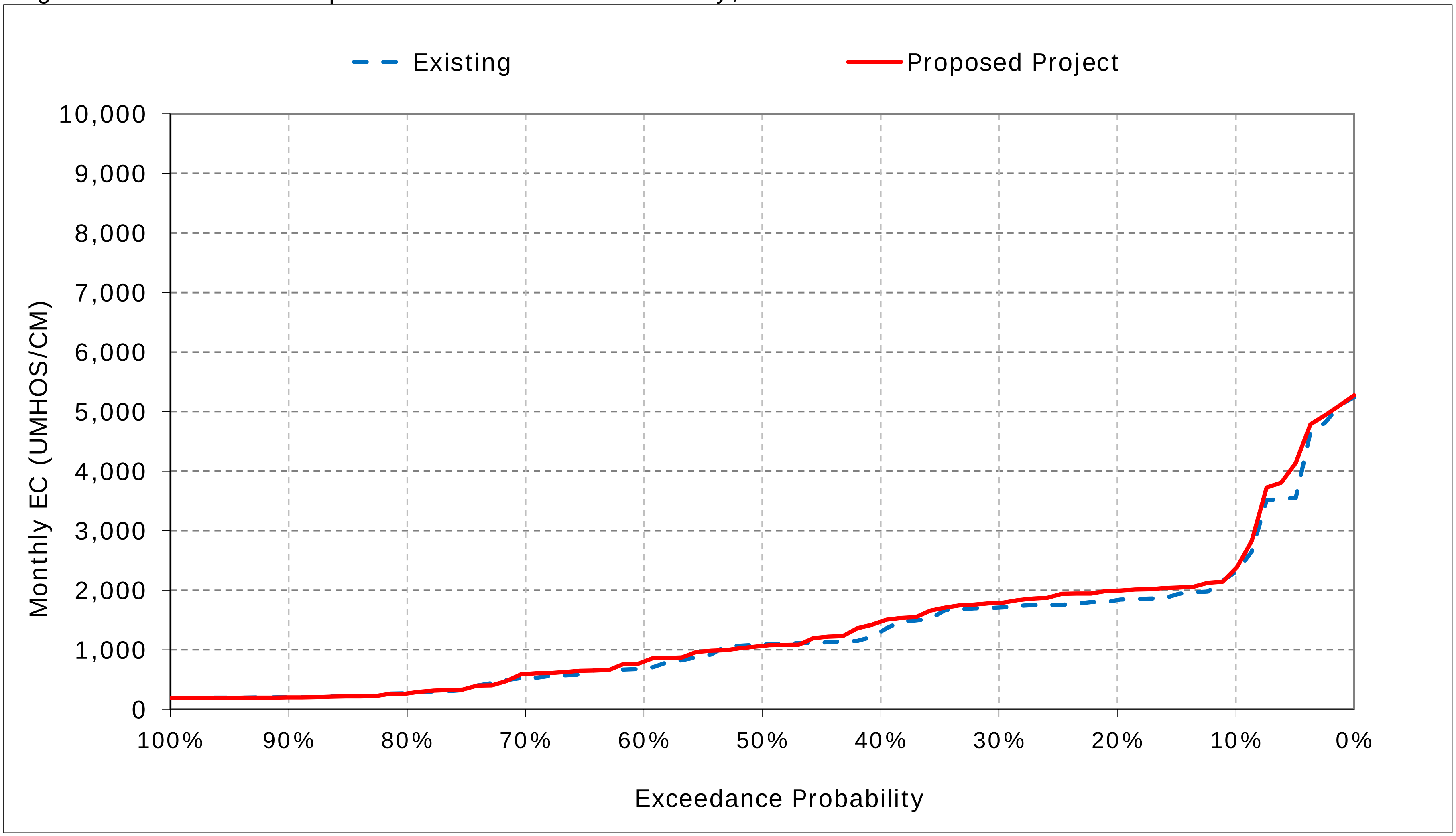


Figure 11-13. San Joaquin River at Antioch Salinity, July EC

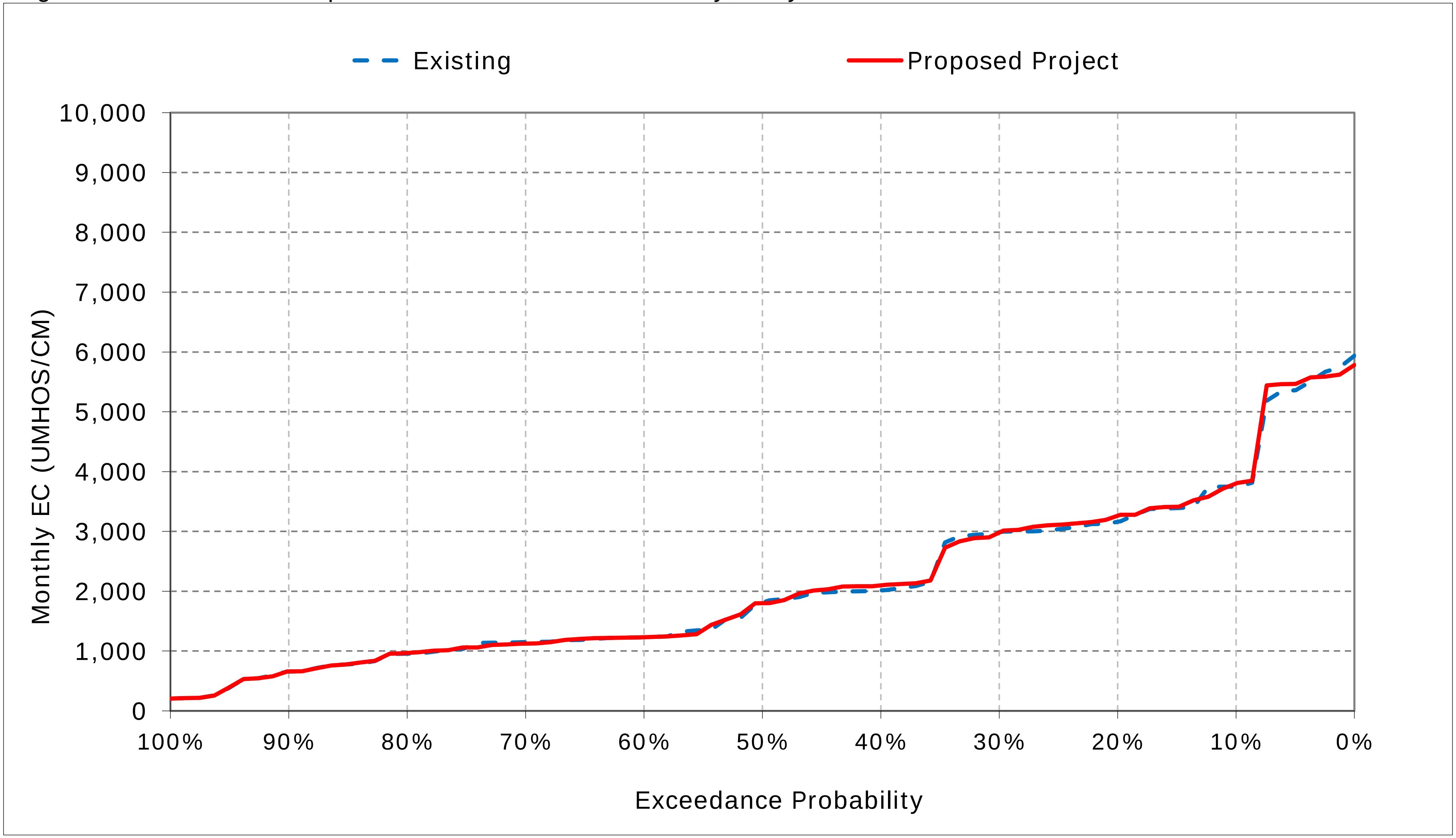


Figure 11-14. San Joaquin River at Antioch Salinity, August EC

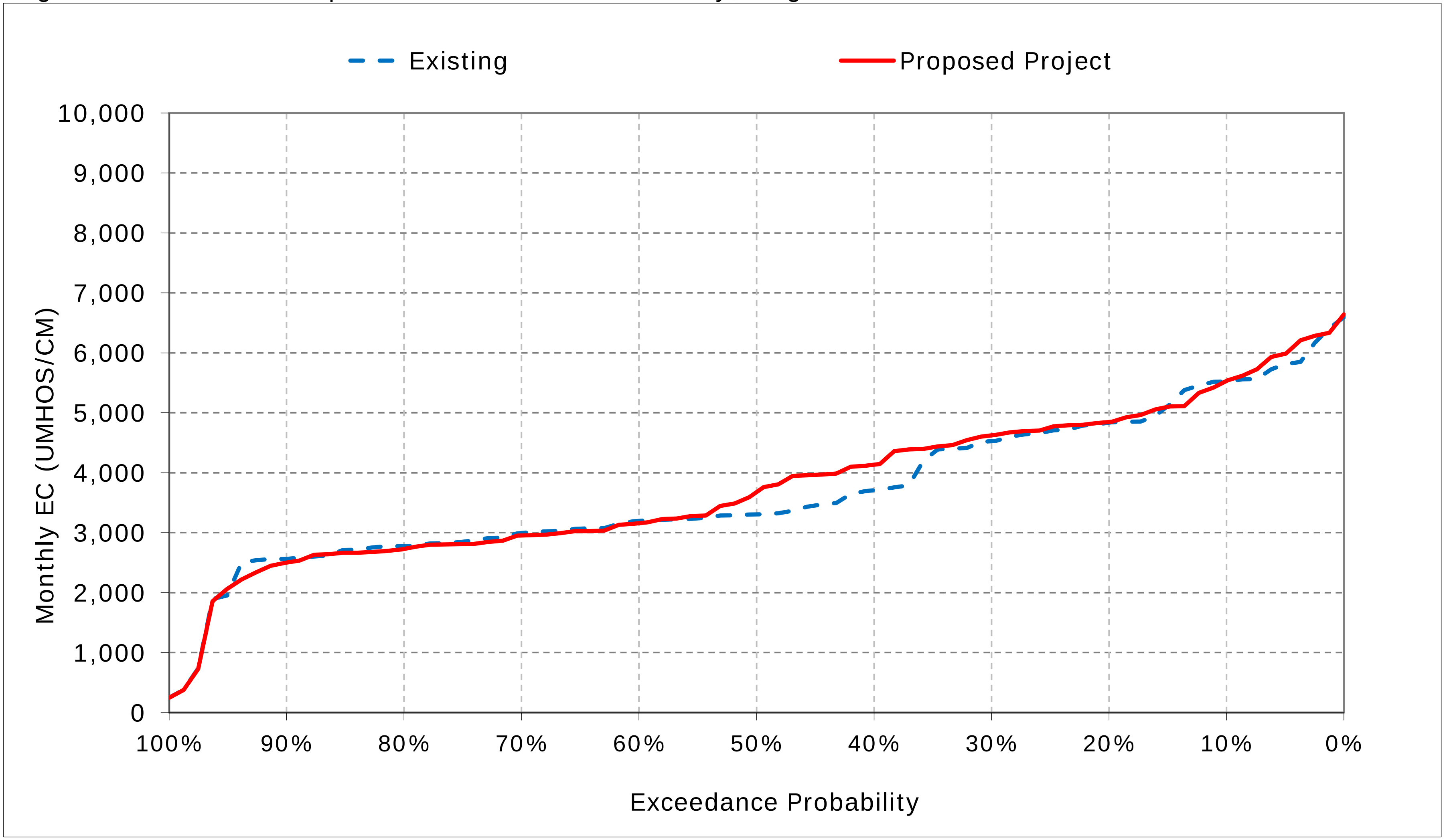


Figure 11-15. San Joaquin River at Antioch Salinity, September EC

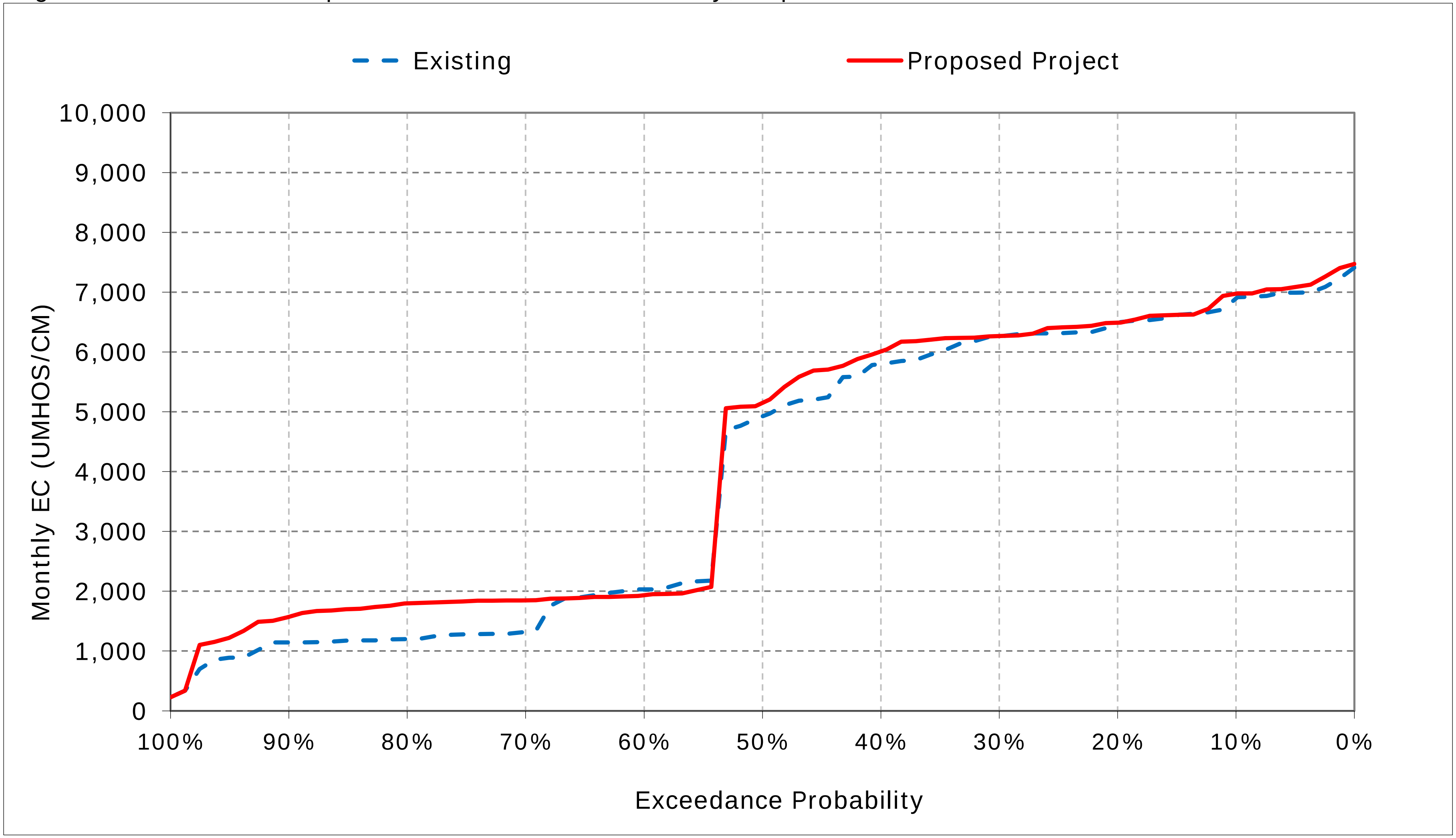


Figure 11-16. San Joaquin River at Antioch Salinity, October EC

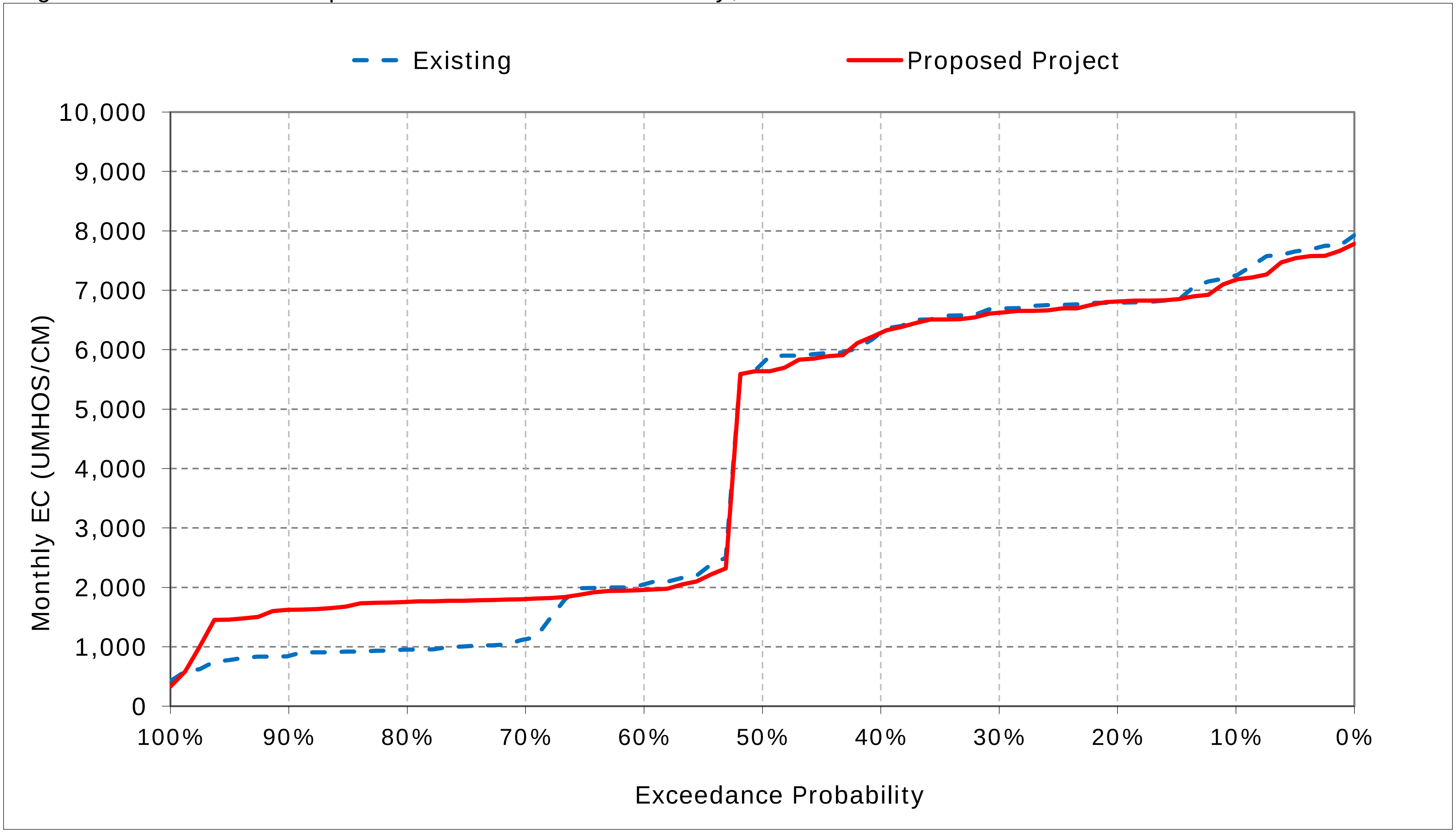


Figure 11-17. San Joaquin River at Antioch Salinity, November EC

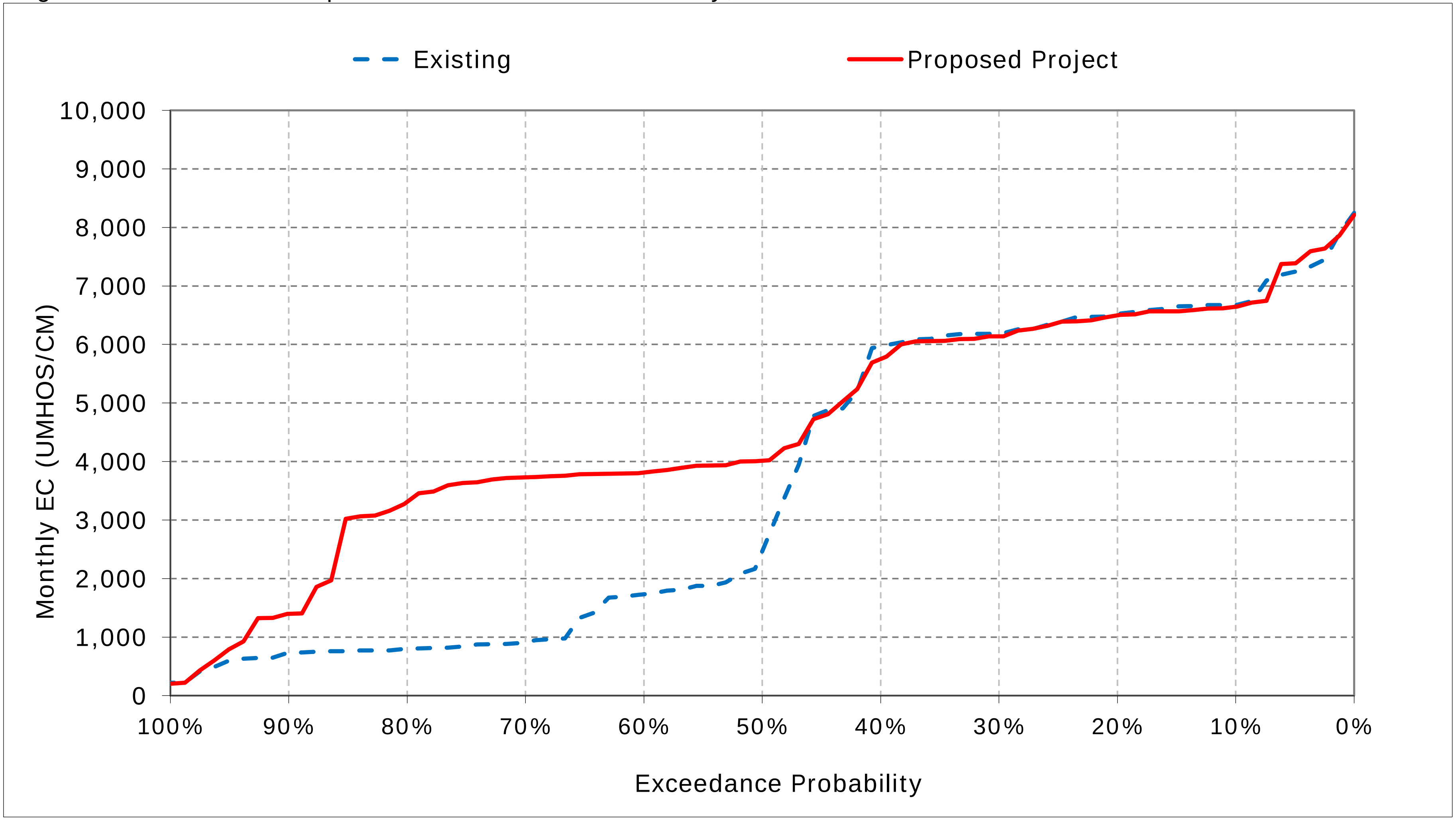


Figure 11-18. San Joaquin River at Antioch Salinity, December EC

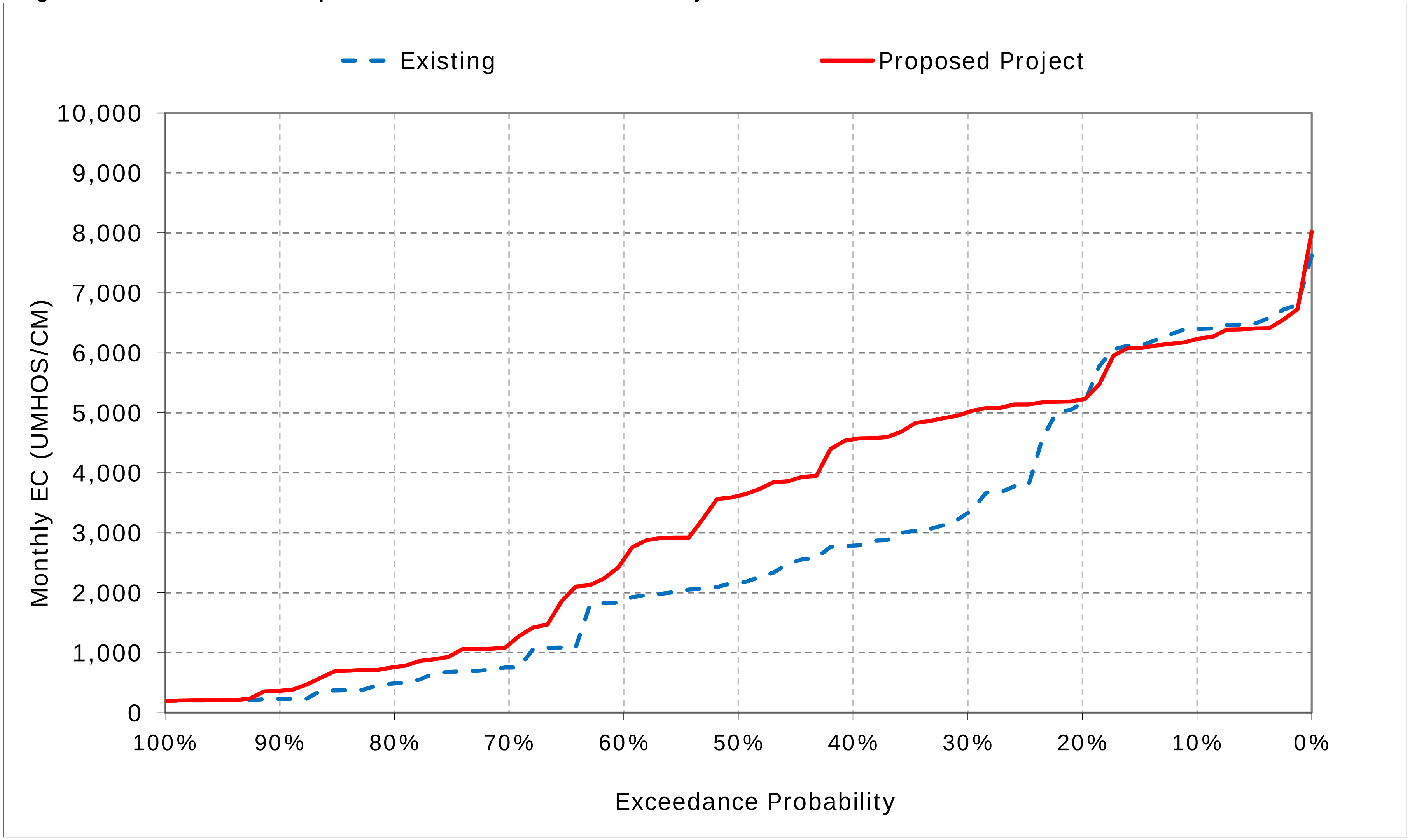


Table 12-1. San Joaquin River at Jersey Point Salinity, Monthly EC

Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	2,437	2,408	2,326	1,362	568	339	307	395	562	1,431	1,744	2,423
20%	2,258	2,253	2,053	1,126	397	274	249	303	470	1,136	1,546	2,323
30%	2,157	2,128	1,532	889	309	244	236	266	446	888	1,473	2,249
40%	2,064	1,889	1,271	674	290	236	230	247	365	808	1,374	2,127
50%	1,775	1,285	831	515	270	228	224	240	311	595	1,300	1,910
60%	562	637	743	352	252	222	221	233	256	491	1,208	1,028
70%	369	399	507	264	237	214	219	227	231	442	1,148	967
80%	312	322	308	234	219	209	214	222	209	337	1,065	909
90%	287	267	215	218	213	200	209	207	203	246	1,000	876
Long Term												
Full Simulation Period[a]	1,354	1,310	1,133	668	342	255	243	283	401	754	1,304	1,613
Water Year Types[b]												
Wet (32%)	1,021	898	480	277	234	219	218	215	223	335	990	819
Above Normal (15%)	1,495	1,286	1,114	516	267	222	224	229	276	429	1,124	942
Below Normal (17%)	1,417	1,465	1,437	744	289	233	232	247	328	746	1,402	2,286
Dry (22%)	1,430	1,529	1,355	865	391	256	239	277	449	1,141	1,475	2,261
Critical (15%)	1,747	1,716	1,876	1,282	637	387	332	534	923	1,413	1,795	2,248

Proposed Project

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	2,418	2,437	2,461	1,628	622	337	328	451	588	1,452	1,808	2,544
20%	2,262	2,267	2,327	1,287	413	275	249	367	521	1,019	1,640	2,480
30%	2,187	2,074	2,186	1,067	326	246	228	309	453	820	1,520	2,338
40%	2,021	1,877	1,951	879	294	239	220	235	381	754	1,420	2,160
50%	1,775	1,744	1,630	536	273	232	215	217	299	558	1,305	1,953
60%	619	1,507	1,358	381	258	225	211	207	247	465	1,181	935
70%	561	1,441	688	268	236	217	207	201	223	422	1,134	867
80%	488	1,223	525	240	220	209	205	195	200	340	1,047	792
90%	412	704	274	225	214	204	201	192	196	245	933	662
Long Term												
Full Simulation Period[a]	1,409	1,687	1,493	760	372	261	242	290	411	739	1,322	1,613
Water Year Types[b]												
Wet (32%)	1,109	1,363	724	295	235	221	208	202	223	330	946	708
Above Normal (15%)	1,570	1,723	1,647	644	276	226	211	205	260	418	1,127	865
Below Normal (17%)	1,488	1,822	1,844	829	293	233	224	246	324	691	1,511	2,479
Dry (22%)	1,474	1,822	1,806	1,038	445	262	243	313	482	1,102	1,487	2,281
Critical (15%)	1,712	1,989	2,123	1,383	745	417	364	584	968	1,453	1,863	2,311

Proposed Project minus Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	-19	29	135	266	54	-2	21	56	26	21	64	122
20%	4	15	275	161	16	1	-1	64	51	-117	93	157
30%	29	-54	654	178	17	2	-8	44	7	-68	47	90
40%	-43	-12	679	206	5	3	-10	-11	15	-54	46	33
50%	0	460	798	21	3	3	-9	-23	-12	-38	5	44
60%	57	871	614	30	6	4	-10	-25	-9	-25	-27	-93
70%	192	1,042	180	5	0	3	-12	-26	-8	-21	-15	-100
80%	175	901	217	6	0	0	-10	-26	-9	3	-18	-117
90%	125	437	59	6	1	3	-8	-15	-7	-1	-67	-214
Long Term												
Full Simulation Period[a]	56	377	360	92	30	7	-1	7	10	-15	17	0
Water Year Types[b]												
Wet (32%)	88	465	244	18	1	2	-10	-13	-1	-4	-45	-111
Above Normal (15%)	75	437	533	128	9	4	-13	-24	-16	-10	3	-77
Below Normal (17%)	71	357	406	86	4	0	-8	-1	-4	-55	110	193
Dry (22%)	44	293	451	173	54	6	4	36	33	-39	12	20
Critical (15%)	-35	273	247	100	108	29	31	50	44	40	68	63

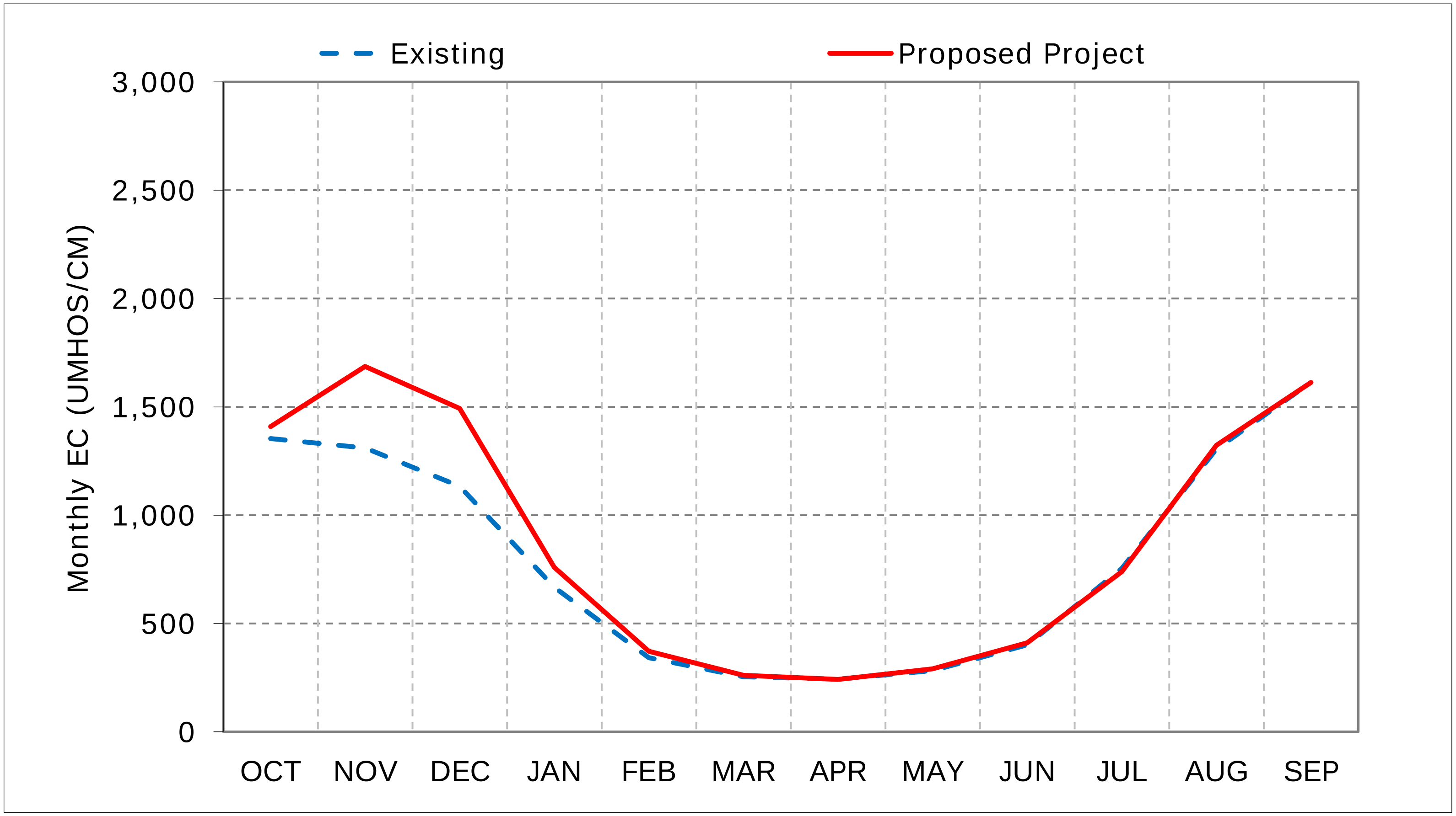
a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

c These results are displayed with water year - year type sorting.

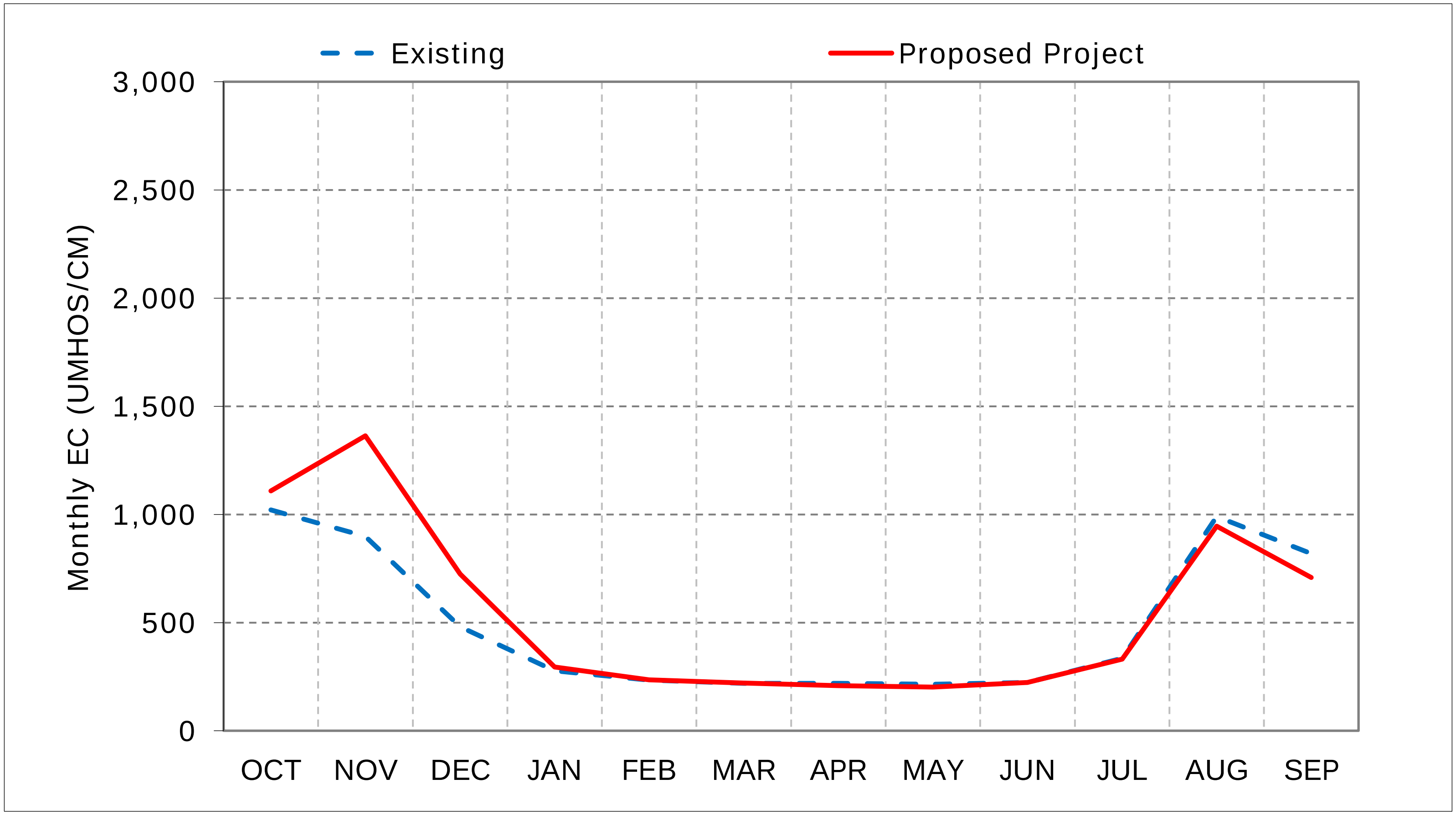
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 12-1. San Joaquin River at Jersey Point Salinity, Long-Term Average EC



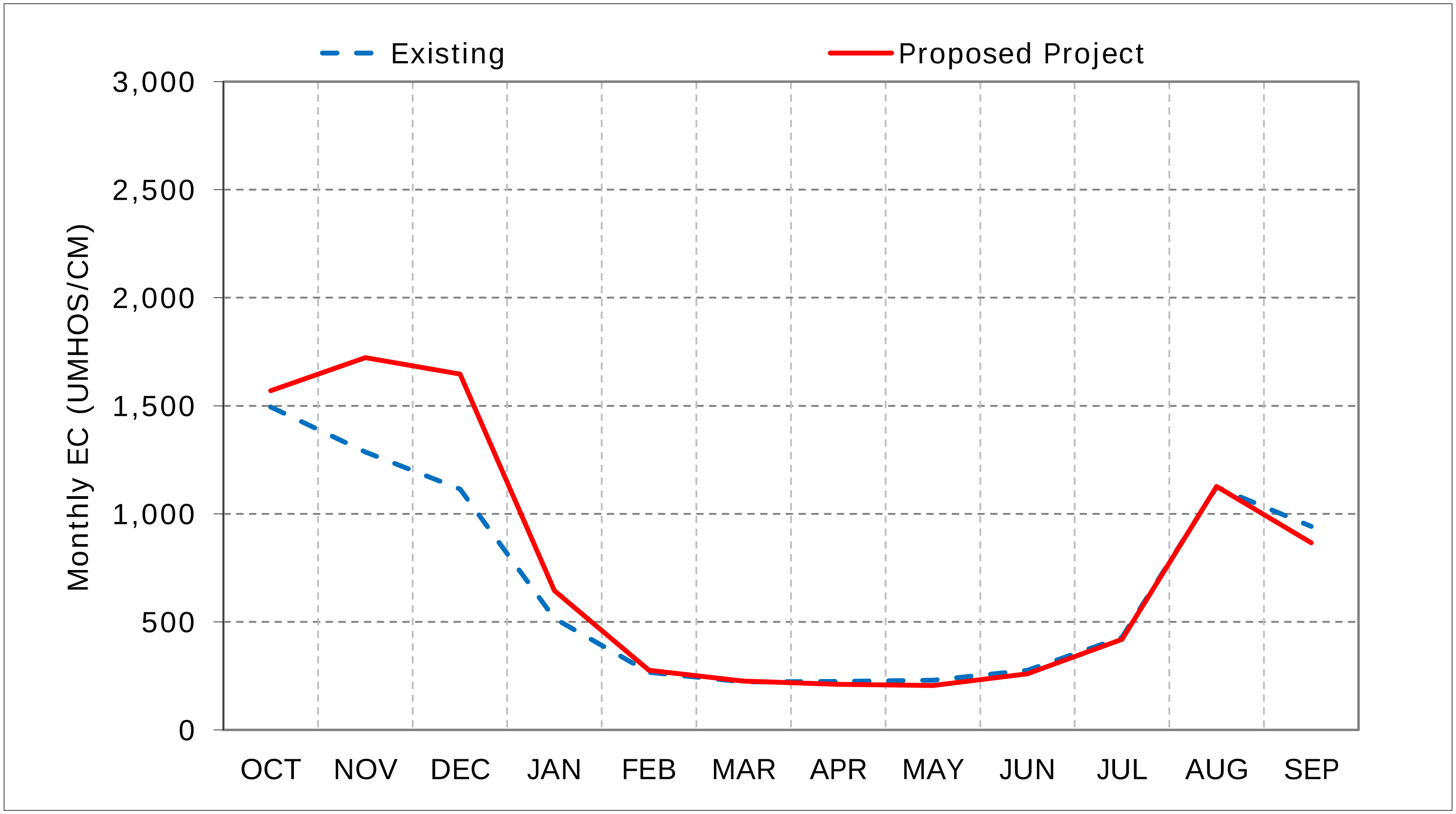
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 12-2. San Joaquin River at Jersey Point Salinity, Wet Year Average EC



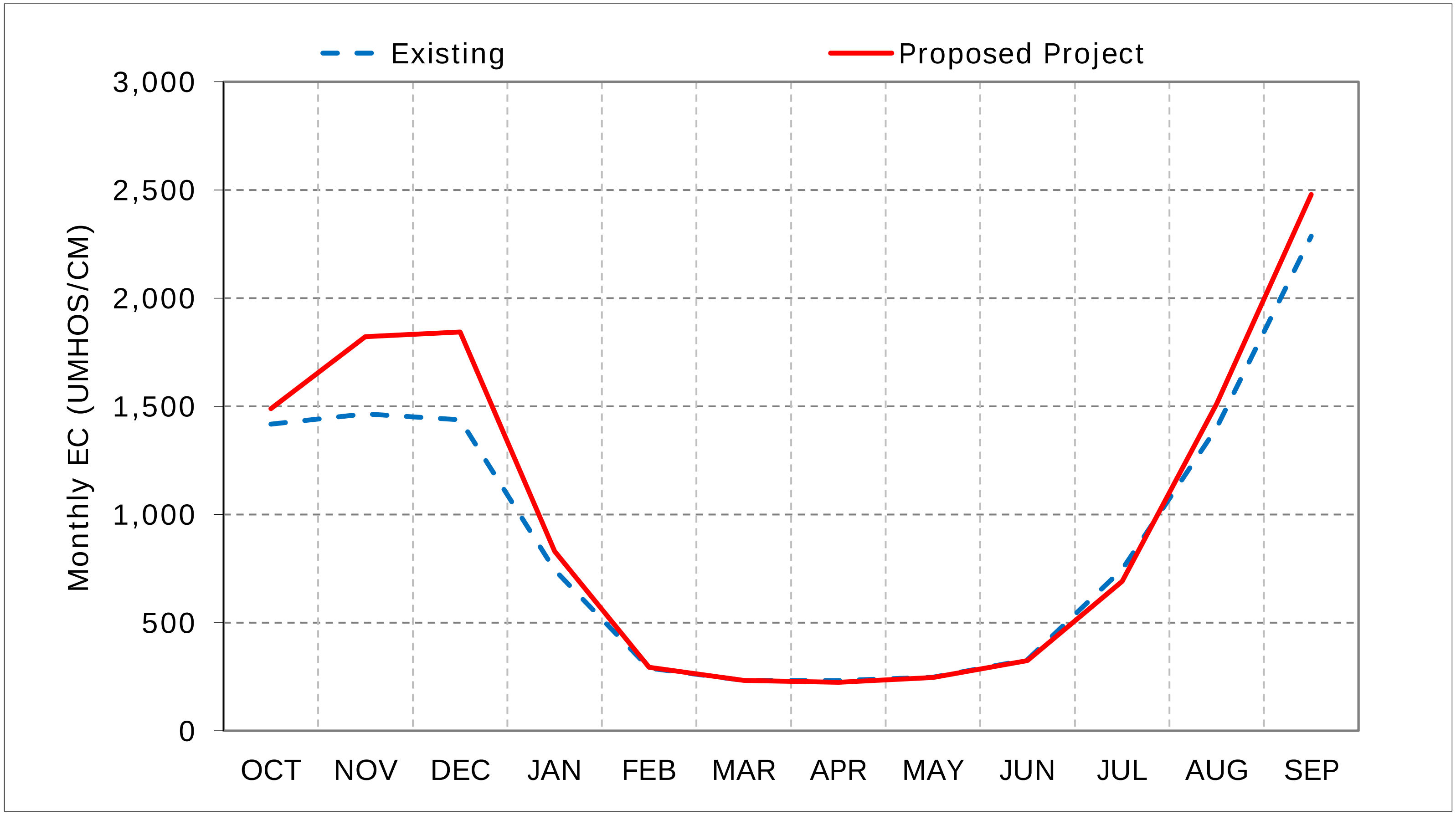
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 12-3. San Joaquin River at Jersey Point Salinity, Above Normal Year Averag



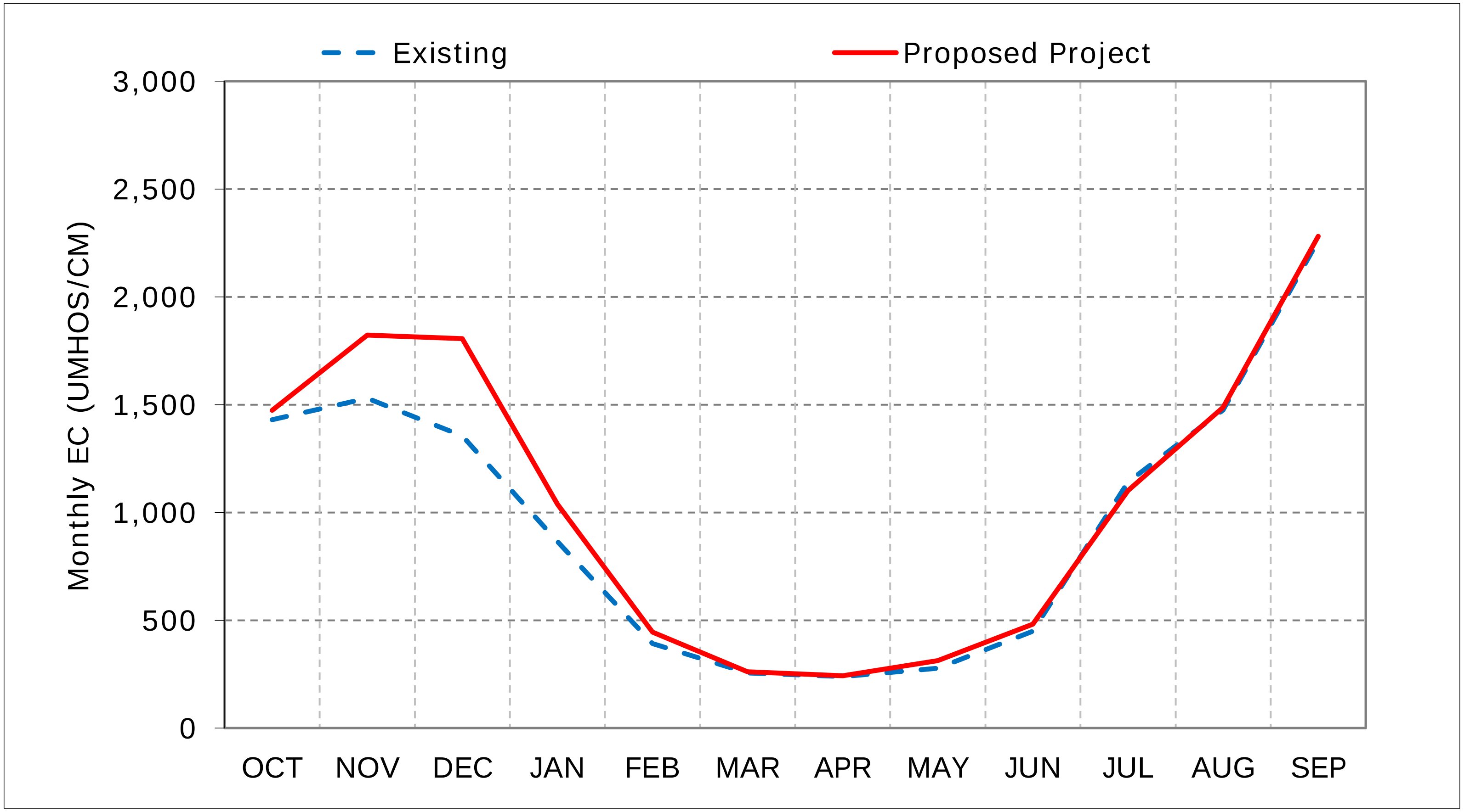
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 12-4. San Joaquin River at Jersey Point Salinity, Below Normal Year Averag



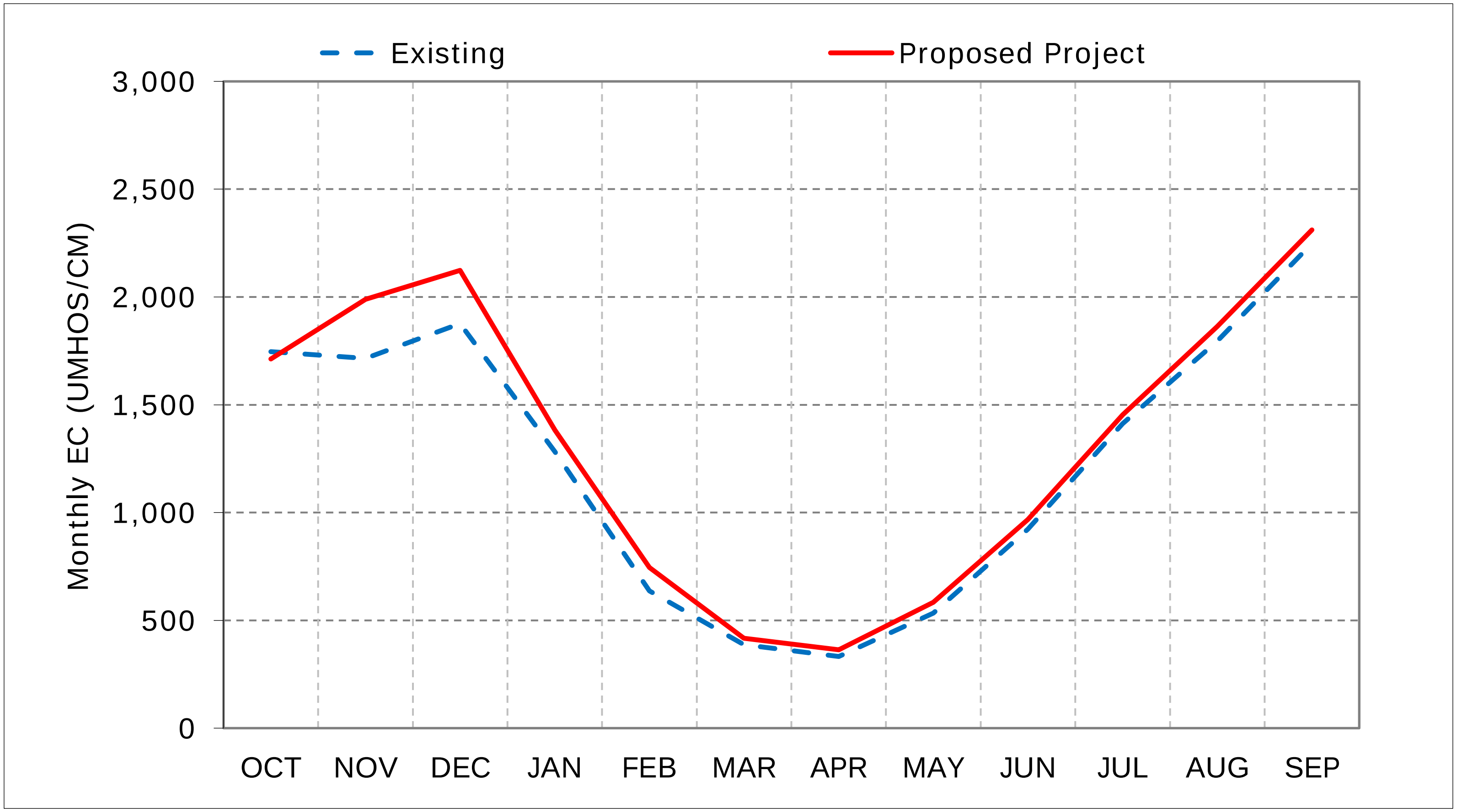
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 12-5. San Joaquin River at Jersey Point Salinity, Dry Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 12-6. San Joaquin River at Jersey Point Salinity, Critical Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 12-7. San Joaquin River at Jersey Point Salinity, January EC

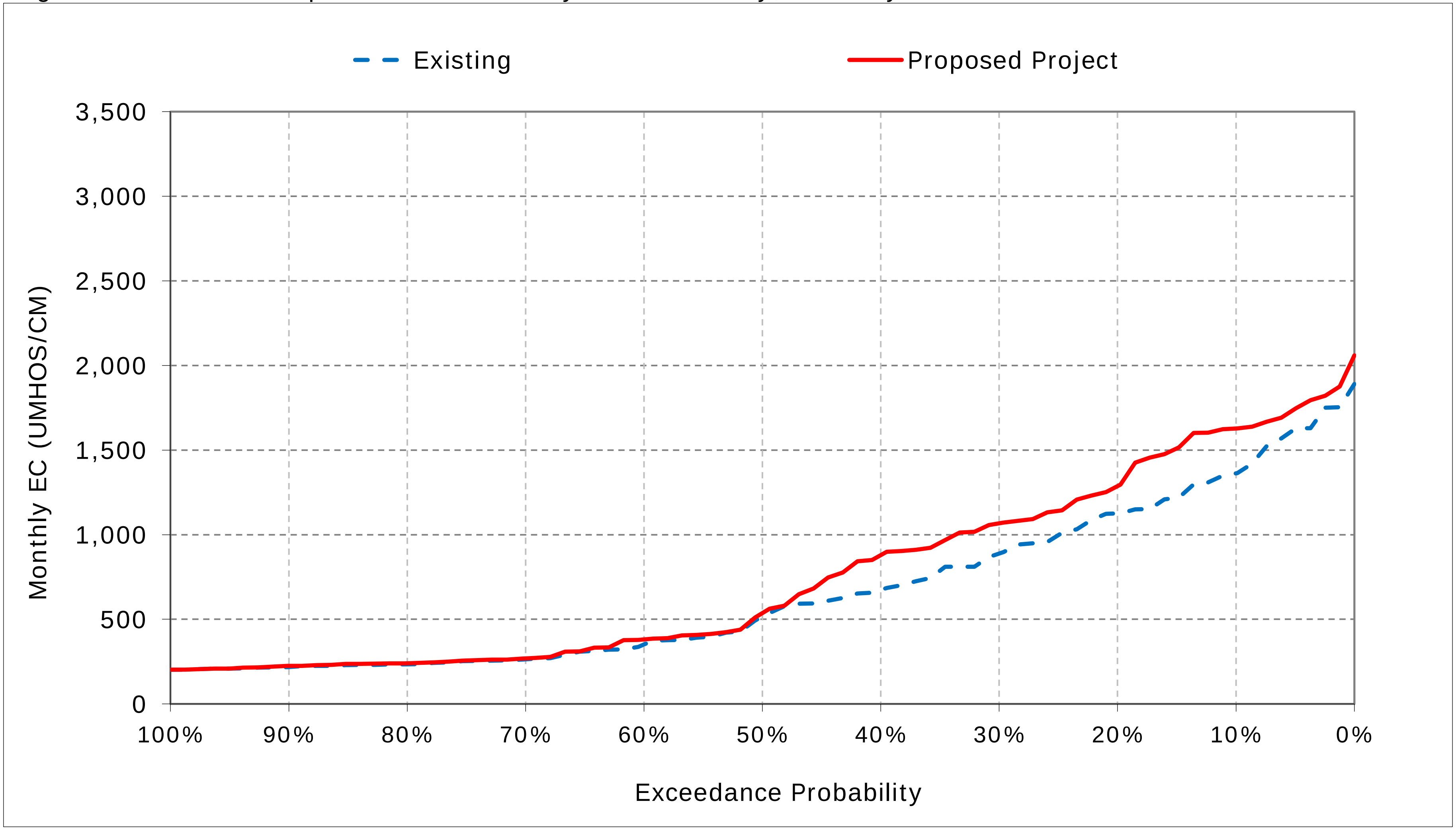


Figure 12-8. San Joaquin River at Jersey Point Salinity, February EC

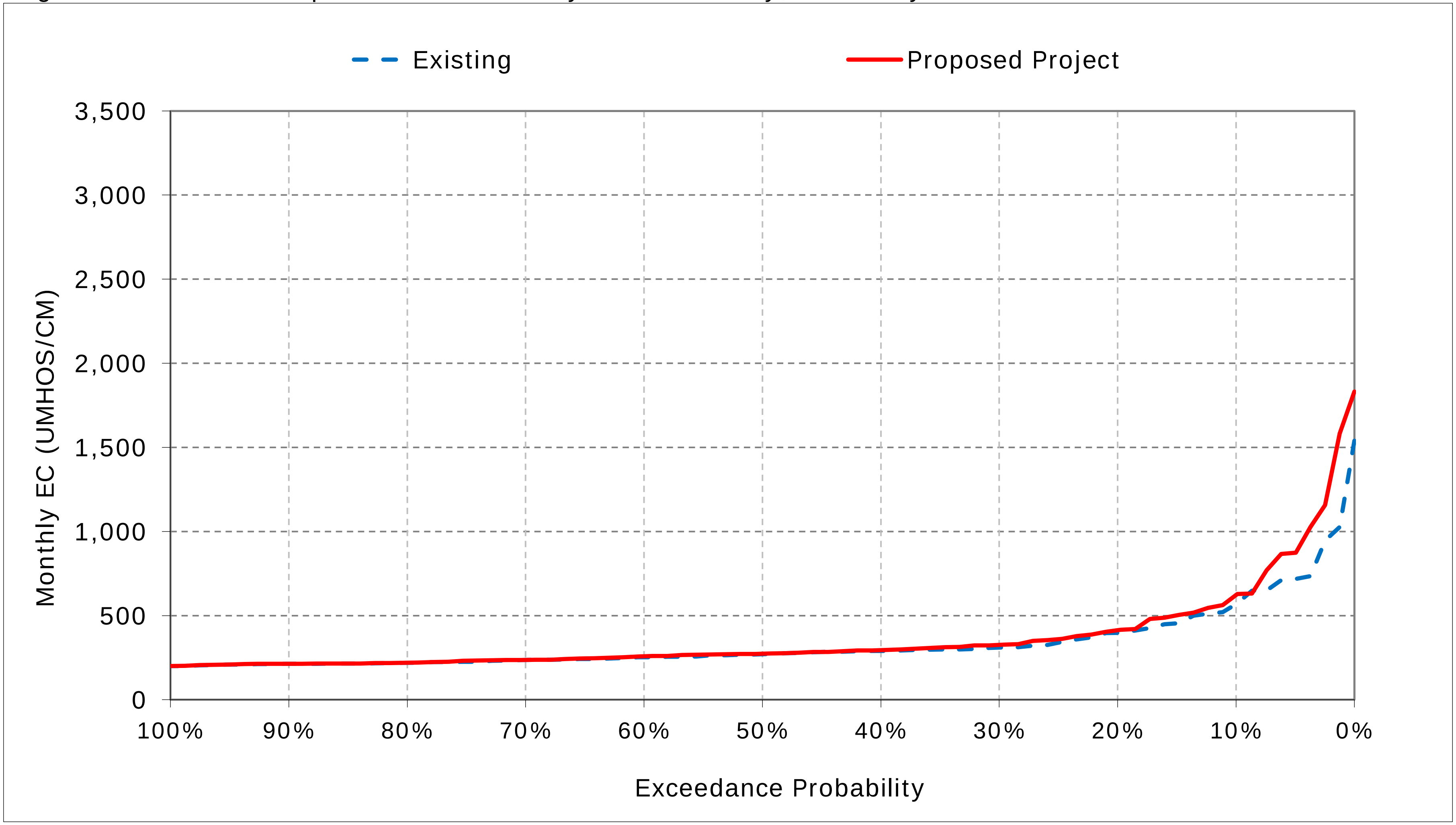


Figure 12-9. San Joaquin River at Jersey Point Salinity, March EC

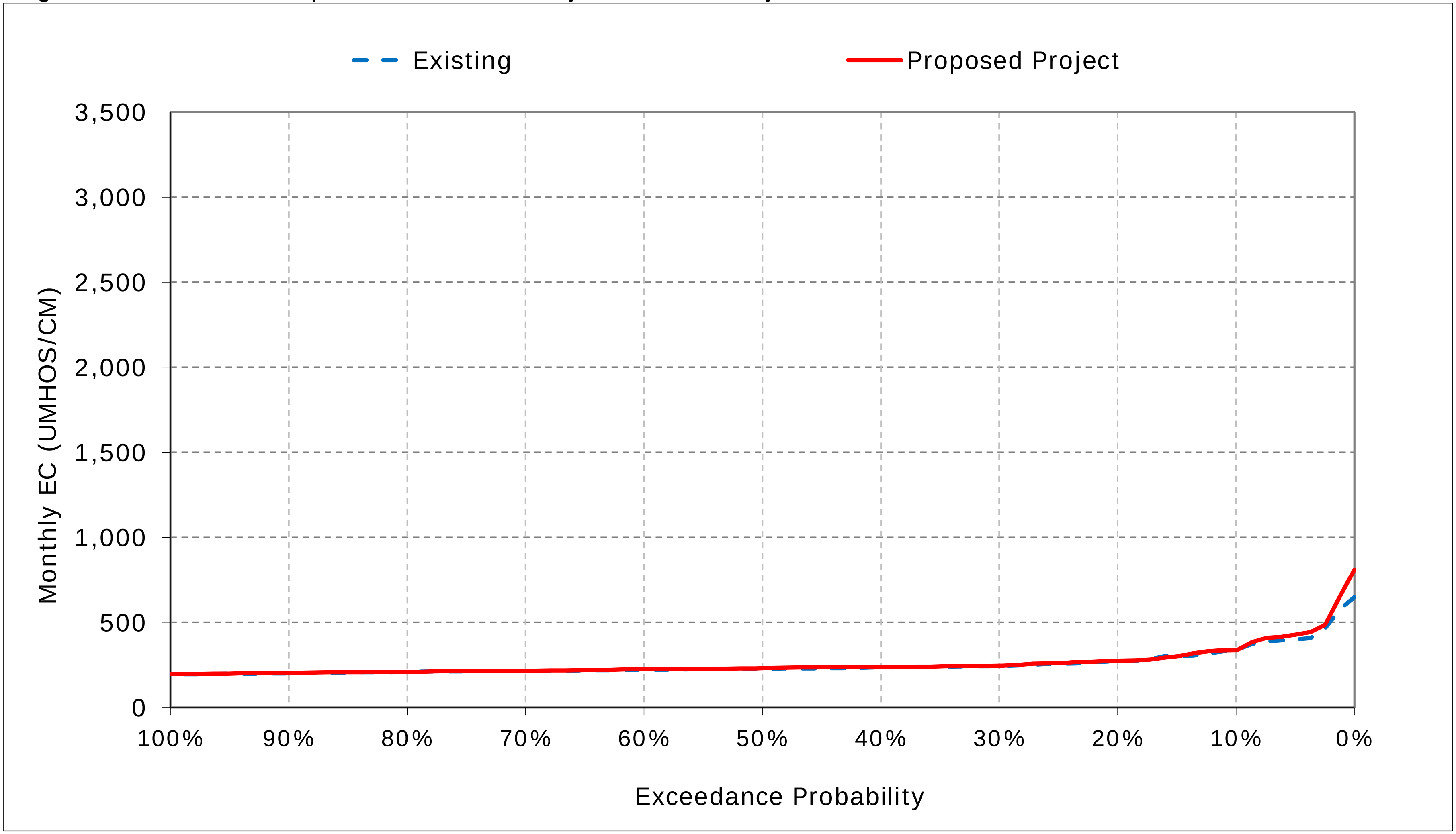


Figure 12-10. San Joaquin River at Jersey Point Salinity, April EC

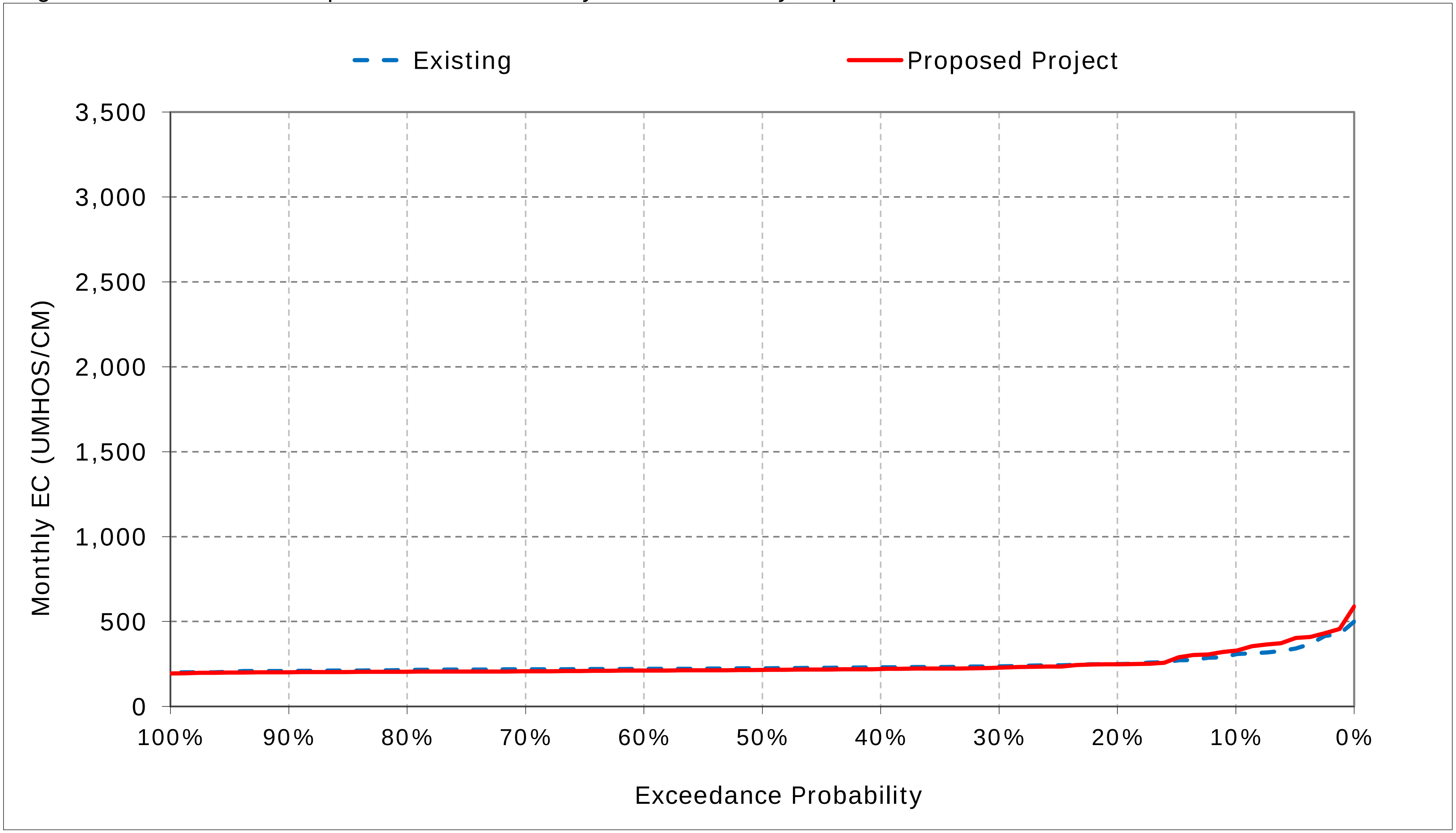


Figure 12-11. San Joaquin River at Jersey Point Salinity, May EC

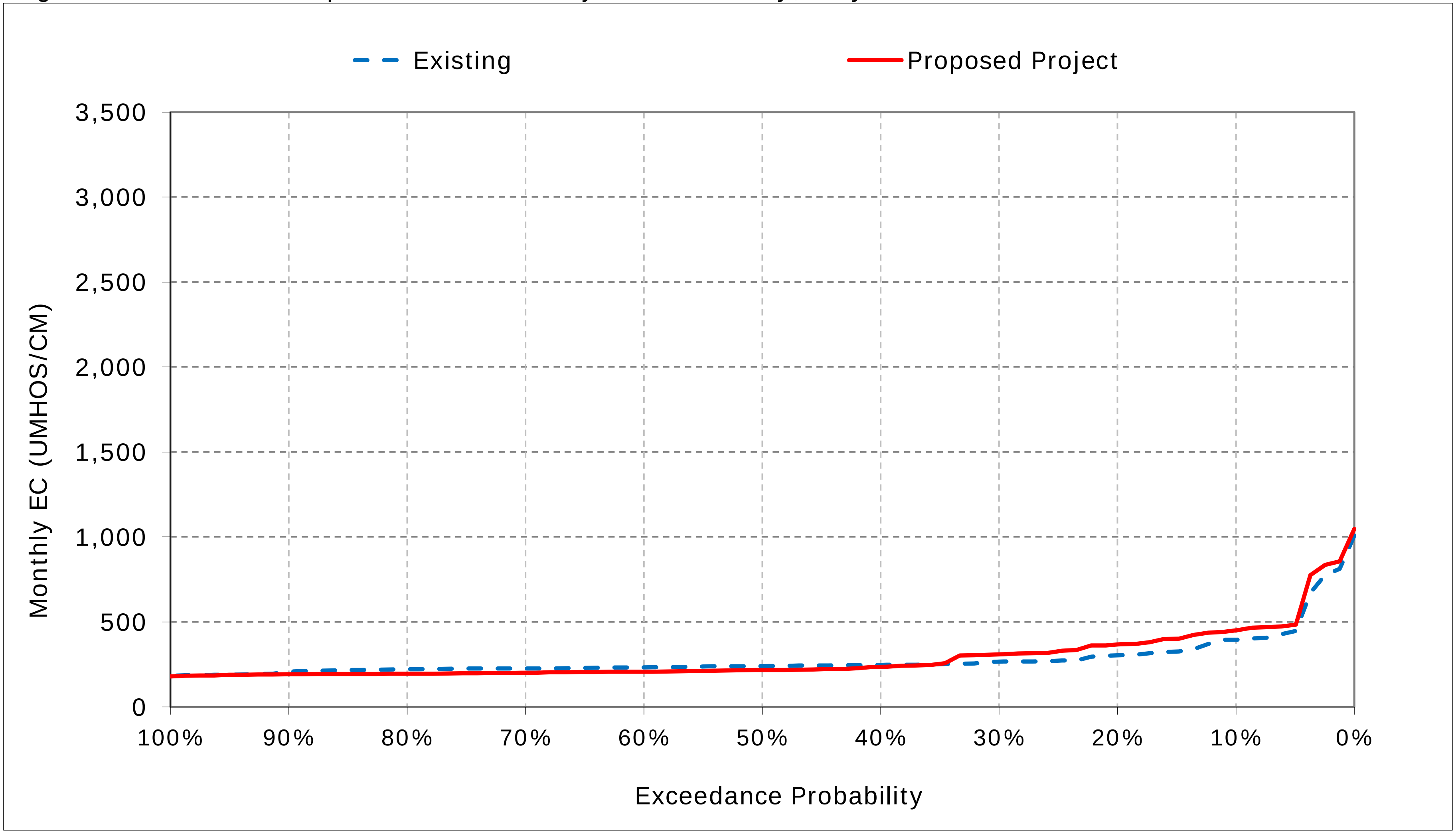


Figure 12-12. San Joaquin River at Jersey Point Salinity, June EC

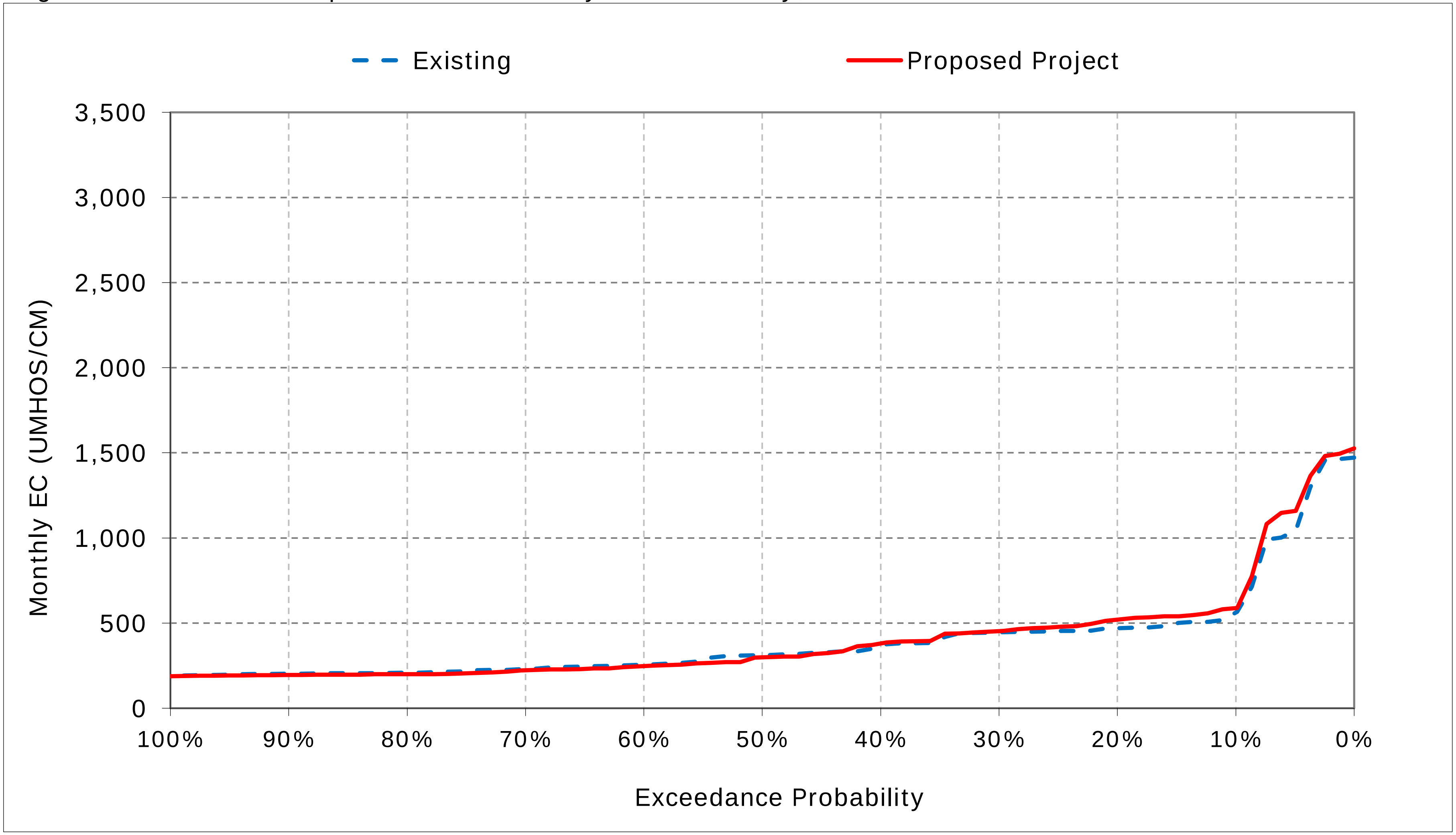


Figure 12-13. San Joaquin River at Jersey Point Salinity, July EC

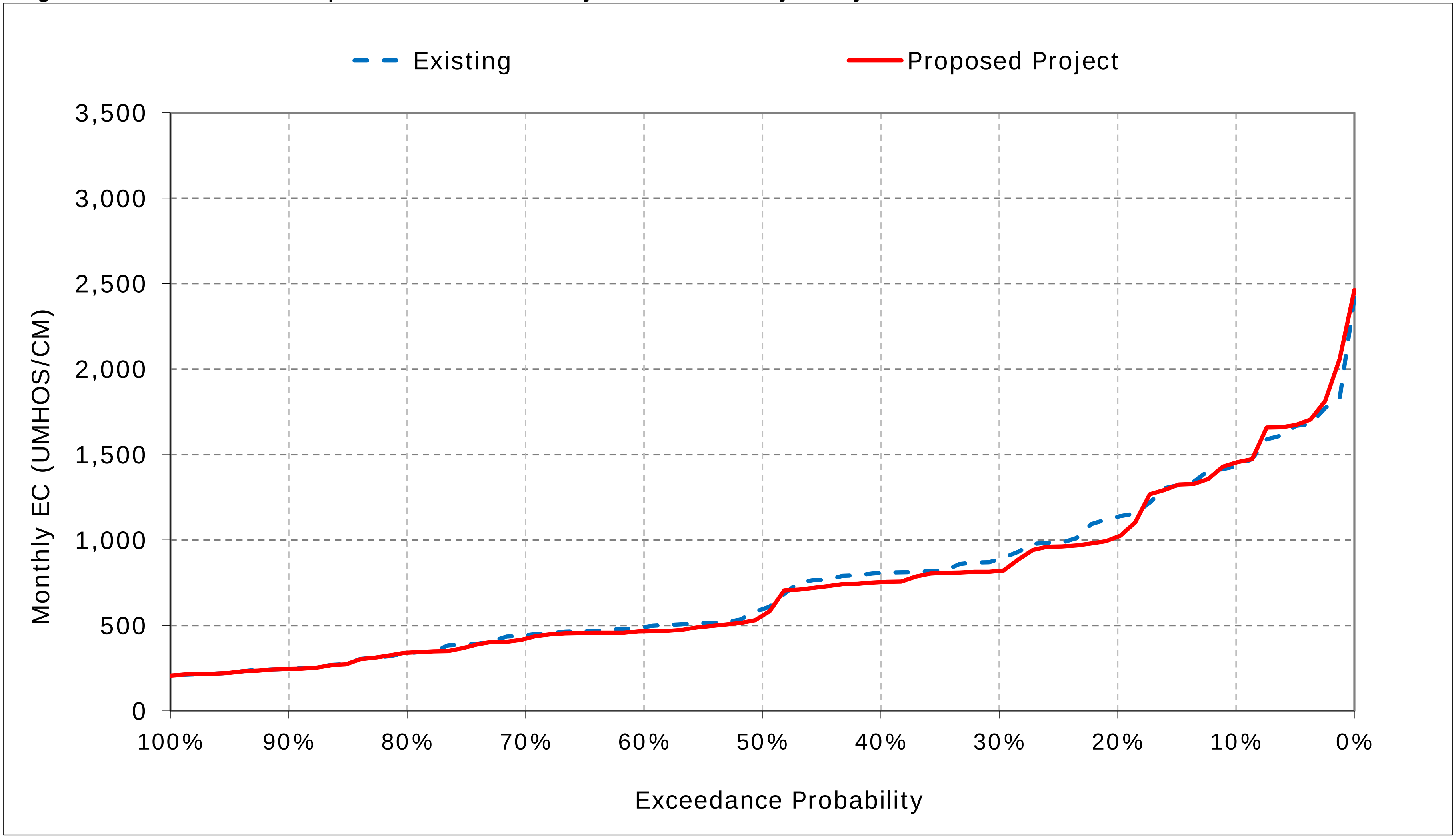


Figure 12-14. San Joaquin River at Jersey Point Salinity, August EC

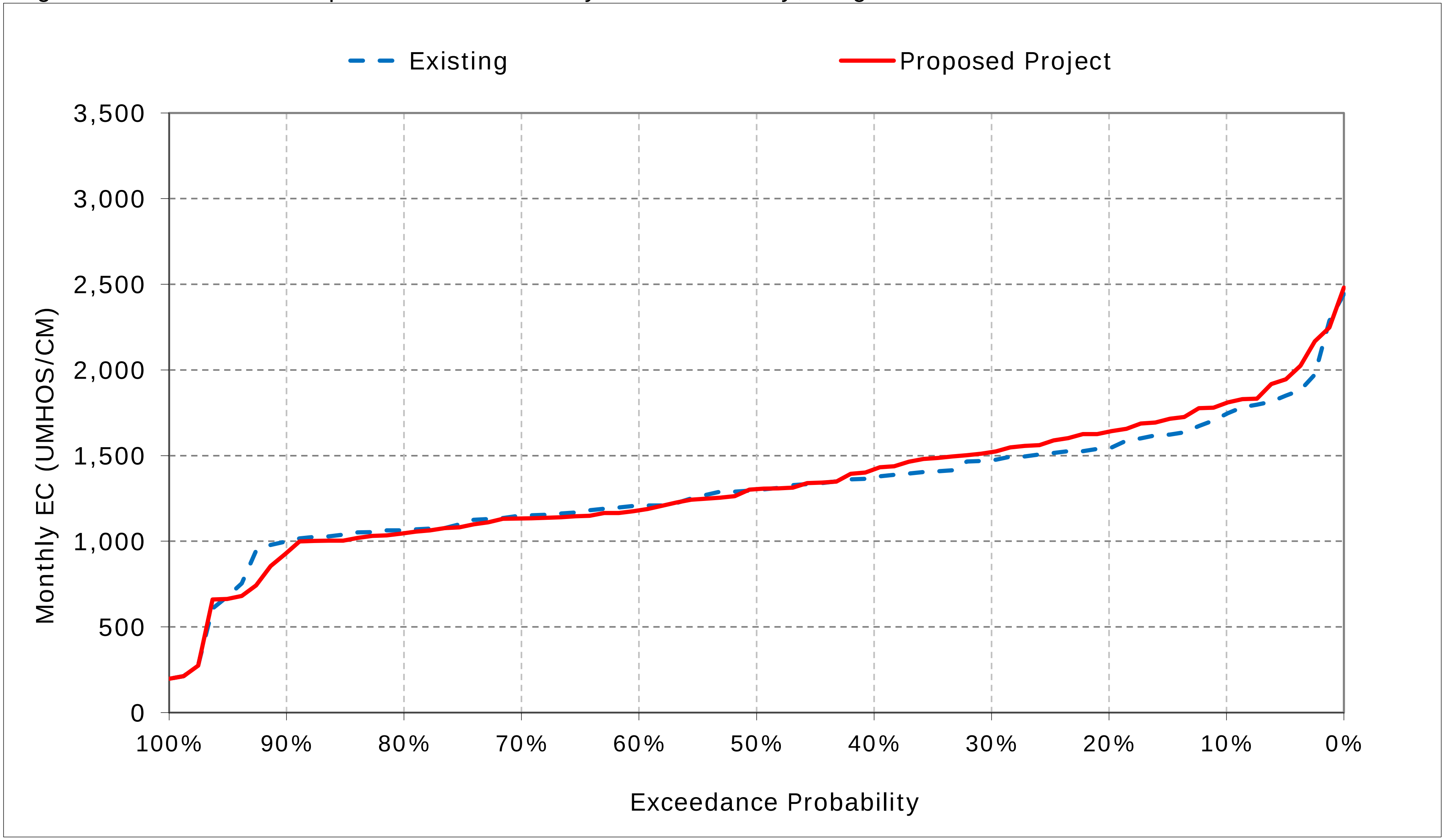


Figure 12-15. San Joaquin River at Jersey Point Salinity, September EC

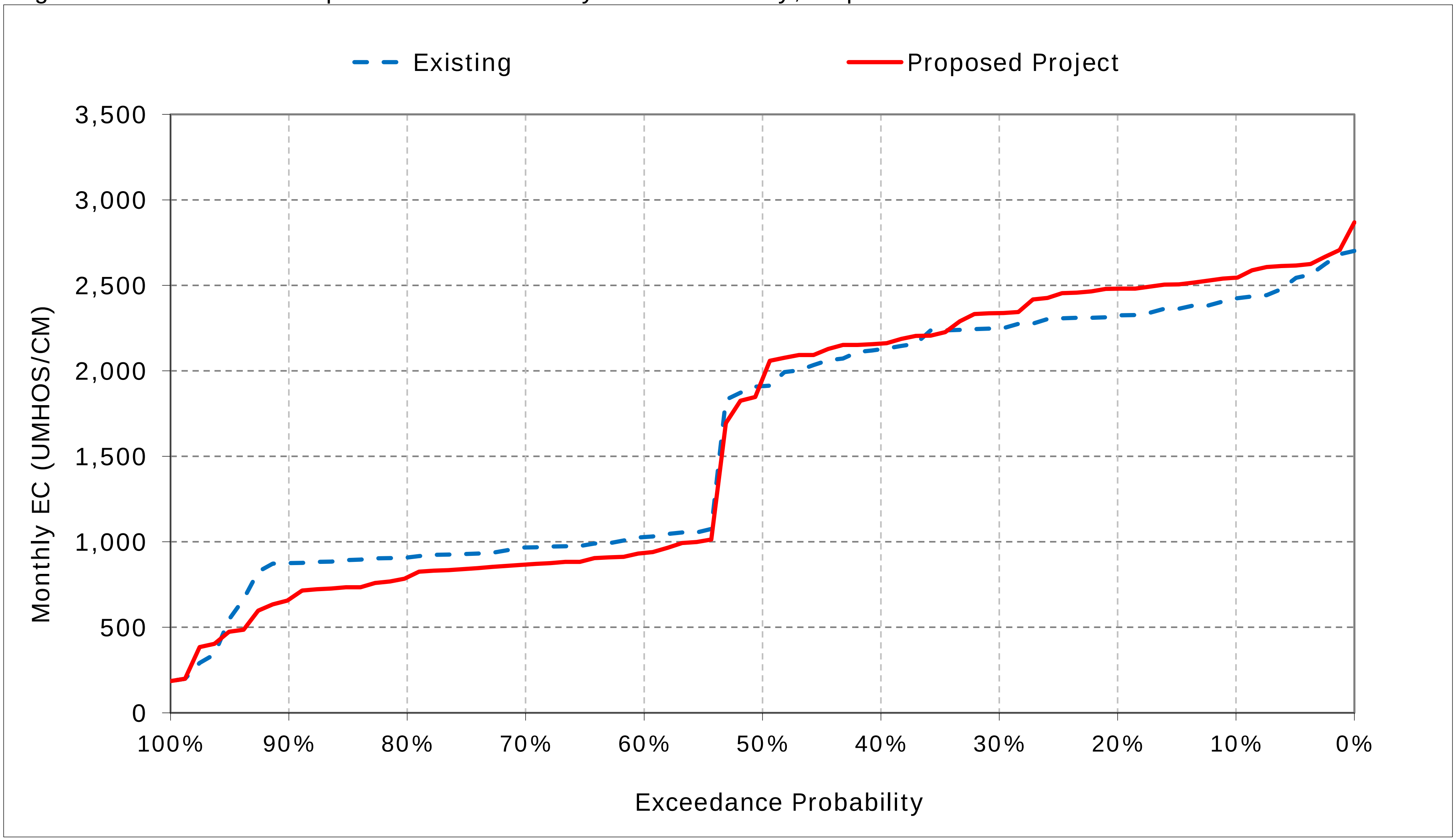


Figure 12-16. San Joaquin River at Jersey Point Salinity, October EC

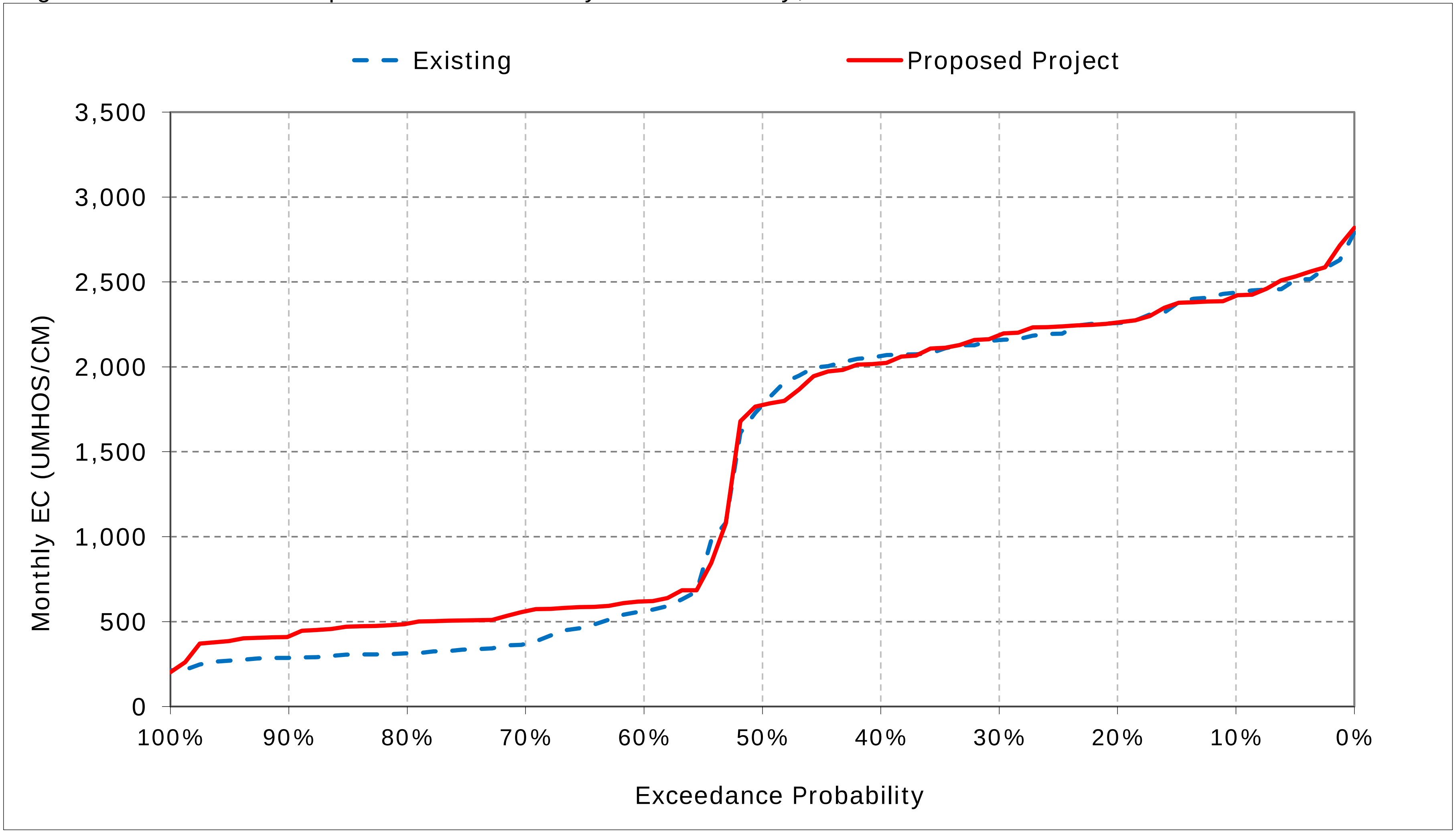


Figure 12-17. San Joaquin River at Jersey Point Salinity, November EC

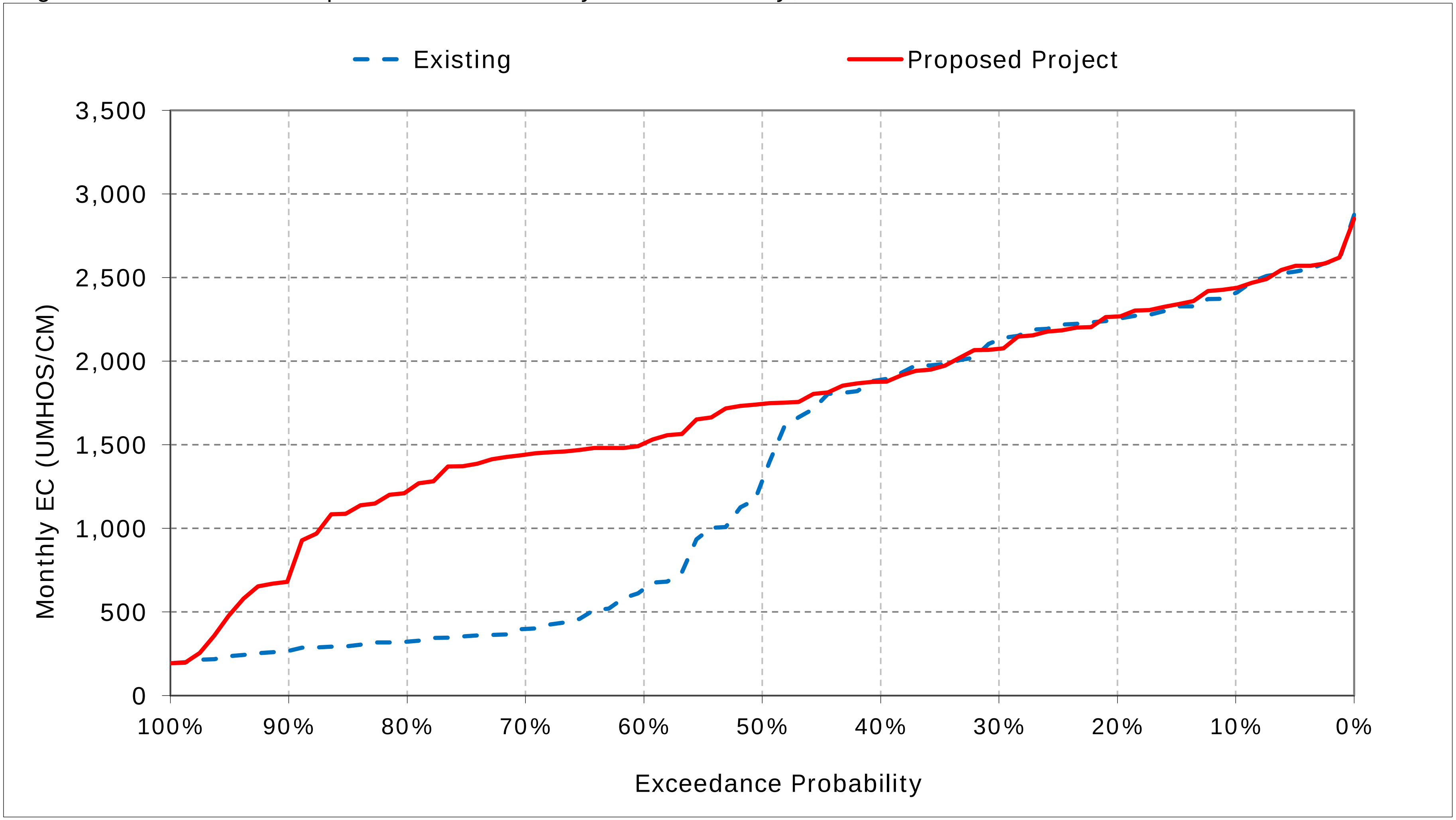


Figure 12-18. San Joaquin River at Jersey Point Salinity, December EC

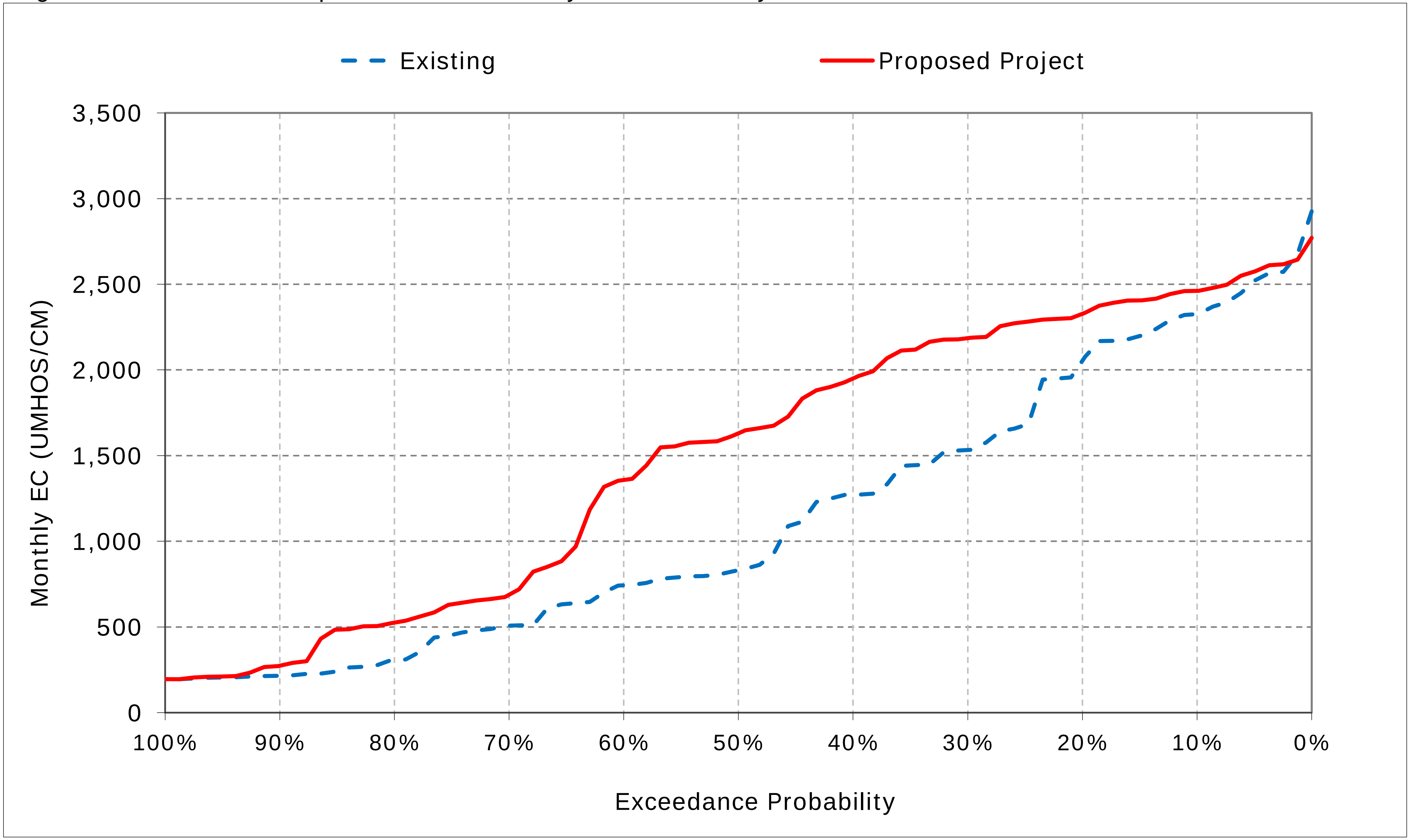


Table 13-1. San Joaquin River at San Andreas, Monthly EC

Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	652	638	694	569	318	233	241	246	236	360	470	586
20%	584	586	652	496	274	227	232	241	219	301	424	567
30%	564	560	581	414	245	217	226	237	215	267	391	539
40%	544	523	470	362	232	211	222	232	210	255	359	516
50%	500	422	322	308	227	206	217	224	206	220	341	470
60%	219	258	290	258	219	202	212	217	202	210	322	411
70%	213	215	263	230	208	197	208	214	194	204	292	372
80%	207	204	223	212	199	194	205	203	192	197	284	304
90%	203	198	195	202	195	191	192	185	188	193	272	272
Long Term												
Full Simulation Period[a]	410	409	419	353	244	212	218	225	217	259	351	448
Water Year Types[b]												
Wet (32%)	340	325	268	226	205	198	202	201	193	198	276	349
Above Normal (15%)	448	408	416	307	225	203	213	217	202	206	295	282
Below Normal (17%)	412	428	482	384	235	212	223	228	205	244	355	532
Dry (22%)	424	453	472	411	261	214	228	235	216	306	412	527
Critical (15%)	498	499	593	551	331	250	235	265	303	389	478	609

Proposed Project

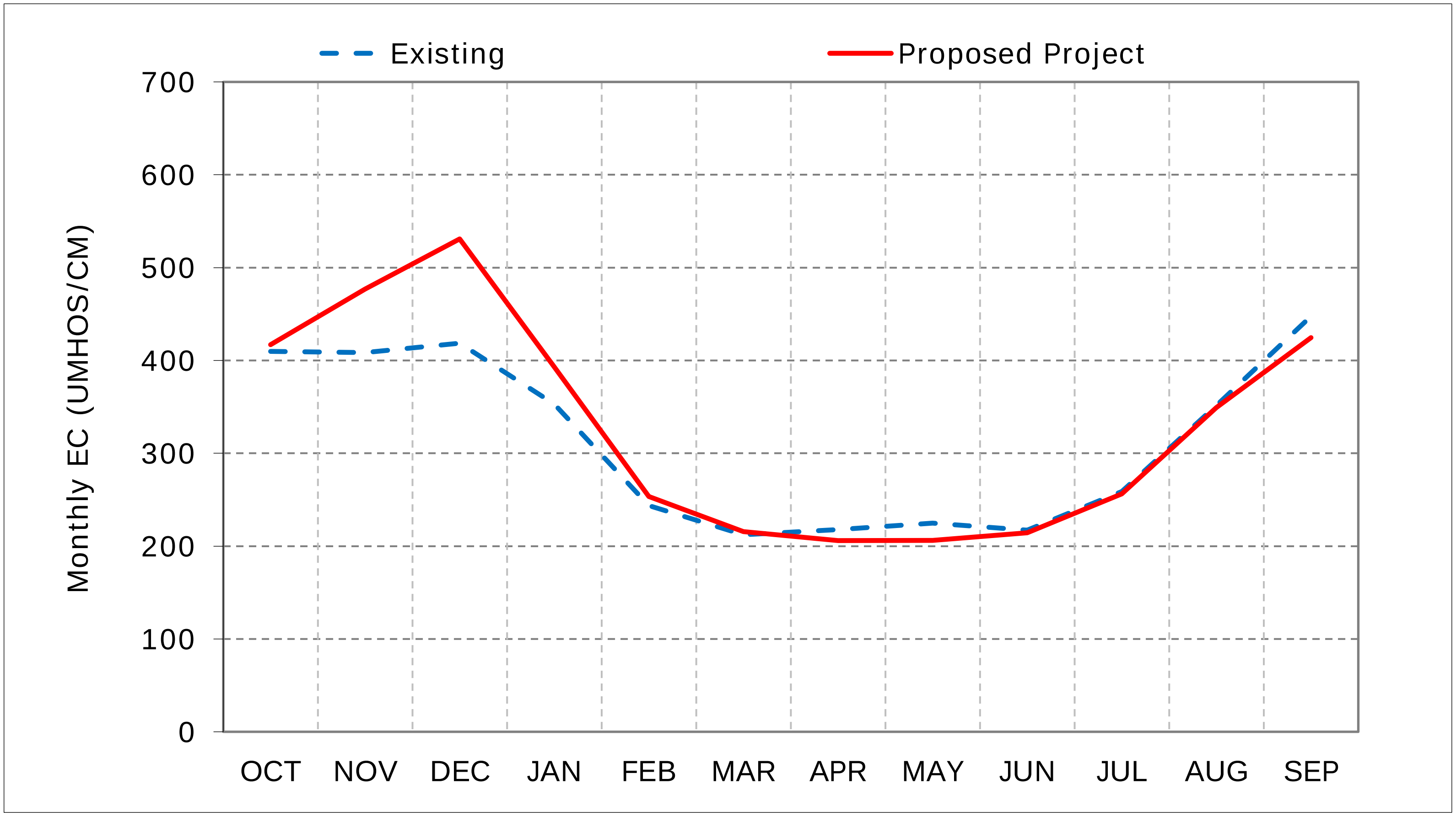
Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	638	664	756	681	338	235	224	231	239	364	465	620
20%	608	613	710	566	278	228	219	220	218	289	418	585
30%	575	572	695	502	250	219	212	211	213	264	386	566
40%	548	532	637	433	233	214	205	204	204	241	366	523
50%	527	491	608	309	229	208	203	200	195	217	336	476
60%	240	410	545	259	221	203	199	193	192	208	313	284
70%	218	375	337	232	208	199	196	190	189	202	289	268
80%	210	338	283	213	201	196	193	185	188	198	281	260
90%	201	278	209	202	195	193	188	179	185	193	256	246
Long Term												
Full Simulation Period[a]	417	477	531	393	253	216	206	206	214	256	349	425
Water Year Types[b]												
Wet (32%)	348	408	344	235	205	199	193	186	189	198	268	248
Above Normal (15%)	455	502	587	365	230	206	199	192	193	204	295	271
Below Normal (17%)	420	489	599	421	235	213	206	201	197	232	358	572
Dry (22%)	429	504	611	487	278	218	211	212	214	300	406	534
Critical (15%)	505	548	679	589	367	261	234	261	310	397	483	625

Proposed Project minus Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	-14	26	62	112	21	2	-18	-16	3	4	-4	34
20%	23	27	58	70	4	1	-14	-21	0	-11	-6	18
30%	11	12	114	88	5	2	-15	-27	-2	-3	-5	27
40%	4	9	167	72	2	3	-16	-28	-6	-14	7	7
50%	27	69	286	1	2	2	-14	-23	-11	-3	-5	6
60%	20	152	254	1	2	1	-13	-24	-10	-2	-9	-126
70%	5	161	74	2	0	3	-12	-25	-4	-2	-3	-104
80%	3	134	60	0	2	2	-11	-19	-5	0	-4	-44
90%	-2	80	14	0	0	2	-4	-5	-4	0	-16	-26
Long Term												
Full Simulation Period[a]	7	68	112	40	10	4	-12	-19	-3	-3	-2	-23
Water Year Types[b]												
Wet (32%)	8	82	76	9	0	1	-9	-15	-3	0	-7	-101
Above Normal (15%)	7	94	172	58	4	3	-15	-24	-9	-1	1	-11
Below Normal (17%)	8	60	116	37	0	1	-17	-28	-7	-13	3	40
Dry (22%)	5	50	140	76	17	4	-17	-23	-2	-6	-6	7
Critical (15%)	6	50	86	38	36	11	-1	-4	7	7	6	15

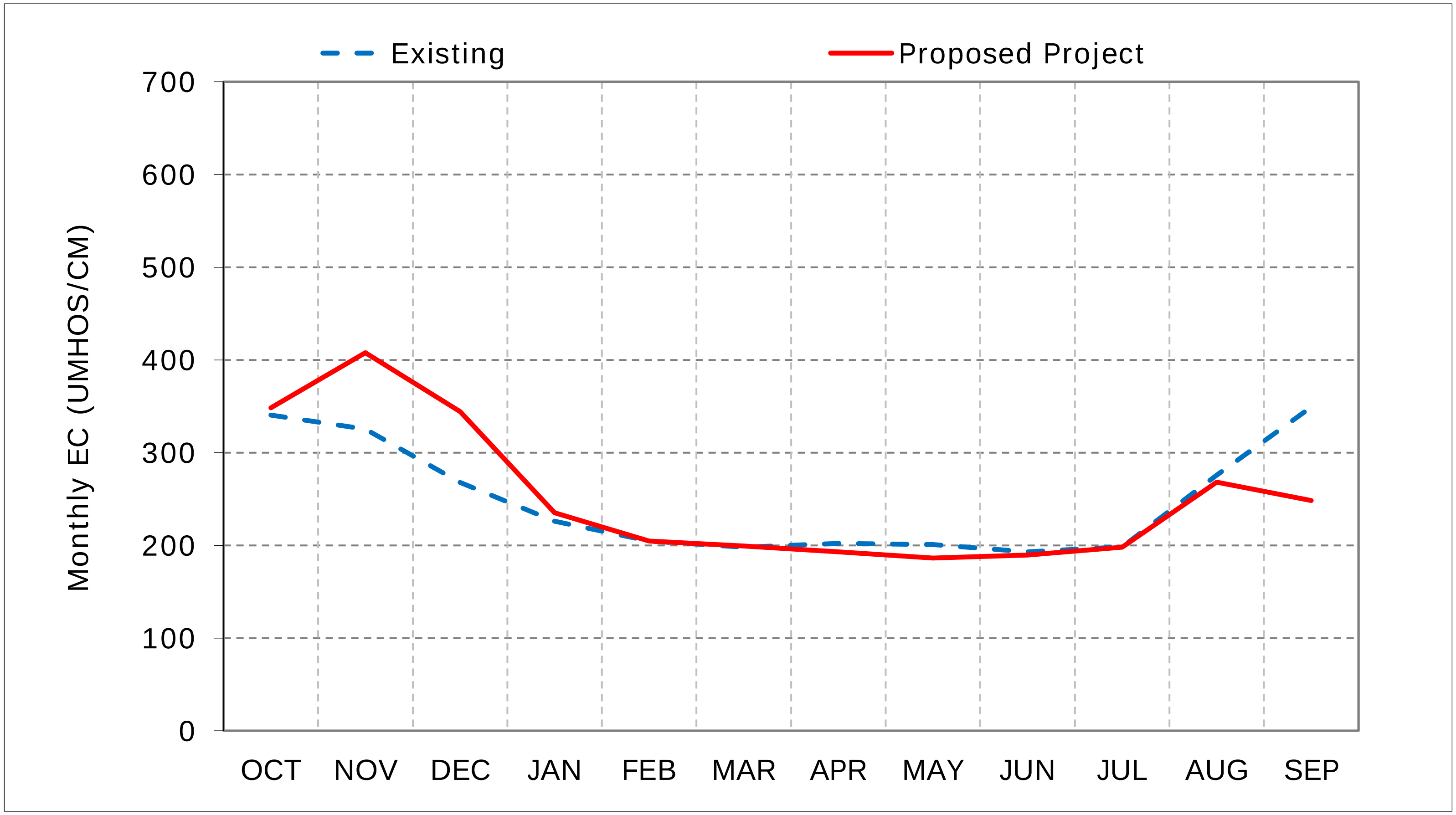
a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with water year - year type sorting.
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 13-1. San Joaquin River at San Andreas, Long-Term Average EC



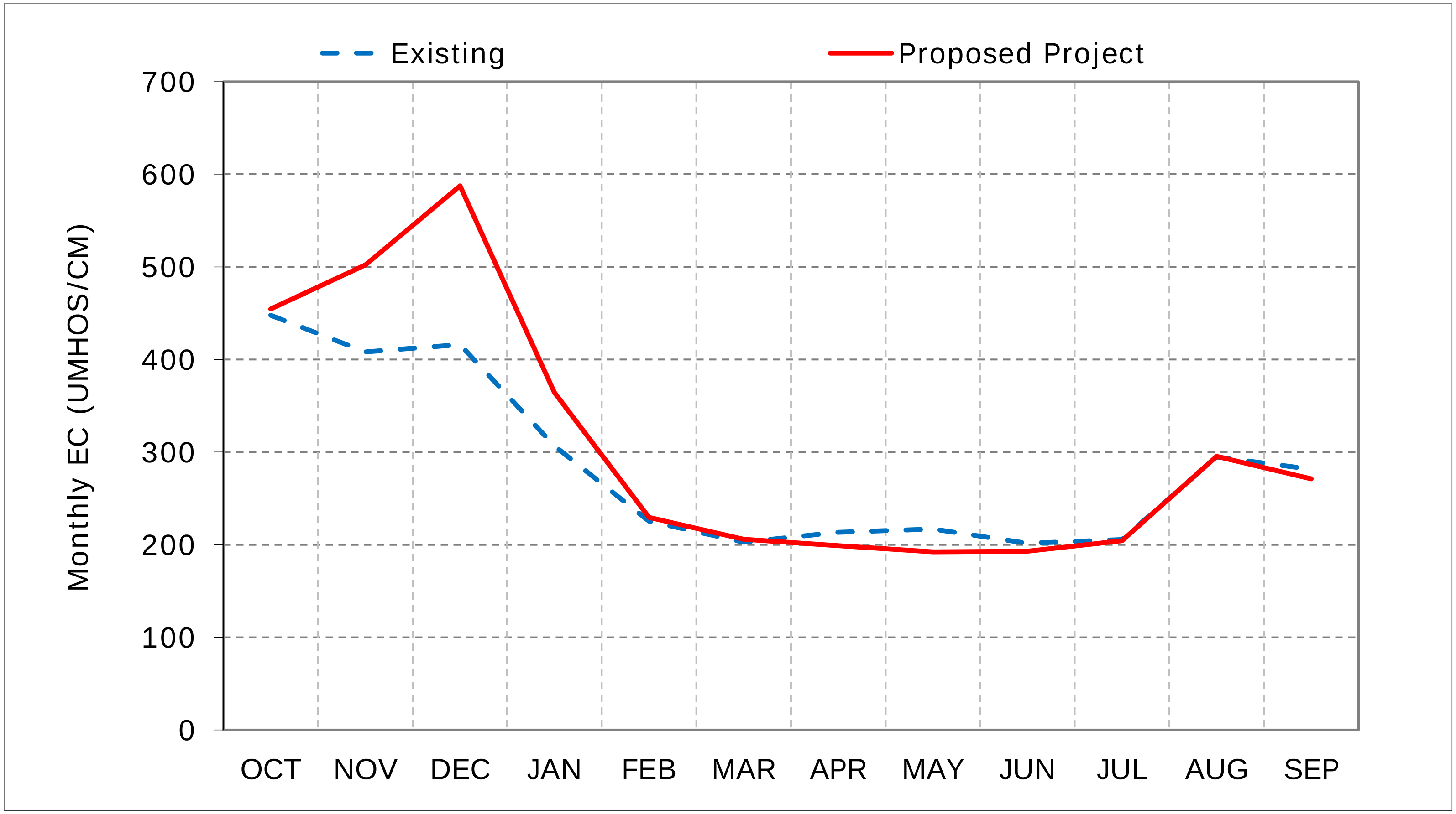
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 13-2. San Joaquin River at San Andreas, Wet Year Average EC



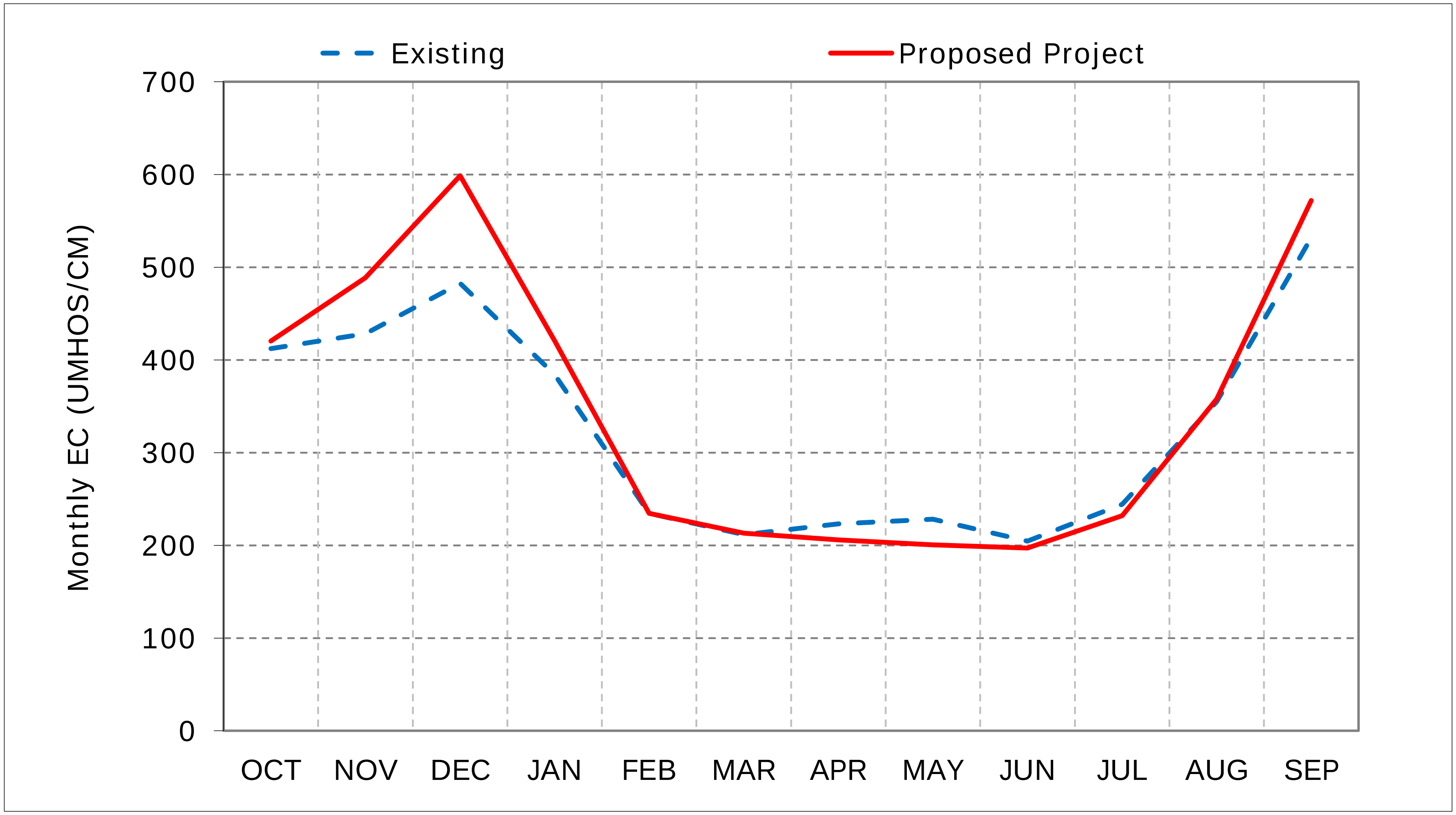
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 13-3. San Joaquin River at San Andreas, Above Normal Year Average EC



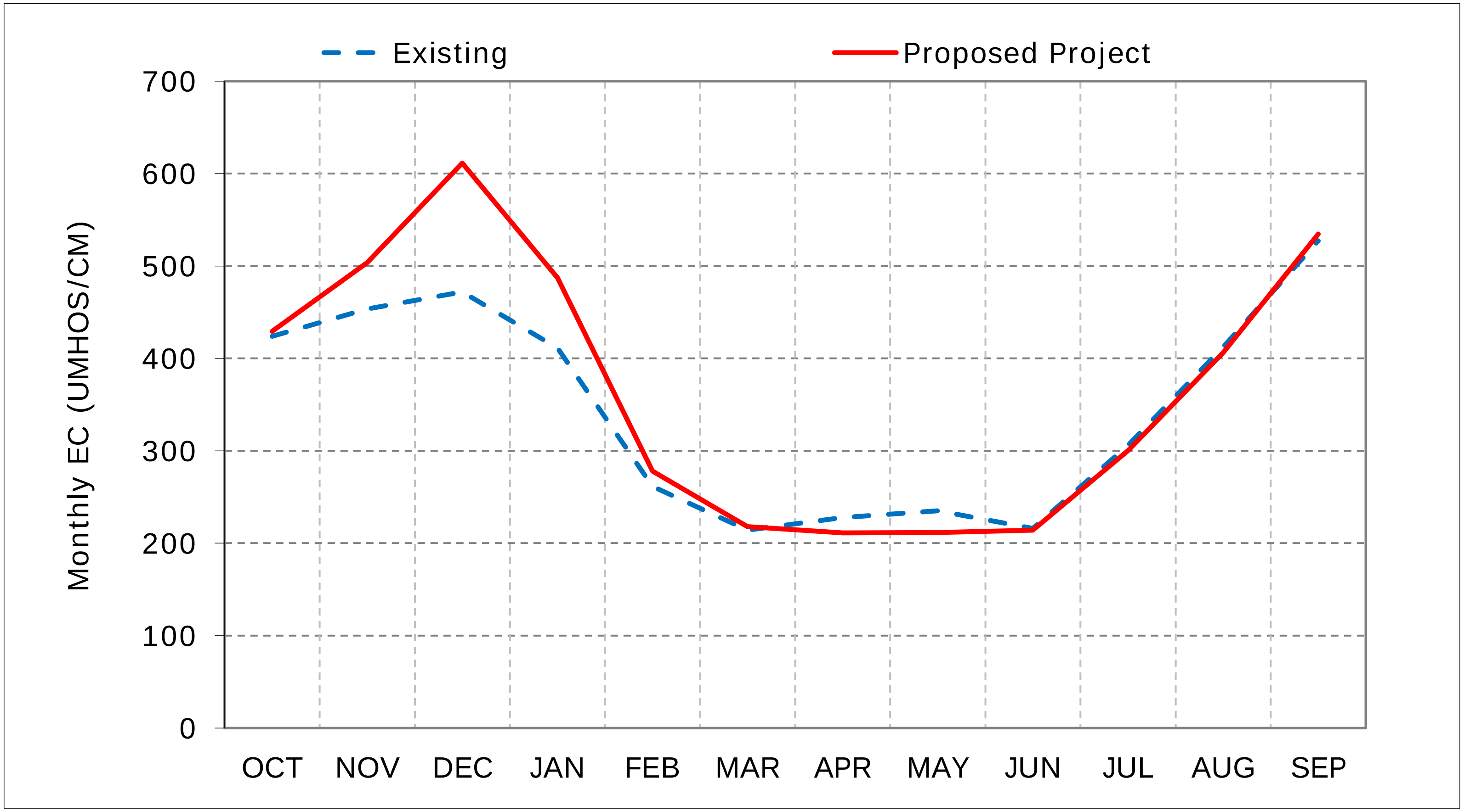
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 13-4. San Joaquin River at San Andreas, Below Normal Year Average EC



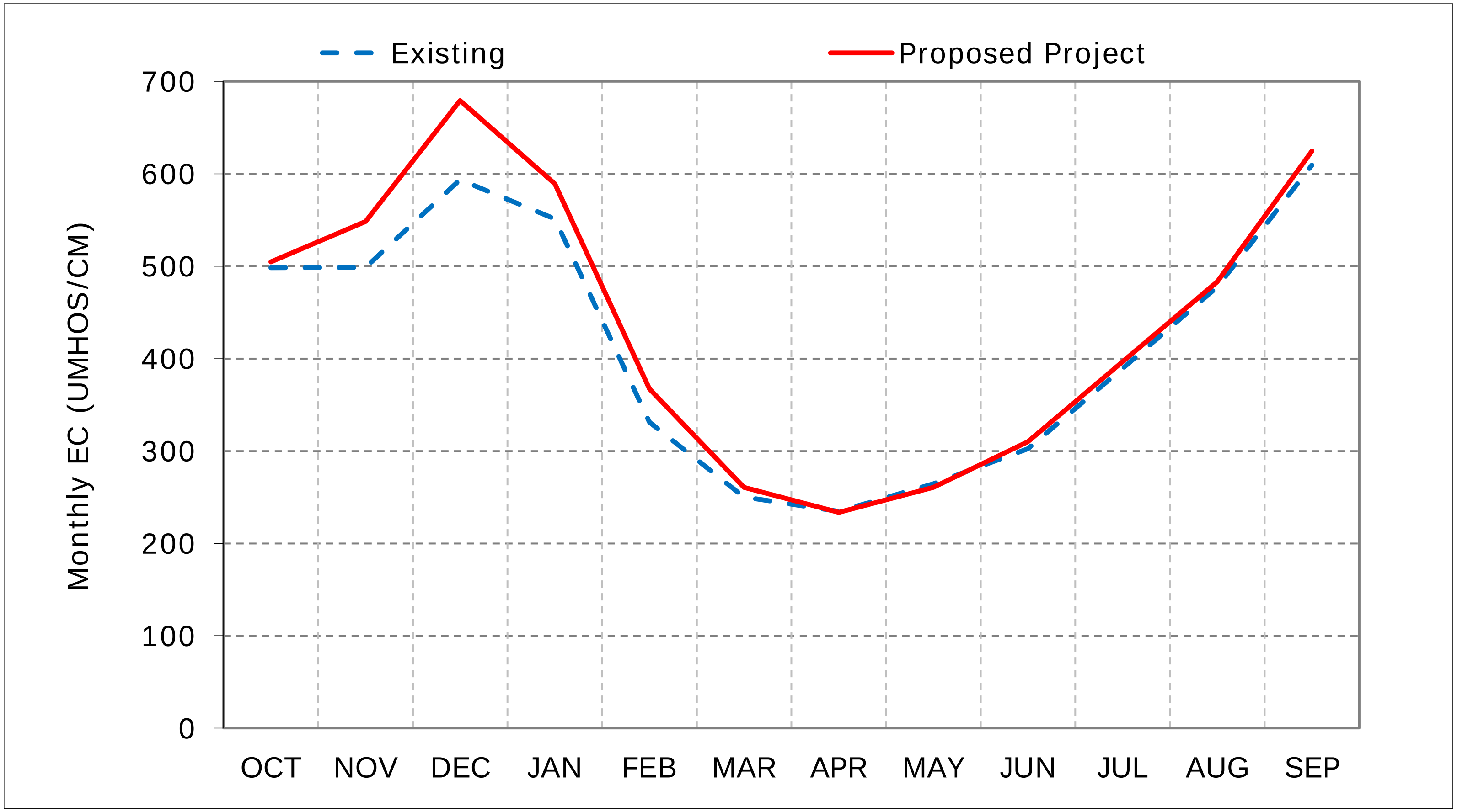
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 13-5. San Joaquin River at San Andreas, Dry Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 13-6. San Joaquin River at San Andreas, Critical Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 13-7. San Joaquin River at San Andreas, January EC

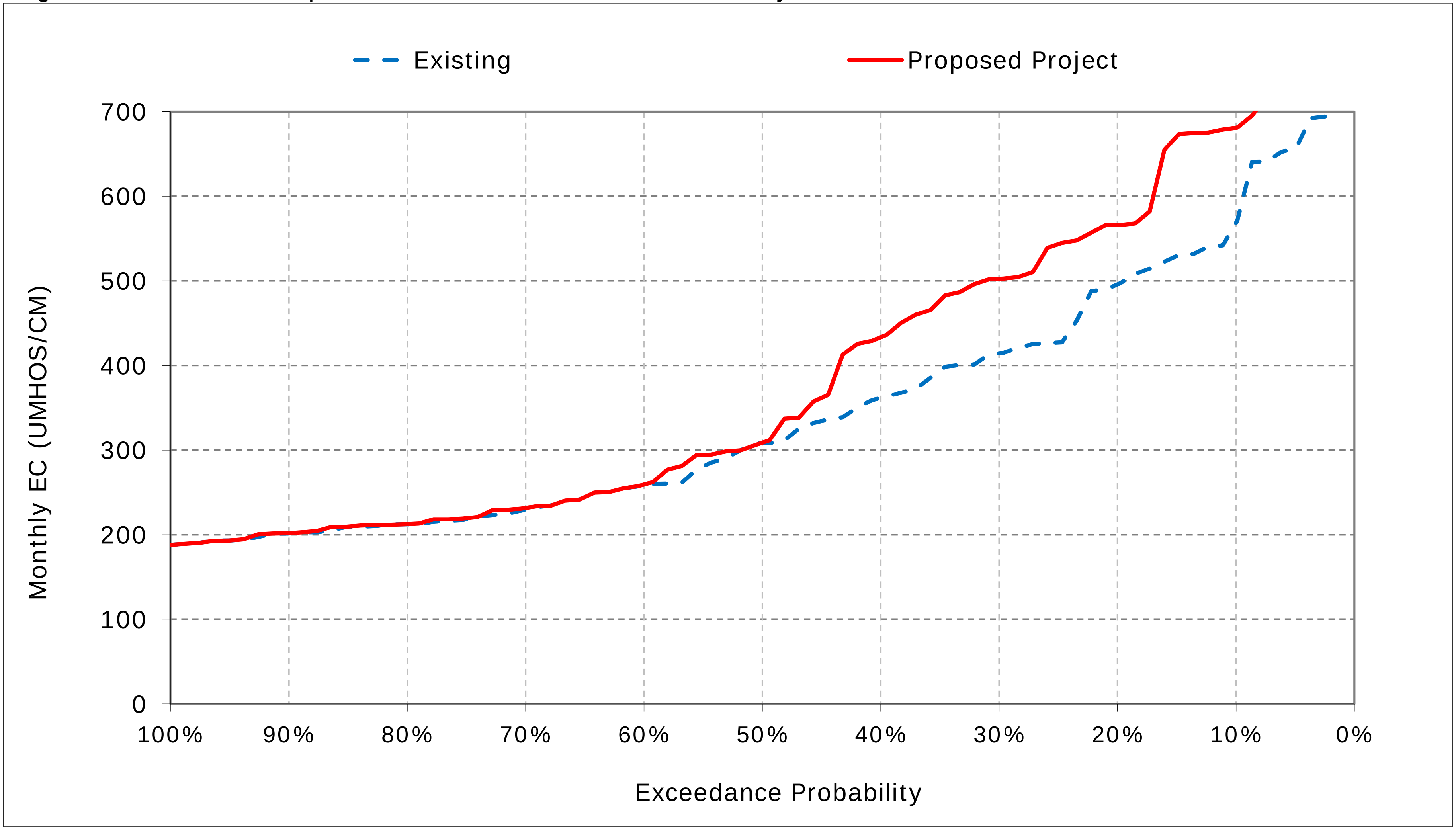


Figure 13-8. San Joaquin River at San Andreas, February EC

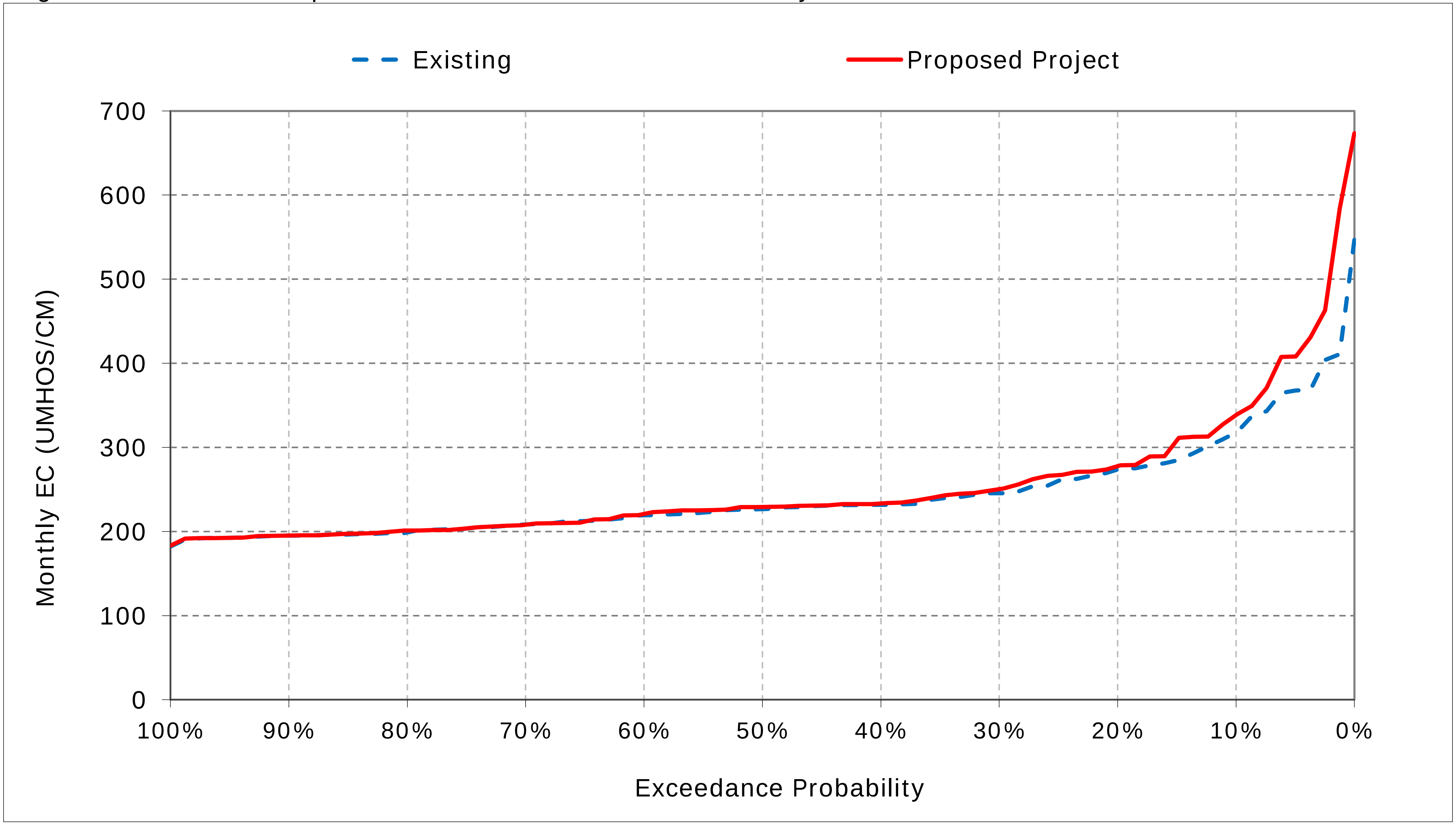


Figure 13-9. San Joaquin River at San Andreas, March EC

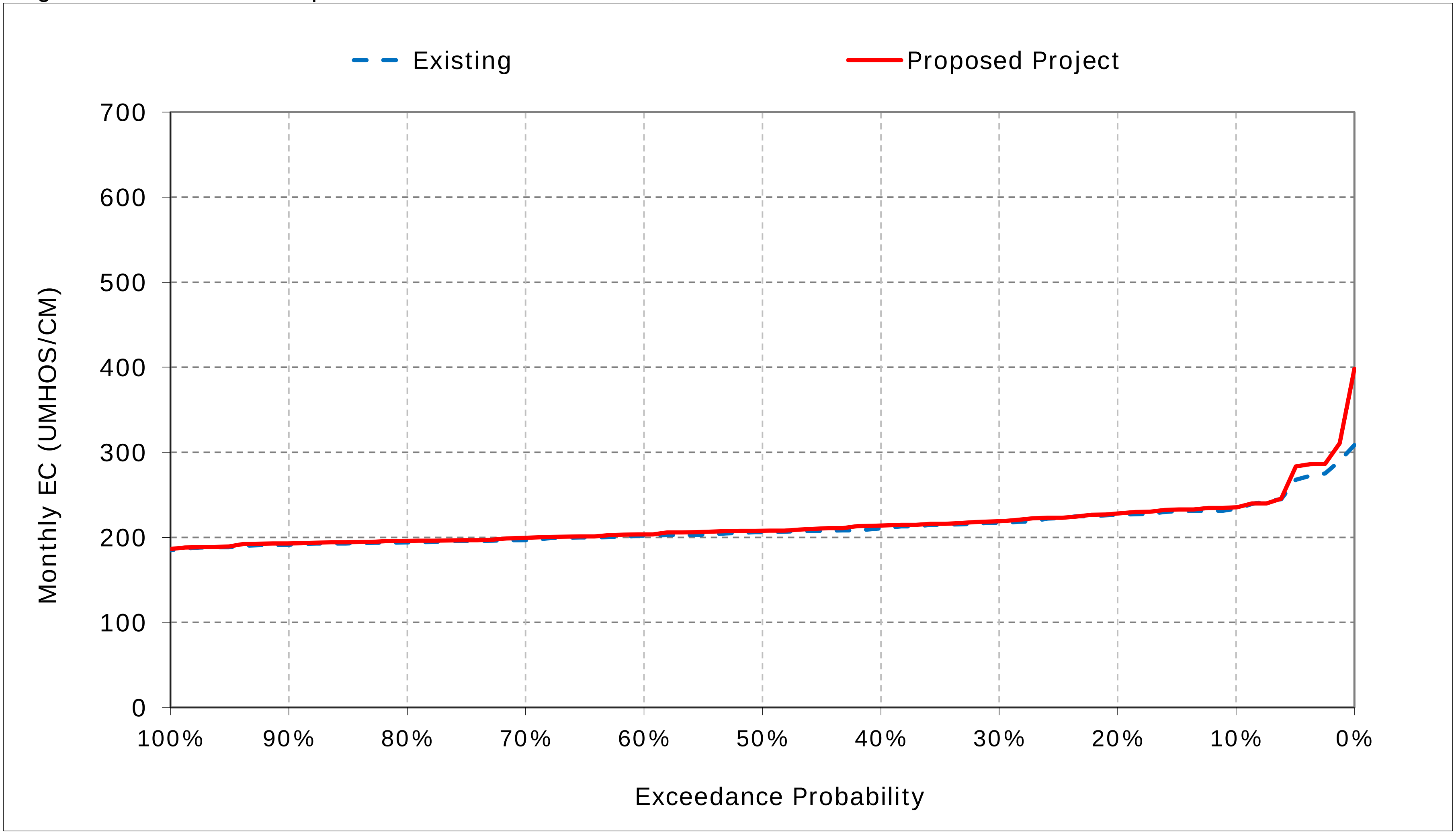


Figure 13-10. San Joaquin River at San Andreas, April EC

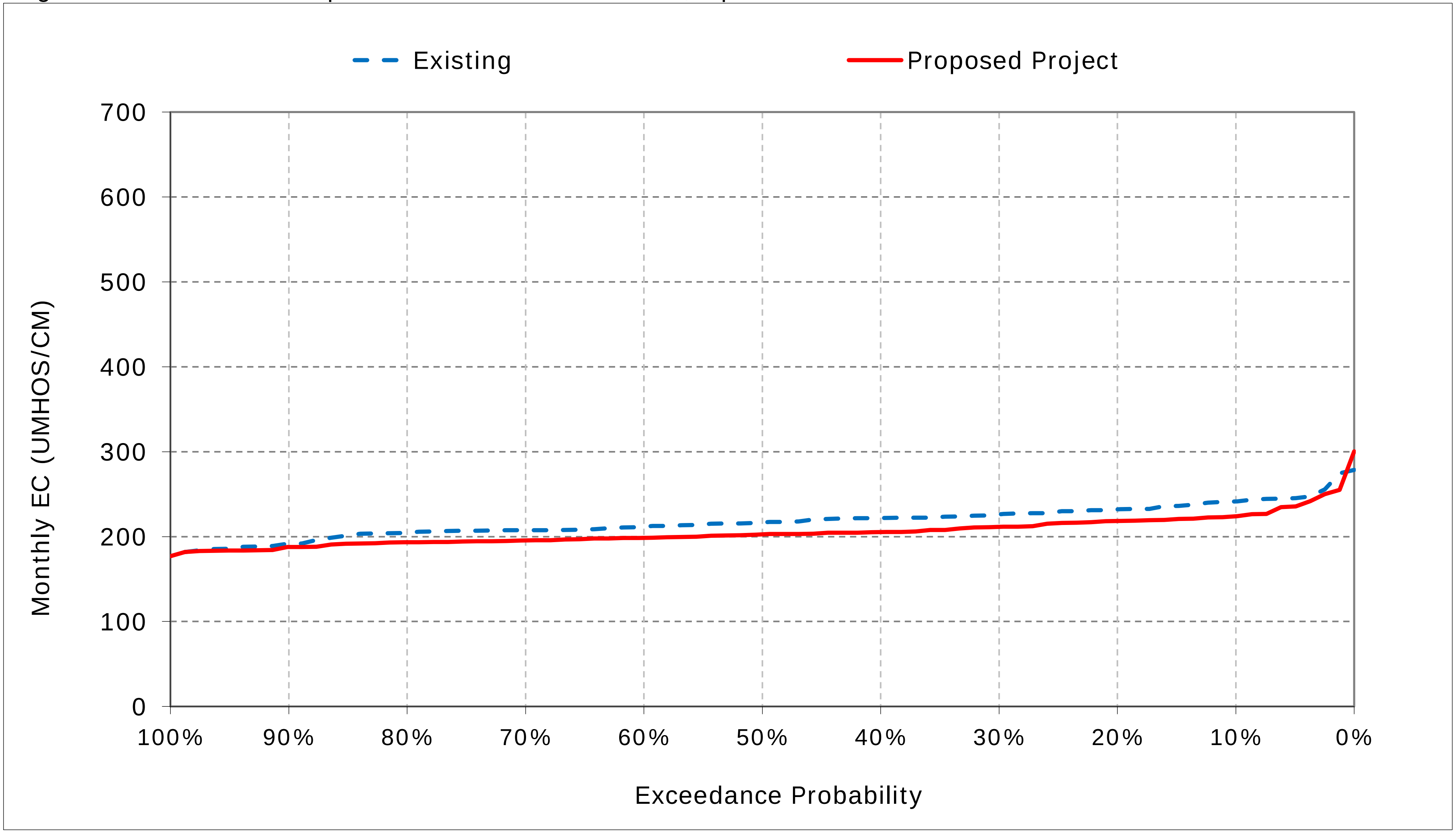


Figure 13-11. San Joaquin River at San Andreas, May EC

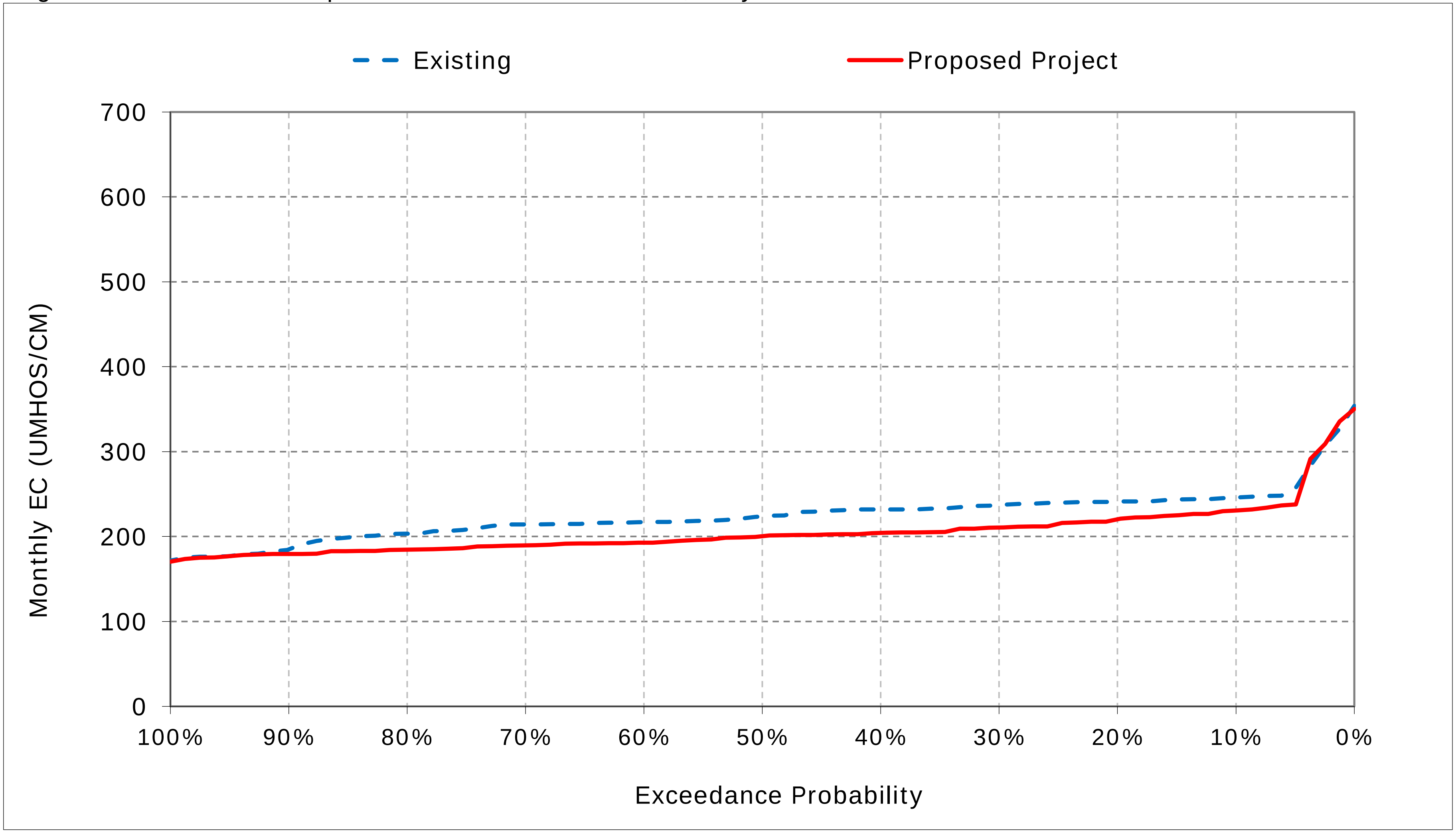


Figure 13-12. San Joaquin River at San Andreas, June EC

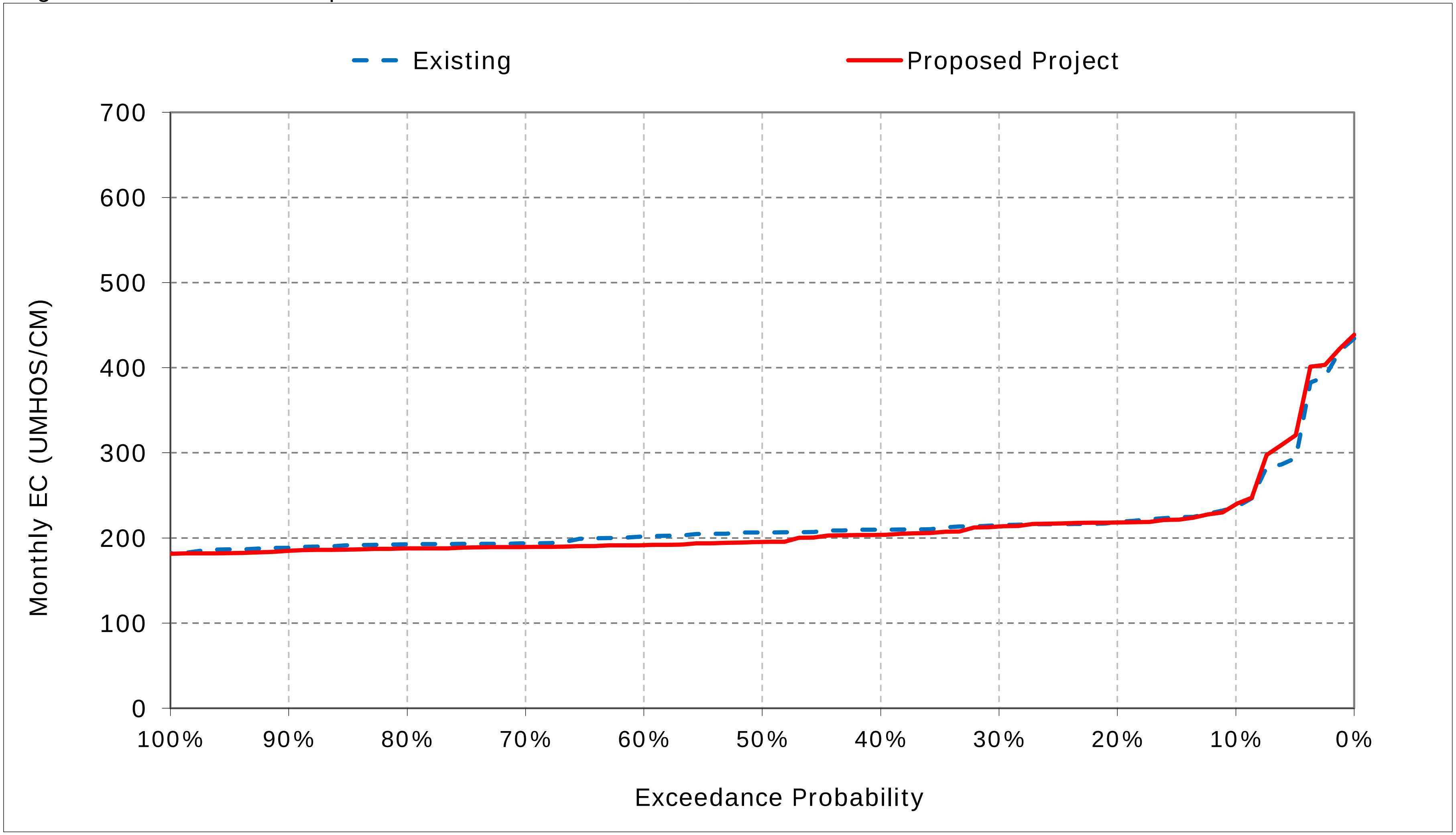


Figure 13-13. San Joaquin River at San Andreas, July EC

Figure 13-14. San Joaquin River at San Andreas, August EC

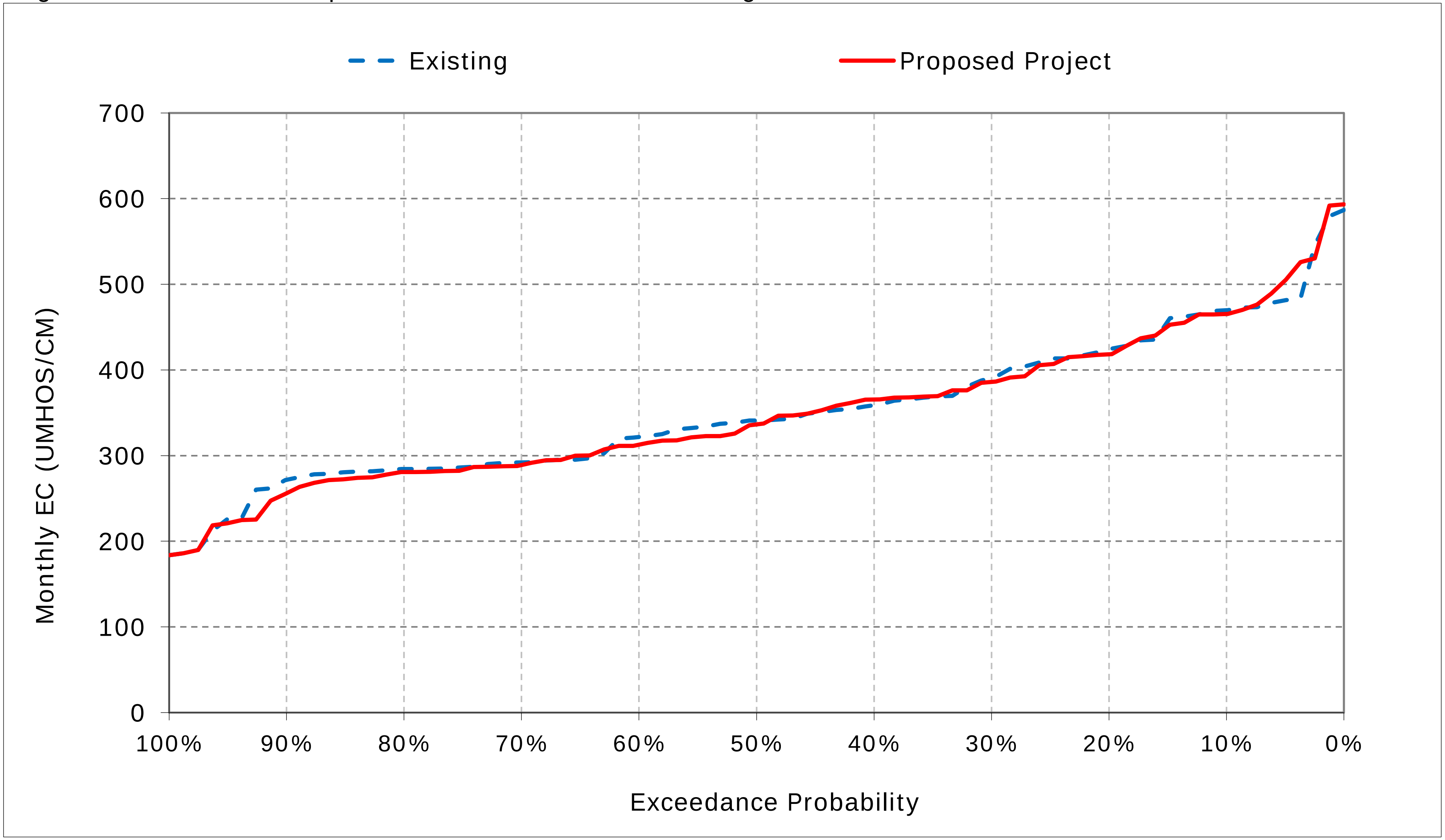


Figure 13-15. San Joaquin River at San Andreas, September EC

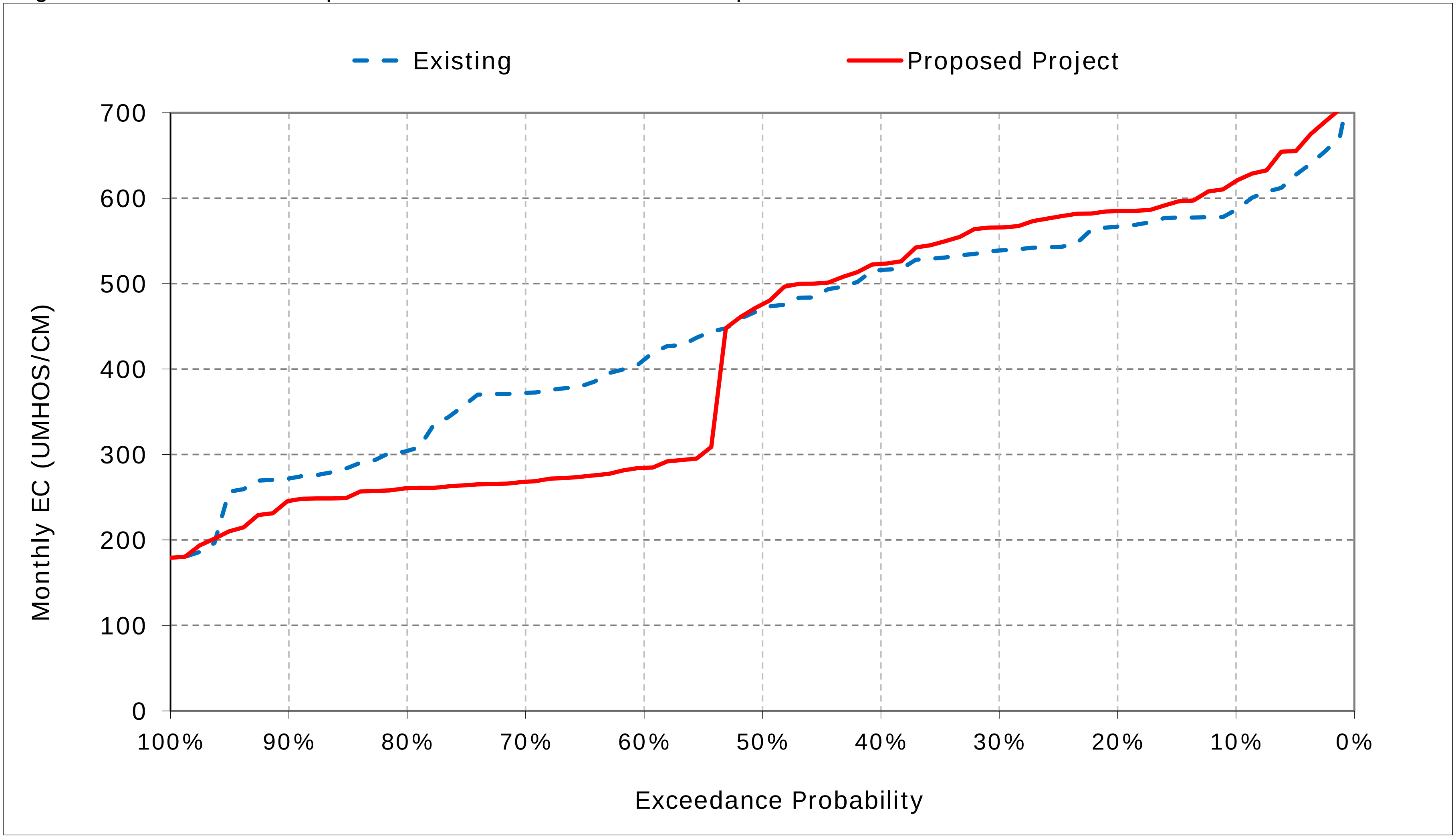


Figure 13-16. San Joaquin River at San Andreas, October EC

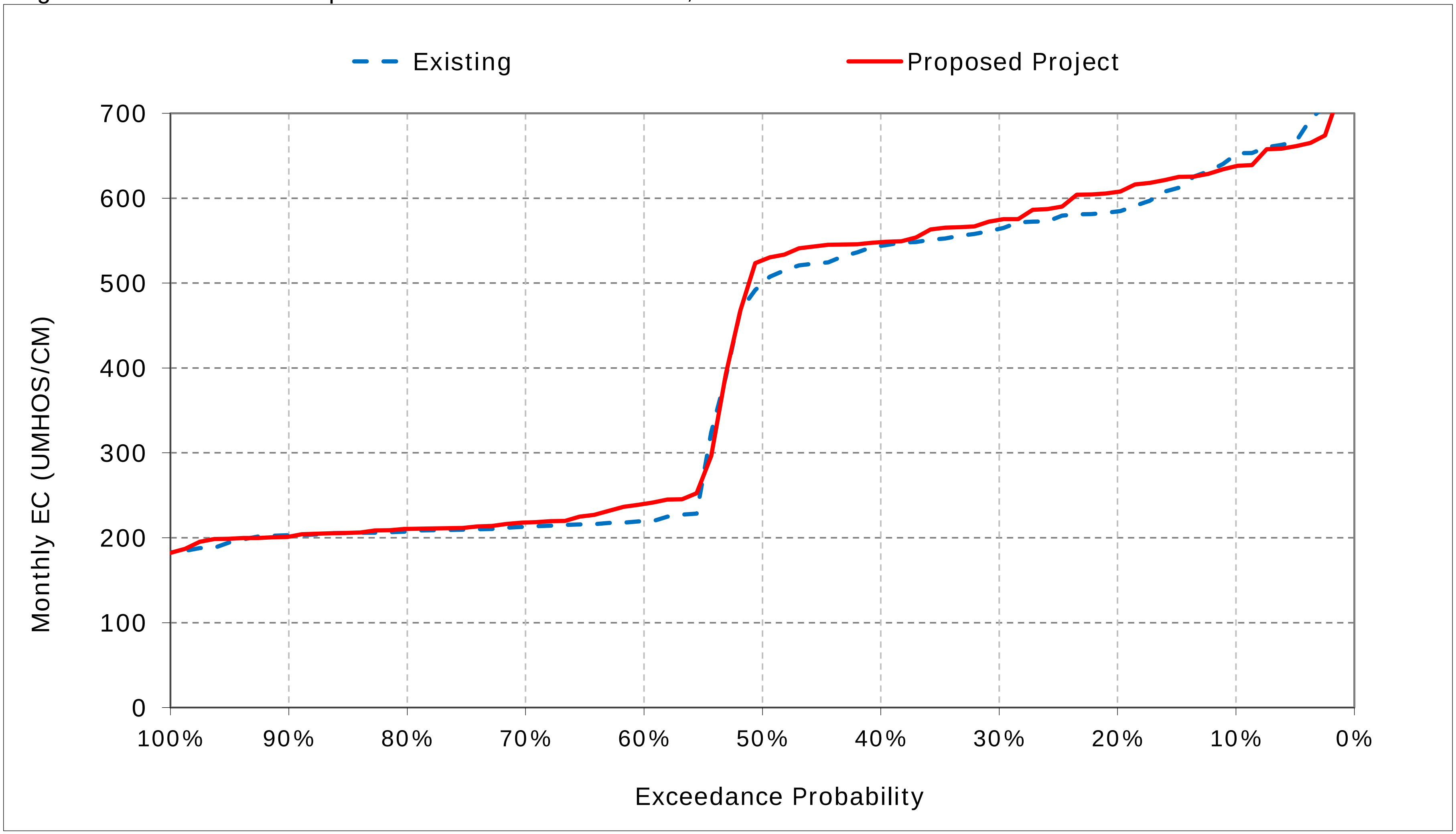


Figure 13-17. San Joaquin River at San Andreas, November EC

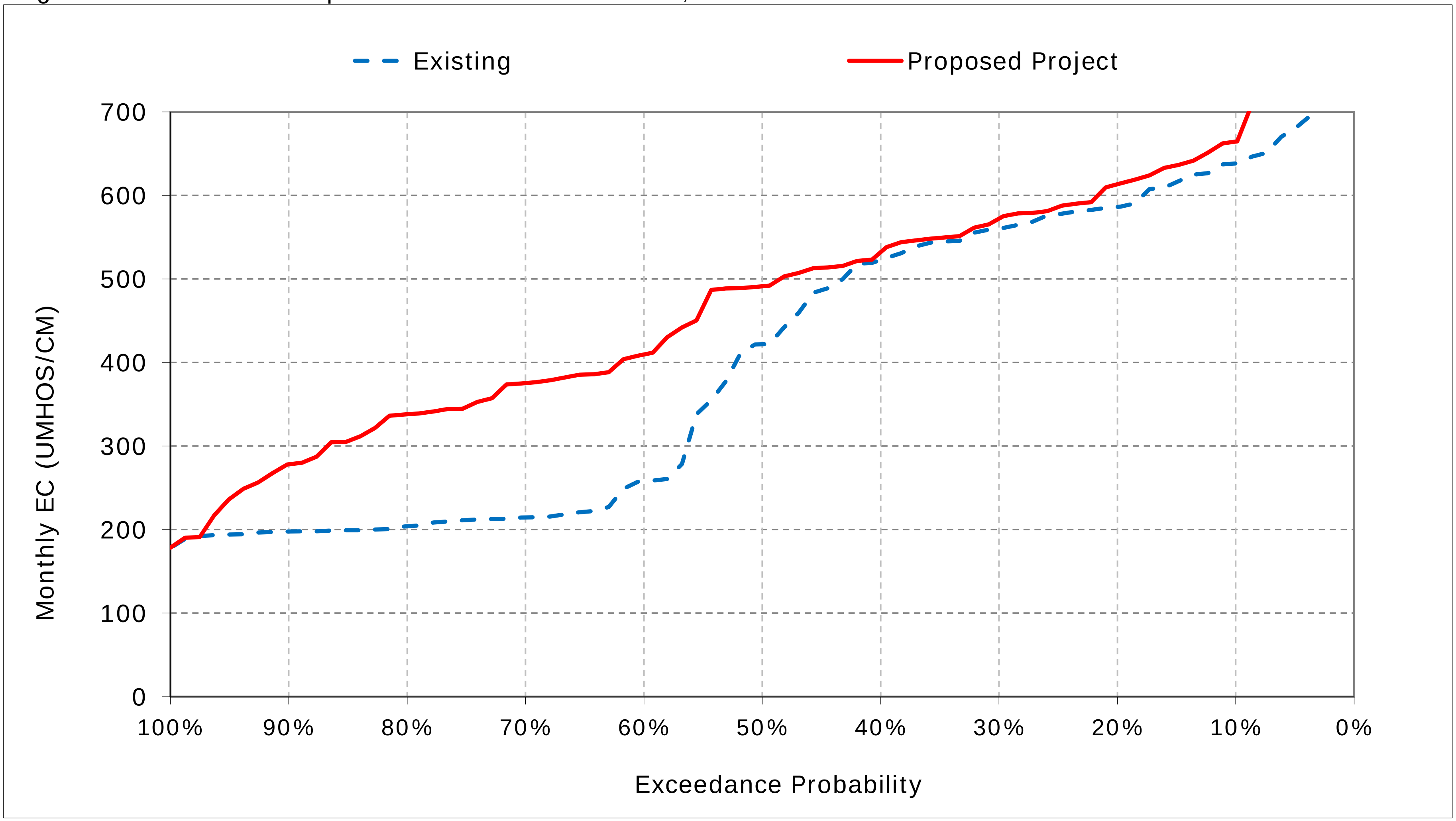


Figure 13-18. San Joaquin River at San Andreas, December EC

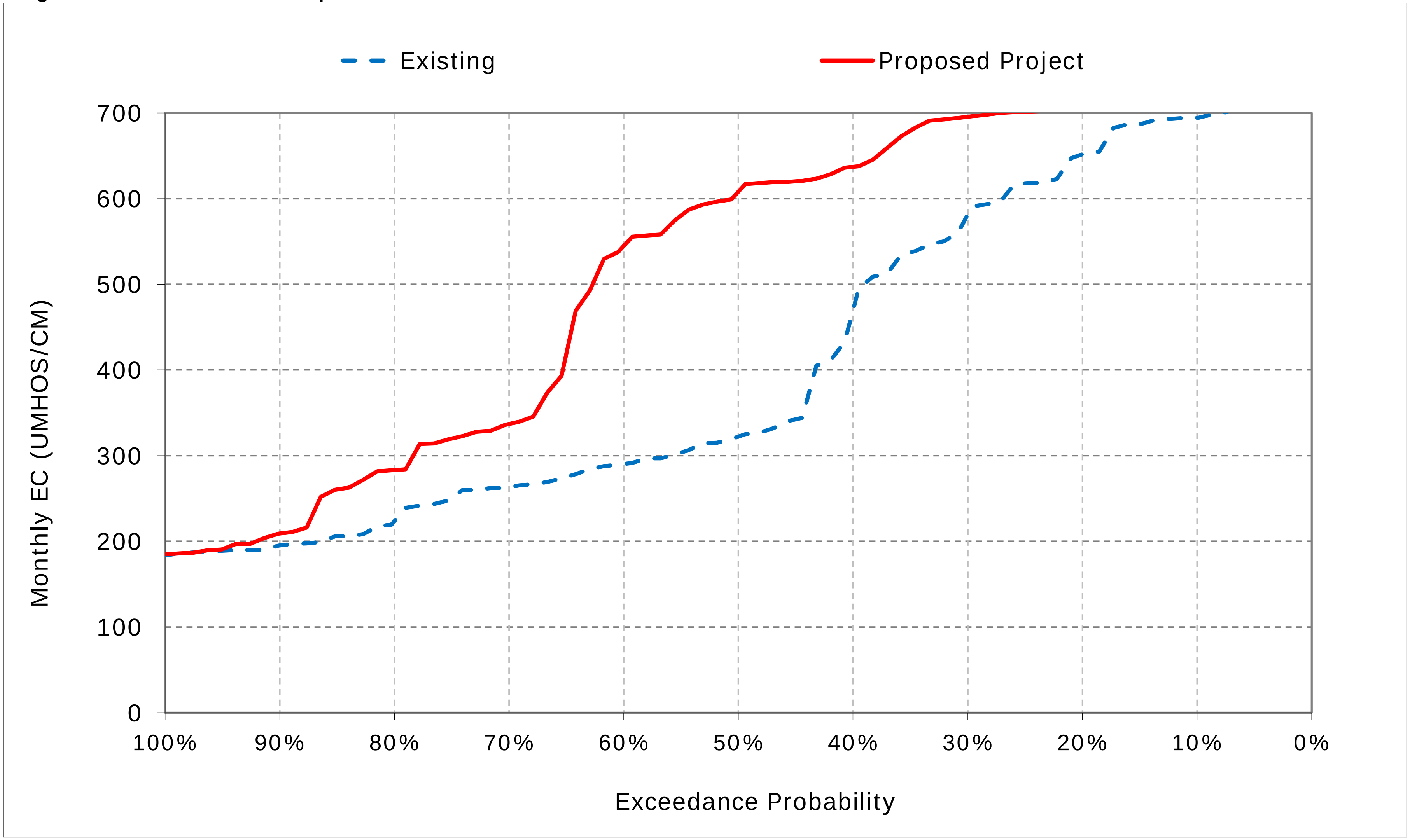


Table 14-1. San Joaquin River at Prisoners Point, Monthly EC

Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	599	595	688	651	443	341	366	352	292	375	473	569
20%	565	550	649	545	396	323	353	336	274	301	407	549
30%	550	524	588	507	382	308	341	328	264	278	379	519
40%	534	484	505	423	355	298	329	322	253	262	359	495
50%	495	450	374	402	335	282	317	316	247	253	338	463
60%	261	275	308	376	315	276	313	307	243	231	314	433
70%	247	242	284	346	287	269	294	300	241	224	287	410
80%	236	231	253	318	278	254	275	283	235	219	280	358
90%	227	224	237	286	265	240	257	226	228	208	271	322
Long Term												
Full Simulation Period[a]	410	402	438	438	340	290	313	306	259	271	347	453
Water Year Types[b]												
Wet (23%)	394	388	401	362	337	298	261	248	266	237	264	339
Above Normal (24%)	421	418	429	417	348	302	321	314	245	223	318	452
Below Normal (10%)	374	333	344	389	325	293	340	316	233	237	323	438
Dry (16%)	386	365	413	446	310	278	350	338	246	290	396	523
Critical (27%)	441	445	526	536	360	278	320	325	282	347	426	515

Proposed Project

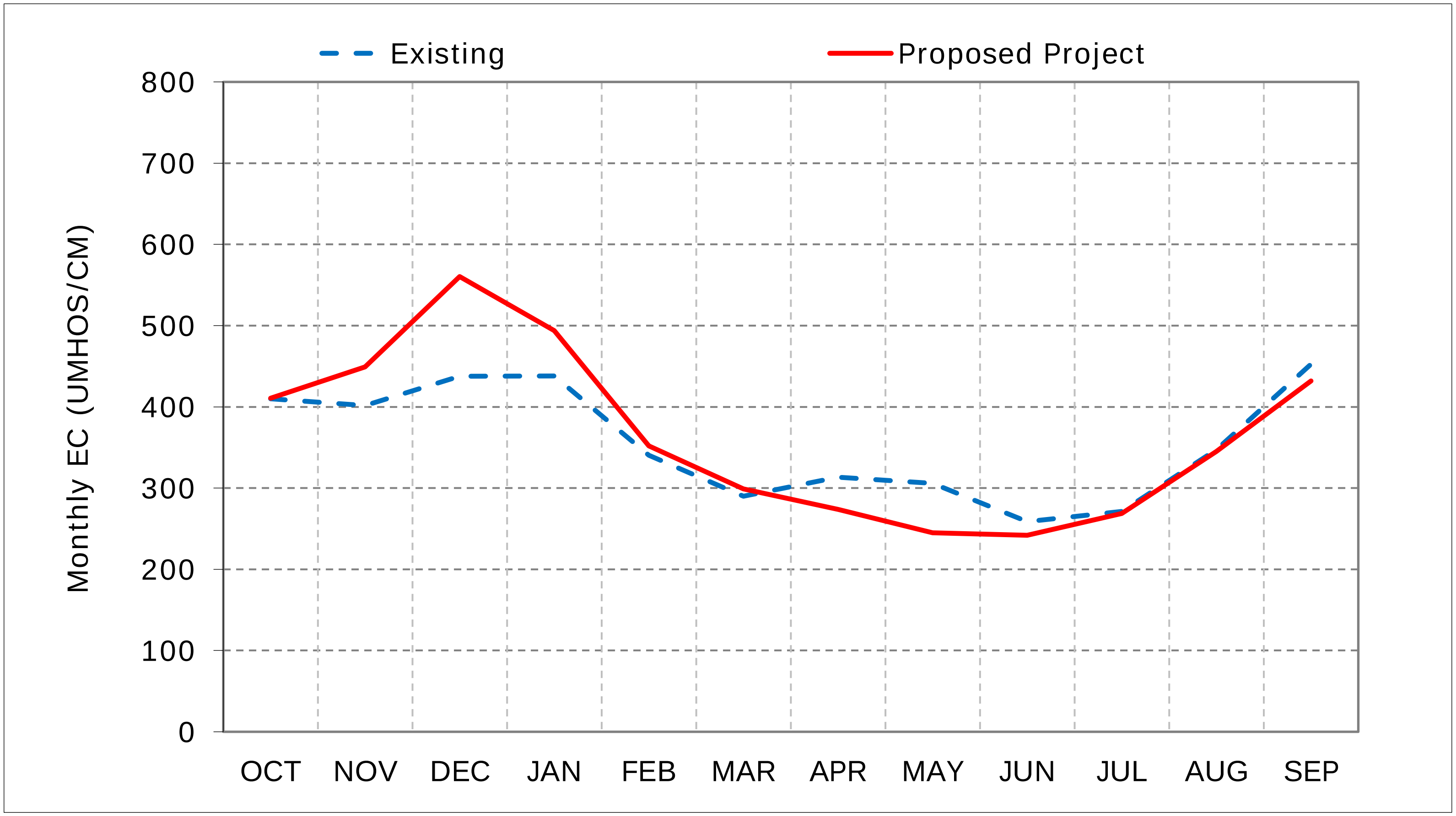
Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	603	618	748	748	444	355	319	266	288	375	474	614
20%	584	569	706	681	417	336	304	260	266	290	398	575
30%	562	539	677	621	393	315	287	256	250	266	375	546
40%	546	508	649	531	367	302	282	249	236	257	353	491
50%	509	465	626	433	344	290	275	247	229	243	339	435
60%	235	401	577	384	315	283	266	242	223	229	307	340
70%	224	351	432	349	295	270	255	235	218	221	285	319
80%	217	310	388	325	280	261	245	230	211	216	275	309
90%	214	268	296	296	264	243	234	213	203	207	255	288
Long Term												
Full Simulation Period[a]	411	449	560	494	352	299	274	245	242	269	345	432
Water Year Types[b]												
Wet (23%)	396	429	480	372	334	298	248	227	261	238	256	272
Above Normal (24%)	426	459	518	450	346	307	287	246	217	217	313	411
Below Normal (10%)	362	438	550	525	347	314	299	241	209	227	313	408
Dry (16%)	377	419	597	543	323	293	284	248	222	281	395	546
Critical (27%)	446	480	650	598	391	290	270	260	272	351	433	530

Proposed Project minus Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	5	23	59	97	1	14	-47	-85	-4	0	0	45
20%	19	19	57	136	20	13	-49	-76	-9	-11	-8	25
30%	13	14	89	113	11	7	-54	-72	-14	-12	-5	28
40%	12	24	145	108	12	4	-47	-73	-18	-5	-6	-4
50%	15	15	252	31	9	8	-42	-69	-19	-10	2	-28
60%	-27	126	269	8	0	7	-47	-64	-20	-2	-7	-93
70%	-23	110	148	3	8	1	-39	-65	-23	-3	-1	-91
80%	-19	78	135	7	3	8	-30	-53	-23	-2	-5	-49
90%	-13	44	59	10	-1	3	-23	-13	-24	-1	-16	-35
Long Term												
Full Simulation Period[a]	1	48	123	56	11	9	-40	-61	-17	-3	-2	-21
Water Year Types[b]												
Wet (23%)	2	40	79	10	-3	0	-13	-21	-6	1	-8	-67
Above Normal (24%)	5	41	90	34	-2	5	-34	-68	-27	-5	-4	-41
Below Normal (10%)	-12	105	206	136	22	22	-41	-76	-24	-11	-10	-29
Dry (16%)	-9	54	184	97	13	16	-66	-90	-24	-9	-1	23
Critical (27%)	5	36	124	62	31	12	-51	-65	-10	4	6	15

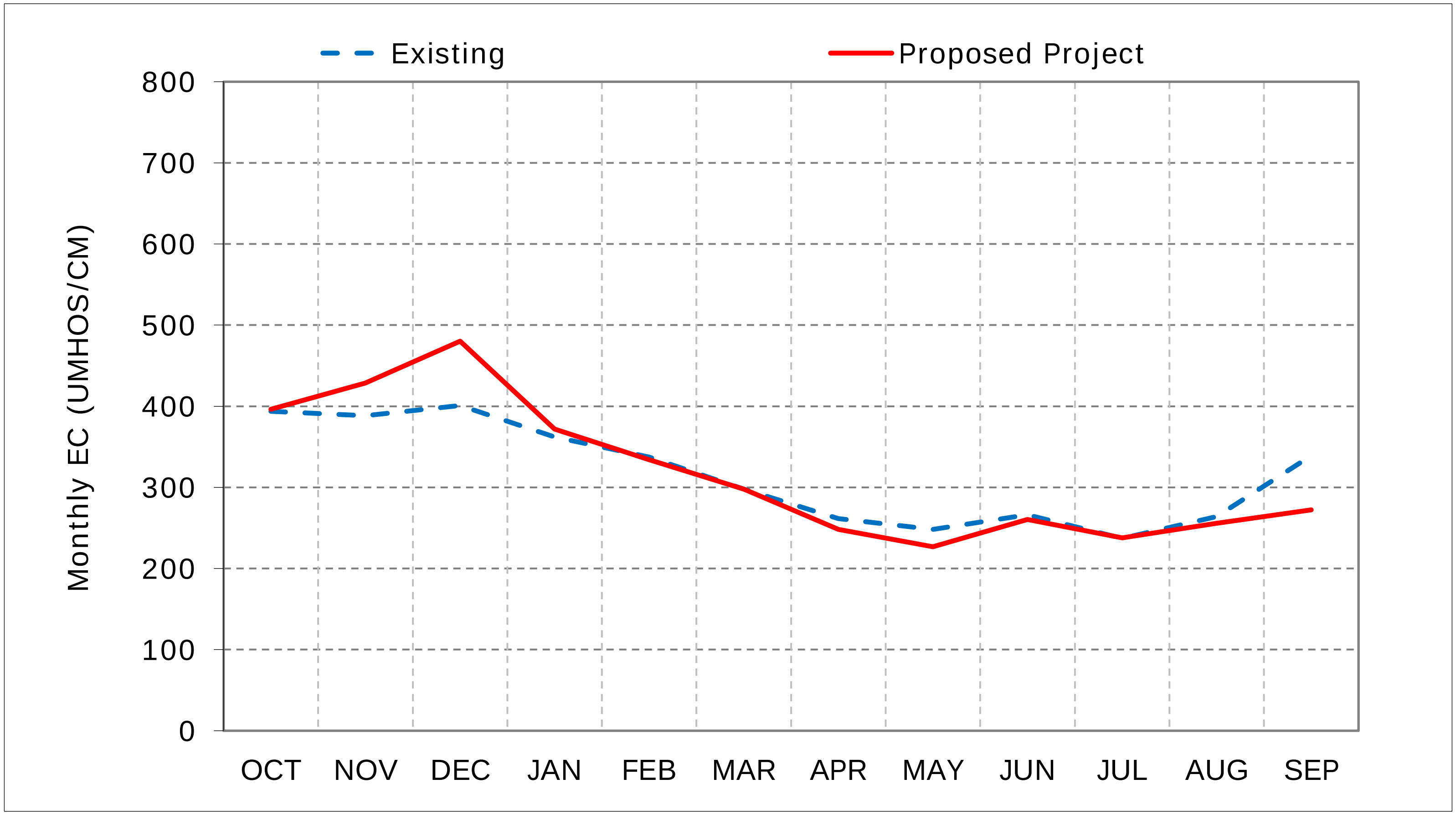
a Based on the 82-year simulation period.
b As defined by the San Joaquin Valley 60-20-20 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with water year - year type sorting.
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 14-1. San Joaquin River at Prisoners Point, Long-Term Average EC



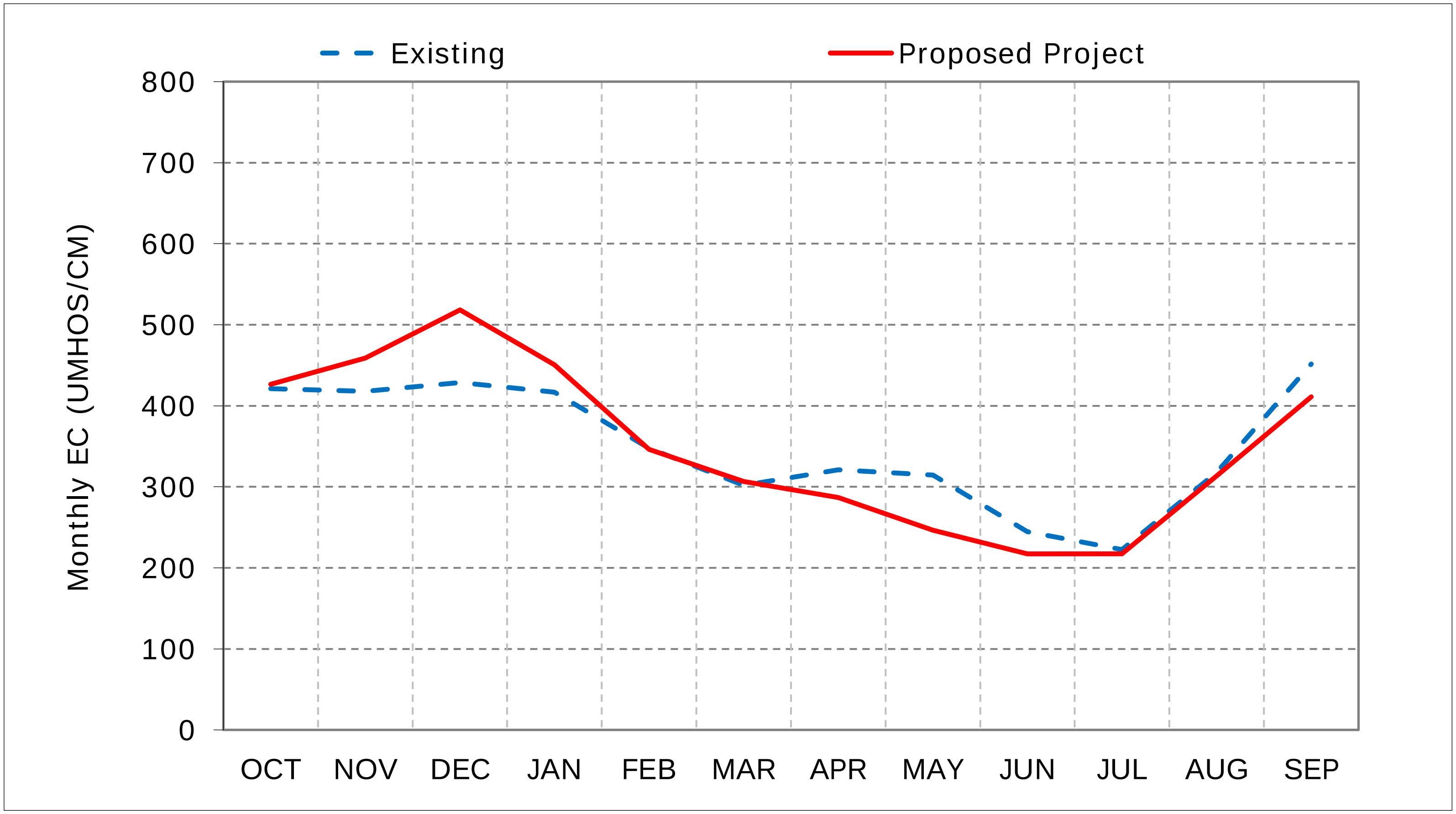
*As defined by the San Joaquin Valley 60-20-20 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 14-2. San Joaquin River at Prisoners Point, Wet Year Average EC



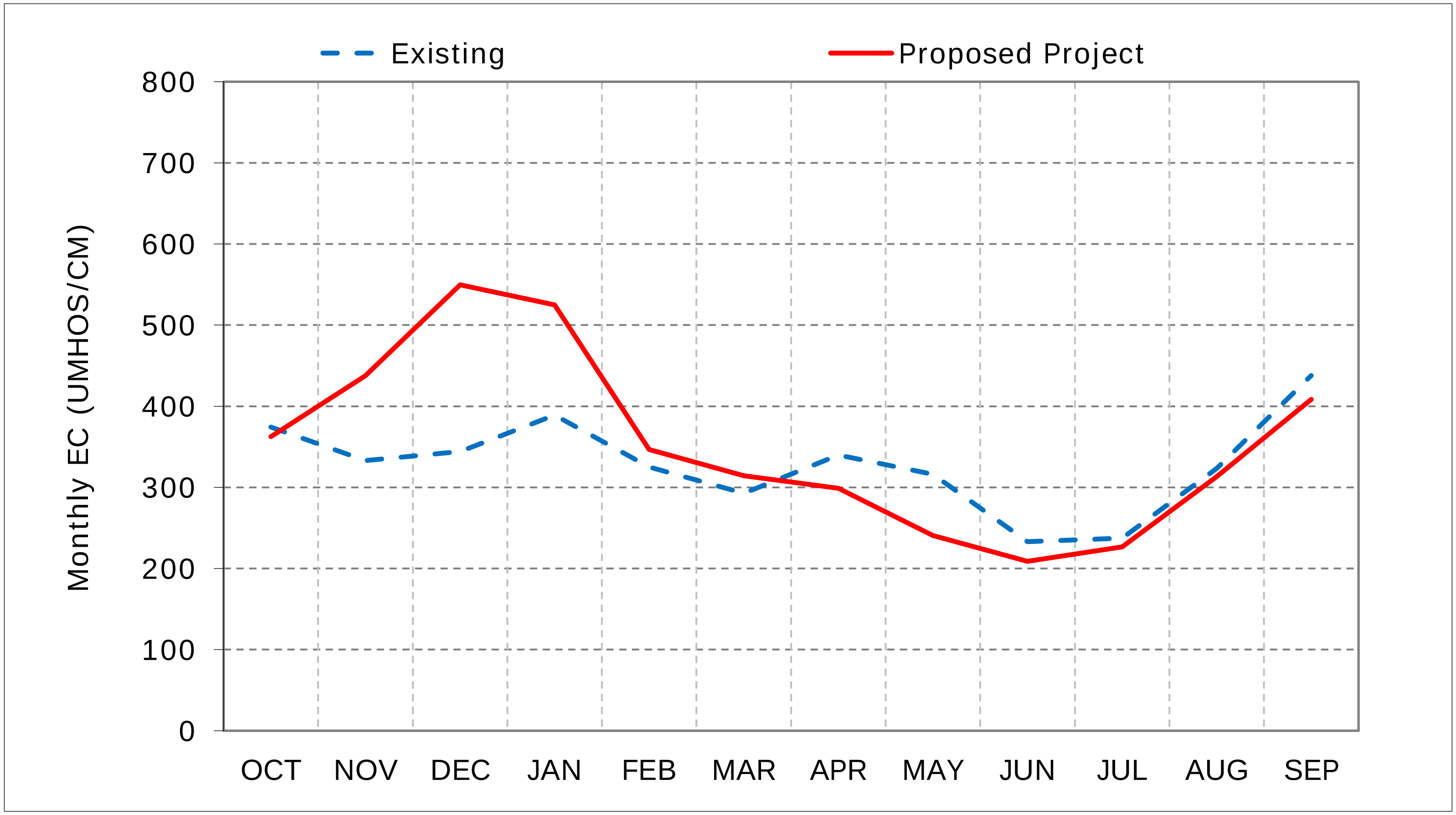
*As defined by the San Joaquin Valley 60-20-20 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 14-3. San Joaquin River at Prisoners Point, Above Normal Year Average EC



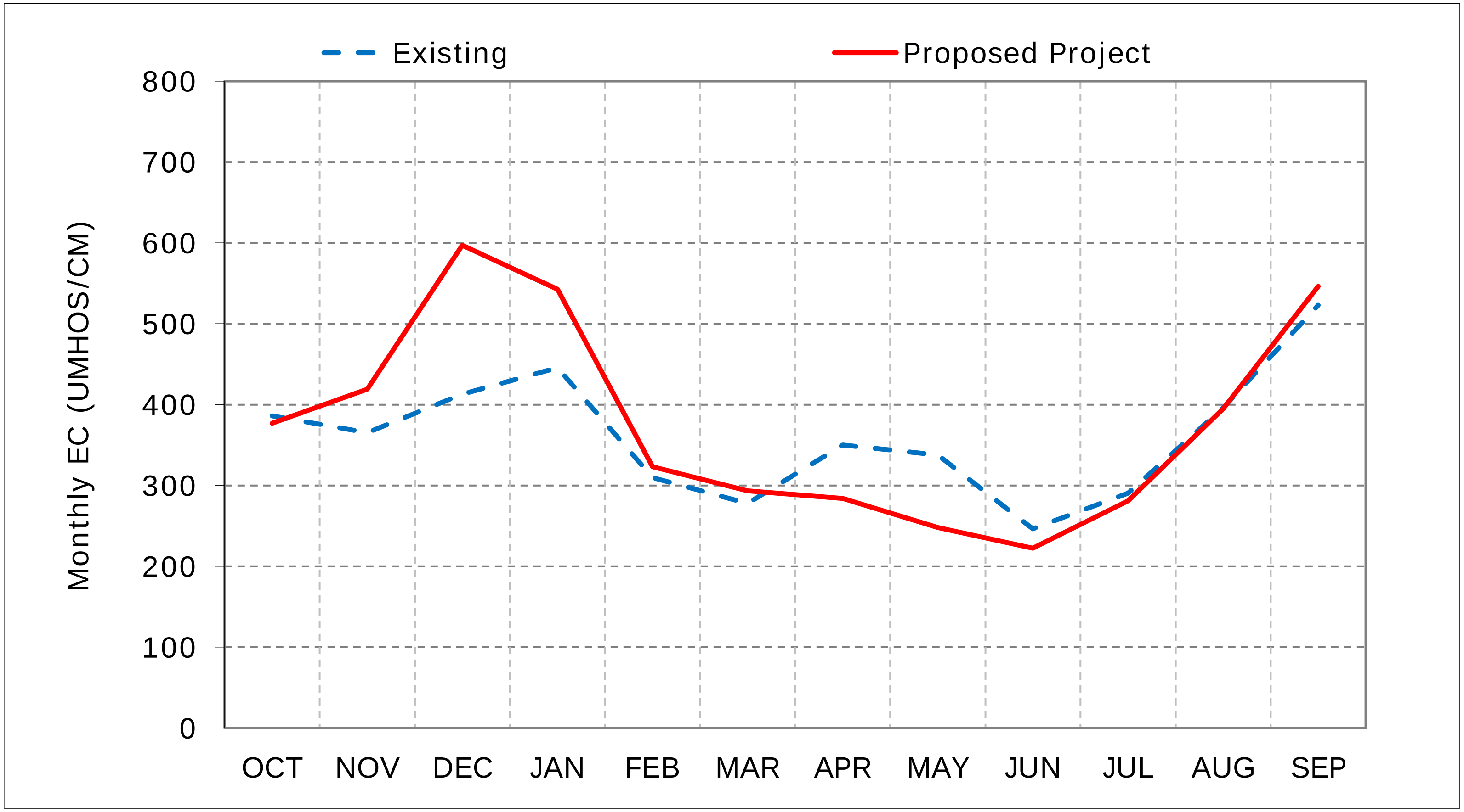
*As defined by the San Joaquin Valley 60-20-20 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 14-4. San Joaquin River at Prisoners Point, Below Normal Year Average EC



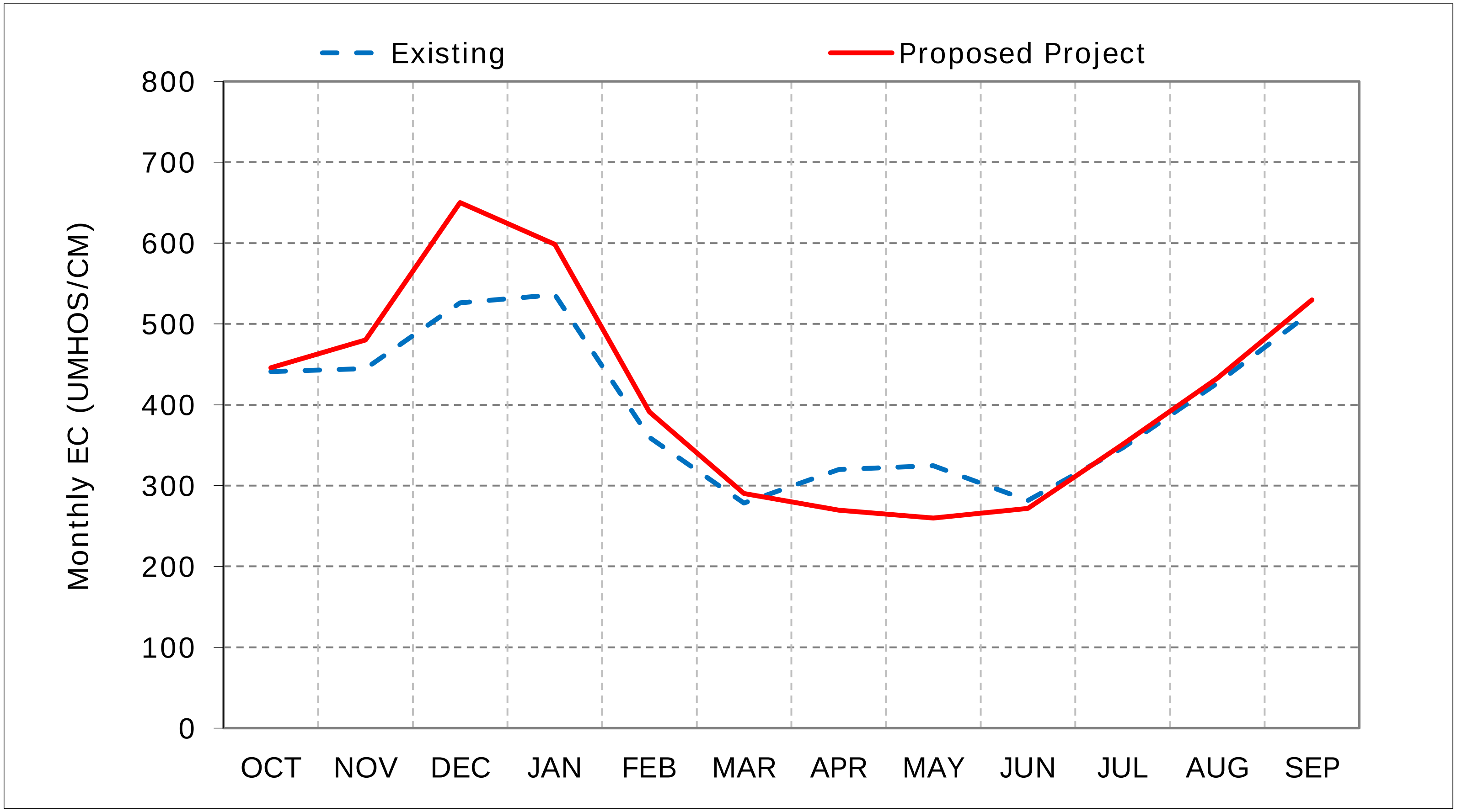
*As defined by the San Joaquin Valley 60-20-20 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 14-5. San Joaquin River at Prisoners Point, Dry Year Average EC



*As defined by the San Joaquin Valley 60-20-20 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 14-6. San Joaquin River at Prisoners Point, Critical Year Average EC



*As defined by the San Joaquin Valley 60-20-20 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 14-7. San Joaquin River at Prisoners Point, January EC

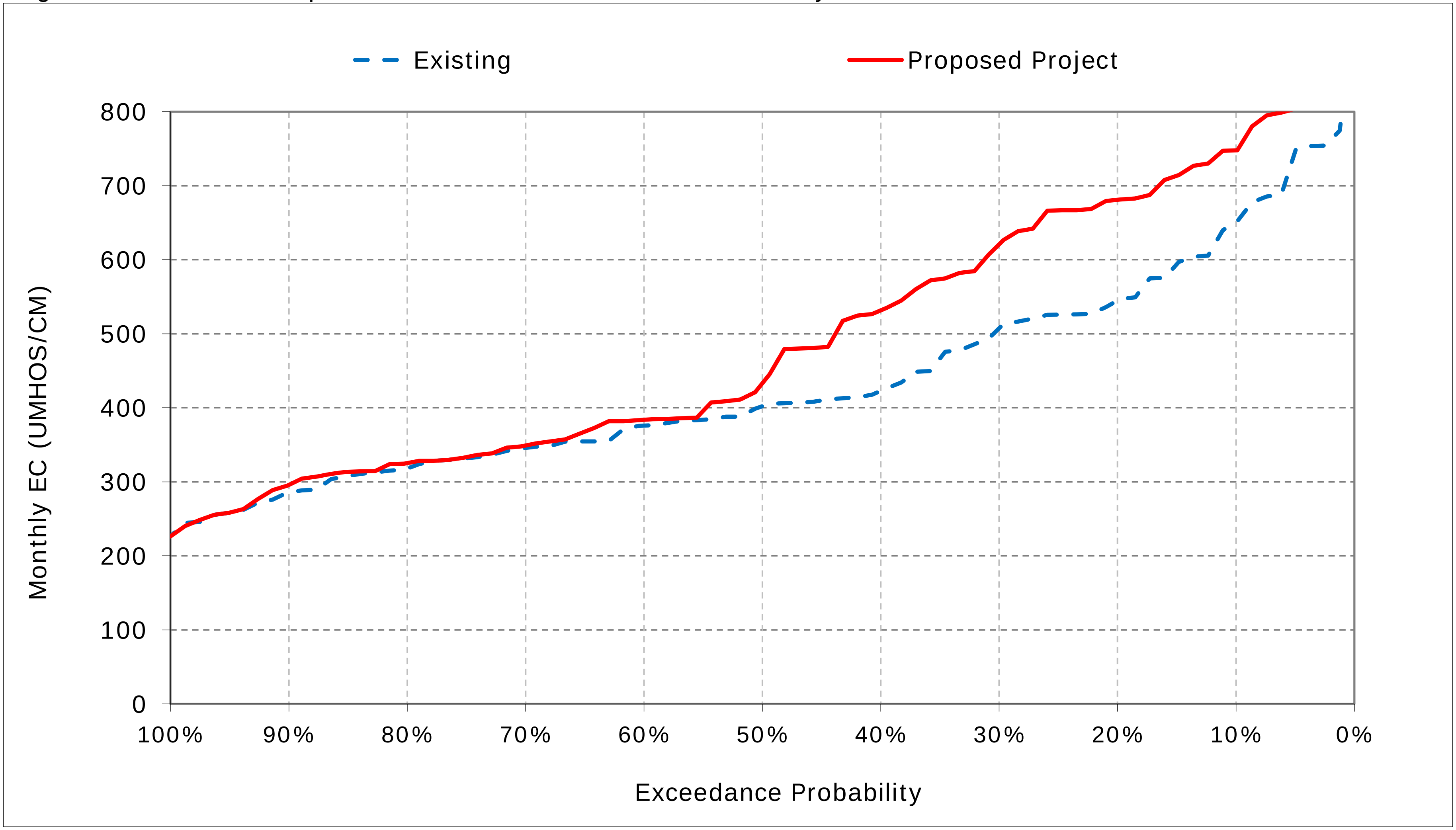


Figure 14-8. San Joaquin River at Prisoners Point, February EC

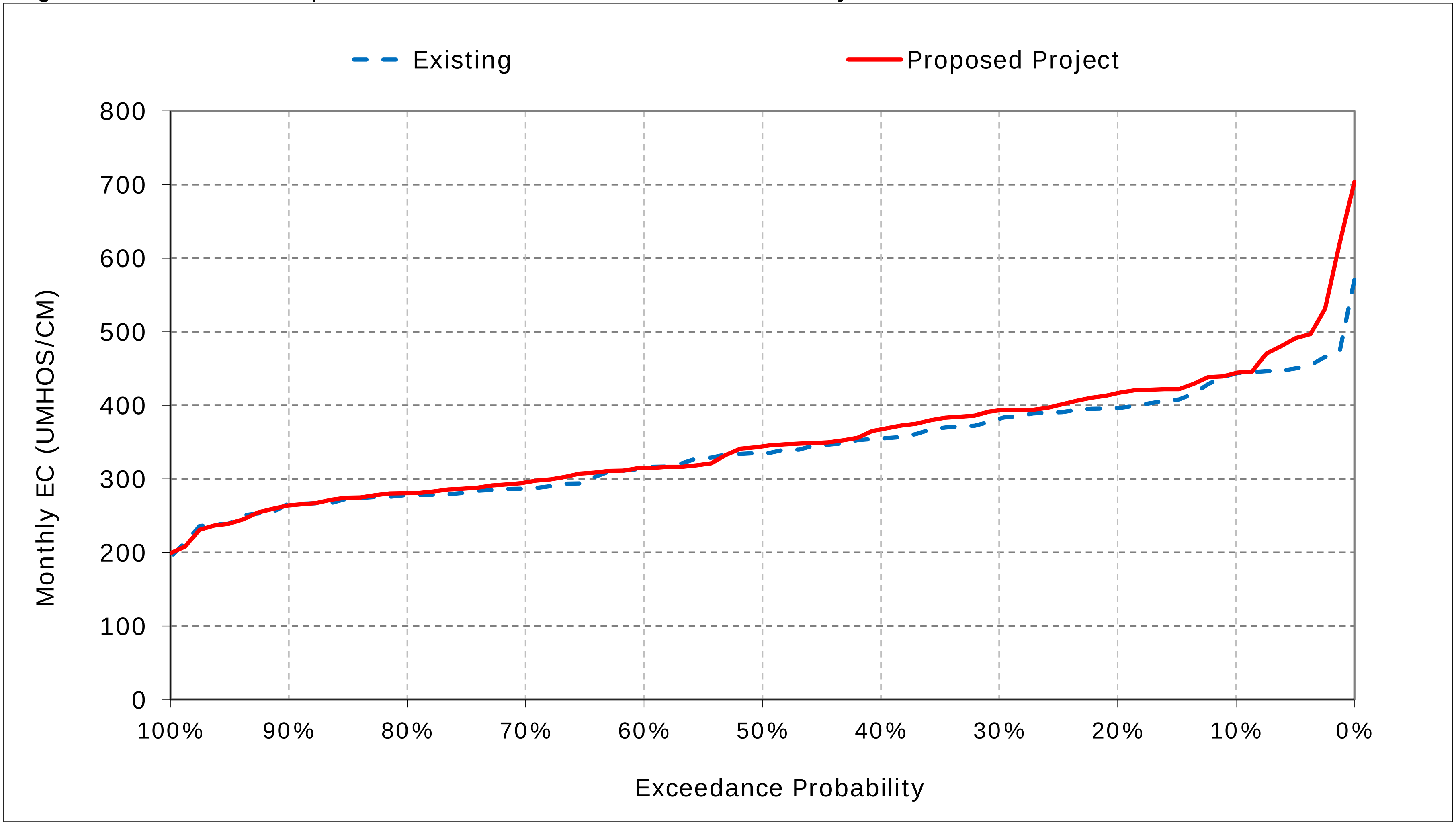


Figure 14-9. San Joaquin River at Prisoners Point, March EC

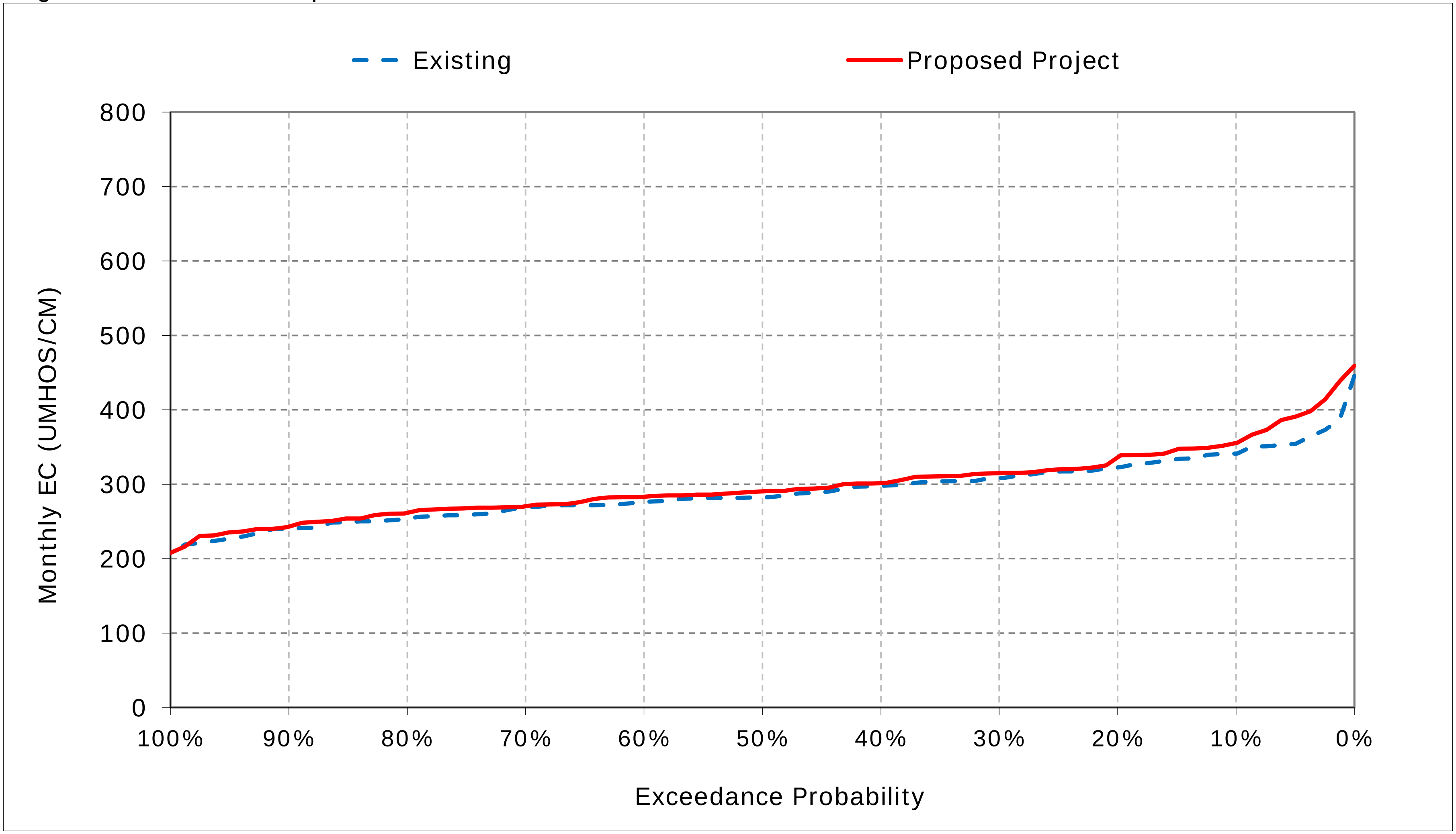


Figure 14-10. San Joaquin River at Prisoners Point, April EC

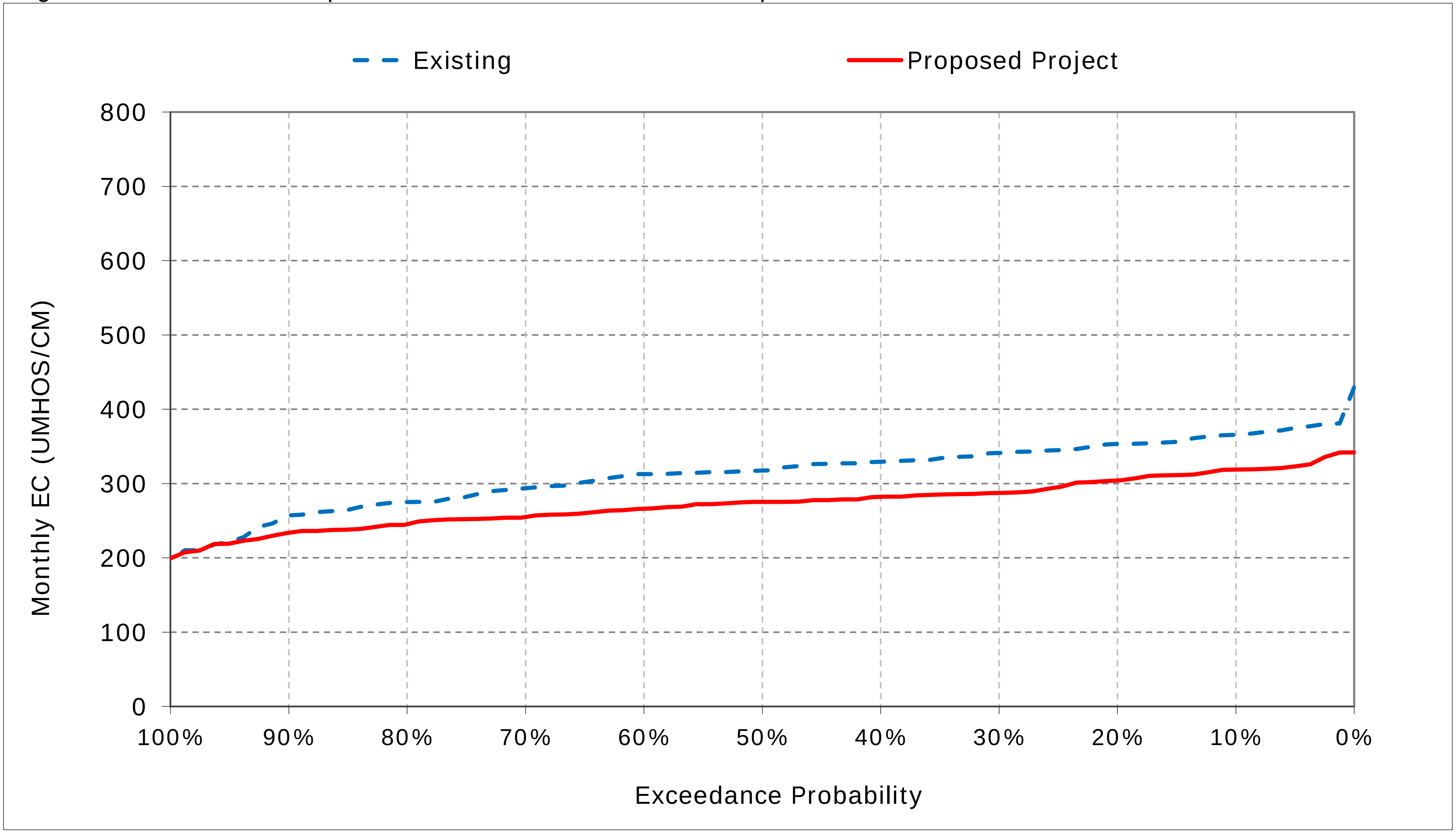


Figure 14-11. San Joaquin River at Prisoners Point, May EC

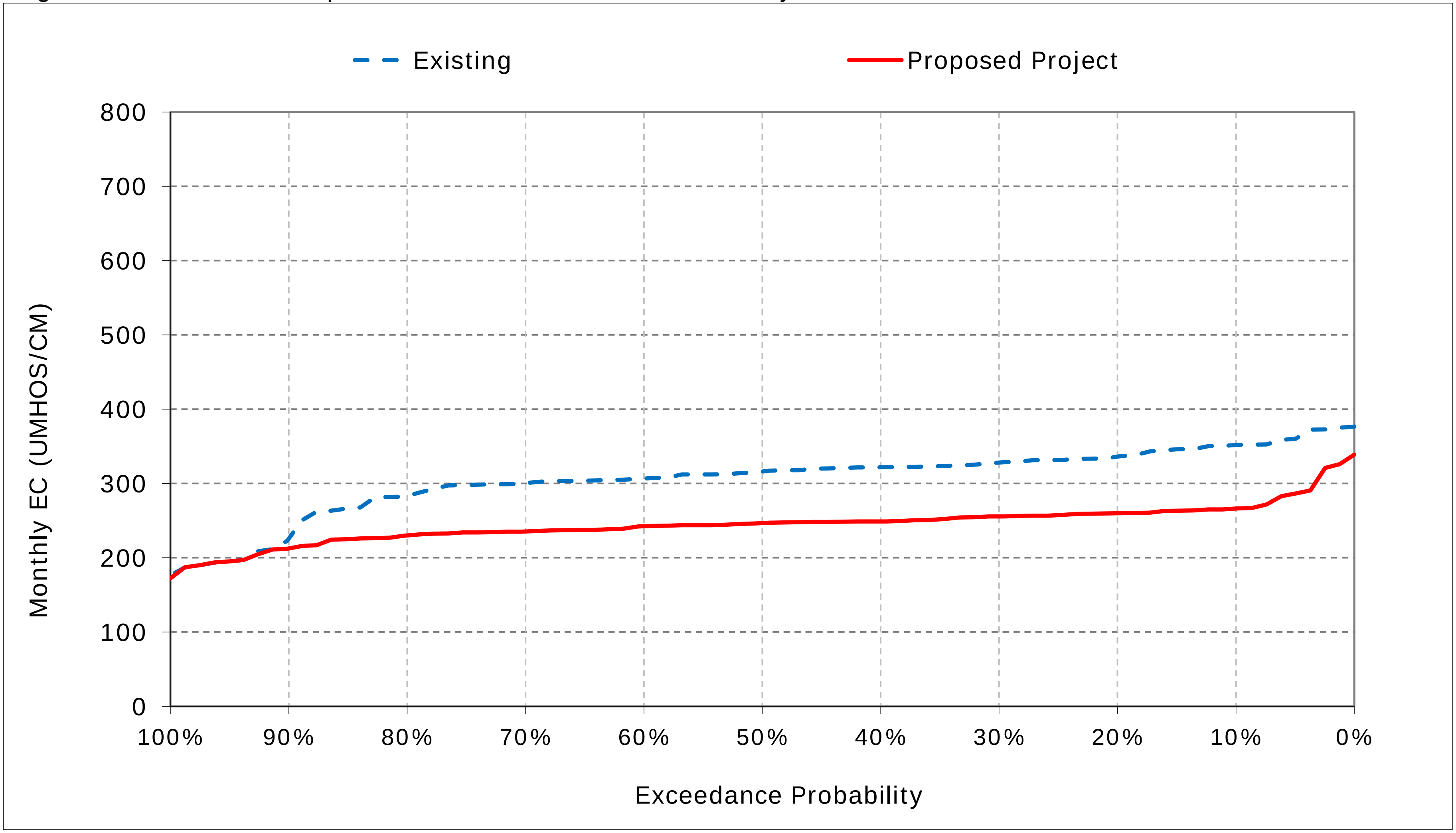


Figure 14-12. San Joaquin River at Prisoners Point, June EC

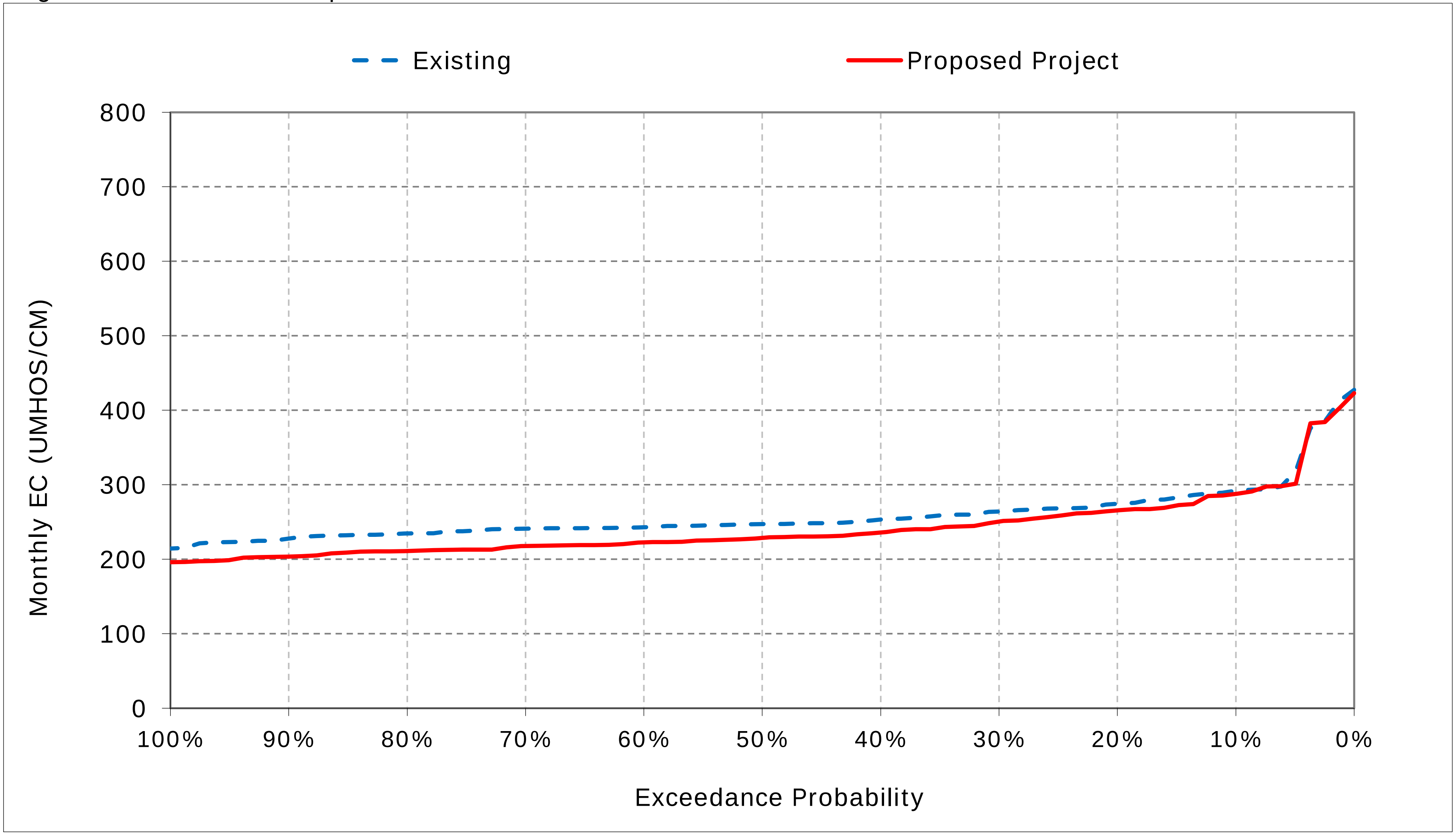


Figure 14-13. San Joaquin River at Prisoners Point, July EC

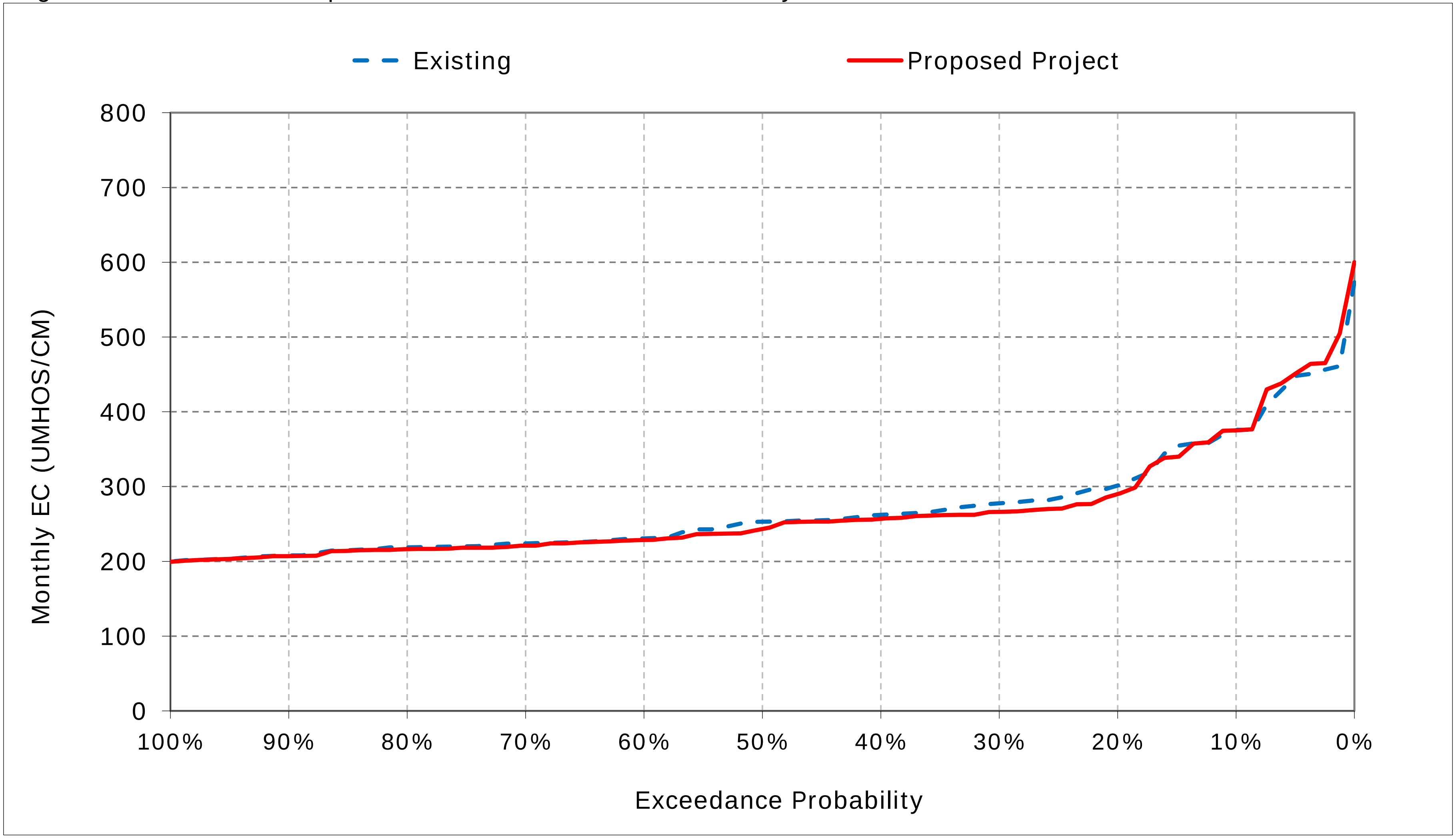


Figure 14-14. San Joaquin River at Prisoners Point, August EC

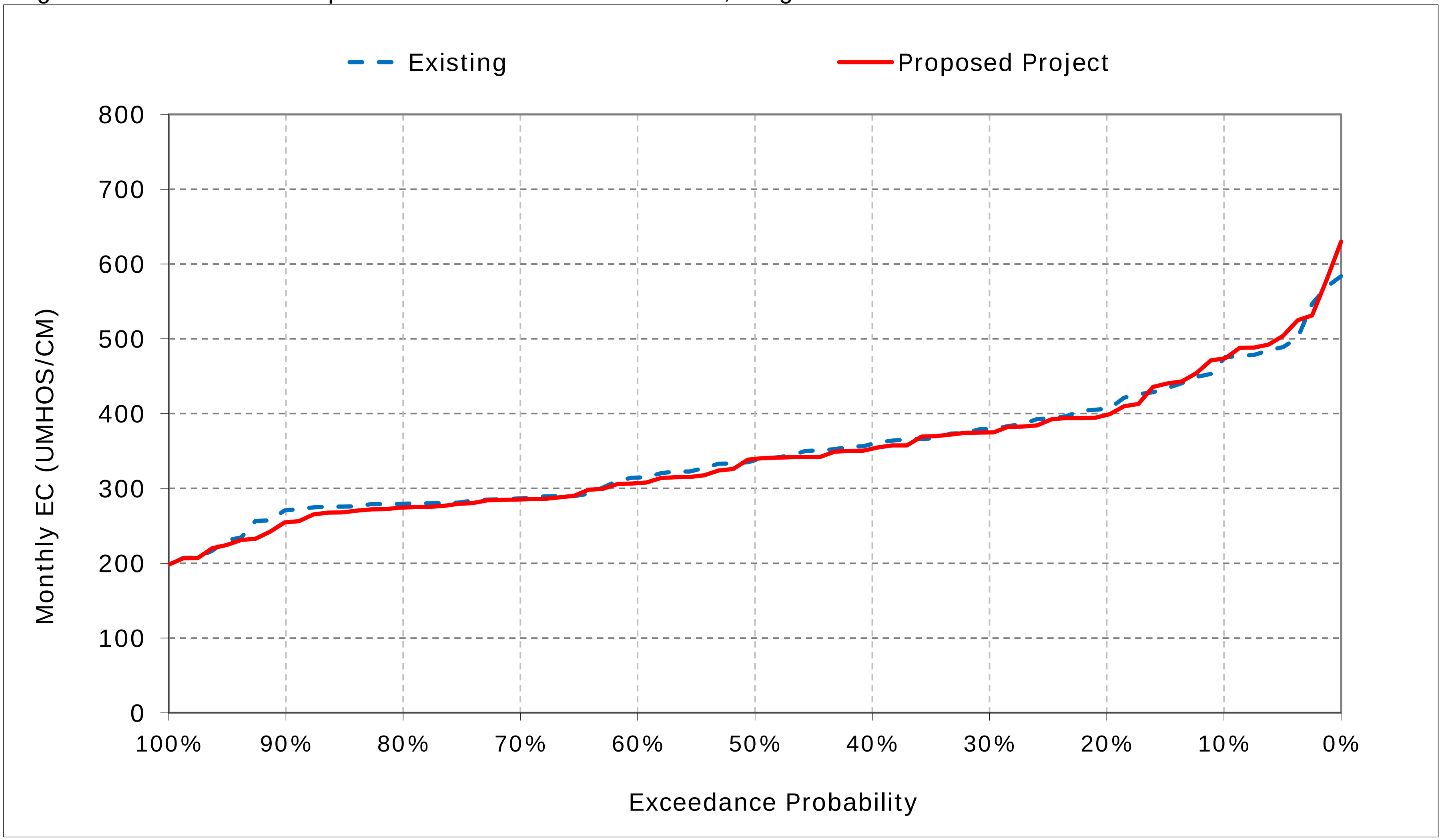


Figure 14-15. San Joaquin River at Prisoners Point, September EC

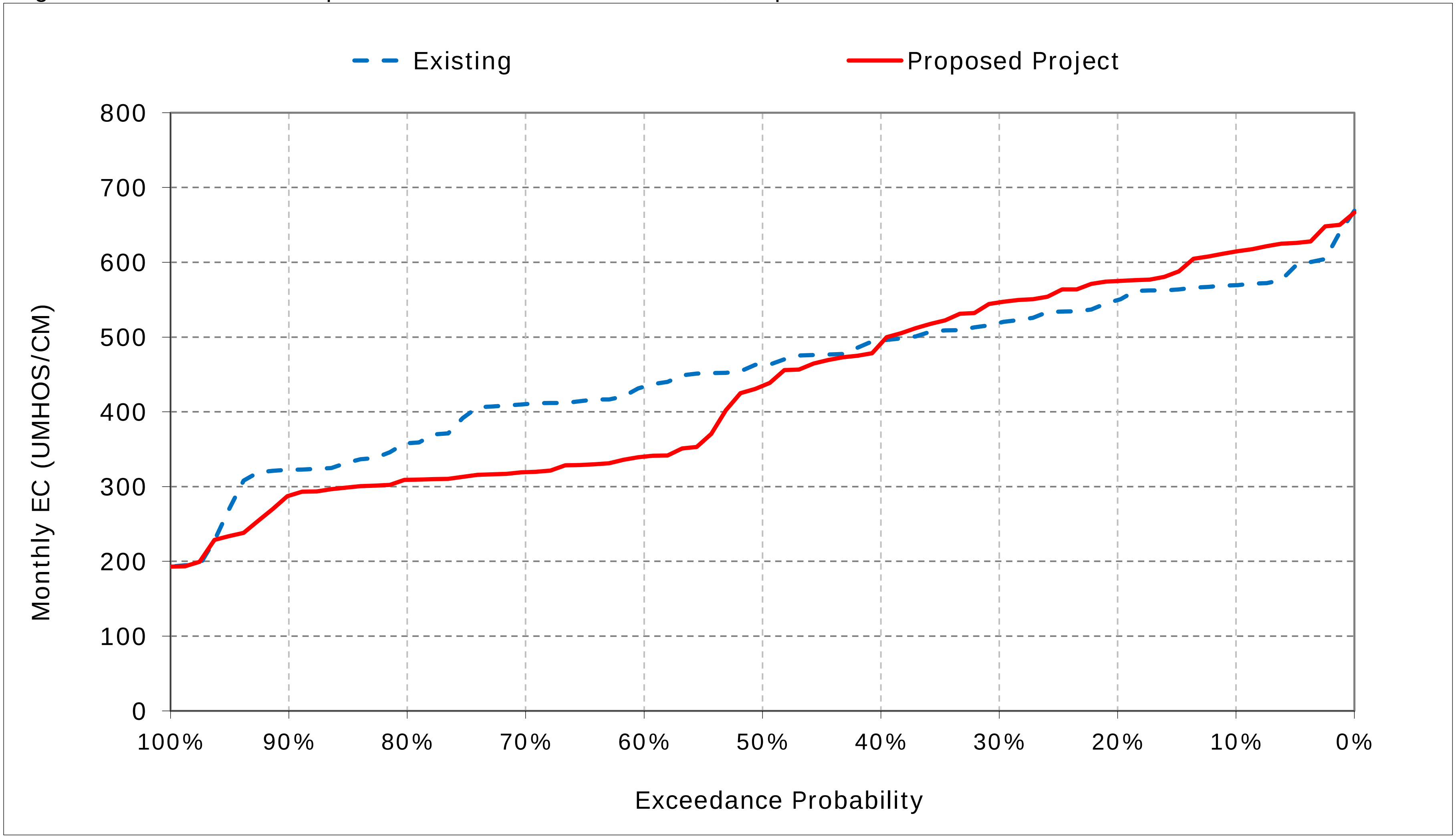


Figure 14-16. San Joaquin River at Prisoners Point, October EC

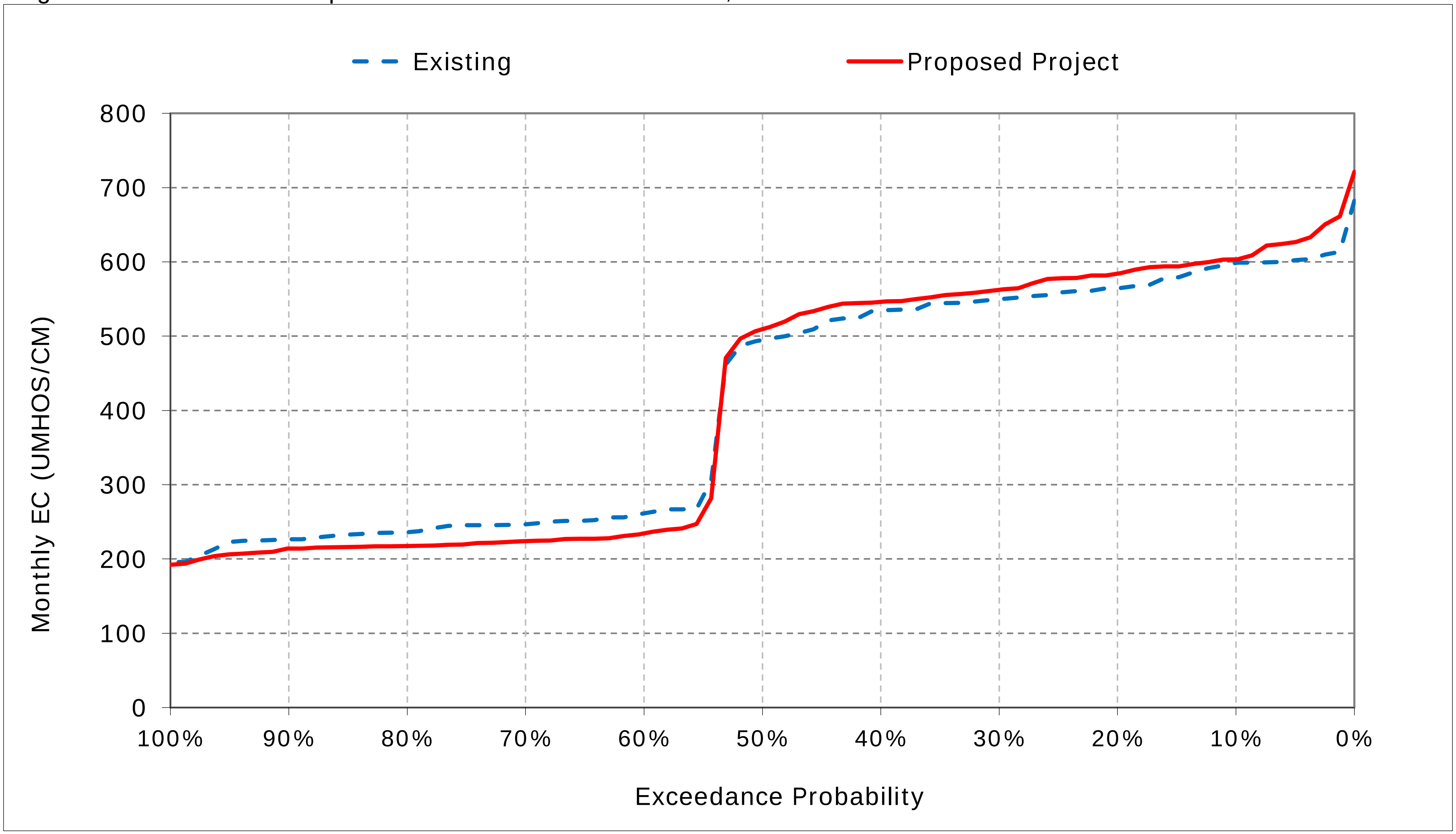


Figure 14-17. San Joaquin River at Prisoners Point, November EC

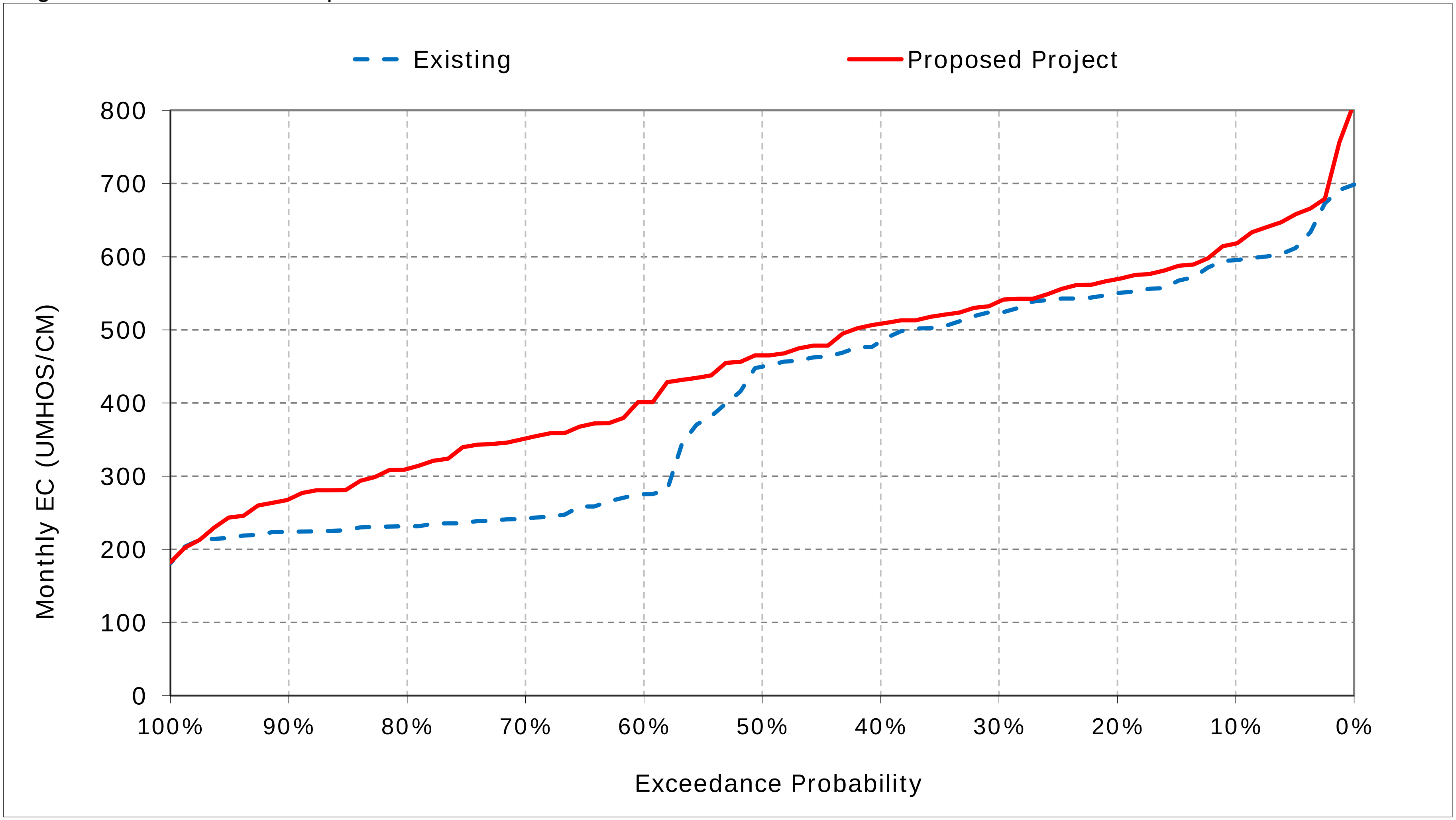


Figure 14-18. San Joaquin River at Prisoners Point, December EC

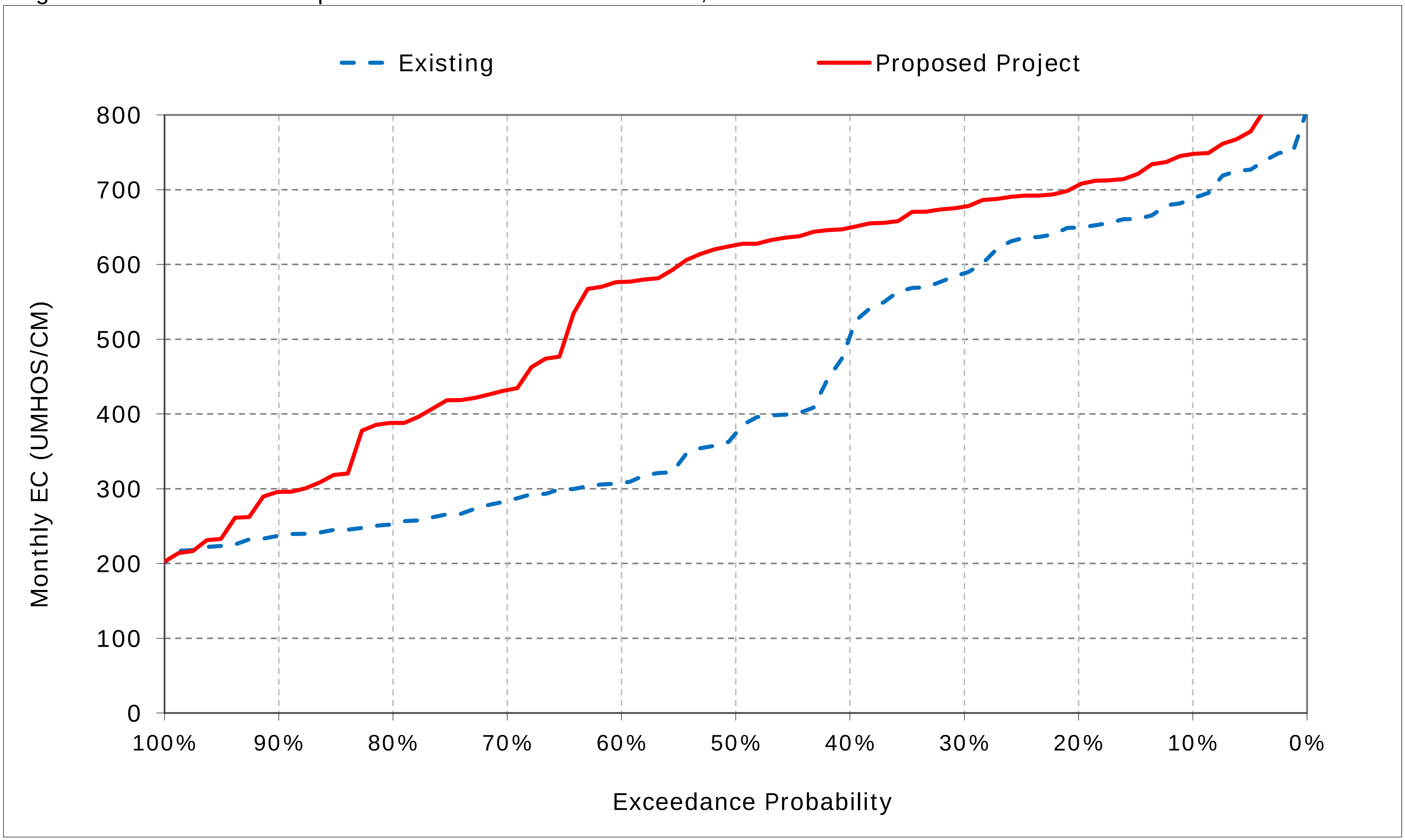


Table 15-1. Old River at Rock Slough Salinity, Monthly EC

Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	871	839	912	833	508	361	357	375	301	483	645	799
20%	831	768	869	699	418	316	339	352	273	374	544	774
30%	806	729	787	610	394	295	324	325	263	338	495	722
40%	776	673	627	524	360	287	309	314	259	303	471	664
50%	714	588	444	459	341	273	301	308	256	272	432	622
60%	275	310	342	419	306	264	288	298	252	254	397	571
70%	263	251	299	342	289	254	283	293	248	245	357	535
80%	259	236	272	312	275	243	270	282	240	230	344	476
90%	249	223	243	275	262	233	247	247	233	220	324	436
Long Term												
Full Simulation Period[a]	555	522	544	517	360	285	302	308	270	319	449	614
Water Year Types[b]												
Wet (32%)	459	415	371	343	331	285	289	280	243	235	335	492
Above Normal (15%)	618	541	542	485	345	286	321	328	252	244	361	454
Below Normal (17%)	573	549	617	591	338	270	317	335	252	305	470	762
Dry (22%)	560	571	617	566	361	268	296	309	264	389	545	686
Critical (15%)	668	632	729	769	459	330	301	315	373	487	613	755

Proposed Project

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	888	843	976	1,020	531	385	298	277	285	489	644	863
20%	857	797	924	884	489	338	281	262	264	345	527	804
30%	823	731	891	810	408	303	276	254	251	320	498	761
40%	787	703	857	694	378	295	273	243	241	297	463	676
50%	731	628	823	523	350	285	265	238	236	268	433	587
60%	266	528	763	449	320	270	257	234	230	249	389	468
70%	251	447	556	350	300	263	252	230	223	239	352	433
80%	242	394	494	325	283	251	243	227	218	228	336	411
90%	230	321	304	284	265	244	237	222	213	220	299	380
Long Term												
Full Simulation Period[a]	560	598	723	597	380	298	268	247	254	315	444	591
Water Year Types[b]												
Wet (32%)	463	510	521	372	332	295	257	230	228	235	324	378
Above Normal (15%)	628	649	792	617	371	302	264	231	225	240	362	439
Below Normal (17%)	575	619	793	679	344	280	270	242	228	283	467	822
Dry (22%)	562	622	810	694	395	284	266	252	252	380	532	695
Critical (15%)	683	673	879	822	513	347	297	298	375	503	628	779

Proposed Project minus Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	18	4	64	188	24	24	-59	-98	-16	6	-1	63
20%	26	28	54	185	71	22	-58	-90	-9	-29	-17	30
30%	17	2	105	201	14	9	-48	-71	-12	-19	3	39
40%	11	30	230	171	18	8	-37	-71	-19	-6	-8	13
50%	17	40	379	64	10	13	-35	-70	-20	-3	1	-35
60%	-9	218	421	29	13	6	-31	-65	-23	-5	-9	-103
70%	-12	196	258	8	12	9	-30	-63	-25	-6	-4	-102
80%	-17	157	222	13	8	8	-26	-55	-21	-2	-8	-65
90%	-19	98	60	8	2	11	-9	-25	-20	0	-25	-56
Long Term												
Full Simulation Period[a]	6	75	179	79	21	13	-33	-61	-16	-4	-4	-23
Water Year Types[b]												
Wet (32%)	4	95	150	29	1	11	-31	-50	-15	0	-11	-114
Above Normal (15%)	9	108	250	131	26	15	-57	-97	-27	-4	1	-15
Below Normal (17%)	2	71	176	88	6	10	-47	-93	-25	-21	-3	60
Dry (22%)	1	52	193	128	34	16	-30	-57	-12	-10	-13	8
Critical (15%)	14	41	150	53	55	17	-4	-17	2	15	16	24

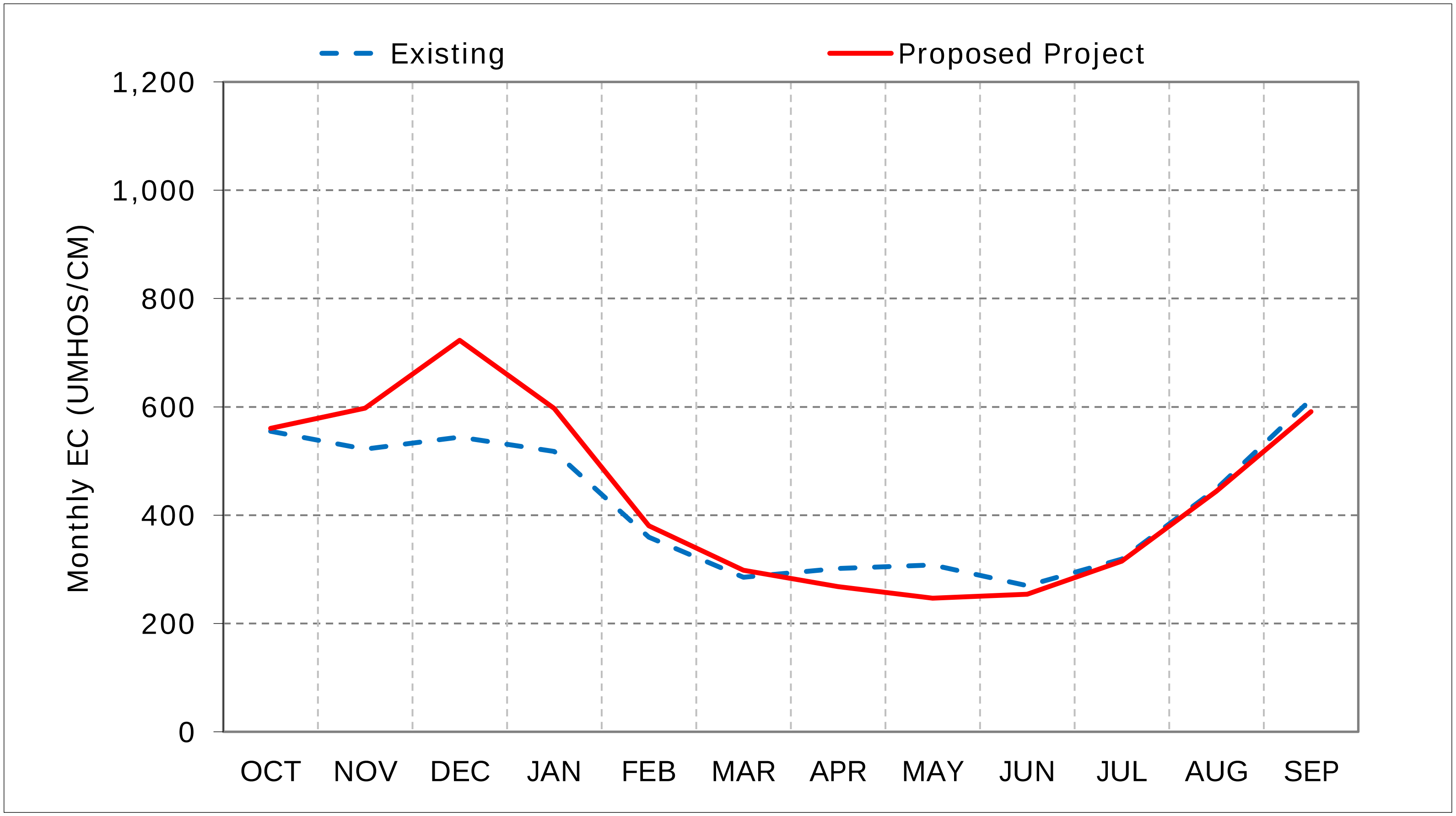
a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

c These results are displayed with water year - year type sorting.

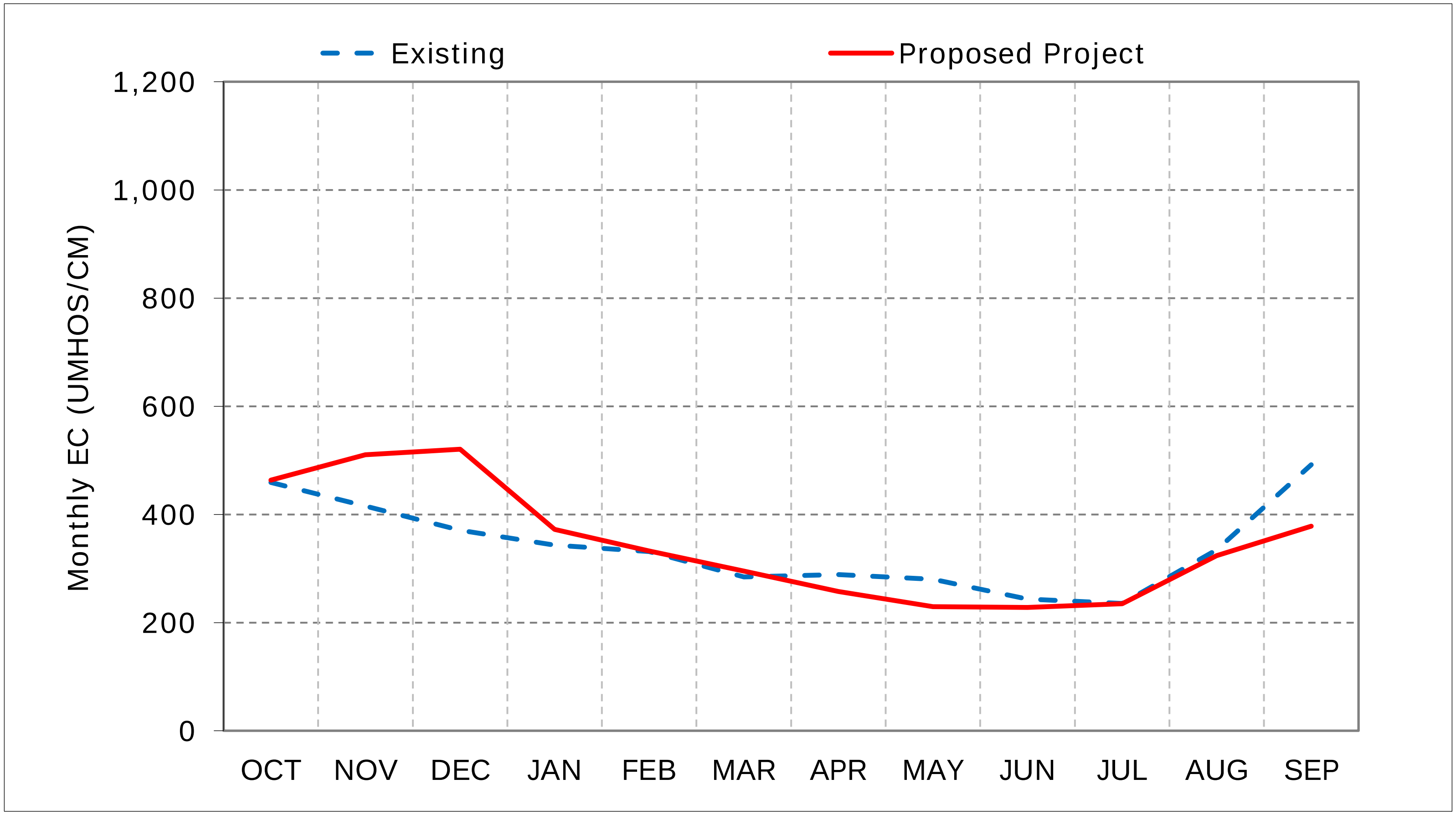
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 15-1. Old River at Rock Slough Salinity, Long-Term Average EC



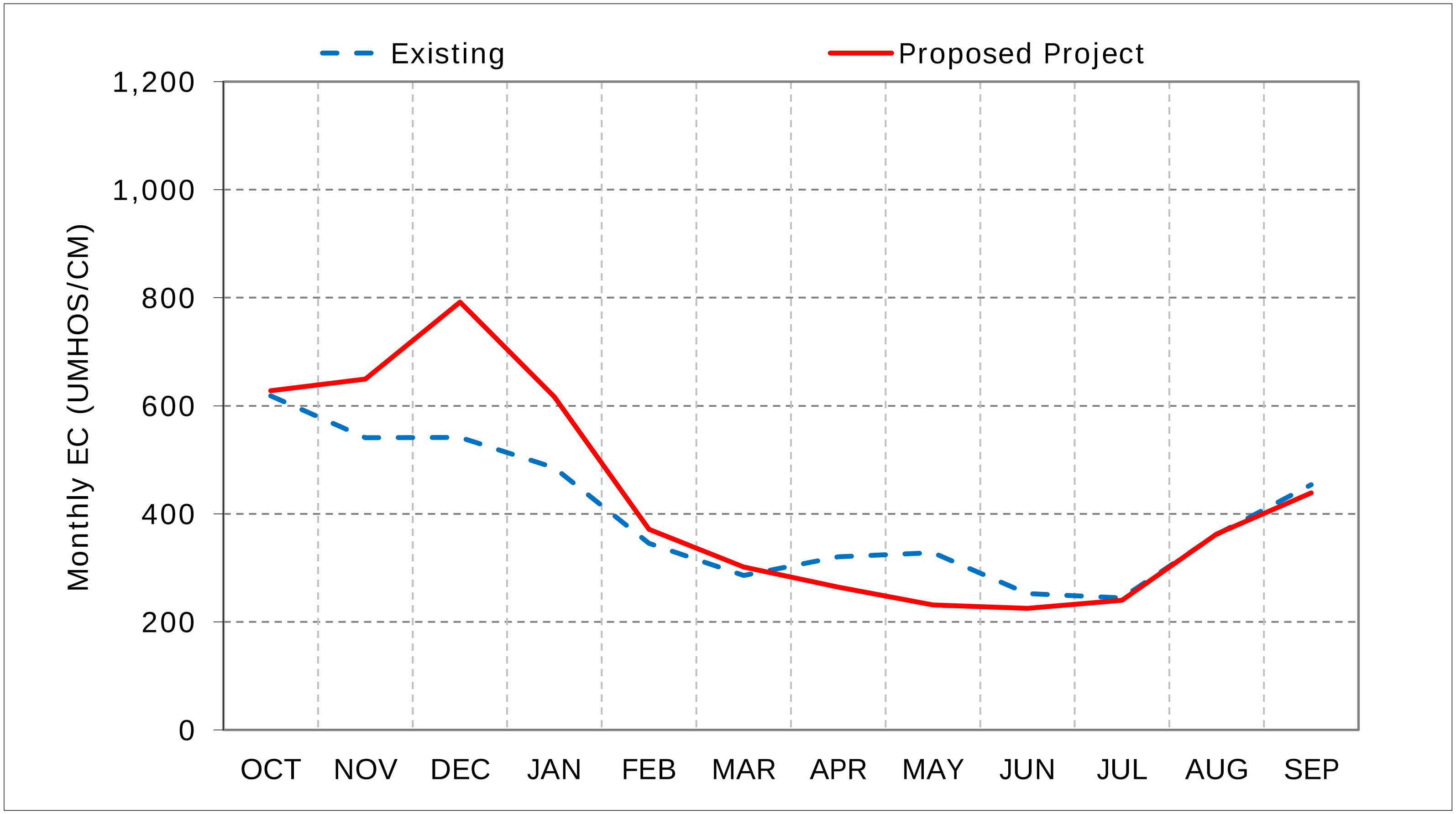
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 15-2. Old River at Rock Slough Salinity, Wet Year Average EC



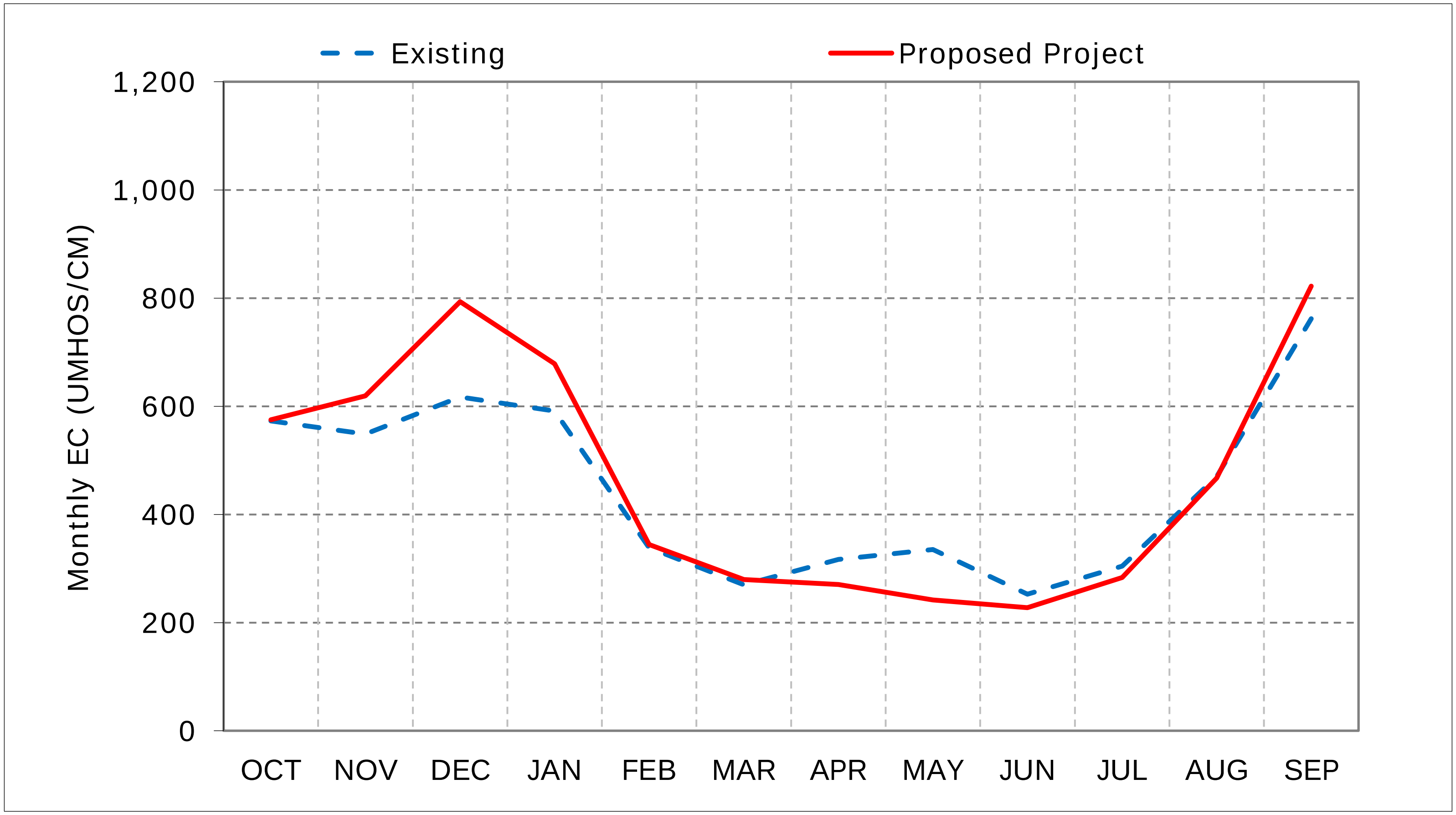
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 15-3. Old River at Rock Slough Salinity, Above Normal Year Average EC



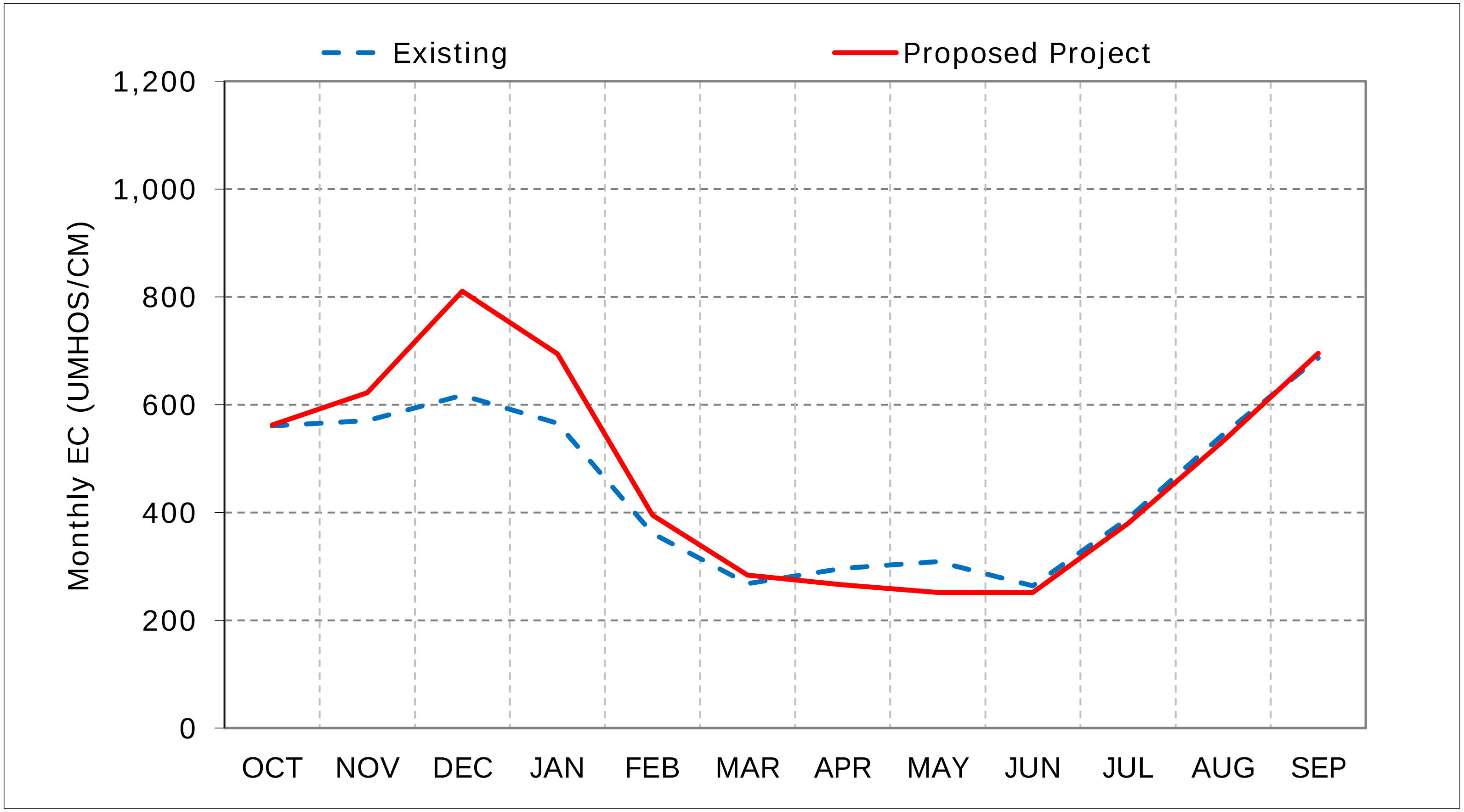
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 15-4. Old River at Rock Slough Salinity, Below Normal Year Average EC



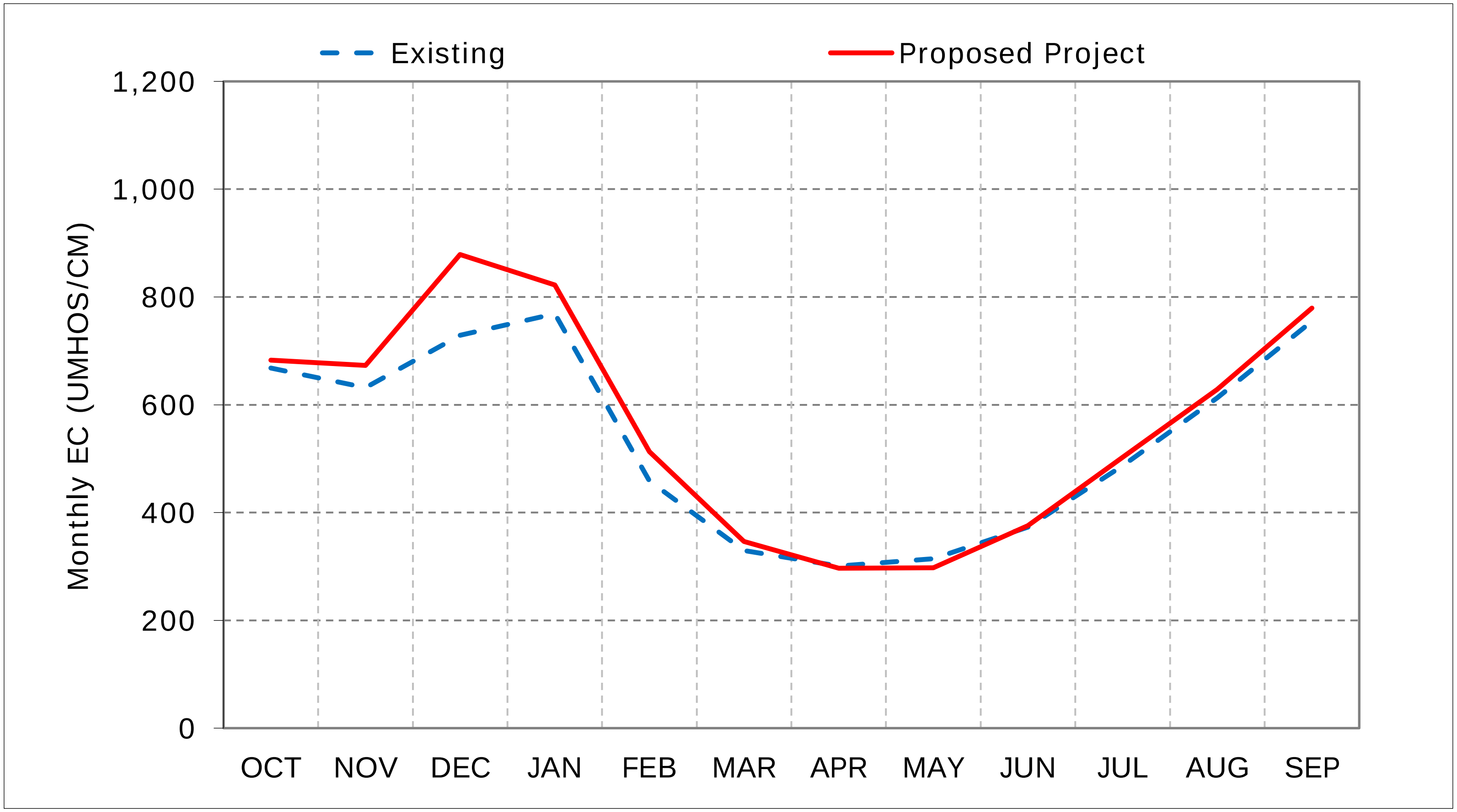
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 15-5. Old River at Rock Slough Salinity, Dry Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 15-6. Old River at Rock Slough Salinity, Critical Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 15-7. Old River at Rock Slough Salinity, January EC

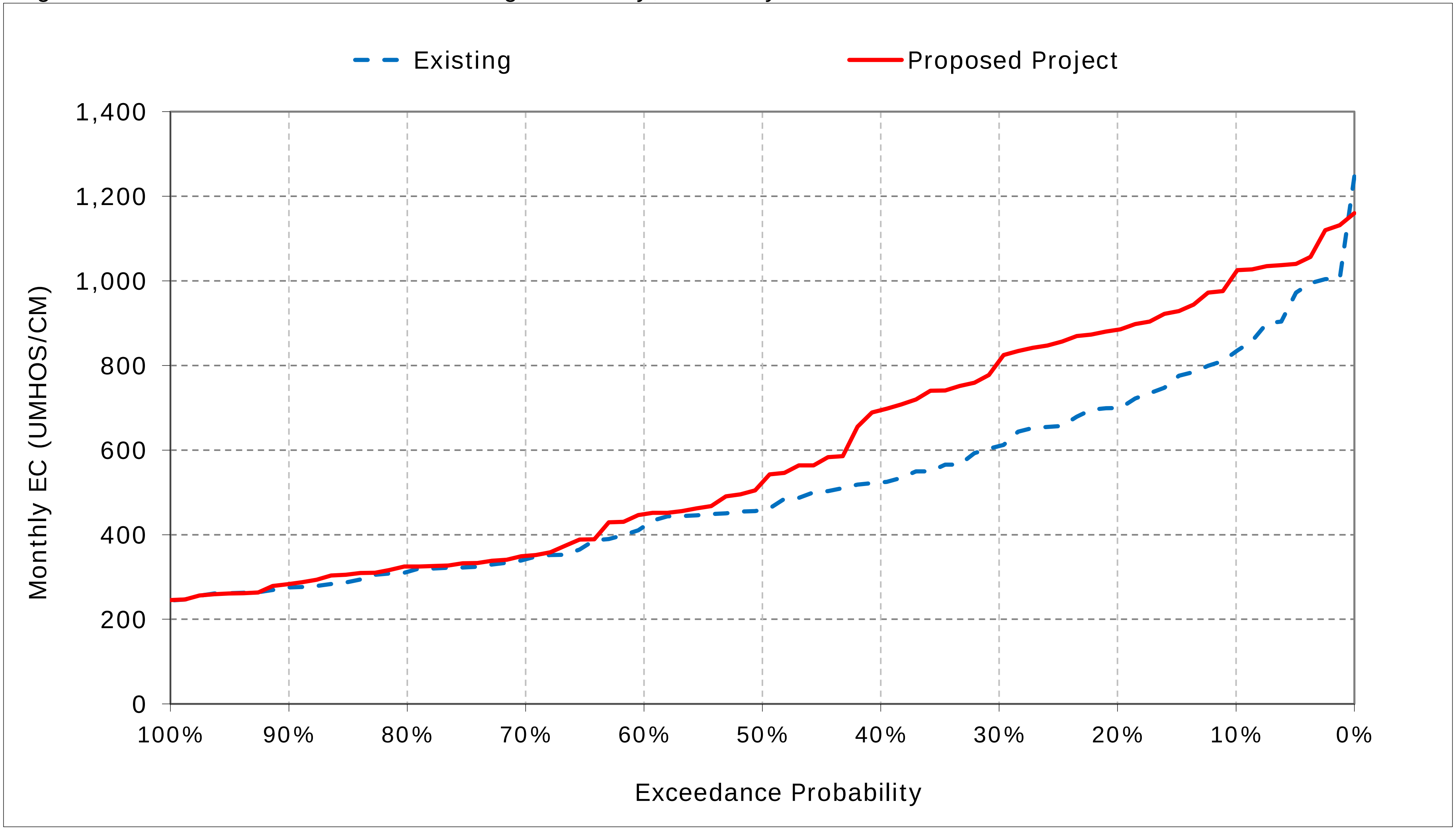


Figure 15-8. Old River at Rock Slough Salinity, February EC

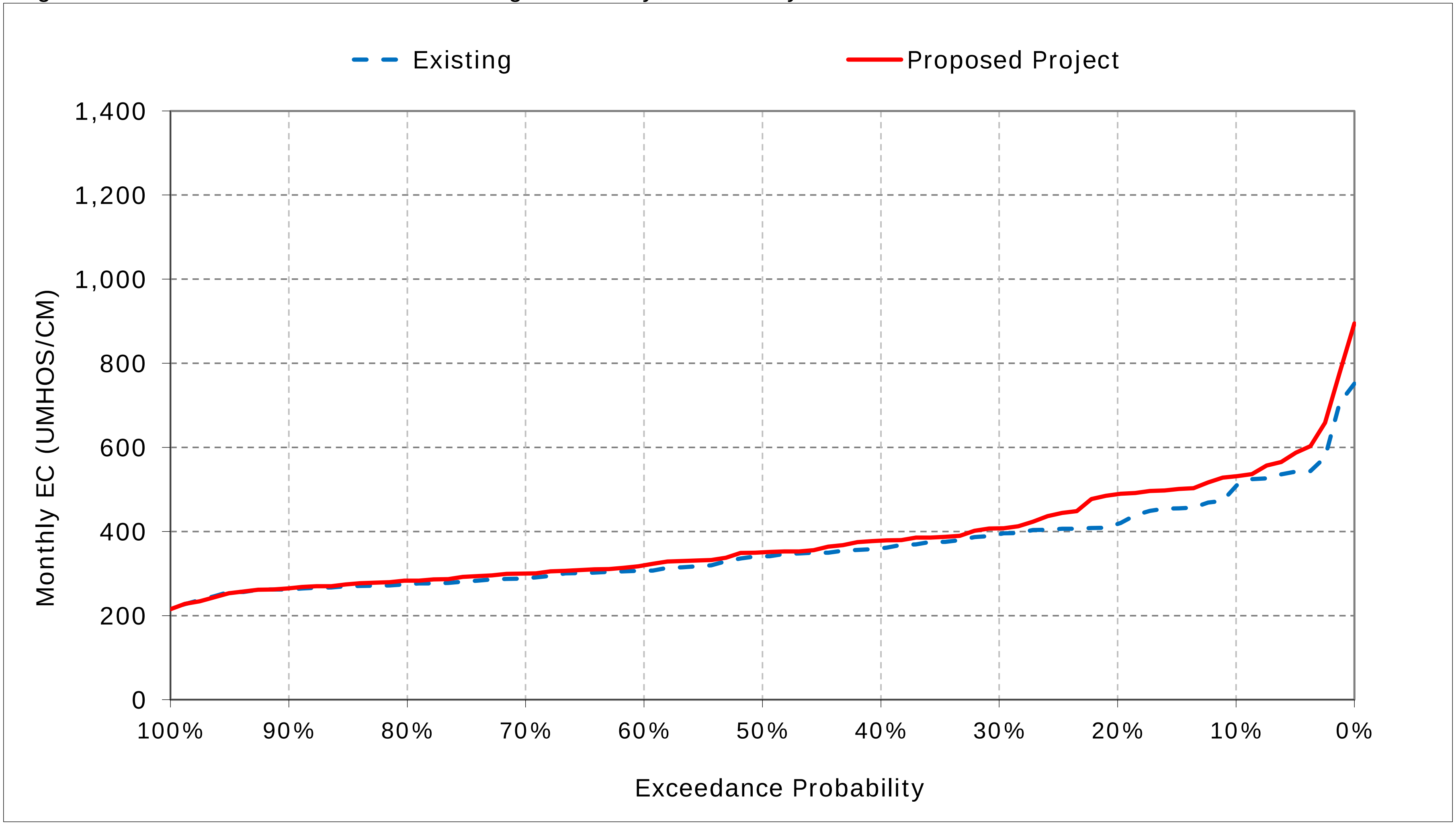


Figure 15-9. Old River at Rock Slough Salinity, March EC

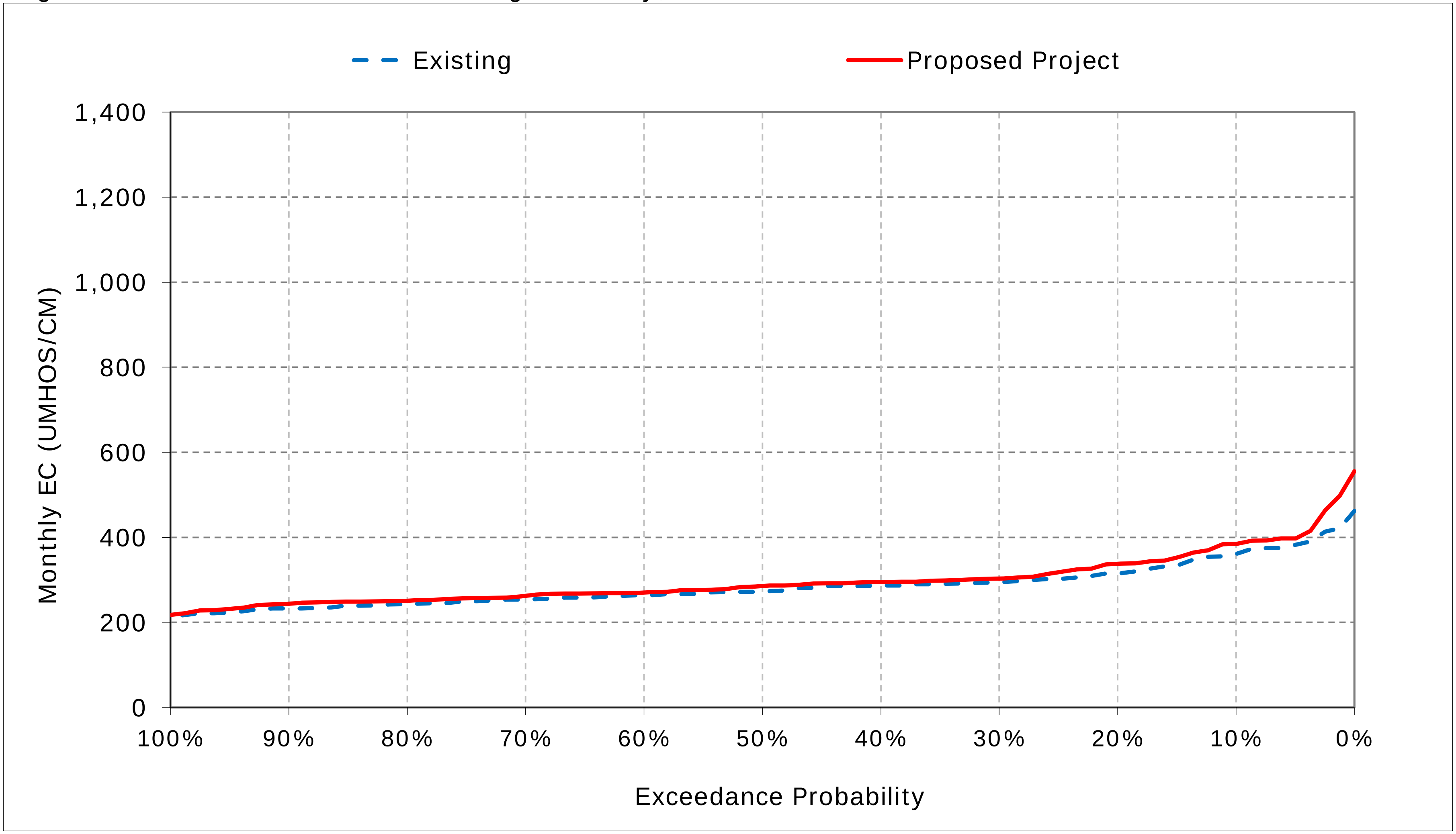


Figure 15-10. Old River at Rock Slough Salinity, April EC

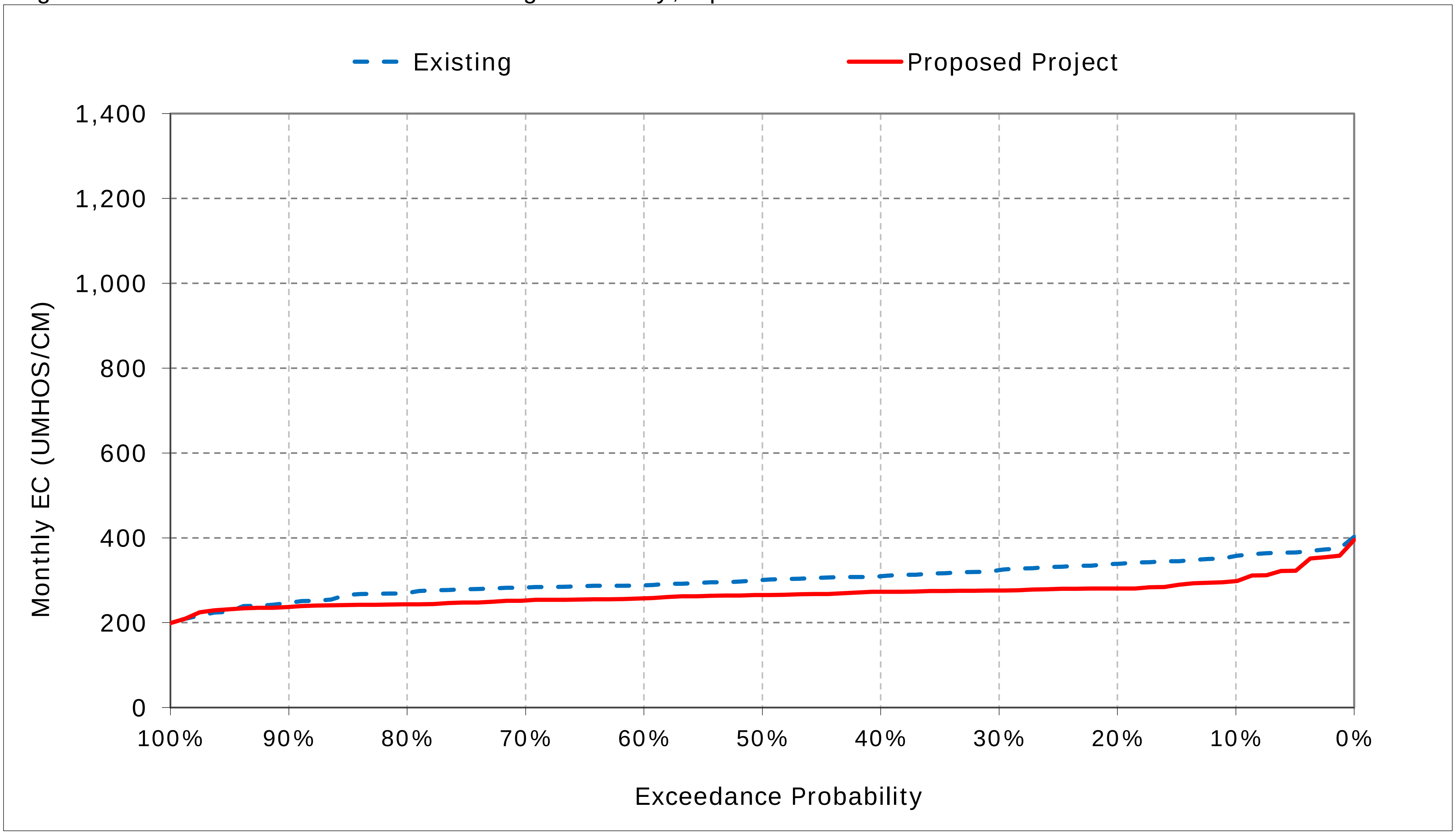


Figure 15-11. Old River at Rock Slough Salinity, May EC

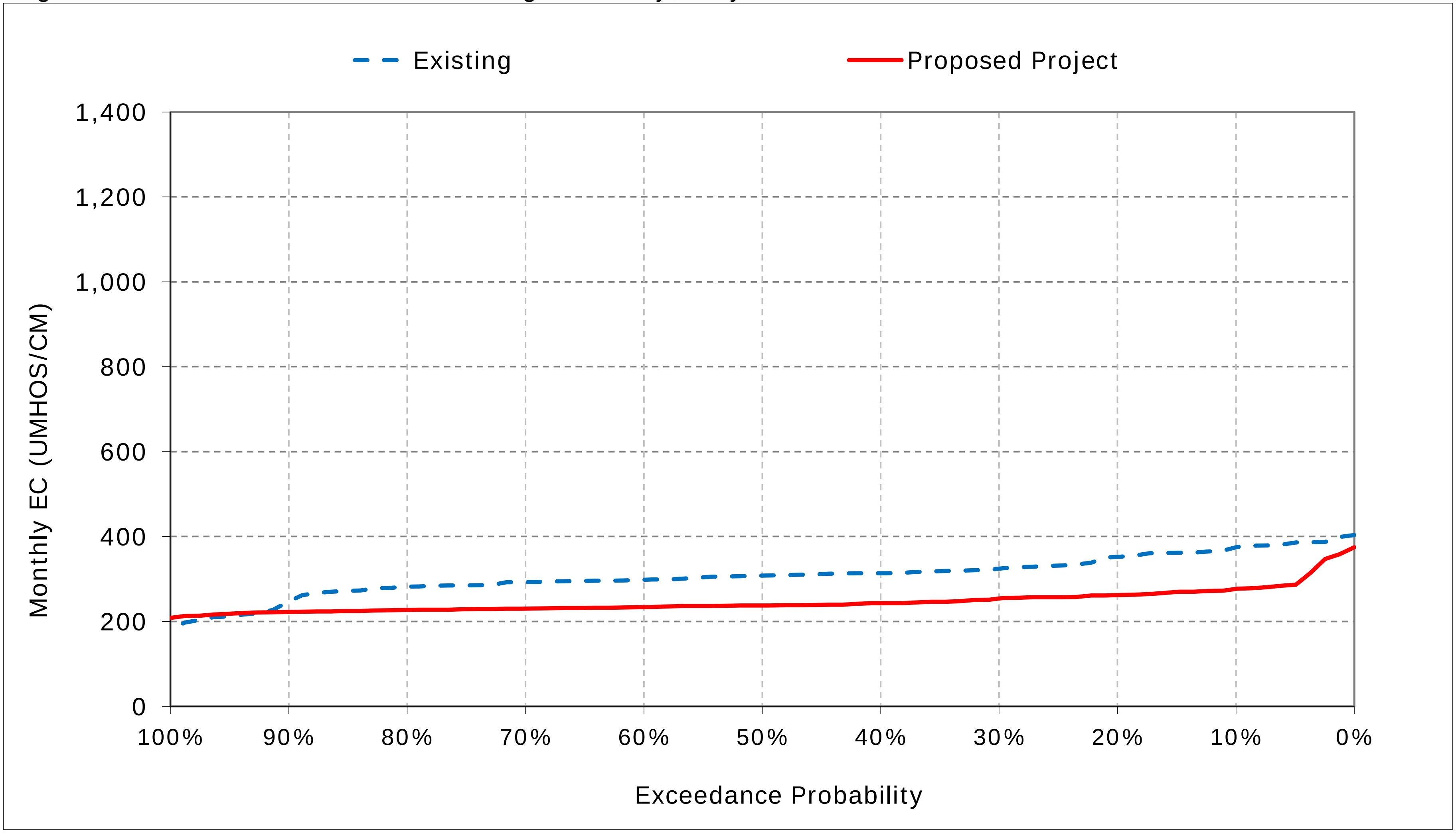


Figure 15-12. Old River at Rock Slough Salinity, June EC

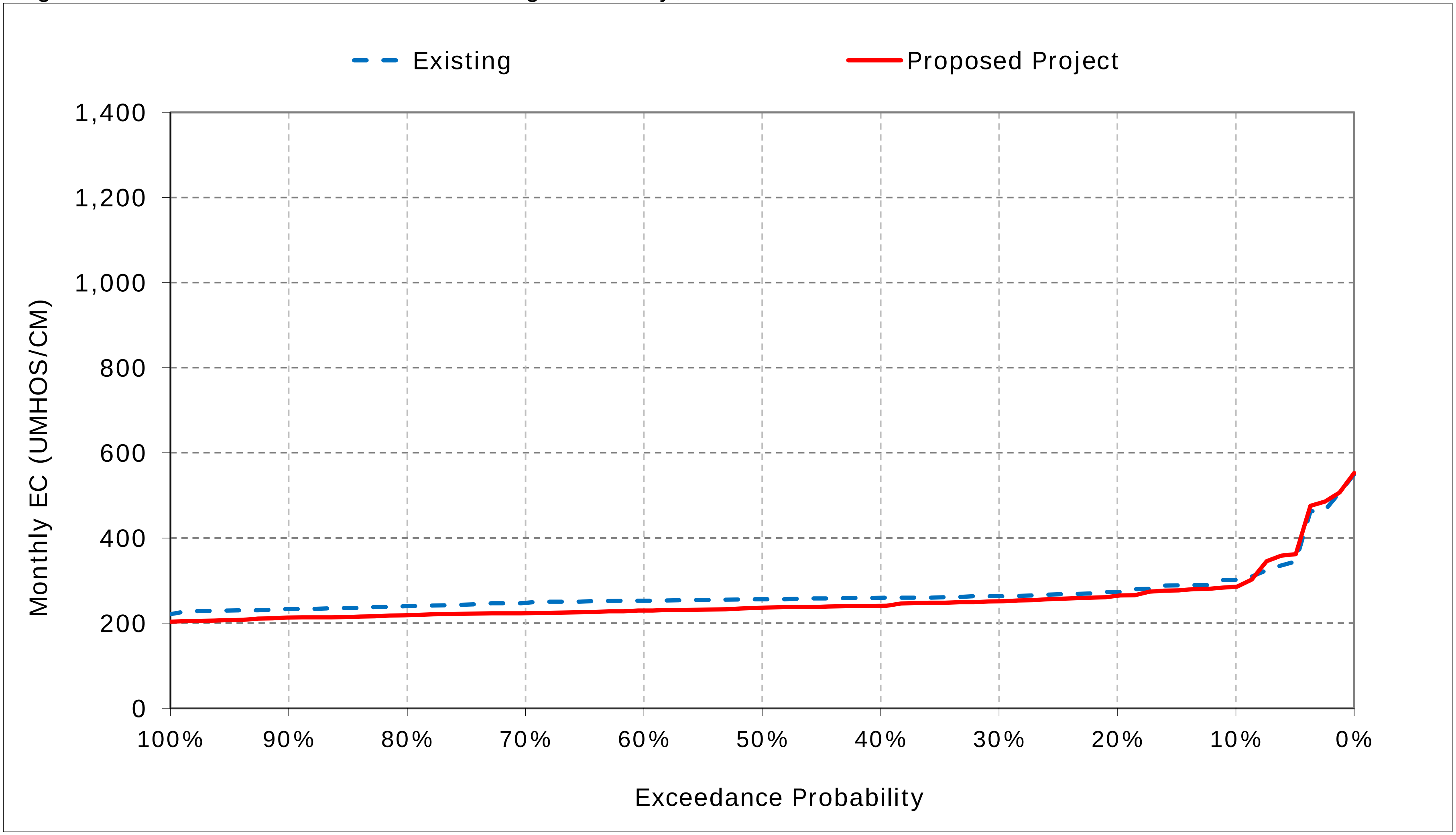


Figure 15-13. Old River at Rock Slough Salinity, July EC

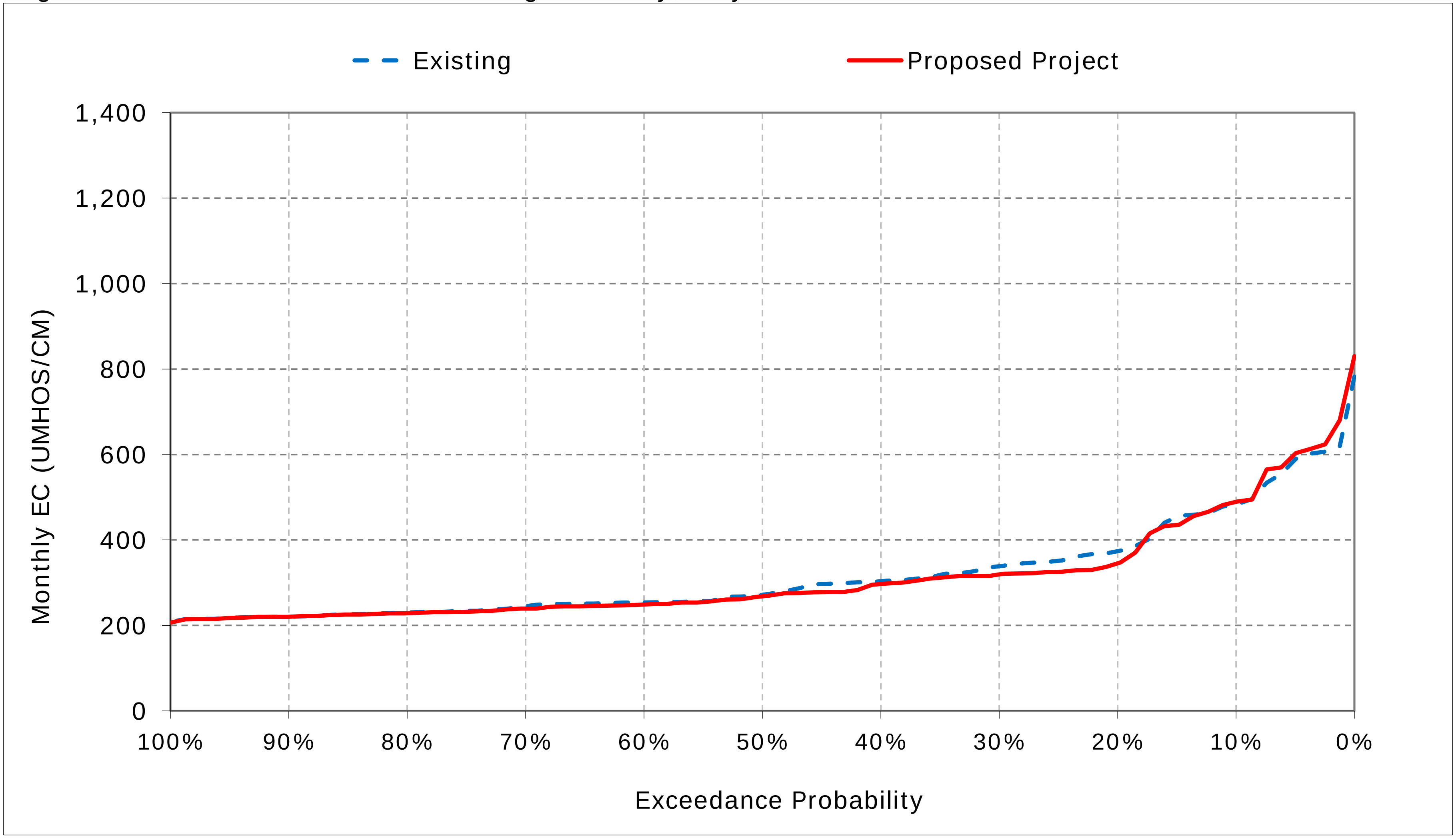


Figure 15-14. Old River at Rock Slough Salinity, August EC

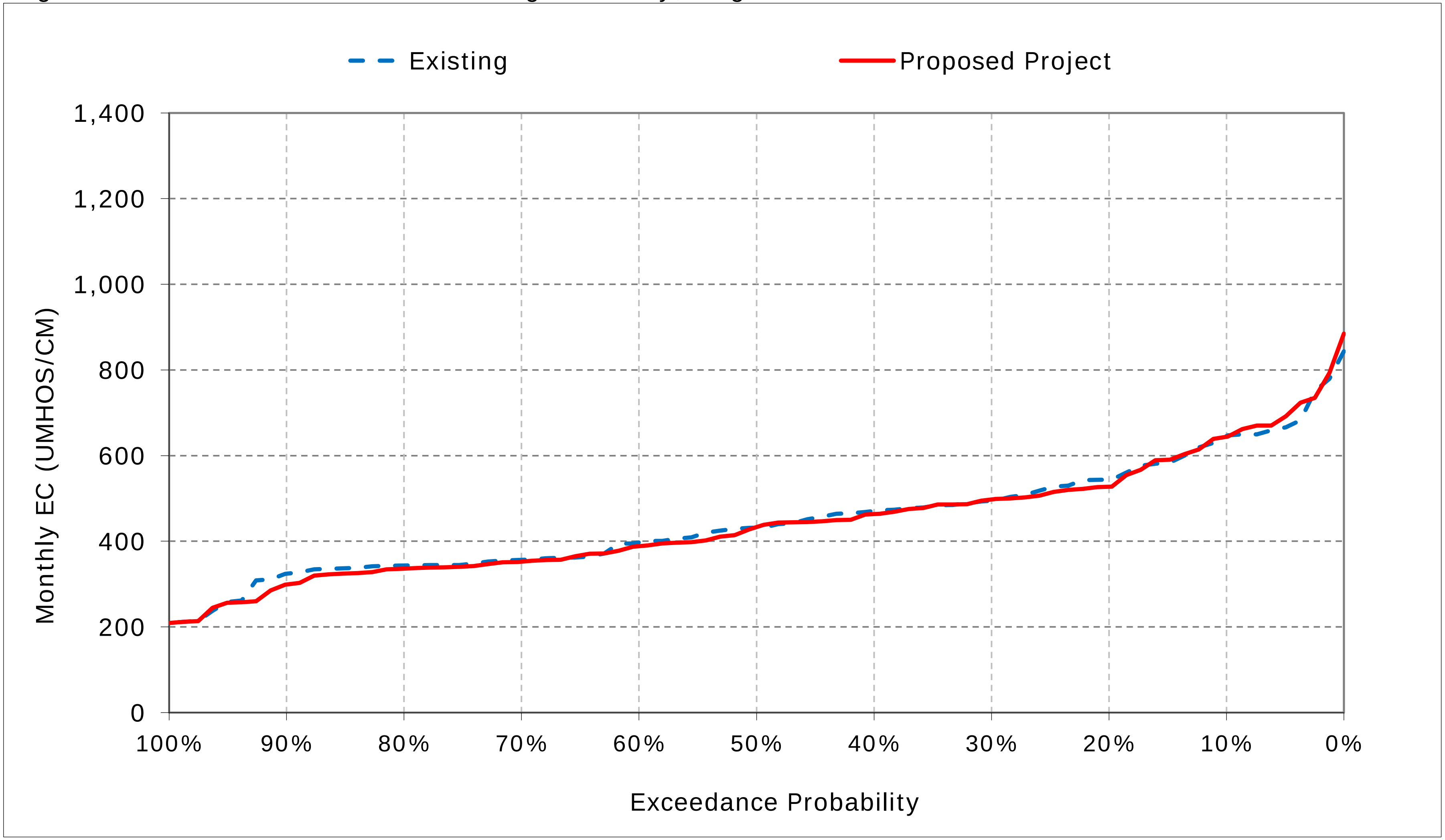


Figure 15-15. Old River at Rock Slough Salinity, September EC

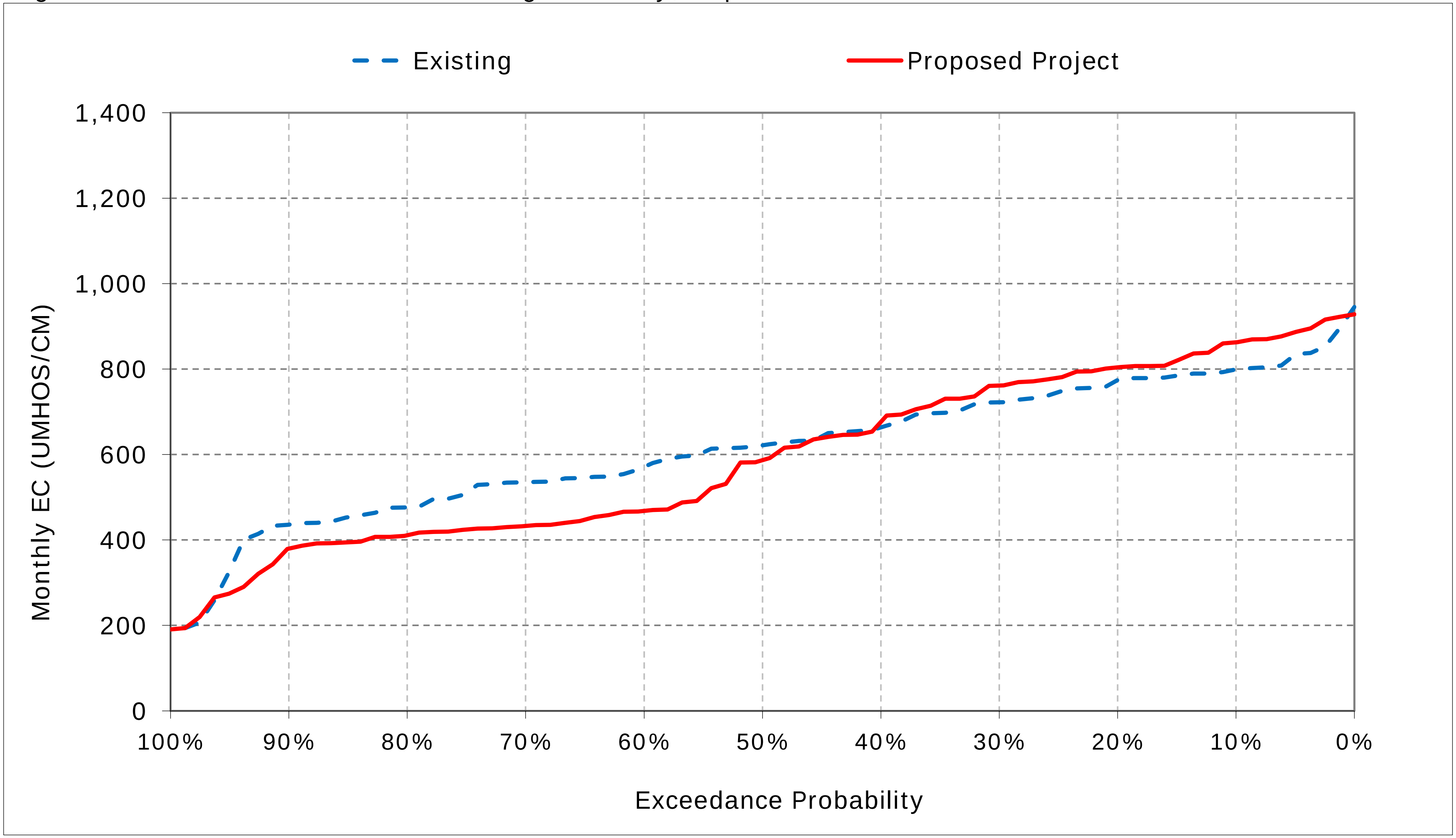


Figure 15-16. Old River at Rock Slough Salinity, October EC

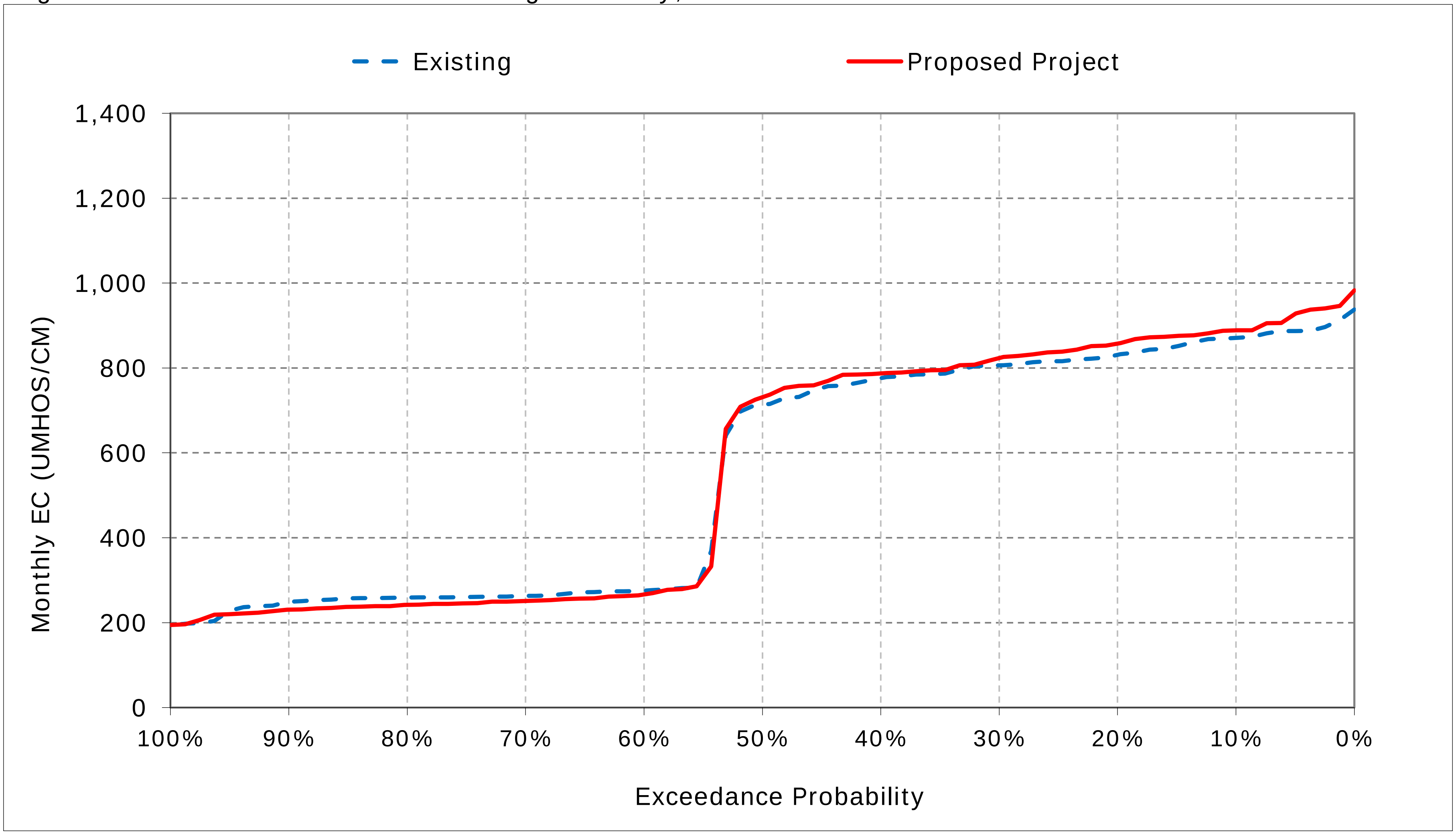


Figure 15-17. Old River at Rock Slough Salinity, November EC

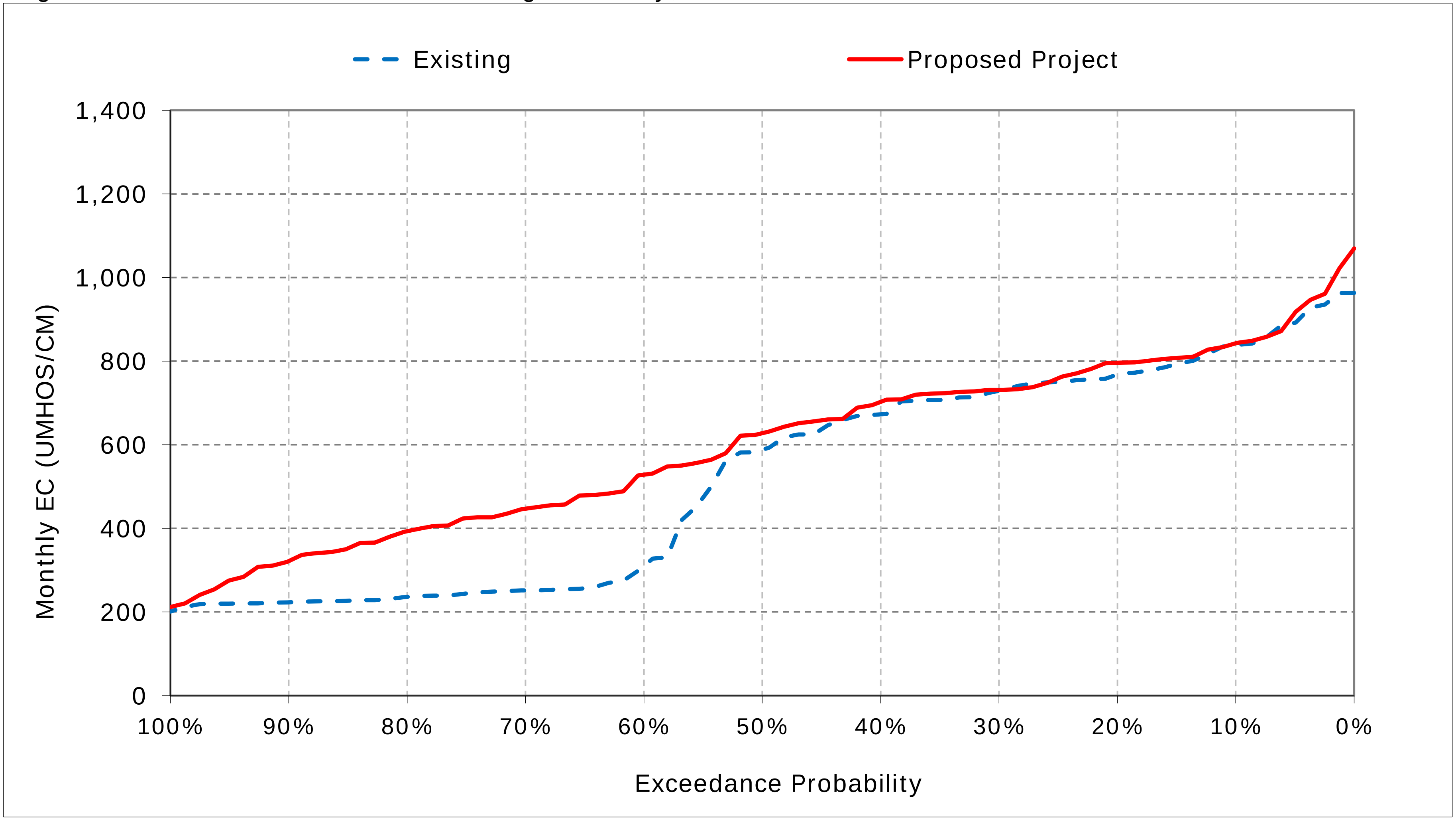


Figure 15-18. Old River at Rock Slough Salinity, December EC

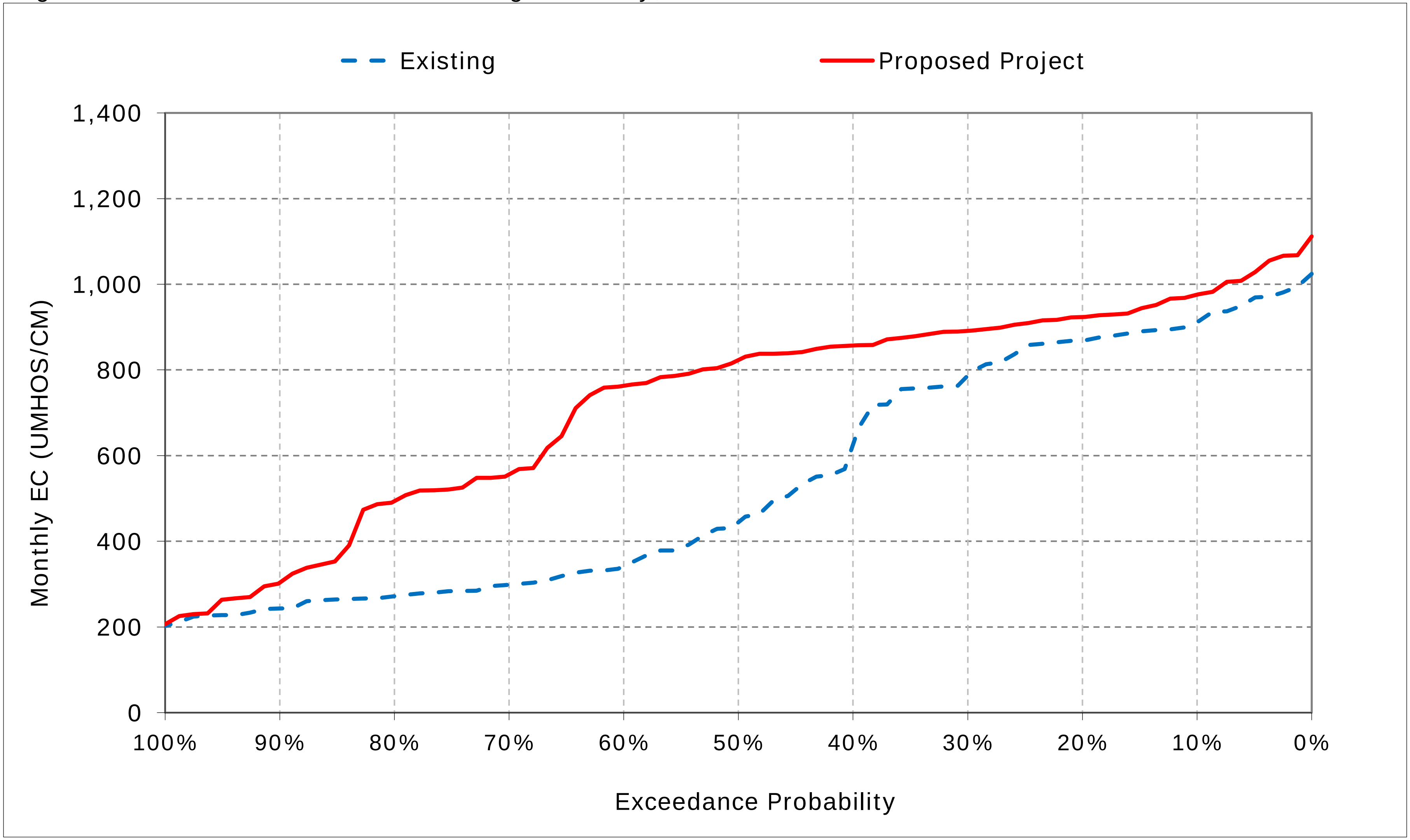


Table 16-1. Banks Pumping Plant South Delta Exports Salinity, Monthly EC

Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	667	668	727	769	621	518	467	469	430	401	532	593
20%	641	604	685	726	567	454	433	442	384	367	435	566
30%	625	592	660	604	520	432	407	427	370	322	393	545
40%	599	570	603	561	503	409	390	414	364	315	380	530
50%	572	549	441	516	461	392	377	397	354	310	351	496
60%	357	336	371	491	443	380	360	385	347	300	328	472
70%	336	311	329	455	418	361	346	360	341	282	311	456
80%	314	301	305	418	398	336	310	334	325	274	304	427
90%	296	294	294	384	346	311	267	230	294	266	293	401
Long Term												
Full Simulation Period[a]	486	469	499	555	477	401	372	381	358	323	376	490
Water Year Types[b]												
Wet (32%)	433	403	409	434	393	337	299	300	312	282	303	437
Above Normal (15%)	528	500	500	554	494	396	362	374	348	285	310	412
Below Normal (17%)	500	478	533	618	483	404	384	398	354	298	382	565
Dry (22%)	484	489	540	582	510	434	420	433	377	341	445	518
Critical (15%)	546	545	589	706	586	487	458	462	447	451	488	555

Proposed Project

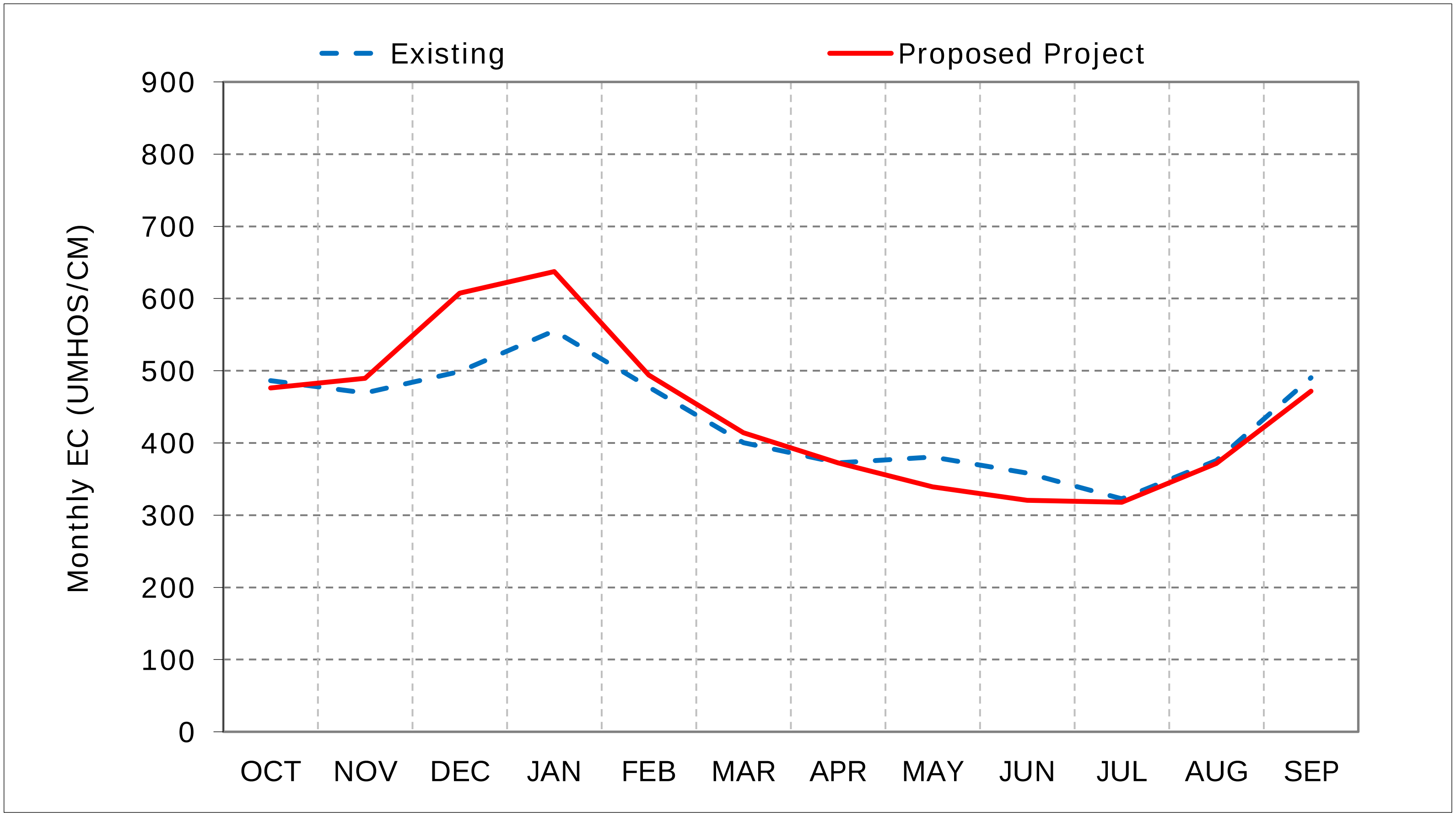
Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	699	653	750	912	684	524	452	423	378	399	533	608
20%	660	630	708	850	615	484	434	391	338	357	416	585
30%	636	591	694	764	558	461	410	376	324	320	389	549
40%	598	580	666	721	518	430	396	347	313	312	373	497
50%	588	558	644	600	502	404	384	332	308	301	348	456
60%	295	395	626	531	444	391	350	320	305	295	328	424
70%	287	363	579	494	419	368	333	311	294	280	310	399
80%	280	331	499	432	388	337	311	302	287	265	303	386
90%	274	310	347	399	337	321	283	257	281	260	284	361
Long Term												
Full Simulation Period[a]	476	490	607	637	494	414	372	339	321	318	371	472
Water Year Types[b]												
Wet (32%)	418	428	507	469	390	342	297	272	288	280	298	361
Above Normal (15%)	520	543	657	698	520	415	356	315	300	277	310	405
Below Normal (17%)	483	495	632	705	495	416	382	340	303	288	375	596
Dry (22%)	473	499	648	701	543	456	427	383	328	336	434	519
Critical (15%)	554	549	685	766	619	503	457	443	421	448	494	565

Proposed Project minus Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	32	-15	23	143	63	6	-16	-47	-52	-3	1	15
20%	19	26	23	124	48	30	1	-51	-46	-10	-19	19
30%	11	-1	34	160	38	29	3	-52	-46	-3	-4	5
40%	-2	10	64	160	15	21	5	-67	-51	-3	-7	-32
50%	16	8	202	84	41	12	7	-64	-47	-8	-2	-40
60%	-62	59	255	39	1	11	-10	-65	-43	-5	1	-47
70%	-49	52	250	39	0	6	-13	-49	-47	-2	-1	-56
80%	-34	30	194	14	-11	0	2	-32	-38	-9	0	-41
90%	-22	16	53	15	-9	11	16	26	-13	-6	-9	-40
Long Term												
Full Simulation Period[a]	-10	20	109	82	17	13	0	-41	-38	-5	-4	-18
Water Year Types[b]												
Wet (32%)	-15	25	98	35	-3	4	-1	-28	-23	-1	-5	-76
Above Normal (15%)	-9	43	156	145	26	19	-6	-59	-47	-8	1	-8
Below Normal (17%)	-16	17	100	87	12	12	-2	-59	-51	-11	-7	31
Dry (22%)	-11	11	109	119	33	22	8	-50	-49	-4	-11	1
Critical (15%)	9	4	96	60	33	16	-1	-19	-26	-3	5	10

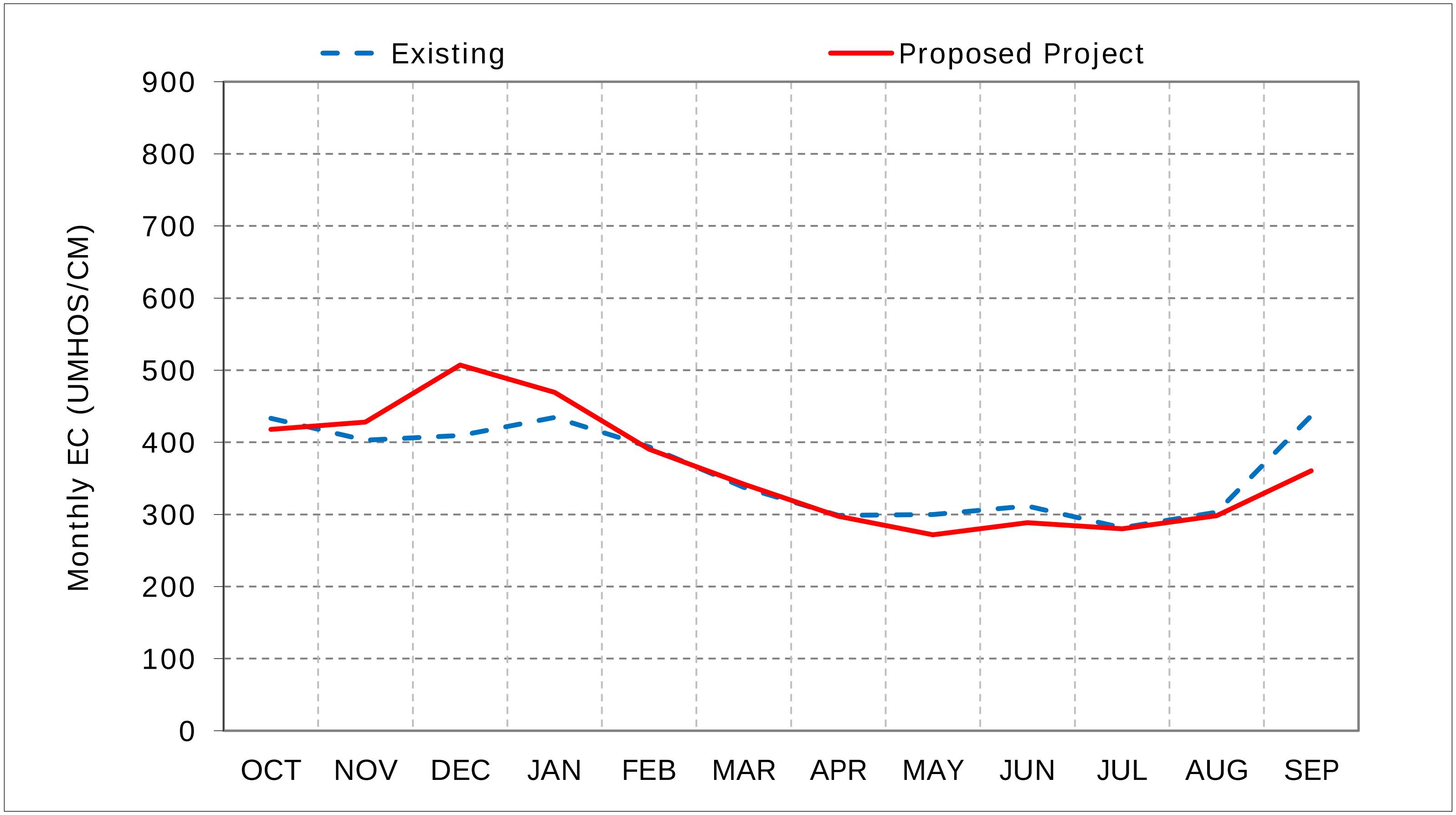
a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with water year - year type sorting.
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 16-1. Banks Pumping Plant South Delta Exports Salinity, Long-Term Averag



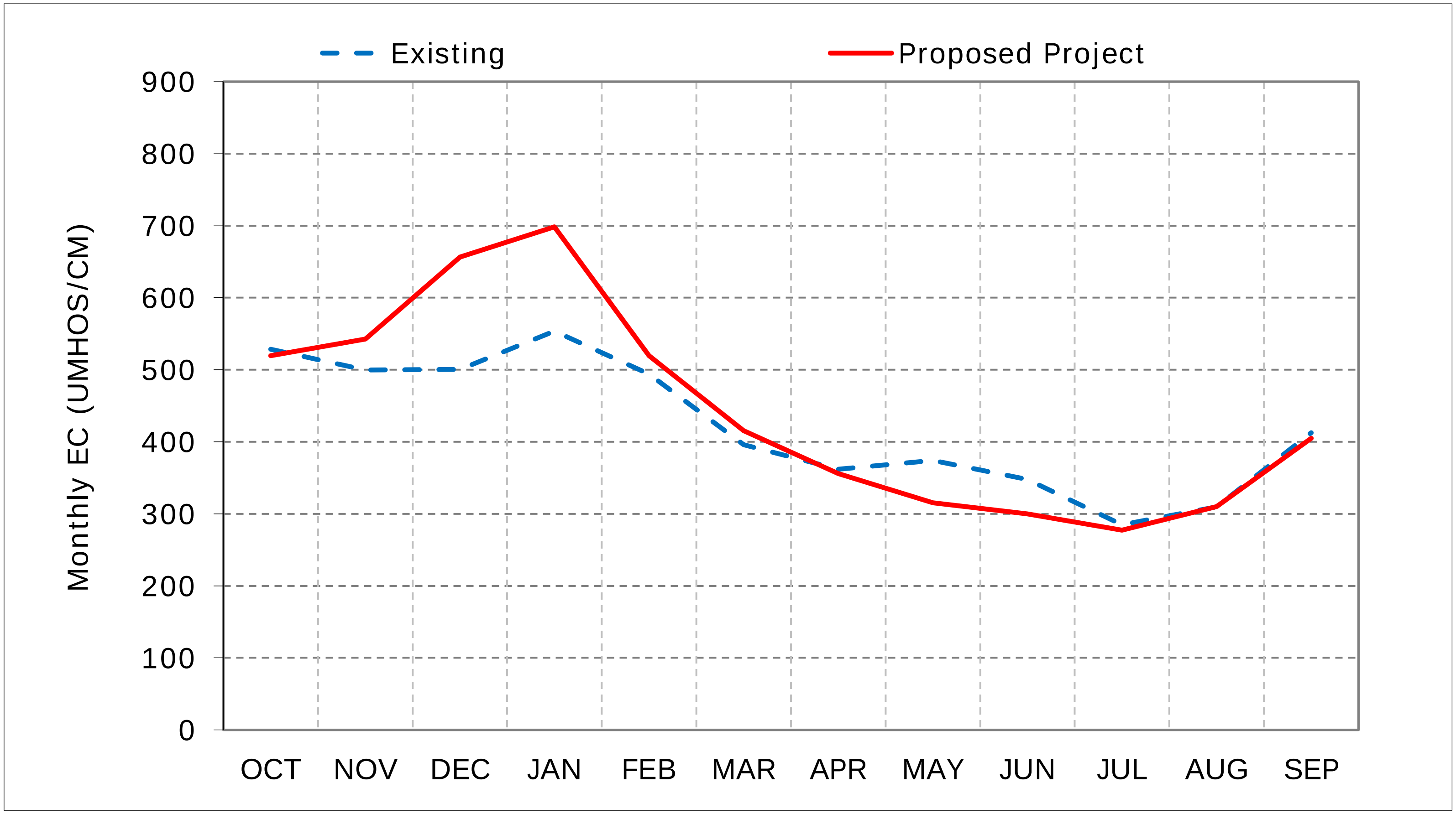
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 16-2. Banks Pumping Plant South Delta Exports Salinity, Wet Year Average



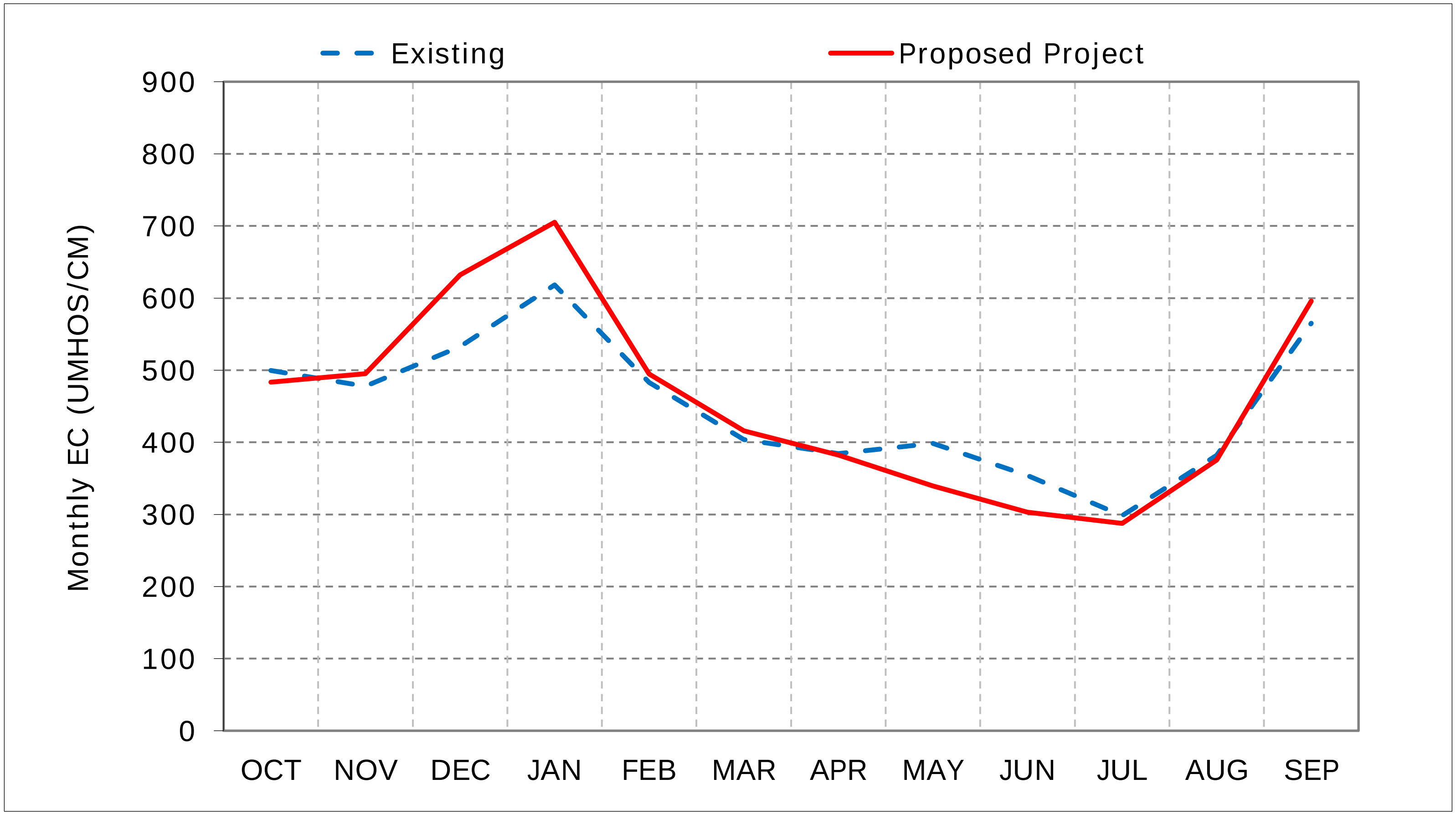
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 16-3. Banks Pumping Plant South Delta Exports Salinity, Above Normal Yea



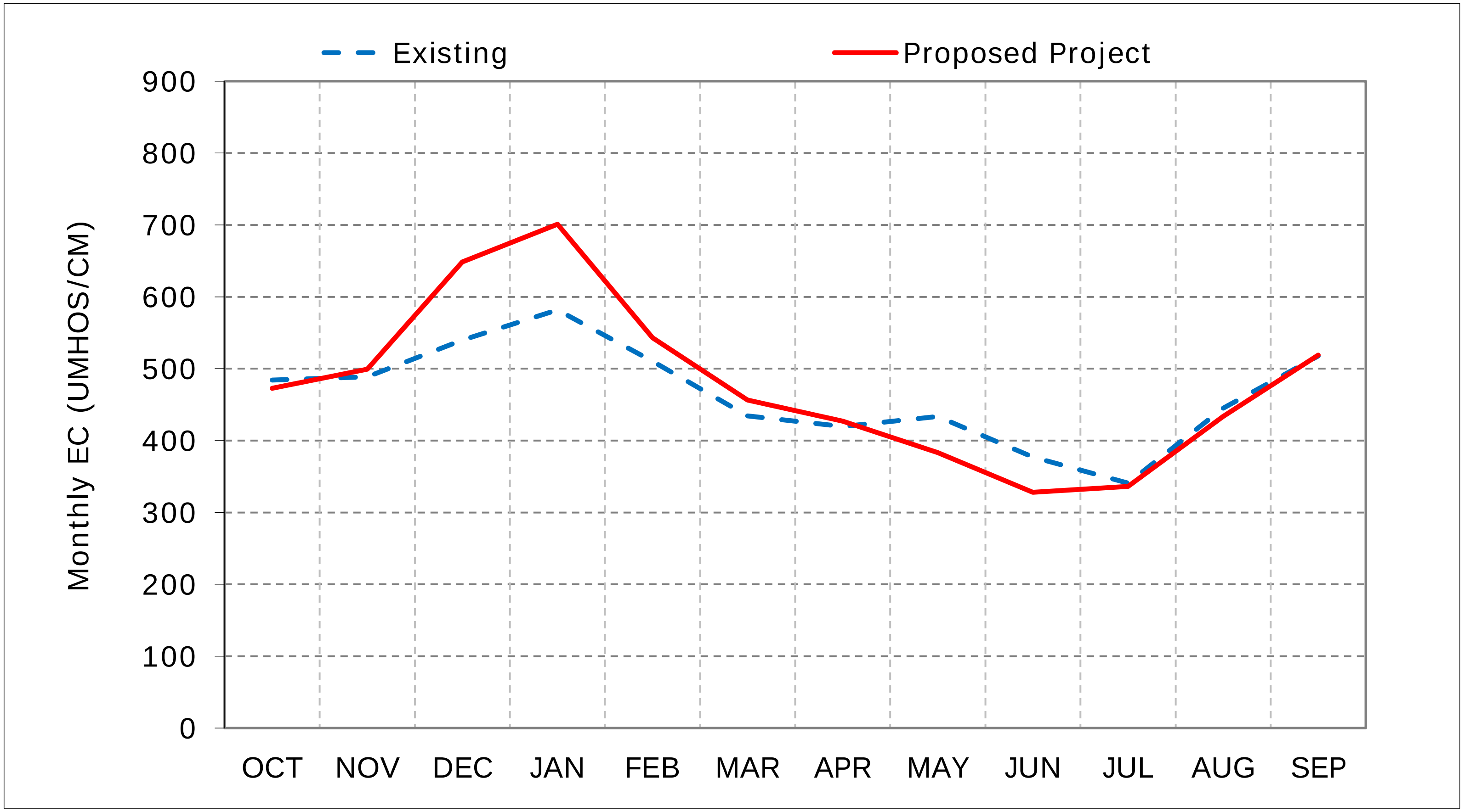
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 16-4. Banks Pumping Plant South Delta Exports Salinity, Below Normal Yea



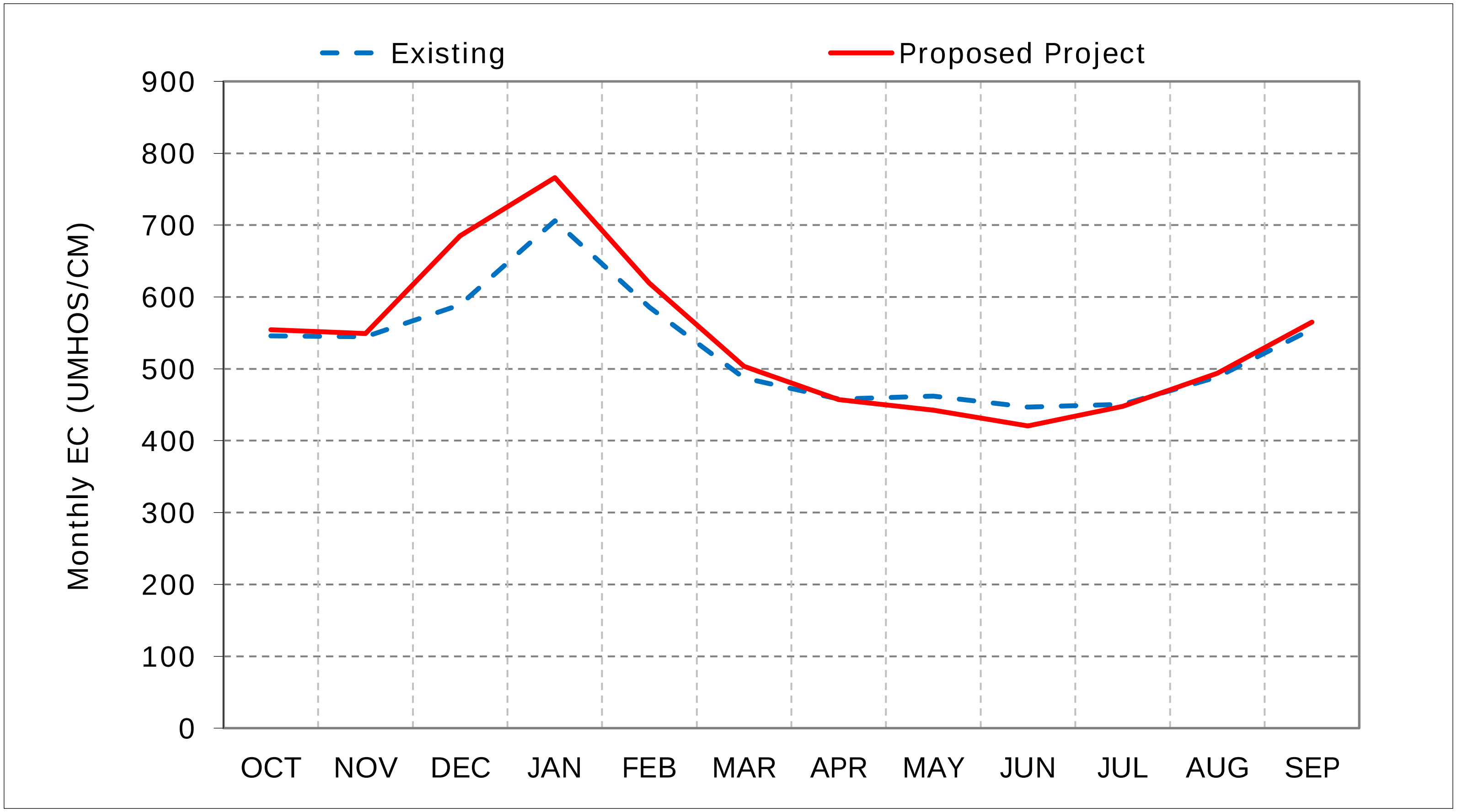
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 16-5. Banks Pumping Plant South Delta Exports Salinity, Dry Year Average



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 16-6. Banks Pumping Plant South Delta Exports Salinity, Critical Year Avera



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 16-7. Banks Pumping Plant South Delta Exports Salinity, January EC

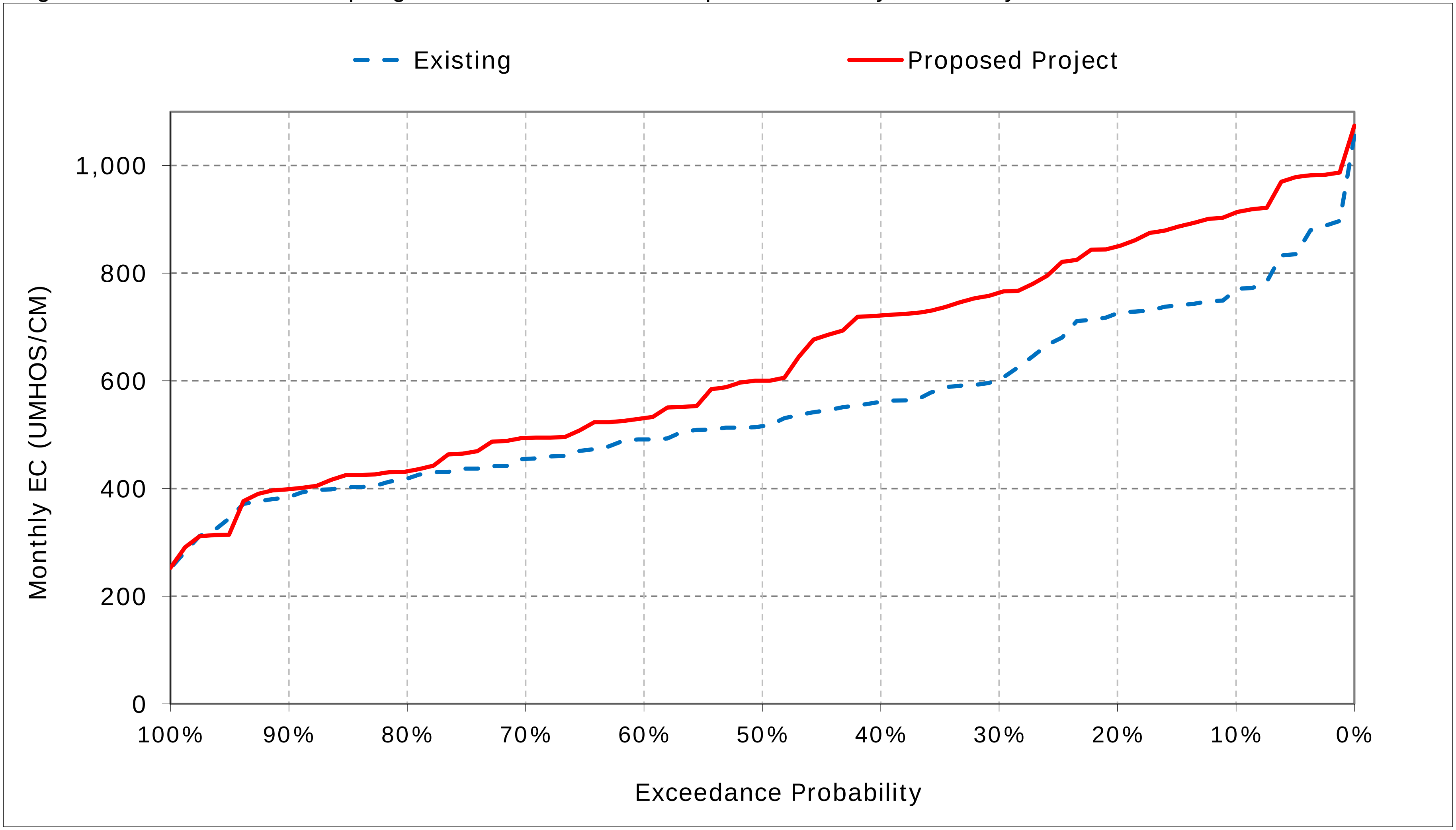


Figure 16-8. Banks Pumping Plant South Delta Exports Salinity, February EC

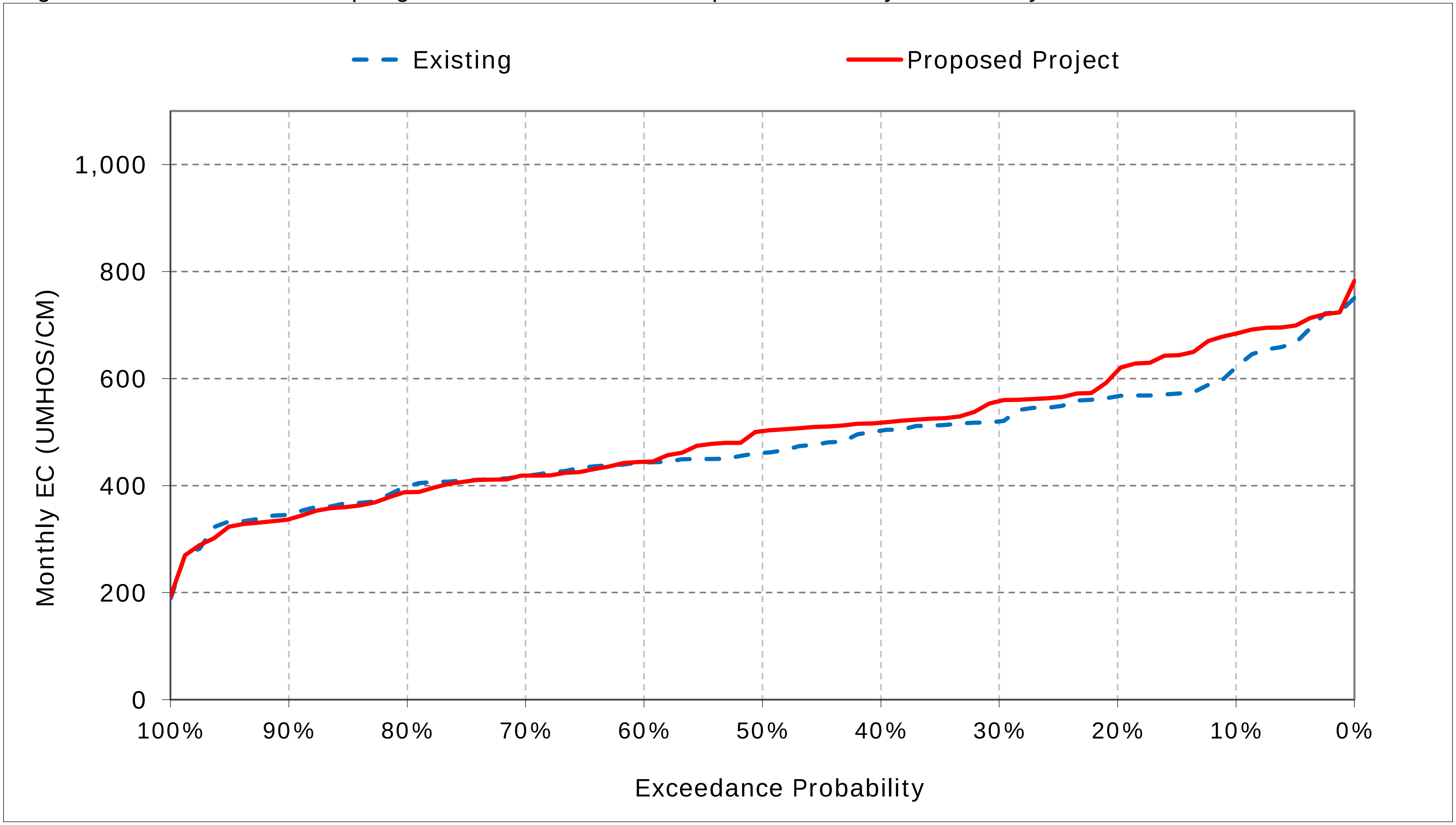


Figure 16-9. Banks Pumping Plant South Delta Exports Salinity, March EC

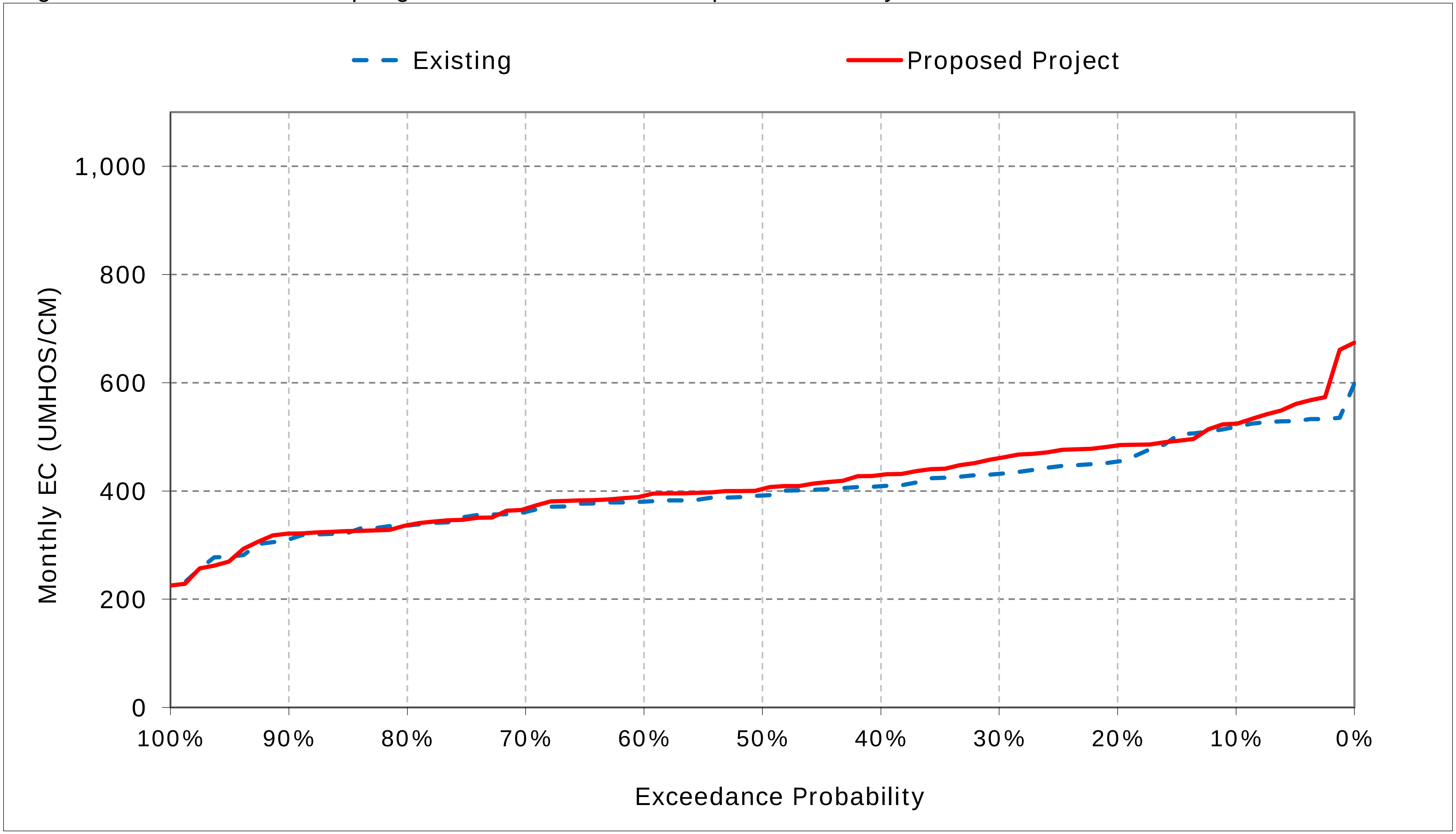


Figure 16-10. Banks Pumping Plant South Delta Exports Salinity, April EC

Figure 16-11. Banks Pumping Plant South Delta Exports Salinity, May EC

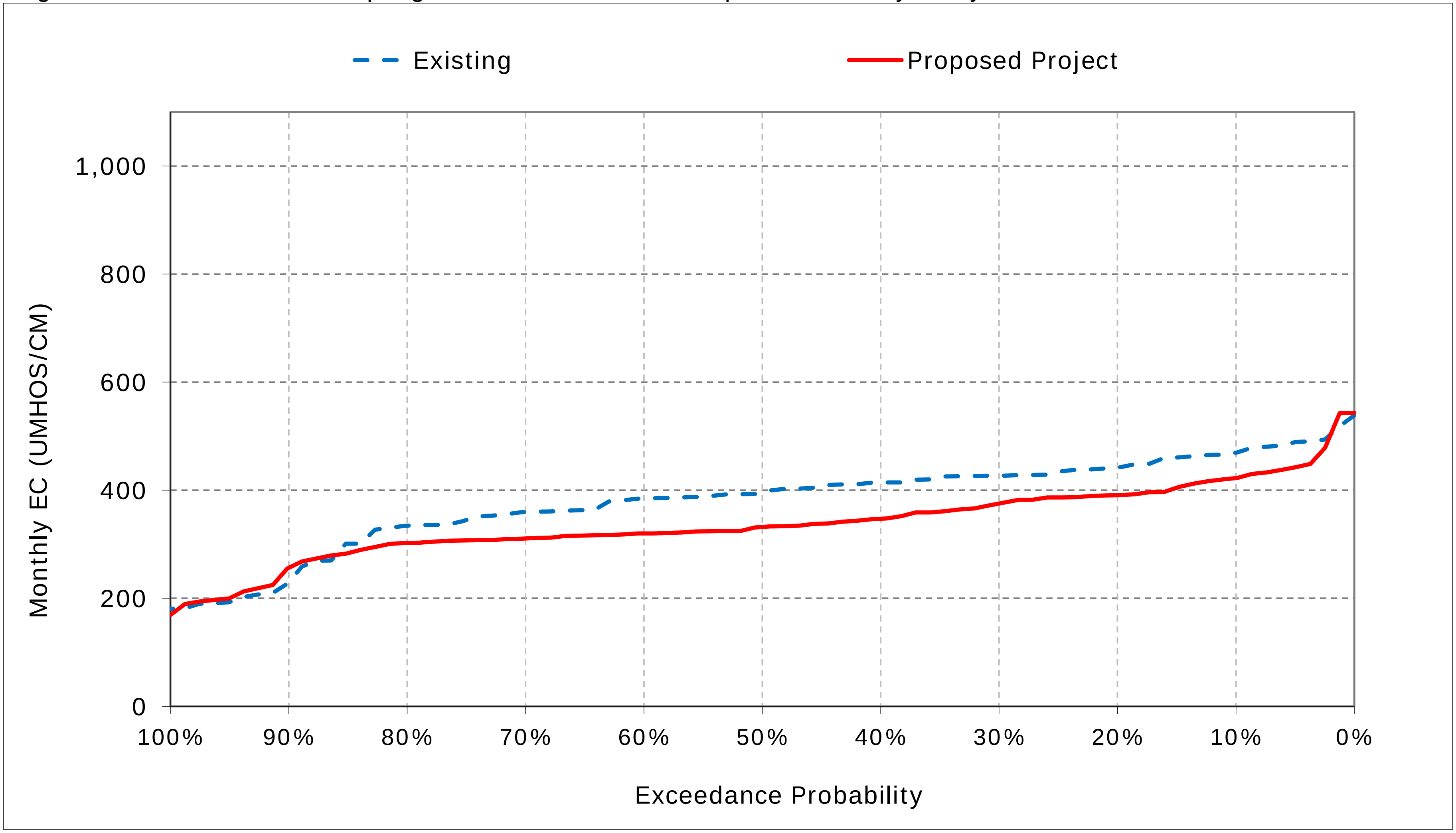


Figure 16-12. Banks Pumping Plant South Delta Exports Salinity, June EC

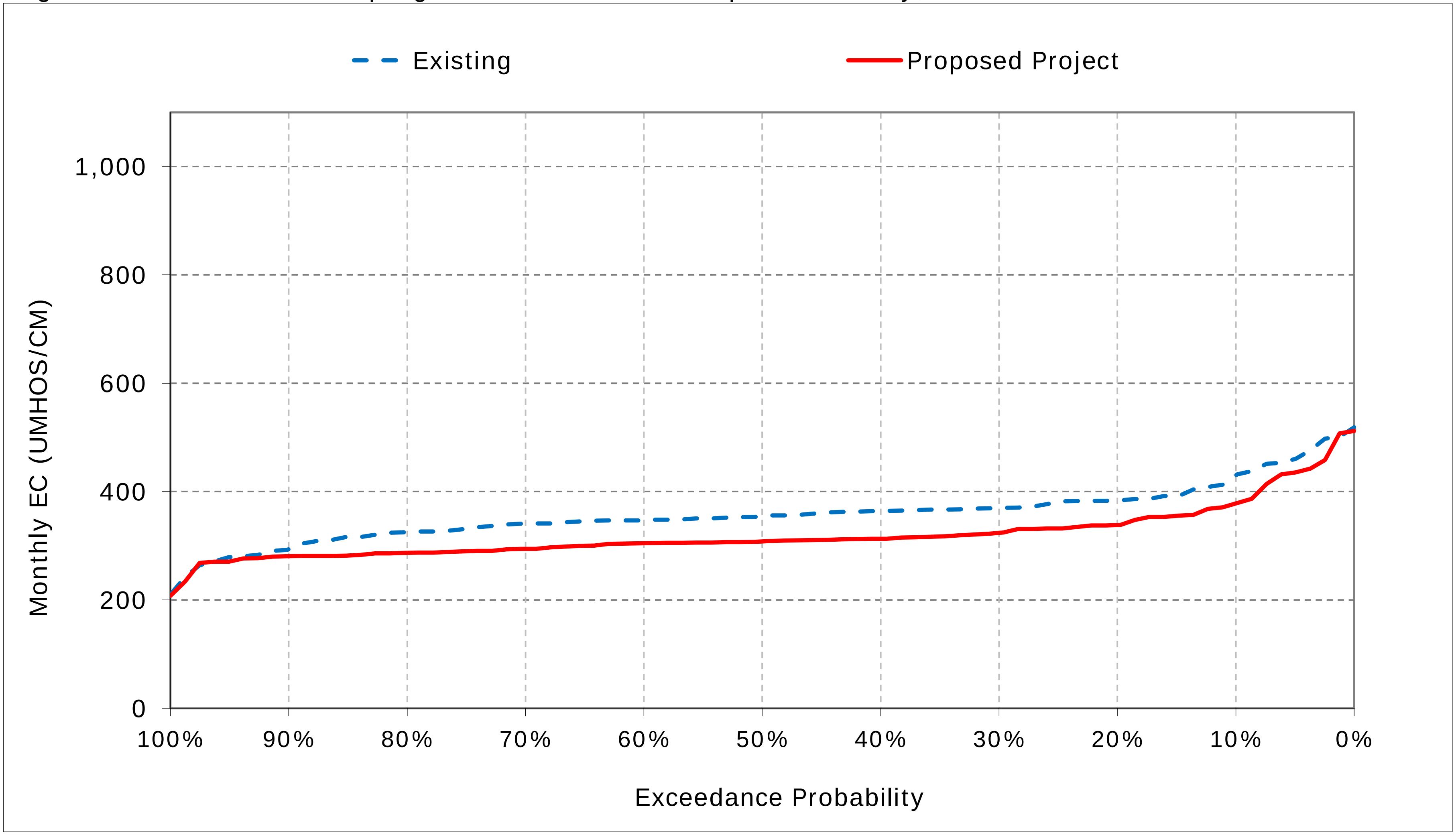


Figure 16-13. Banks Pumping Plant South Delta Exports Salinity, July EC

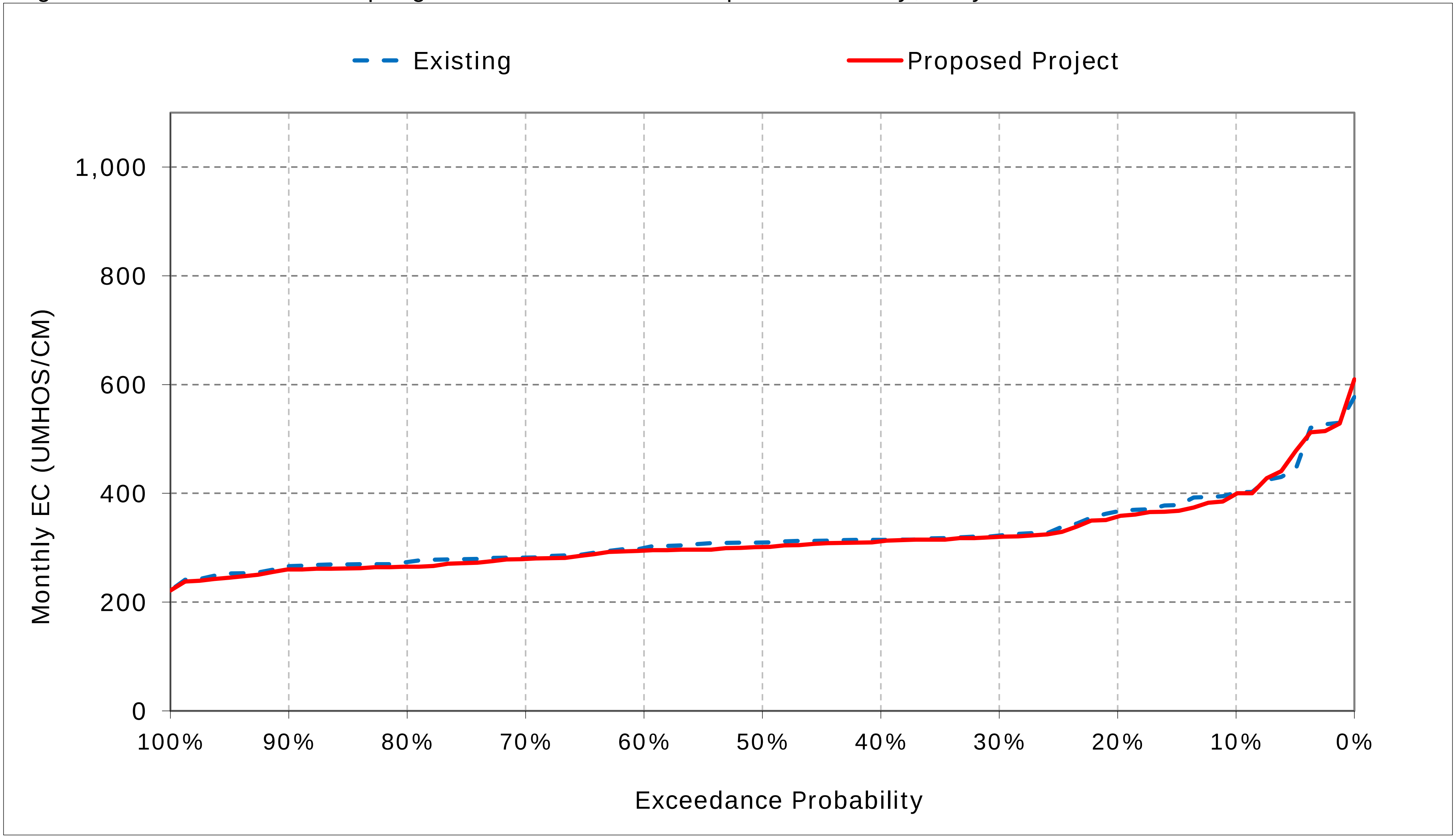


Figure 16-14. Banks Pumping Plant South Delta Exports Salinity, August EC

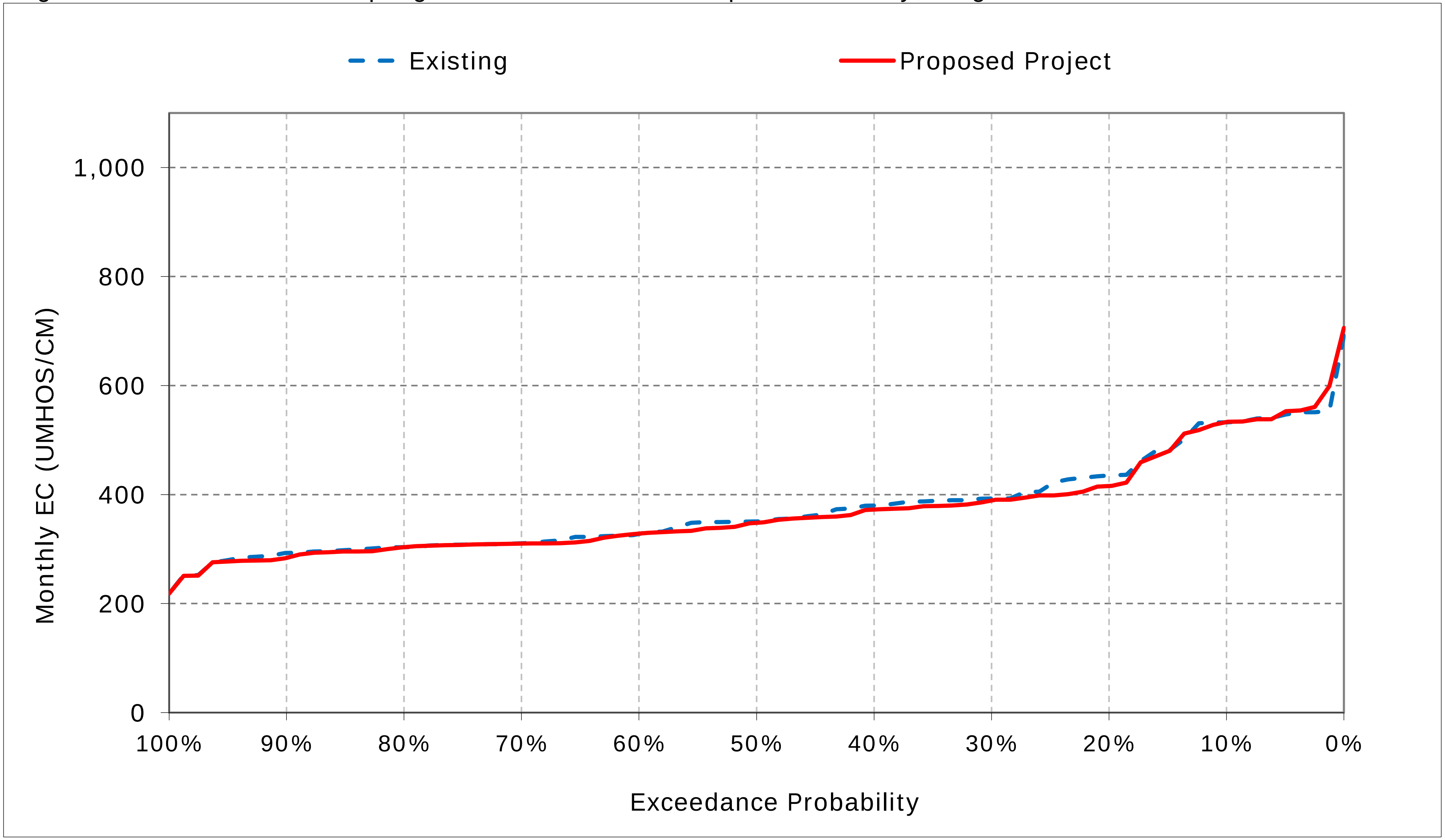


Figure 16-15. Banks Pumping Plant South Delta Exports Salinity, September EC

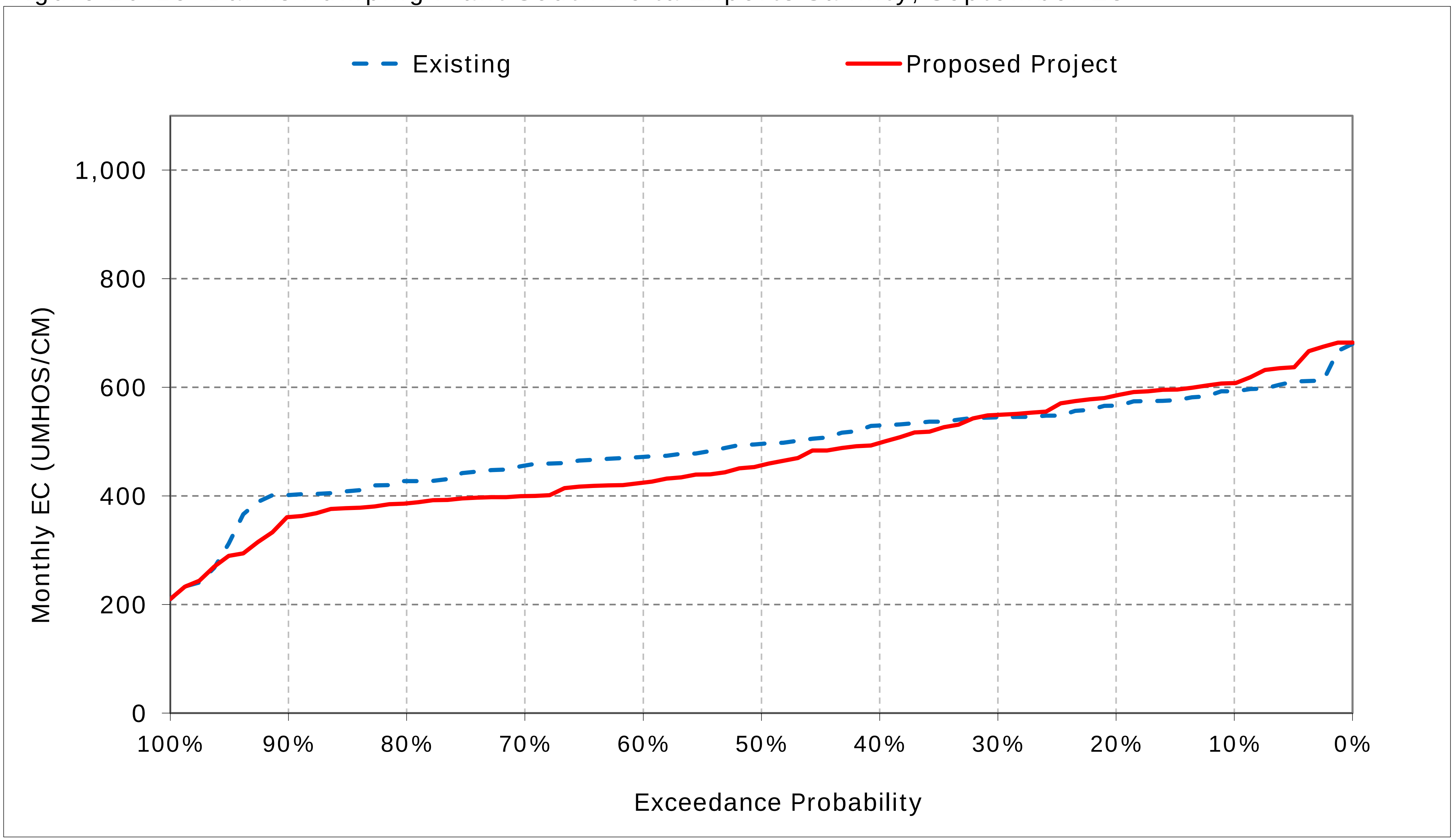


Figure 16-16. Banks Pumping Plant South Delta Exports Salinity, October EC

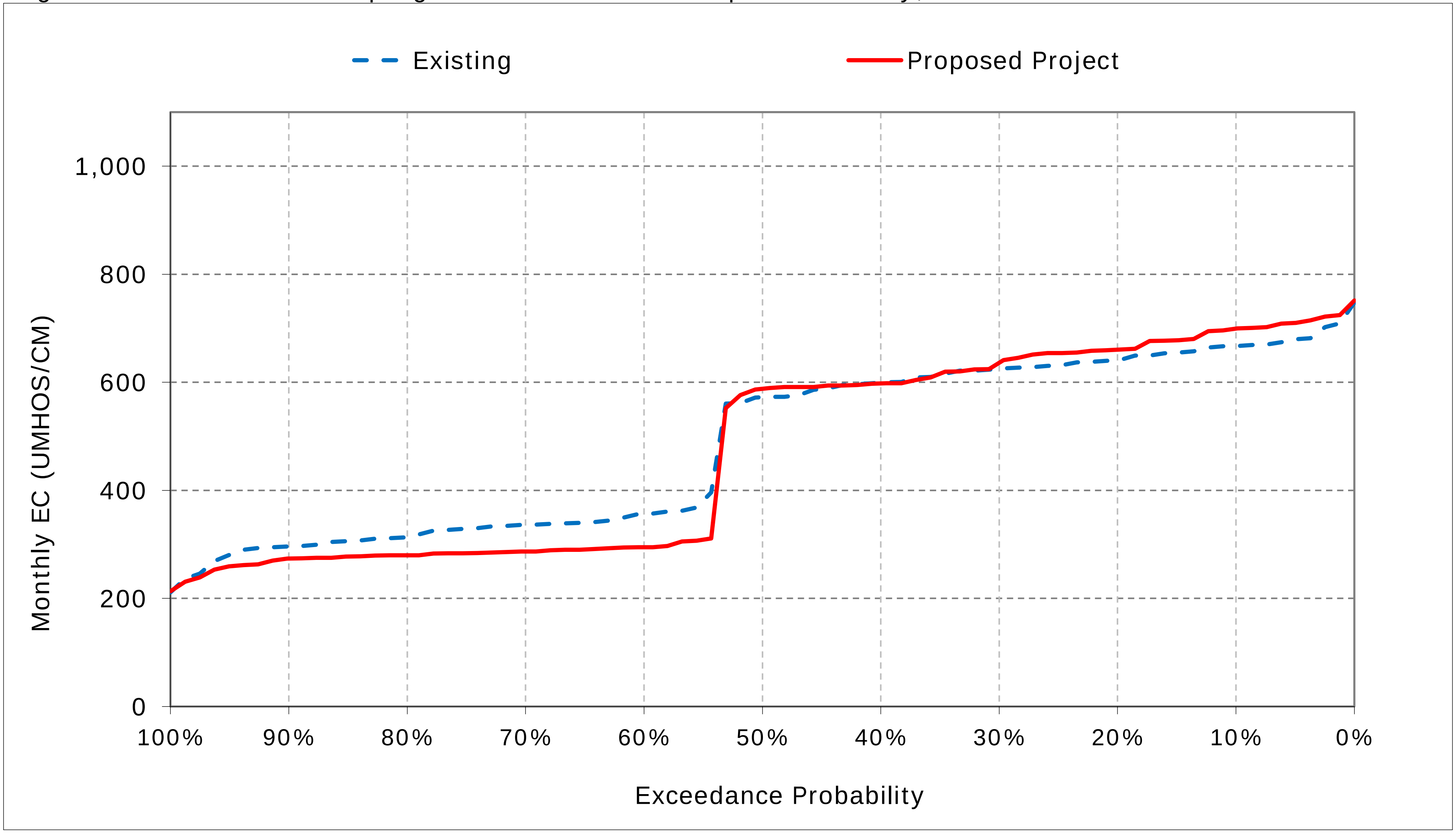


Figure 16-17. Banks Pumping Plant South Delta Exports Salinity, November EC

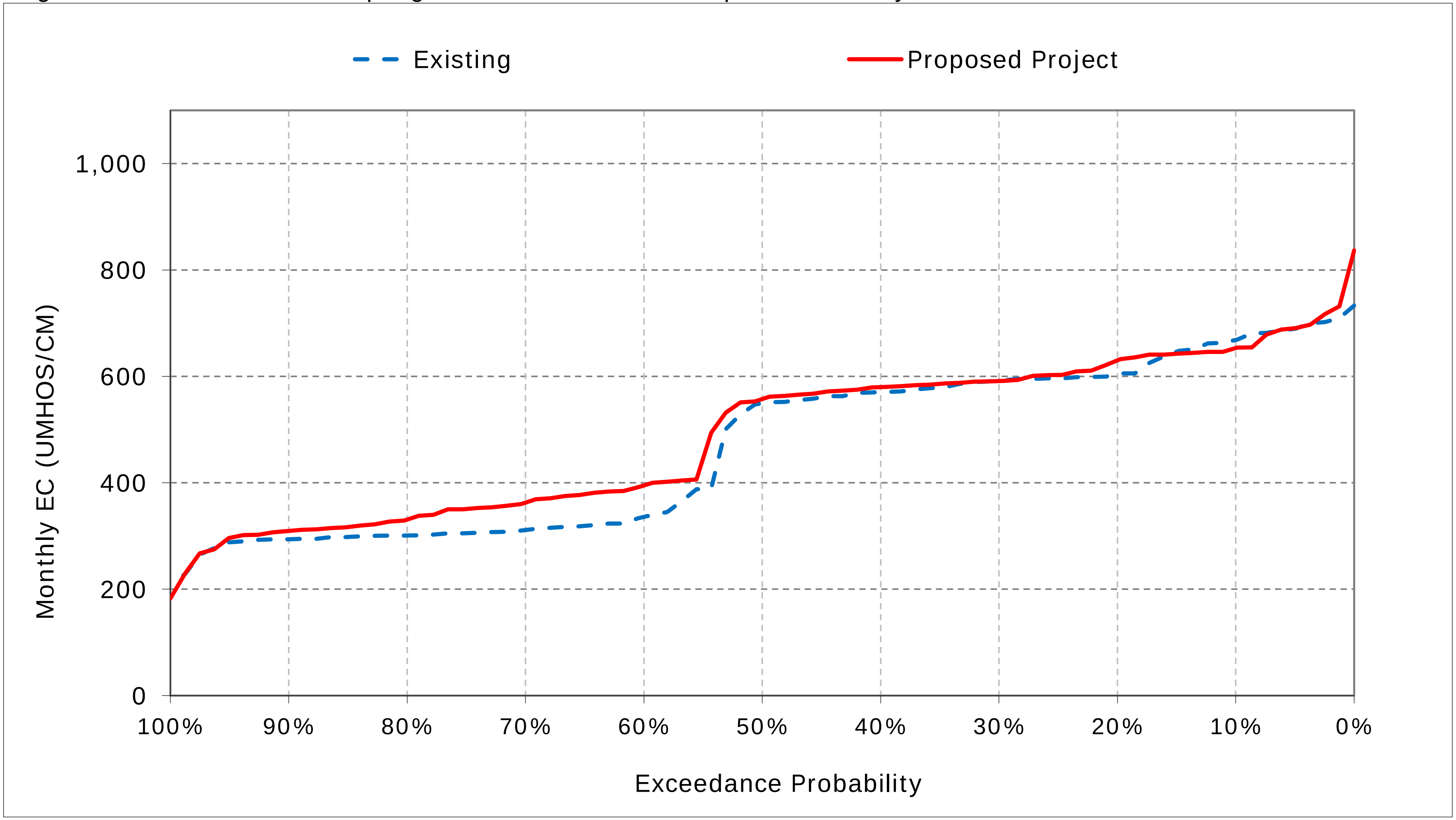


Figure 16-18. Banks Pumping Plant South Delta Exports Salinity, December EC

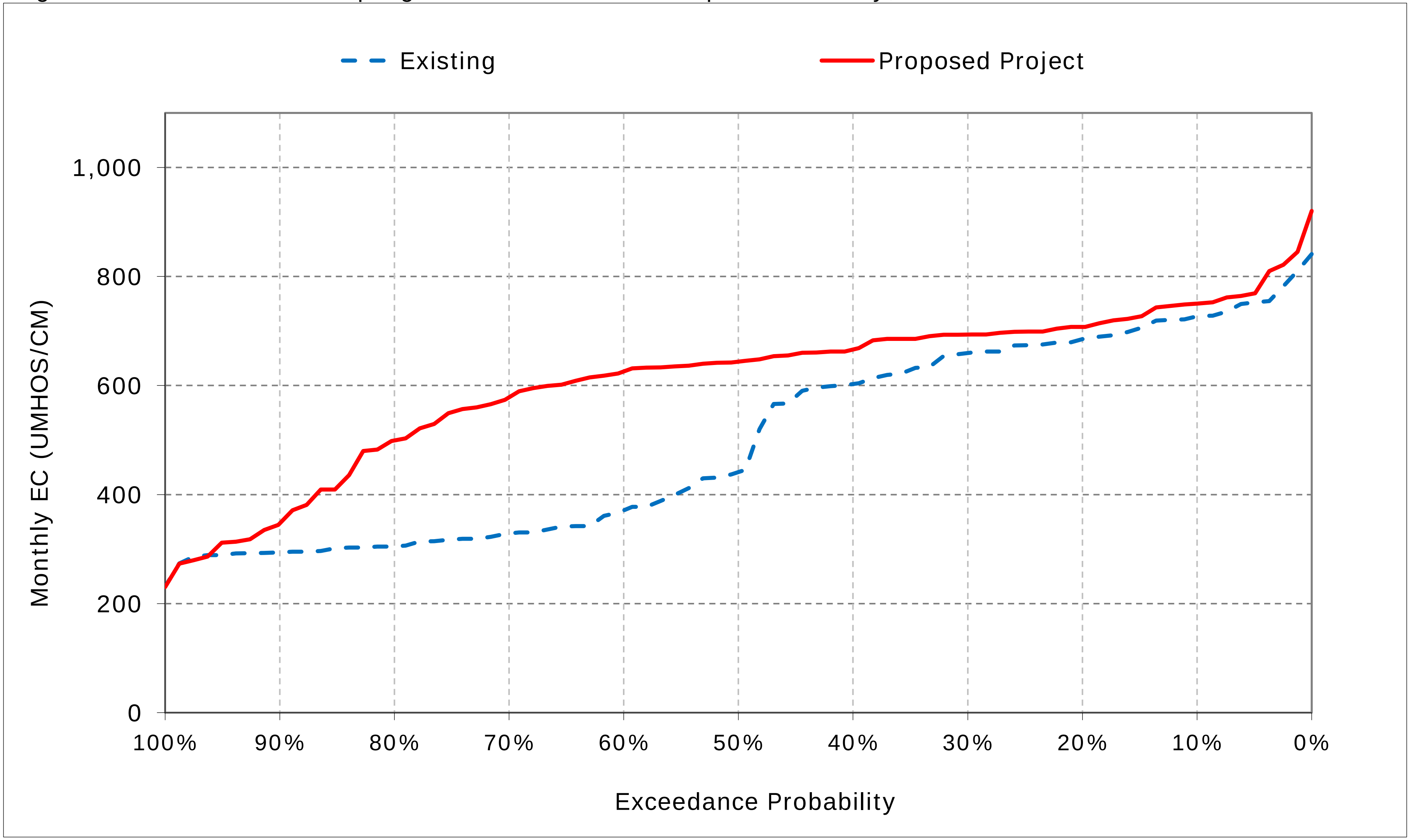


Table 17-1. Jones Pumping Plant South Delta Exports Salinity, Monthly EC

Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	652	661	764	777	681	619	511	463	409	413	537	597
20%	633	604	726	752	660	591	487	445	384	385	464	580
30%	618	593	699	674	617	552	459	431	377	377	425	556
40%	596	572	654	643	592	530	437	420	370	365	413	546
50%	566	548	543	613	569	490	403	392	366	345	392	516
60%	372	405	497	580	523	415	375	376	360	338	369	484
70%	358	359	453	547	470	362	341	363	354	323	347	456
80%	343	339	433	522	399	323	304	333	342	309	338	434
90%	330	329	426	427	331	299	251	226	329	291	329	403
Long Term												
Full Simulation Period[a]	492	489	577	614	534	472	393	380	368	355	404	501
Water Year Types[b]												
Wet (32%)	440	430	502	503	406	343	295	299	343	324	330	436
Above Normal (15%)	531	508	575	615	544	413	377	375	366	330	347	422
Below Normal (17%)	502	500	599	653	523	464	409	399	363	340	416	571
Dry (22%)	494	509	610	651	627	566	458	433	367	369	471	537
Critical (15%)	548	556	663	750	679	680	505	458	433	447	504	585

Proposed Project

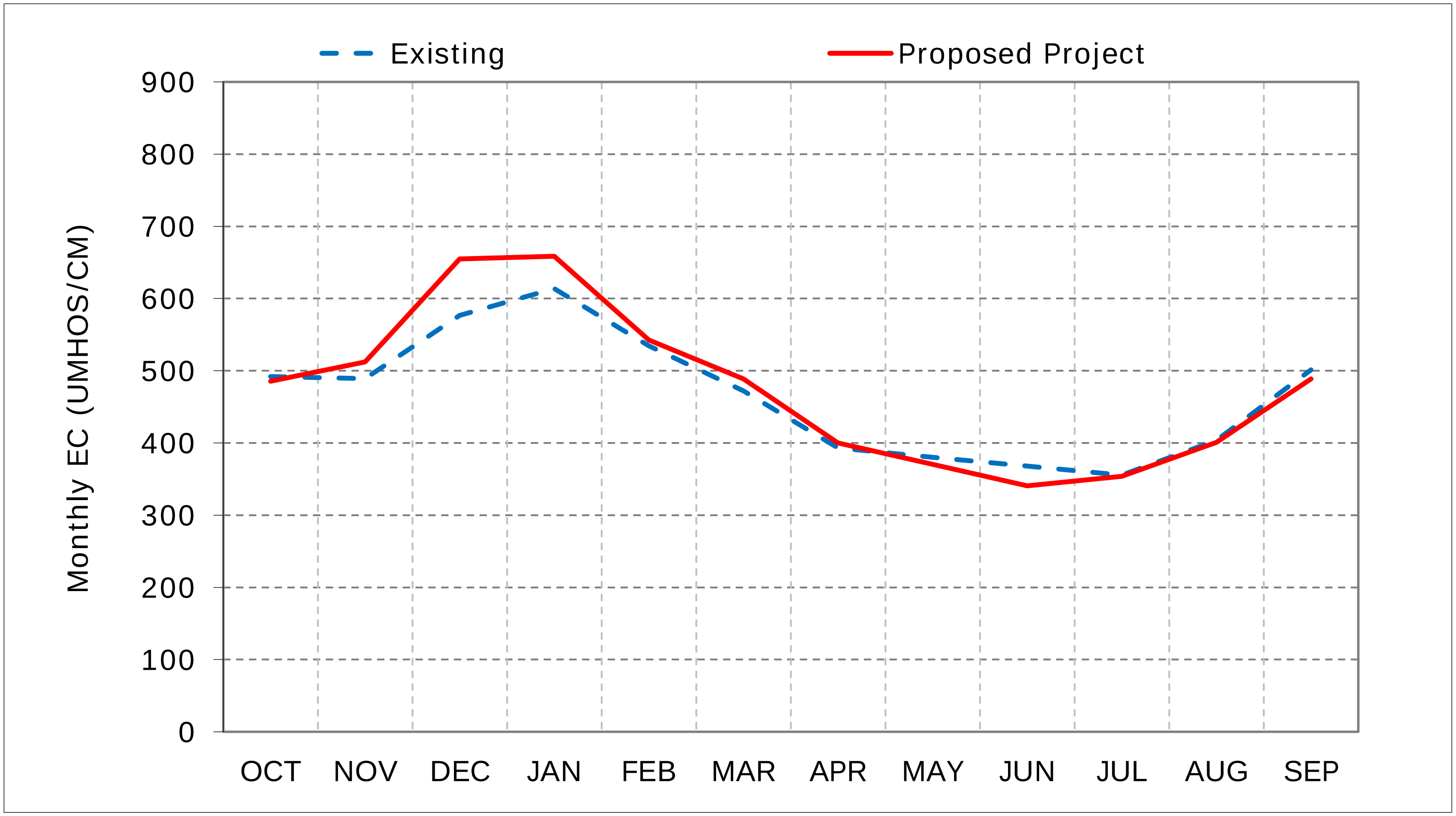
Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	662	653	775	851	735	675	573	497	385	413	542	620
20%	626	621	742	823	680	616	516	462	366	392	446	589
30%	611	595	725	767	634	579	469	428	352	378	426	565
40%	589	583	712	734	605	540	415	377	339	358	408	539
50%	568	564	694	665	563	508	379	355	333	338	385	489
60%	355	443	677	610	518	443	352	342	328	328	366	440
70%	341	416	633	554	460	365	332	334	320	316	347	419
80%	335	392	547	522	400	327	306	312	311	305	338	402
90%	326	360	466	427	336	296	246	222	296	286	316	377
Long Term												
Full Simulation Period[a]	485	512	655	659	543	489	400	370	341	354	401	489
Water Year Types[b]												
Wet (32%)	435	460	565	519	401	350	284	280	328	323	325	375
Above Normal (15%)	522	553	693	695	551	417	349	335	332	324	347	423
Below Normal (17%)	488	517	674	700	524	489	392	362	327	336	412	596
Dry (22%)	491	523	692	723	641	598	479	437	331	365	462	540
Critical (15%)	548	563	734	780	713	698	591	509	407	452	514	597

Proposed Project minus Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	10	-8	11	74	55	56	62	34	-24	1	5	23
20%	-7	17	16	71	20	25	29	17	-18	7	-18	9
30%	-6	3	25	92	17	27	10	-3	-24	1	1	10
40%	-6	10	58	92	13	11	-22	-43	-30	-7	-5	-7
50%	1	17	151	51	-6	18	-24	-37	-33	-7	-6	-27
60%	-18	38	180	31	-6	28	-23	-34	-32	-10	-4	-44
70%	-17	57	180	7	-10	2	-9	-29	-34	-7	0	-36
80%	-8	54	114	0	1	5	1	-21	-31	-4	0	-32
90%	-4	31	41	0	5	-3	-5	-4	-33	-5	-13	-26
Long Term												
Full Simulation Period[a]	-6	23	78	45	8	17	7	-10	-27	-2	-3	-13
Water Year Types[b]												
Wet (32%)	-5	30	62	16	-4	7	-11	-19	-15	0	-5	-61
Above Normal (15%)	-10	46	118	80	7	3	-28	-40	-34	-6	0	1
Below Normal (17%)	-14	16	74	48	2	24	-17	-37	-36	-4	-4	24
Dry (22%)	-4	14	82	71	14	33	21	4	-36	-4	-9	3
Critical (15%)	-1	7	71	30	34	18	86	51	-26	5	9	12

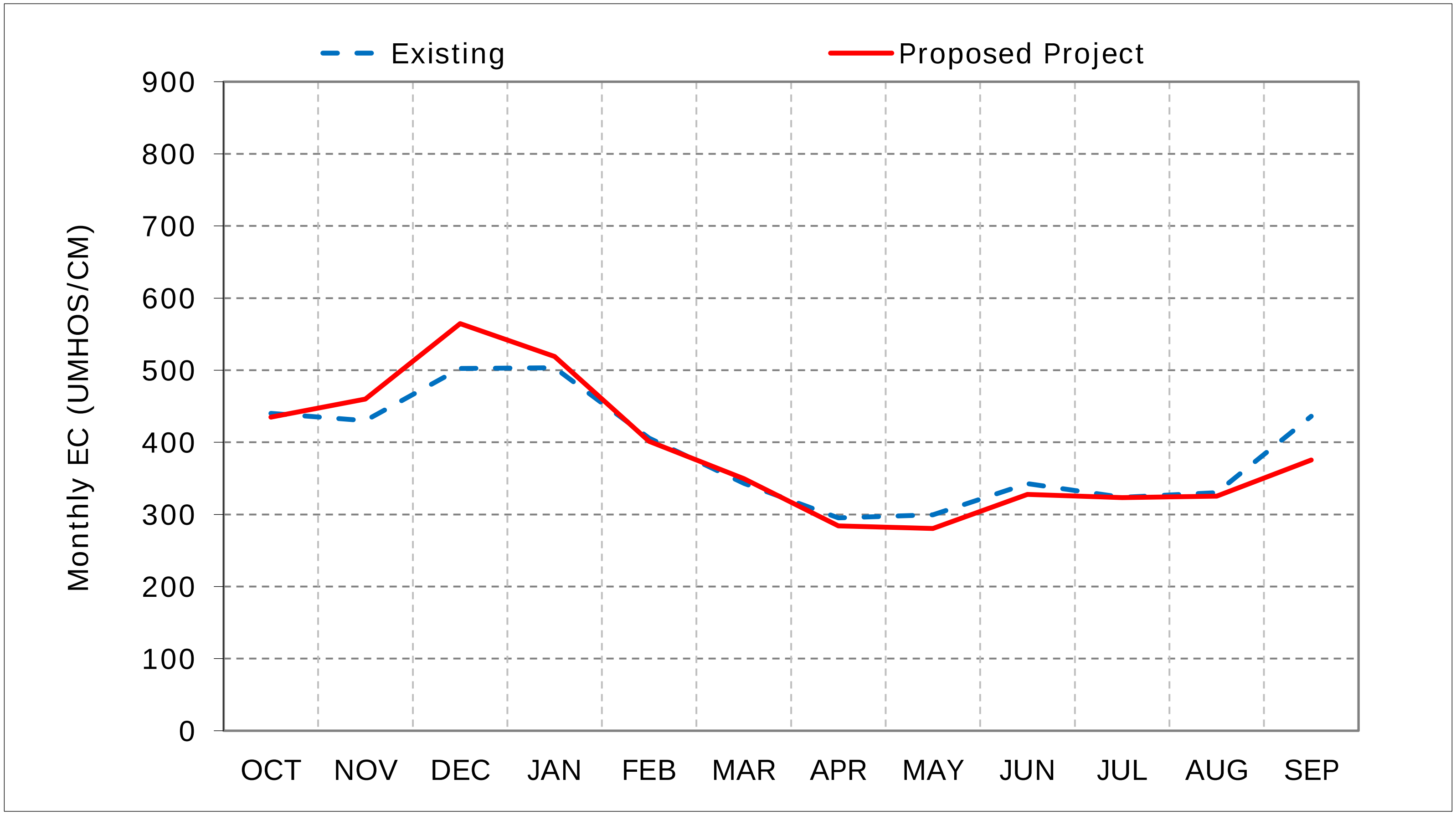
a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with water year - year type sorting.
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 17-1. Jones Pumping Plant South Delta Exports Salinity, Long-Term Averag



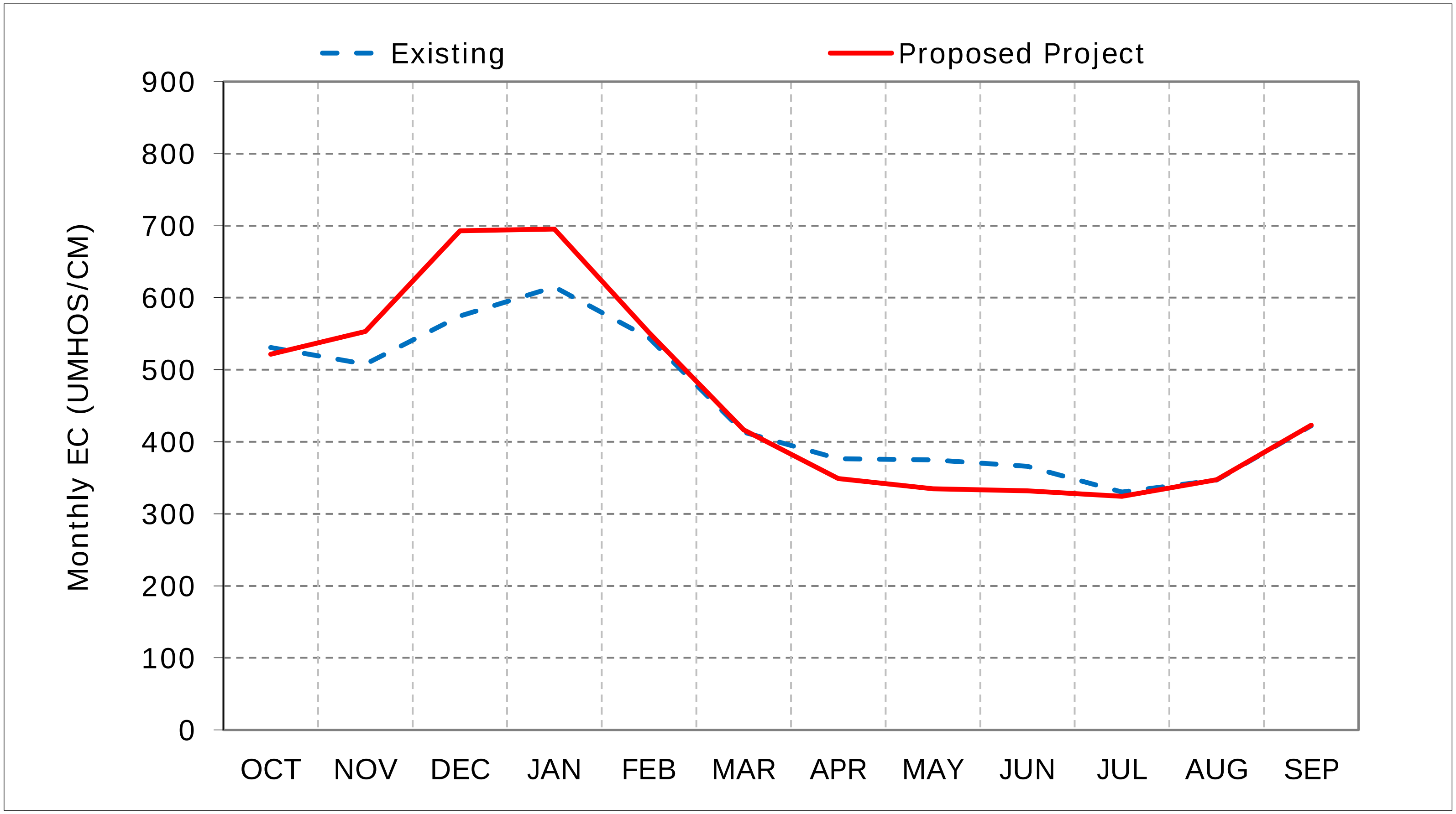
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 17-2. Jones Pumping Plant South Delta Exports Salinity, Wet Year Average



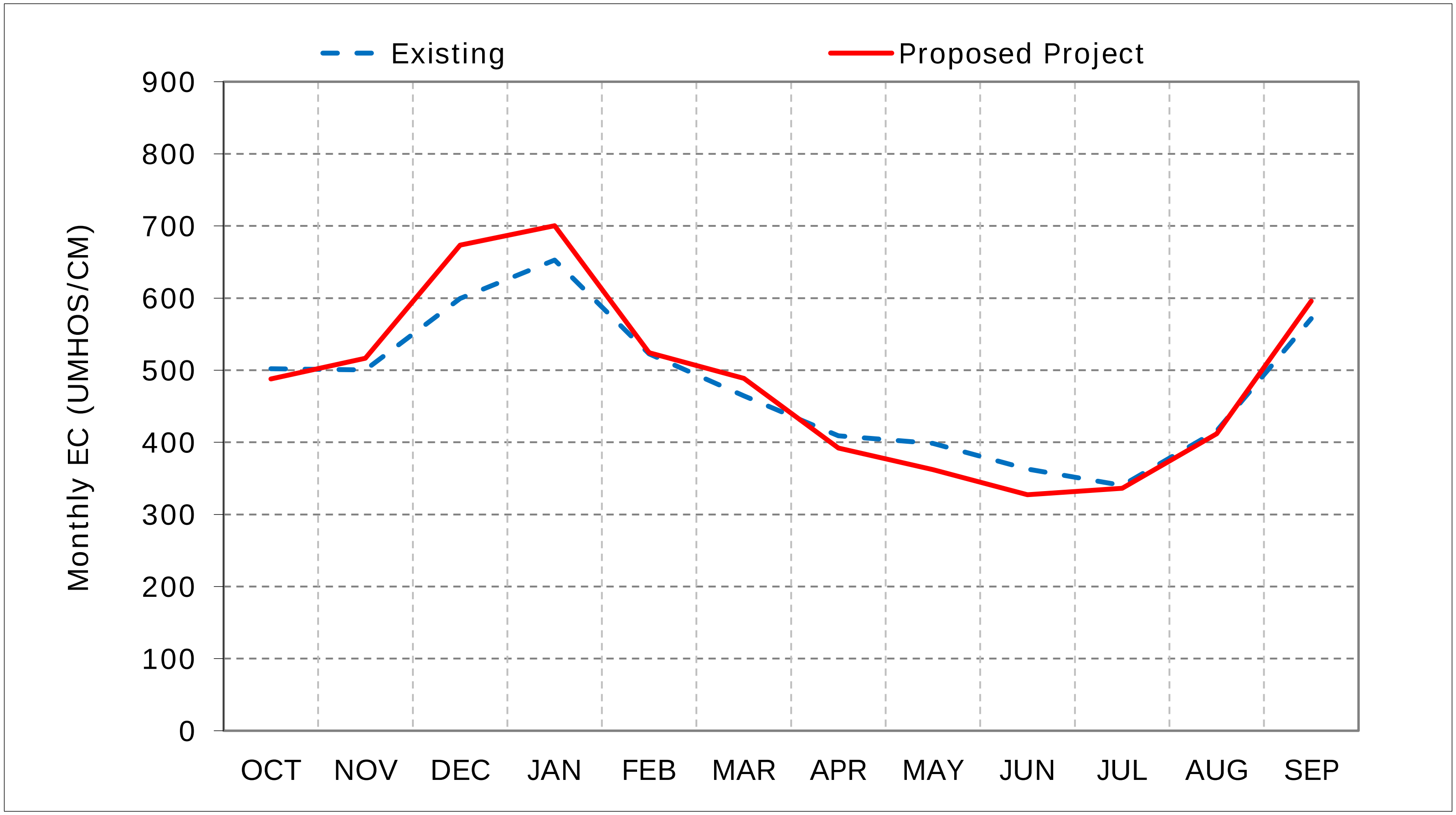
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 17-3. Jones Pumping Plant South Delta Exports Salinity, Above Normal Yea



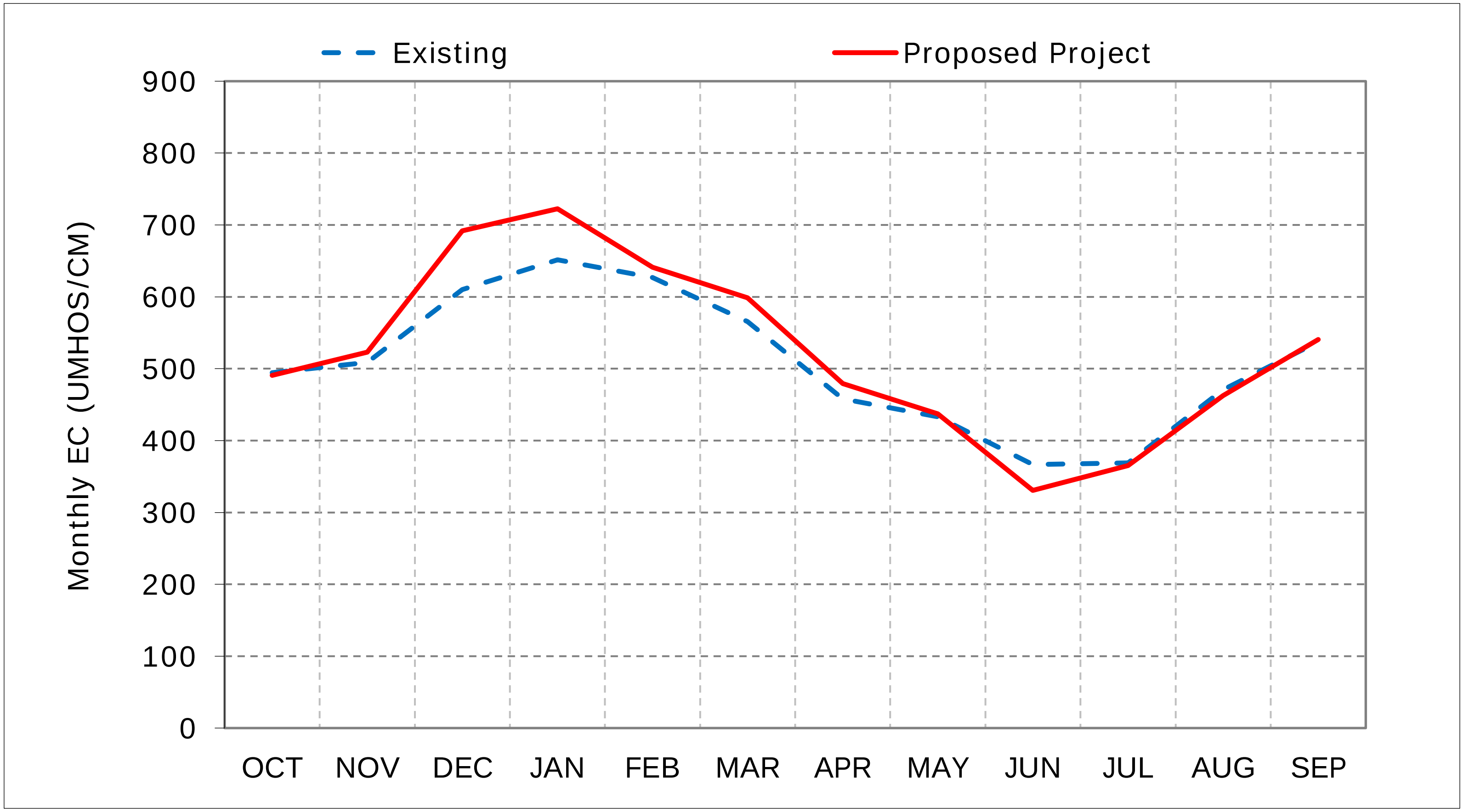
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 17-4. Jones Pumping Plant South Delta Exports Salinity, Below Normal Yea



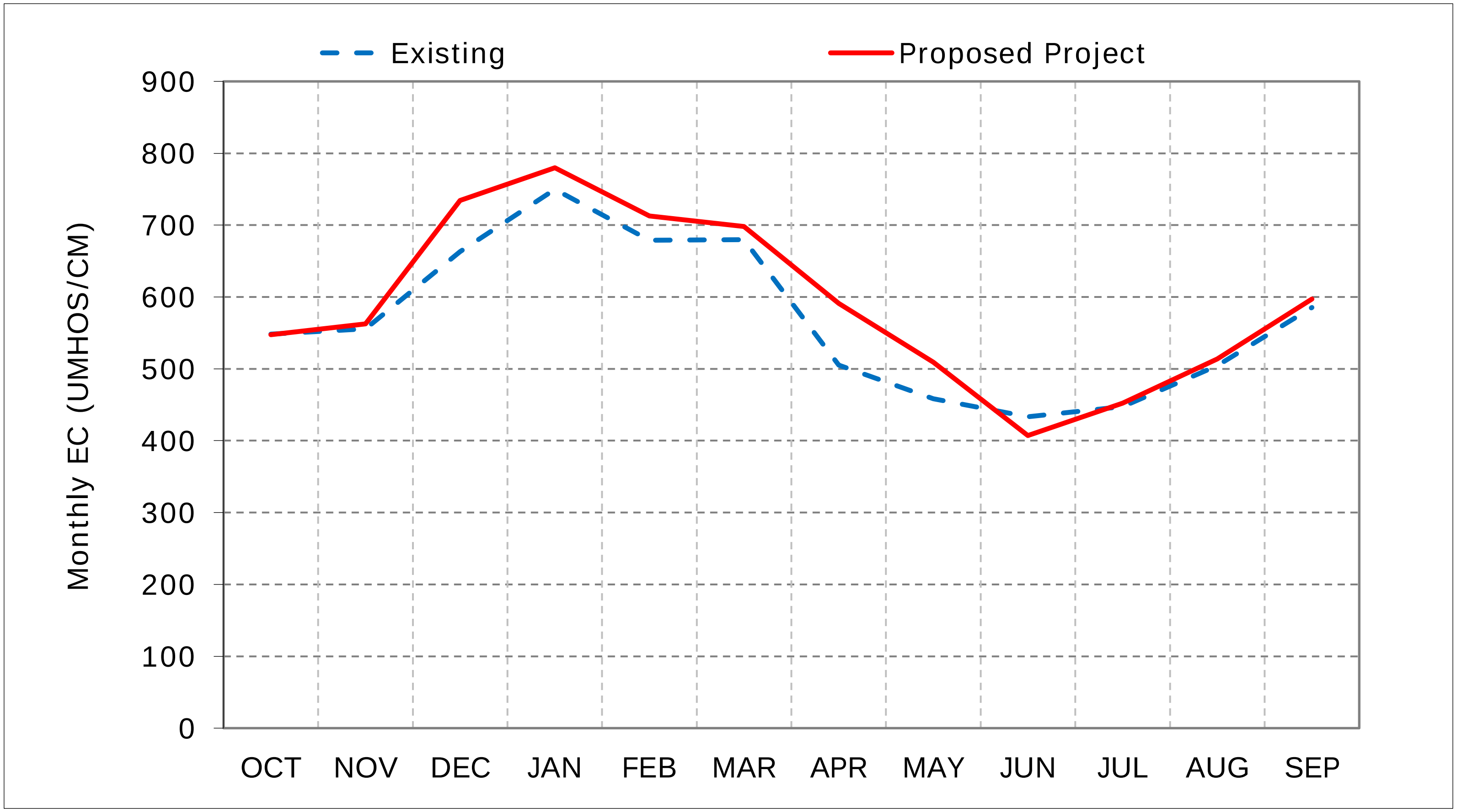
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 17-5. Jones Pumping Plant South Delta Exports Salinity, Dry Year Average



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 17-6. Jones Pumping Plant South Delta Exports Salinity, Critical Year Avera



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 17-7. Jones Pumping Plant South Delta Exports Salinity, January EC

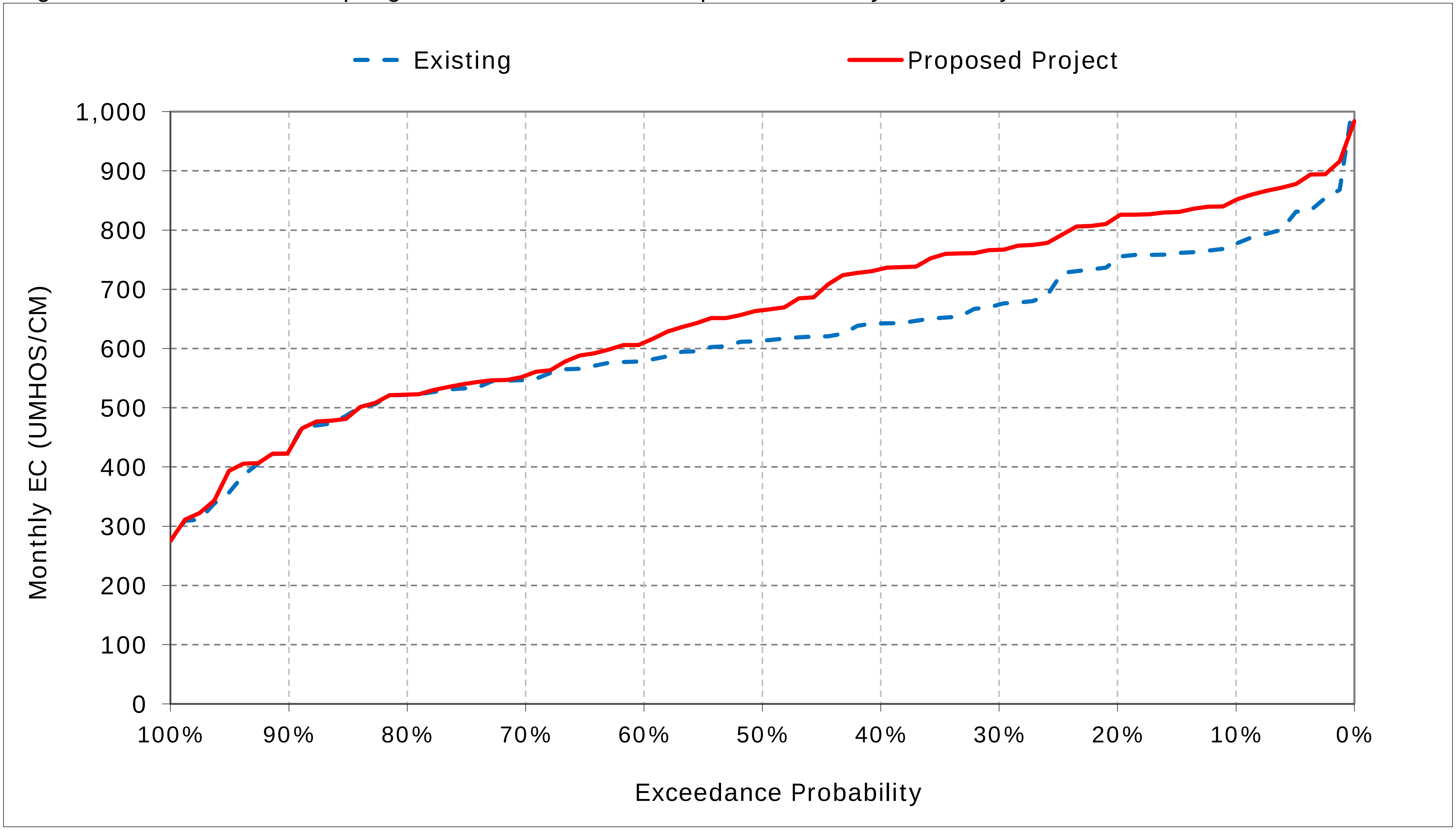


Figure 17-8. Jones Pumping Plant South Delta Exports Salinity, February EC

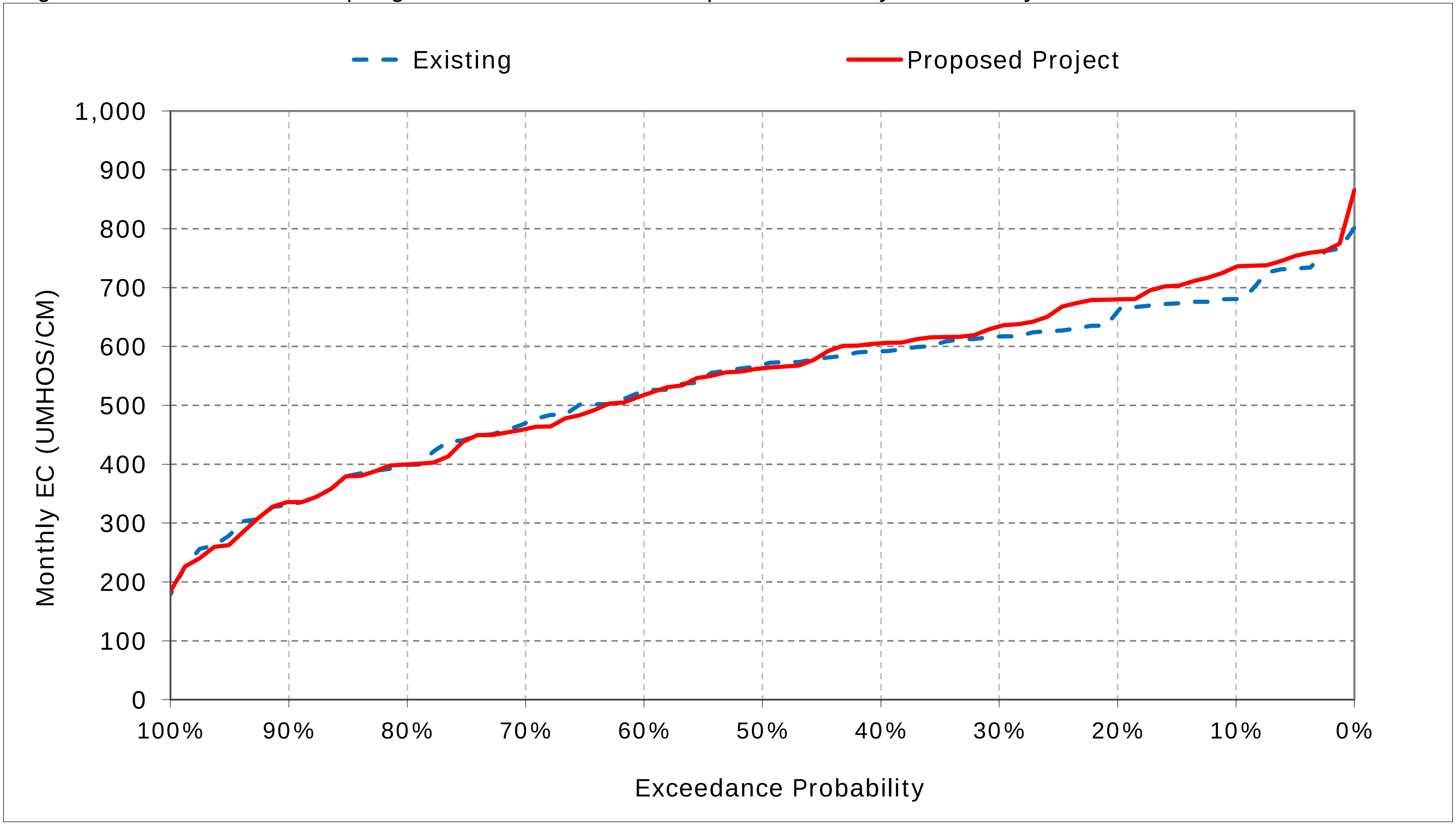


Figure 17-9. Jones Pumping Plant South Delta Exports Salinity, March EC

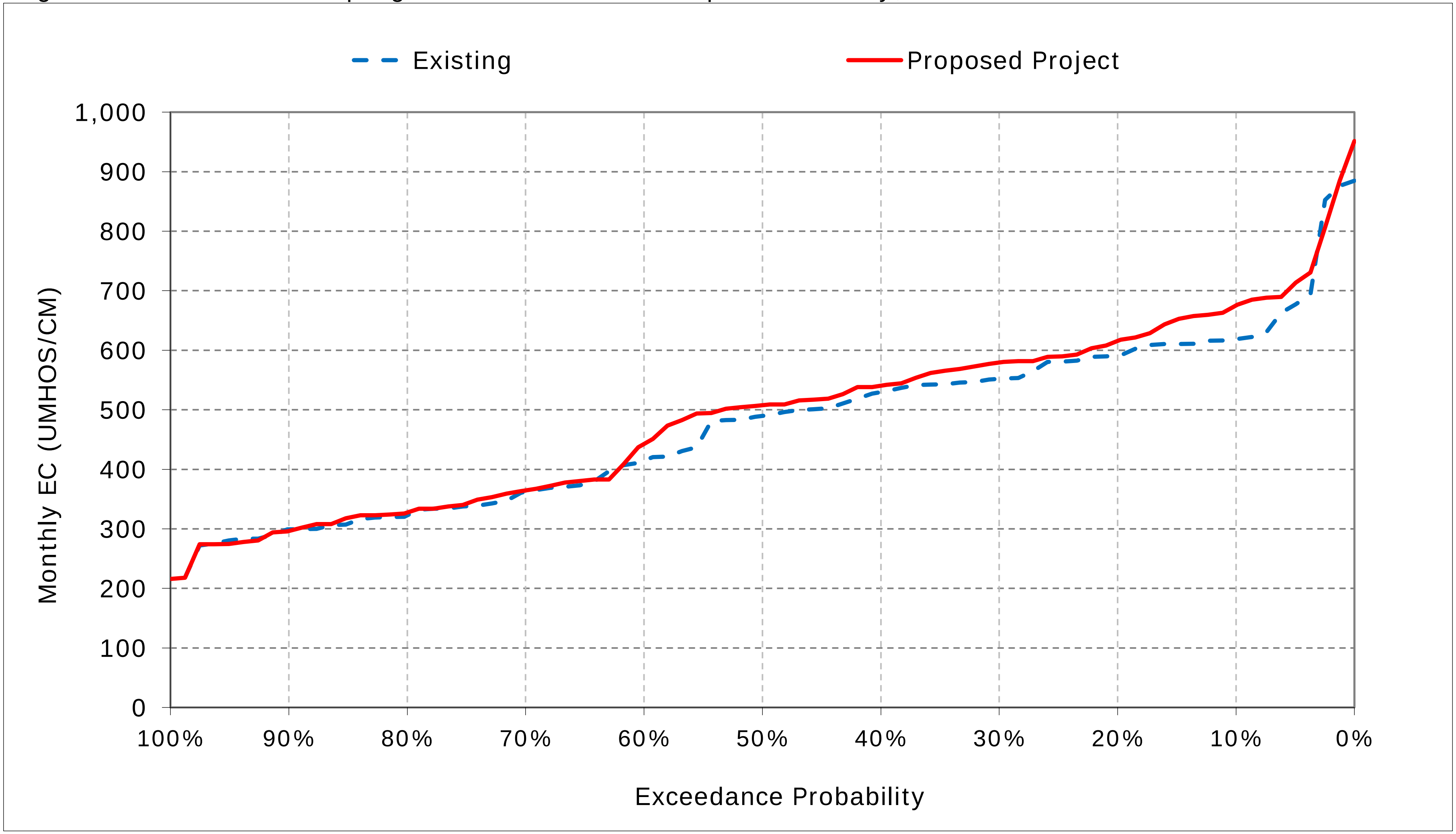


Figure 17-10. Jones Pumping Plant South Delta Exports Salinity, April EC

Figure 17-11. Jones Pumping Plant South Delta Exports Salinity, May EC

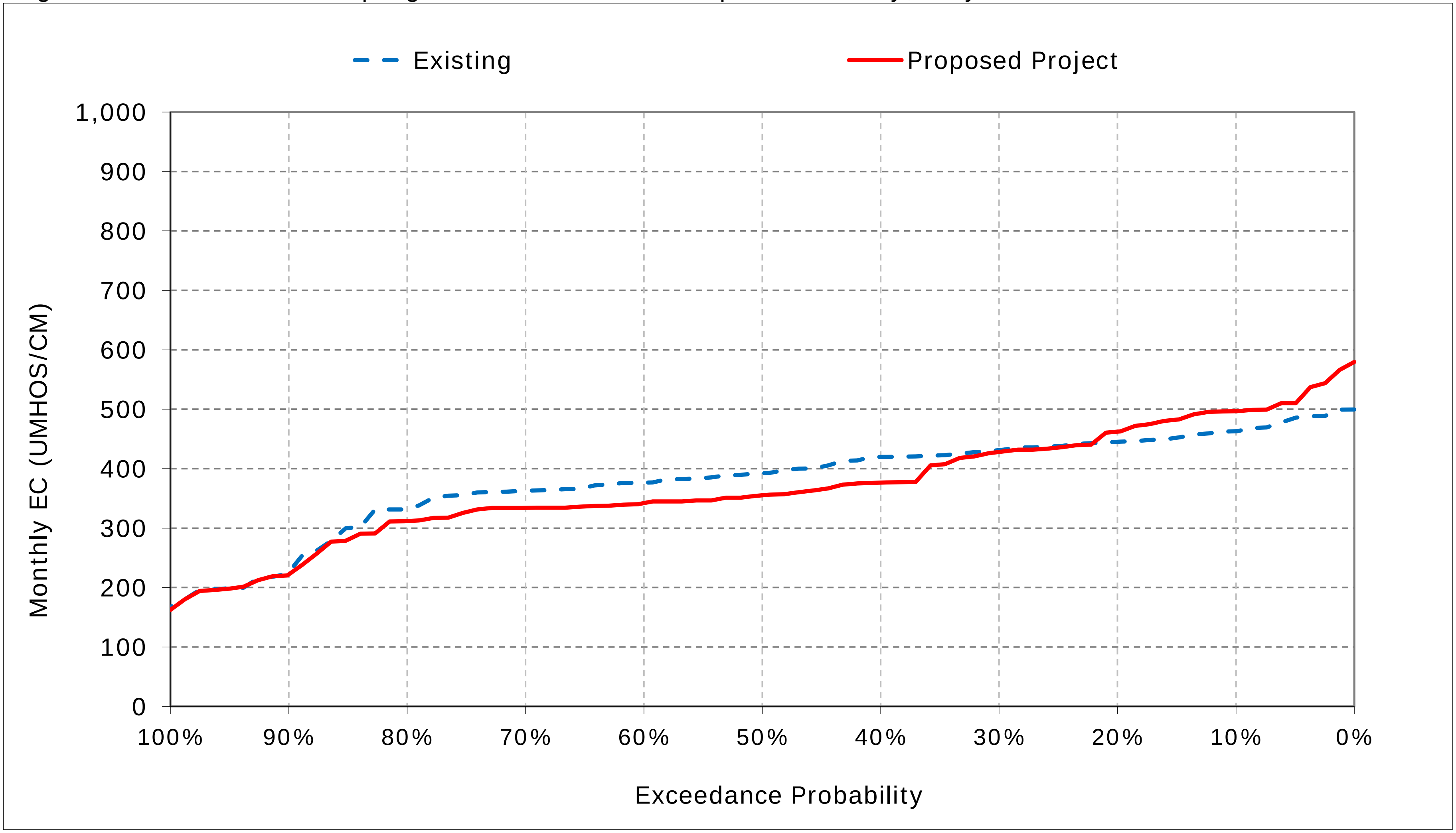


Figure 17-12. Jones Pumping Plant South Delta Exports Salinity, June EC

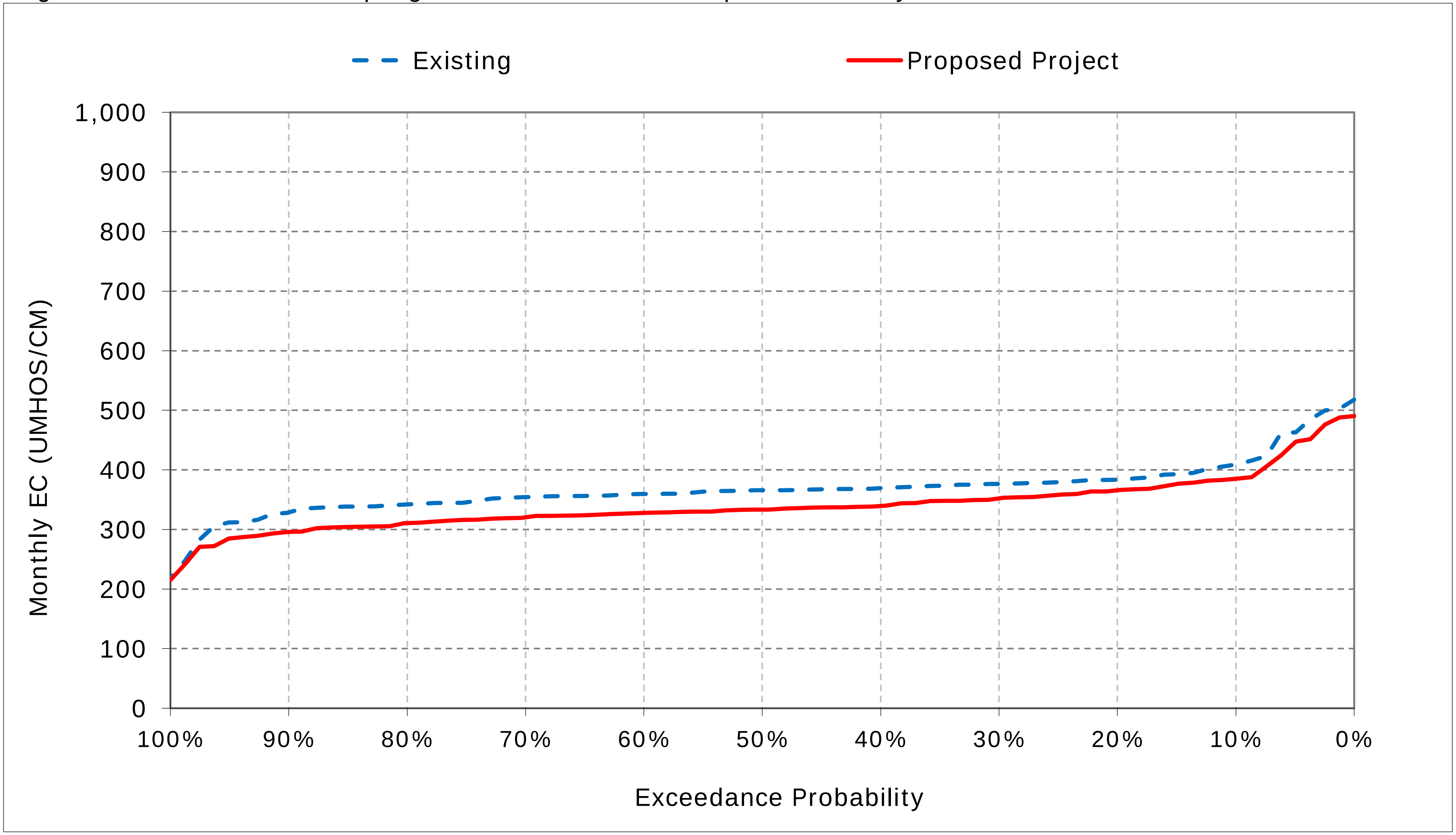


Figure 17-13. Jones Pumping Plant South Delta Exports Salinity, July EC

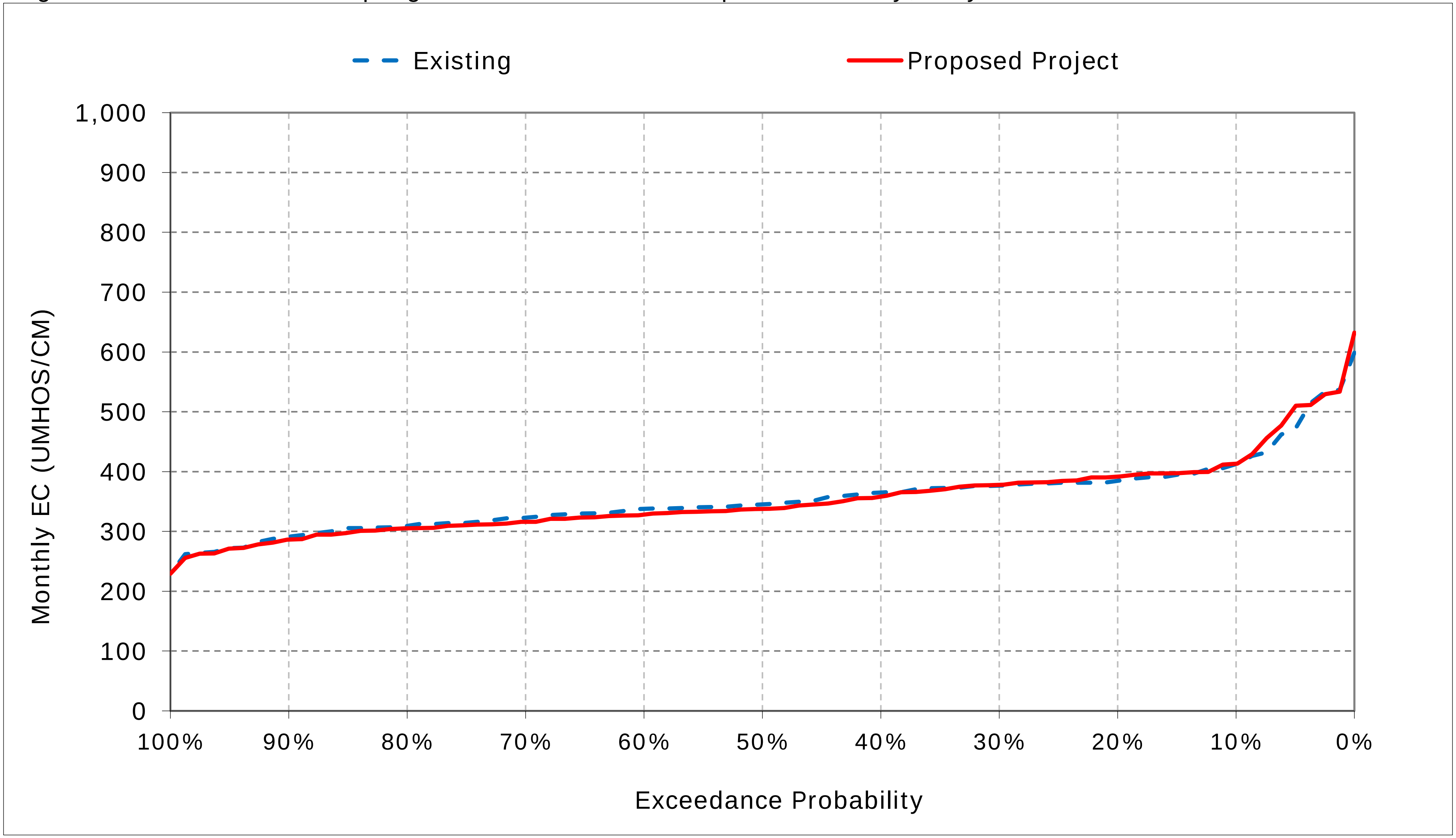


Figure 17-14. Jones Pumping Plant South Delta Exports Salinity, August EC

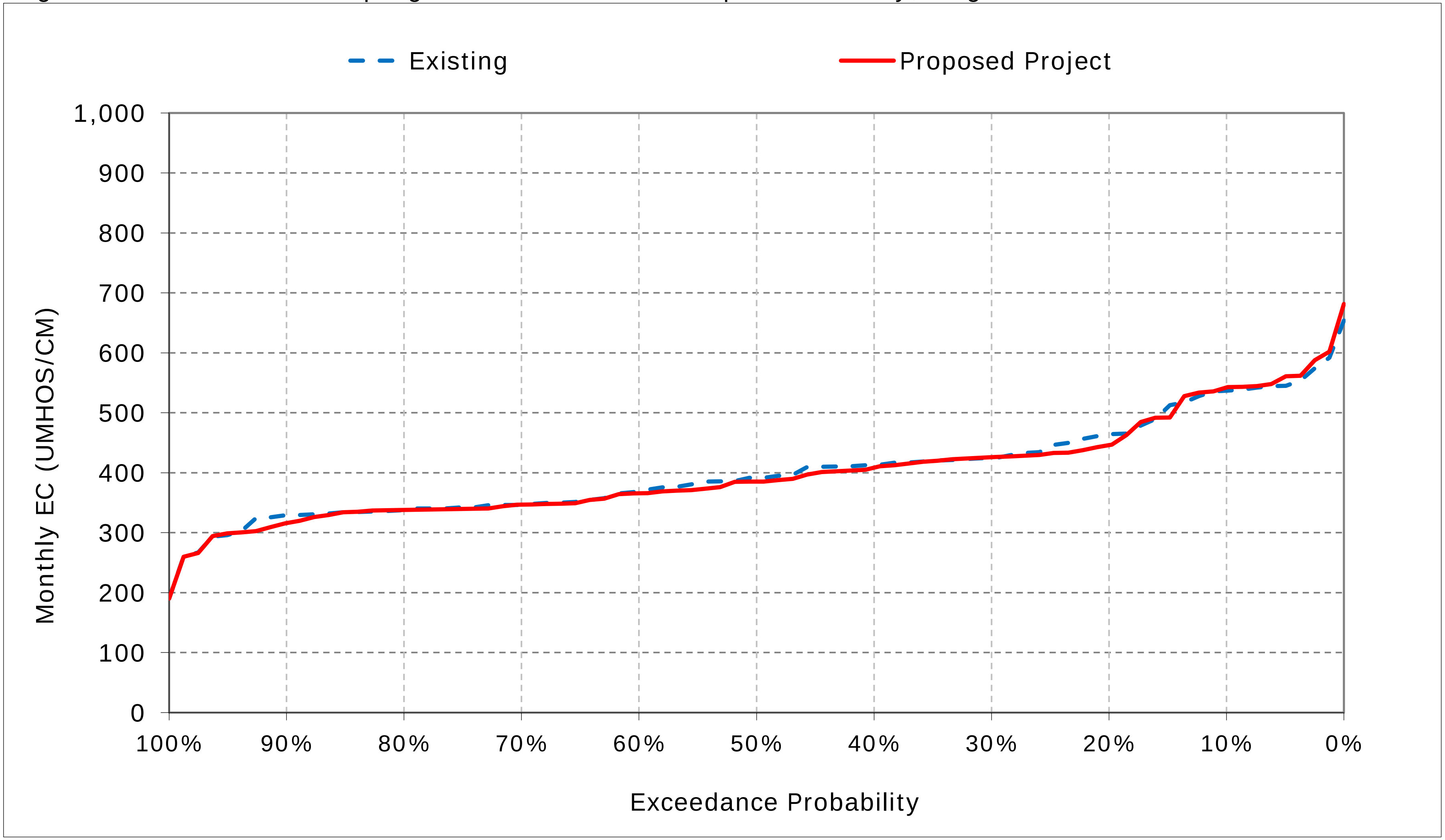


Figure 17-15. Jones Pumping Plant South Delta Exports Salinity, September EC

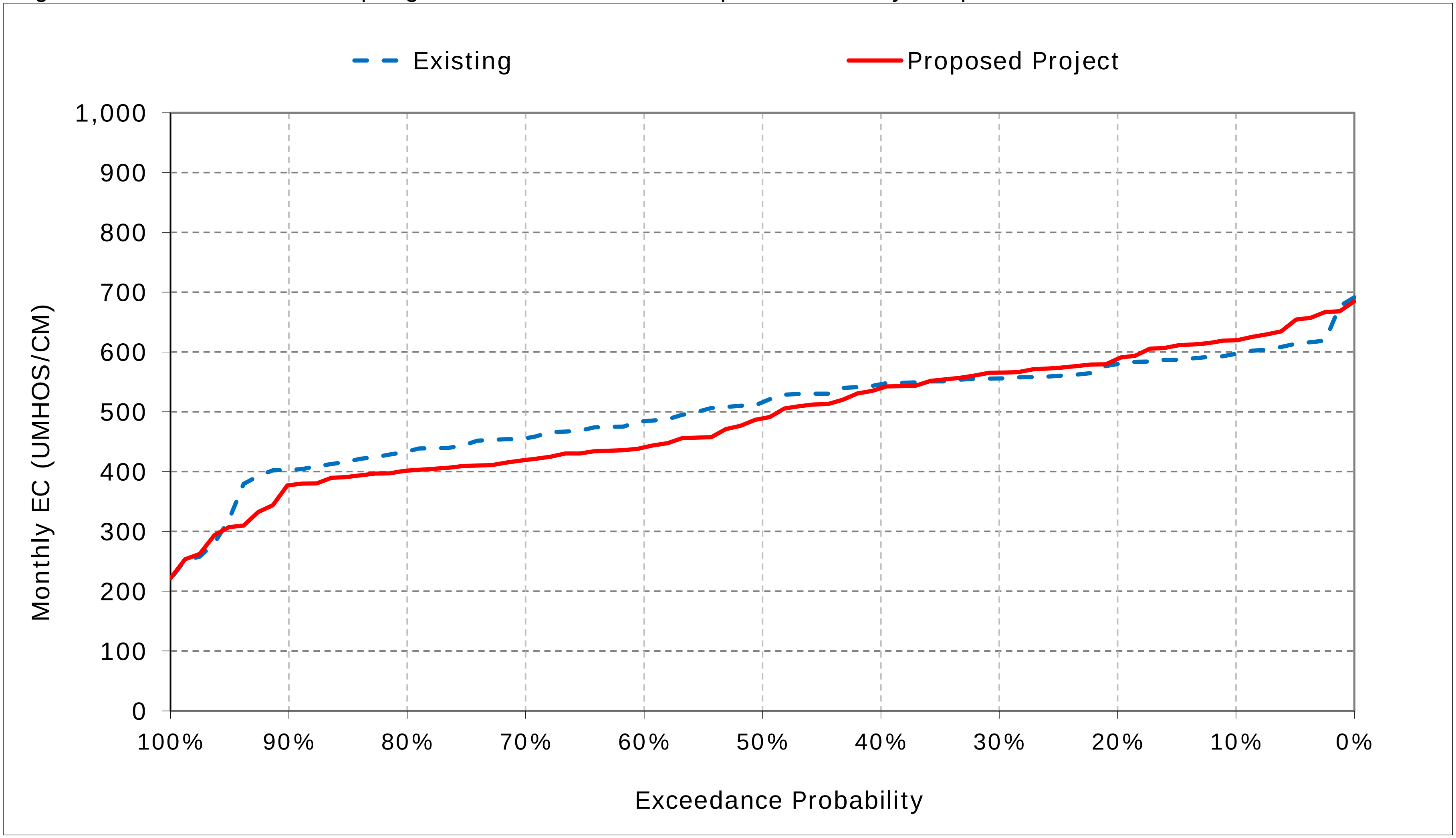


Figure 17-16. Jones Pumping Plant South Delta Exports Salinity, October EC

Figure 17-17. Jones Pumping Plant South Delta Exports Salinity, November EC

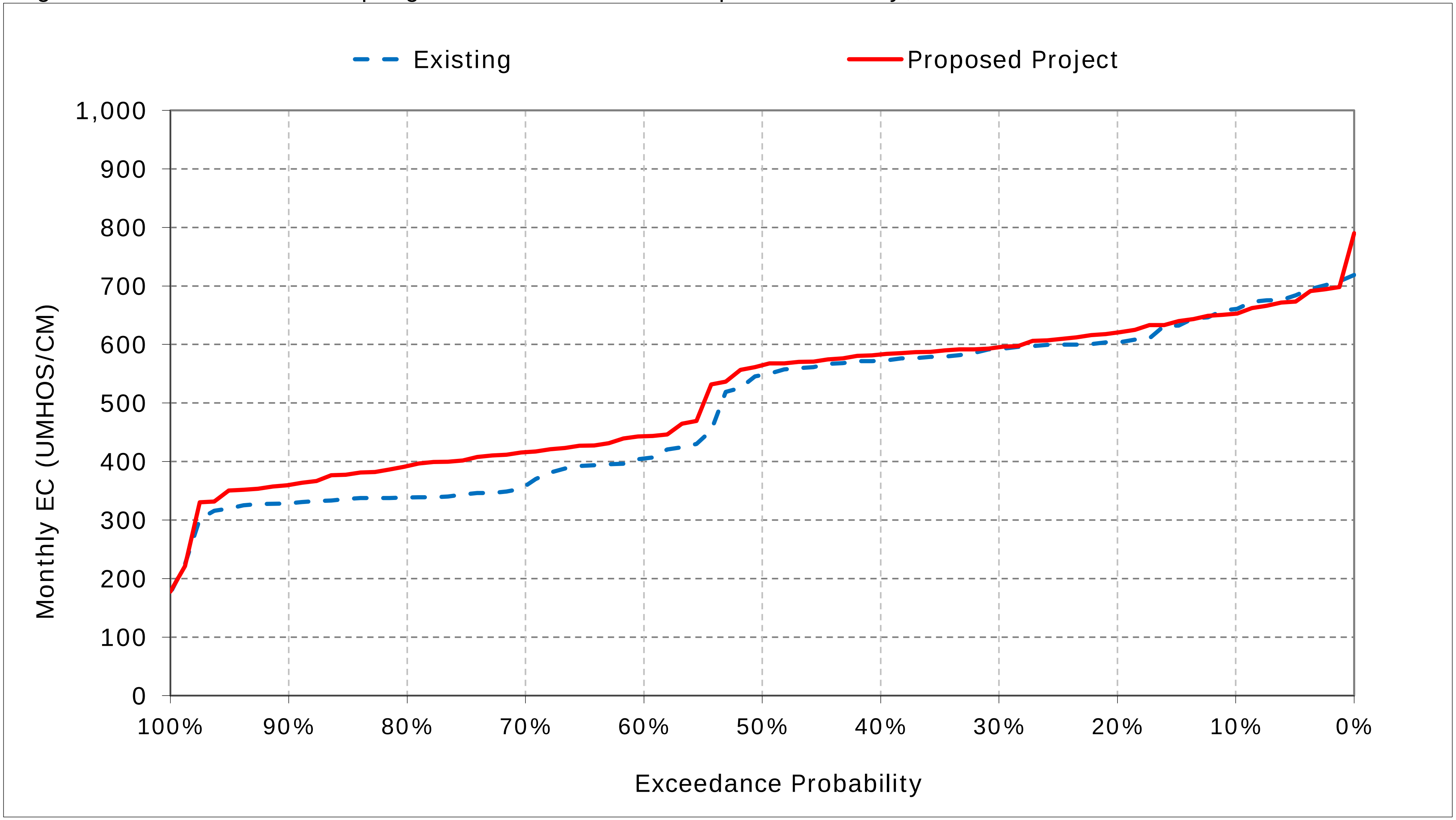


Figure 17-18. Jones Pumping Plant South Delta Exports Salinity, December EC

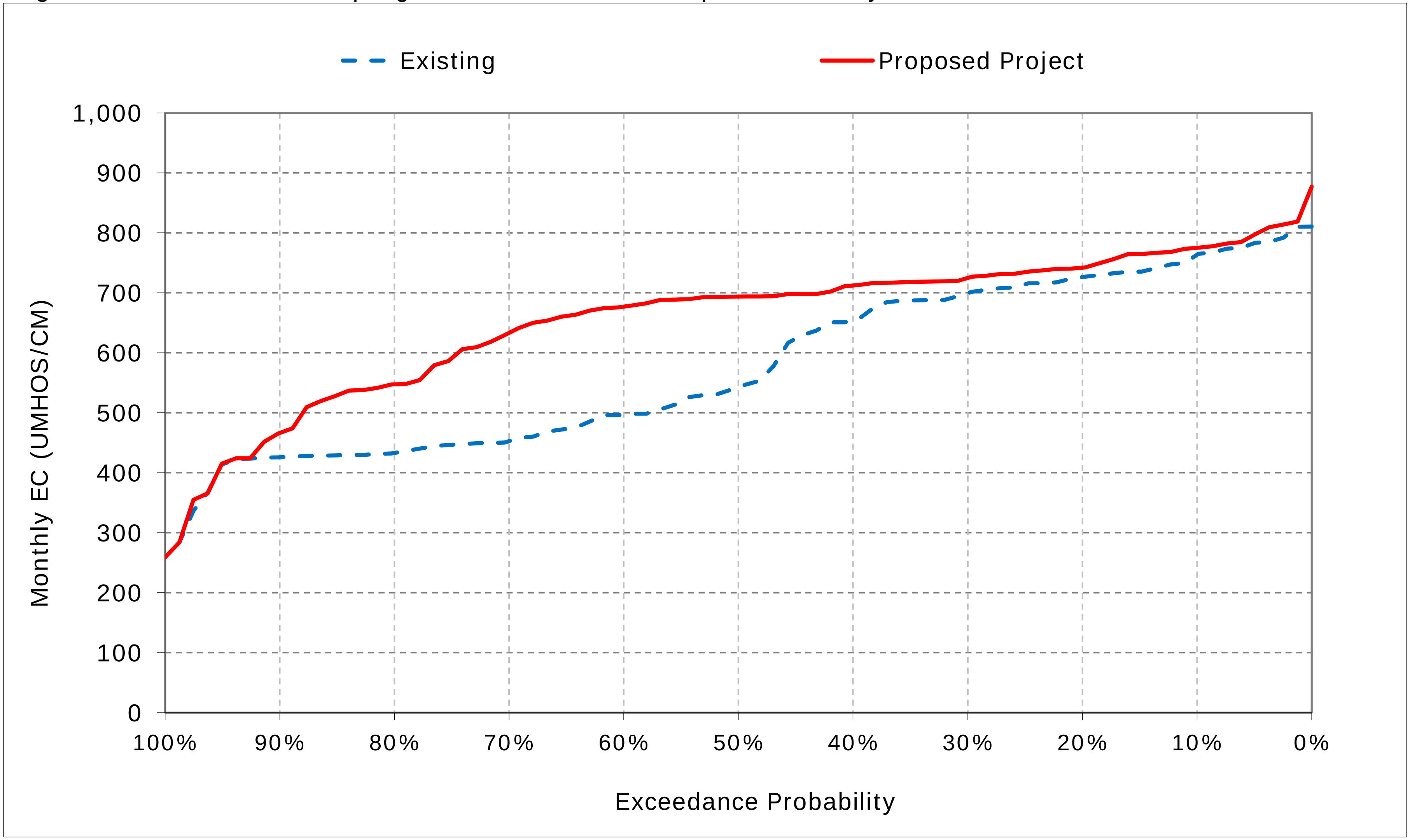


Table 18-1. Old River at Highway 4, Monthly EC

Existing

Statistic	Monthly EC (UMHOS/CM)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	753	741	807	782	558	435	417	418	360	425	570	689
20%	725	677	768	719	512	406	401	402	327	352	482	660
30%	710	650	722	612	487	370	380	391	315	332	442	624
40%	678	620	613	561	458	359	374	385	310	315	423	590
50%	634	580	424	518	421	347	363	377	307	290	387	559
60%	319	322	368	471	387	338	351	367	303	275	364	516
70%	303	286	313	429	366	324	336	354	297	268	330	496
80%	292	273	286	373	348	314	299	331	286	261	320	448
90%	278	266	280	351	327	288	246	220	273	252	309	418
Long Term												
Full Simulation Period[a]	516	492	519	552	435	356	350	357	315	321	408	547
Water Year Types[b]												
Wet (32%)	444	410	395	417	389	331	288	293	283	265	317	464
Above Normal (15%)	566	513	517	540	450	351	352	363	303	266	333	433
Below Normal (17%)	533	510	570	612	422	346	364	381	304	301	422	656
Dry (22%)	518	525	575	581	443	359	390	394	316	362	492	596
Critical (15%)	599	580	649	741	523	419	409	407	408	457	541	644

Proposed Project

Statistic	Monthly EC (UMHOS/CM)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	774	732	831	956	612	477	406	355	345	431	577	731
20%	748	687	812	874	546	414	383	334	303	342	468	684
30%	715	650	777	774	488	394	368	321	286	323	443	640
40%	680	632	761	704	457	376	348	306	281	305	417	584
50%	647	587	739	582	428	367	337	292	275	282	384	524
60%	282	454	676	508	412	348	330	283	271	273	356	443
70%	270	398	586	449	382	337	319	278	264	262	328	415
80%	262	358	511	405	353	323	306	271	259	258	316	397
90%	257	316	329	359	328	303	282	261	249	251	296	370
Long Term												
Full Simulation Period[a]	512	536	662	631	451	374	340	301	289	317	405	527
Water Year Types[b]												
Wet (32%)	437	467	518	451	388	344	292	261	265	264	310	369
Above Normal (15%)	564	585	720	675	467	376	330	281	267	261	334	421
Below Normal (17%)	524	550	708	698	429	366	353	299	267	286	417	701
Dry (22%)	512	552	725	701	473	384	368	325	287	356	481	601
Critical (15%)	607	598	771	792	567	429	395	377	389	467	554	661

Proposed Project minus Existing

Statistic	Monthly EC (UMHOS/CM)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	21	-9	24	174	53	42	-11	-62	-15	6	7	42
20%	24	10	44	155	34	8	-17	-68	-24	-10	-14	24
30%	5	0	55	162	0	24	-12	-70	-29	-9	2	16
40%	2	12	148	143	-1	18	-26	-79	-30	-10	-5	-7
50%	13	8	314	64	8	20	-25	-85	-33	-9	-3	-35
60%	-37	132	308	37	25	10	-22	-83	-31	-3	-8	-73
70%	-33	113	273	20	16	13	-17	-76	-33	-7	-1	-81
80%	-29	85	225	32	5	9	7	-60	-27	-3	-4	-51
90%	-21	50	50	8	0	14	36	42	-24	-1	-13	-48
Long Term												
Full Simulation Period[a]	-4	44	143	79	16	18	-11	-55	-26	-3	-4	-20
Water Year Types[b]												
Wet (32%)	-7	57	123	33	-1	12	4	-31	-18	-1	-8	-95
Above Normal (15%)	-2	71	202	135	17	25	-22	-82	-36	-6	1	-12
Below Normal (17%)	-9	40	137	86	6	20	-11	-82	-36	-15	-5	45
Dry (22%)	-7	27	151	121	30	25	-22	-69	-29	-6	-11	5
Critical (15%)	8	18	123	51	44	10	-14	-29	-19	9	13	17

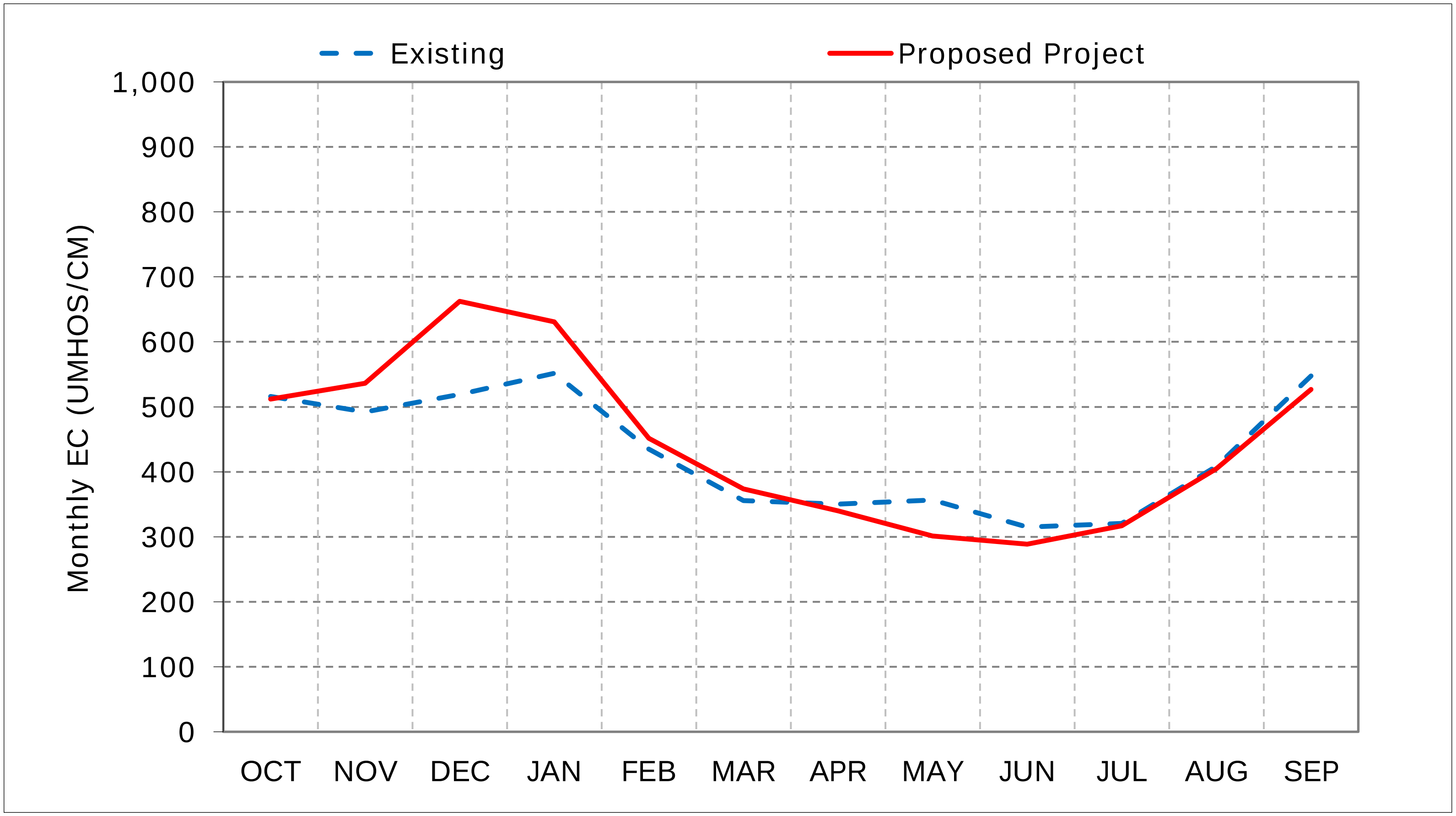
a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

c These results are displayed with water year - year type sorting.

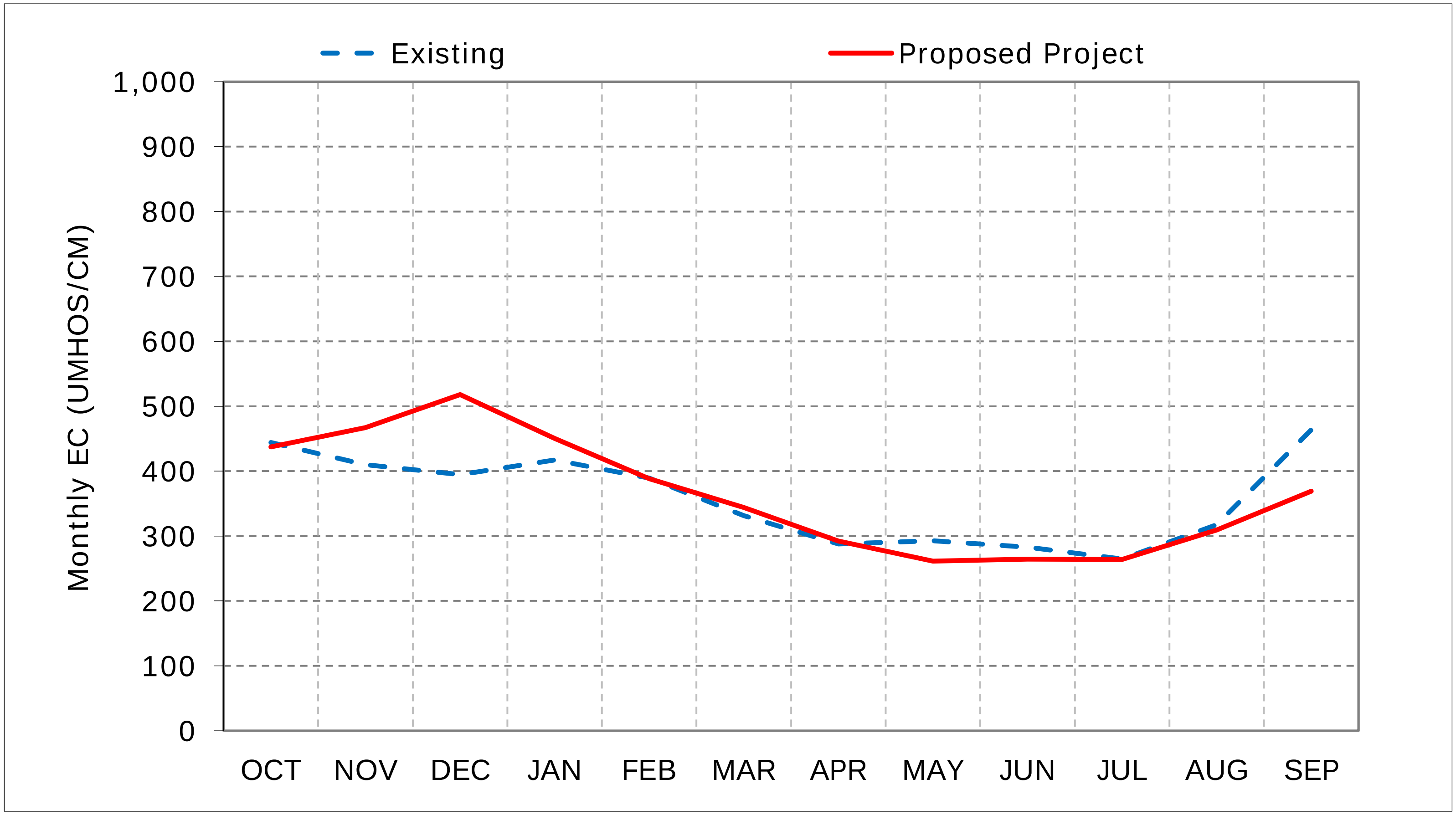
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 18-1. Old River at Highway 4, Long-Term Average EC



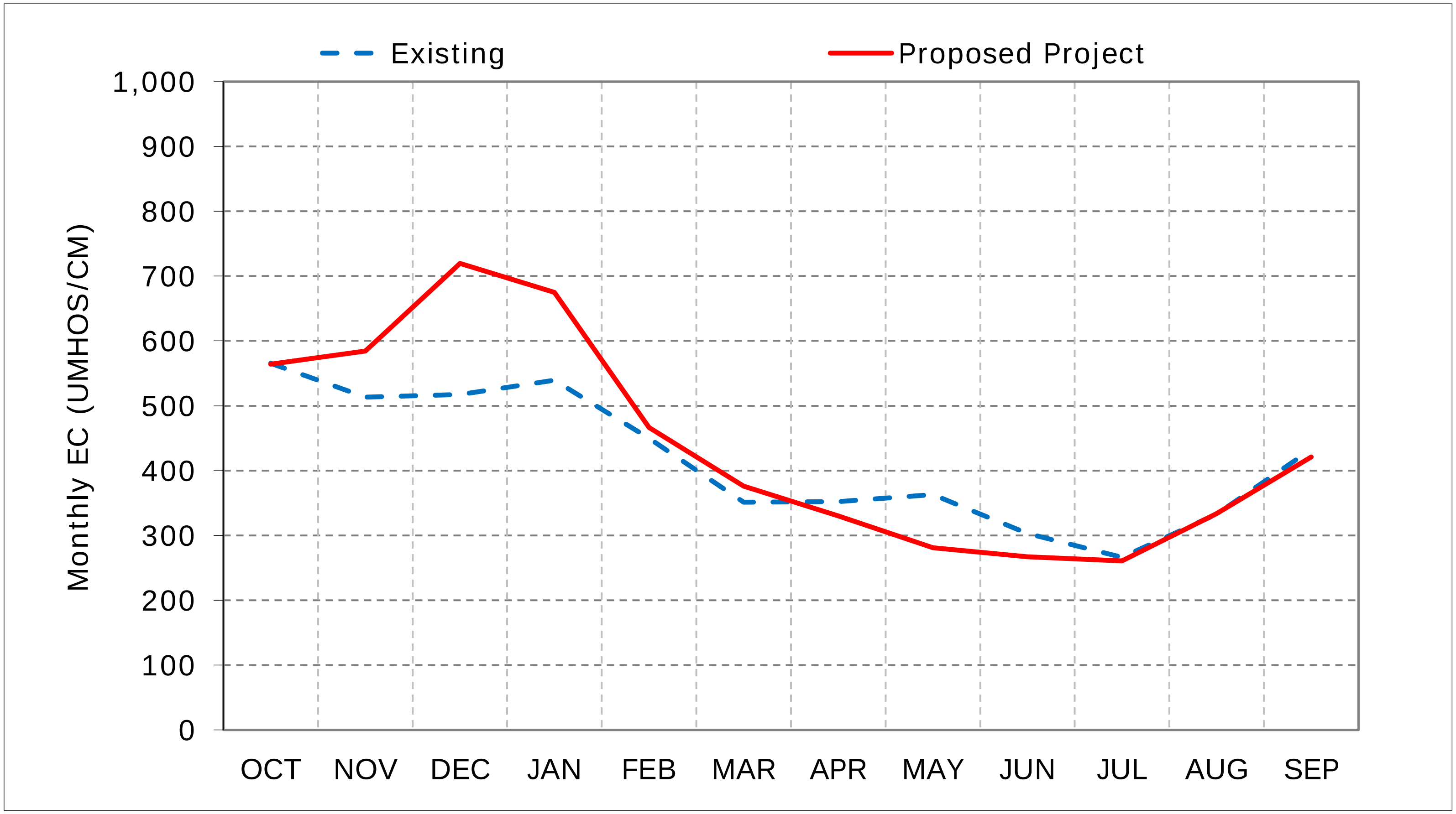
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 18-2. Old River at Highway 4, Wet Year Average EC



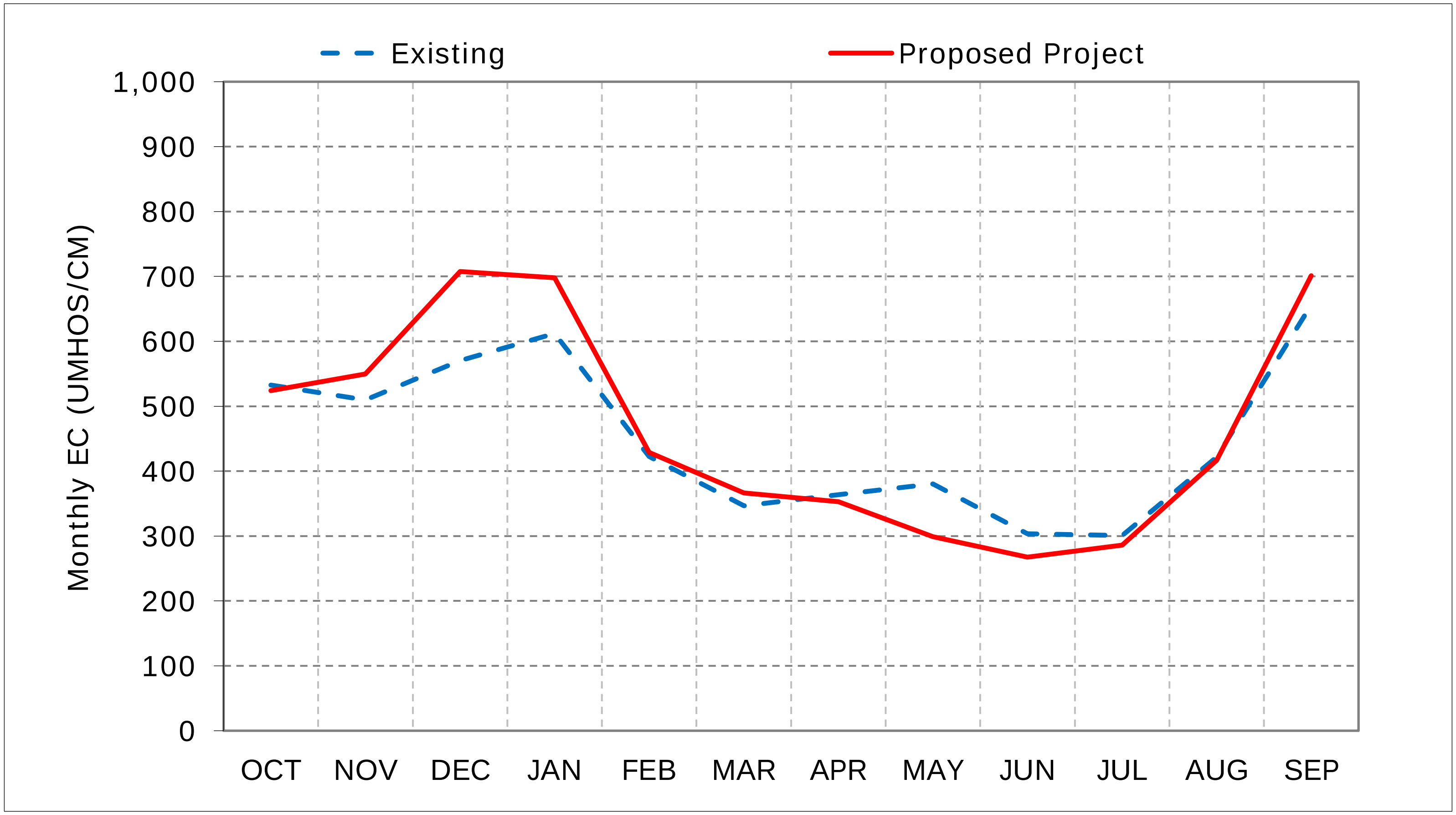
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 18-3. Old River at Highway 4, Above Normal Year Average EC



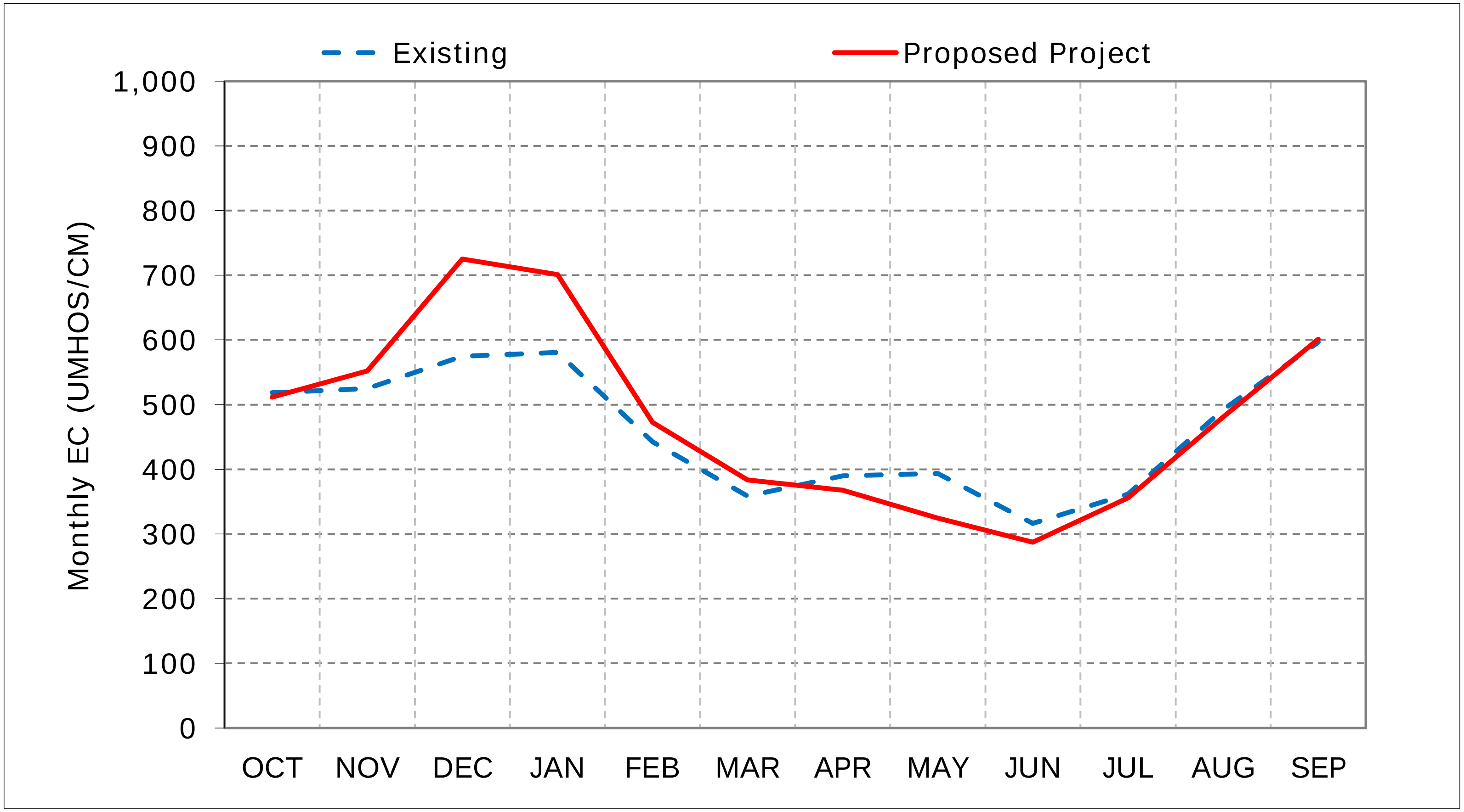
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 18-4. Old River at Highway 4, Below Normal Year Average EC



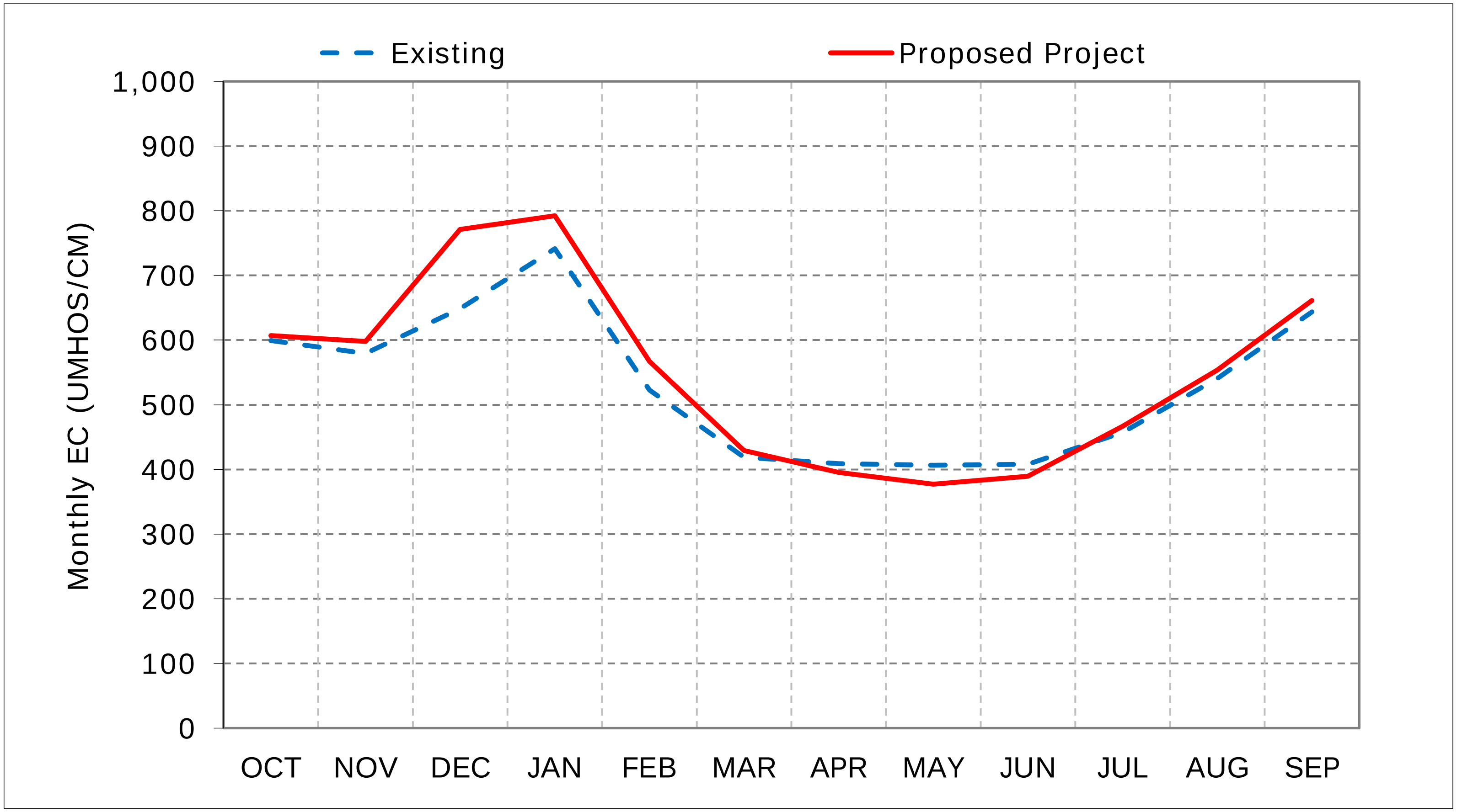
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 18-5. Old River at Highway 4, Dry Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 18-6. Old River at Highway 4, Critical Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 18-7. Old River at Highway 4, January EC

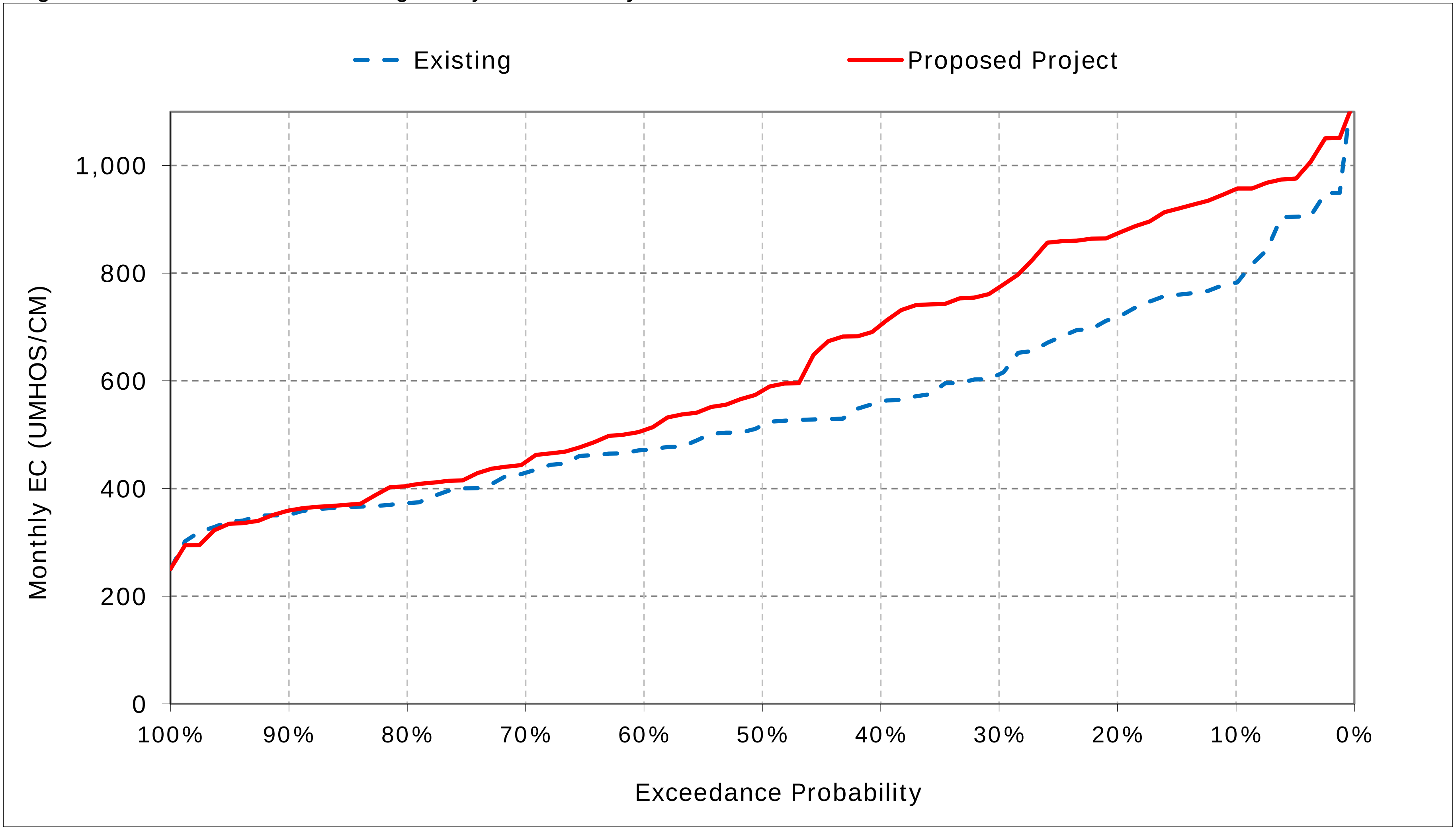


Figure 18-8. Old River at Highway 4, February EC

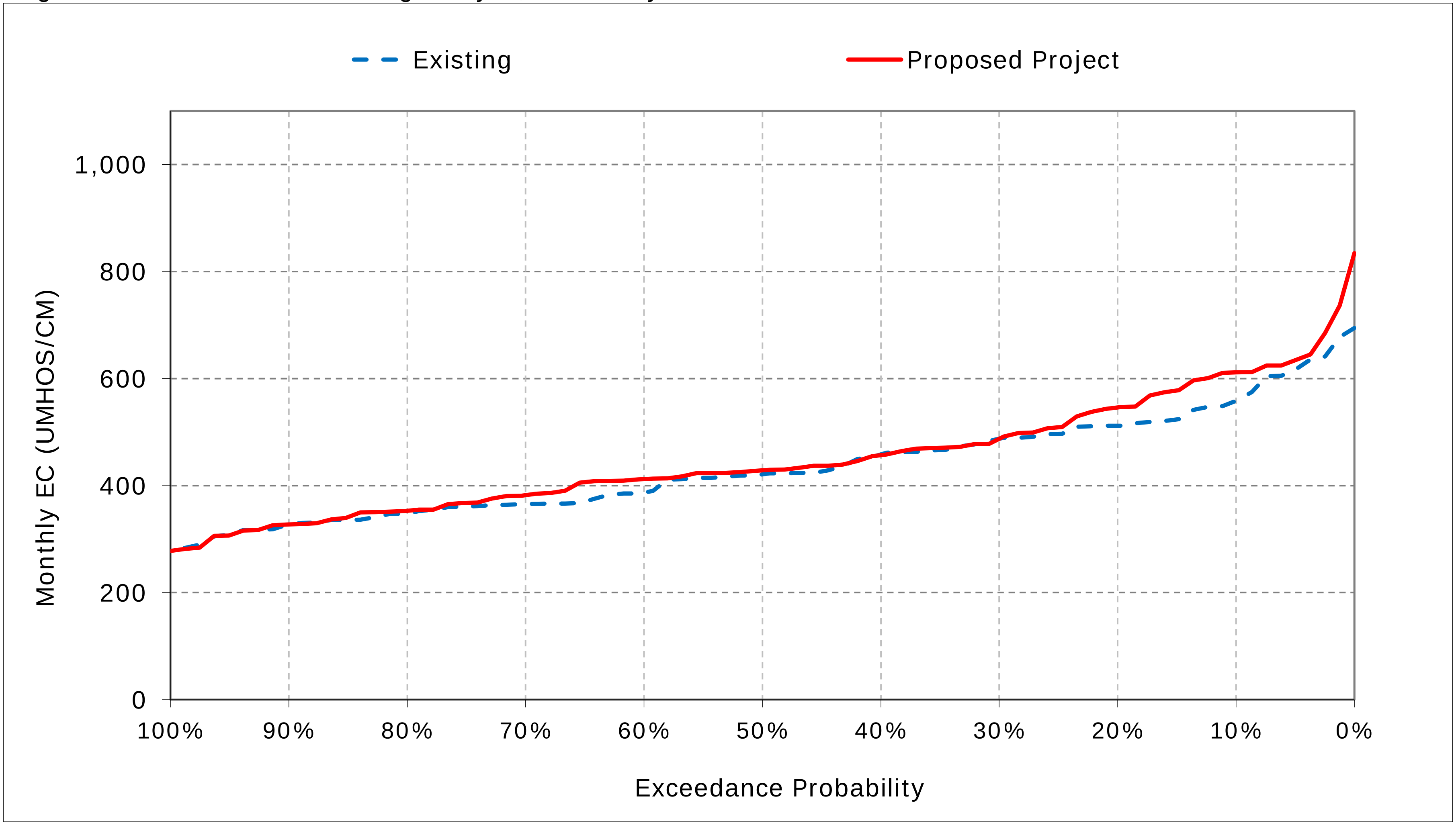


Figure 18-9. Old River at Highway 4, March EC

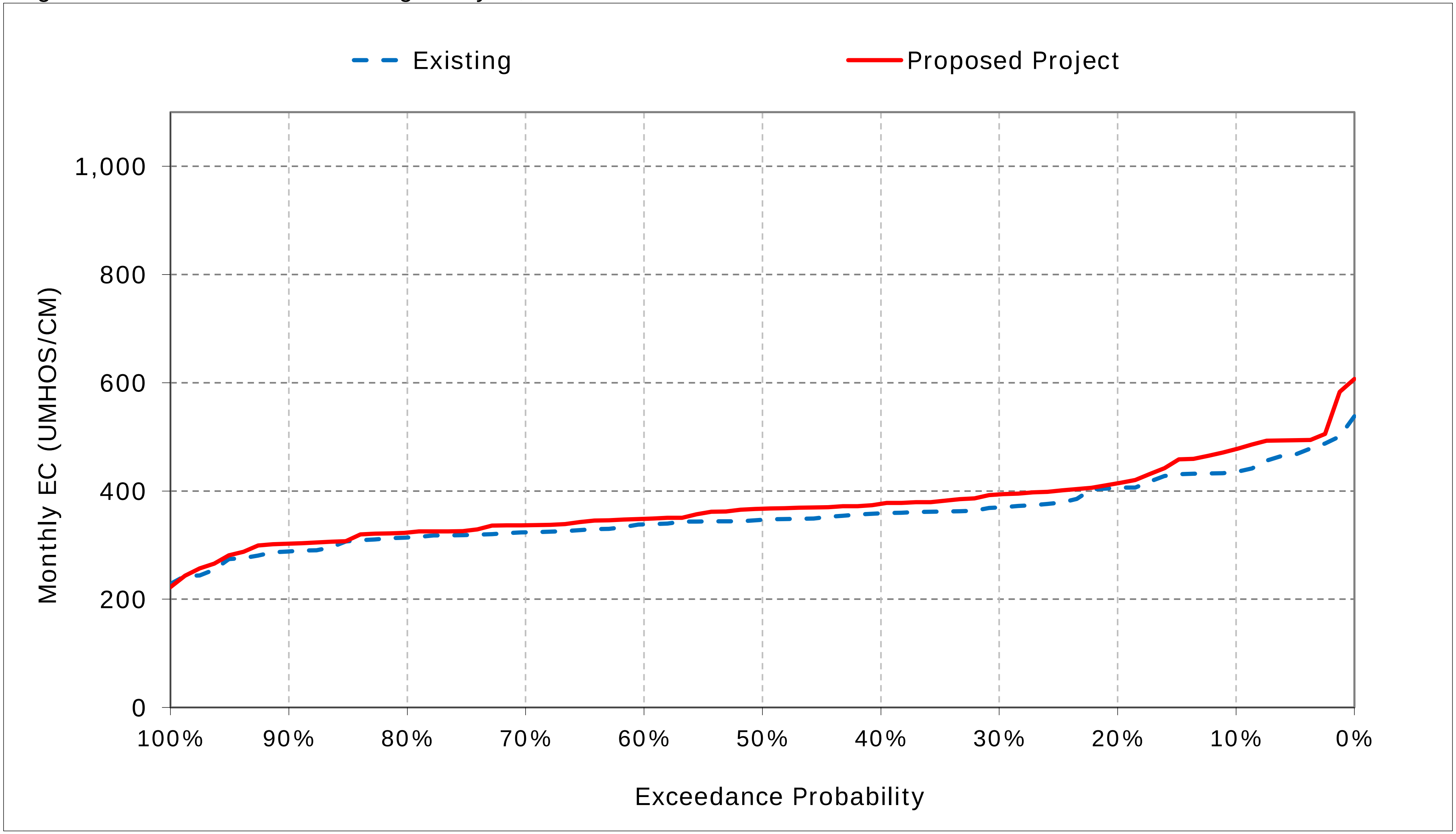


Figure 18-10. Old River at Highway 4, April EC

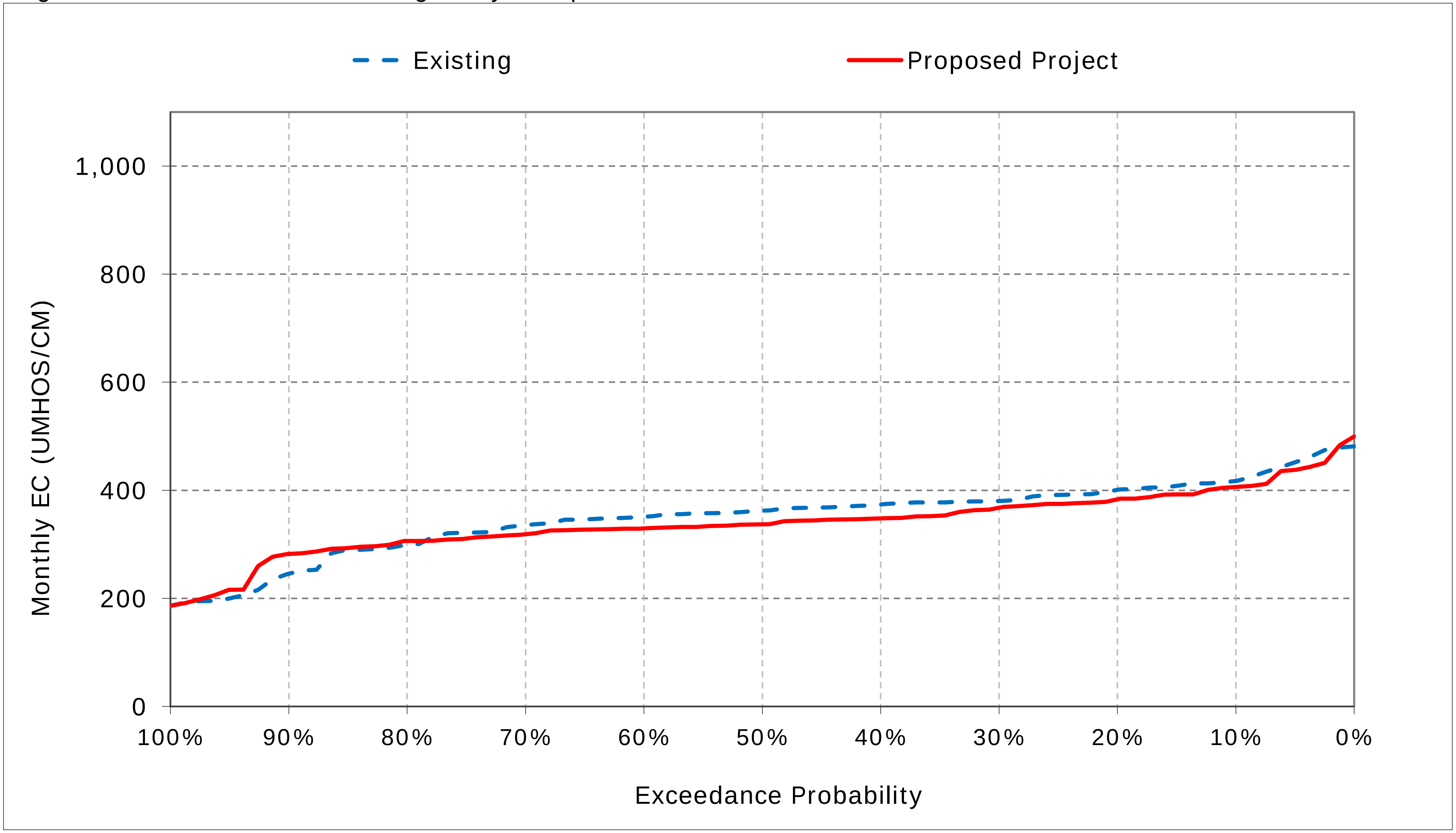


Figure 18-11. Old River at Highway 4, May EC

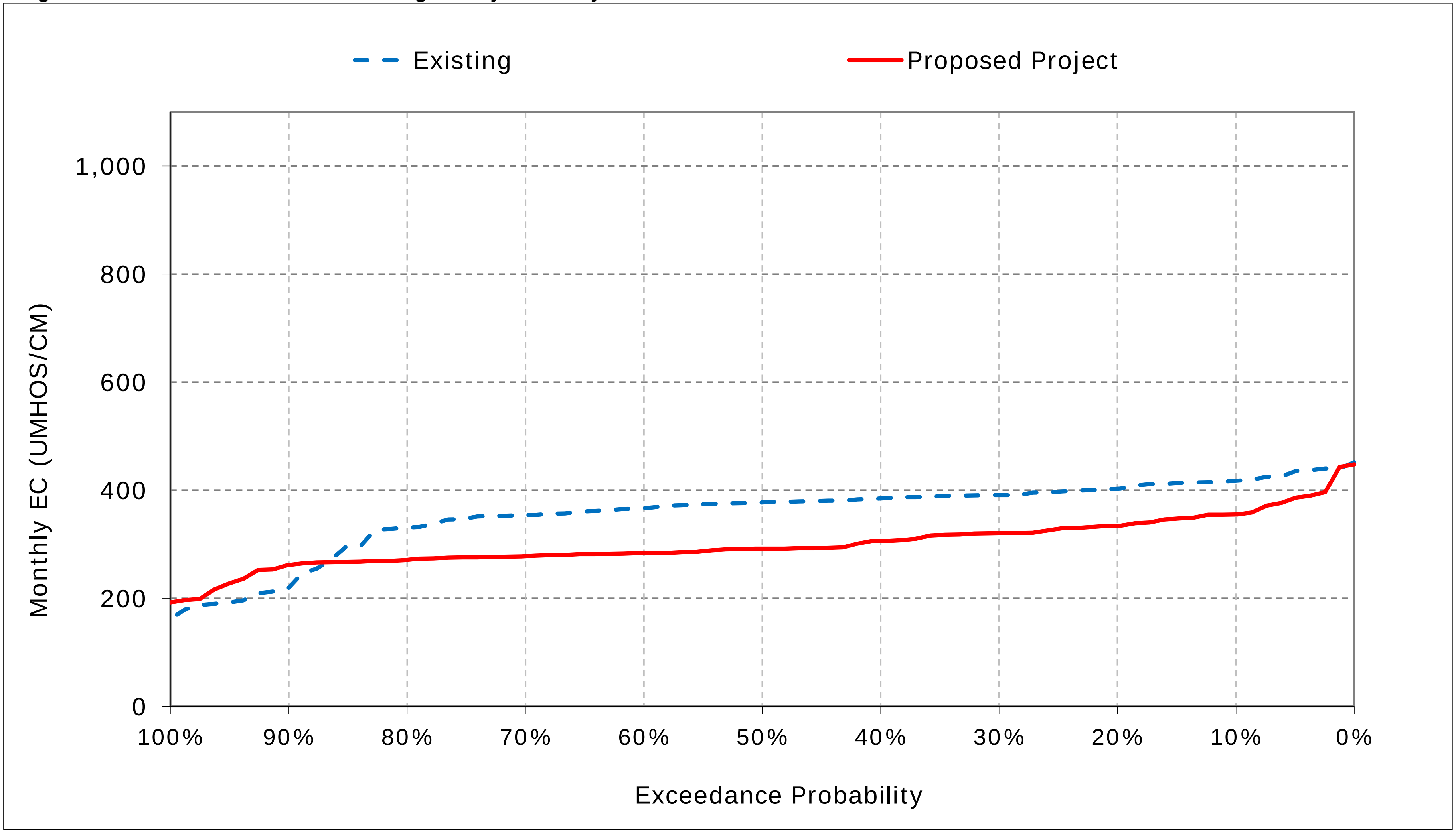


Figure 18-12. Old River at Highway 4, June EC

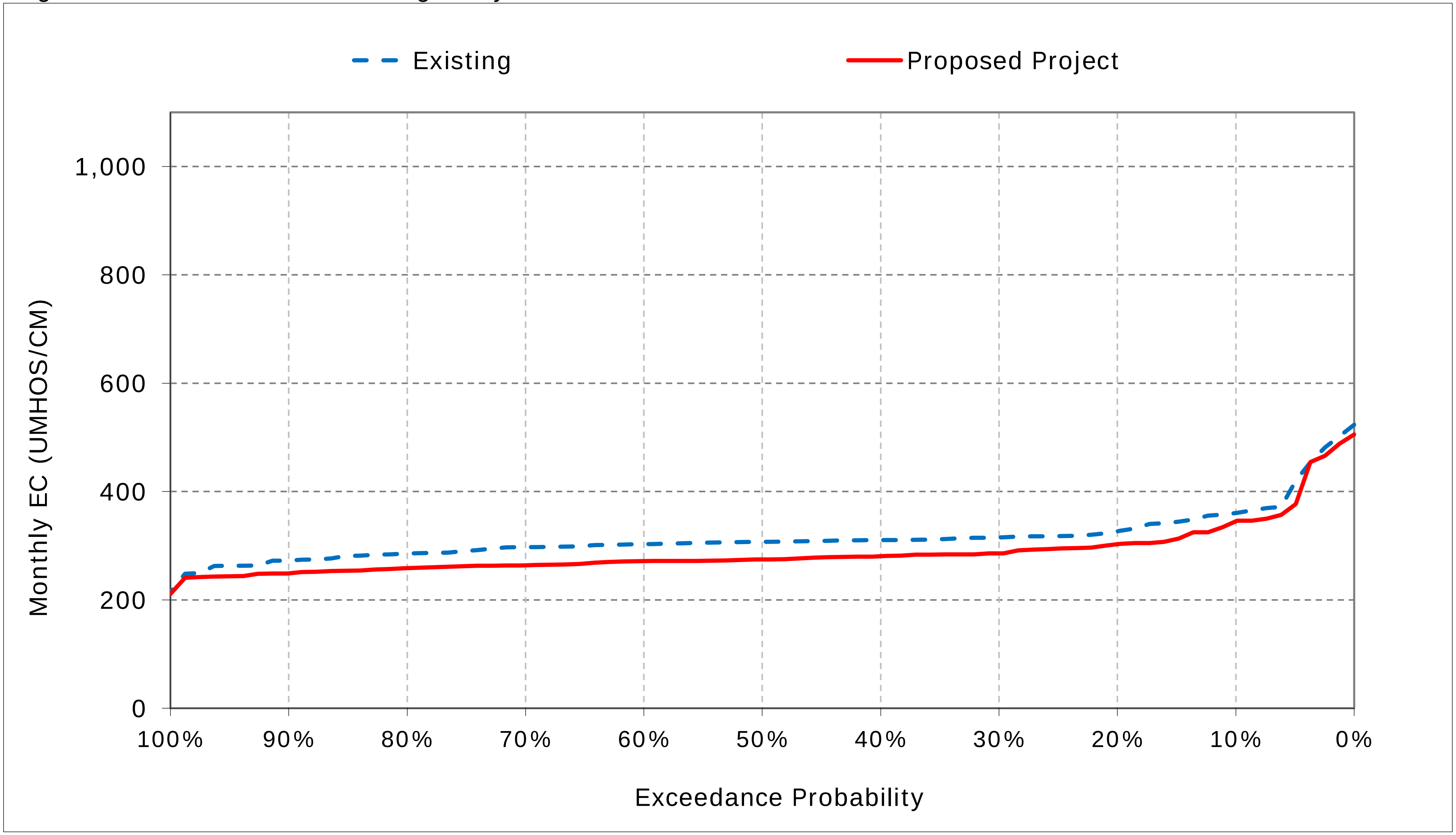


Figure 18-13. Old River at Highway 4, July EC

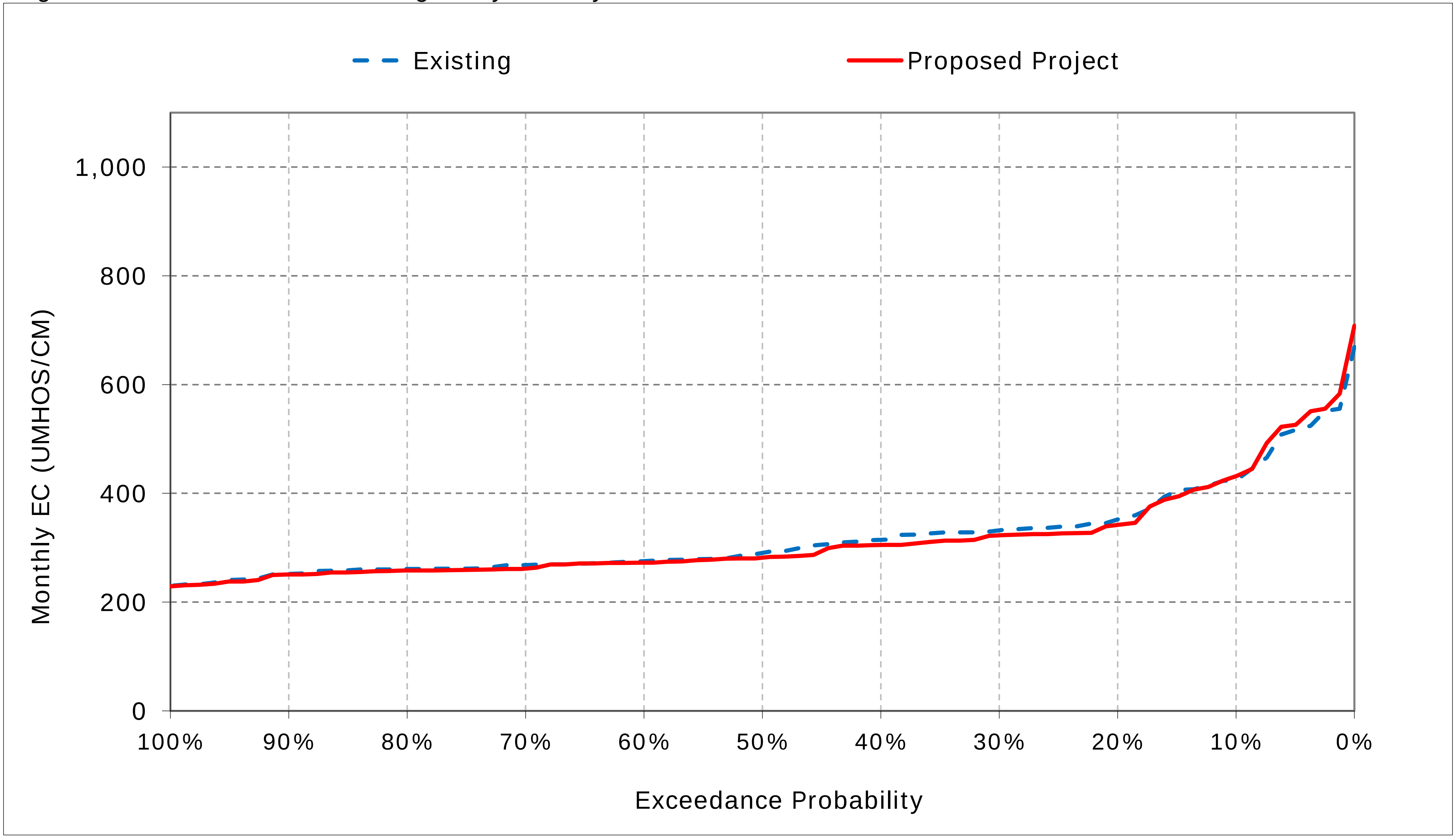


Figure 18-14. Old River at Highway 4, August EC

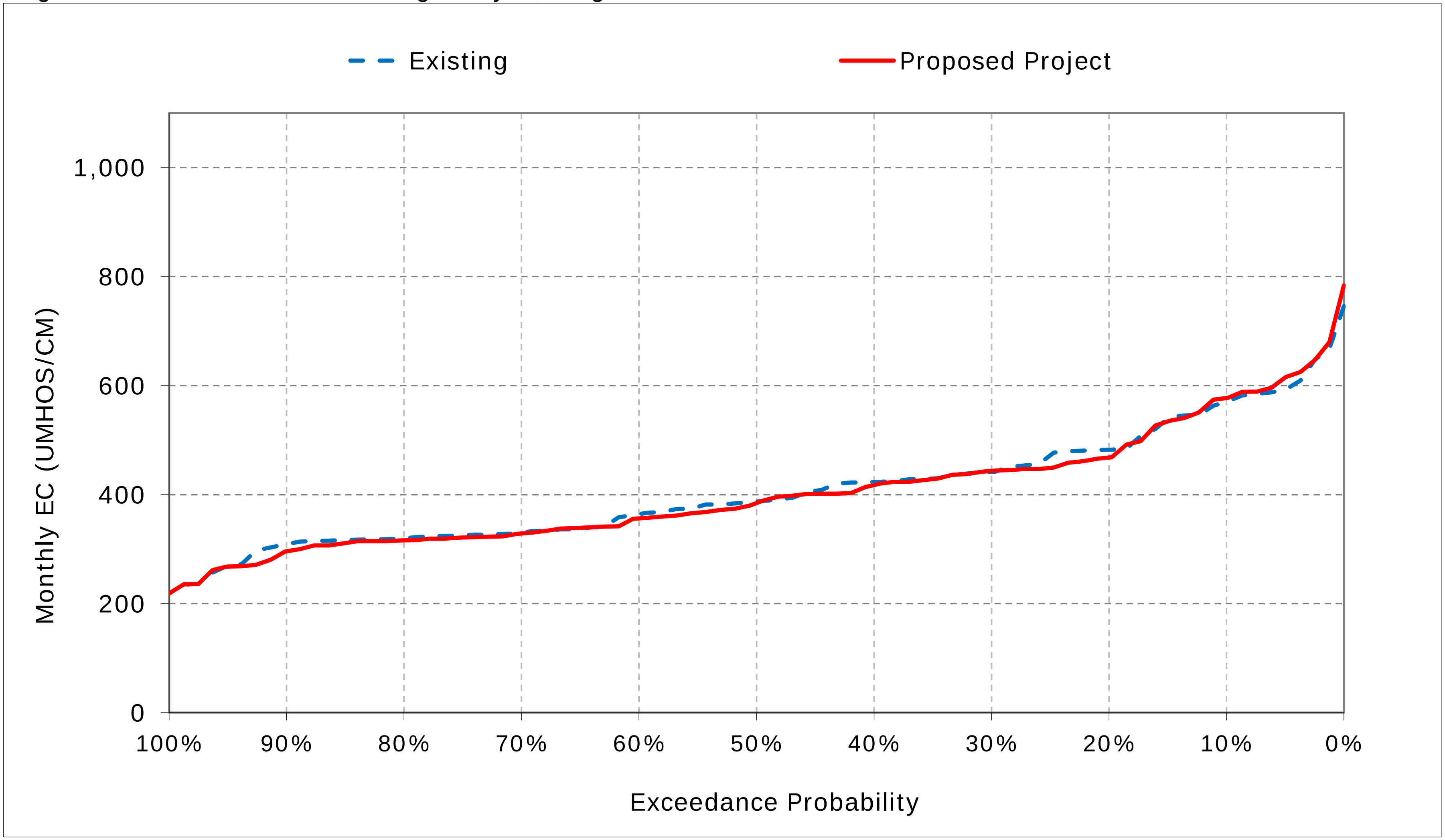


Figure 18-15. Old River at Highway 4, September EC

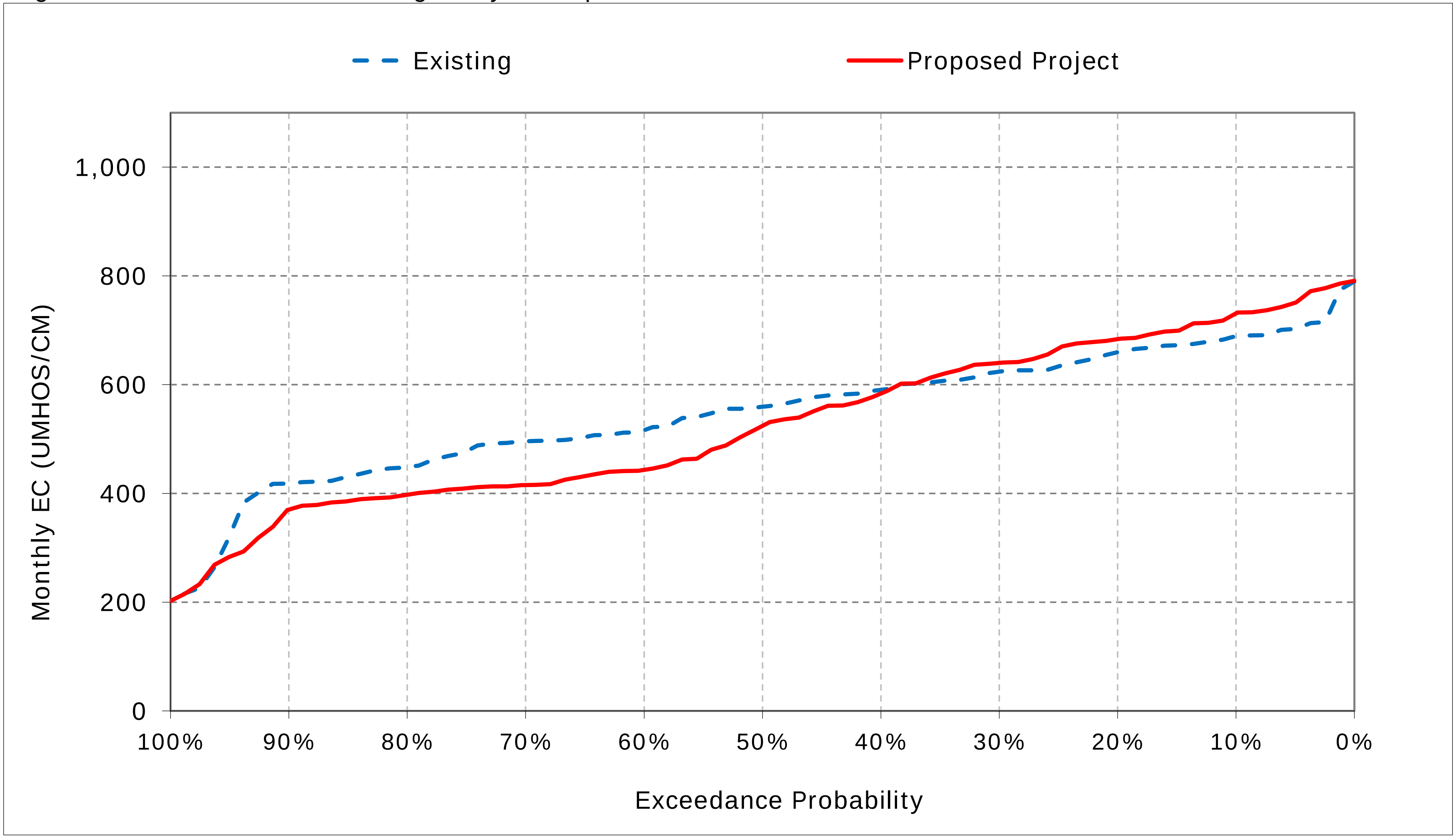


Figure 18-16. Old River at Highway 4, October EC

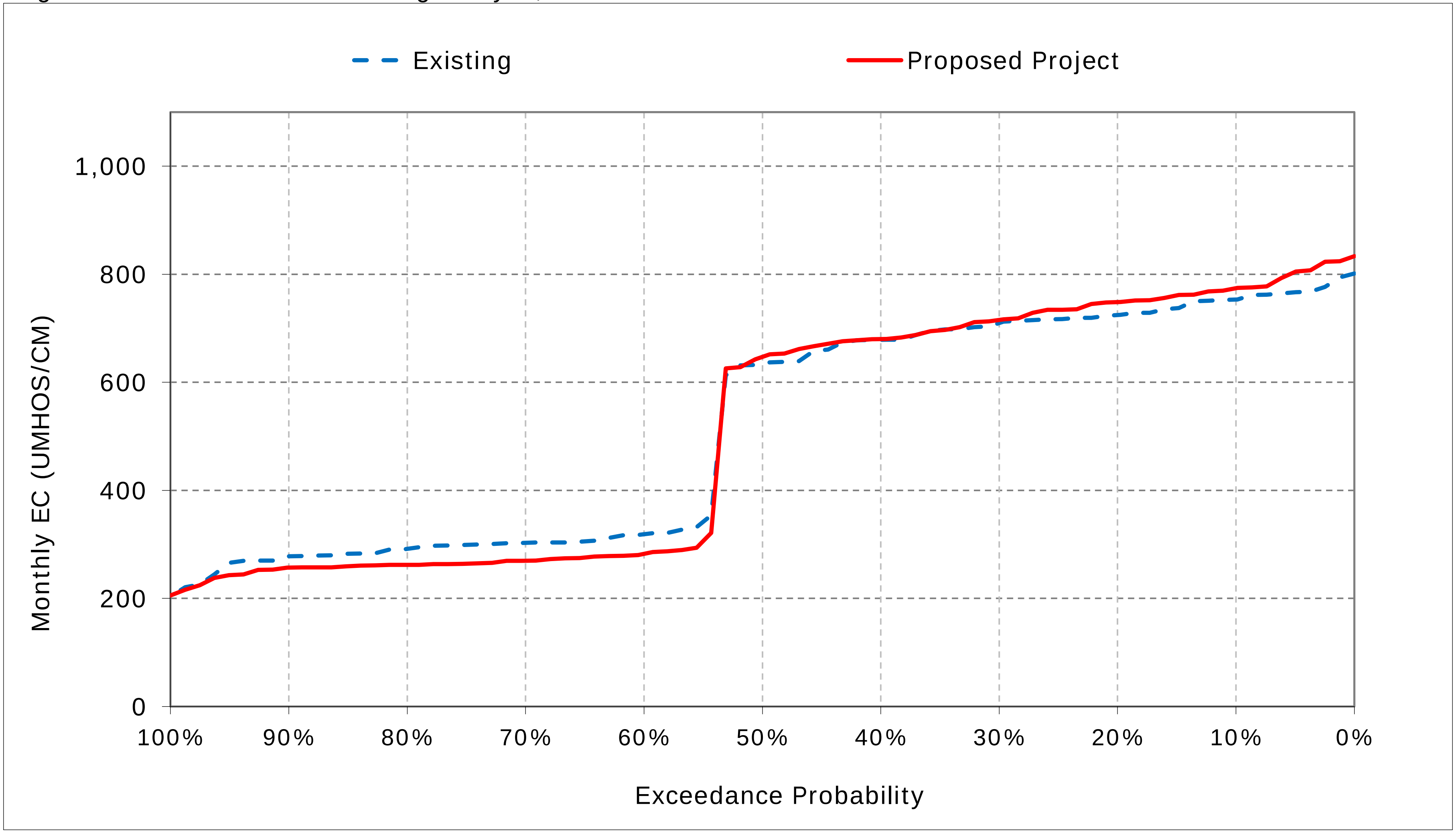


Figure 18-17. Old River at Highway 4, November EC

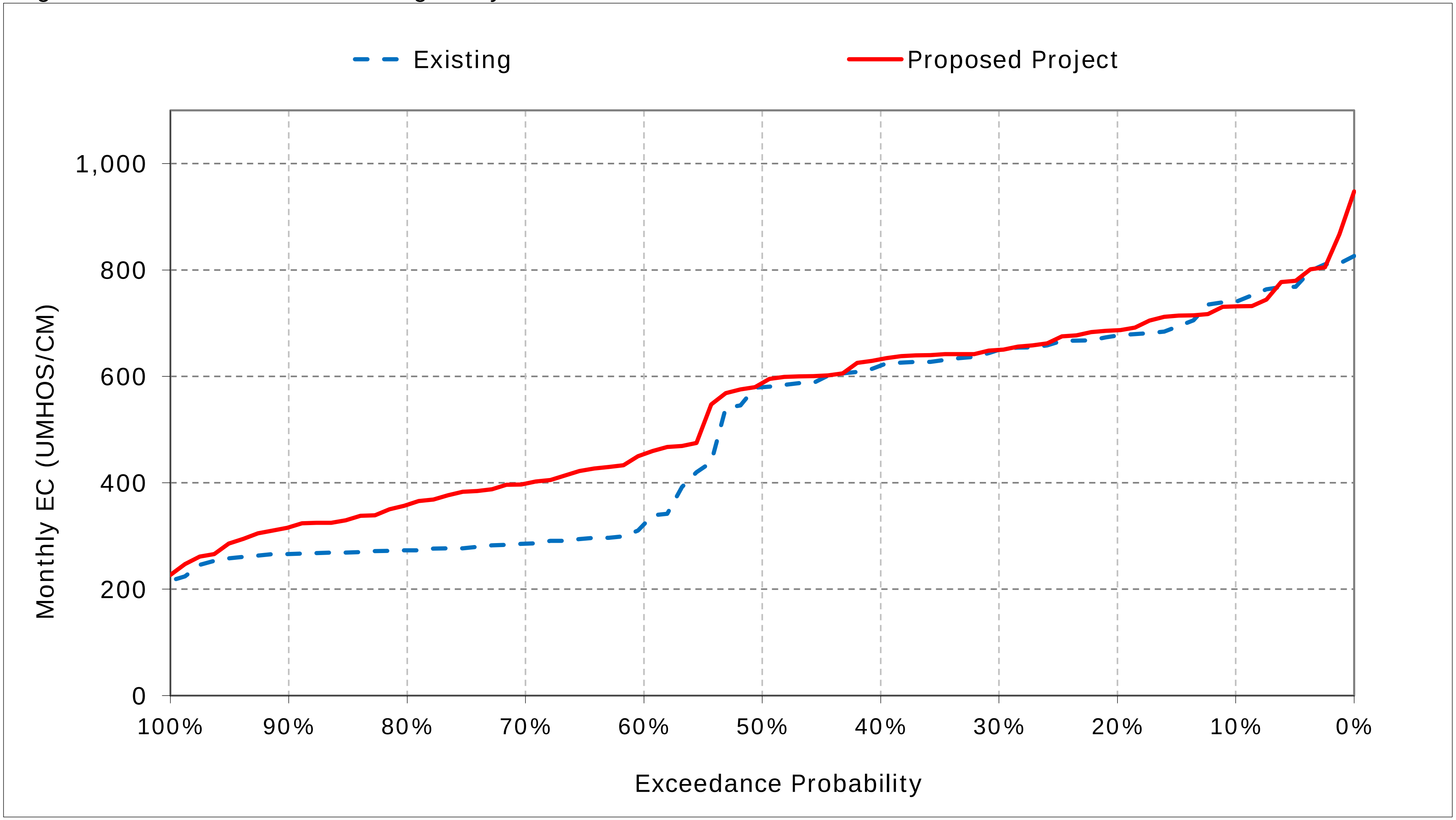


Figure 18-18. Old River at Highway 4, December EC

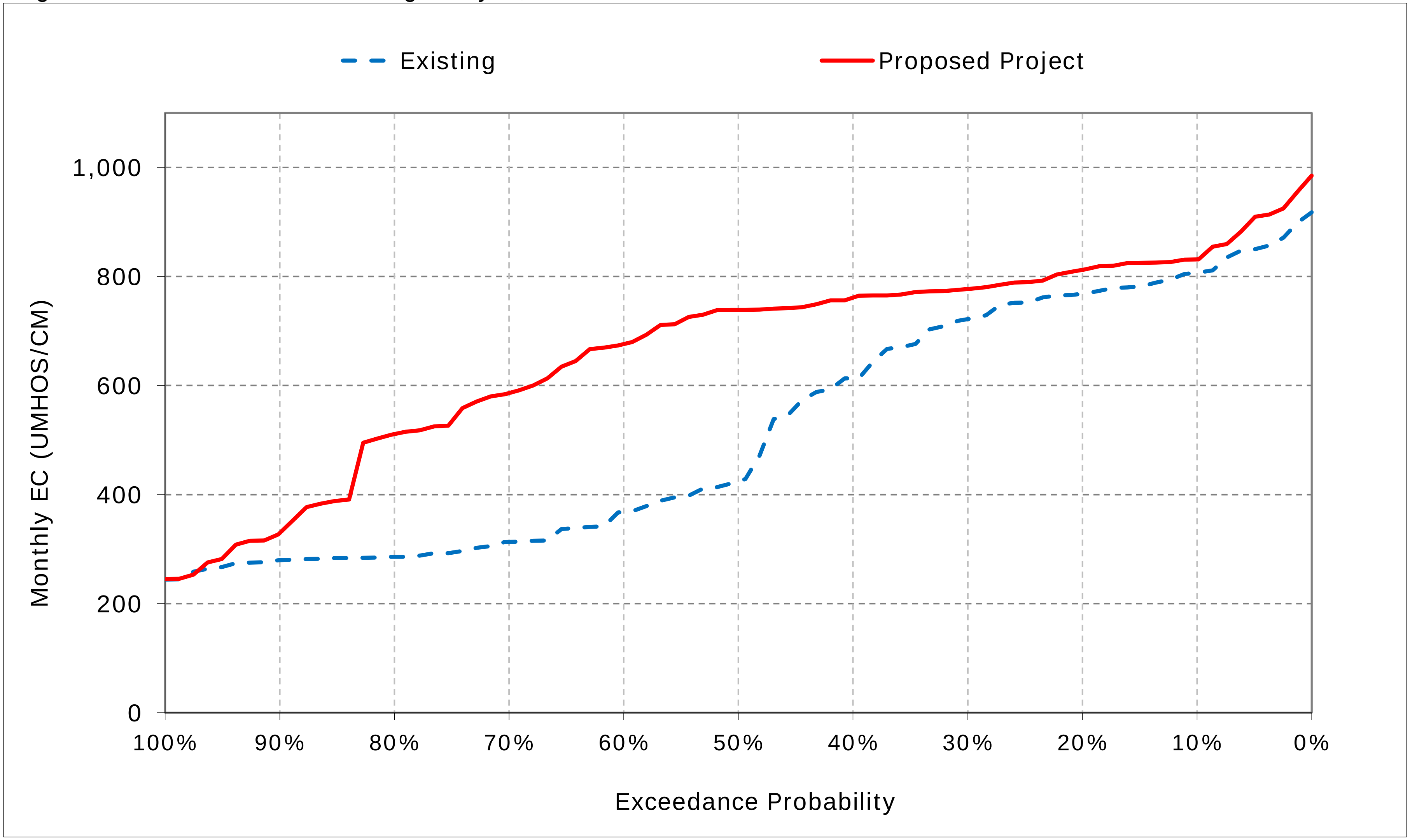


Table 19-1. Victoria Canal Salinity, Monthly EC

Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	512	528	585	672	620	535	496	471	426	368	427	458
20%	490	483	556	646	576	497	470	453	386	356	378	446
30%	477	467	538	583	550	481	450	438	375	327	350	439
40%	467	453	514	553	537	464	430	420	369	310	330	427
50%	446	431	436	526	503	440	410	389	363	298	308	412
60%	368	359	377	502	482	419	369	374	358	289	301	394
70%	354	348	337	481	469	395	333	359	348	280	293	386
80%	333	341	318	448	432	347	302	327	336	271	284	355
90%	320	330	295	427	368	323	246	215	322	258	270	338
Long Term												
Full Simulation Period[a]	418	414	443	541	501	433	387	379	365	311	330	401
Water Year Types[b]												
Wet (32%)	388	377	400	477	428	362	292	293	330	303	285	374
Above Normal (15%)	440	433	440	544	528	427	375	370	360	295	281	344
Below Normal (17%)	421	414	455	572	513	447	402	398	360	282	321	425
Dry (22%)	420	424	463	549	535	488	462	438	376	301	380	418
Critical (15%)	451	463	498	628	568	492	471	466	432	391	416	465

Proposed Project

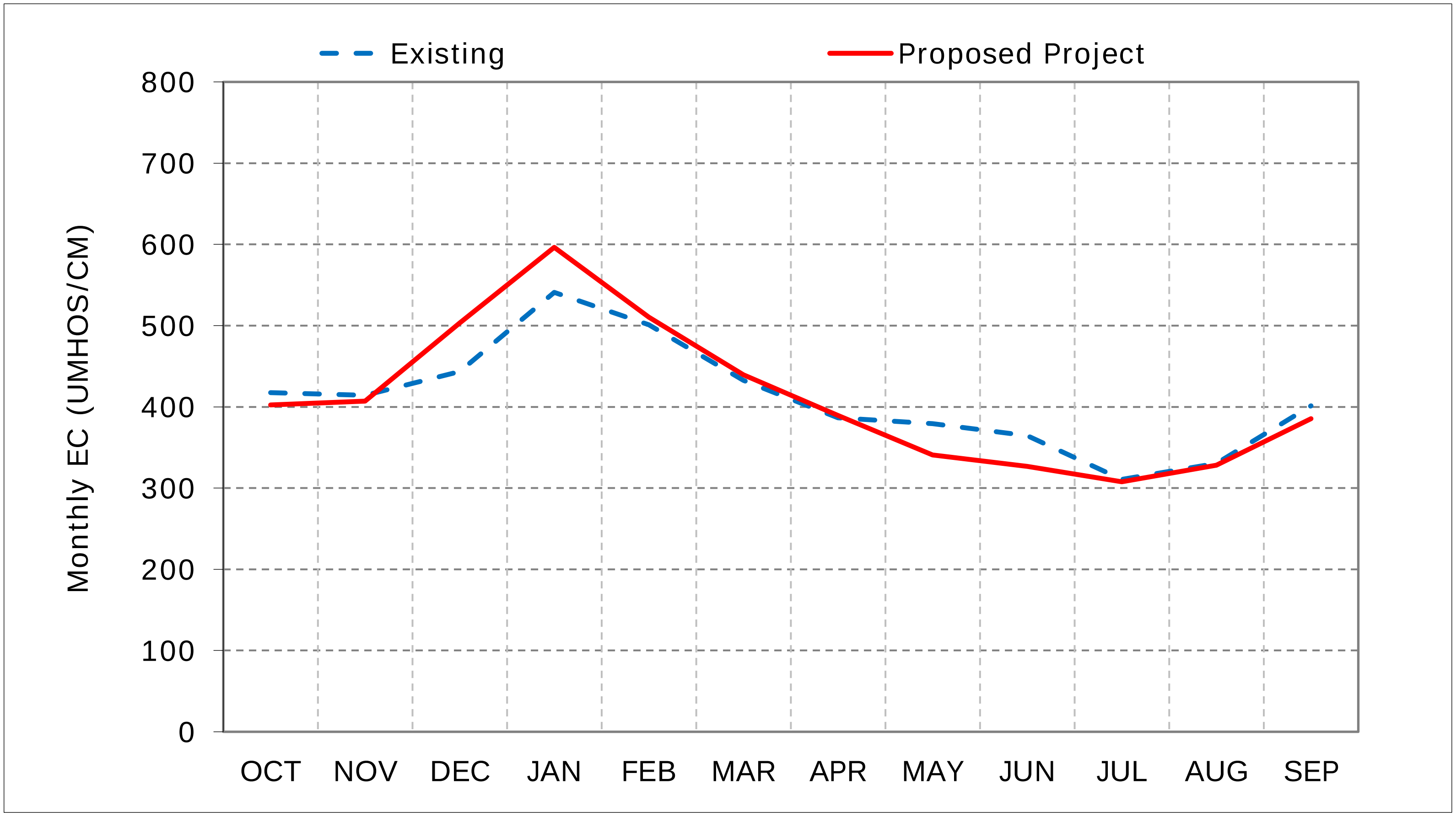
Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	527	522	619	770	655	548	483	411	365	371	426	464
20%	498	501	572	720	609	509	462	388	350	356	363	453
30%	484	469	552	674	567	486	441	375	335	328	343	434
40%	470	448	542	646	533	470	425	354	329	307	325	419
50%	457	436	519	582	511	446	407	344	322	296	306	391
60%	310	338	500	556	484	424	378	336	317	284	299	353
70%	301	326	471	516	465	384	346	327	310	274	291	337
80%	295	313	426	481	441	359	319	317	301	260	283	330
90%	287	305	357	434	370	327	289	253	290	254	271	313
Long Term												
Full Simulation Period[a]	402	407	503	596	510	439	389	341	327	308	328	386
Water Year Types[b]												
Wet (32%)	366	368	449	494	427	366	309	283	313	302	283	314
Above Normal (15%)	426	439	536	648	546	434	372	328	321	287	282	339
Below Normal (17%)	402	401	506	630	515	454	417	348	315	277	317	441
Dry (22%)	406	417	524	633	551	500	462	381	323	299	373	419
Critical (15%)	453	450	553	672	590	495	439	410	382	390	418	471

Proposed Project minus Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	16	-6	34	99	35	13	-13	-60	-60	4	-1	7
20%	8	18	16	74	34	12	-8	-65	-37	-1	-15	7
30%	7	2	14	90	16	5	-9	-63	-40	1	-7	-5
40%	2	-5	29	93	-4	7	-4	-66	-40	-3	-5	-8
50%	11	5	83	57	8	5	-3	-44	-41	-2	-2	-21
60%	-58	-21	123	54	2	4	9	-38	-41	-4	-2	-41
70%	-53	-22	133	35	-3	-11	13	-32	-39	-6	-2	-49
80%	-38	-28	109	32	9	12	17	-9	-34	-11	0	-25
90%	-32	-25	62	6	2	4	43	38	-31	-4	1	-25
Long Term												
Full Simulation Period[a]	-15	-7	60	55	9	7	3	-38	-38	-3	-2	-16
Water Year Types[b]												
Wet (32%)	-22	-9	49	17	-1	4	17	-10	-17	-2	-2	-59
Above Normal (15%)	-14	7	96	104	18	8	-2	-42	-39	-7	1	-5
Below Normal (17%)	-19	-12	50	58	1	7	15	-49	-45	-5	-4	16
Dry (22%)	-14	-7	61	84	17	12	0	-57	-53	-1	-7	1
Critical (15%)	2	-13	55	45	22	3	-31	-56	-50	-1	2	6

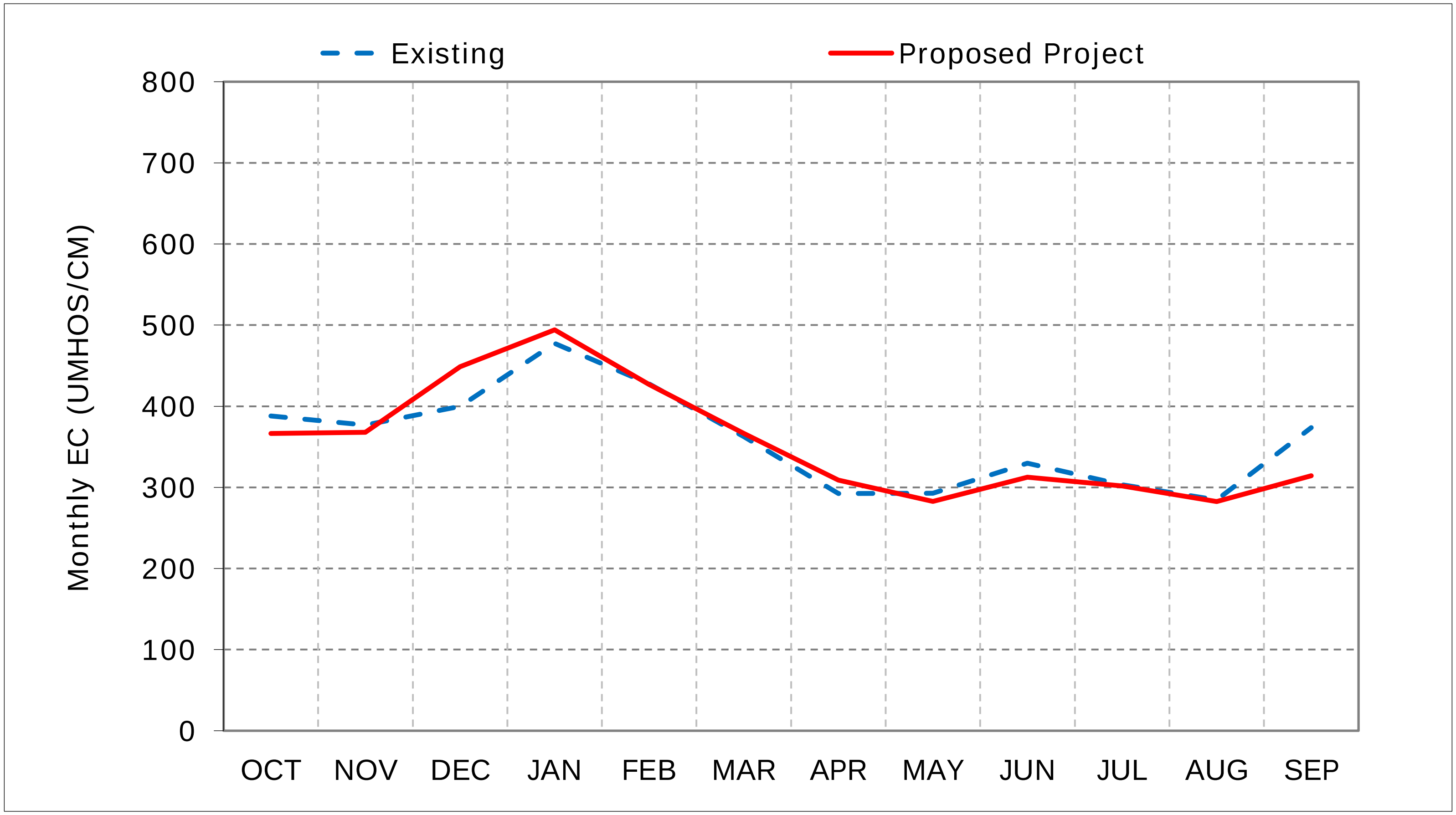
a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with water year - year type sorting.
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 19-1. Victoria Canal Salinity, Long-Term Average EC



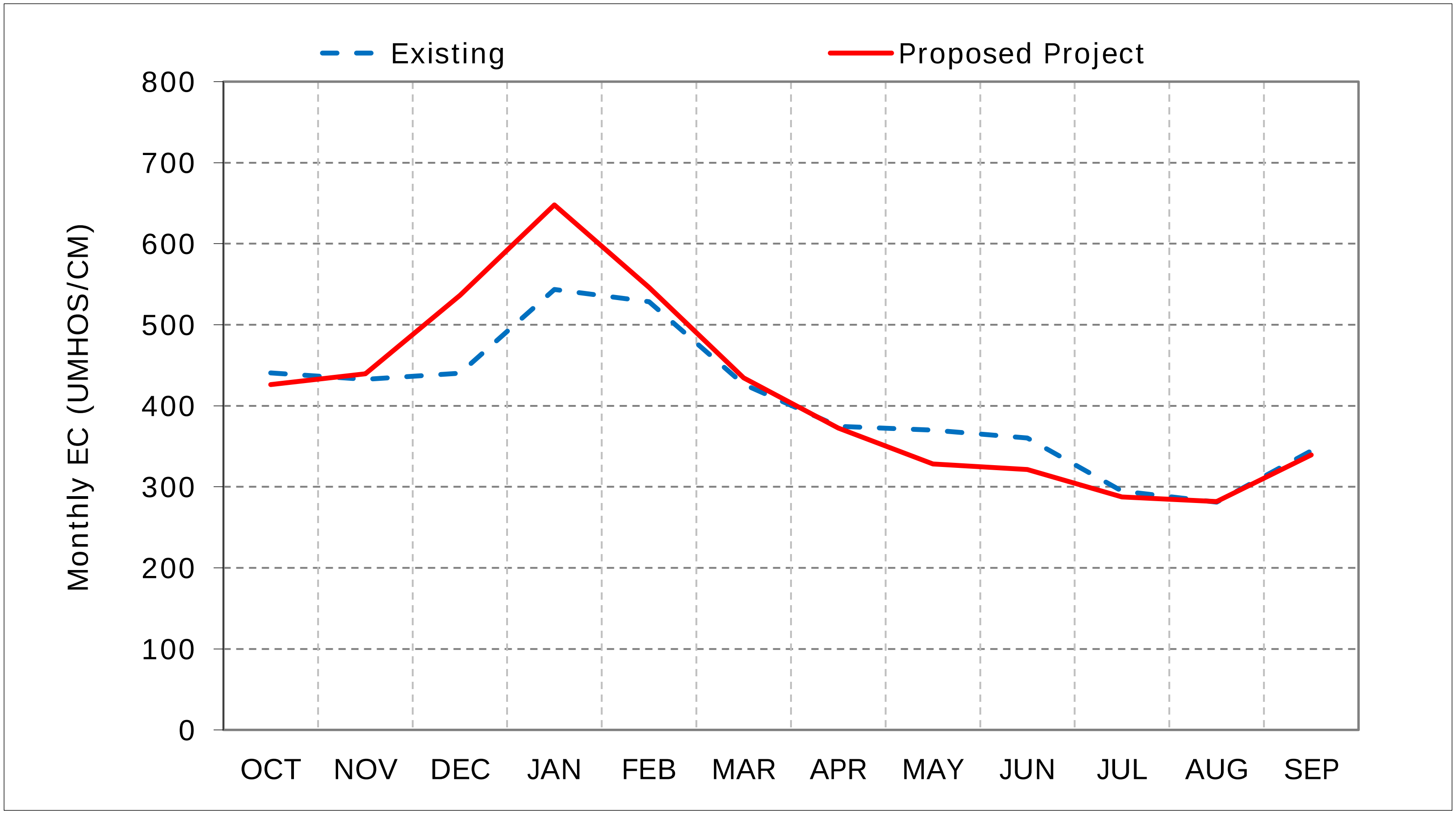
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 19-2. Victoria Canal Salinity, Wet Year Average EC



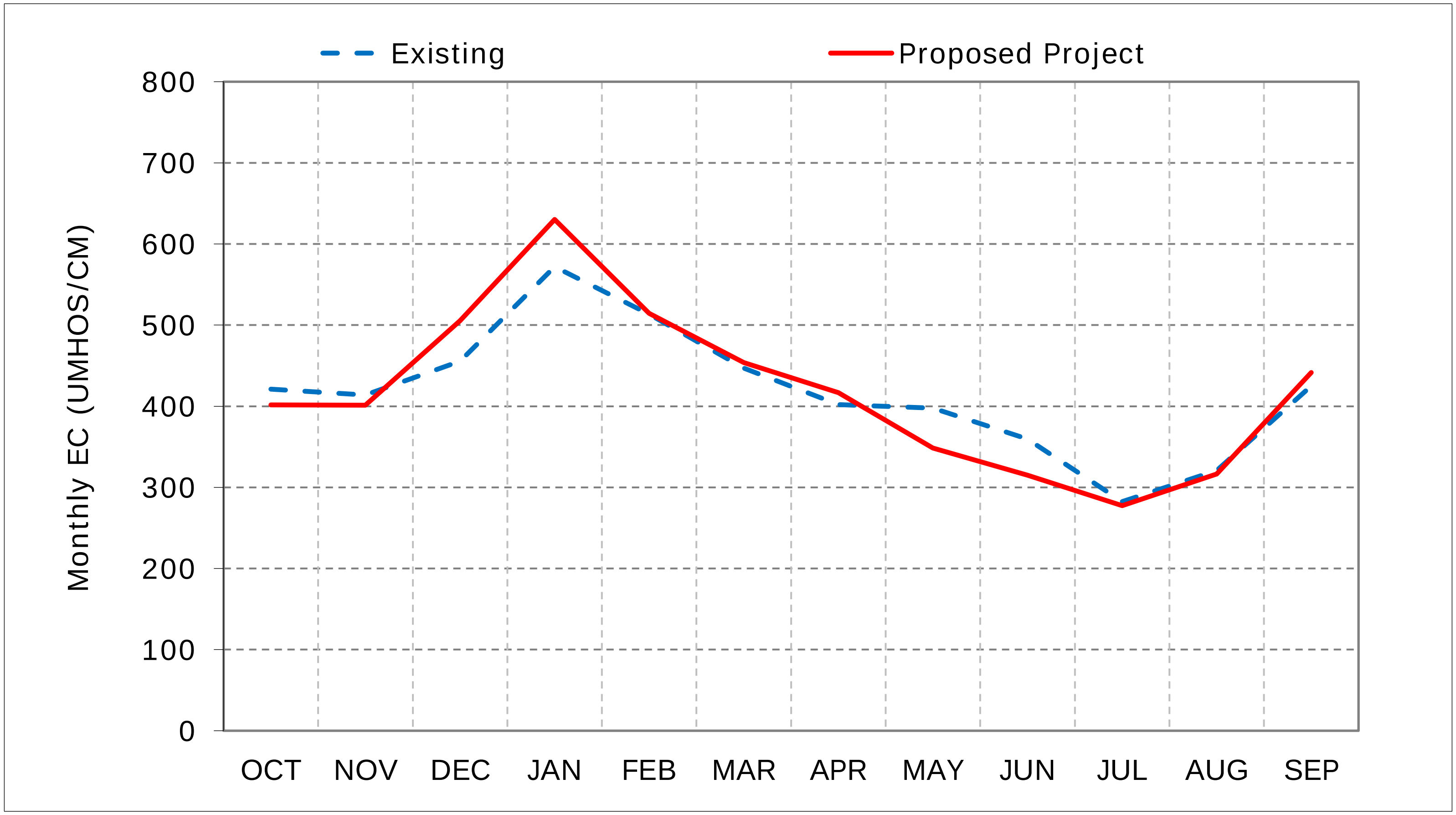
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 19-3. Victoria Canal Salinity, Above Normal Year Average EC



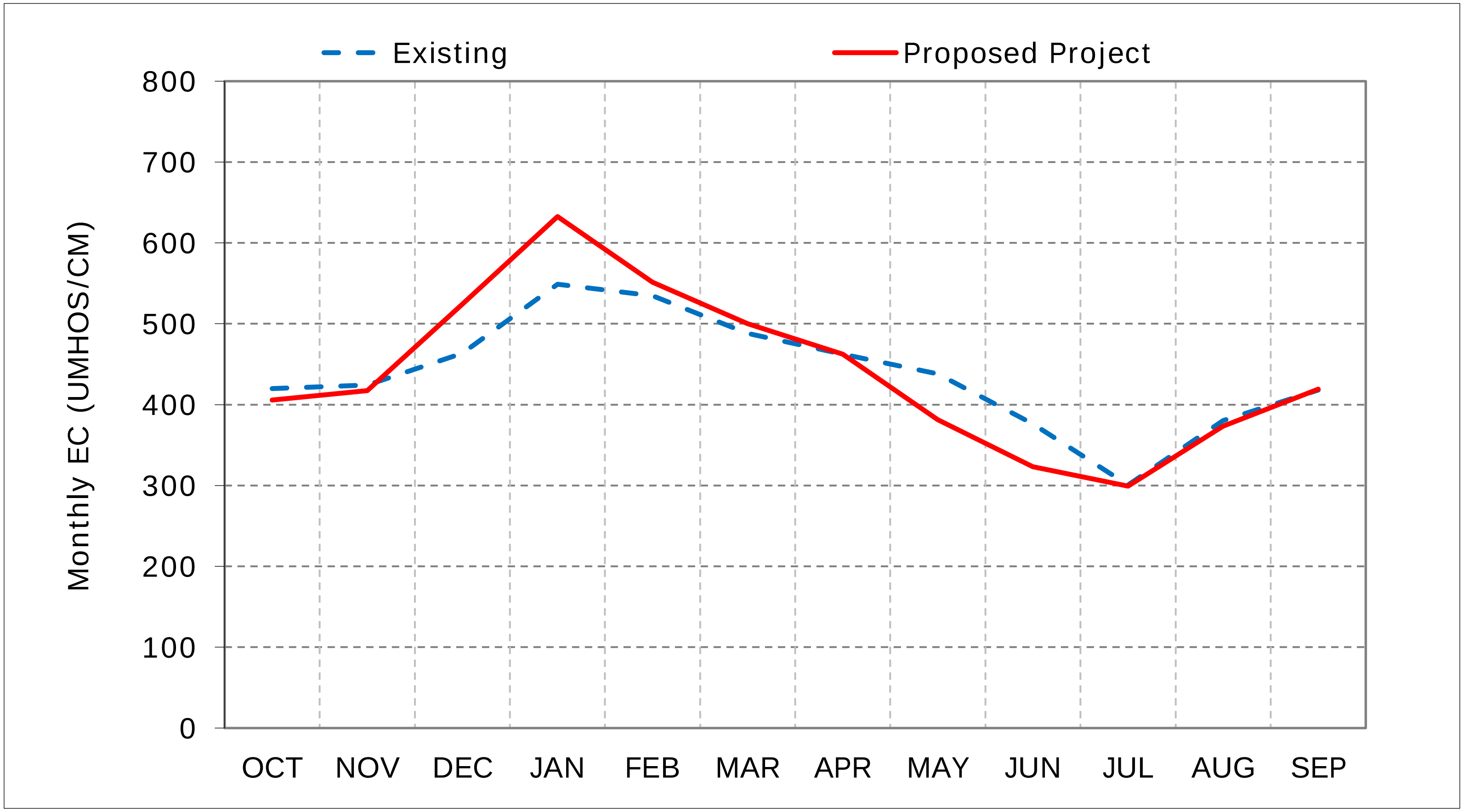
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 19-4. Victoria Canal Salinity, Below Normal Year Average EC



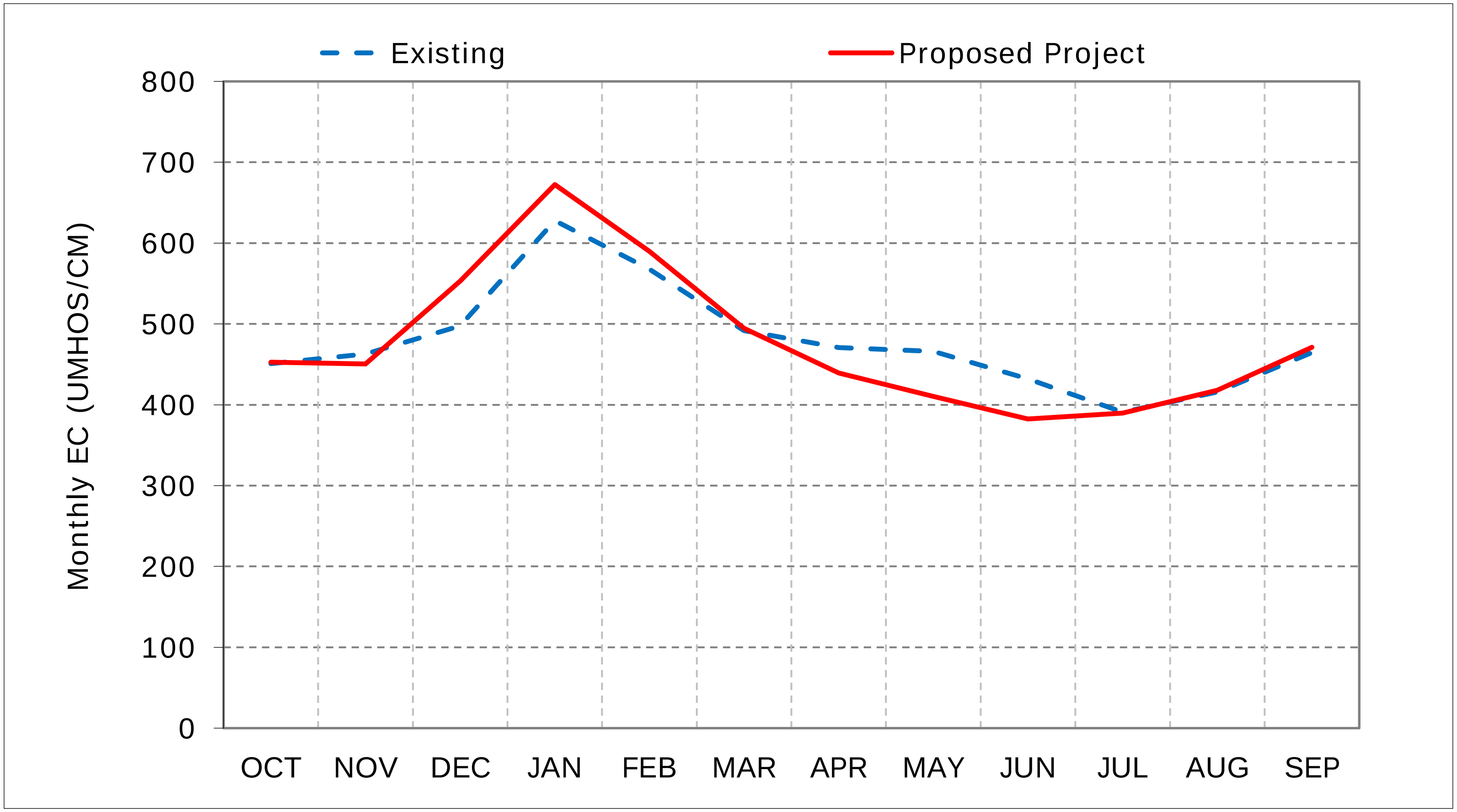
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 19-5. Victoria Canal Salinity, Dry Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 19-6. Victoria Canal Salinity, Critical Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 19-7. Victoria Canal Salinity, January EC

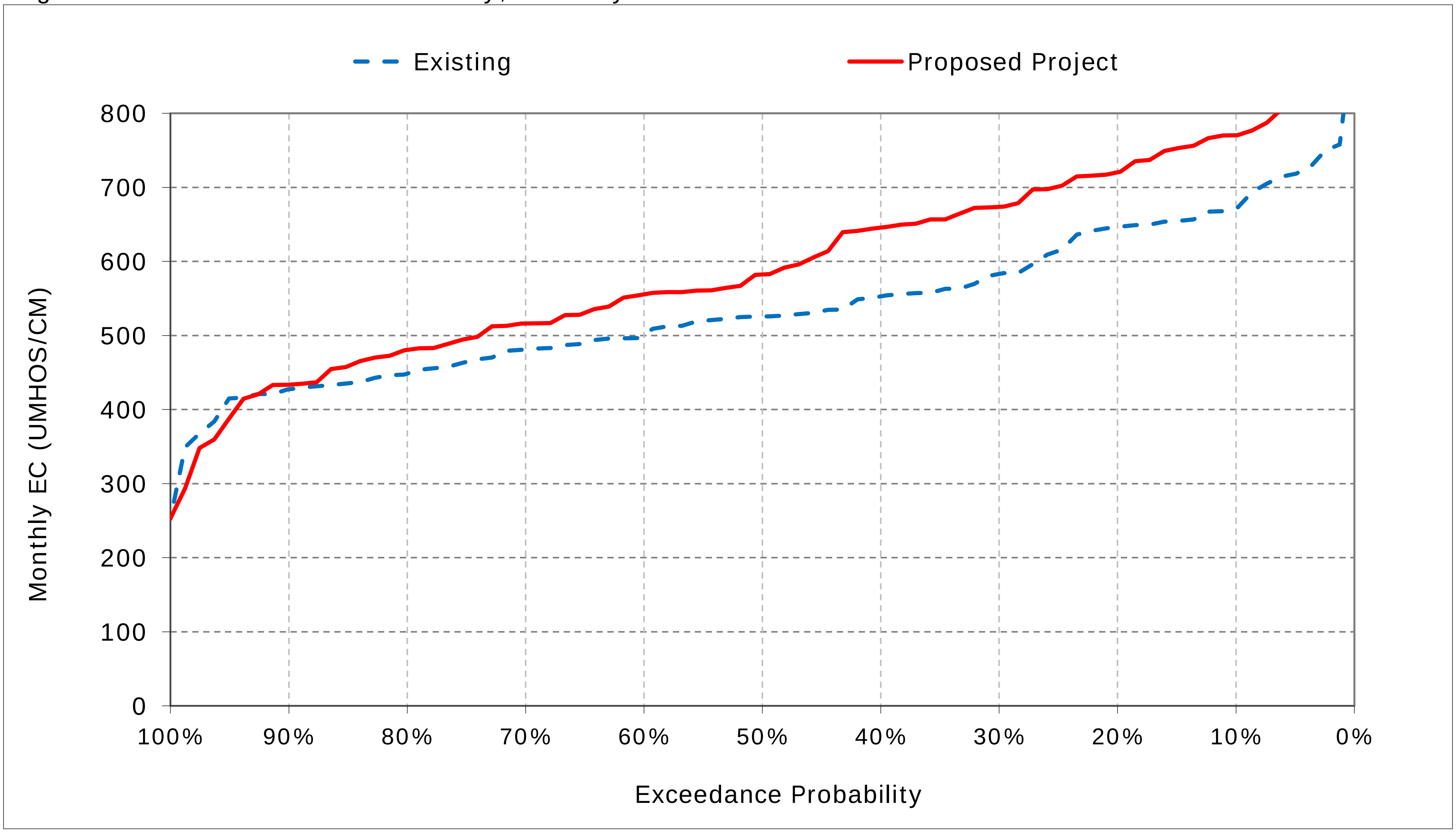


Figure 19-8. Victoria Canal Salinity, February EC

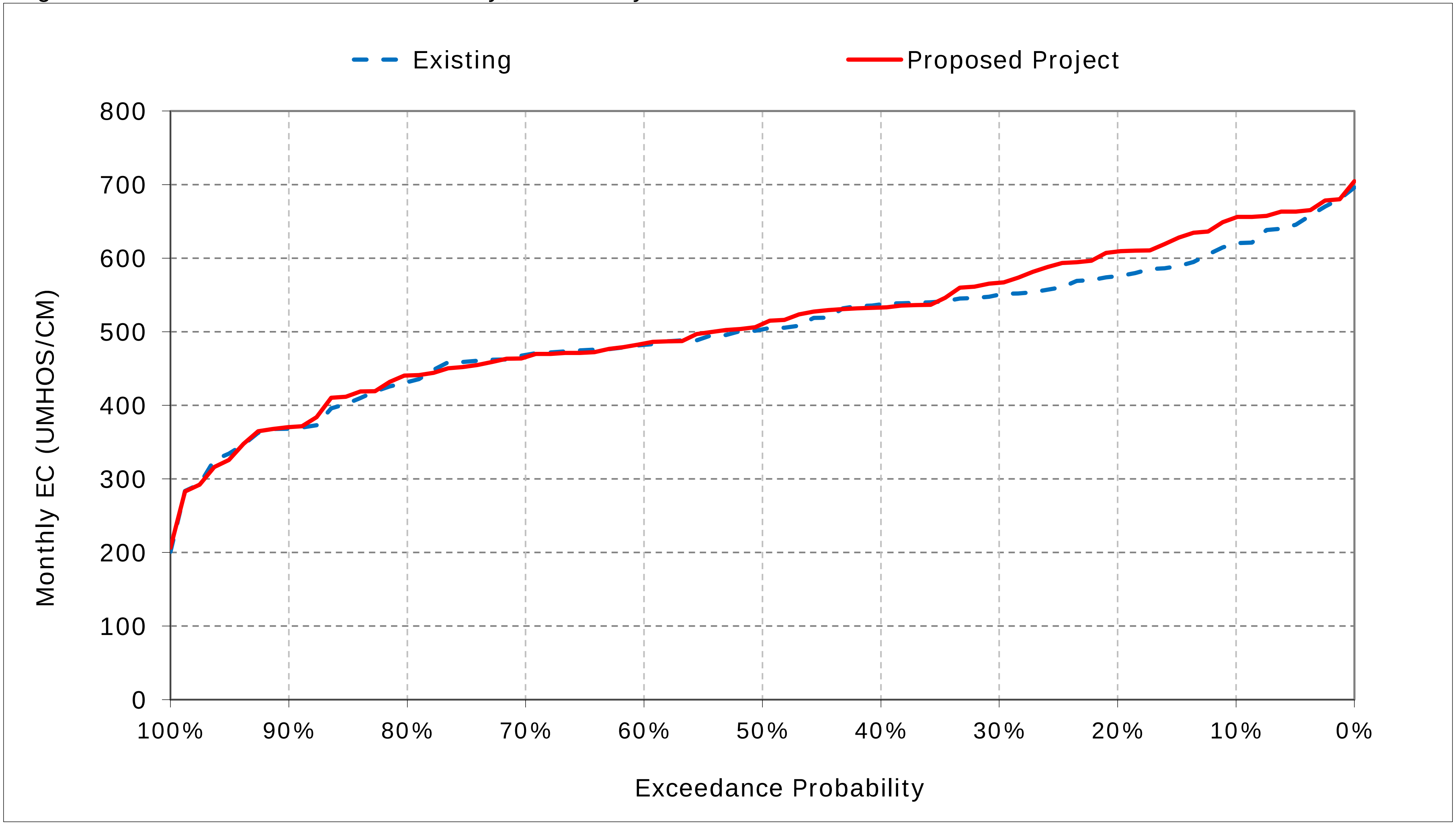


Figure 19-9. Victoria Canal Salinity, March EC

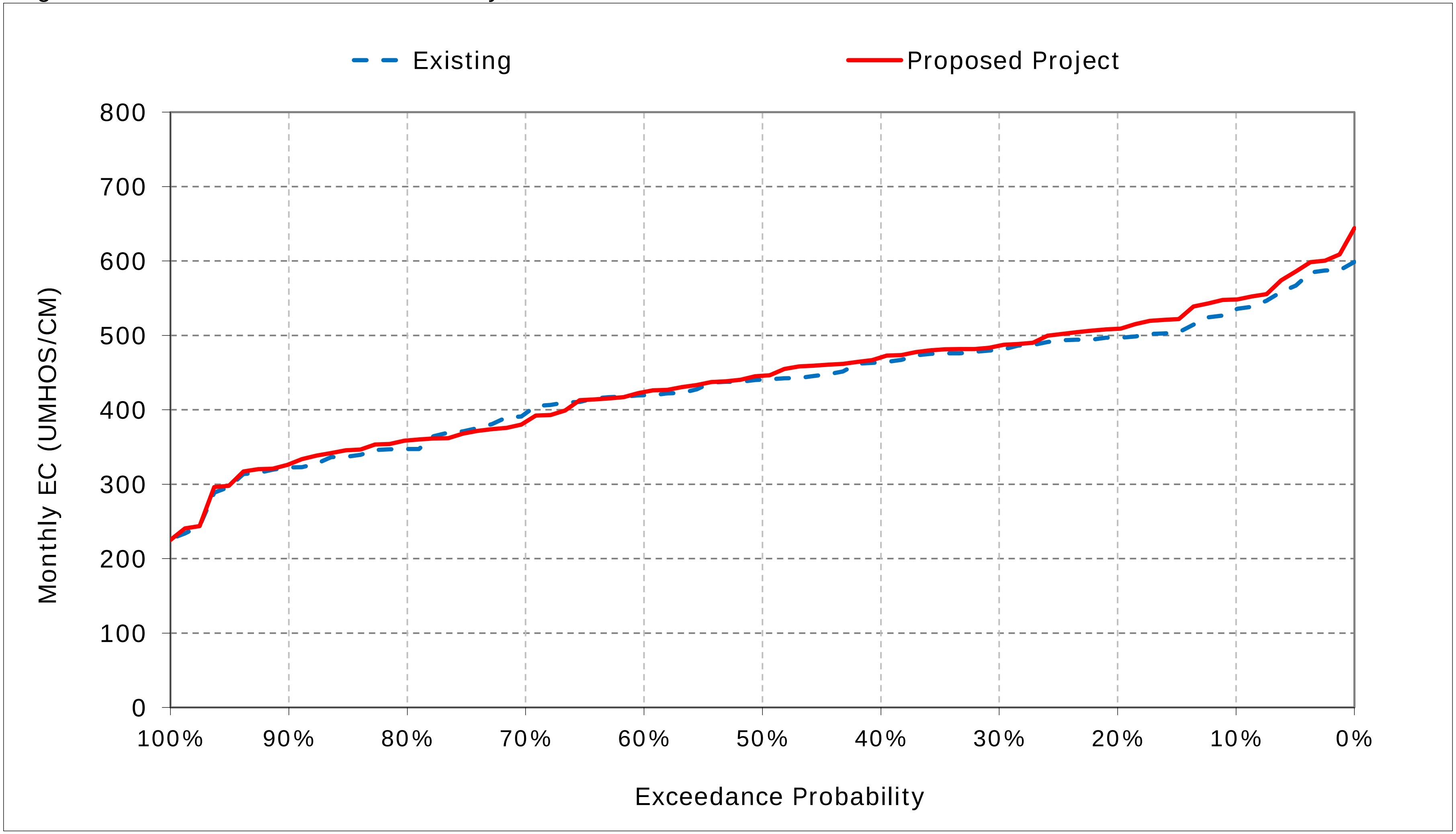


Figure 19-10. Victoria Canal Salinity, April EC

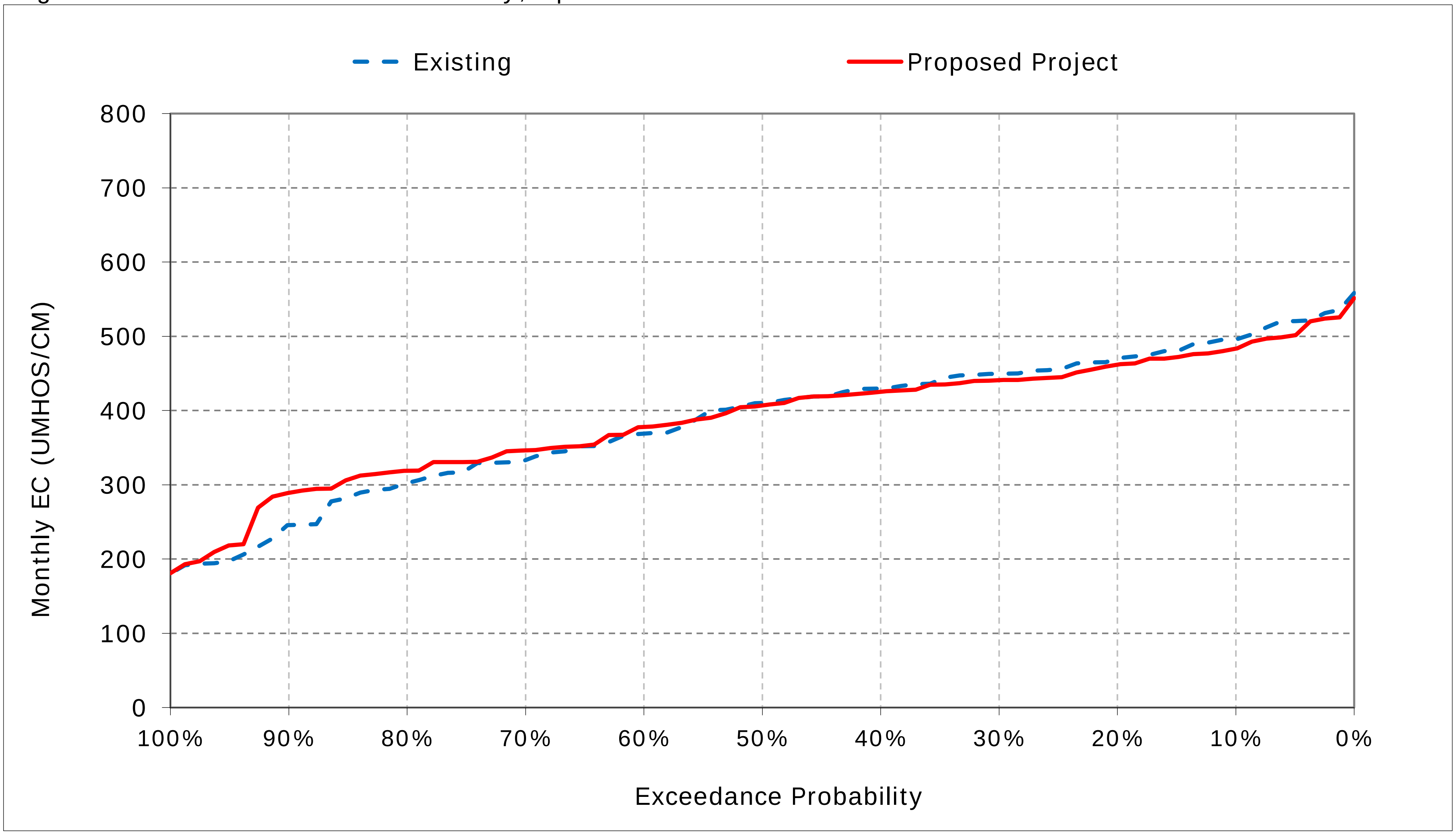


Figure 19-11. Victoria Canal Salinity, May EC

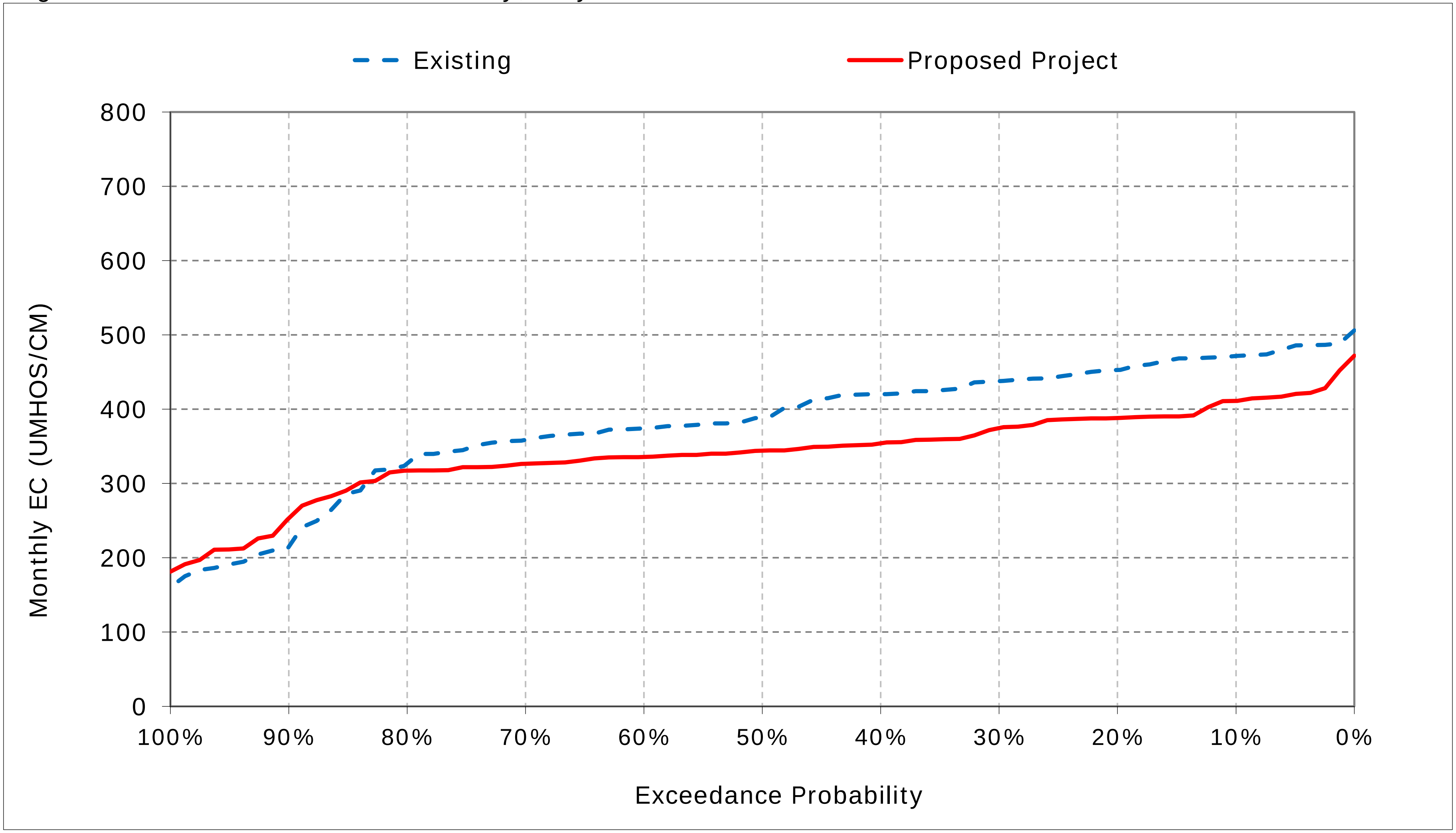


Figure 19-12. Victoria Canal Salinity, June EC

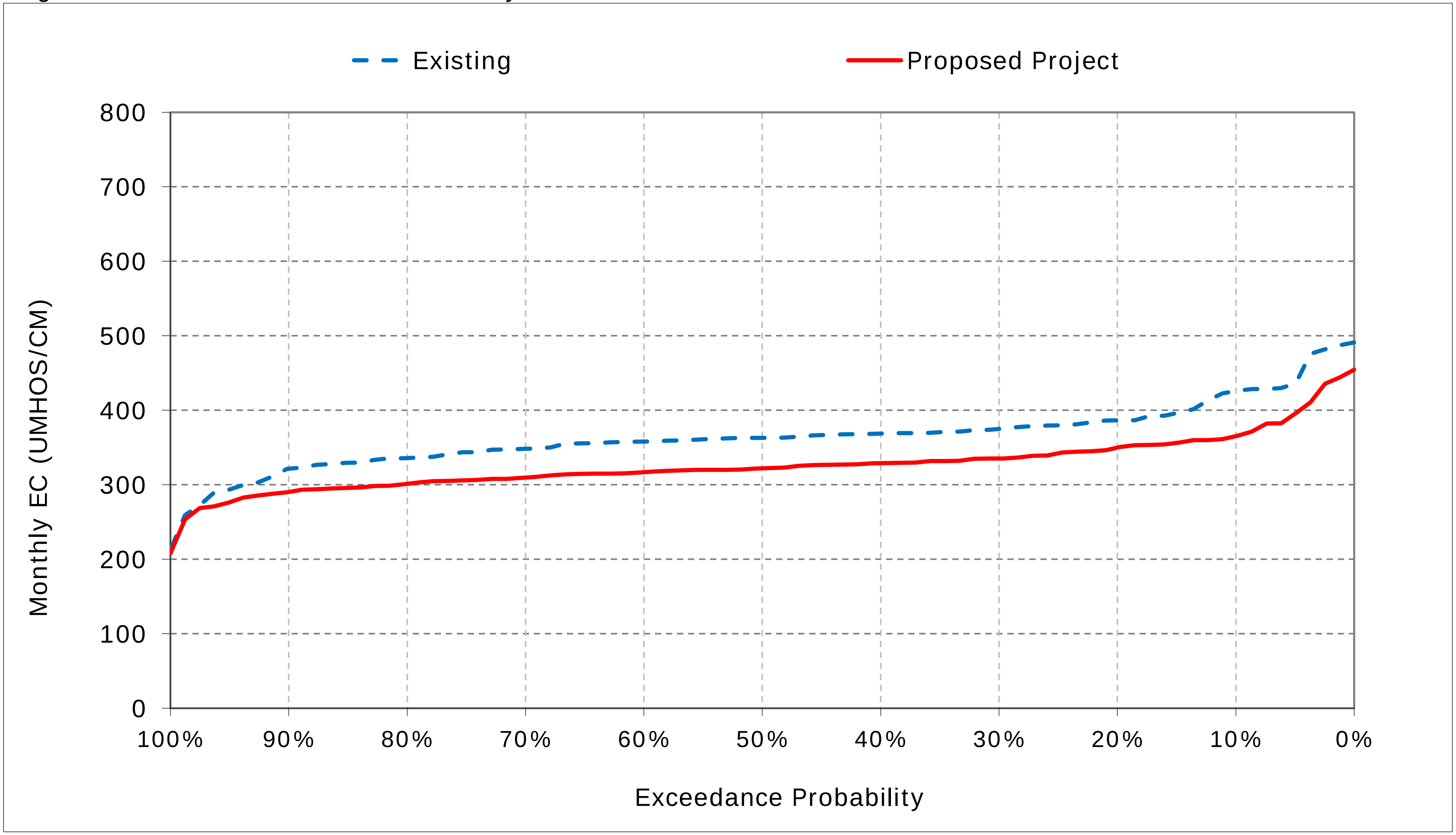


Figure 19-13. Victoria Canal Salinity, July EC

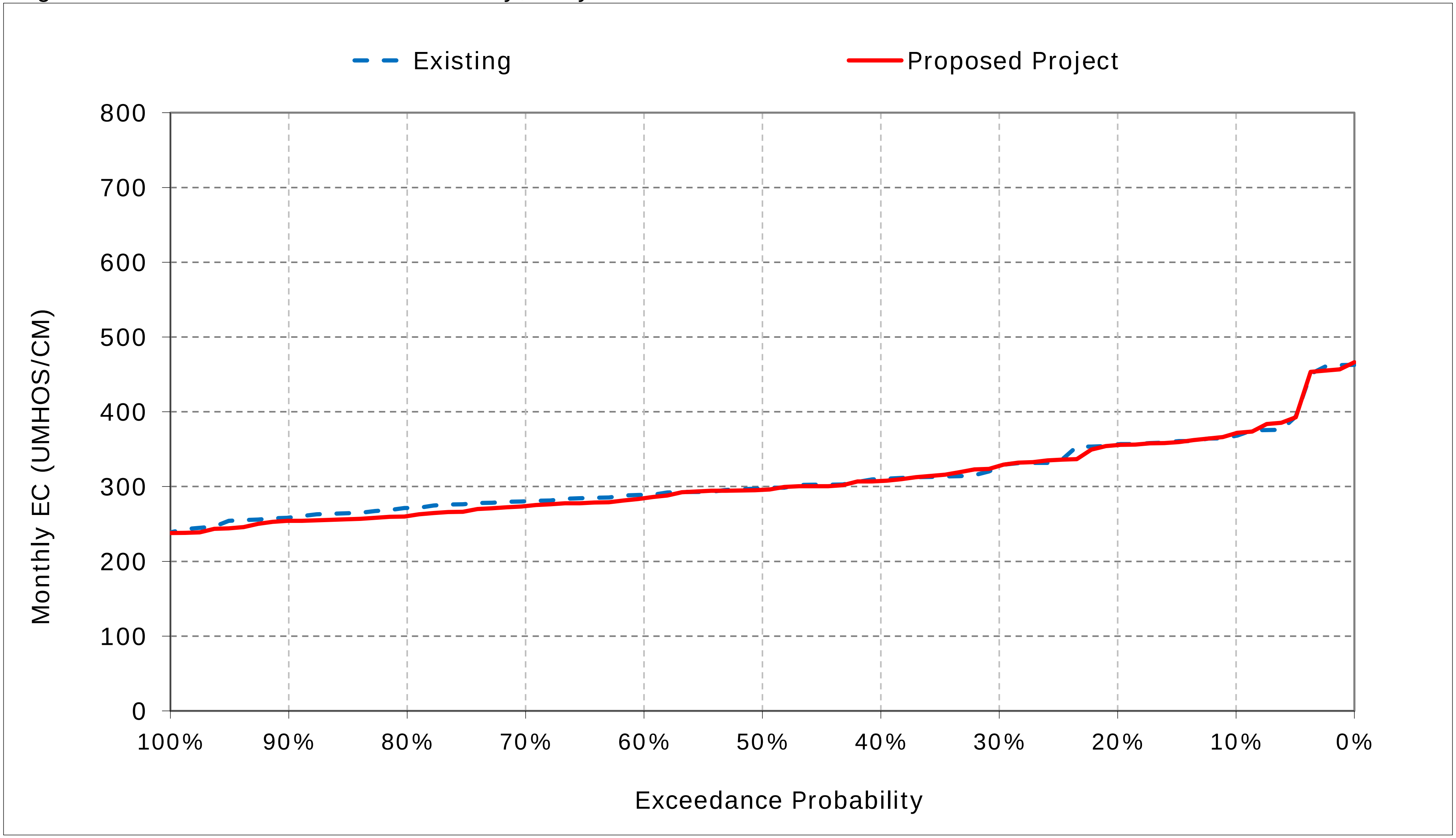


Figure 19-14. Victoria Canal Salinity, August EC

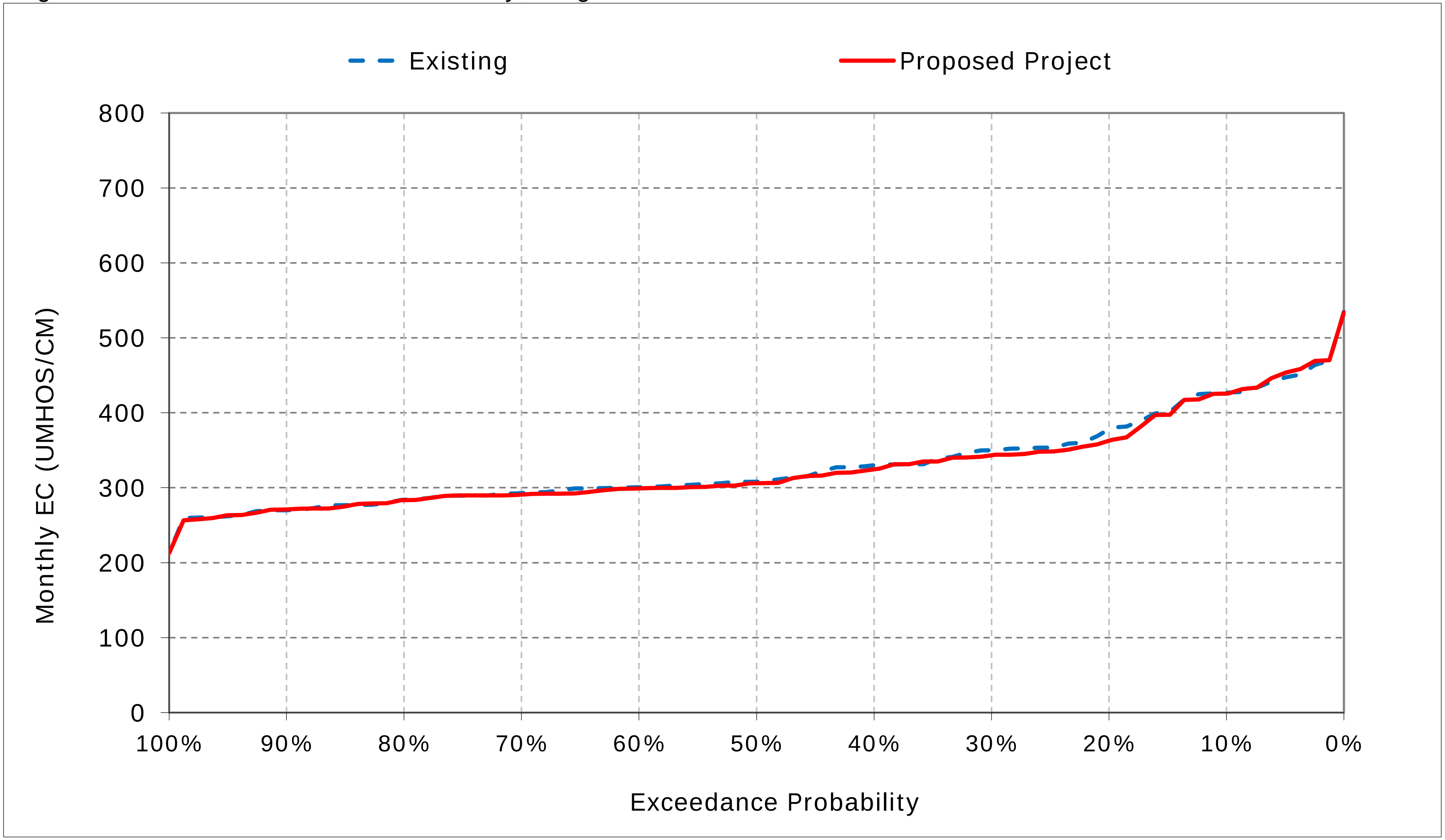


Figure 19-15. Victoria Canal Salinity, September EC

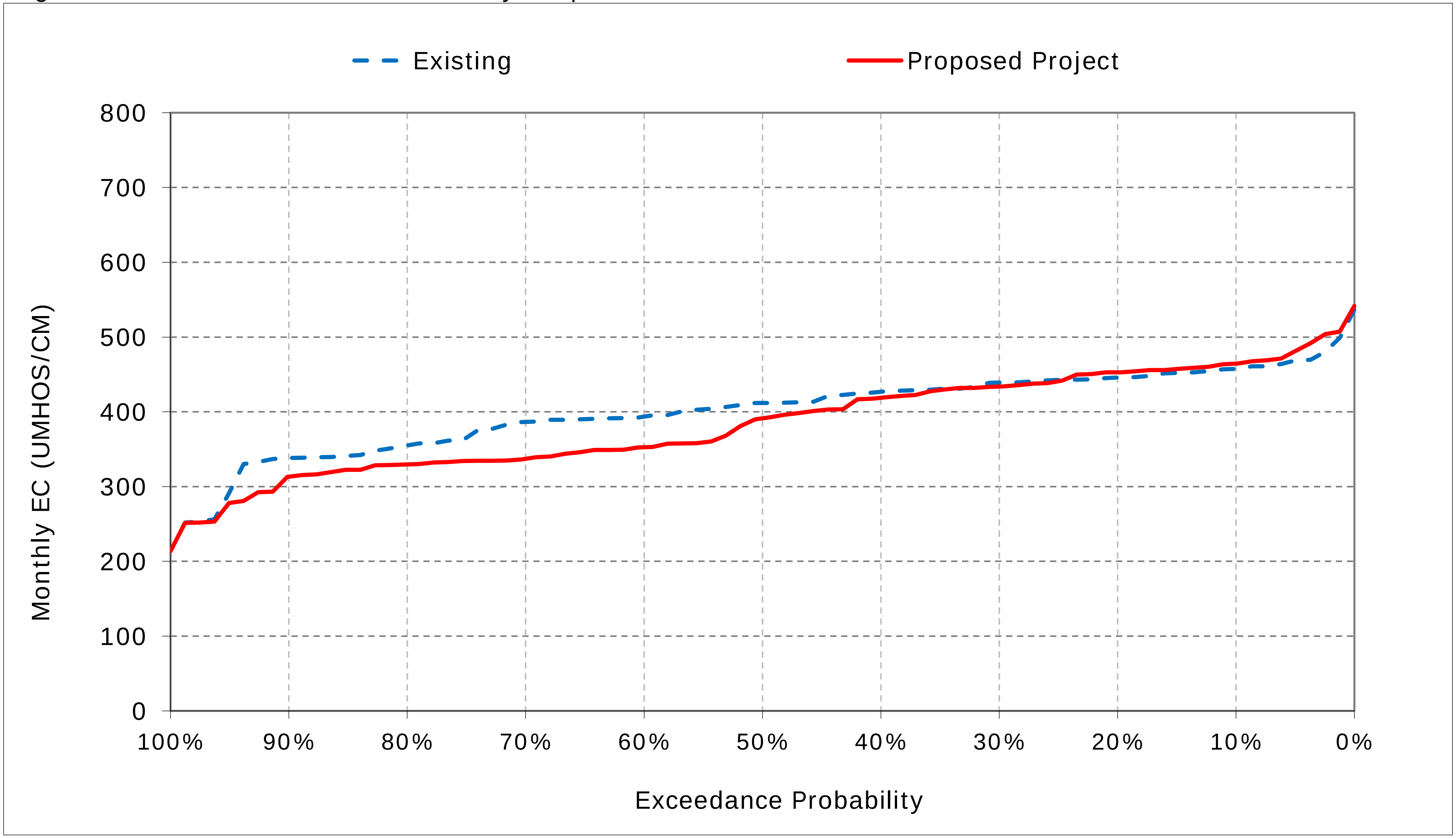


Figure 19-16. Victoria Canal Salinity, October EC

Figure 19-17. Victoria Canal Salinity, November EC

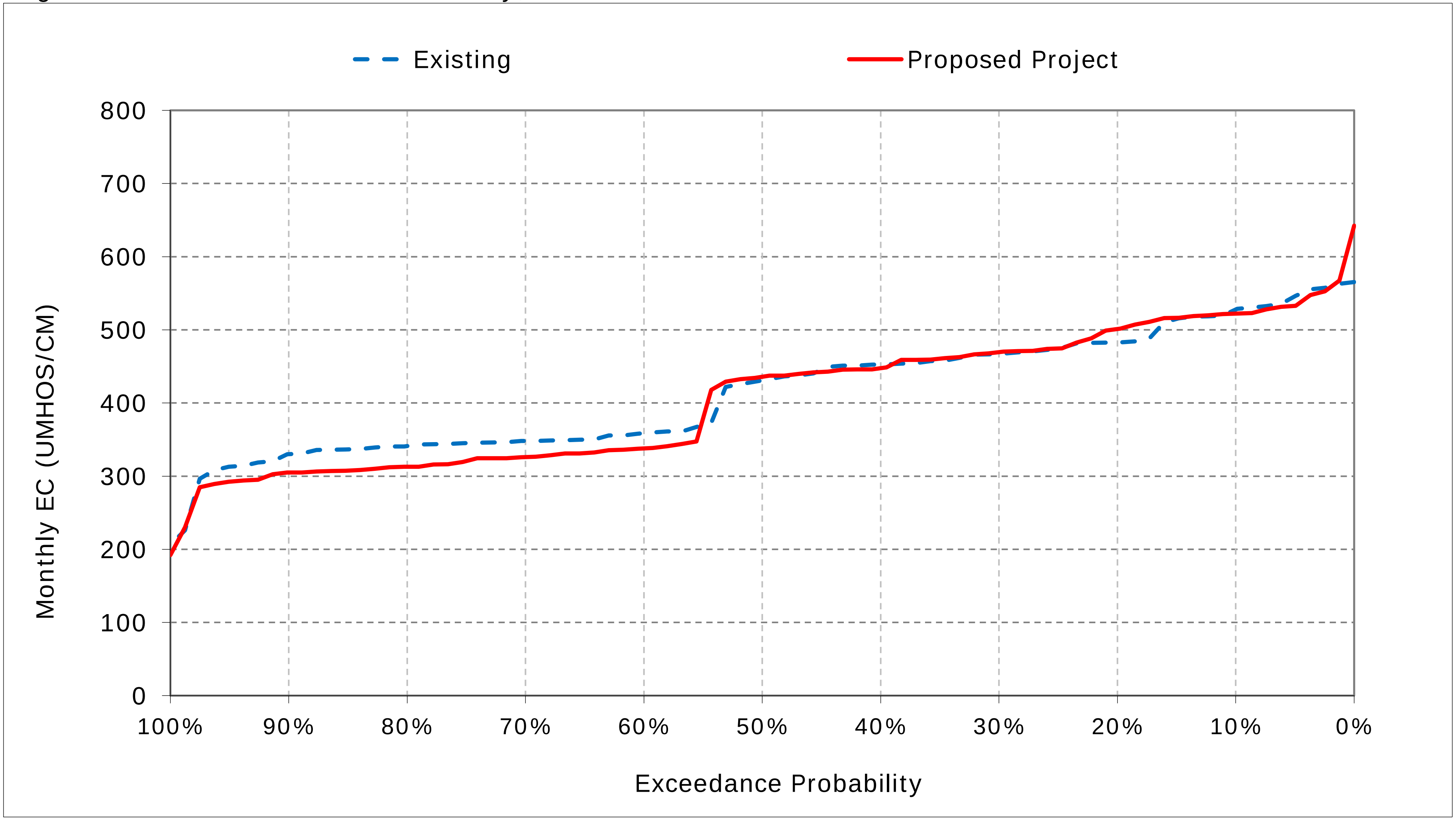


Figure 19-18. Victoria Canal Salinity, December EC

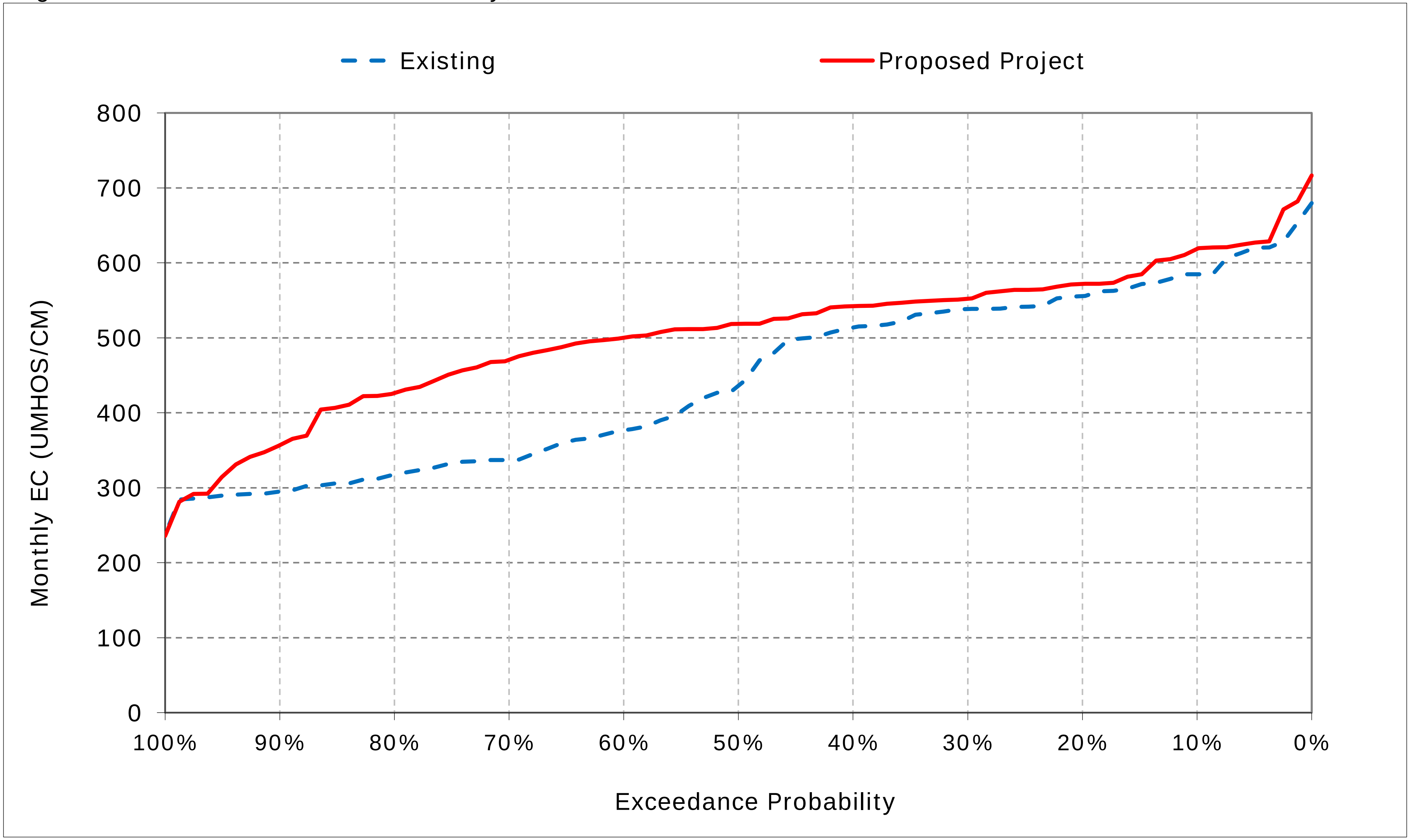


Table 20-1. Montezuma Slough at Hunter Cut, Monthly EC

Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	14,303	13,057	12,428	8,885	5,277	7,041	8,378	9,233	11,109	13,262	15,769	17,520
20%	13,613	12,740	11,353	7,778	3,597	4,779	5,007	7,390	9,703	12,148	14,600	16,623
30%	13,446	12,375	9,063	6,661	2,354	2,382	3,009	6,006	8,988	11,691	14,302	16,320
40%	13,049	11,875	7,384	4,663	1,667	1,942	2,465	4,098	7,777	10,014	12,642	15,391
50%	11,963	7,496	5,410	4,054	1,009	1,394	2,116	2,838	6,228	9,244	11,794	14,703
60%	6,829	6,147	5,020	2,313	587	578	895	1,861	5,217	8,225	11,379	10,866
70%	4,377	4,057	3,532	783	380	345	568	1,202	4,086	7,598	10,682	8,378
80%	4,087	3,878	2,109	425	256	267	294	537	2,288	6,285	10,276	8,012
90%	3,952	3,596	826	267	225	214	220	223	513	4,037	10,092	7,606
Long Term												
Full Simulation Period[a]	9,361	8,338	6,453	4,148	1,994	2,333	2,847	3,994	6,400	9,152	12,245	12,699
Water Year Types[b]												
Wet (32%)	7,609	5,949	2,748	930	345	428	588	1,023	2,551	5,354	9,579	7,450
Above Normal (15%)	9,683	8,294	6,445	2,967	906	587	851	1,651	4,553	7,411	10,619	10,803
Below Normal (17%)	9,724	9,042	7,837	4,942	1,574	2,075	2,419	3,513	6,467	9,511	12,205	15,013
Dry (22%)	9,817	9,417	7,993	6,187	3,273	3,494	4,332	6,146	8,990	11,860	14,461	16,483
Critical (15%)	11,730	11,119	10,564	8,319	5,223	6,765	8,012	10,109	12,627	14,640	16,371	17,592

Proposed Project

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	14,267	13,064	12,423	9,696	5,334	6,969	8,787	9,519	11,291	13,287	15,774	17,469
20%	13,593	12,688	11,261	8,620	3,574	4,844	5,411	8,580	10,312	12,358	14,720	16,632
30%	13,413	12,273	10,122	7,310	2,605	2,361	3,487	7,209	9,543	11,724	14,373	16,444
40%	12,985	11,609	9,739	5,072	1,656	1,670	2,800	5,326	8,507	8,505	11,416	14,546
50%	11,598	8,831	9,178	4,098	1,017	1,138	2,474	3,849	6,957	8,078	10,738	13,770
60%	6,488	8,429	7,615	2,319	556	542	1,158	2,758	6,197	7,073	10,379	10,748
70%	6,389	8,173	4,518	805	375	325	658	1,757	4,479	6,513	10,068	10,430
80%	6,138	7,821	3,122	424	255	268	320	740	2,424	5,534	8,677	10,341
90%	5,659	5,038	1,322	310	232	222	222	252	552	4,043	7,852	9,734
Long Term												
Full Simulation Period[a]	9,828	9,575	7,532	4,396	2,080	2,286	3,065	4,642	6,859	8,672	11,542	13,181
Water Year Types[b]												
Wet (32%)	8,230	7,563	3,600	973	342	410	716	1,454	2,965	5,438	9,501	9,550
Above Normal (15%)	10,244	9,670	7,946	3,195	835	515	1,047	2,446	5,107	7,388	10,660	10,439
Below Normal (17%)	10,213	10,224	9,072	5,089	1,532	1,921	2,731	4,514	7,053	6,334	8,084	14,146
Dry (22%)	10,299	10,501	9,192	6,711	3,514	3,401	4,601	6,949	9,511	11,993	14,538	16,540
Critical (15%)	11,721	11,695	11,353	8,732	5,577	6,877	8,258	10,431	12,844	14,711	16,385	17,628

Proposed Project minus Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	-36	7	-5	811	57	-72	409	286	182	25	6	-51
20%	-20	-52	-92	842	-23	65	405	1,190	609	210	121	9
30%	-33	-102	1,059	648	251	-21	478	1,203	555	33	71	125
40%	-63	-265	2,355	409	-11	-272	335	1,227	730	-1,509	-1,226	-845
50%	-364	1,335	3,767	44	8	-256	357	1,011	729	-1,166	-1,056	-934
60%	-340	2,282	2,595	7	-32	-37	264	897	981	-1,152	-1,000	-118
70%	2,013	4,115	987	21	-5	-20	90	556	393	-1,085	-614	2,051
80%	2,050	3,944	1,012	0	-1	1	26	204	137	-750	-1,599	2,328
90%	1,707	1,442	496	43	7	7	2	29	39	6	-2,240	2,128
Long Term												
Full Simulation Period[a]	467	1,237	1,079	247	86	-46	218	647	459	-479	-704	482
Water Year Types[b]												
Wet (32%)	621	1,614	852	42	-4	-18	127	431	414	84	-78	2,100
Above Normal (15%)	561	1,376	1,501	228	-70	-72	196	795	554	-23	41	-364
Below Normal (17%)	488	1,183	1,234	147	-42	-153	311	1,000	586	-3,177	-4,122	-867
Dry (22%)	482	1,084	1,199	523	241	-92	270	803	521	133	77	57
Critical (15%)	-9	576	789	413	354	112	247	322	217	71	13	35

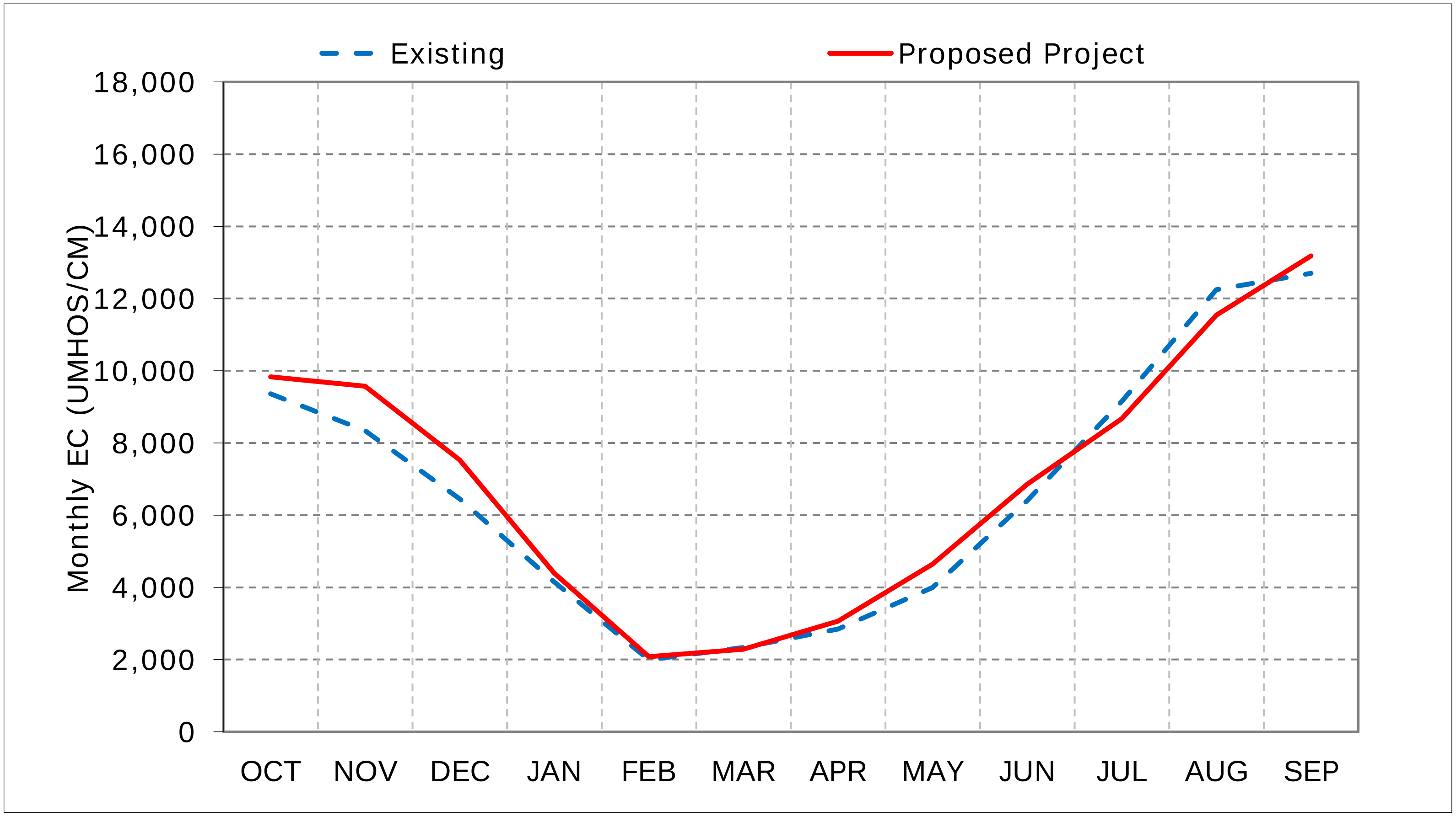
a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

c These results are displayed with water year - year type sorting.

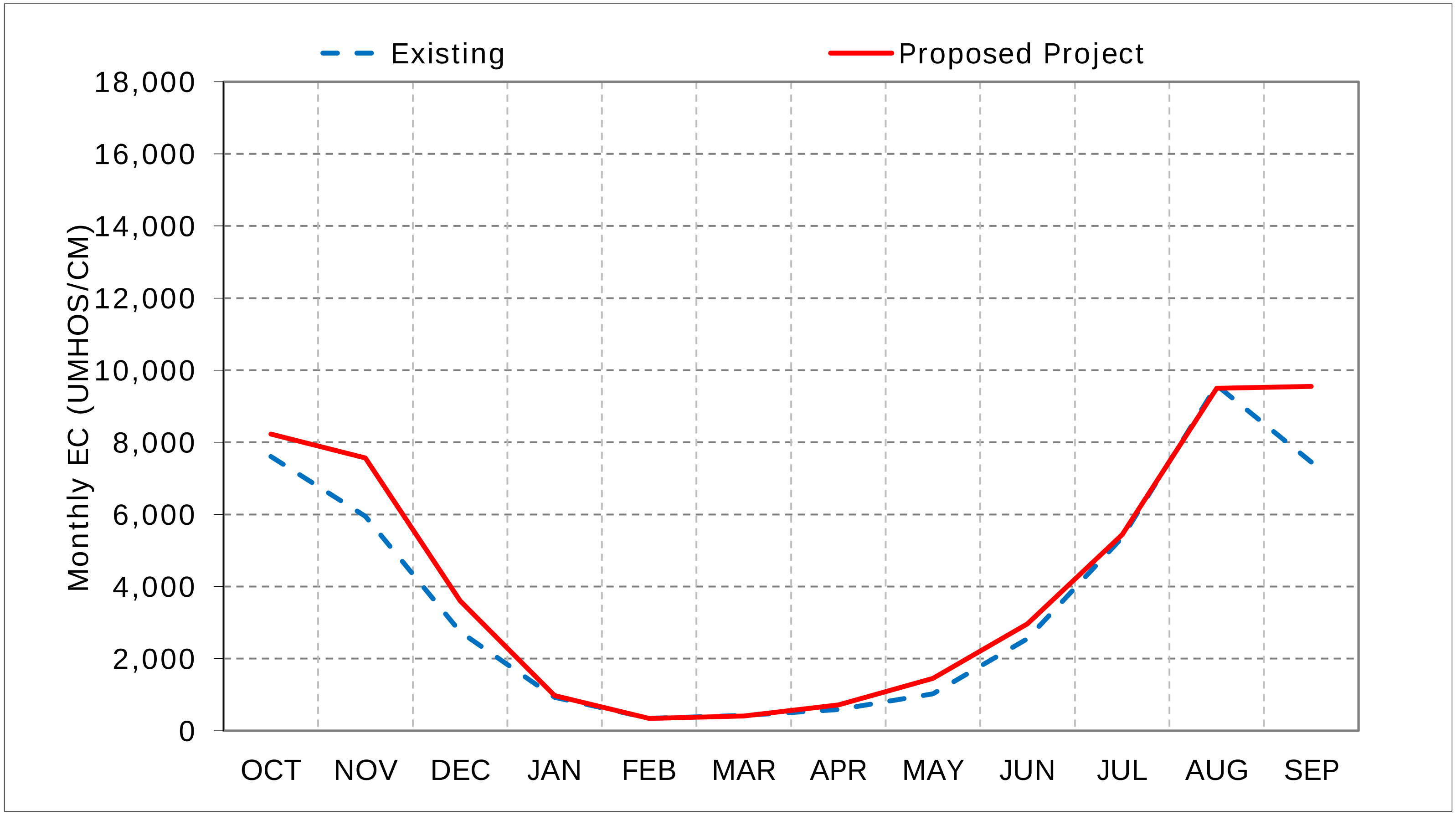
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 20-1. Montezuma Slough at Hunter Cut, Long-Term Average EC



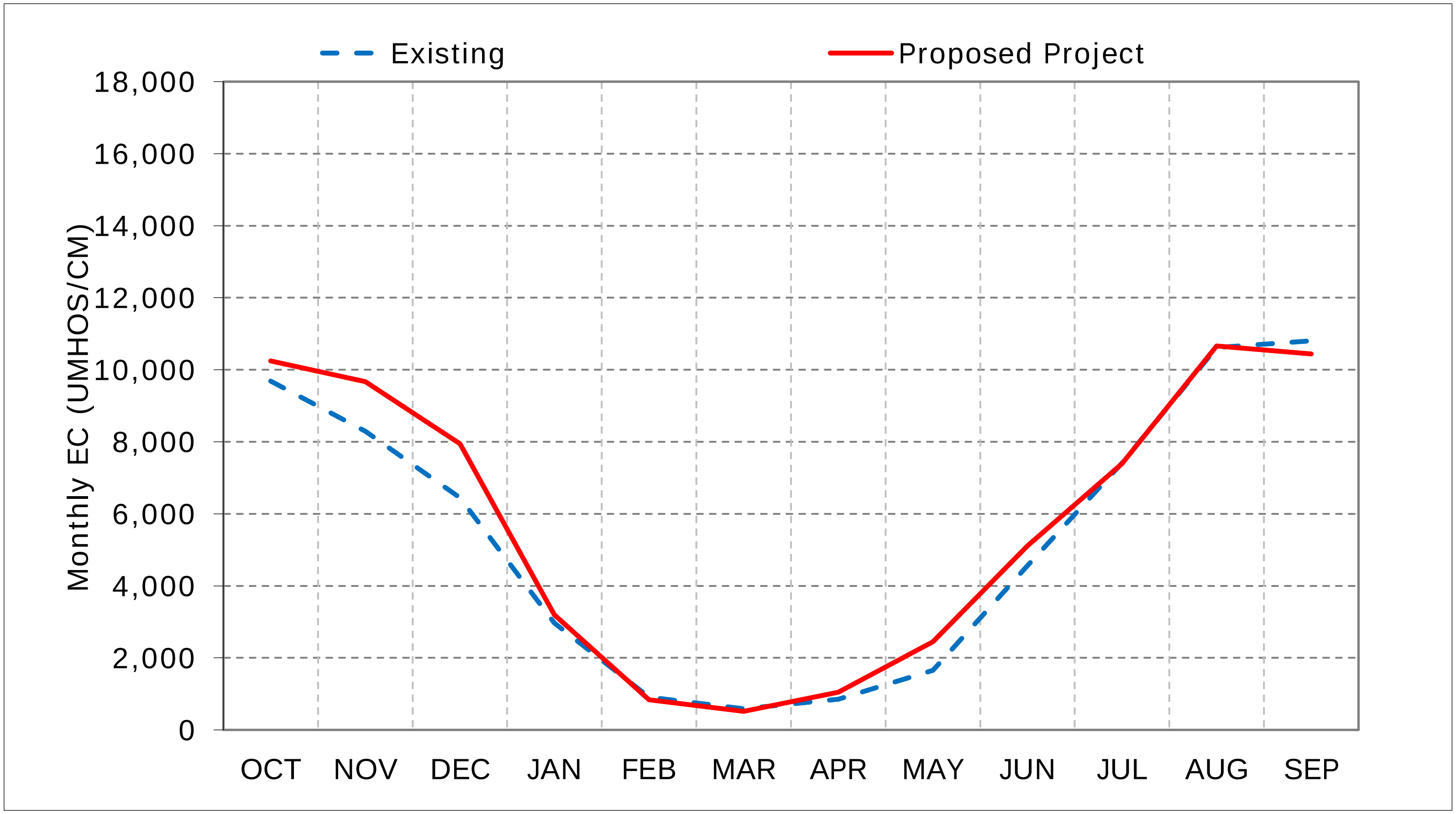
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 20-2. Montezuma Slough at Hunter Cut, Wet Year Average EC



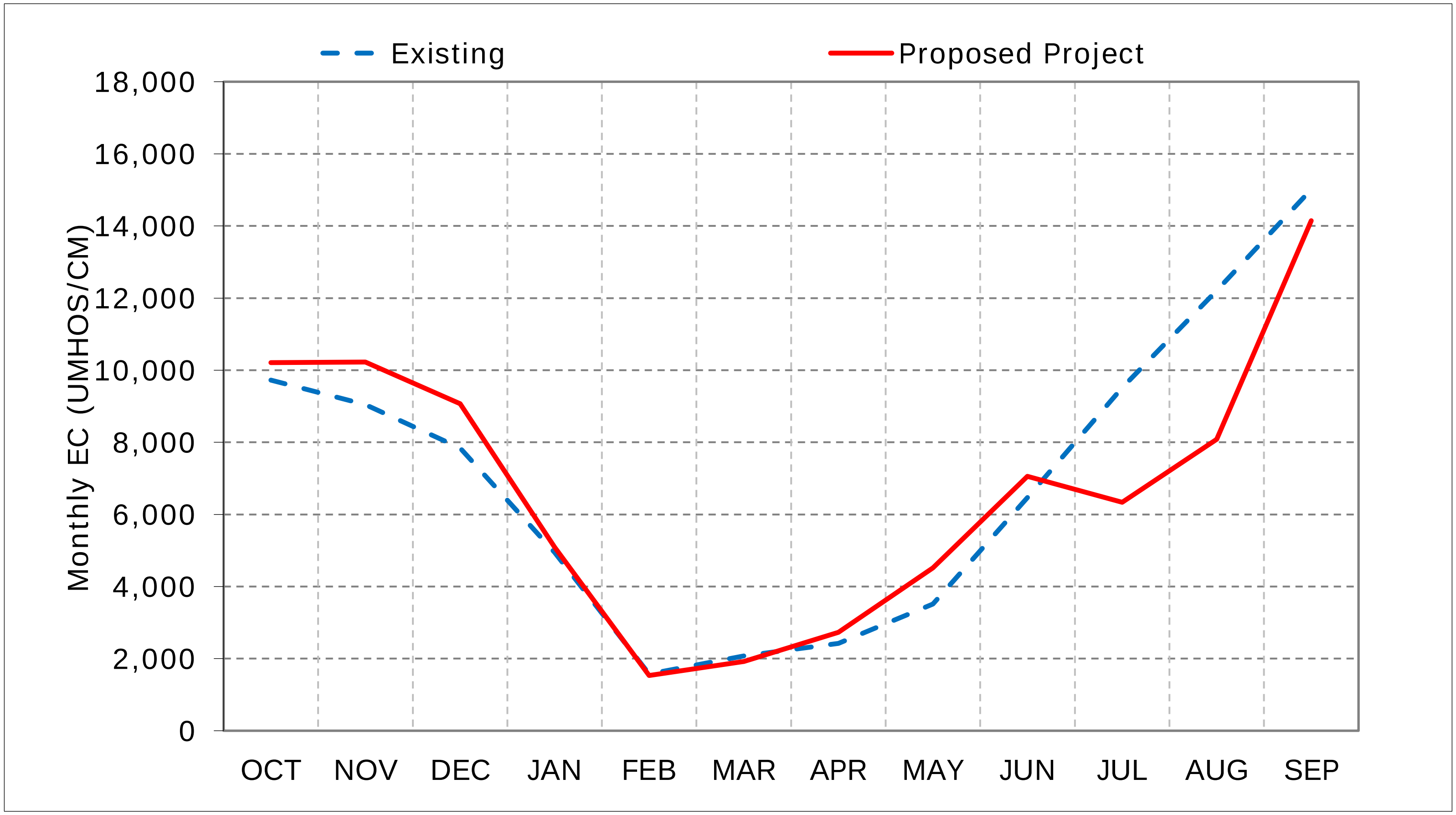
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 20-3. Montezuma Slough at Hunter Cut, Above Normal Year Average EC



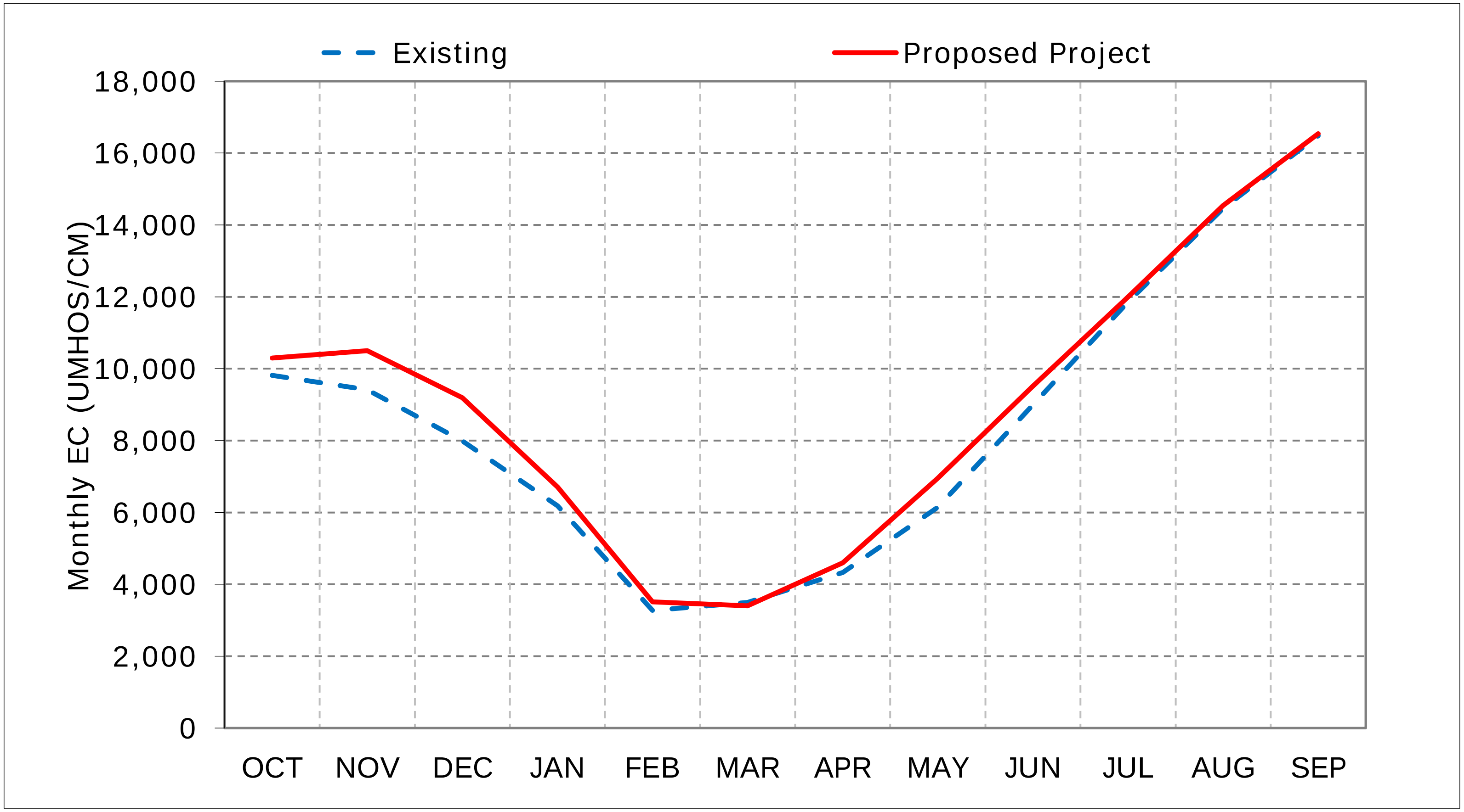
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 20-4. Montezuma Slough at Hunter Cut, Below Normal Year Average EC



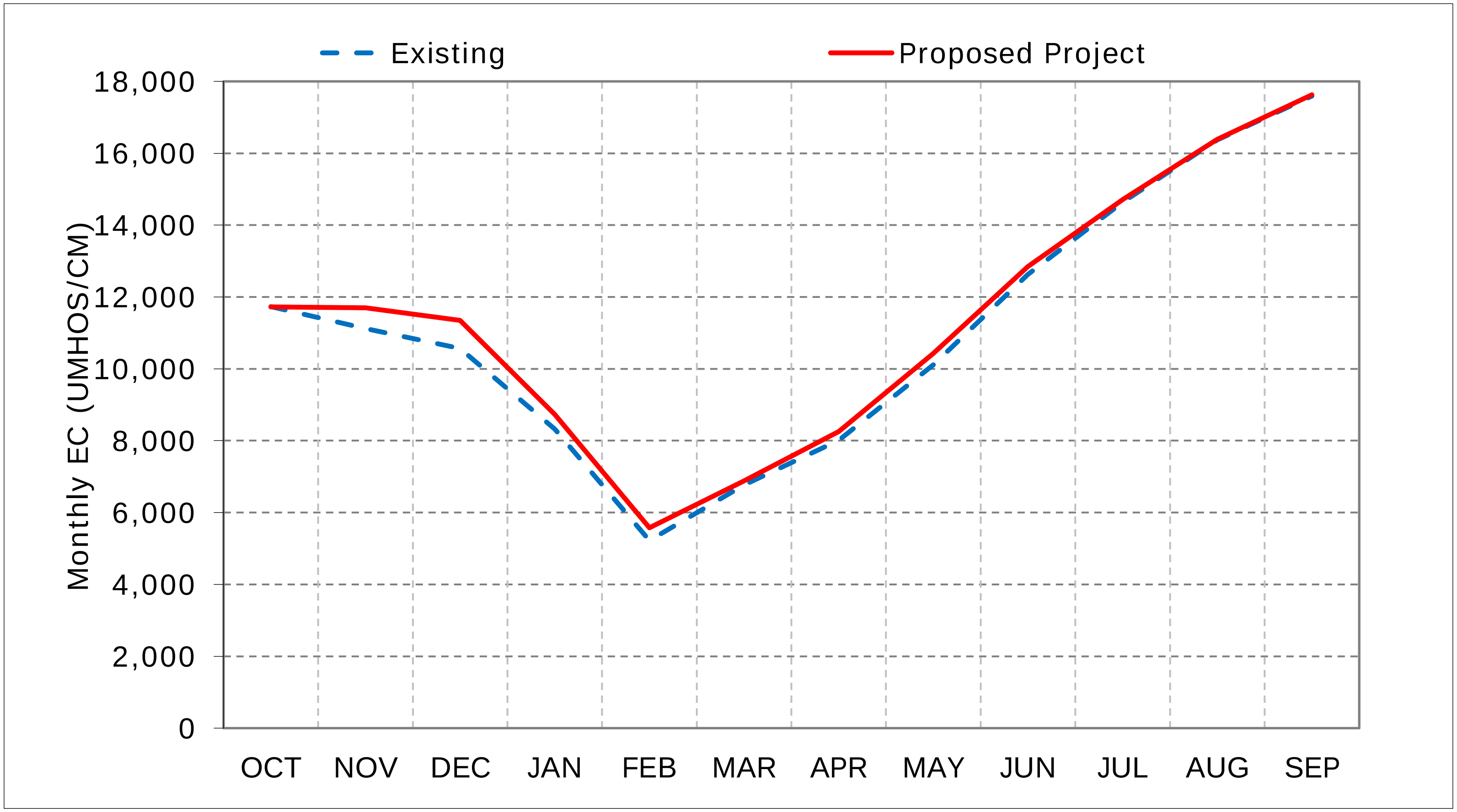
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 20-5. Montezuma Slough at Hunter Cut, Dry Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 20-6. Montezuma Slough at Hunter Cut, Critical Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 20-7. Montezuma Slough at Hunter Cut, January EC

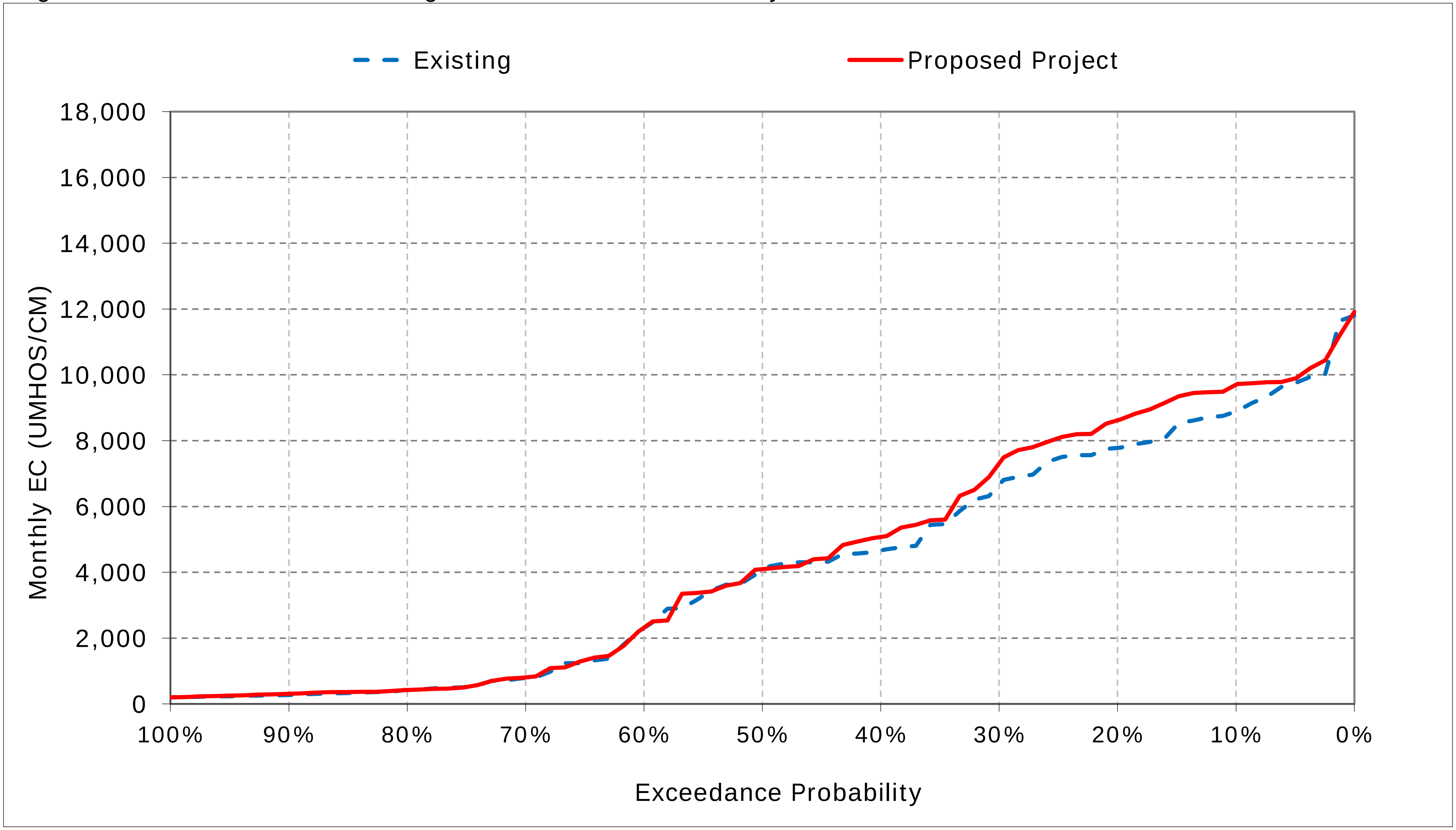


Figure 20-8. Montezuma Slough at Hunter Cut, February EC

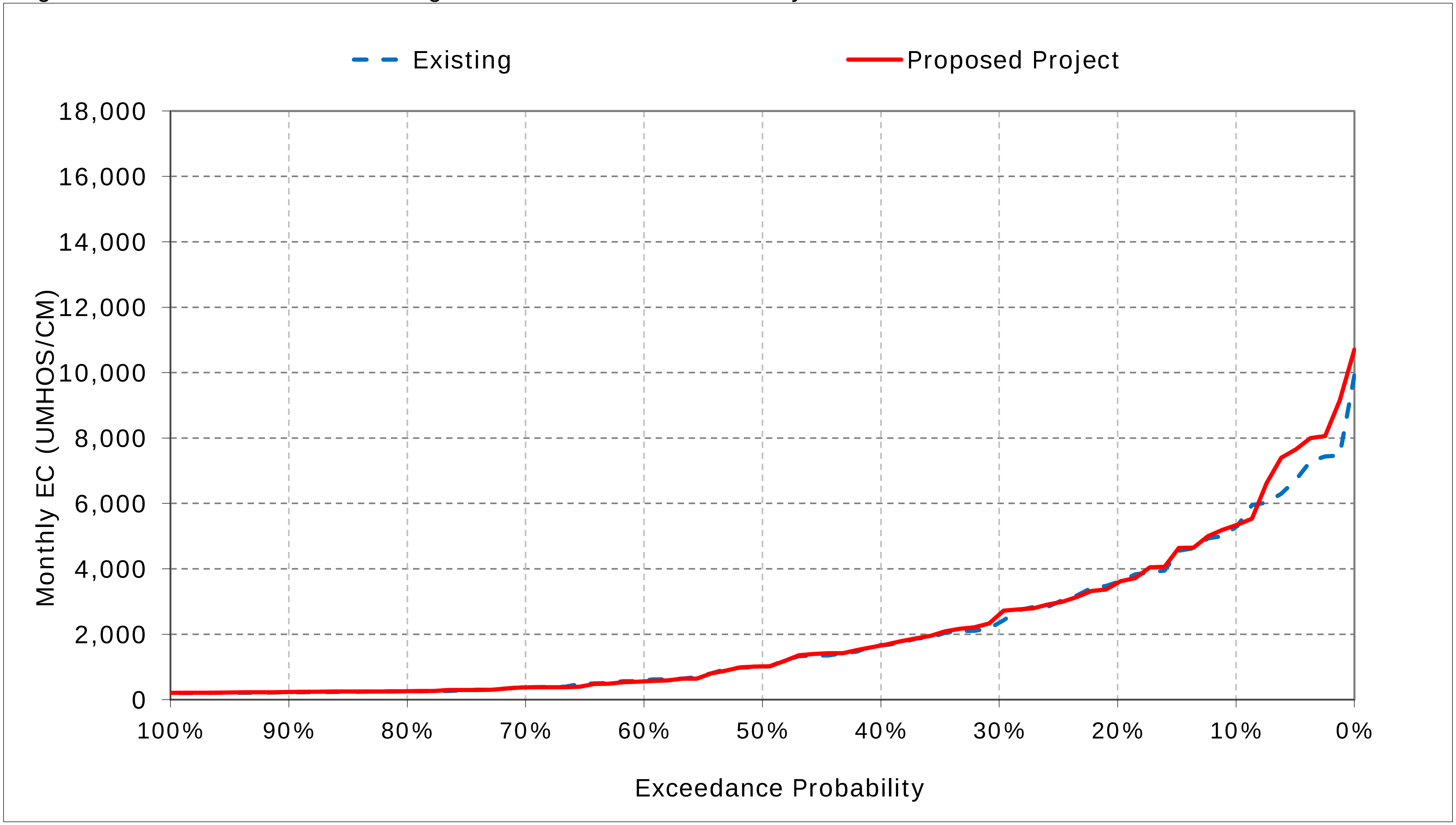


Figure 20-9. Montezuma Slough at Hunter Cut, March EC

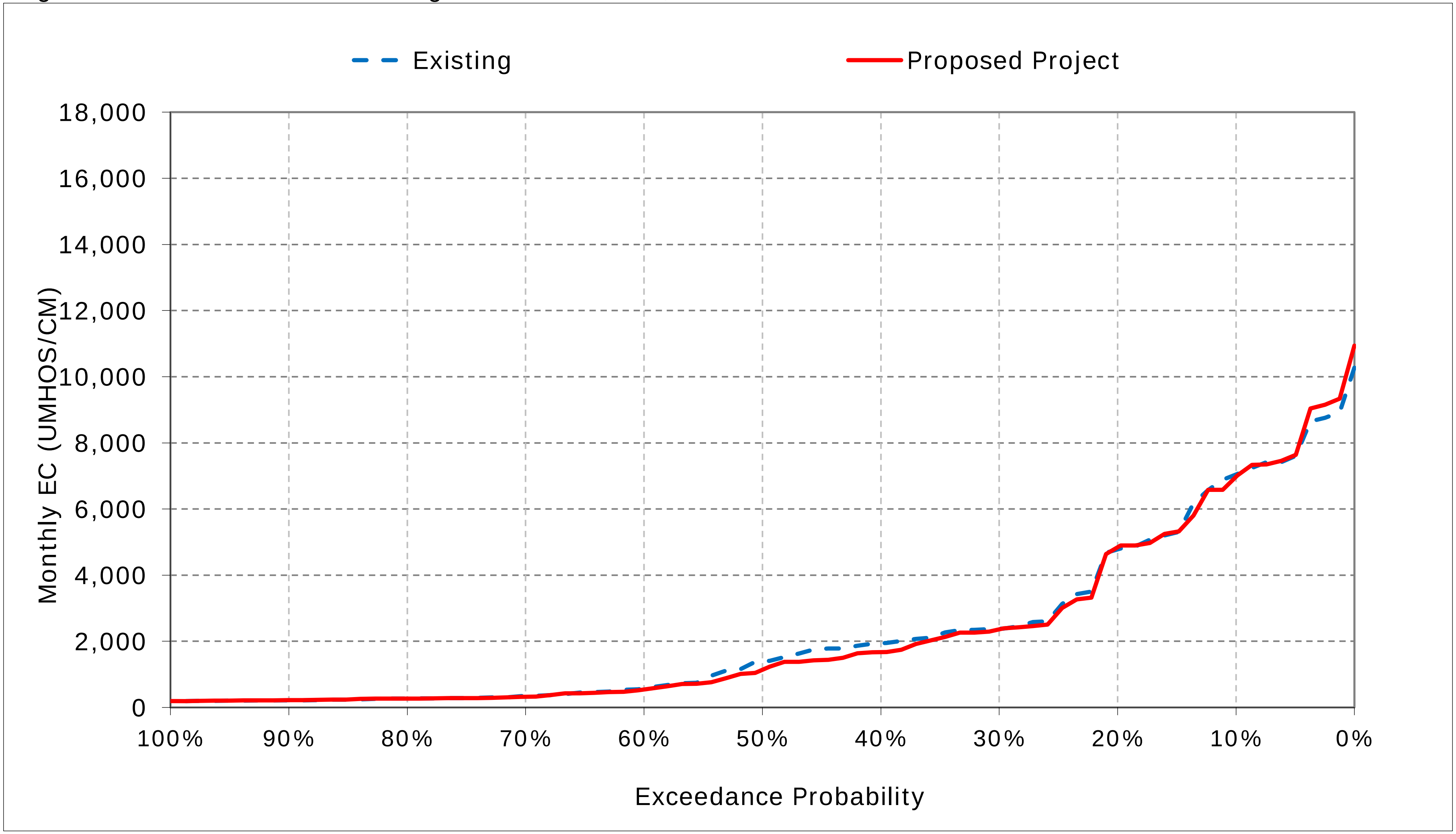


Figure 20-10. Montezuma Slough at Hunter Cut, April EC

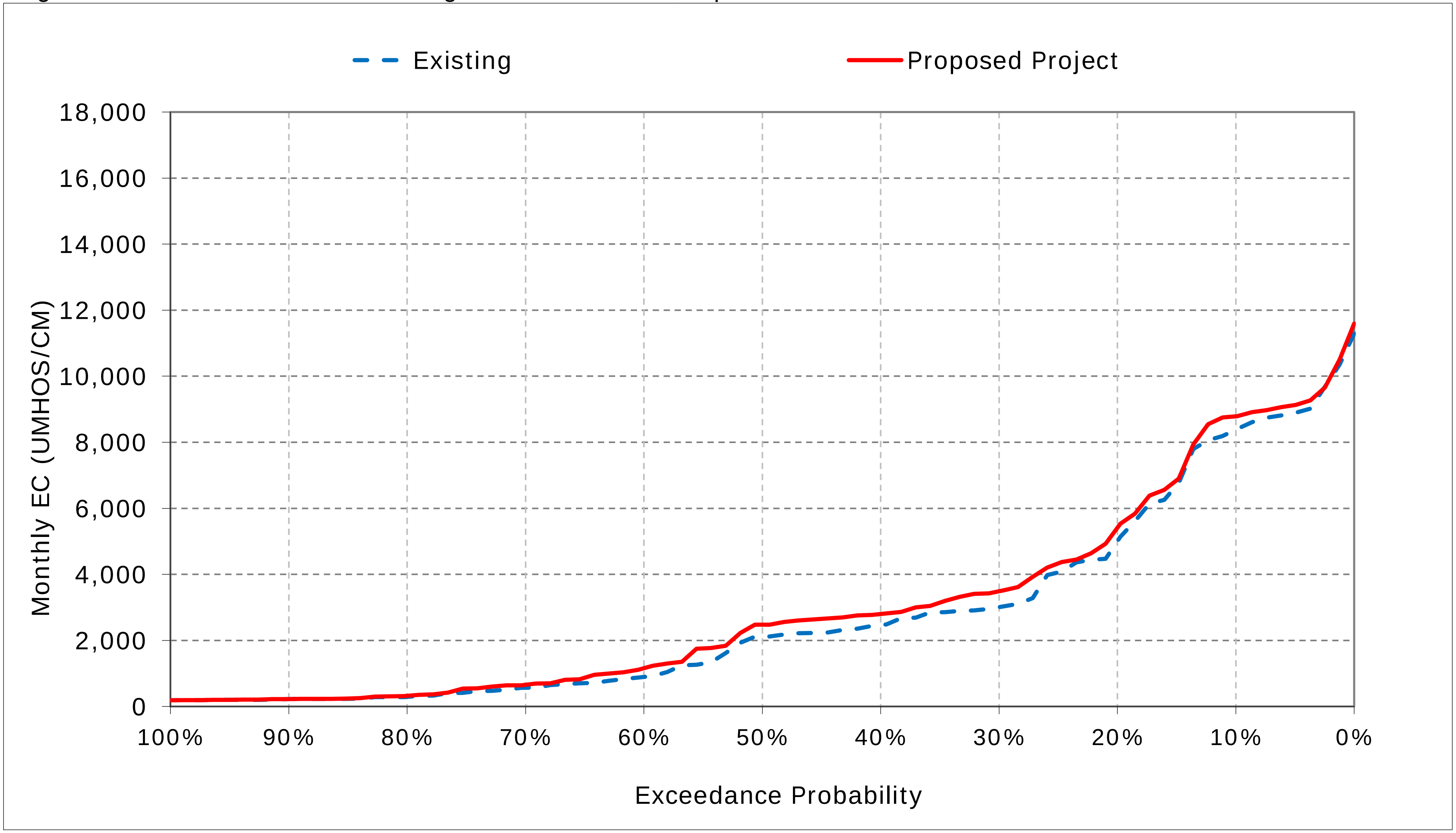


Figure 20-11. Montezuma Slough at Hunter Cut, May EC

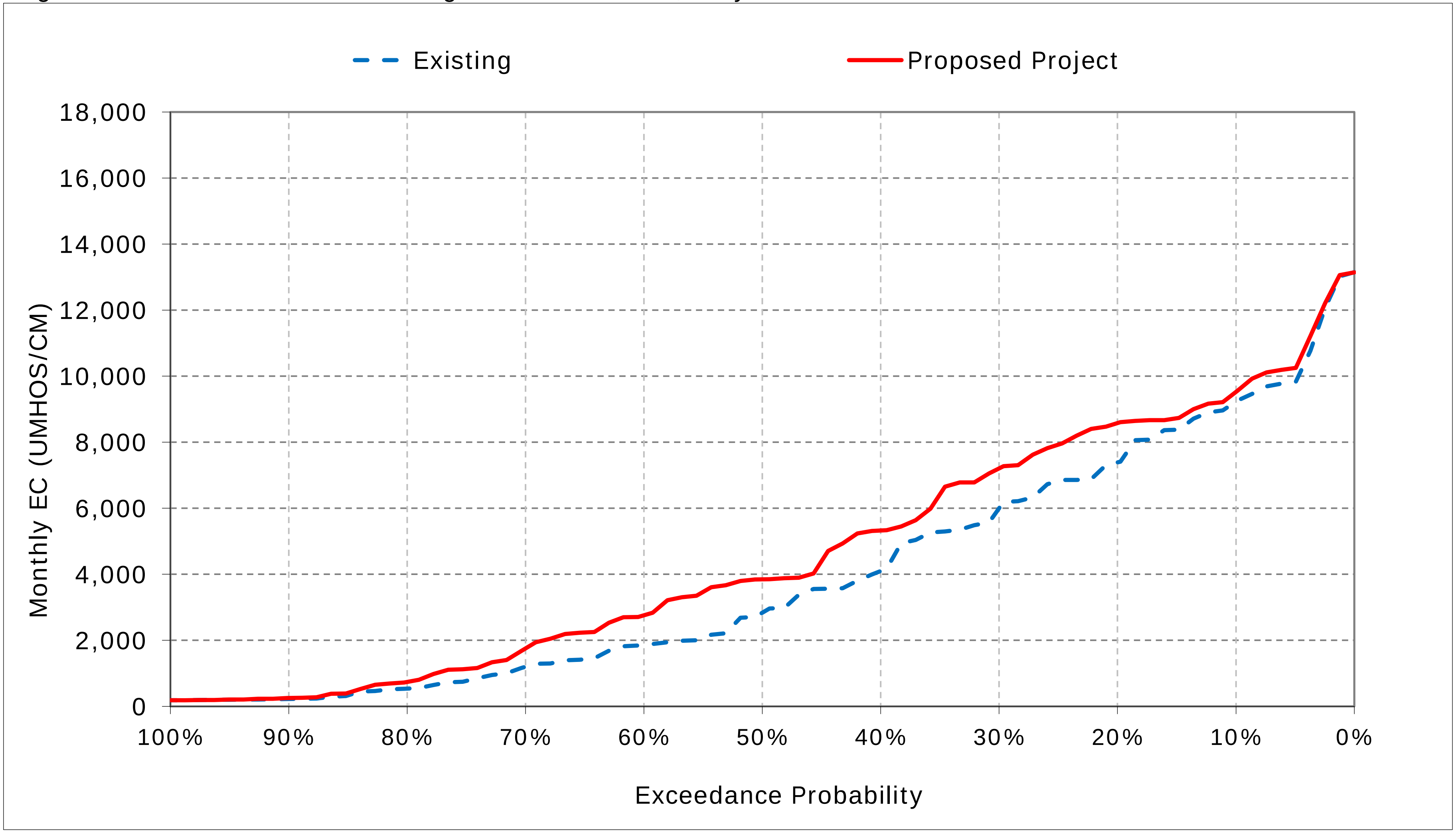


Figure 20-12. Montezuma Slough at Hunter Cut, June EC

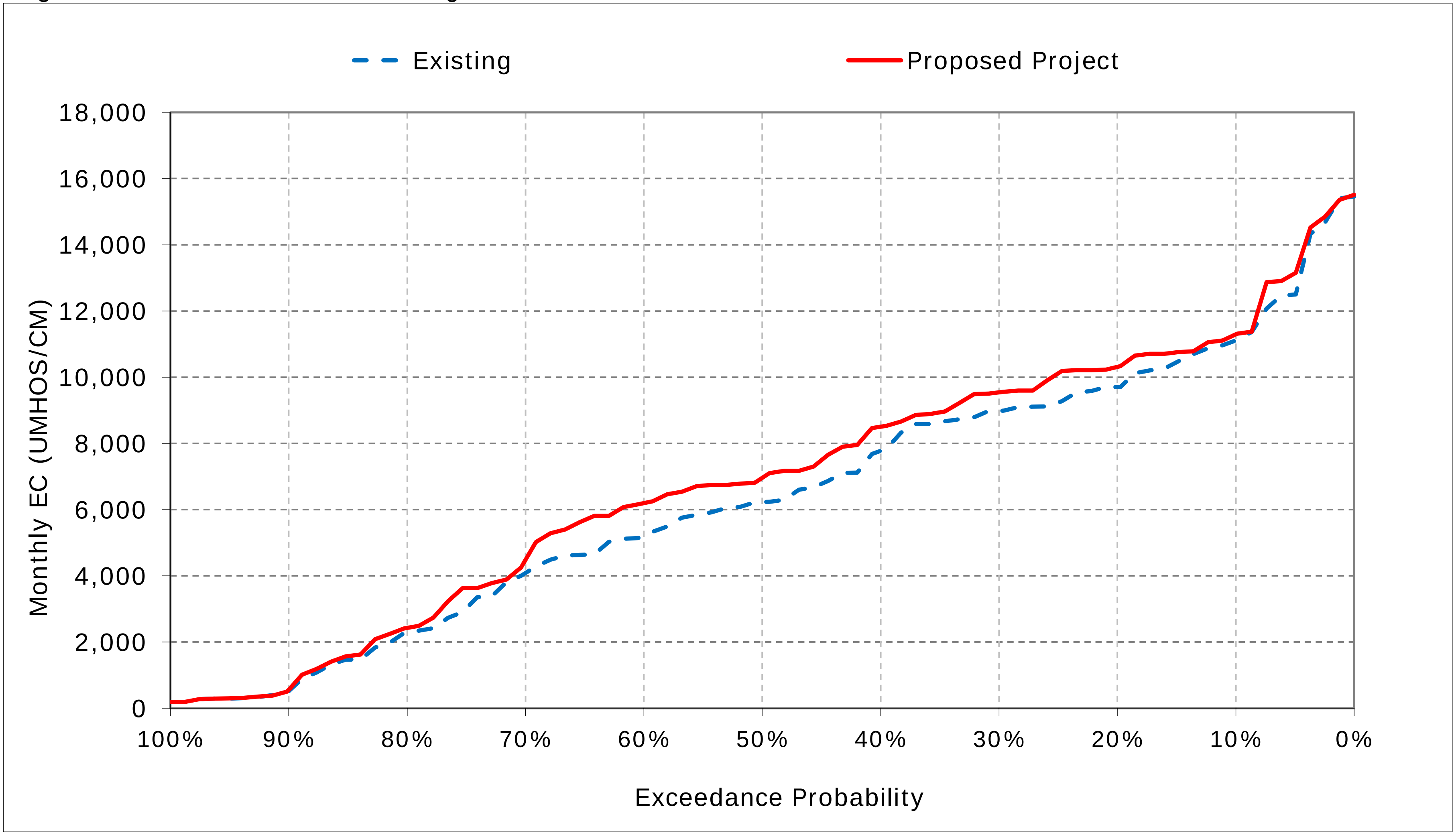


Figure 20-13. Montezuma Slough at Hunter Cut, July EC

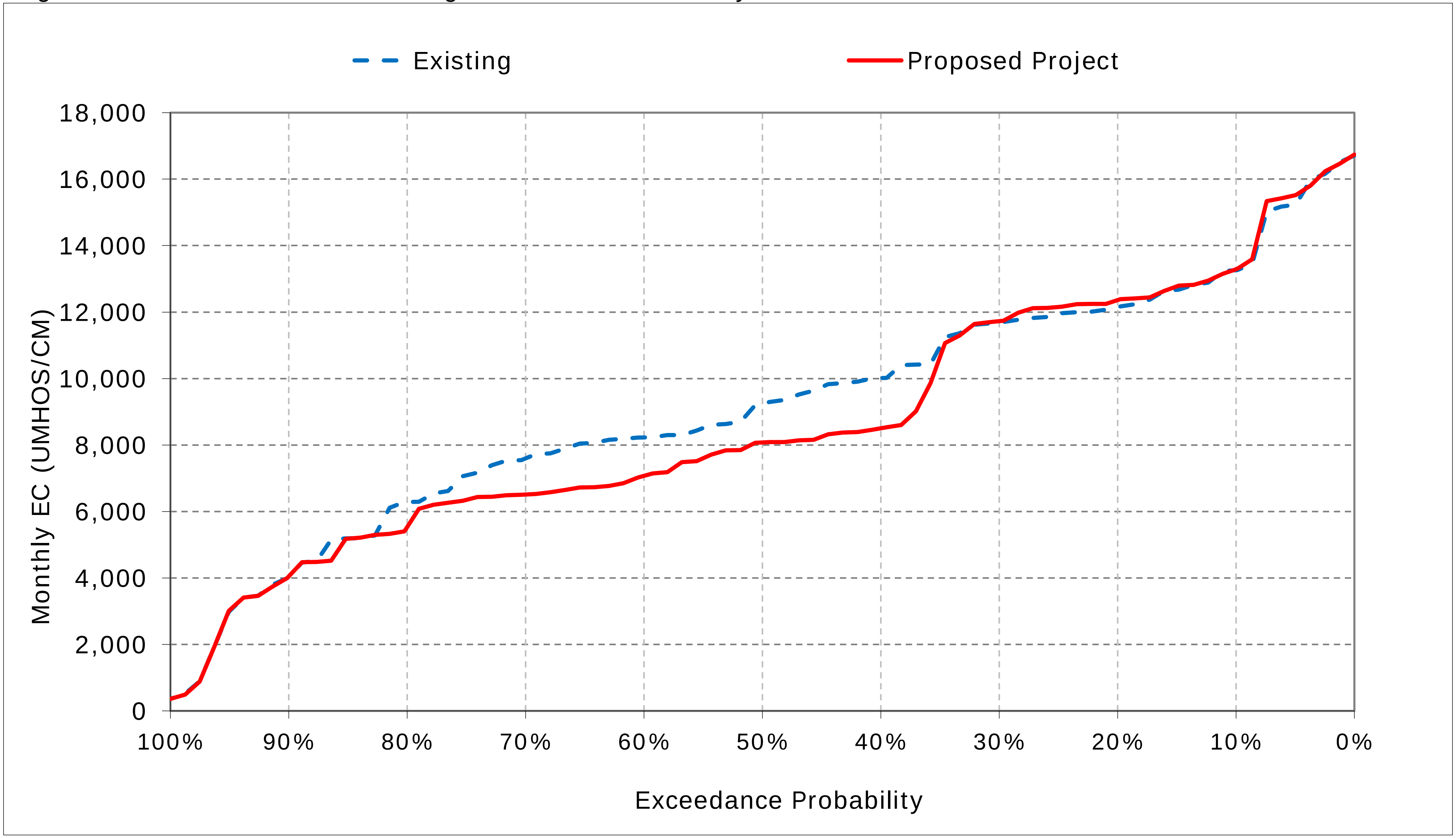


Figure 20-14. Montezuma Slough at Hunter Cut, August EC

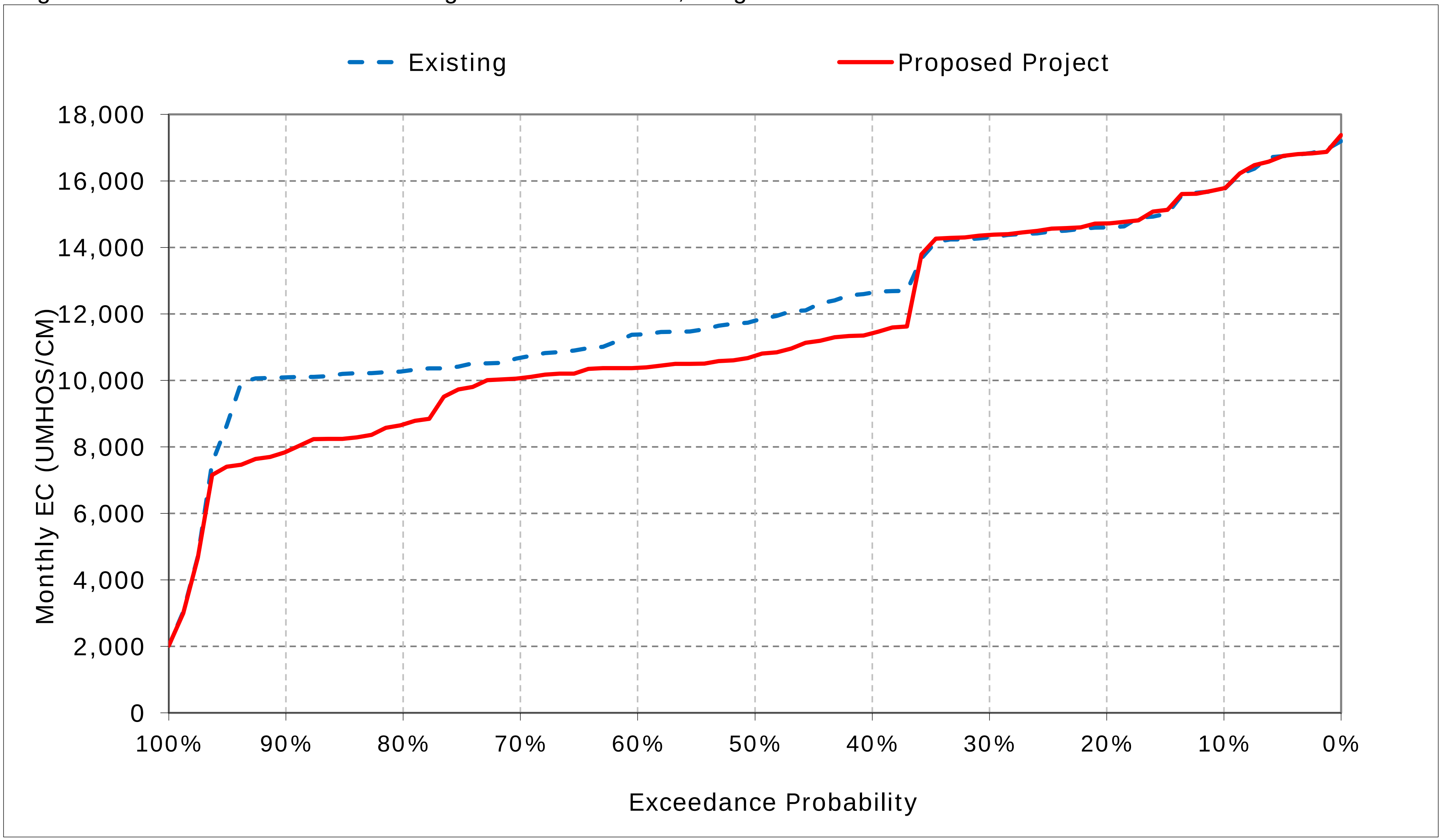


Figure 20-15. Montezuma Slough at Hunter Cut, September EC

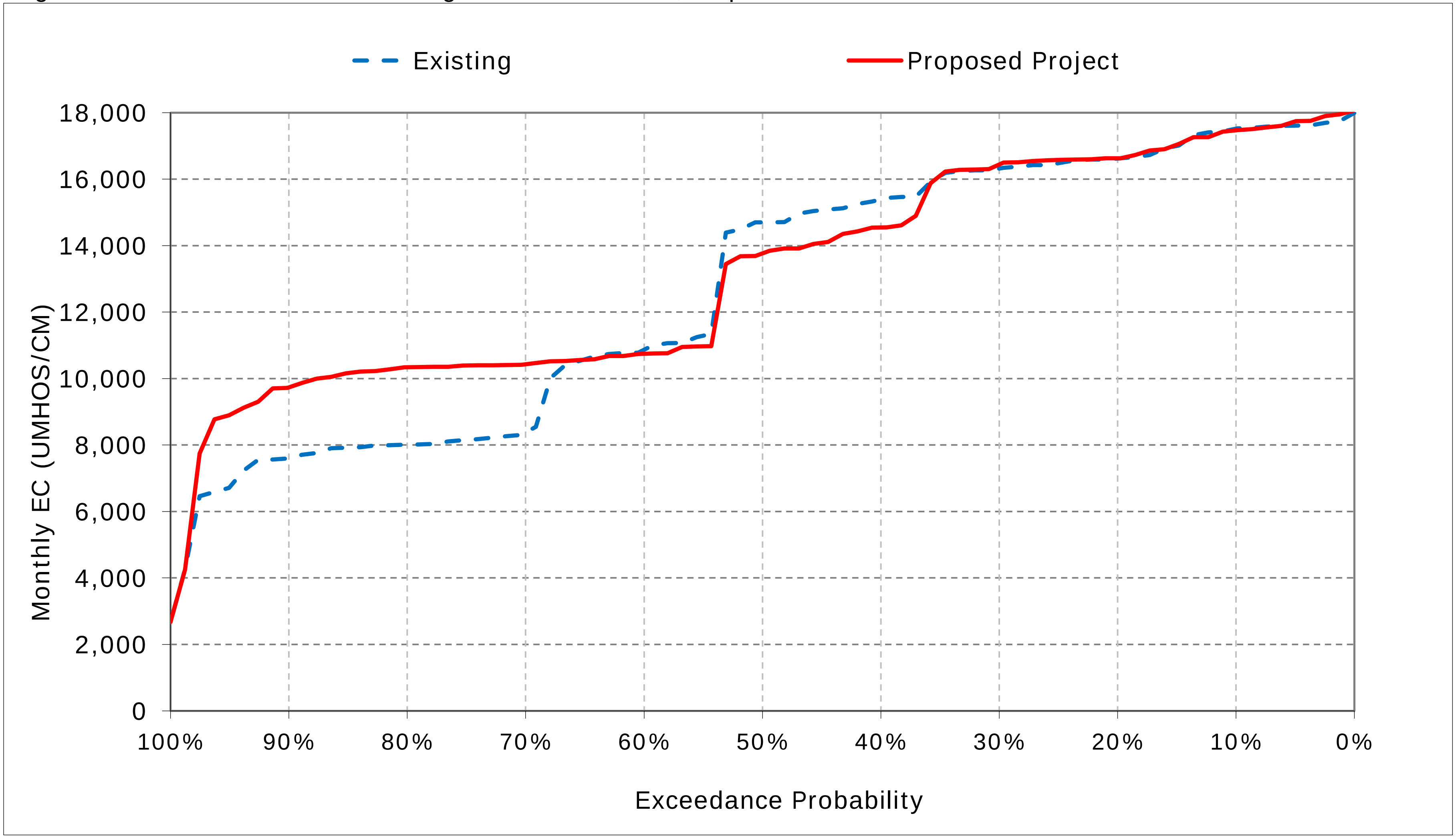


Figure 20-16. Montezuma Slough at Hunter Cut, October EC

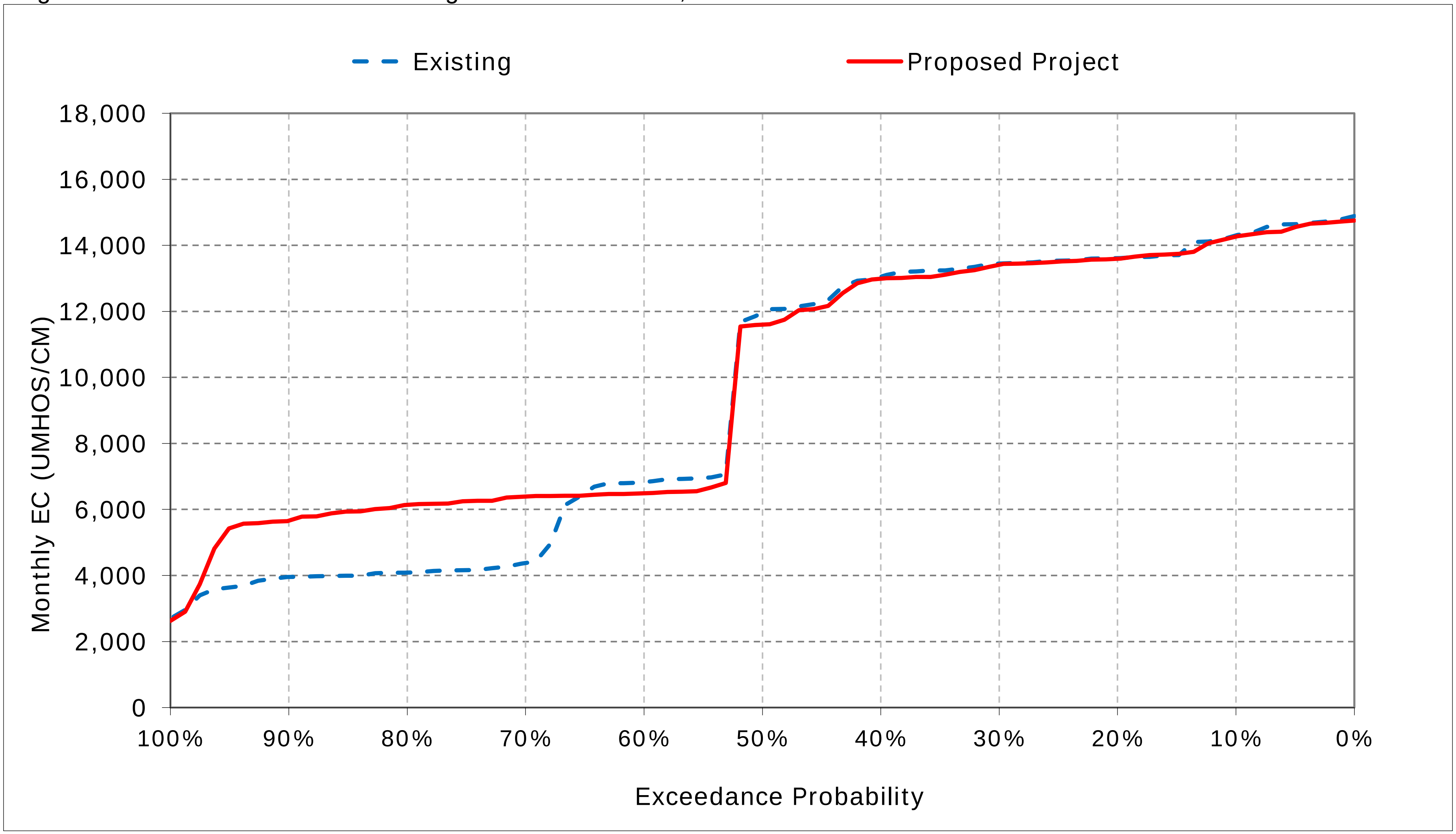


Figure 20-17. Montezuma Slough at Hunter Cut, November EC

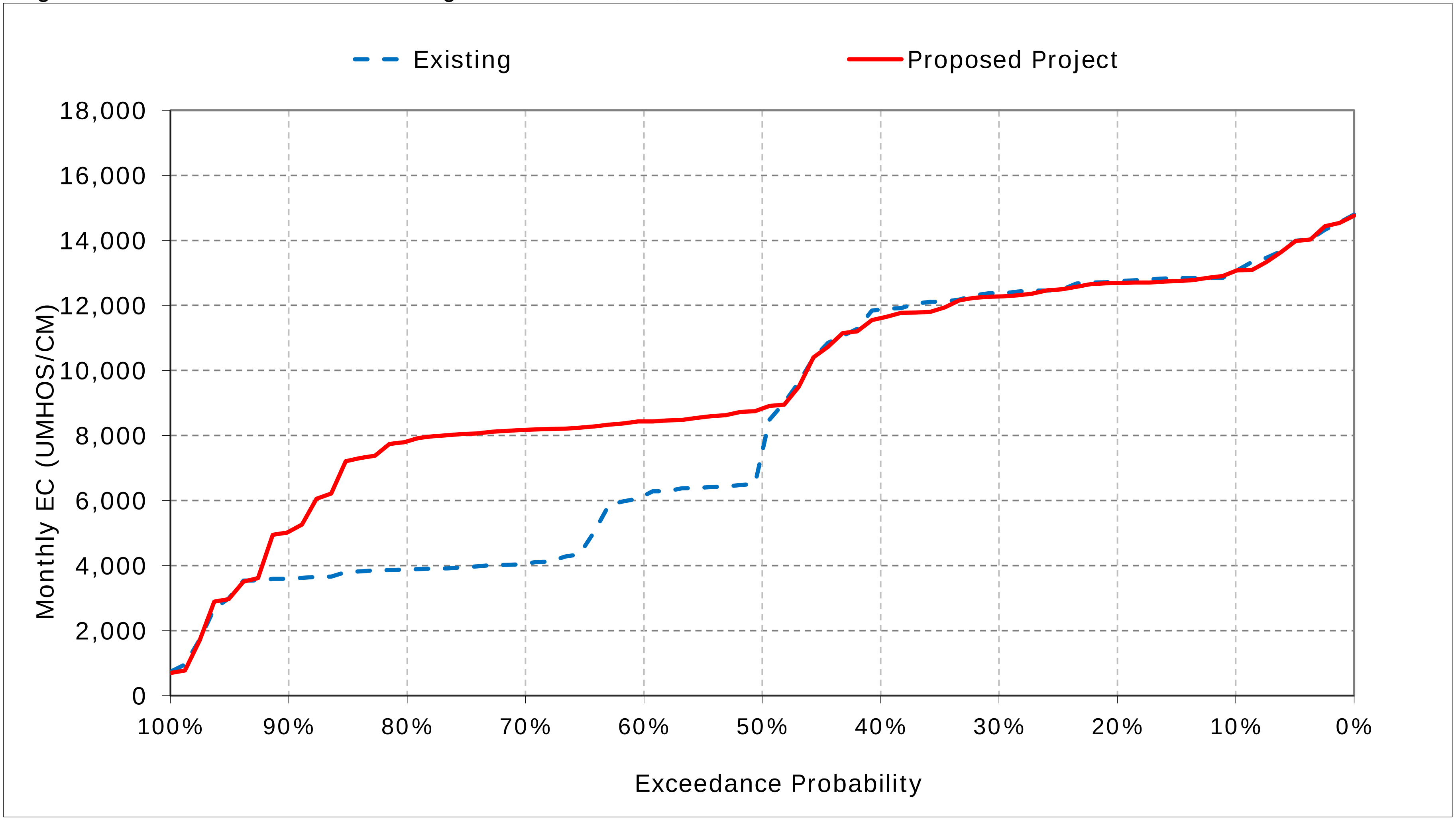


Figure 20-18. Montezuma Slough at Hunter Cut, December EC

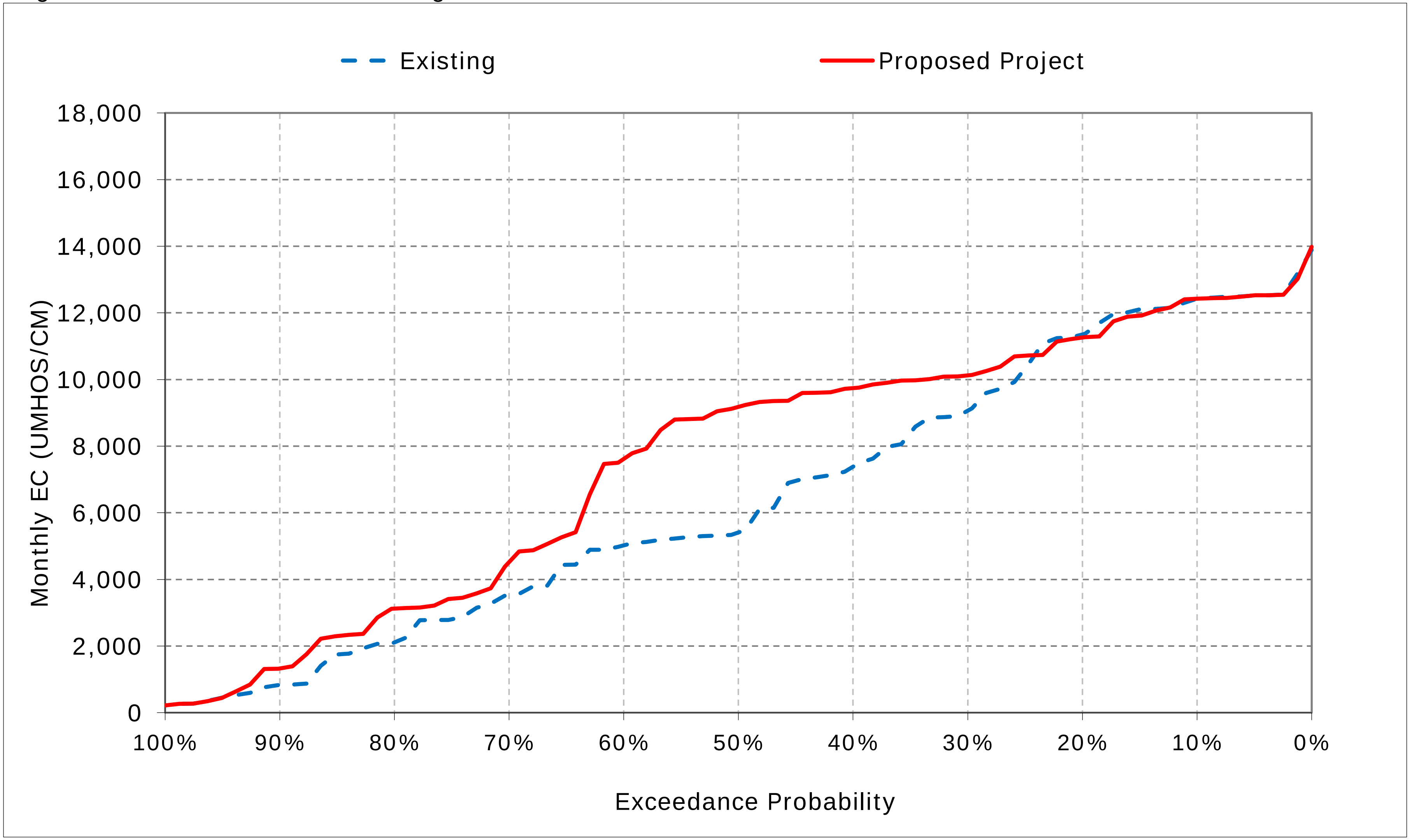


Table 21-1. Montezuma Slough at Beldons Landing, Monthly EC

Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	10,397	9,185	8,459	4,859	1,913	4,528	6,910	7,642	9,408	11,291	13,926	16,150
20%	9,726	8,768	6,977	4,038	1,247	2,844	3,734	5,911	7,904	10,245	12,836	15,110
30%	9,507	8,484	4,779	3,185	773	1,475	2,438	4,408	6,998	9,651	12,376	14,722
40%	9,254	7,931	3,817	1,903	557	1,021	1,574	2,715	5,707	8,399	10,521	13,462
50%	7,993	3,576	2,678	1,632	309	853	1,248	1,882	4,248	7,091	9,759	12,895
60%	3,553	2,817	2,383	718	232	347	586	1,126	3,297	6,637	9,000	9,885
70%	1,942	1,552	1,139	269	208	236	365	672	2,535	5,545	8,218	8,353
80%	1,727	1,379	809	210	198	210	239	366	1,132	4,226	8,042	7,889
90%	1,622	1,278	280	196	191	195	195	200	293	2,201	7,617	7,573
Long Term												
Full Simulation Period[a]	6,094	5,097	3,652	2,040	821	1,517	2,173	3,003	4,836	7,331	10,172	11,631
Water Year Types[b]												
Wet (32%)	4,627	3,136	1,198	410	220	288	391	672	1,598	3,726	7,266	7,212
Above Normal (15%)	6,377	5,107	3,446	1,297	368	370	528	1,022	2,874	5,632	8,335	9,858
Below Normal (17%)	6,393	5,547	4,642	2,292	548	1,255	1,742	2,463	4,577	7,545	10,081	13,190
Dry (22%)	6,458	5,971	4,487	3,024	1,240	2,210	3,276	4,600	7,033	9,806	12,571	14,904
Critical (15%)	8,098	7,502	6,769	4,543	2,264	4,595	6,530	8,271	10,822	12,880	14,817	16,249

Proposed Project

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	10,353	9,191	8,452	5,543	1,985	4,477	7,275	7,861	9,547	11,359	13,927	16,052
20%	9,690	8,738	6,987	4,531	1,232	2,829	3,663	6,531	8,622	10,406	12,964	15,064
30%	9,432	8,419	6,315	3,429	829	1,496	2,622	5,458	7,890	9,703	12,467	14,832
40%	8,912	7,831	5,745	2,107	554	888	1,778	3,810	6,151	7,127	9,181	11,493
50%	7,649	5,324	4,938	1,672	311	680	1,456	2,352	4,851	6,365	8,350	10,787
60%	3,289	4,936	3,689	728	222	335	674	1,822	4,295	4,818	8,101	9,977
70%	3,129	4,761	1,862	270	207	230	410	1,022	2,902	3,286	7,713	9,627
80%	2,951	4,480	1,131	213	200	208	243	442	1,457	3,109	5,547	9,406
90%	2,655	2,226	564	195	192	195	197	205	316	2,070	4,839	8,928
Long Term												
Full Simulation Period[a]	6,349	6,130	4,440	2,213	880	1,499	2,285	3,488	5,333	6,676	9,308	11,727
Water Year Types[b]												
Wet (32%)	4,995	4,471	1,731	420	214	279	449	957	1,990	3,863	7,223	8,666
Above Normal (15%)	6,650	6,190	4,562	1,453	333	326	613	1,543	3,476	5,673	8,378	9,617
Below Normal (17%)	6,664	6,523	5,580	2,384	533	1,167	1,886	3,206	5,266	3,068	4,920	11,149
Dry (22%)	6,744	6,926	5,435	3,390	1,370	2,173	3,399	5,265	7,628	10,007	12,667	14,970
Critical (15%)	8,018	8,011	7,368	4,892	2,538	4,688	6,729	8,579	11,071	12,986	14,833	16,282

Proposed Project minus Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	-44	6	-6	684	72	-51	365	219	139	68	1	-98
20%	-35	-29	10	493	-15	-15	-72	620	719	161	128	-46
30%	-76	-65	1,536	244	55	21	184	1,050	891	52	90	110
40%	-342	-100	1,927	204	-3	-134	204	1,095	444	-1,272	-1,339	-1,968
50%	-344	1,747	2,261	41	3	-172	208	470	603	-726	-1,408	-2,108
60%	-264	2,118	1,306	10	-10	-12	87	696	998	-1,819	-899	92
70%	1,187	3,209	723	1	-1	-7	45	350	367	-2,259	-505	1,275
80%	1,224	3,101	322	3	2	-2	3	76	325	-1,117	-2,496	1,516
90%	1,033	948	284	0	0	0	2	5	23	-131	-2,778	1,355
Long Term												
Full Simulation Period[a]	254	1,032	788	173	59	-19	112	484	497	-655	-865	96
Water Year Types[b]												
Wet (32%)	369	1,334	533	10	-6	-9	58	284	392	138	-43	1,454
Above Normal (15%)	273	1,083	1,116	156	-34	-44	85	521	602	41	43	-241
Below Normal (17%)	271	976	937	92	-15	-88	144	743	689	-4,476	-5,160	-2,041
Dry (22%)	285	955	948	366	130	-37	123	665	595	200	97	66
Critical (15%)	-80	509	599	350	273	93	200	308	249	106	16	33

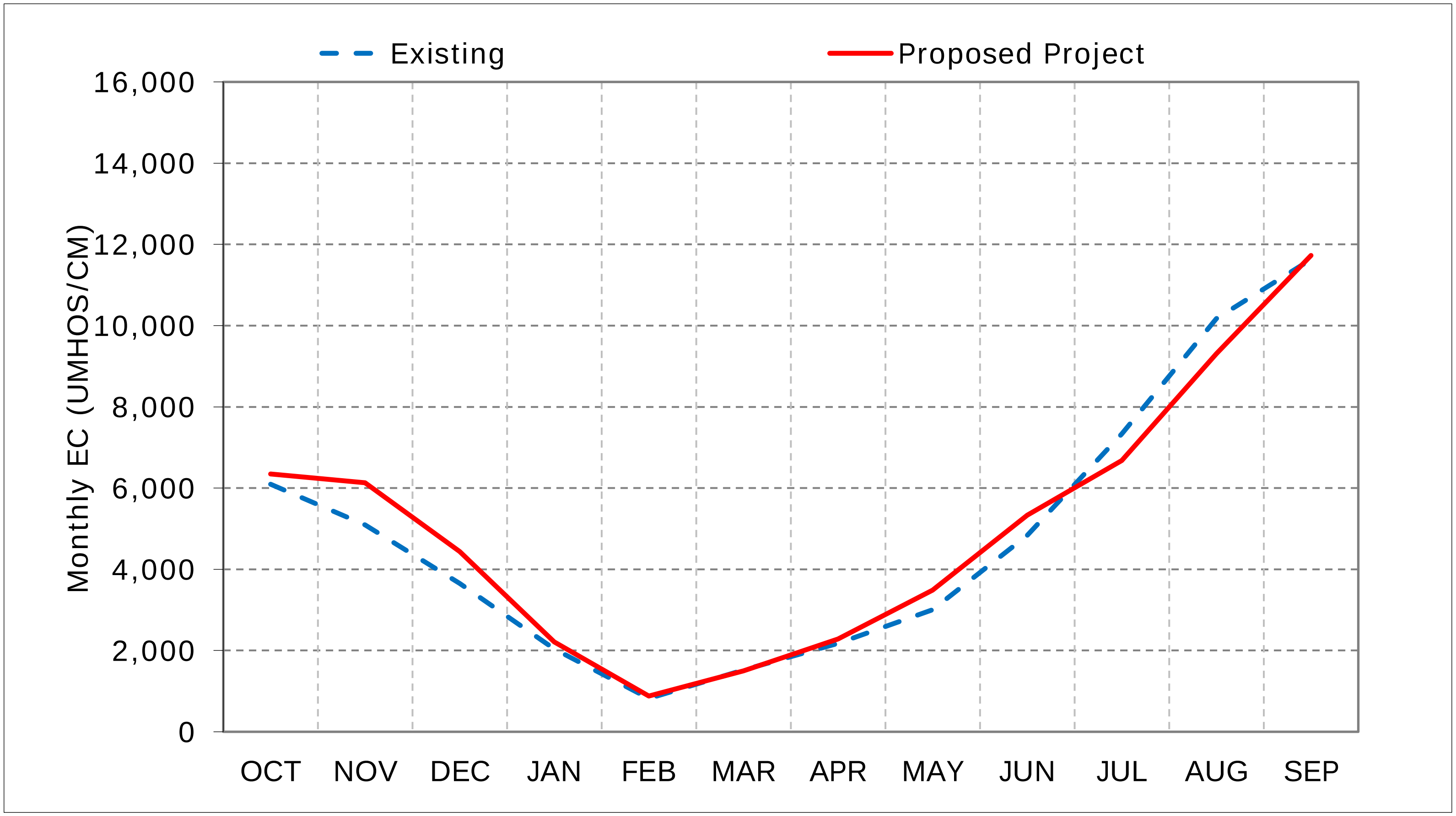
a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

c These results are displayed with water year - year type sorting.

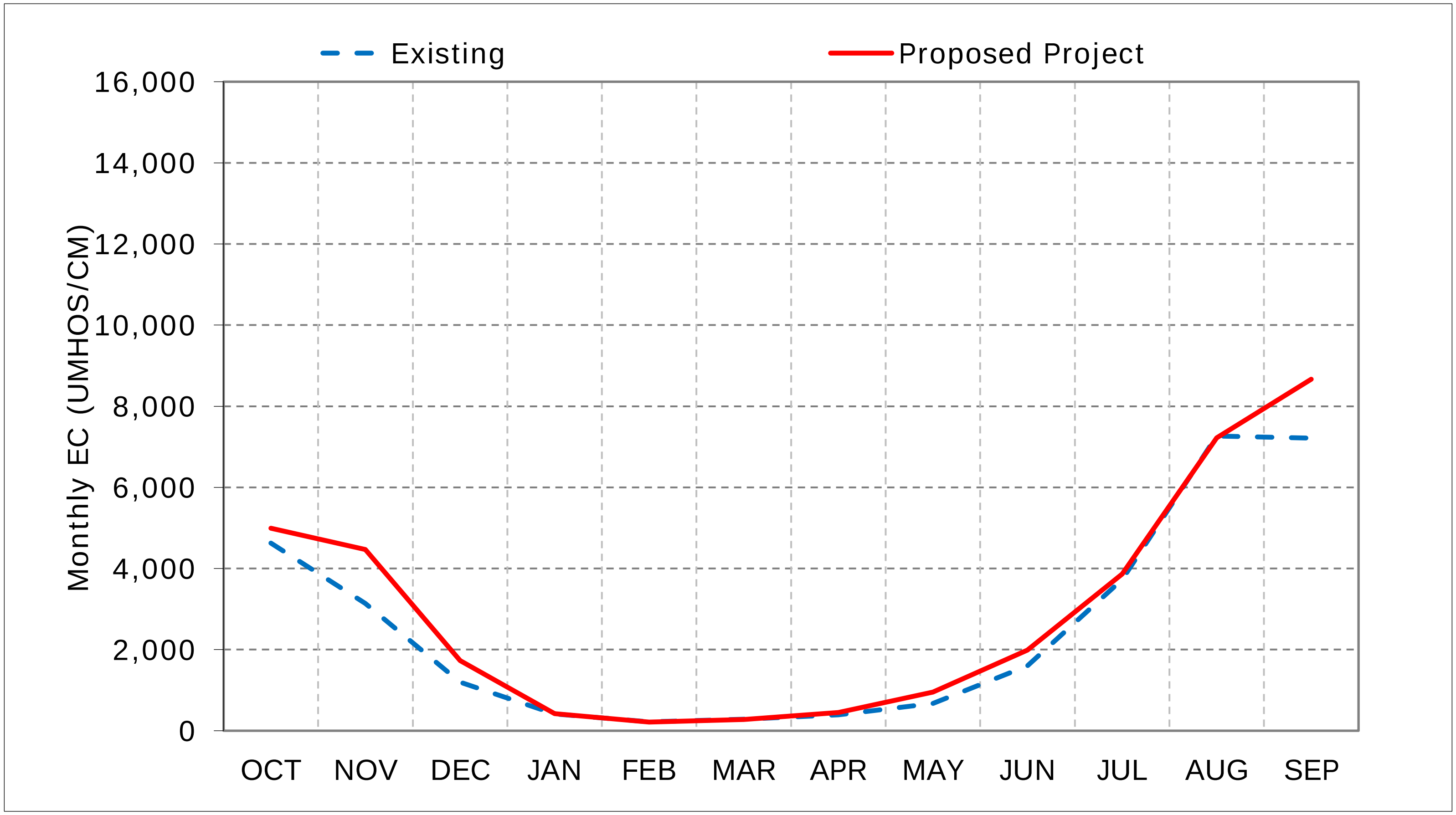
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 21-1. Montezuma Slough at Beldons Landing, Long-Term Average EC



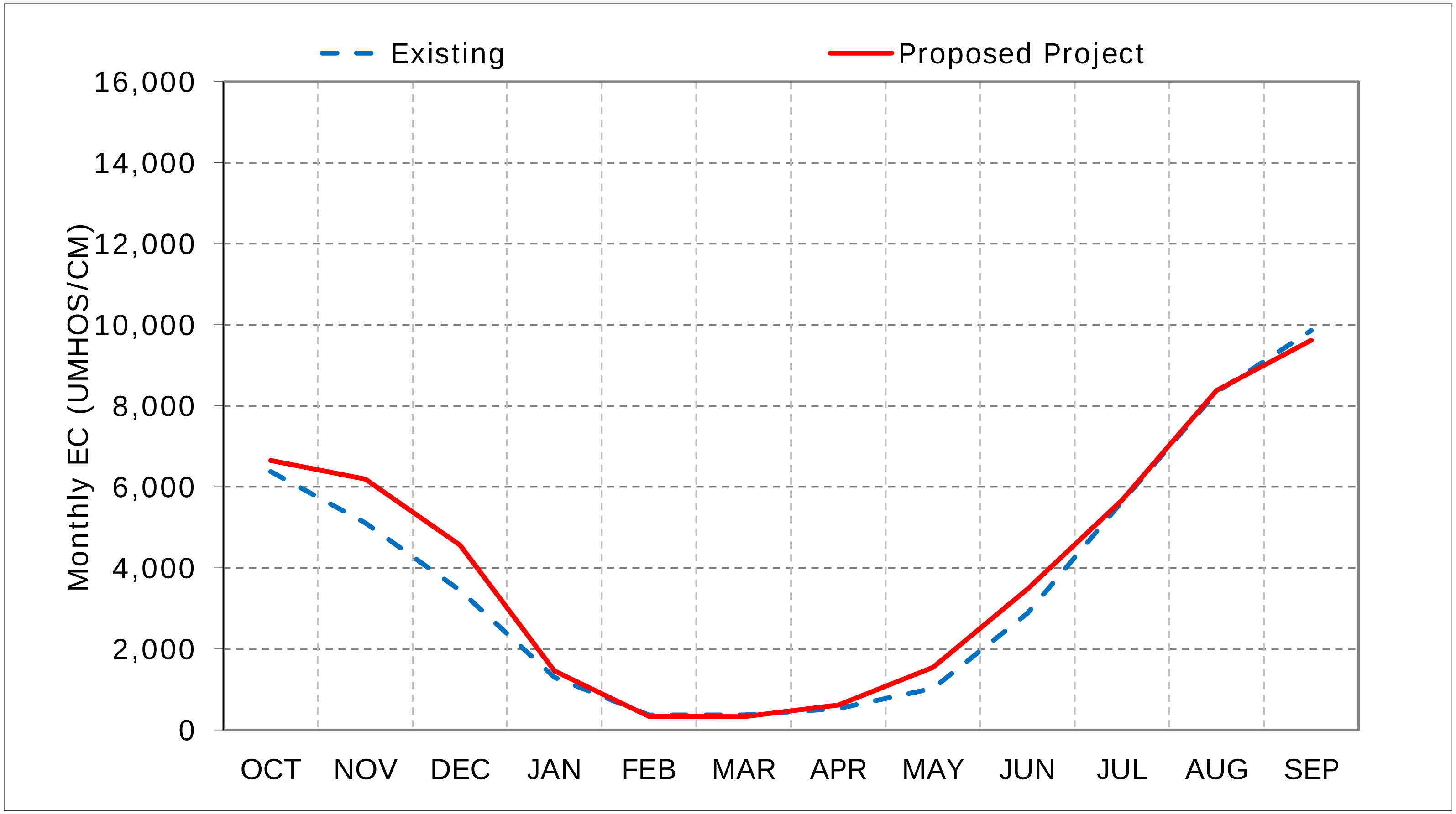
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 21-2. Montezuma Slough at Beldons Landing, Wet Year Average EC



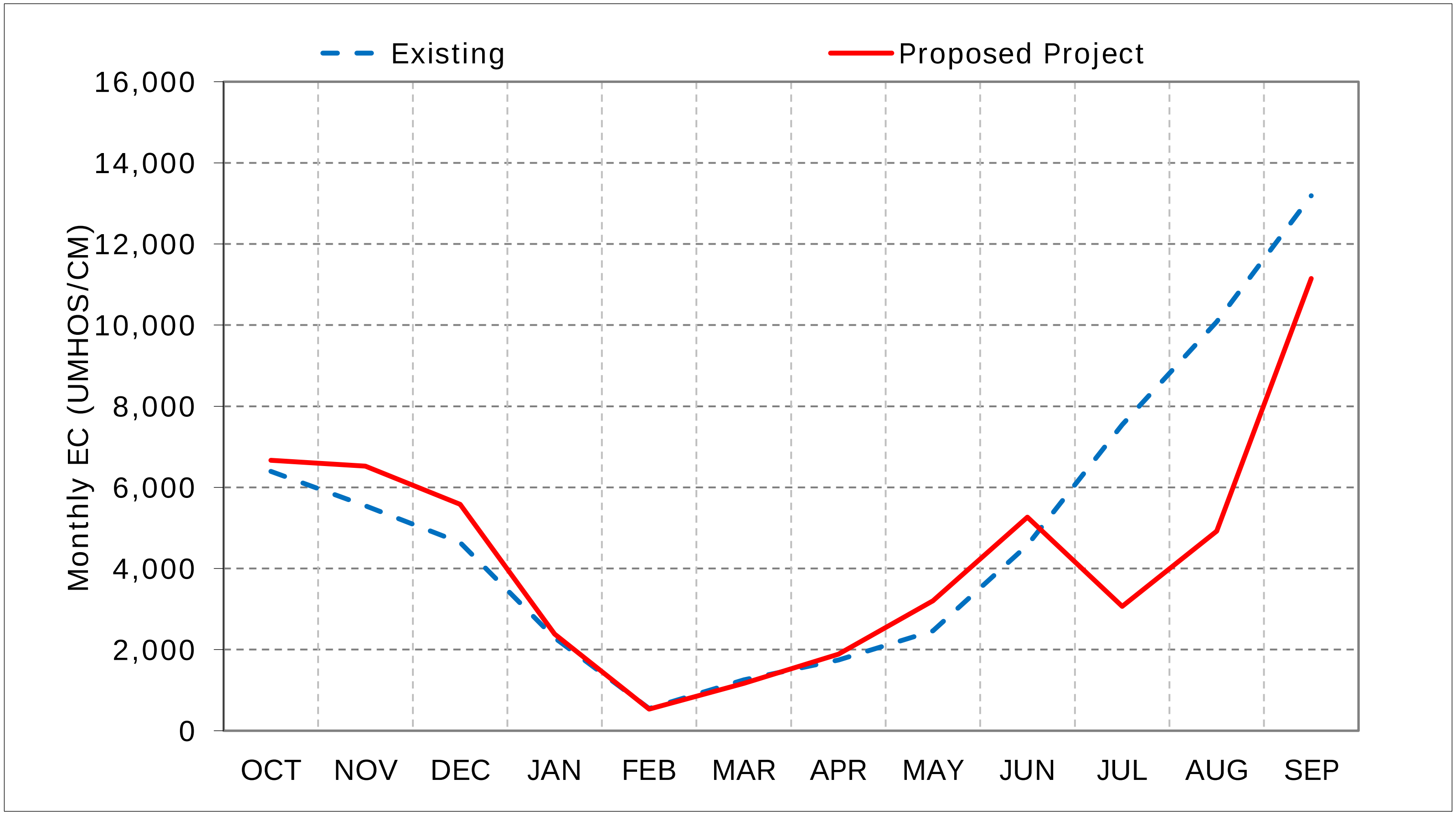
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 21-3. Montezuma Slough at Beldons Landing, Above Normal Year Average I



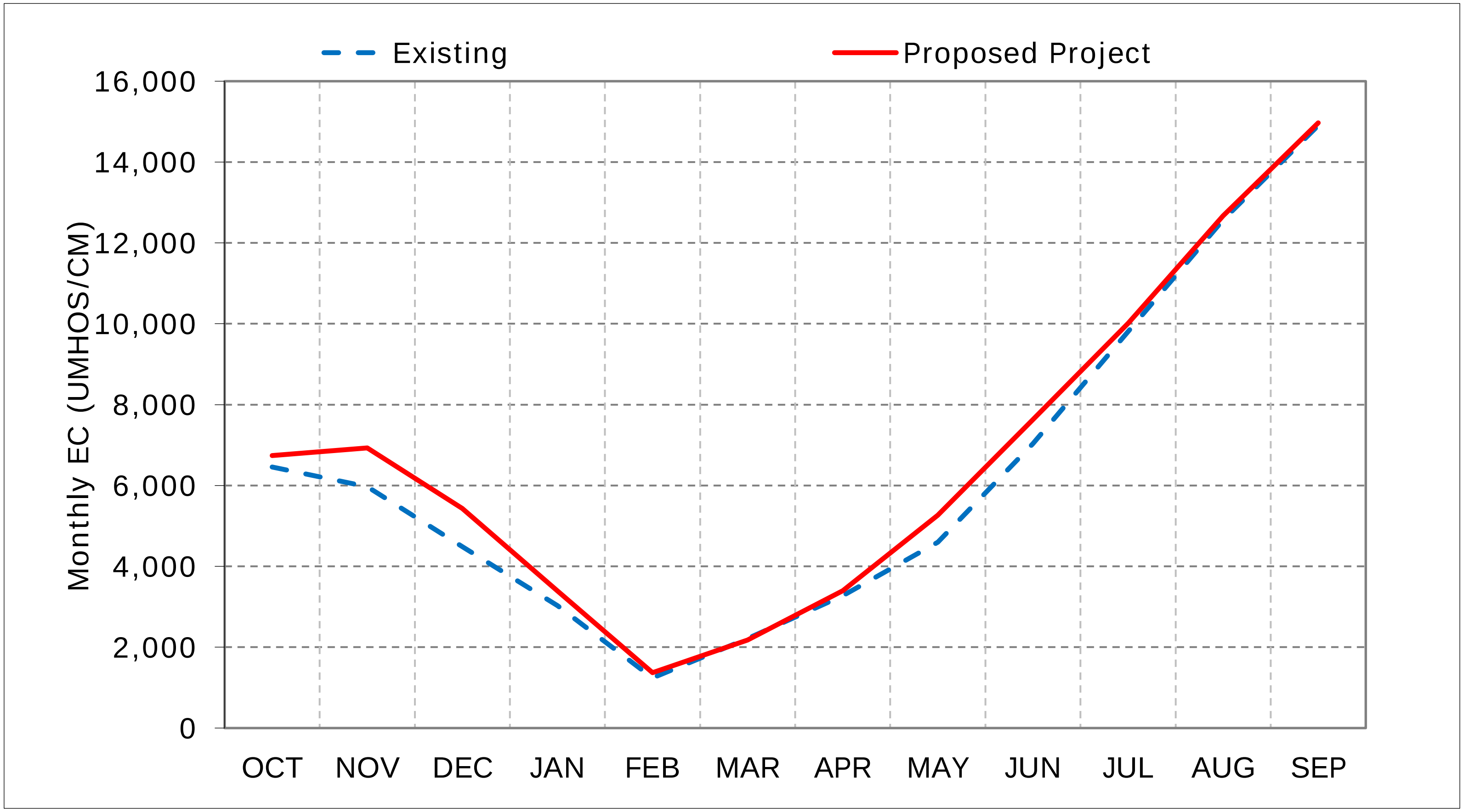
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 21-4. Montezuma Slough at Beldons Landing, Below Normal Year Average E



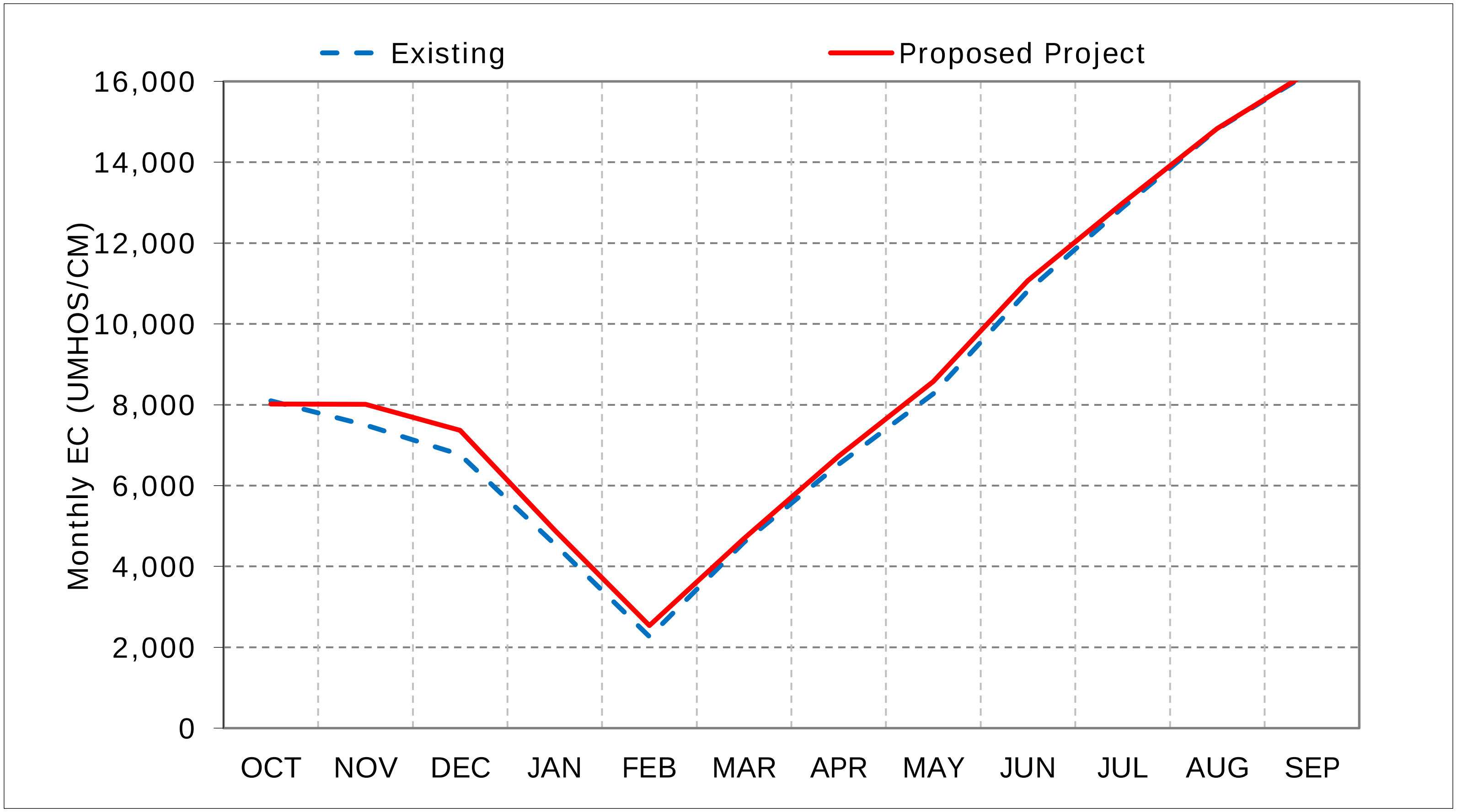
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 21-5. Montezuma Slough at Beldons Landing, Dry Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 21-6. Montezuma Slough at Beldons Landing, Critical Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 21-7. Montezuma Slough at Beldons Landing, January EC

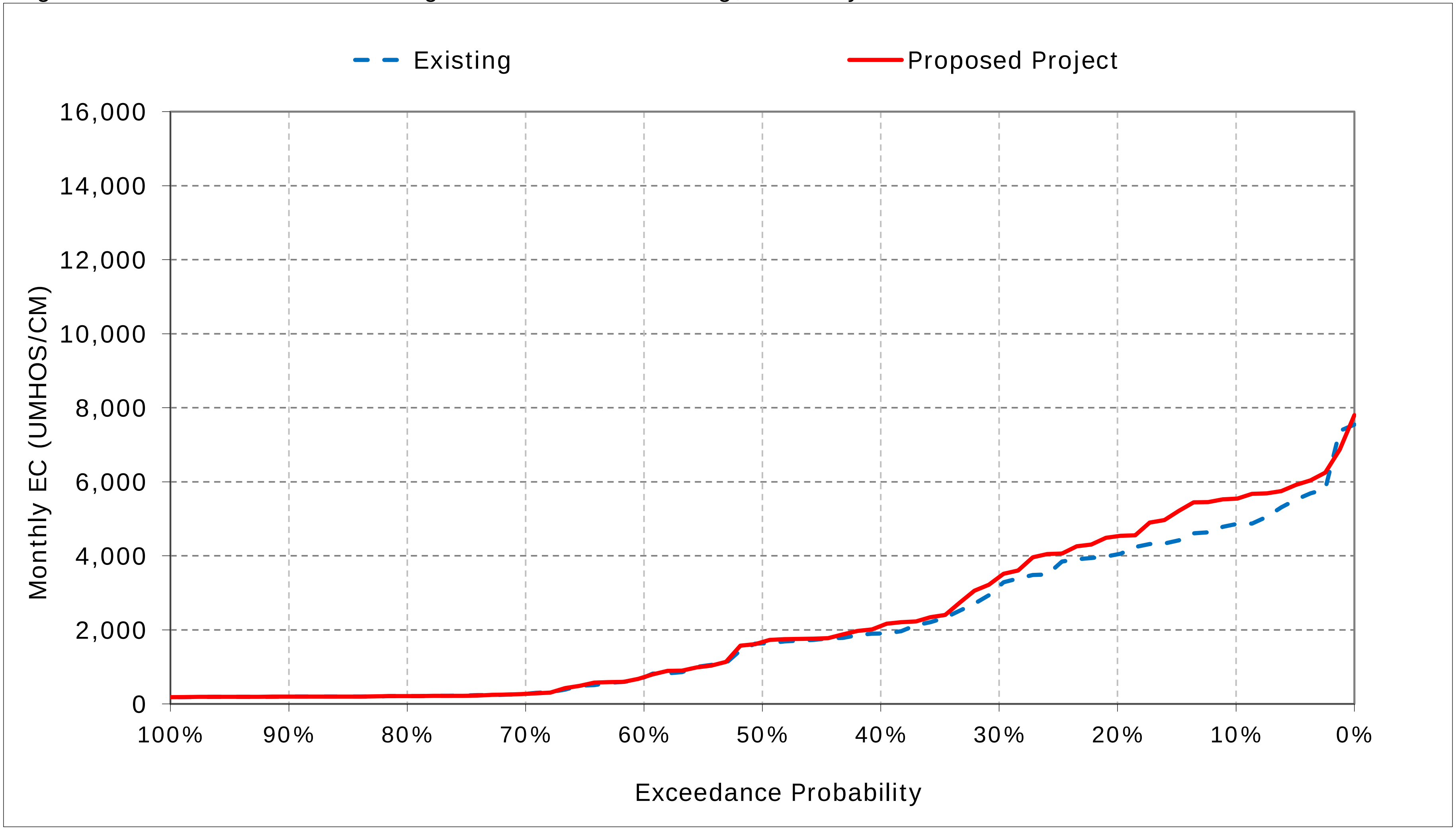


Figure 21-8. Montezuma Slough at Beldons Landing, February EC

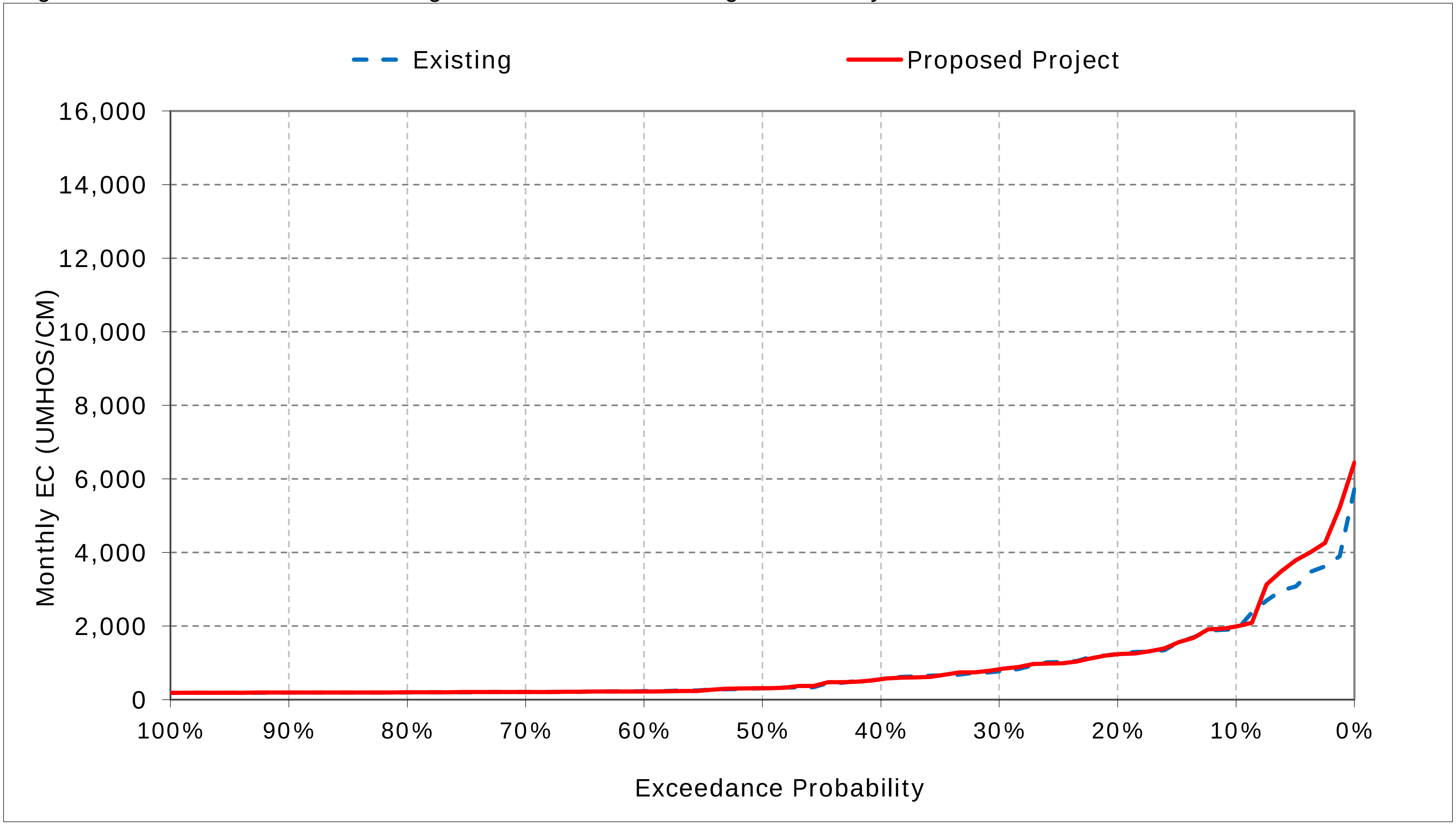


Figure 21-9. Montezuma Slough at Beldons Landing, March EC

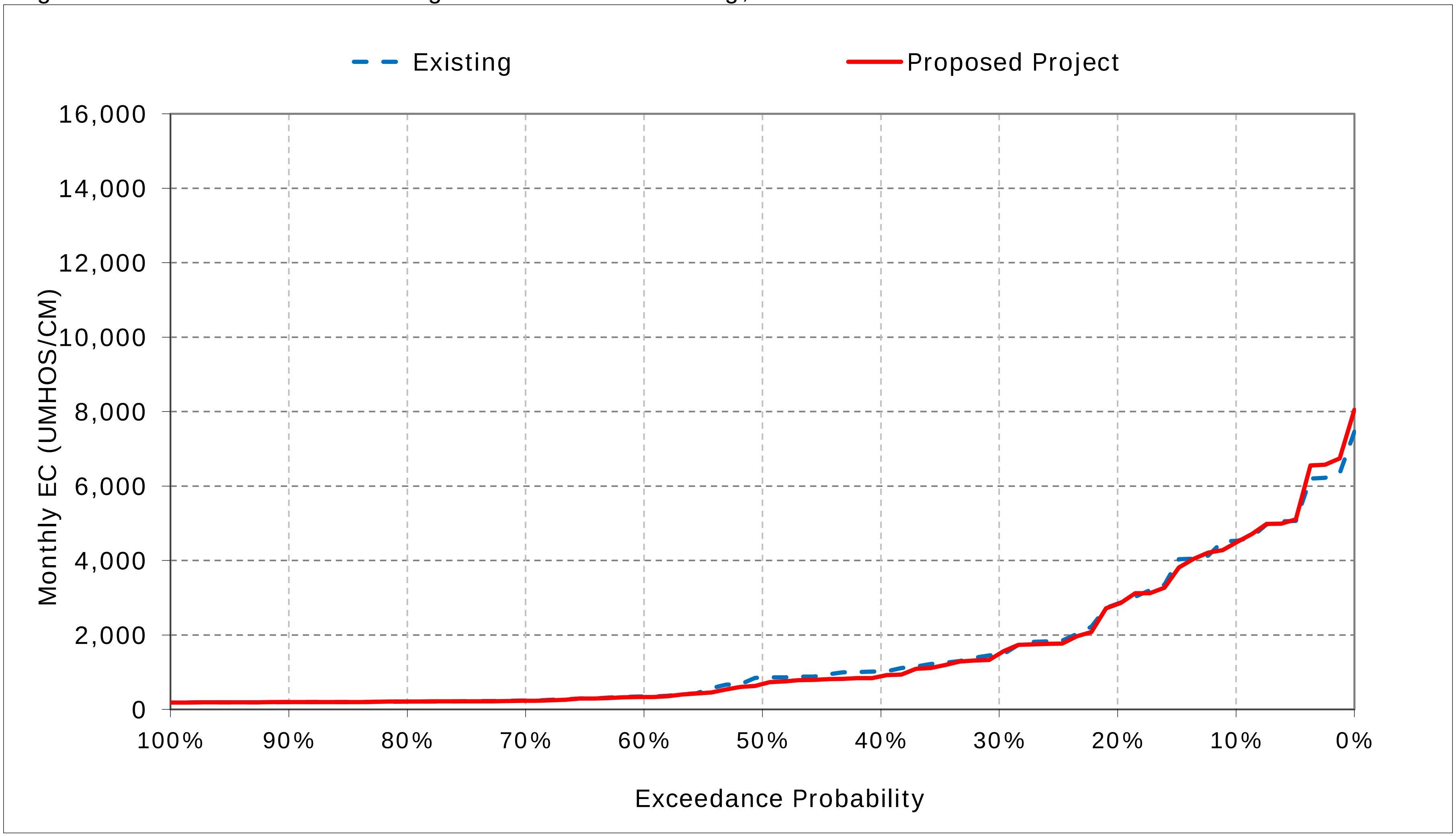


Figure 21-10. Montezuma Slough at Beldons Landing, April EC

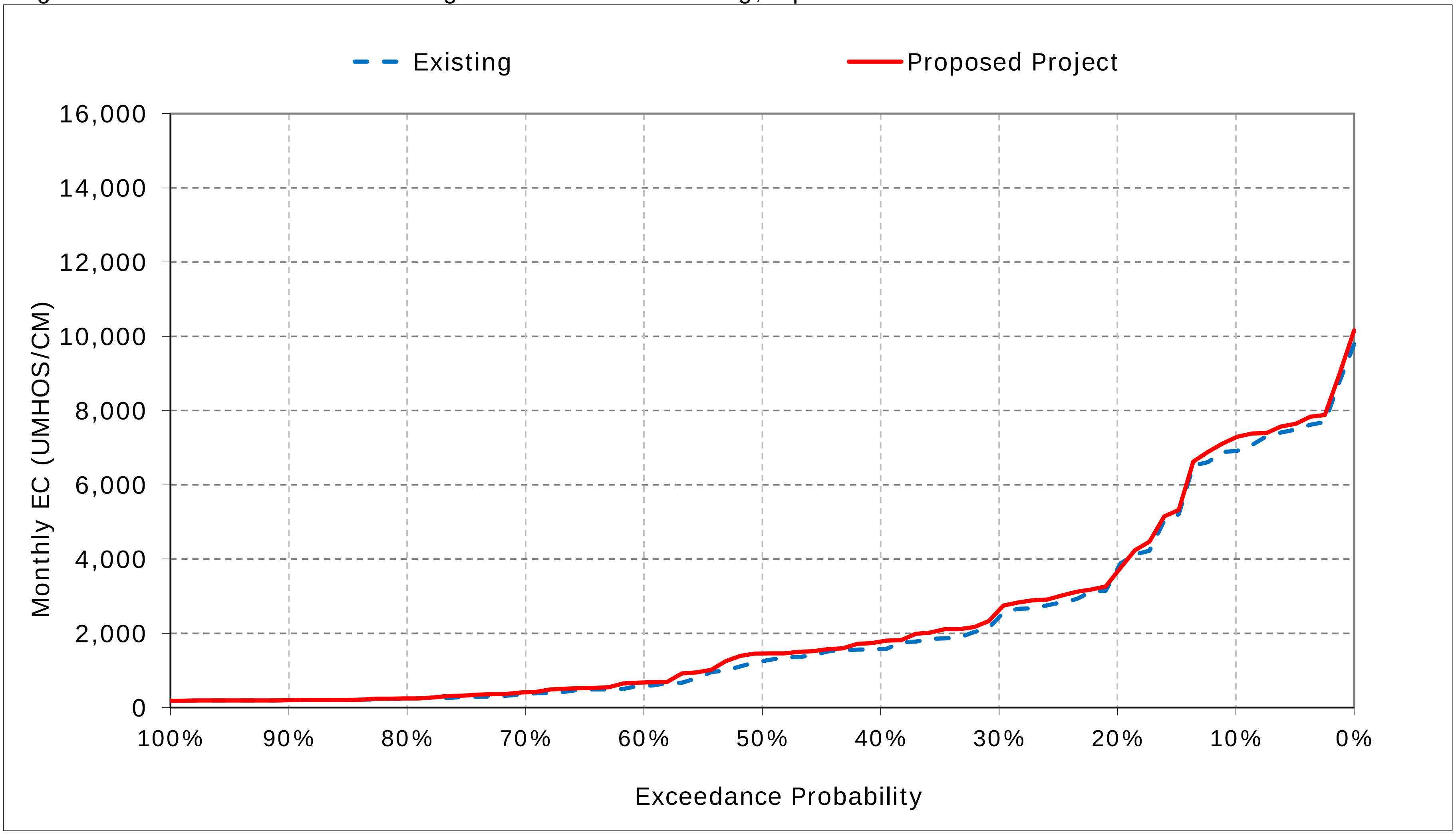


Figure 21-11. Montezuma Slough at Beldons Landing, May EC

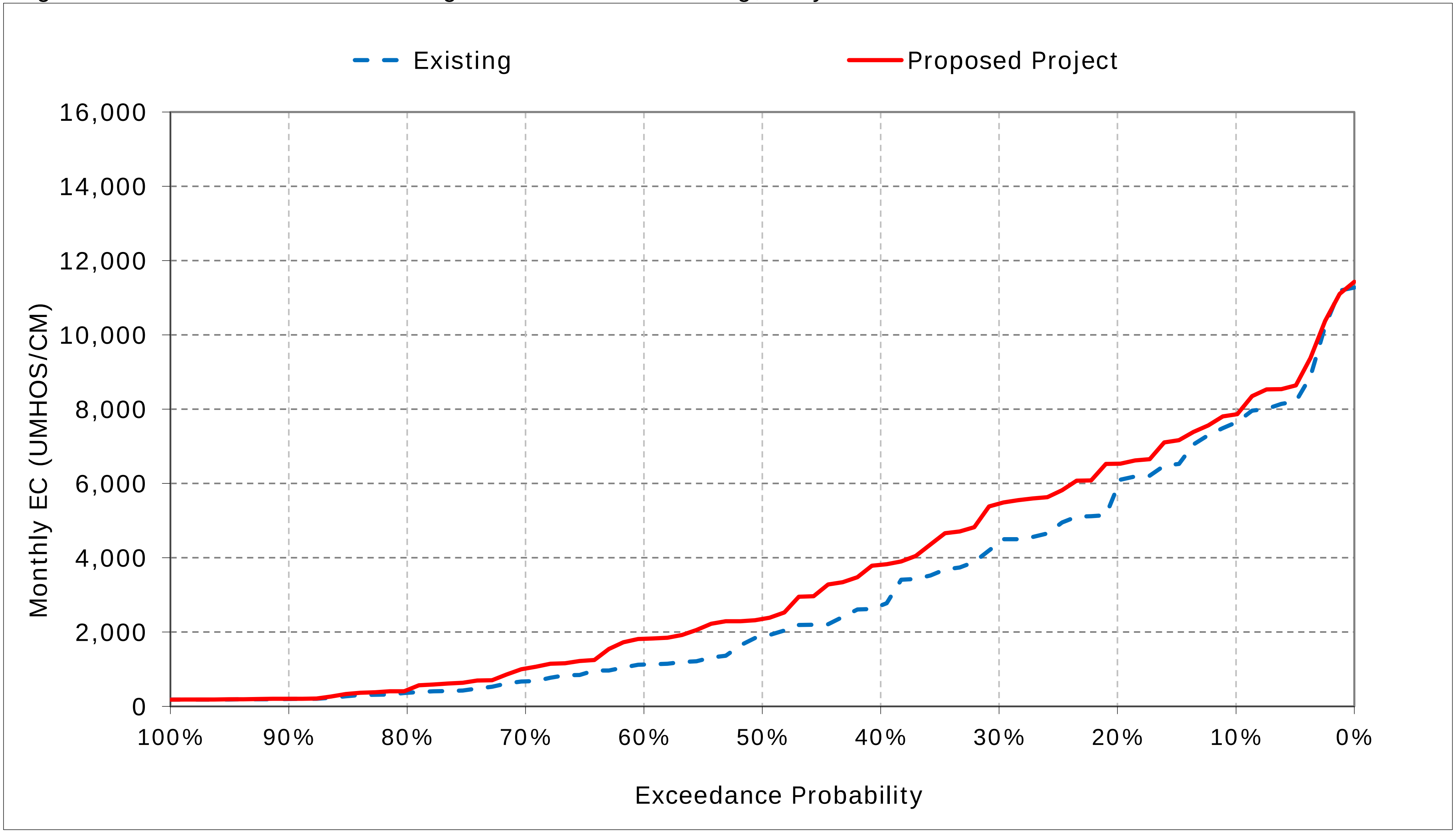


Figure 21-12. Montezuma Slough at Beldons Landing, June EC

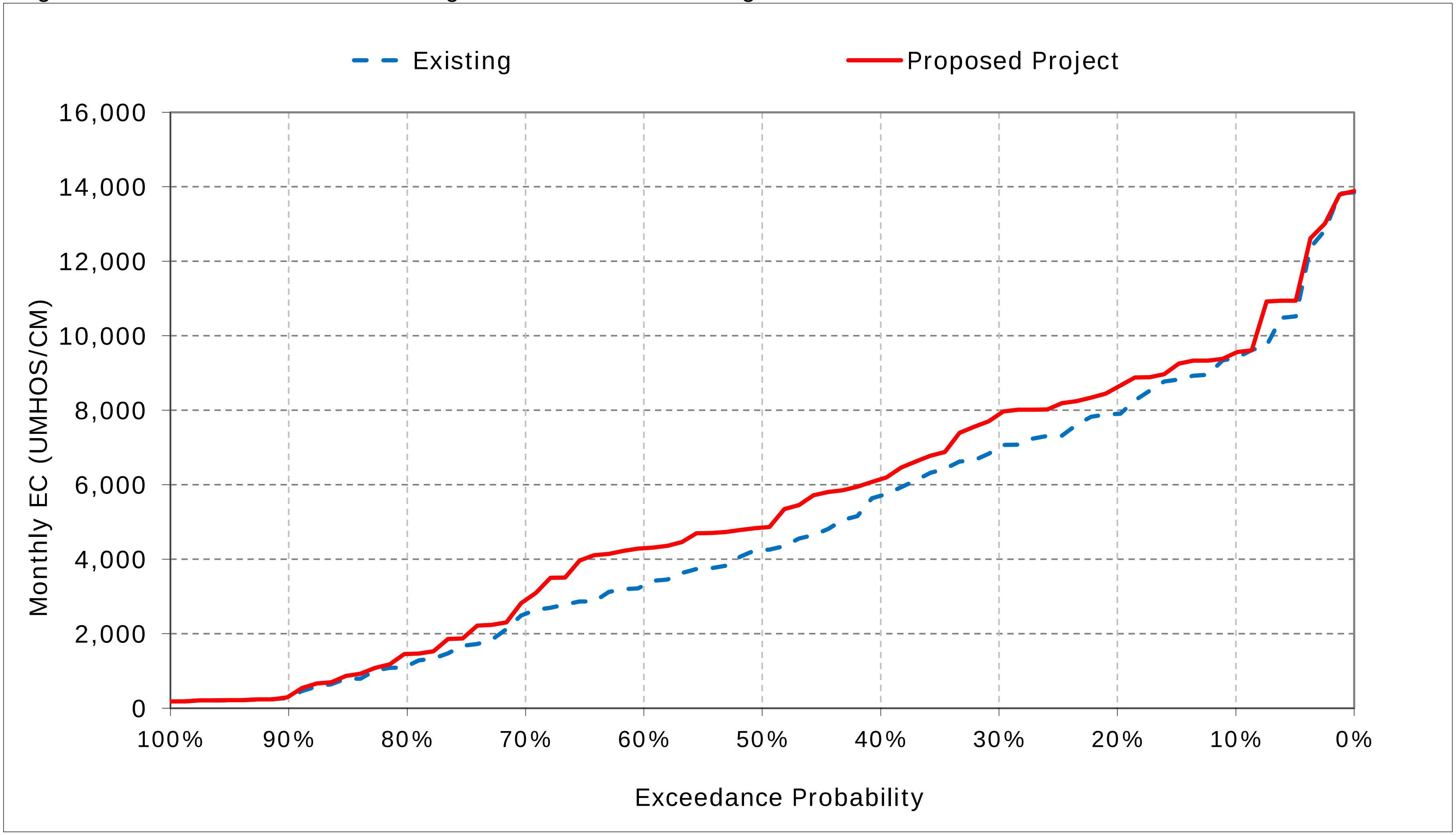


Figure 21-13. Montezuma Slough at Beldons Landing, July EC

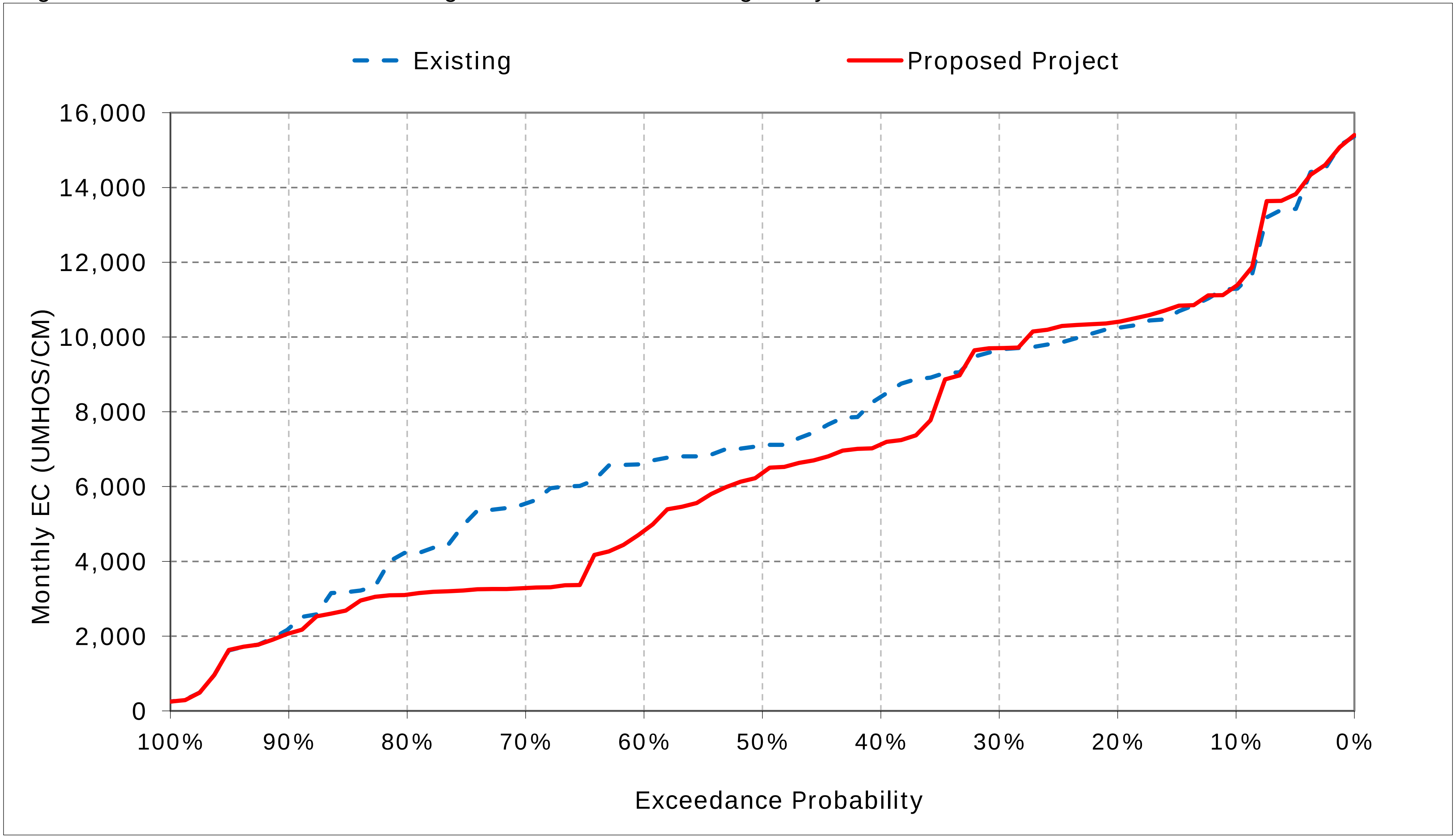


Figure 21-14. Montezuma Slough at Beldons Landing, August EC

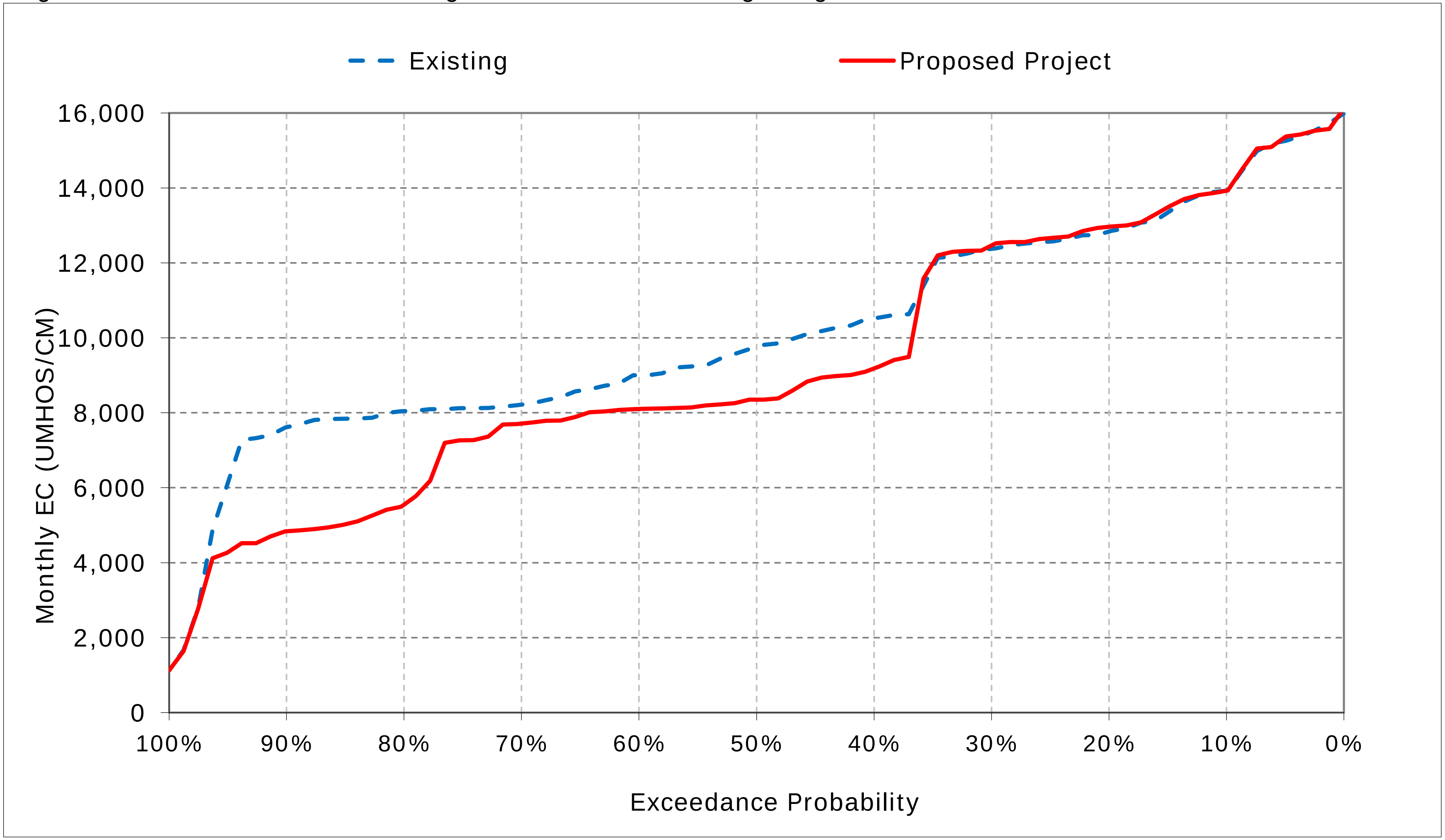


Figure 21-15. Montezuma Slough at Beldons Landing, September EC

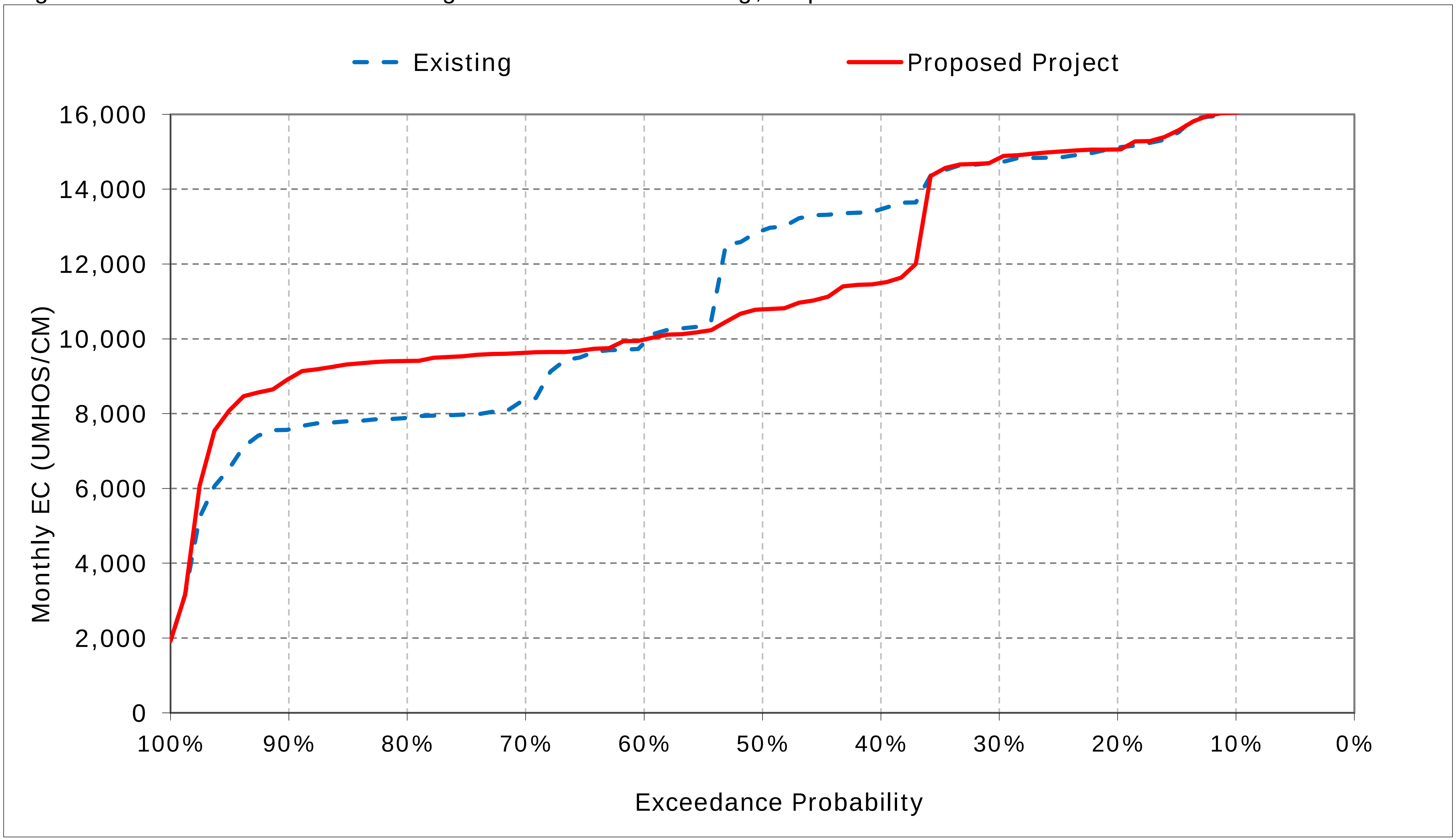


Figure 21-16. Montezuma Slough at Beldons Landing, October EC

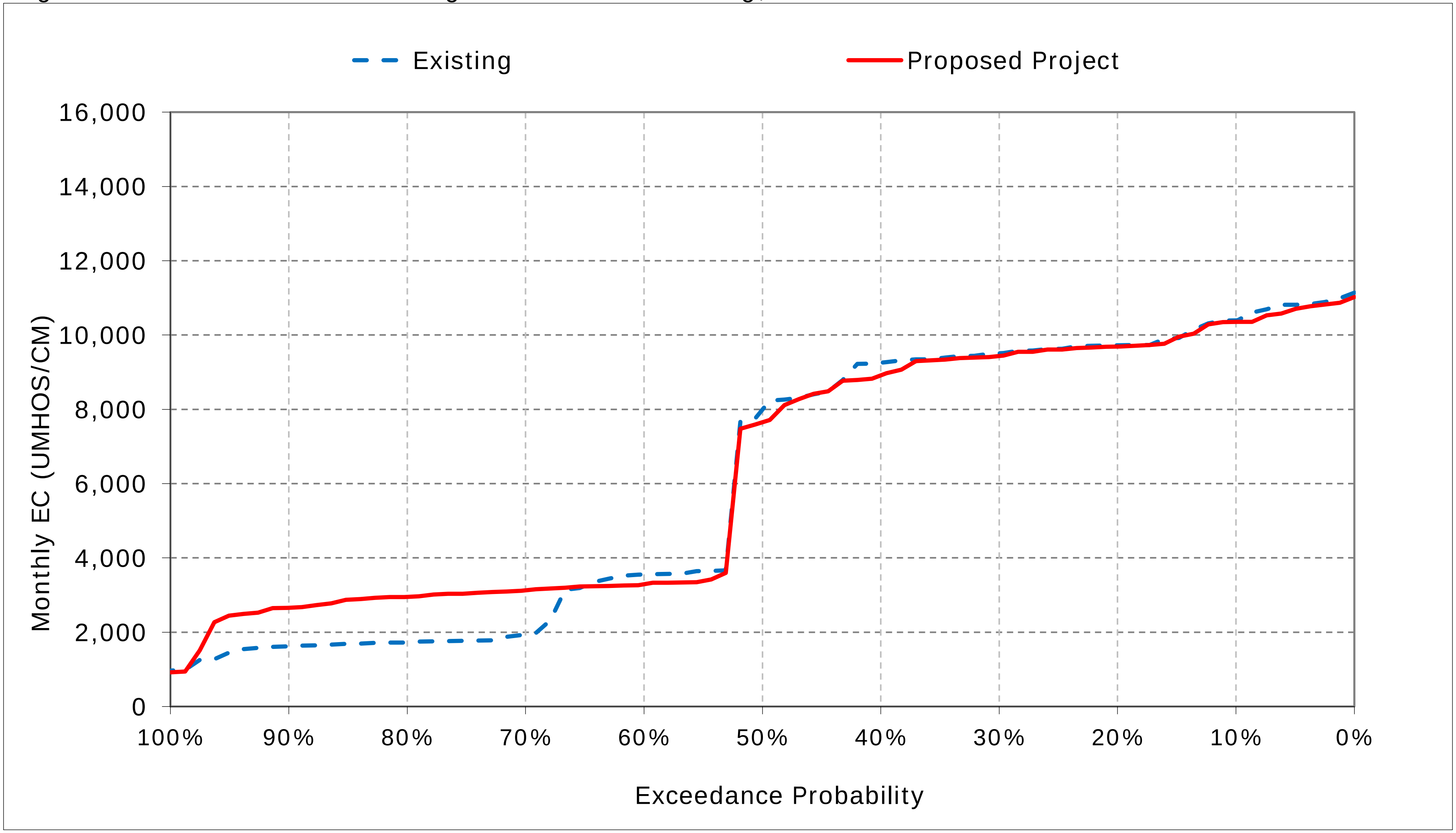


Figure 21-17. Montezuma Slough at Beldons Landing, November EC

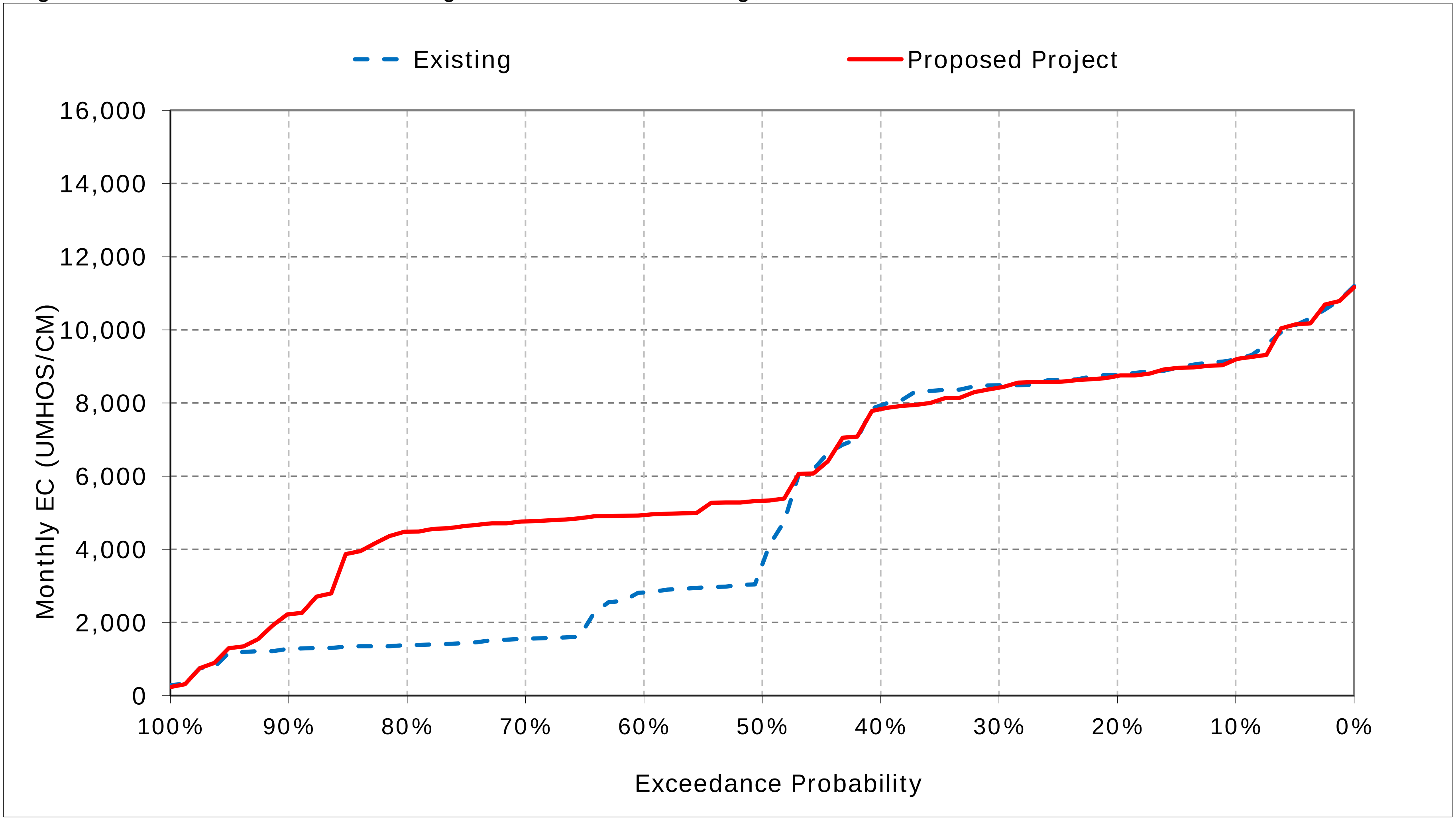


Figure 21-18. Montezuma Slough at Beldons Landing, December EC

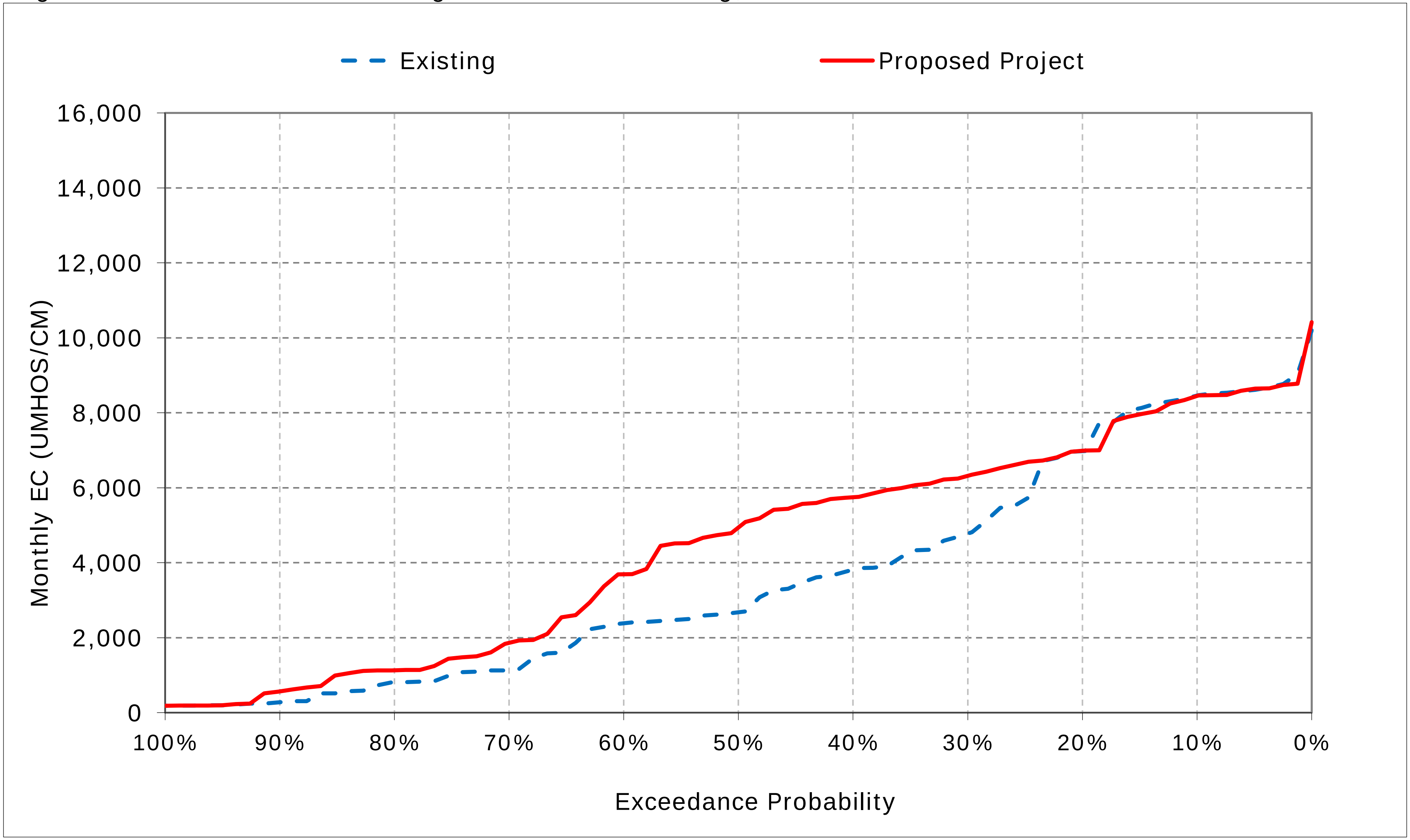


Table 22-1. Montezuma Slough at National Steel, Monthly EC

Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	9,954	9,125	8,457	4,653	1,816	2,545	3,804	4,644	6,213	8,195	10,808	12,703
20%	9,229	8,637	6,804	3,899	1,124	1,367	1,768	3,345	4,995	7,041	9,632	11,765
30%	9,052	8,374	4,484	2,833	652	572	901	2,305	4,418	6,564	9,202	11,431
40%	8,727	7,798	3,679	1,533	404	420	647	1,272	3,512	5,011	7,333	10,280
50%	7,640	3,102	2,891	1,212	294	314	517	795	2,474	4,376	6,703	9,444
60%	3,261	2,578	2,661	560	216	219	258	476	1,892	3,681	6,260	5,782
70%	1,713	1,418	984	234	201	197	219	317	1,279	3,211	5,581	3,969
80%	1,581	1,192	526	206	196	192	198	215	583	2,384	5,361	3,625
90%	1,454	1,079	216	194	190	188	190	191	202	1,260	5,181	3,495
Long Term												
Full Simulation Period[a]	5,761	4,915	3,553	1,861	748	792	1,141	1,755	3,112	4,810	7,313	7,990
Water Year Types[b]												
Wet (32%)	4,322	2,914	1,051	377	206	212	243	368	902	2,087	4,915	3,315
Above Normal (15%)	6,040	4,890	3,344	1,082	327	225	276	462	1,698	3,150	5,651	5,655
Below Normal (17%)	6,054	5,358	4,640	1,977	471	564	734	1,238	2,758	4,649	7,004	9,832
Dry (22%)	6,143	5,820	4,349	2,849	1,103	1,044	1,594	2,553	4,454	6,716	9,368	11,615
Critical (15%)	7,687	7,403	6,723	4,237	2,133	2,501	3,744	5,458	7,717	9,698	11,446	12,866

Proposed Project

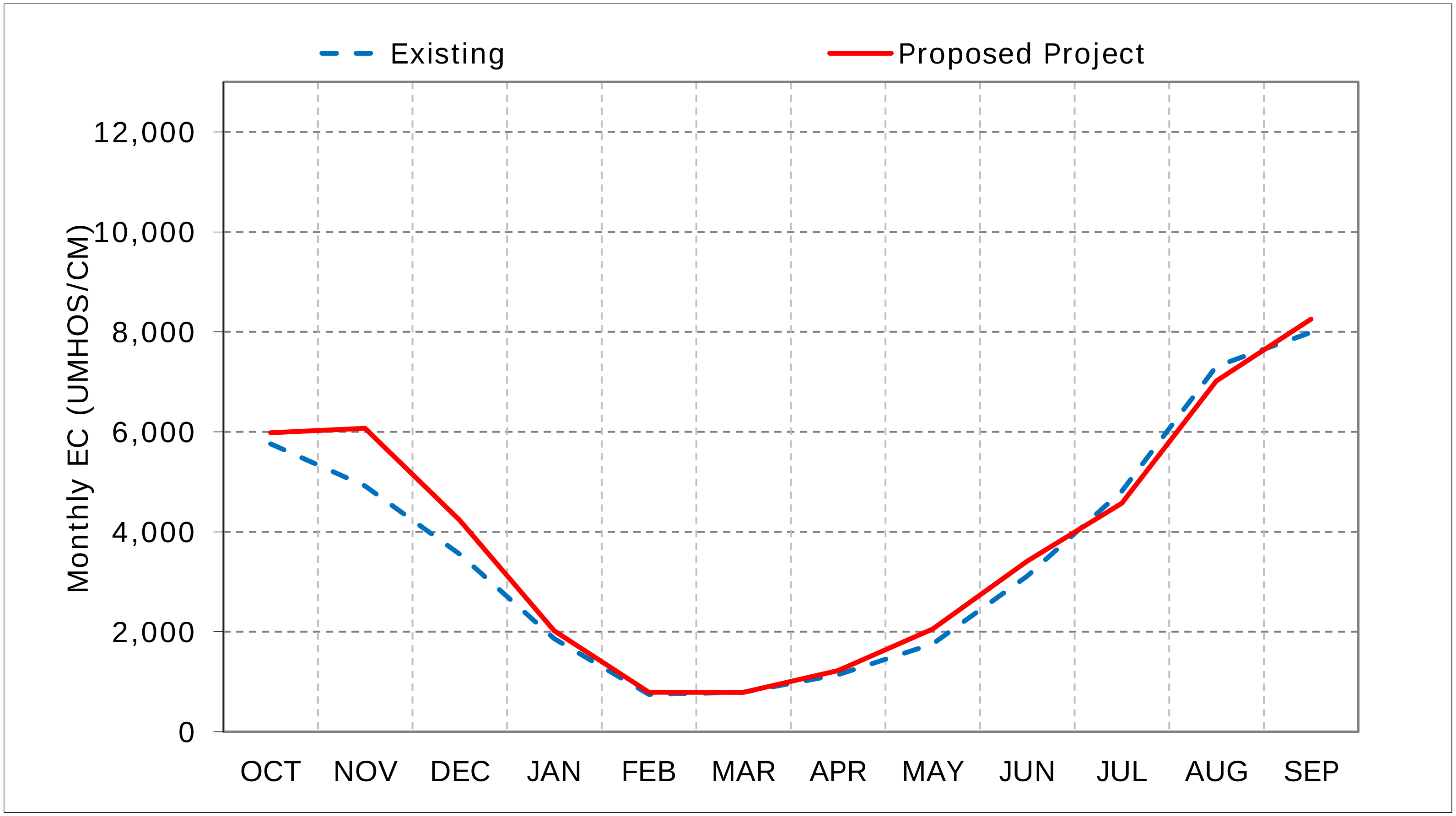
Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	9,819	8,963	8,417	5,355	1,785	2,510	4,092	4,875	6,381	8,226	10,816	12,711
20%	9,224	8,644	6,803	4,345	1,111	1,341	1,880	3,926	5,486	7,243	9,698	11,745
30%	9,032	8,295	6,289	3,075	667	563	1,047	3,029	4,919	6,571	9,234	11,579
40%	8,379	7,795	5,692	1,684	393	361	756	1,899	3,984	3,904	6,355	9,242
50%	7,333	5,475	4,672	1,217	319	288	617	1,150	2,926	3,539	5,783	8,306
60%	3,039	5,127	3,284	549	216	215	295	806	2,428	3,122	5,483	5,679
70%	2,869	4,919	1,298	237	203	196	227	427	1,454	2,857	5,386	5,418
80%	2,691	4,303	789	203	196	192	198	228	614	2,325	5,216	5,240
90%	2,416	1,794	344	194	190	189	188	184	203	1,266	4,843	4,991
Long Term												
Full Simulation Period[a]	5,982	6,073	4,232	2,023	793	788	1,223	2,057	3,412	4,572	7,020	8,254
Water Year Types[b]												
Wet (32%)	4,654	4,390	1,438	375	203	209	270	514	1,123	2,156	4,858	4,814
Above Normal (15%)	6,262	6,110	4,358	1,199	281	215	313	715	1,999	3,155	5,686	5,364
Below Normal (17%)	6,295	6,448	5,488	2,034	454	530	837	1,684	3,131	2,876	5,260	8,743
Dry (22%)	6,409	6,883	5,205	3,208	1,205	1,026	1,719	3,036	4,863	6,865	9,451	11,675
Critical (15%)	7,576	8,028	7,236	4,624	2,359	2,561	3,906	5,708	7,931	9,763	11,446	12,898

Proposed Project minus Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	-135	-162	-39	702	-32	-34	288	231	168	31	8	9
20%	-5	7	-1	446	-13	-26	112	581	491	202	66	-20
30%	-20	-79	1,804	242	16	-9	146	724	501	7	32	148
40%	-348	-3	2,013	151	-11	-60	109	628	472	-1,107	-978	-1,038
50%	-307	2,373	1,781	6	25	-26	101	355	451	-838	-921	-1,138
60%	-221	2,549	623	-10	0	-4	37	329	536	-559	-777	-103
70%	1,156	3,501	314	4	2	-1	9	110	175	-354	-196	1,449
80%	1,111	3,110	263	-4	1	0	0	14	31	-59	-144	1,615
90%	962	715	128	0	0	0	-2	-7	1	5	-338	1,496
Long Term												
Full Simulation Period[a]	221	1,158	679	162	45	-3	82	302	299	-238	-293	265
Water Year Types[b]												
Wet (32%)	333	1,476	387	-2	-3	-3	26	146	222	69	-58	1,499
Above Normal (15%)	222	1,220	1,014	117	-46	-10	37	254	302	5	35	-291
Below Normal (17%)	240	1,090	848	57	-18	-34	103	446	373	-1,773	-1,744	-1,089
Dry (22%)	266	1,063	856	360	102	-19	125	483	409	149	83	60
Critical (15%)	-112	625	512	387	226	60	162	249	214	65	0	32

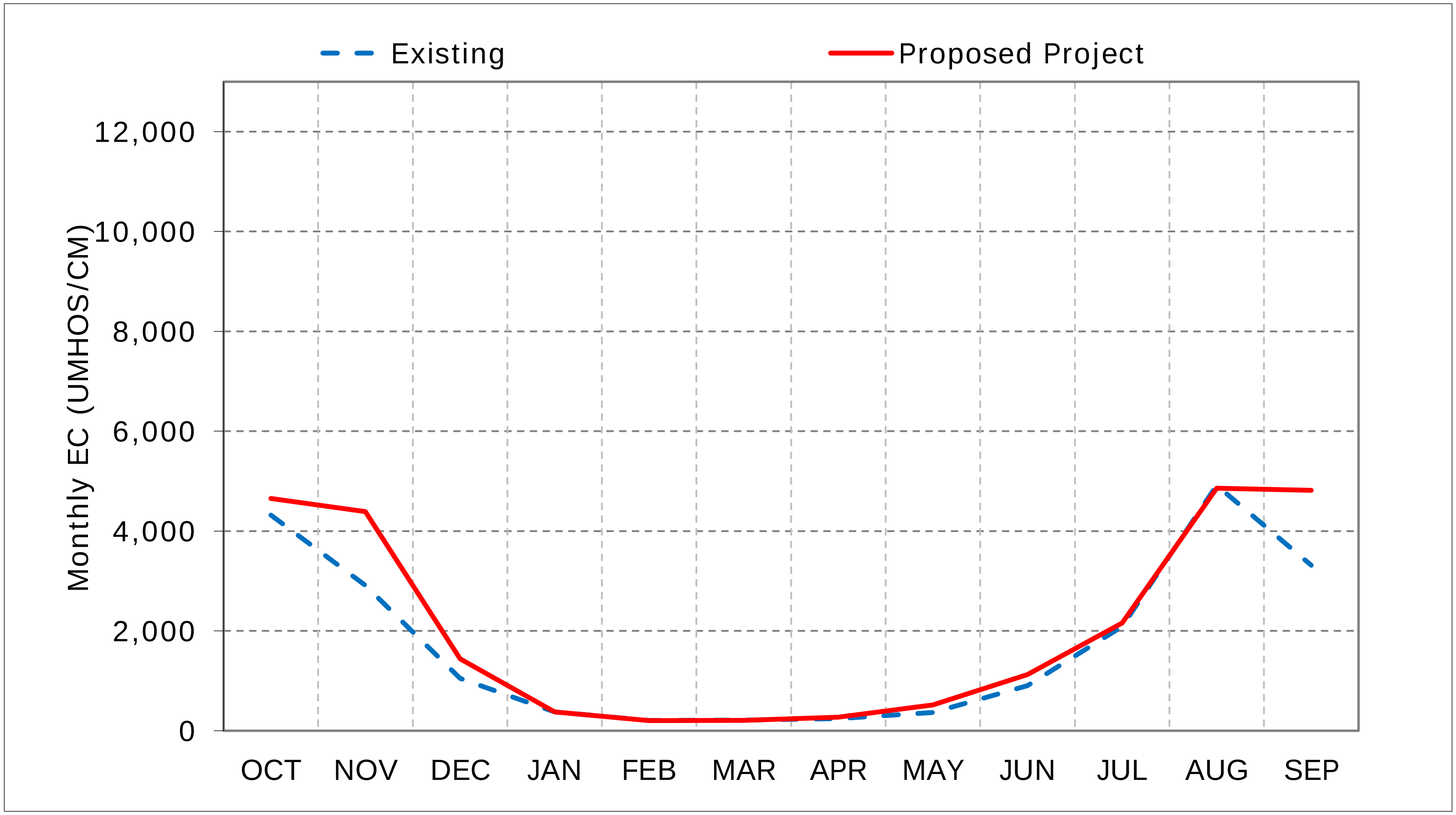
a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with water year - year type sorting.
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 22-1. Montezuma Slough at National Steel, Long-Term Average EC



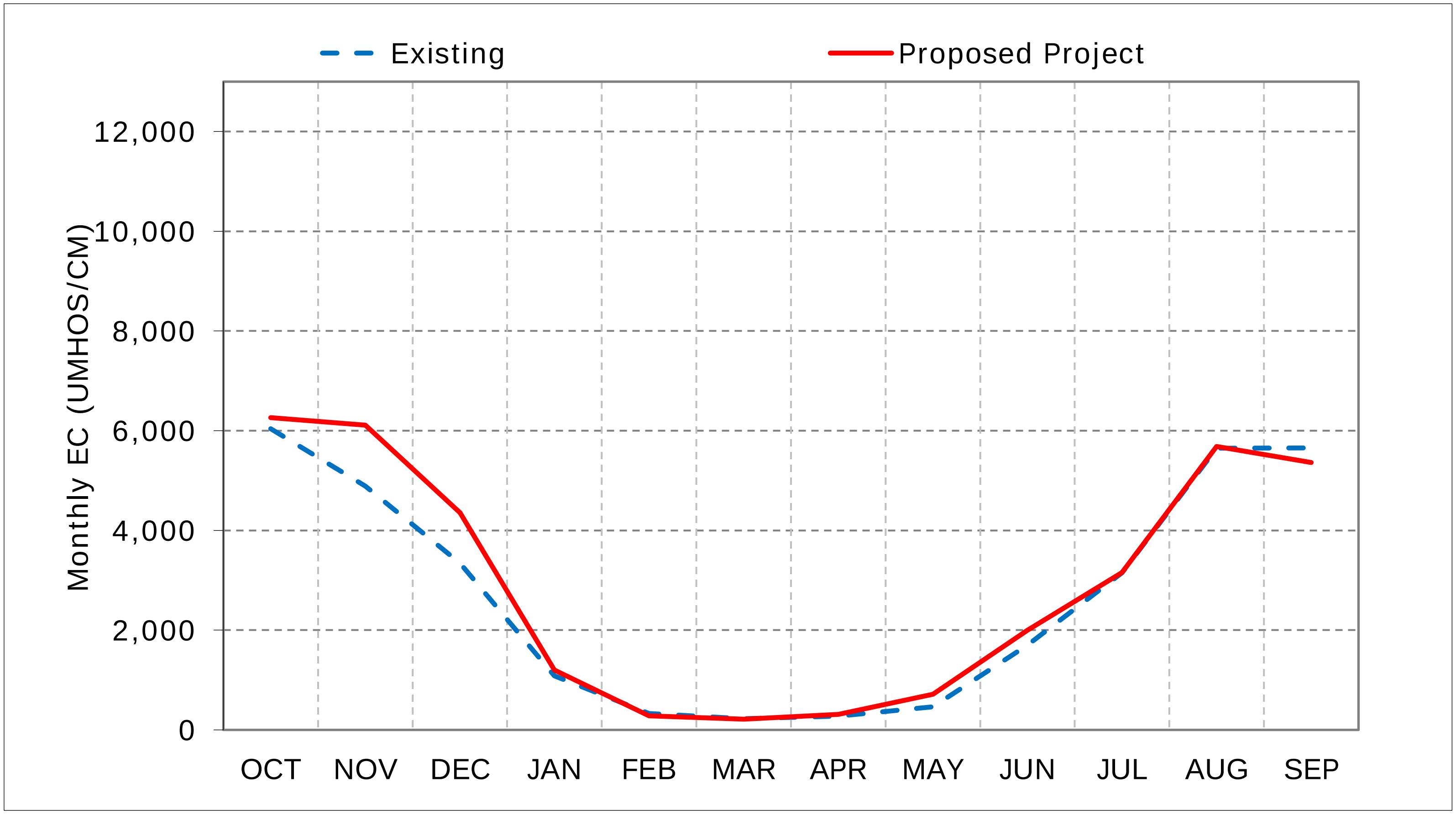
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 22-2. Montezuma Slough at National Steel, Wet Year Average EC



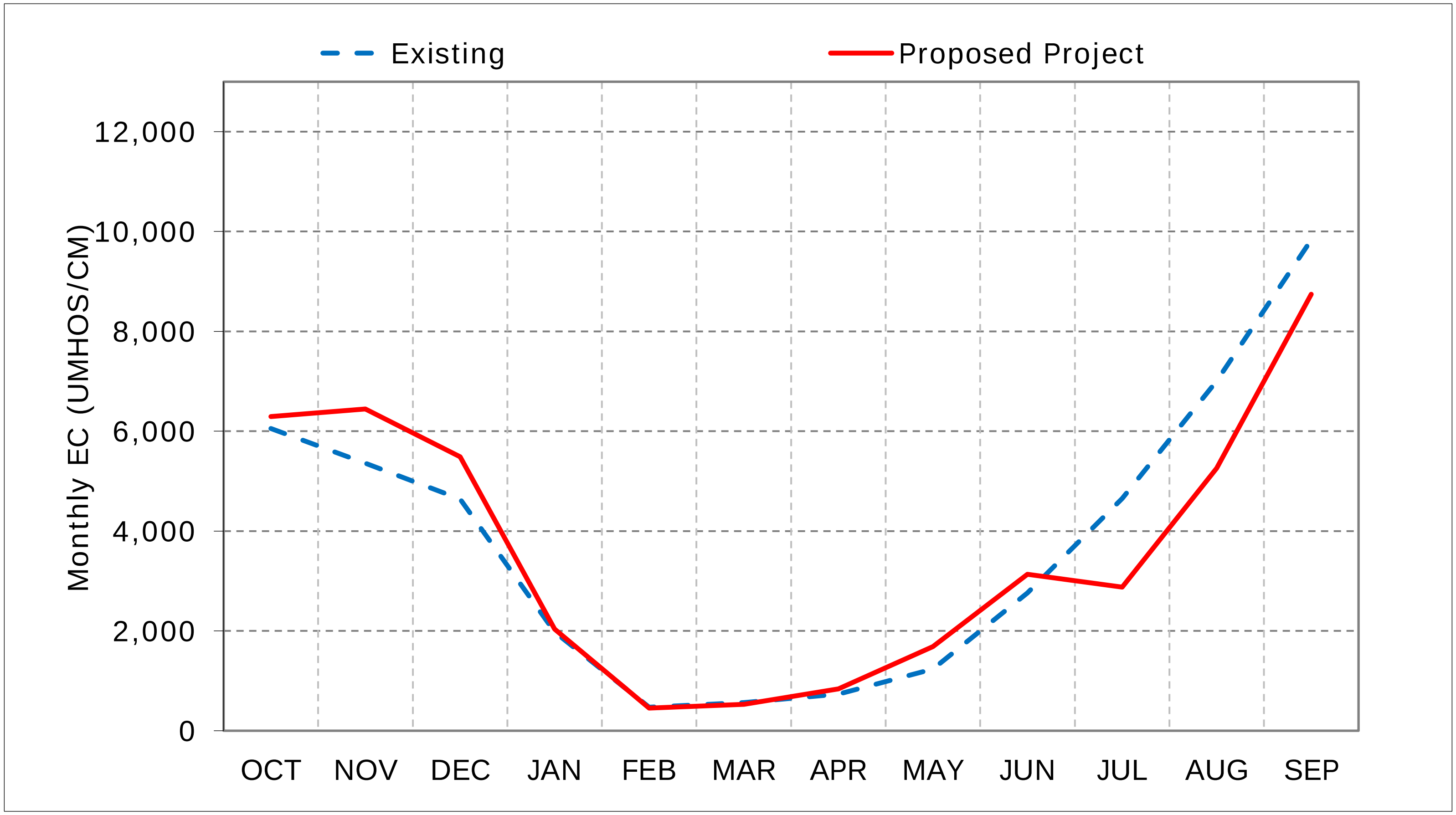
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 22-3. Montezuma Slough at National Steel, Above Normal Year Average EC



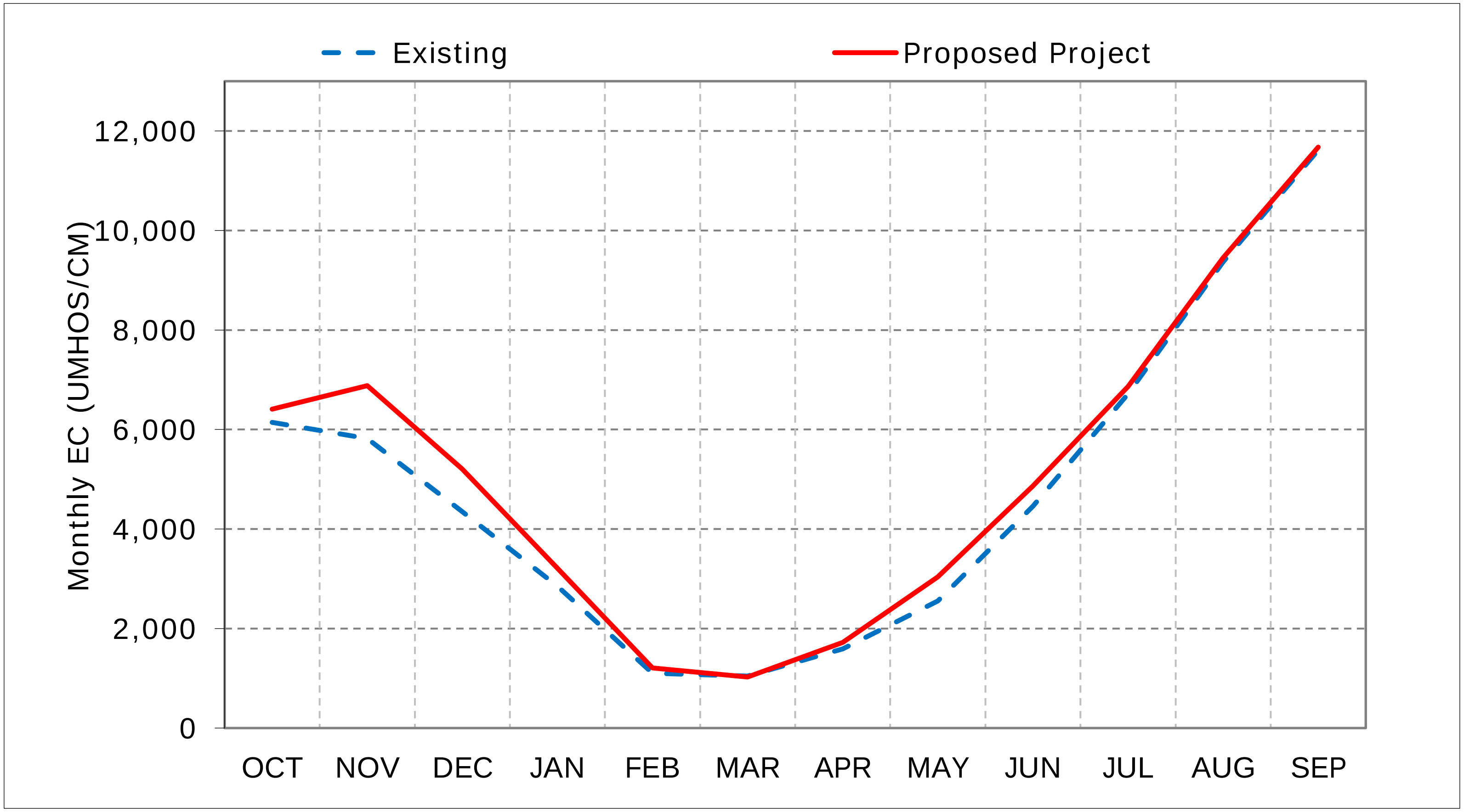
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 22-4. Montezuma Slough at National Steel, Below Normal Year Average EC



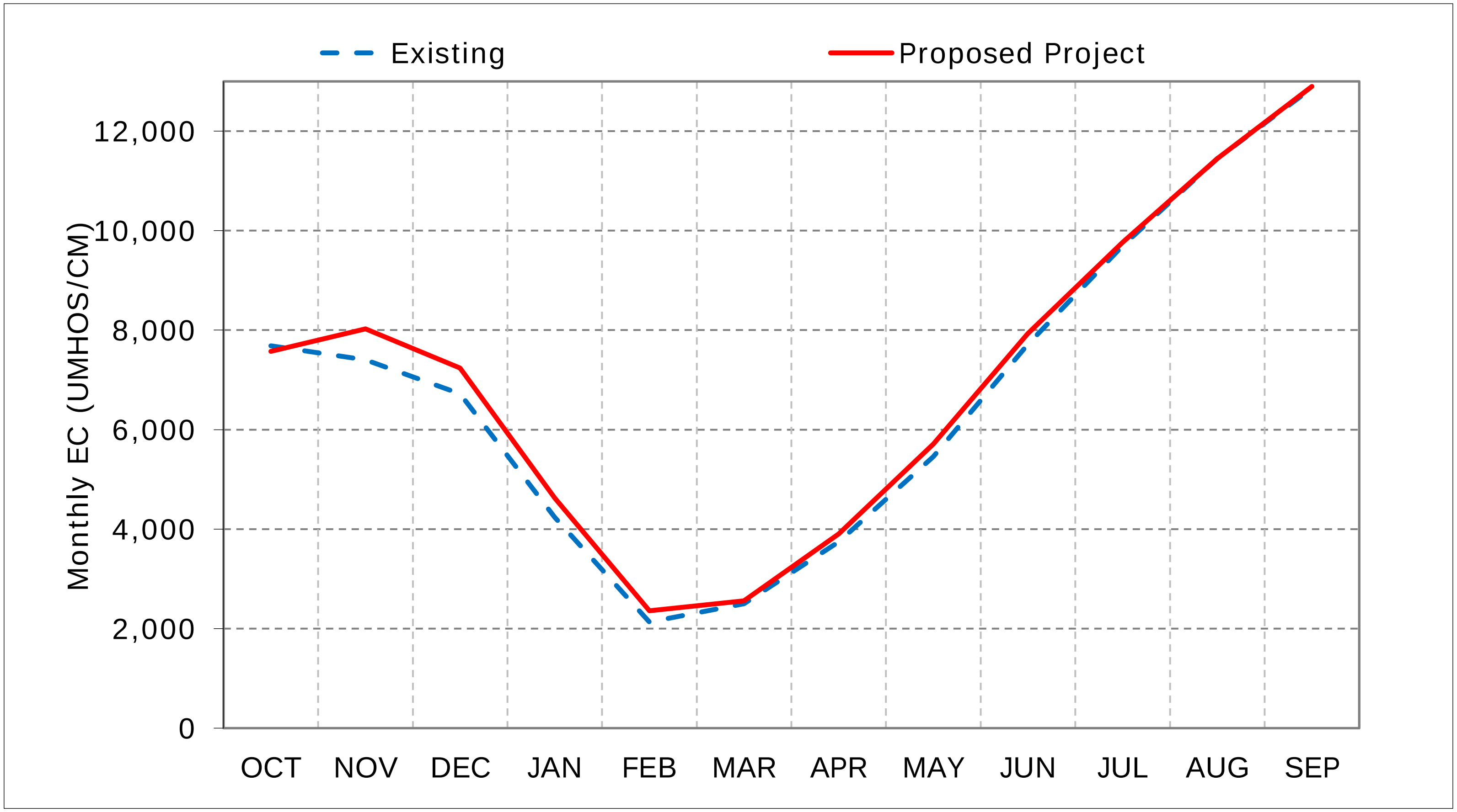
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 22-5. Montezuma Slough at National Steel, Dry Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 22-6. Montezuma Slough at National Steel, Critical Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 22-7. Montezuma Slough at National Steel, January EC

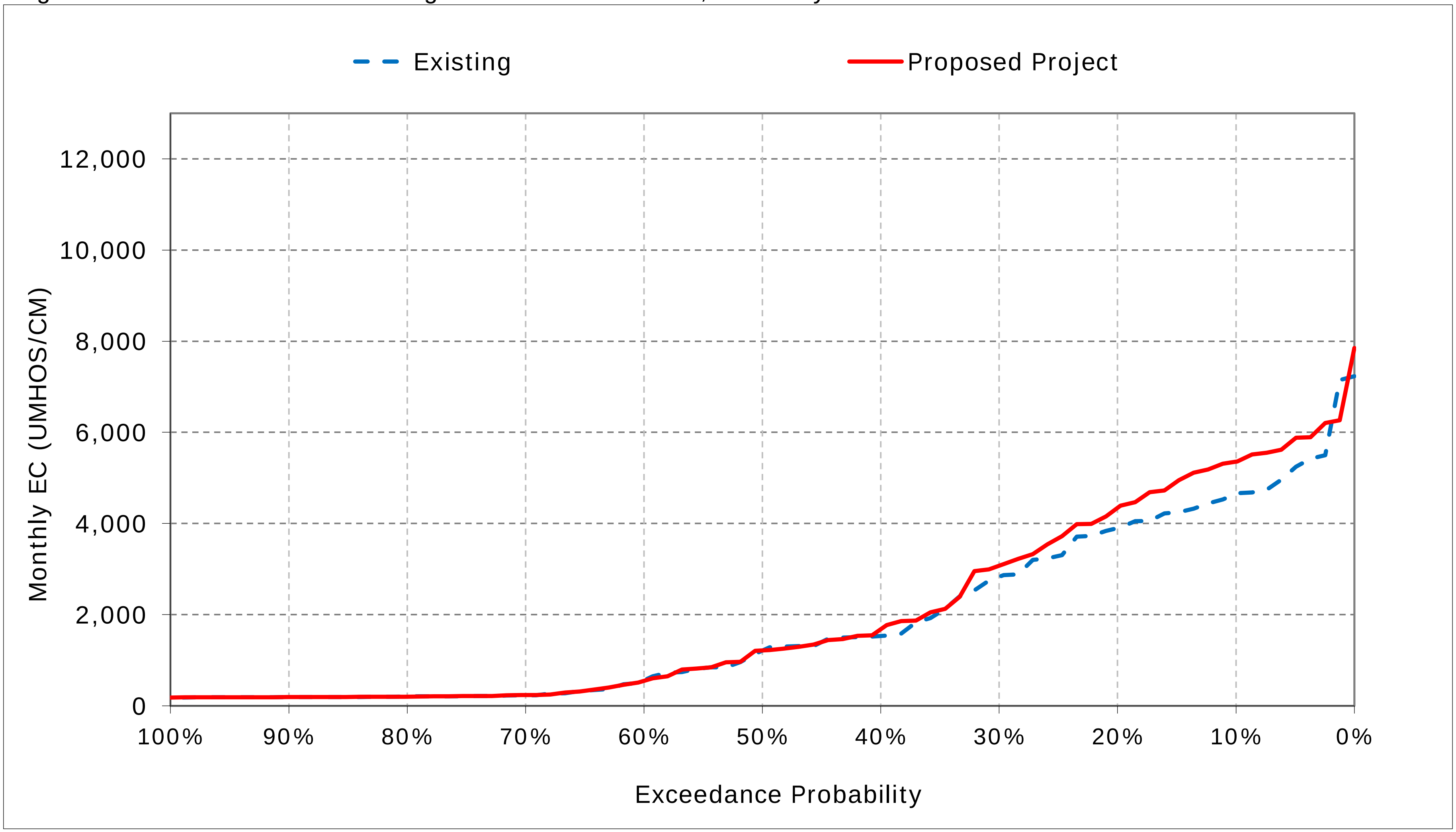


Figure 22-8. Montezuma Slough at National Steel, February EC

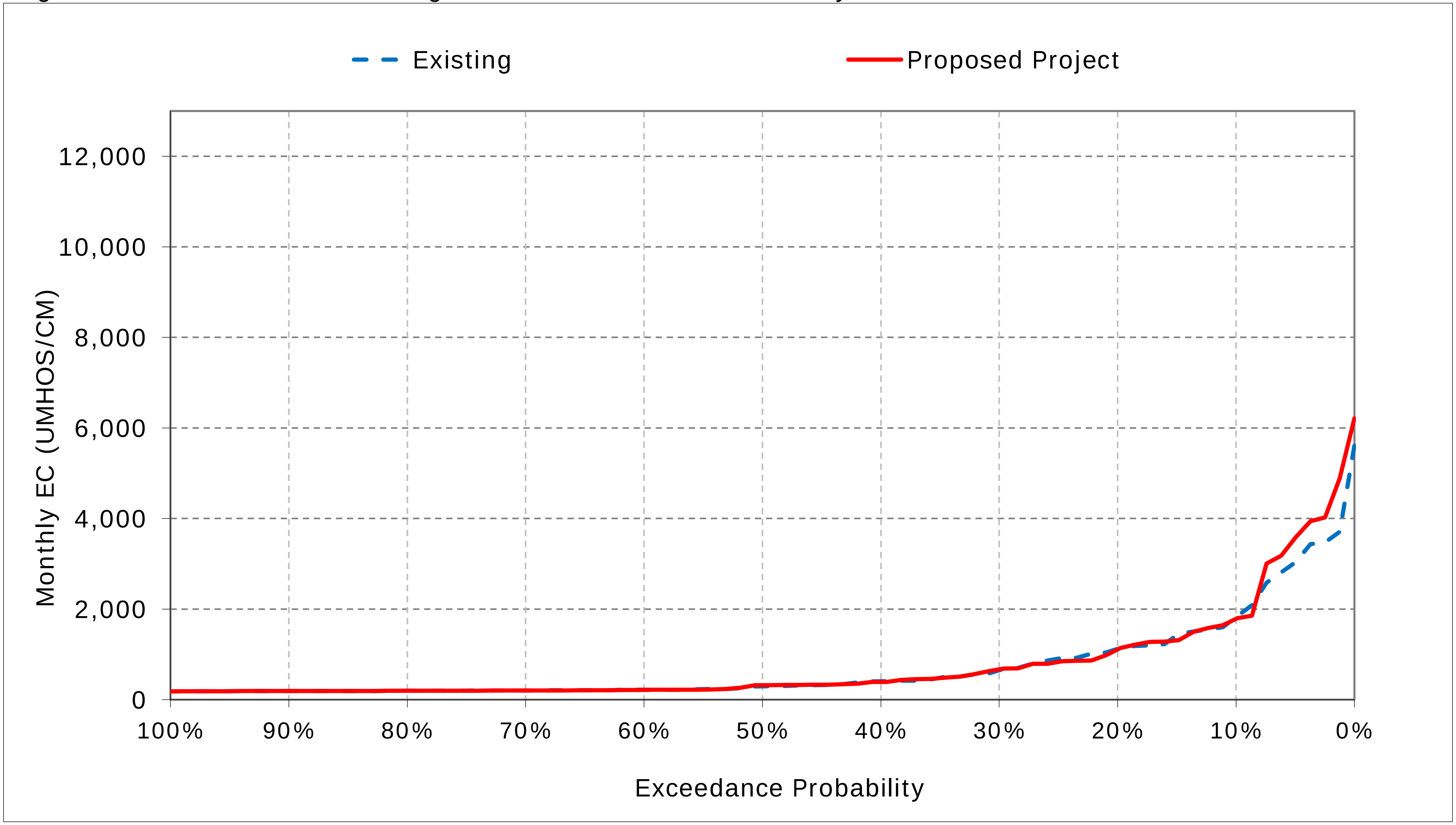


Figure 22-9. Montezuma Slough at National Steel, March EC

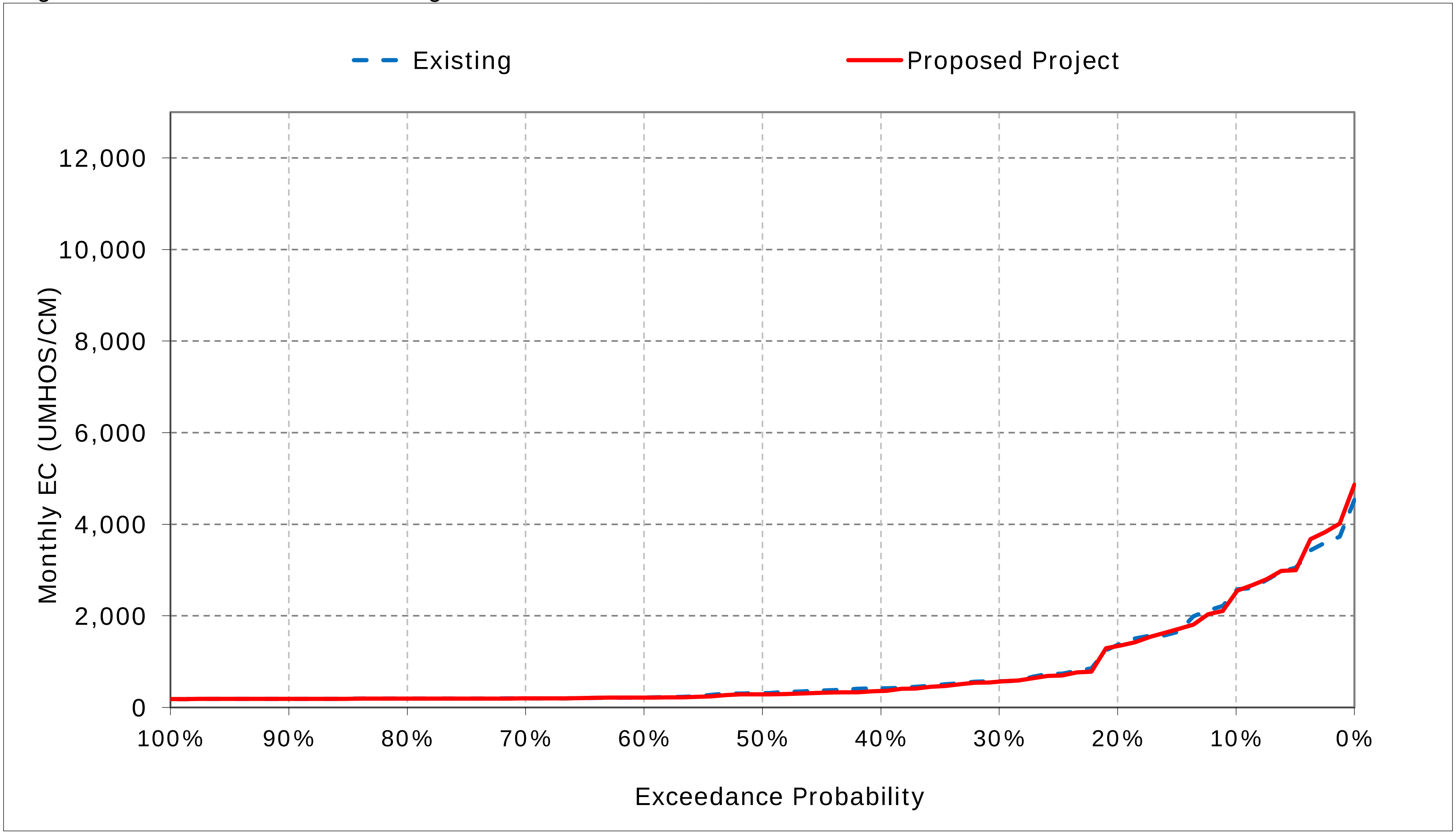


Figure 22-10. Montezuma Slough at National Steel, April EC

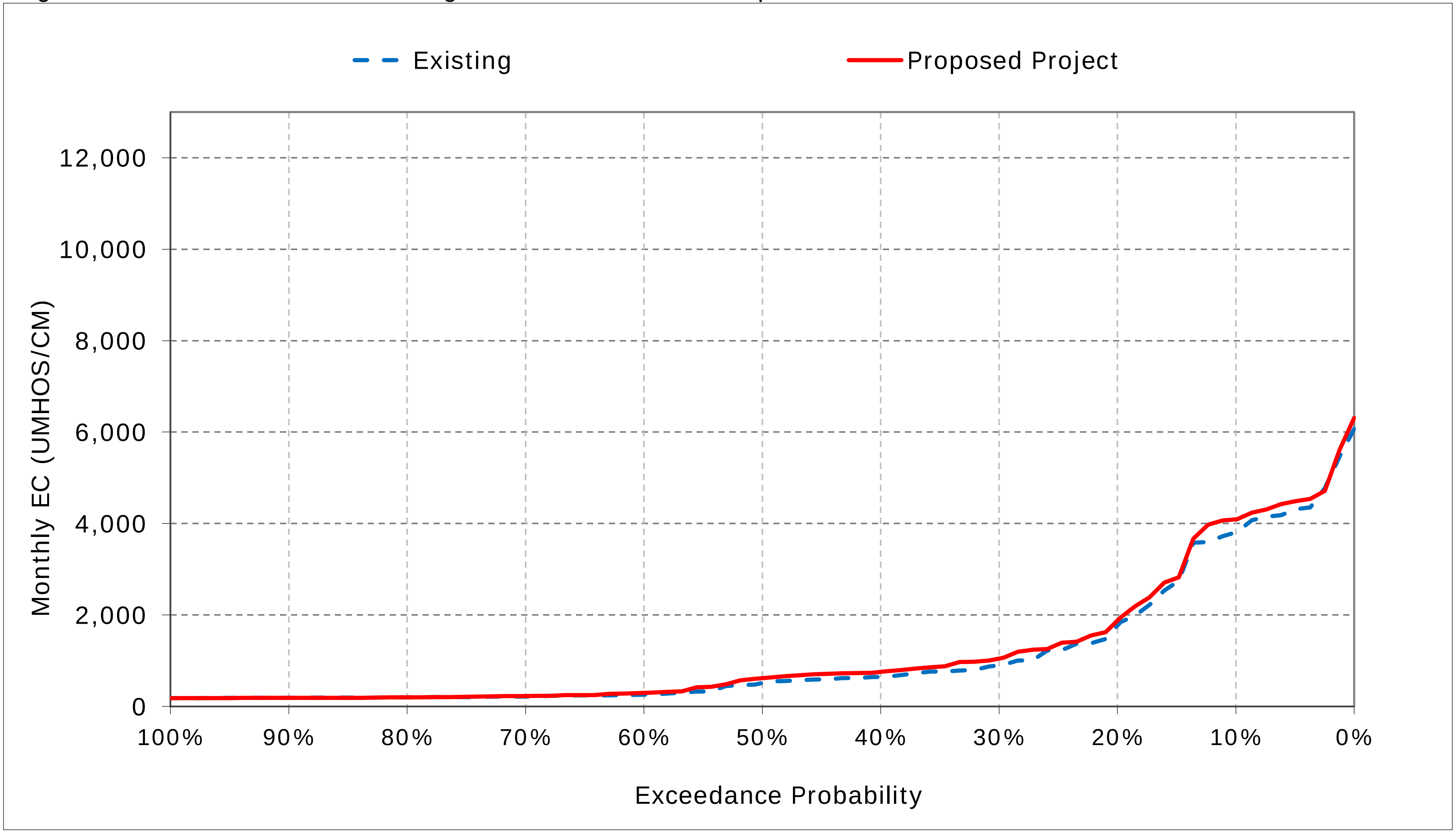


Figure 22-11. Montezuma Slough at National Steel, May EC

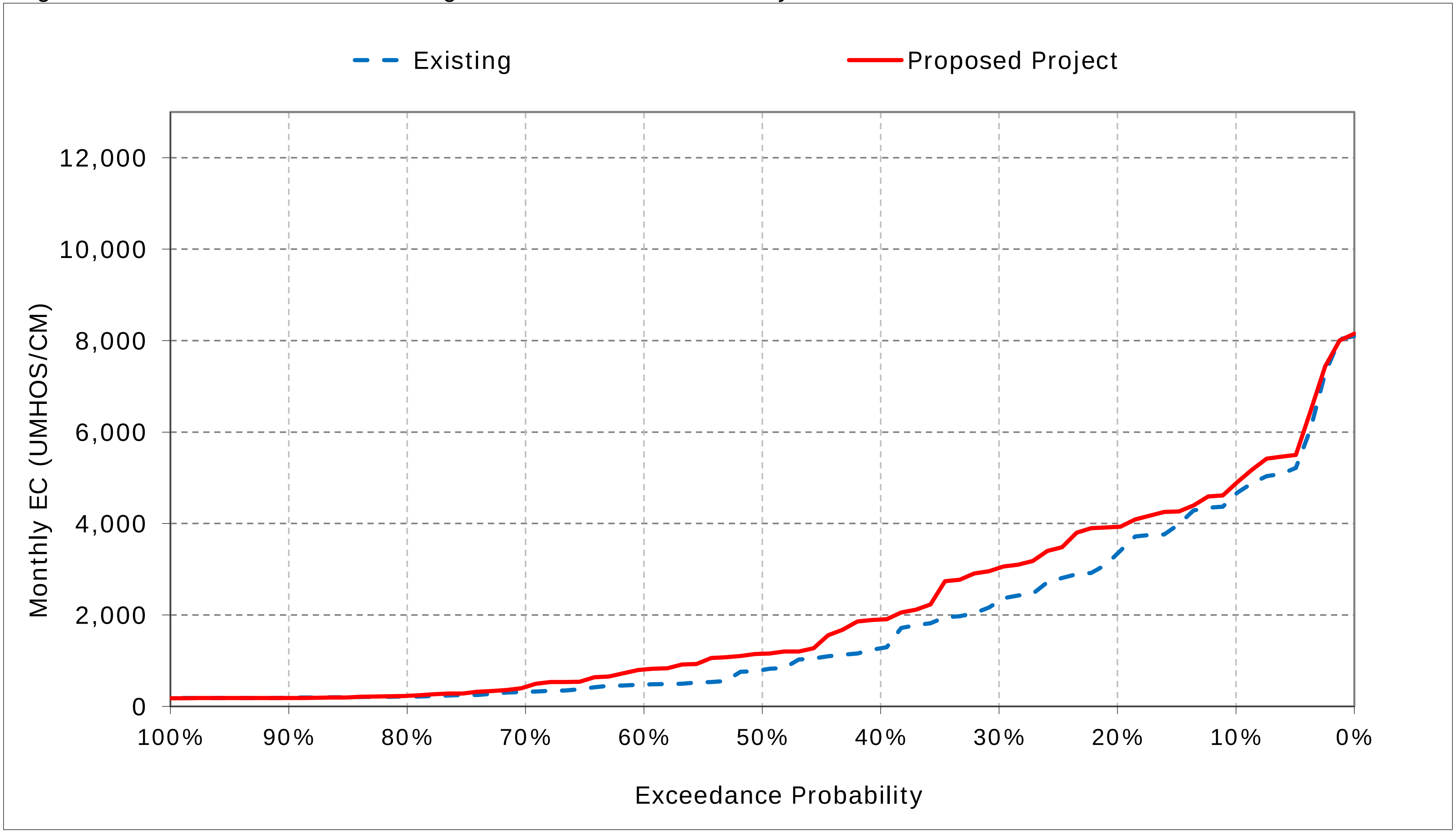


Figure 22-12. Montezuma Slough at National Steel, June EC

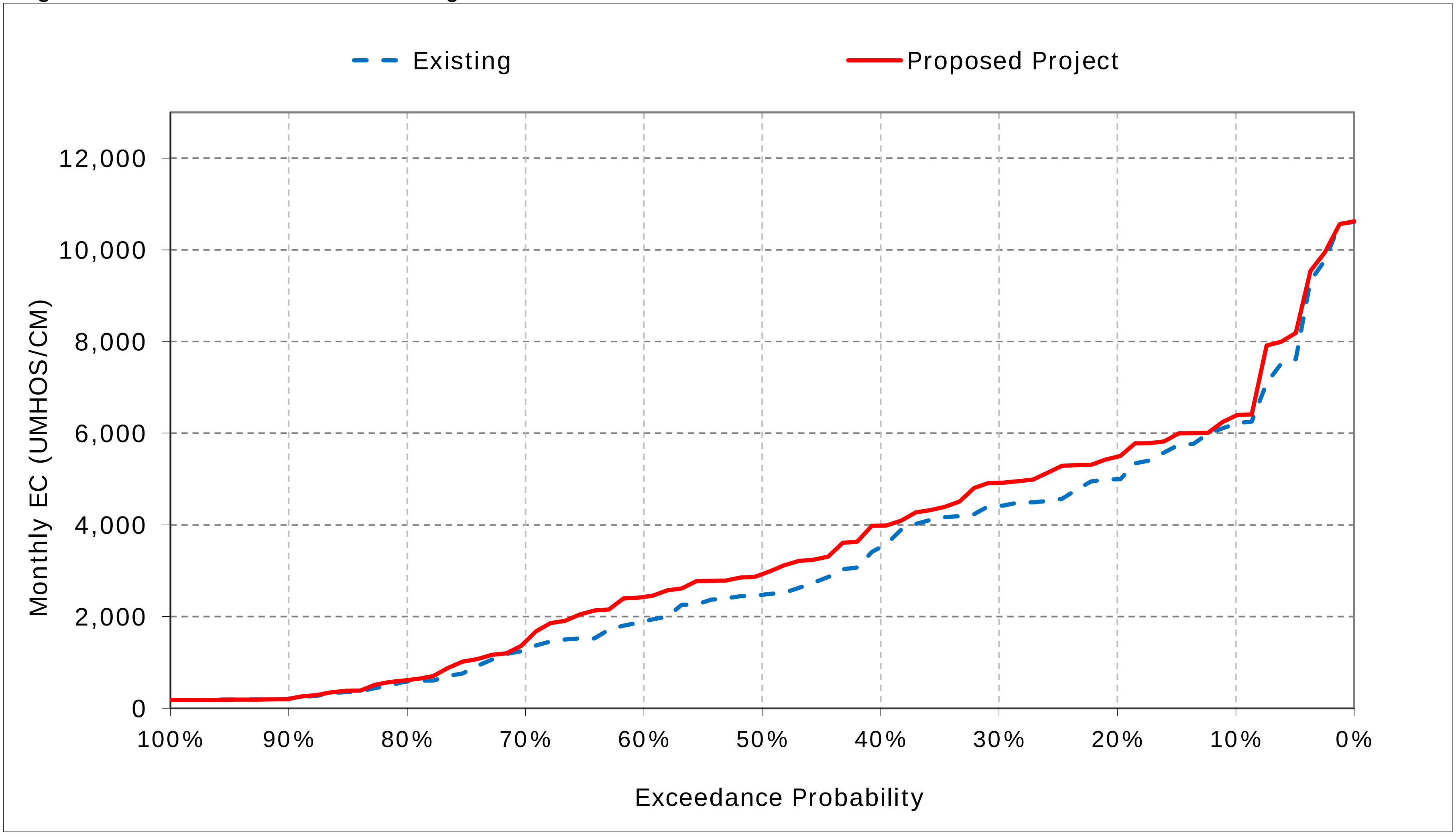


Figure 22-13. Montezuma Slough at National Steel, July EC

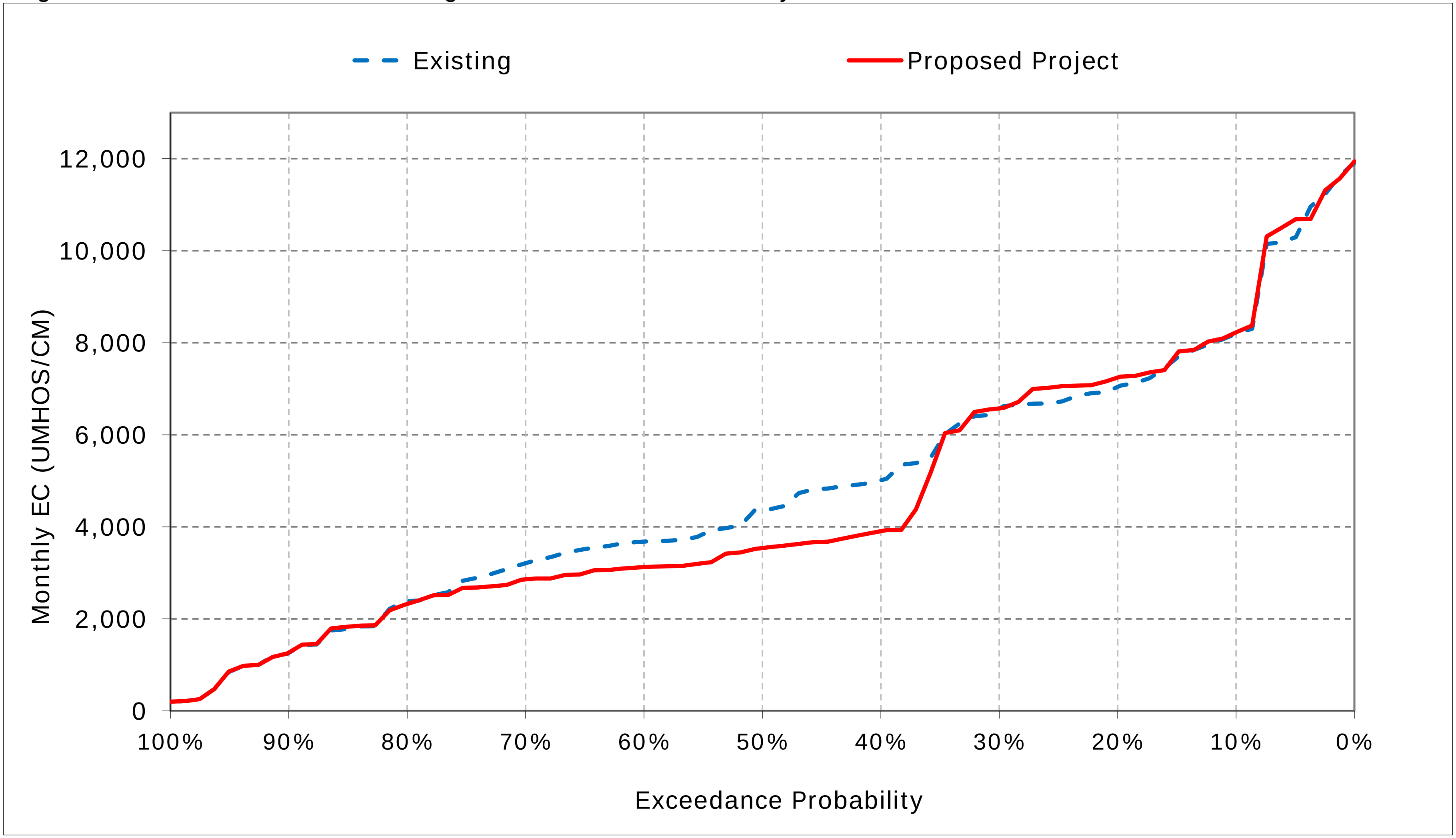


Figure 22-14. Montezuma Slough at National Steel, August EC

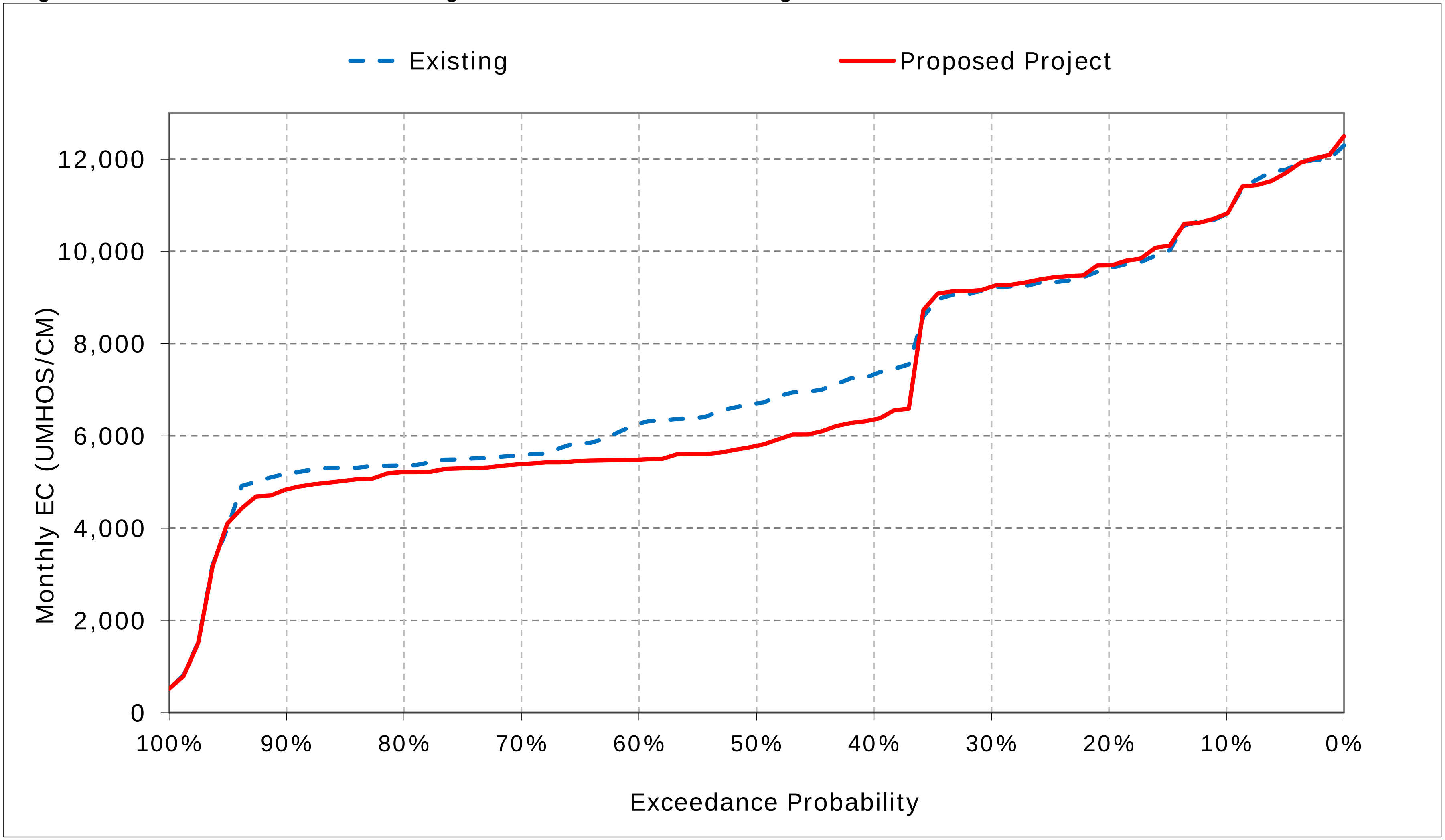


Figure 22-15. Montezuma Slough at National Steel, September EC

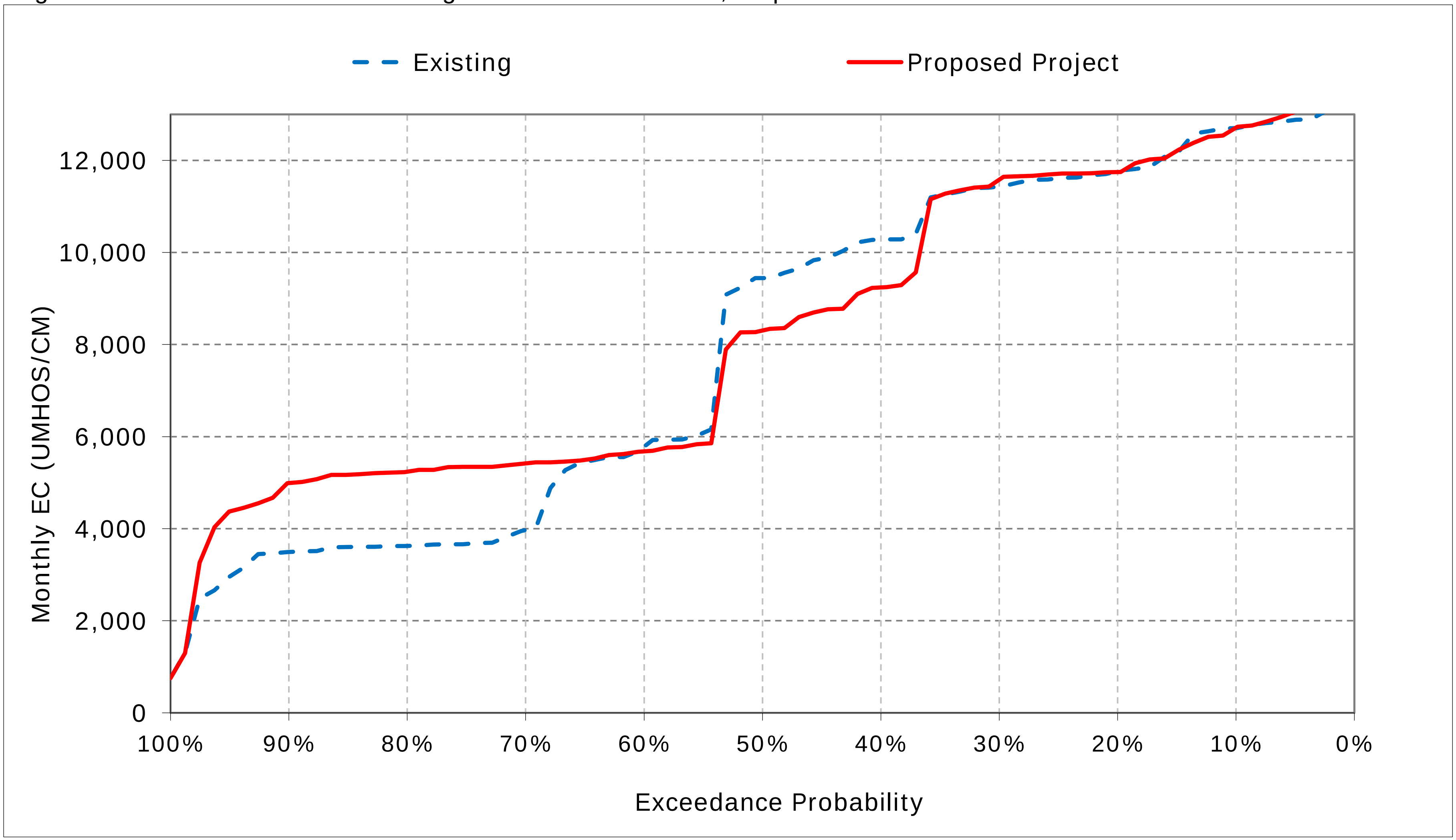


Figure 22-16. Montezuma Slough at National Steel, October EC

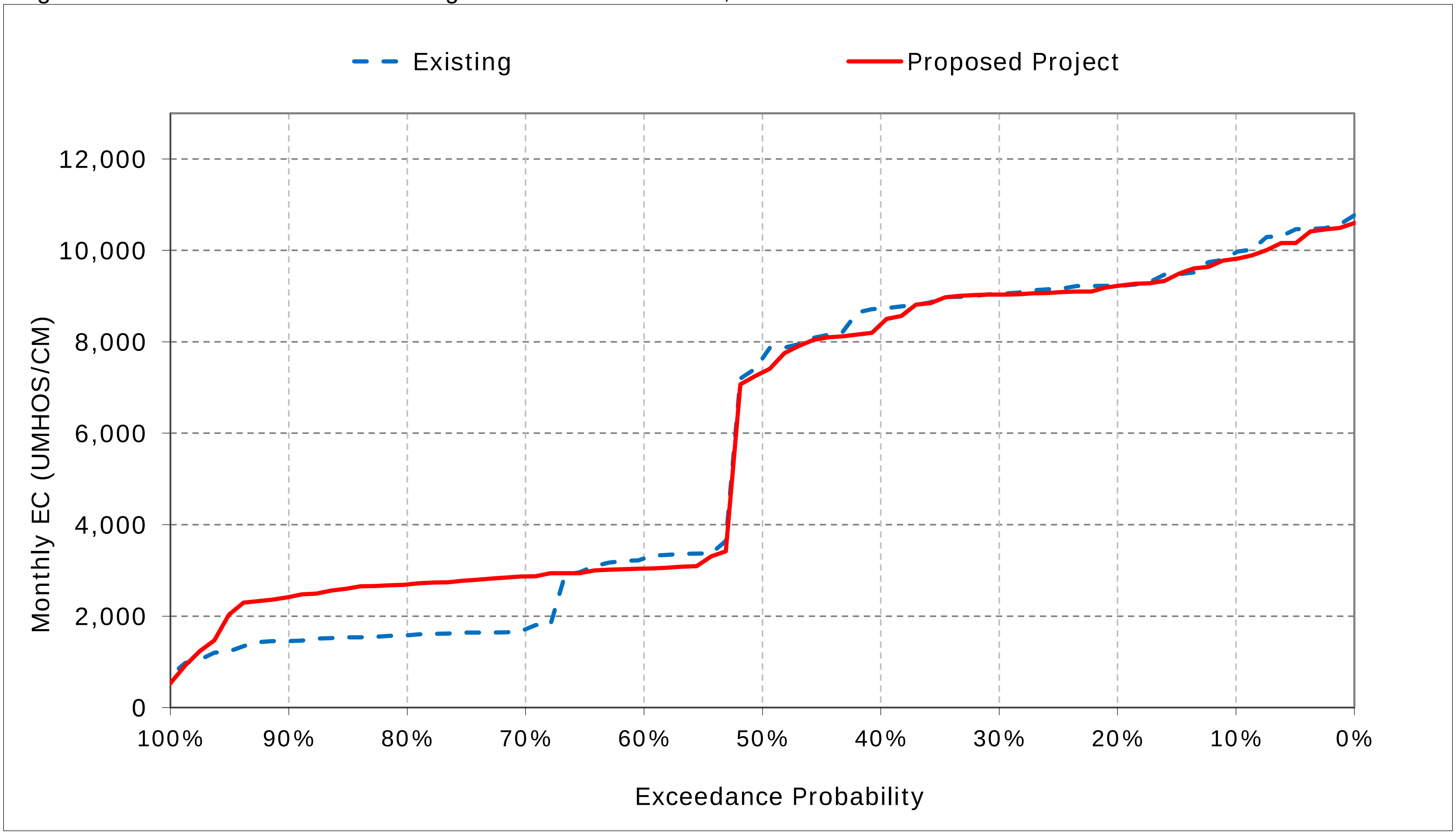


Figure 22-17. Montezuma Slough at National Steel, November EC

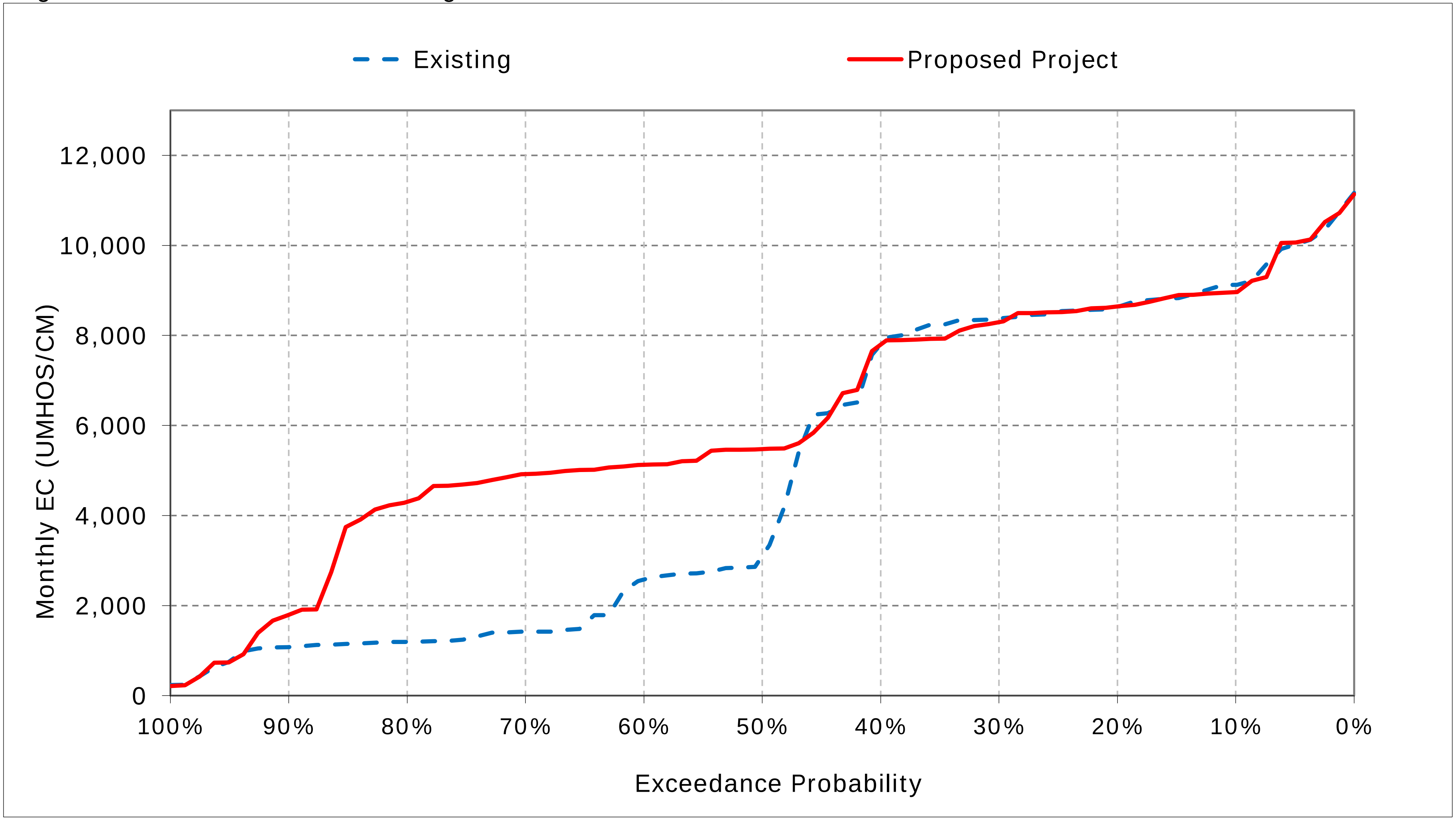


Figure 22-18. Montezuma Slough at National Steel, December EC

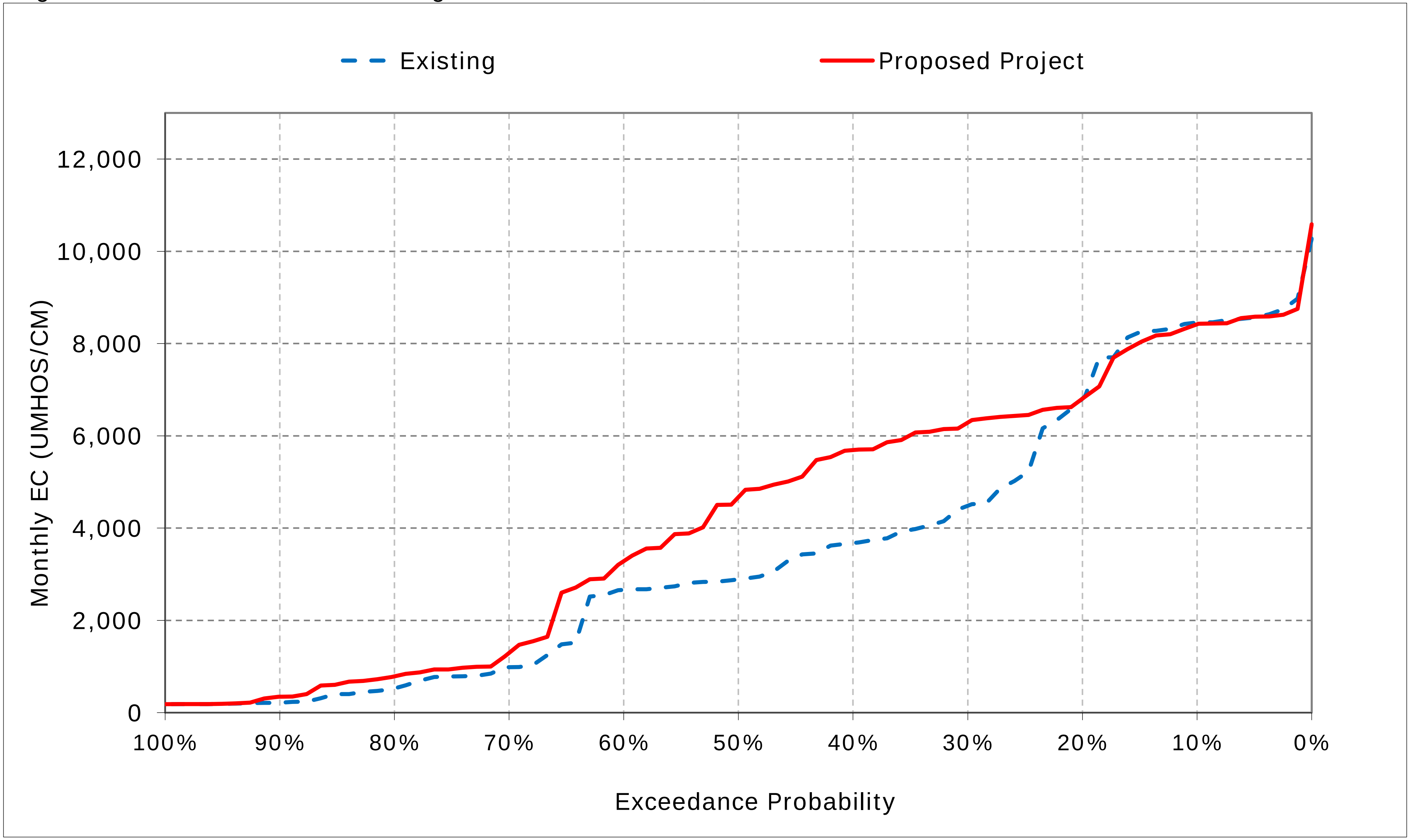


Table 24-1. Suisun Bay near Ryer, Monthly EC

Existing

Statistic	Monthly EC (UMHOS/CM)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	16,703	16,015	15,488	11,386	7,089	6,452	6,809	8,008	10,019	12,230	14,812	16,142
20%	16,148	15,774	14,171	10,495	4,725	3,858	3,849	6,638	8,637	11,068	13,505	15,448
30%	15,916	15,470	11,450	8,581	2,917	1,699	2,338	5,281	8,222	10,697	13,287	15,185
40%	15,735	14,990	9,986	5,728	1,498	1,354	1,874	3,479	7,141	8,868	11,631	14,351
50%	14,602	9,441	8,019	4,311	971	778	1,301	2,191	5,868	8,434	10,884	13,391
60%	8,926	8,249	7,489	2,674	460	410	657	1,505	4,956	6,859	10,648	8,464
70%	5,620	5,430	3,989	611	227	232	375	901	3,747	6,559	10,126	5,357
80%	5,344	5,115	1,942	256	209	200	235	424	2,021	5,757	9,751	4,985
90%	5,183	4,760	700	200	195	193	194	203	408	3,978	9,429	4,569
Long Term												
Full Simulation Period[a]	11,389	10,451	8,186	5,114	2,419	1,908	2,260	3,446	5,856	8,256	11,405	10,801
Water Year Types[b]												
Wet (32%)	9,330	7,468	3,198	977	293	340	467	836	2,318	4,779	9,075	4,646
Above Normal (15%)	11,798	10,318	8,360	3,352	937	390	637	1,293	4,323	6,367	9,917	8,307
Below Normal (17%)	11,868	11,458	10,147	5,928	1,744	1,595	1,737	2,893	5,947	8,438	11,257	13,867
Dry (22%)	11,938	11,818	10,281	8,042	4,052	2,794	3,382	5,287	8,126	10,864	13,402	15,325
Critical (15%)	14,060	13,820	13,391	10,499	6,844	5,860	6,696	9,139	11,546	13,558	15,118	16,271

Proposed Project

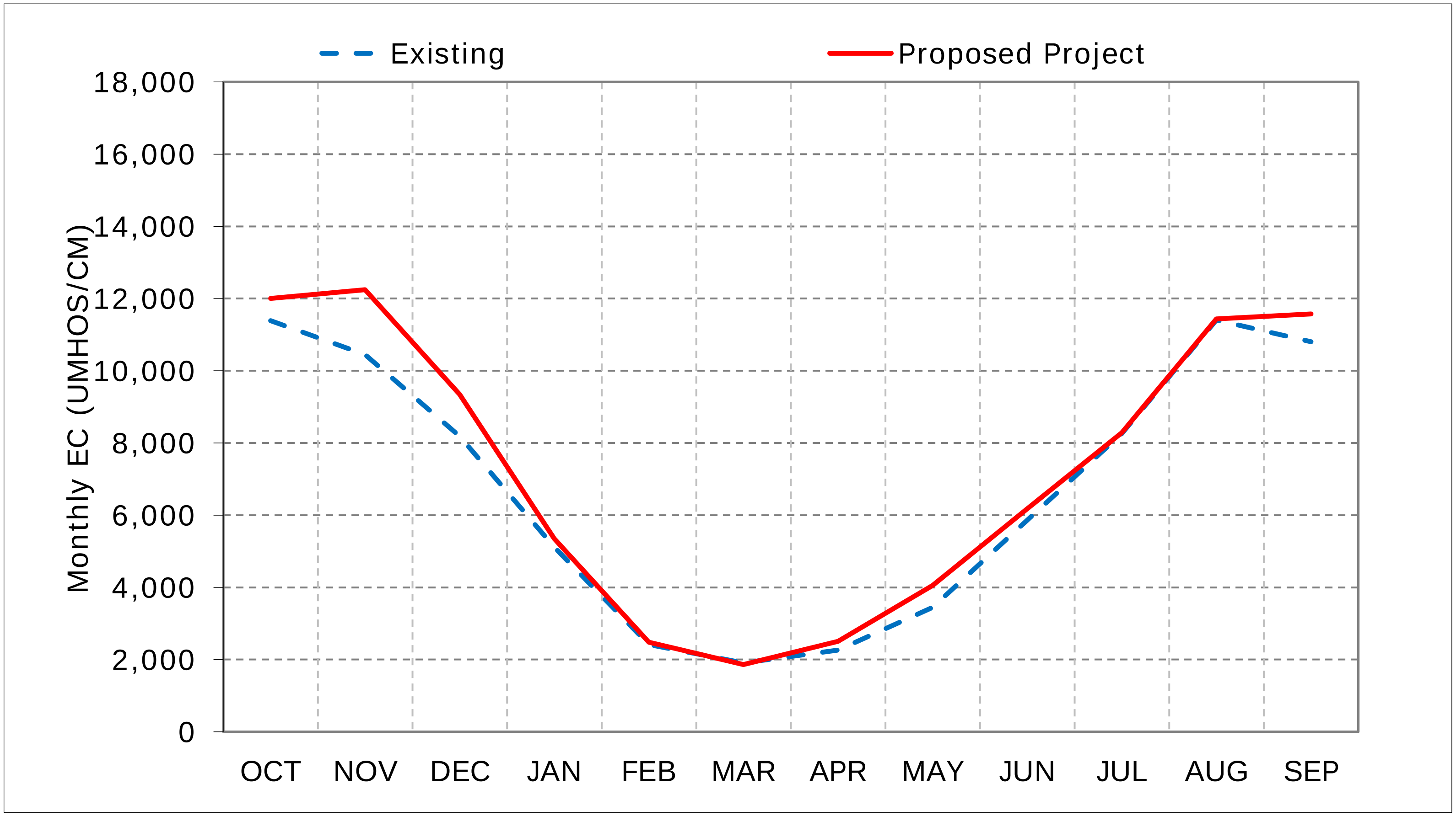
Statistic	Monthly EC (UMHOS/CM)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	16,640	16,023	15,483	12,591	7,000	6,423	7,154	8,388	10,051	12,236	14,822	16,123
20%	16,110	15,757	14,007	11,228	4,178	3,775	4,671	7,478	9,177	11,175	13,611	15,482
30%	15,918	15,377	13,297	9,190	2,893	1,587	2,964	6,411	8,300	10,711	13,337	15,297
40%	15,481	14,734	12,738	6,090	1,592	1,231	2,245	4,483	7,908	8,938	12,004	14,543
50%	14,449	11,770	11,732	4,377	904	688	1,506	3,181	6,299	8,257	11,007	13,456
60%	8,422	11,447	9,765	2,589	358	343	775	2,396	5,674	6,815	10,509	8,117
70%	8,246	11,267	4,902	613	226	225	488	1,442	4,031	6,612	10,053	7,946
80%	7,940	10,794	2,896	249	211	202	245	574	2,136	5,791	9,718	7,686
90%	7,593	6,276	819	200	196	193	193	211	426	3,984	9,291	7,269
Long Term												
Full Simulation Period[a]	12,004	12,244	9,347	5,350	2,483	1,862	2,509	4,055	6,180	8,286	11,435	11,576
Water Year Types[b]												
Wet (32%)	10,137	9,796	3,991	973	282	322	594	1,225	2,634	4,804	8,963	7,183
Above Normal (15%)	12,551	12,361	10,093	3,477	770	348	835	2,021	4,655	6,305	9,954	7,821
Below Normal (17%)	12,515	13,173	11,523	5,965	1,660	1,462	2,104	3,834	6,295	8,485	11,523	14,012
Dry (22%)	12,578	13,312	11,625	8,655	4,302	2,678	3,739	6,076	8,522	10,944	13,466	15,374
Critical (15%)	14,045	14,747	14,250	11,030	7,199	5,957	6,957	9,449	11,739	13,592	15,122	16,309

Proposed Project minus Existing

Statistic	Monthly EC (UMHOS/CM)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	-63	8	-4	1,205	-89	-29	345	379	32	7	10	-19
20%	-37	-17	-164	733	-546	-84	822	840	540	107	106	34
30%	2	-93	1,847	609	-24	-112	626	1,130	77	14	50	112
40%	-254	-256	2,752	362	93	-123	371	1,004	767	71	373	192
50%	-154	2,329	3,713	66	-67	-91	205	989	432	-177	123	65
60%	-504	3,197	2,276	-85	-102	-68	117	892	718	-44	-139	-347
70%	2,626	5,838	913	2	-2	-7	113	541	285	53	-73	2,588
80%	2,596	5,679	954	-7	1	2	10	150	115	34	-33	2,701
90%	2,410	1,517	120	0	1	0	-1	9	18	5	-139	2,700
Long Term												
Full Simulation Period[a]	615	1,794	1,161	236	64	-46	249	609	323	29	30	775
Water Year Types[b]												
Wet (32%)	806	2,329	793	-4	-11	-19	127	389	316	25	-112	2,537
Above Normal (15%)	754	2,043	1,733	125	-167	-42	198	728	332	-62	37	-486
Below Normal (17%)	647	1,715	1,375	37	-84	-134	367	940	348	47	266	145
Dry (22%)	640	1,494	1,344	614	250	-116	358	789	395	80	64	49
Critical (15%)	-15	927	859	530	355	97	260	310	193	34	4	38

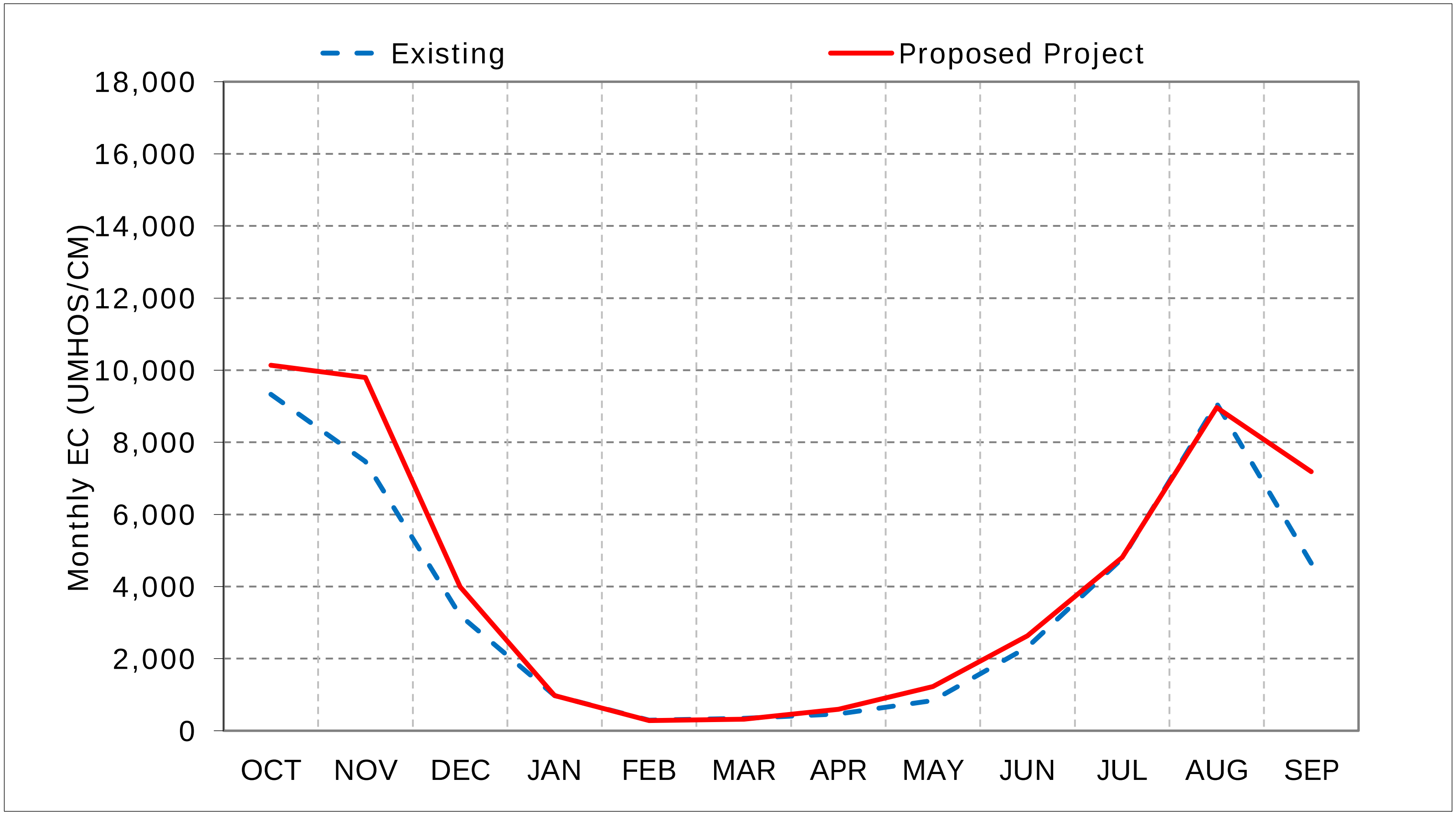
a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with water year - year type sorting.
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 24-1. Suisun Bay near Ryer, Long-Term Average EC



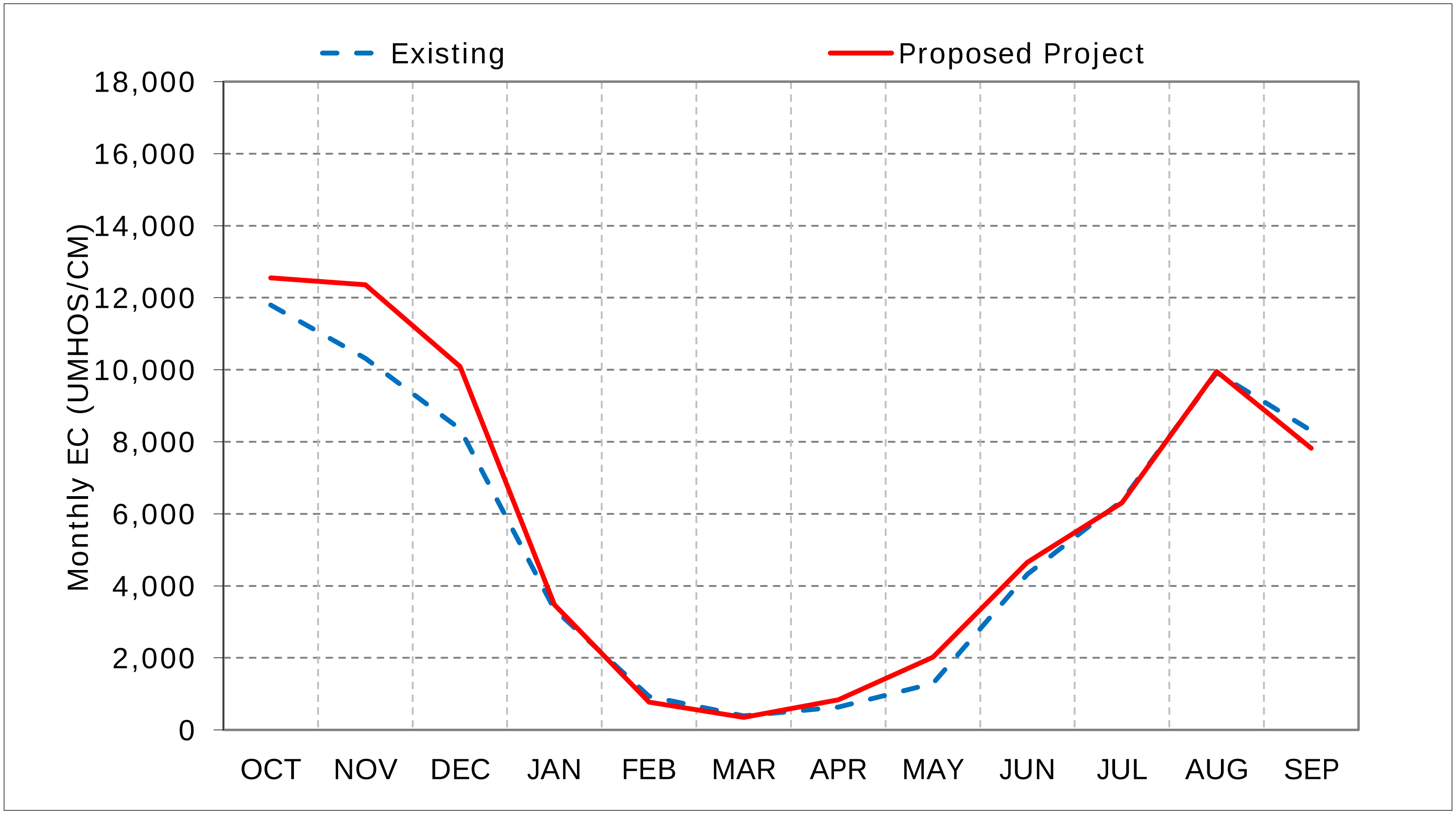
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 24-2. Suisun Bay near Ryer, Wet Year Average EC



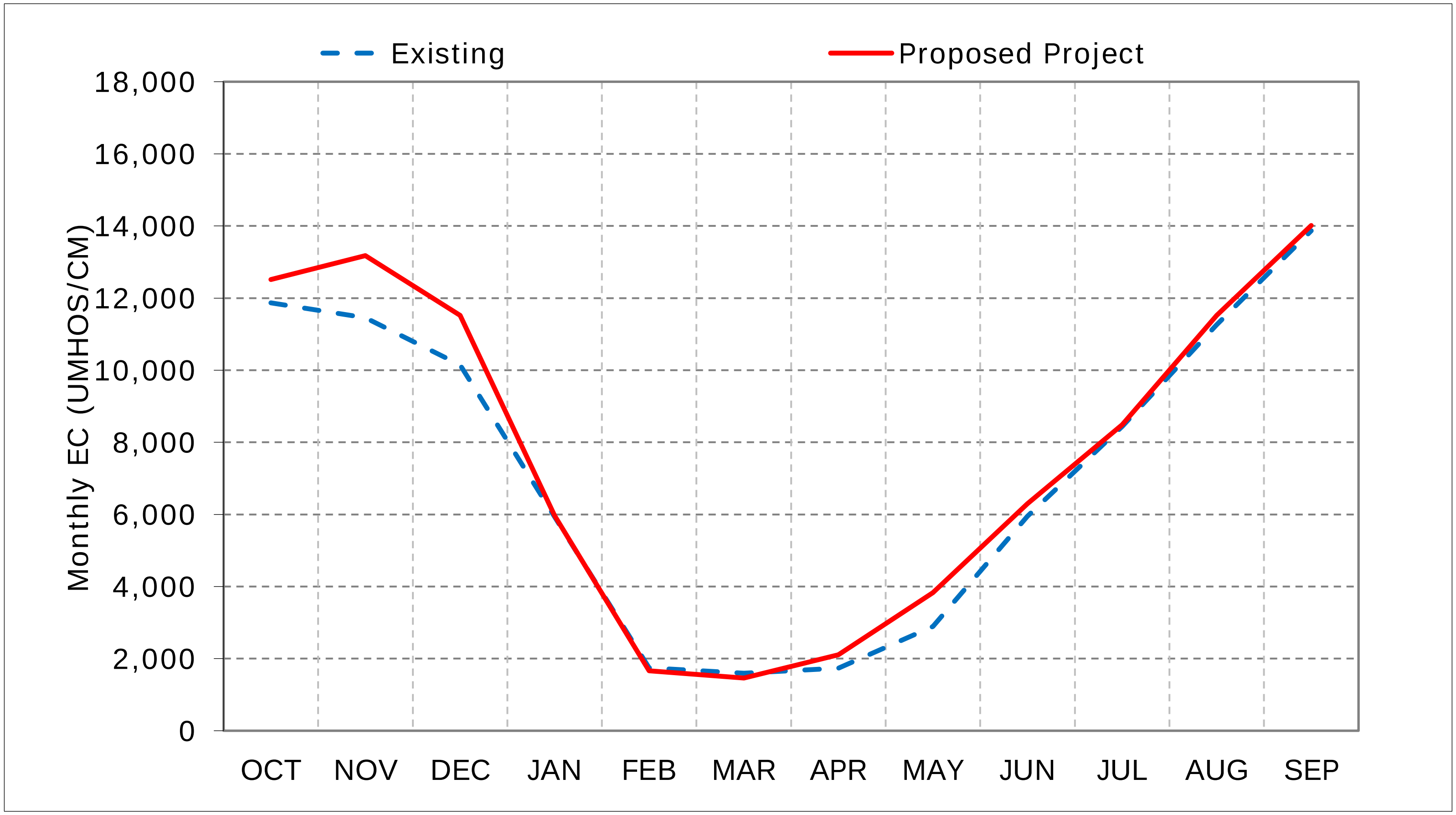
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 24-3. Suisun Bay near Ryer, Above Normal Year Average EC



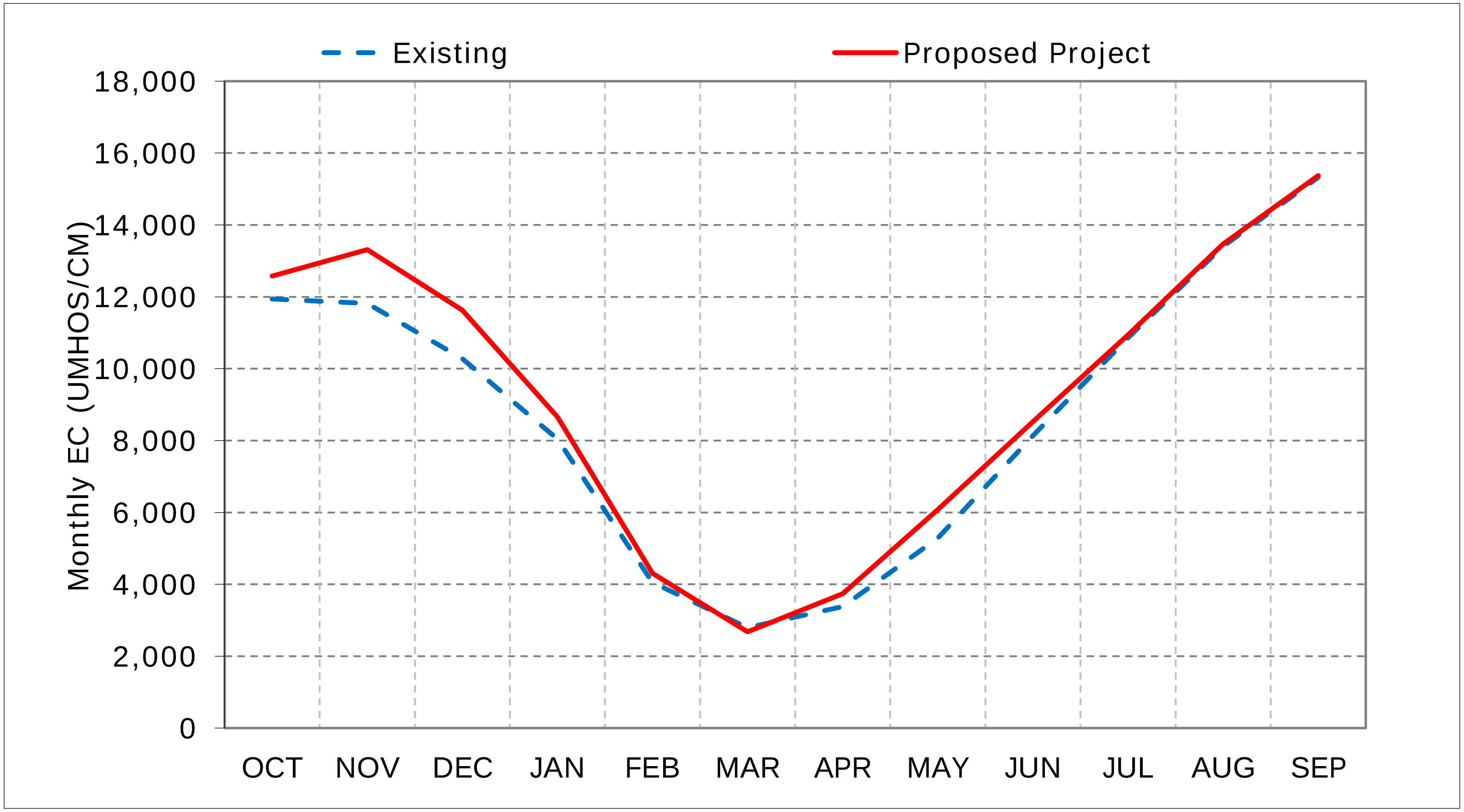
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 24-4. Suisun Bay near Ryer, Below Normal Year Average EC



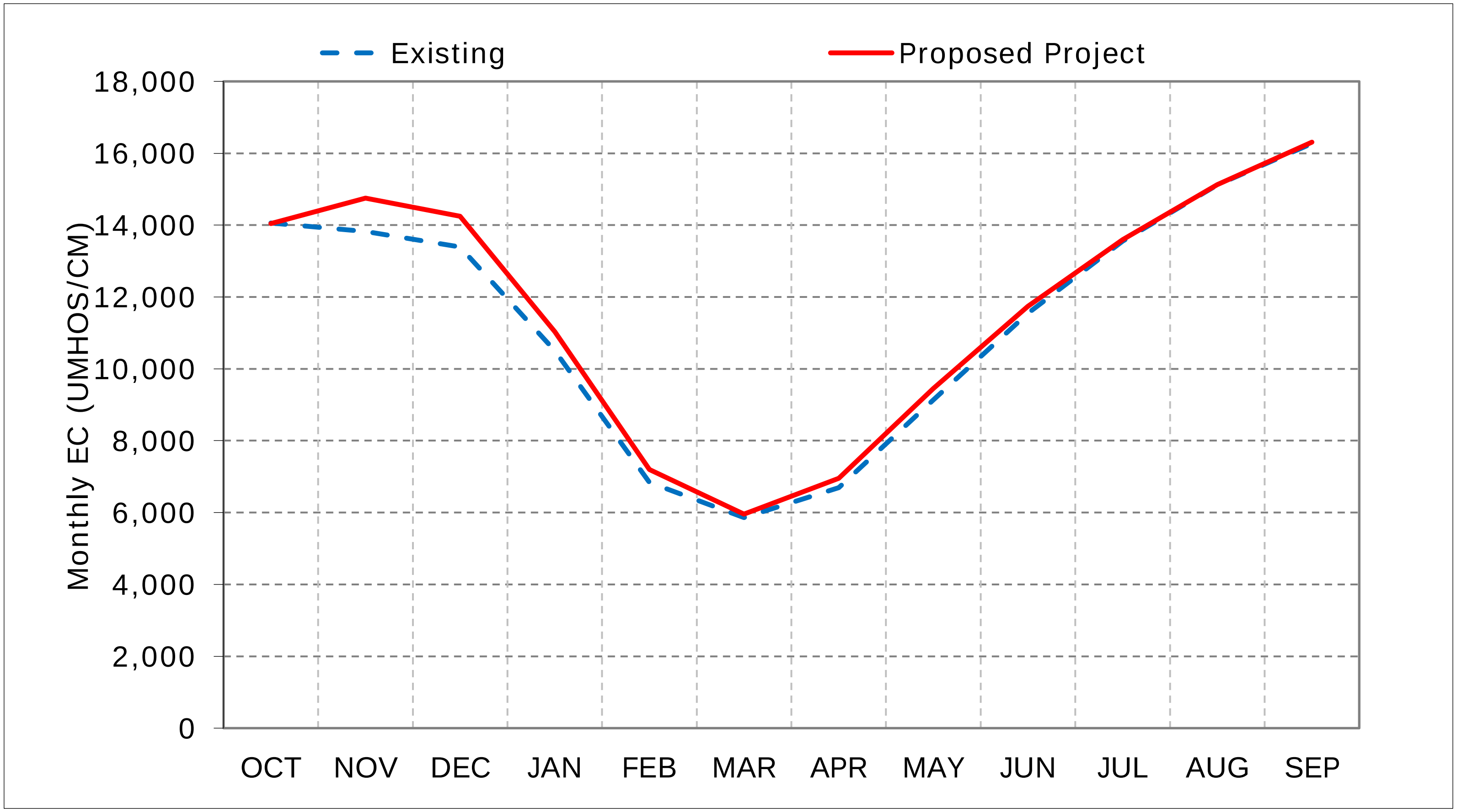
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 24-5. Suisun Bay near Ryer, Dry Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 24-6. Suisun Bay near Ryer, Critical Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 24-7. Suisun Bay near Ryer, January EC

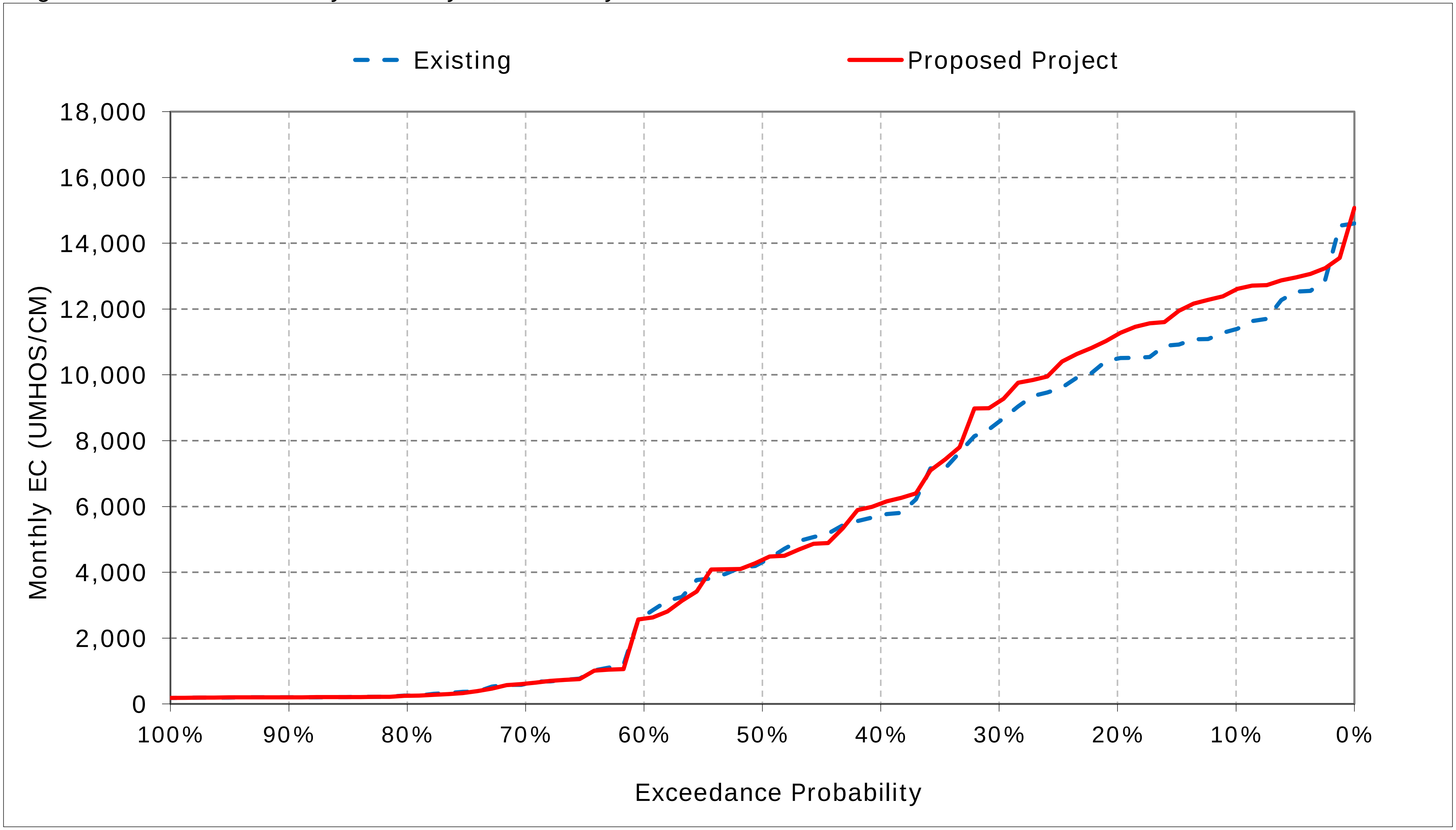


Figure 24-8. Suisun Bay near Ryer, February EC

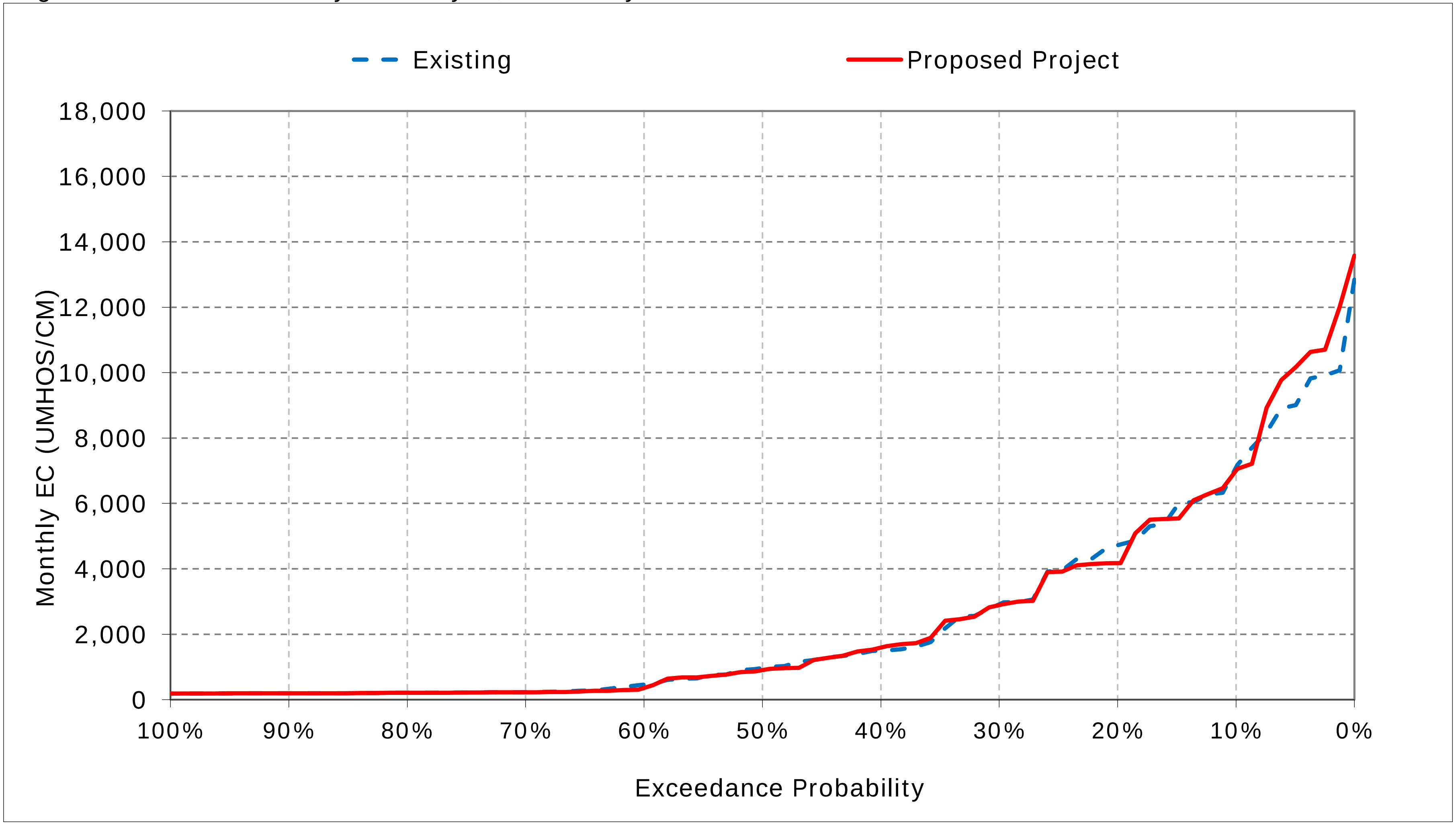


Figure 24-9. Suisun Bay near Ryer, March EC

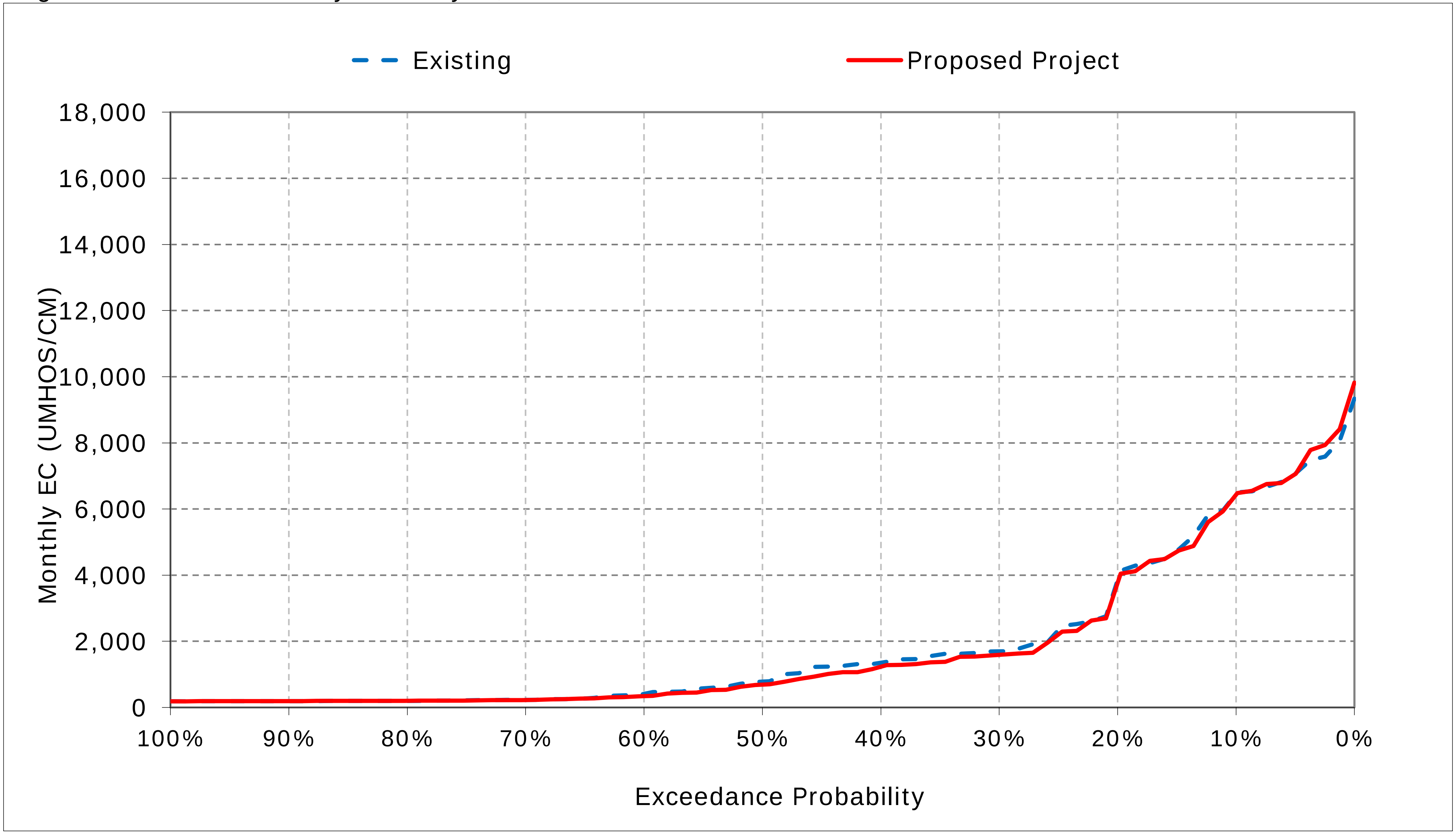


Figure 24-10. Suisun Bay near Ryer, April EC

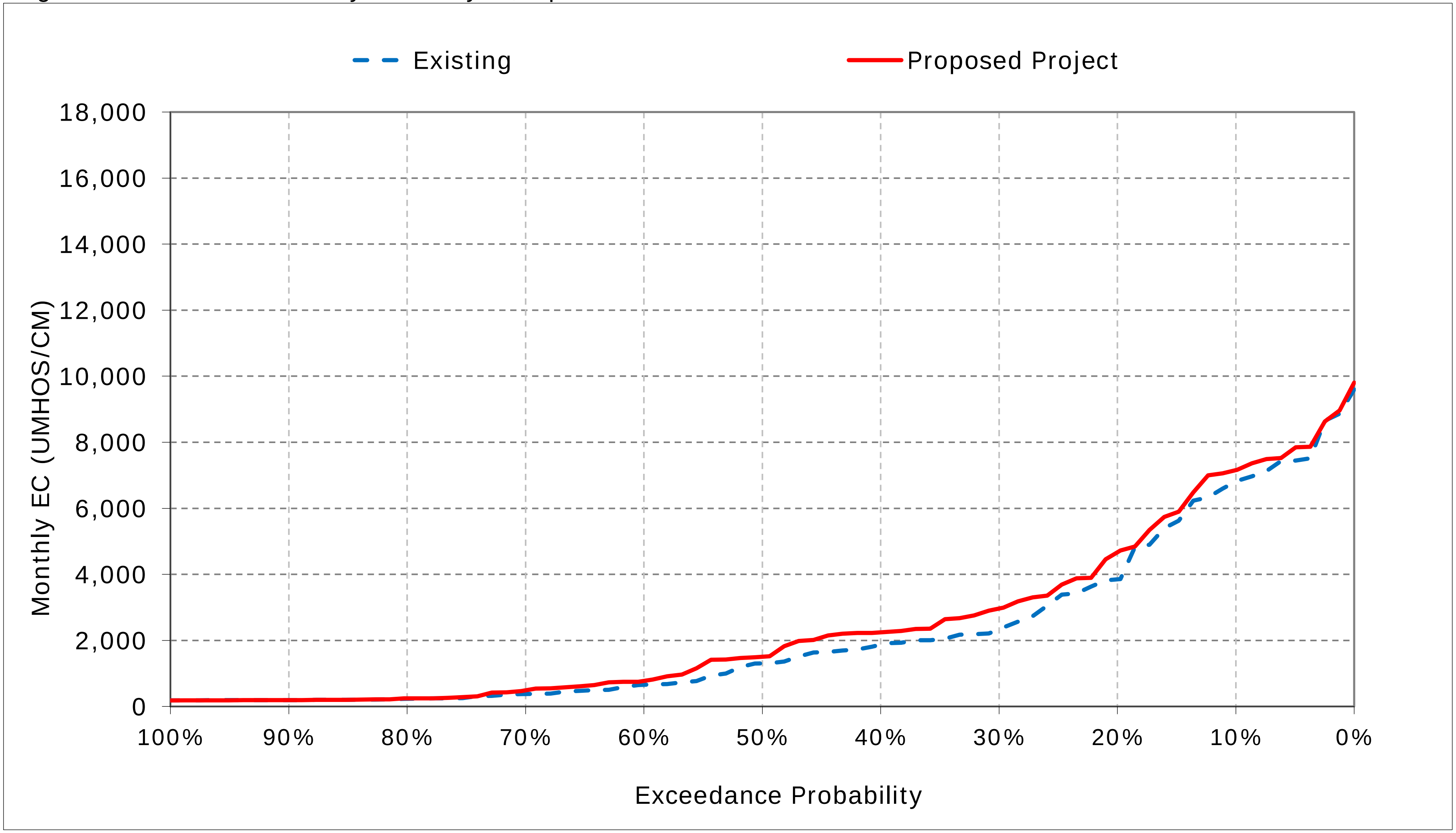


Figure 24-11. Suisun Bay near Ryer, May EC

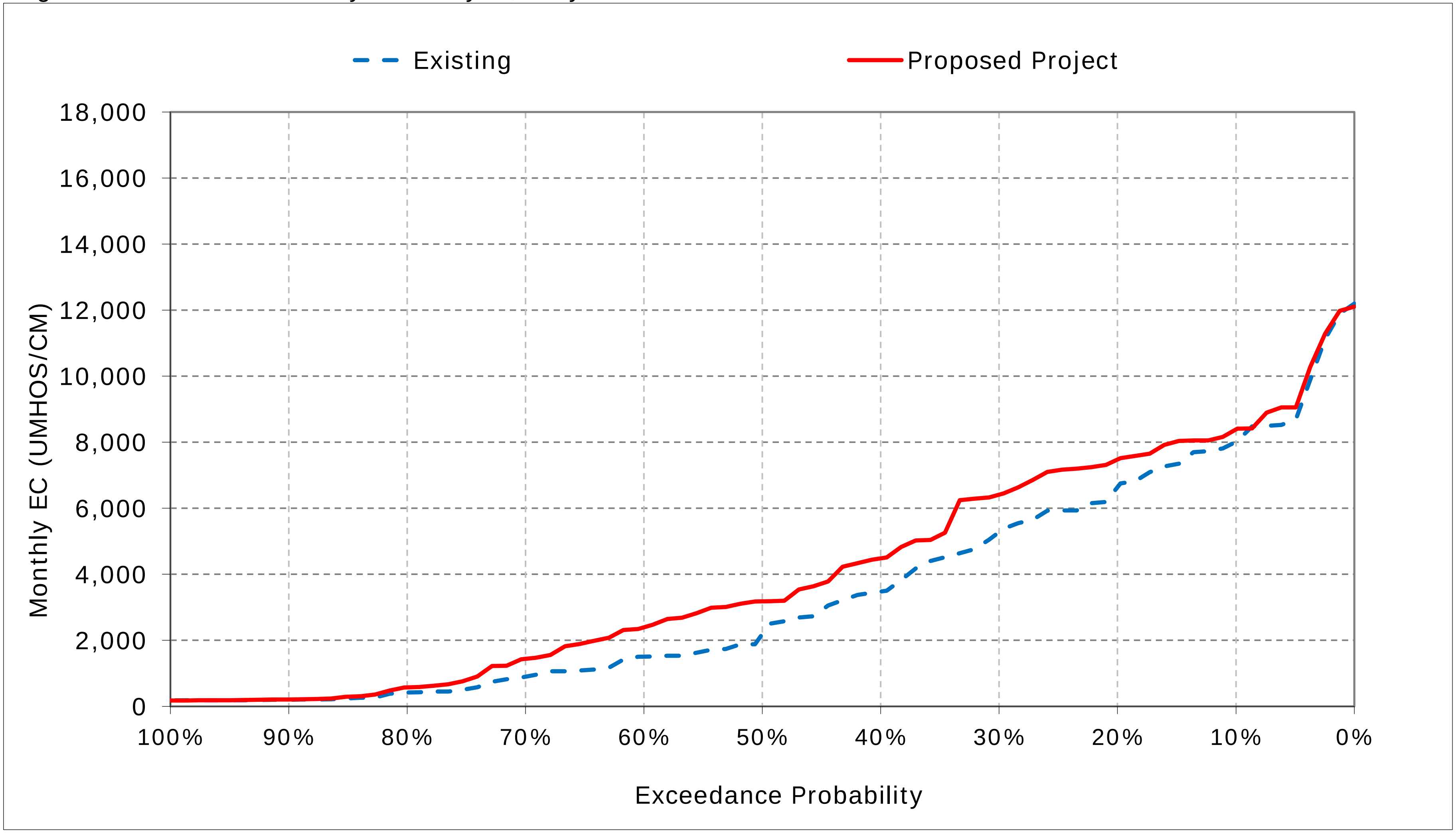


Figure 24-12. Suisun Bay near Ryer, June EC

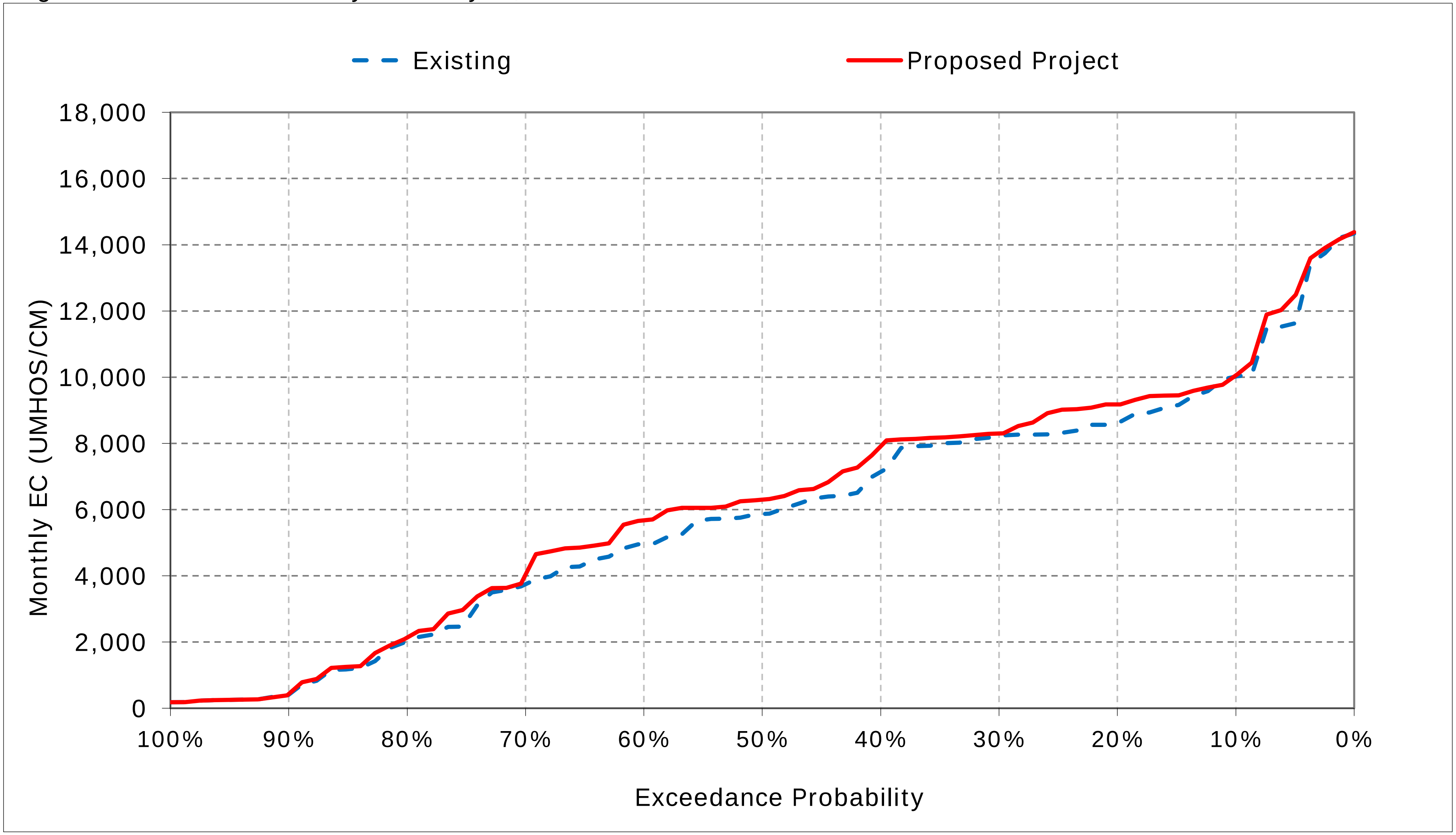


Figure 24-13. Suisun Bay near Ryer, July EC

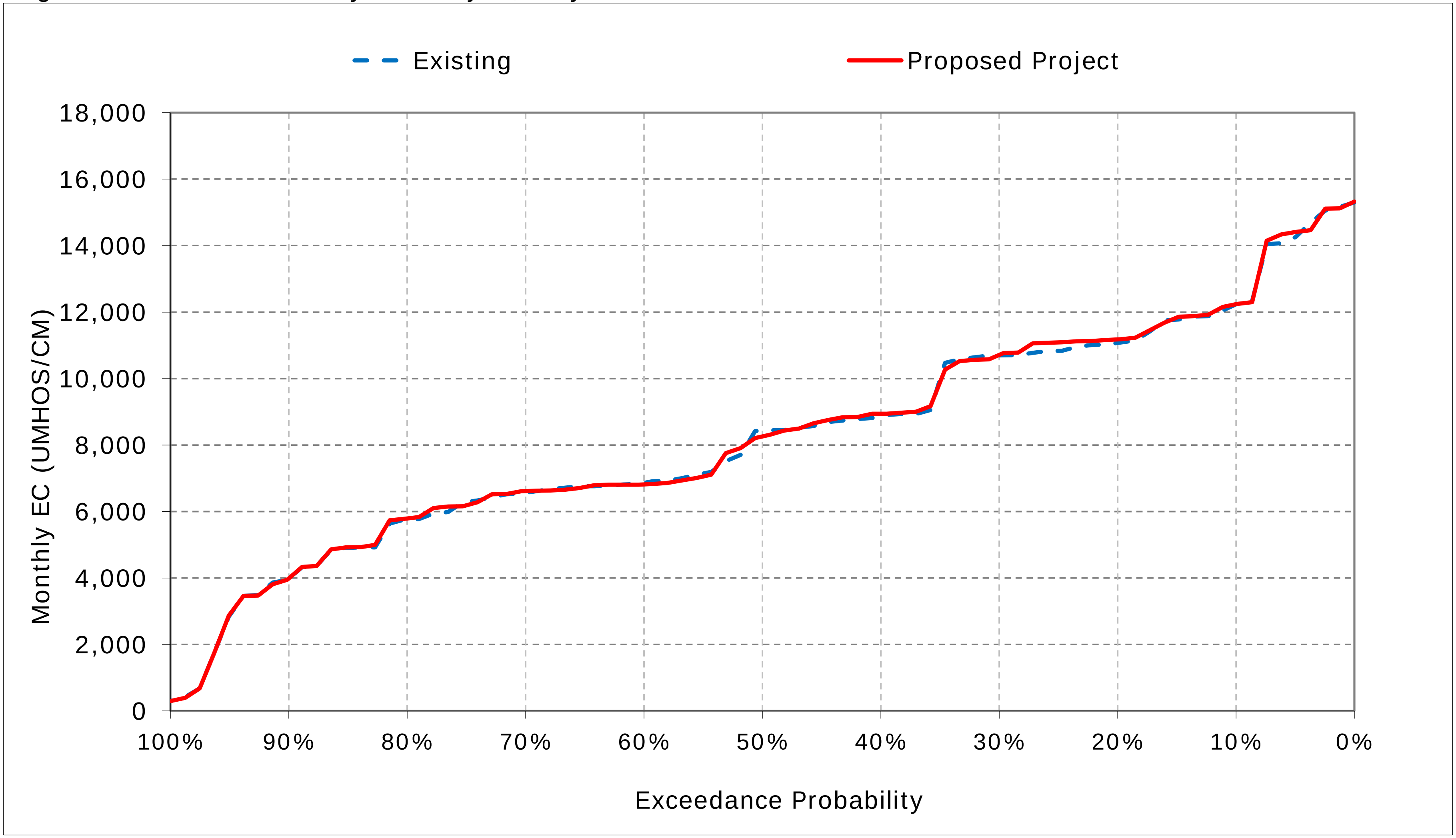


Figure 24-14. Suisun Bay near Ryer, August EC

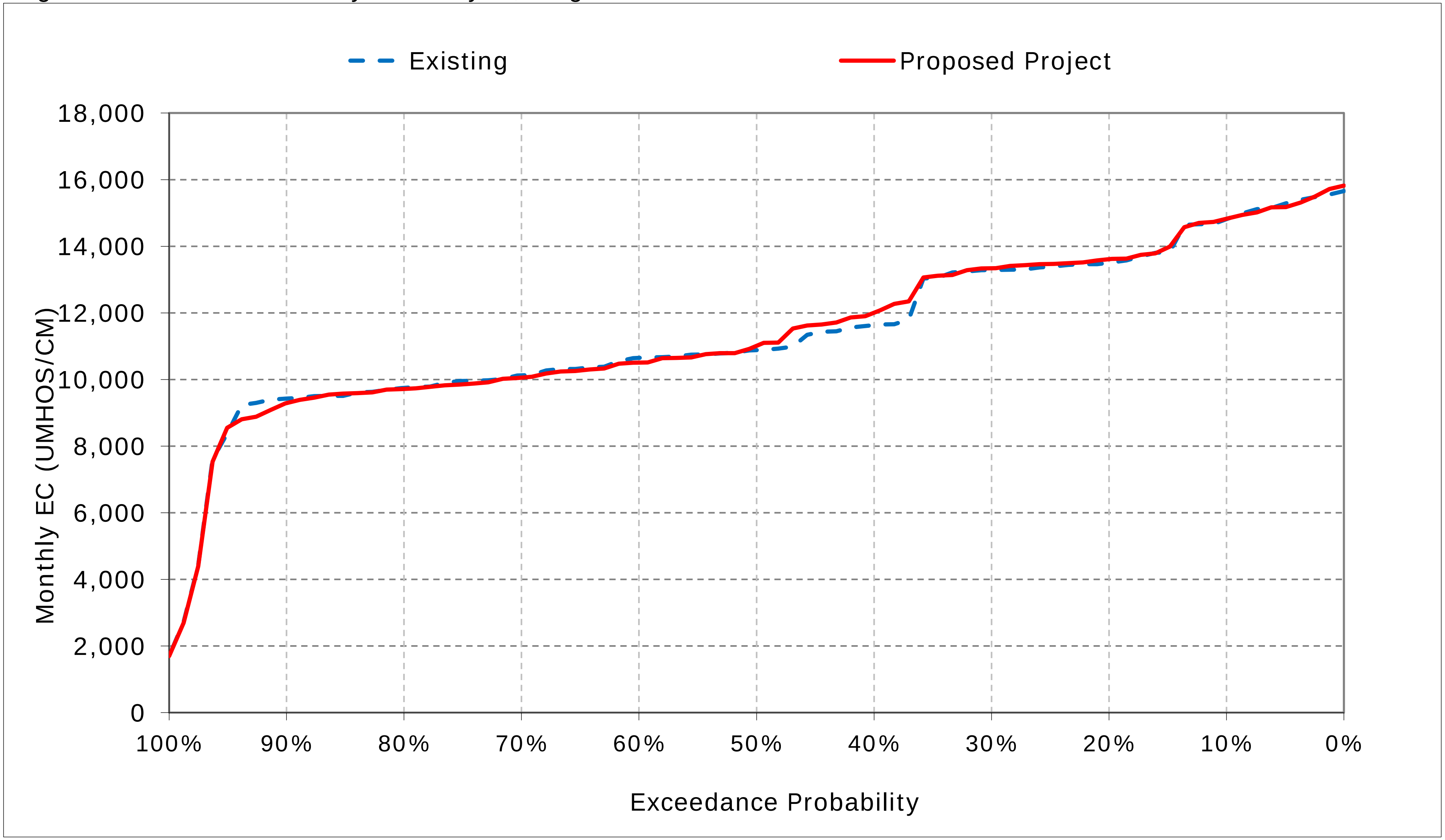


Figure 24-15. Suisun Bay near Ryer, September EC

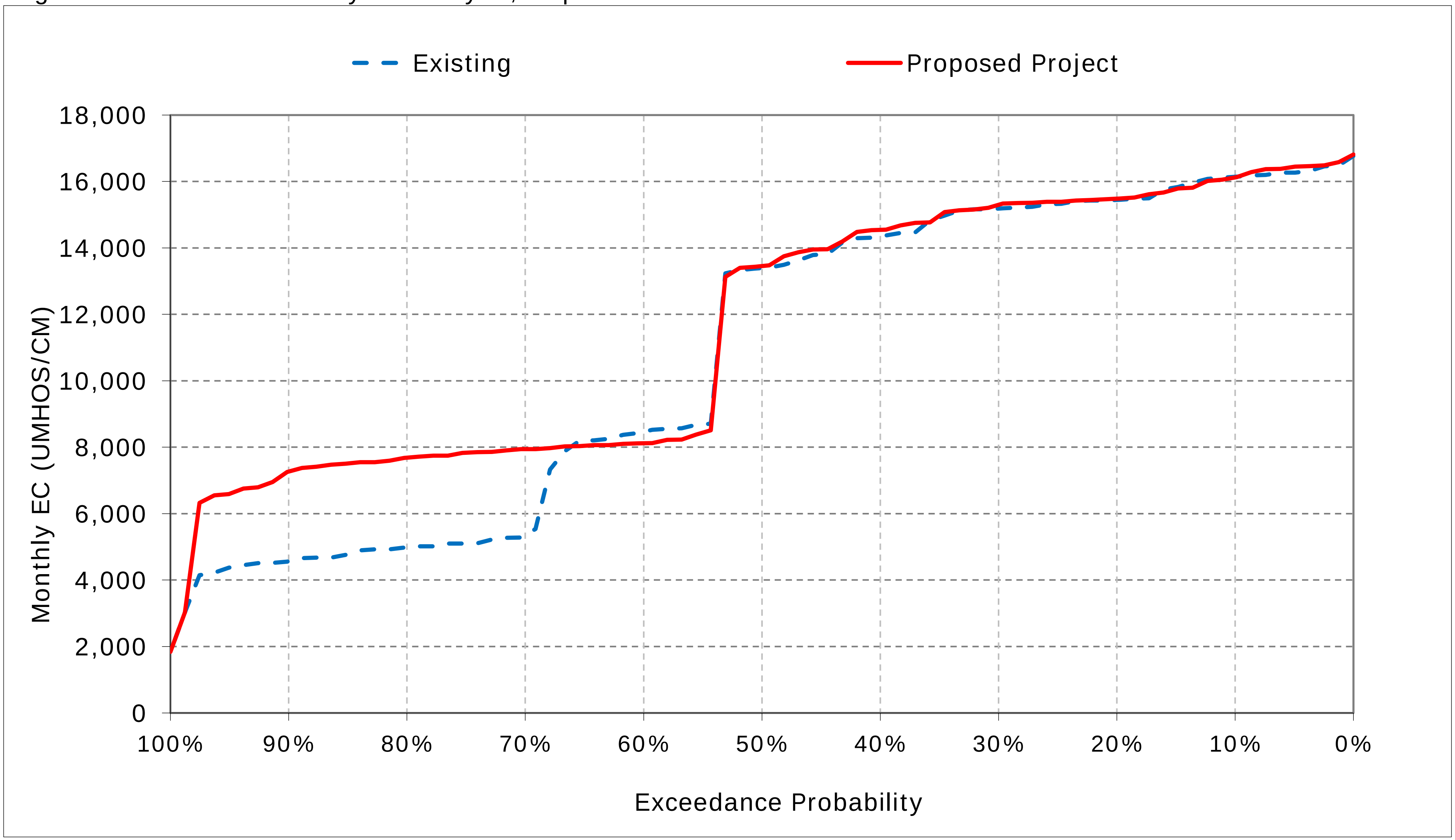


Figure 24-16. Suisun Bay near Ryer, October EC

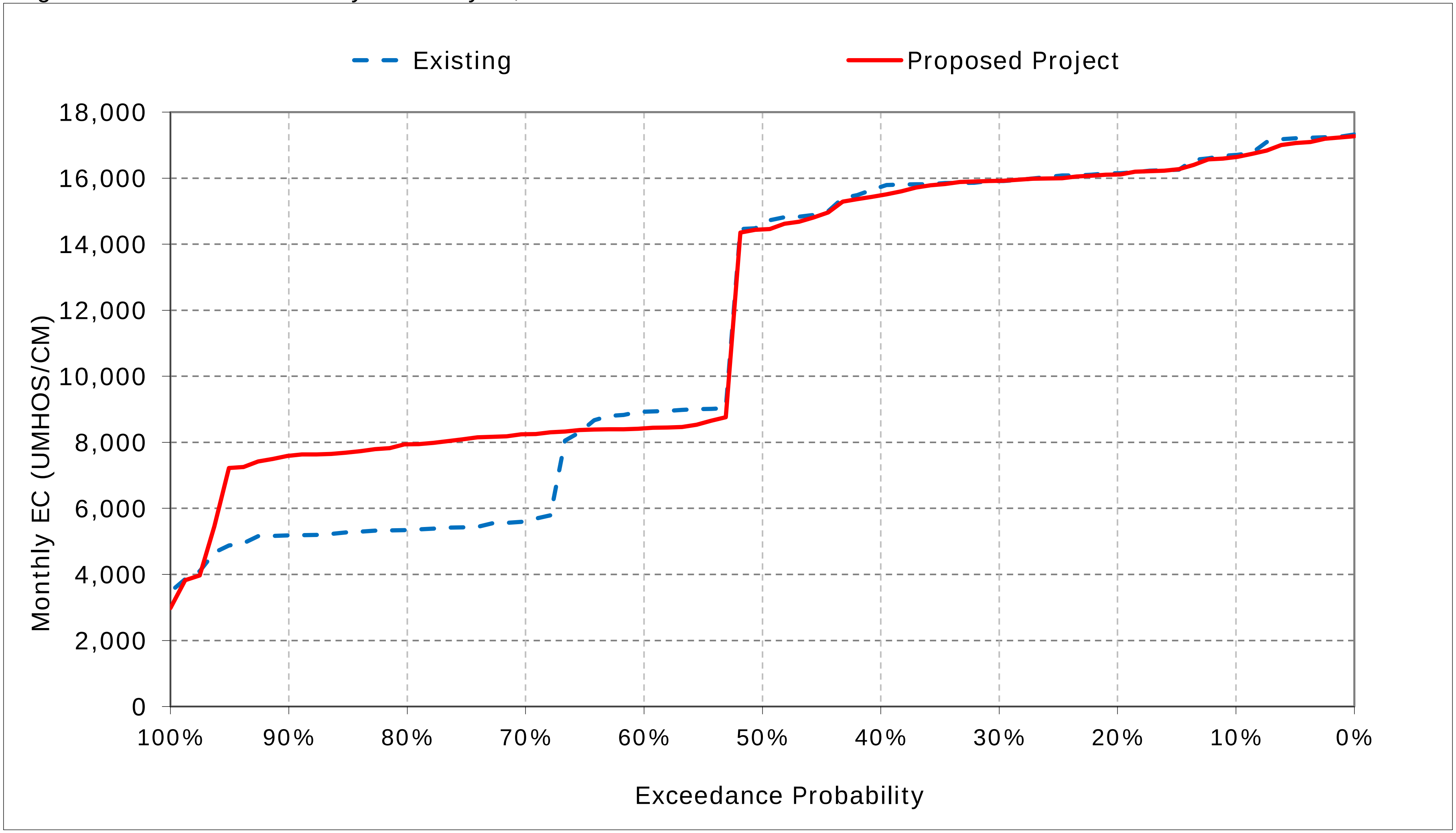


Figure 24-17. Suisun Bay near Ryer, November EC

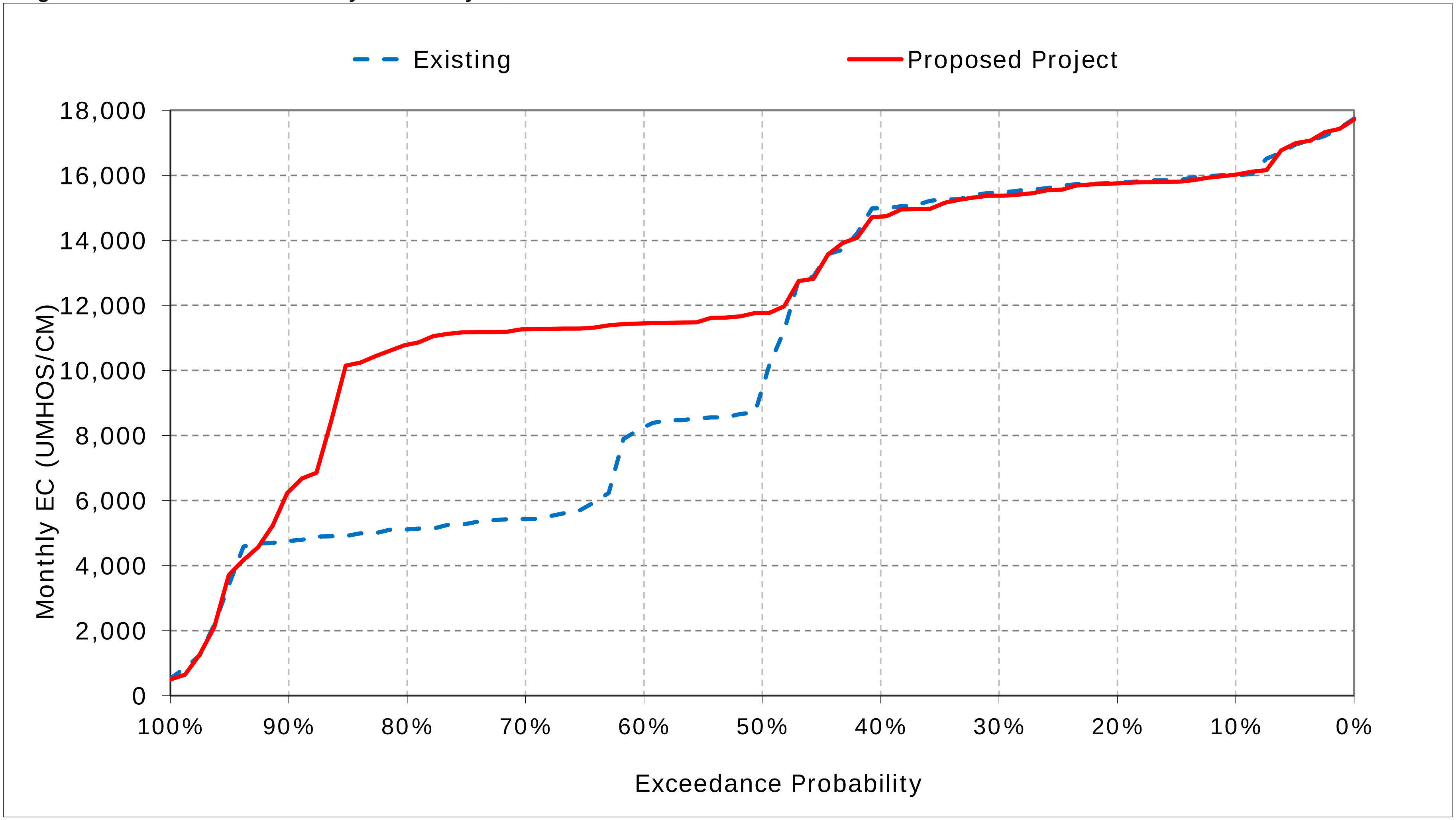


Figure 24-18. Suisun Bay near Ryer, December EC

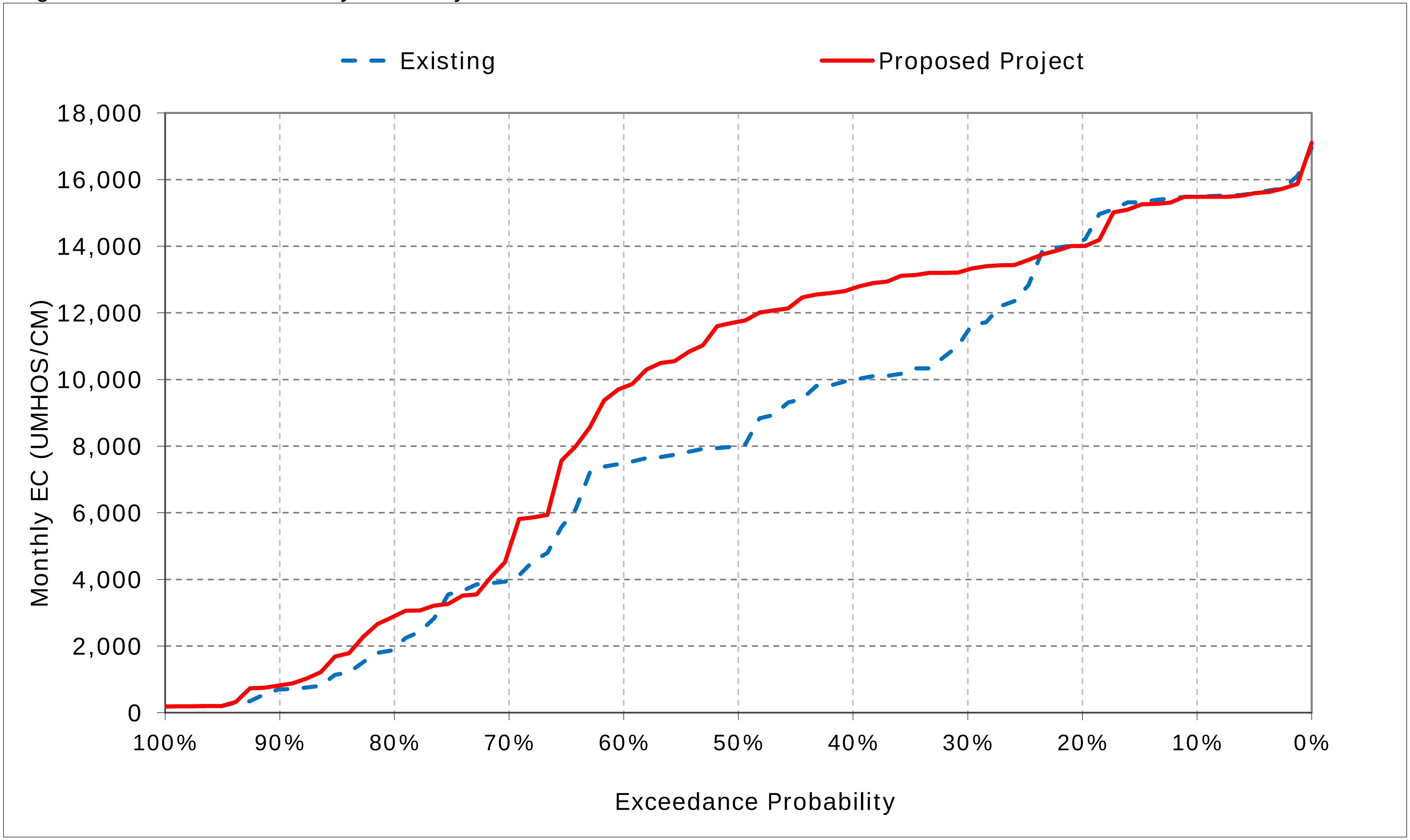


Table 25-1. Goodyear Slough Outfall at Naval Fleet, Monthly EC

Existing

Statistic	Monthly EC (UMHOS/CM)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	15,892	14,512	13,771	11,027	6,751	6,925	8,314	9,177	10,969	13,003	15,505	17,386
20%	15,210	14,126	13,187	9,217	5,084	4,597	5,072	7,317	9,558	11,956	14,356	16,448
30%	15,018	13,803	11,361	8,298	3,298	2,680	3,253	5,694	8,748	11,430	14,002	16,127
40%	14,589	13,202	8,662	6,455	2,889	1,936	2,477	3,954	7,467	9,981	12,348	15,121
50%	13,454	9,486	6,219	5,439	1,454	1,551	1,999	2,768	5,876	8,944	11,483	14,507
60%	8,092	7,681	5,684	3,477	1,052	651	917	1,705	4,846	8,278	10,936	11,184
70%	5,206	5,149	4,838	1,426	591	444	622	1,129	3,773	7,413	10,196	9,021
80%	4,926	5,008	3,536	719	389	349	343	539	1,971	5,929	9,848	8,689
90%	4,779	4,733	1,399	394	273	269	243	238	470	3,501	9,518	8,221
Long Term												
Full Simulation Period[a]	10,631	9,660	7,630	5,272	2,747	2,402	2,853	3,891	6,149	8,927	11,897	12,834
Water Year Types[b]												
Wet (32%)	8,799	7,246	3,710	1,360	541	465	598	999	2,365	5,094	9,112	8,043
Above Normal (15%)	10,954	9,676	7,687	4,170	1,394	717	857	1,601	4,190	7,257	10,188	11,099
Below Normal (17%)	11,001	10,398	9,021	6,431	2,384	2,126	2,465	3,412	6,121	9,317	11,872	14,786
Dry (22%)	11,093	10,708	9,331	7,590	4,475	3,591	4,329	5,975	8,734	11,602	14,206	16,297
Critical (15%)	13,156	12,445	11,890	10,023	6,709	6,824	7,974	9,880	12,462	14,438	16,208	17,477

Proposed Project

Statistic	Monthly EC (UMHOS/CM)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	15,872	14,389	13,763	11,145	6,962	6,751	8,822	9,348	11,112	13,007	15,501	17,339
20%	15,220	14,048	13,044	10,570	5,202	4,518	5,115	8,343	10,225	12,168	14,495	16,450
30%	15,038	13,724	11,491	9,027	3,520	2,672	3,389	6,933	9,403	11,478	14,085	16,253
40%	14,378	12,959	11,215	6,883	2,808	1,677	2,680	5,173	8,166	8,620	11,003	14,116
50%	13,073	10,051	10,768	5,540	1,553	1,228	2,323	3,625	6,597	8,184	10,248	13,418
60%	7,735	9,368	9,556	3,388	937	628	1,157	2,629	5,875	7,818	9,949	11,075
70%	7,570	9,097	6,021	1,499	626	436	703	1,587	4,201	7,145	9,706	10,821
80%	7,281	8,865	4,614	779	393	359	370	747	2,225	5,957	9,301	10,643
90%	6,955	6,708	2,527	515	326	271	274	269	516	3,508	8,597	10,143
Long Term												
Full Simulation Period[a]	11,199	10,813	8,921	5,602	2,871	2,372	3,029	4,511	6,657	8,692	11,407	13,210
Water Year Types[b]												
Wet (32%)	9,541	8,764	4,879	1,471	551	457	703	1,406	2,808	5,199	9,046	9,857
Above Normal (15%)	11,652	10,977	9,395	4,518	1,348	638	1,017	2,345	4,825	7,242	10,232	10,797
Below Normal (17%)	11,588	11,503	10,438	6,693	2,351	1,991	2,704	4,366	6,803	7,492	8,968	13,771
Dry (22%)	11,656	11,722	10,678	8,211	4,805	3,541	4,532	6,759	9,300	11,751	14,288	16,358
Critical (15%)	13,199	12,918	12,800	10,449	7,129	6,948	8,204	10,203	12,691	14,521	16,223	17,513

Proposed Project minus Existing

Statistic	Monthly EC (UMHOS/CM)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	-20	-123	-8	118	211	-174	509	171	143	3	-3	-47
20%	10	-78	-142	1,354	118	-79	43	1,026	667	212	139	2
30%	20	-79	130	729	222	-8	136	1,239	655	47	84	126
40%	-212	-243	2,553	428	-81	-259	203	1,219	699	-1,361	-1,346	-1,005
50%	-381	566	4,550	101	99	-323	325	856	721	-760	-1,234	-1,089
60%	-357	1,687	3,872	-89	-115	-22	241	924	1,029	-459	-987	-109
70%	2,365	3,948	1,183	73	35	-8	80	458	428	-268	-490	1,801
80%	2,355	3,857	1,078	60	4	10	27	208	253	28	-547	1,955
90%	2,176	1,976	1,128	121	52	3	31	31	46	8	-921	1,922
Long Term												
Full Simulation Period[a]	568	1,152	1,292	329	125	-30	176	620	508	-235	-490	376
Water Year Types[b]												
Wet (32%)	742	1,518	1,169	111	10	-8	105	407	444	106	-65	1,814
Above Normal (15%)	698	1,301	1,708	348	-47	-79	160	744	635	-15	44	-302
Below Normal (17%)	587	1,105	1,417	261	-33	-136	239	954	682	-1,825	-2,904	-1,015
Dry (22%)	564	1,015	1,347	621	330	-50	202	784	566	150	82	61
Critical (15%)	43	474	910	427	420	124	231	323	229	83	15	36

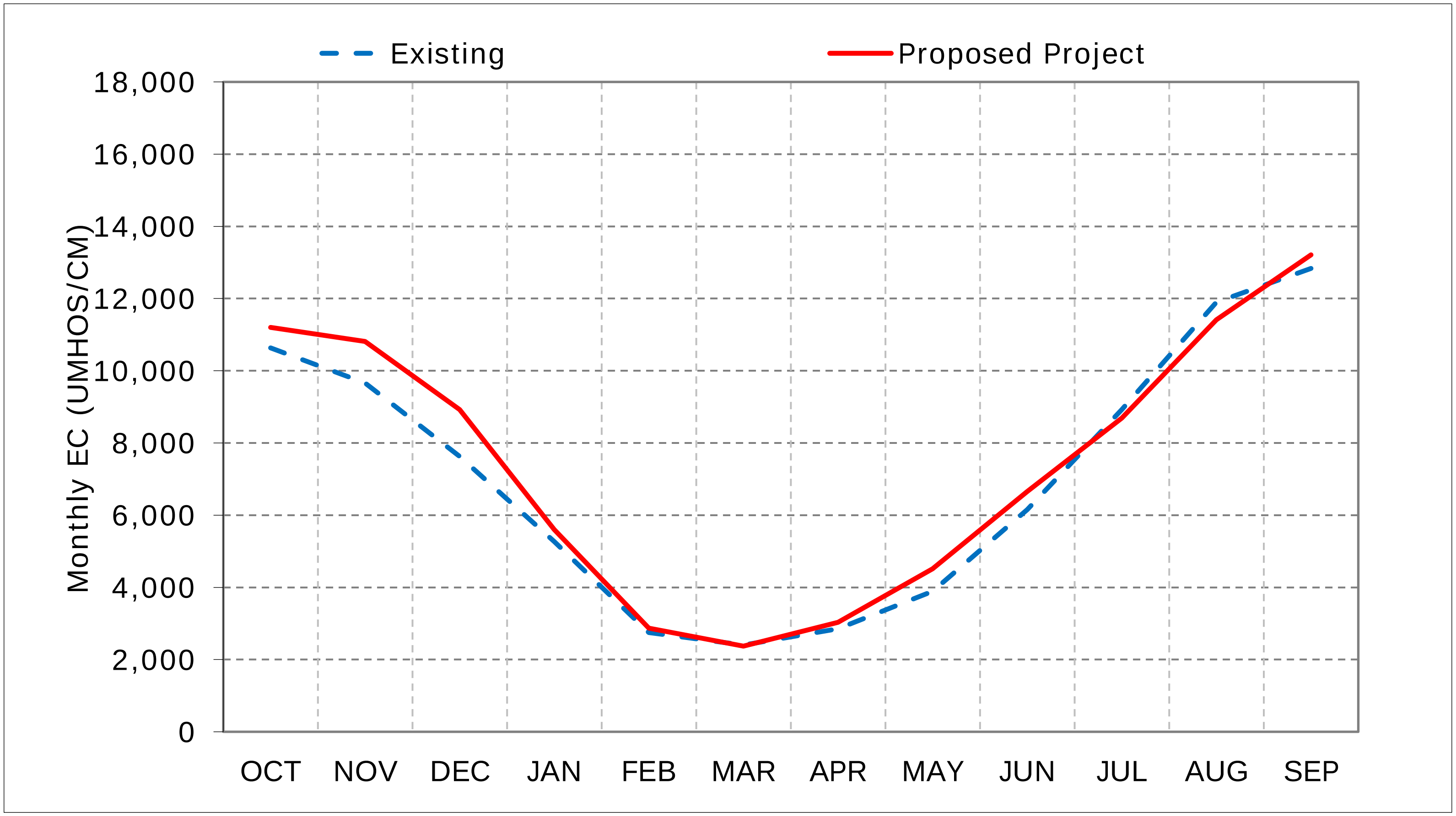
a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

c These results are displayed with water year - year type sorting.

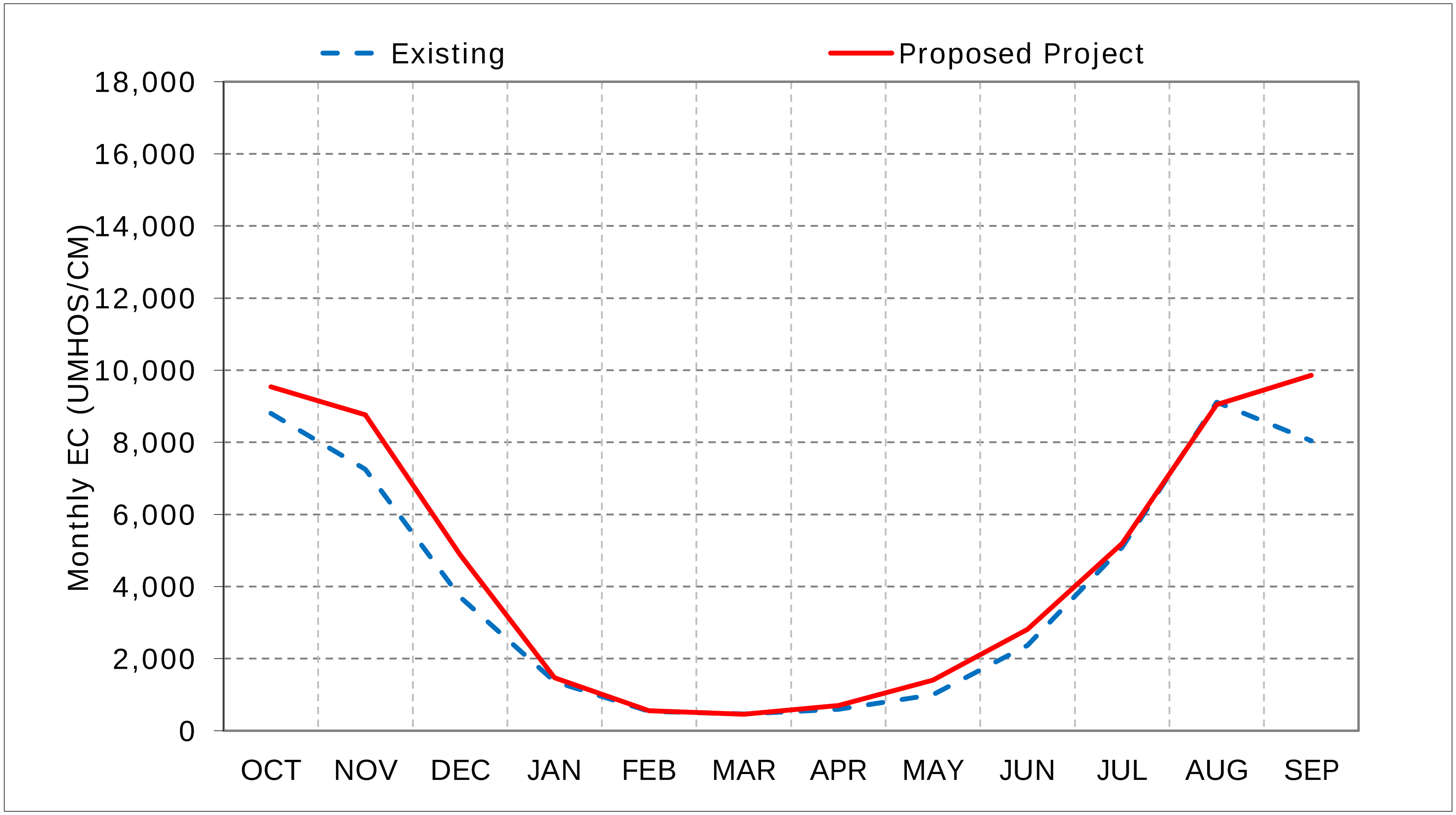
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 25-1. Goodyear Slough Outfall at Naval Fleet, Long-Term Average EC



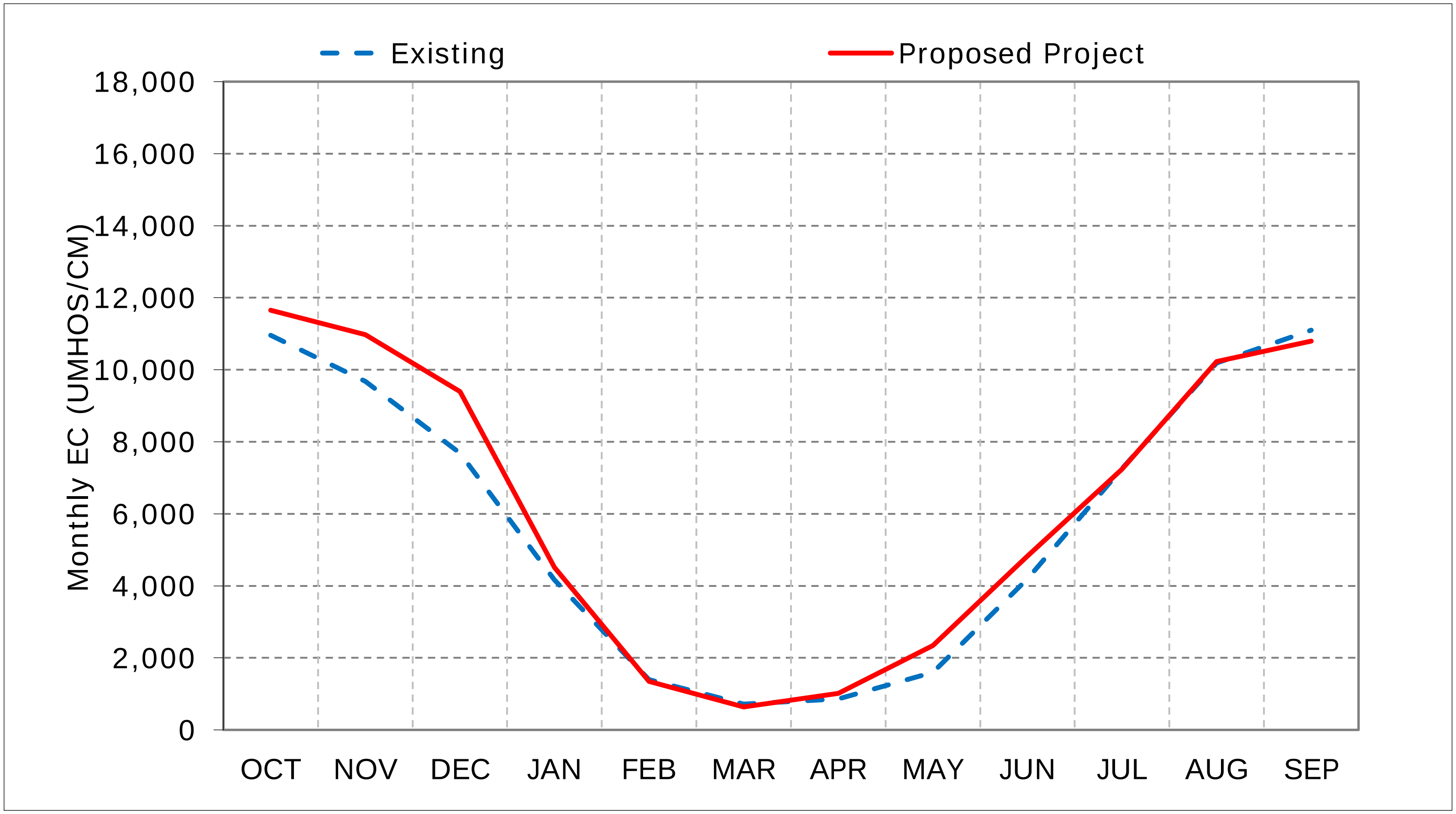
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 25-2. Goodyear Slough Outfall at Naval Fleet, Wet Year Average EC



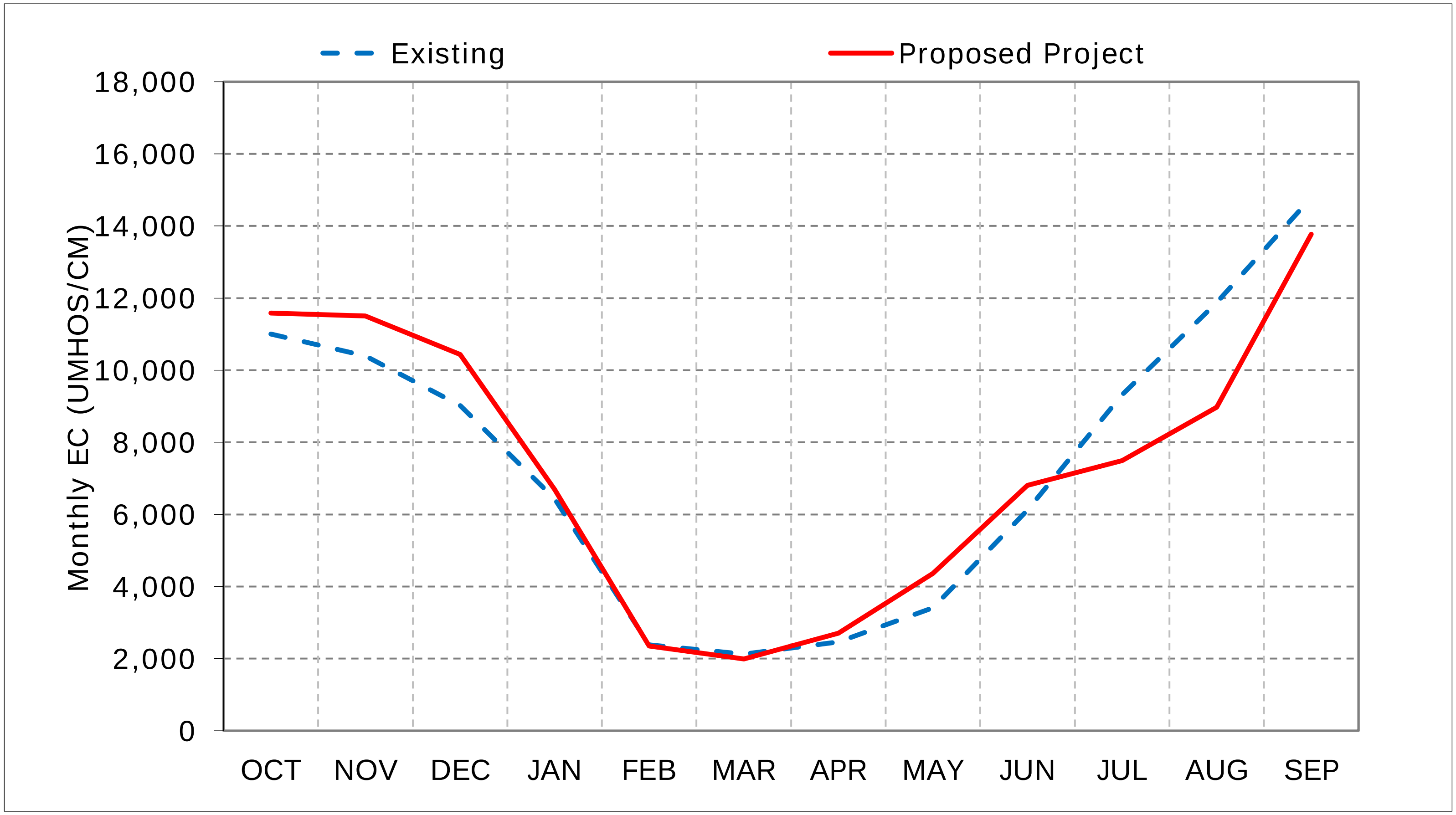
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 25-3. Goodyear Slough Outfall at Naval Fleet, Above Normal Year Average I



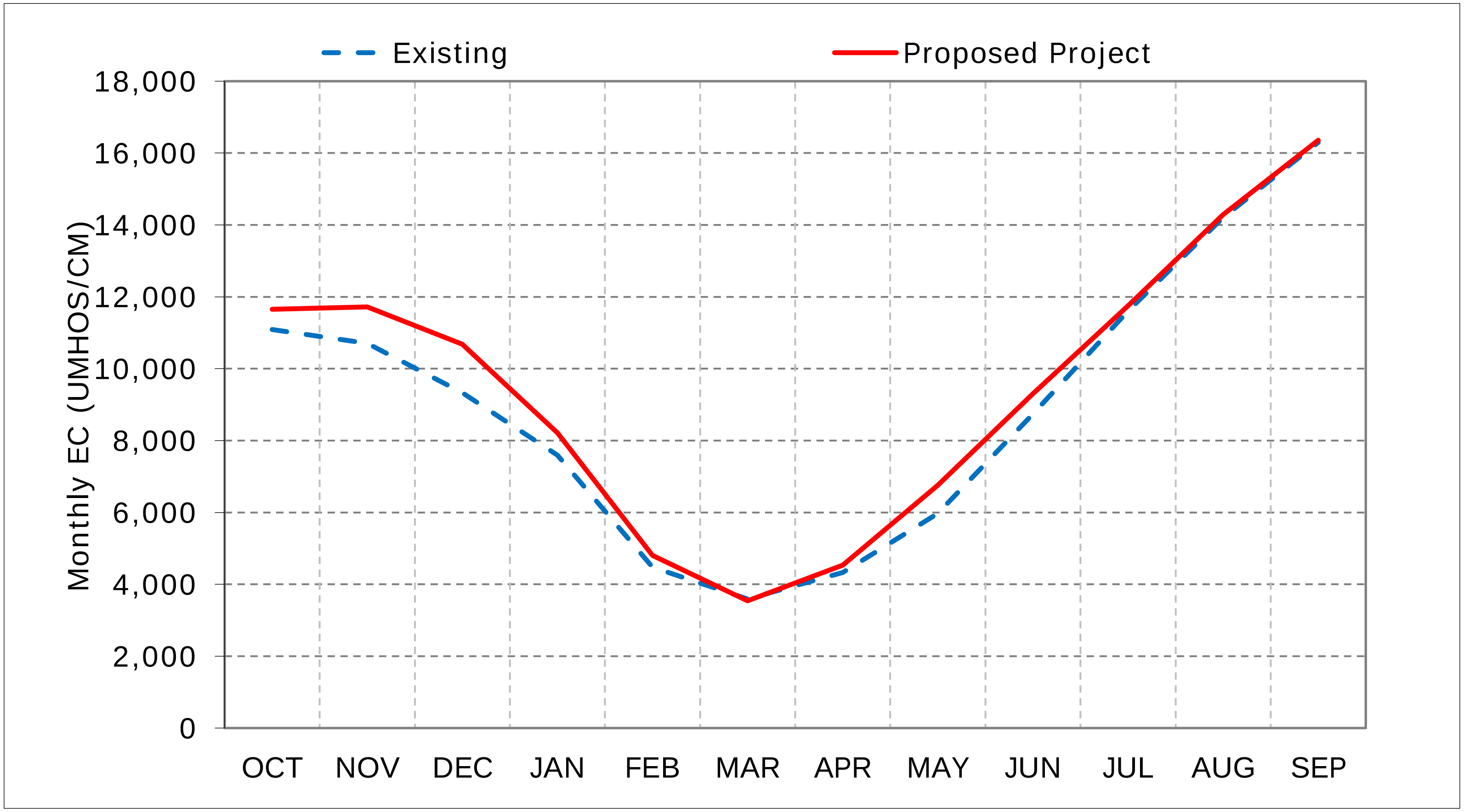
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 25-4. Goodyear Slough Outfall at Naval Fleet, Below Normal Year Average E



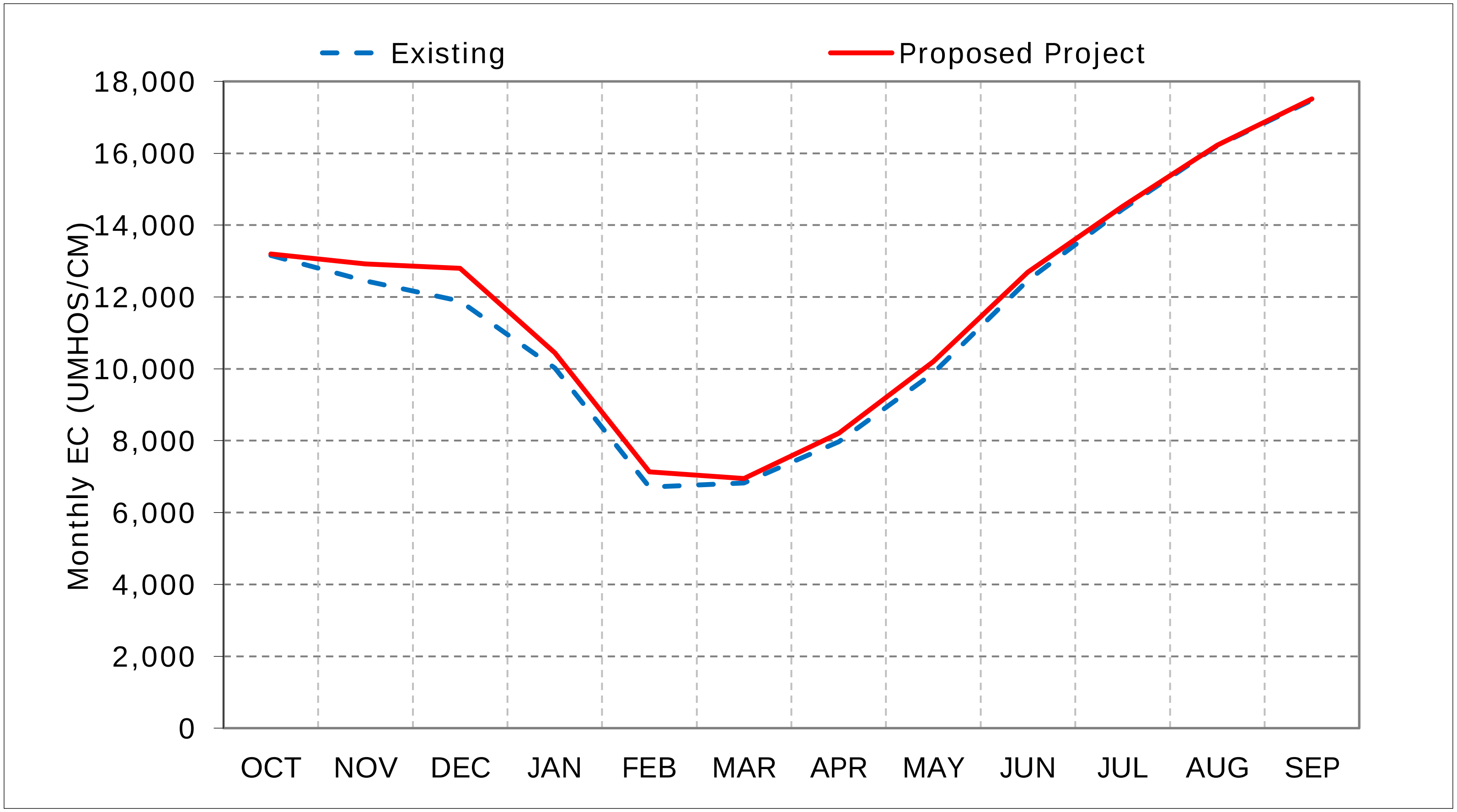
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 25-5. Goodyear Slough Outfall at Naval Fleet, Dry Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 25-6. Goodyear Slough Outfall at Naval Fleet, Critical Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 25-7. Goodyear Slough Outfall at Naval Fleet, January EC

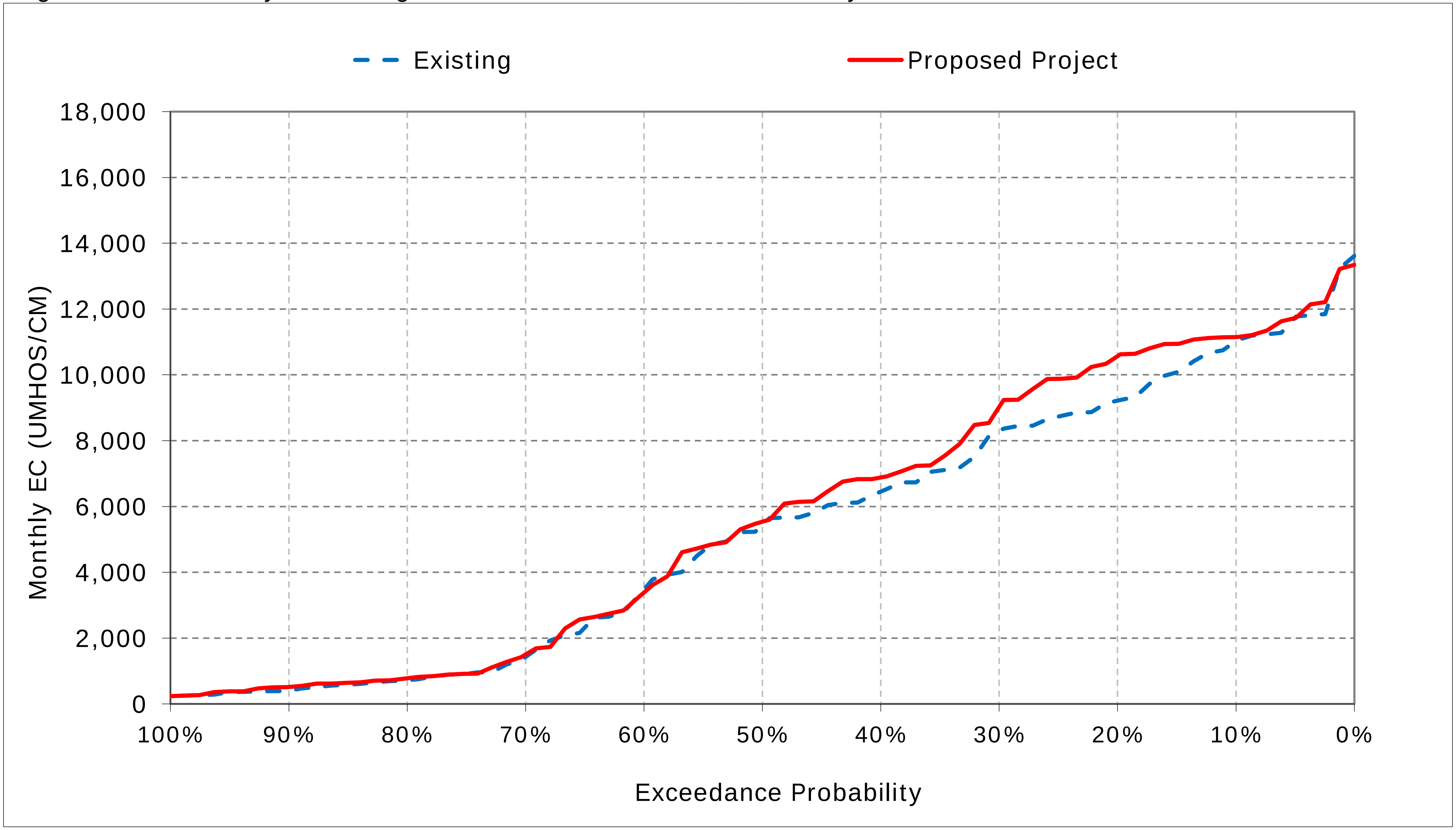


Figure 25-8. Goodyear Slough Outfall at Naval Fleet, February EC

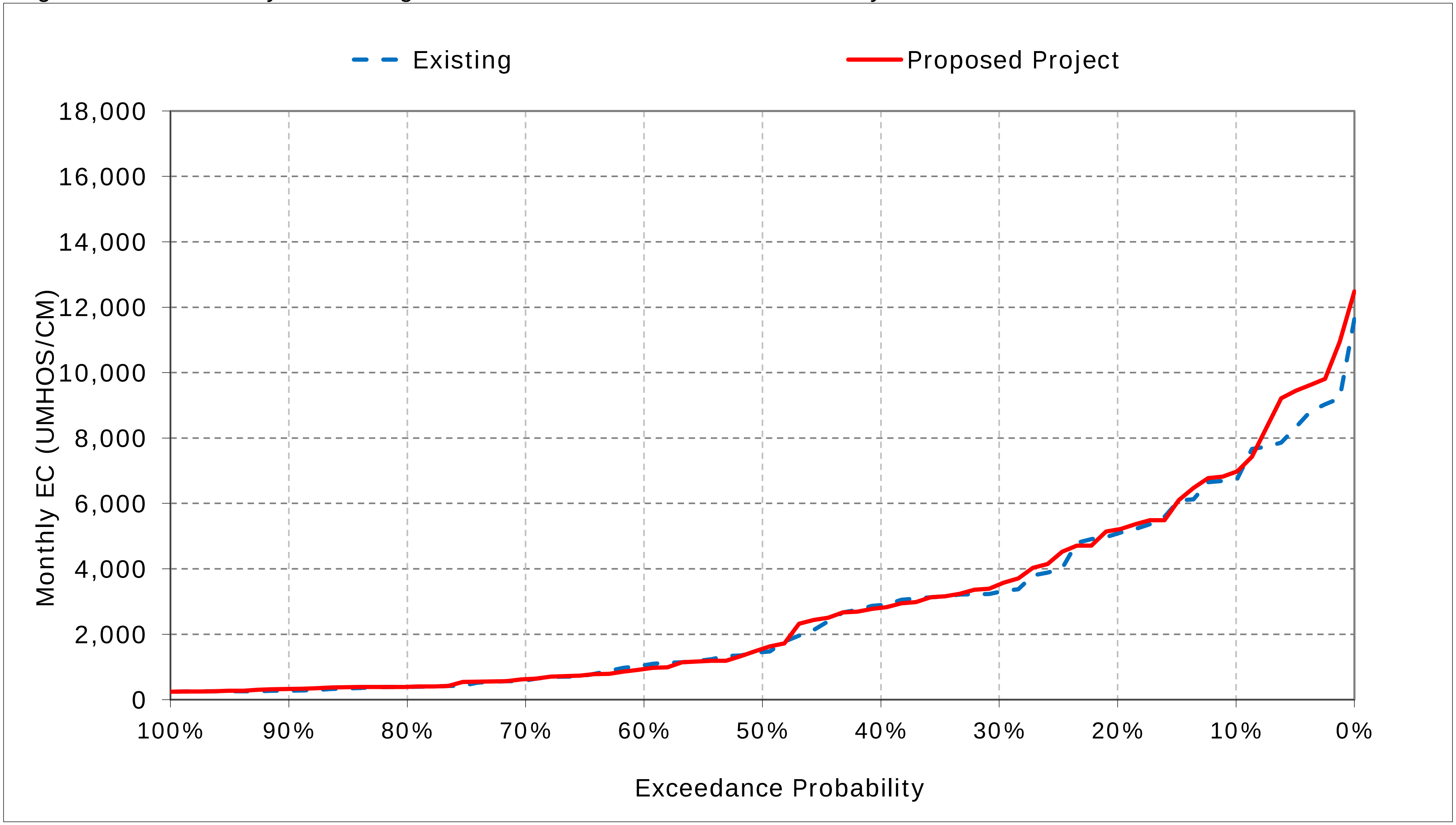


Figure 25-9. Goodyear Slough Outfall at Naval Fleet, March EC

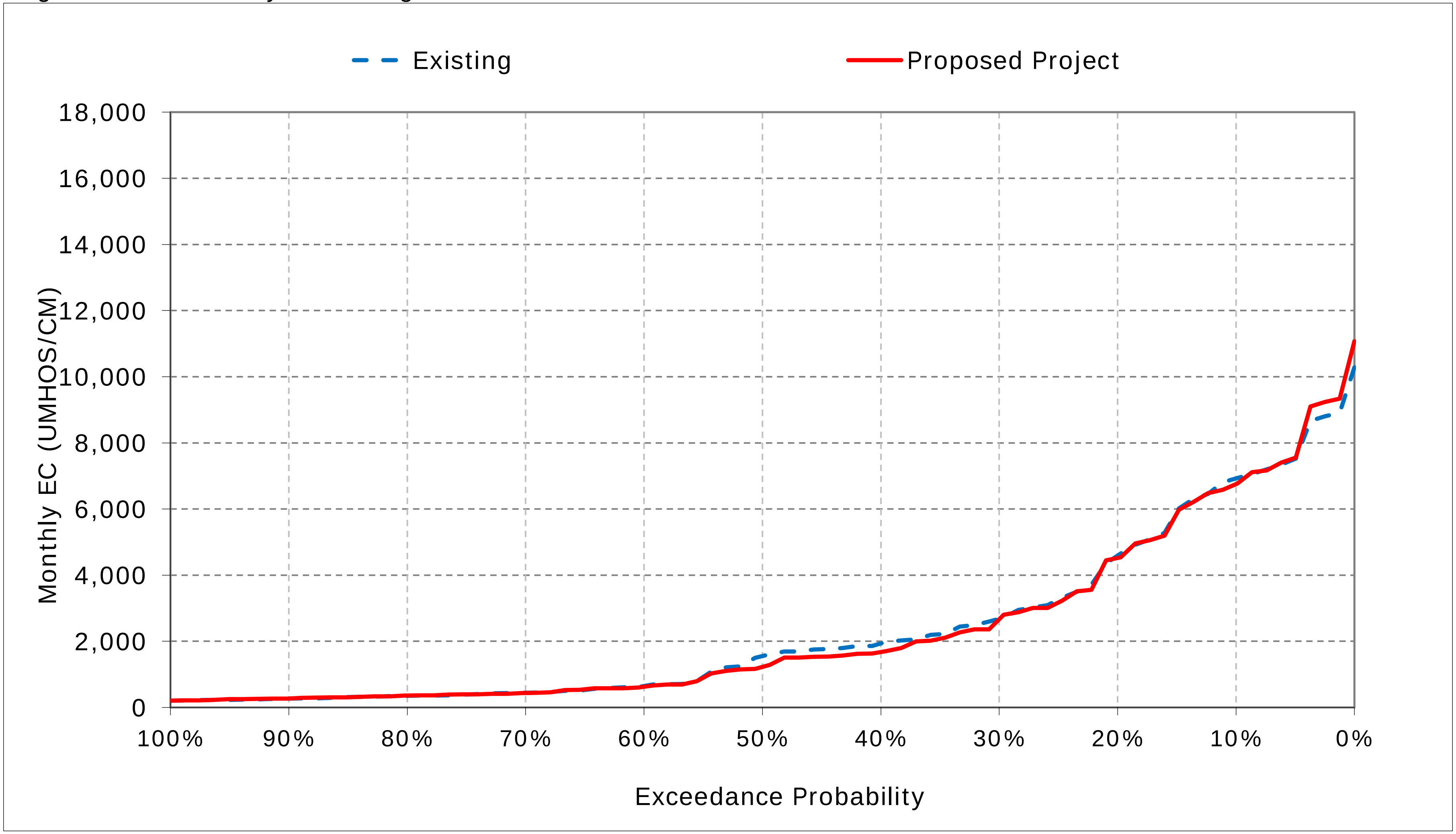


Figure 25-10. Goodyear Slough Outfall at Naval Fleet, April EC

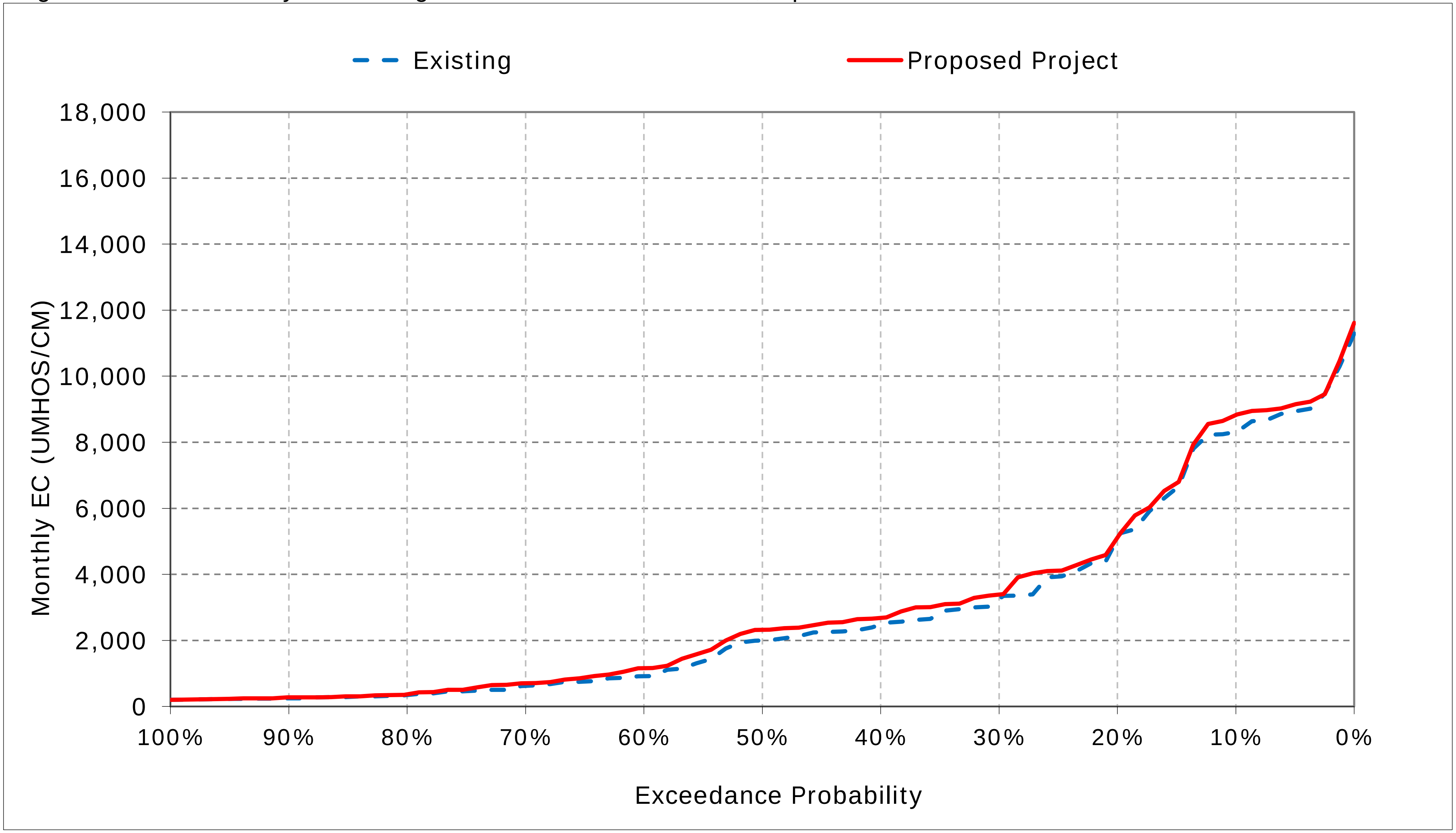


Figure 25-11. Goodyear Slough Outfall at Naval Fleet, May EC

Figure 25-12. Goodyear Slough Outfall at Naval Fleet, June EC

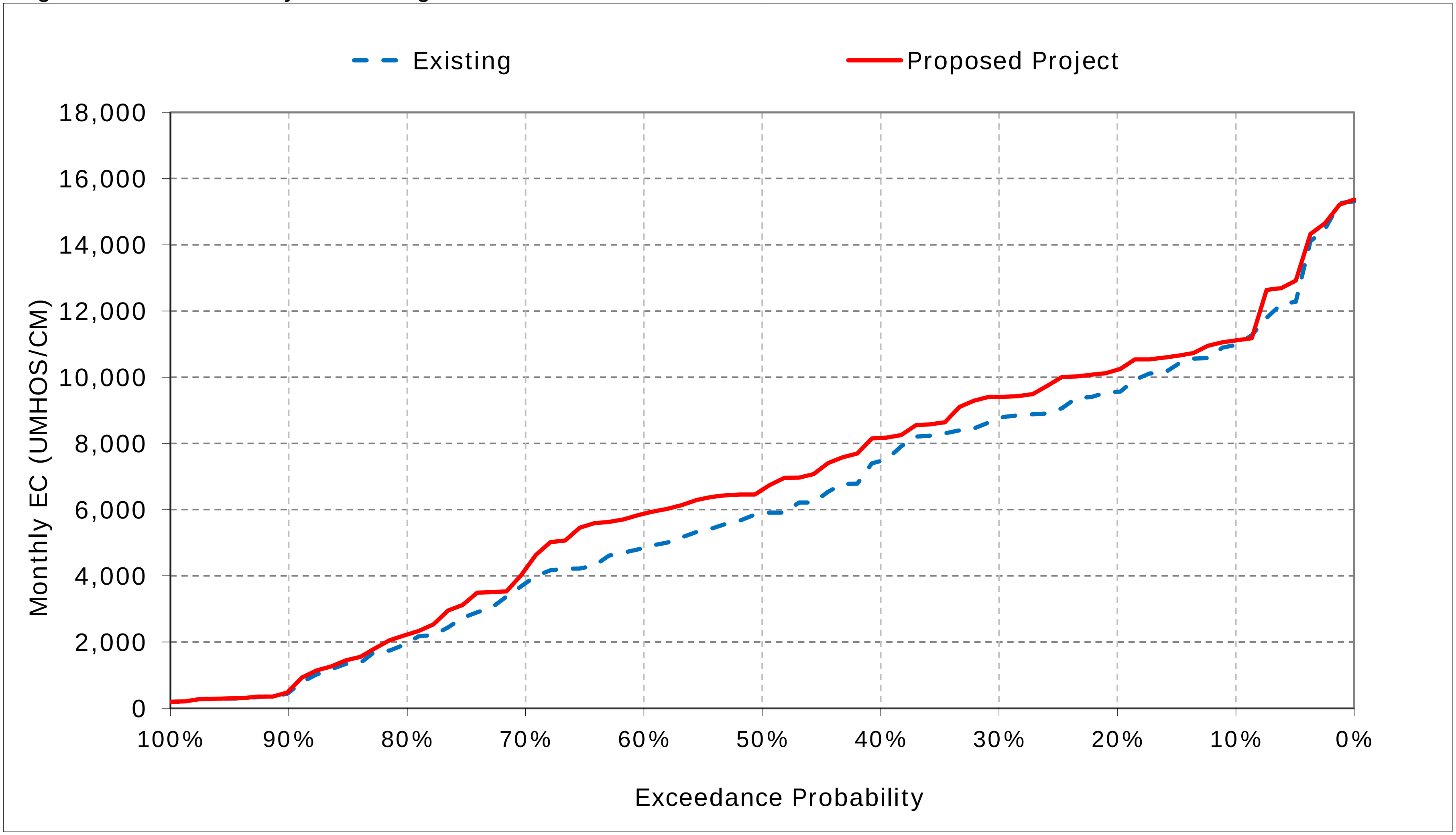


Figure 25-13. Goodyear Slough Outfall at Naval Fleet, July EC

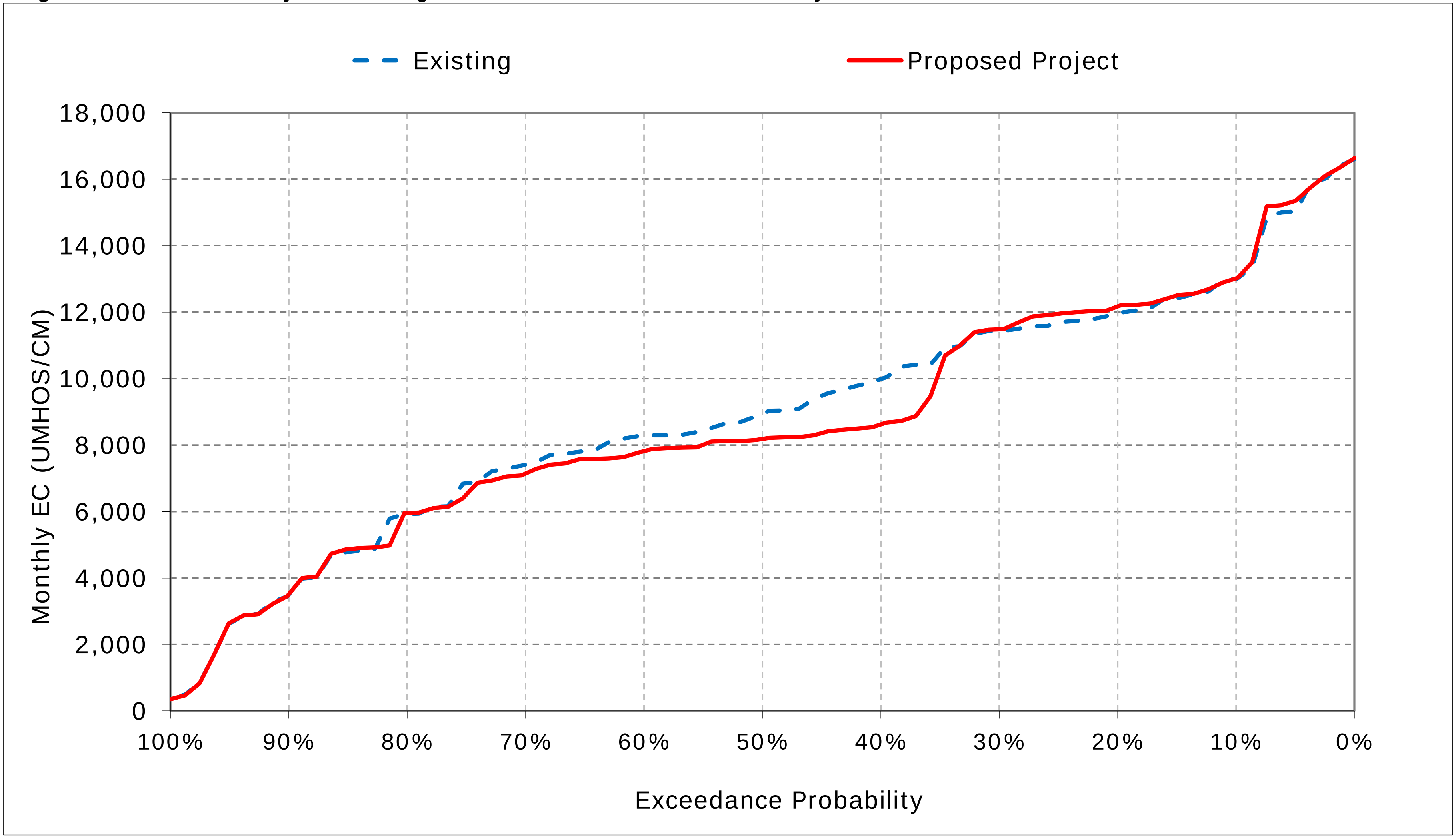


Figure 25-14. Goodyear Slough Outfall at Naval Fleet, August EC

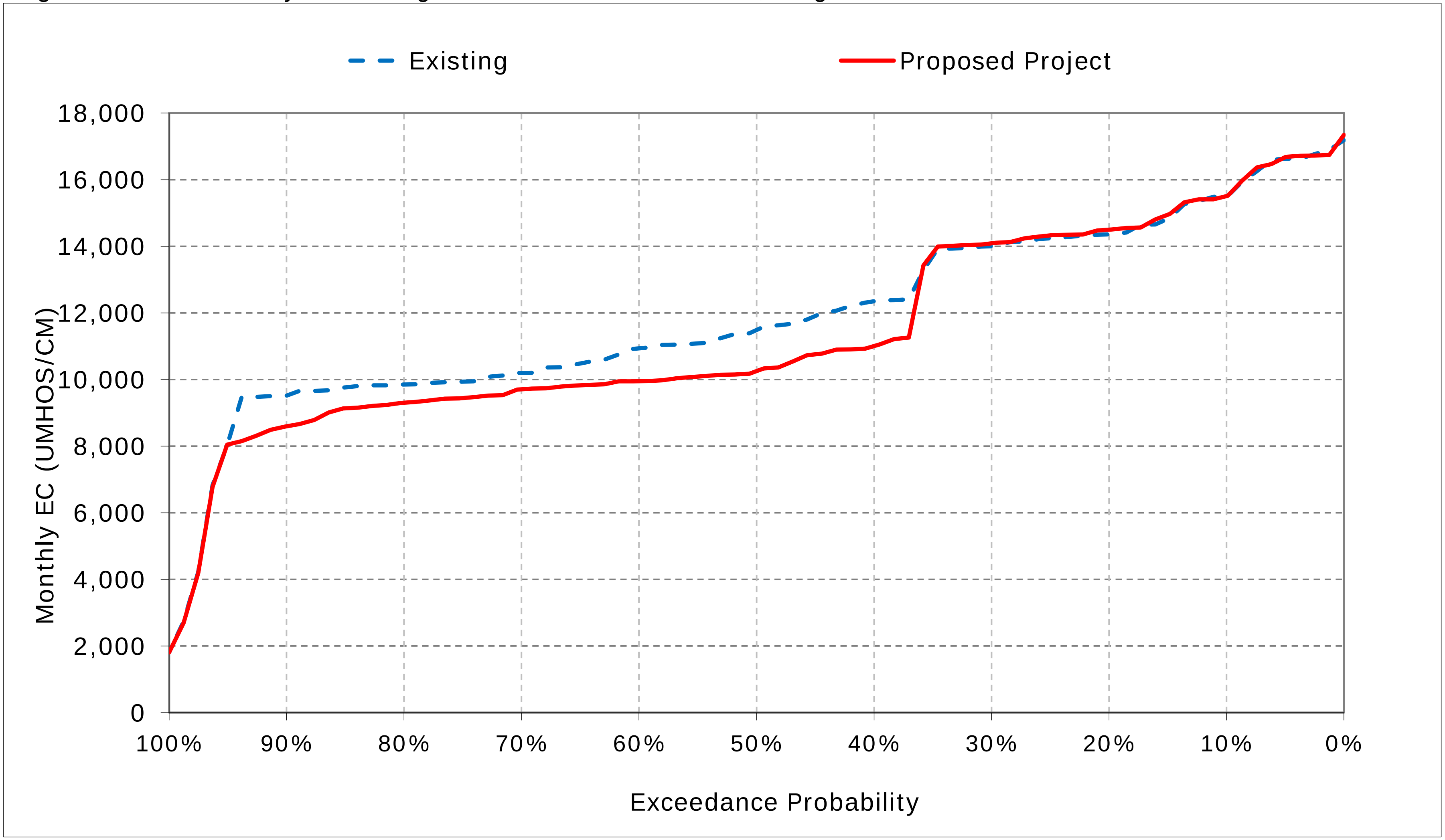


Figure 25-15. Goodyear Slough Outfall at Naval Fleet, September EC

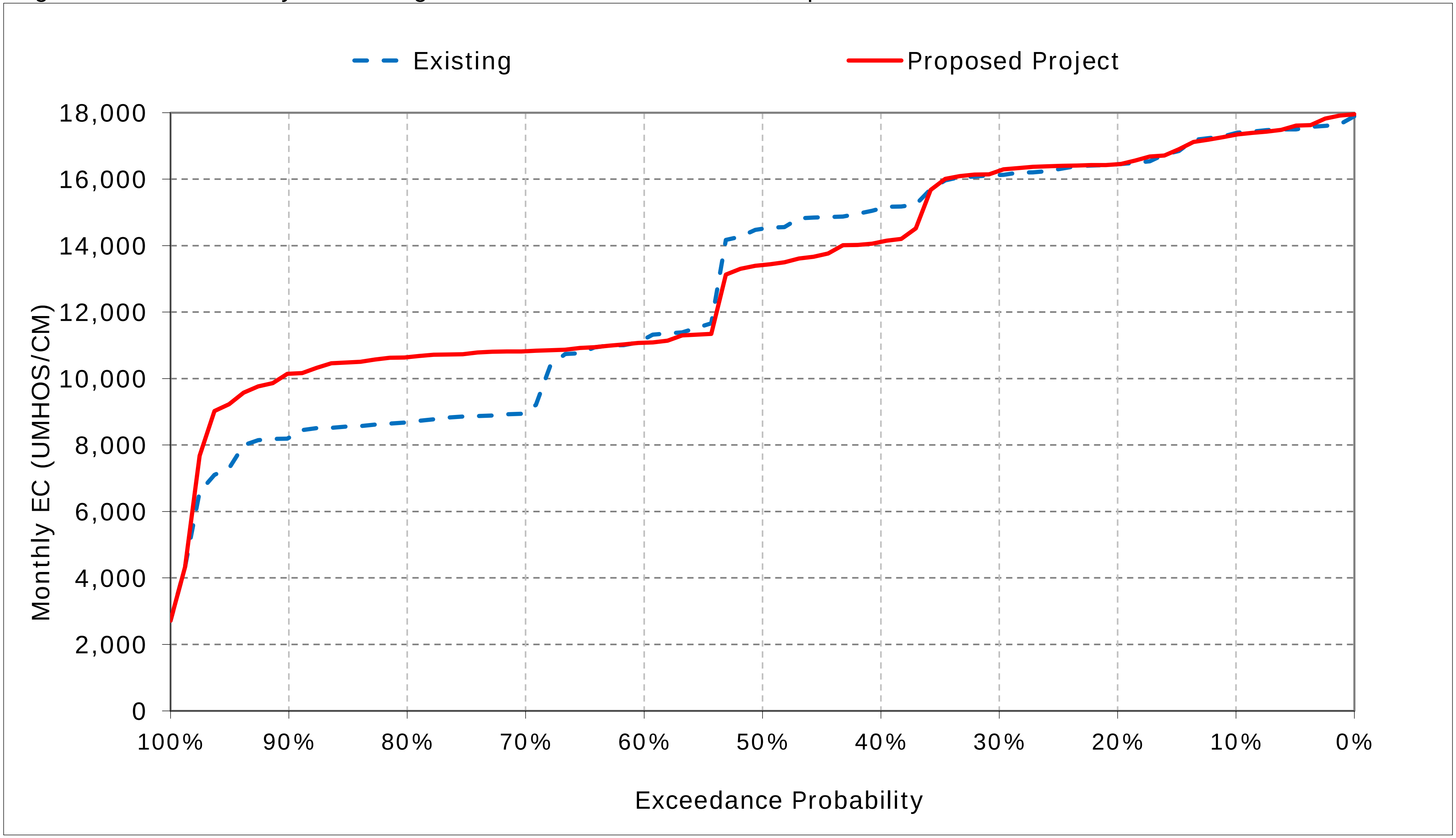


Figure 25-16. Goodyear Slough Outfall at Naval Fleet, October EC

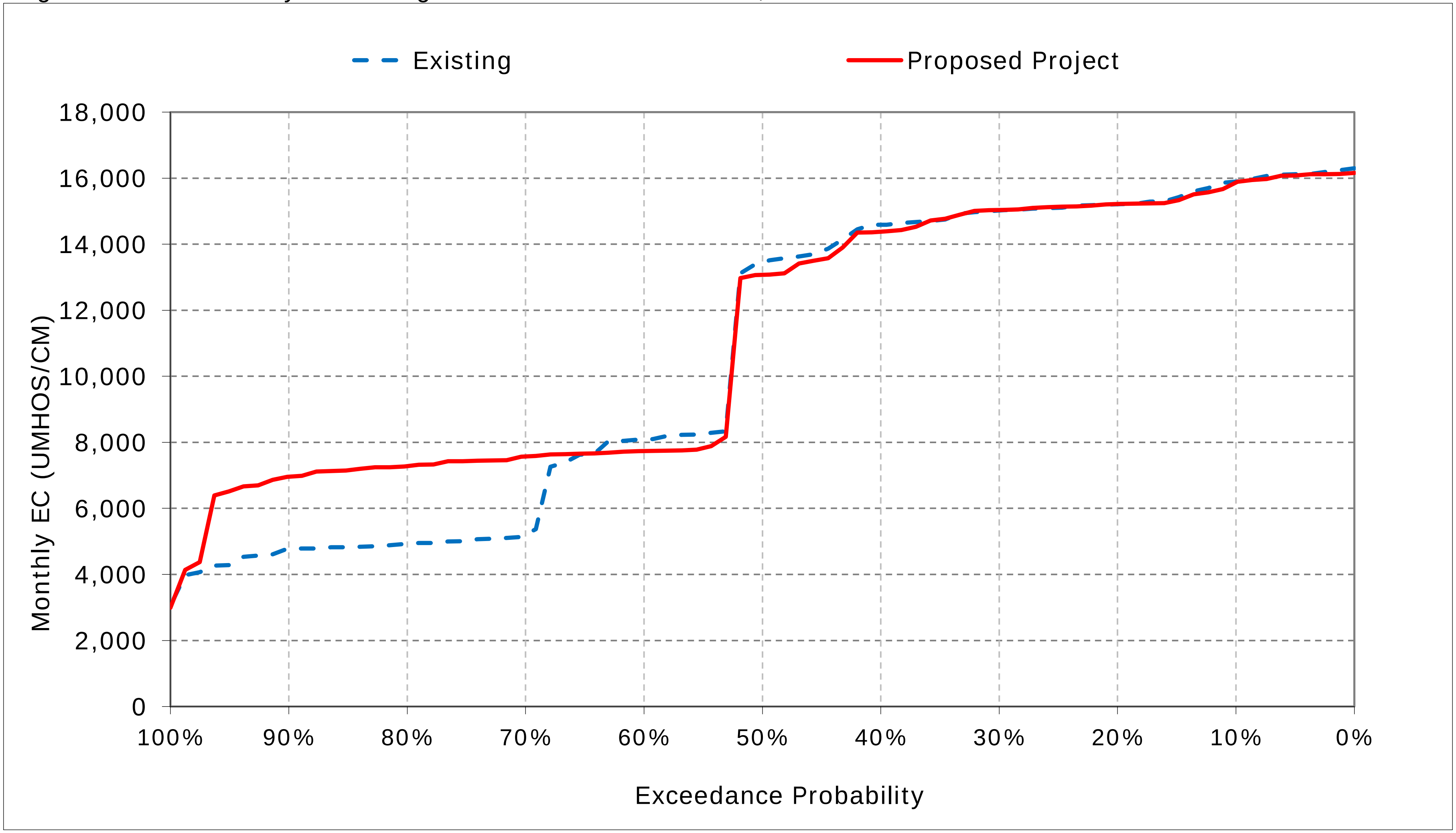


Figure 25-17. Goodyear Slough Outfall at Naval Fleet, November EC

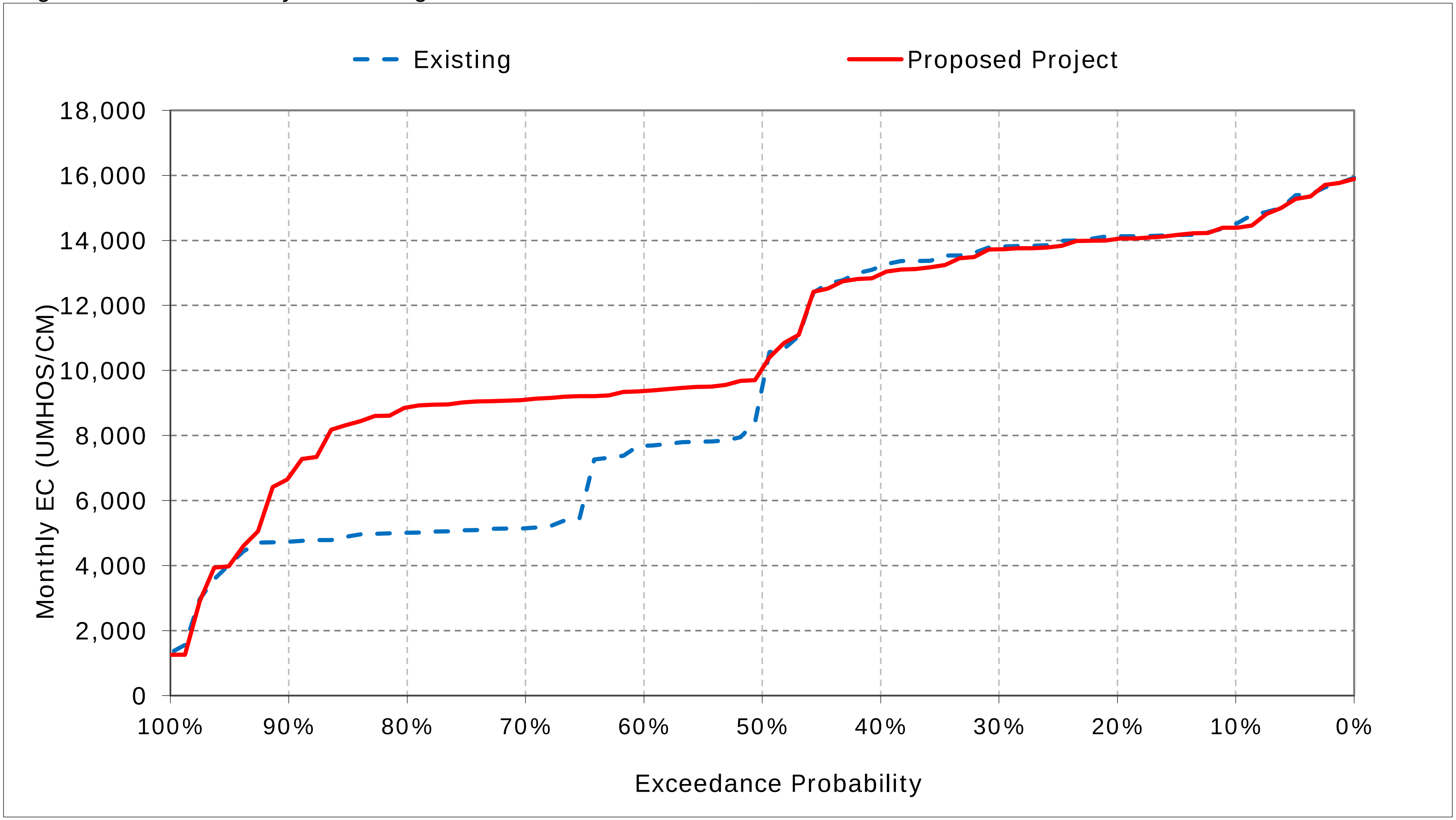
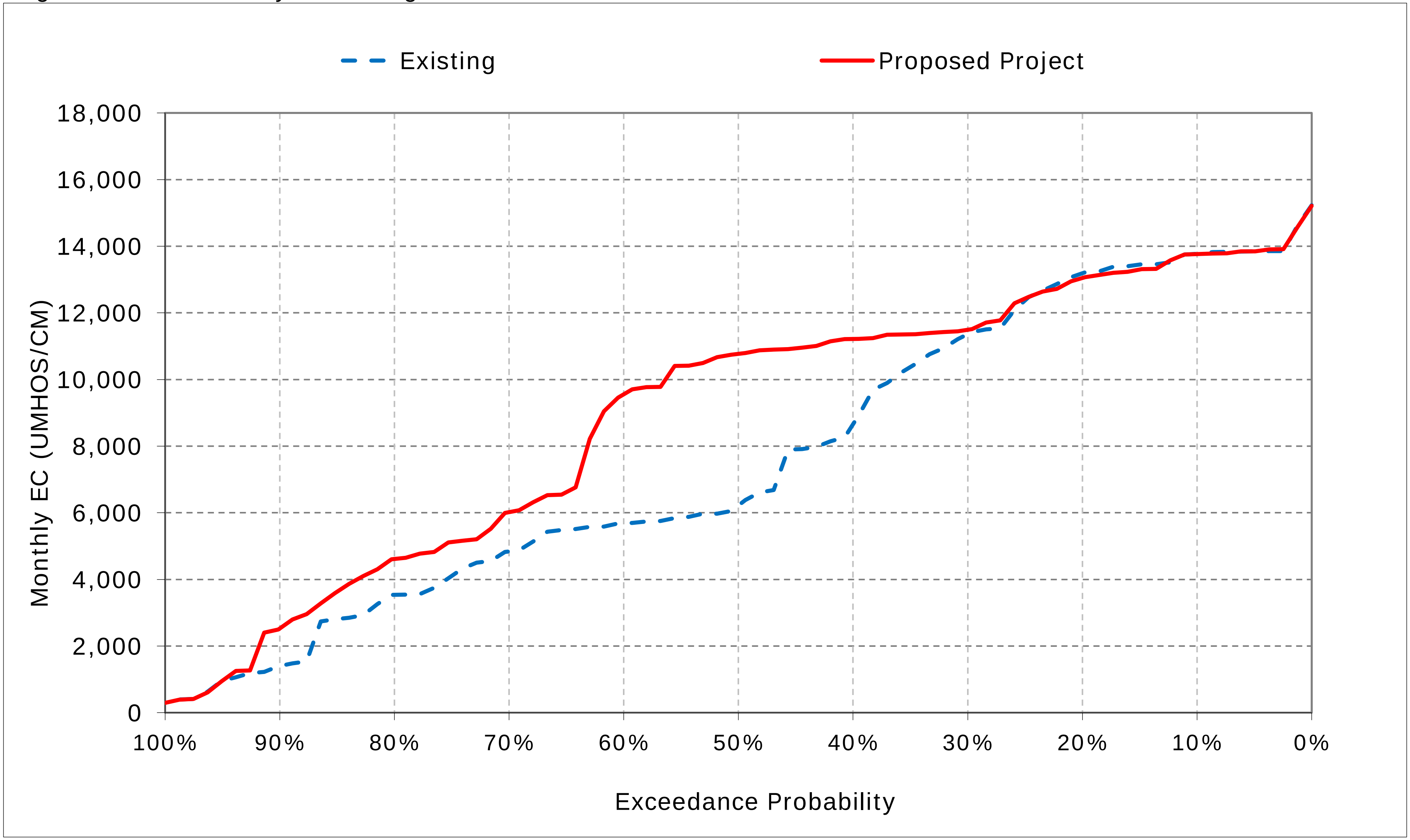


Figure 25-18. Goodyear Slough Outfall at Naval Fleet, December EC



Appendix C – Modeling

Attachment 2-8 – Chloride Results (DSM2-QUAL)

The following results of the DSM2-QUAL model are included for Delta chloride conditions for the following alternatives:

- Existing Conditions
- Proposed Project

Table 2-8.1. Chloride Results (DSM2-QUAL)

Title	Model Parameter	Table Numbers	Figure Numbers
Sacramento River at Mallard Slough Salinity	RSAC075	1-1	1-1 to 1-18
Sacramento River at Rio Vista Salinity	RSAC101	2-1	2-1 to 2-18
Sacramento River at Collinsville Salinity	RSAC081	3-1	3-1 to 3-18
San Joaquin River at Jersey Point Salinity	RSAN018	4-1	4-1 to 4-18
San Joaquin River at San Andreas Salinity	RSAN032	5-1	5-1 to 5-18
San Joaquin River at Prisoners Point Salinity	RSAN037	6-1	6-1 to 6-18
Old River at Highway 4	ROLD034	7-1	7-1 to 7-18
Victoria Canal	CHVCT000	8-1	8-1 to 8-18
Contra Costa Pumping Plant Chloride	ROLD024	9-1	9-1 to 9-18
San Joaquin River at Antioch Chloride	RSAN007	10-1	10-1 to 10-18
Banks Pumping Plant South Delta Exports Chloride	CLIFTON_COURT	11-1	11-1 to 11-18
Jones Pumping Plant South Delta Exports Chloride	CHDMC006	12-1	12-1 to 12-18
North Bay Aqueduct Chloride	SLBAR002	13-1	13-1 to 13-18

Report formats

- Monthly tables comparing two scenarios (exceedance values, long-term average, and average by water year type)
- Monthly pattern charts (long-term average and average by water year type) including all scenarios
- Monthly exceedance charts (all months) including all scenarios

Table 1-1. Sacramento River at Mallard Slough Chloride, Monthly Cl

Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Cl (mg/L)											
Probability of Exceedance												
10%	4,015	3,822	3,637	2,412	1,260	1,094	1,174	1,545	2,008	2,652	3,365	3,719
20%	3,828	3,720	3,179	2,137	783	590	617	1,178	1,669	2,310	2,998	3,544
30%	3,766	3,614	2,348	1,643	415	223	316	914	1,595	2,196	2,917	3,478
40%	3,689	3,468	1,973	946	181	149	236	544	1,352	1,697	2,436	3,232
50%	3,369	1,816	1,688	682	99	71	127	307	1,109	1,552	2,267	2,911
60%	1,826	1,581	1,537	367	32	29	53	182	867	1,225	2,209	1,505
70%	1,068	943	625	52	21	19	29	93	633	1,144	2,080	835
80%	1,001	848	256	21	18	18	19	29	282	1,004	1,998	746
90%	957	760	54	17	17	17	17	17	31	696	1,910	672
Long Term												
Full Simulation Period[a]	2,564	2,279	1,738	981	404	292	353	605	1,127	1,633	2,438	2,279
Water Year Types[b]												
Wet (32%)	2,021	1,495	562	147	27	31	48	106	378	831	1,852	686
Above Normal (15%)	2,675	2,250	1,740	575	125	35	66	162	779	1,119	2,036	1,473
Below Normal (17%)	2,687	2,514	2,225	1,090	249	208	229	447	1,098	1,600	2,353	3,062
Dry (22%)	2,713	2,638	2,183	1,578	677	422	517	919	1,575	2,241	2,957	3,511
Critical (15%)	3,265	3,198	3,046	2,170	1,272	1,020	1,199	1,840	2,458	3,012	3,430	3,778

Proposed Project

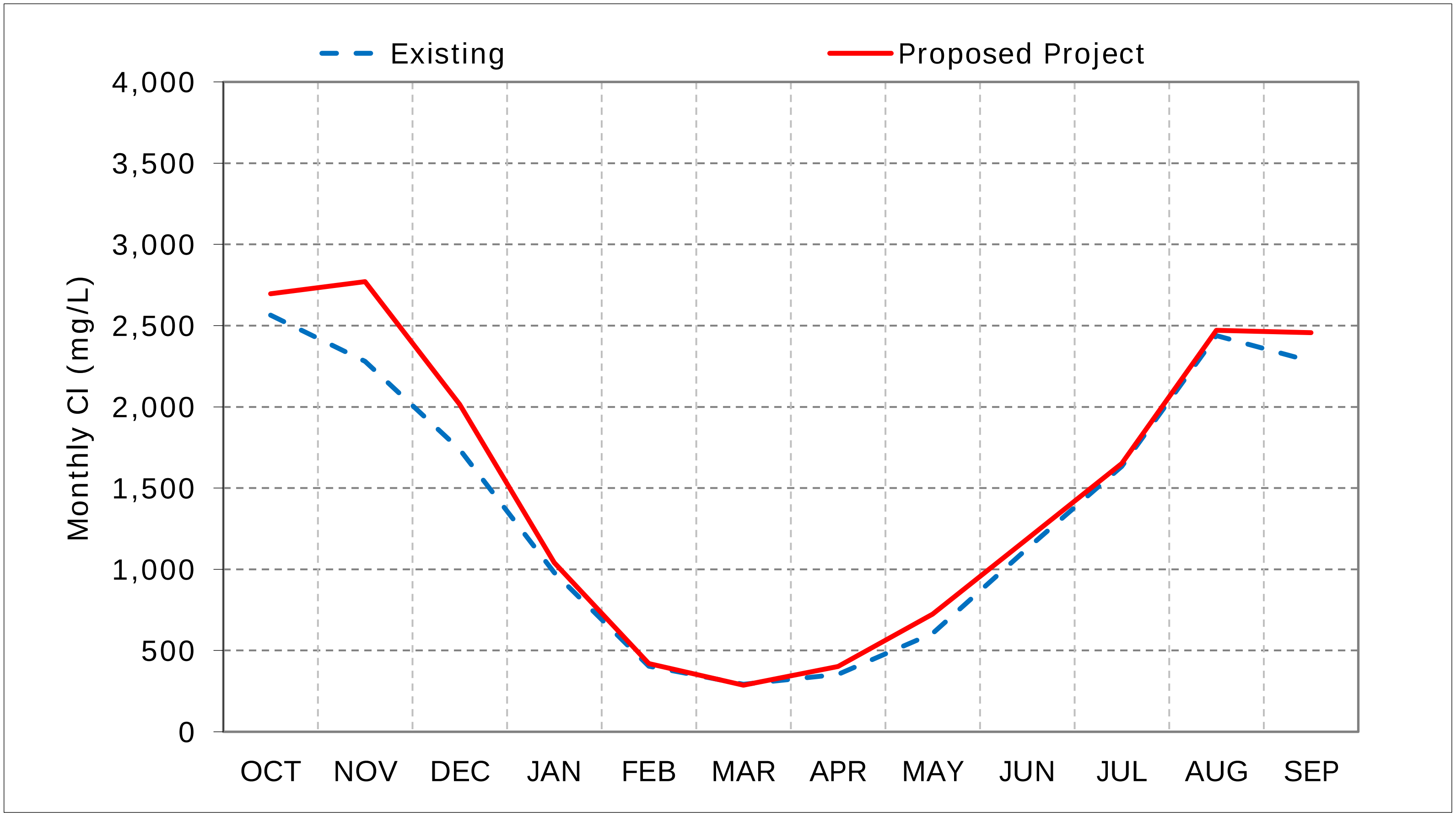
Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Cl (mg/L)											
Probability of Exceedance												
10%	3,988	3,790	3,613	2,705	1,204	1,102	1,248	1,618	2,025	2,651	3,340	3,717
20%	3,805	3,712	3,167	2,298	741	556	757	1,387	1,801	2,340	3,009	3,559
30%	3,750	3,609	3,004	1,781	394	186	455	1,178	1,649	2,177	2,929	3,493
40%	3,590	3,422	2,813	1,014	201	134	315	722	1,496	1,790	2,708	3,348
50%	3,305	2,647	2,461	692	95	56	179	475	1,166	1,591	2,439	2,948
60%	1,717	2,538	1,898	343	25	25	71	341	1,007	1,212	2,191	1,437
70%	1,652	2,479	768	54	21	19	36	167	717	1,133	2,069	1,390
80%	1,572	2,275	443	21	18	18	19	43	299	1,014	1,984	1,320
90%	1,480	1,083	80	18	17	17	17	17	32	698	1,897	1,212
Long Term												
Full Simulation Period[a]	2,696	2,771	2,015	1,042	420	287	402	725	1,187	1,651	2,471	2,456
Water Year Types[b]												
Wet (32%)	2,200	2,126	728	145	26	29	69	176	437	834	1,822	1,236
Above Normal (15%)	2,830	2,795	2,164	608	90	31	98	287	826	1,104	2,046	1,356
Below Normal (17%)	2,825	2,980	2,563	1,100	234	189	299	627	1,151	1,684	2,573	3,151
Dry (22%)	2,856	3,061	2,522	1,730	727	402	596	1,092	1,659	2,262	2,974	3,525
Critical (15%)	3,244	3,464	3,253	2,319	1,357	1,041	1,258	1,916	2,509	3,016	3,429	3,789

Proposed Project minus Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Cl (mg/L)											
Probability of Exceedance												
10%	-27	-31	-24	293	-56	9	74	73	17	-1	-25	-2
20%	-23	-8	-13	161	-43	-34	139	209	131	31	10	15
30%	-16	-5	656	138	-20	-36	139	264	54	-18	11	16
40%	-99	-47	840	68	20	-15	78	178	144	93	272	116
50%	-63	831	773	9	-4	-14	52	168	57	39	173	37
60%	-109	956	361	-24	-6	-4	18	159	140	-13	-18	-68
70%	585	1,537	143	2	0	0	8	73	84	-11	-12	554
80%	571	1,427	187	0	0	0	0	14	18	10	-14	573
90%	523	323	25	0	0	0	-1	0	0	1	-13	540
Long Term												
Full Simulation Period[a]	131	491	277	61	16	-6	49	120	61	18	33	177
Water Year Types[b]												
Wet (32%)	179	631	166	-2	-2	-2	21	69	59	3	-31	550
Above Normal (15%)	155	546	424	33	-35	-4	32	126	47	-15	10	-117
Below Normal (17%)	139	466	338	10	-14	-19	70	180	53	84	220	89
Dry (22%)	143	423	339	152	51	-20	79	173	84	21	17	14
Critical (15%)	-21	266	207	149	86	22	60	75	51	4	-1	11

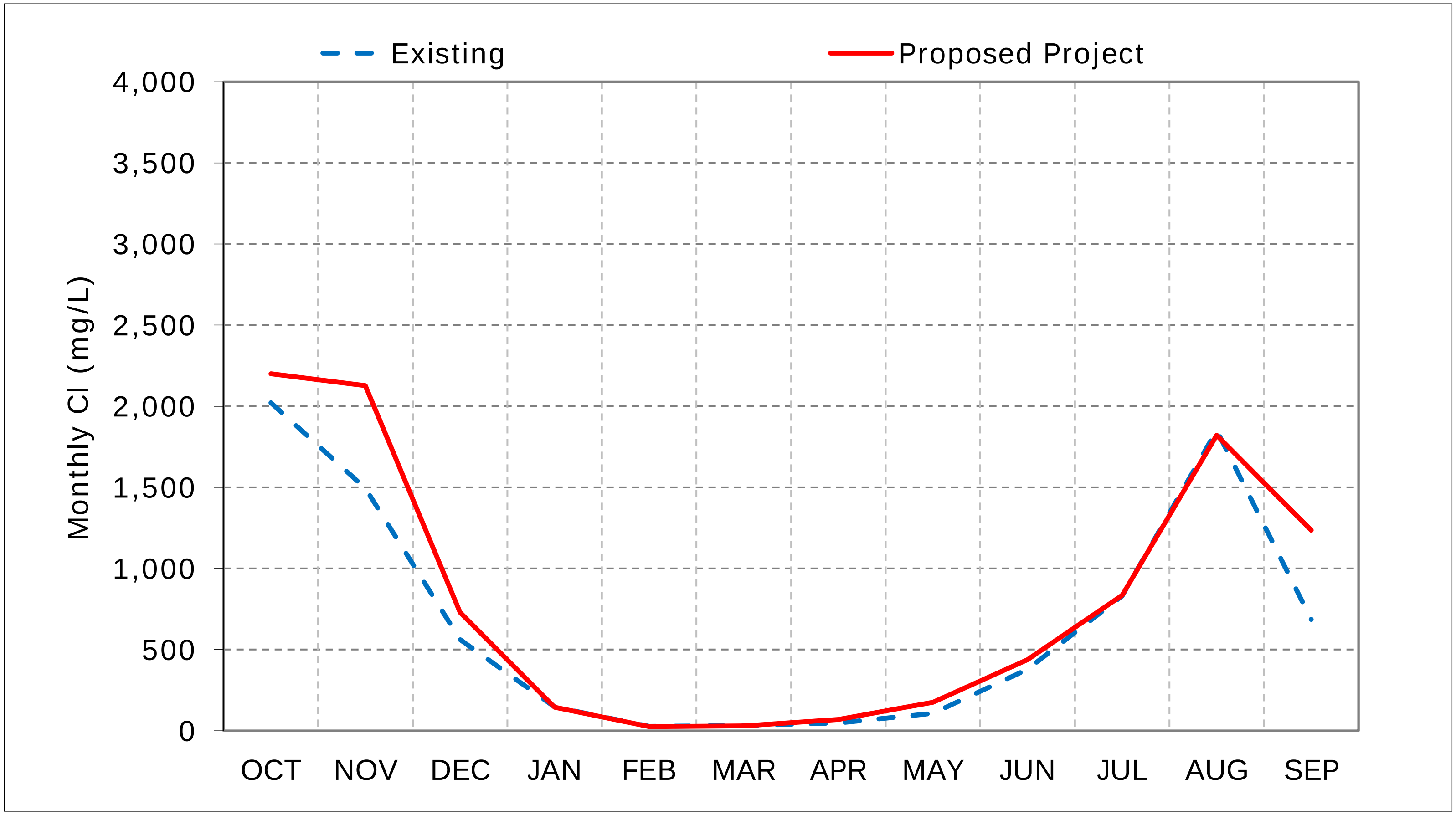
a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with water year - year type sorting.
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 1-1. Sacramento River at Mallard Slough Chloride, Long-Term Average Cl



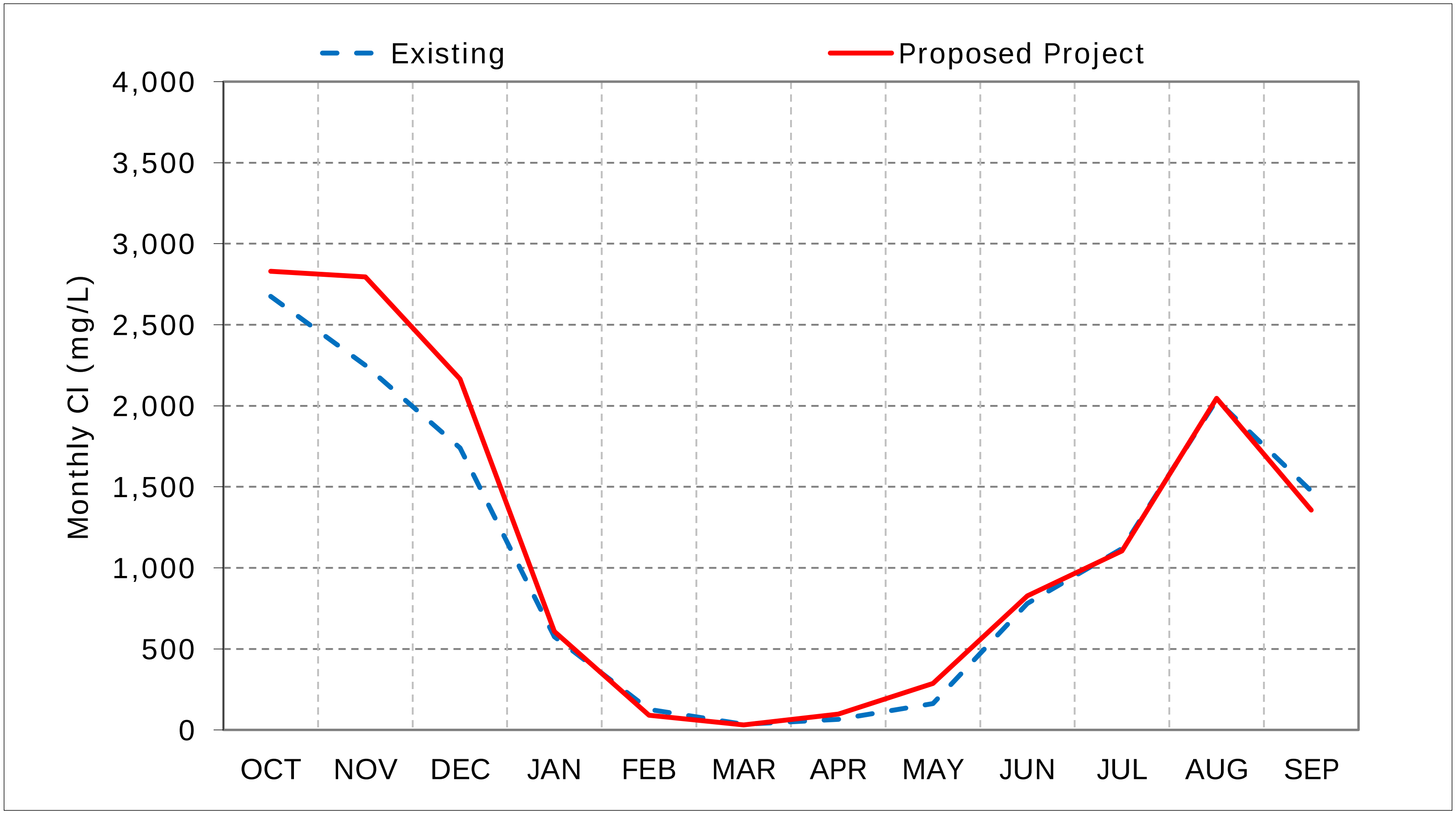
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 1-2. Sacramento River at Mallard Slough Chloride, Wet Year Average Cl



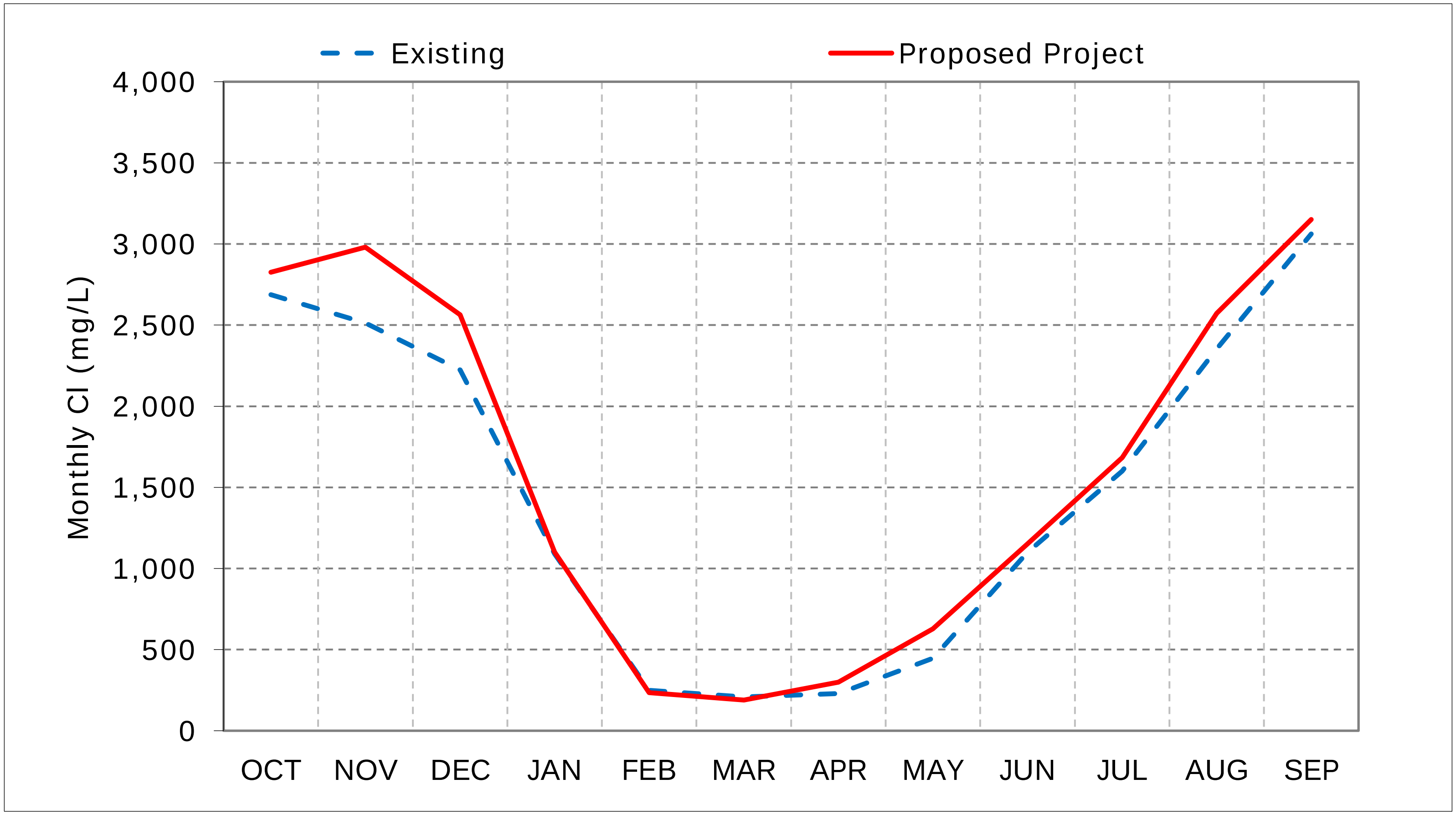
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 1-3. Sacramento River at Mallard Slough Chloride, Above Normal Year Aver



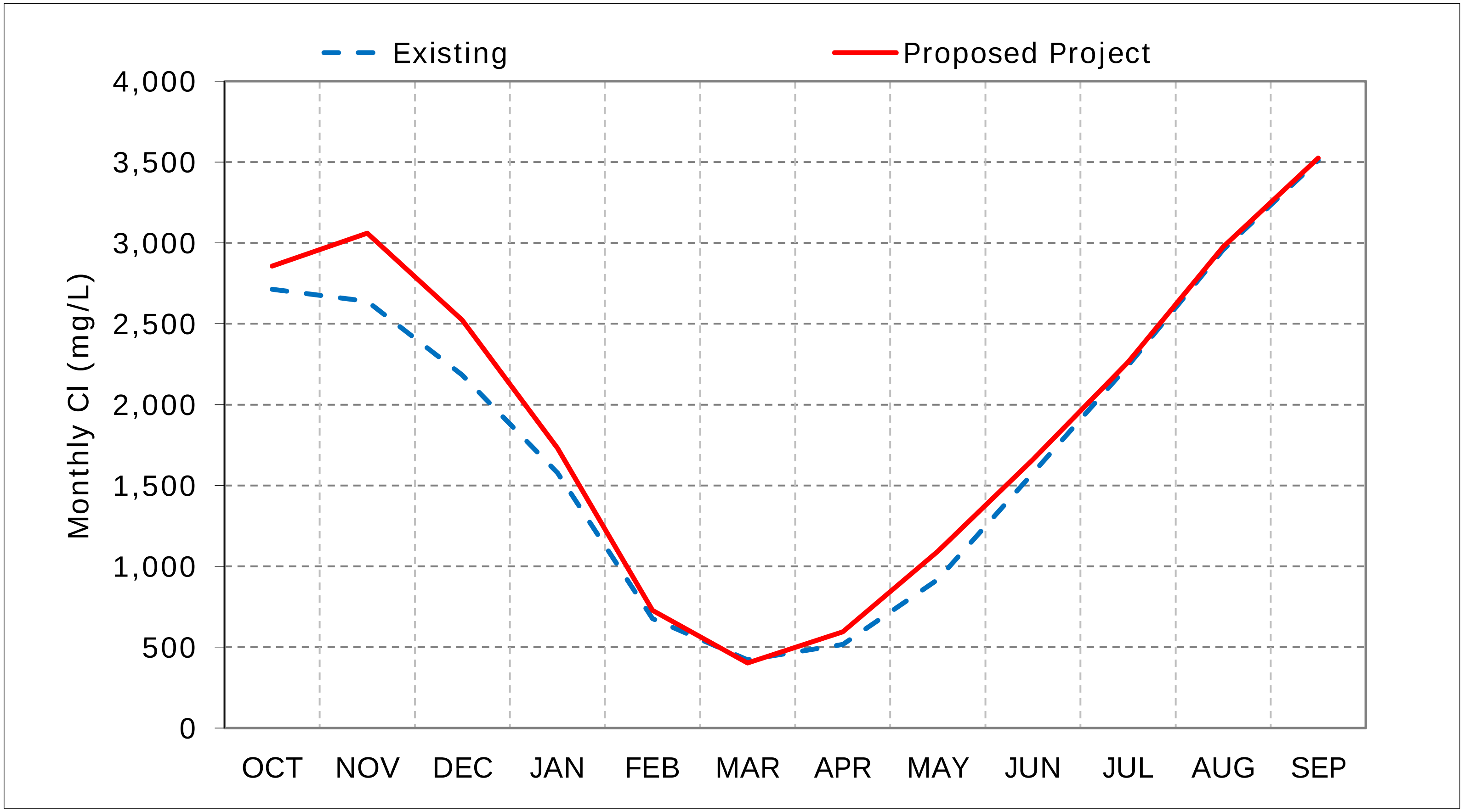
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 1-4. Sacramento River at Mallard Slough Chloride, Below Normal Year Aver



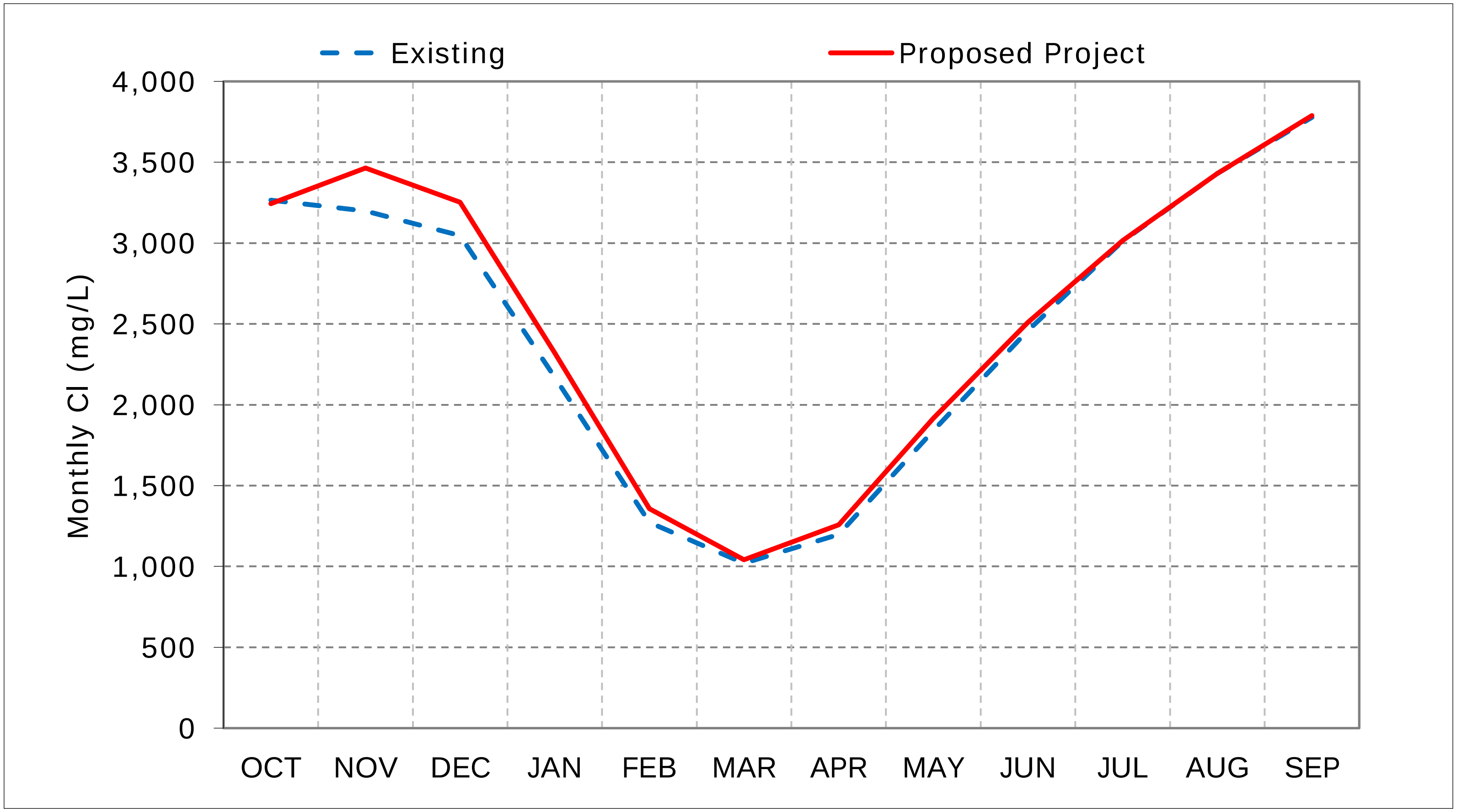
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 1-5. Sacramento River at Mallard Slough Chloride, Dry Year Average Cl



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 1-6. Sacramento River at Mallard Slough Chloride, Critical Year Average Cl



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 1-7. Sacramento River at Mallard Slough Chloride, January Cl

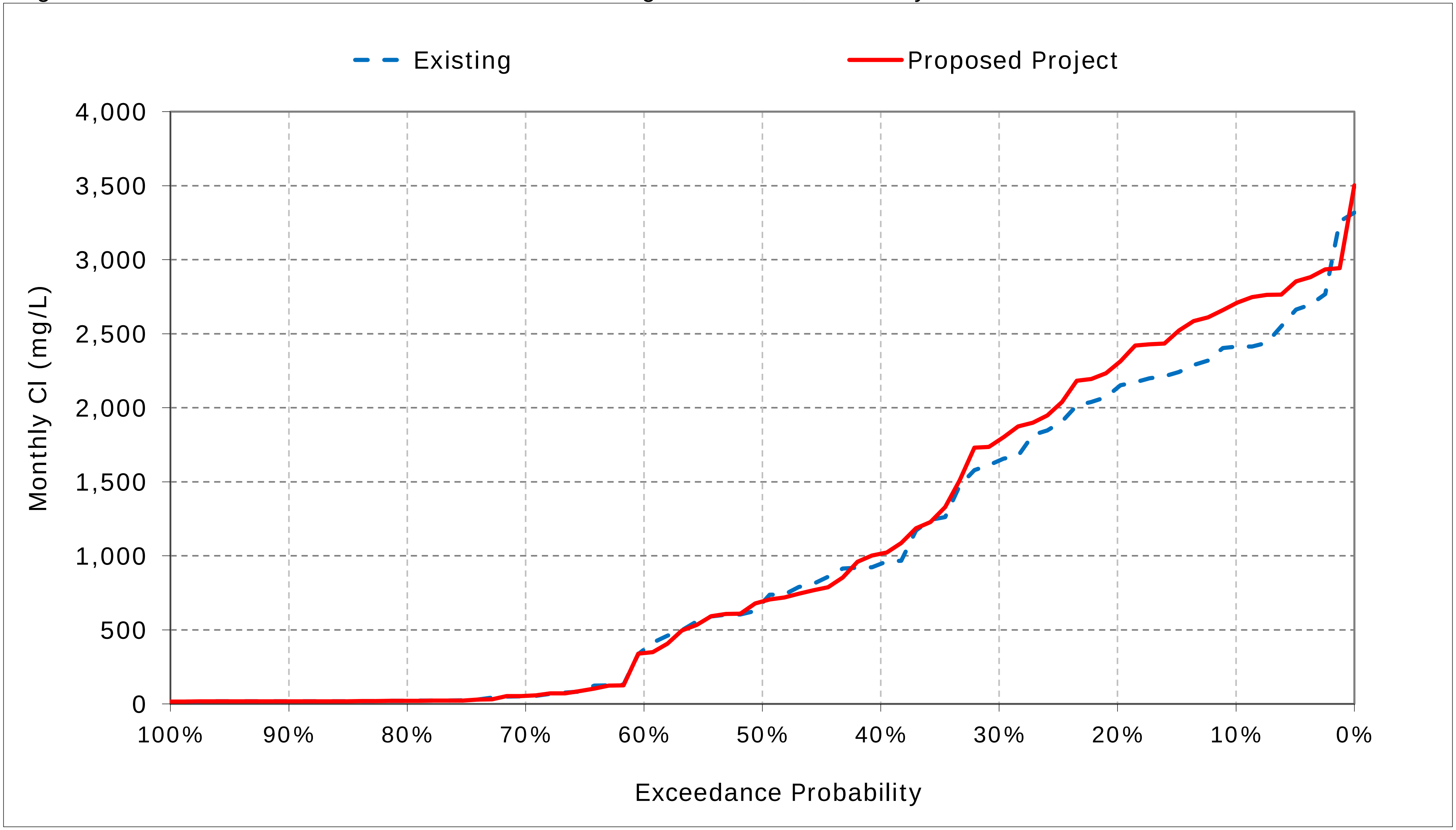


Figure 1-8. Sacramento River at Mallard Slough Chloride, February Cl

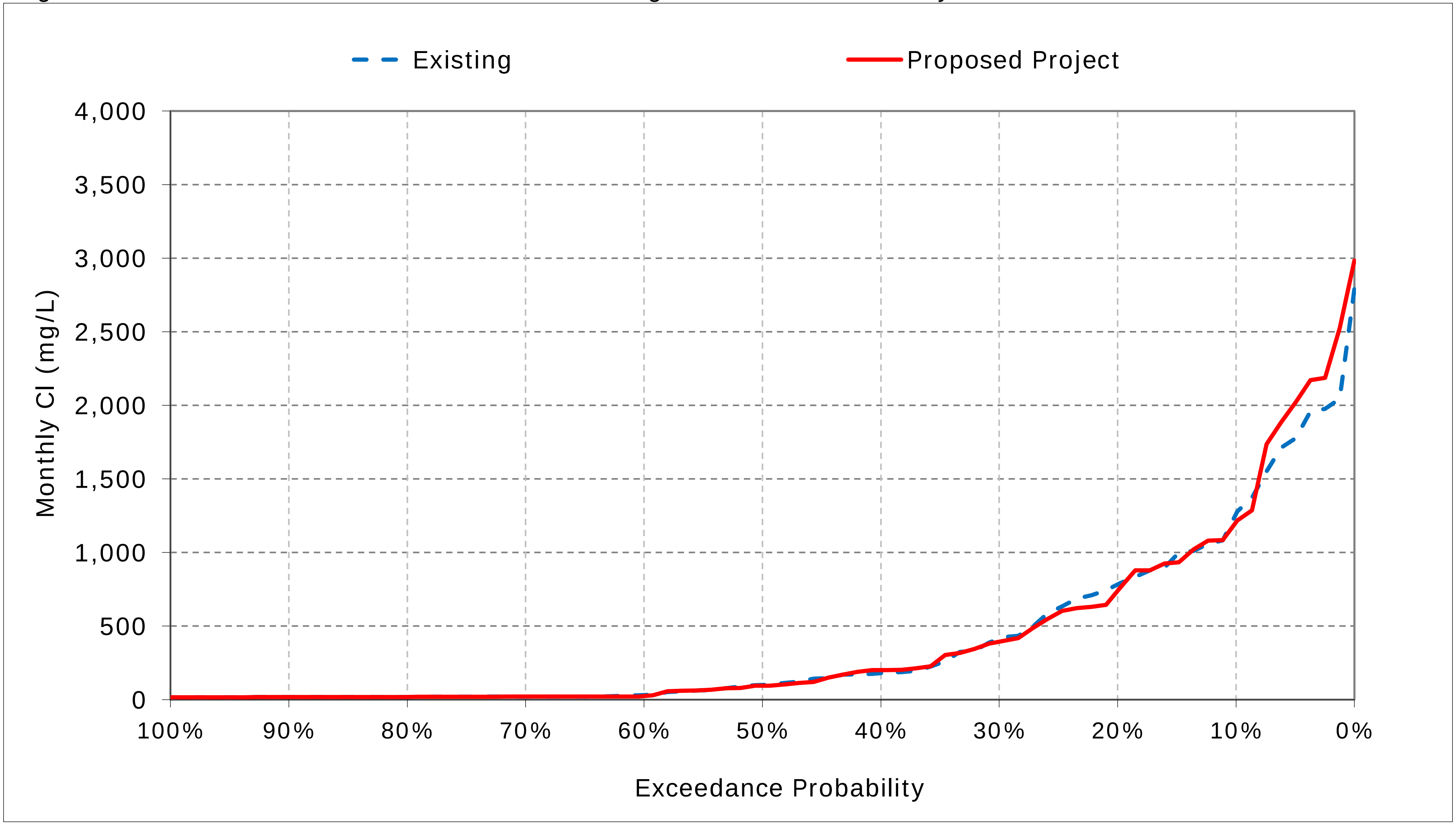


Figure 1-9. Sacramento River at Mallard Slough Chloride, March Cl

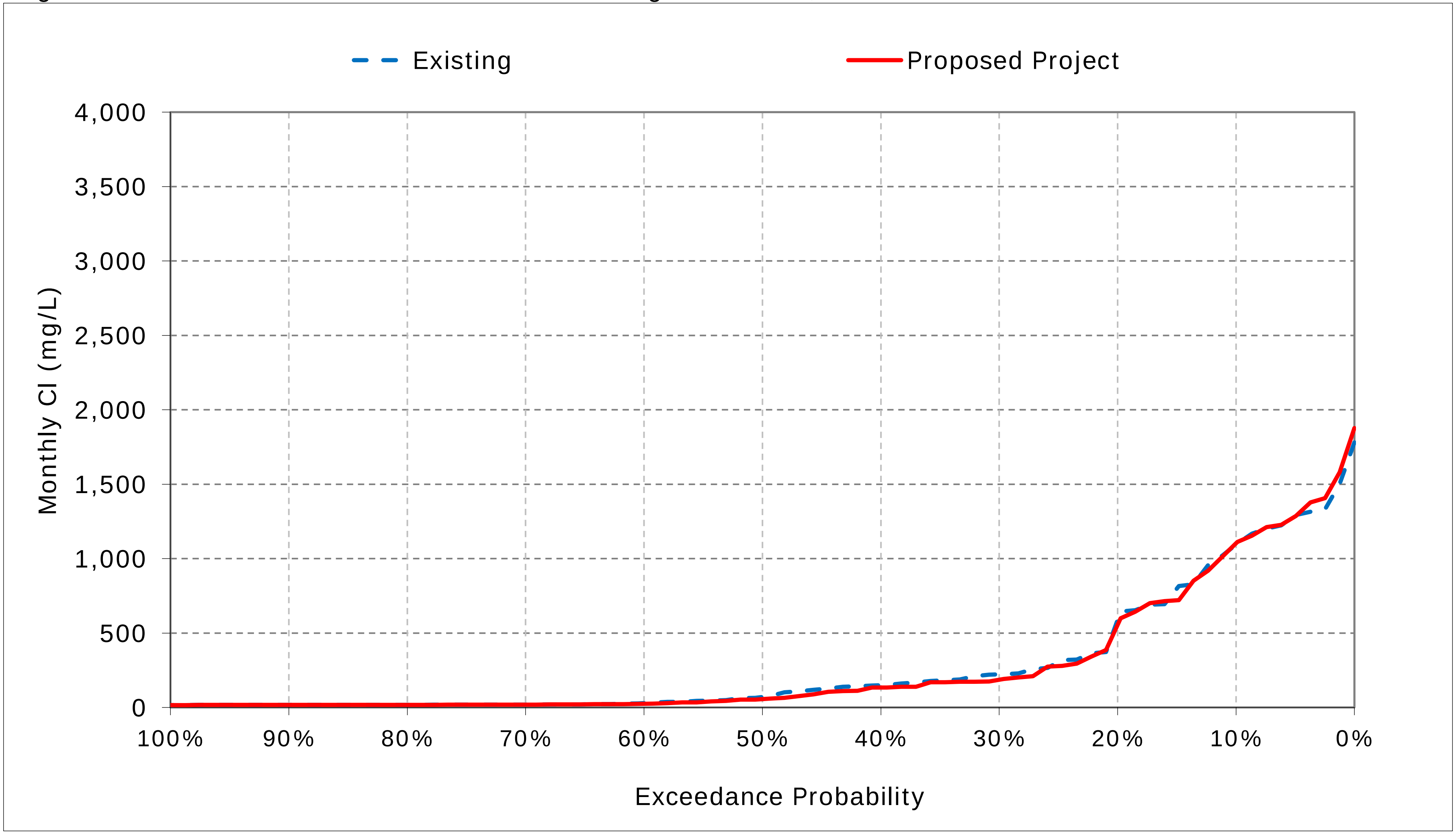


Figure 1-10. Sacramento River at Mallard Slough Chloride, April Cl

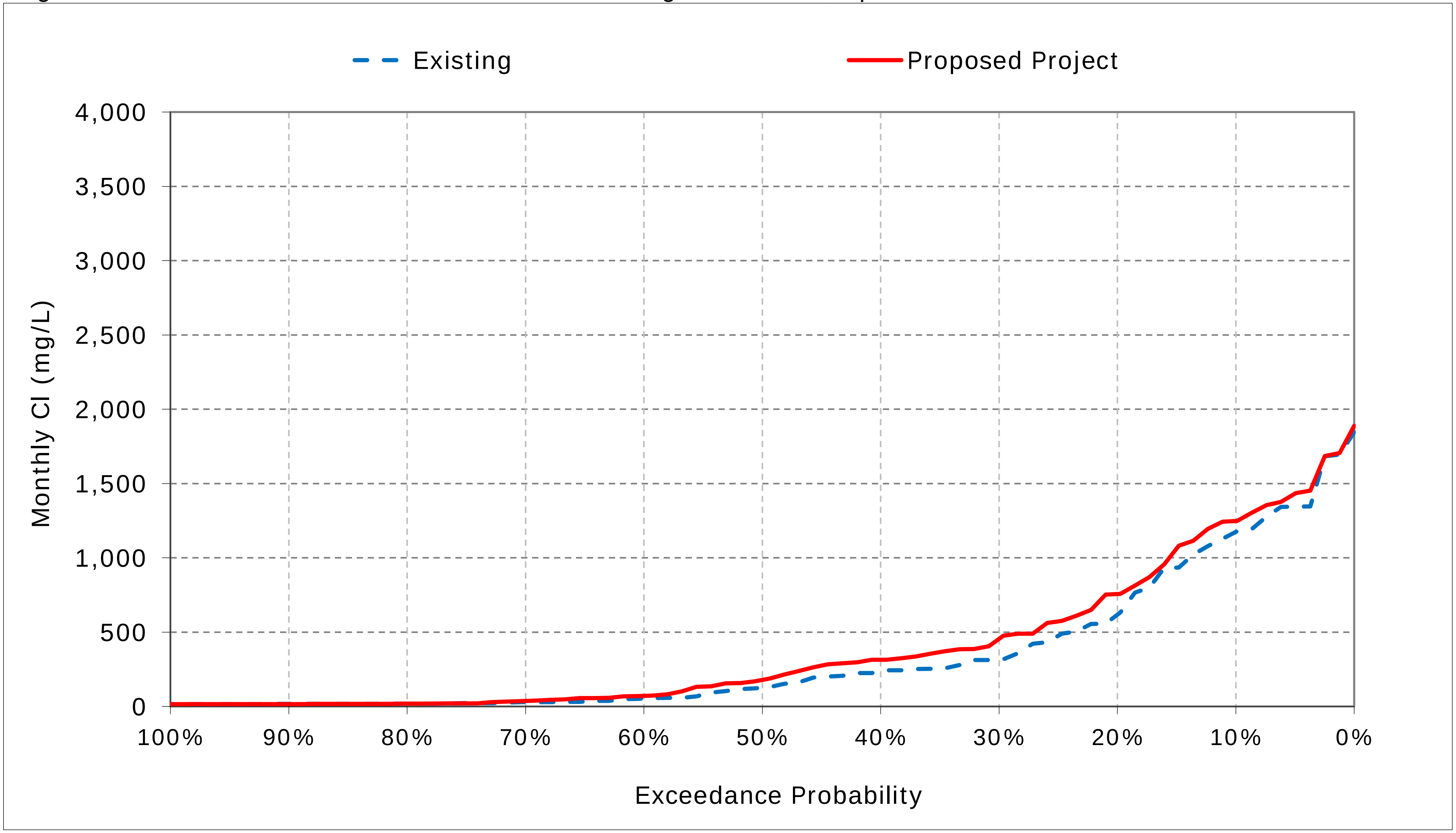


Figure 1-11. Sacramento River at Mallard Slough Chloride, May Cl

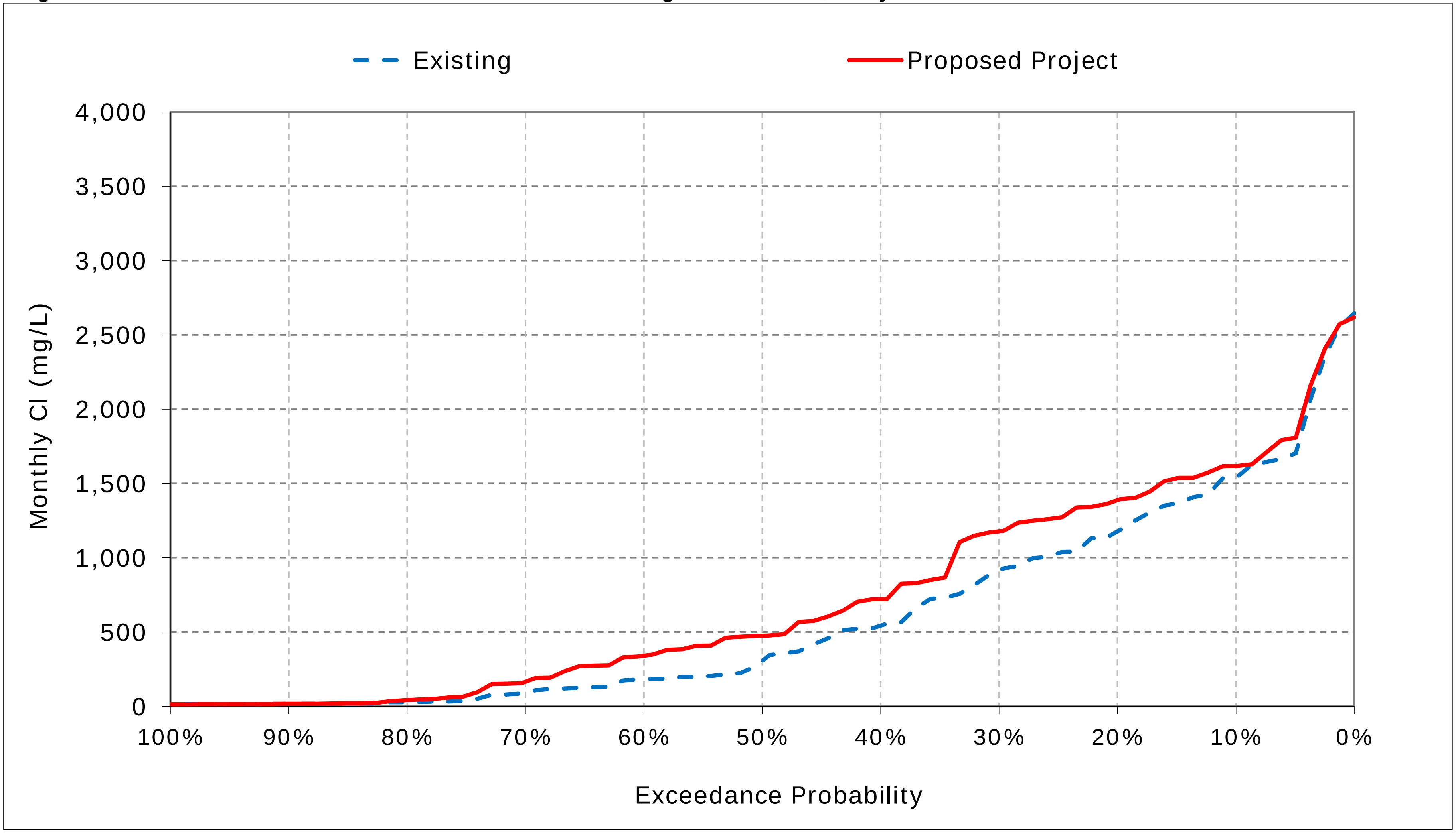


Figure 1-12. Sacramento River at Mallard Slough Chloride, June Cl

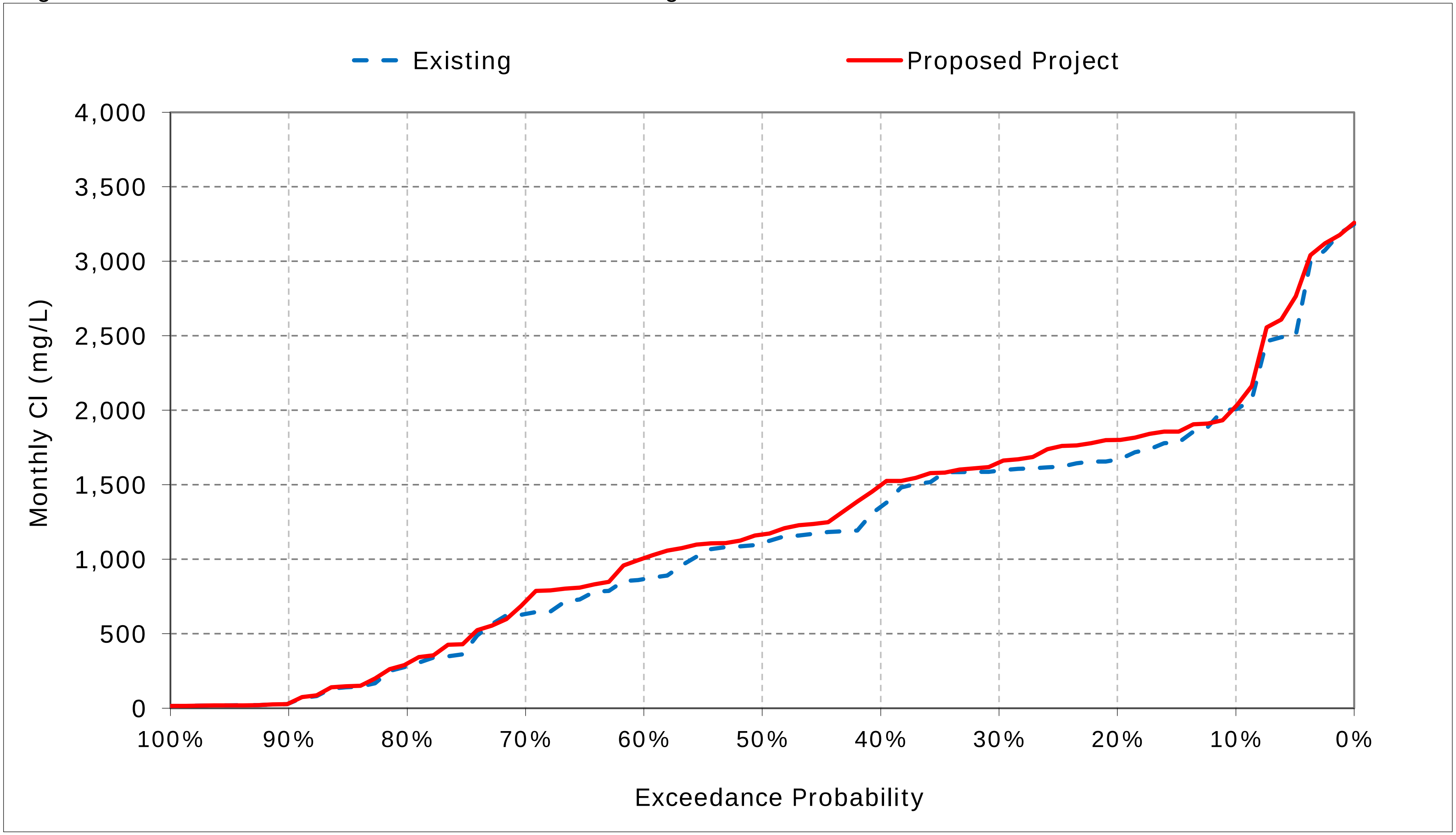


Figure 1-13. Sacramento River at Mallard Slough Chloride, July Cl

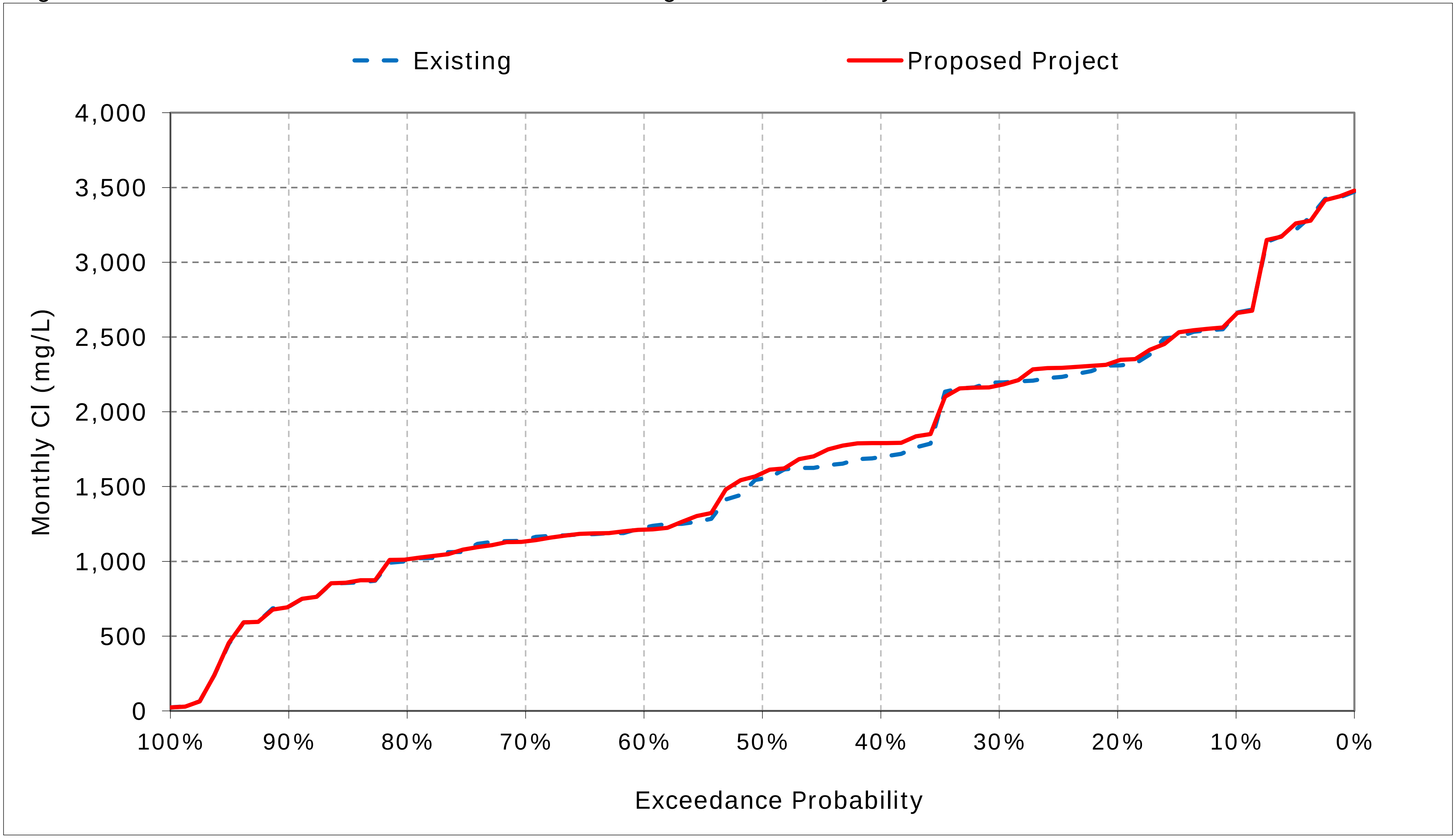


Figure 1-14. Sacramento River at Mallard Slough Chloride, August Cl

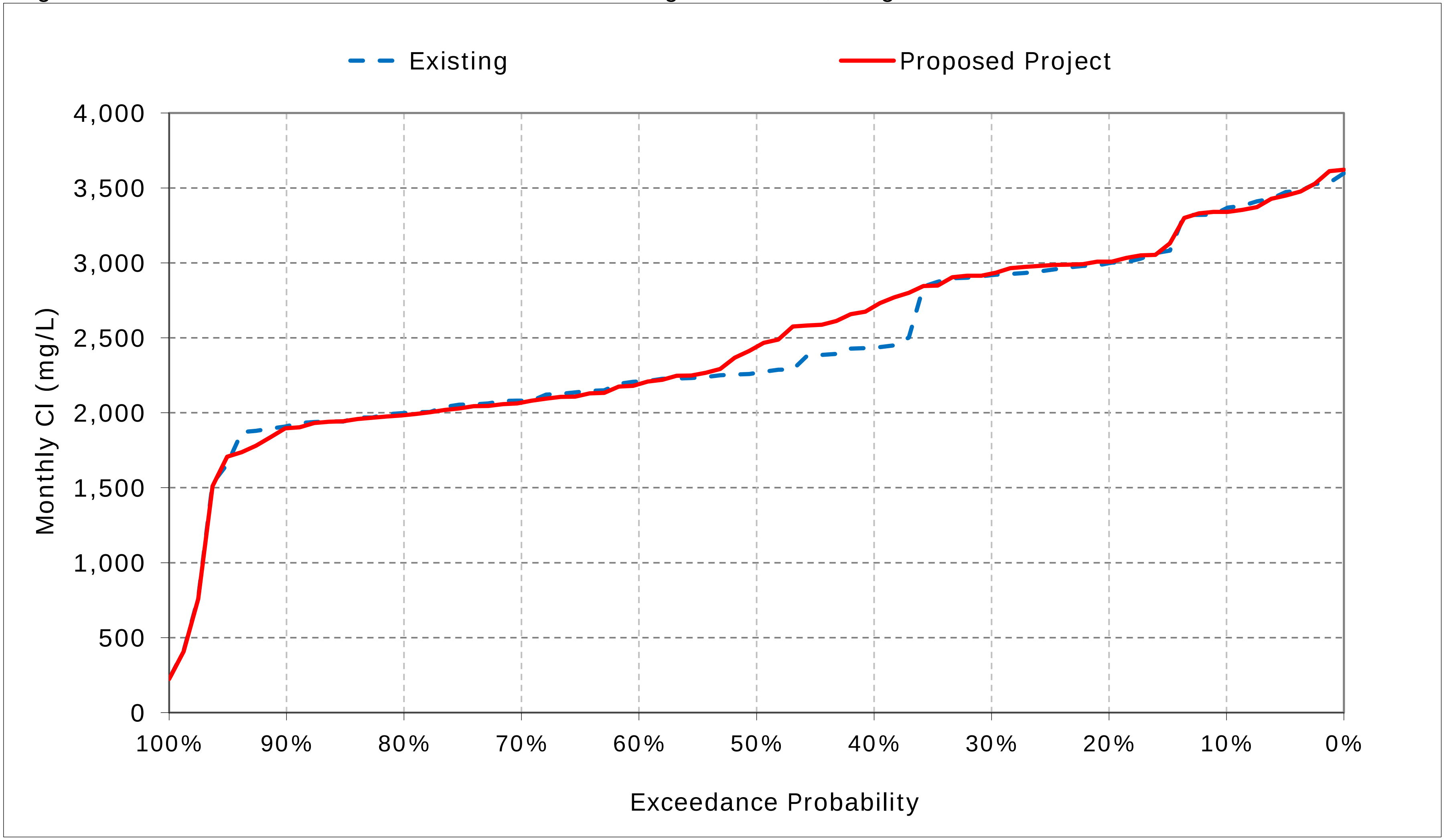


Figure 1-15. Sacramento River at Mallard Slough Chloride, September Cl

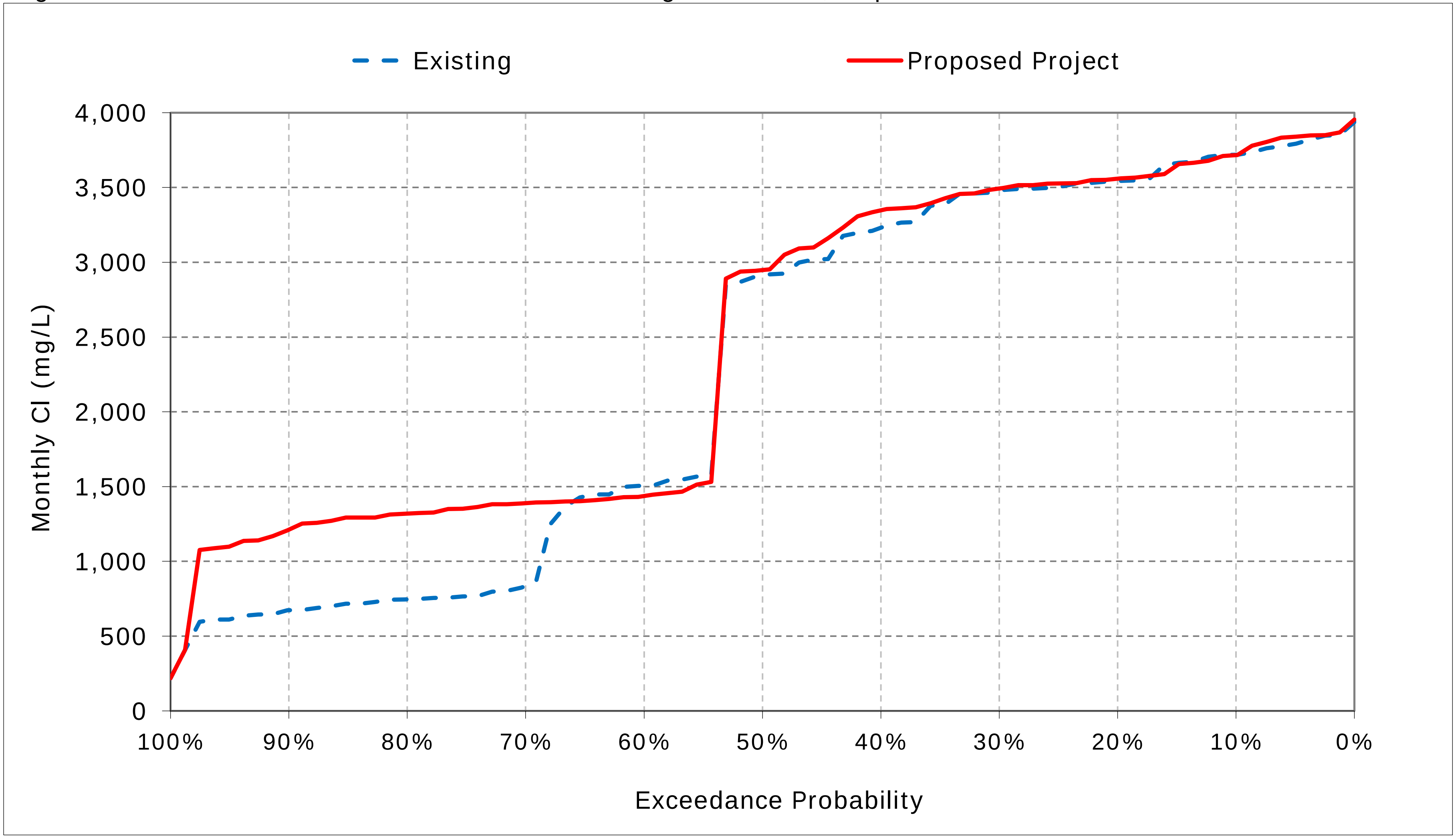


Figure 1-16. Sacramento River at Mallard Slough Chloride, October Cl

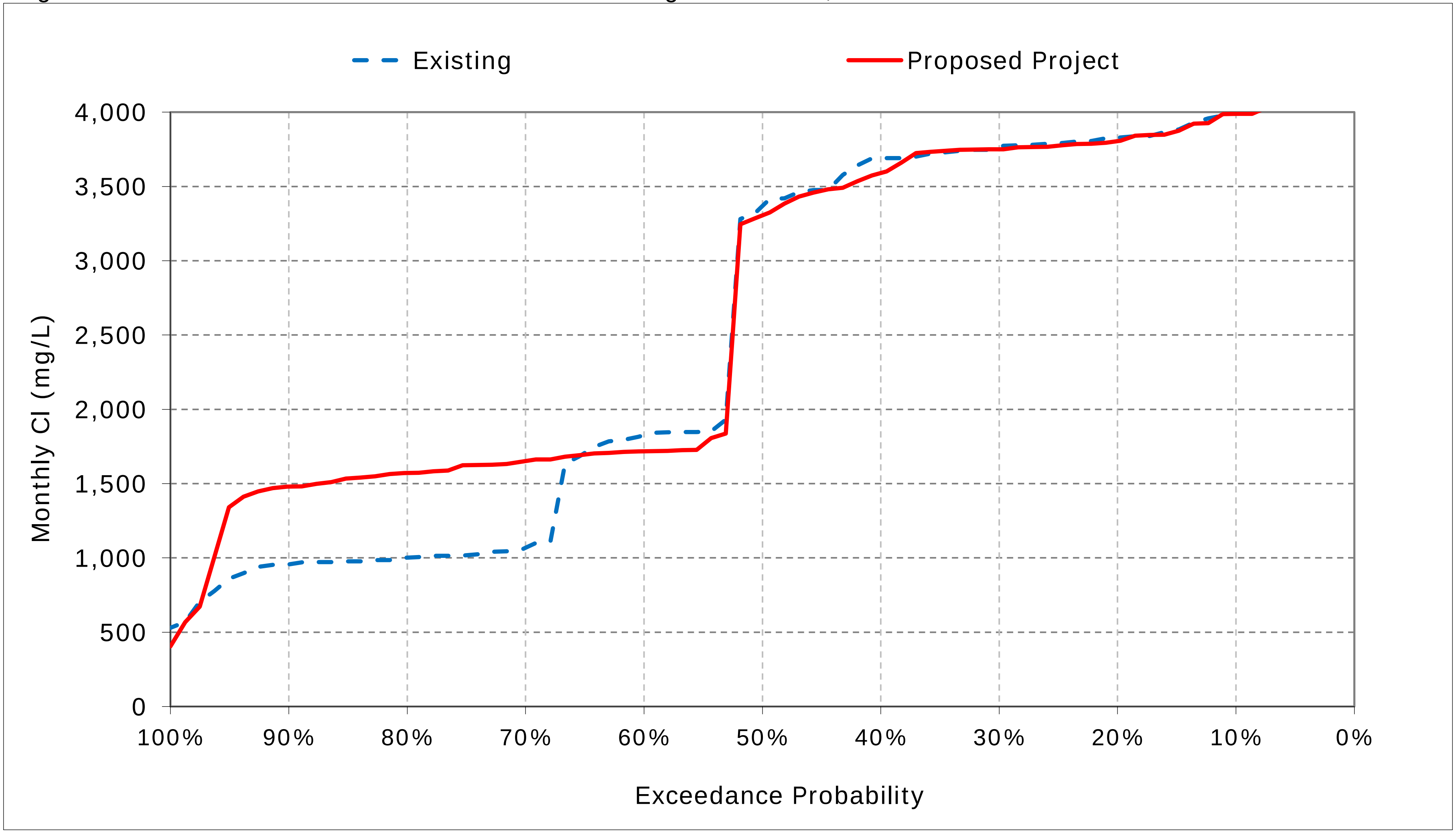


Figure 1-17. Sacramento River at Mallard Slough Chloride, November Cl

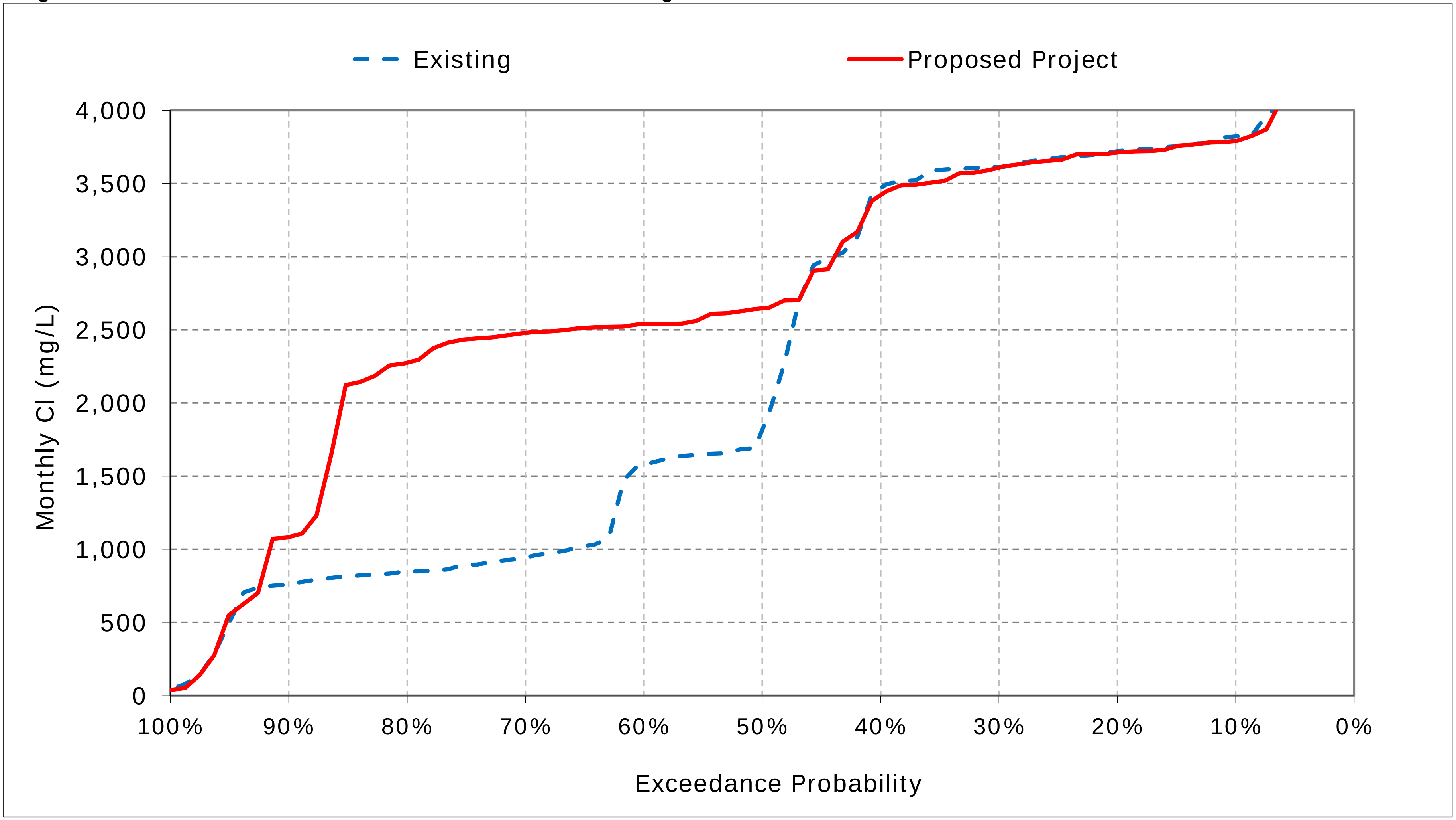


Figure 1-18. Sacramento River at Mallard Slough Chloride, December Cl

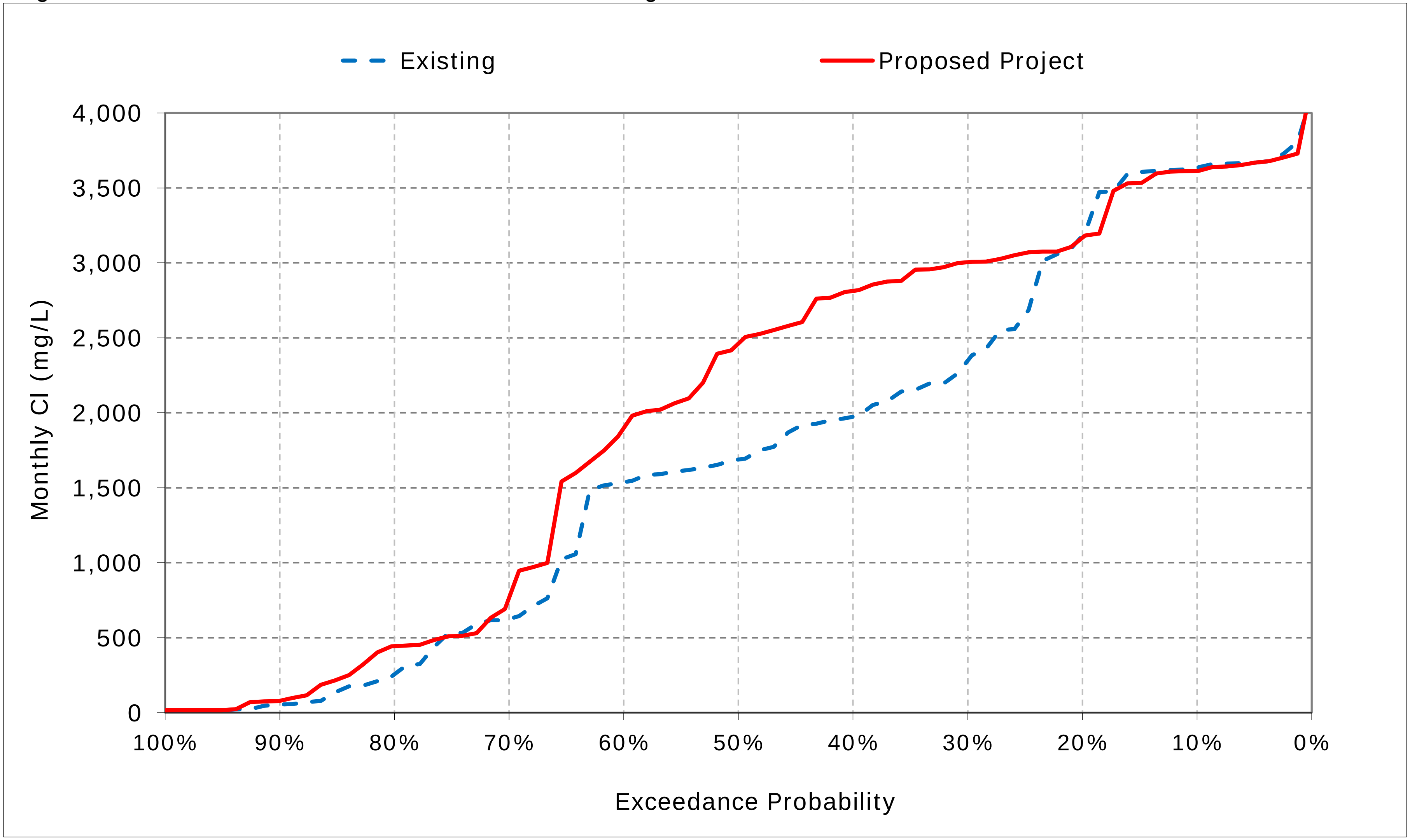


Table 2-1. Sacramento River at Rio Vista Chloride, Monthly Cl

Existing

Statistic	Monthly Cl (mg/L) Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	90	70	55	25	18	17	17	18	20	30	55	80
20%	70	52	34	22	17	16	16	17	18	23	44	60
30%	64	46	23	20	17	16	16	16	17	21	40	56
40%	56	35	20	19	17	16	16	16	17	18	24	44
50%	42	18	19	18	16	15	15	16	17	17	23	31
60%	18	16	18	17	16	15	15	15	16	16	22	17
70%	16	15	16	17	15	15	15	15	16	16	21	15
80%	16	15	16	16	15	15	15	15	15	16	20	15
90%	16	15	15	15	15	15	15	15	15	15	20	15
Long Term												
Full Simulation Period[a]	45	35	26	19	16	16	16	16	19	22	31	39
Water Year Types[b]												
Wet (32%)	34	22	17	16	15	15	15	15	15	16	20	15
Above Normal (15%)	45	36	22	18	16	15	15	15	16	16	21	17
Below Normal (17%)	44	31	32	19	16	16	16	16	16	17	23	38
Dry (22%)	50	43	27	21	17	16	16	16	18	22	41	57
Critical (15%)	61	55	45	25	19	17	17	21	32	45	60	87

Proposed Project

Statistic	Monthly Cl (mg/L) Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	84	70	54	27	18	17	17	18	20	29	56	77
20%	70	53	38	23	17	16	16	17	18	23	43	60
30%	63	47	30	21	17	16	16	16	18	21	39	56
40%	50	36	27	18	17	16	16	16	17	17	25	51
50%	38	24	23	18	16	15	15	15	16	17	24	35
60%	17	24	20	17	16	15	15	15	16	16	22	17
70%	17	23	17	16	15	15	15	15	15	16	21	17
80%	17	21	16	16	15	15	15	15	15	16	20	17
90%	16	16	15	15	15	15	15	15	15	15	20	16
Long Term												
Full Simulation Period[a]	44	38	29	20	17	16	16	16	19	21	31	41
Water Year Types[b]												
Wet (32%)	33	25	17	16	15	15	15	15	15	16	20	17
Above Normal (15%)	43	39	25	18	16	15	15	15	16	16	21	17
Below Normal (17%)	44	34	35	19	16	16	15	15	16	17	24	43
Dry (22%)	49	46	31	22	17	16	16	16	18	22	41	58
Critical (15%)	60	57	48	27	19	17	17	21	33	44	58	87

Proposed Project minus Existing

Statistic	Monthly Cl (mg/L) Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	-7	-1	0	3	0	0	0	0	0	0	0	-3
20%	0	1	4	1	0	0	0	0	0	0	-1	0
30%	-1	1	7	1	0	0	0	0	0	0	-1	1
40%	-5	1	7	0	0	0	0	0	0	0	1	7
50%	-3	6	5	0	0	0	0	0	0	0	1	4
60%	0	7	3	0	0	0	0	0	0	0	0	0
70%	1	8	0	0	0	0	0	0	0	0	0	1
80%	1	6	0	0	0	0	0	0	0	0	0	2
90%	1	1	0	0	0	0	0	0	0	0	0	1
Long Term												
Full Simulation Period[a]	-1	3	2	1	0	0	0	0	0	0	0	2
Water Year Types[b]												
Wet (32%)	-1	3	1	0	0	0	0	0	0	0	0	1
Above Normal (15%)	-3	3	3	0	0	0	0	0	0	0	0	0
Below Normal (17%)	0	3	3	0	0	0	0	0	0	0	1	5
Dry (22%)	0	3	4	1	0	0	0	0	0	0	0	1
Critical (15%)	-1	2	2	2	1	0	0	0	1	-1	-2	0

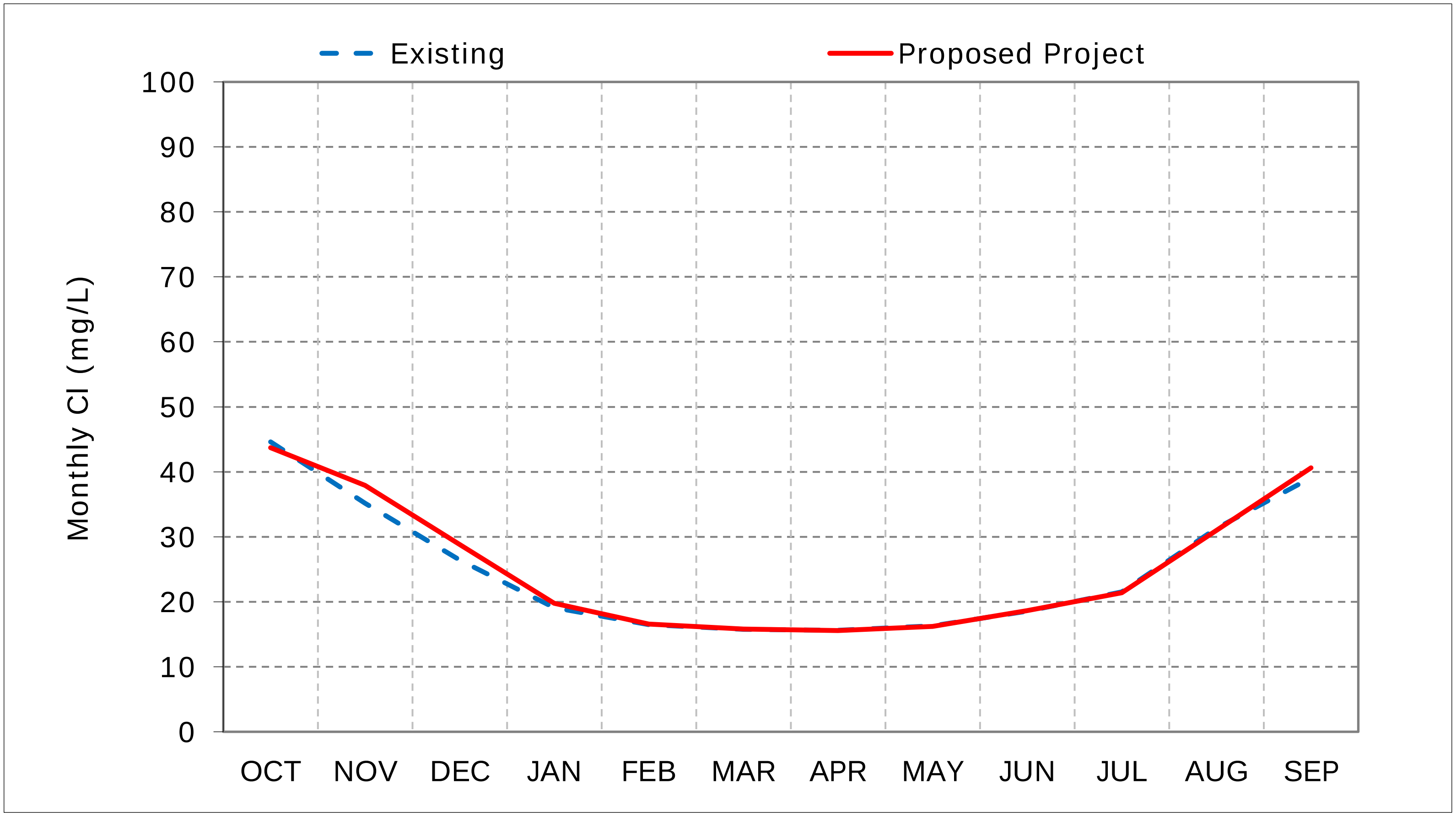
a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

c These results are displayed with water year - year type sorting.

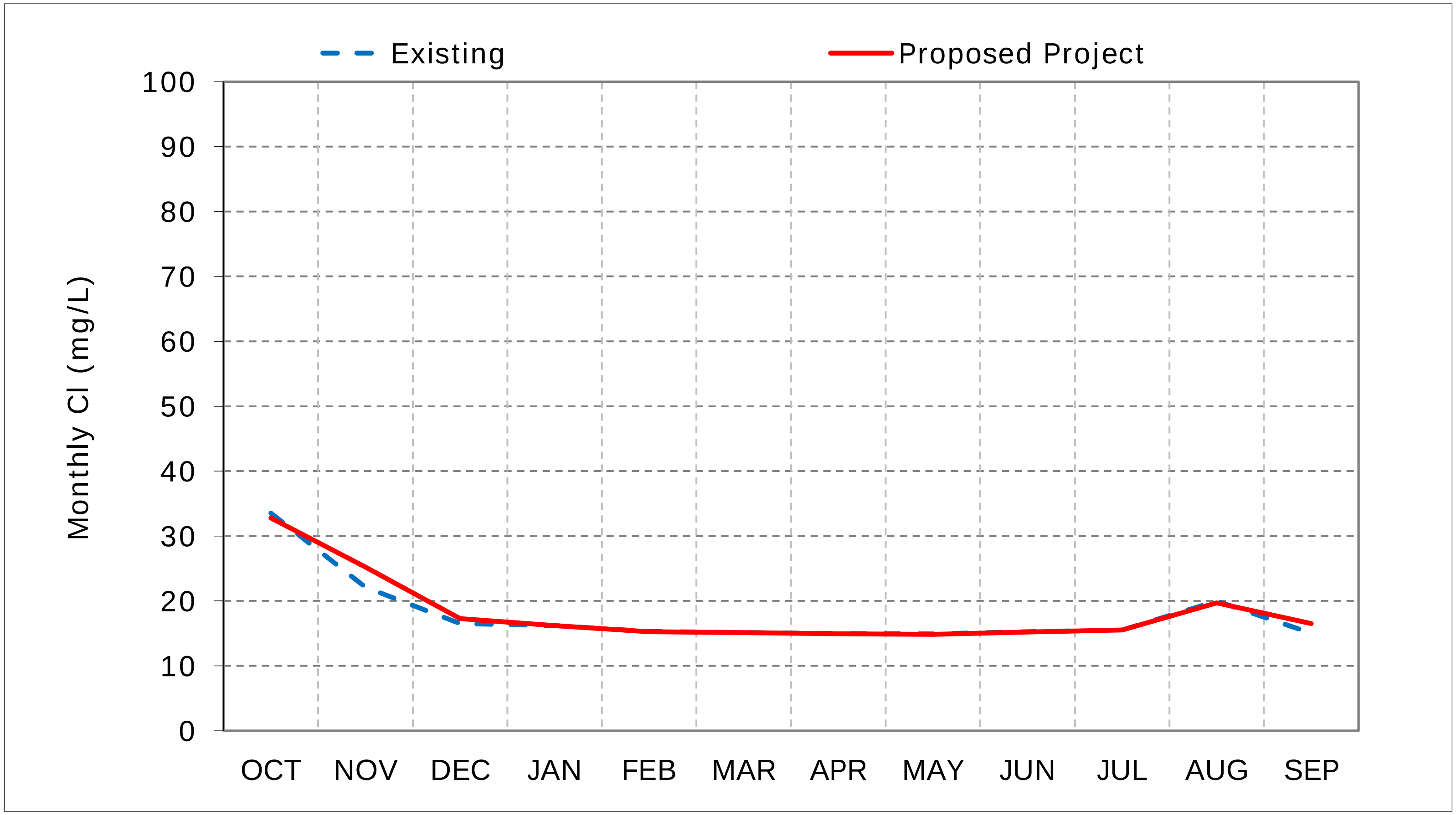
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 2-1. Sacramento River at Rio Vista Chloride, Long-Term Average Cl



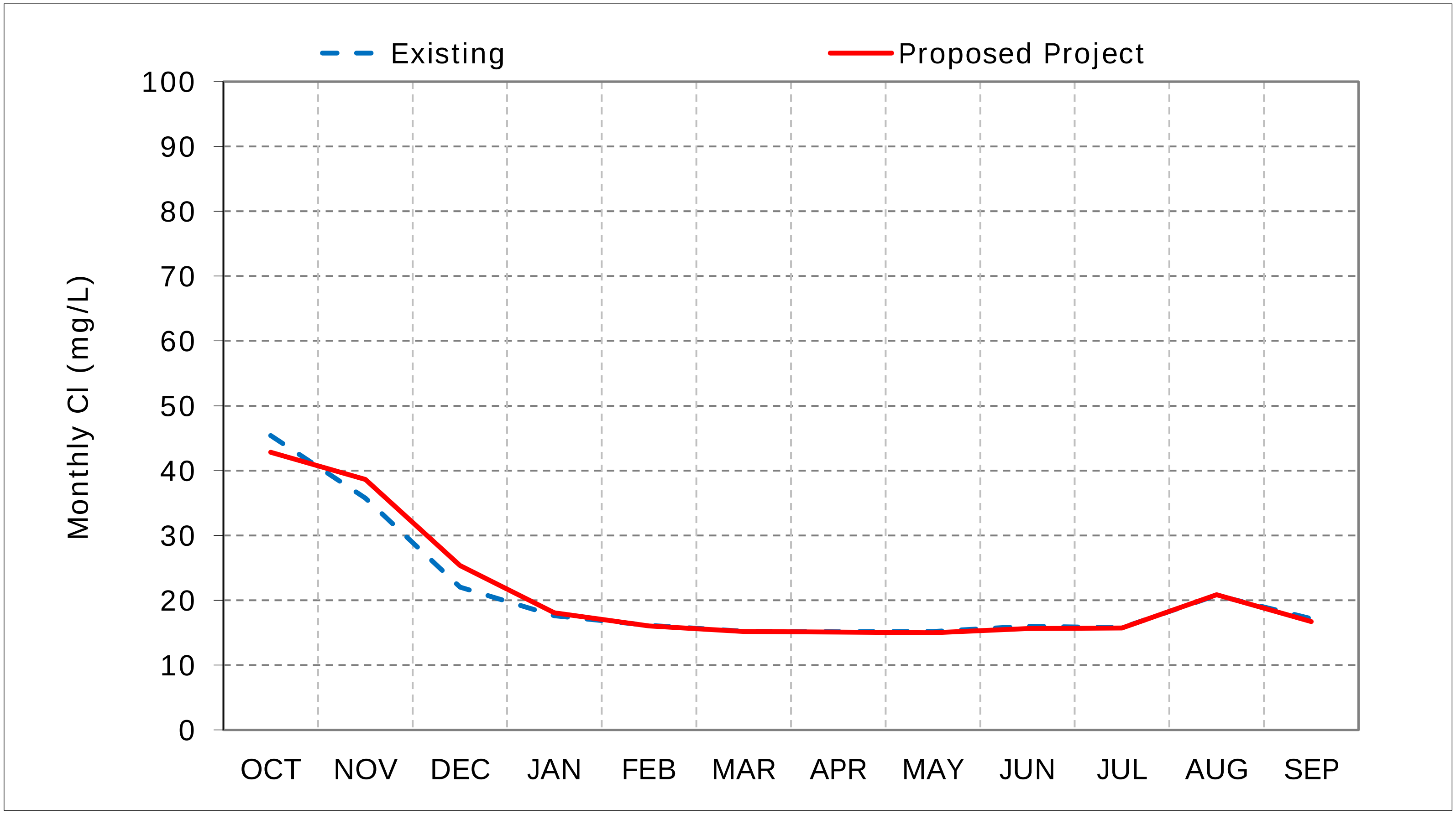
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 2-2. Sacramento River at Rio Vista Chloride, Wet Year Average Cl



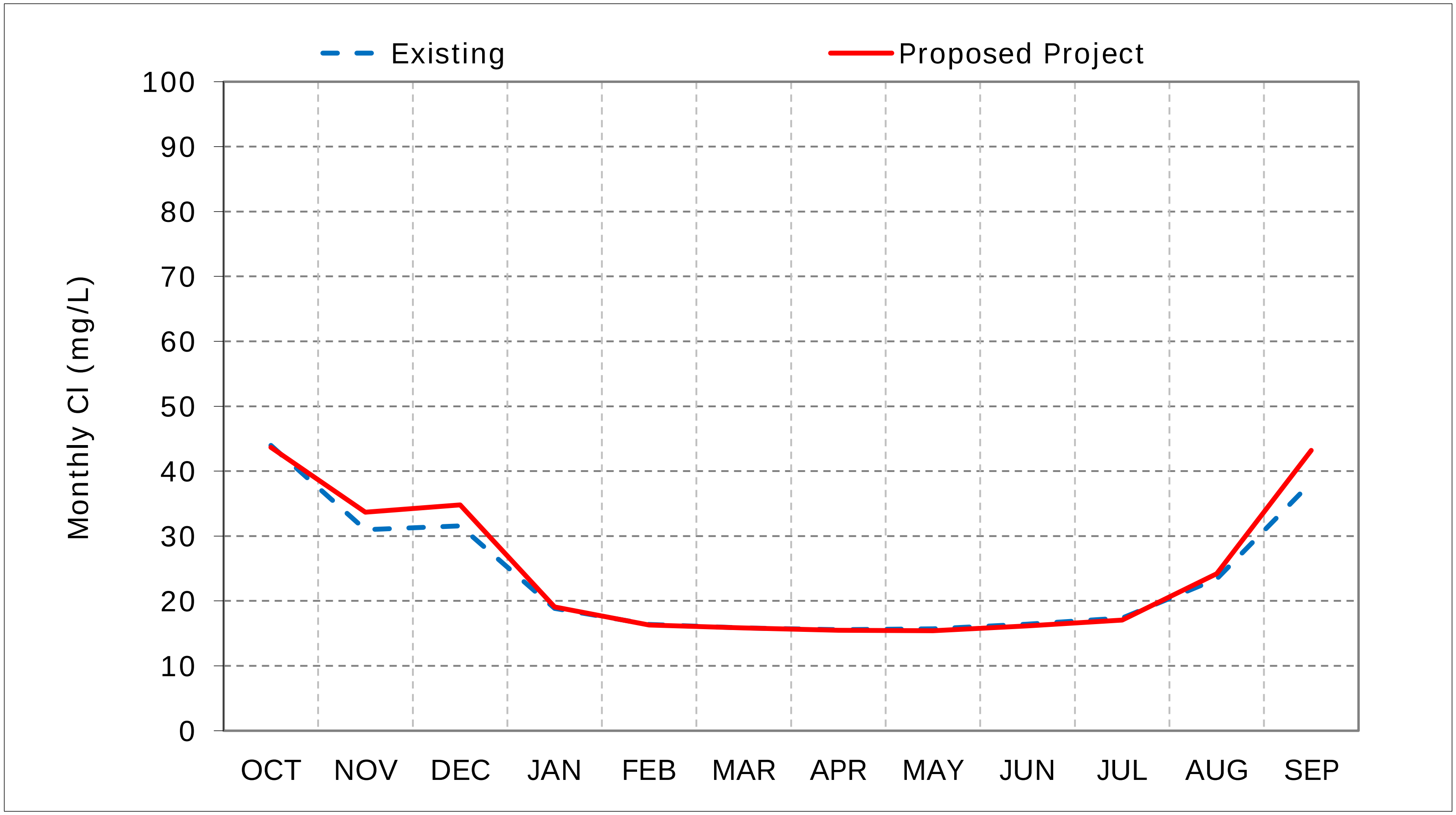
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 2-3. Sacramento River at Rio Vista Chloride, Above Normal Year Average Cl



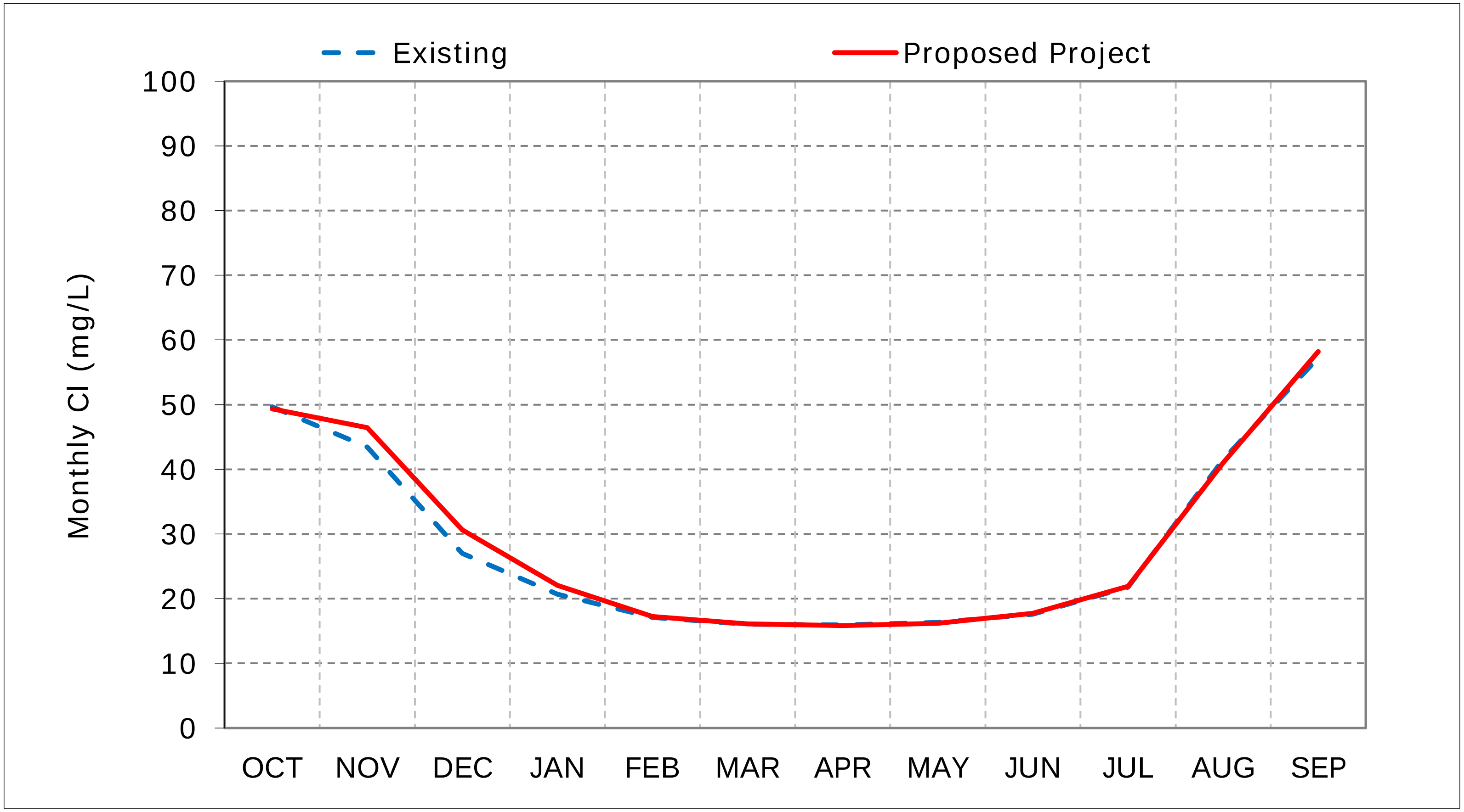
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 2-4. Sacramento River at Rio Vista Chloride, Below Normal Year Average Cl



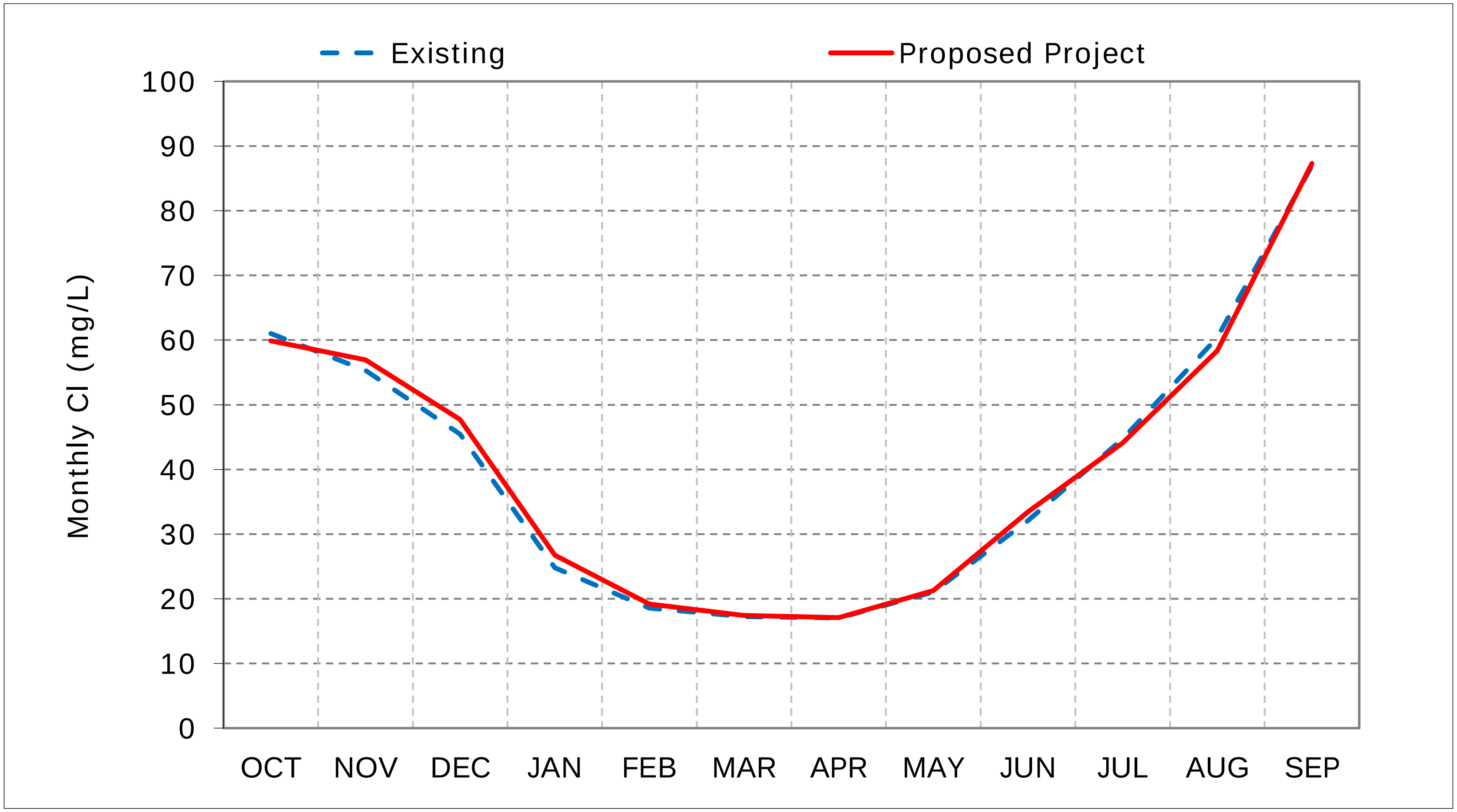
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 2-5. Sacramento River at Rio Vista Chloride, Dry Year Average Cl



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 2-6. Sacramento River at Rio Vista Chloride, Critical Year Average Cl



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 2-7. Sacramento River at Rio Vista Chloride, January Cl

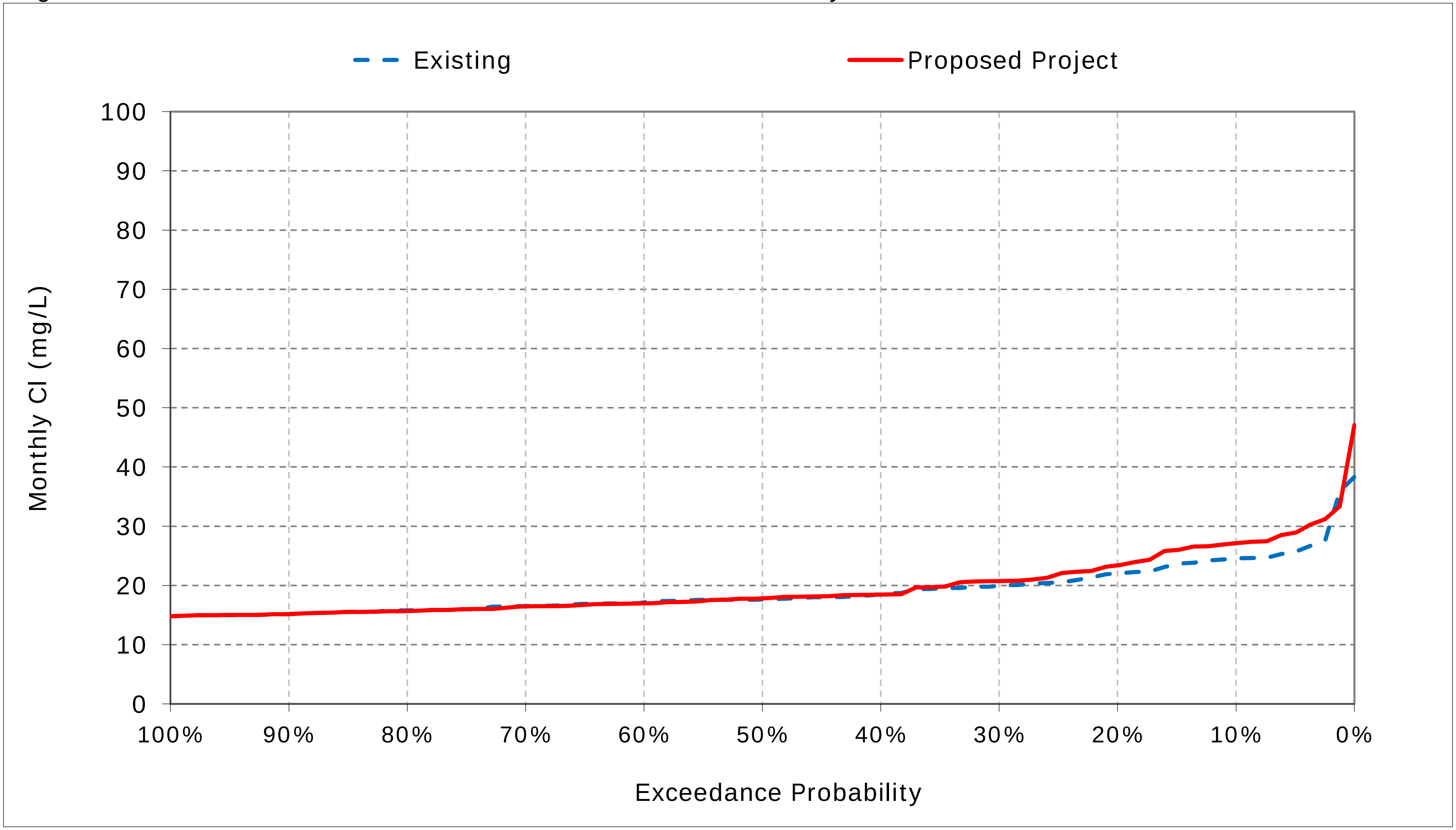


Figure 2-8. Sacramento River at Rio Vista Chloride, February Cl

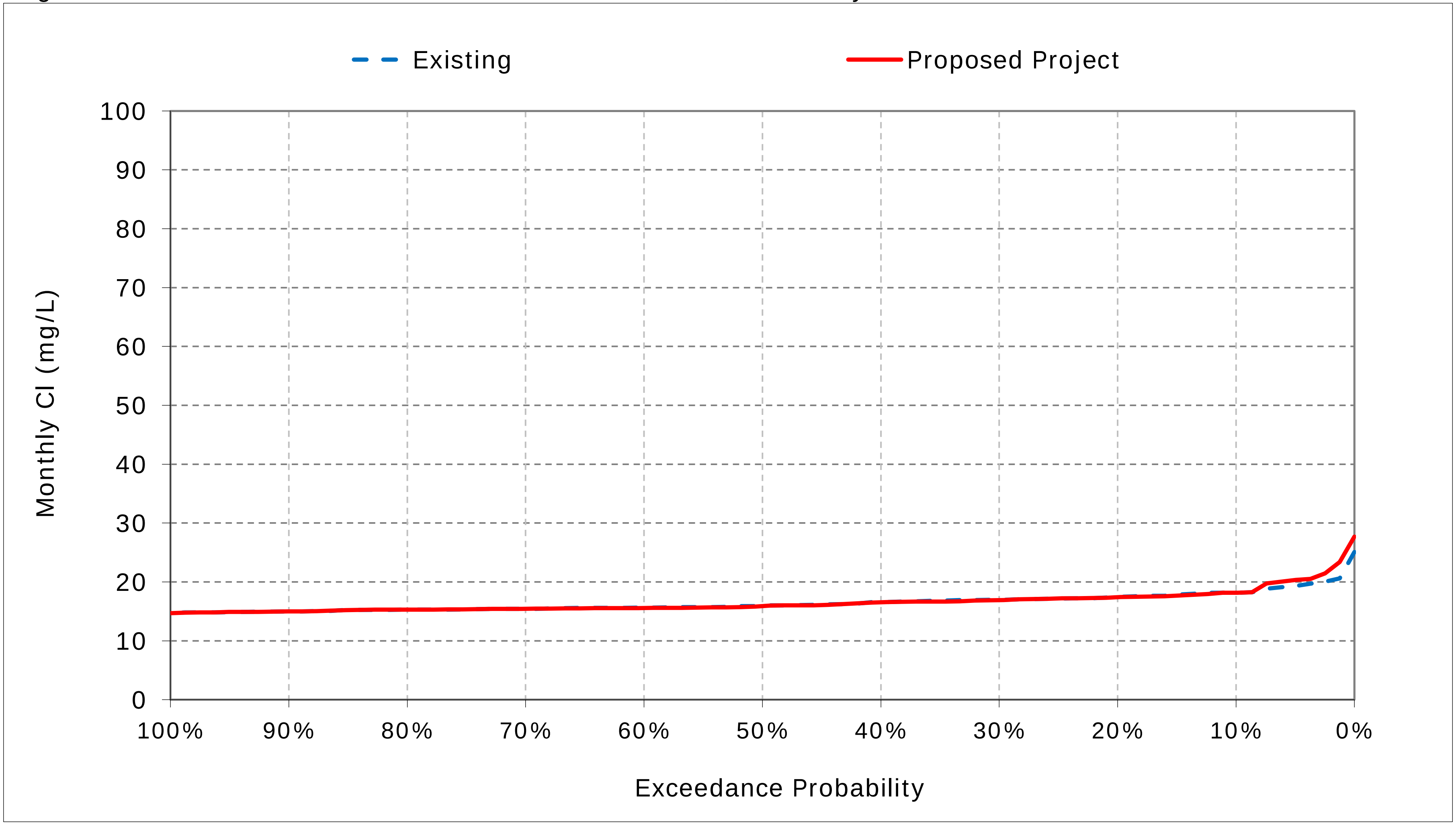


Figure 2-9. Sacramento River at Rio Vista Chloride, March Cl

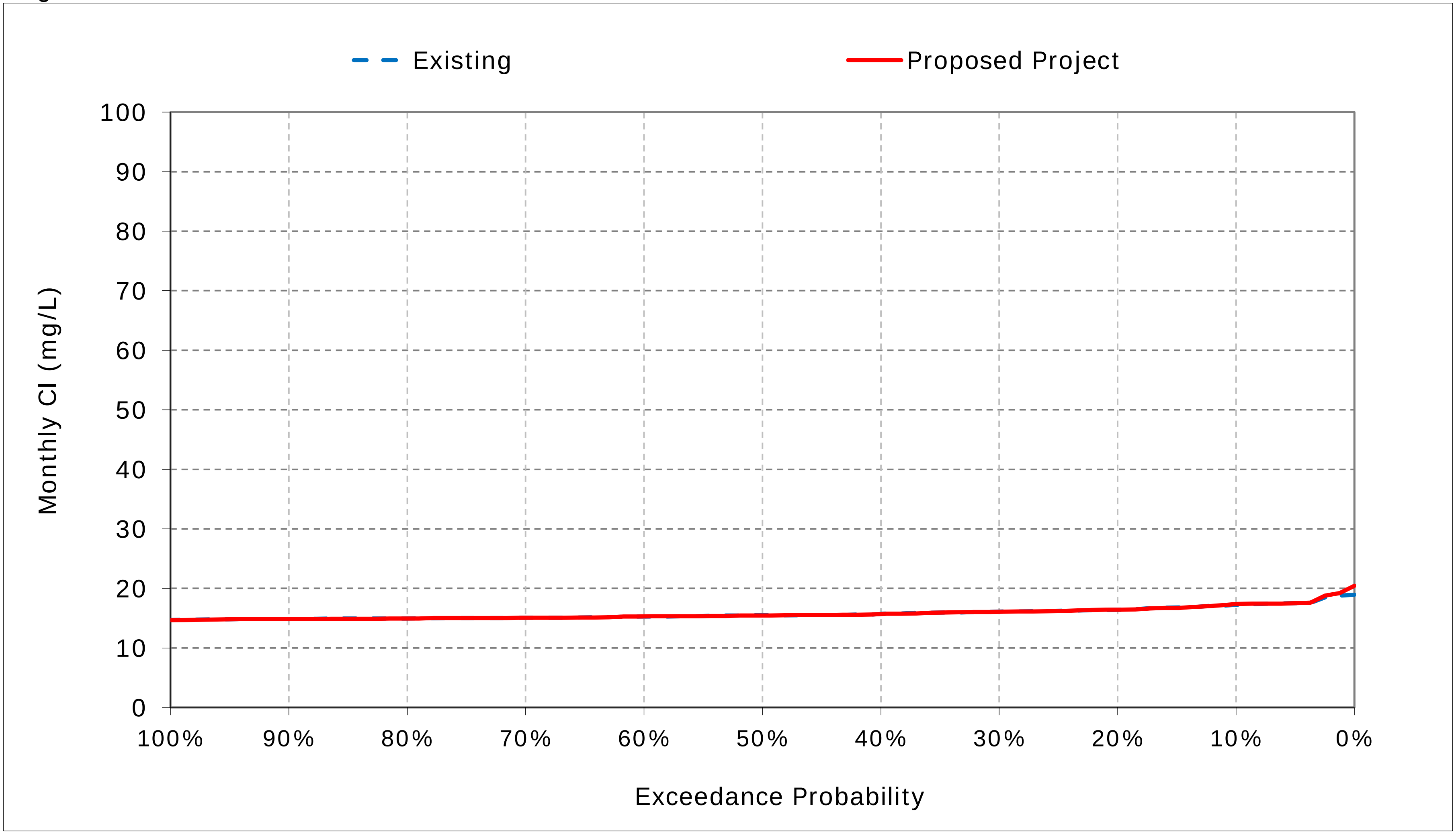


Figure 2-10. Sacramento River at Rio Vista Chloride, April Cl

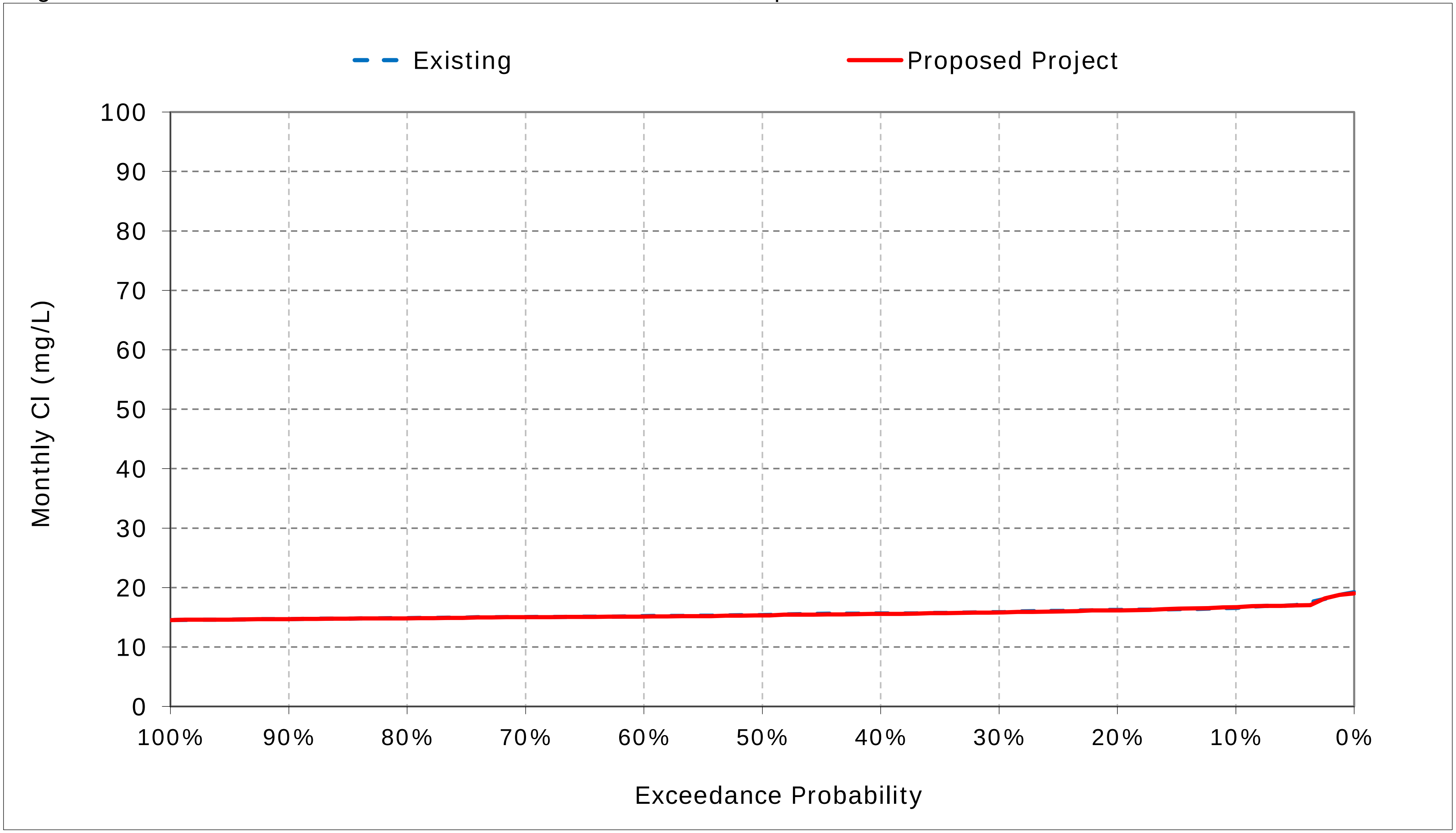


Figure 2-11. Sacramento River at Rio Vista Chloride, May Cl

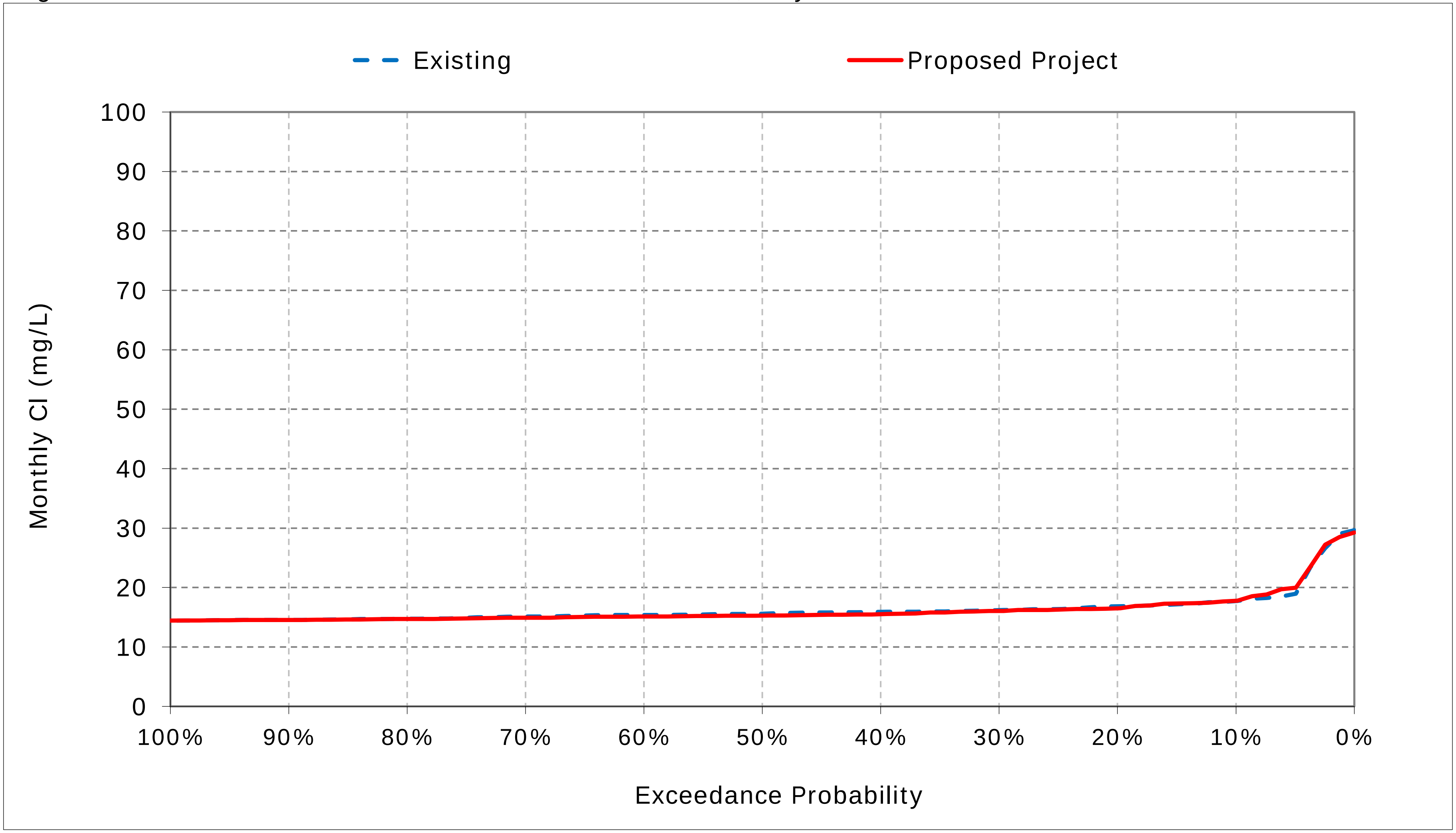


Figure 2-12. Sacramento River at Rio Vista Chloride, June Cl

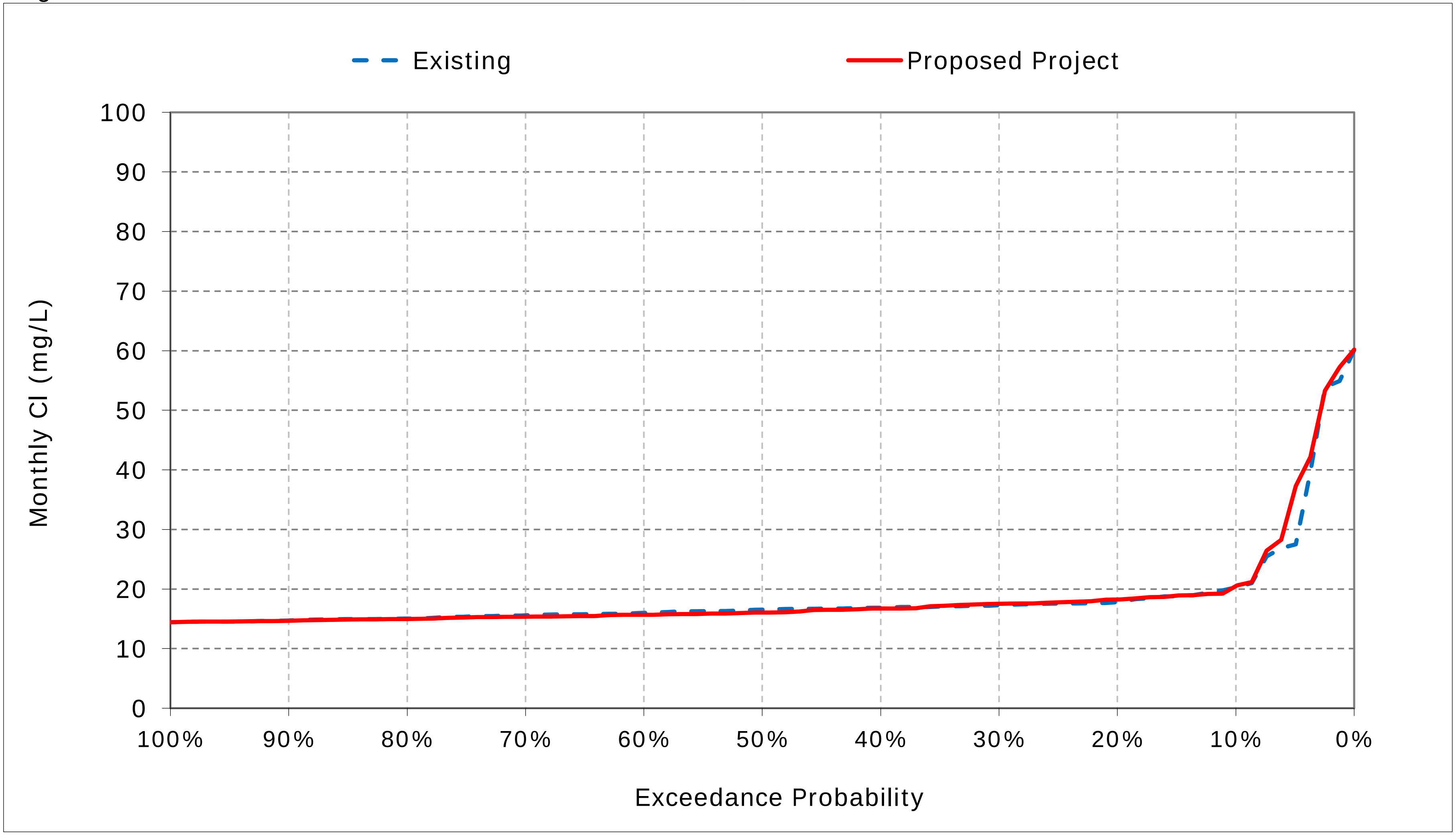


Figure 2-13. Sacramento River at Rio Vista Chloride, July Cl

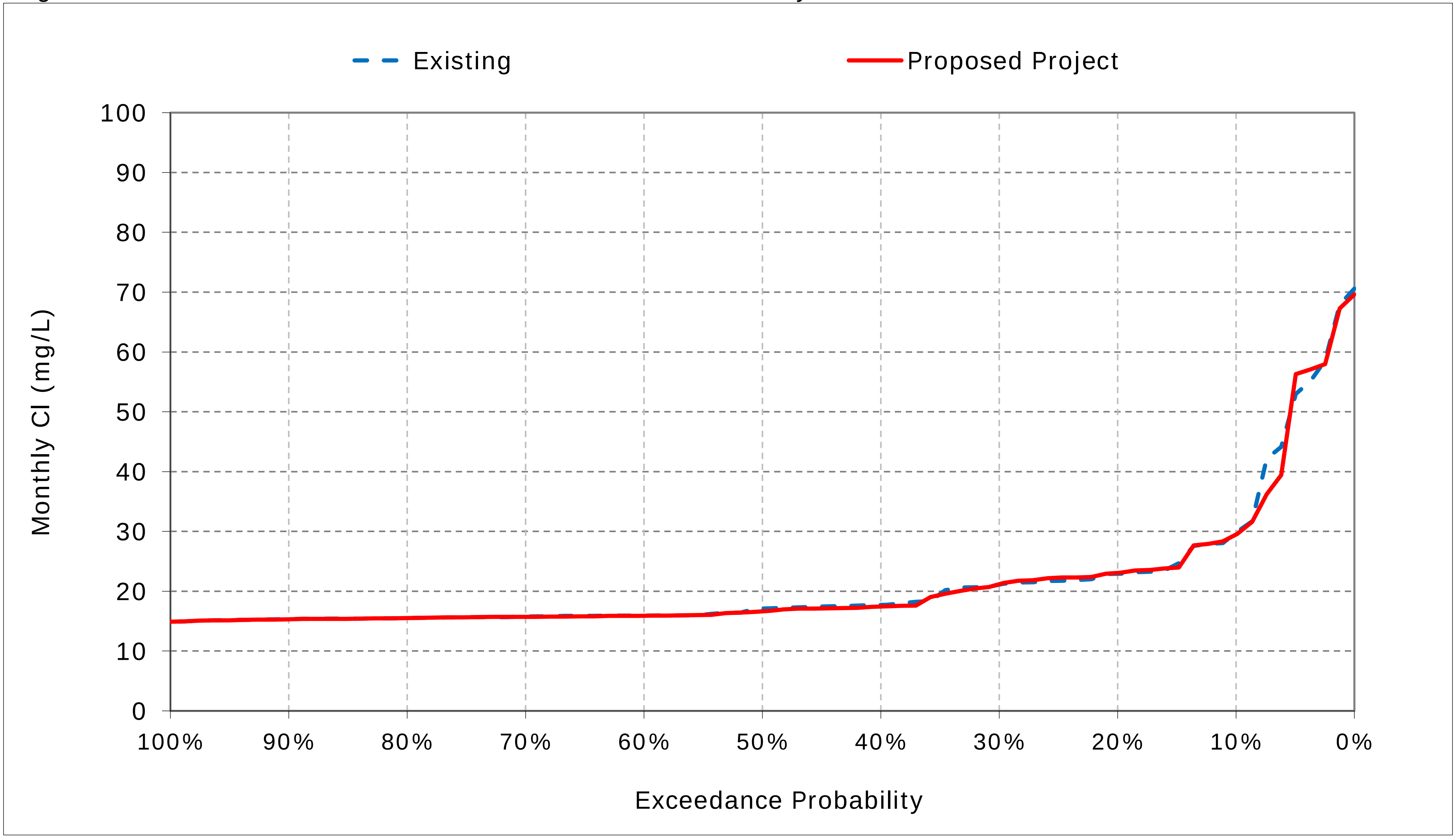


Figure 2-14. Sacramento River at Rio Vista Chloride, August Cl

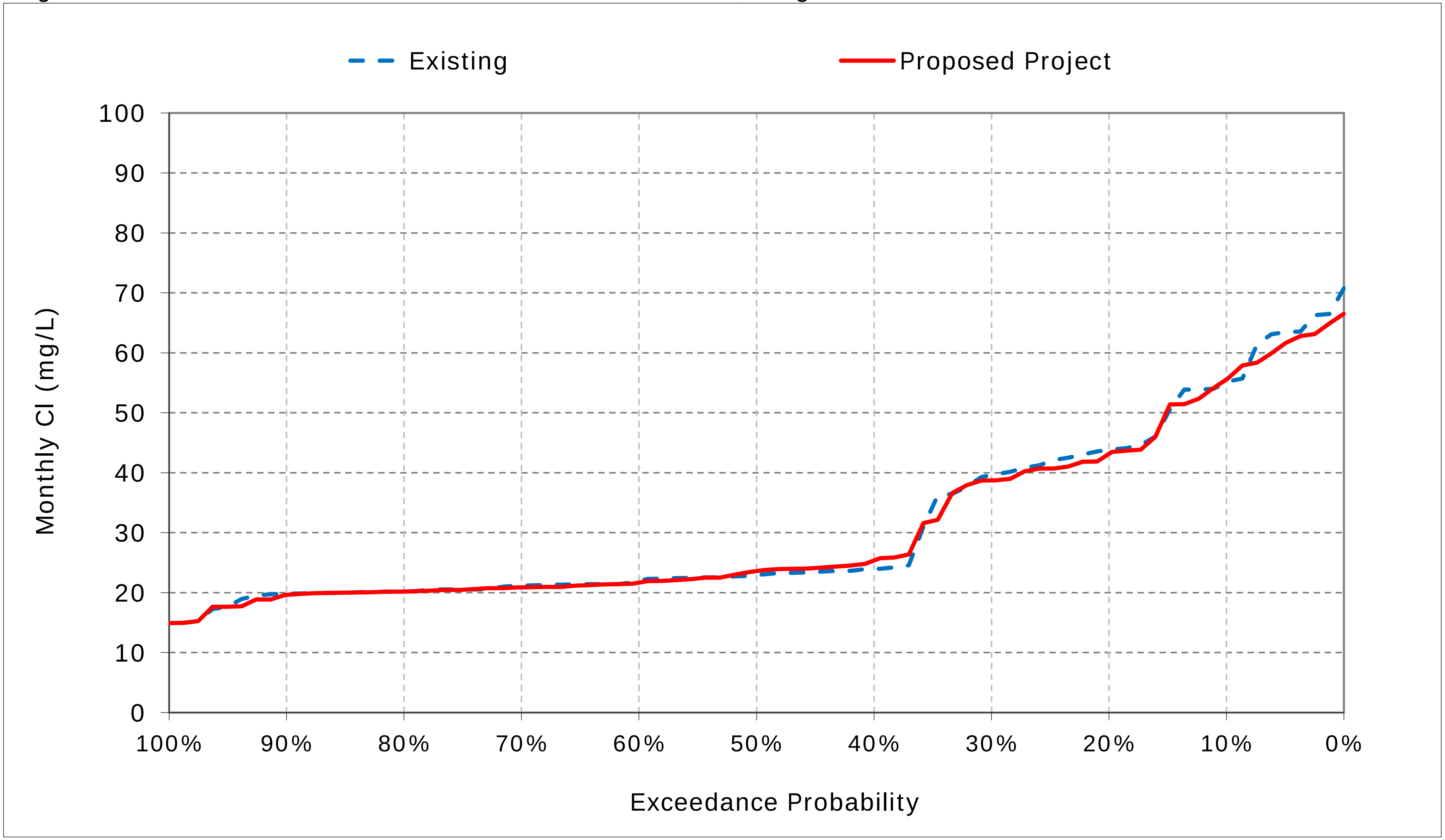


Figure 2-15. Sacramento River at Rio Vista Chloride, September Cl

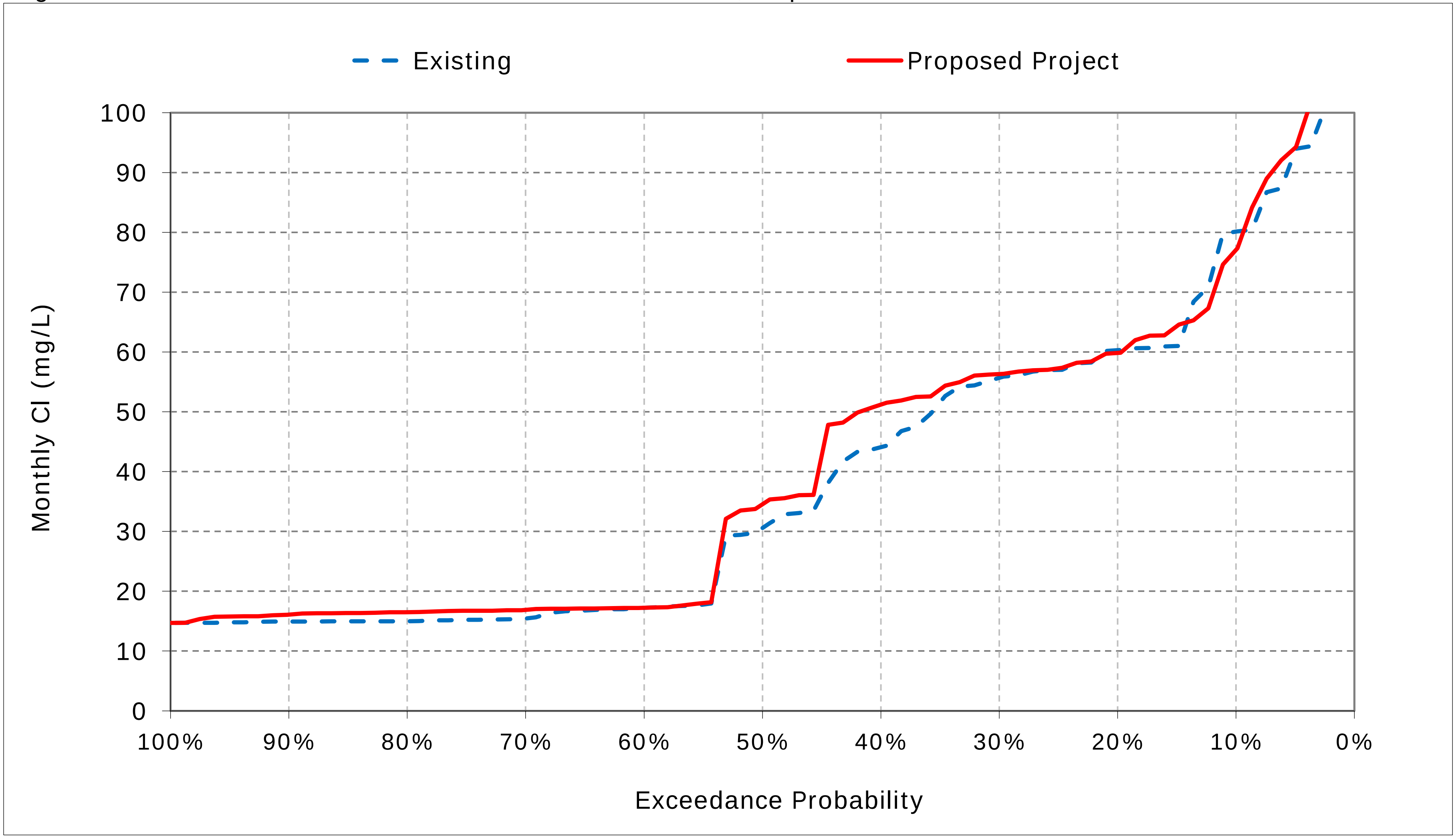


Figure 2-16. Sacramento River at Rio Vista Chloride, October Cl

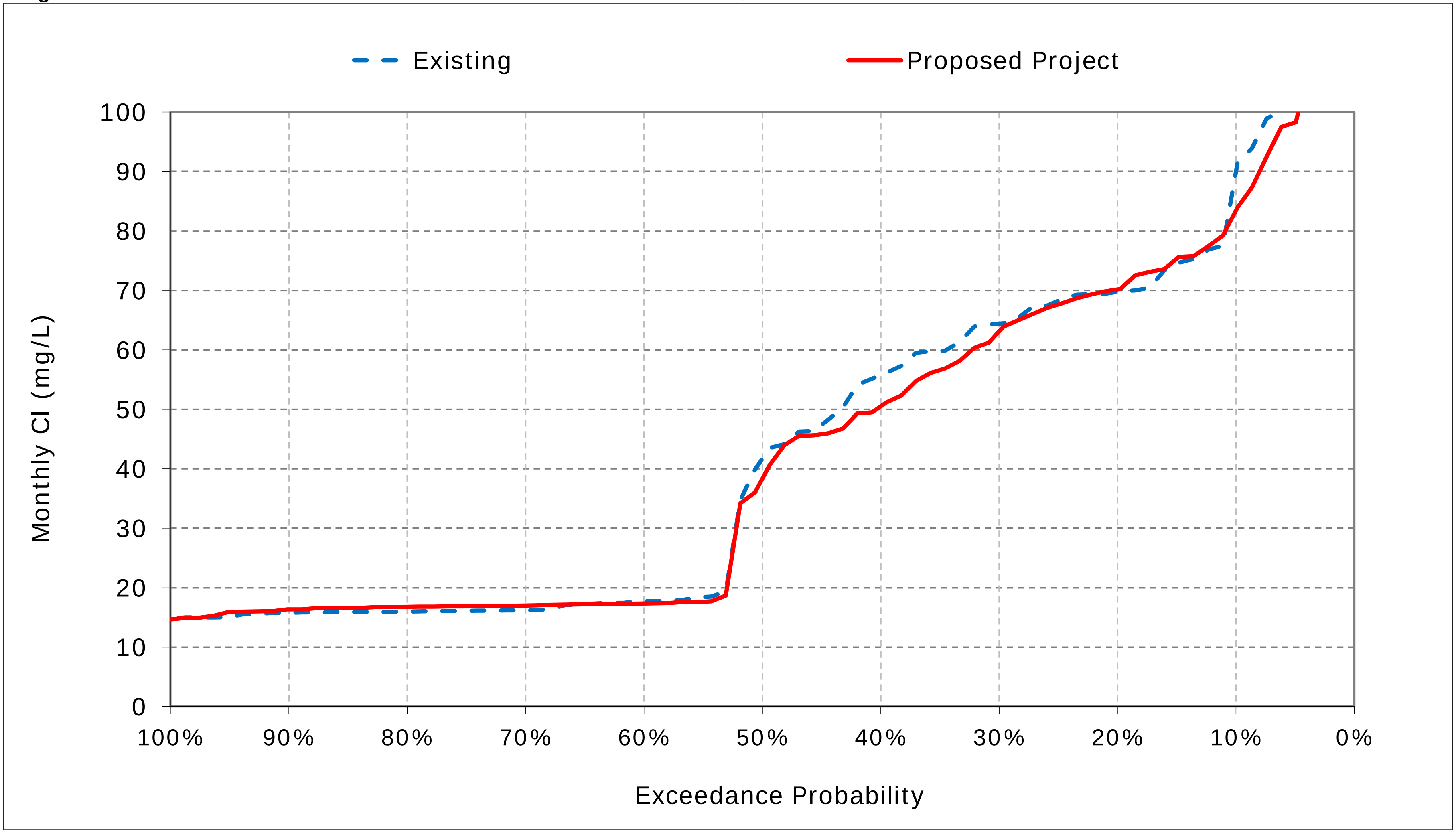


Figure 2-17. Sacramento River at Rio Vista Chloride, November Cl

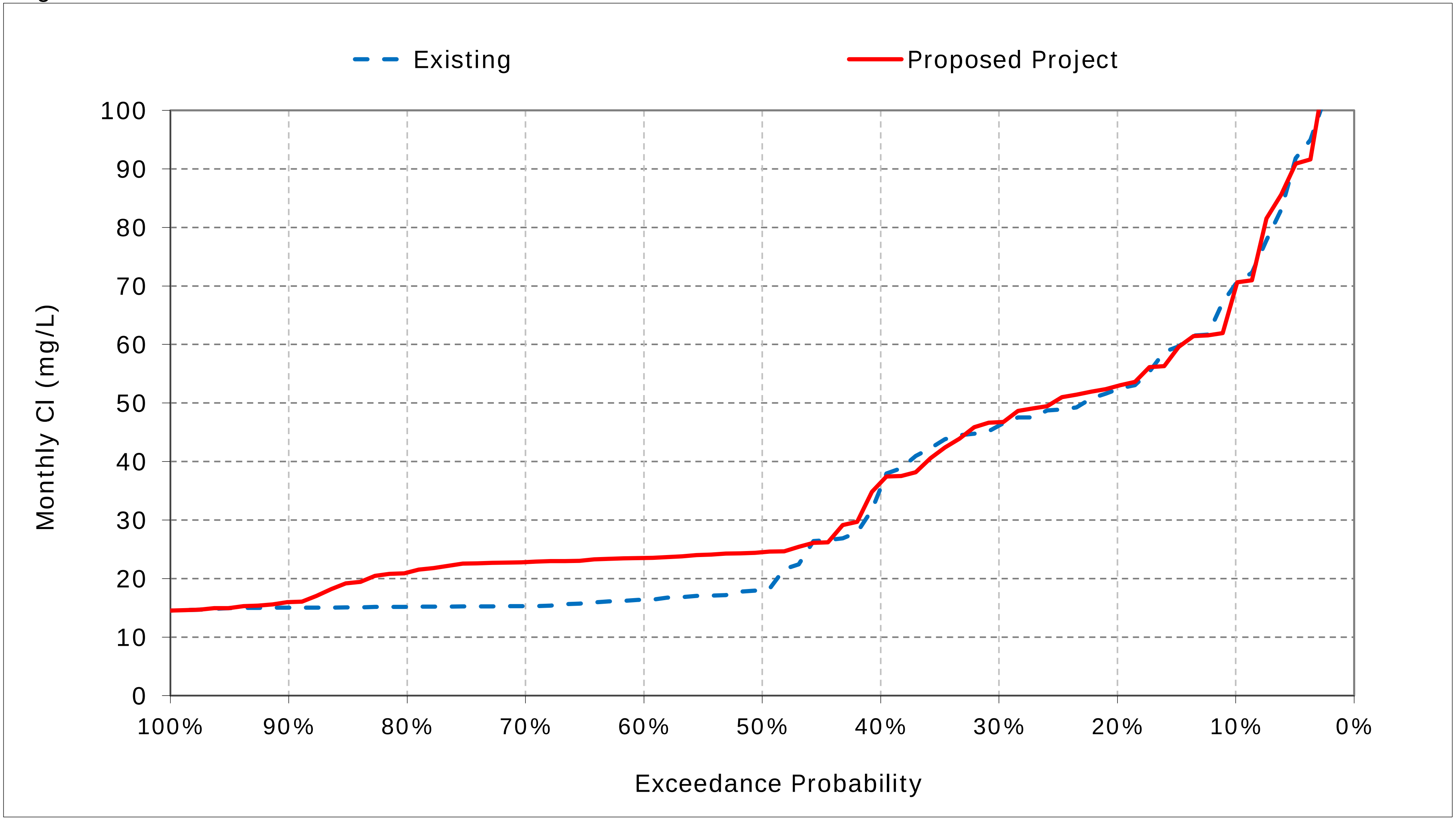


Figure 2-18. Sacramento River at Rio Vista Chloride, December Cl

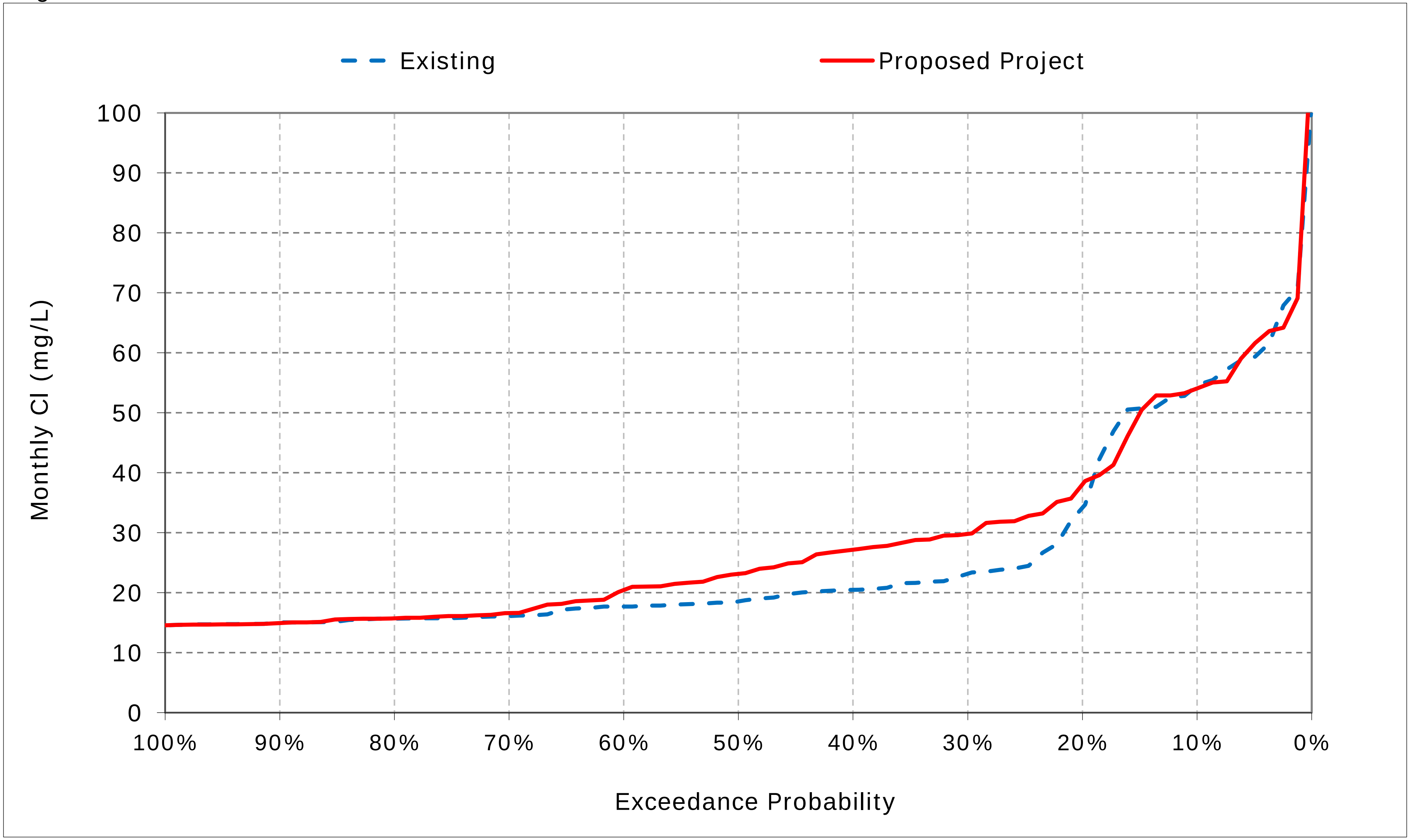


Table 3-1. Sacramento River at Collinsville Chloride, Monthly Cl

Existing

	Monthly Cl (mg/L)											
Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	2,964	2,757	2,546	1,405	564	475	527	828	1,134	1,699	2,329	2,681
20%	2,755	2,593	2,051	1,164	332	225	243	552	893	1,378	1,993	2,497
30%	2,699	2,527	1,366	835	142	67	103	399	851	1,249	1,923	2,440
40%	2,607	2,353	1,119	422	62	39	66	193	676	874	1,456	2,189
50%	2,303	928	893	304	37	24	30	94	555	752	1,331	1,866
60%	1,010	788	826	135	20	19	21	49	375	560	1,295	739
70%	520	412	239	23	18	17	19	27	258	508	1,204	359
80%	479	342	98	19	17	16	17	18	83	433	1,135	309
90%	444	307	22	16	16	16	16	16	18	304	1,068	278
Long Term												
Full Simulation Period[a]	1,724	1,470	1,062	533	190	126	153	295	603	906	1,519	1,479
Water Year Types[b]												
Wet (32%)	1,290	859	281	74	19	18	23	43	161	366	1,053	279
Above Normal (15%)	1,810	1,460	1,010	283	56	19	27	51	364	504	1,163	719
Below Normal (17%)	1,814	1,610	1,401	563	99	72	80	175	533	807	1,393	2,014
Dry (22%)	1,847	1,752	1,317	851	303	167	201	413	832	1,297	1,952	2,468
Critical (15%)	2,290	2,221	2,029	1,268	634	471	574	1,048	1,539	2,007	2,383	2,732

Proposed Project

	Monthly Cl (mg/L)											
Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	2,925	2,692	2,545	1,627	533	480	578	885	1,153	1,684	2,292	2,671
20%	2,741	2,600	2,060	1,296	324	205	318	685	974	1,409	1,997	2,513
30%	2,690	2,534	1,916	941	147	54	155	572	880	1,235	1,935	2,446
40%	2,499	2,337	1,761	469	58	32	96	288	757	951	1,738	2,315
50%	2,214	1,681	1,406	295	39	22	48	165	562	799	1,495	1,902
60%	948	1,575	985	118	20	19	22	106	441	550	1,281	702
70%	885	1,526	335	24	18	17	19	44	310	500	1,197	668
80%	833	1,331	194	18	17	16	17	18	88	440	1,117	622
90%	742	520	35	16	16	16	16	16	18	306	1,055	553
Long Term												
Full Simulation Period[a]	1,796	1,835	1,261	581	203	126	176	356	637	921	1,551	1,587
Water Year Types[b]												
Wet (32%)	1,396	1,323	388	72	18	18	29	72	192	368	1,029	583
Above Normal (15%)	1,884	1,849	1,314	314	39	18	36	98	378	493	1,171	646
Below Normal (17%)	1,891	1,953	1,652	577	93	67	110	260	555	875	1,605	2,119
Dry (22%)	1,932	2,084	1,569	961	333	161	242	515	886	1,316	1,966	2,481
Critical (15%)	2,257	2,422	2,179	1,387	699	484	610	1,101	1,582	2,005	2,378	2,742

Proposed Project minus Existing

	Monthly Cl (mg/L)											
Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	-39	-65	-1	222	-30	6	50	58	19	-15	-37	-10
20%	-14	7	8	132	-8	-20	75	133	82	31	4	16
30%	-9	7	549	106	5	-12	52	174	29	-14	12	6
40%	-108	-16	641	47	-4	-7	30	96	81	78	282	126
50%	-89	753	513	-9	2	-2	17	70	7	48	164	36
60%	-63	788	160	-17	0	-1	1	57	66	-10	-14	-37
70%	365	1,114	96	1	0	0	0	18	51	-8	-7	309
80%	354	989	96	-1	0	0	-1	0	5	7	-18	313
90%	298	213	13	0	0	0	0	-1	0	1	-13	275
Long Term												
Full Simulation Period[a]	72	365	199	48	12	0	23	61	34	15	32	108
Water Year Types[b]												
Wet (32%)	106	464	107	-1	-1	0	7	29	31	2	-24	305
Above Normal (15%)	74	389	304	31	-17	-1	9	47	15	-11	8	-73
Below Normal (17%)	77	343	251	13	-6	-5	30	84	22	68	211	106
Dry (22%)	85	332	252	109	30	-6	41	103	54	20	14	13
Critical (15%)	-32	200	151	120	65	14	36	53	43	-2	-5	9

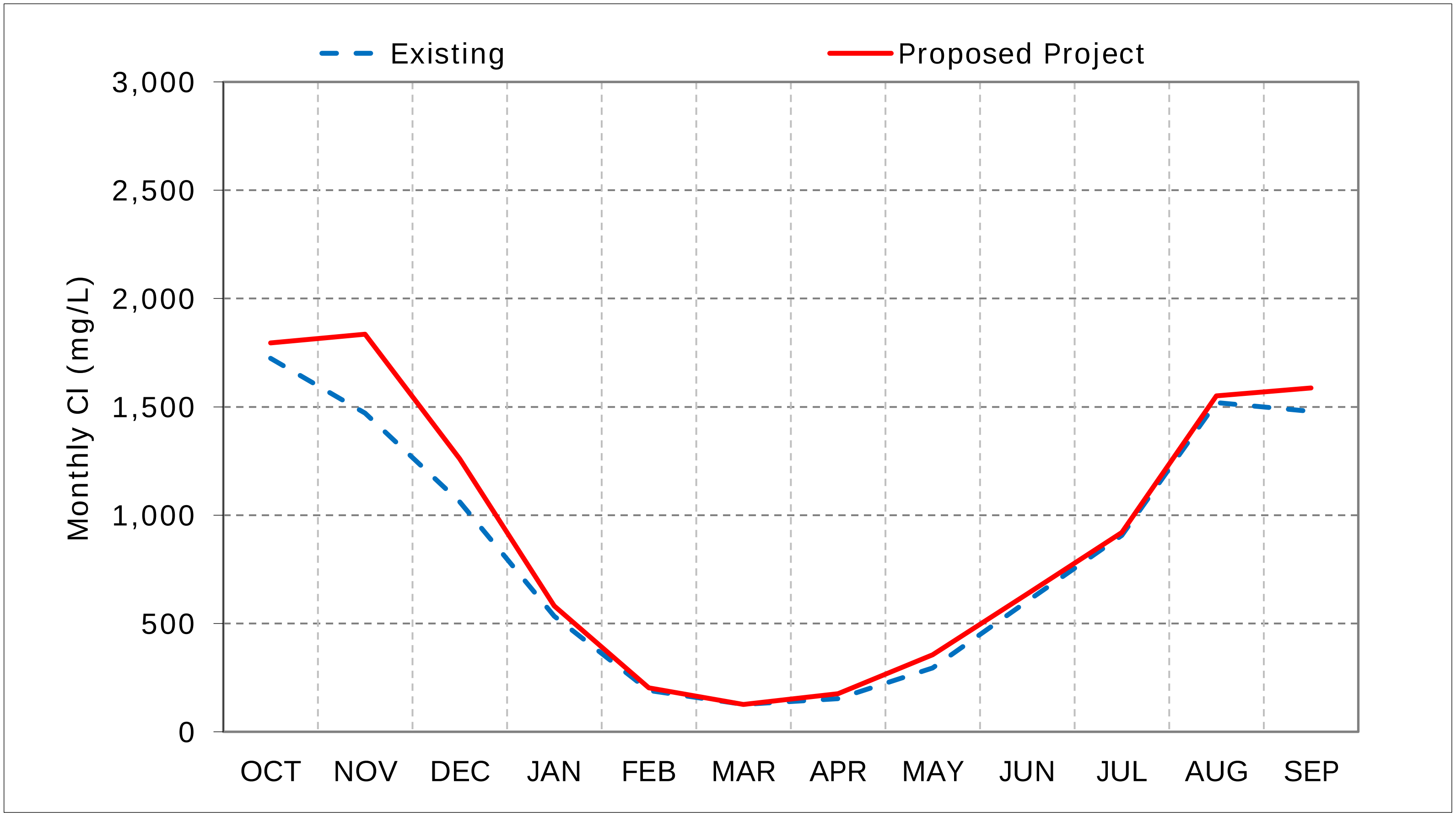
a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

c These results are displayed with water year - year type sorting.

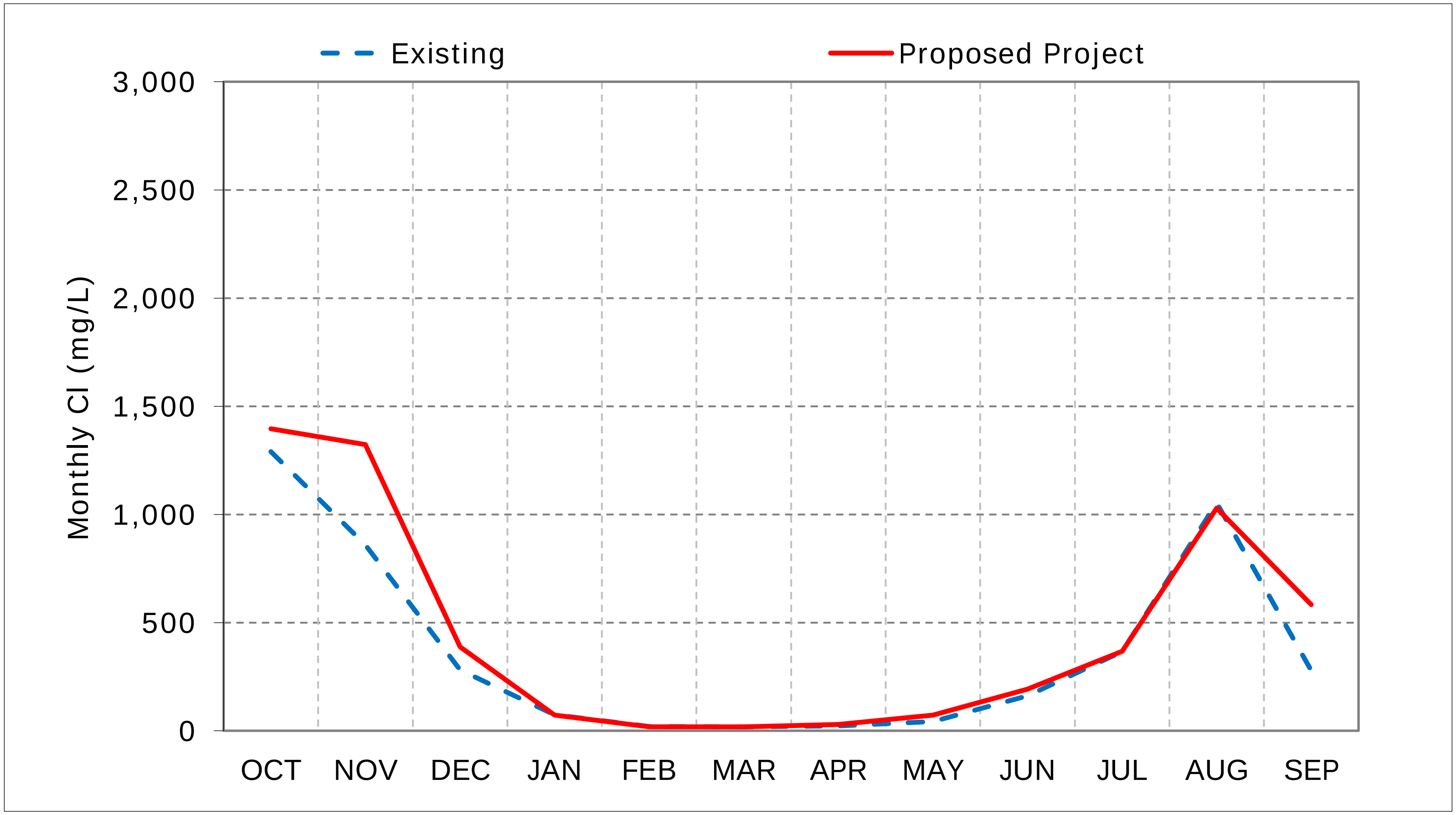
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 3-1. Sacramento River at Collinsville Chloride, Long-Term Average Cl



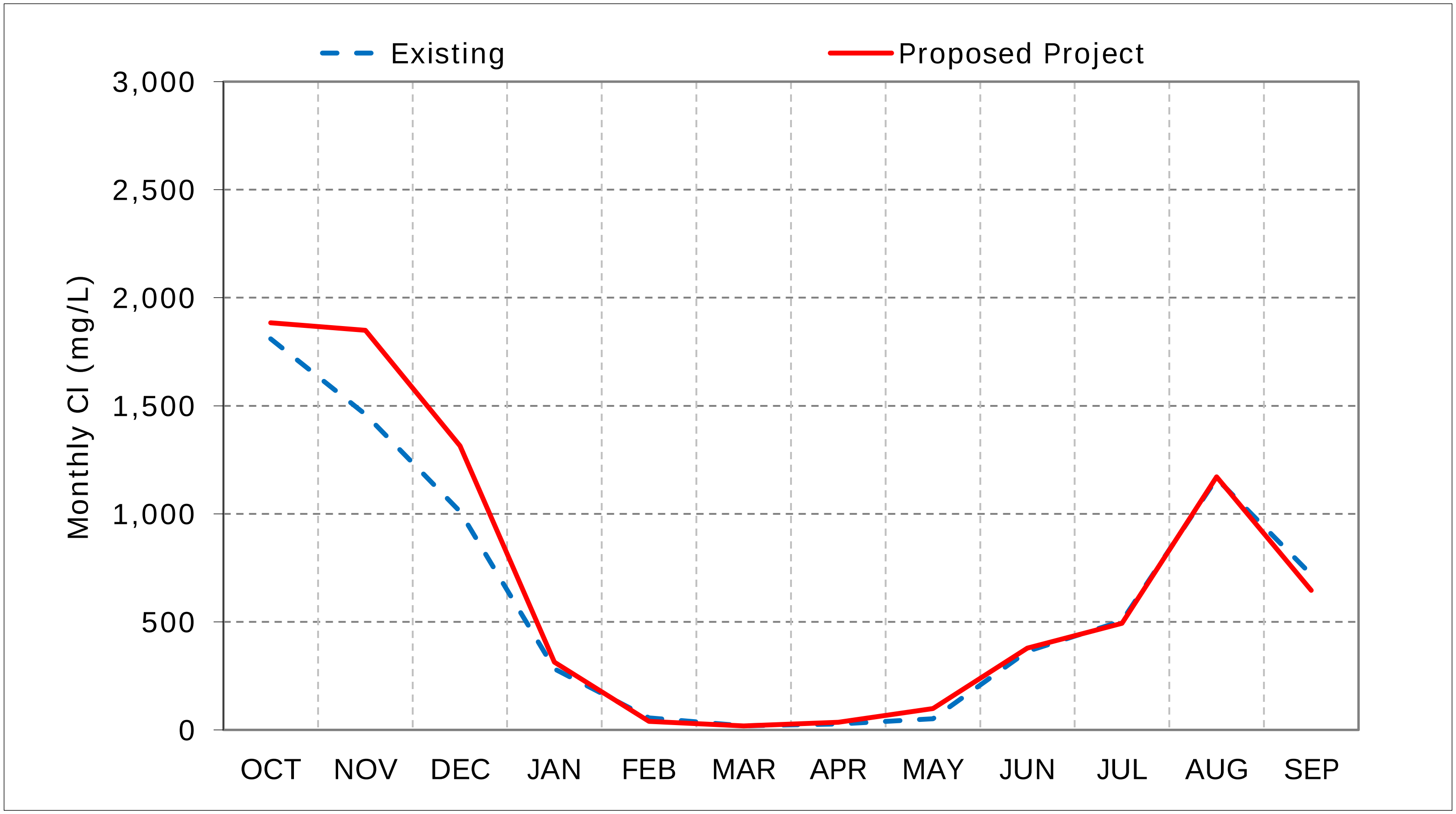
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 3-2. Sacramento River at Collinsville Chloride, Wet Year Average Cl



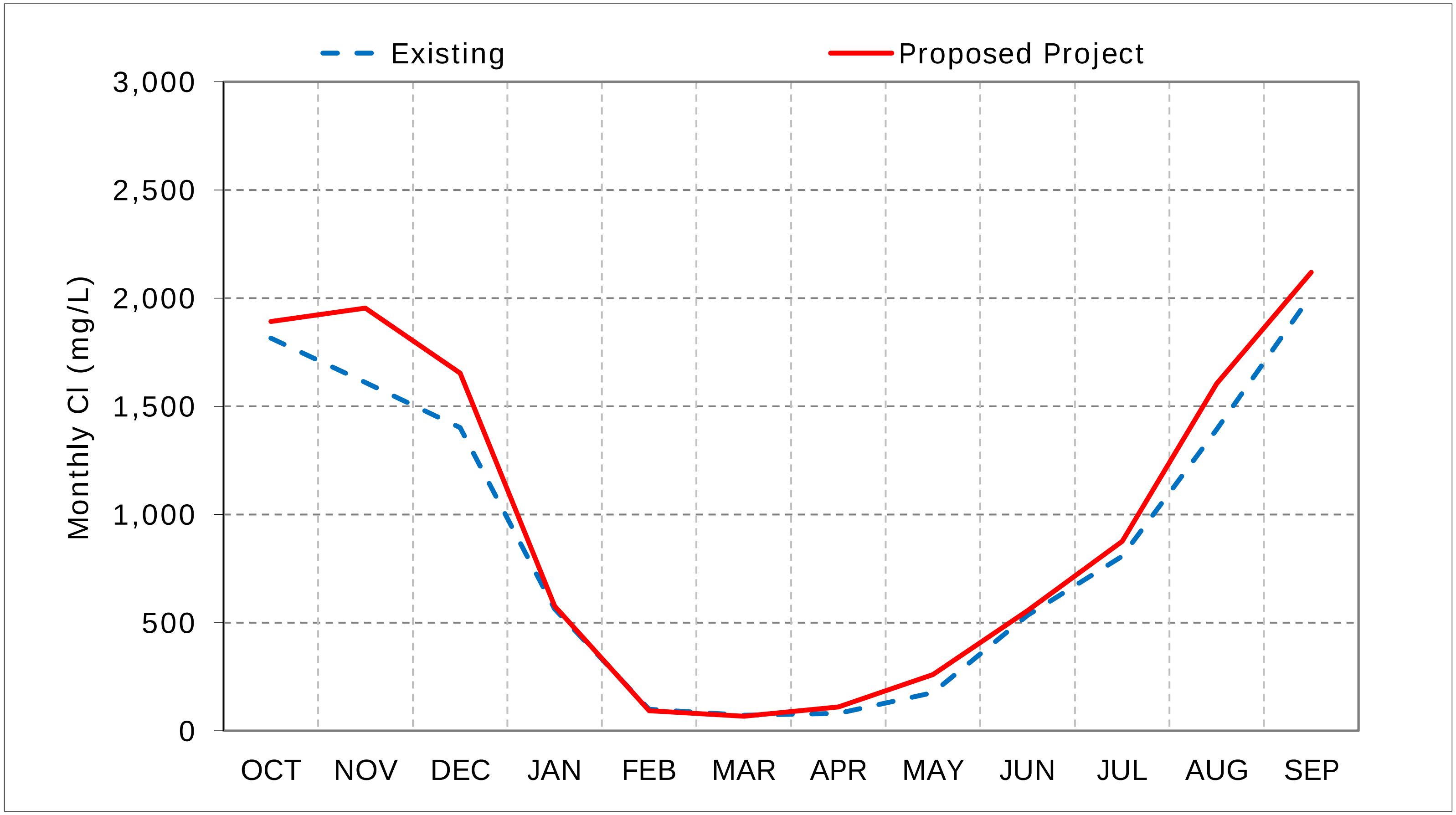
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 3-3. Sacramento River at Collinsville Chloride, Above Normal Year Average



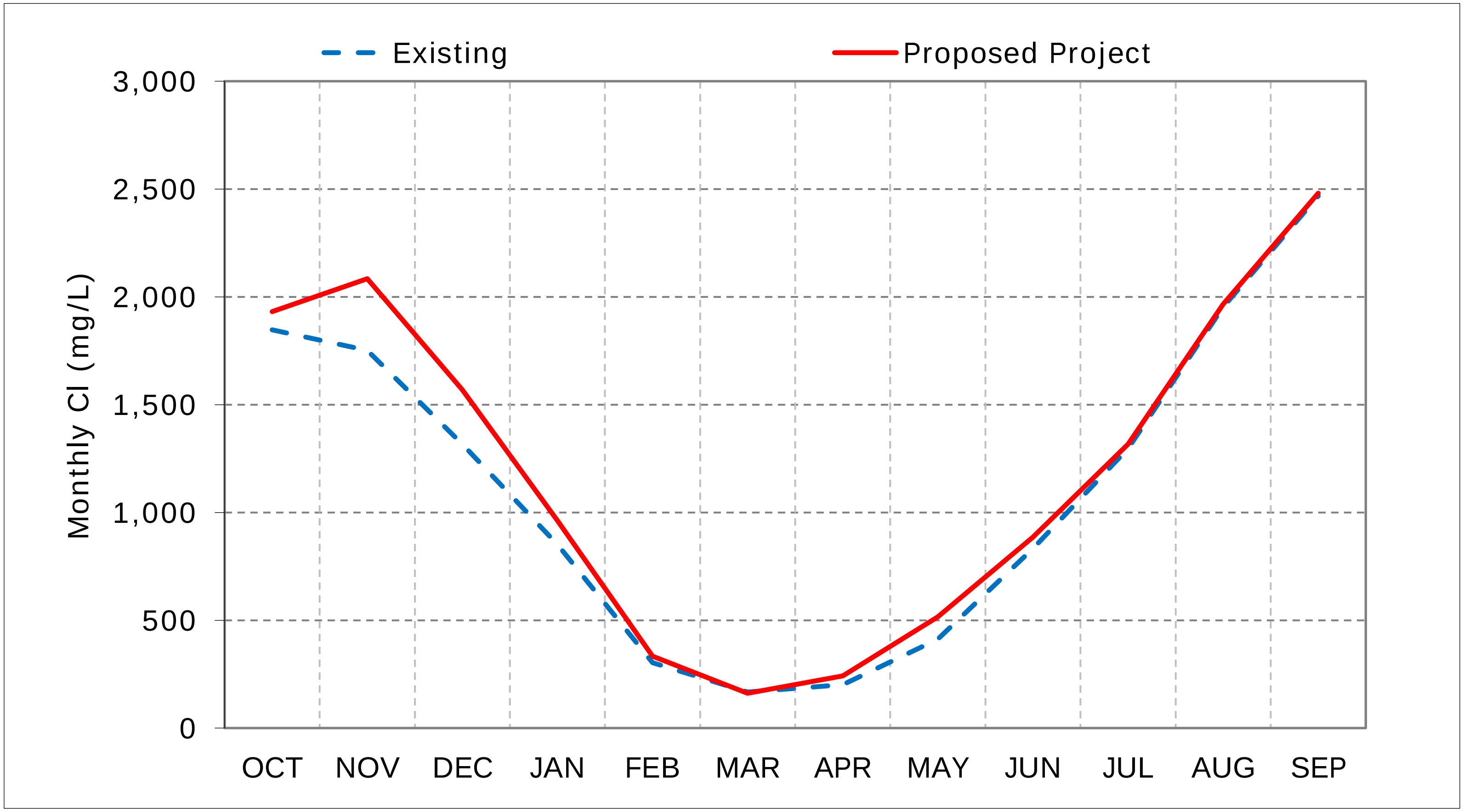
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 3-4. Sacramento River at Collinsville Chloride, Below Normal Year Average



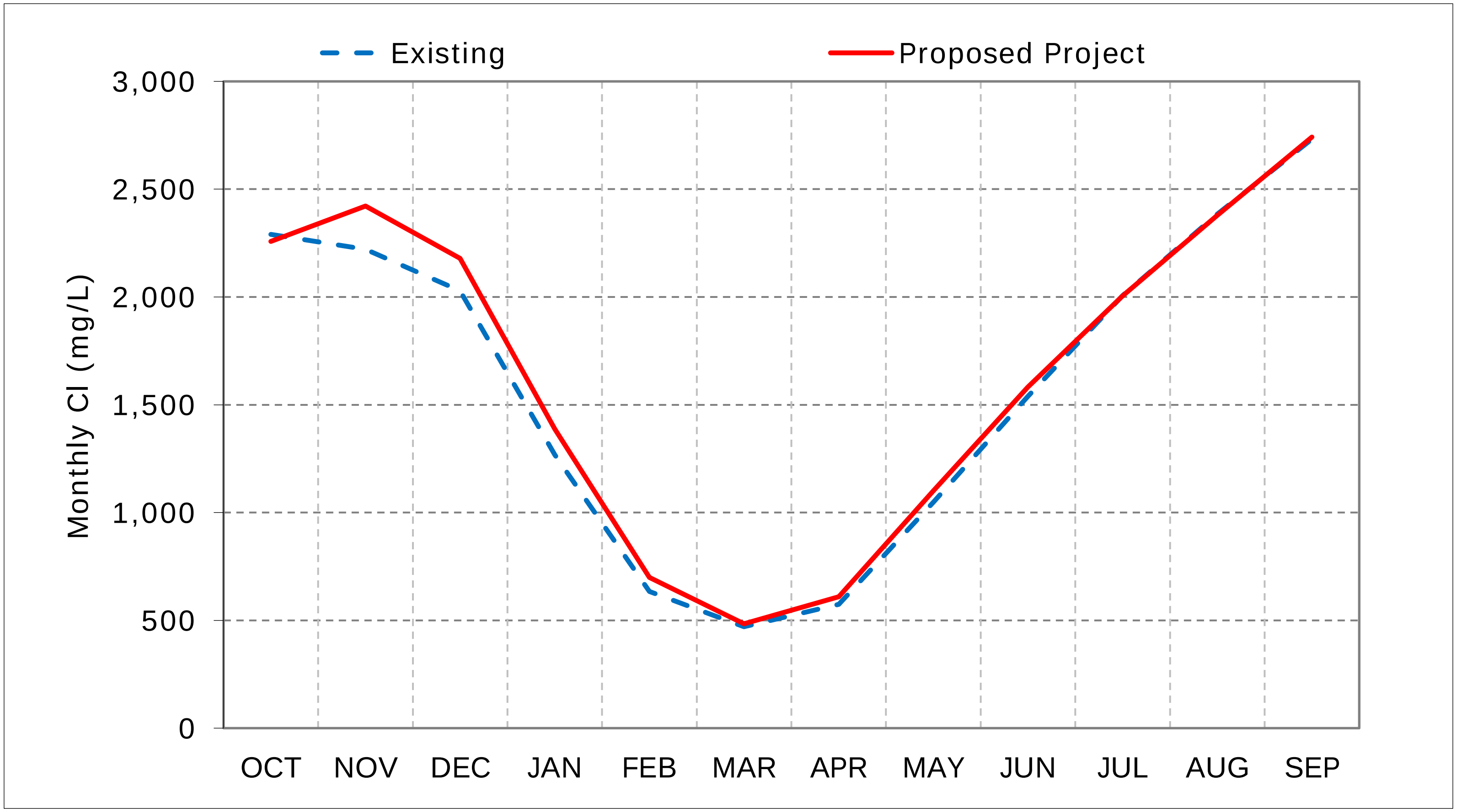
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 3-5. Sacramento River at Collinsville Chloride, Dry Year Average Cl



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 3-6. Sacramento River at Collinsville Chloride, Critical Year Average Cl



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 3-7. Sacramento River at Collinsville Chloride, January Cl

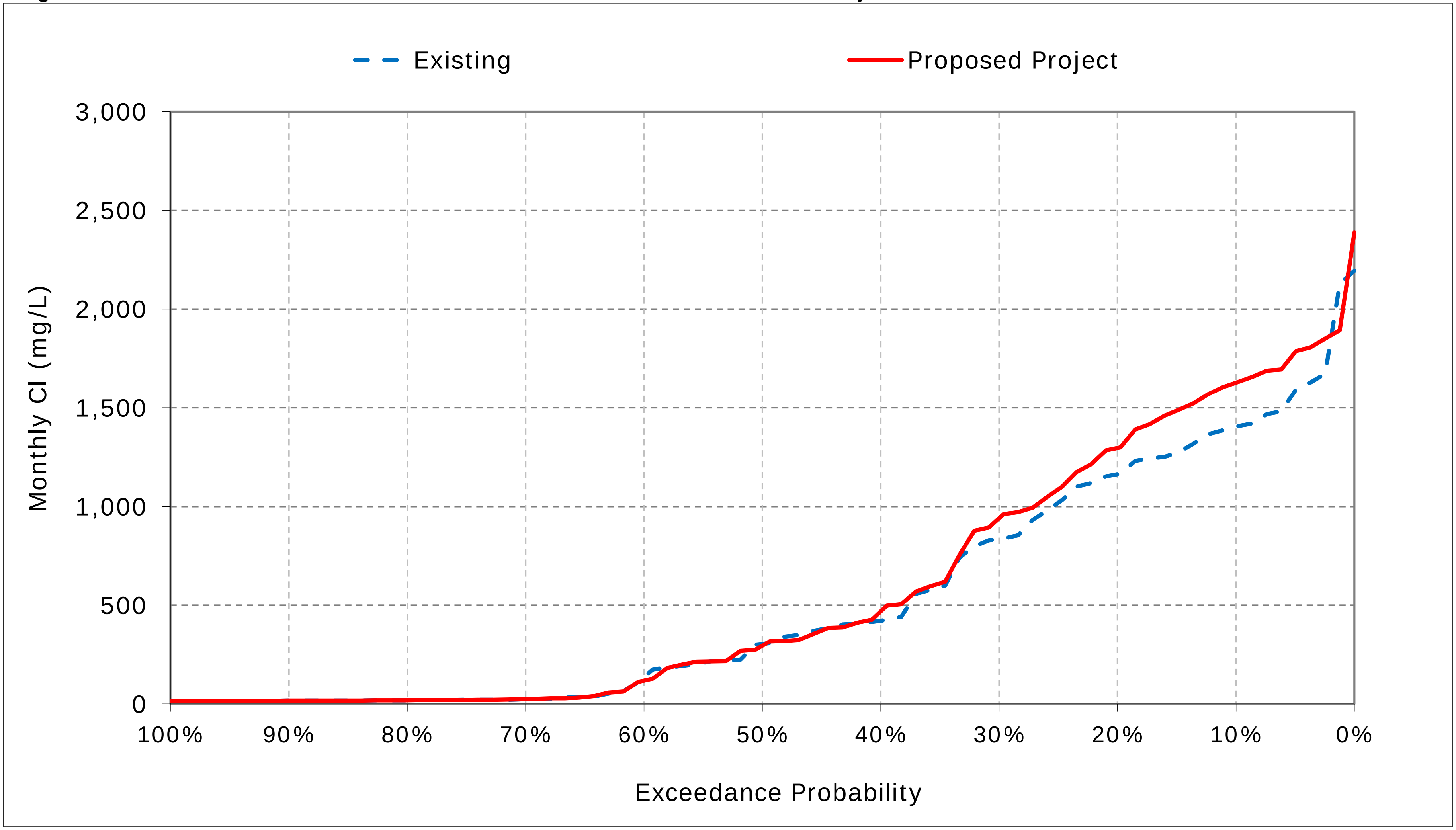


Figure 3-8. Sacramento River at Collinsville Chloride, February Cl

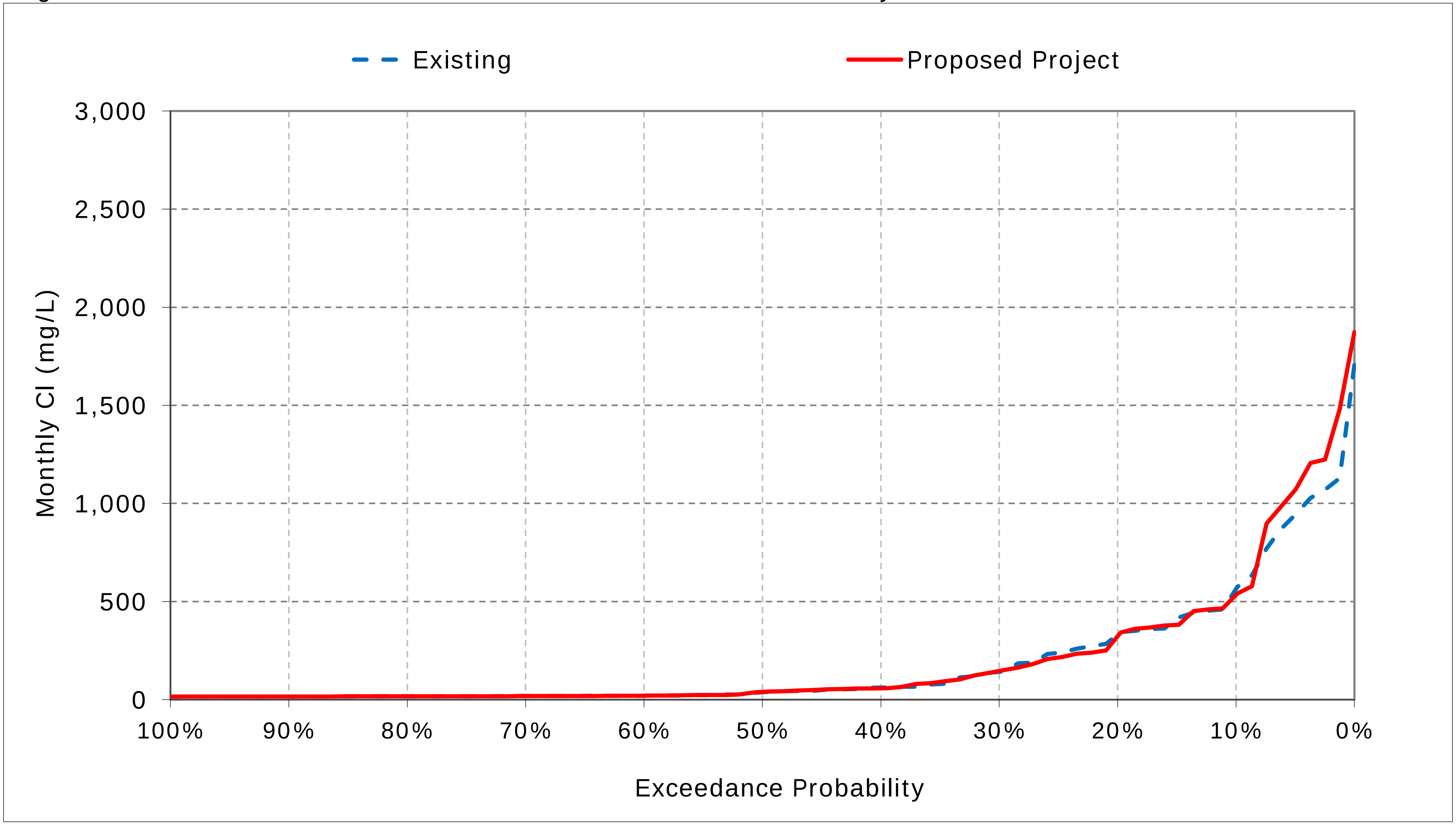


Figure 3-9. Sacramento River at Collinsville Chloride, March CI

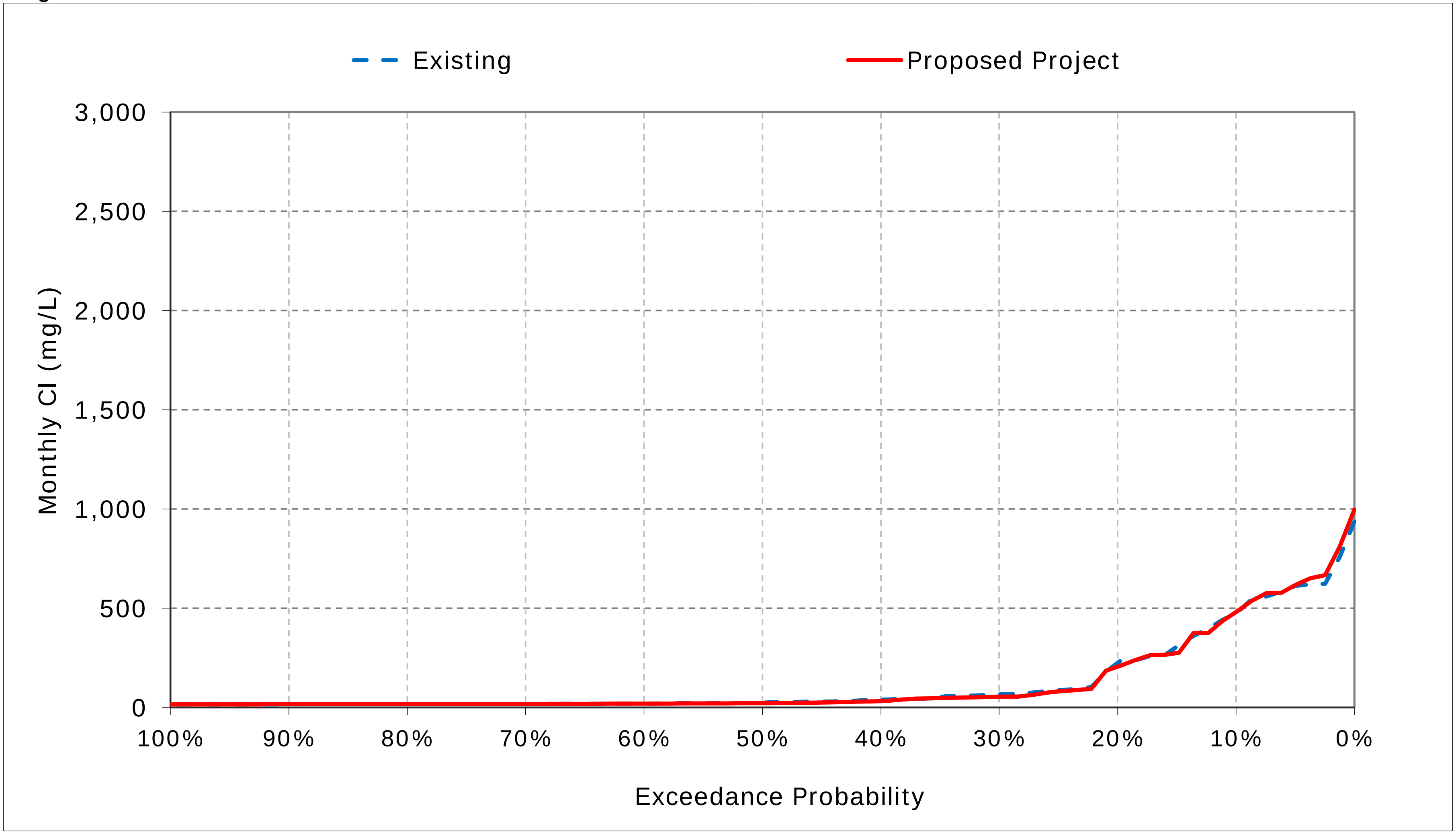


Figure 3-10. Sacramento River at Collinsville Chloride, April Cl

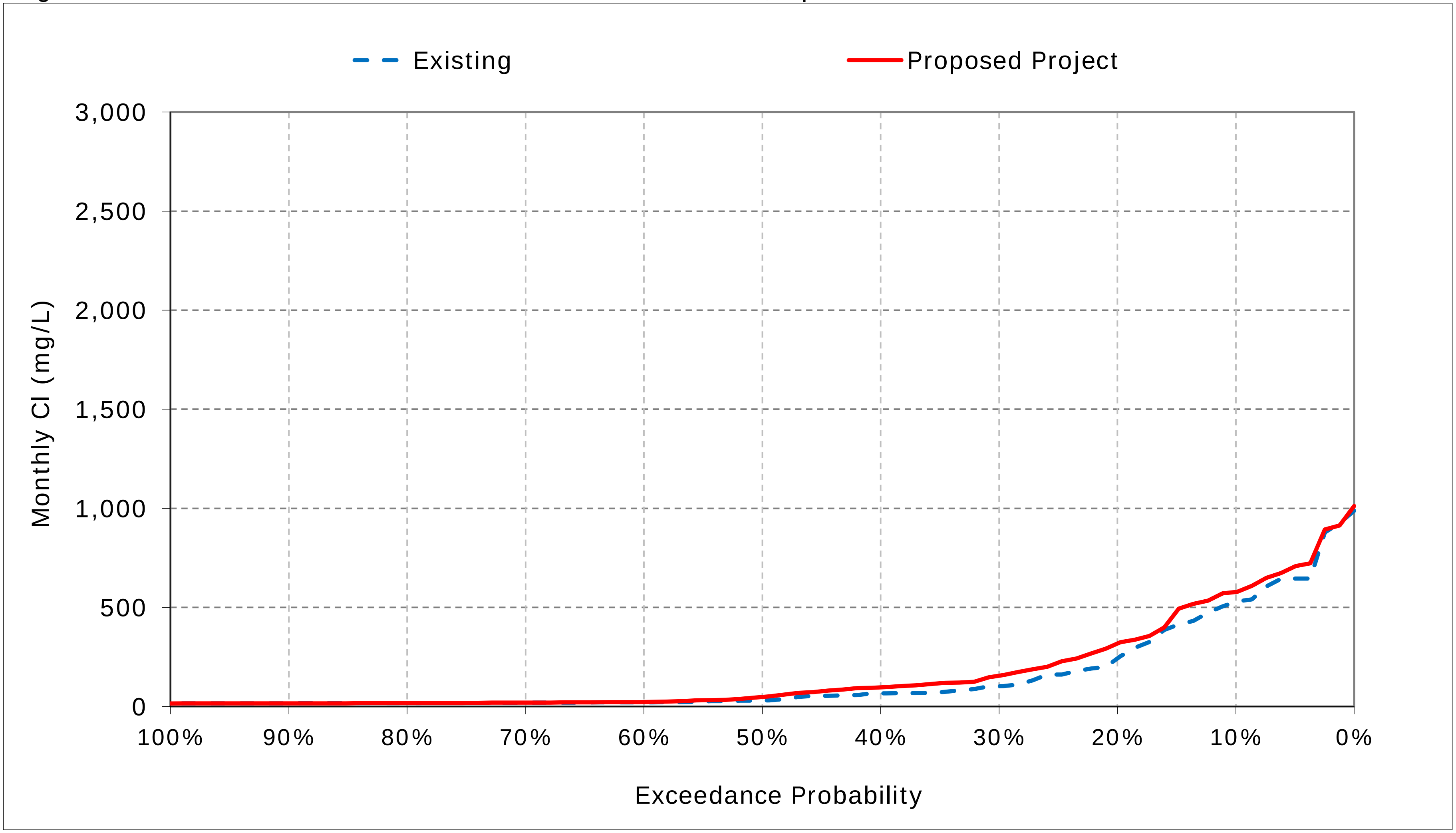


Figure 3-11. Sacramento River at Collinsville Chloride, May Cl

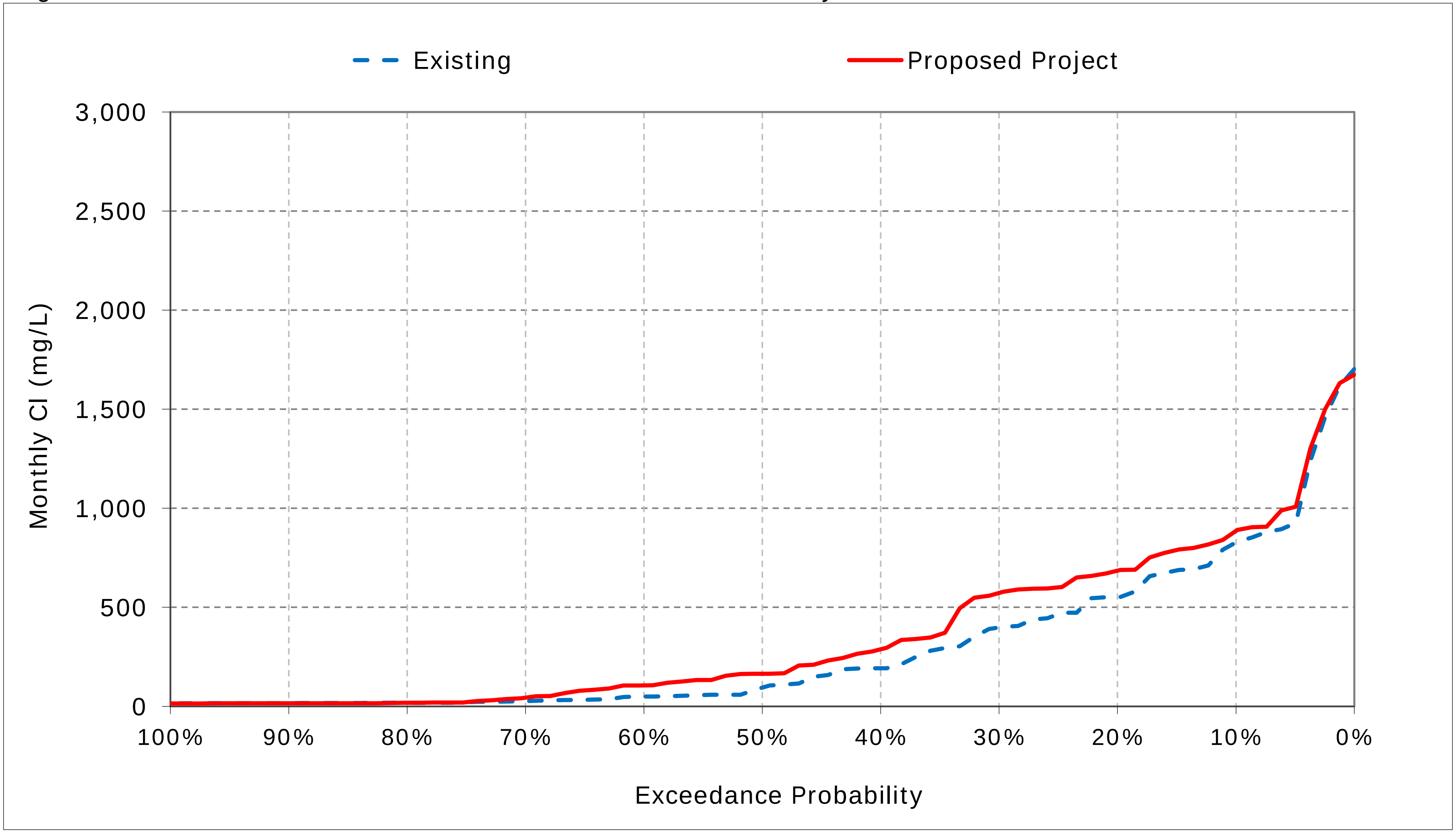


Figure 3-12. Sacramento River at Collinsville Chloride, June Cl

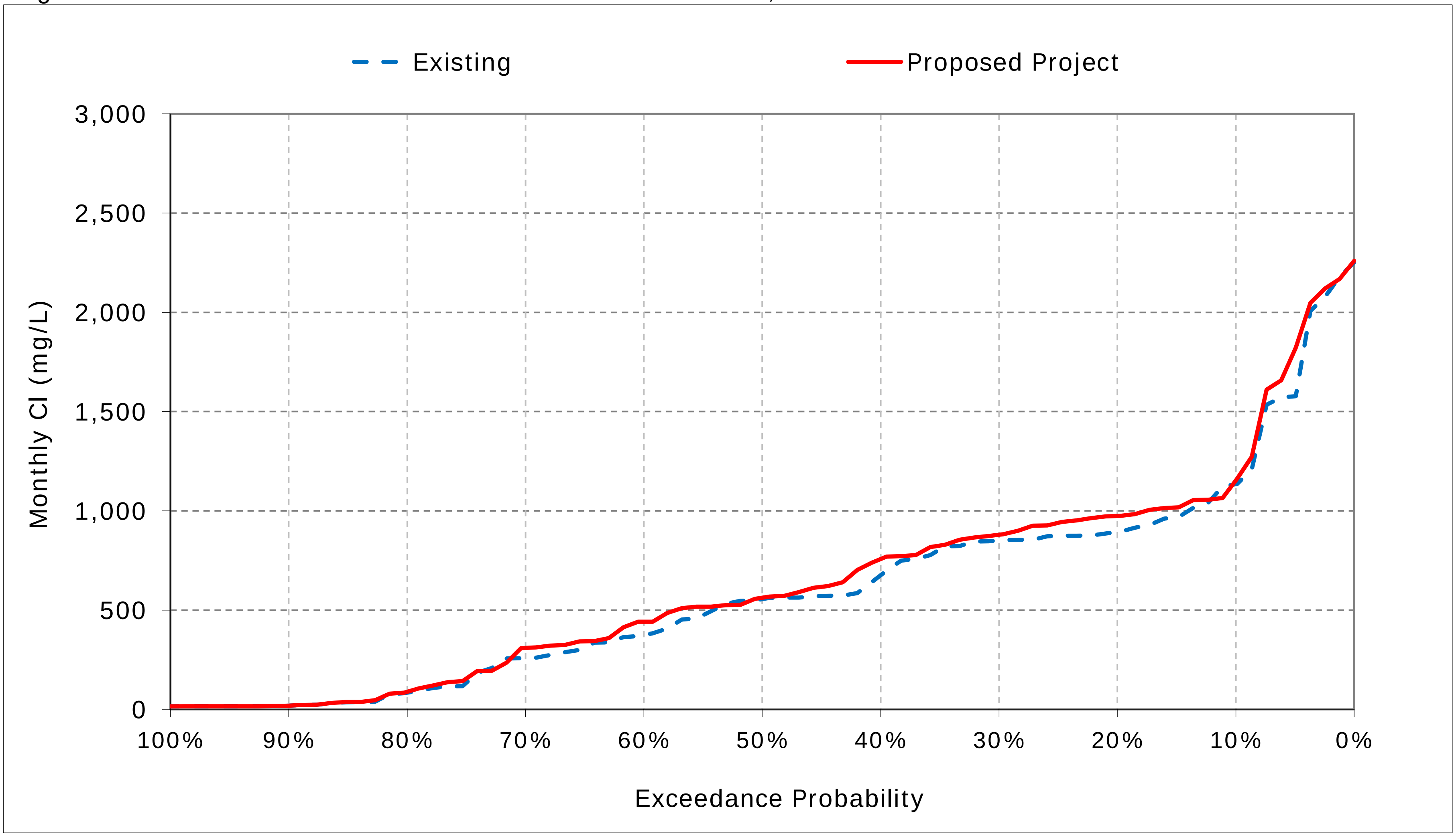


Figure 3-13. Sacramento River at Collinsville Chloride, July Cl

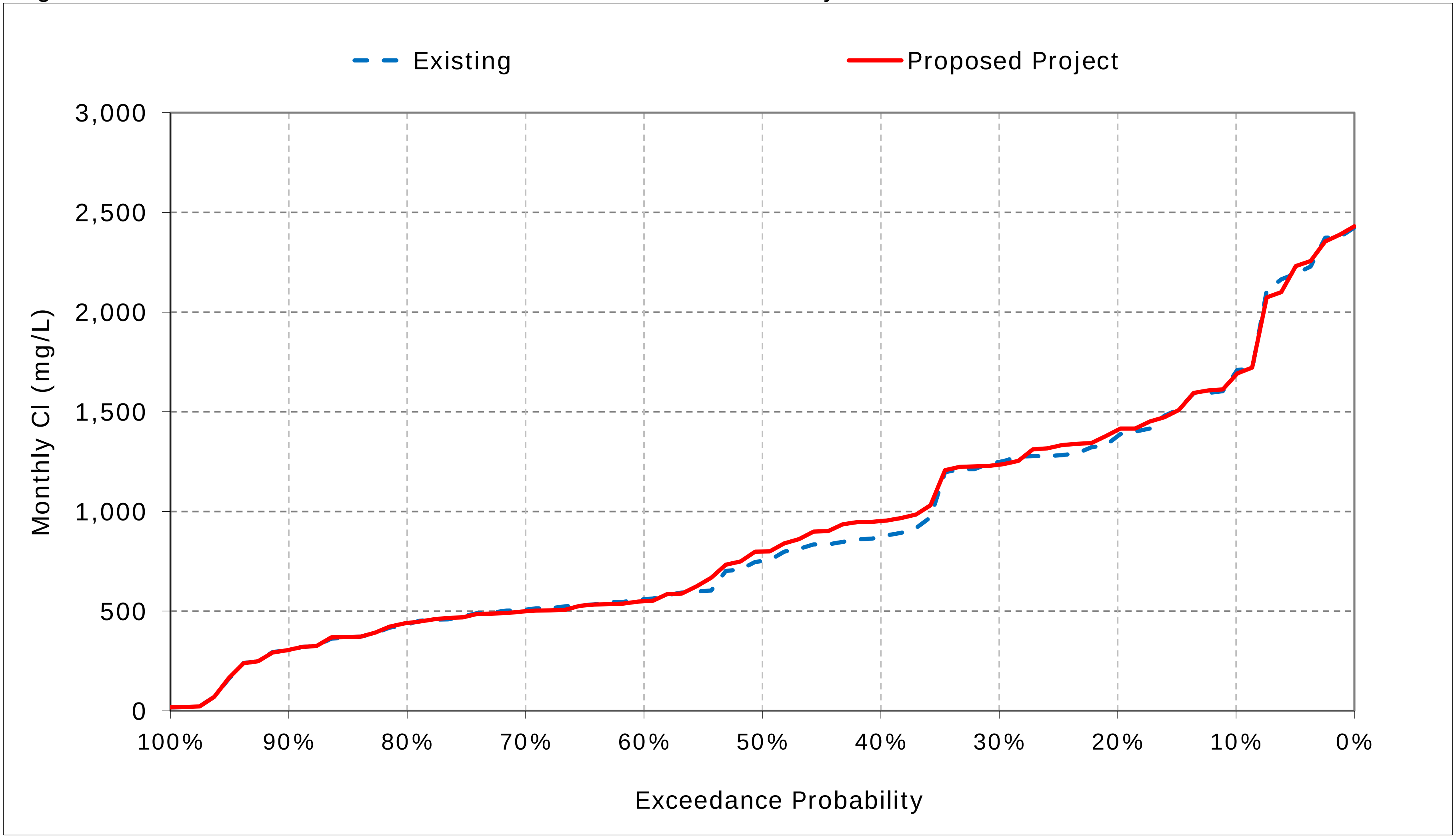


Figure 3-14. Sacramento River at Collinsville Chloride, August Cl

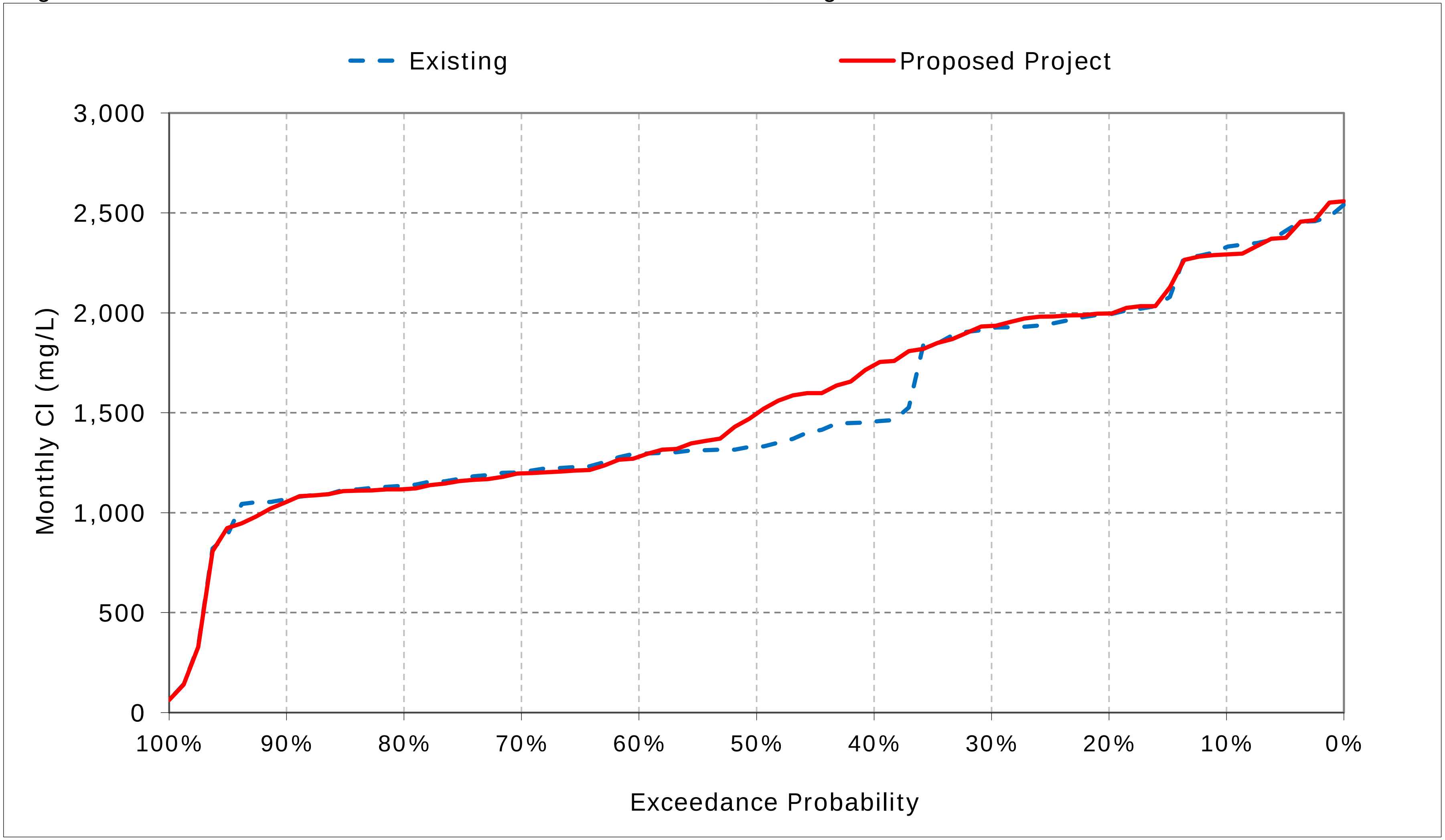


Figure 3-15. Sacramento River at Collinsville Chloride, September Cl

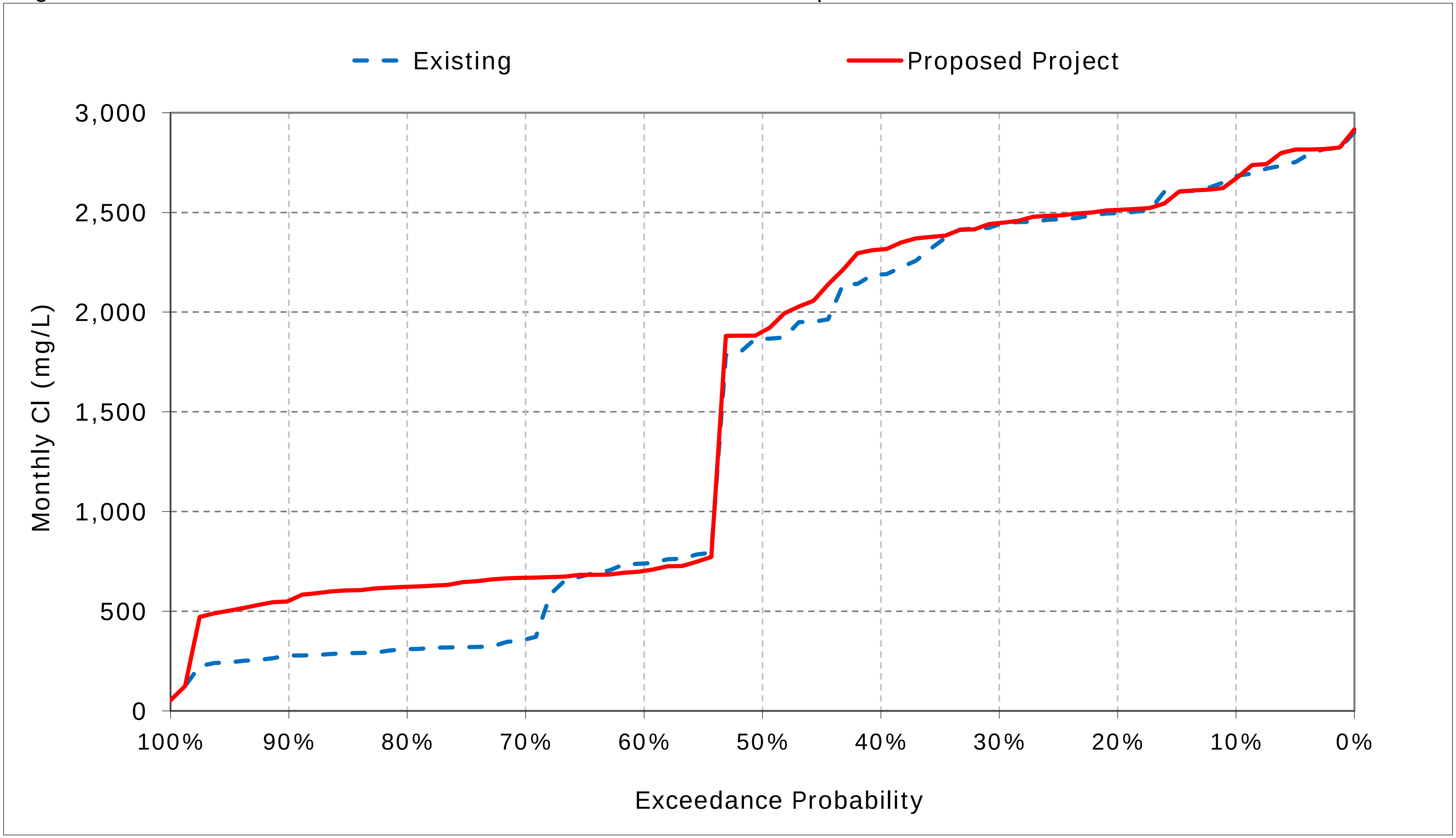


Figure 3-16. Sacramento River at Collinsville Chloride, October Cl

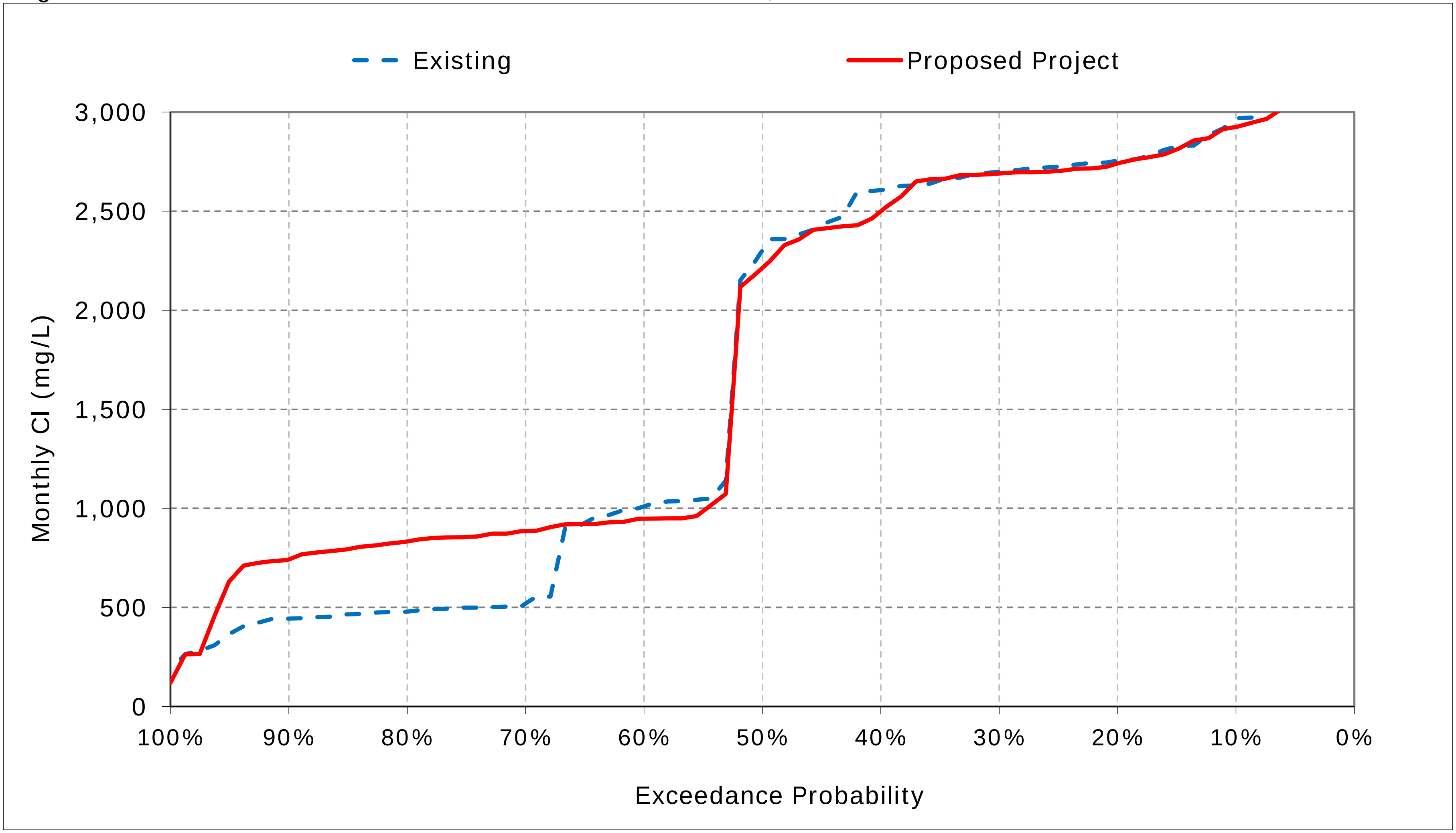


Figure 3-17. Sacramento River at Collinsville Chloride, November Cl

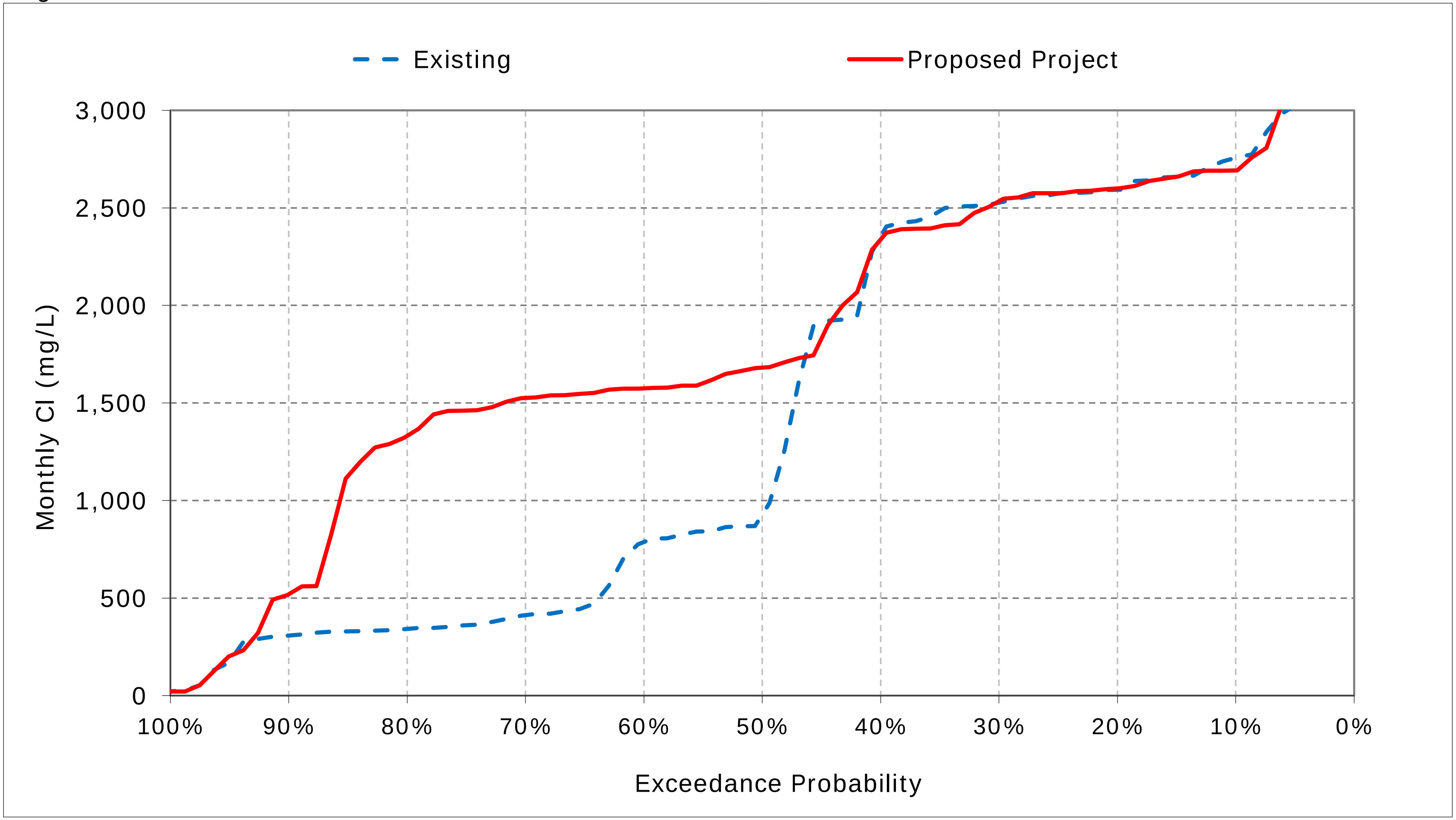


Figure 3-18. Sacramento River at Collinsville Chloride, December Cl

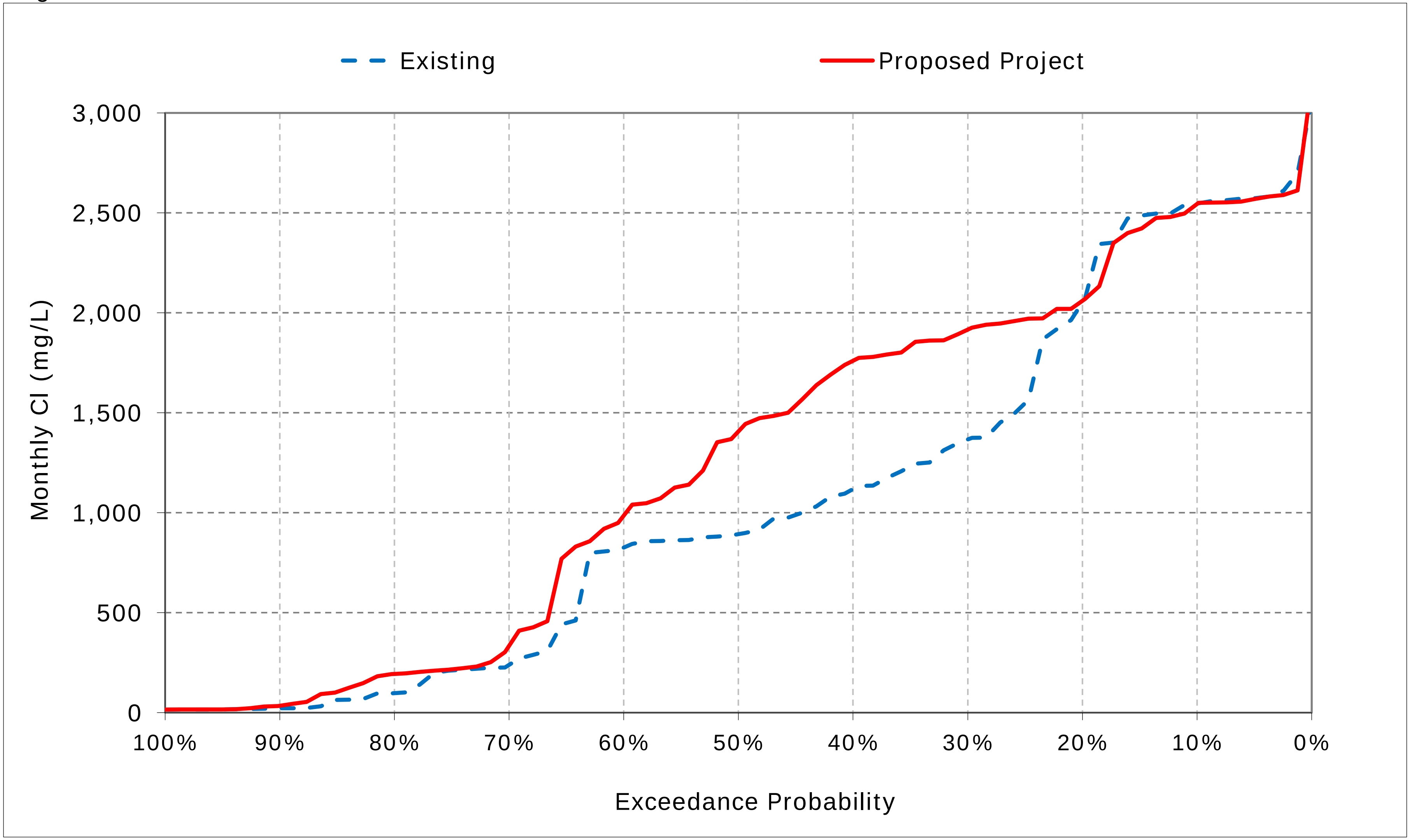


Table 4-1. San Joaquin River at Jersey Point Chloride, Monthly Cl

Existing

Statistic	Monthly Cl (mg/L)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	645	636	613	338	112	47	37	63	110	358	447	640
20%	593	592	535	271	63	29	25	36	84	274	391	612
30%	565	557	387	203	38	25	23	28	77	203	370	591
40%	538	488	312	142	33	23	23	25	54	180	342	556
50%	456	316	187	97	29	22	22	24	39	120	320	494
60%	110	132	162	50	26	21	21	23	26	90	294	243
70%	55	64	95	28	24	20	21	22	23	76	277	226
80%	39	42	38	23	21	19	20	21	19	46	254	209
90%	32	28	20	21	20	18	19	19	18	25	235	200
Long Term												
Full Simulation Period[a]	336	324	274	143	51	29	26	36	68	166	322	410
Water Year Types[b]												
Wet (32%)	242	208	91	34	23	21	21	20	22	48	233	184
Above Normal (15%)	376	317	268	99	30	21	22	22	32	73	270	219
Below Normal (17%)	354	368	360	163	35	23	23	25	46	163	349	602
Dry (22%)	357	386	336	197	63	28	24	31	78	275	370	594
Critical (15%)	448	439	485	315	132	61	46	102	213	353	461	591

Proposed Project

Statistic	Monthly Cl (mg/L)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	639	645	651	414	127	46	43	78	118	364	465	675
20%	595	596	613	317	68	29	25	55	98	240	417	657
30%	573	541	573	254	43	25	22	38	79	184	383	616
40%	526	485	506	201	34	24	21	23	58	165	355	566
50%	456	447	414	103	29	23	20	21	35	109	322	507
60%	127	380	337	59	27	22	20	19	25	83	287	216
70%	110	361	146	28	23	21	19	18	21	70	273	197
80%	89	298	100	24	21	19	19	17	18	47	248	176
90%	67	151	29	22	20	19	18	17	17	25	216	139
Long Term												
Full Simulation Period[a]	352	431	376	169	59	31	26	39	71	161	327	410
Water Year Types[b]												
Wet (32%)	267	340	159	39	24	21	19	18	23	47	220	153
Above Normal (15%)	397	441	420	135	32	22	20	19	29	70	271	197
Below Normal (17%)	374	469	475	187	36	23	22	27	46	147	381	656
Dry (22%)	370	469	465	246	78	30	26	42	88	264	374	600
Critical (15%)	438	517	555	344	162	69	55	116	226	364	481	609

Proposed Project minus Existing

Statistic	Monthly Cl (mg/L)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	-6	8	38	76	15	0	6	16	7	6	18	35
20%	1	4	78	46	5	0	0	18	15	-33	27	45
30%	8	-16	186	51	5	0	-1	10	2	-19	13	26
40%	-12	-3	194	59	1	0	-1	-2	4	-15	13	9
50%	0	131	228	6	0	1	-1	-3	-3	-11	2	12
60%	16	248	175	8	1	1	-1	-4	-1	-7	-8	-26
70%	55	297	51	1	0	0	-2	-4	-1	-6	-4	-29
80%	50	257	62	1	0	0	-1	-4	-1	1	-5	-33
90%	36	123	9	1	0	0	-1	-2	-1	0	-19	-61
Long Term												
Full Simulation Period[a]	16	107	102	26	8	2	1	4	4	-4	5	0
Water Year Types[b]												
Wet (32%)	25	132	67	5	0	0	-2	-2	1	-1	-13	-32
Above Normal (15%)	21	124	152	36	2	1	-2	-4	-4	-3	1	-22
Below Normal (17%)	20	101	116	24	1	0	-1	2	0	-16	31	55
Dry (22%)	13	83	129	49	15	1	1	10	10	-11	3	6
Critical (15%)	-10	78	70	29	31	8	9	14	13	11	19	18

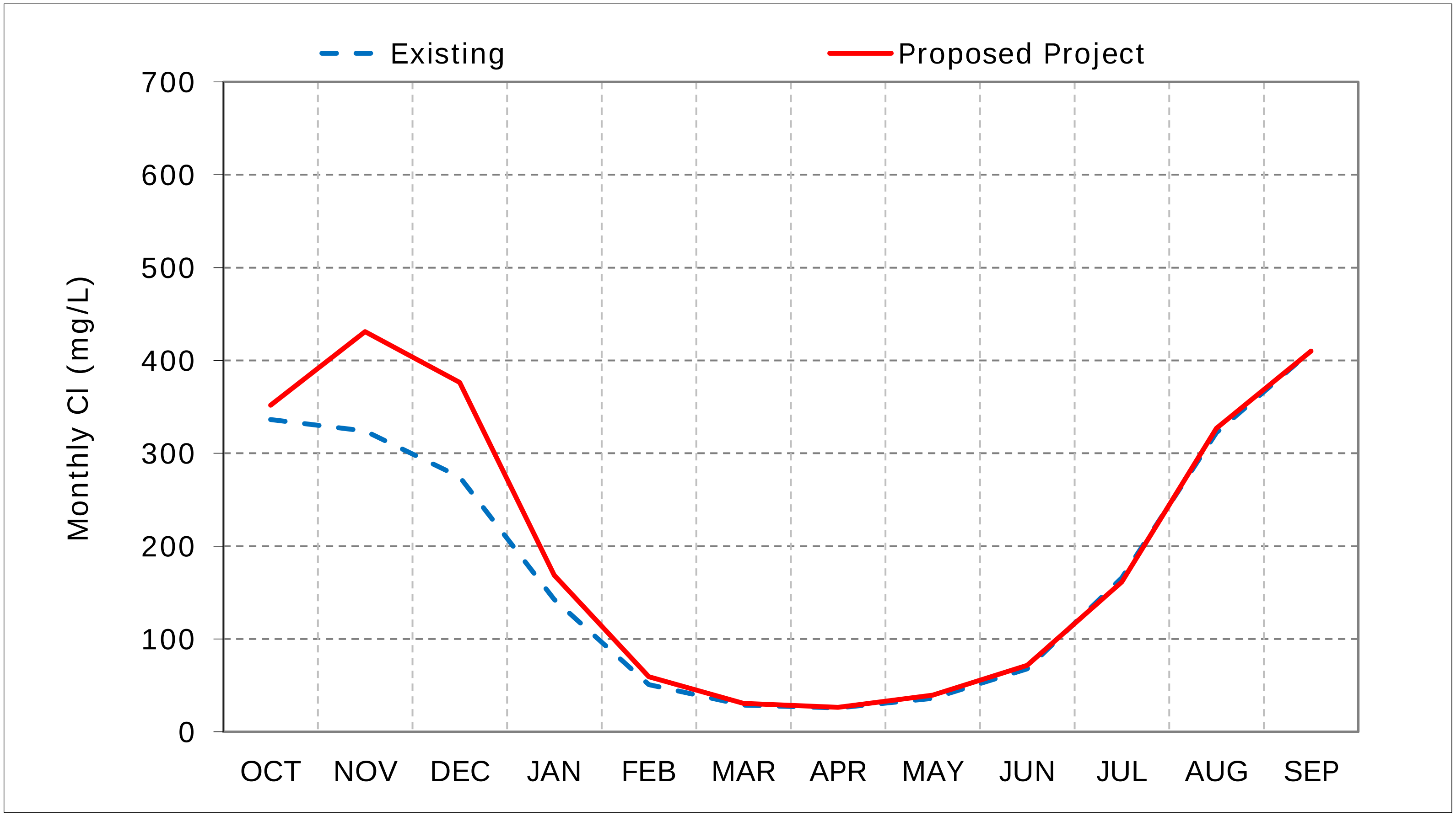
a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

c These results are displayed with water year - year type sorting.

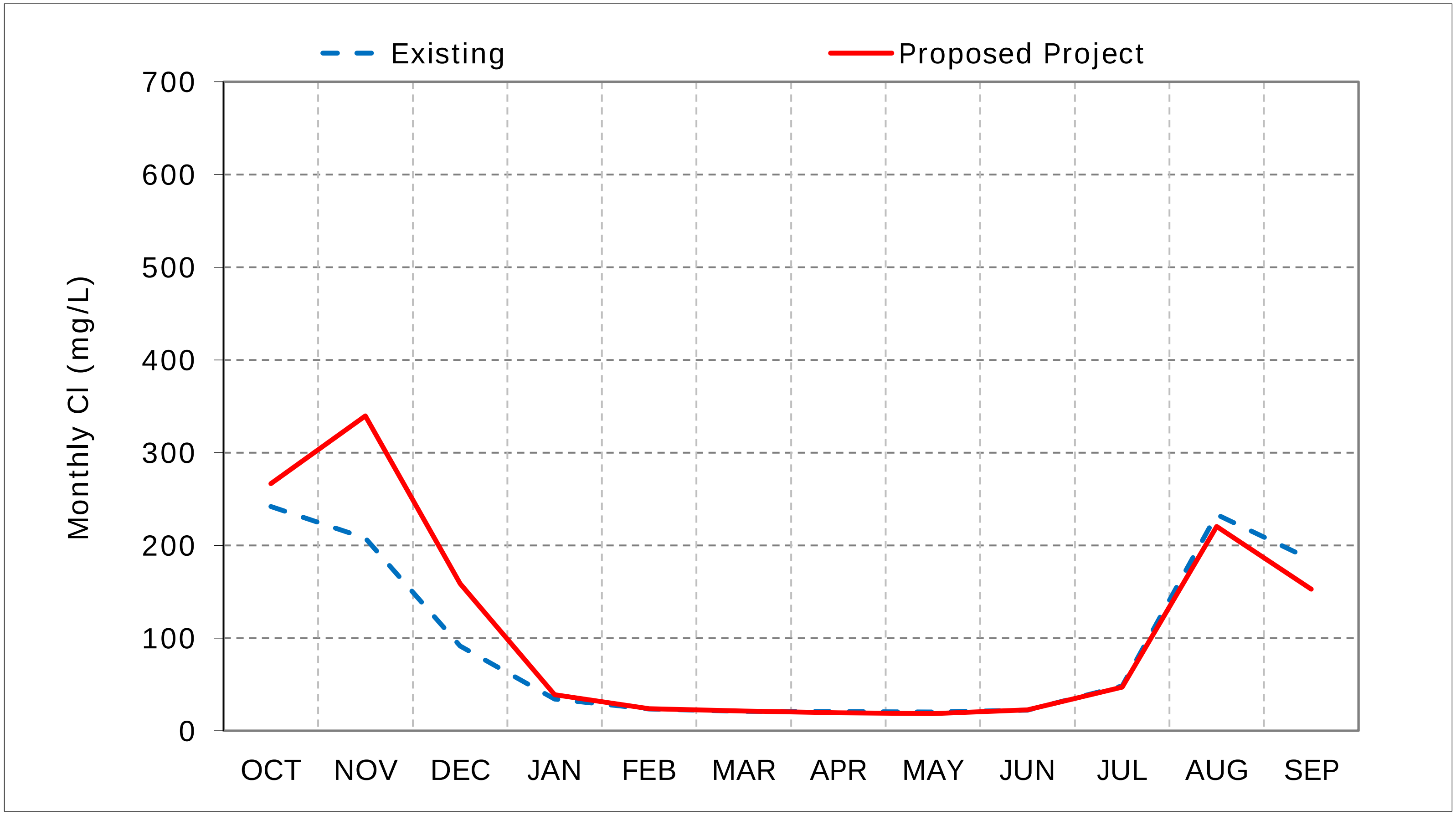
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 4-1. San Joaquin River at Jersey Point Chloride, Long-Term Average Cl



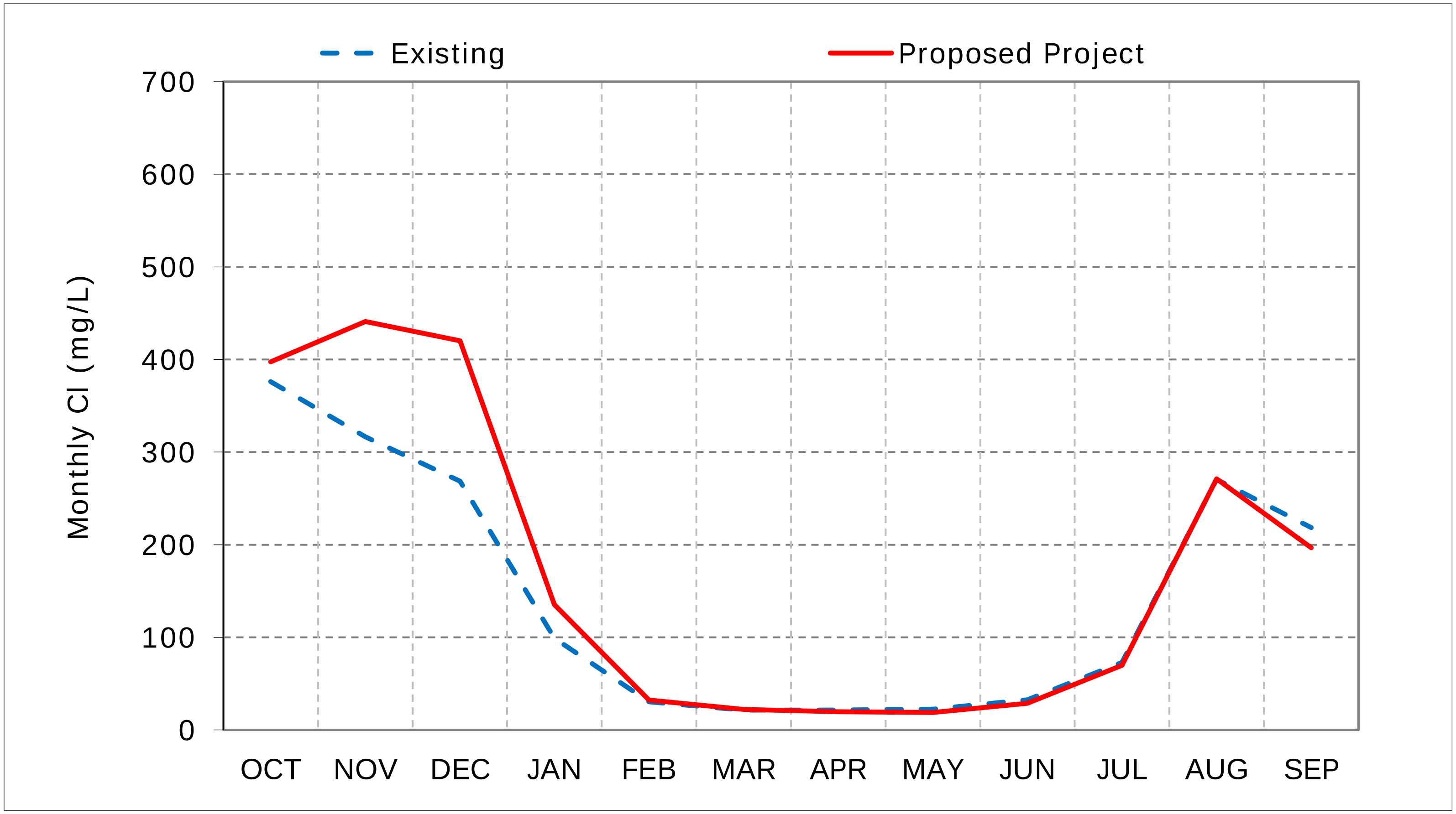
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 4-2. San Joaquin River at Jersey Point Chloride, Wet Year Average Cl



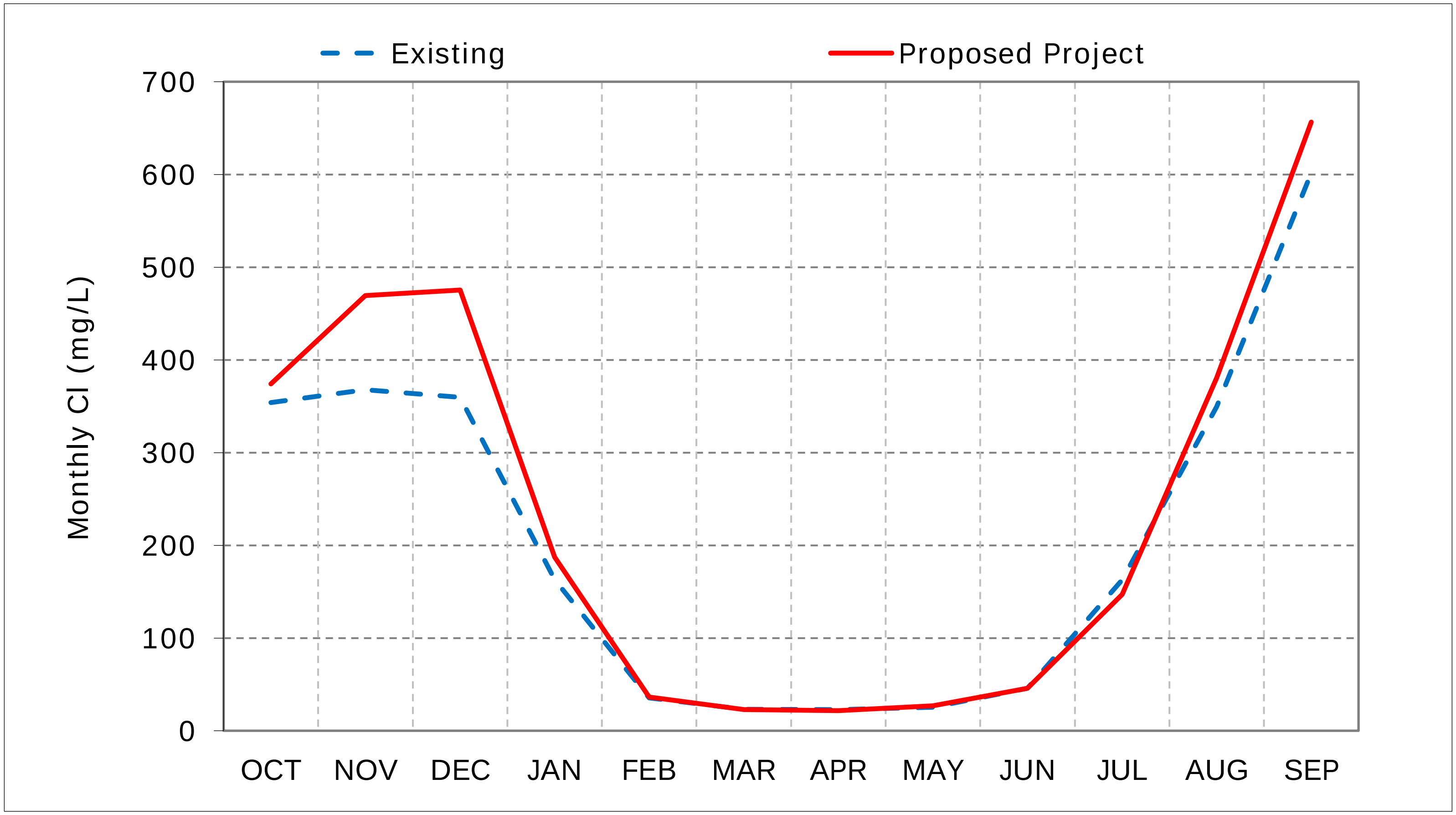
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 4-3. San Joaquin River at Jersey Point Chloride, Above Normal Year Averag



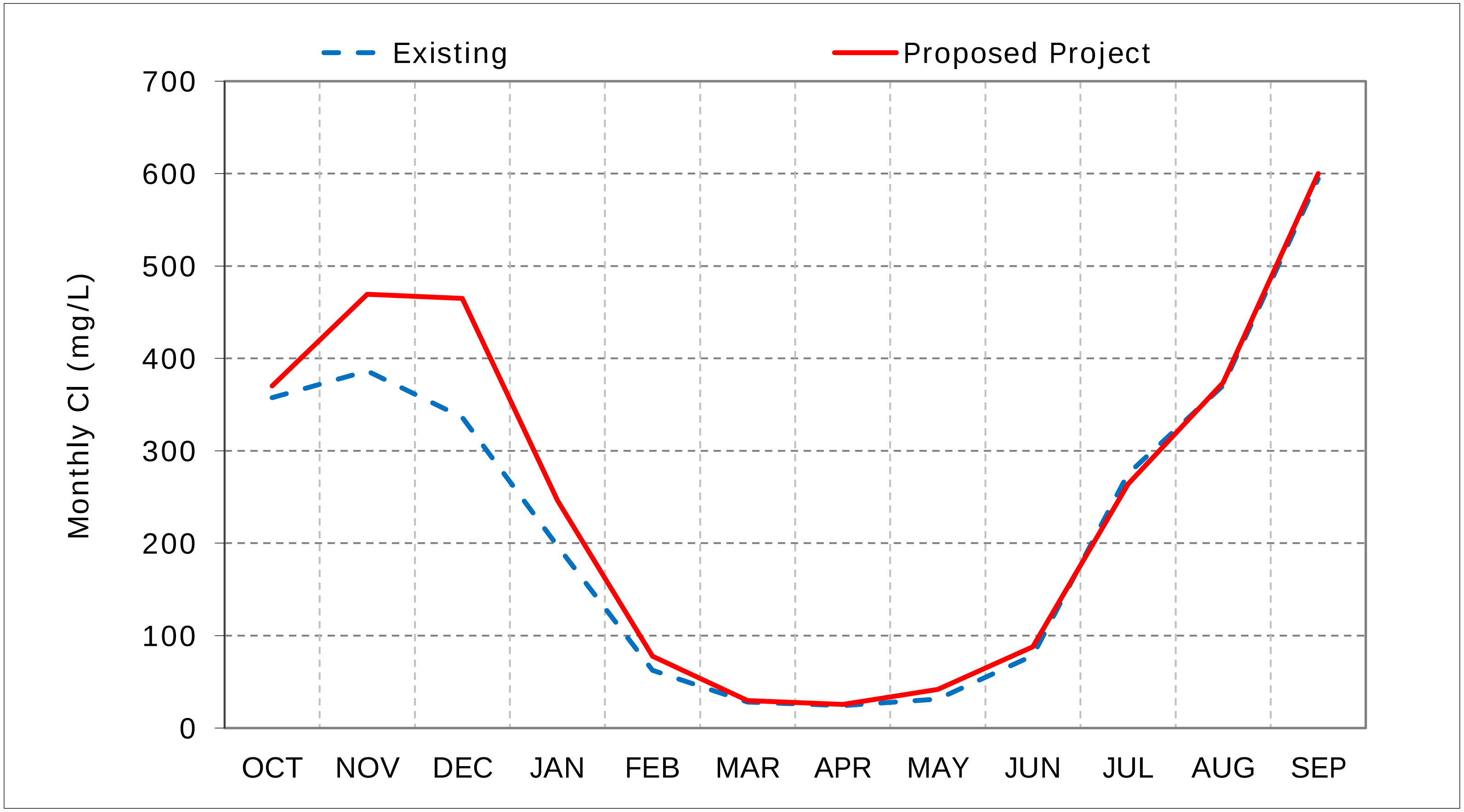
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 4-4. San Joaquin River at Jersey Point Chloride, Below Normal Year Averag



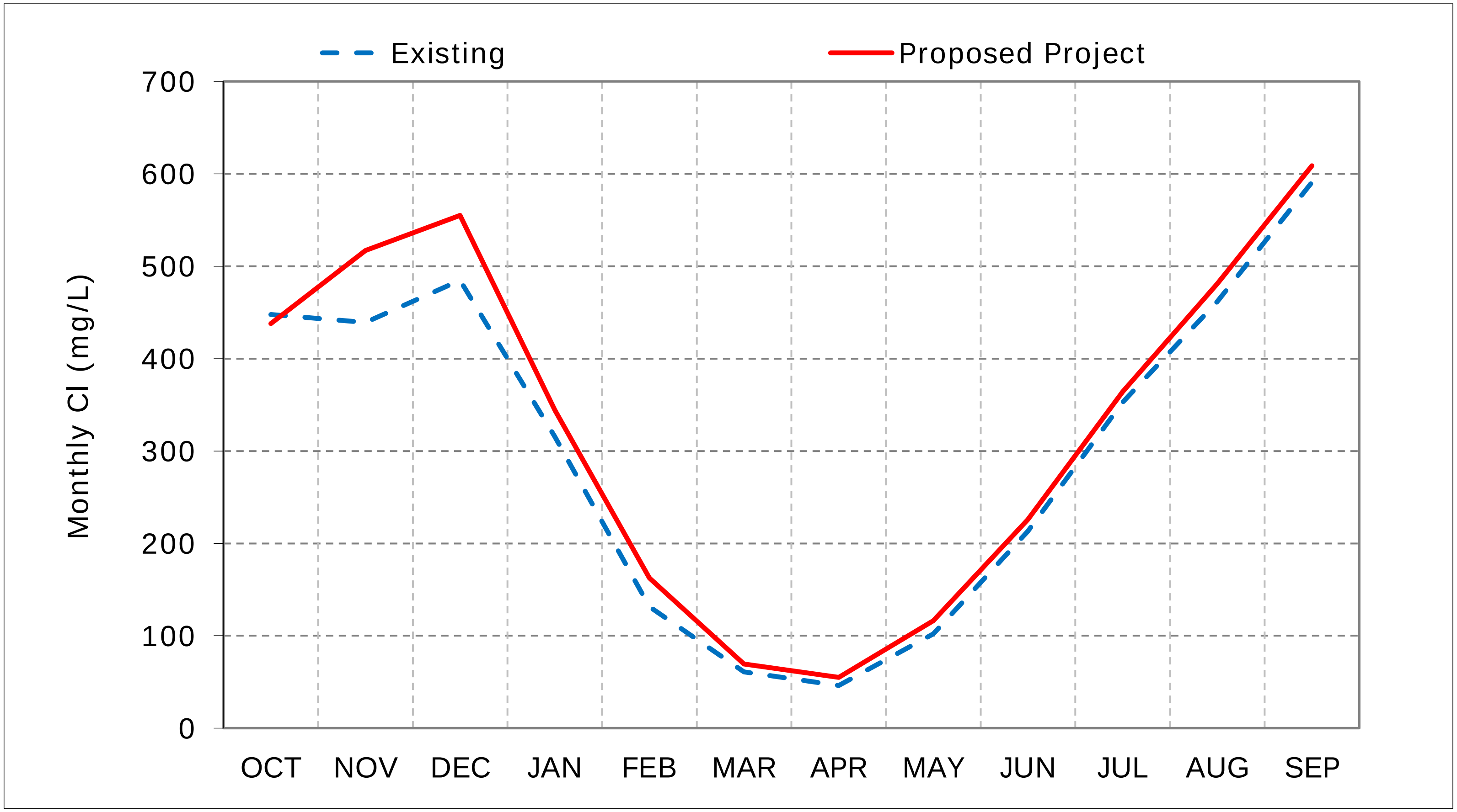
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 4-5. San Joaquin River at Jersey Point Chloride, Dry Year Average Cl



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 4-6. San Joaquin River at Jersey Point Chloride, Critical Year Average Cl



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 4-7. San Joaquin River at Jersey Point Chloride, January Cl

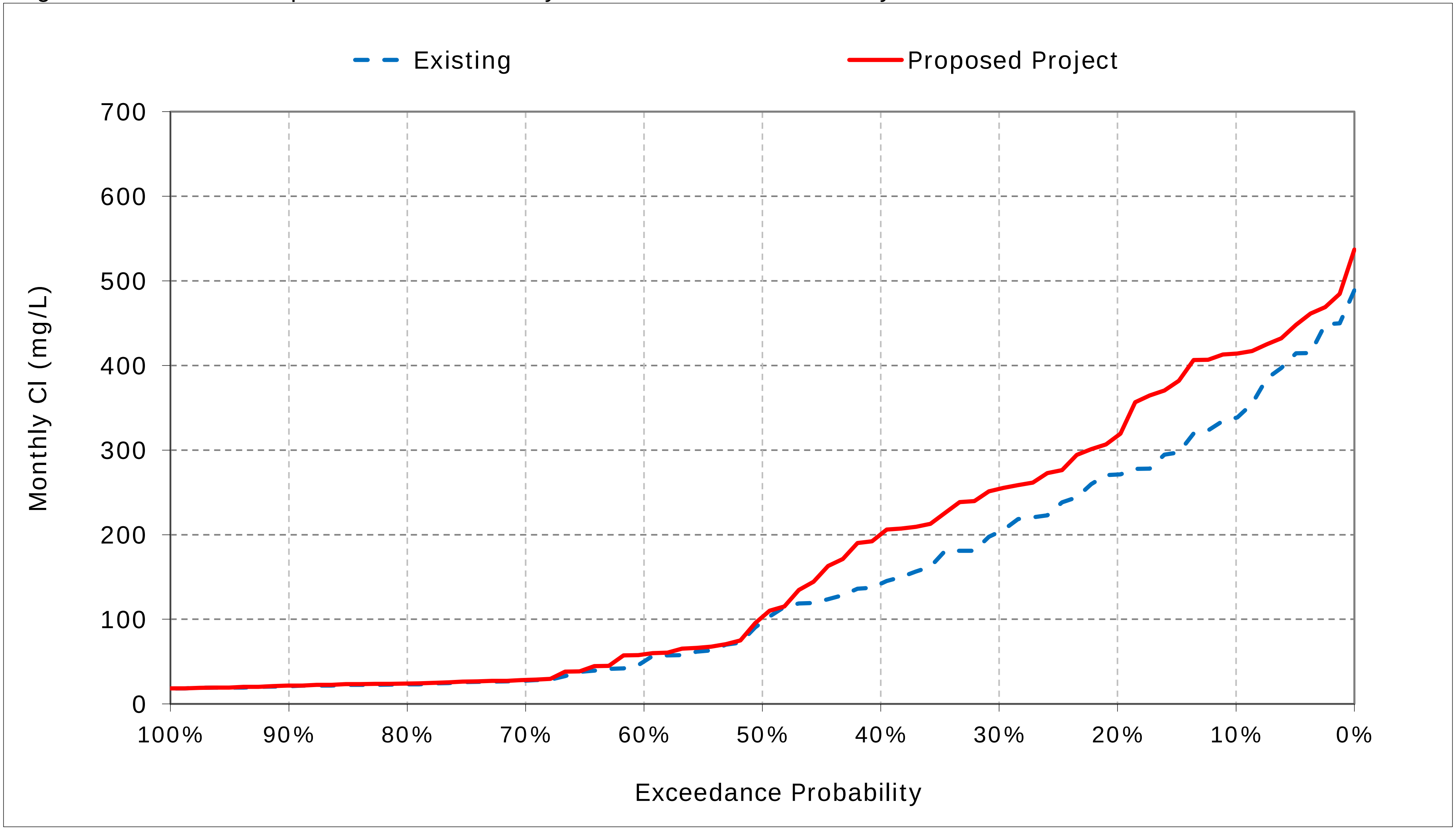


Figure 4-8. San Joaquin River at Jersey Point Chloride, February Cl

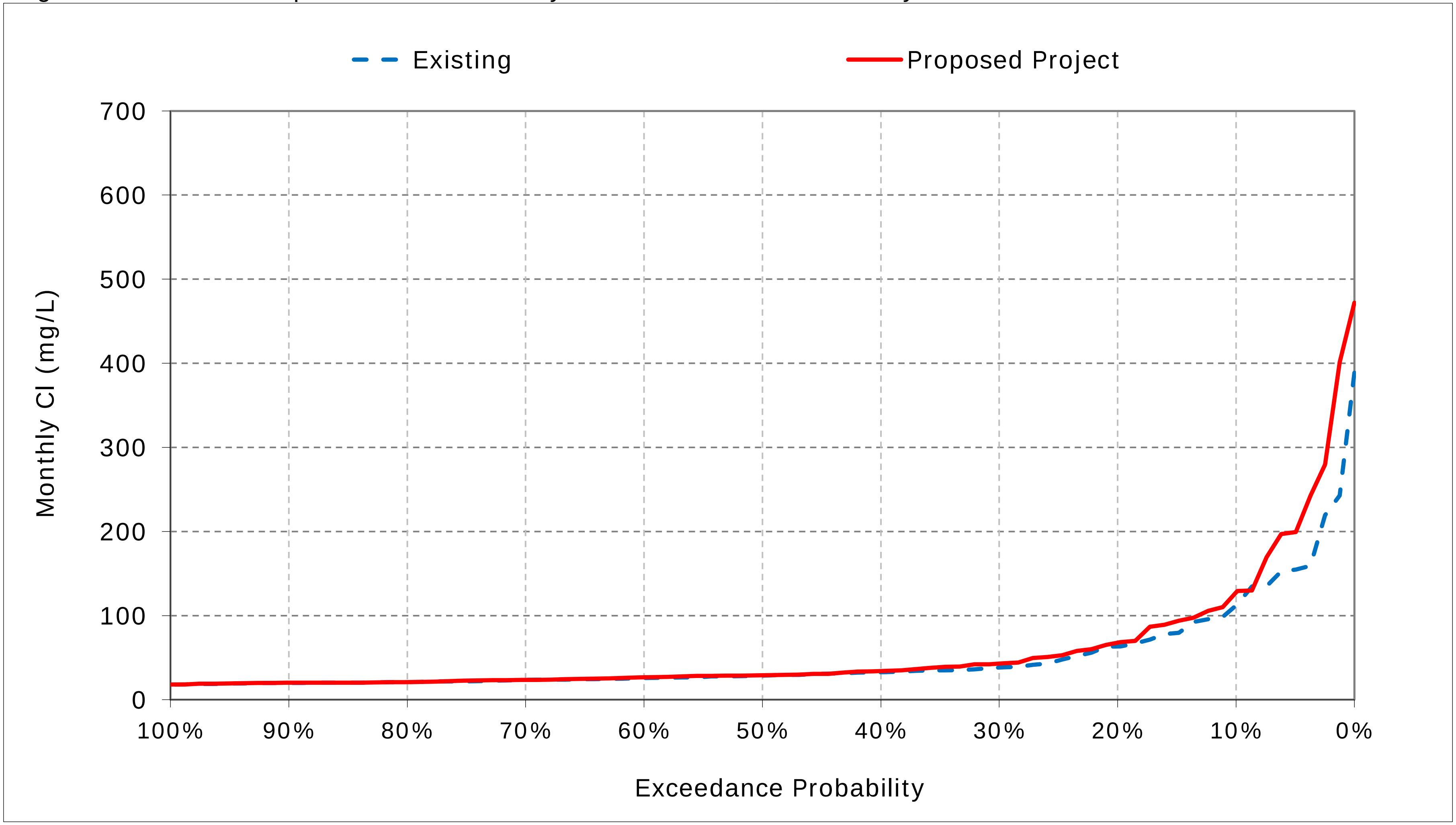


Figure 4-9. San Joaquin River at Jersey Point Chloride, March Cl

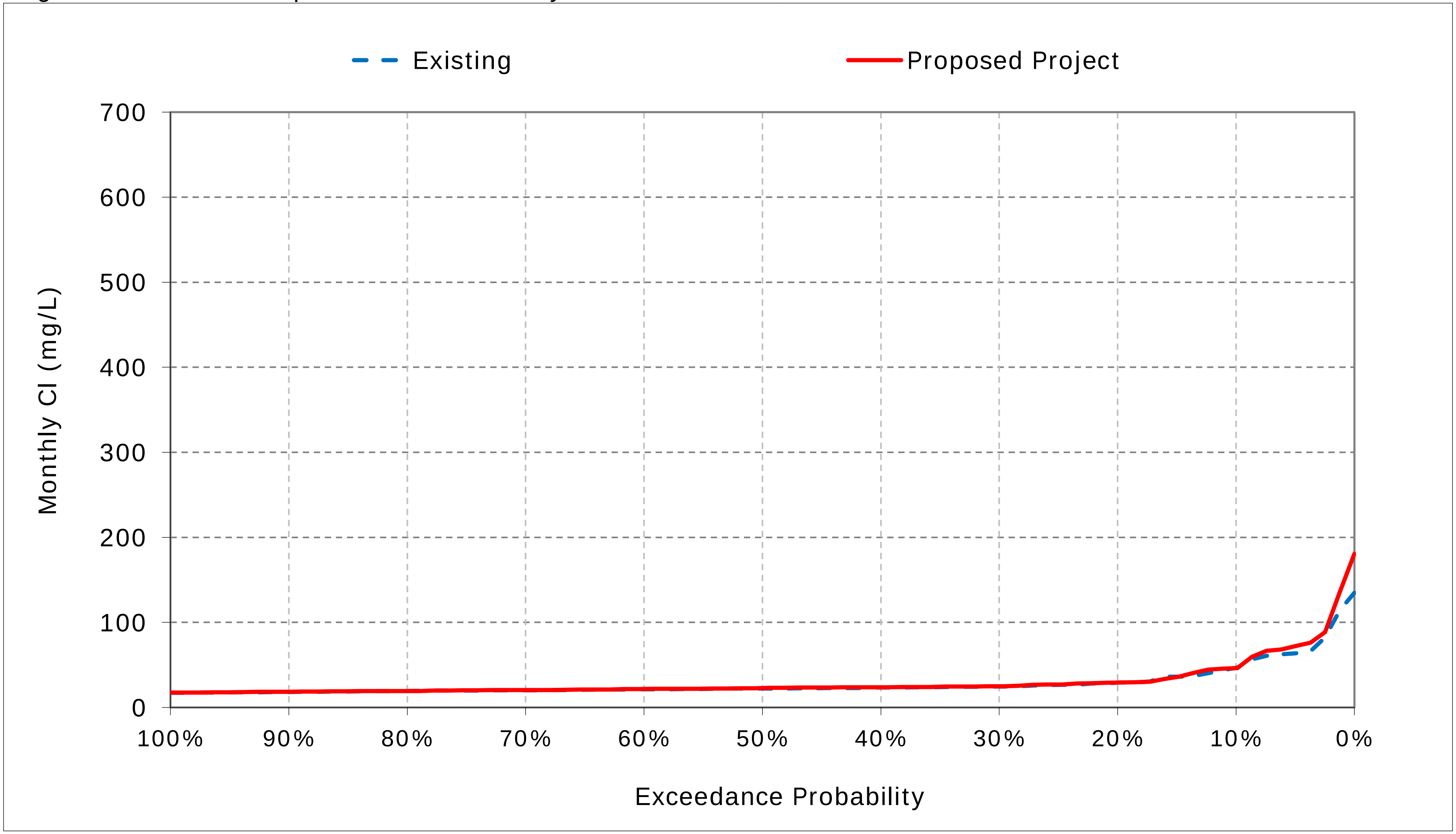


Figure 4-10. San Joaquin River at Jersey Point Chloride, April Cl

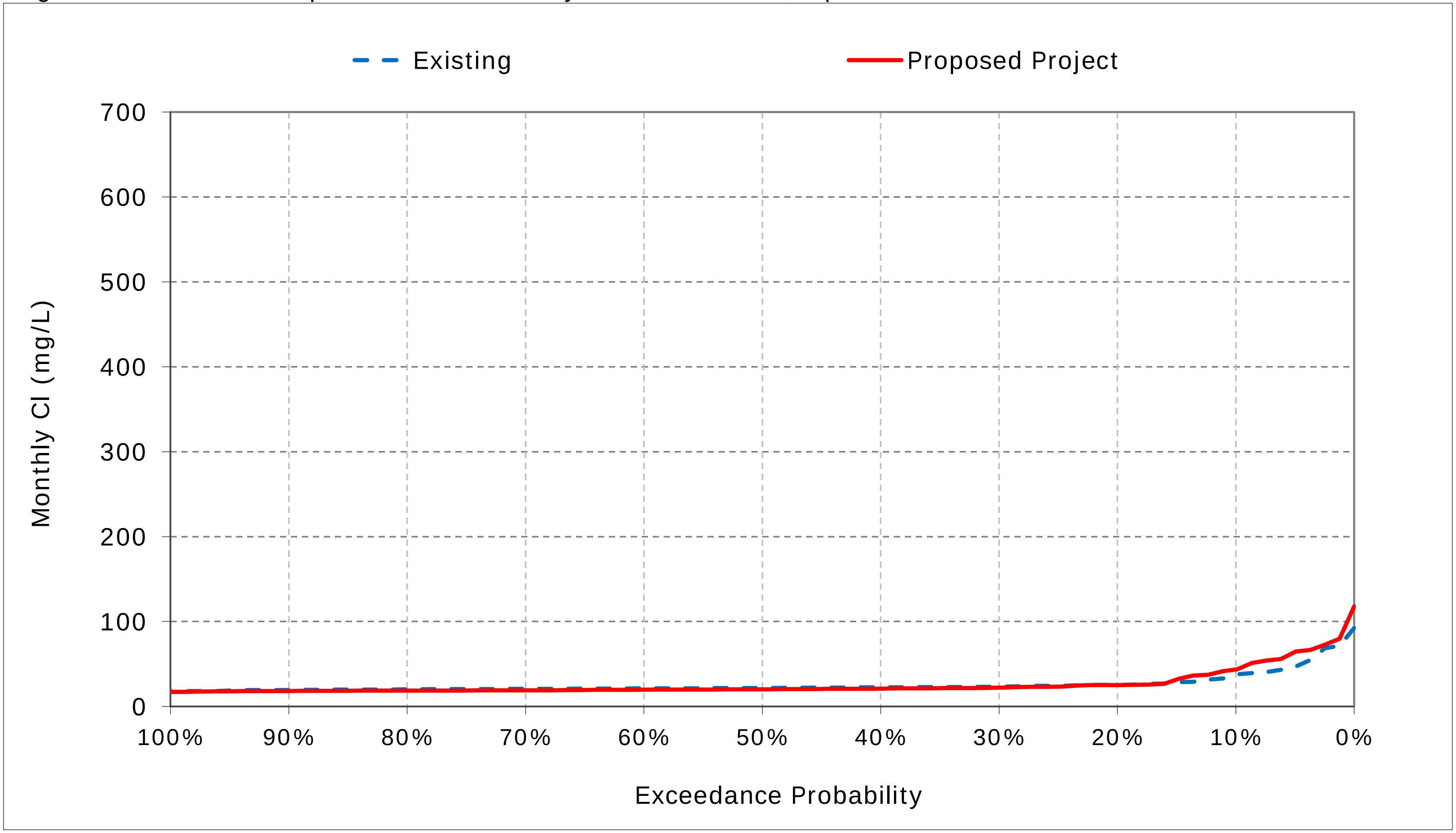


Figure 4-11. San Joaquin River at Jersey Point Chloride, May Cl

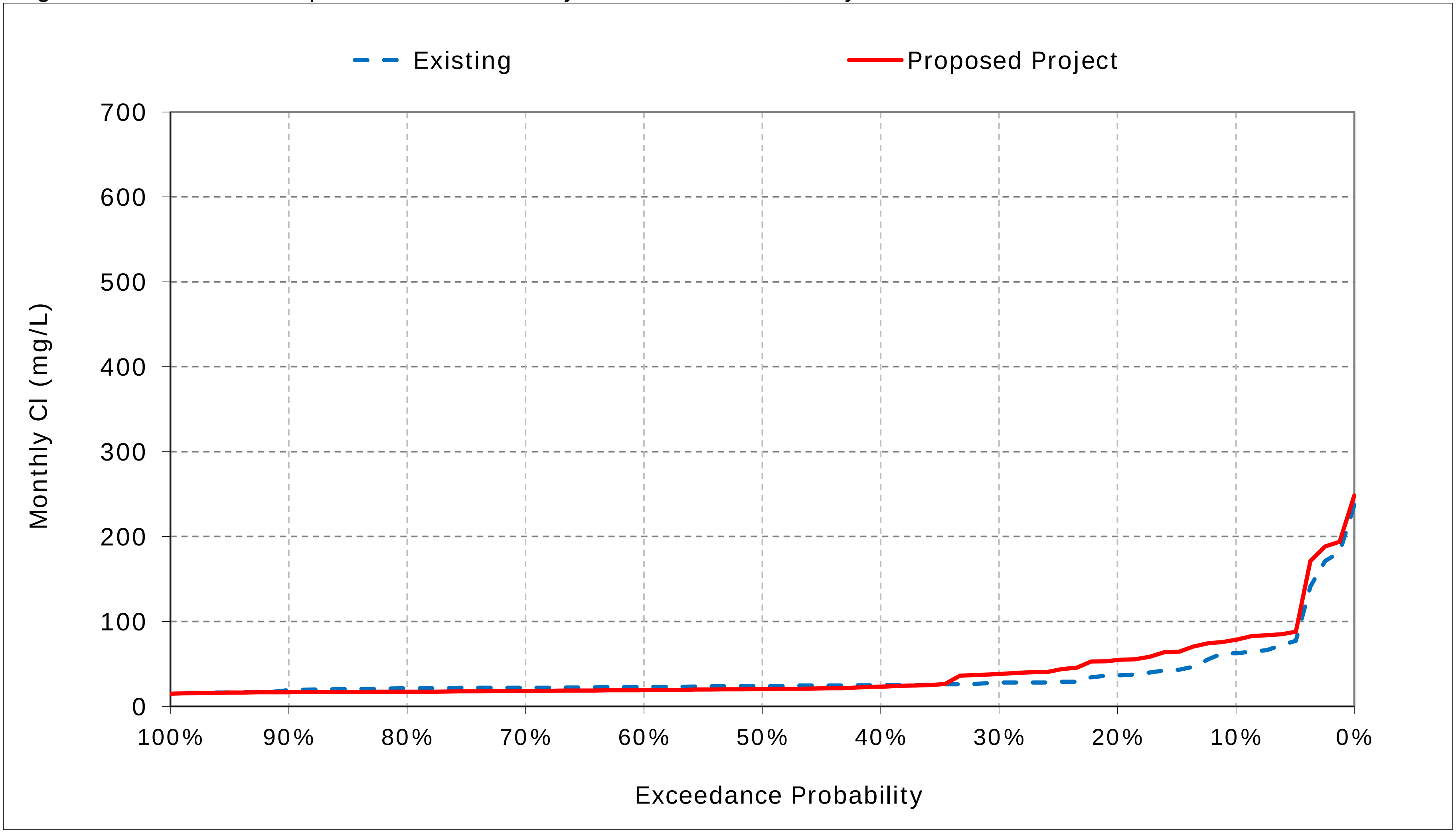


Figure 4-12. San Joaquin River at Jersey Point Chloride, June Cl

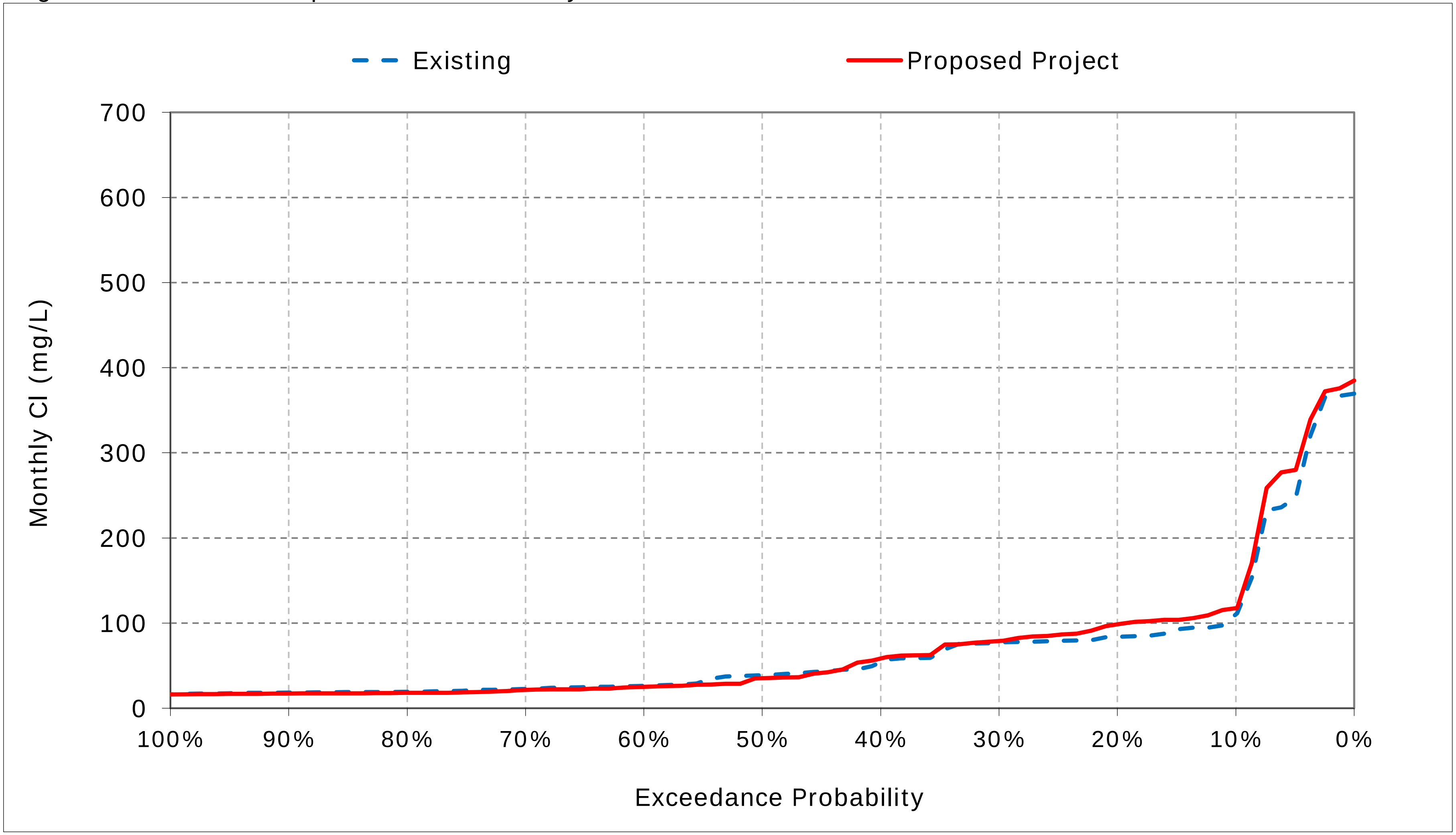


Figure 4-13. San Joaquin River at Jersey Point Chloride, July Cl

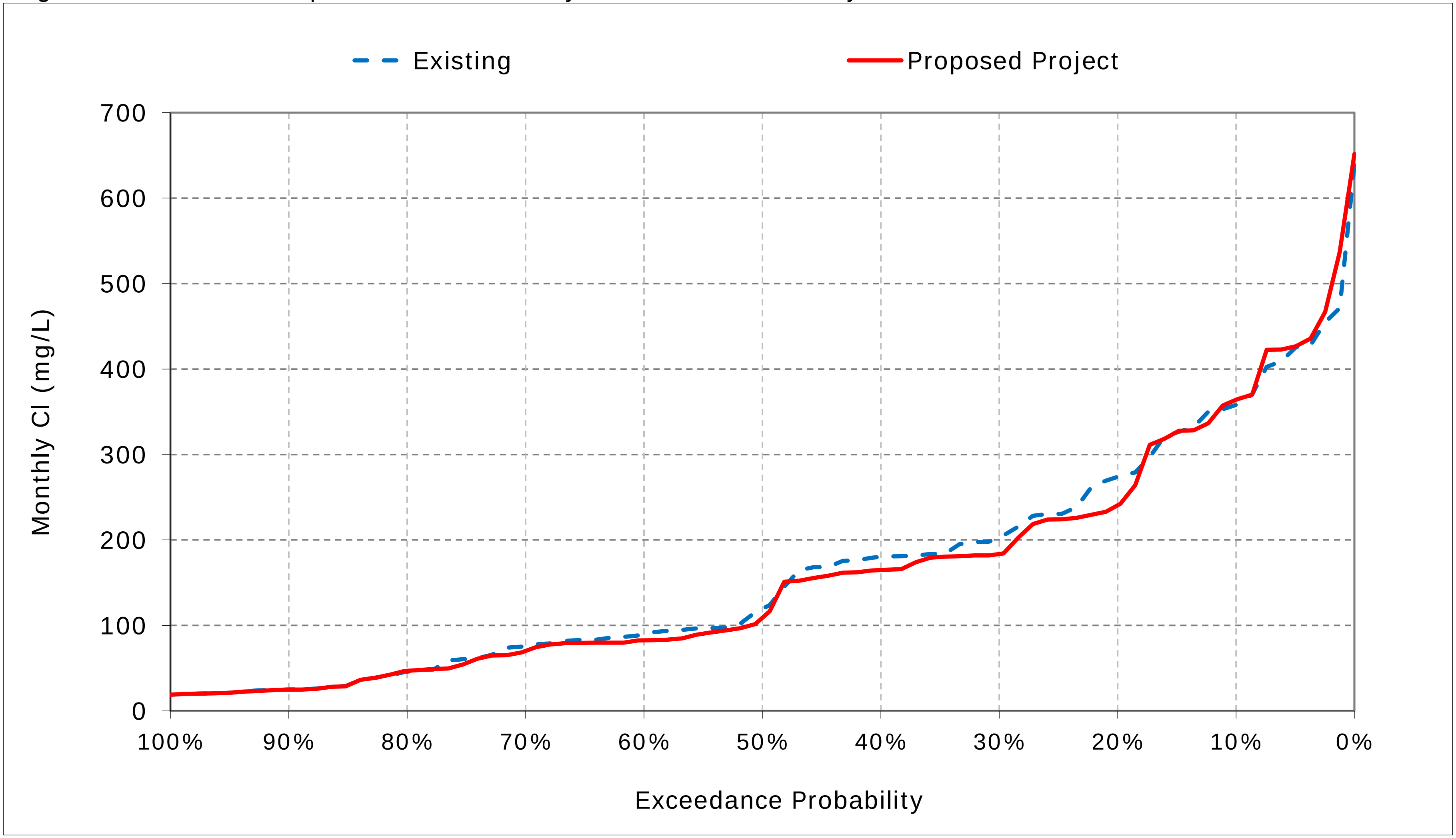


Figure 4-14. San Joaquin River at Jersey Point Chloride, August Cl

Figure 4-15. San Joaquin River at Jersey Point Chloride, September Cl

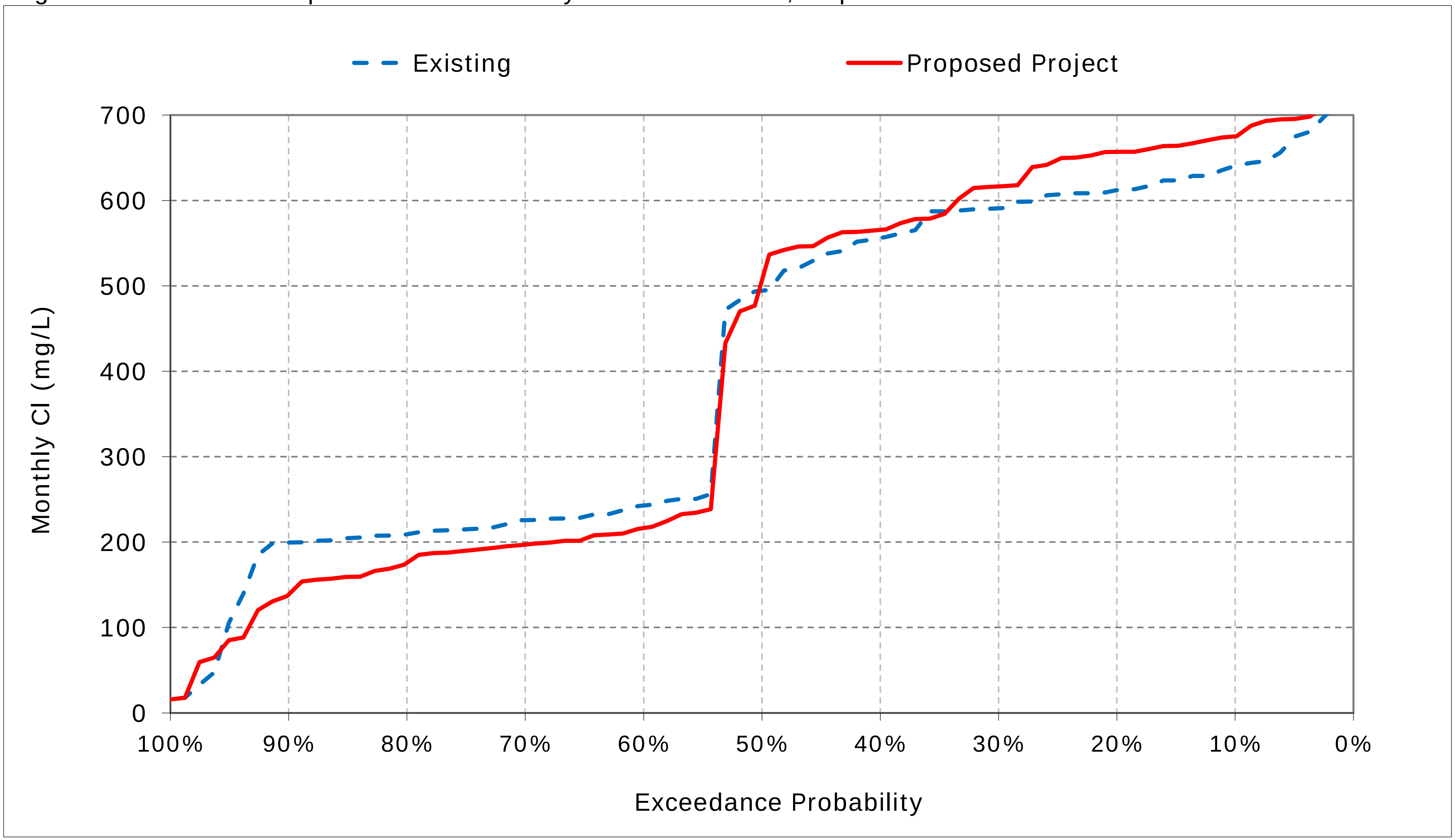


Figure 4-16. San Joaquin River at Jersey Point Chloride, October Cl

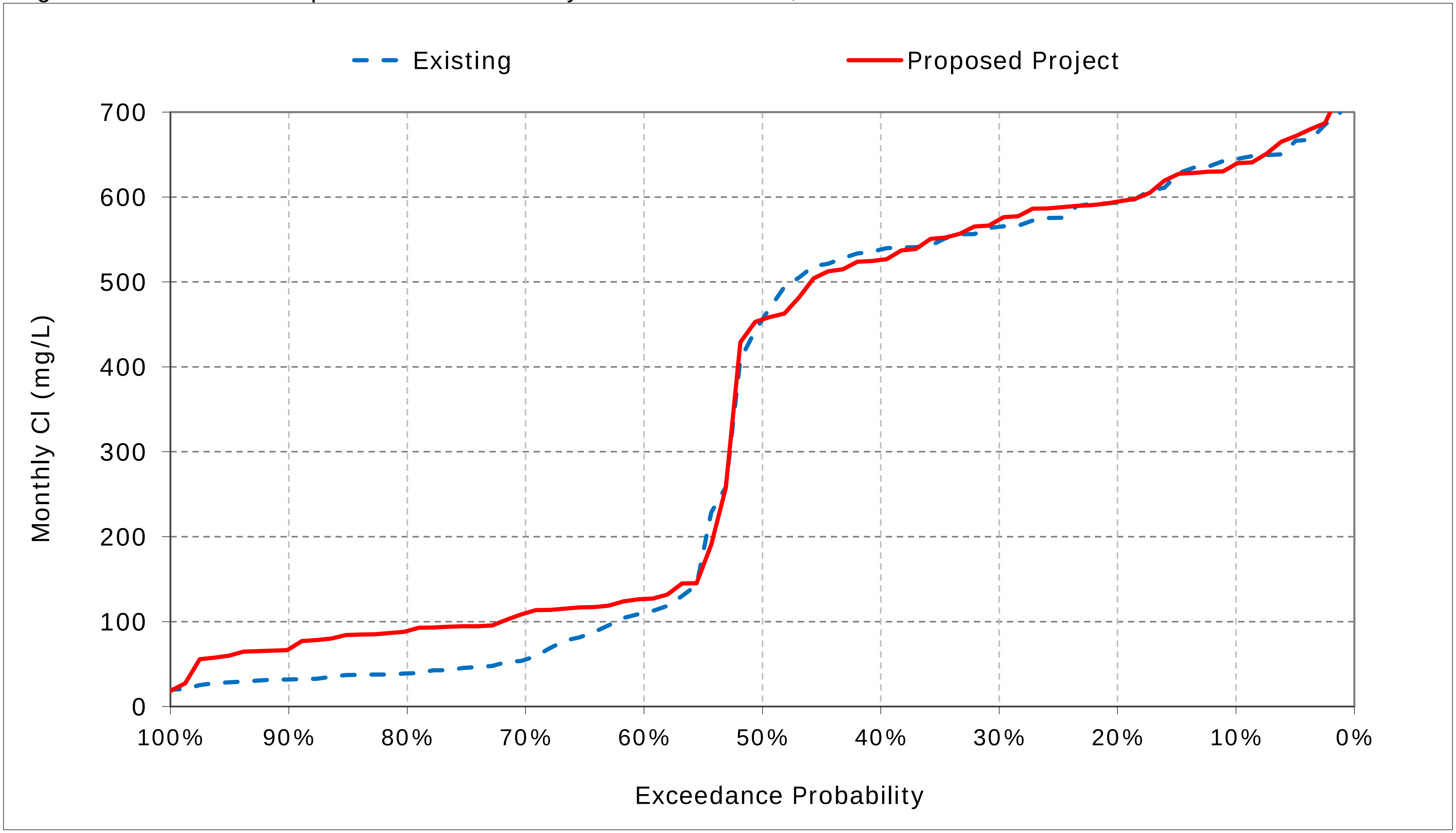


Figure 4-17. San Joaquin River at Jersey Point Chloride, November Cl

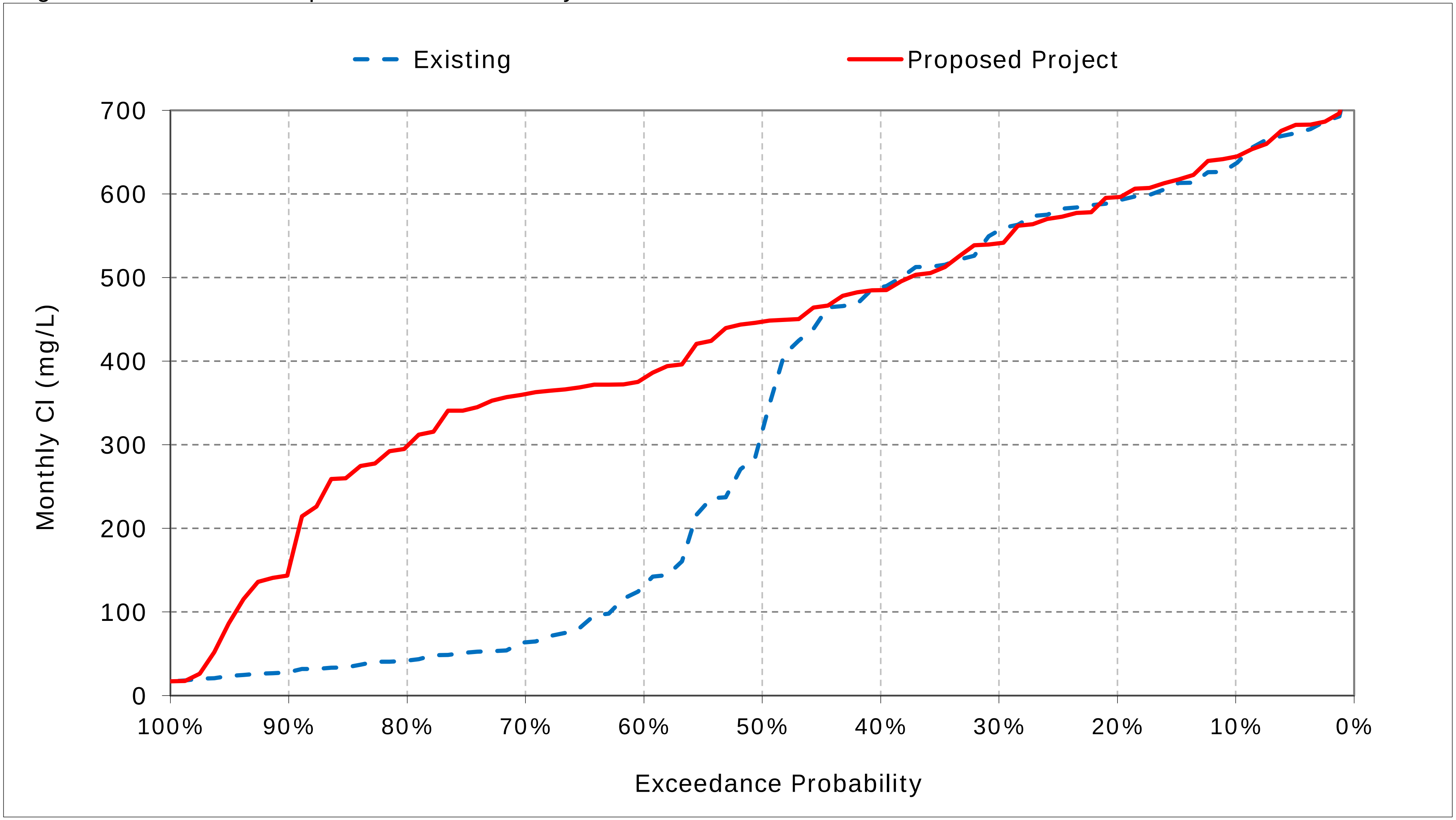


Figure 4-18. San Joaquin River at Jersey Point Chloride, December Cl

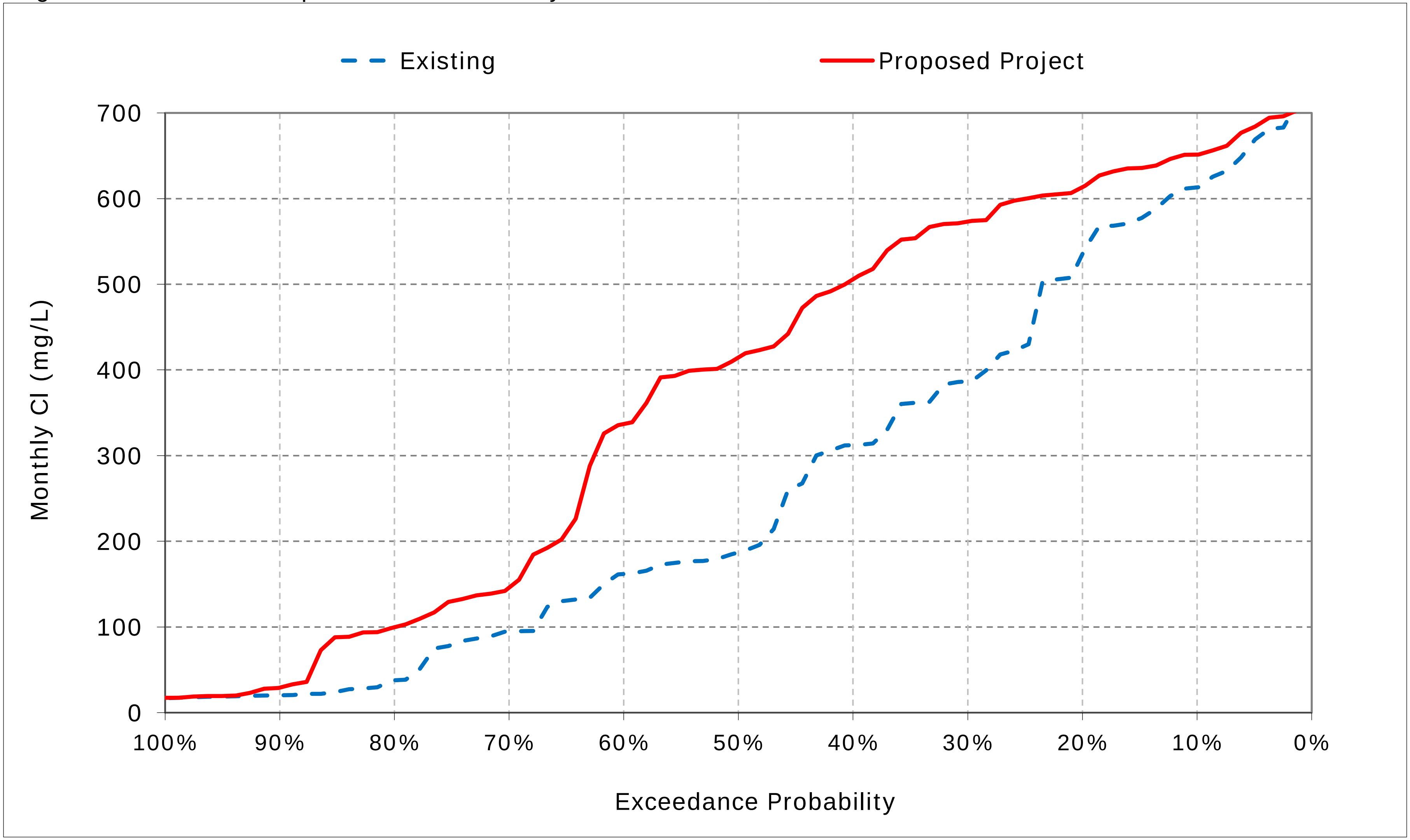


Table 5-1. San Joaquin River at San Andreas Chloride, Monthly Cl

Existing

Statistic	Monthly Cl (mg/L) Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	136	132	148	112	41	23	24	25	23	53	84	117
20%	117	117	136	91	29	22	23	24	21	36	71	112
30%	111	110	116	68	25	21	22	24	20	28	61	104
40%	105	99	84	53	23	20	21	23	19	26	52	97
50%	92	70	42	38	22	19	20	22	19	21	47	84
60%	21	27	33	27	21	18	20	21	18	19	42	67
70%	20	20	27	22	19	18	19	20	17	19	33	56
80%	19	19	21	20	18	17	19	19	17	18	31	37
90%	18	18	17	18	17	17	17	16	16	17	29	29
Long Term												
Full Simulation Period[a]	71	71	72	54	26	20	21	22	21	30	51	78
Water Year Types[b]												
Wet (32%)	53	49	33	23	19	18	18	18	17	18	31	52
Above Normal (15%)	81	70	70	41	22	18	20	21	18	19	34	31
Below Normal (17%)	72	76	89	61	23	20	21	22	19	25	51	102
Dry (22%)	75	82	85	68	29	20	22	23	20	38	67	100
Critical (15%)	94	94	119	107	46	26	23	29	39	62	86	124

Proposed Project

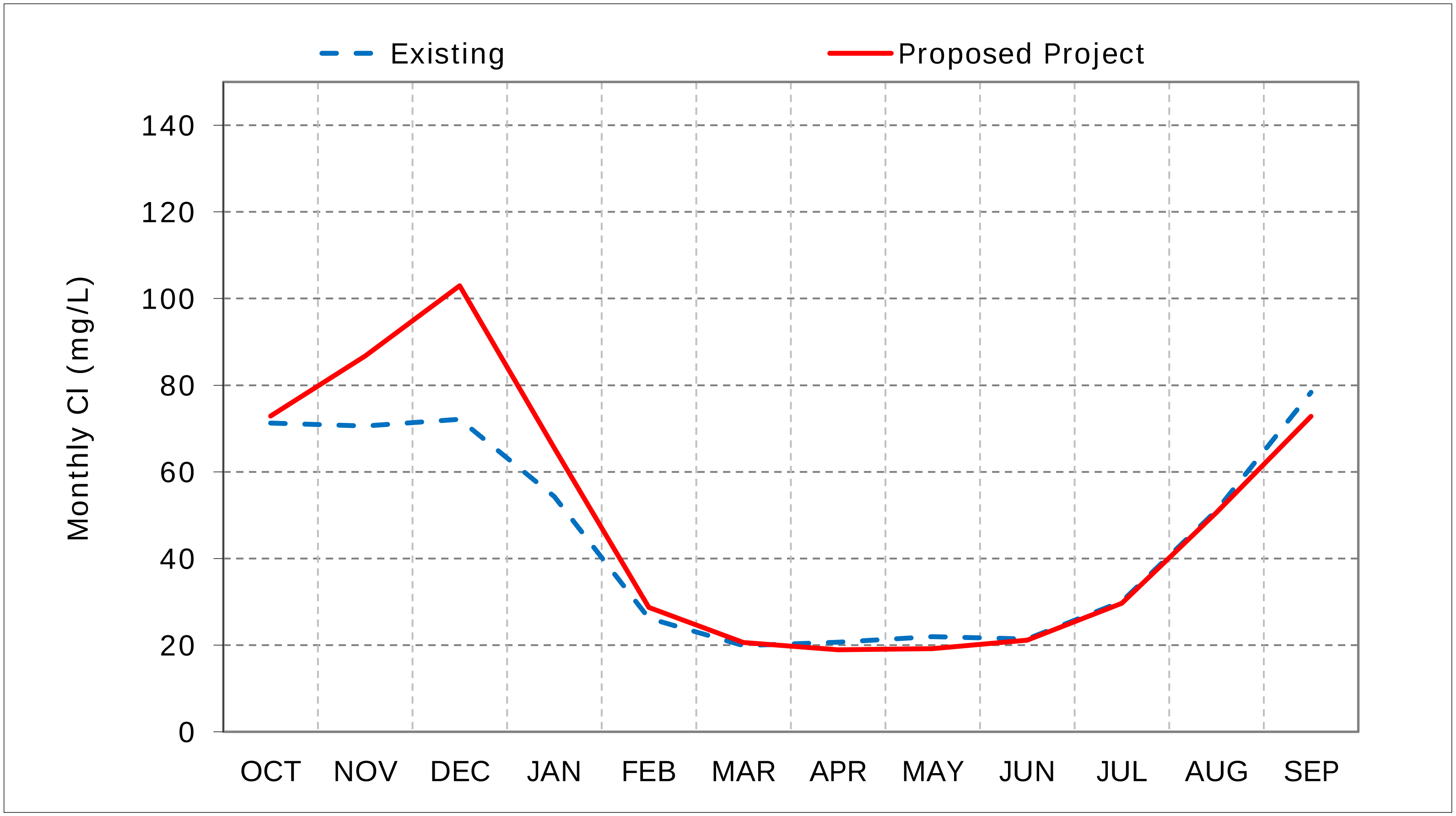
Statistic	Monthly Cl (mg/L) Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	132	139	166	144	46	23	22	23	24	54	83	127
20%	123	125	152	111	30	22	21	21	21	32	69	117
30%	114	113	148	93	26	21	20	20	20	28	60	111
40%	106	102	132	73	23	20	19	19	19	24	54	99
50%	100	90	123	38	22	19	18	18	17	21	46	86
60%	24	67	105	27	21	19	18	17	17	19	39	31
70%	21	57	46	23	19	18	17	16	16	18	32	28
80%	20	46	31	20	18	17	17	16	16	18	30	27
90%	18	30	19	18	17	17	16	15	16	17	26	25
Long Term												
Full Simulation Period[a]	73	87	103	66	29	21	19	19	21	30	51	73
Water Year Types[b]												
Wet (32%)	55	68	52	25	19	18	17	16	16	18	30	25
Above Normal (15%)	83	93	118	57	23	19	18	17	17	19	34	29
Below Normal (17%)	74	89	121	71	23	20	19	18	18	23	52	113
Dry (22%)	77	94	125	90	33	21	20	20	20	37	66	102
Critical (15%)	96	106	144	118	56	29	23	29	41	64	88	128

Proposed Project minus Existing

Statistic	Monthly Cl (mg/L) Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	-4	7	18	32	6	0	-3	-2	0	1	-1	10
20%	7	8	17	20	1	0	-2	-3	0	-3	-2	5
30%	3	3	33	25	1	0	-2	-4	0	0	-1	8
40%	1	3	48	20	0	0	-2	-4	-1	-2	2	2
50%	8	20	81	0	0	0	-2	-4	-2	0	-1	2
60%	3	40	73	0	0	0	-2	-4	-1	0	-3	-36
70%	1	37	19	0	0	0	-2	-4	-1	0	-1	-28
80%	0	28	9	0	0	0	-2	-3	-1	0	-1	-10
90%	0	12	2	0	0	0	-1	-1	-1	0	-2	-4
Long Term												
Full Simulation Period[a]	2	16	31	11	3	1	-2	-3	0	0	0	-6
Water Year Types[b]												
Wet (32%)	2	19	19	2	0	0	-1	-2	-1	0	-2	-26
Above Normal (15%)	1	23	49	16	1	0	-2	-4	-1	0	0	-2
Below Normal (17%)	2	13	33	10	0	0	-3	-4	-1	-2	1	11
Dry (22%)	1	12	39	21	4	1	-3	-4	0	-1	-2	2
Critical (15%)	1	12	24	11	10	3	0	0	2	2	2	4

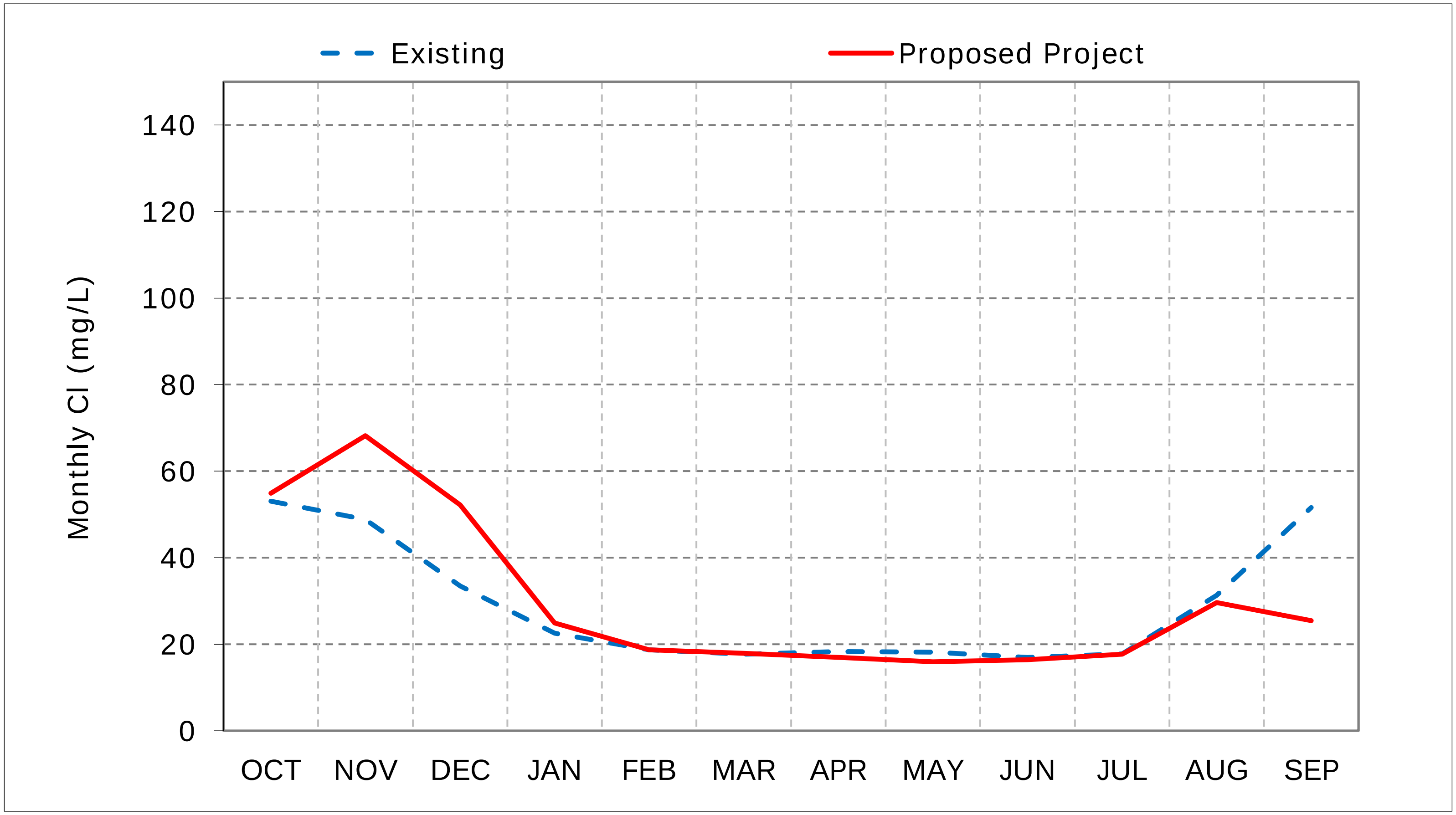
a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with water year - year type sorting.
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 5-1. San Joaquin River at San Andreas Chloride, Long-Term Average Cl



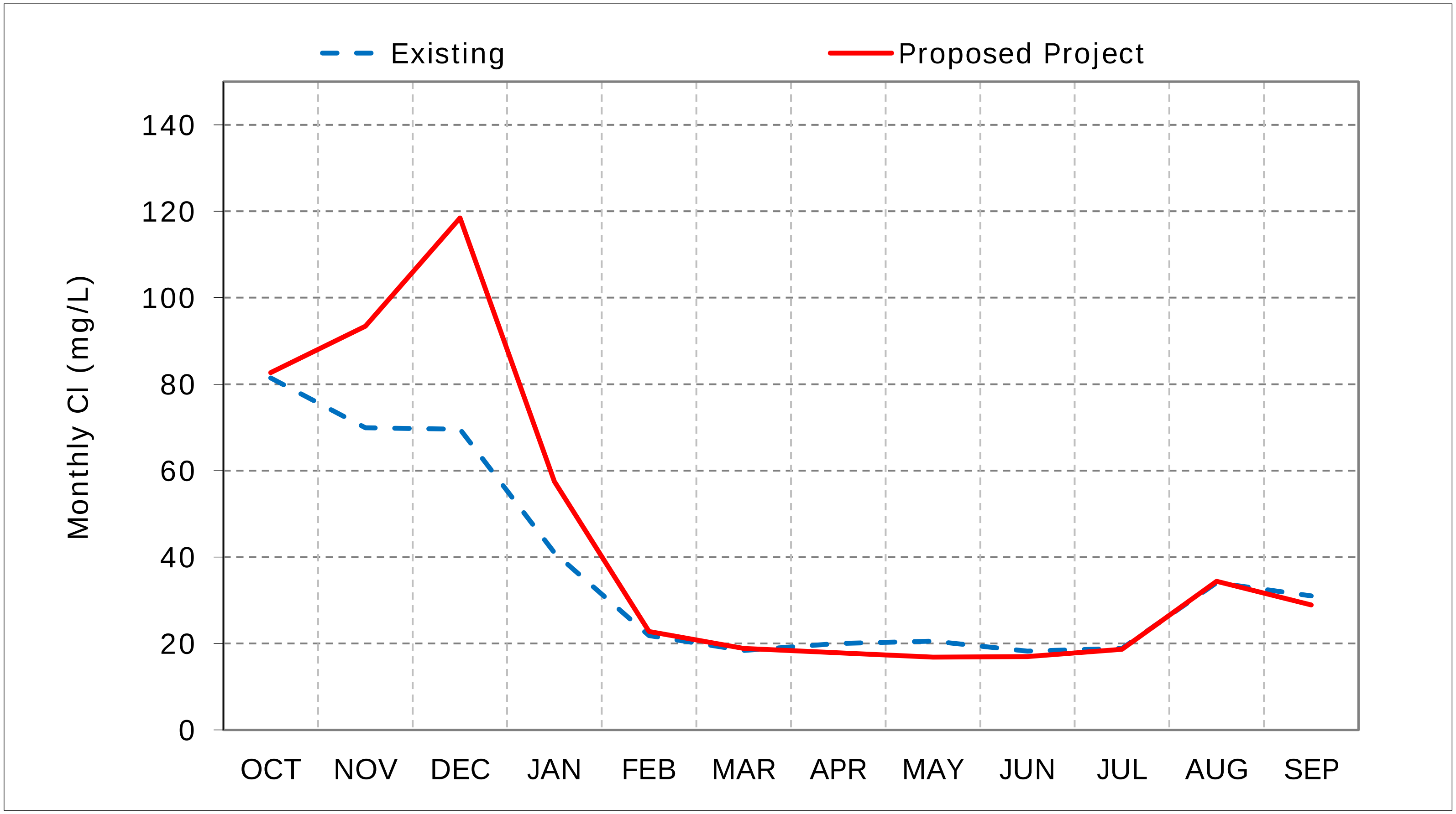
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 5-2. San Joaquin River at San Andreas Chloride, Wet Year Average Cl



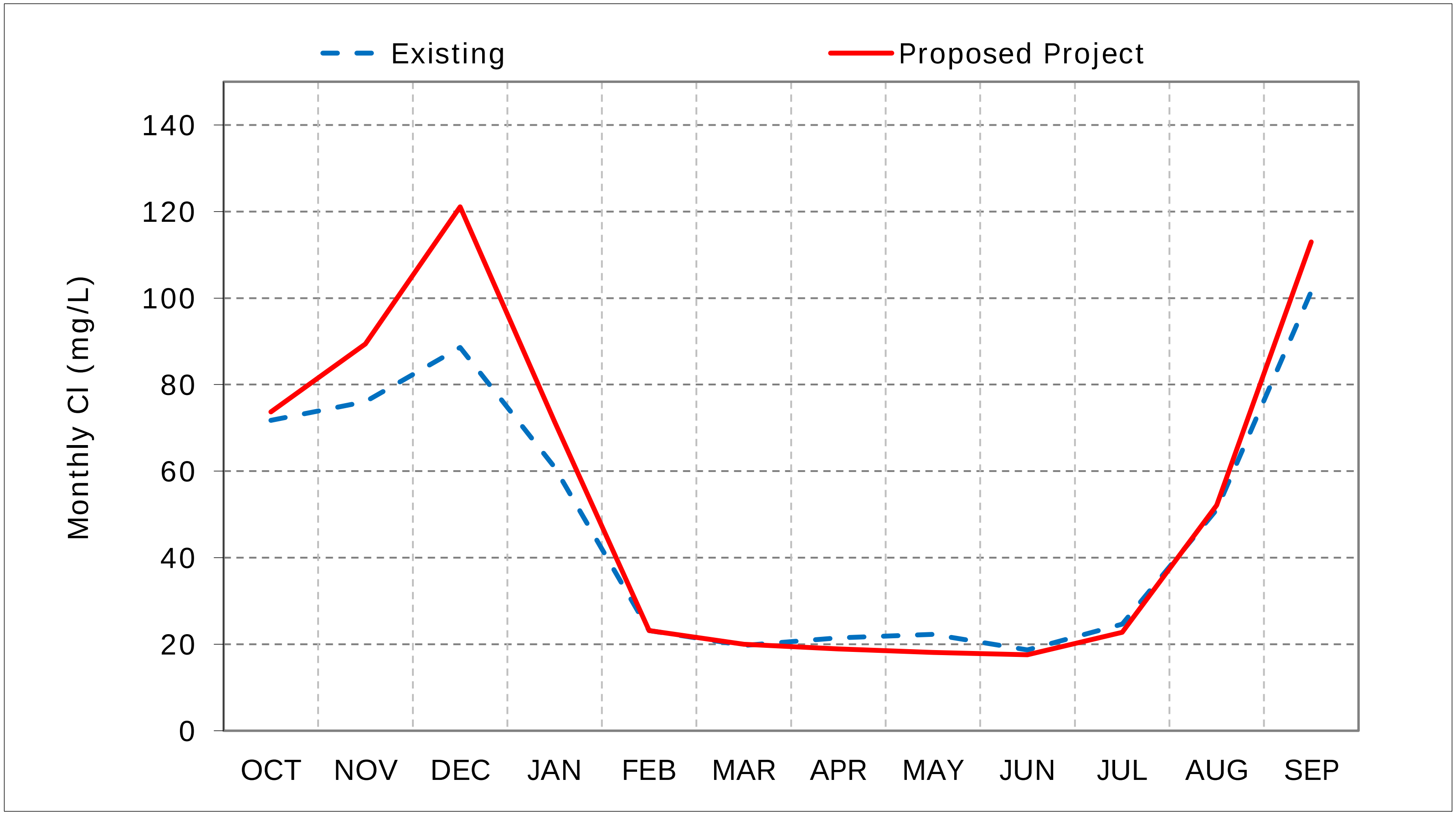
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 5-3. San Joaquin River at San Andreas Chloride, Above Normal Year Averag



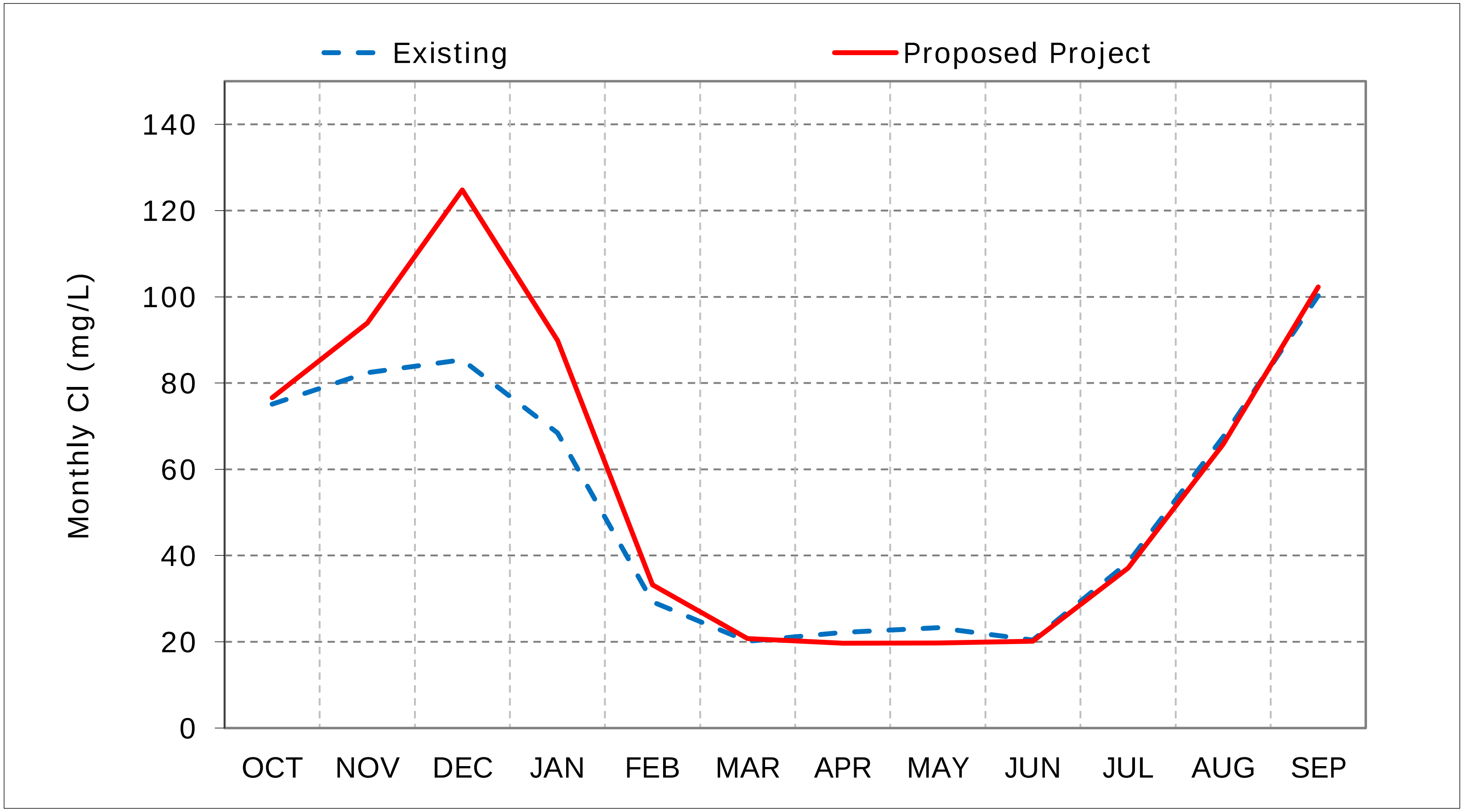
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 5-4. San Joaquin River at San Andreas Chloride, Below Normal Year Averag



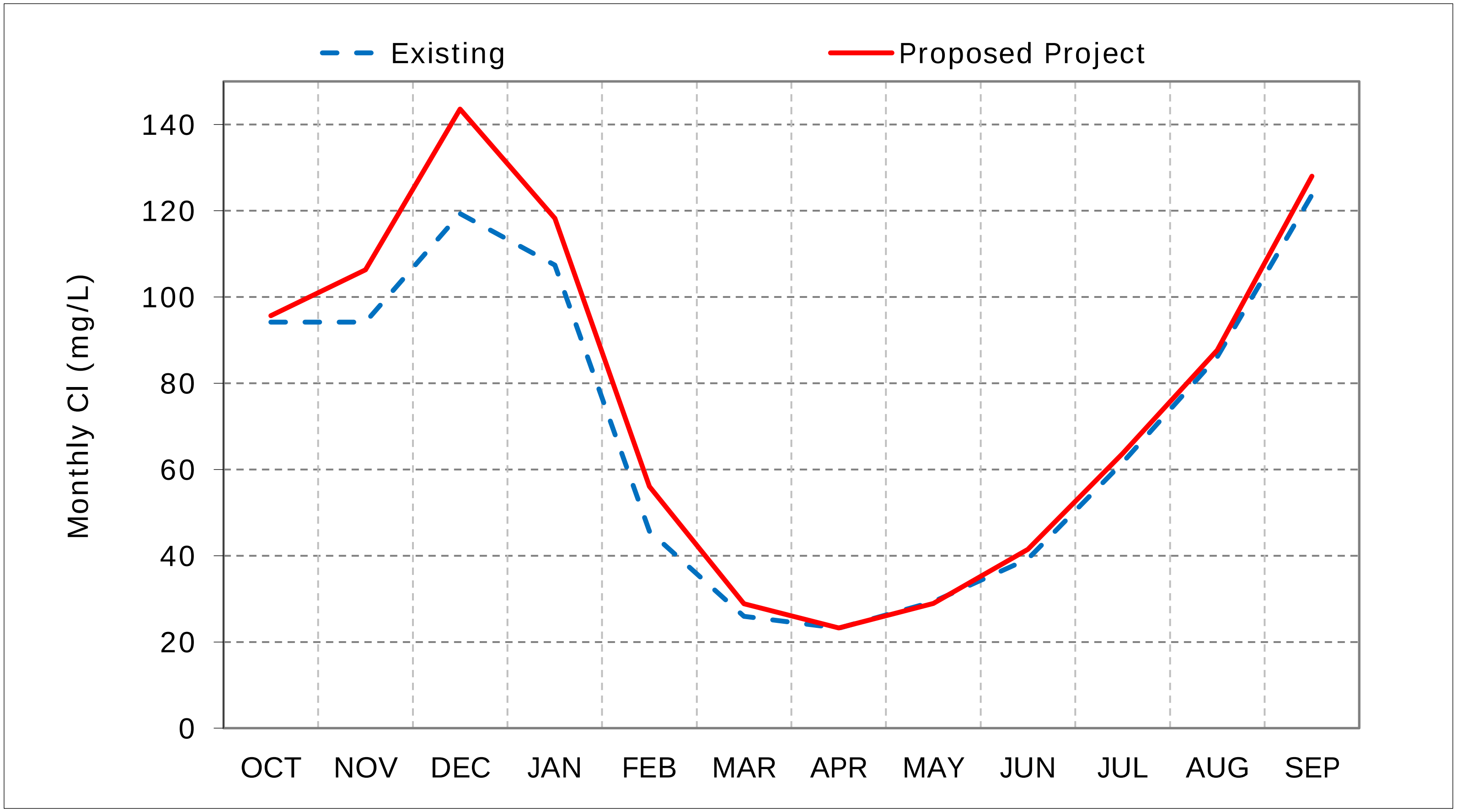
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 5-5. San Joaquin River at San Andreas Chloride, Dry Year Average Cl



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 5-6. San Joaquin River at San Andreas Chloride, Critical Year Average Cl



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 5-7. San Joaquin River at San Andreas Chloride, January Cl

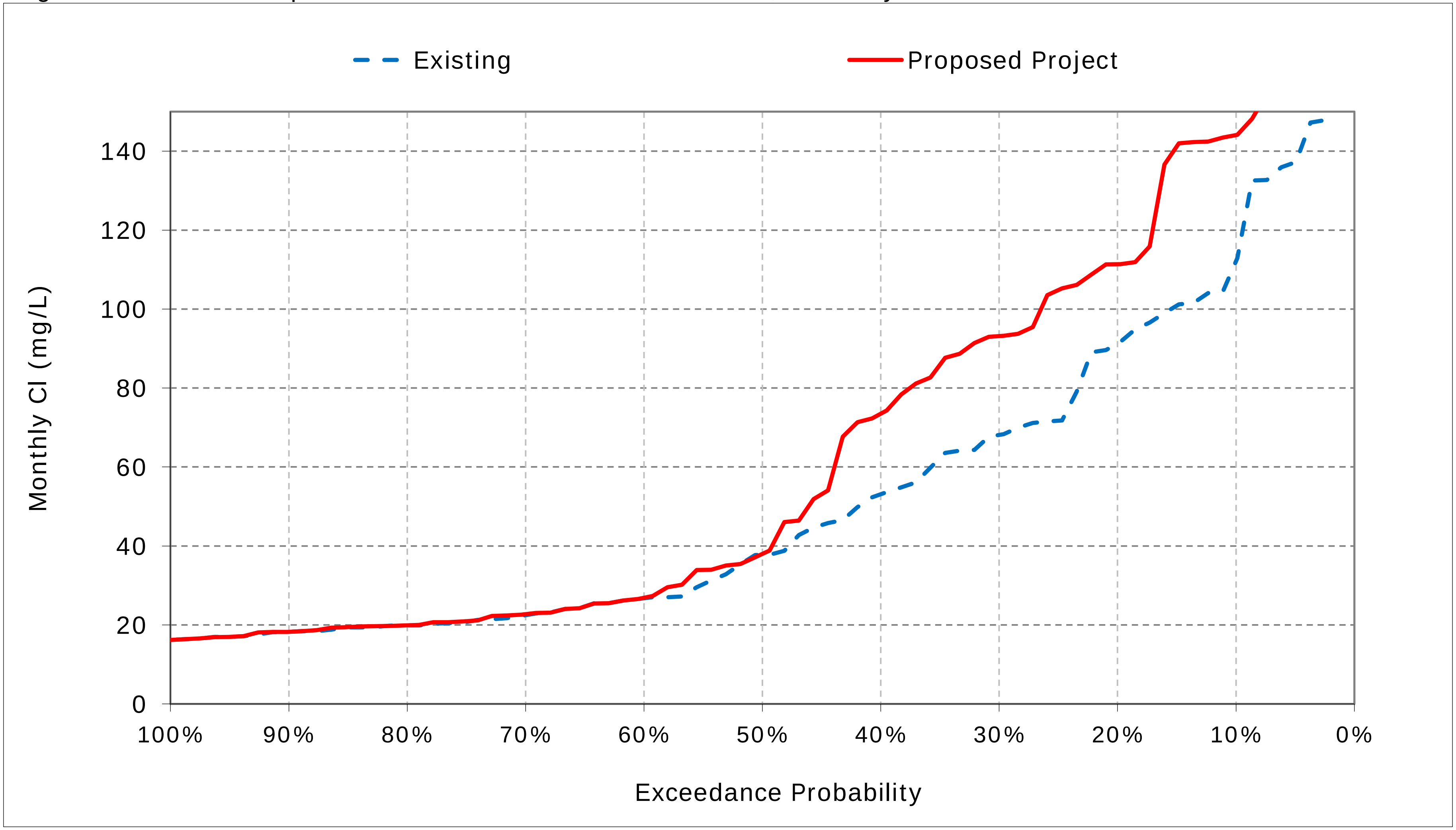


Figure 5-8. San Joaquin River at San Andreas Chloride, February Cl

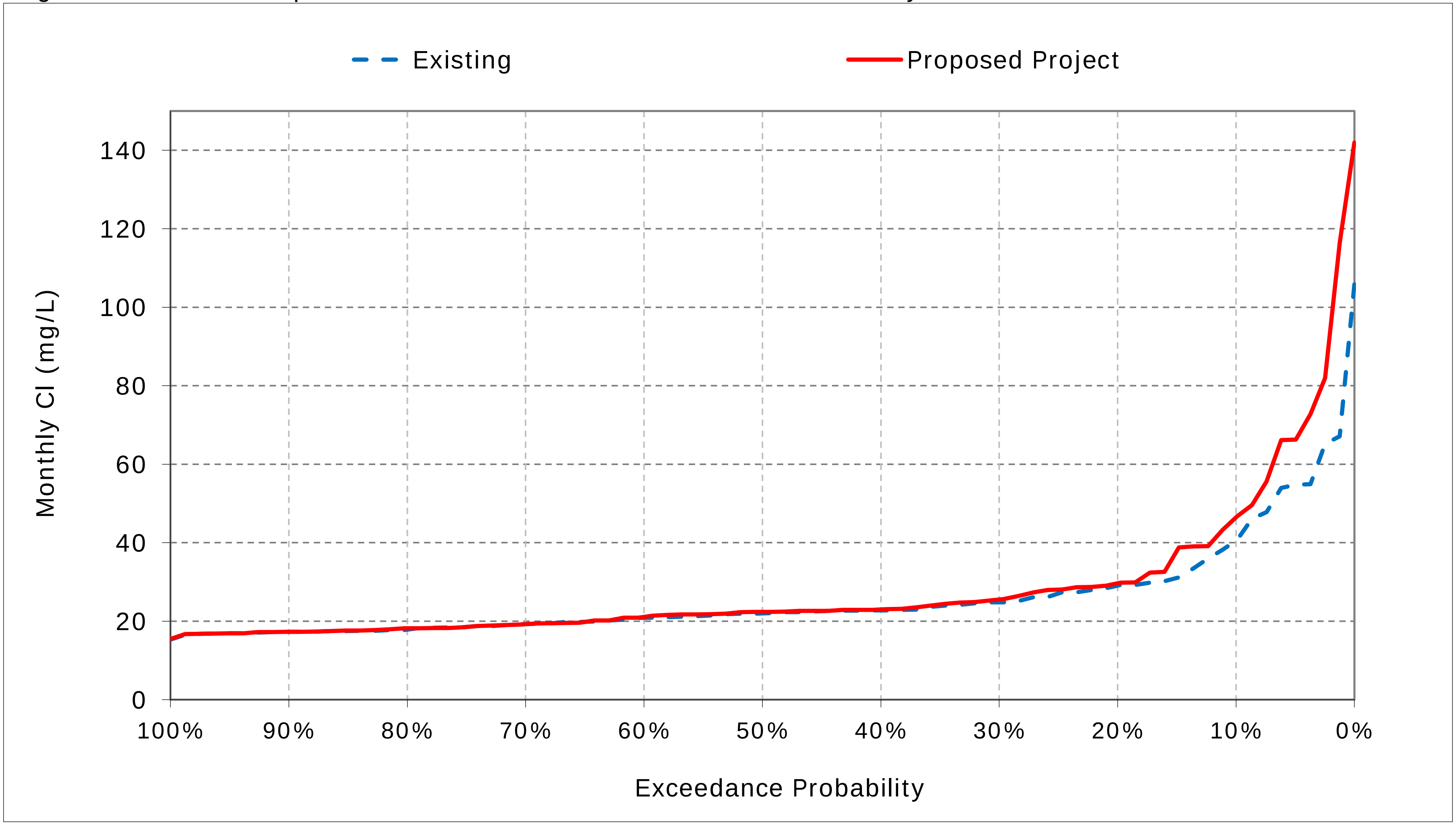


Figure 5-9. San Joaquin River at San Andreas Chloride, March Cl

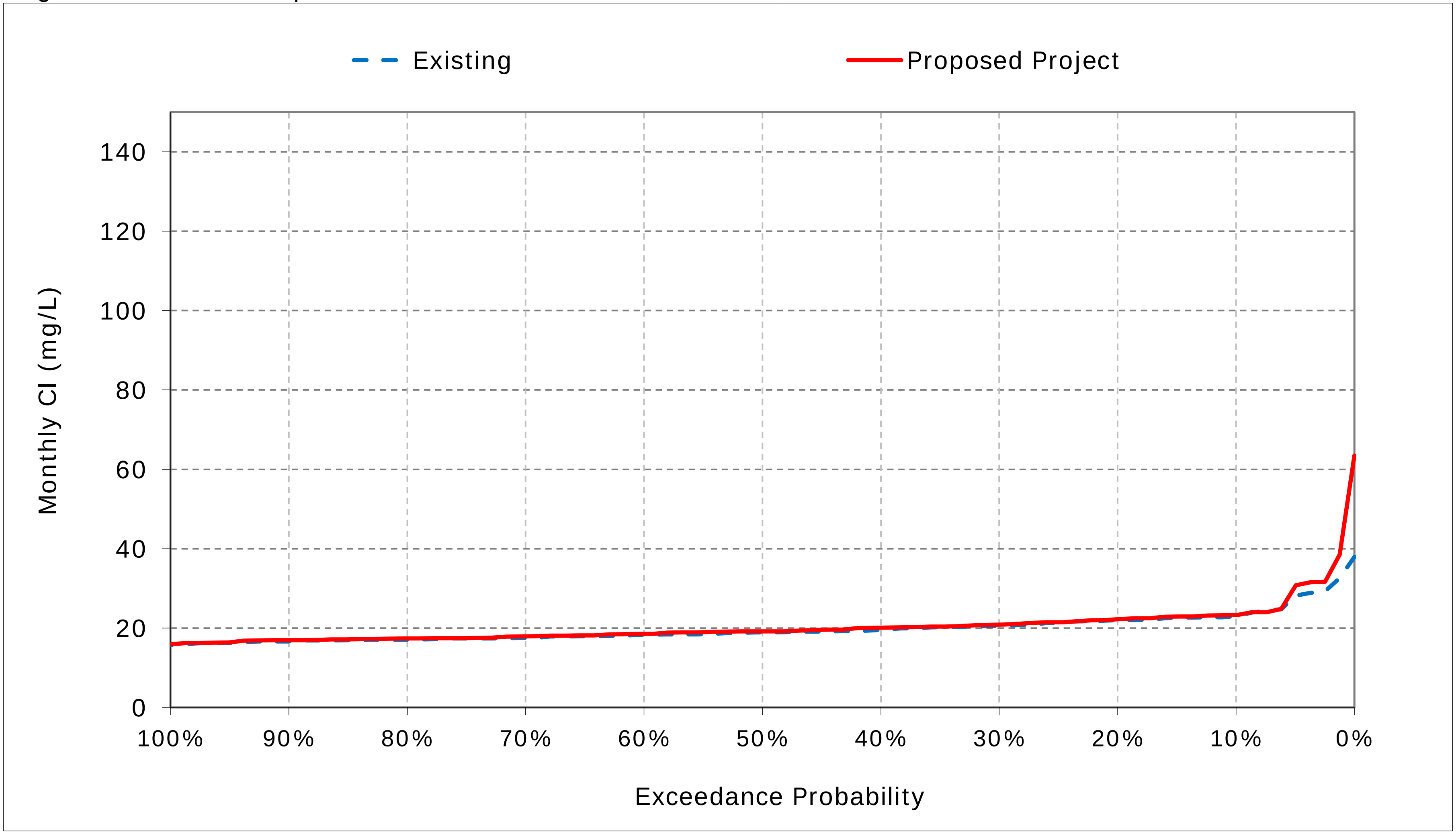


Figure 5-10. San Joaquin River at San Andreas Chloride, April Cl

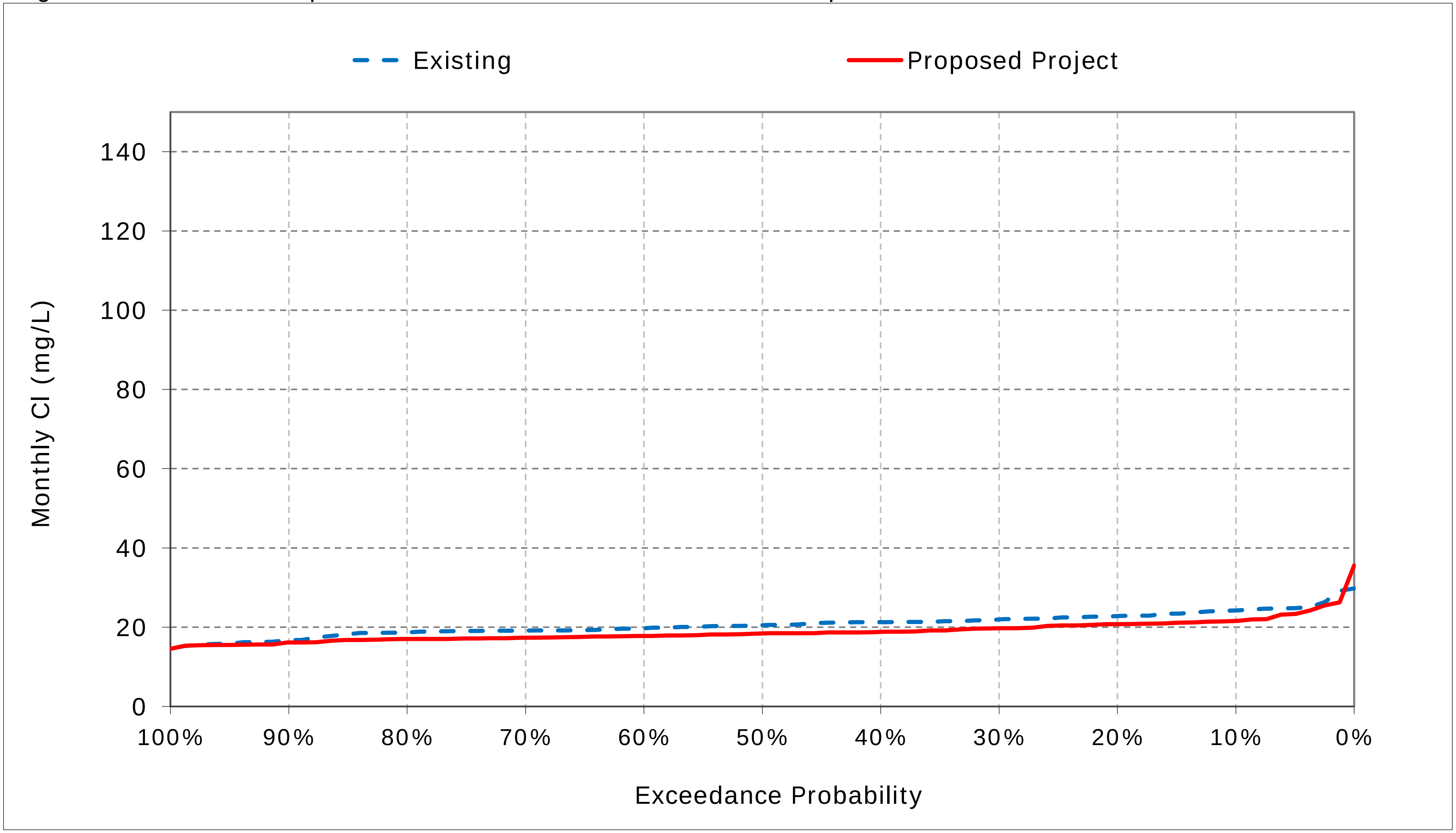


Figure 5-11. San Joaquin River at San Andreas Chloride, May Cl

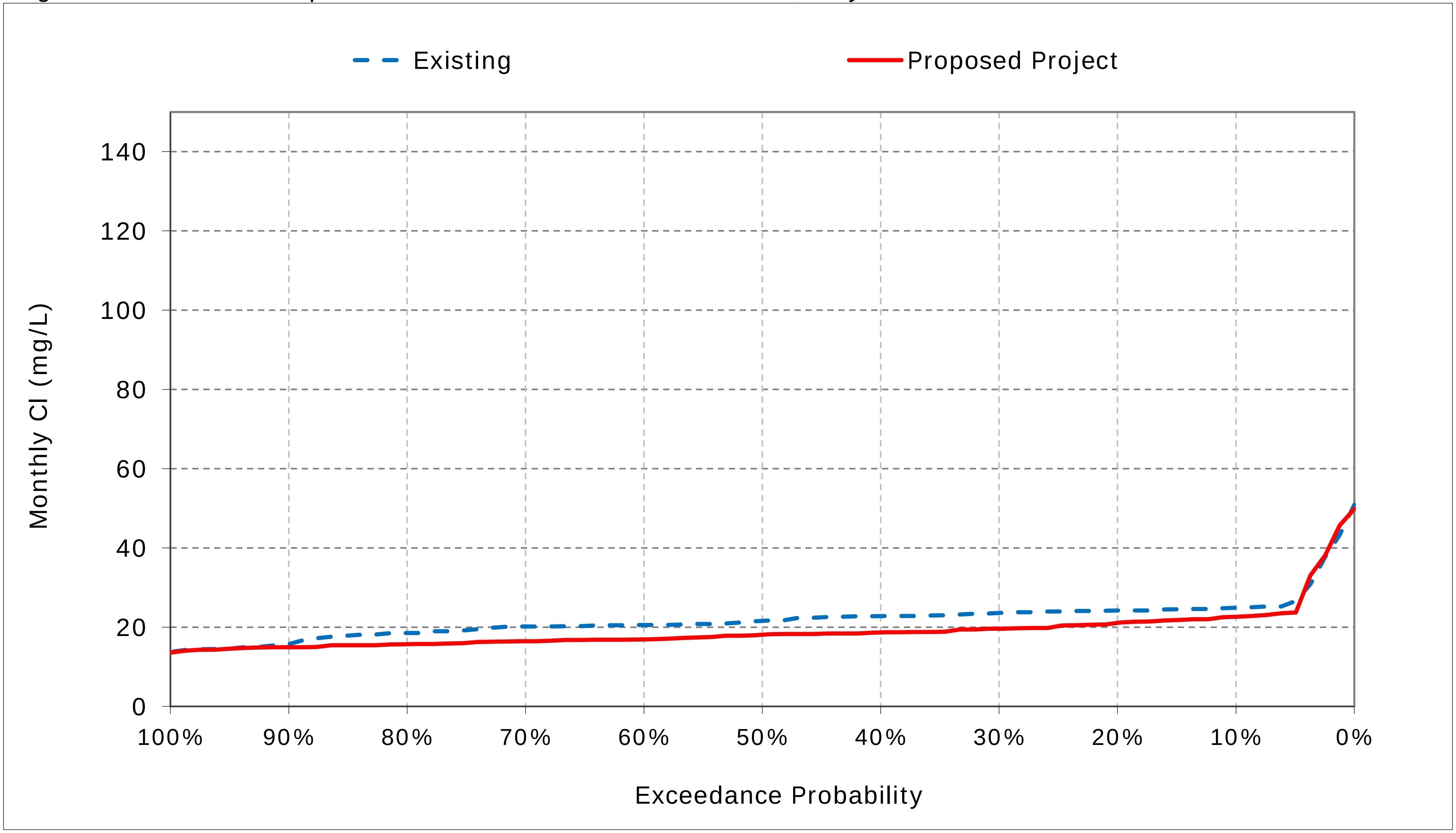


Figure 5-12. San Joaquin River at San Andreas Chloride, June Cl

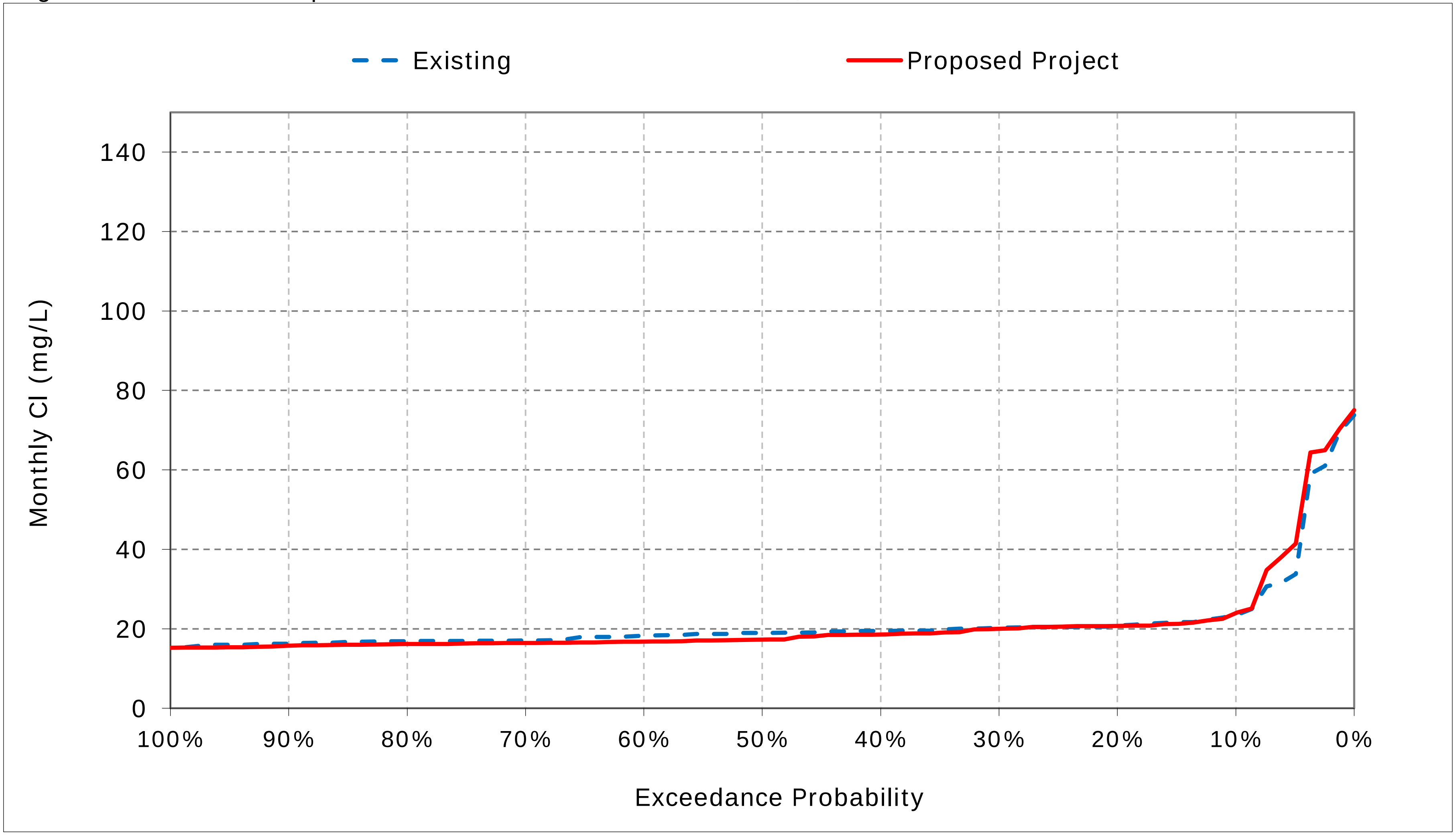


Figure 5-13. San Joaquin River at San Andreas Chloride, July Cl

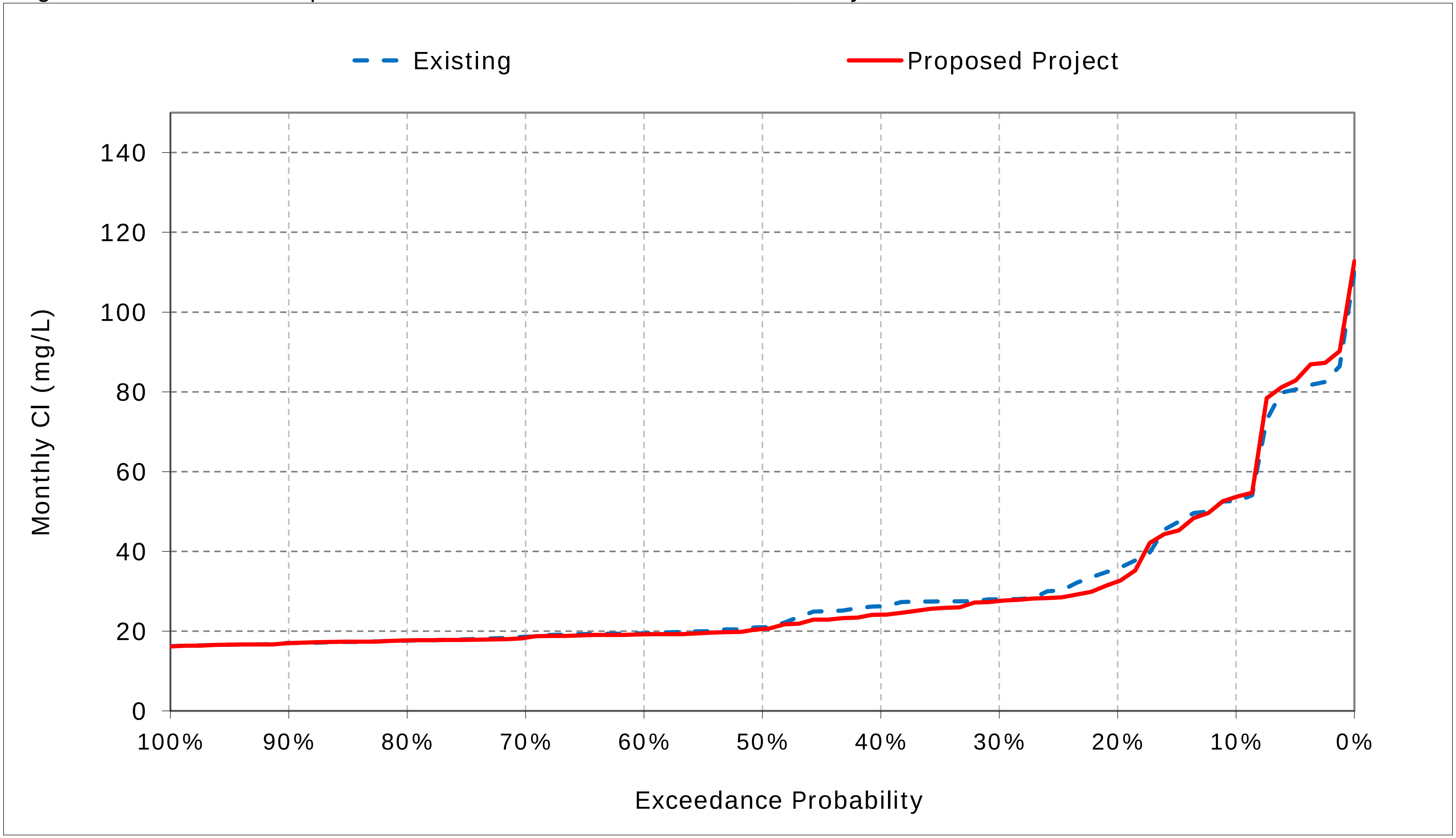


Figure 5-14. San Joaquin River at San Andreas Chloride, August Cl

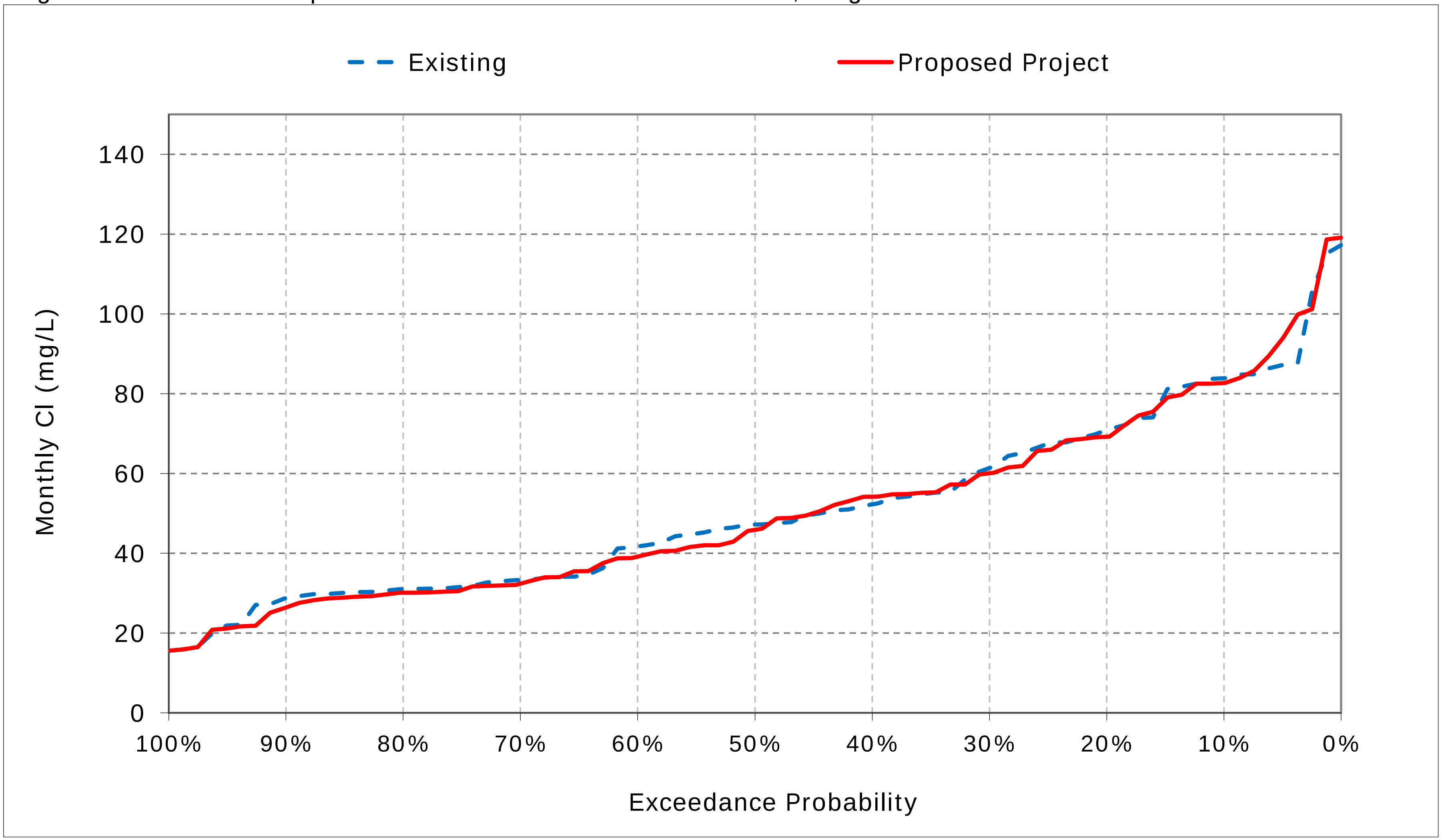


Figure 5-15. San Joaquin River at San Andreas Chloride, September Cl

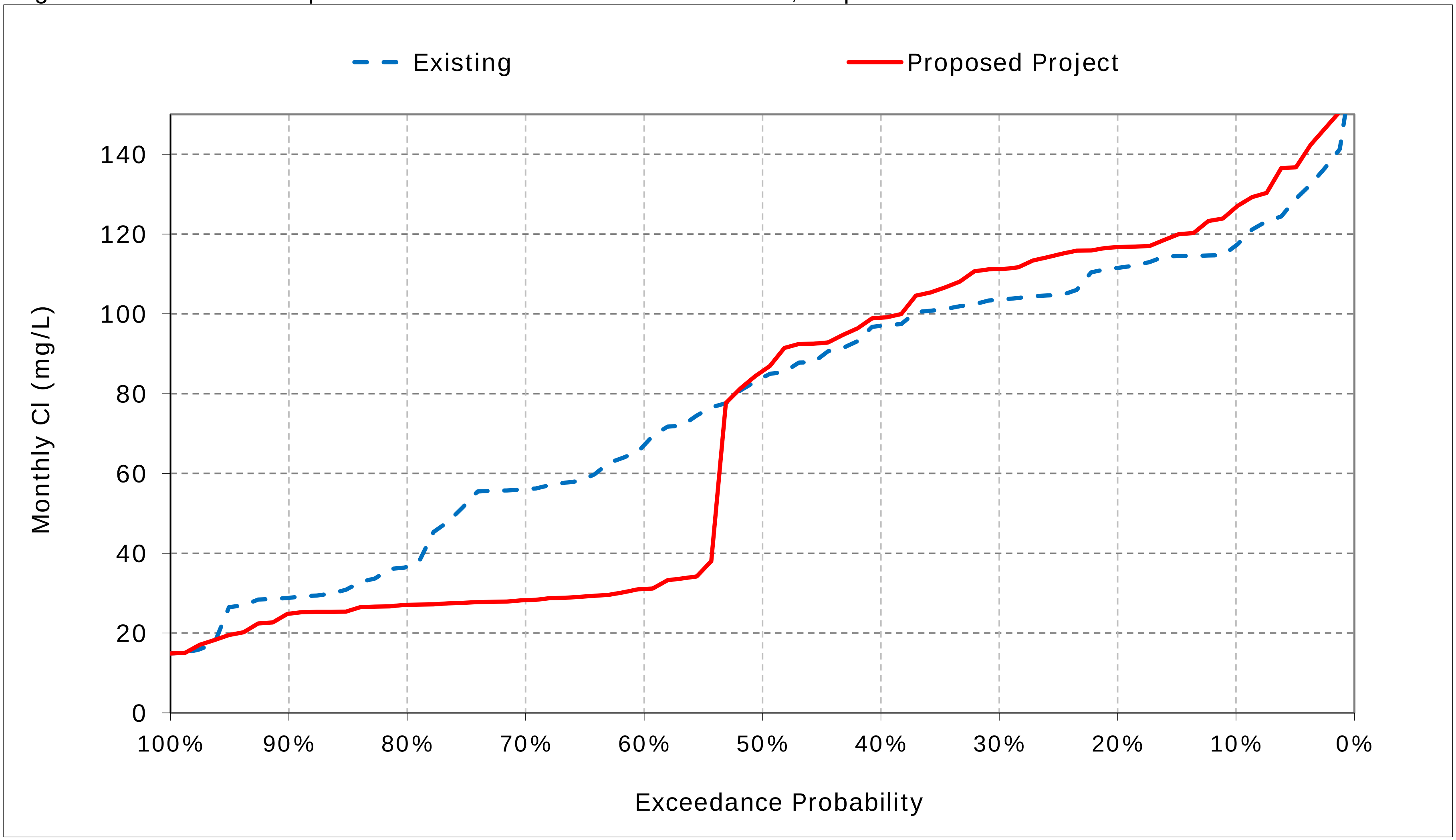


Figure 5-16. San Joaquin River at San Andreas Chloride, October Cl

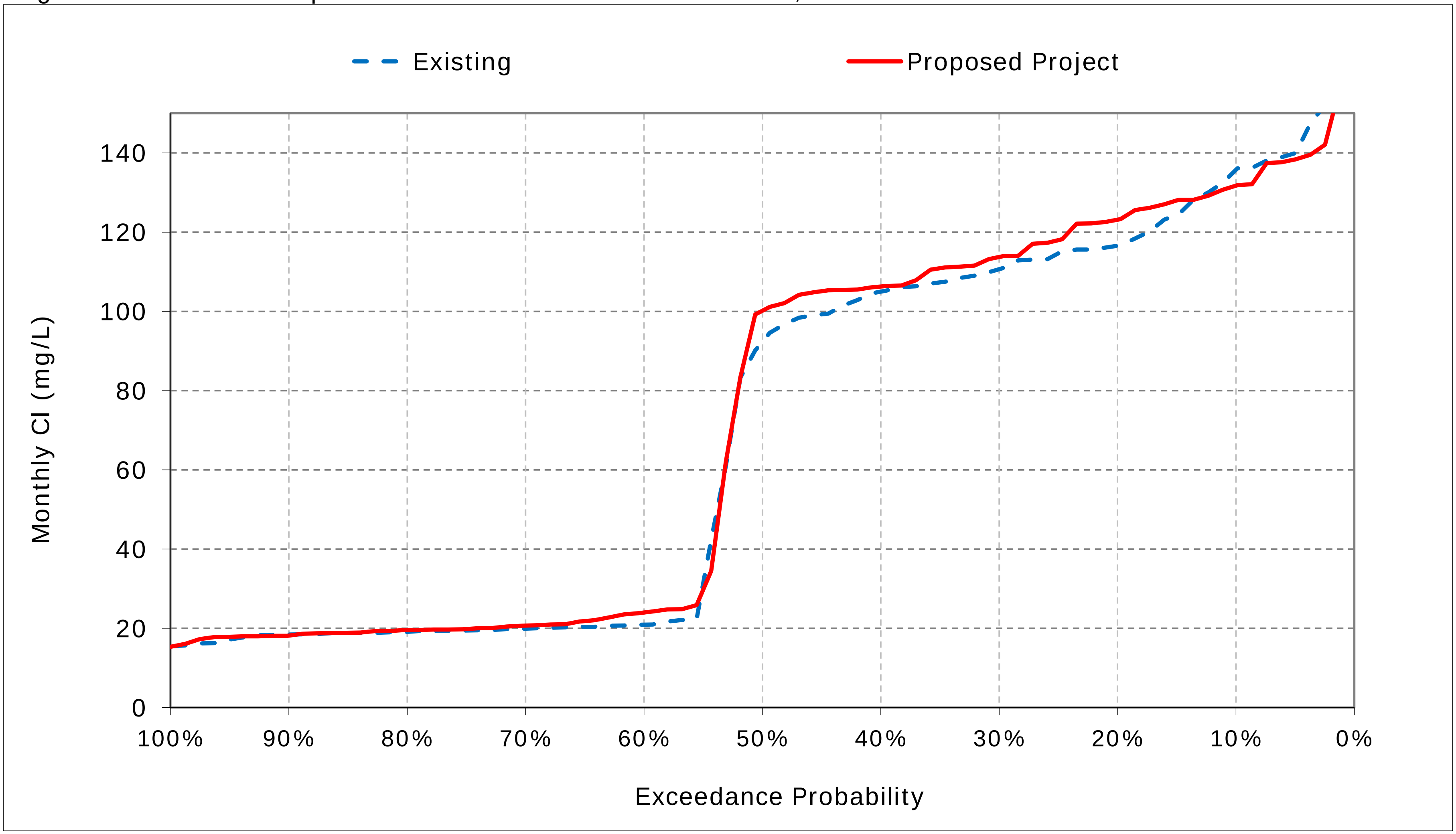


Figure 5-17. San Joaquin River at San Andreas Chloride, November Cl

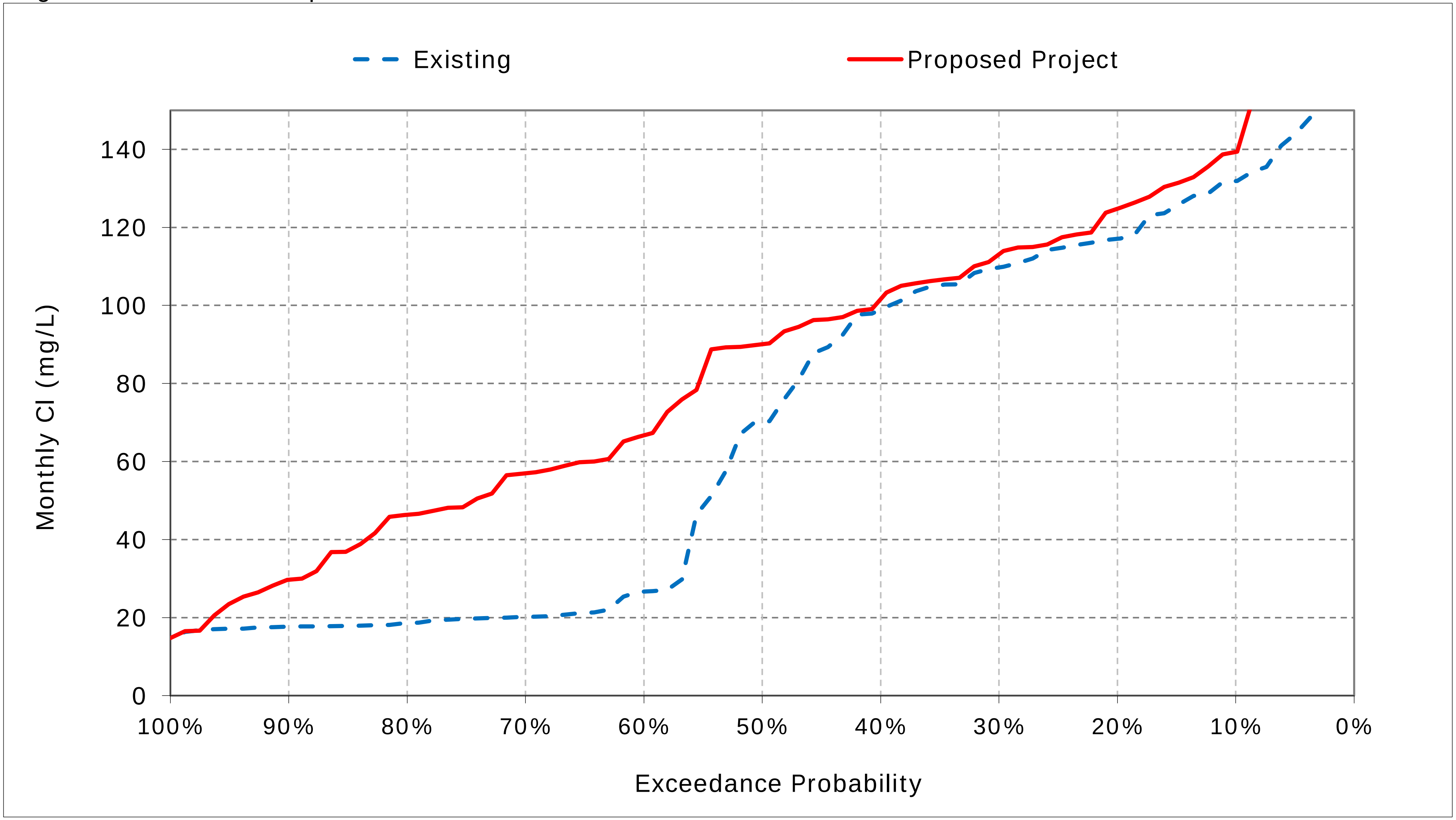


Figure 5-18. San Joaquin River at San Andreas Chloride, December Cl

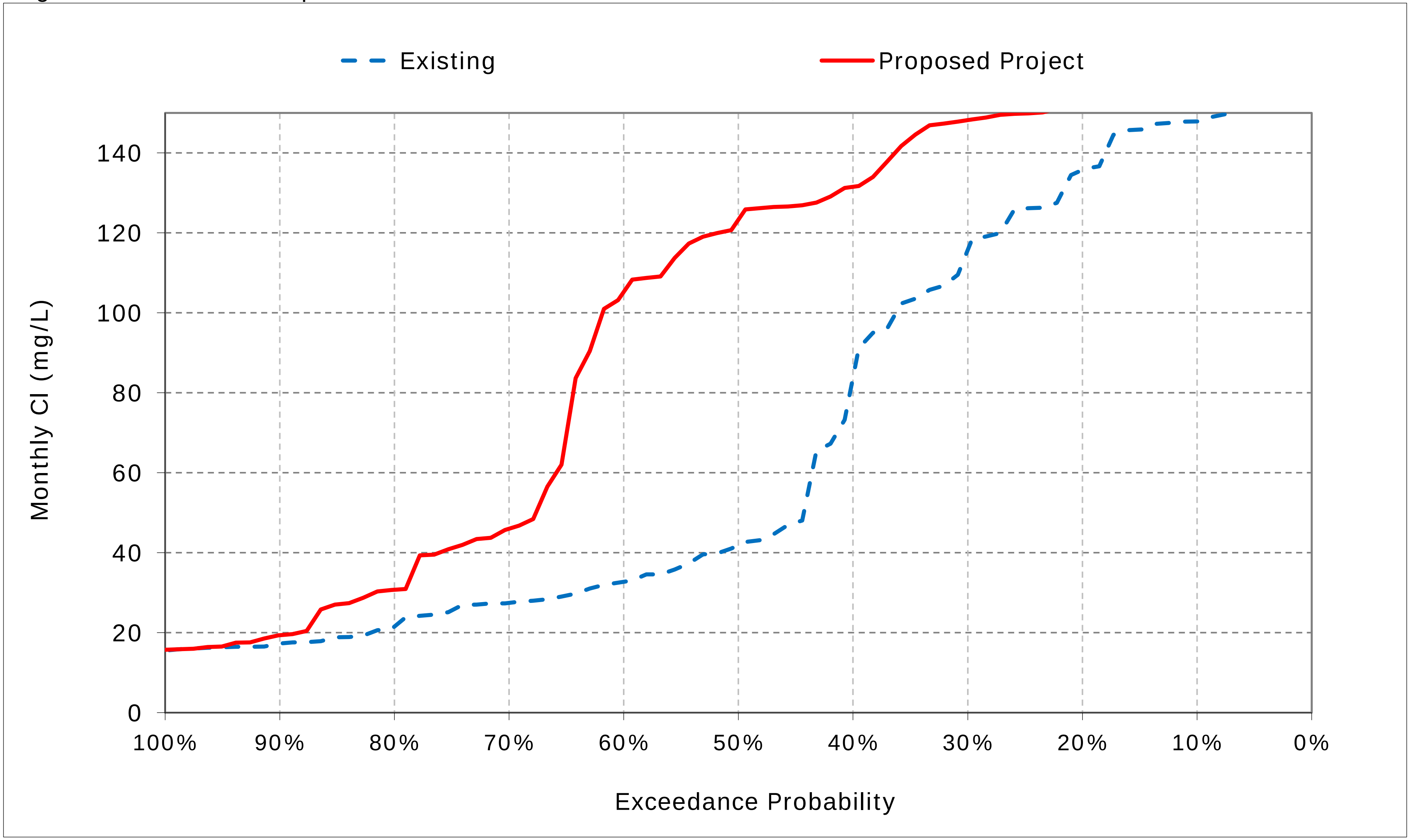


Table 6-1. San Joaquin River at Prisoners Point Chloride, Monthly Cl

Existing

Statistic	Monthly Cl (mg/L)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	121	120	146	135	76	47	54	50	33	57	85	112
20%	111	107	135	105	63	42	51	46	29	36	66	107
30%	107	99	118	95	59	38	47	44	28	30	58	98
40%	102	88	94	71	51	35	44	42	26	27	52	91
50%	91	78	57	65	45	31	40	40	25	26	46	82
60%	27	29	38	57	40	29	39	37	24	23	40	74
70%	25	24	31	49	32	28	34	36	24	22	32	67
80%	23	23	26	41	30	26	29	31	23	21	30	52
90%	22	22	24	31	28	24	27	22	22	19	29	42
Long Term												
Full Simulation Period[a]	69	67	76	75	48	34	40	39	28	32	50	80
Water Year Types[b]												
Wet (32%)	55	51	45	46	40	32	31	30	26	22	31	61
Above Normal (15%)	80	69	75	69	52	39	41	38	26	21	33	45
Below Normal (17%)	72	72	91	87	48	35	47	43	24	26	53	106
Dry (22%)	71	74	88	81	46	32	48	45	25	40	66	92
Critical (15%)	86	83	110	121	62	37	41	44	42	59	79	104

Proposed Project

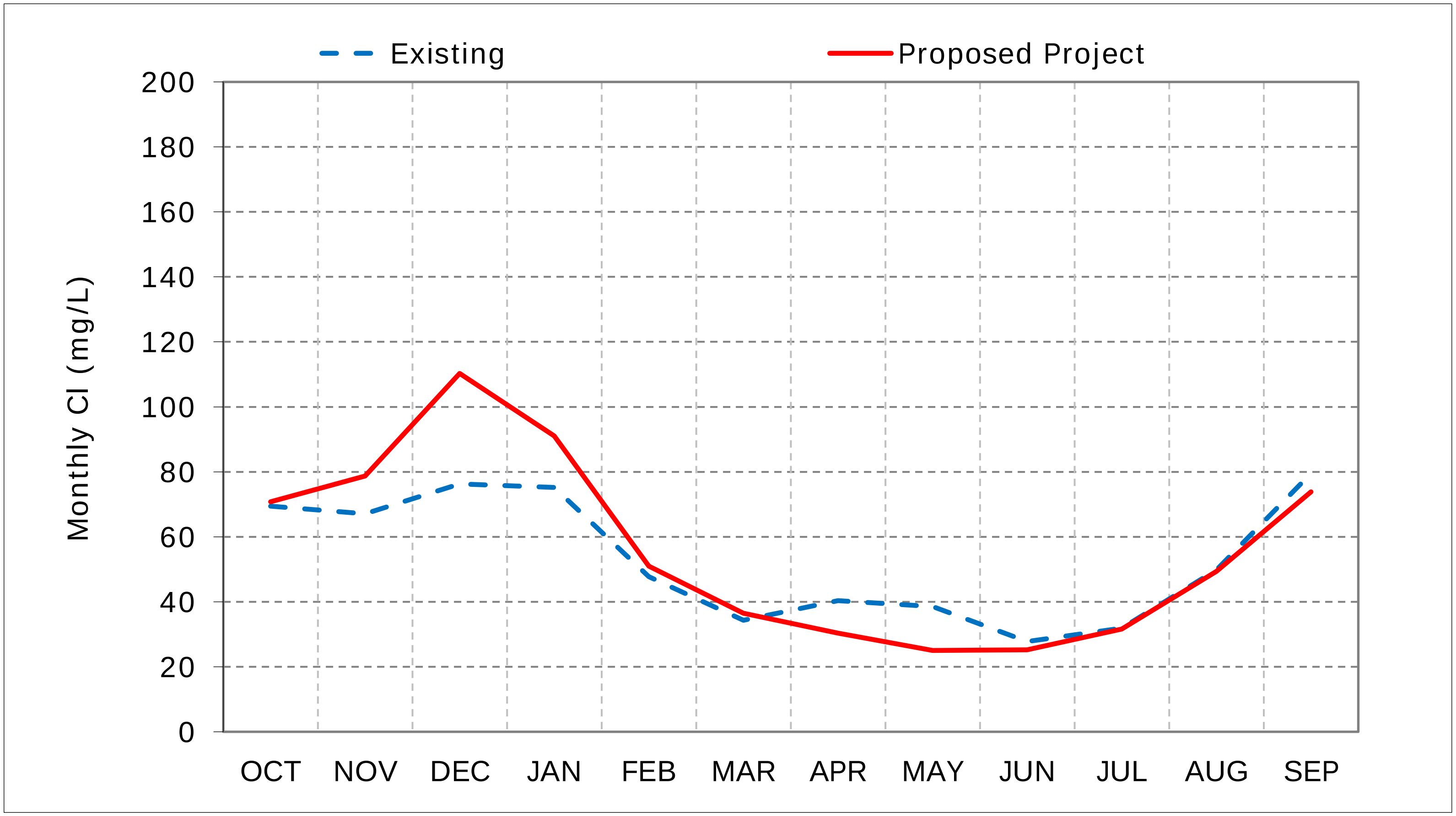
Statistic	Monthly Cl (mg/L)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	122	126	163	163	77	51	41	28	32	57	85	125
20%	116	112	151	144	69	46	37	27	28	33	63	114
30%	110	103	143	127	62	40	32	26	26	28	57	106
40%	106	95	135	101	55	36	30	25	23	27	51	90
50%	95	83	128	73	48	33	29	25	22	24	47	74
60%	23	64	114	59	40	31	28	24	21	22	38	47
70%	22	50	73	49	34	29	26	23	21	21	31	41
80%	21	38	61	43	30	27	25	23	20	20	29	38
90%	20	28	34	34	28	24	23	20	19	19	26	32
Long Term												
Full Simulation Period[a]	71	79	110	91	51	37	30	25	25	32	49	74
Water Year Types[b]												
Wet (32%)	56	64	70	51	40	33	27	22	24	22	30	35
Above Normal (15%)	82	89	126	95	54	42	31	24	23	21	34	42
Below Normal (17%)	73	82	124	104	48	37	33	25	20	24	52	117
Dry (22%)	72	82	128	108	52	36	33	25	22	38	64	94
Critical (15%)	88	91	139	133	74	40	30	32	40	62	82	109

Proposed Project minus Existing

Statistic	Monthly Cl (mg/L)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	1	6	17	28	0	4	-13	-22	-1	0	0	13
20%	6	6	16	39	6	4	-14	-19	-1	-3	-2	7
30%	4	4	25	32	3	2	-15	-17	-2	-2	-1	8
40%	3	7	41	31	4	1	-13	-16	-3	-1	-2	-1
50%	4	4	72	9	3	2	-11	-15	-3	-1	1	-8
60%	-4	35	77	2	0	1	-11	-13	-3	0	-2	-27
70%	-3	26	42	1	2	0	-7	-12	-4	0	0	-26
80%	-3	16	35	2	0	1	-4	-8	-4	0	-1	-14
90%	-2	7	11	3	0	0	-3	-2	-4	0	-2	-10
Long Term												
Full Simulation Period[a]	1	12	34	16	3	2	-10	-13	-3	0	0	-6
Water Year Types[b]												
Wet (32%)	1	14	25	5	0	0	-5	-8	-2	0	-2	-27
Above Normal (15%)	2	20	51	26	2	3	-10	-14	-4	0	0	-3
Below Normal (17%)	1	9	34	17	0	2	-14	-17	-4	-2	0	11
Dry (22%)	1	8	39	27	6	4	-15	-19	-3	-1	-2	2
Critical (15%)	2	8	29	11	11	3	-10	-13	-1	3	4	5

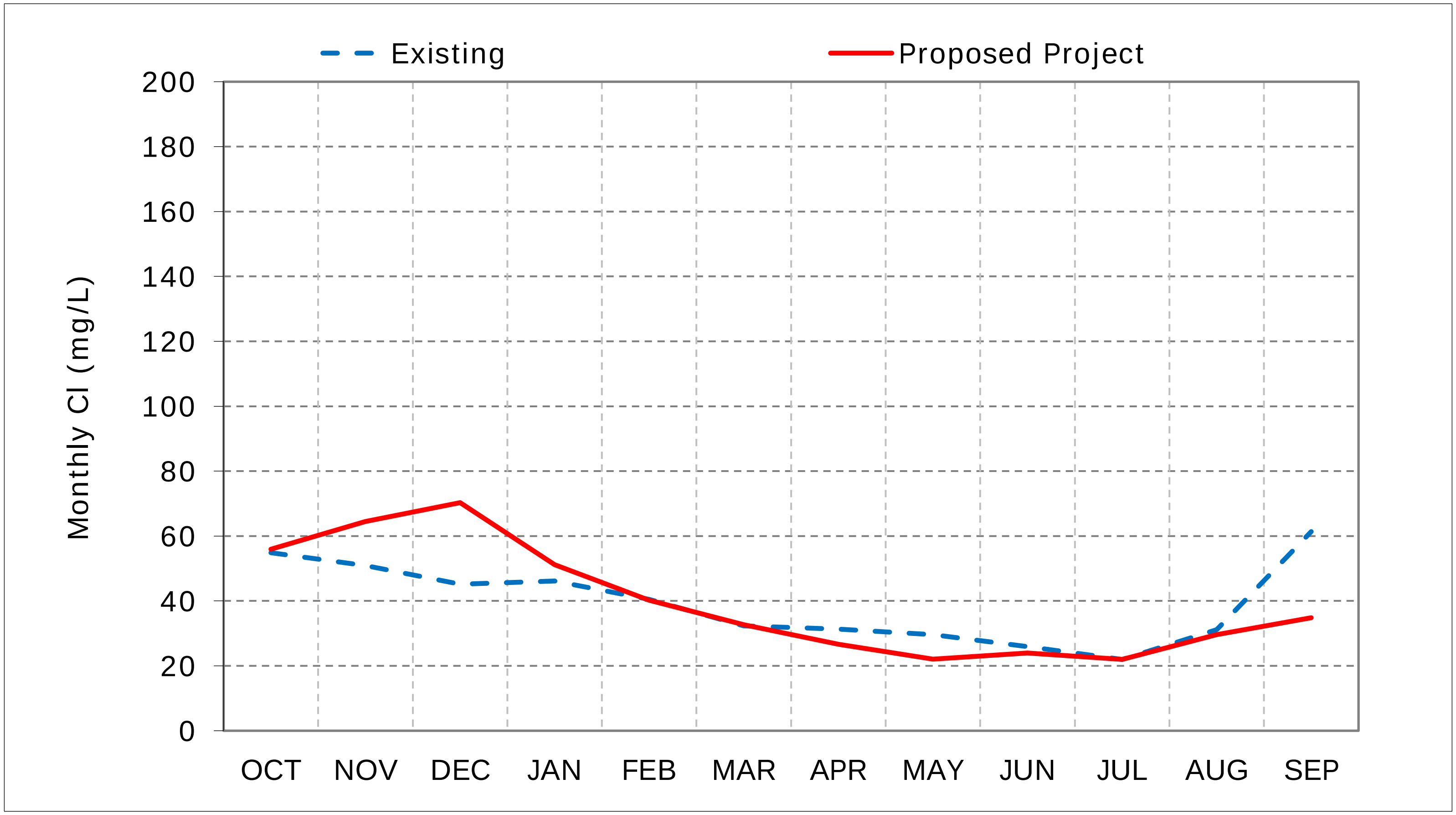
a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with water year - year type sorting.
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 6-1. San Joaquin River at Prisoners Point Chloride, Long-Term Average Cl



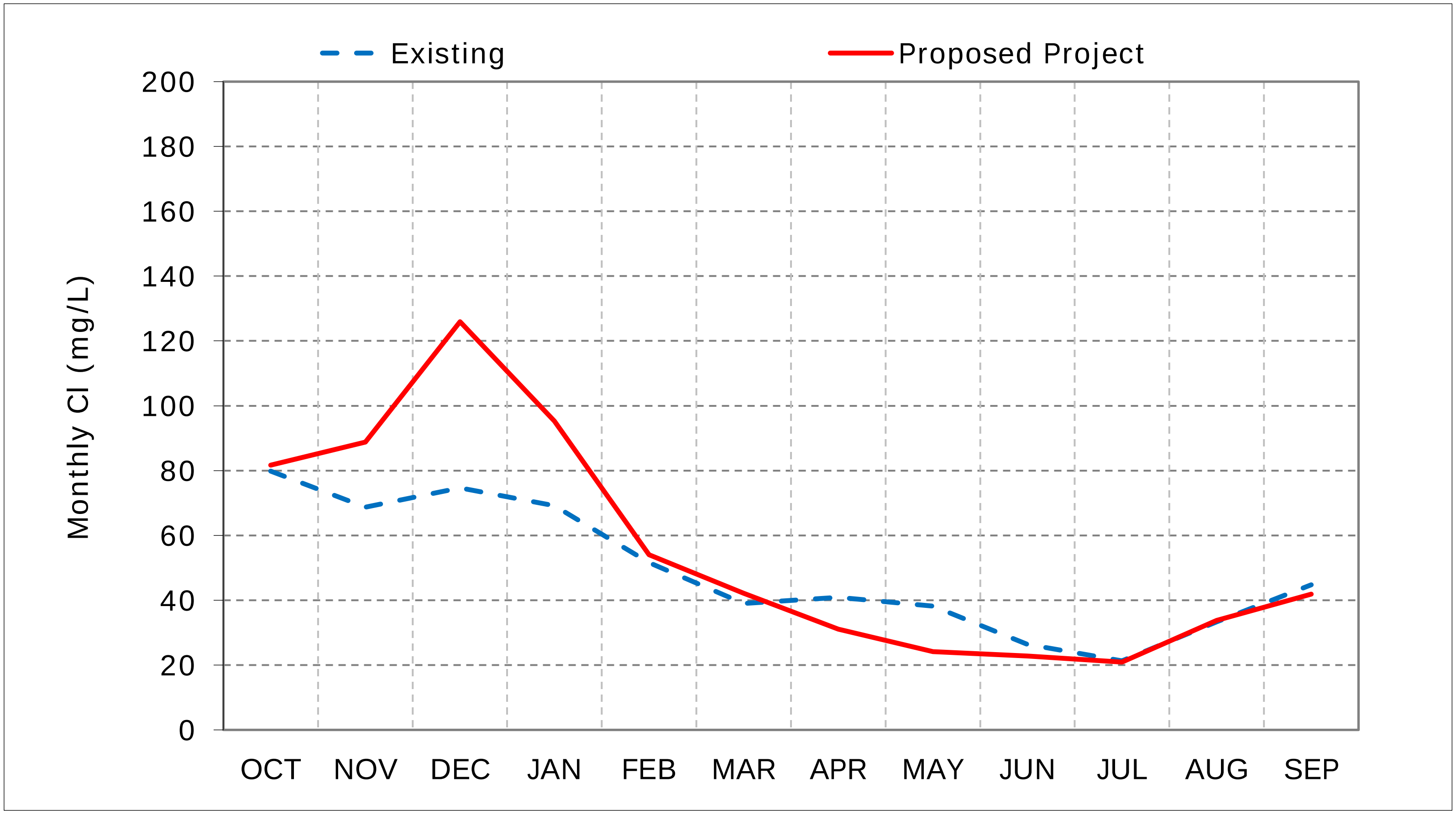
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 6-2. San Joaquin River at Prisoners Point Chloride, Wet Year Average Cl



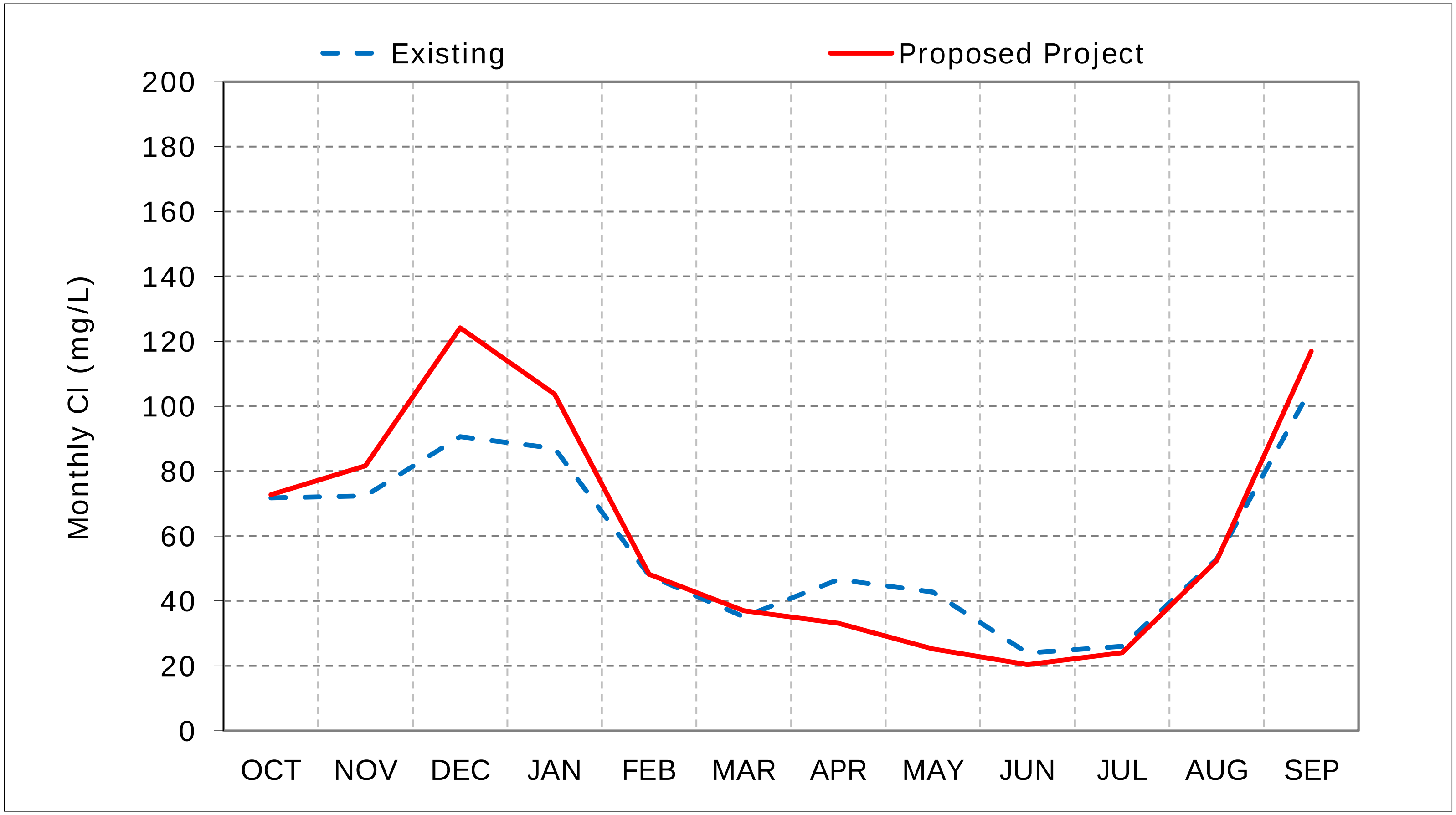
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 6-3. San Joaquin River at Prisoners Point Chloride, Above Normal Year Ave



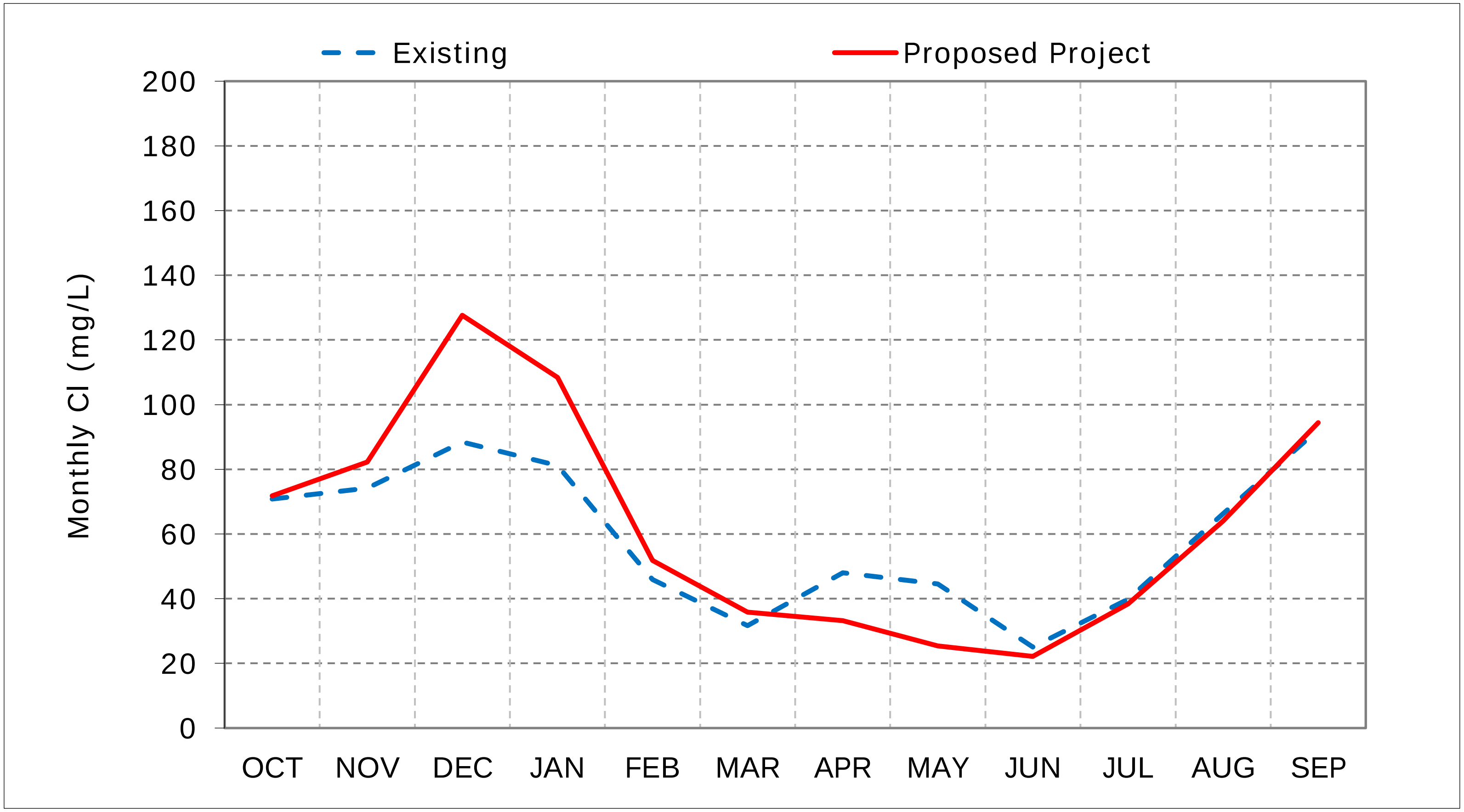
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 6-4. San Joaquin River at Prisoners Point Chloride, Below Normal Year Ave



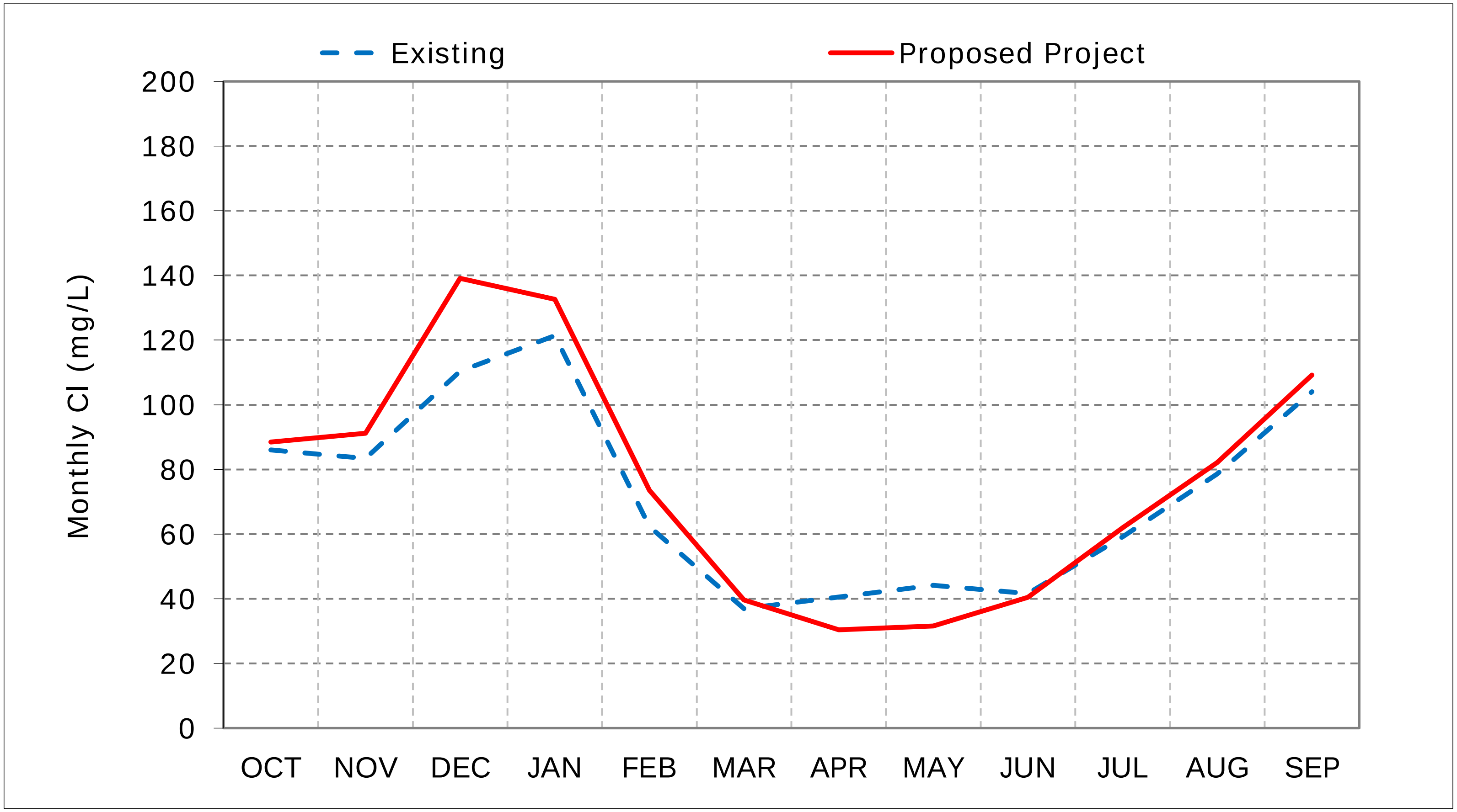
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 6-5. San Joaquin River at Prisoners Point Chloride, Dry Year Average Cl



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 6-6. San Joaquin River at Prisoners Point Chloride, Critical Year Average Cl



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 6-7. San Joaquin River at Prisoners Point Chloride, January Cl

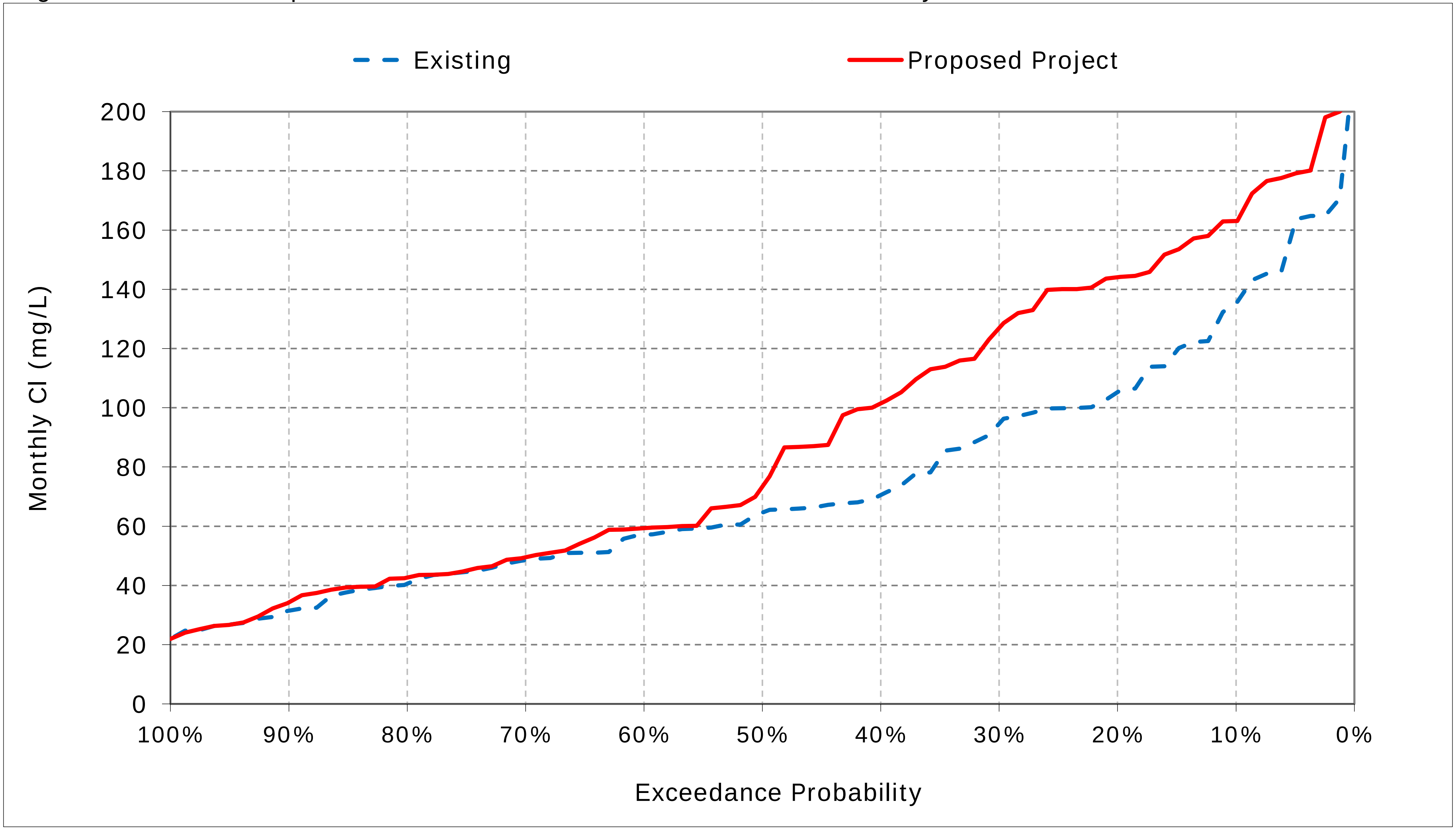


Figure 6-8. San Joaquin River at Prisoners Point Chloride, February Cl

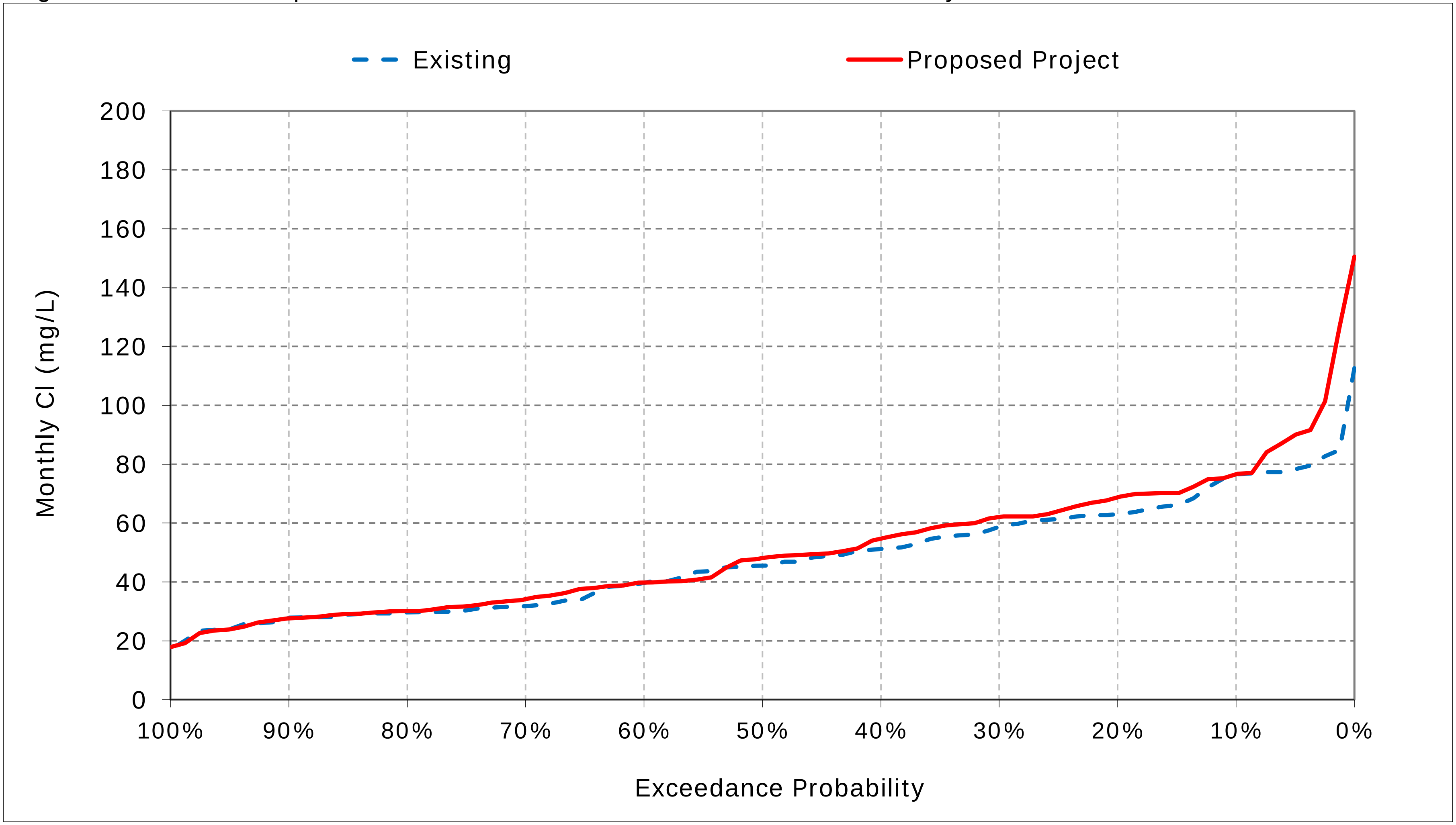


Figure 6-9. San Joaquin River at Prisoners Point Chloride, March Cl

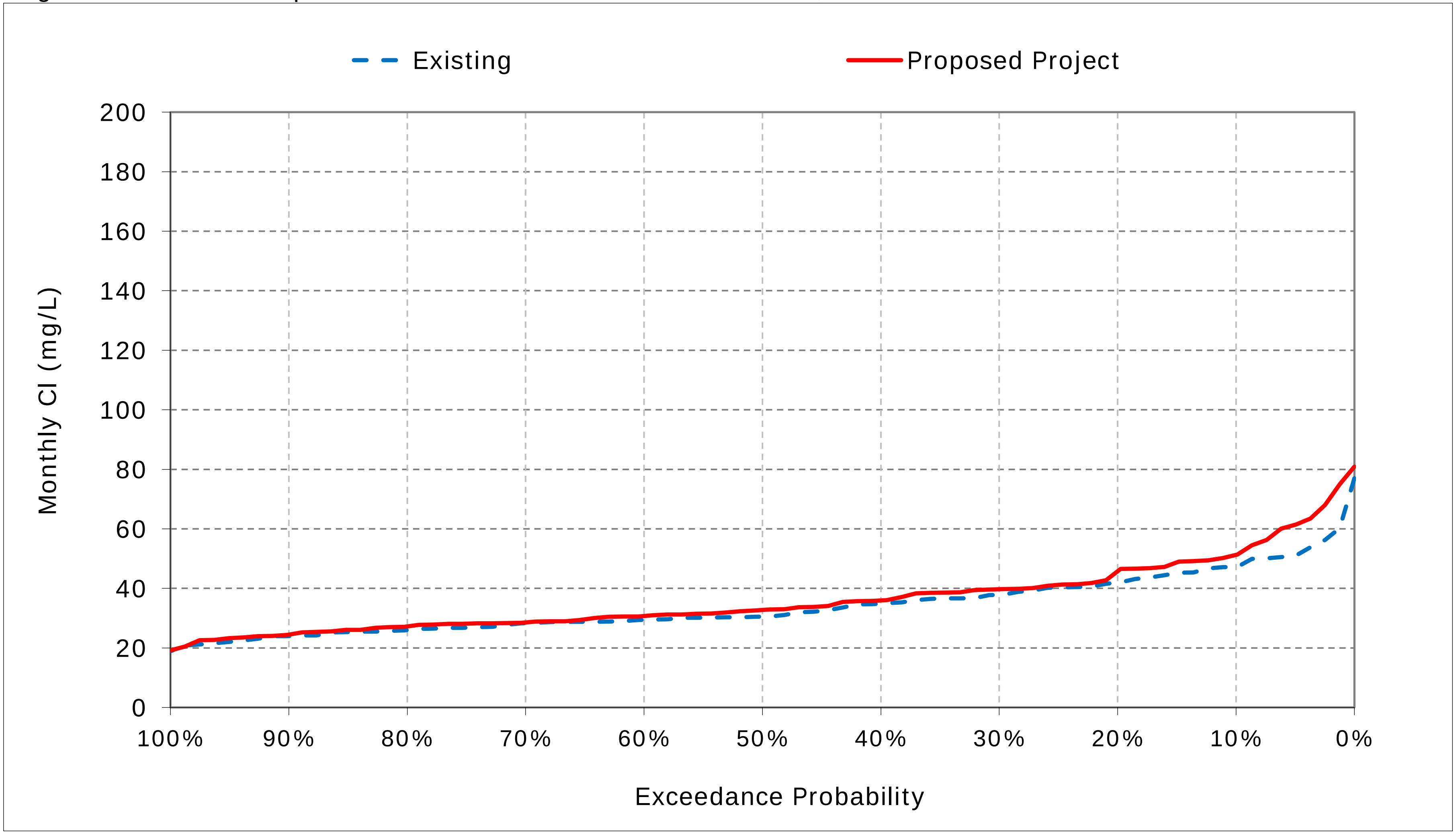


Figure 6-10. San Joaquin River at Prisoners Point Chloride, April Cl

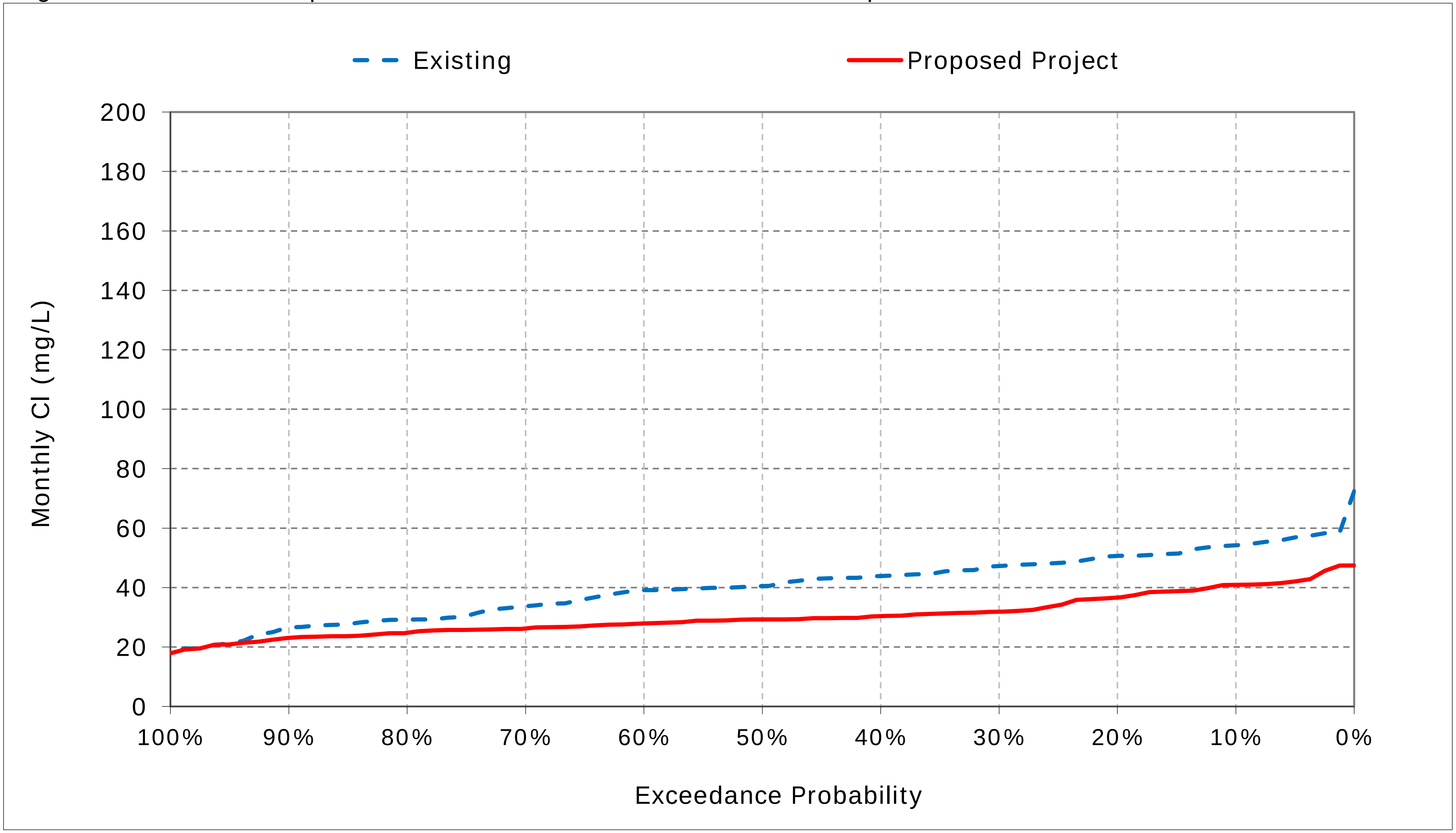


Figure 6-11. San Joaquin River at Prisoners Point Chloride, May Cl

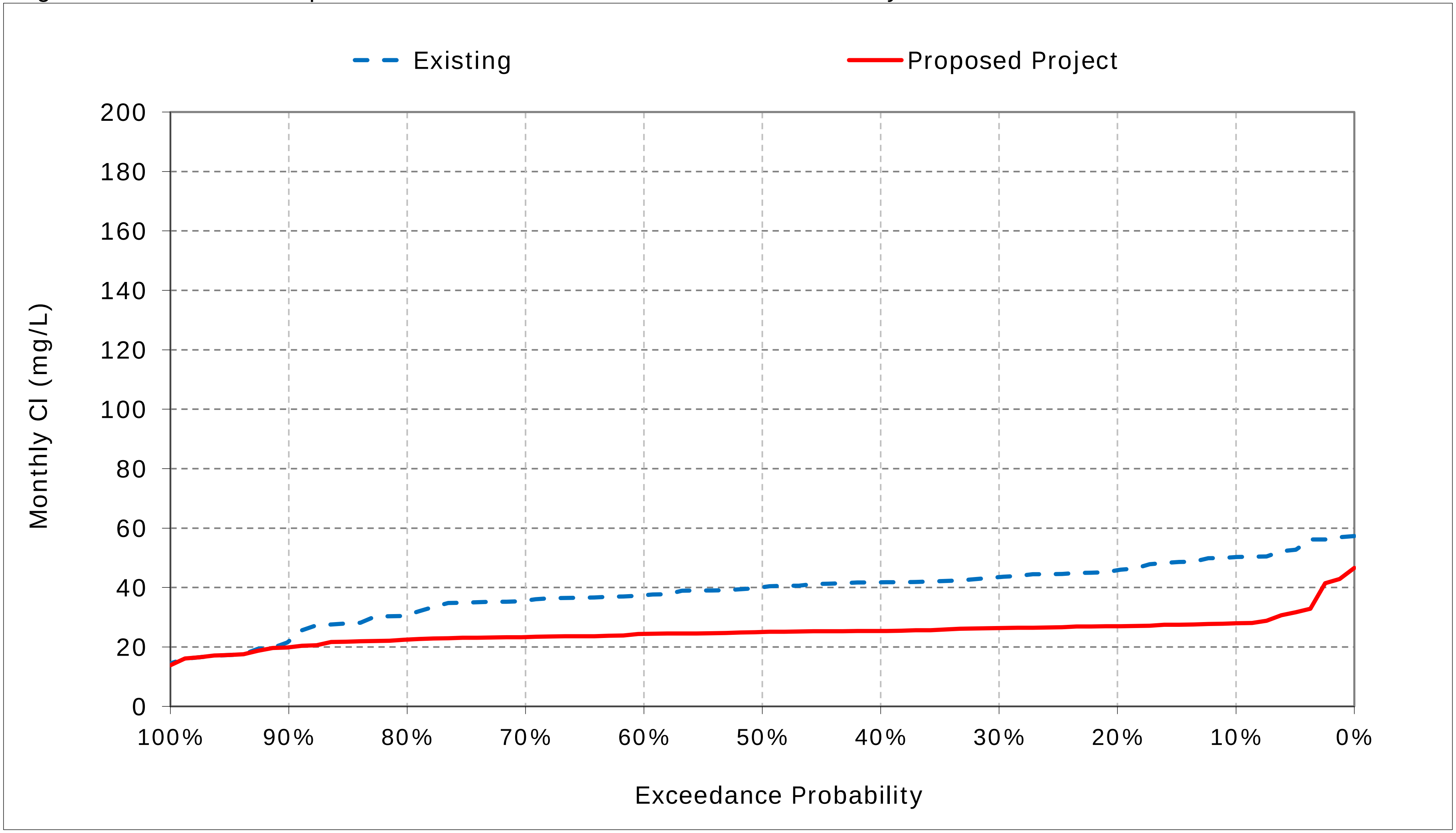


Figure 6-12. San Joaquin River at Prisoners Point Chloride, June Cl

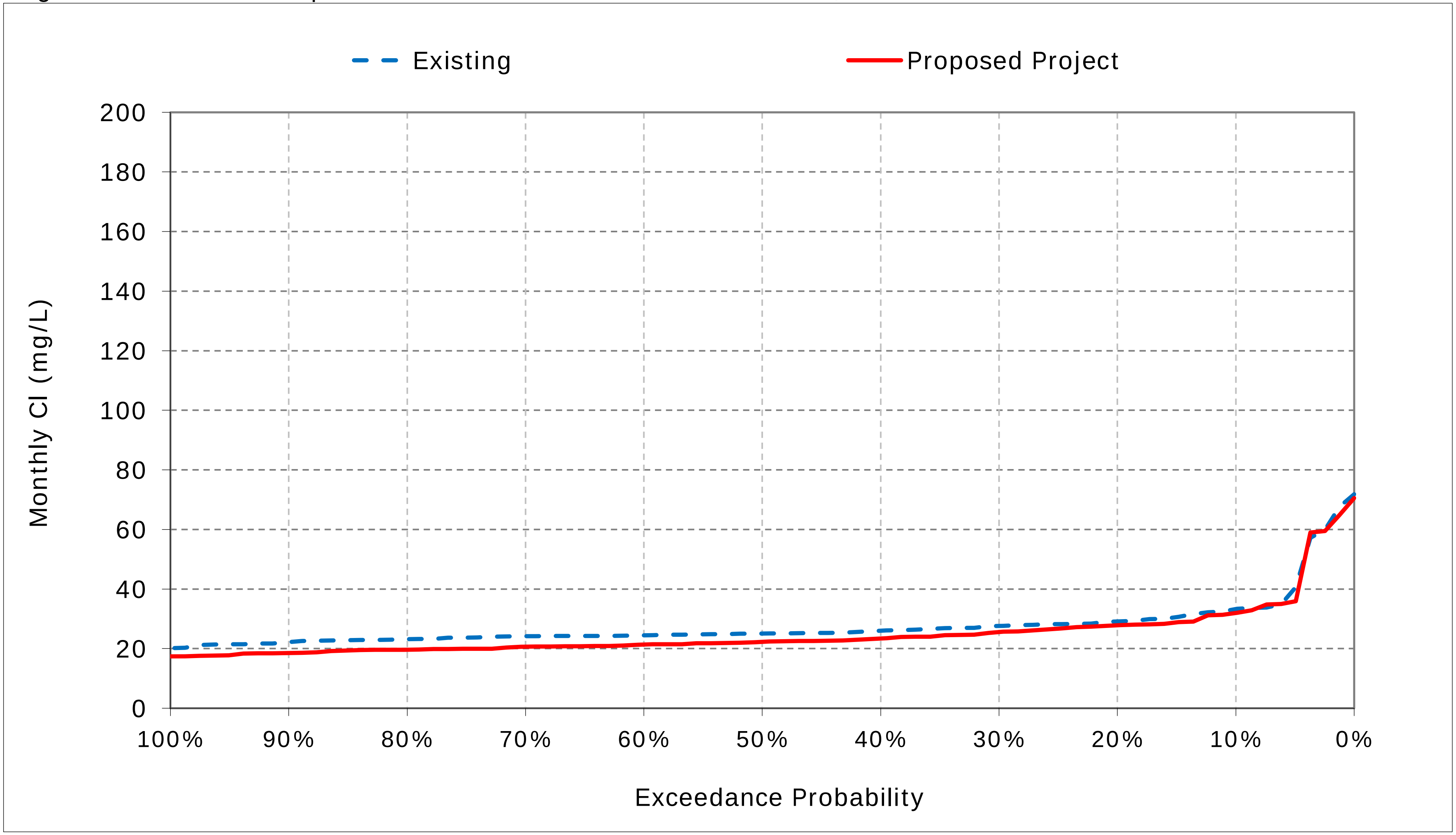


Figure 6-13. San Joaquin River at Prisoners Point Chloride, July Cl

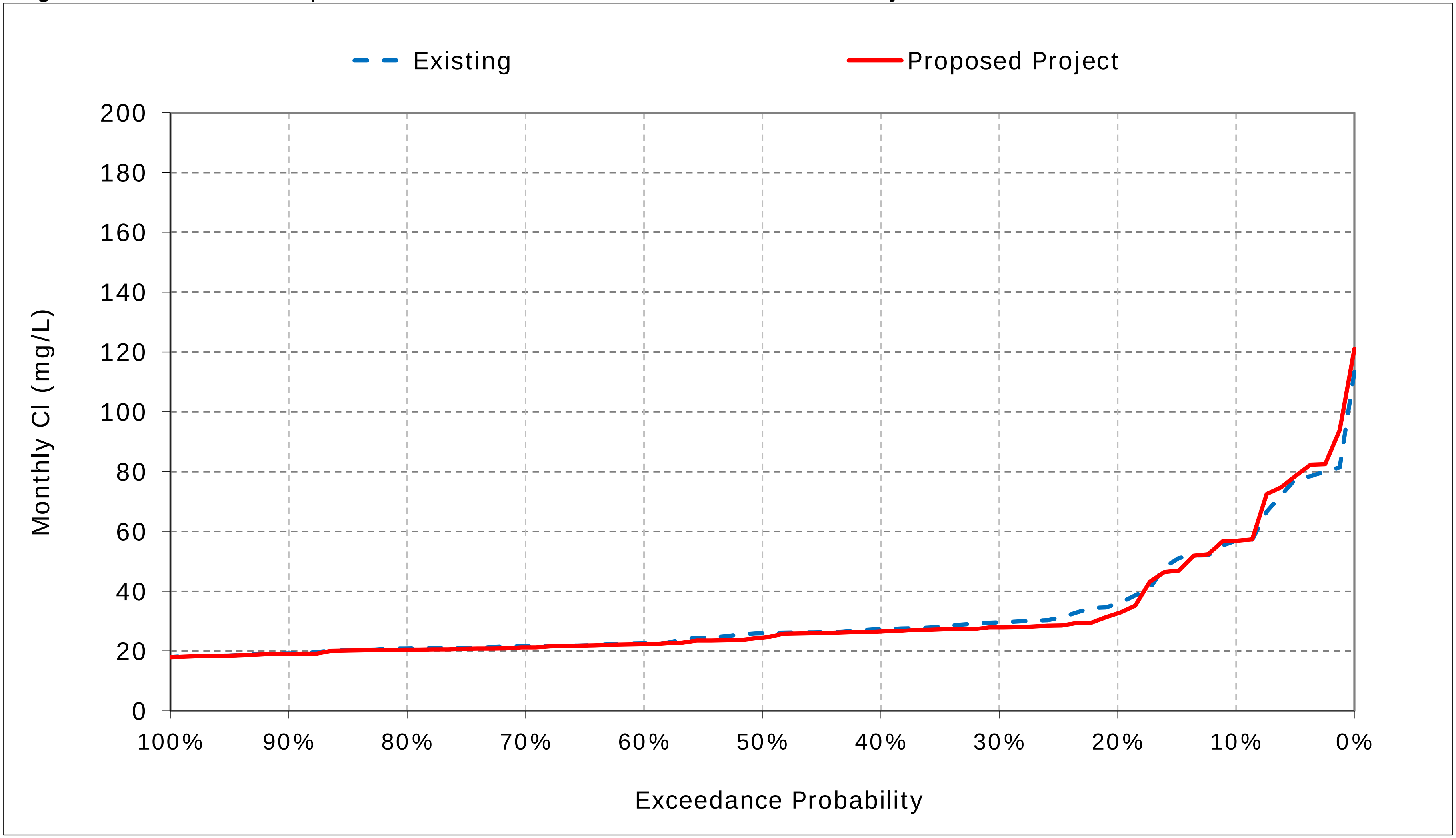


Figure 6-14. San Joaquin River at Prisoners Point Chloride, August Cl

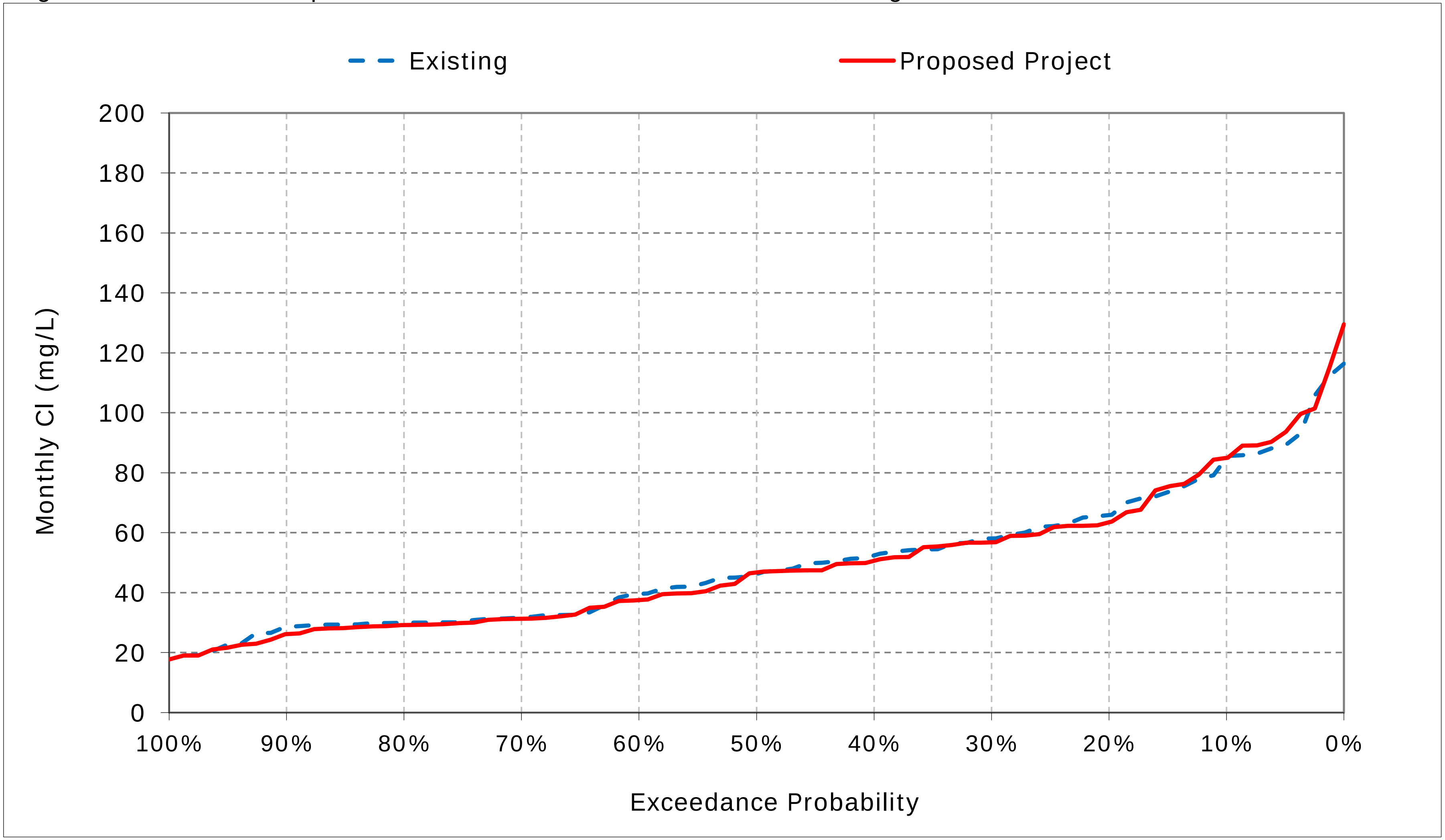


Figure 6-15. San Joaquin River at Prisoners Point Chloride, September Cl

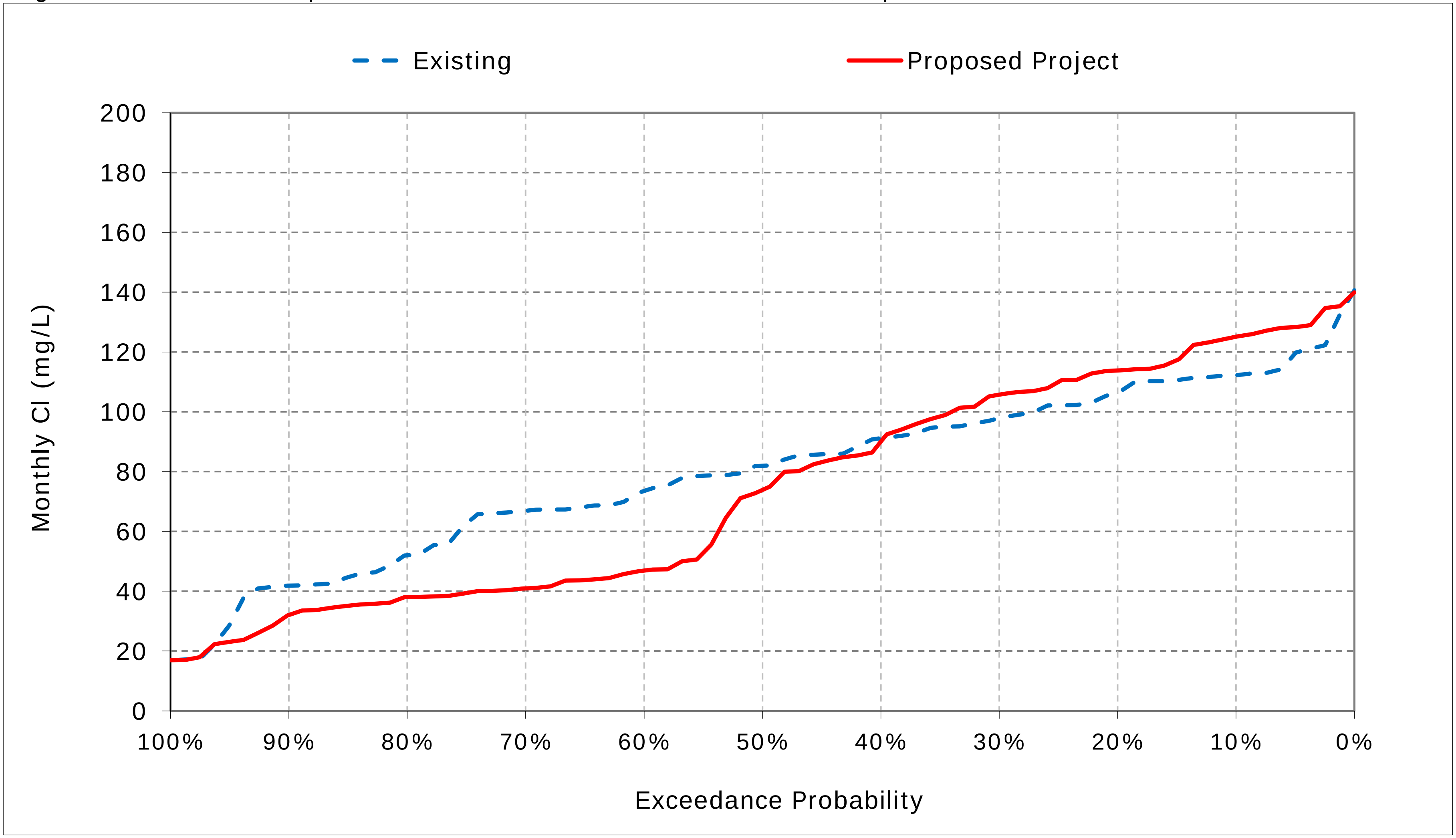


Figure 6-16. San Joaquin River at Prisoners Point Chloride, October Cl

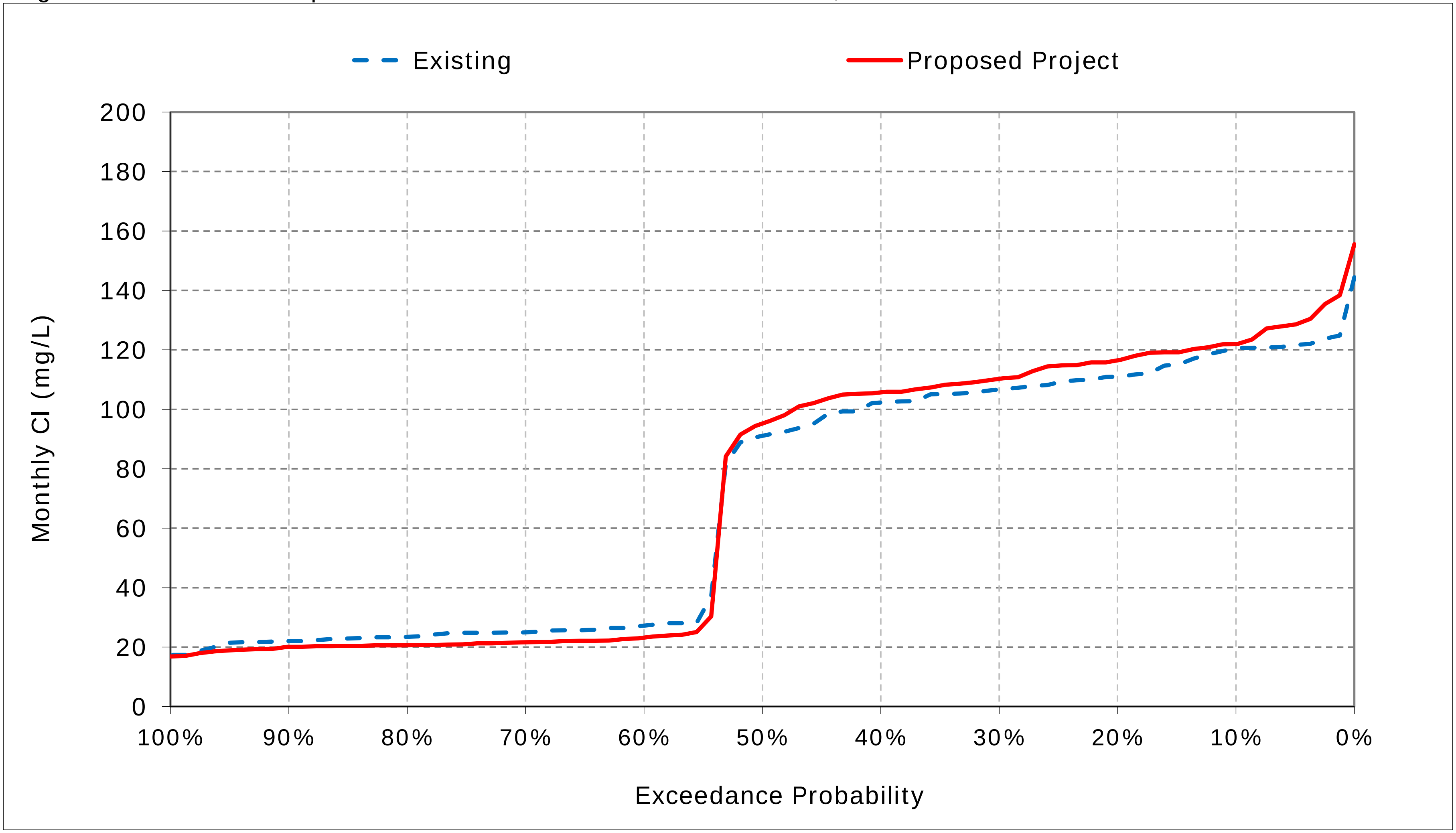


Figure 6-17. San Joaquin River at Prisoners Point Chloride, November Cl

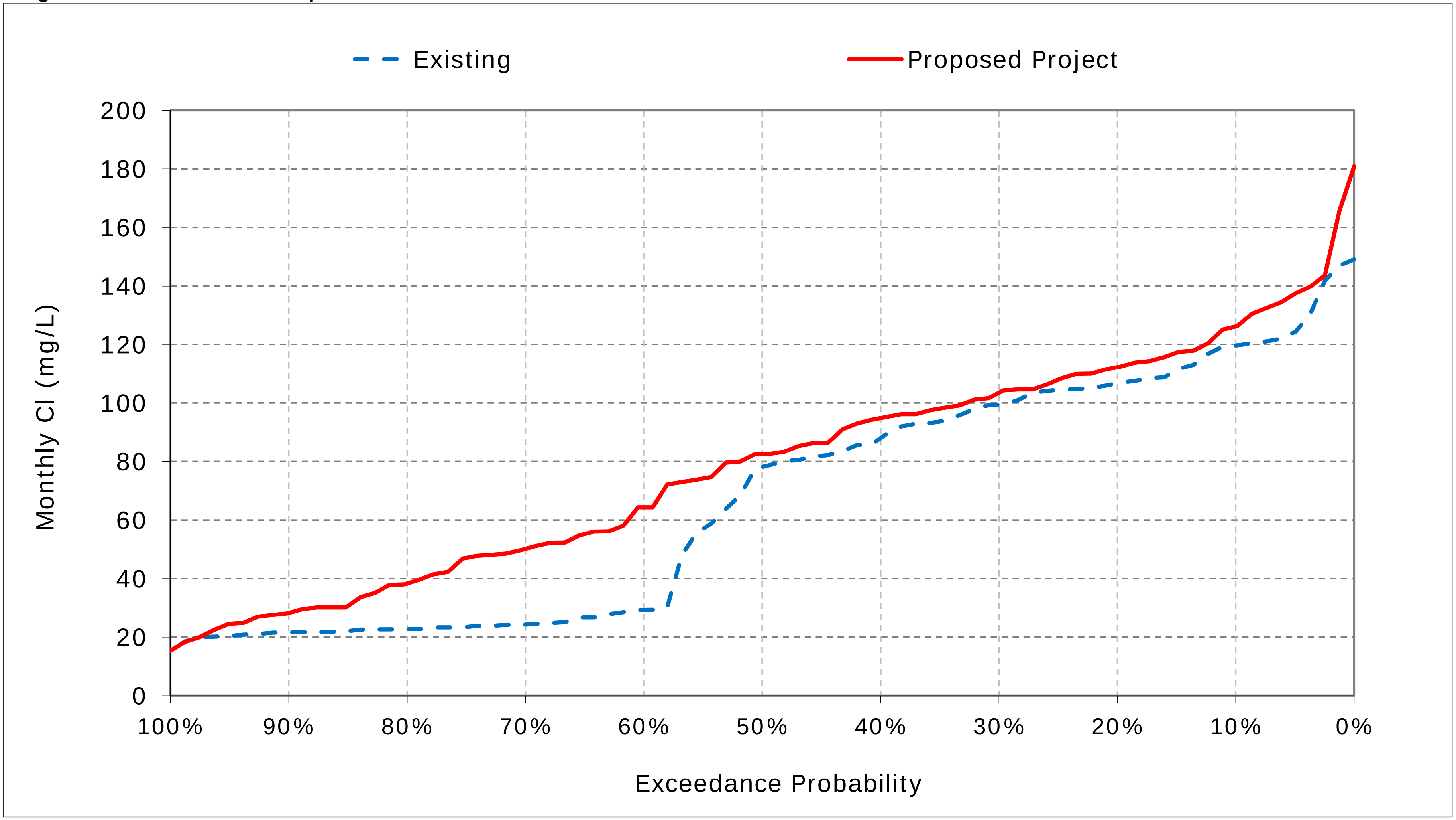


Figure 6-18. San Joaquin River at Prisoners Point Chloride, December Cl

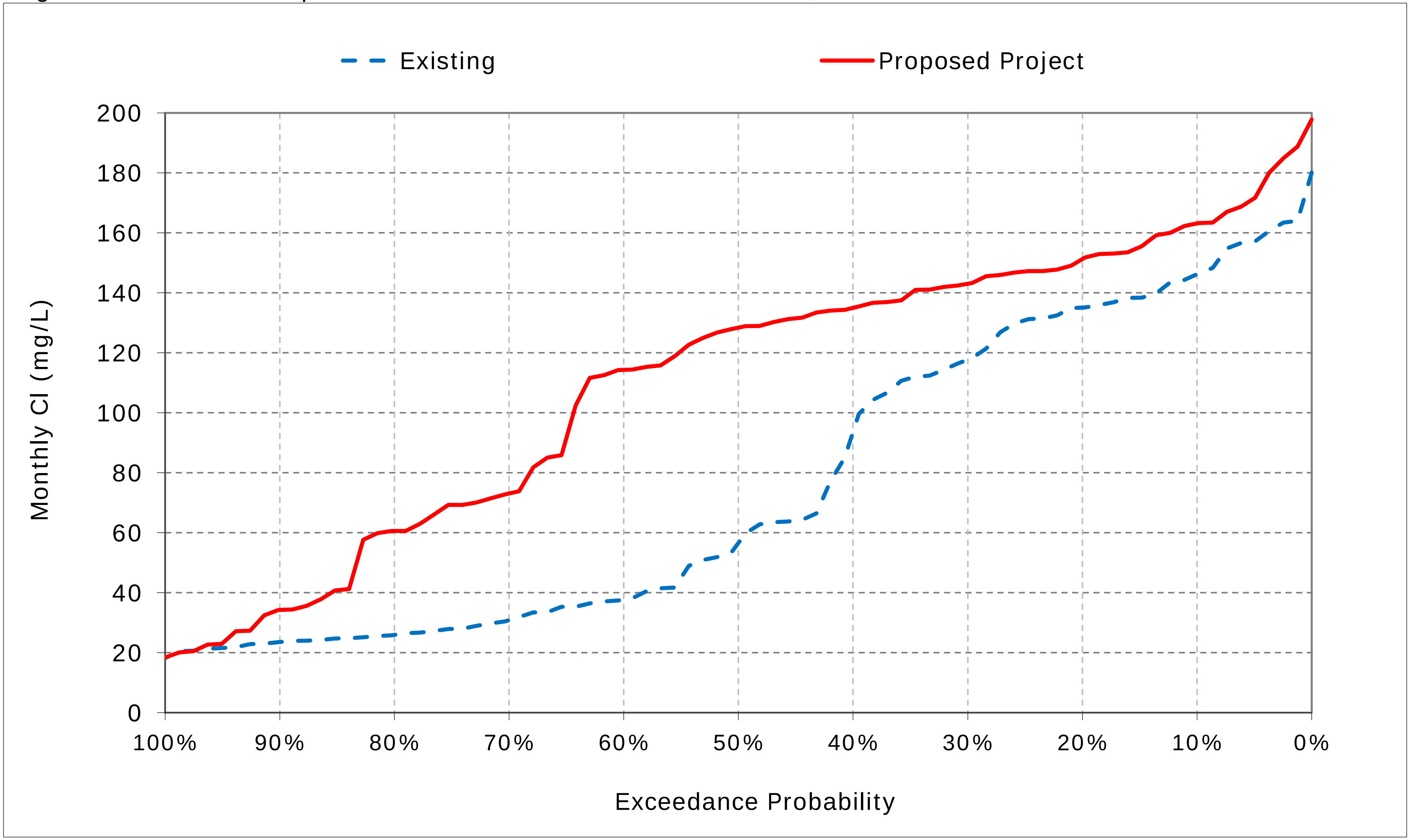


Table 7-1. Old River at Highway 4 Chloride, Monthly Cl

Existing

Statistic	Monthly Cl (mg/L)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	165	161	180	173	109	74	69	69	53	71	112	146
20%	157	143	169	155	96	66	64	65	43	50	87	138
30%	152	135	156	124	89	55	58	61	40	45	76	128
40%	143	127	125	110	81	52	56	60	38	40	71	118
50%	131	115	71	97	70	49	53	58	38	33	60	109
60%	41	42	55	84	60	46	50	55	36	29	54	97
70%	36	31	39	72	54	42	46	51	35	28	44	91
80%	33	29	31	56	49	39	35	44	31	27	41	78
90%	30	28	30	50	43	32	25	21	29	26	38	69
Long Term												
Full Simulation Period[a]	98	91	98	107	74	52	51	53	40	43	67	106
Water Year Types[b]												
Wet (32%)	78	68	63	69	61	45	36	38	32	28	41	83
Above Normal (15%)	111	97	97	104	78	51	50	54	37	28	45	73
Below Normal (17%)	102	96	113	124	70	49	54	58	37	36	70	137
Dry (22%)	98	100	114	115	76	52	61	62	40	53	90	120
Critical (15%)	121	115	135	161	99	69	67	66	66	80	104	133

Proposed Project

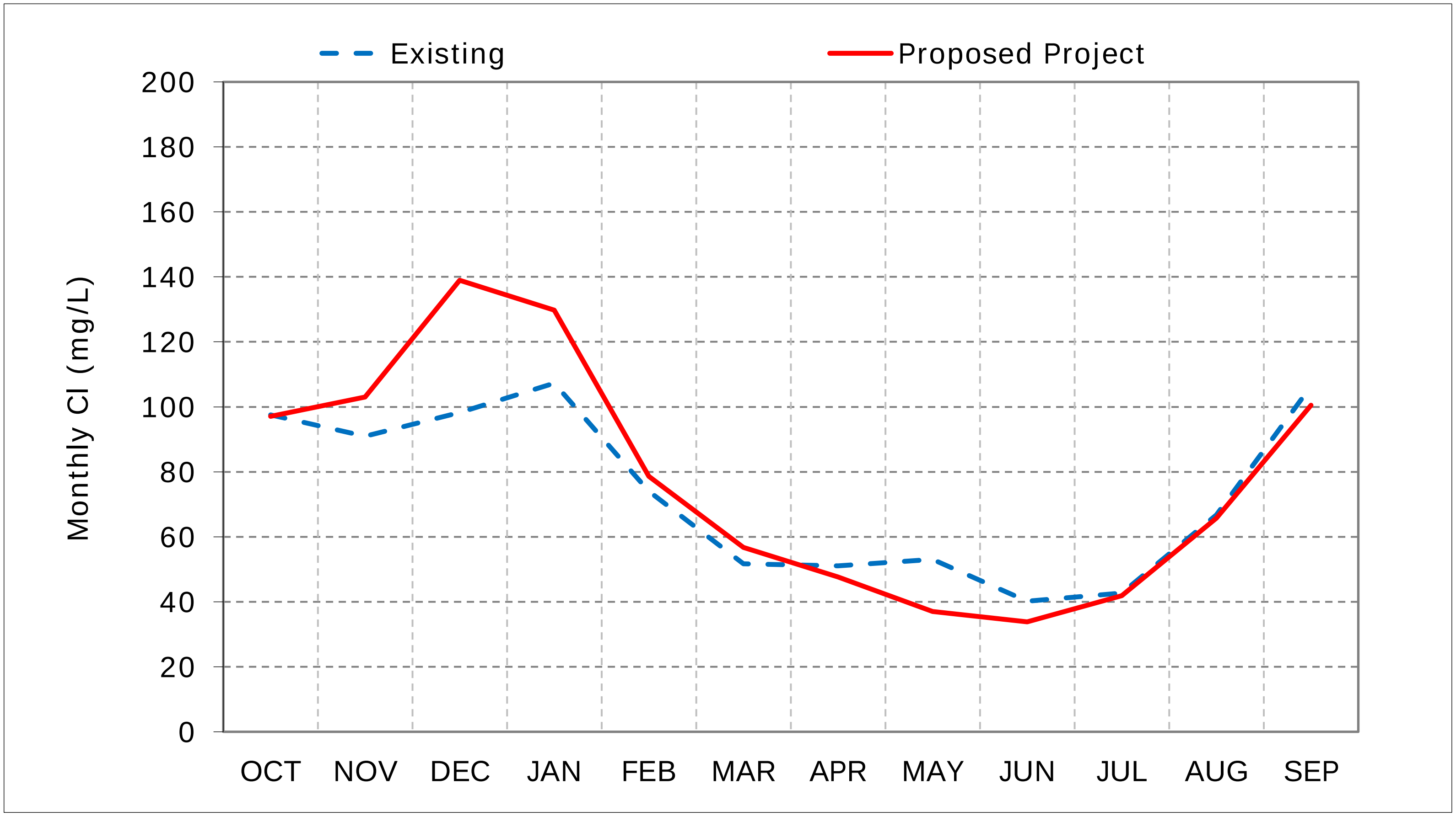
Statistic	Monthly Cl (mg/L)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	171	159	187	222	124	86	66	51	48	73	115	158
20%	163	146	181	199	106	68	59	45	36	47	83	145
30%	154	135	171	171	89	62	55	41	31	42	76	132
40%	144	130	167	151	80	57	49	37	30	37	69	116
50%	134	117	161	116	72	55	46	33	29	30	59	99
60%	31	79	143	95	67	49	44	31	29	29	52	76
70%	28	64	117	78	59	46	41	30	28	27	44	68
80%	27	52	96	65	51	42	37	29	27	27	40	63
90%	27	40	44	52	43	36	30	27	25	26	34	55
Long Term												
Full Simulation Period[a]	97	103	139	130	79	57	48	37	34	42	66	101
Water Year Types[b]												
Wet (32%)	77	84	98	79	61	48	36	28	28	28	39	56
Above Normal (15%)	111	117	155	142	83	58	44	30	28	27	45	70
Below Normal (17%)	101	107	152	149	72	54	51	35	28	32	69	150
Dry (22%)	97	107	157	150	85	59	55	42	32	51	87	121
Critical (15%)	123	120	170	176	112	72	63	58	61	83	108	138

Proposed Project minus Existing

Statistic	Monthly Cl (mg/L)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	6	-3	7	50	15	12	-3	-18	-4	2	2	12
20%	7	3	13	44	10	2	-5	-19	-7	-3	-4	7
30%	2	0	16	46	0	7	-4	-20	-8	-3	0	5
40%	0	3	42	41	0	5	-7	-22	-8	-3	-2	-2
50%	4	2	90	18	2	6	-7	-24	-8	-2	-1	-10
60%	-10	38	88	10	7	3	-6	-24	-8	0	-2	-21
70%	-8	32	78	6	5	4	-5	-21	-7	-1	0	-23
80%	-6	23	64	9	1	3	2	-16	-5	0	-1	-14
90%	-3	12	14	2	0	4	6	6	-4	0	-4	-14
Long Term												
Full Simulation Period[a]	0	12	41	23	5	5	-3	-16	-6	-1	-1	-6
Water Year Types[b]												
Wet (32%)	-1	16	35	9	0	3	0	-10	-4	0	-2	-27
Above Normal (15%)	0	20	58	39	5	7	-6	-23	-8	-1	0	-3
Below Normal (17%)	-1	11	39	24	2	6	-3	-23	-8	-4	-1	13
Dry (22%)	-1	8	43	34	9	7	-6	-20	-8	-2	-3	1
Critical (15%)	2	5	35	15	13	3	-4	-8	-5	3	4	5

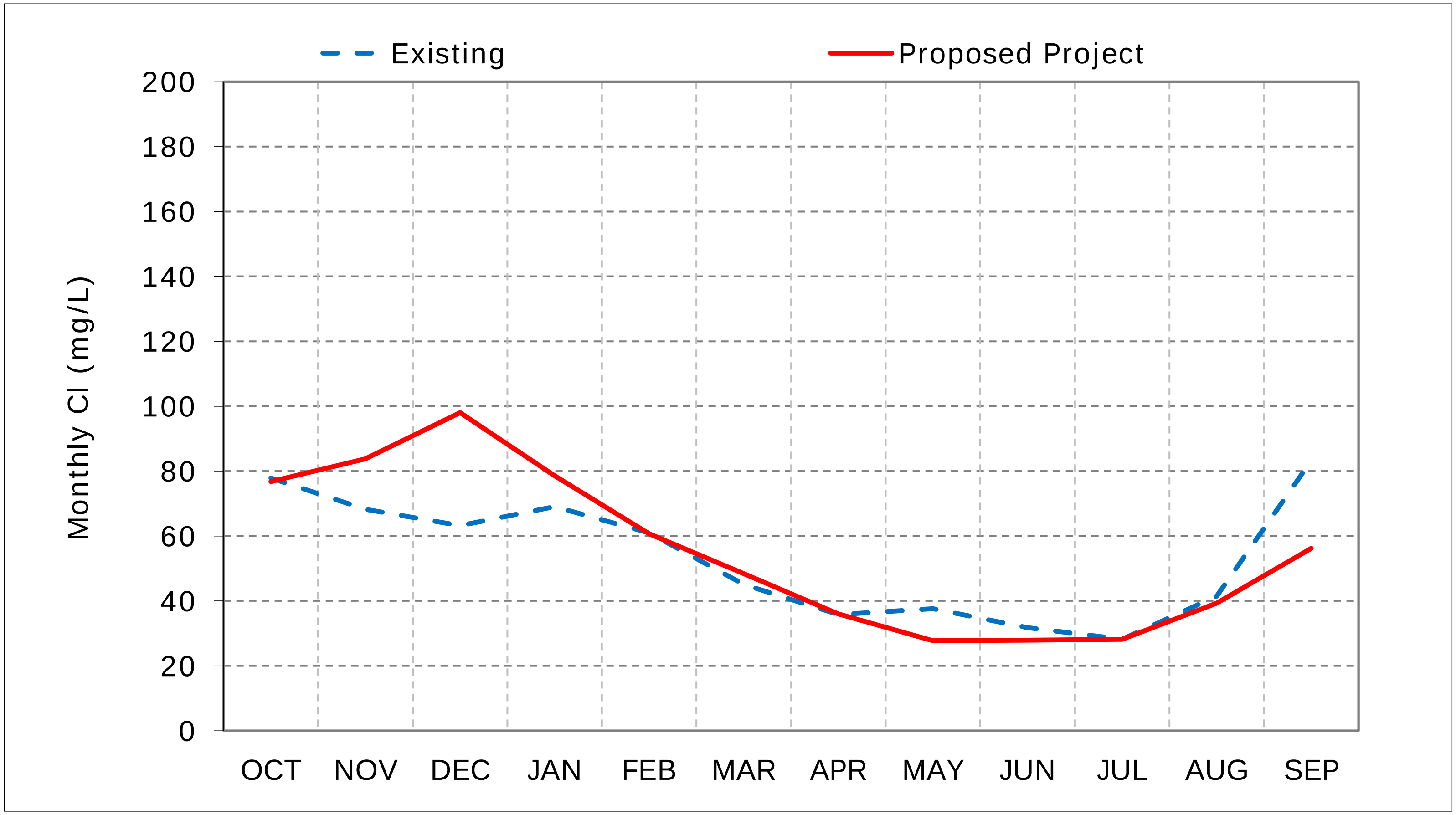
a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with water year - year type sorting.
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 7-1. Old River at Highway 4 Chloride, Long-Term Average Cl



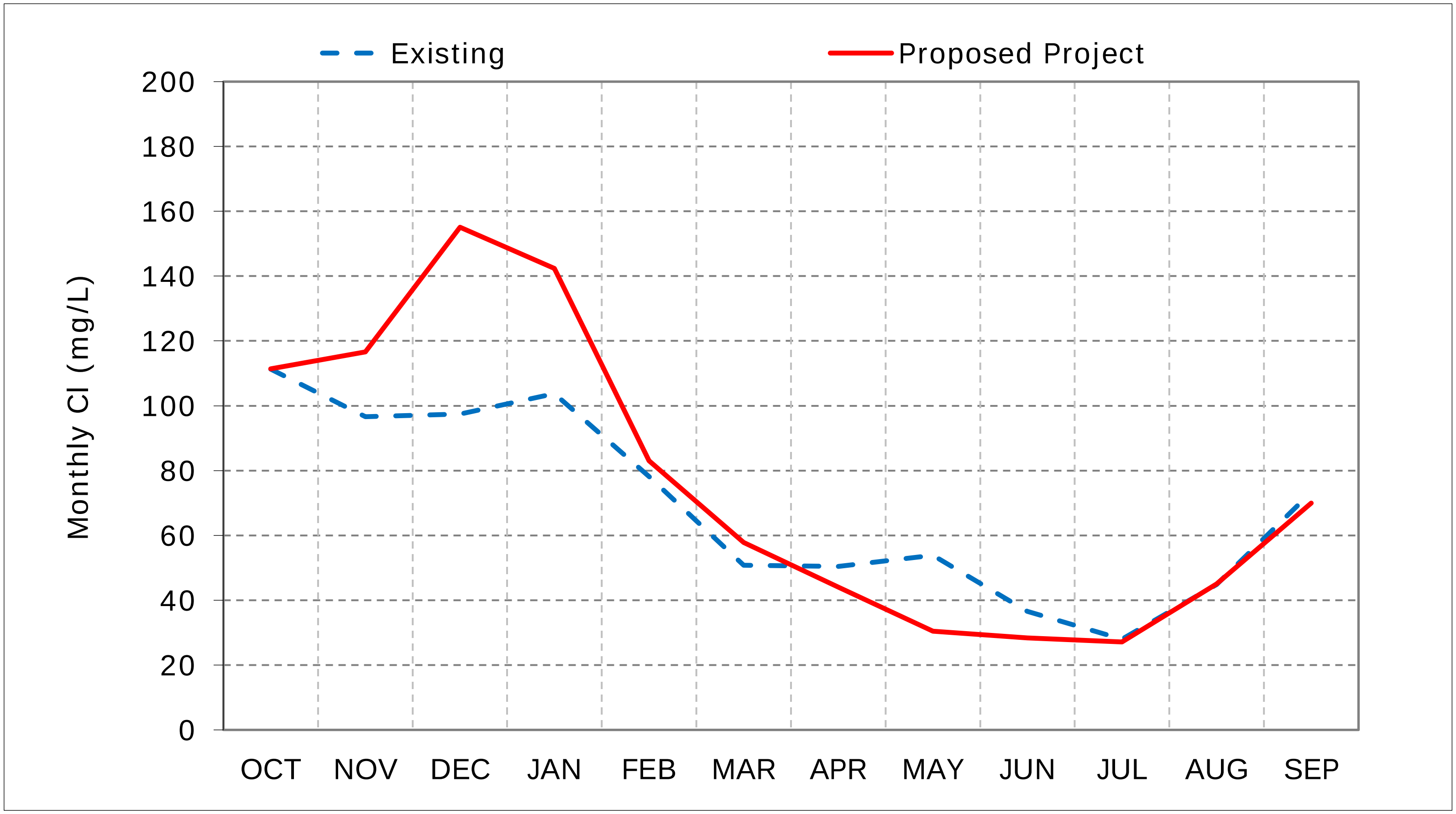
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 7-2. Old River at Highway 4 Chloride, Wet Year Average Cl



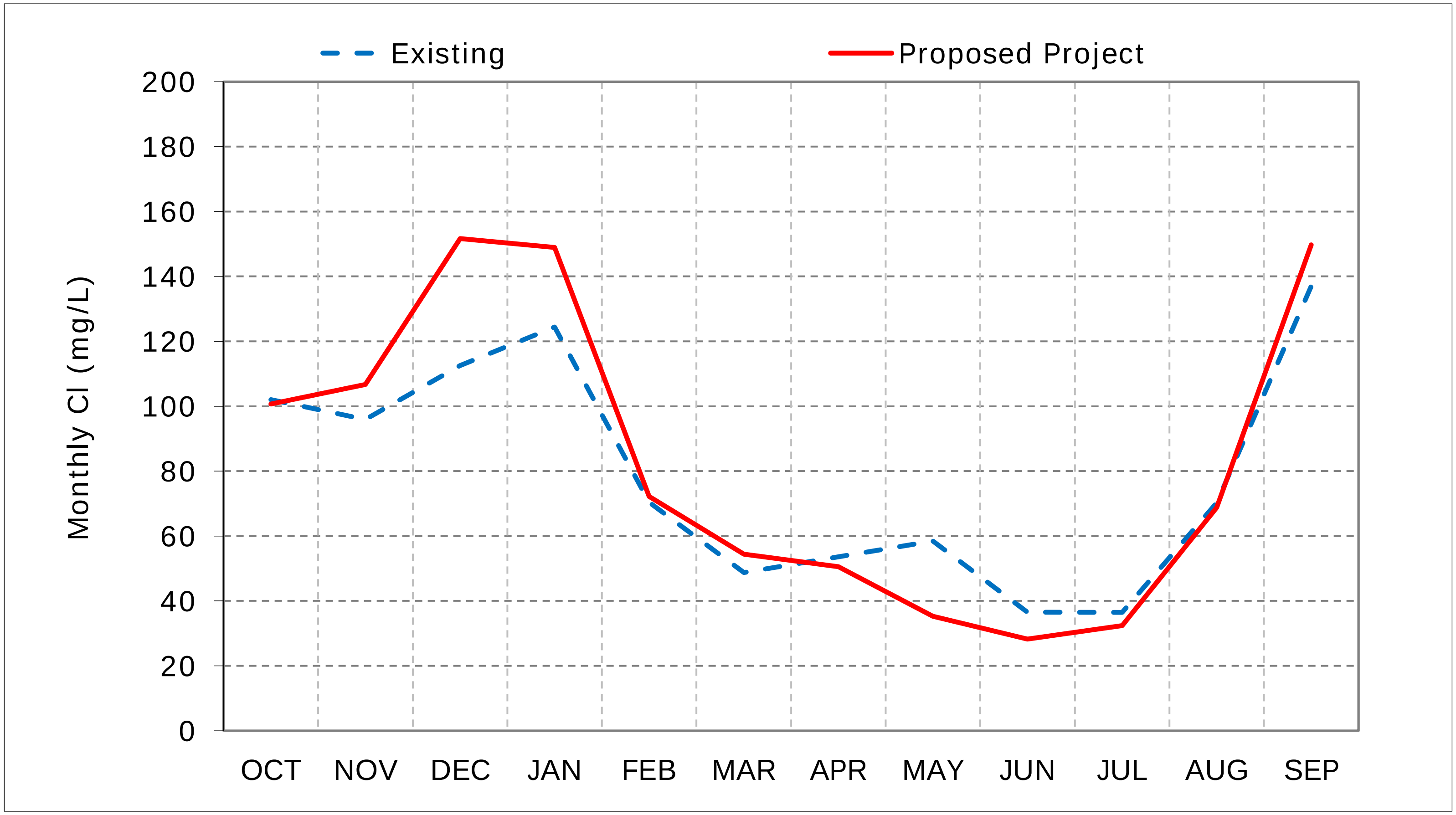
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 7-3. Old River at Highway 4 Chloride, Above Normal Year Average Cl



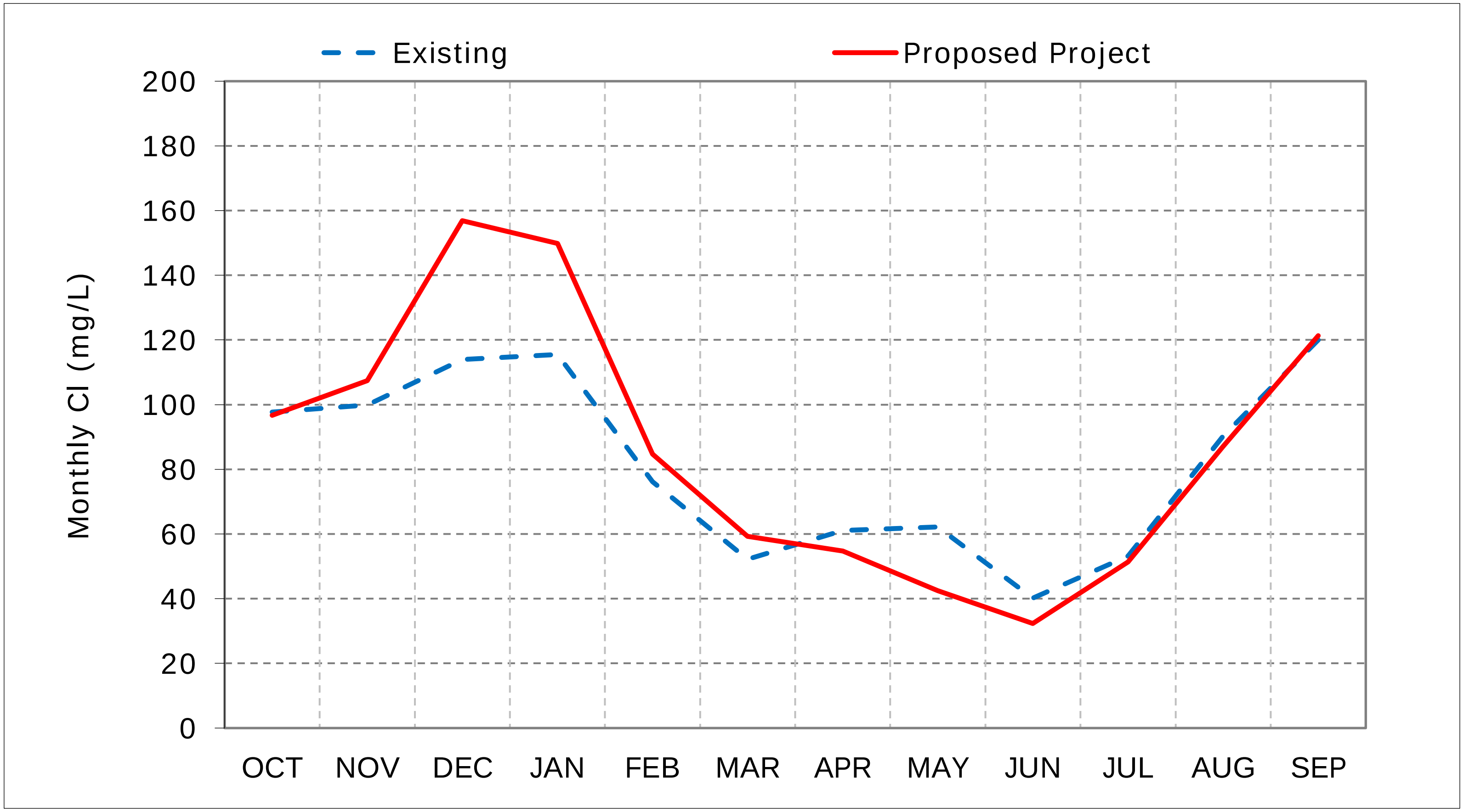
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 7-4. Old River at Highway 4 Chloride, Below Normal Year Average Cl



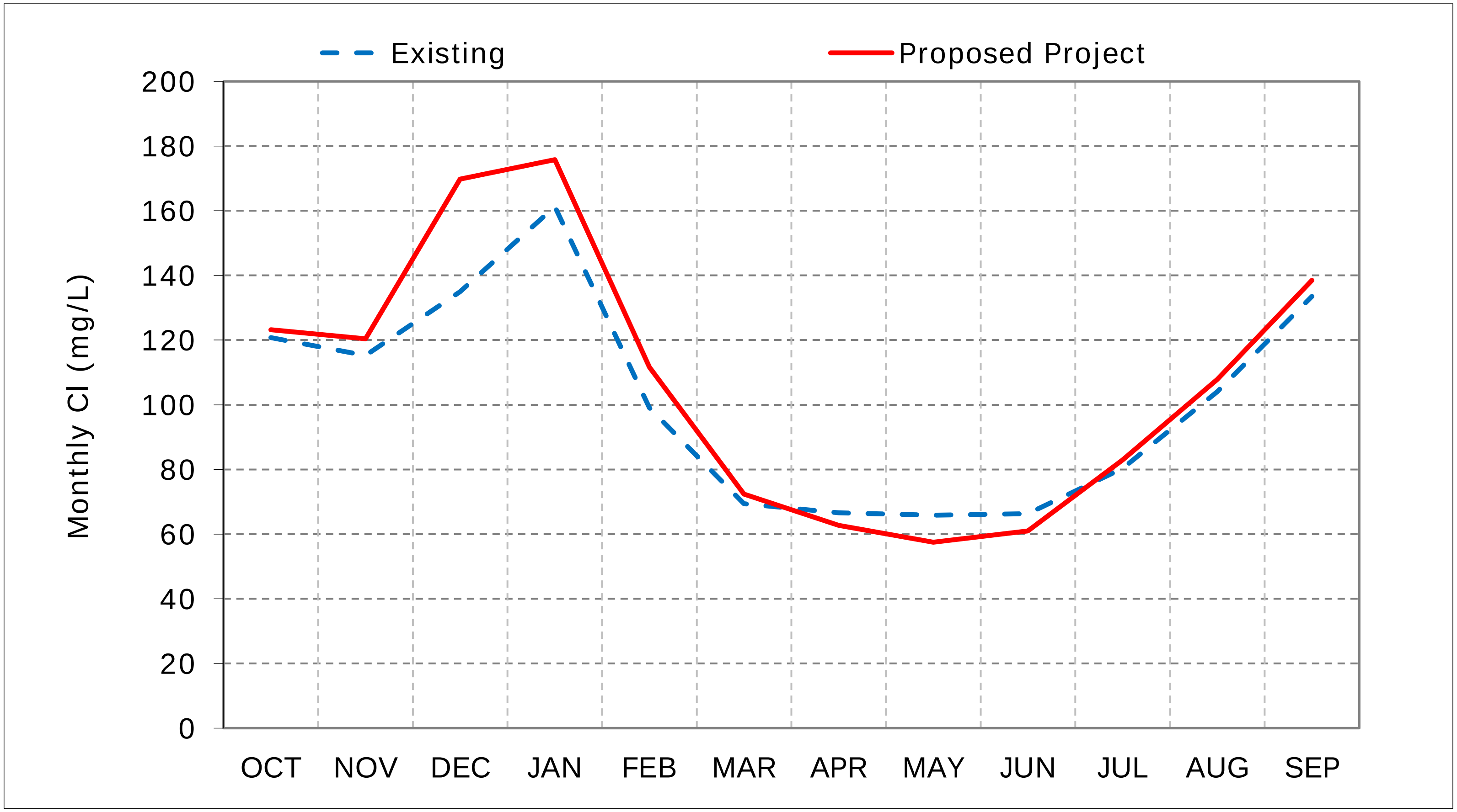
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 7-5. Old River at Highway 4 Chloride, Dry Year Average Cl



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 7-6. Old River at Highway 4 Chloride, Critical Year Average Cl



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 7-7. Old River at Highway 4 Chloride, January Cl

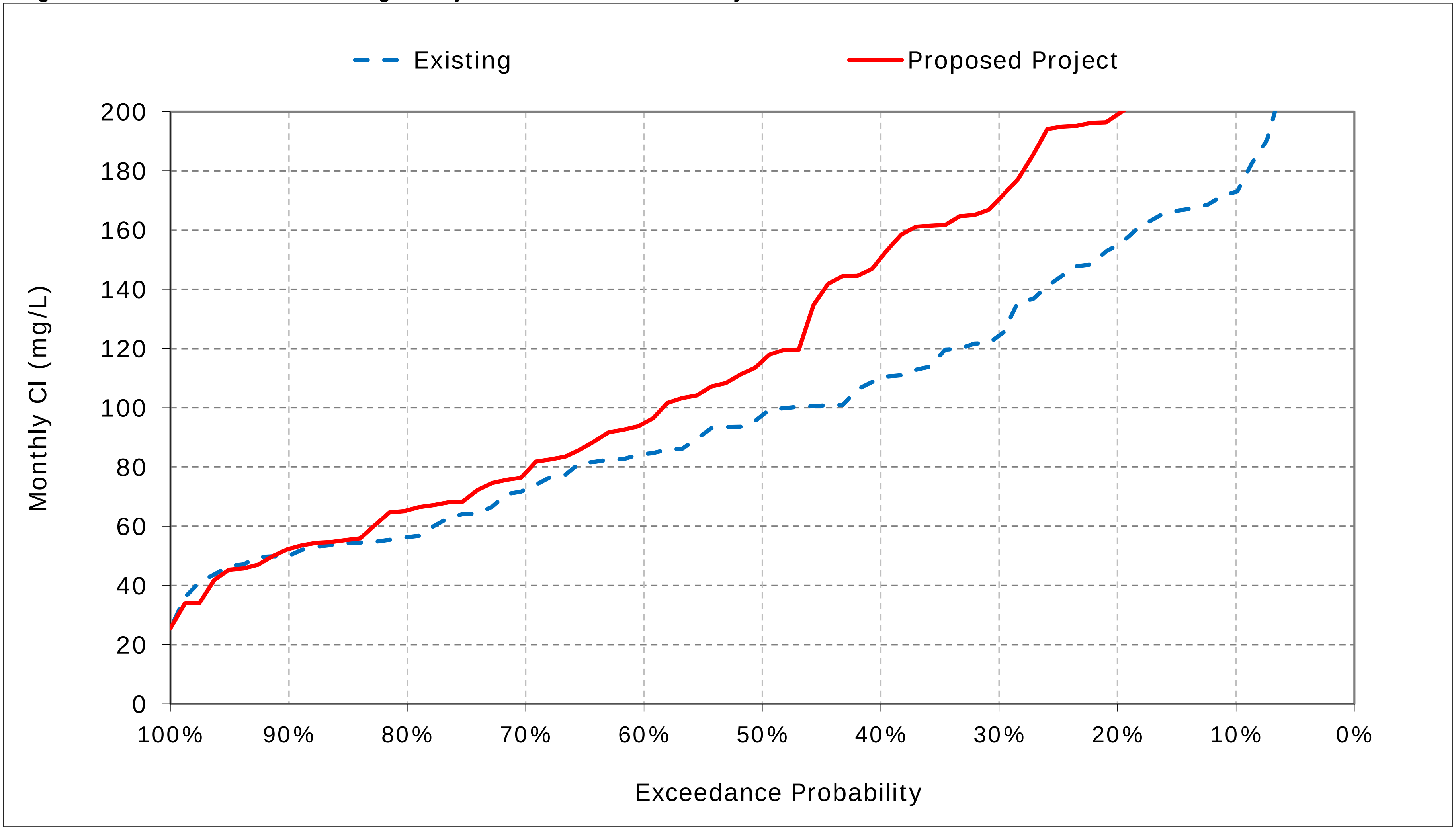


Figure 7-8. Old River at Highway 4 Chloride, February Cl

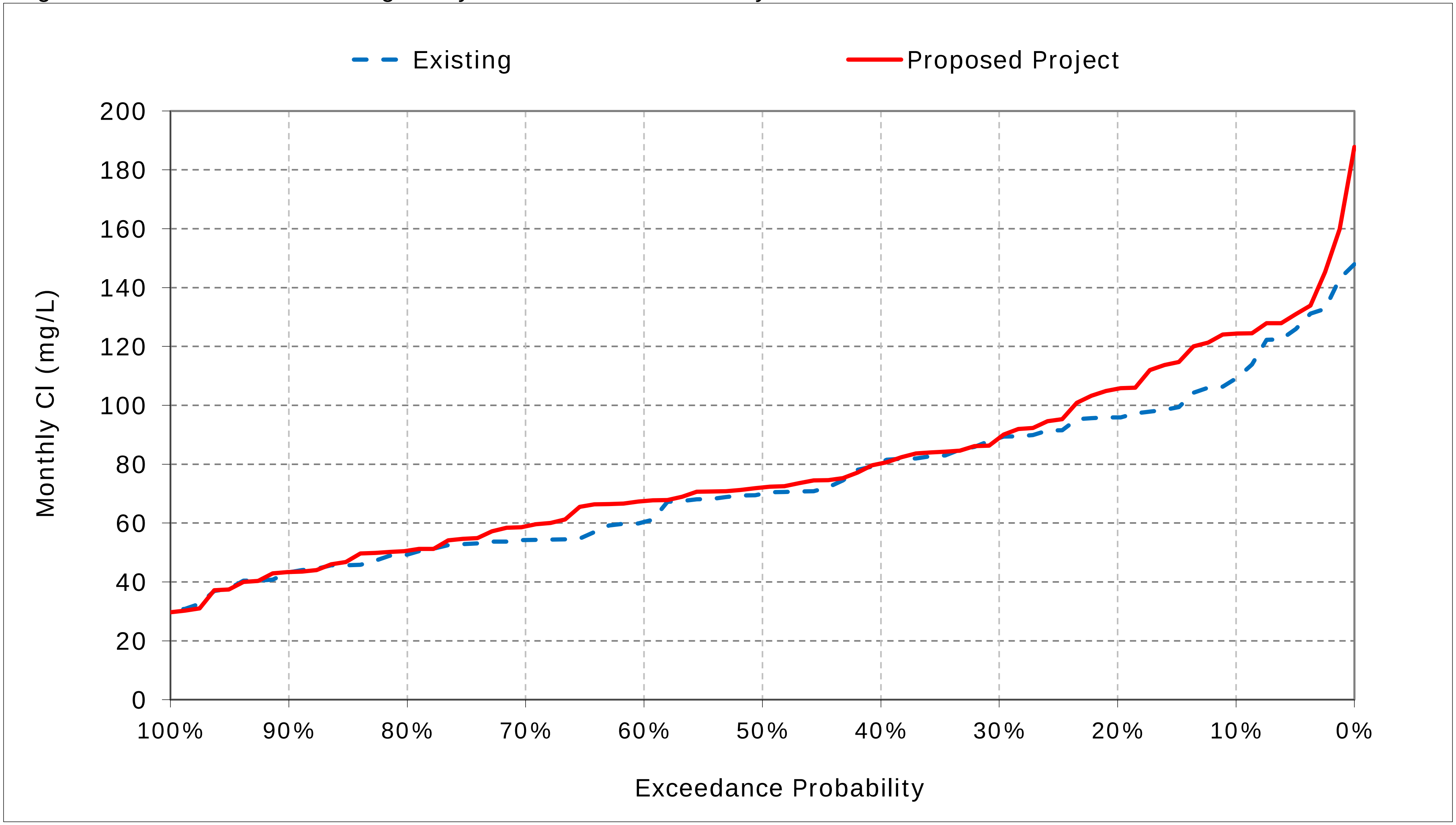


Figure 7-9. Old River at Highway 4 Chloride, March Cl

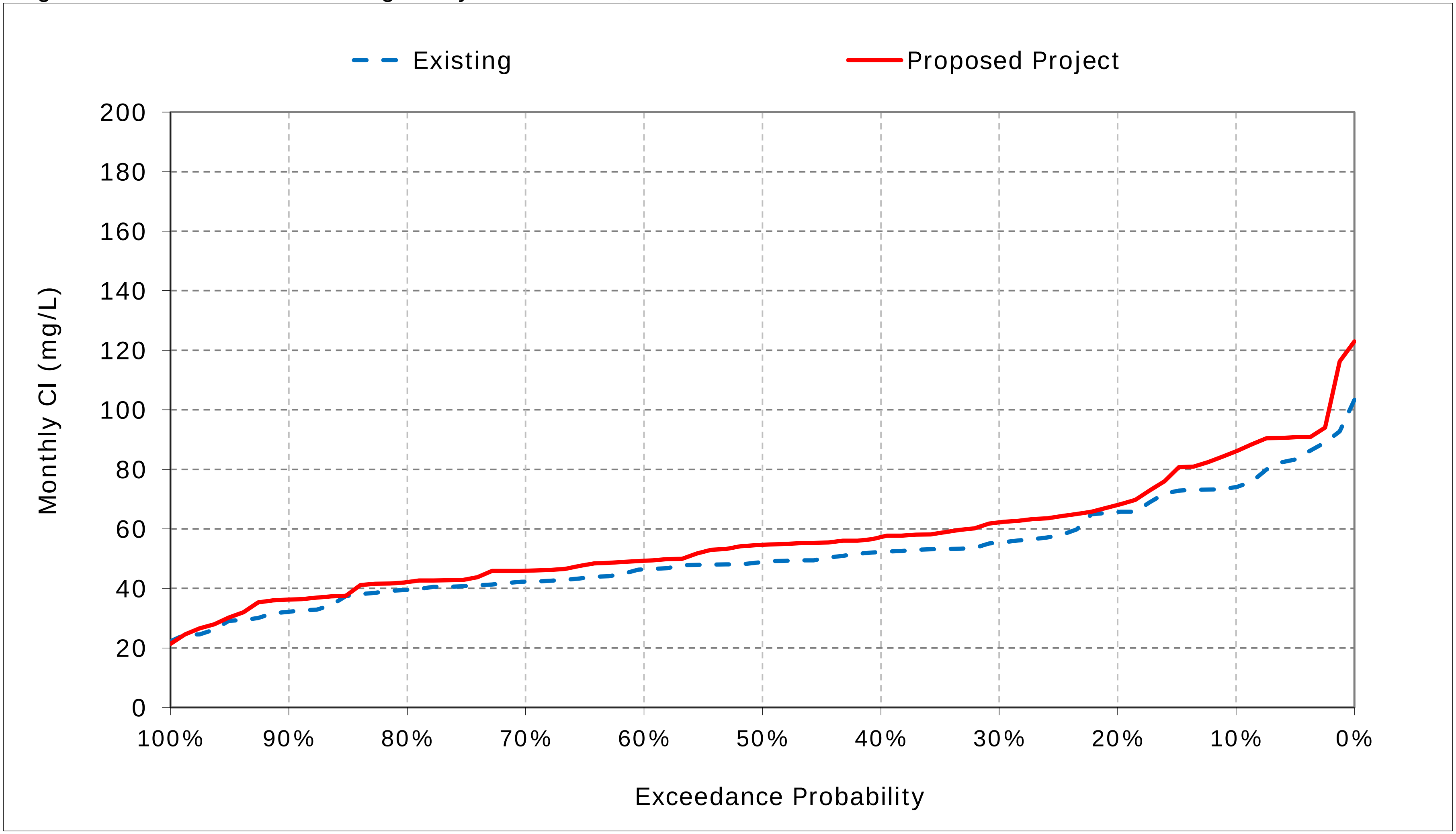


Figure 7-10. Old River at Highway 4 Chloride, April Cl

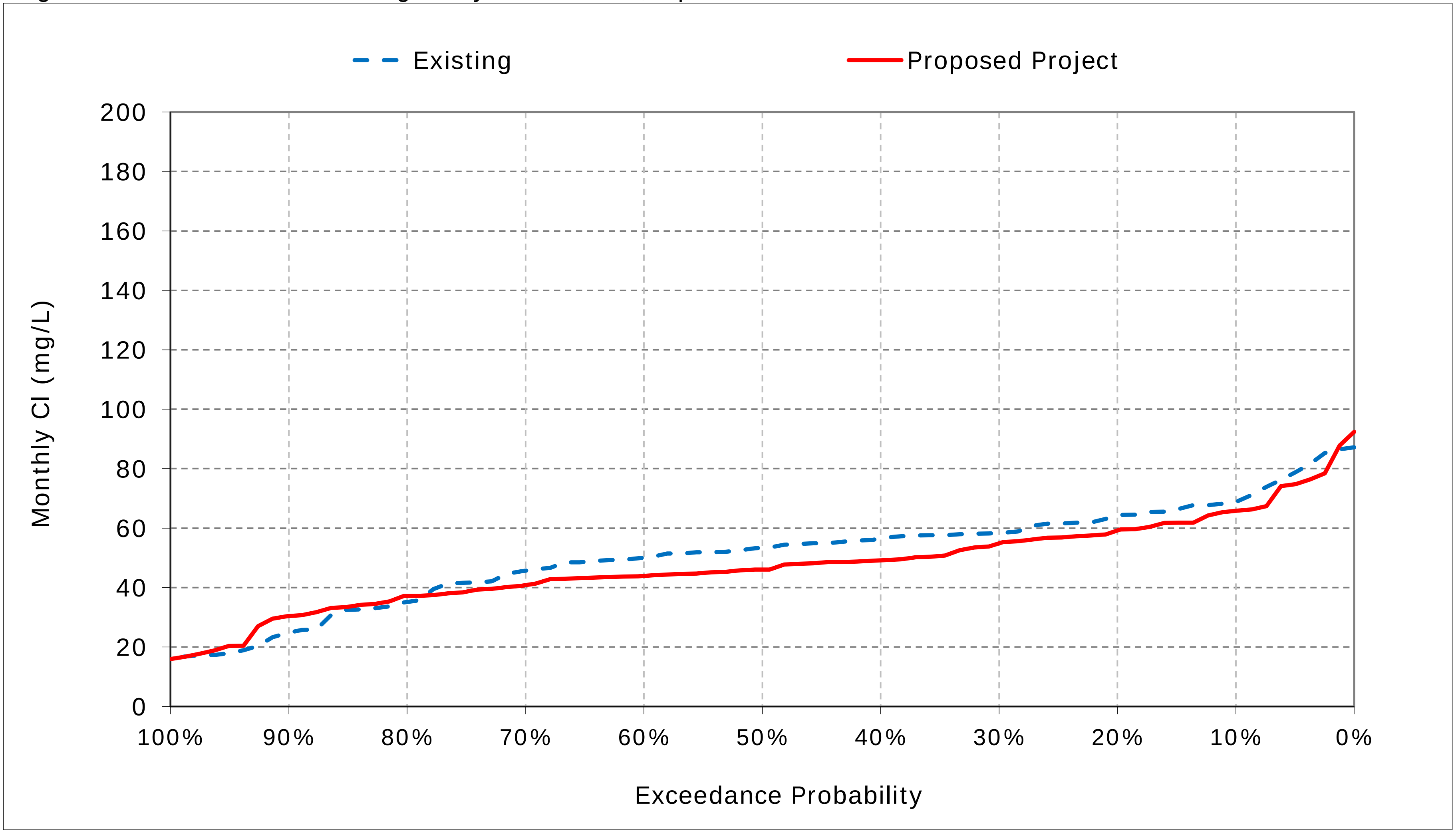


Figure 7-11. Old River at Highway 4 Chloride, May Cl

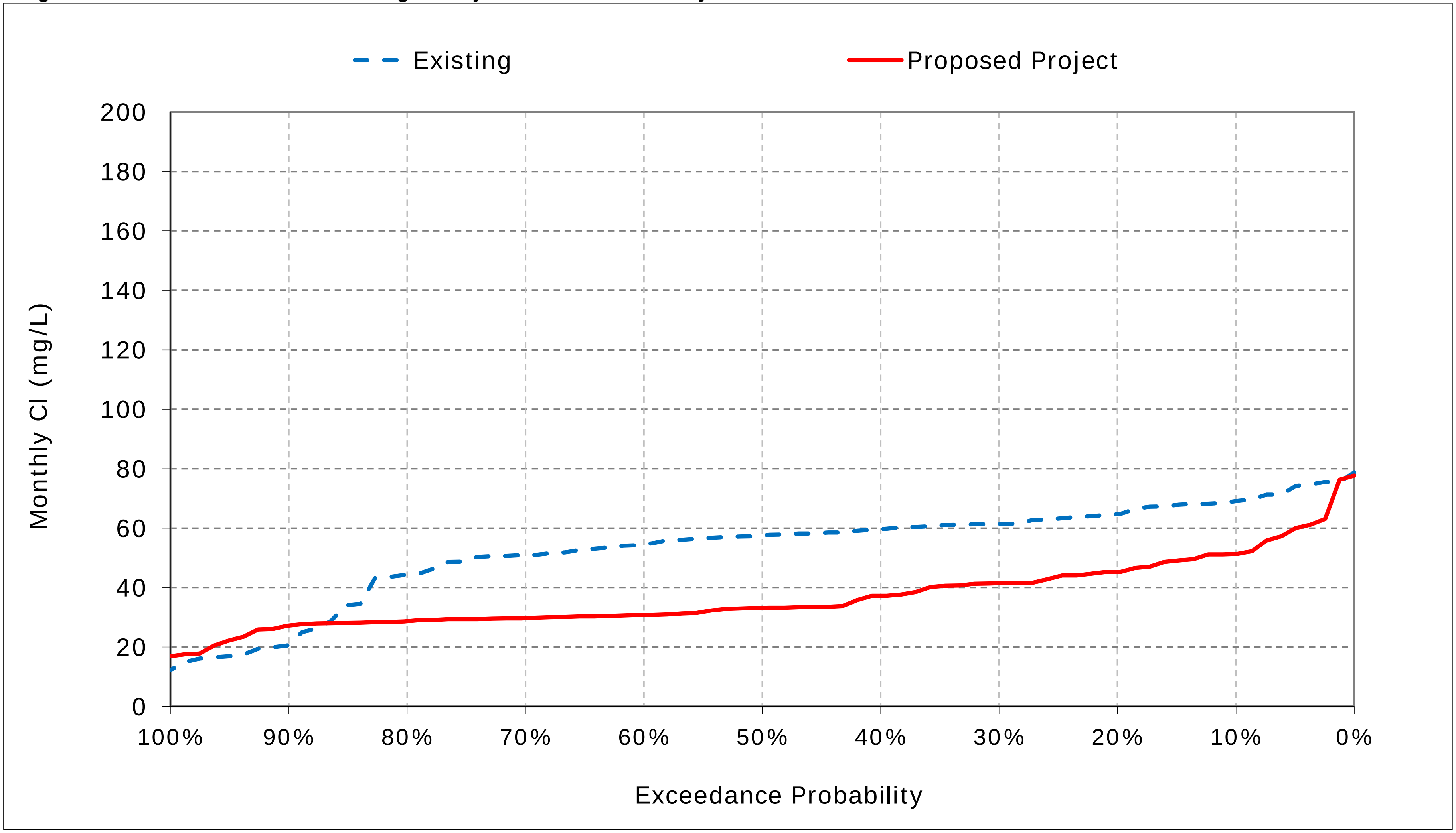


Figure 7-12. Old River at Highway 4 Chloride, June Cl

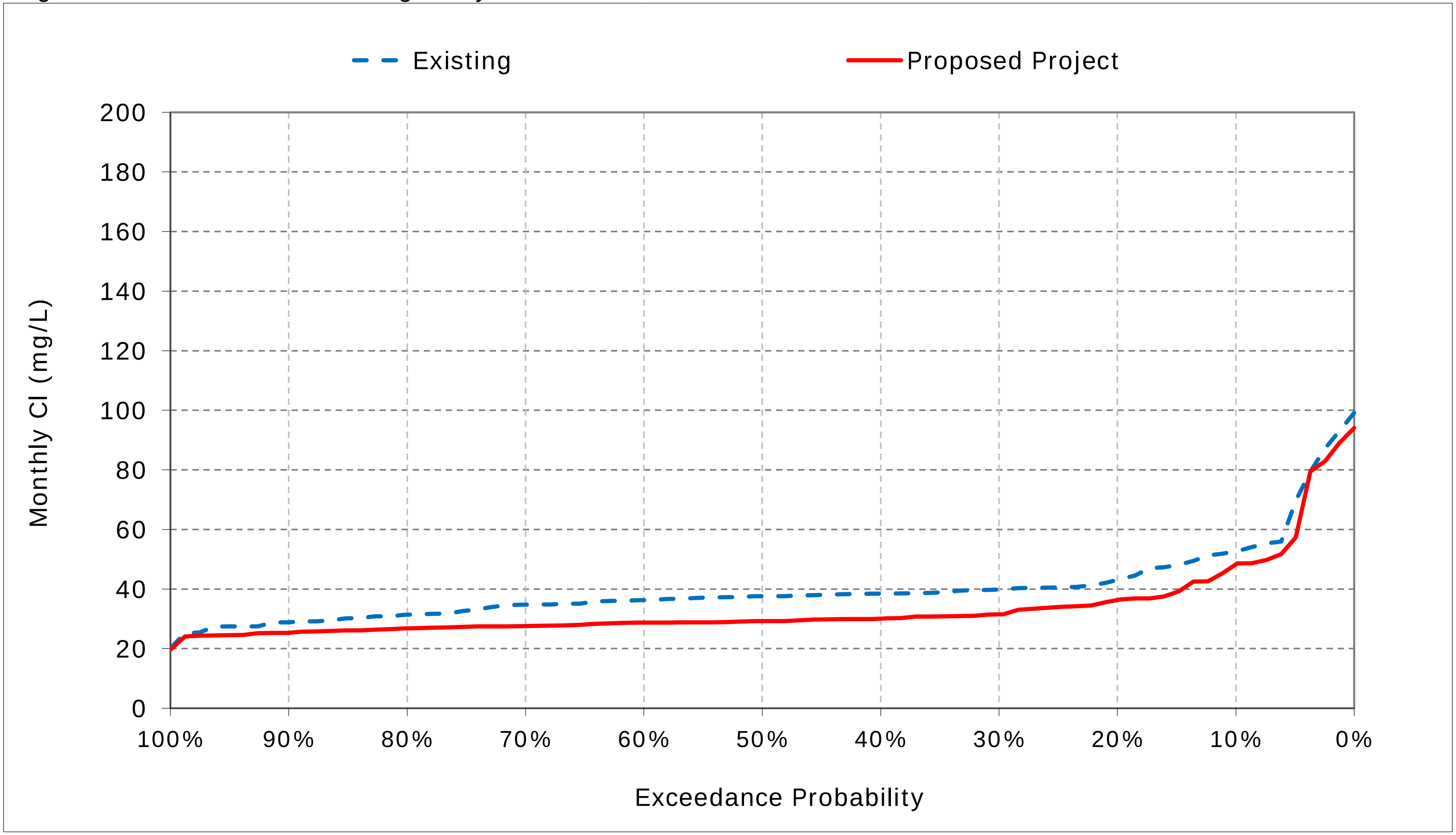


Figure 7-13. Old River at Highway 4 Chloride, July Cl

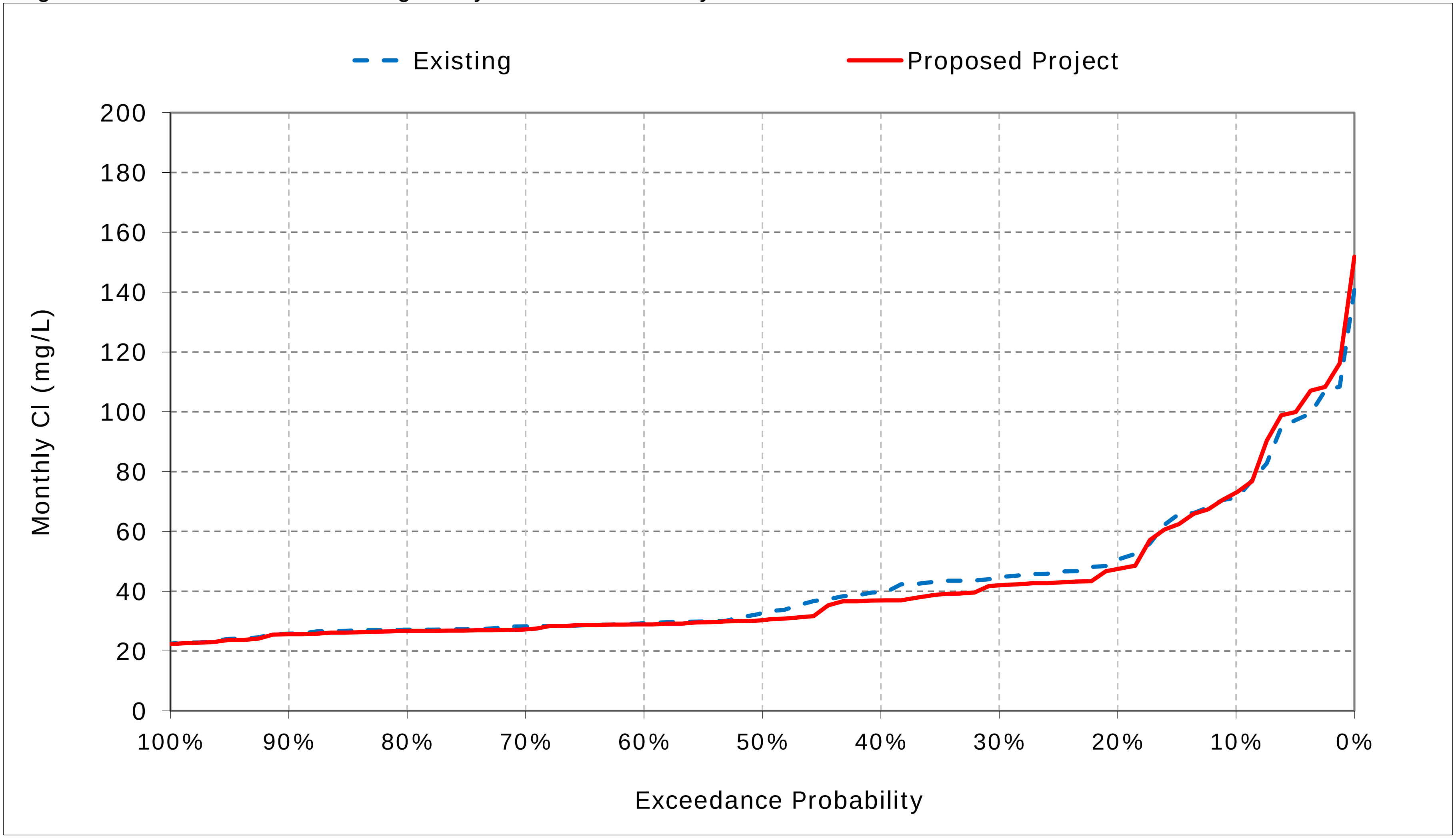


Figure 7-14. Old River at Highway 4 Chloride, August Cl

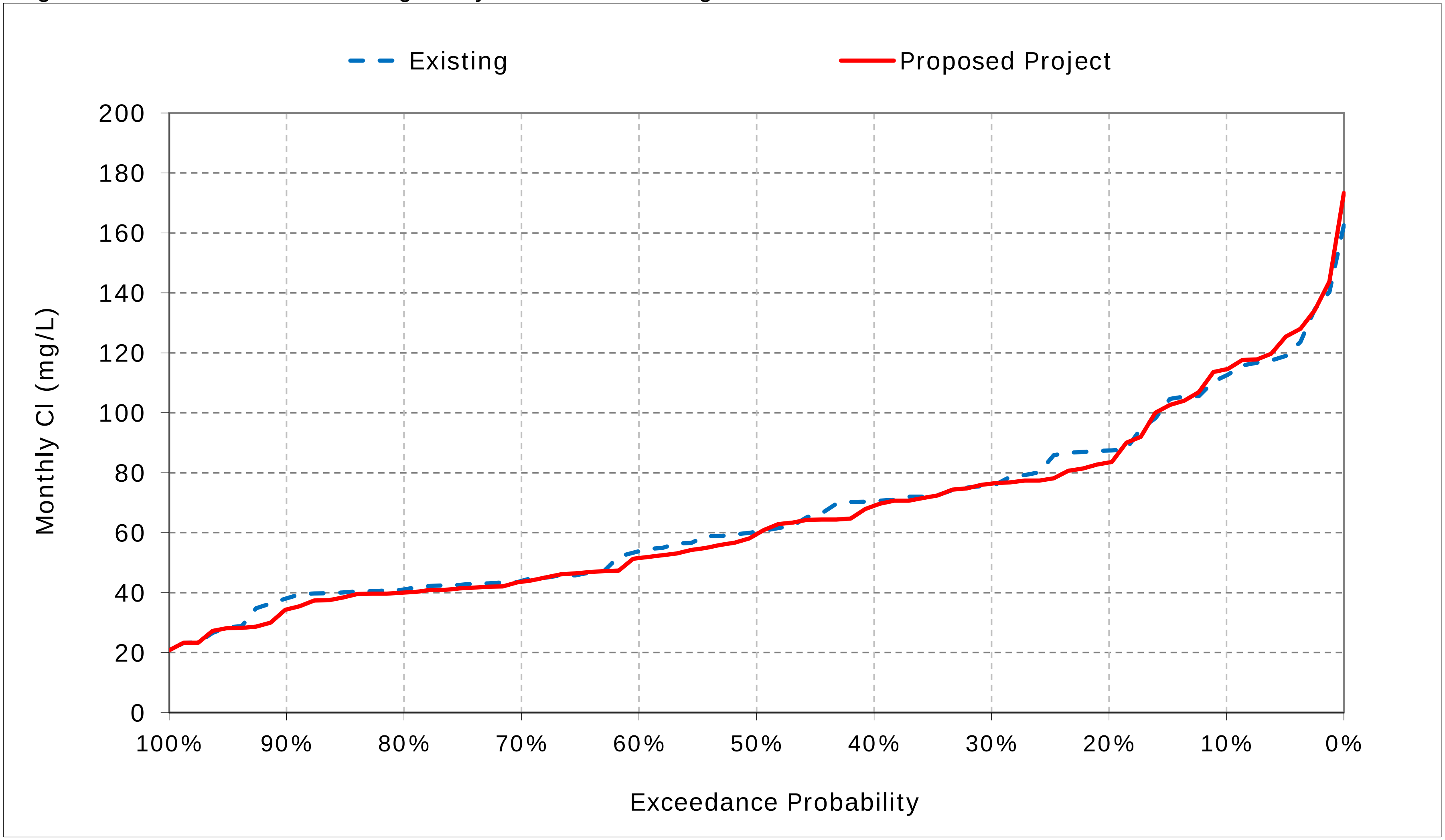


Figure 7-15. Old River at Highway 4 Chloride, September Cl

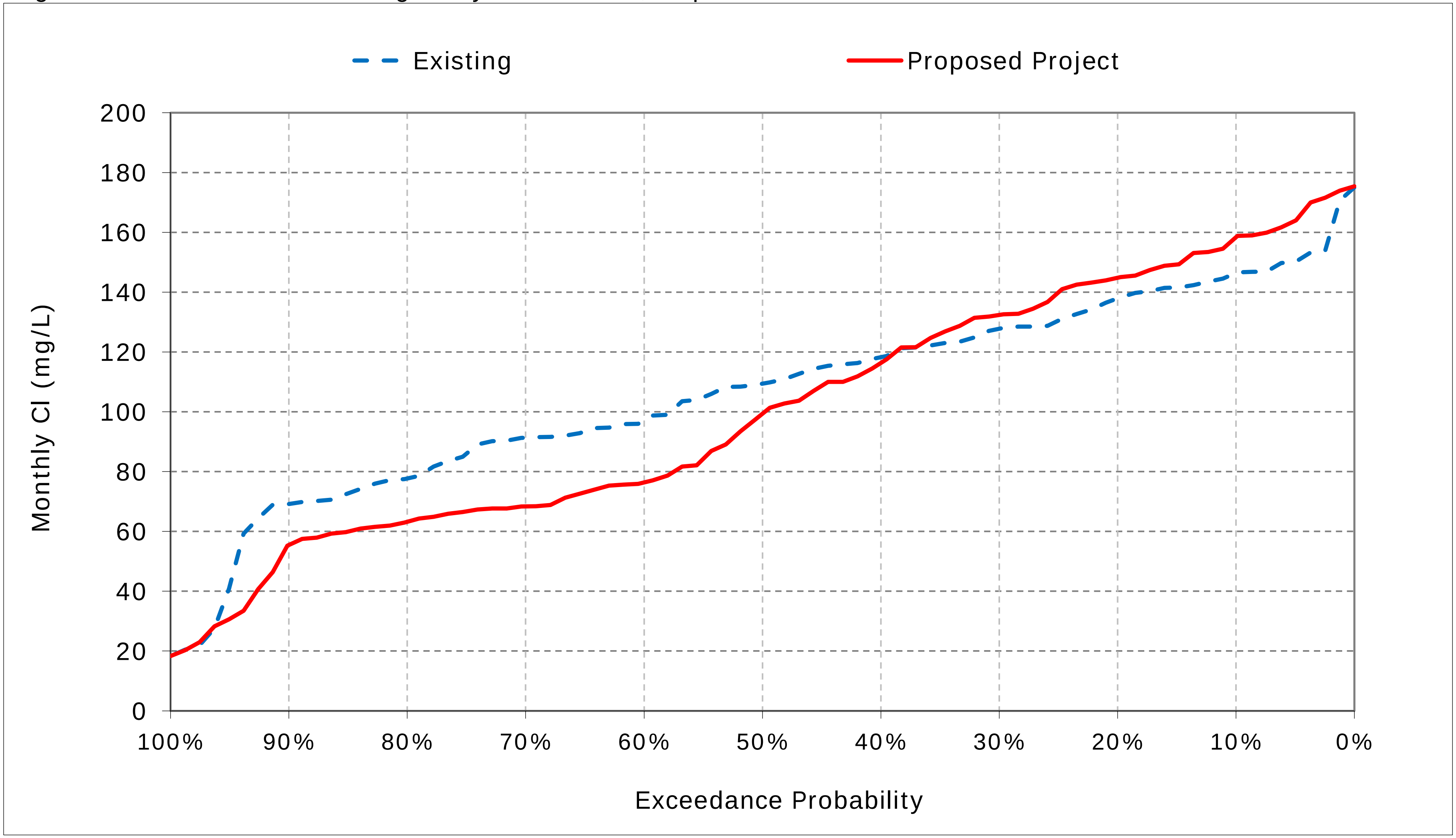


Figure 7-16. Old River at Highway 4 Chloride, October Cl

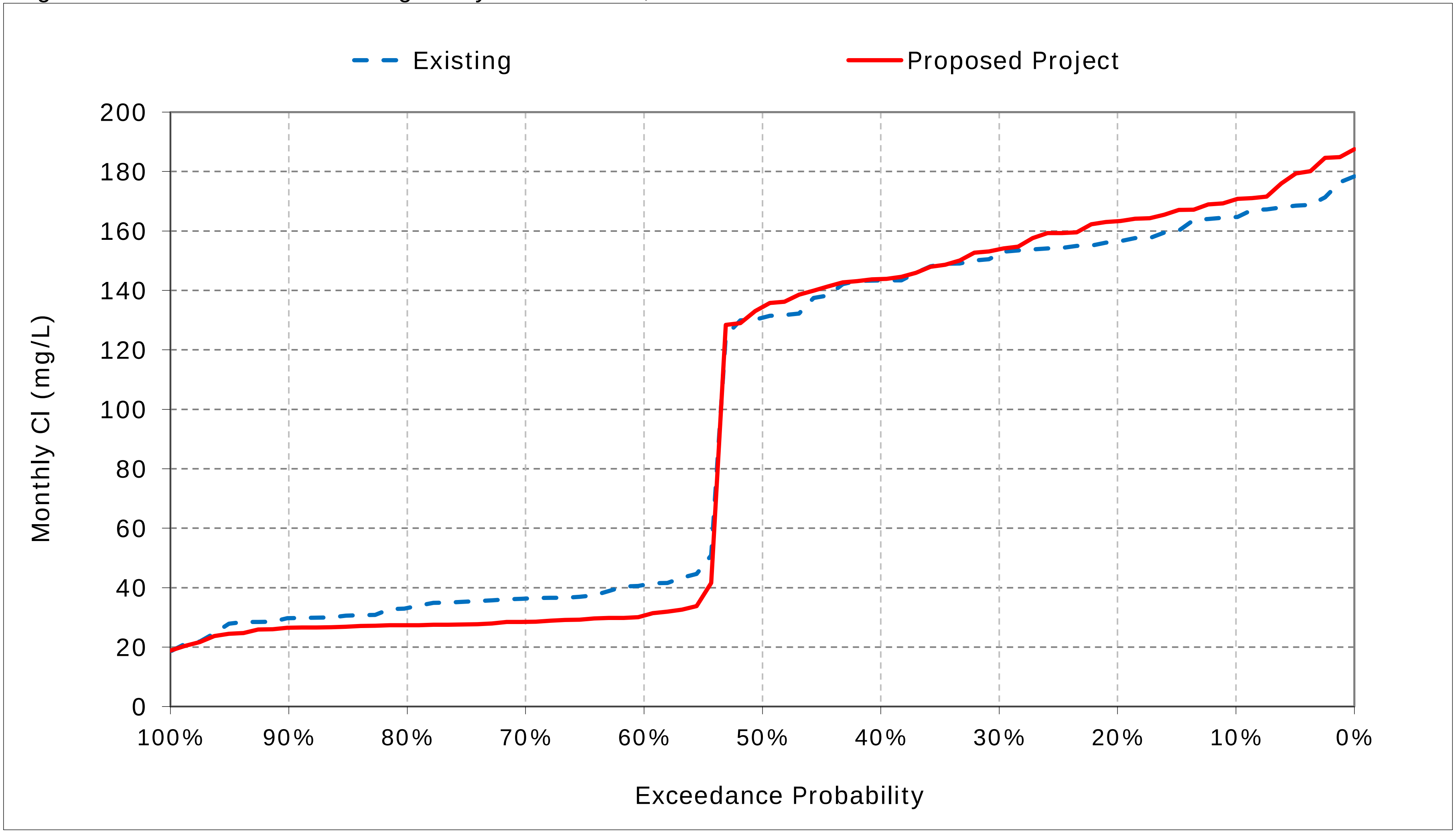


Figure 7-17. Old River at Highway 4 Chloride, November Cl

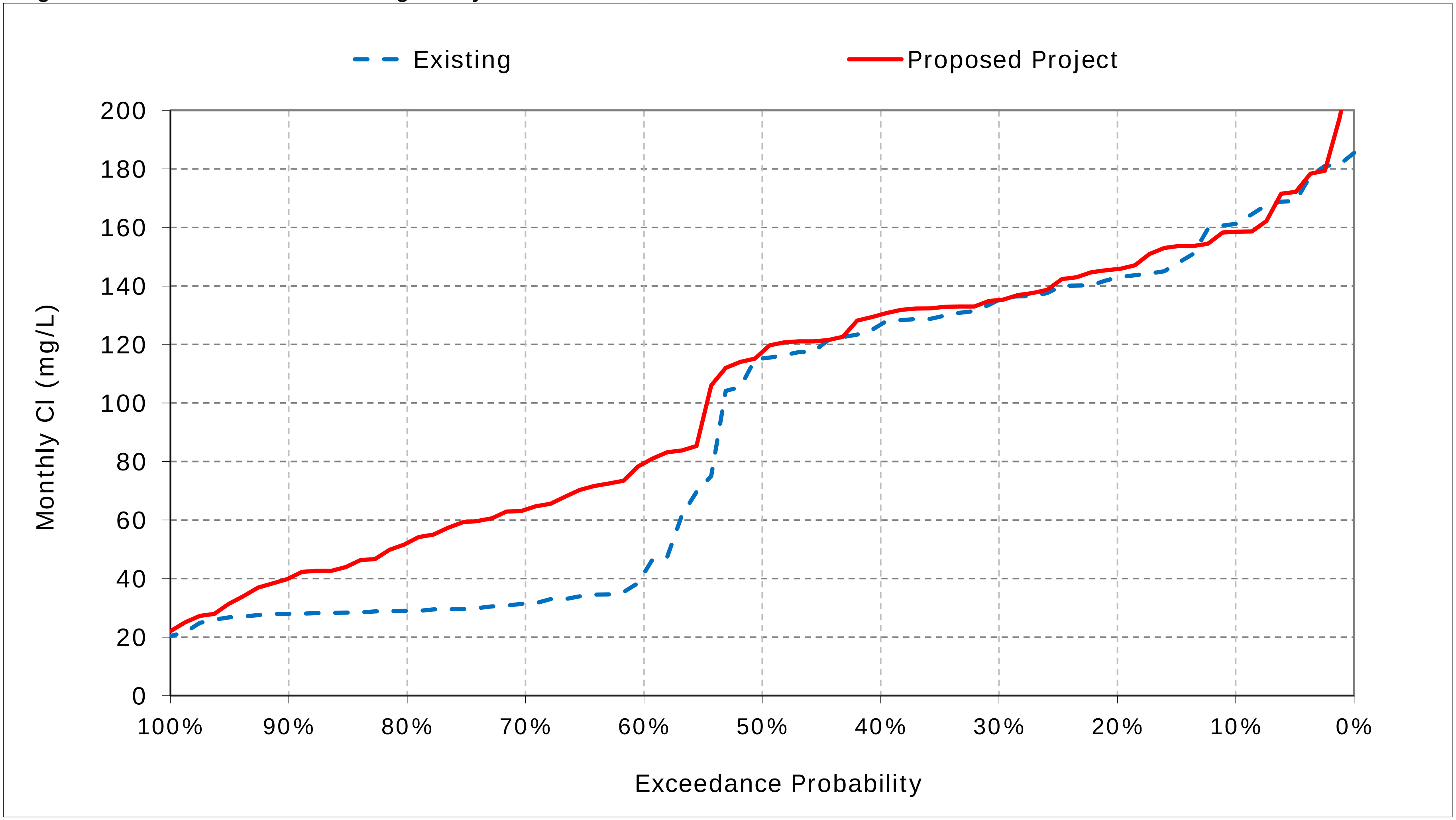


Figure 7-18. Old River at Highway 4 Chloride, December Cl

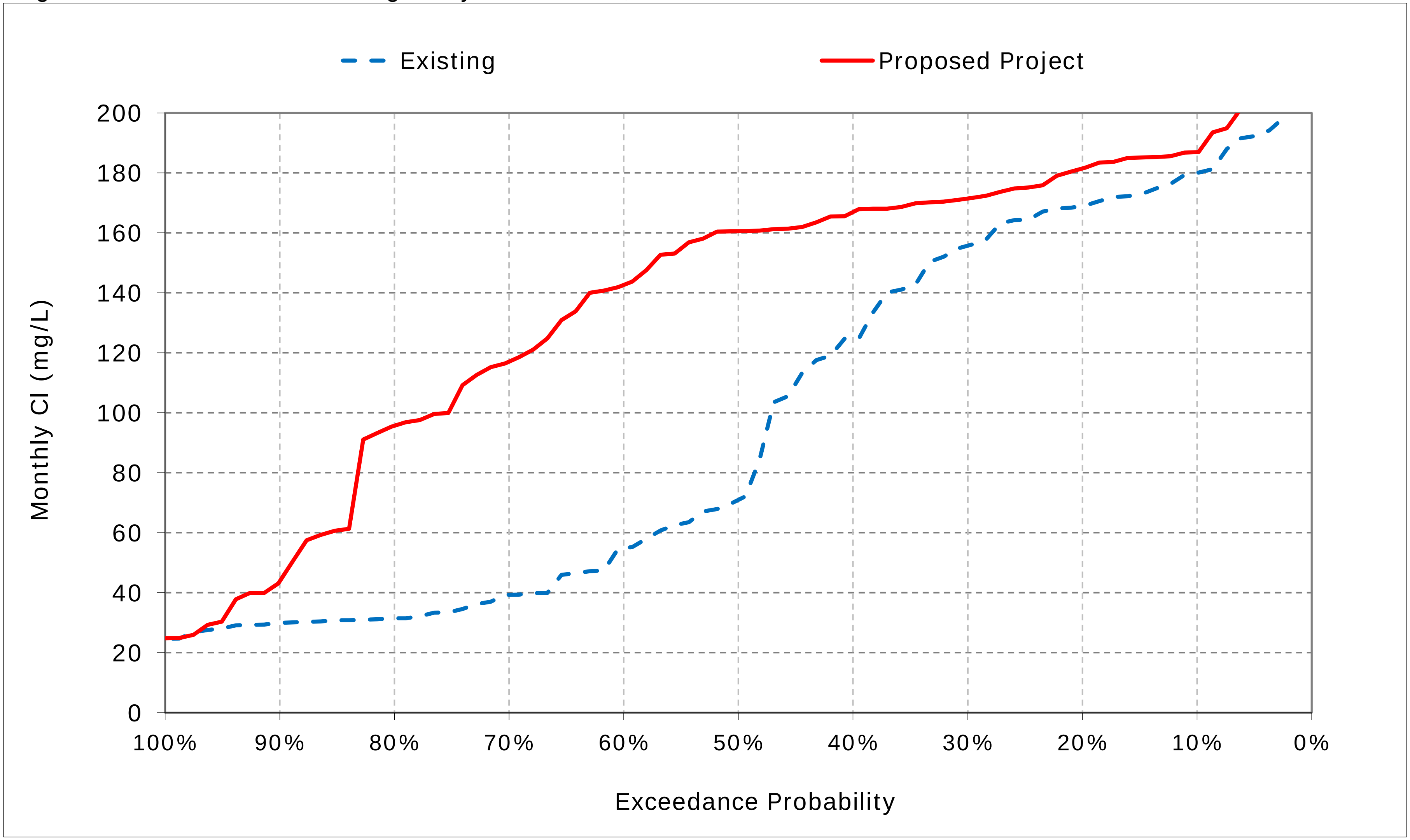


Table 8-1. Victoria Canal Chloride, Monthly Cl

Existing

	Monthly Cl (mg/L)											
Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	96	100	117	141	127	102	91	84	71	55	72	80
20%	90	88	108	134	114	92	84	79	60	51	58	77
30%	86	83	103	116	107	87	78	75	57	43	50	75
40%	83	79	96	108	103	82	72	70	55	38	44	72
50%	77	73	74	100	93	76	67	61	53	35	38	67
60%	55	52	57	93	87	70	55	57	52	32	36	62
70%	51	49	46	87	84	63	45	52	49	30	33	60
80%	45	47	41	78	73	49	36	43	46	29	31	51
90%	41	44	34	72	55	42	25	20	42	27	28	46
Long Term												
Full Simulation Period[a]	69	68	76	104	93	74	61	60	54	39	45	65
Water Year Types[b]												
Wet (32%)	61	58	64	86	72	54	37	38	45	38	32	57
Above Normal (15%)	76	73	75	105	101	72	57	56	53	36	31	48
Below Normal (17%)	70	68	80	113	96	77	65	63	53	31	41	71
Dry (22%)	70	71	82	106	102	89	82	75	57	36	58	69
Critical (15%)	78	82	92	129	112	90	84	83	73	61	68	82

Proposed Project

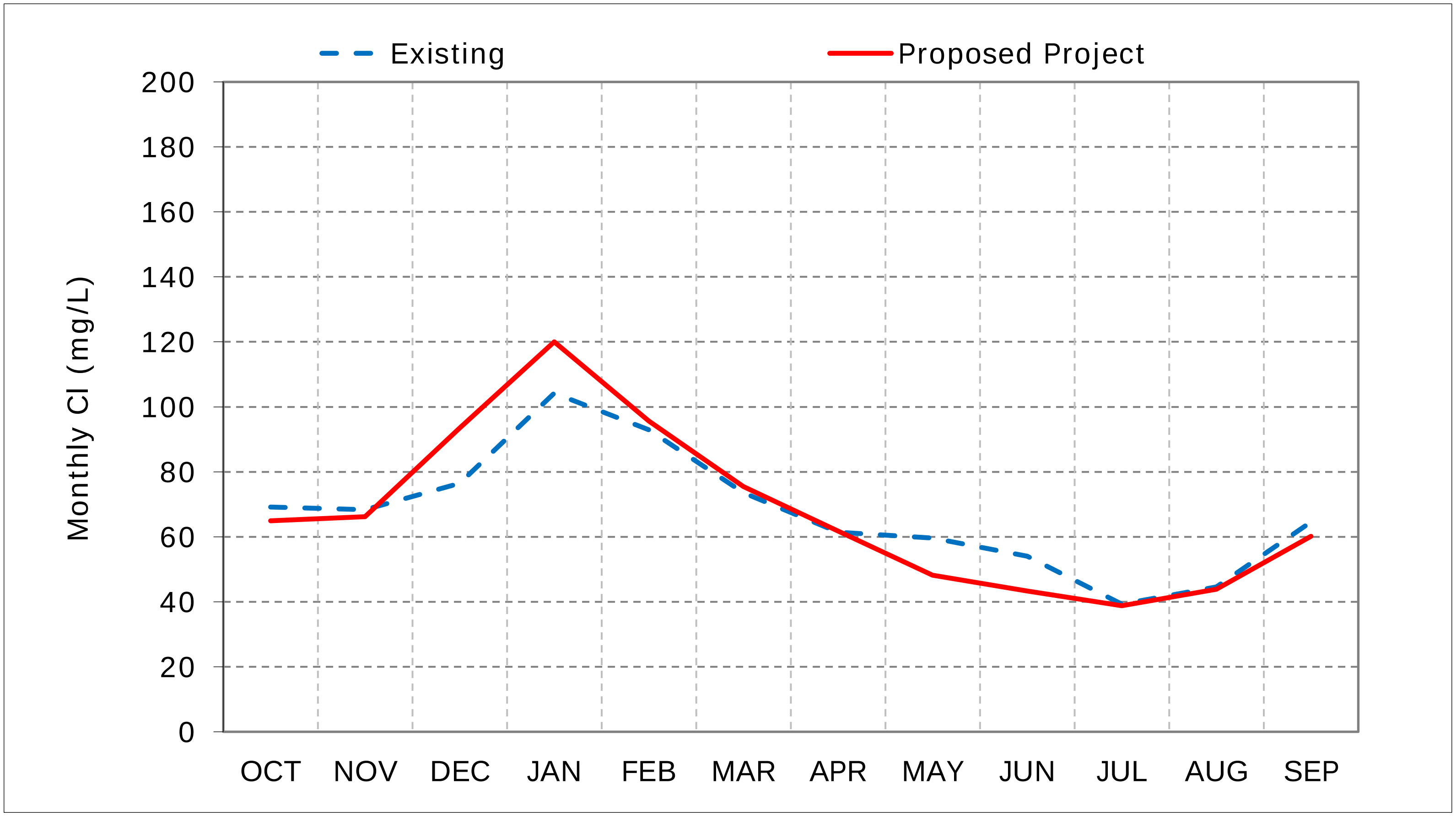
	Monthly Cl (mg/L)											
Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	100	99	126	170	137	106	88	67	54	56	71	82
20%	92	93	113	155	124	95	82	61	50	51	53	79
30%	88	84	107	142	111	89	76	57	46	43	48	74
40%	84	78	105	134	102	84	71	51	44	38	43	69
50%	80	74	98	116	96	77	66	48	42	34	37	62
60%	38	46	93	108	88	71	58	46	40	31	35	50
70%	36	43	84	97	83	59	49	43	38	29	33	46
80%	34	39	71	87	76	52	41	40	36	27	31	44
90%	32	37	52	74	56	43	32	26	33	26	29	39
Long Term												
Full Simulation Period[a]	65	66	93	120	96	75	62	48	43	39	44	60
Water Year Types[b]												
Wet (32%)	55	56	78	91	72	55	41	34	40	37	31	40
Above Normal (15%)	71	75	103	135	106	74	56	44	42	34	31	47
Below Normal (17%)	65	64	94	130	97	79	69	49	40	30	40	76
Dry (22%)	66	69	99	130	107	93	82	59	42	35	56	69
Critical (15%)	79	78	108	142	118	91	75	67	59	61	69	84

Proposed Project minus Existing

	Monthly Cl (mg/L)											
Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	5	-2	10	28	10	4	-4	-17	-17	1	0	2
20%	2	5	5	21	10	3	-2	-18	-10	0	-4	2
30%	2	1	4	26	5	2	-2	-18	-11	0	-2	-2
40%	1	-1	8	26	-1	2	-1	-19	-11	-1	-2	-2
50%	3	1	24	16	2	1	-1	-13	-12	-1	-1	-6
60%	-17	-6	35	15	1	1	3	-11	-12	-1	0	-12
70%	-15	-6	38	10	-1	-3	4	-9	-11	-1	-1	-14
80%	-11	-8	31	9	3	3	5	-3	-10	-2	0	-7
90%	-9	-7	18	2	0	1	8	6	-9	-1	0	-7
Long Term												
Full Simulation Period[a]	-4	-2	17	16	3	2	0	-11	-11	0	-1	-4
Water Year Types[b]												
Wet (32%)	-6	-3	14	5	0	1	3	-4	-5	0	-1	-17
Above Normal (15%)	-4	2	27	30	5	2	-1	-12	-11	-1	0	-1
Below Normal (17%)	-5	-4	14	17	0	2	4	-14	-13	-1	-1	5
Dry (22%)	-4	-2	17	24	5	3	0	-16	-15	0	-2	0
Critical (15%)	1	-4	16	13	6	1	-9	-16	-14	0	1	2

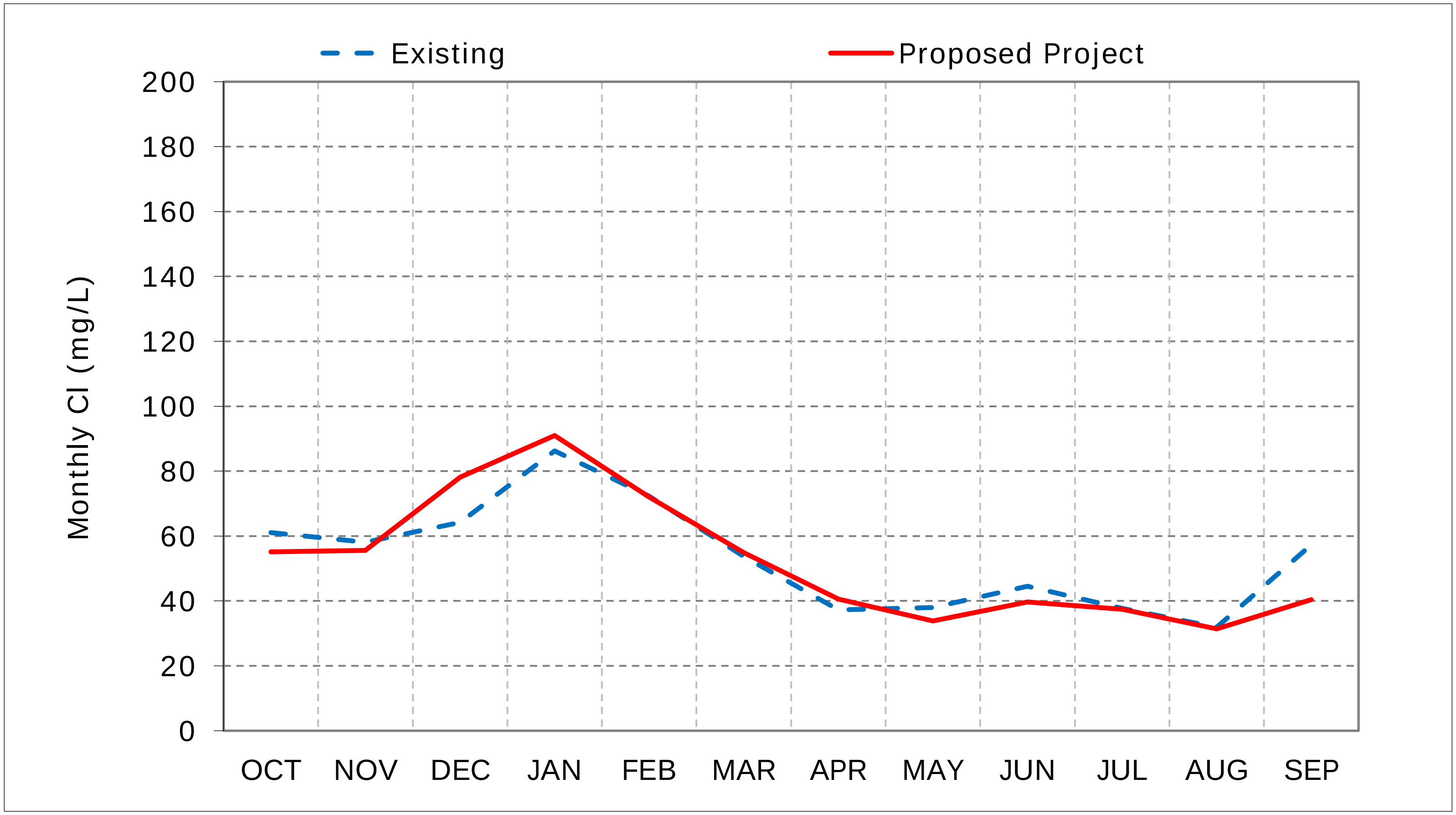
a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with water year - year type sorting.
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 8-1. Victoria Canal Chloride, Long-Term Average Cl



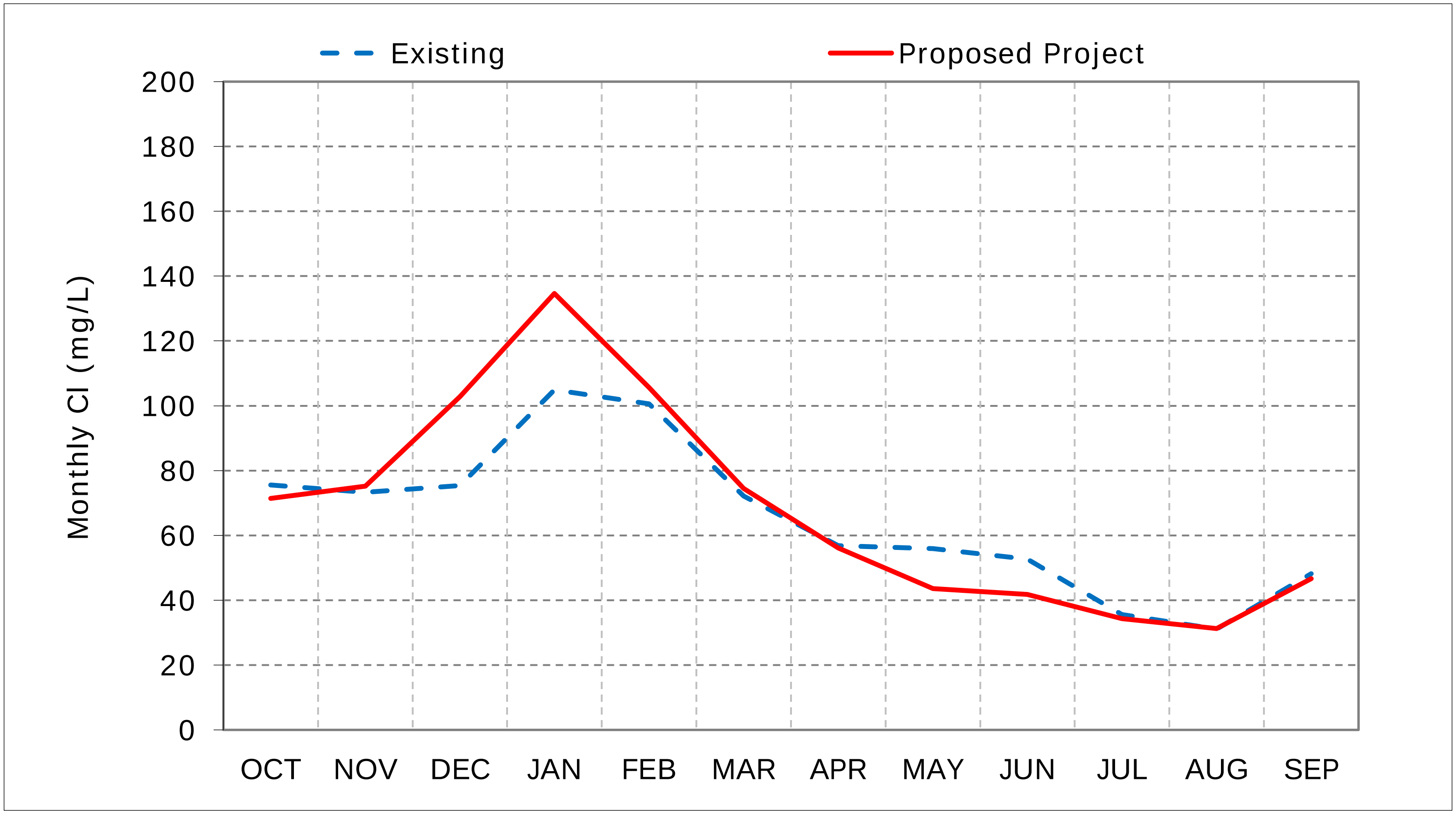
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 8-2. Victoria Canal Chloride, Wet Year Average Cl



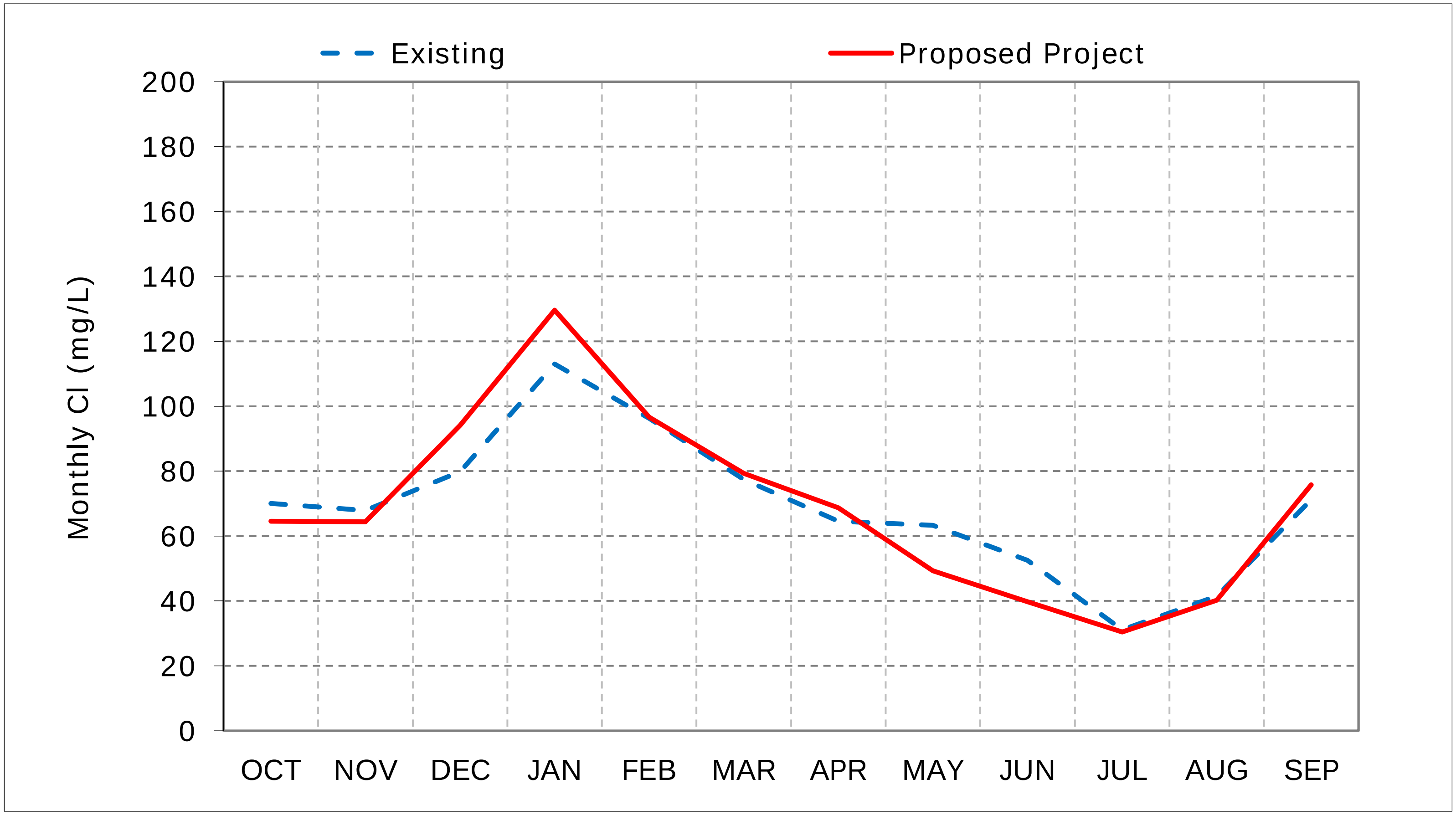
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 8-3. Victoria Canal Chloride, Above Normal Year Average Cl



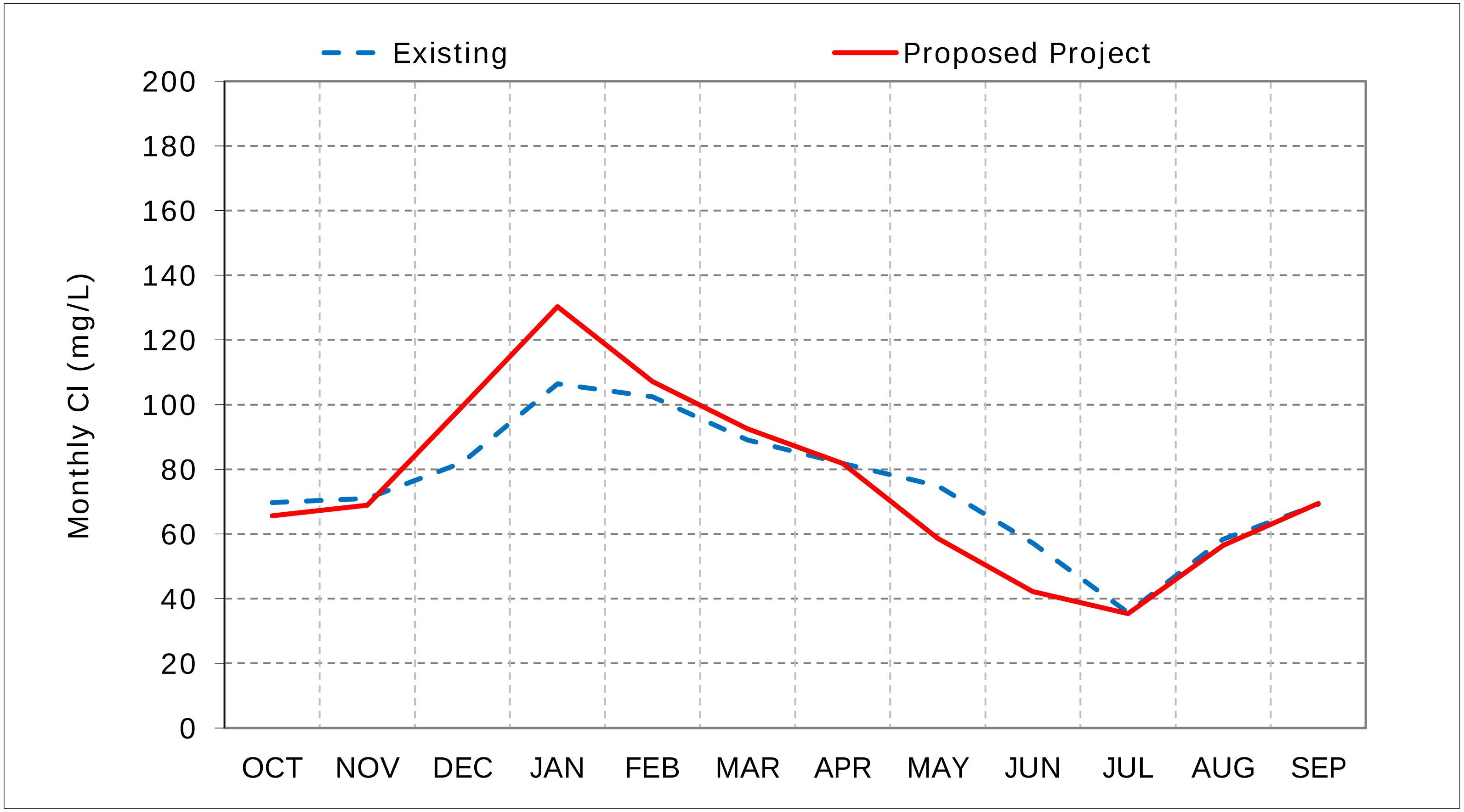
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 8-4. Victoria Canal Chloride, Below Normal Year Average Cl



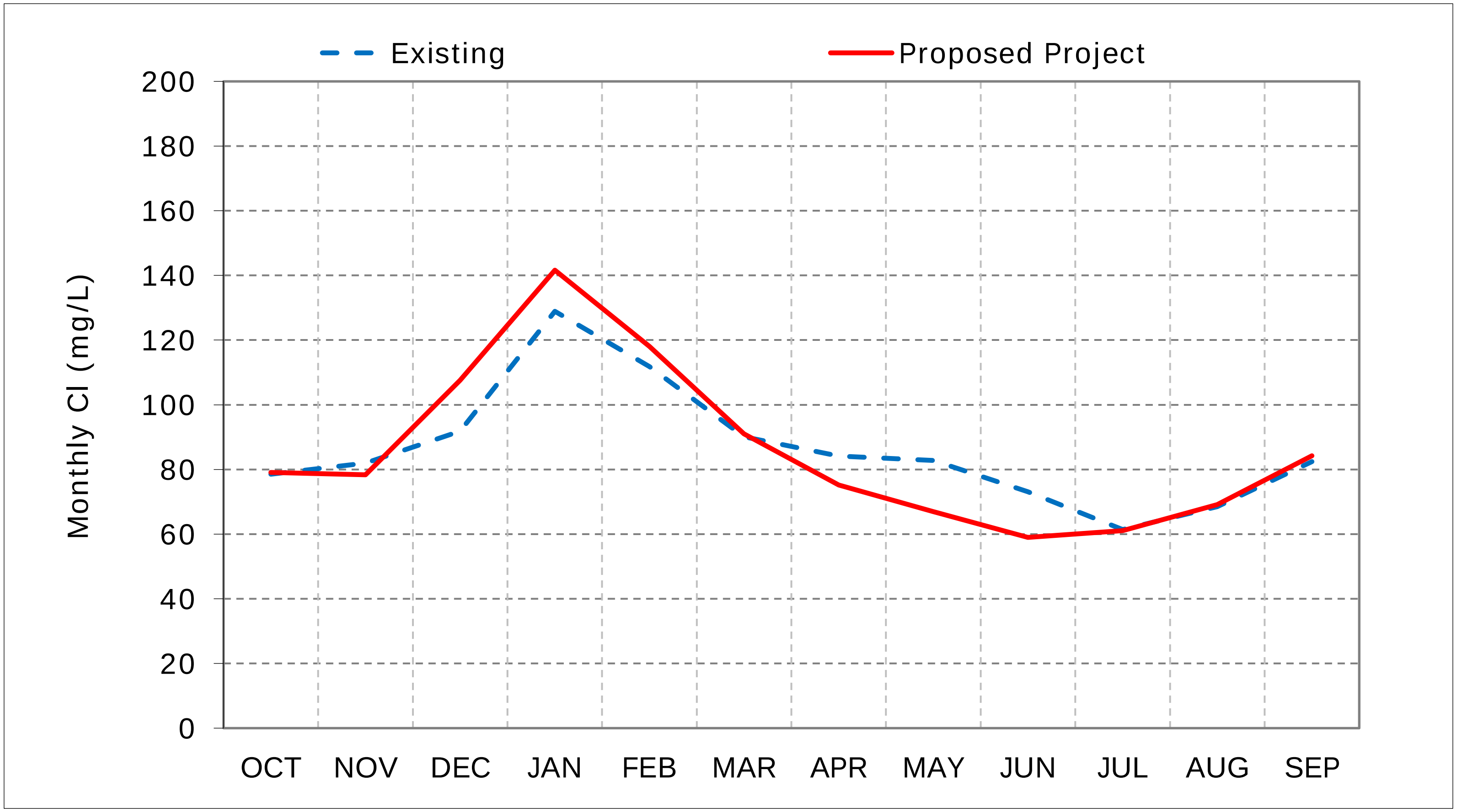
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 8-5. Victoria Canal Chloride, Dry Year Average Cl



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 8-6. Victoria Canal Chloride, Critical Year Average Cl



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 8-7. Victoria Canal Chloride, January Cl

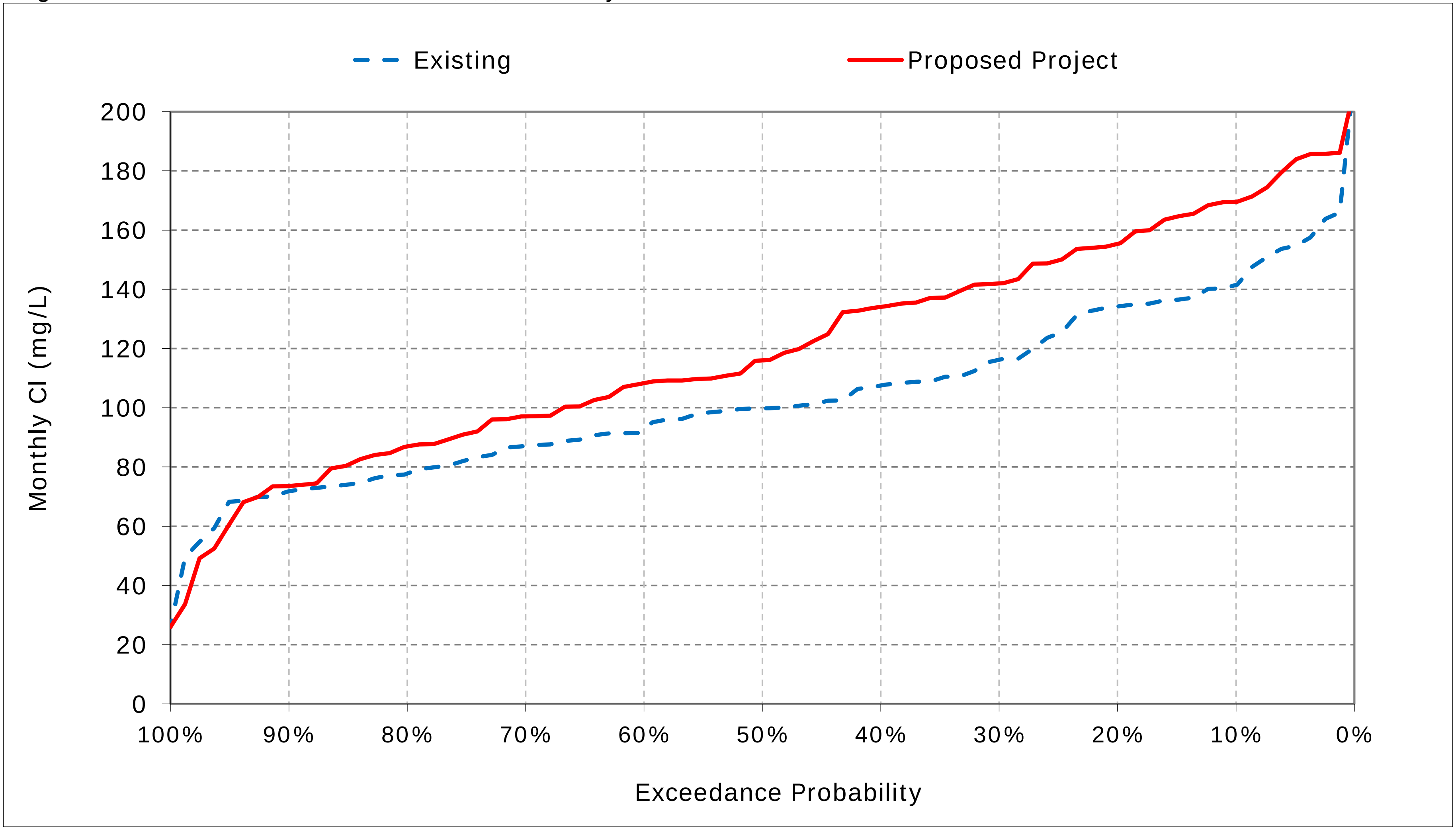


Figure 8-8. Victoria Canal Chloride, February Cl

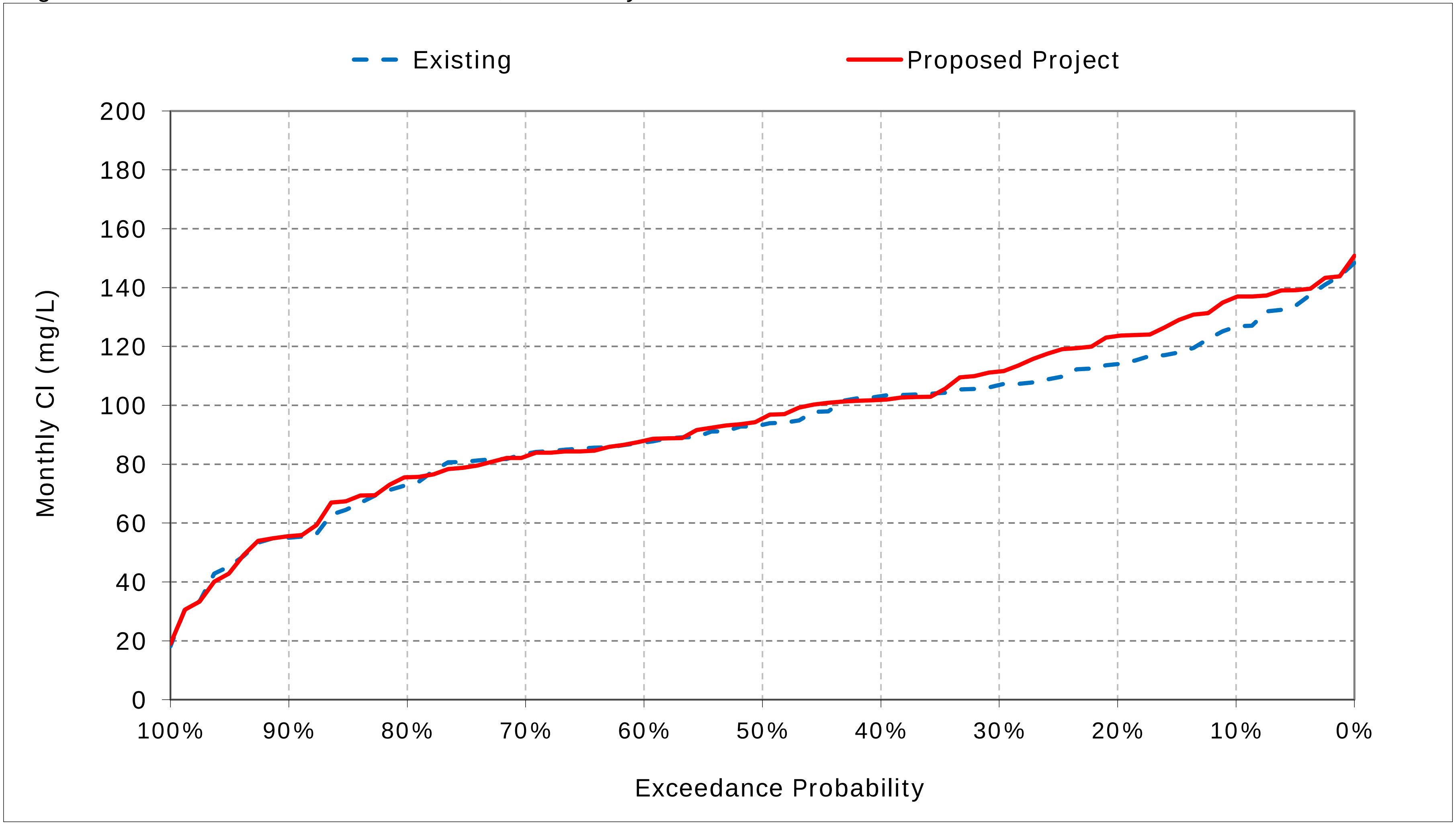


Figure 8-9. Victoria Canal Chloride, March Cl

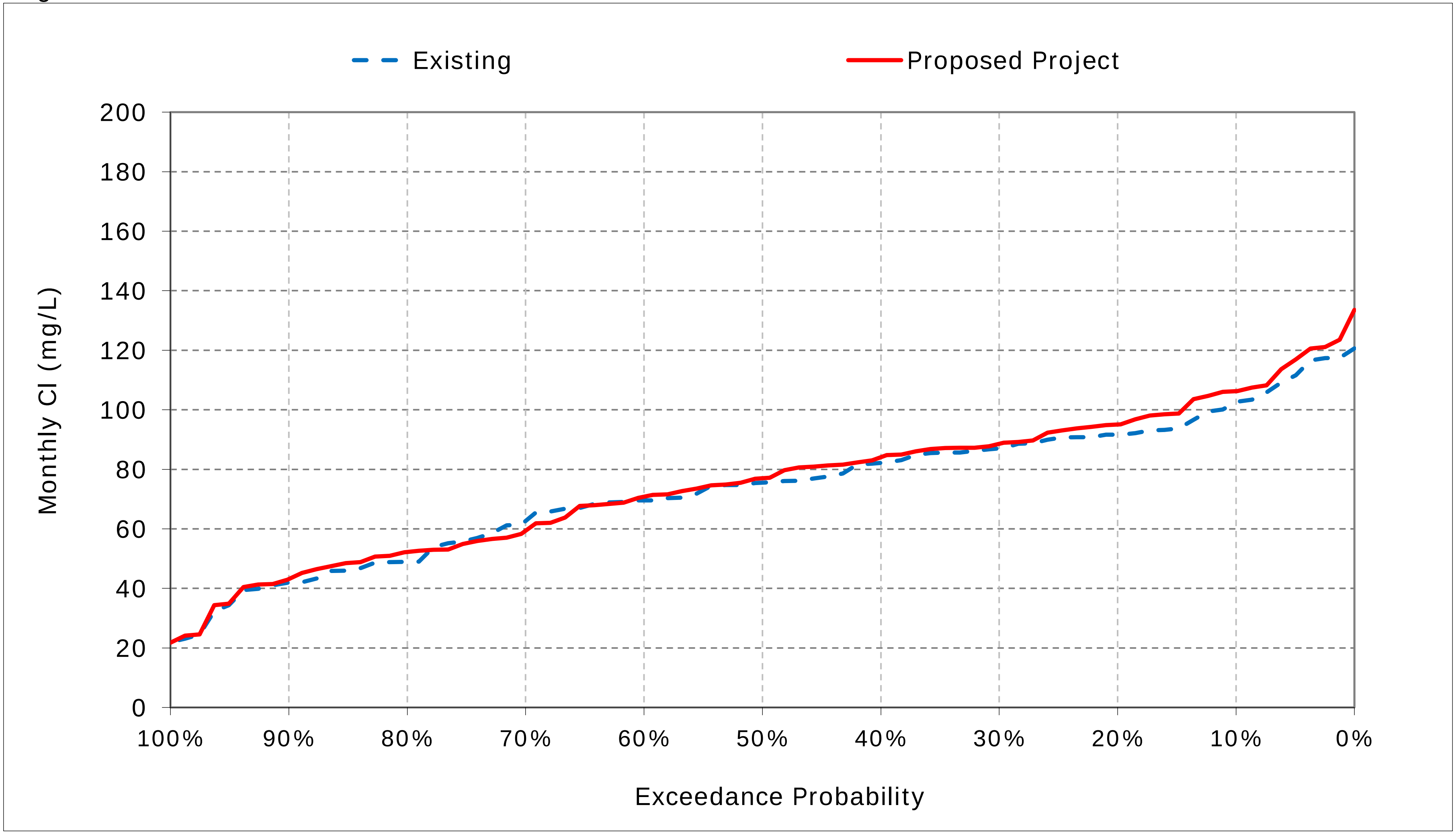


Figure 8-10. Victoria Canal Chloride, April Cl

Figure 8-11. Victoria Canal Chloride, May Cl

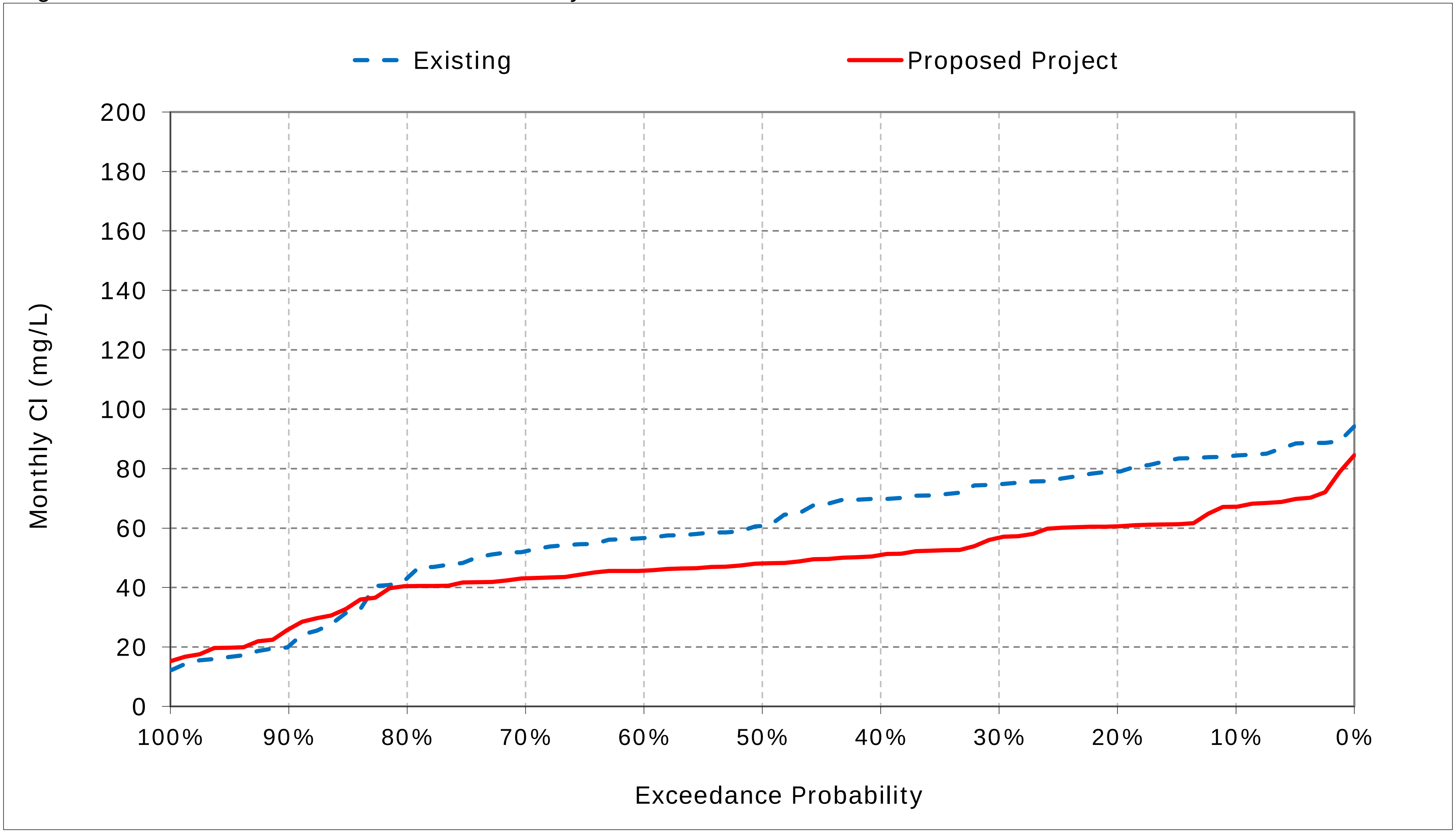


Figure 8-12. Victoria Canal Chloride, June Cl

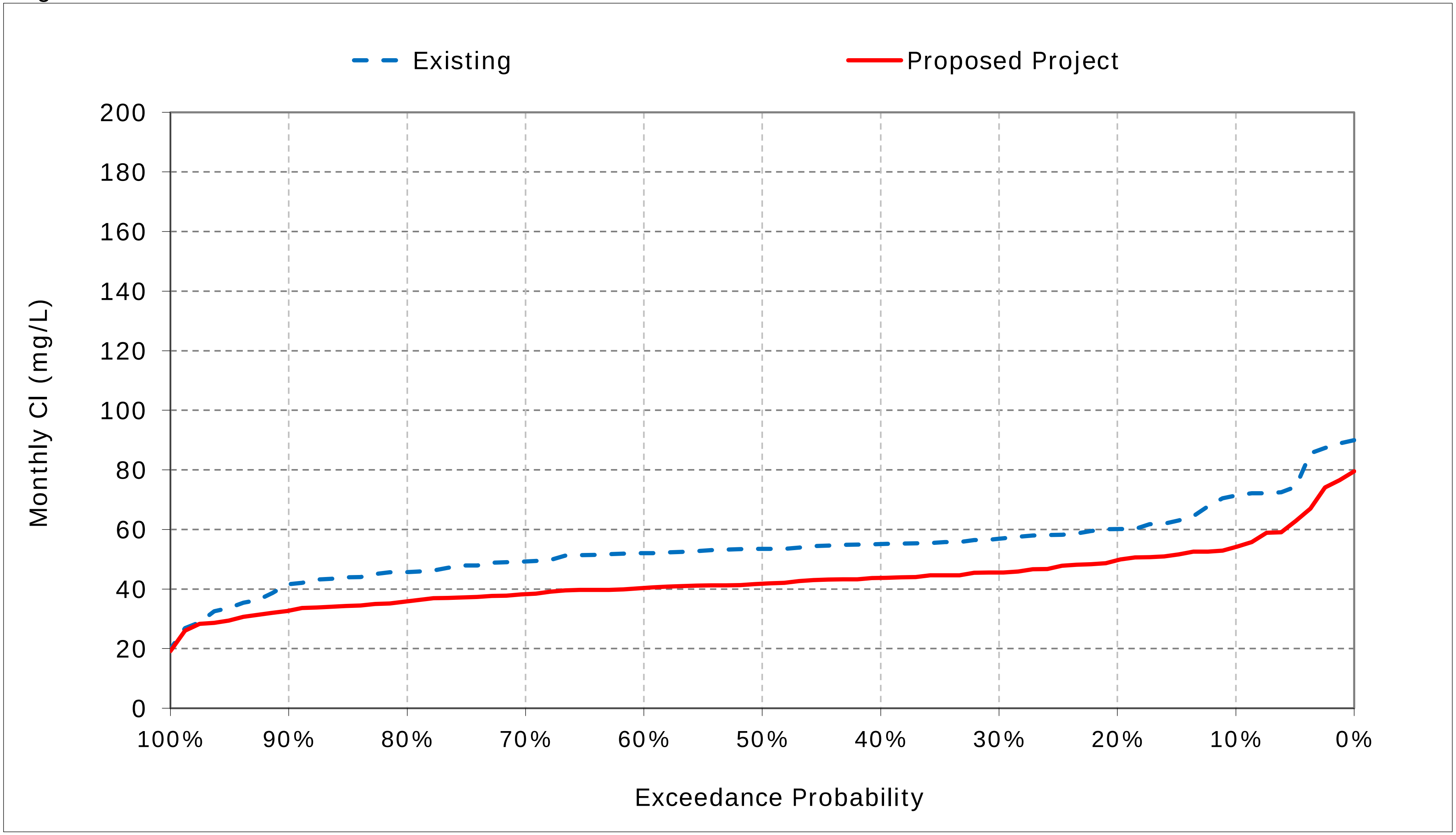


Figure 8-13. Victoria Canal Chloride, July Cl

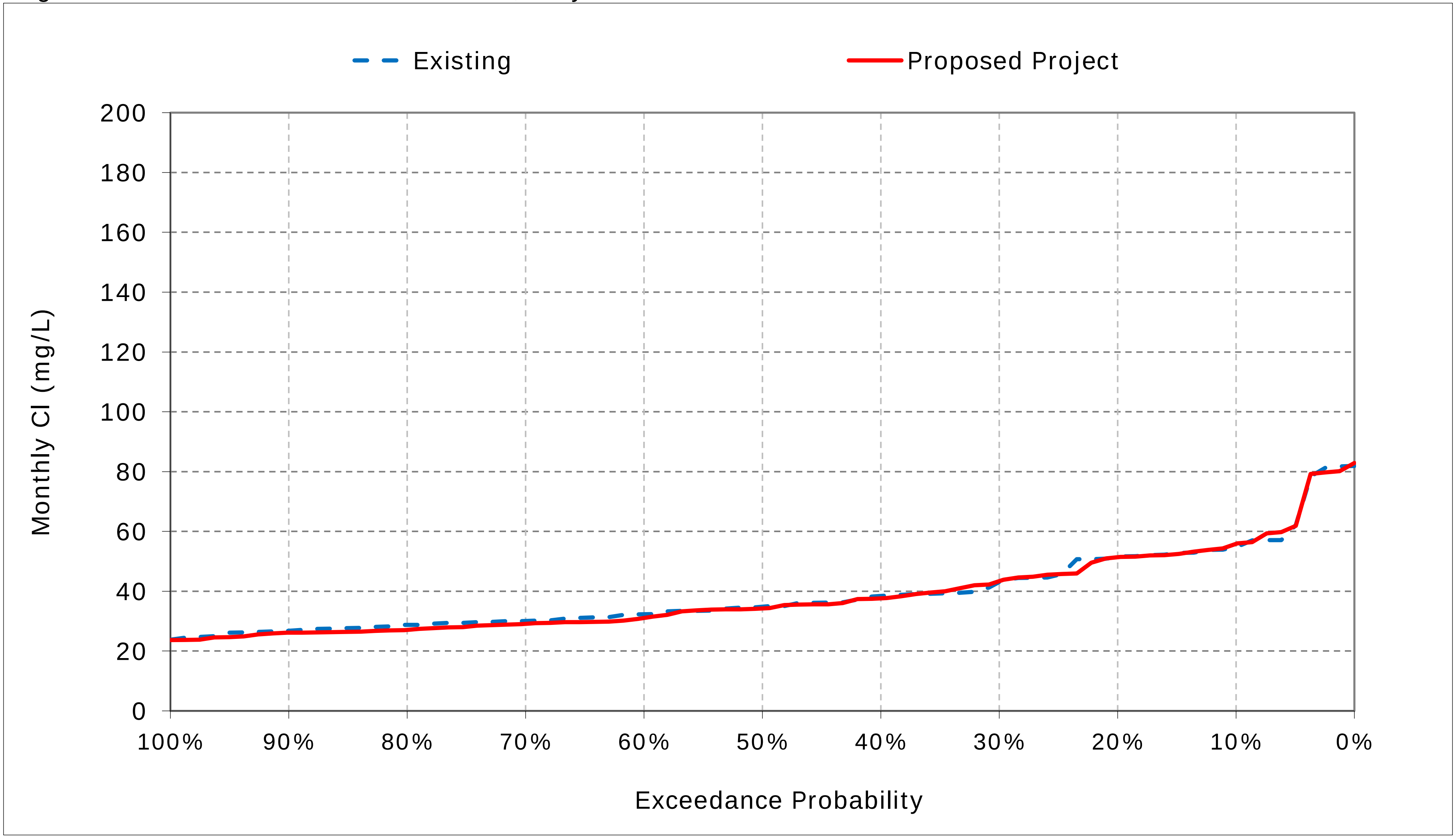


Figure 8-14. Victoria Canal Chloride, August Cl

Figure 8-15. Victoria Canal Chloride, September Cl

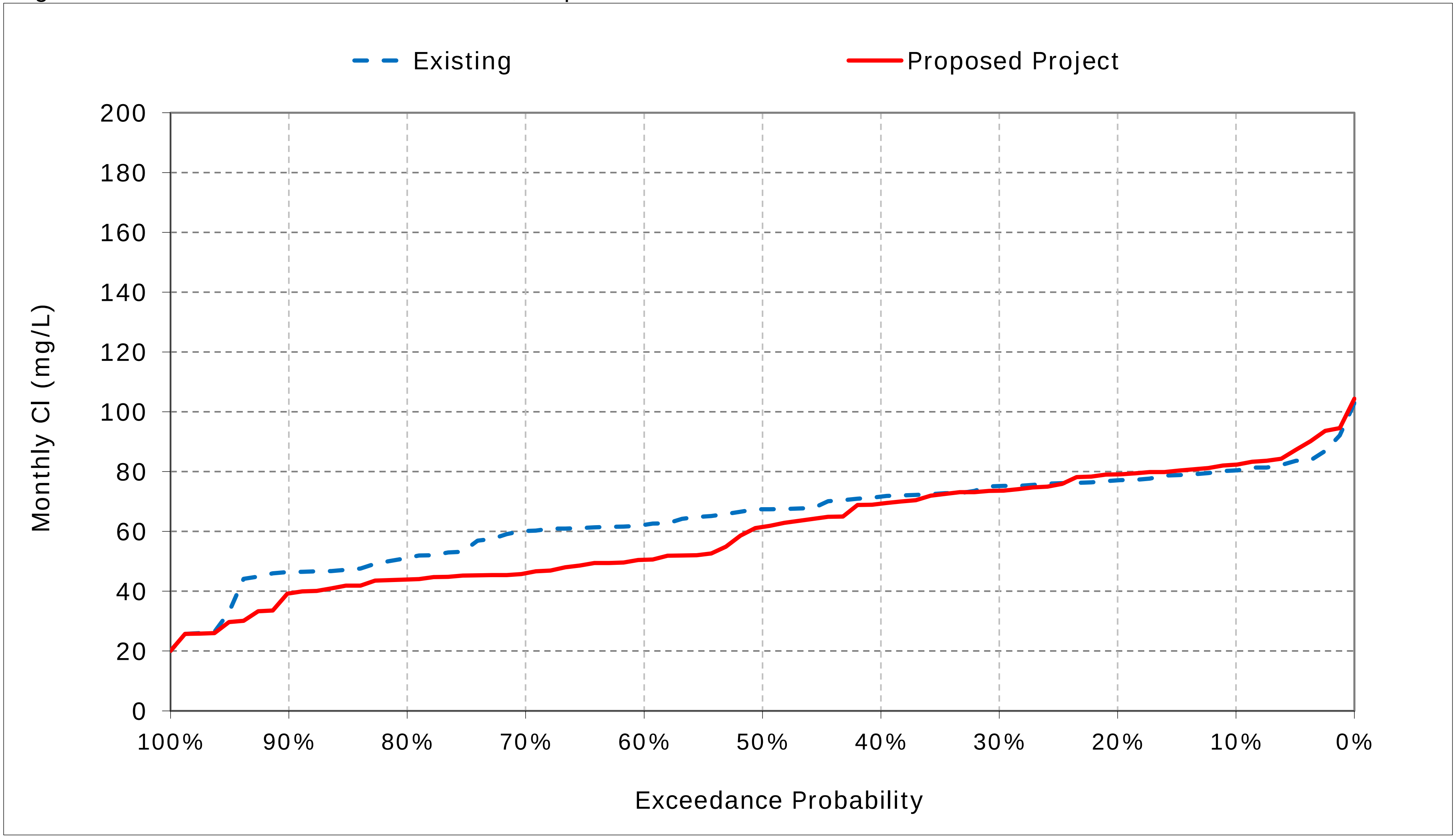


Figure 8-16. Victoria Canal Chloride, October Cl

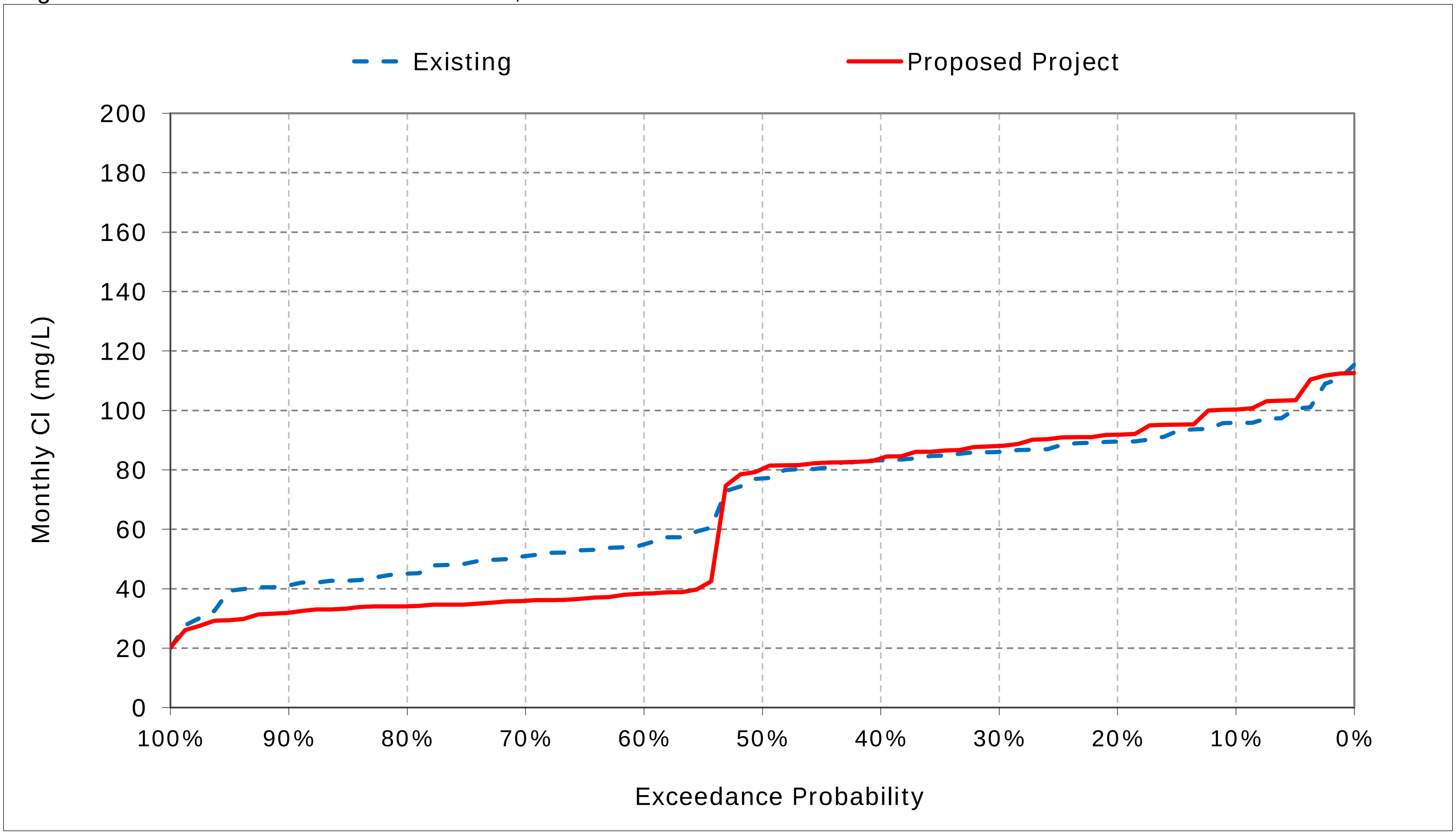


Figure 8-17. Victoria Canal Chloride, November Cl

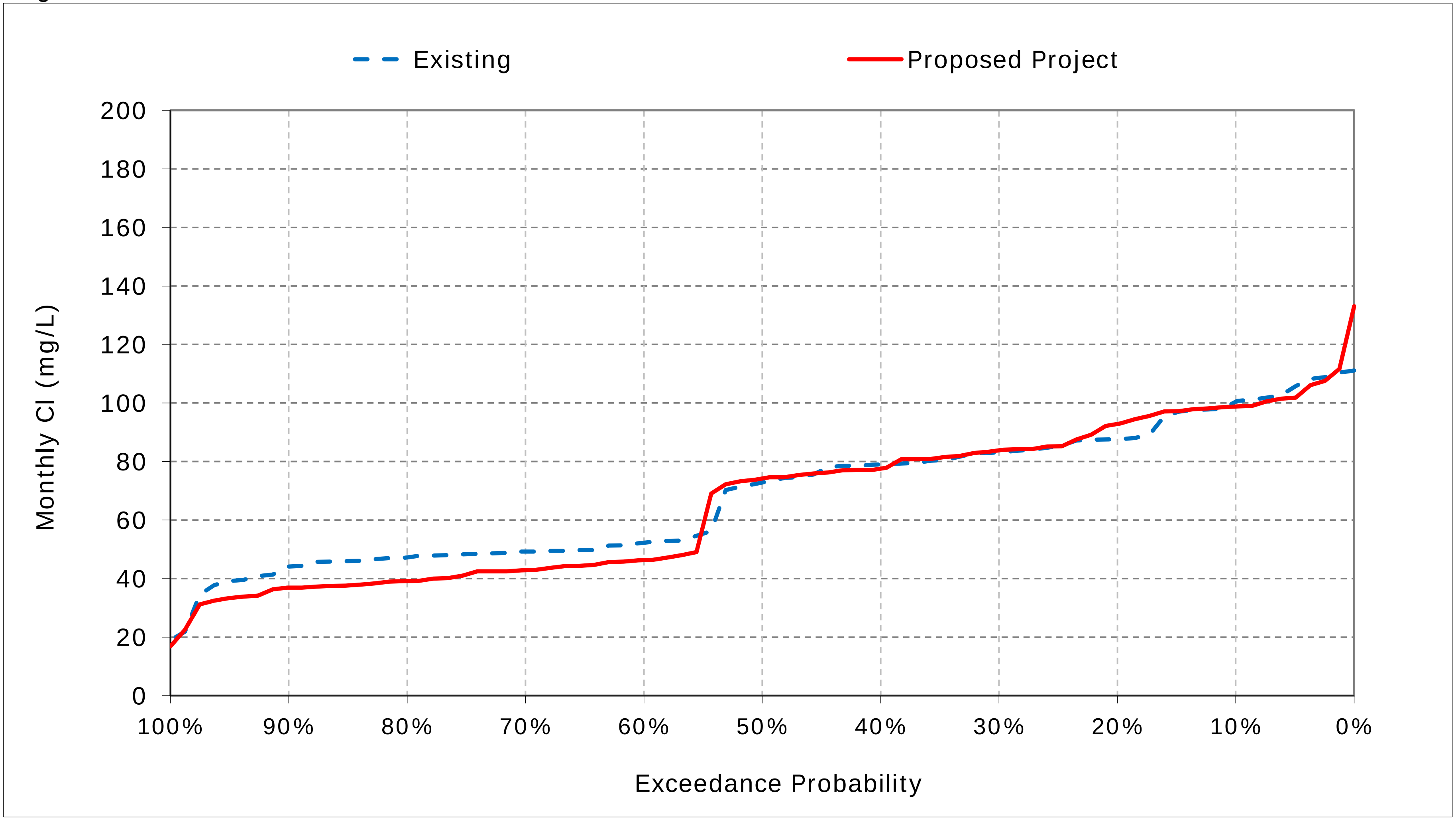


Figure 8-18. Victoria Canal Chloride, December Cl

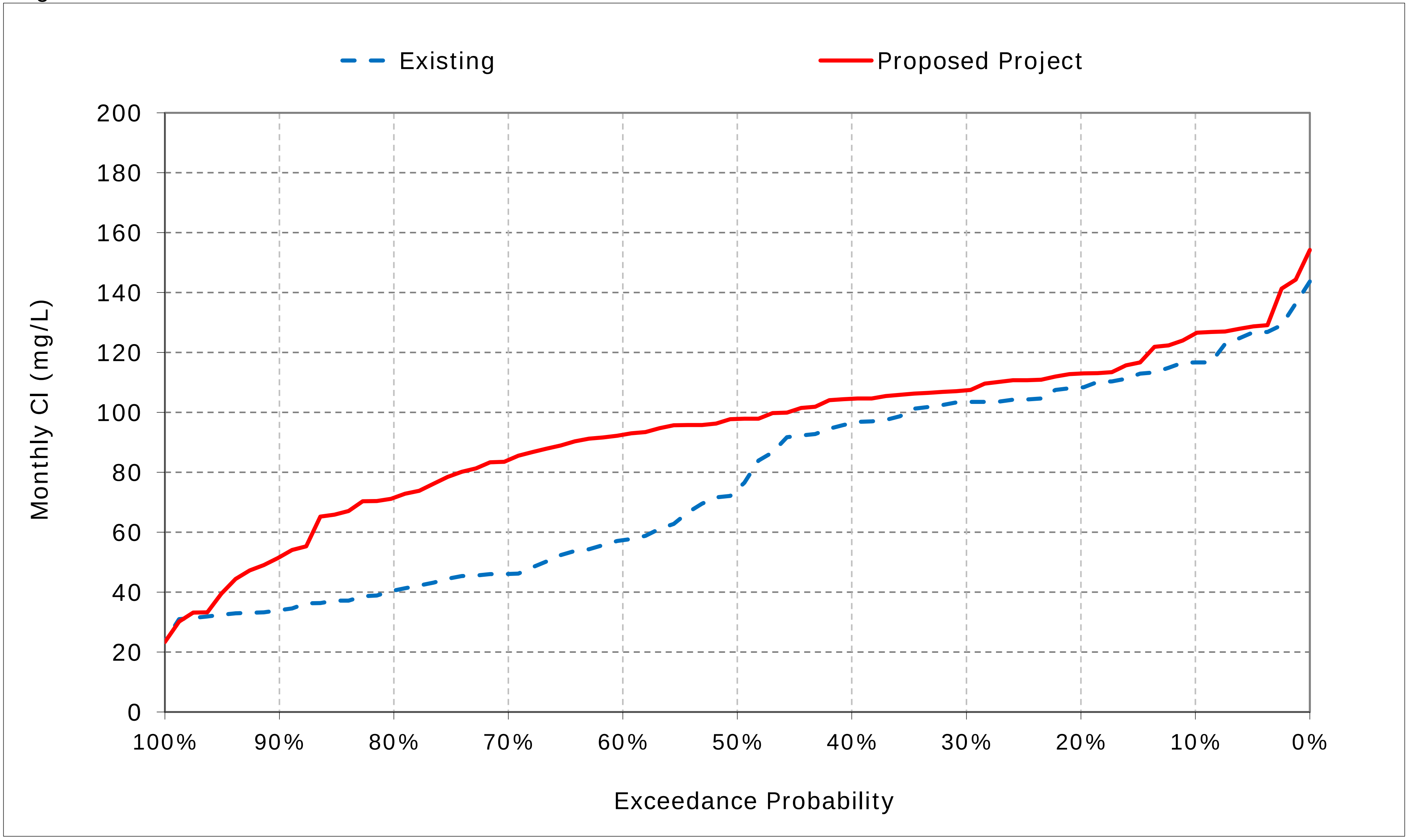


Table 9-1. Contra Costa Pumping Plant #1 Chloride, Monthly Cl

Existing

Statistic	Monthly Cl (mg/L)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	198	189	210	187	95	53	52	57	36	88	134	178
20%	187	169	198	149	69	40	47	50	29	56	105	171
30%	180	158	174	124	62	34	42	43	28	46	91	156
40%	171	142	129	99	53	32	38	39	27	36	84	139
50%	153	117	77	81	47	29	36	38	26	29	73	127
60%	29	38	47	70	37	28	32	35	26	26	63	113
70%	27	26	35	47	32	26	31	33	25	25	52	102
80%	27	23	29	39	29	24	28	30	24	23	48	86
90%	25	21	25	29	27	23	25	25	23	21	42	74
Long Term												
Full Simulation Period[a]	110	101	106	98	53	34	37	39	30	44	78	125
Water Year Types[b]												
Wet (32%)	84	72	58	49	45	34	35	33	25	23	47	92
Above Normal (15%)	127	106	104	89	49	33	42	44	26	25	53	79
Below Normal (17%)	115	109	126	118	47	30	40	45	26	38	84	167
Dry (22%)	111	114	126	111	53	29	36	38	28	61	105	146
Critical (15%)	141	131	158	169	81	44	36	40	56	89	125	165

Proposed Project

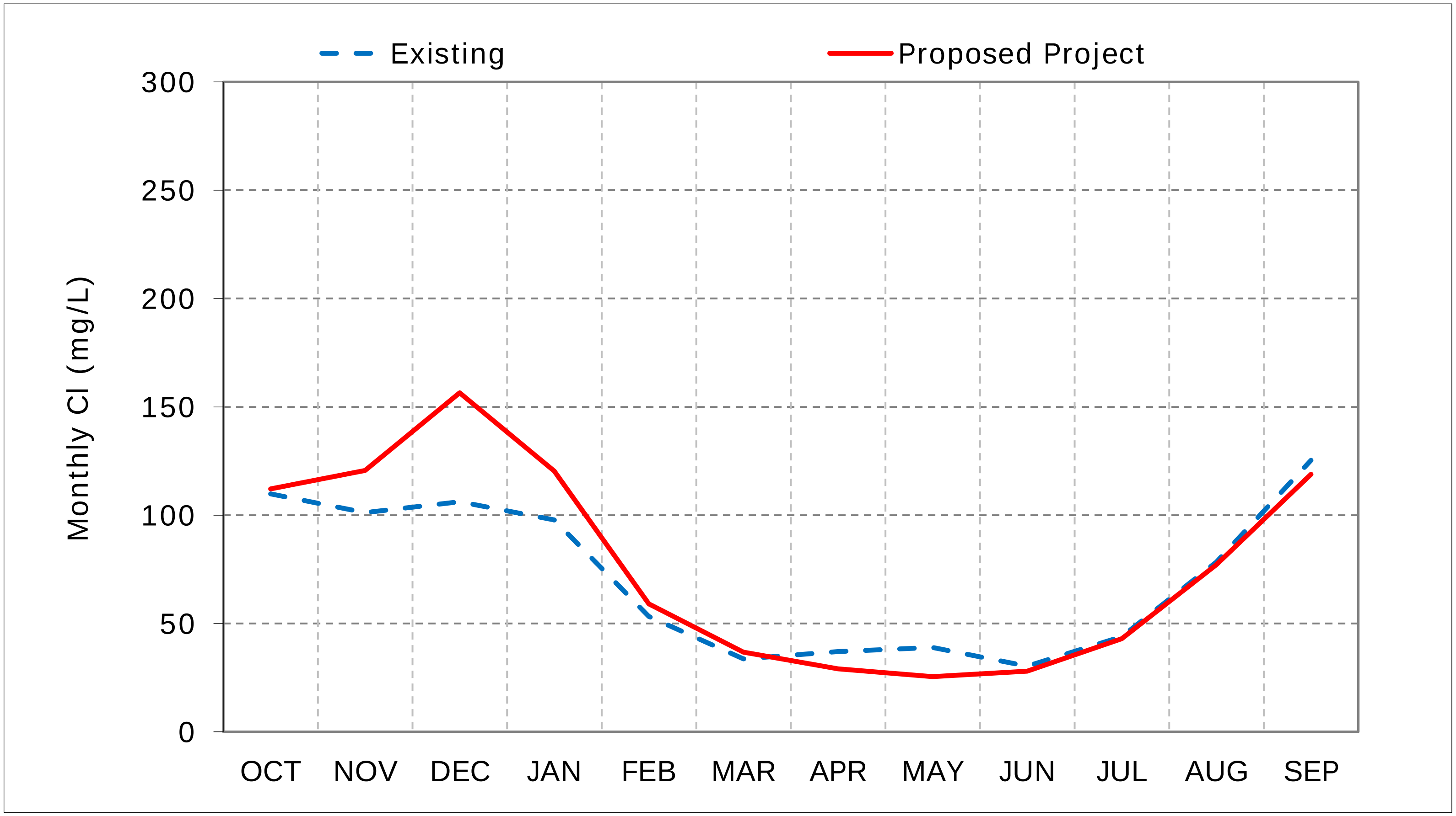
Statistic	Monthly Cl (mg/L)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	203	190	228	241	101	60	35	30	31	89	134	196
20%	194	177	213	202	89	46	30	27	28	48	100	179
30%	185	158	204	181	66	36	29	26	26	41	92	167
40%	174	150	194	148	58	34	29	24	24	35	82	143
50%	158	129	185	99	50	31	28	24	23	28	73	117
60%	28	101	167	78	41	29	27	23	22	25	61	83
70%	26	77	109	50	36	27	26	22	21	24	50	73
80%	24	62	91	42	31	26	25	22	21	22	46	67
90%	23	42	37	31	28	25	24	21	20	21	35	58
Long Term												
Full Simulation Period[a]	112	121	156	120	59	37	29	25	28	43	77	119
Water Year Types[b]												
Wet (32%)	86	96	99	57	45	36	27	22	22	23	44	59
Above Normal (15%)	130	135	176	126	57	37	29	23	22	24	53	75
Below Normal (17%)	116	127	176	143	49	32	29	24	22	33	83	184
Dry (22%)	112	127	181	148	63	33	28	26	26	59	102	148
Critical (15%)	145	142	200	184	97	49	35	36	57	93	129	172

Proposed Project minus Existing

Statistic	Monthly Cl (mg/L)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	5	1	18	53	7	7	-17	-27	-5	2	0	18
20%	7	8	16	53	20	6	-16	-23	-1	-8	-5	9
30%	5	1	30	57	4	2	-13	-16	-2	-5	1	11
40%	3	9	66	49	5	2	-9	-15	-3	-2	-2	4
50%	5	11	108	18	3	2	-8	-14	-3	0	0	-10
60%	-1	62	120	8	4	1	-5	-12	-3	-1	-2	-29
70%	-2	52	73	2	3	1	-5	-11	-4	-1	-1	-29
80%	-3	39	62	4	1	1	-4	-8	-3	0	-2	-19
90%	-3	20	12	2	0	2	-1	-4	-3	0	-7	-16
Long Term												
Full Simulation Period[a]	2	19	50	23	6	3	-8	-13	-2	-1	-1	-6
Water Year Types[b]												
Wet (32%)	2	24	41	8	0	2	-8	-11	-2	0	-3	-32
Above Normal (15%)	3	29	71	37	7	4	-13	-21	-4	-1	0	-4
Below Normal (17%)	1	18	50	25	2	2	-11	-21	-4	-6	-1	17
Dry (22%)	1	13	55	37	10	3	-7	-13	-2	-3	-4	2
Critical (15%)	4	11	43	15	16	5	-1	-4	1	4	4	7

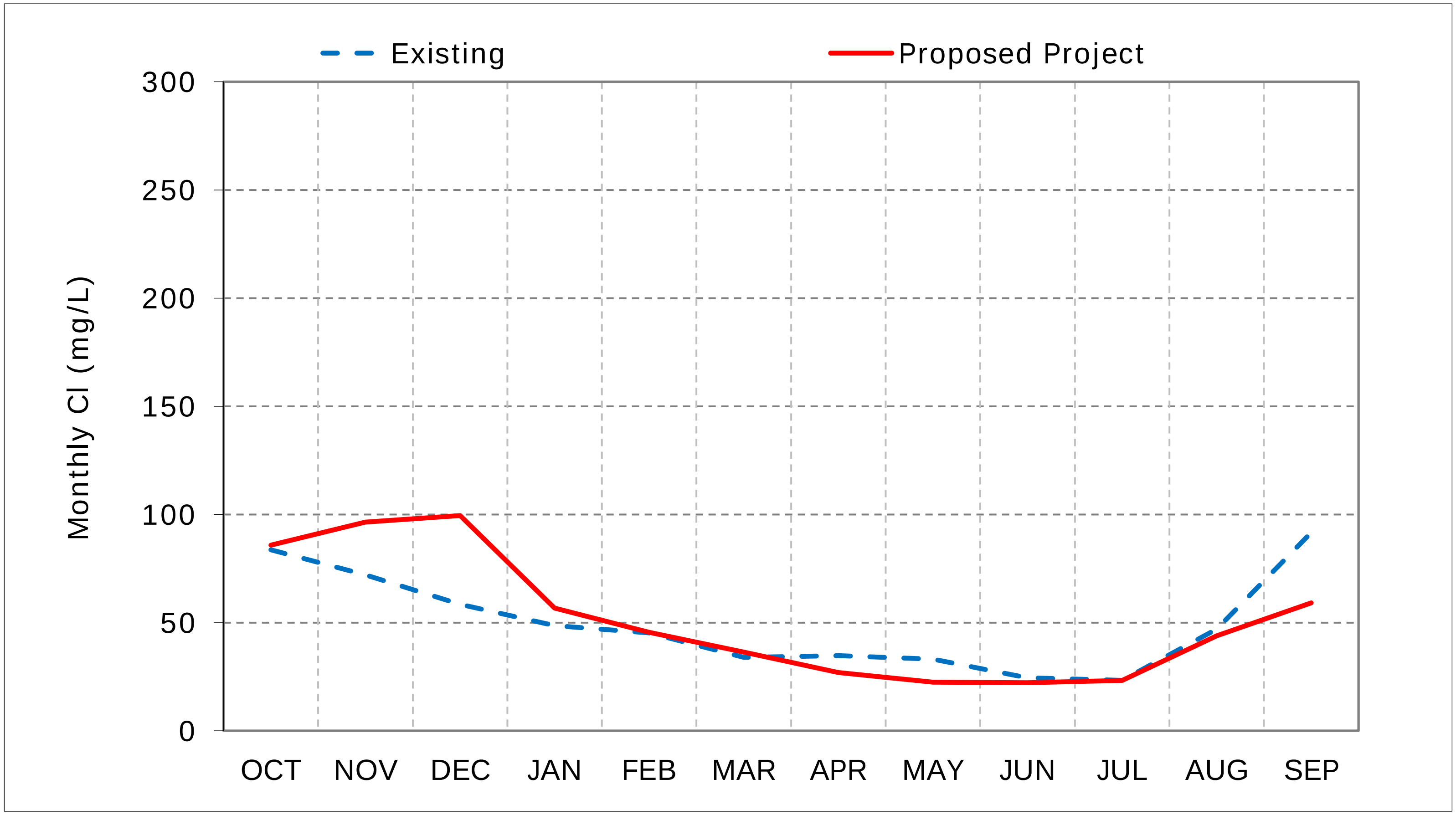
a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with water year - year type sorting.
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 9-1. Contra Costa Pumping Plant #1 Chloride, Long-Term Average Cl



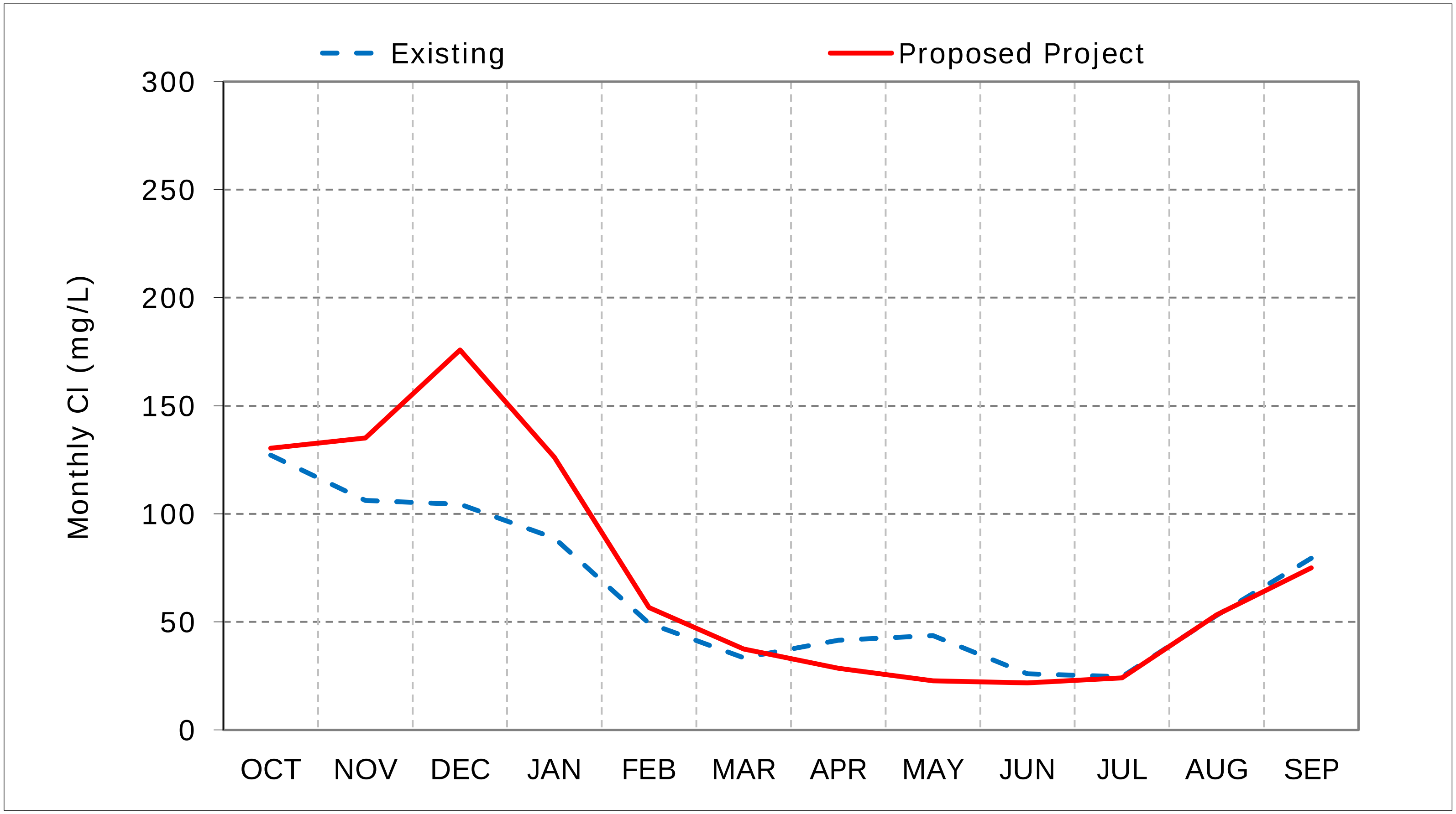
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 9-2. Contra Costa Pumping Plant #1 Chloride, Wet Year Average Cl



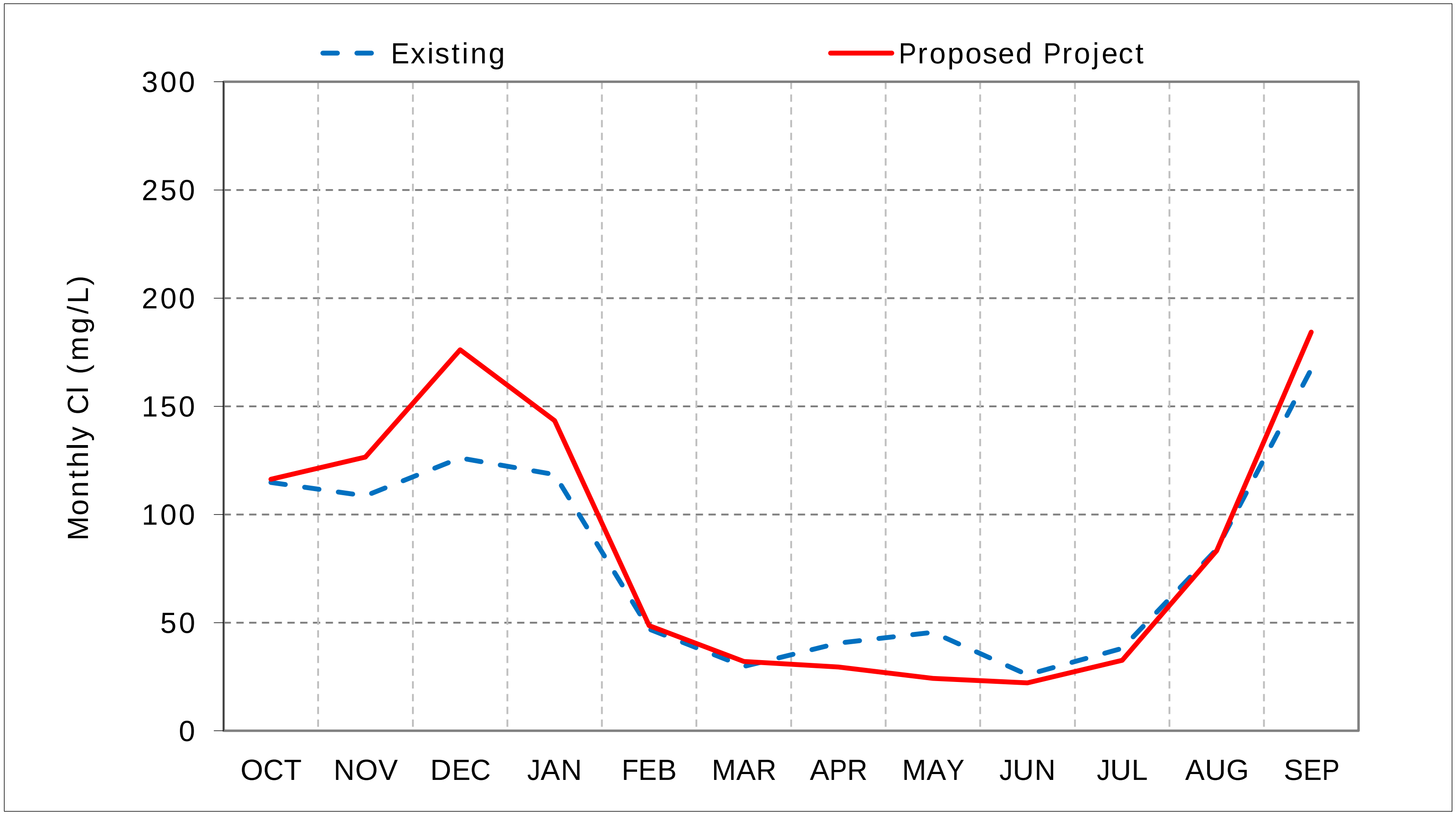
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 9-3. Contra Costa Pumping Plant #1 Chloride, Above Normal Year Average



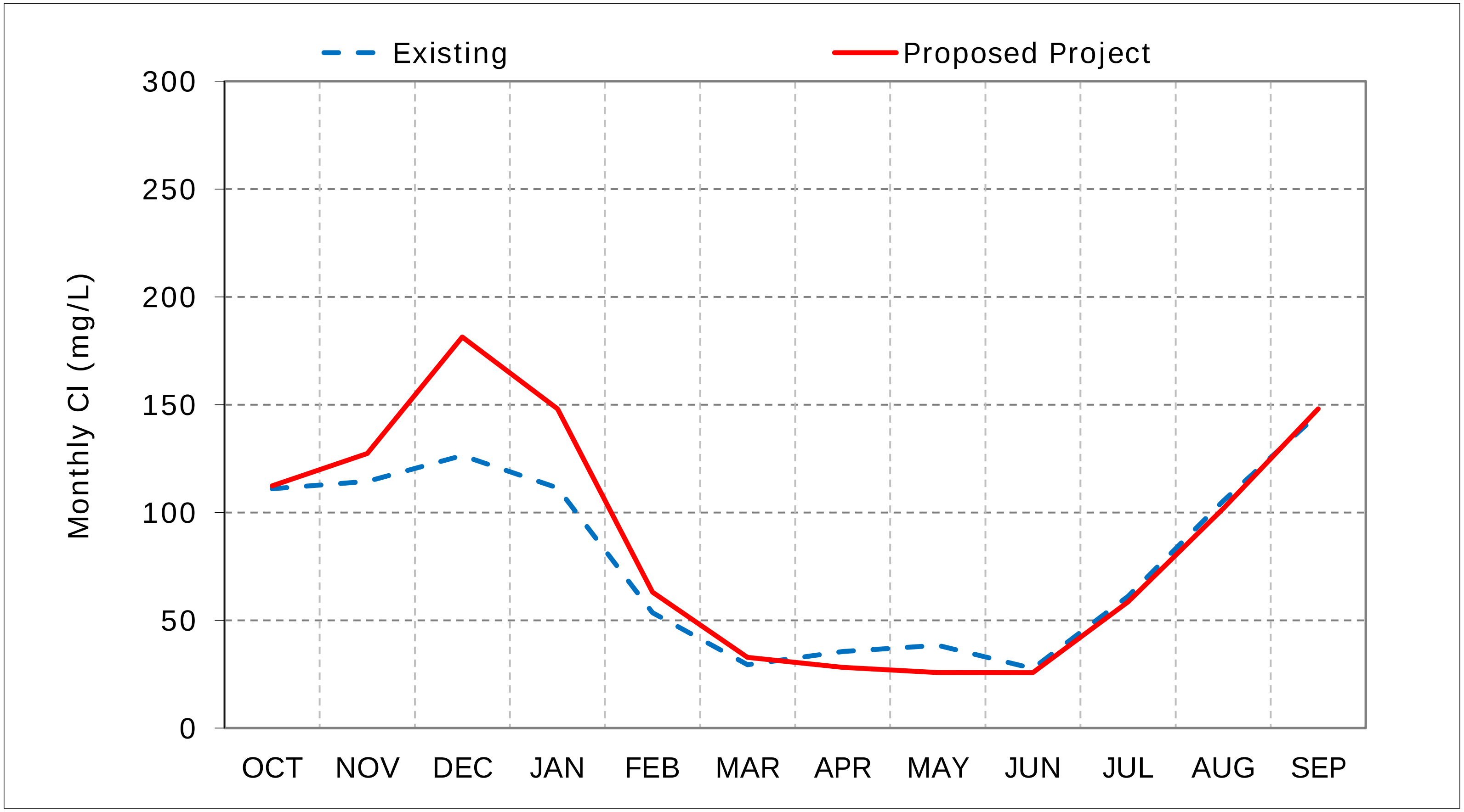
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 9-4. Contra Costa Pumping Plant #1 Chloride, Below Normal Year Average



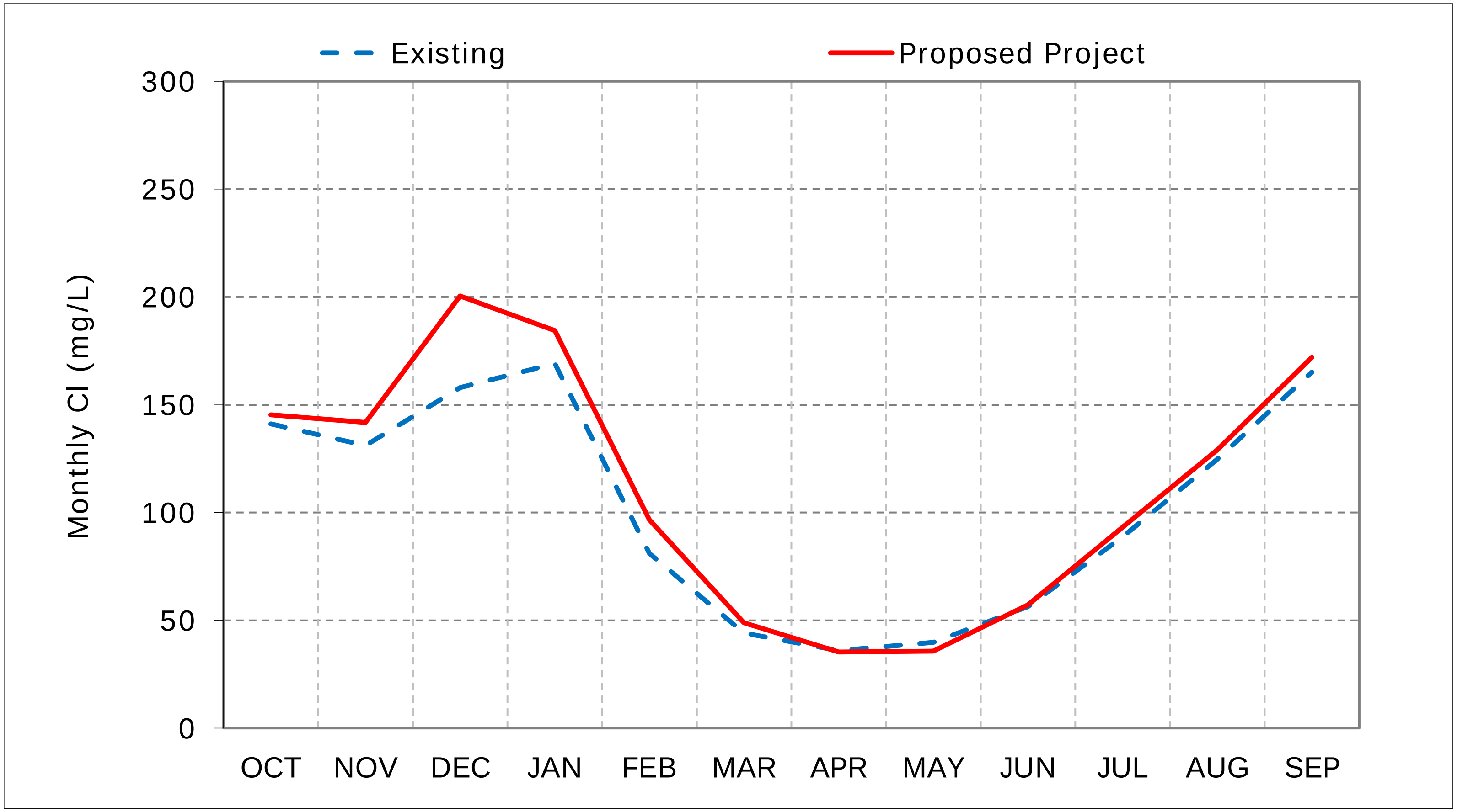
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 9-5. Contra Costa Pumping Plant #1 Chloride, Dry Year Average Cl



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 9-6. Contra Costa Pumping Plant #1 Chloride, Critical Year Average Cl



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 9-7. Contra Costa Pumping Plant #1 Chloride, January Cl

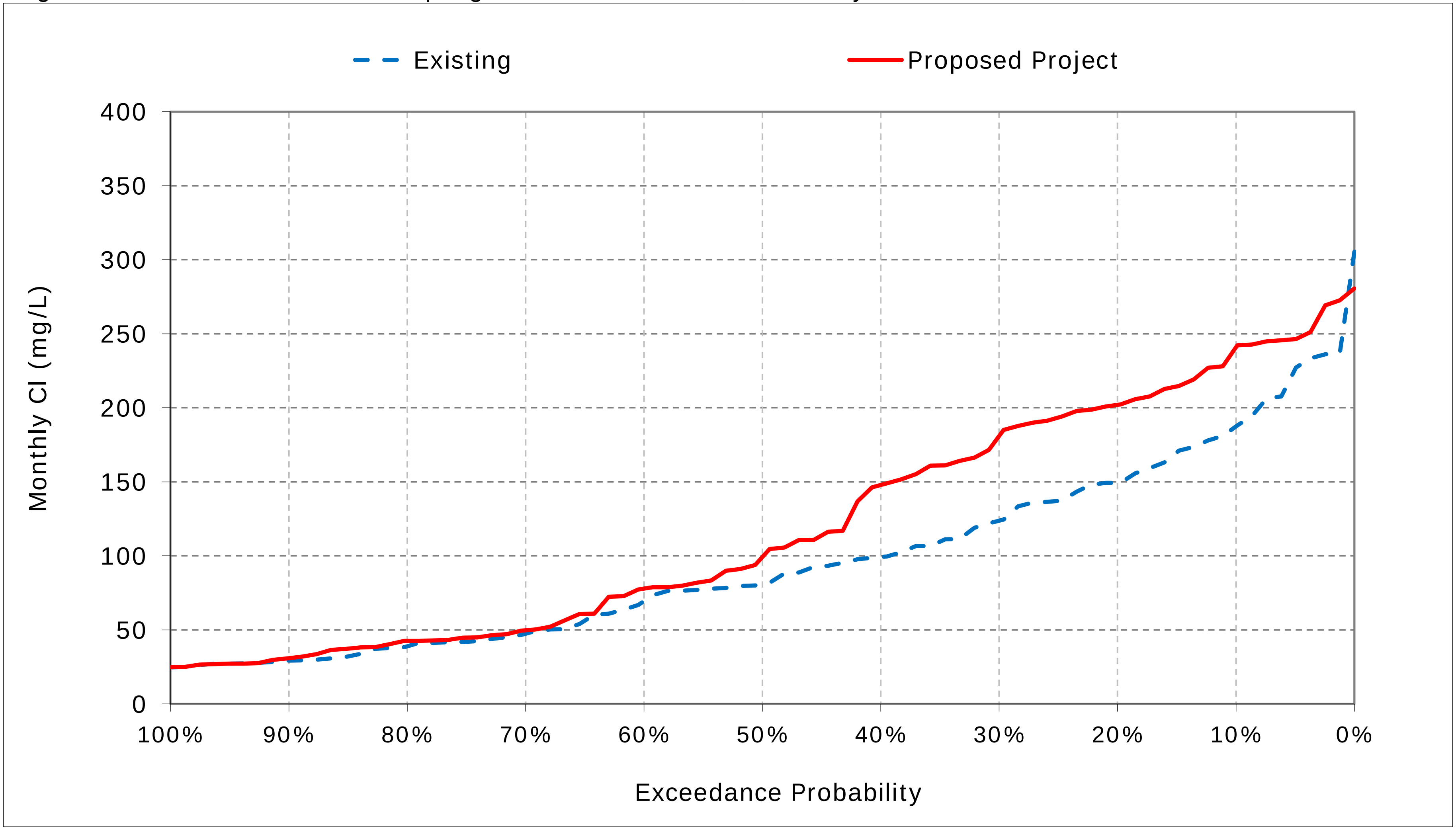


Figure 9-8. Contra Costa Pumping Plant #1 Chloride, February Cl

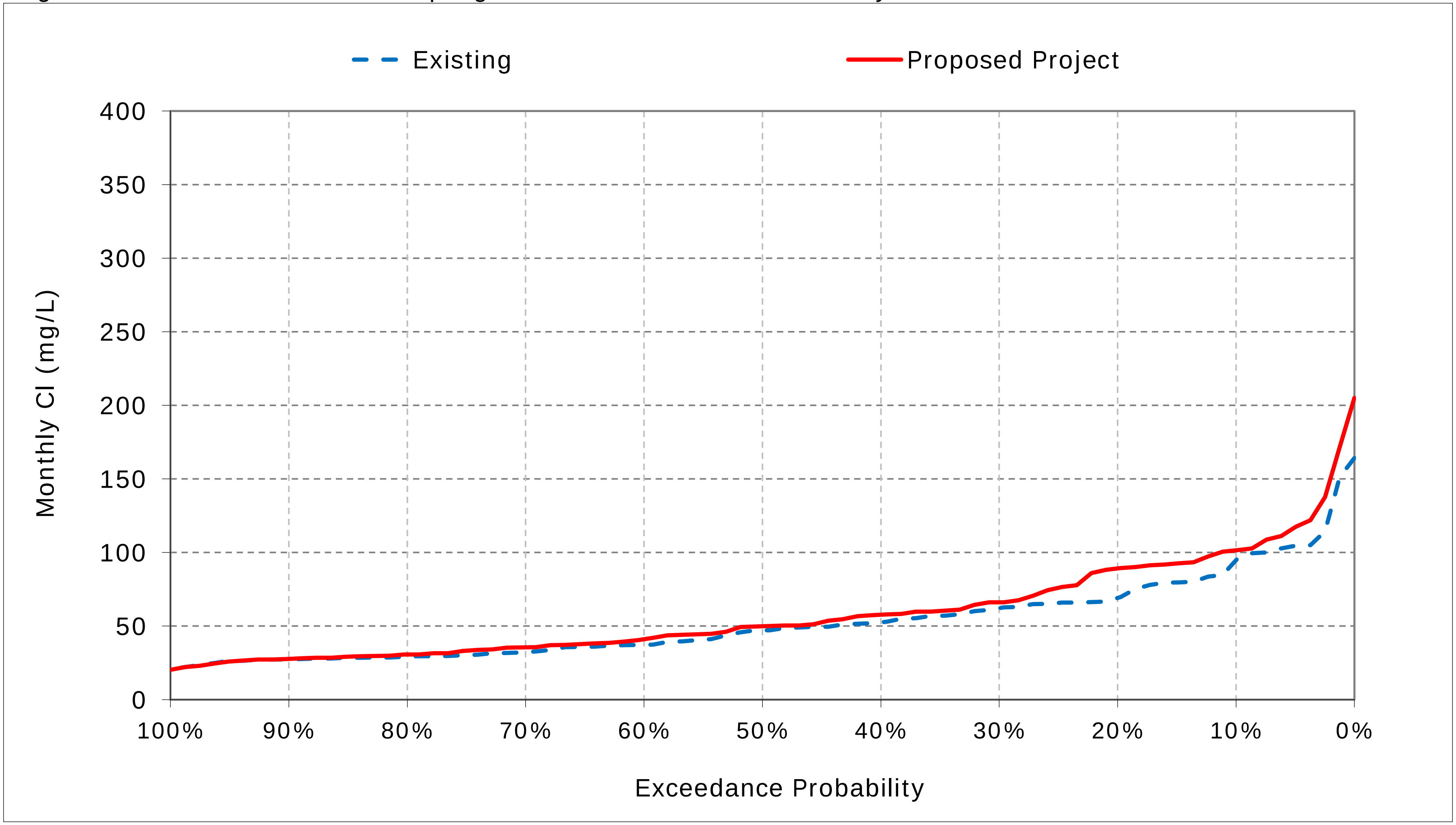


Figure 9-9. Contra Costa Pumping Plant #1 Chloride, March Cl

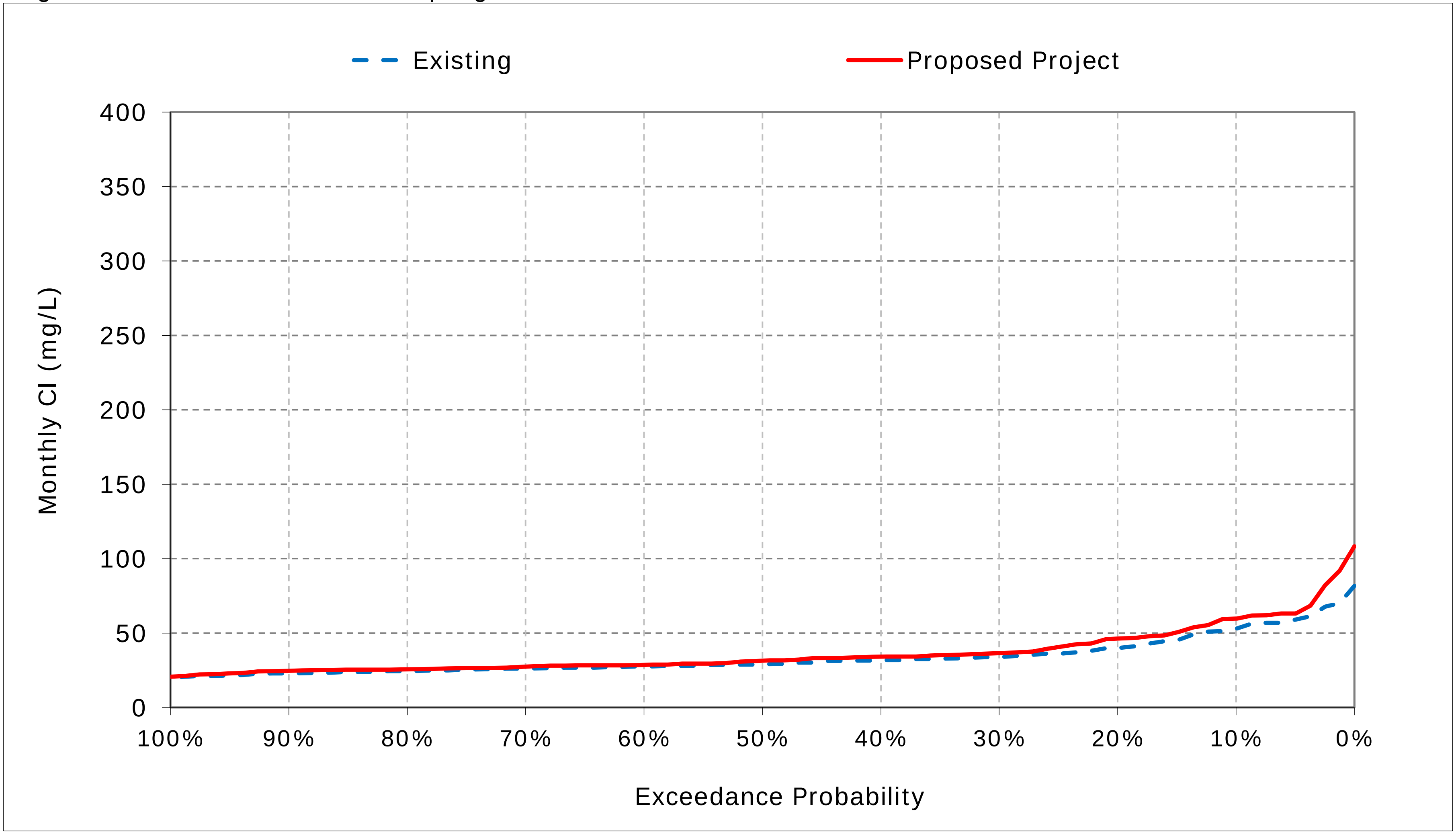


Figure 9-10. Contra Costa Pumping Plant #1 Chloride, April Cl

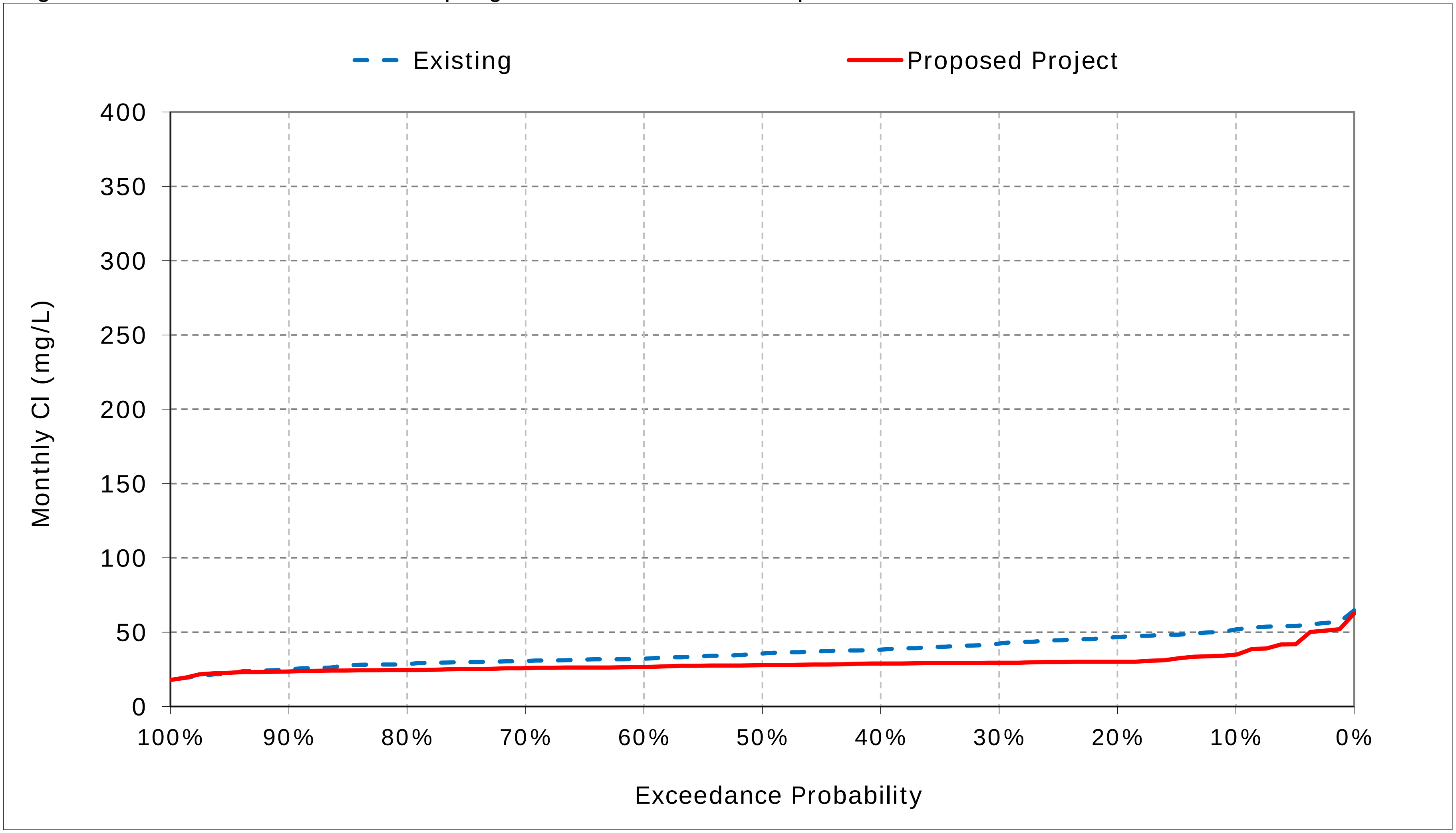


Figure 9-11. Contra Costa Pumping Plant #1 Chloride, May Cl

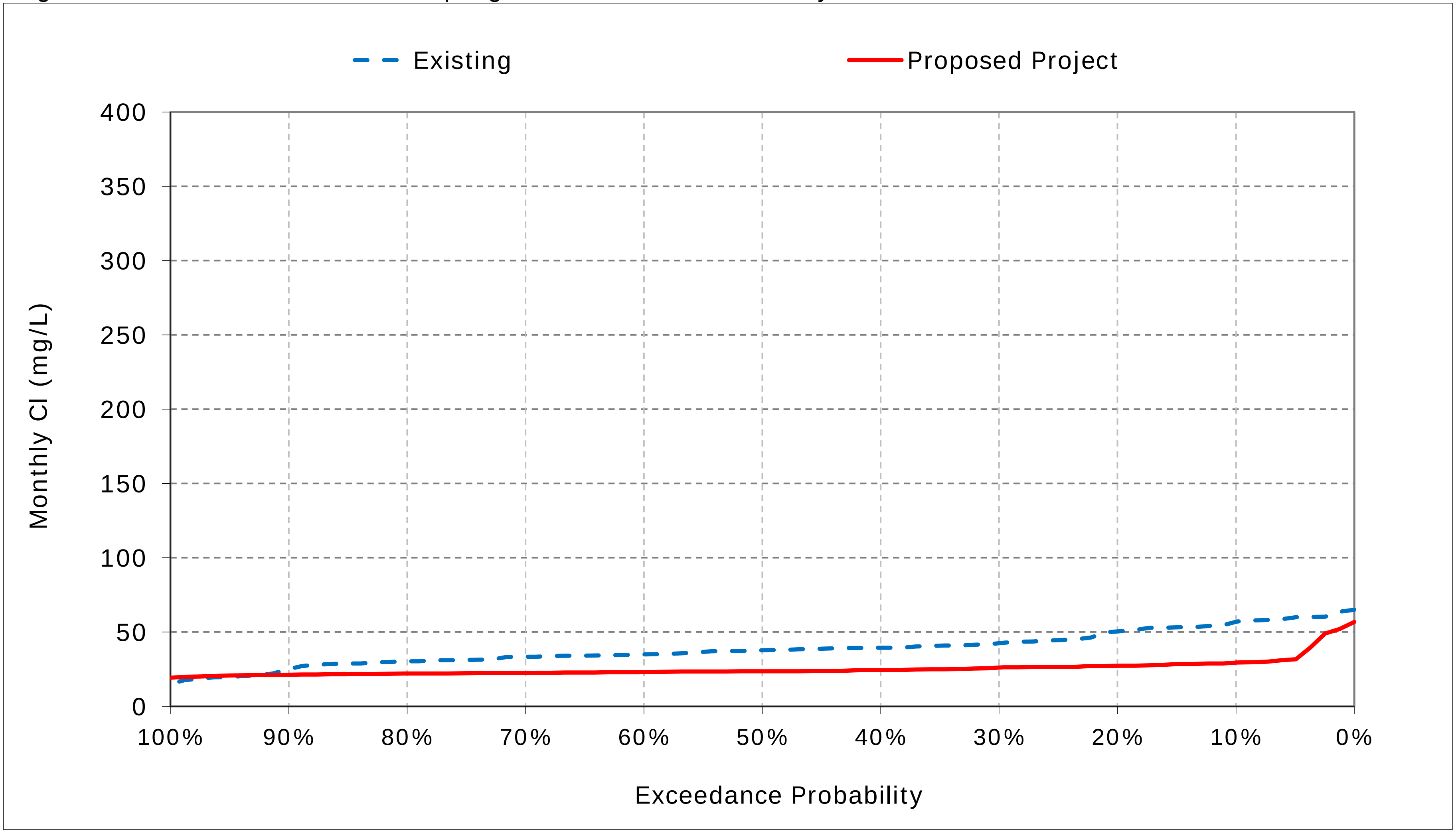


Figure 9-12. Contra Costa Pumping Plant #1 Chloride, June Cl

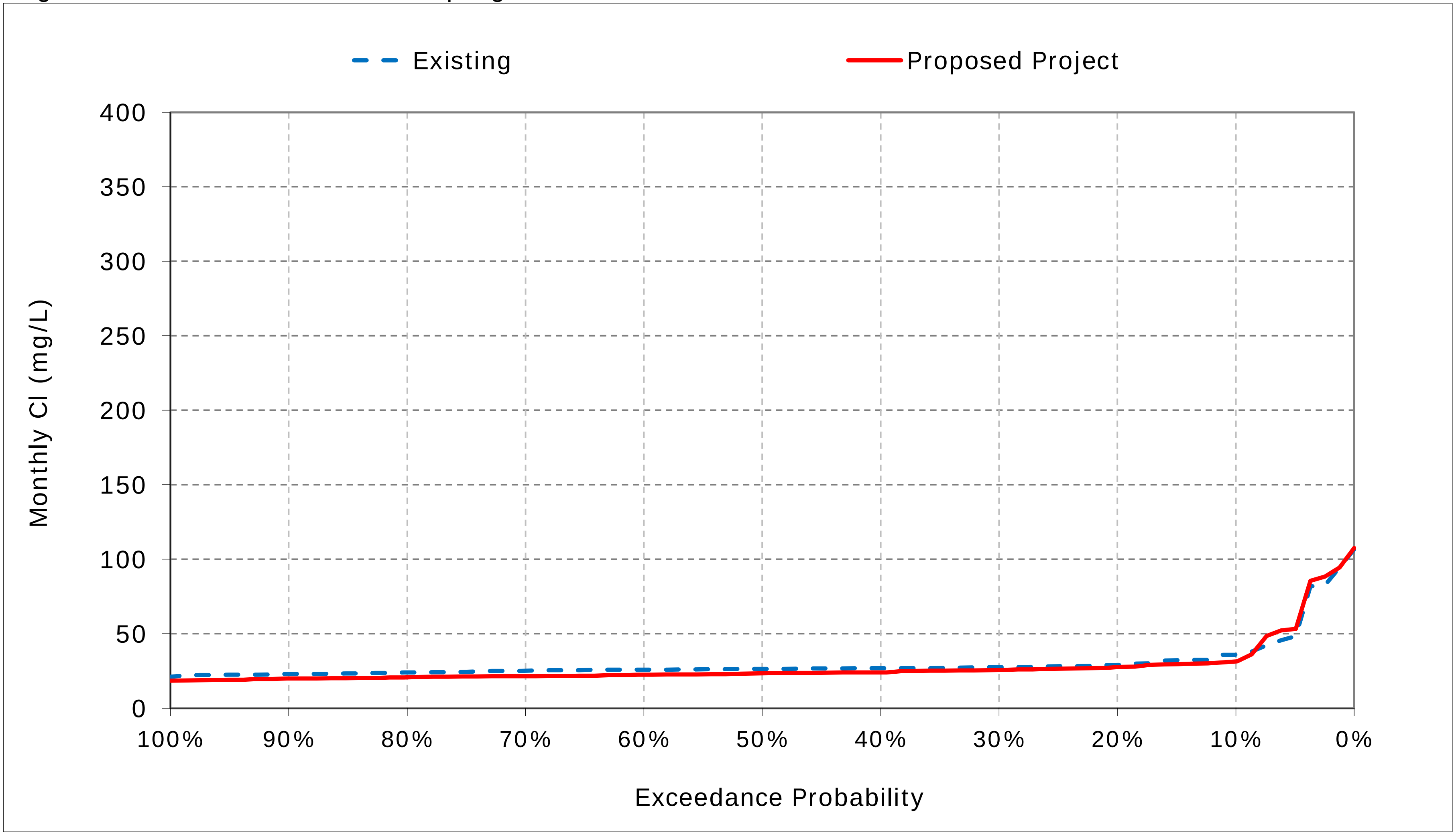


Figure 9-13. Contra Costa Pumping Plant #1 Chloride, July Cl

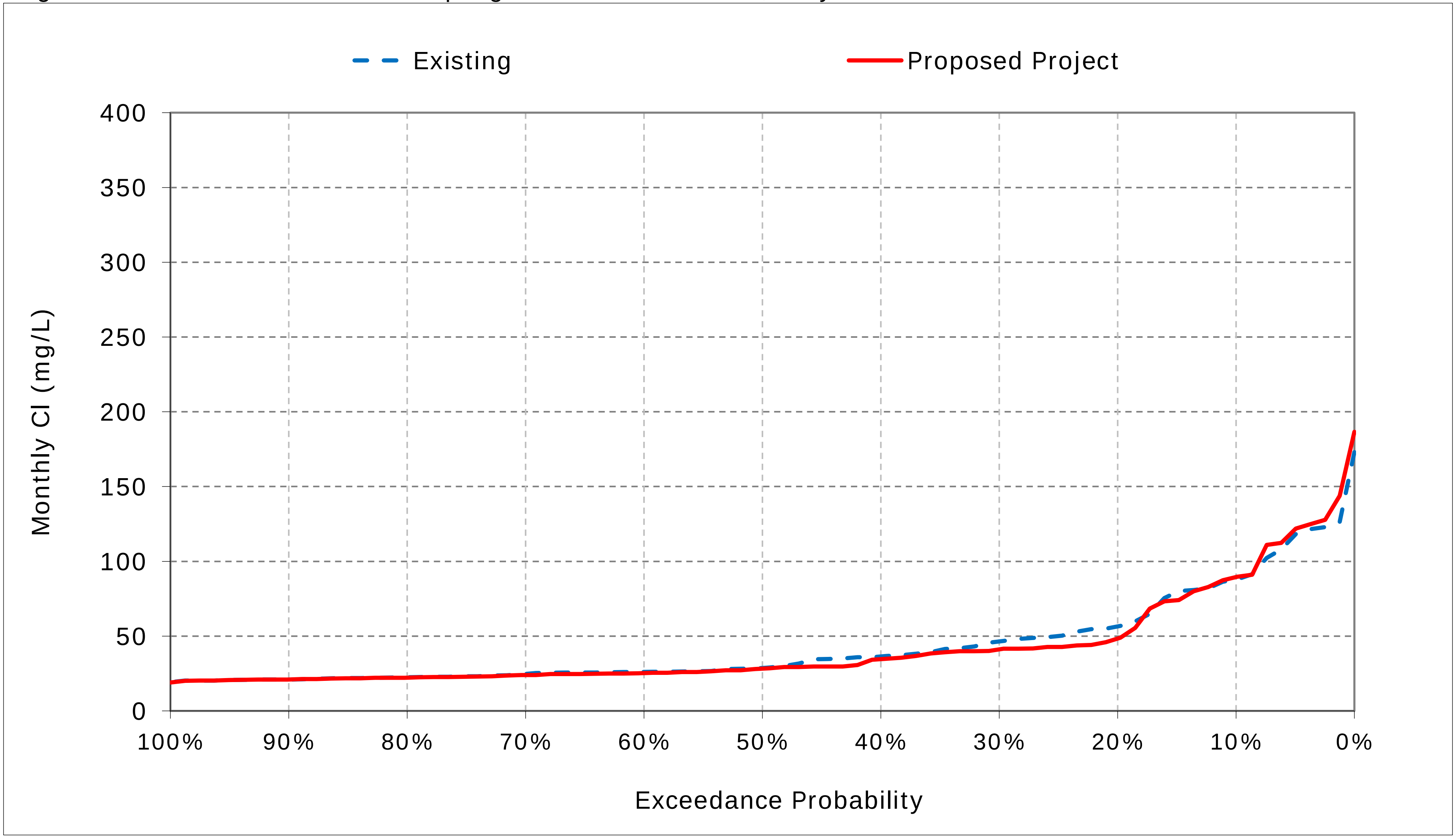


Figure 9-14. Contra Costa Pumping Plant #1 Chloride, August Cl

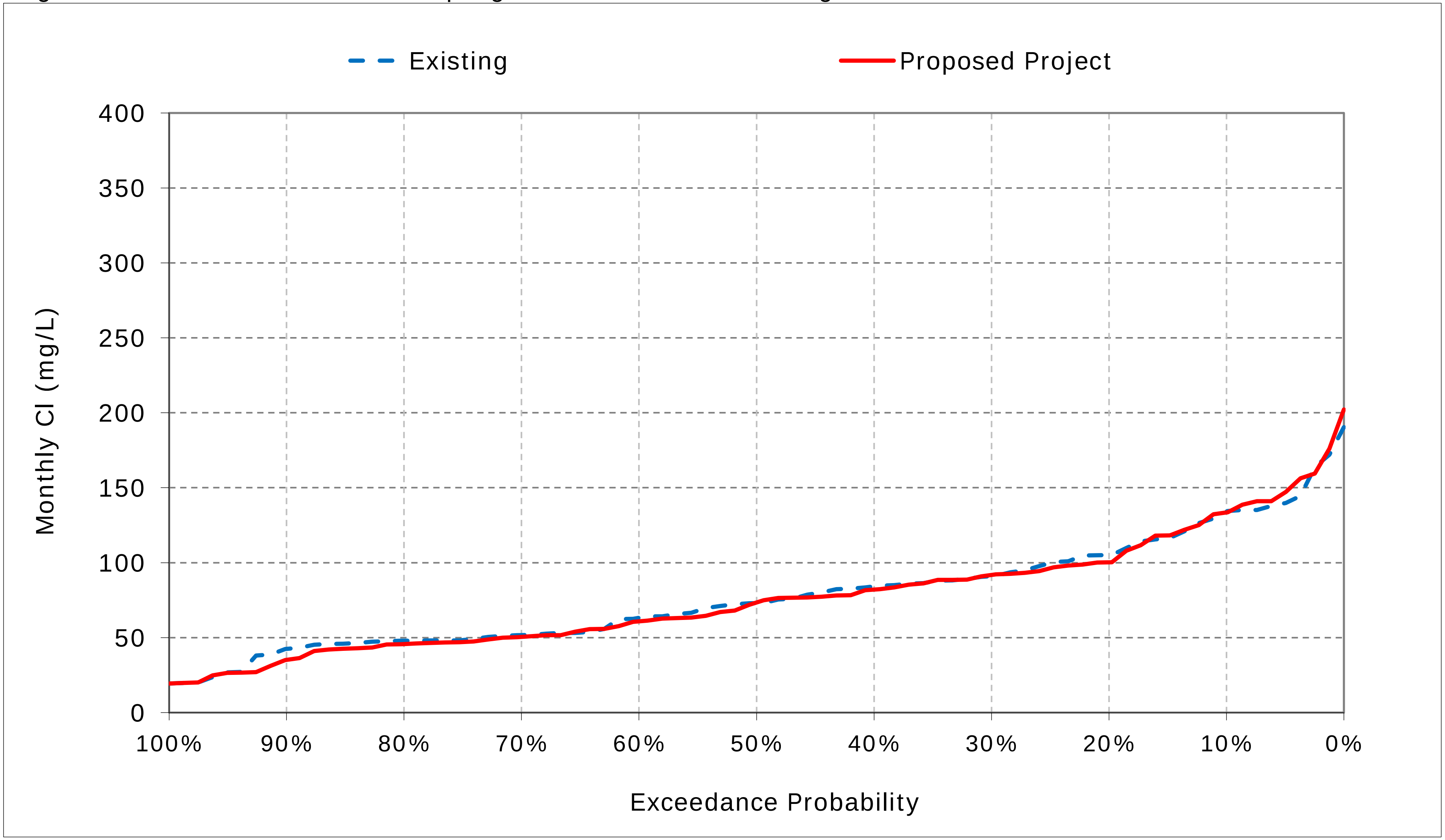


Figure 9-15. Contra Costa Pumping Plant #1 Chloride, September Cl

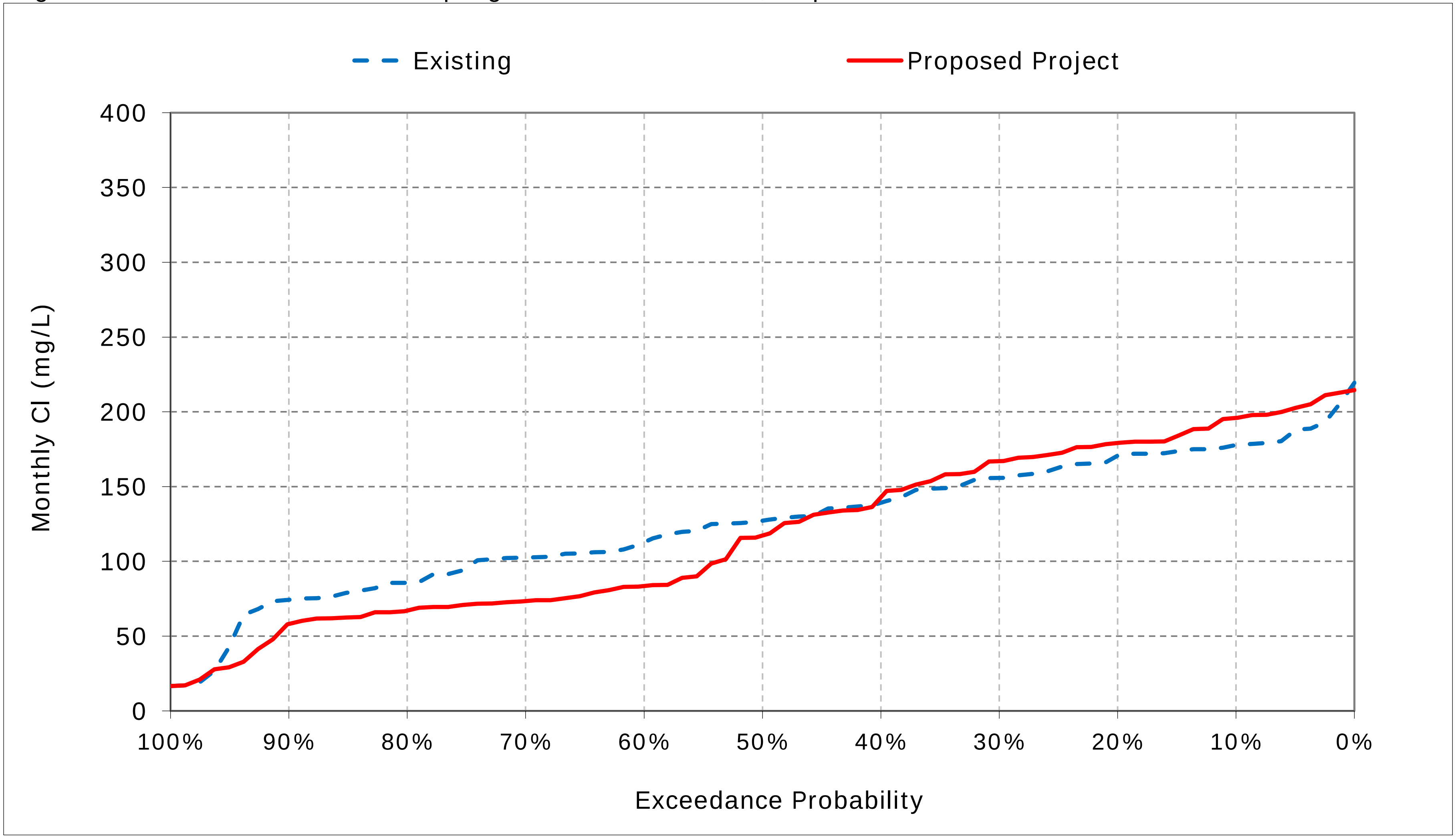


Figure 9-16. Contra Costa Pumping Plant #1 Chloride, October Cl

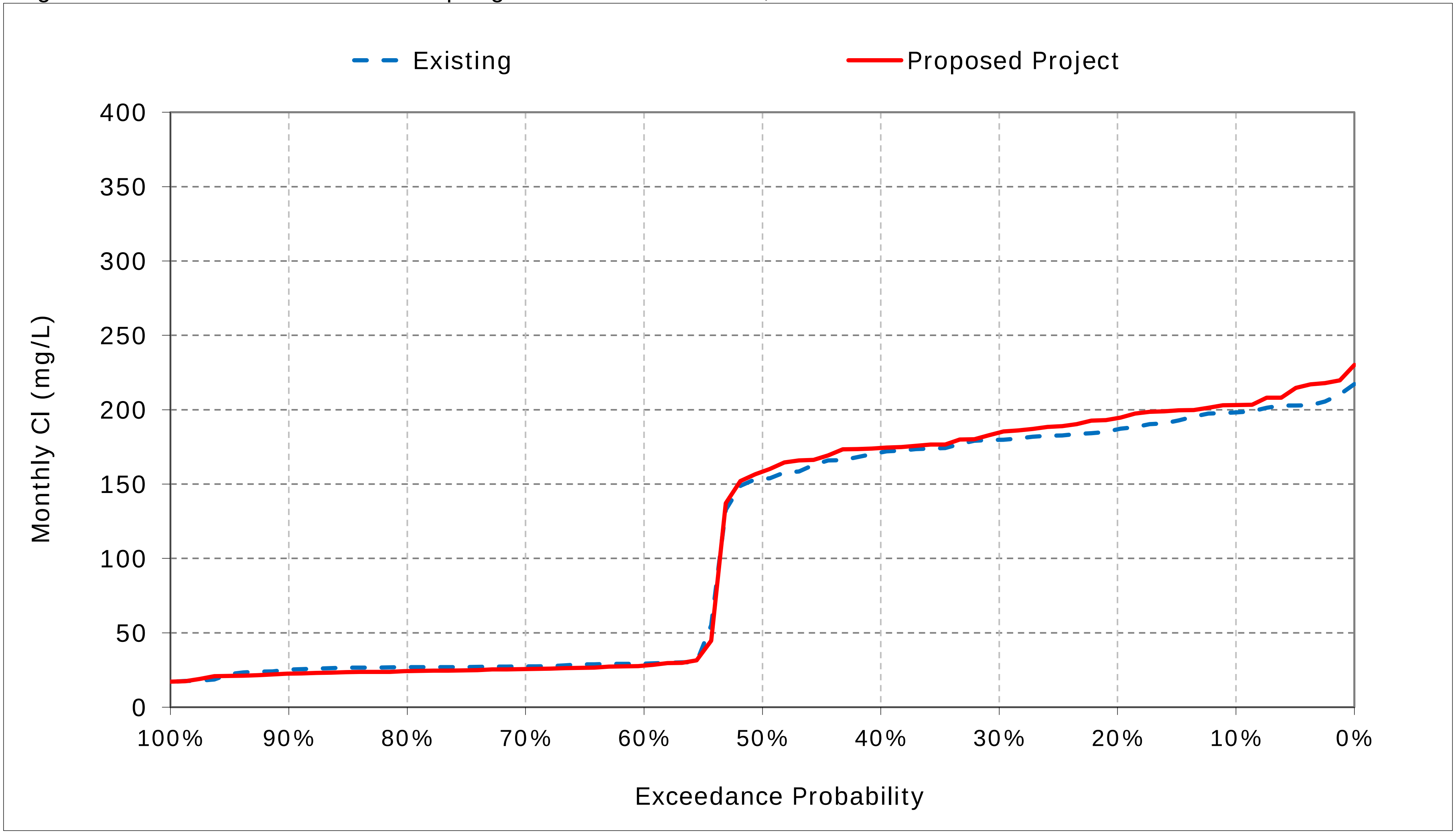


Figure 9-17. Contra Costa Pumping Plant #1 Chloride, November Cl

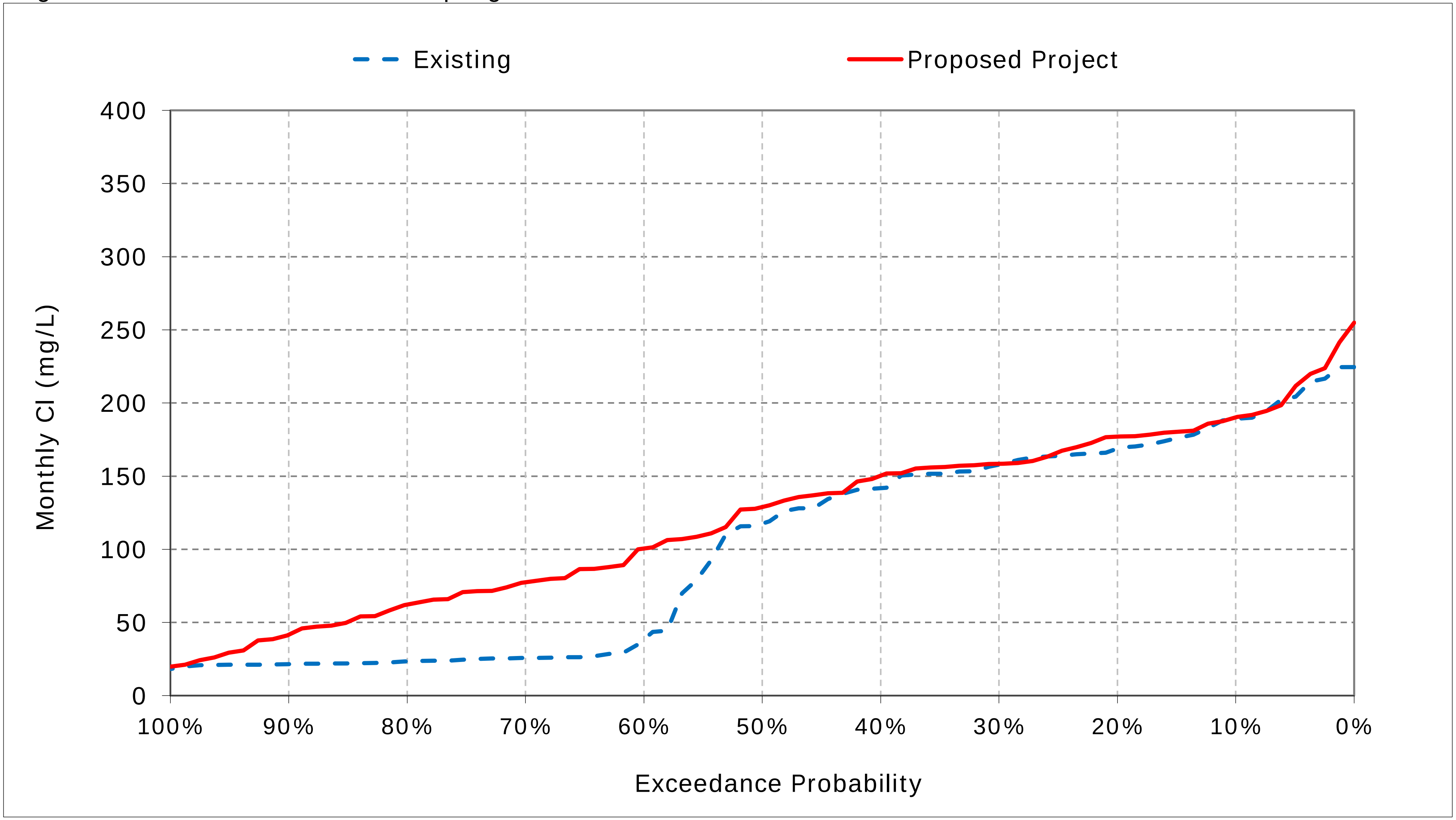


Figure 9-18. Contra Costa Pumping Plant #1 Chloride, December Cl

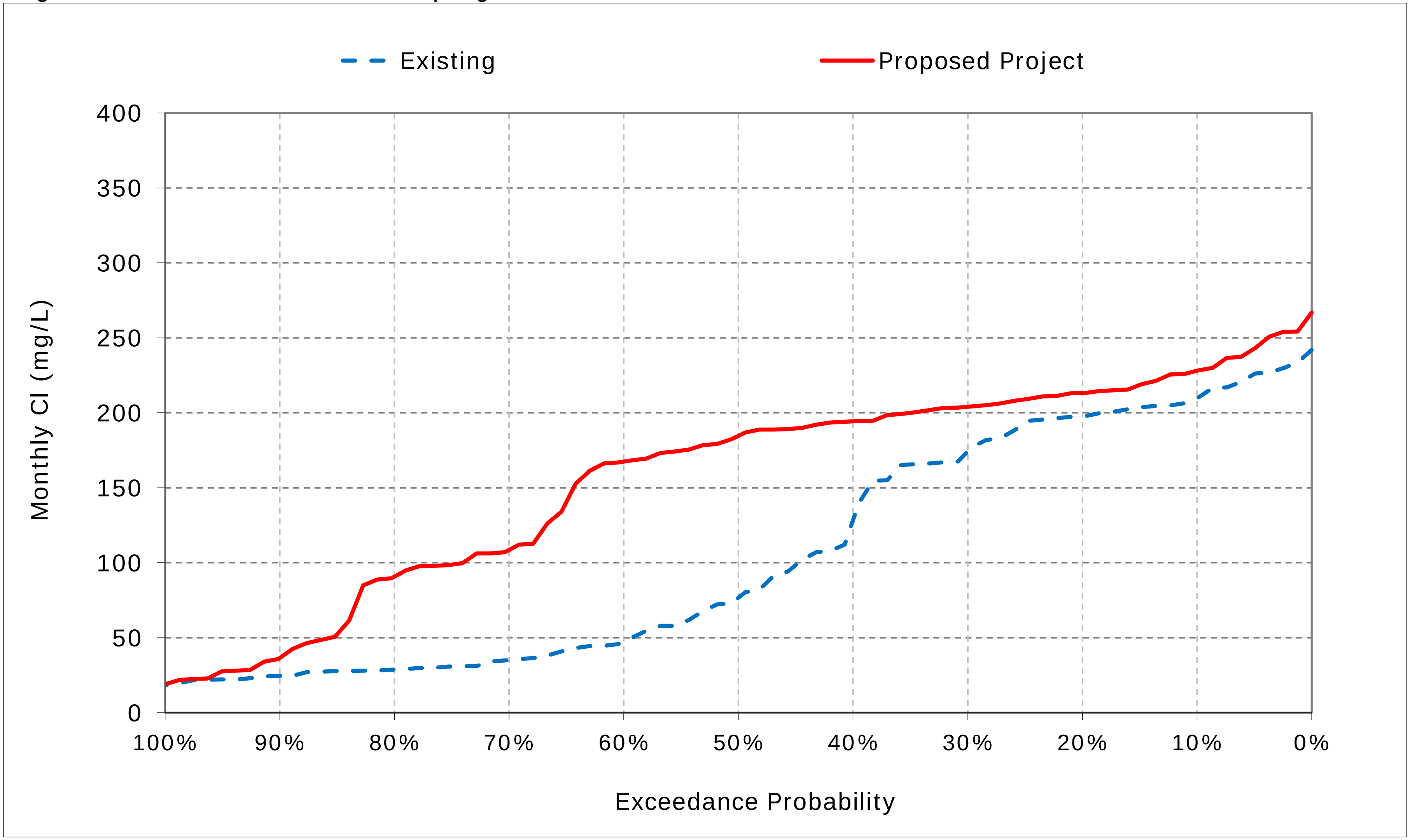


Table 10-1. San Joaquin River at Antioch Chloride, Monthly Cl

Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Cl (mg/L)											
Probability of Exceedance												
10%	2,016	1,853	1,774	907	298	245	224	408	608	1,018	1,523	1,915
20%	1,886	1,807	1,422	756	166	92	94	241	472	851	1,328	1,797
30%	1,857	1,714	898	542	98	34	35	155	437	801	1,240	1,735
40%	1,741	1,651	744	313	55	27	27	70	321	524	1,007	1,603
50%	1,595	652	568	235	31	24	25	33	260	467	892	1,354
60%	534	443	483	90	26	22	22	26	146	301	862	529
70%	271	210	164	27	24	21	21	23	100	278	804	327
80%	221	178	89	23	22	20	20	20	29	222	742	292
90%	191	158	22	21	20	18	19	19	19	138	681	276
Long Term												
Full Simulation Period[a]	1,128	986	722	359	123	71	74	144	319	553	1,004	1,076
Water Year Types[b]												
Wet (32%)	824	571	194	56	25	21	21	26	72	187	682	258
Above Normal (15%)	1,199	987	687	211	45	22	22	27	167	271	762	521
Below Normal (17%)	1,191	1,084	956	389	66	39	37	73	254	487	939	1,471
Dry (22%)	1,210	1,179	886	543	181	84	81	174	430	827	1,280	1,768
Critical (15%)	1,522	1,477	1,382	849	391	246	270	556	913	1,291	1,602	1,906

Proposed Project

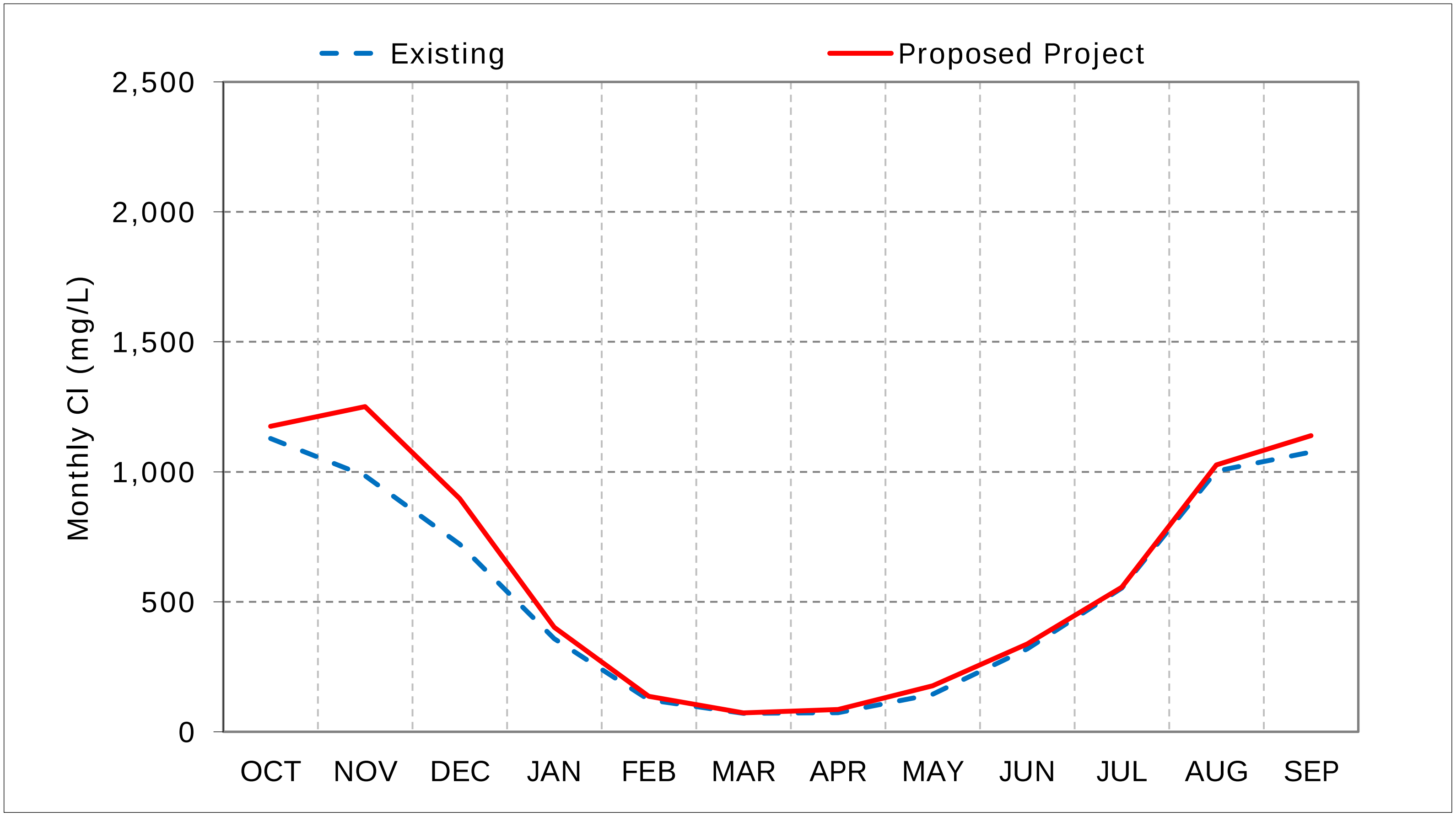
Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Cl (mg/L)											
Probability of Exceedance												
10%	1,996	1,844	1,726	1,107	306	248	266	450	625	1,033	1,526	1,937
20%	1,892	1,802	1,439	865	183	93	127	337	518	879	1,331	1,800
30%	1,837	1,699	1,378	587	103	31	57	267	459	799	1,267	1,736
40%	1,741	1,589	1,249	368	57	26	35	108	369	548	1,128	1,663
50%	1,556	1,094	980	242	34	24	25	56	254	463	998	1,417
60%	507	1,036	678	95	27	22	21	37	179	301	850	501
70%	463	1,013	275	29	24	21	20	22	119	270	792	477
80%	450	893	166	24	22	20	19	17	28	226	728	462
90%	412	348	54	21	20	18	18	17	18	138	663	398
Long Term												
Full Simulation Period[a]	1,176	1,251	897	402	137	73	85	177	338	556	1,026	1,139
Water Year Types[b]												
Wet (32%)	899	906	307	59	25	21	22	36	86	187	660	404
Above Normal (15%)	1,247	1,265	941	254	41	22	23	39	169	262	767	473
Below Normal (17%)	1,246	1,335	1,167	416	65	37	49	114	264	505	1,079	1,578
Dry (22%)	1,261	1,417	1,103	631	210	84	104	241	468	831	1,293	1,779
Critical (15%)	1,493	1,635	1,506	930	450	260	298	600	947	1,297	1,616	1,924

Proposed Project minus Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Cl (mg/L)											
Probability of Exceedance												
10%	-21	-9	-48	199	8	3	42	42	17	14	3	22
20%	6	-6	17	108	17	1	33	96	46	29	3	3
30%	-20	-15	480	44	5	-3	23	112	22	-2	27	1
40%	0	-62	505	55	1	-1	7	38	48	24	121	60
50%	-39	442	412	6	4	0	0	23	-6	-4	106	64
60%	-27	593	194	5	1	0	-1	11	33	0	-12	-28
70%	192	803	111	2	0	0	-1	-1	19	-8	-12	151
80%	228	715	77	1	0	0	-1	-3	0	4	-14	171
90%	221	189	32	0	0	0	-1	-2	-1	0	-18	121
Long Term												
Full Simulation Period[a]	47	265	175	43	14	2	12	33	20	3	23	62
Water Year Types[b]												
Wet (32%)	75	335	113	3	0	0	1	11	14	0	-22	145
Above Normal (15%)	48	279	254	44	-4	0	1	12	2	-9	5	-49
Below Normal (17%)	55	251	210	27	-1	-1	12	41	10	18	141	107
Dry (22%)	52	238	217	88	29	0	23	68	37	4	13	11
Critical (15%)	-29	158	124	80	59	14	28	43	34	6	14	18

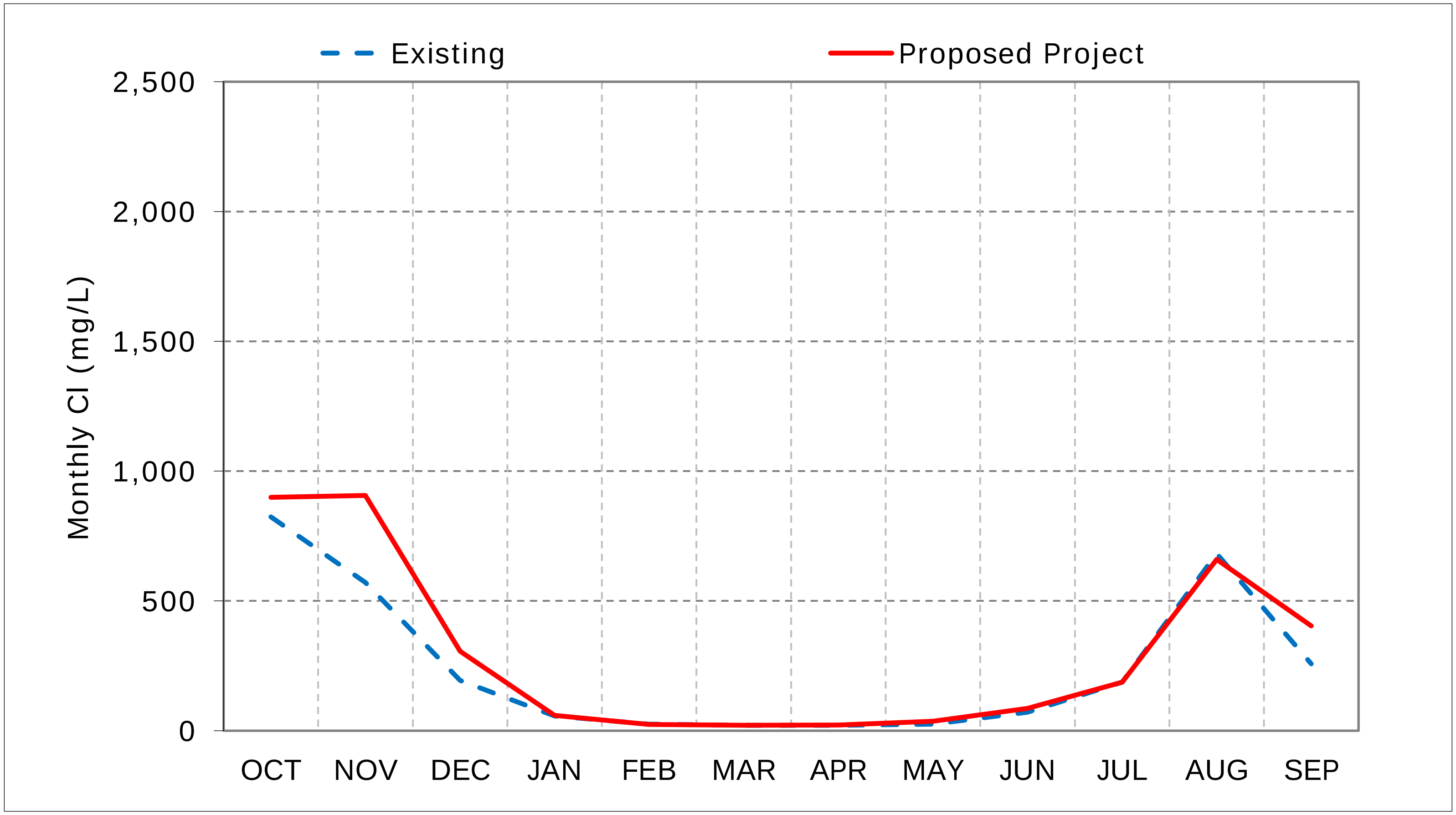
a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with water year - year type sorting.
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 10-1. San Joaquin River at Antioch Chloride, Long-Term Average Cl



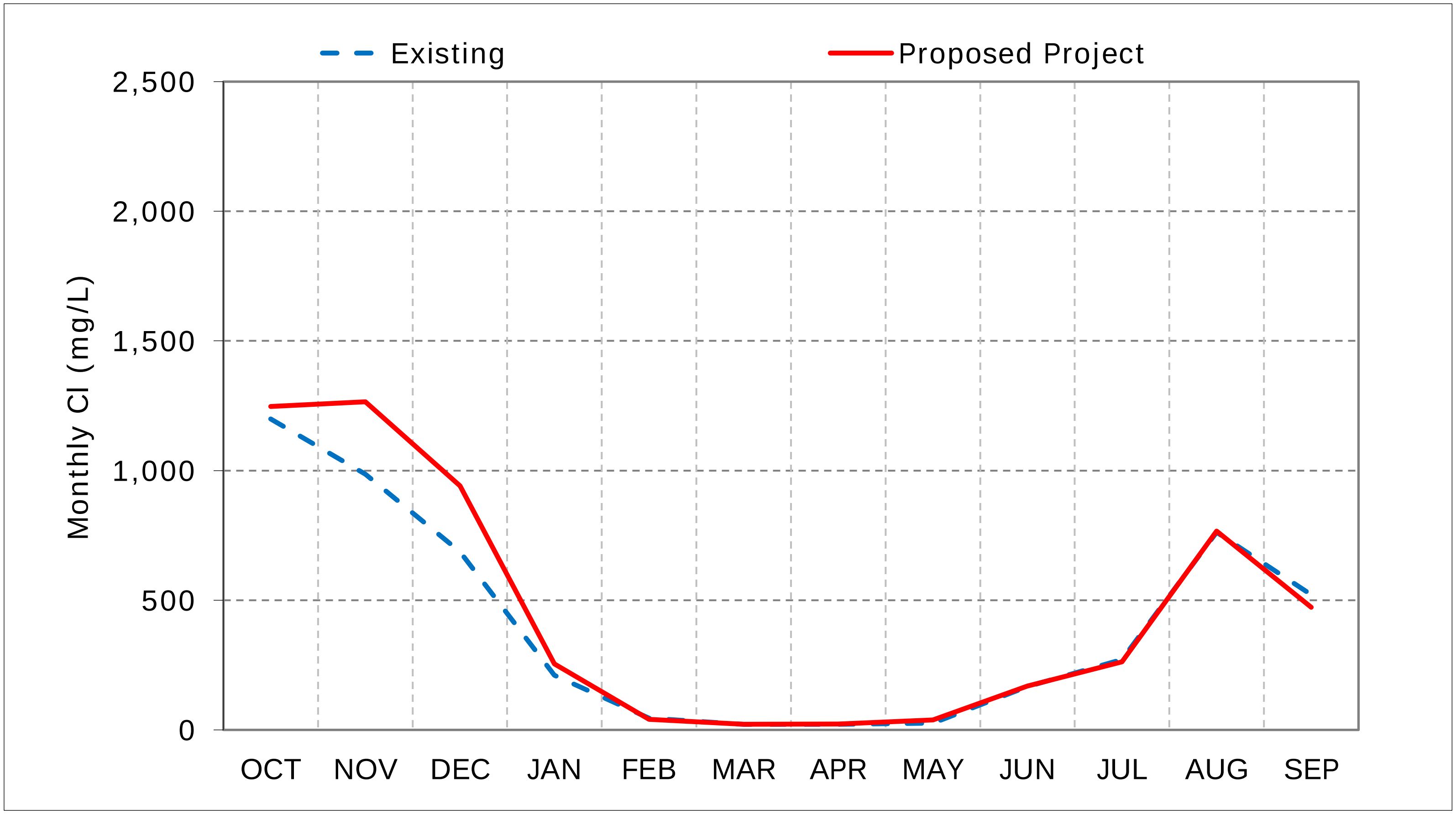
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 10-2. San Joaquin River at Antioch Chloride, Wet Year Average Cl



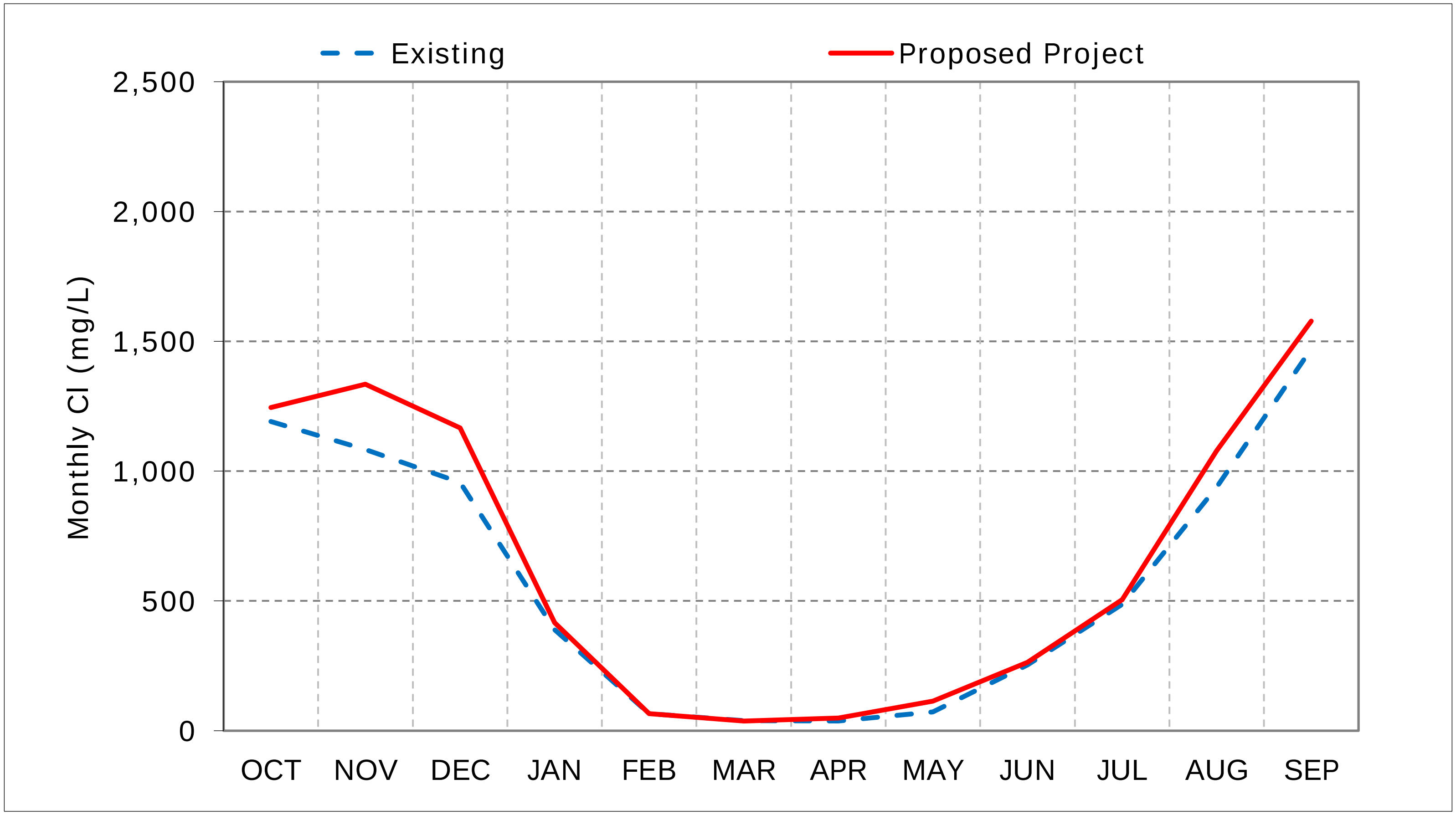
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 10-3. San Joaquin River at Antioch Chloride, Above Normal Year Average C



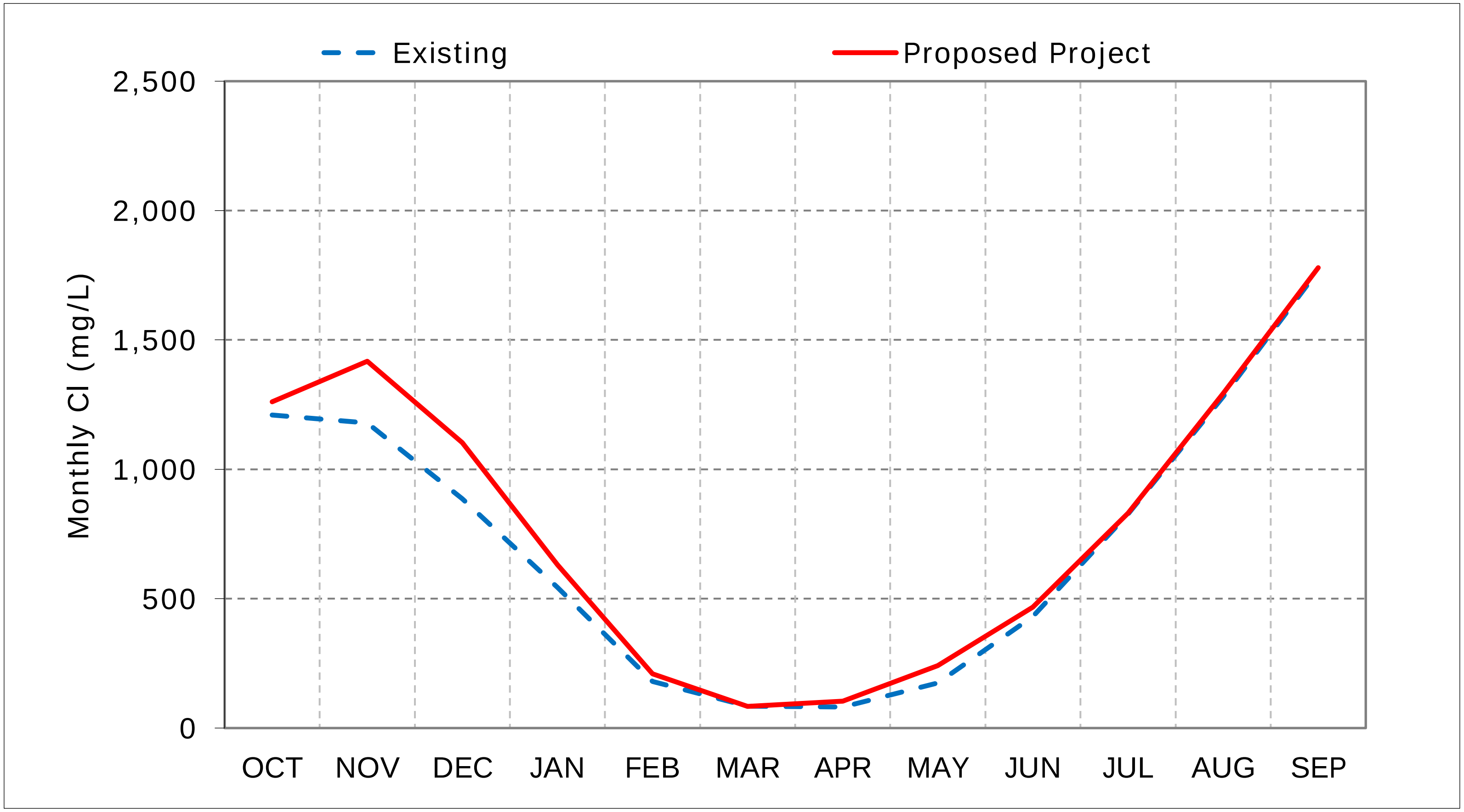
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 10-4. San Joaquin River at Antioch Chloride, Below Normal Year Average C



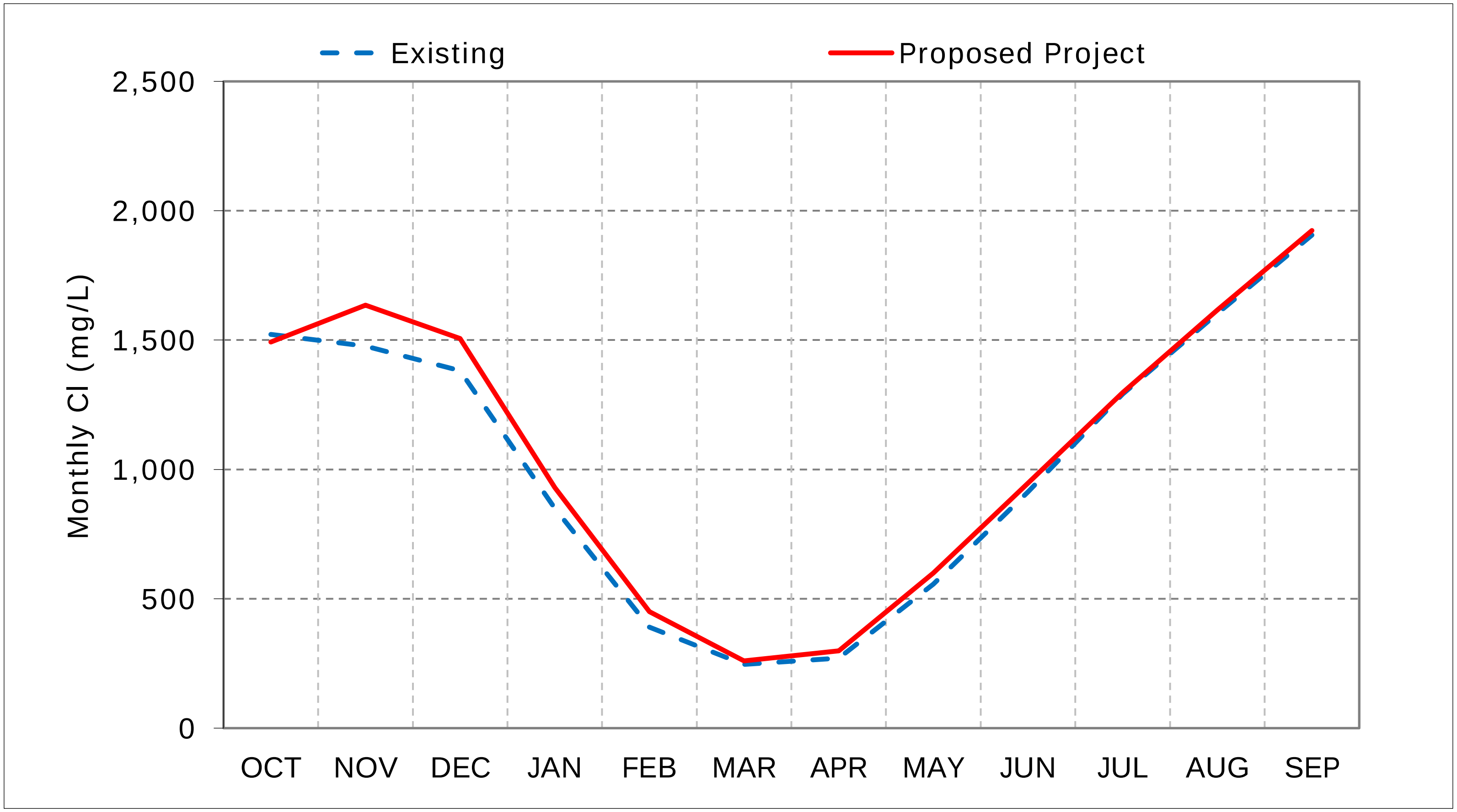
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 10-5. San Joaquin River at Antioch Chloride, Dry Year Average Cl



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 10-6. San Joaquin River at Antioch Chloride, Critical Year Average Cl



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 10-7. San Joaquin River at Antioch Chloride, January Cl

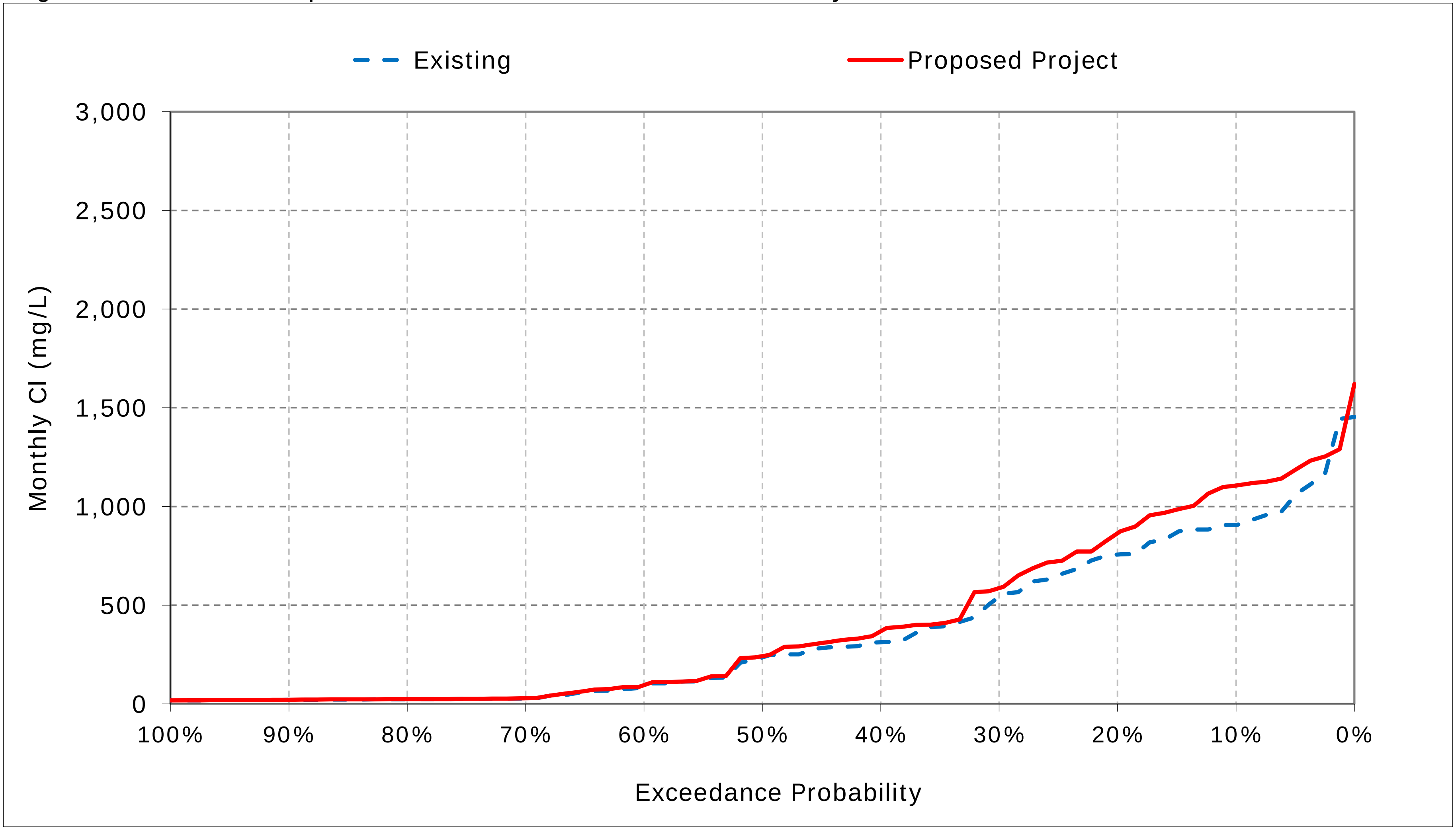


Figure 10-8. San Joaquin River at Antioch Chloride, February Cl

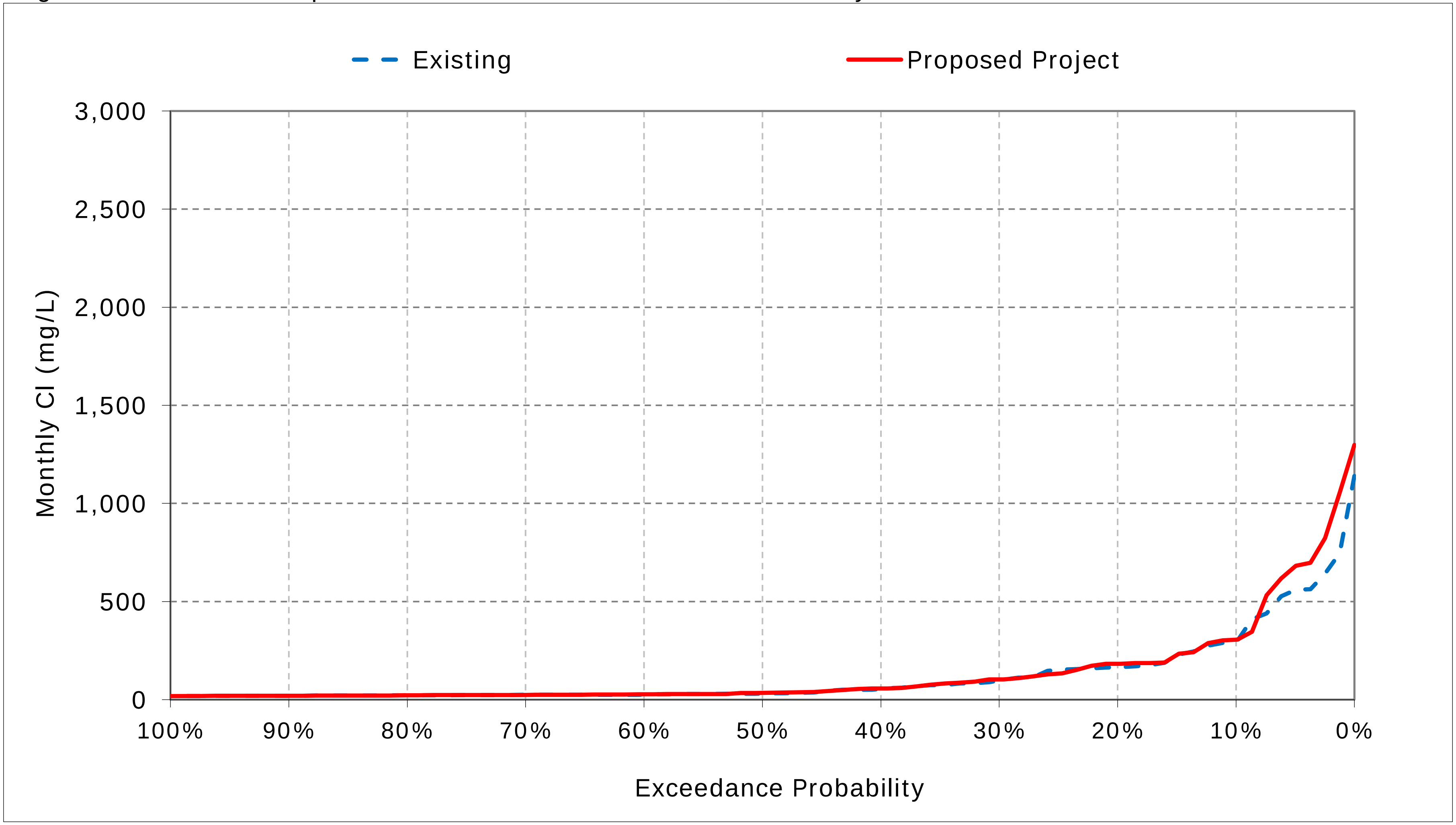


Figure 10-9. San Joaquin River at Antioch Chloride, March Cl

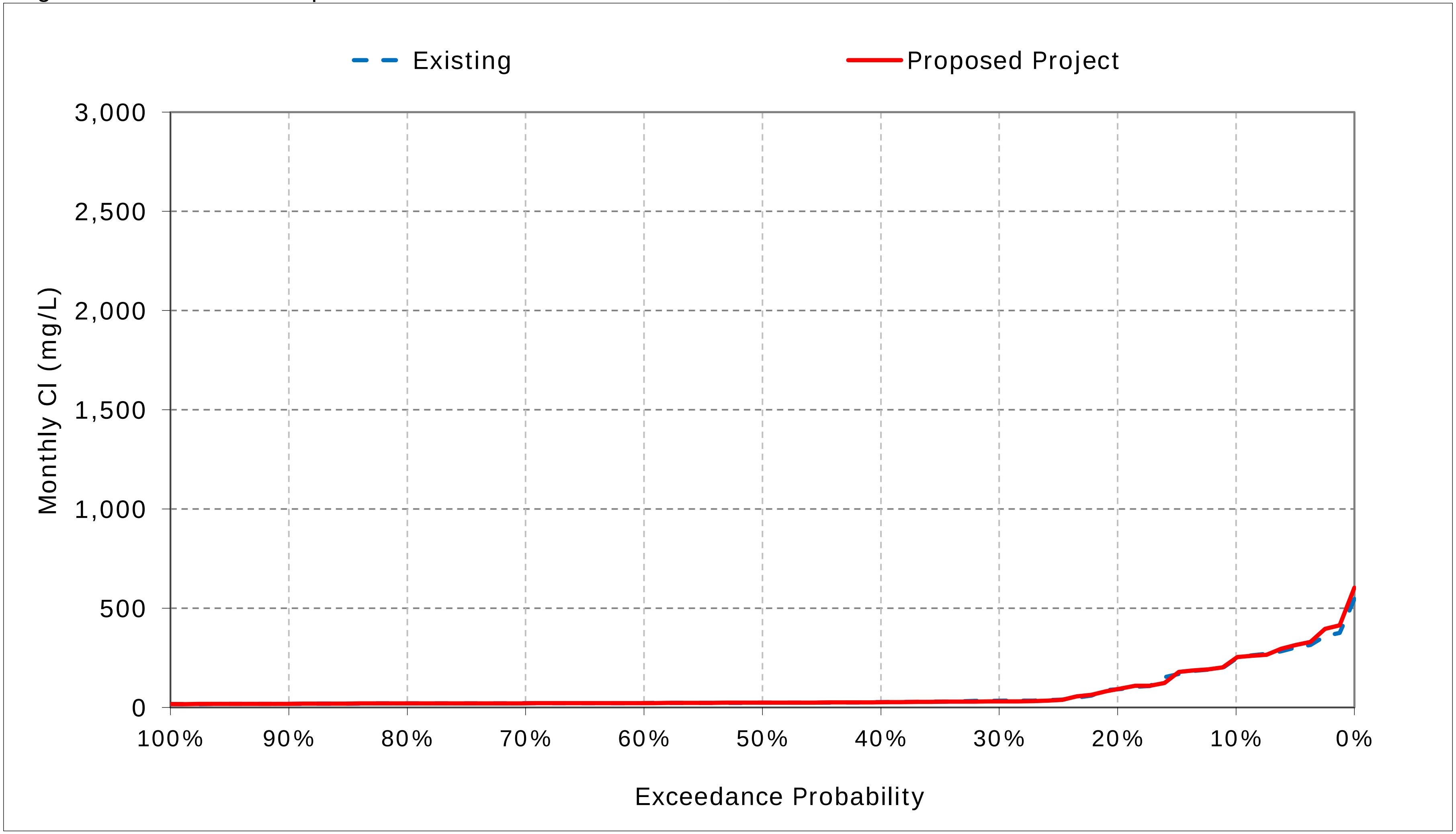


Figure 10-10. San Joaquin River at Antioch Chloride, April Cl

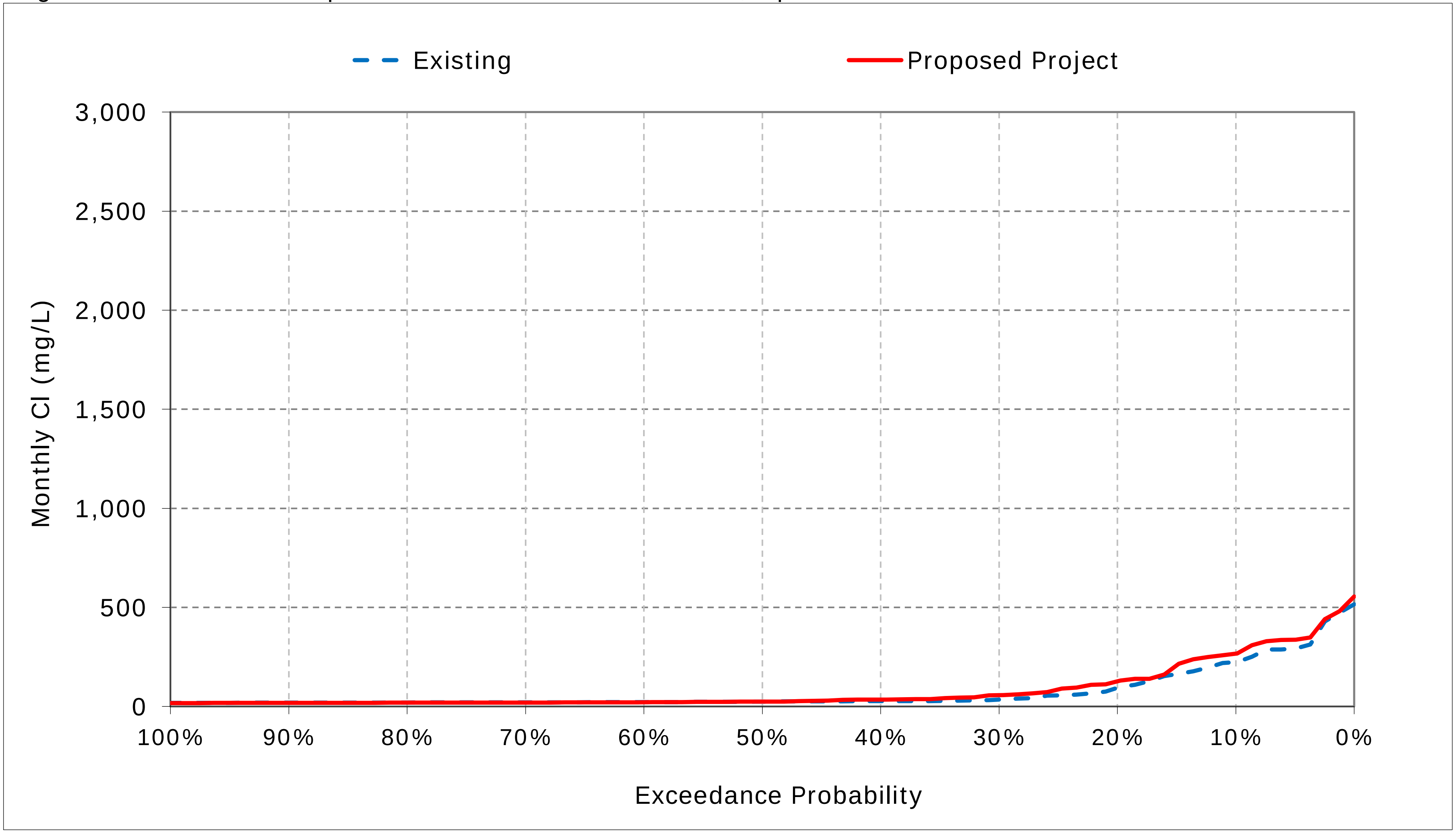


Figure 10-11. San Joaquin River at Antioch Chloride, May Cl

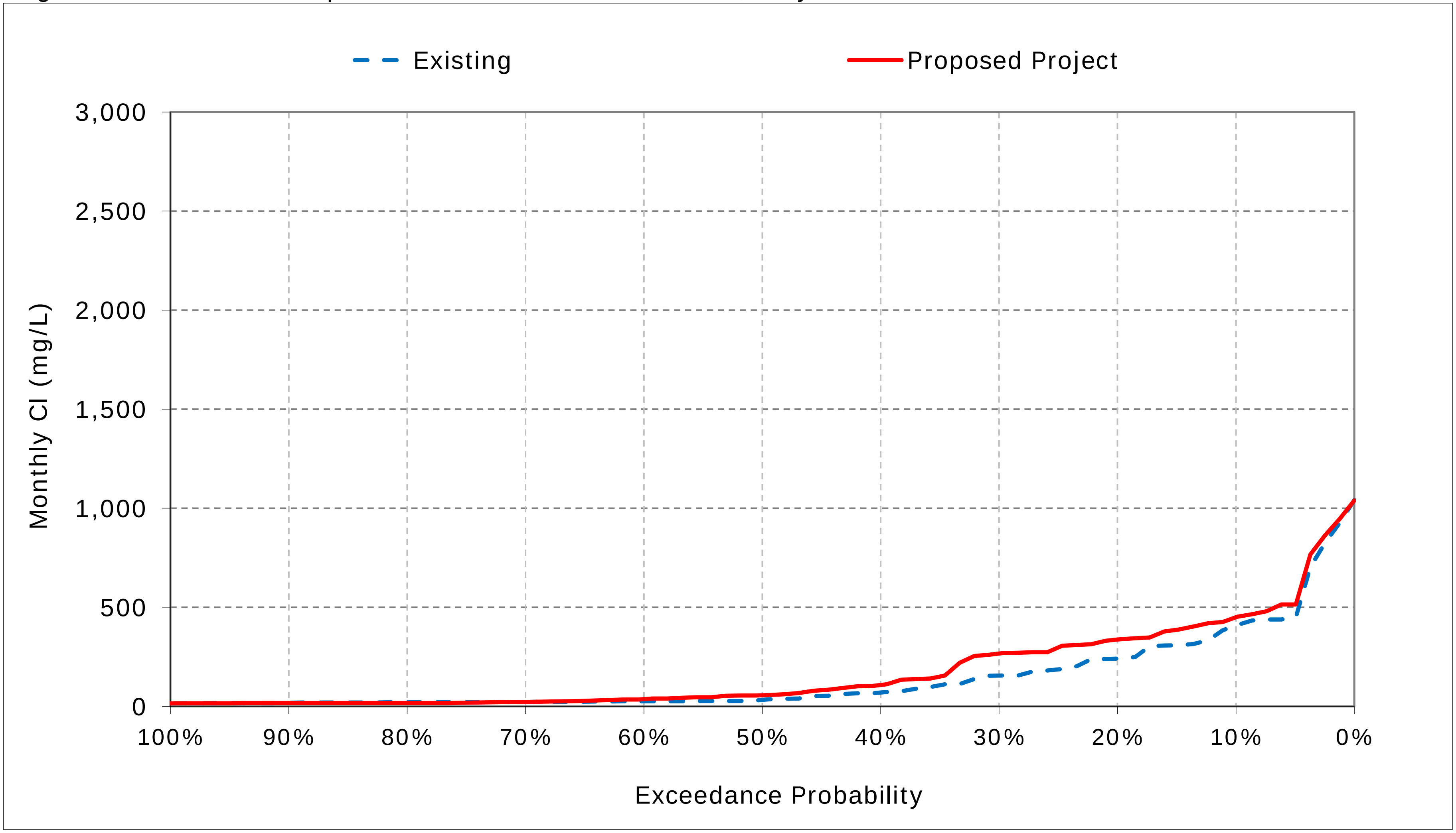


Figure 10-12. San Joaquin River at Antioch Chloride, June Cl

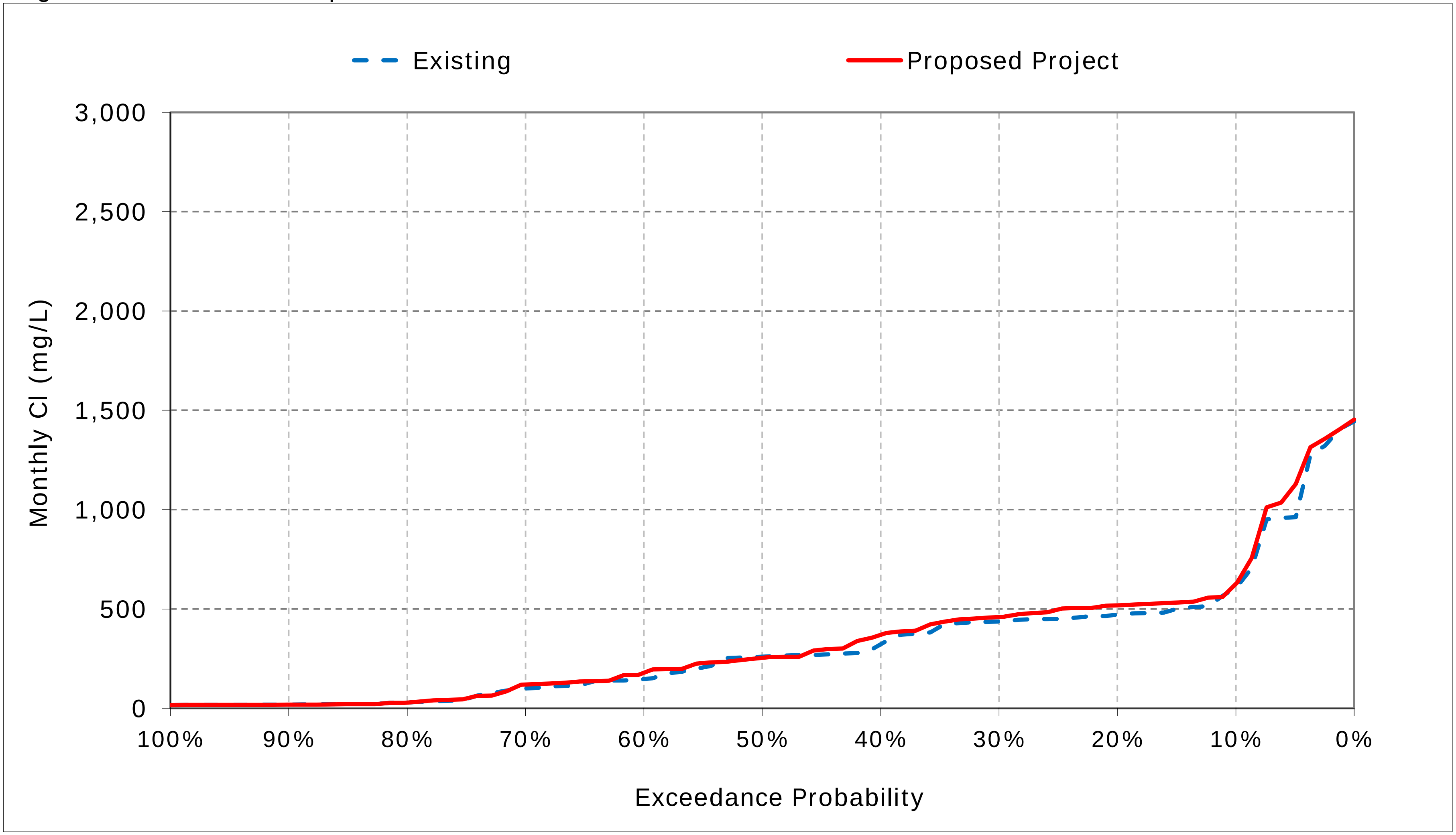


Figure 10-13. San Joaquin River at Antioch Chloride, July Cl

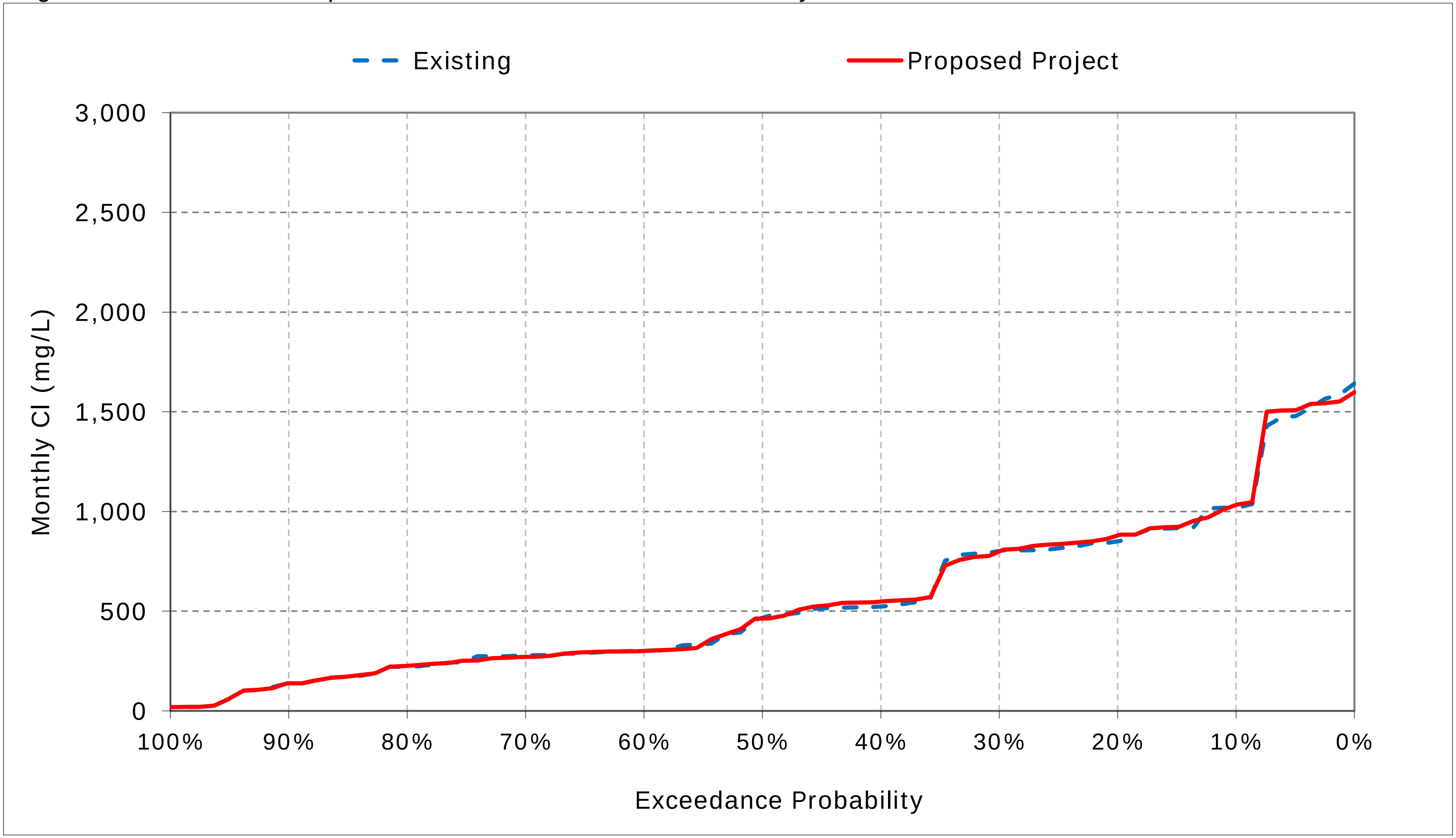


Figure 10-14. San Joaquin River at Antioch Chloride, August Cl

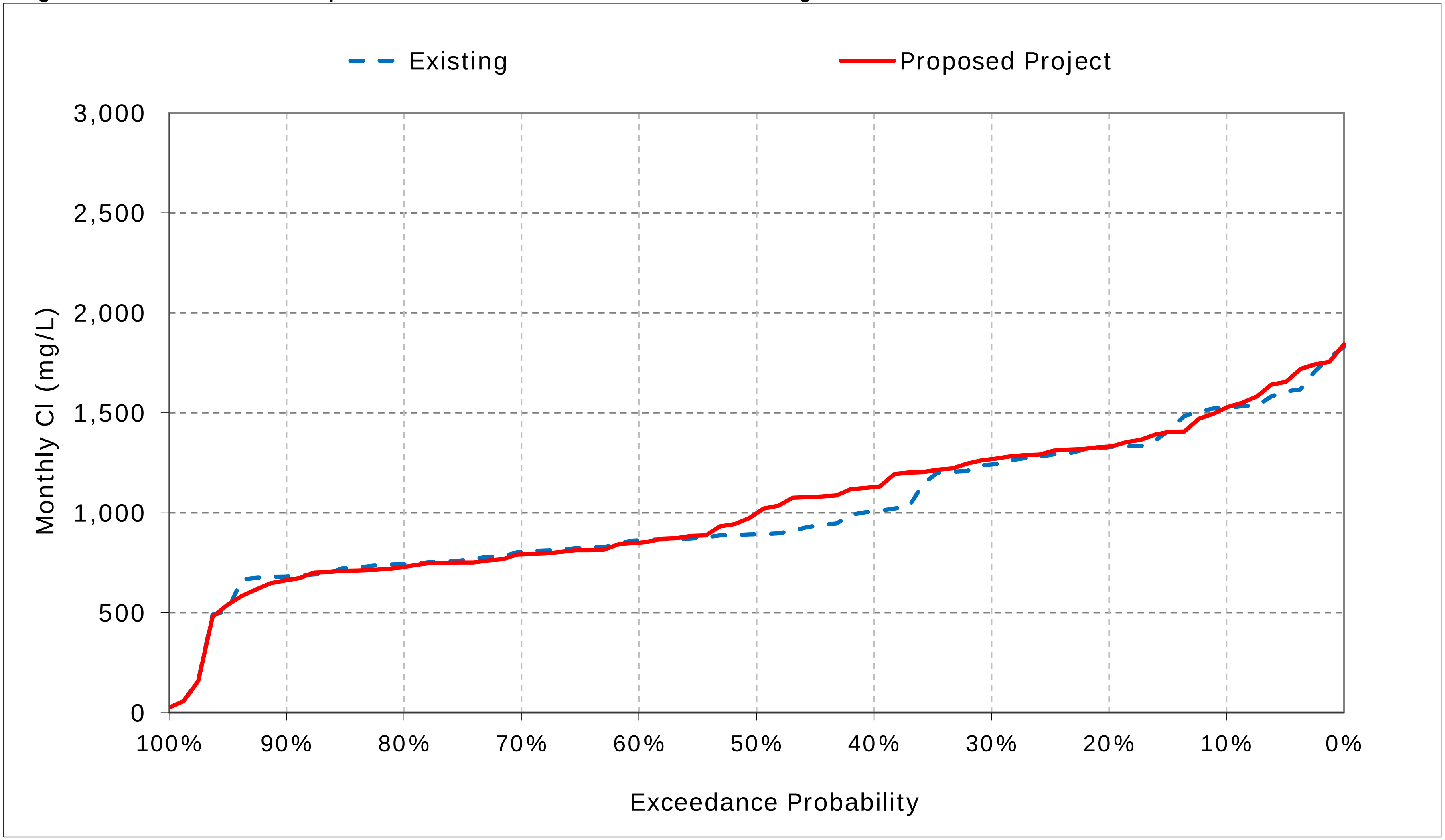


Figure 10-15. San Joaquin River at Antioch Chloride, September Cl

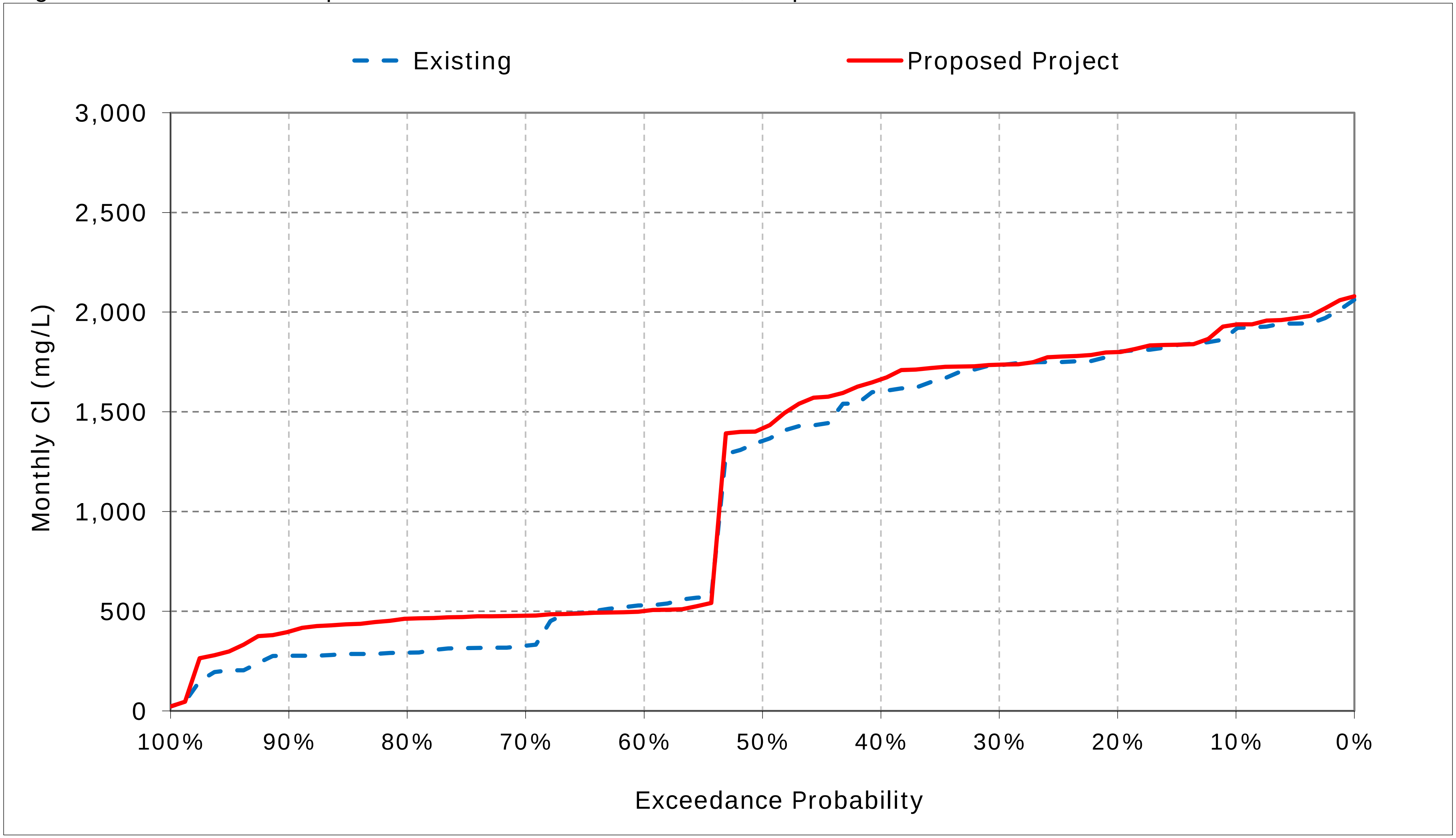


Figure 10-16. San Joaquin River at Antioch Chloride, October Cl

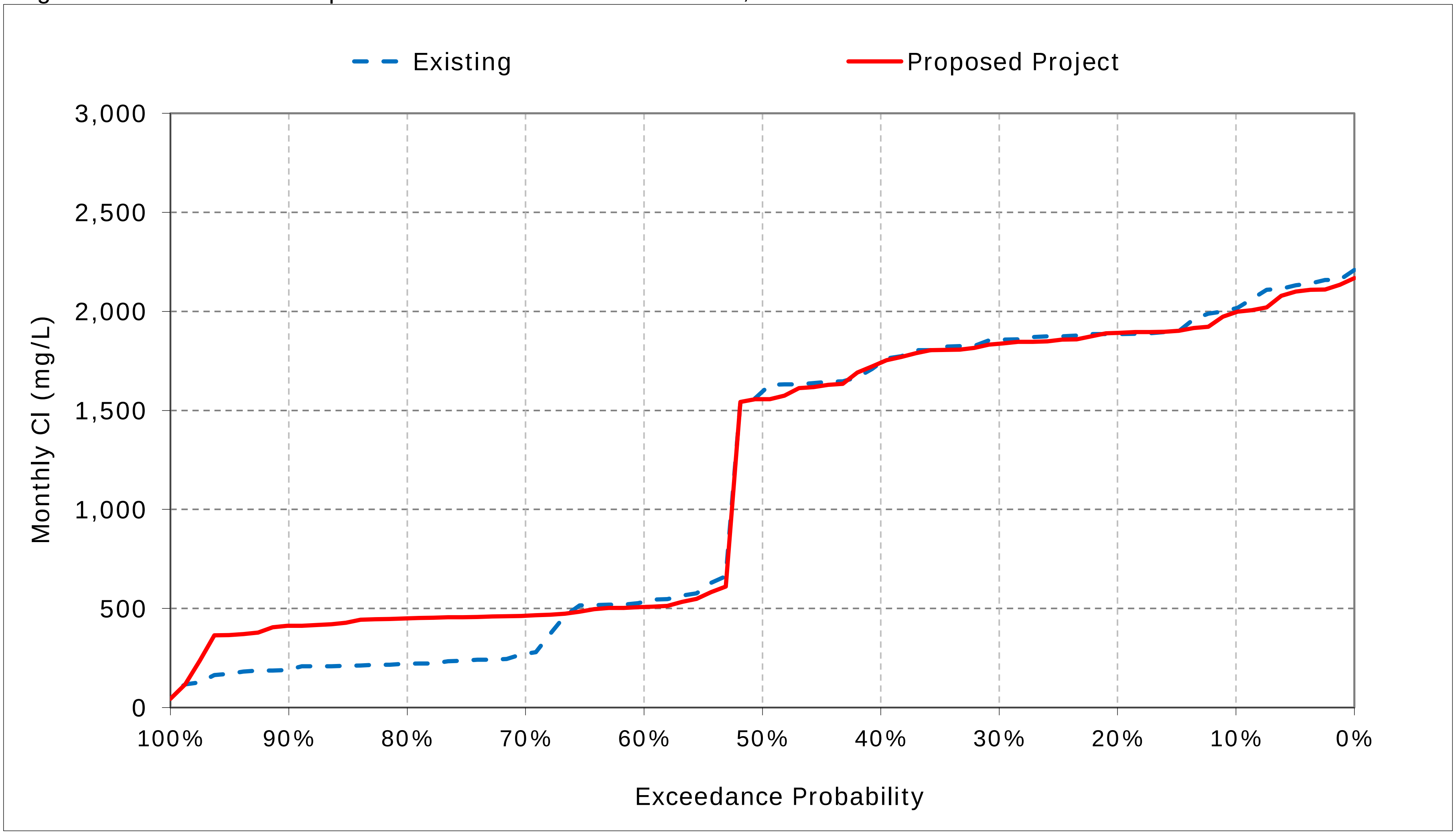


Figure 10-17. San Joaquin River at Antioch Chloride, November Cl

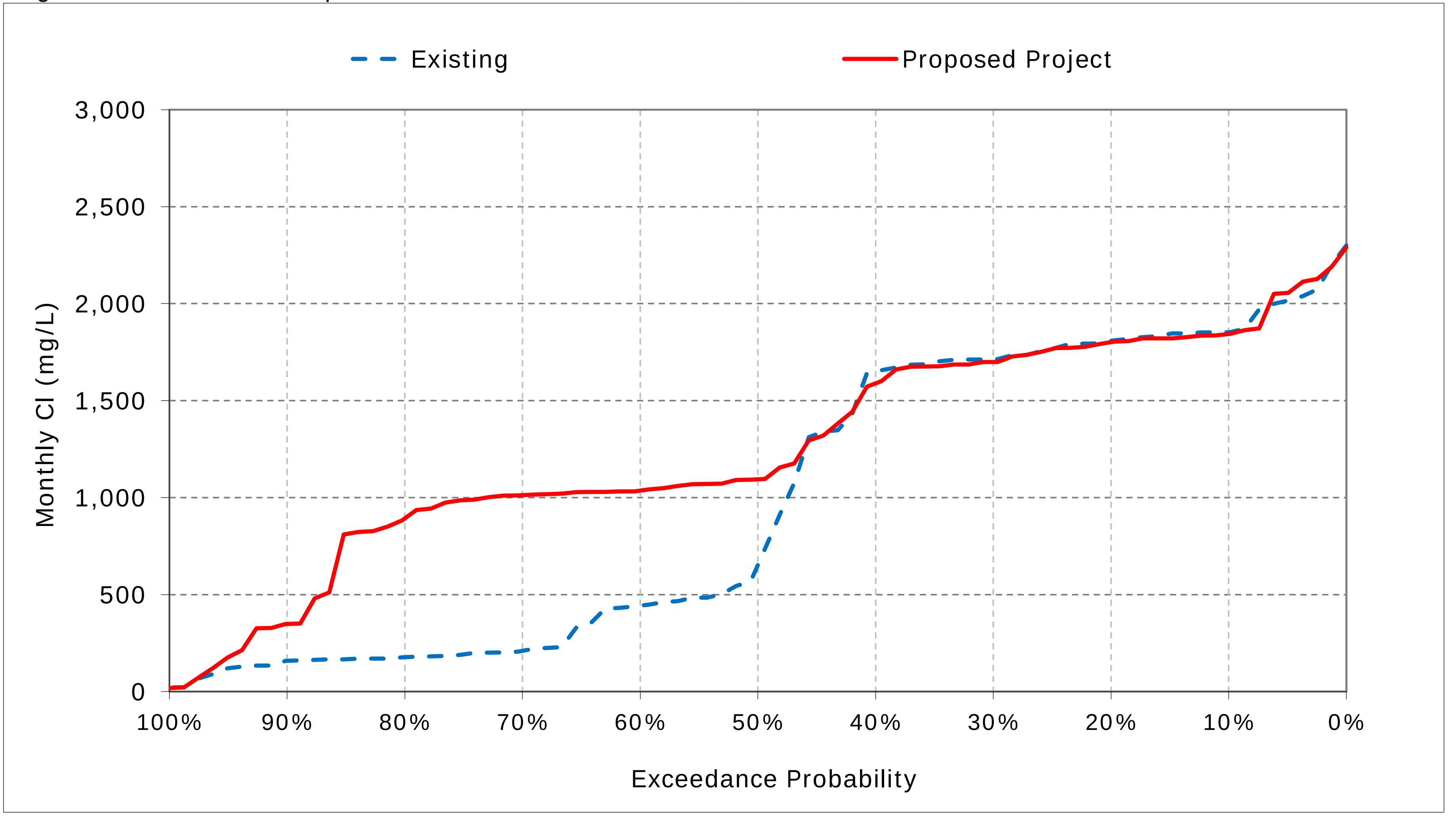


Figure 10-18. San Joaquin River at Antioch Chloride, December Cl

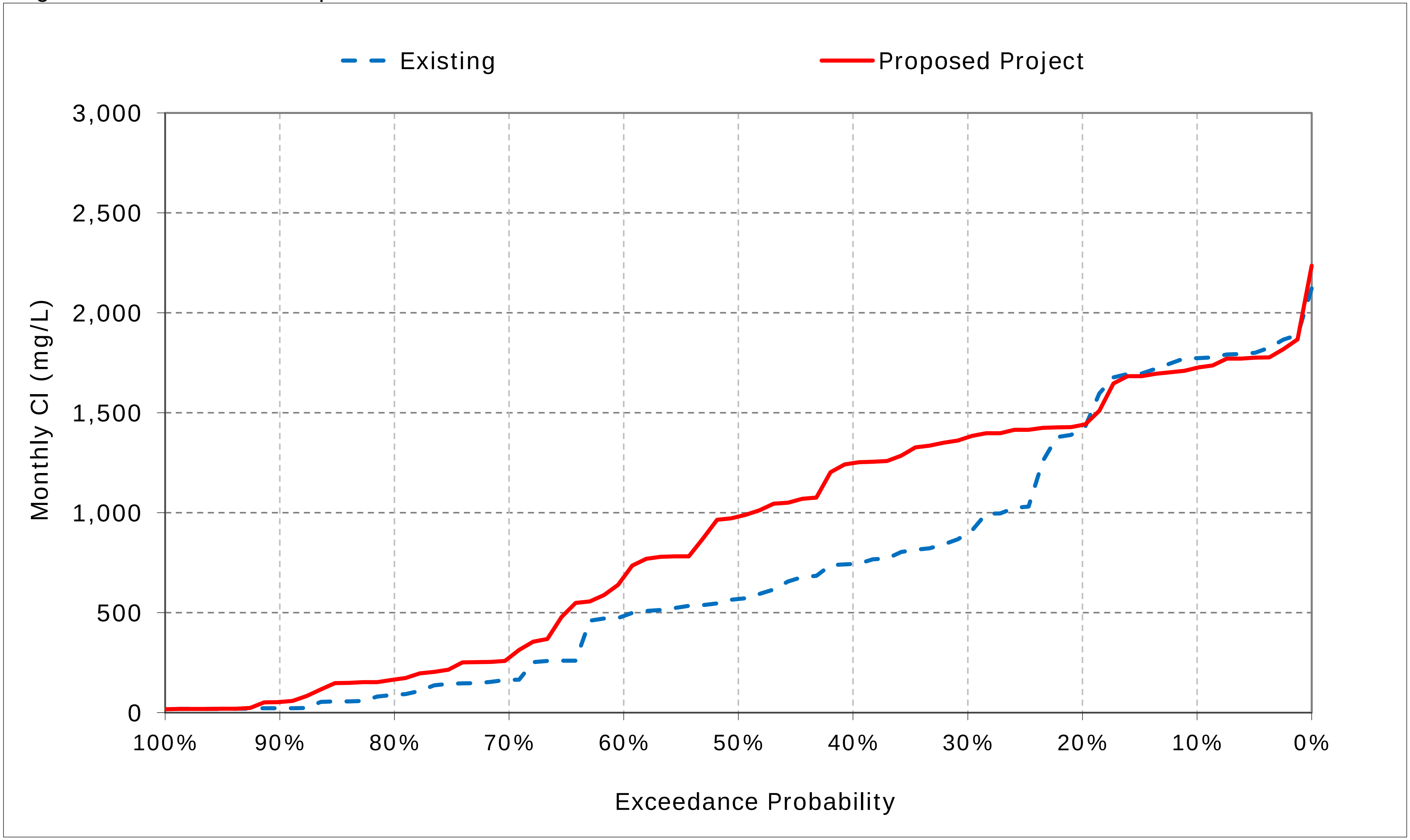


Table 11-1. Banks Pumping Plant South Delta Exports Chloride, Monthly Cl

Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Cl (mg/L)											
Probability of Exceedance												
10%	140	141	157	169	127	98	83	84	73	64	102	119
20%	133	122	145	157	112	79	73	76	59	55	74	111
30%	128	119	138	122	98	73	66	72	55	42	62	105
40%	121	113	122	110	93	67	61	68	54	40	58	101
50%	113	107	76	97	81	62	58	63	51	38	50	91
60%	52	46	56	90	76	58	52	60	49	35	43	84
70%	46	39	44	80	69	53	49	53	47	30	39	80
80%	39	36	37	69	64	46	38	45	43	29	37	72
90%	34	34	34	60	49	39	28	23	34	28	34	64
Long Term												
Full Simulation Period[a]	89	84	92	108	86	64	57	60	52	43	57	90
Water Year Types[b]												
Wet (32%)	74	66	67	74	63	47	38	40	40	32	37	75
Above Normal (15%)	101	92	93	108	91	63	53	57	49	32	38	68
Below Normal (17%)	92	86	102	126	88	65	59	64	51	35	59	111
Dry (22%)	88	89	104	116	95	74	70	74	57	47	77	98
Critical (15%)	106	105	118	151	117	89	80	82	77	78	89	108

Proposed Project

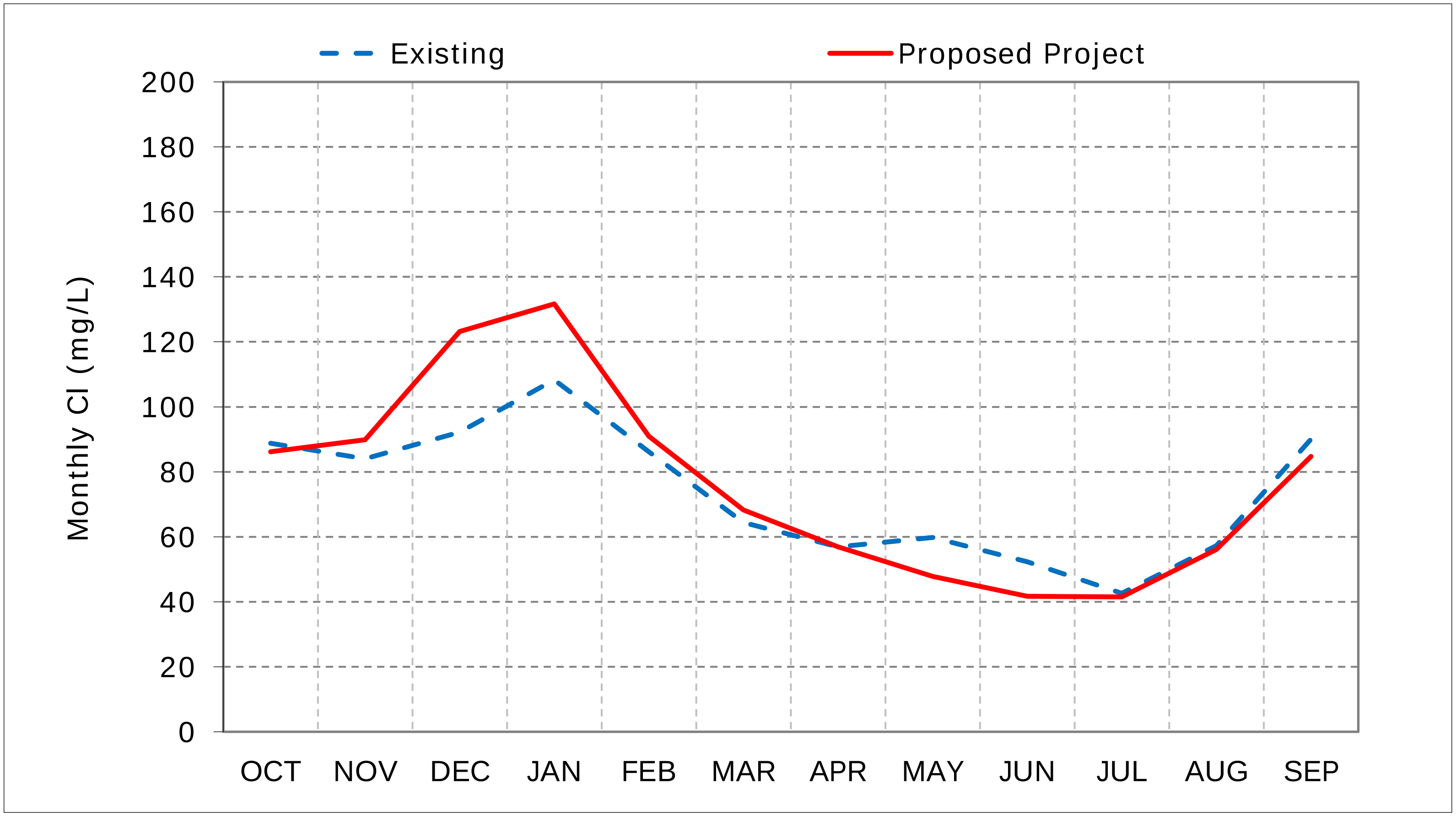
Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Cl (mg/L)											
Probability of Exceedance												
10%	149	136	164	210	145	99	79	70	58	64	102	123
20%	138	130	152	192	125	88	74	61	46	52	69	117
30%	131	118	148	168	109	81	67	57	42	41	61	107
40%	120	115	140	156	97	72	63	49	39	39	56	92
50%	118	109	133	121	93	65	59	45	38	36	49	80
60%	34	63	128	101	77	62	50	41	37	34	44	71
70%	32	53	115	91	69	55	45	39	34	30	38	64
80%	30	44	92	73	60	46	39	36	32	28	36	60
90%	29	38	49	64	46	42	31	27	30	27	31	53
Long Term												
Full Simulation Period[a]	86	90	123	132	91	68	57	48	42	42	56	85
Water Year Types[b]												
Wet (32%)	70	73	95	84	62	48	37	31	33	32	36	54
Above Normal (15%)	98	105	137	149	98	69	51	40	36	31	38	65
Below Normal (17%)	88	91	130	151	91	69	59	47	36	33	57	120
Dry (22%)	85	92	135	150	105	80	72	59	43	46	74	98
Critical (15%)	108	106	145	168	126	93	80	76	70	78	91	111

Proposed Project minus Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Cl (mg/L)											
Probability of Exceedance												
10%	9	-4	7	41	18	2	-4	-13	-15	-1	0	4
20%	5	7	6	35	14	9	0	-15	-13	-3	-5	5
30%	3	0	10	46	11	8	1	-15	-13	-1	-1	1
40%	0	3	18	46	4	6	2	-19	-15	-1	-2	-9
50%	4	2	58	24	12	3	2	-18	-13	-2	-1	-11
60%	-18	17	73	11	0	3	-3	-18	-12	-1	0	-14
70%	-14	15	71	11	0	2	-4	-14	-13	0	0	-16
80%	-10	9	55	4	-3	0	0	-9	-11	-1	0	-12
90%	-5	4	15	4	-3	3	3	4	-4	-1	-3	-12
Long Term												
Full Simulation Period[a]	-3	6	31	23	5	4	0	-12	-11	-1	-1	-5
Water Year Types[b]												
Wet (32%)	-4	7	28	10	-1	1	0	-9	-7	0	-1	-22
Above Normal (15%)	-2	12	45	41	7	6	-2	-17	-13	-1	0	-2
Below Normal (17%)	-4	5	28	25	3	3	-1	-17	-15	-3	-2	9
Dry (22%)	-3	3	31	34	9	6	2	-14	-14	-1	-3	0
Critical (15%)	2	1	27	17	10	5	0	-6	-7	-1	2	3

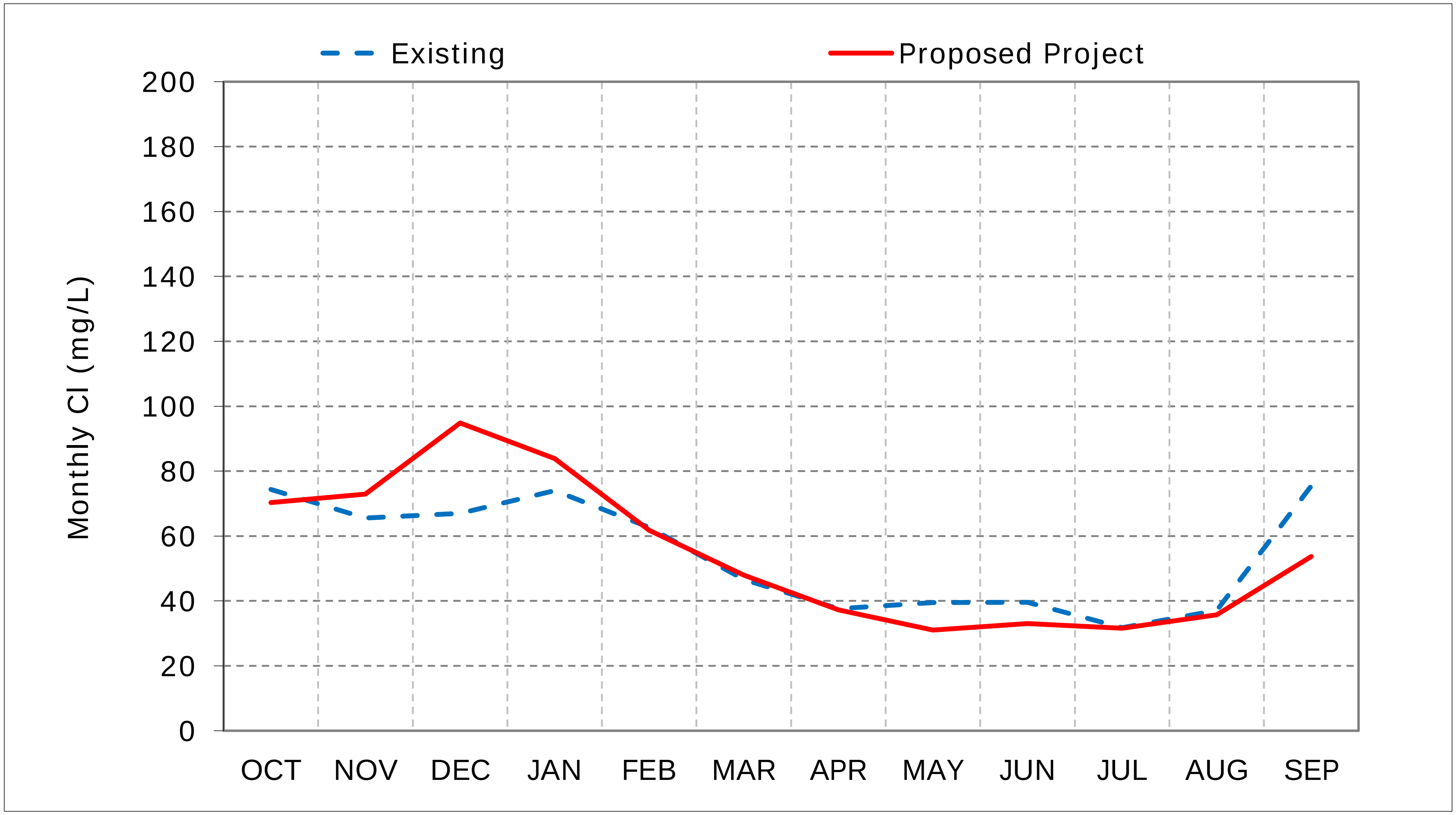
a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with water year - year type sorting.
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 11-1. Banks Pumping Plant South Delta Exports Chloride, Long-Term Avera



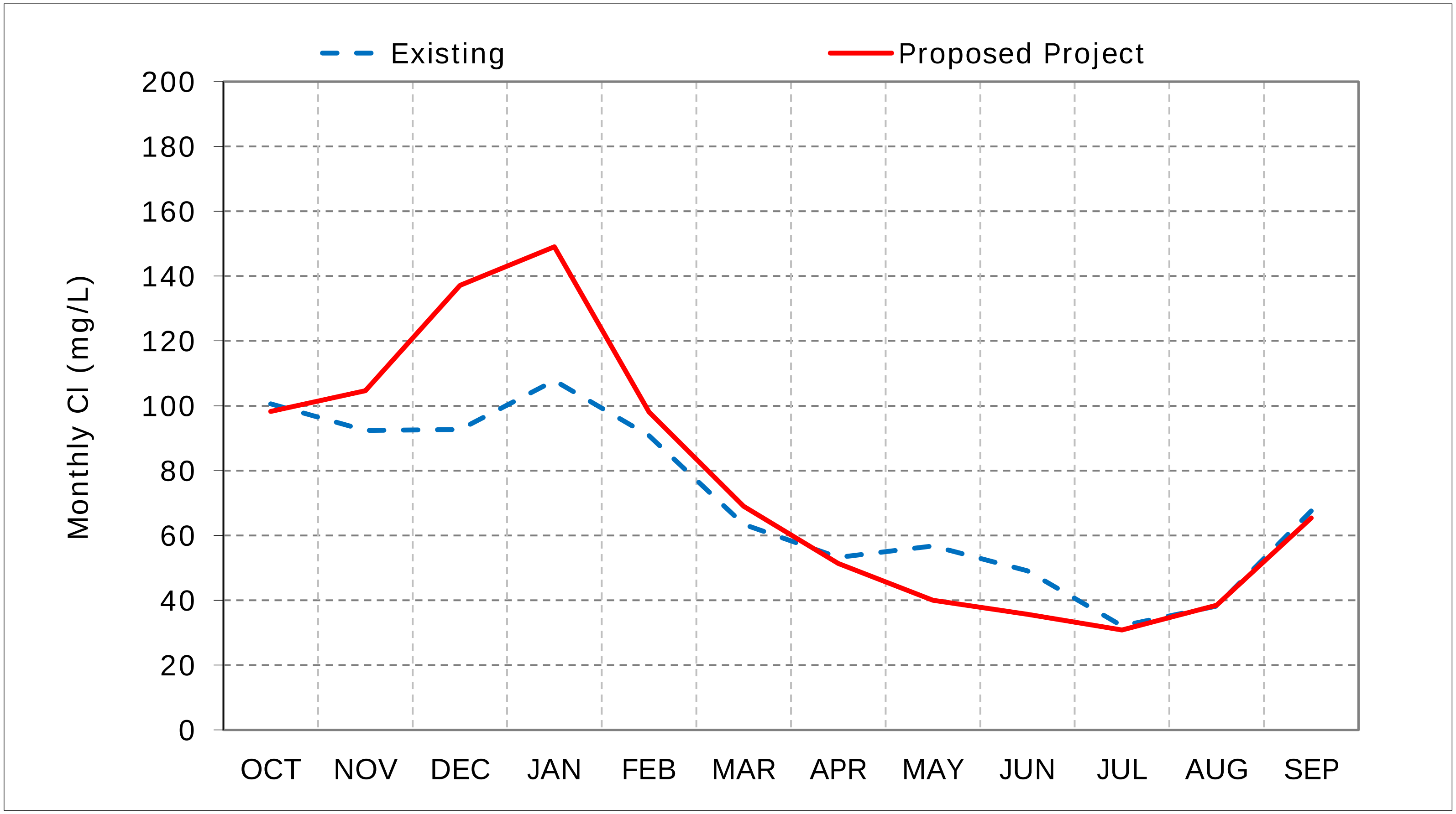
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 11-2. Banks Pumping Plant South Delta Exports Chloride, Wet Year Averag



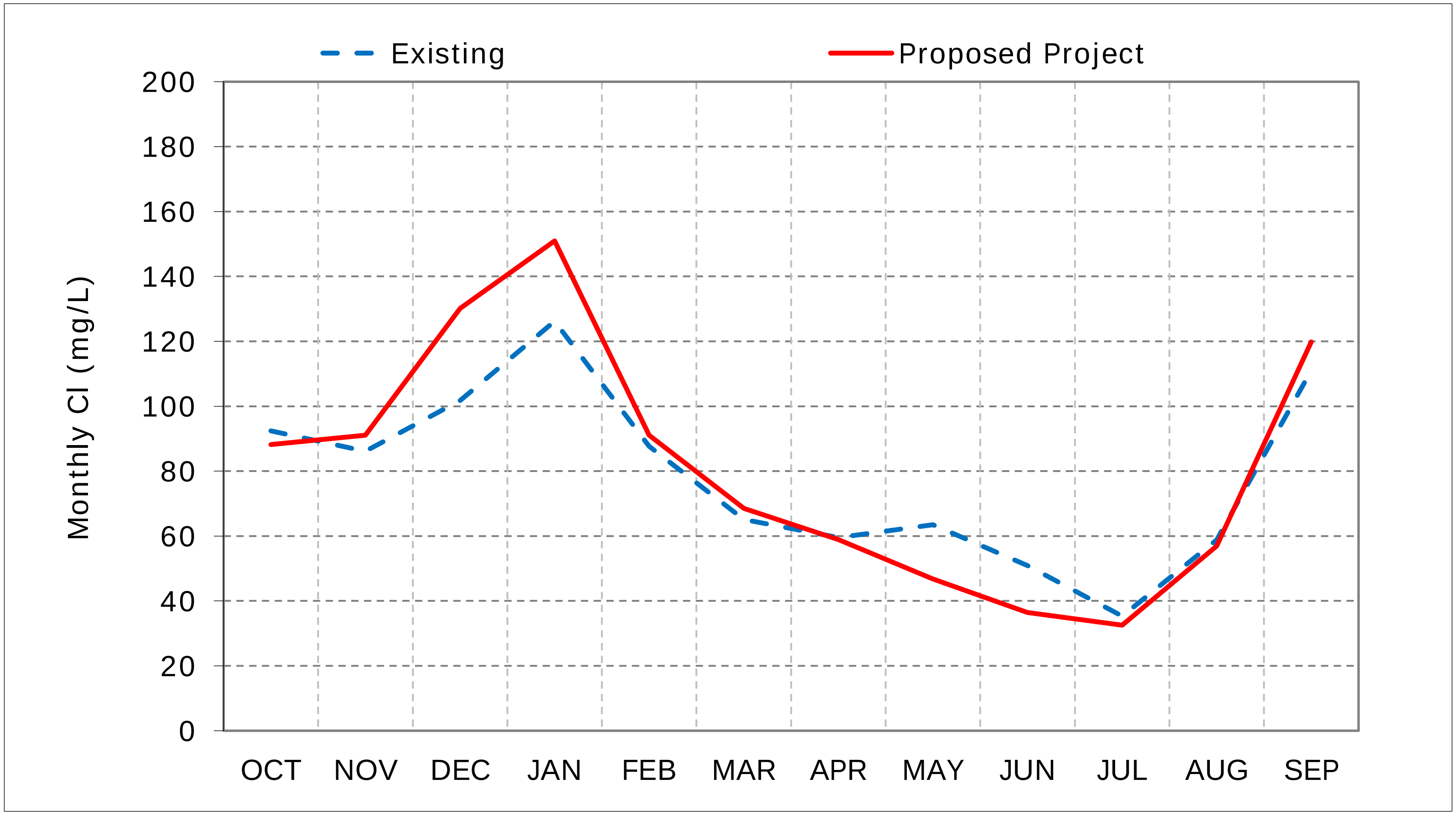
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 11-3. Banks Pumping Plant South Delta Exports Chloride, Above Normal Ye



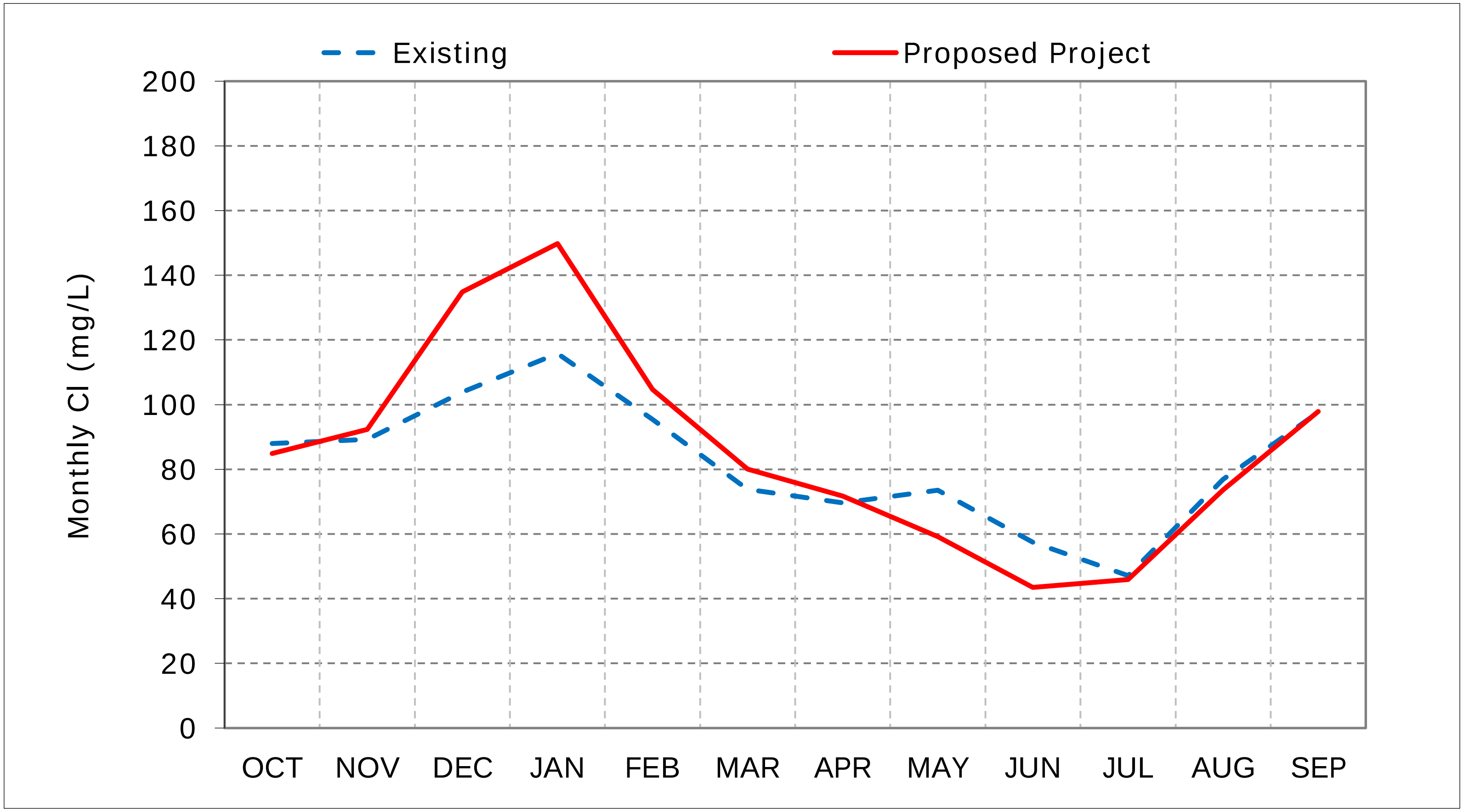
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 11-4. Banks Pumping Plant South Delta Exports Chloride, Below Normal Ye



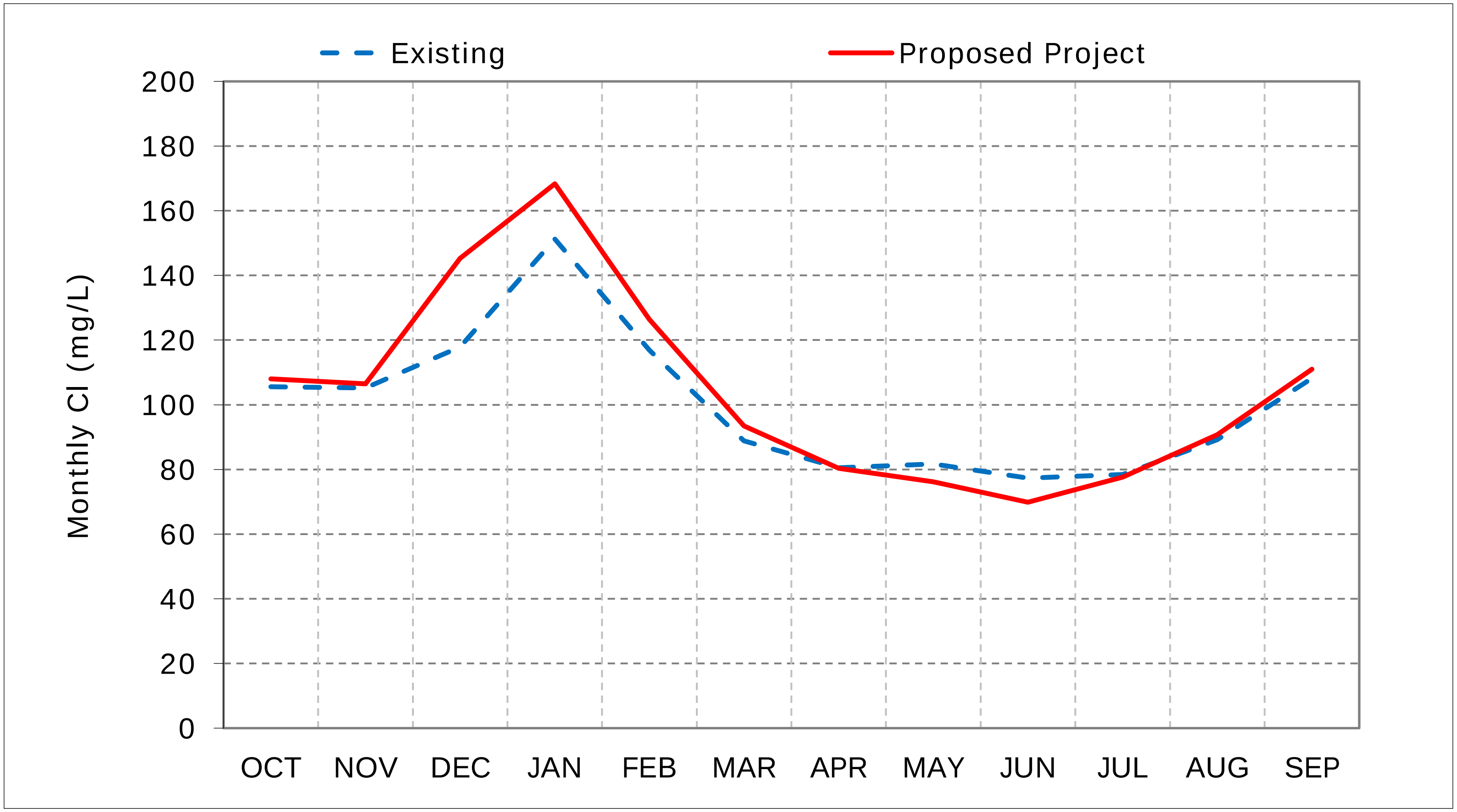
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 11-5. Banks Pumping Plant South Delta Exports Chloride, Dry Year Average



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 11-6. Banks Pumping Plant South Delta Exports Chloride, Critical Year Aver



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 11-7. Banks Pumping Plant South Delta Exports Chloride, January Cl

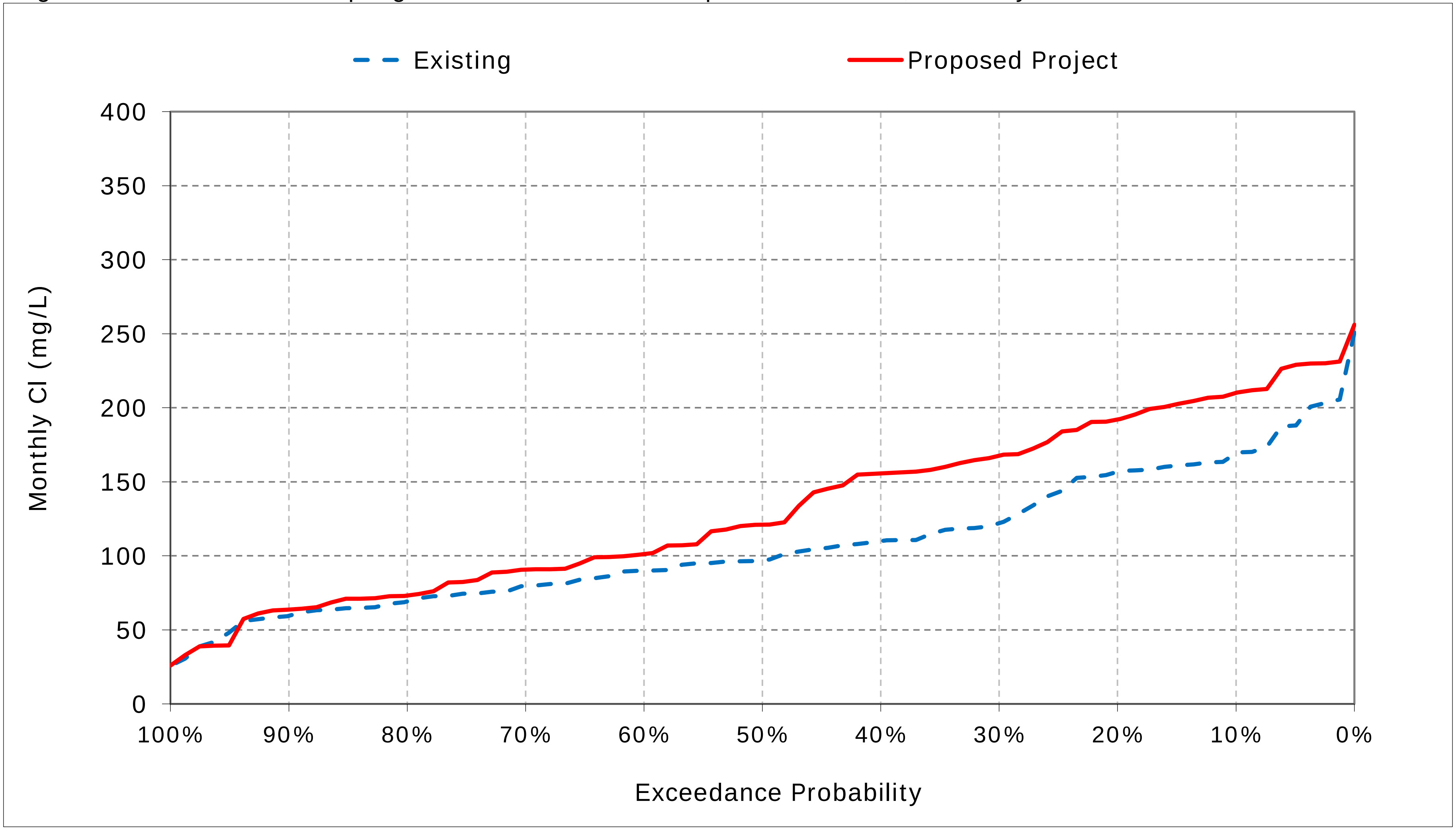


Figure 11-8. Banks Pumping Plant South Delta Exports Chloride, February Cl

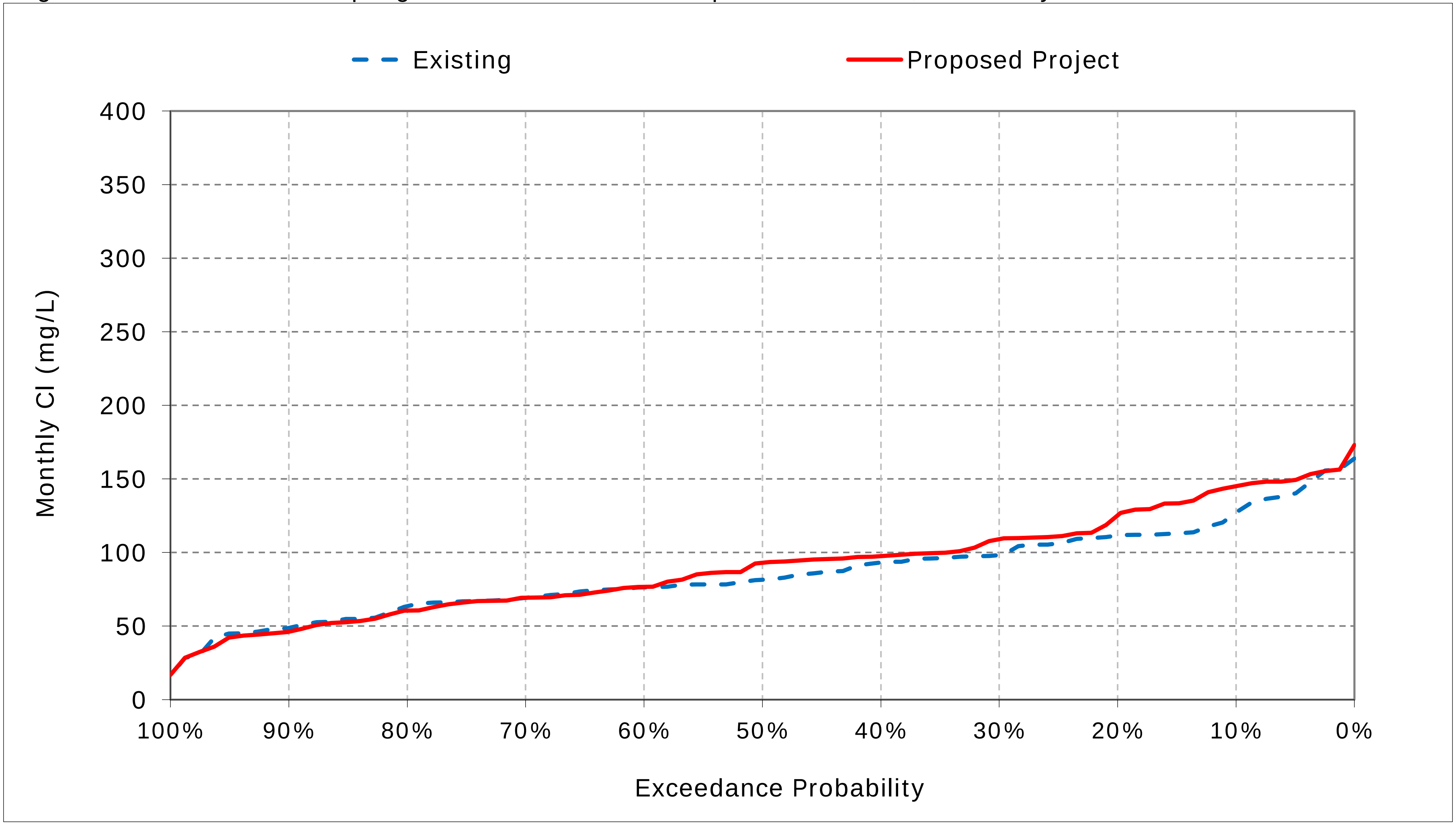


Figure 11-9. Banks Pumping Plant South Delta Exports Chloride, March Cl

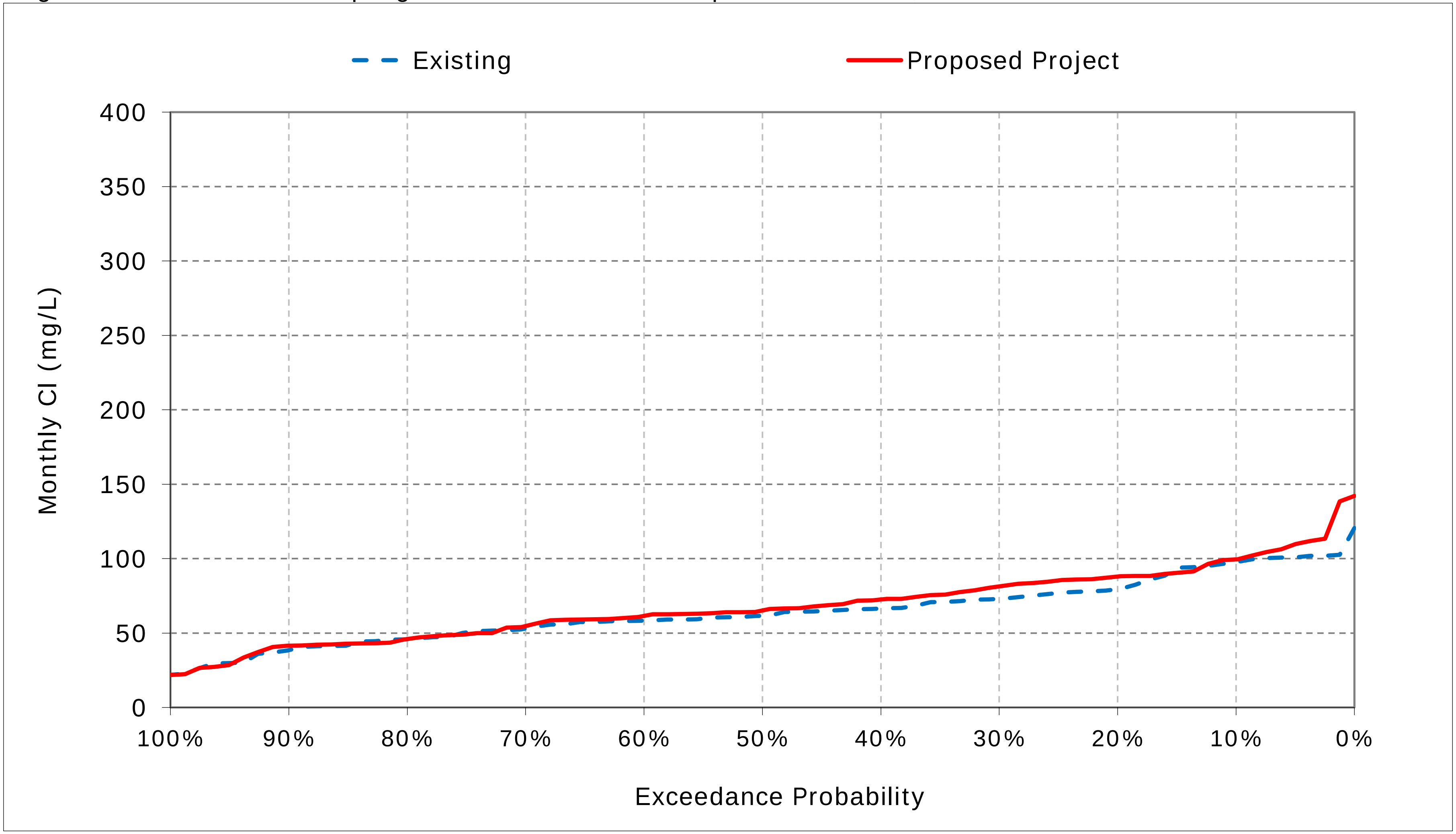


Figure 11-10. Banks Pumping Plant South Delta Exports Chloride, April Cl

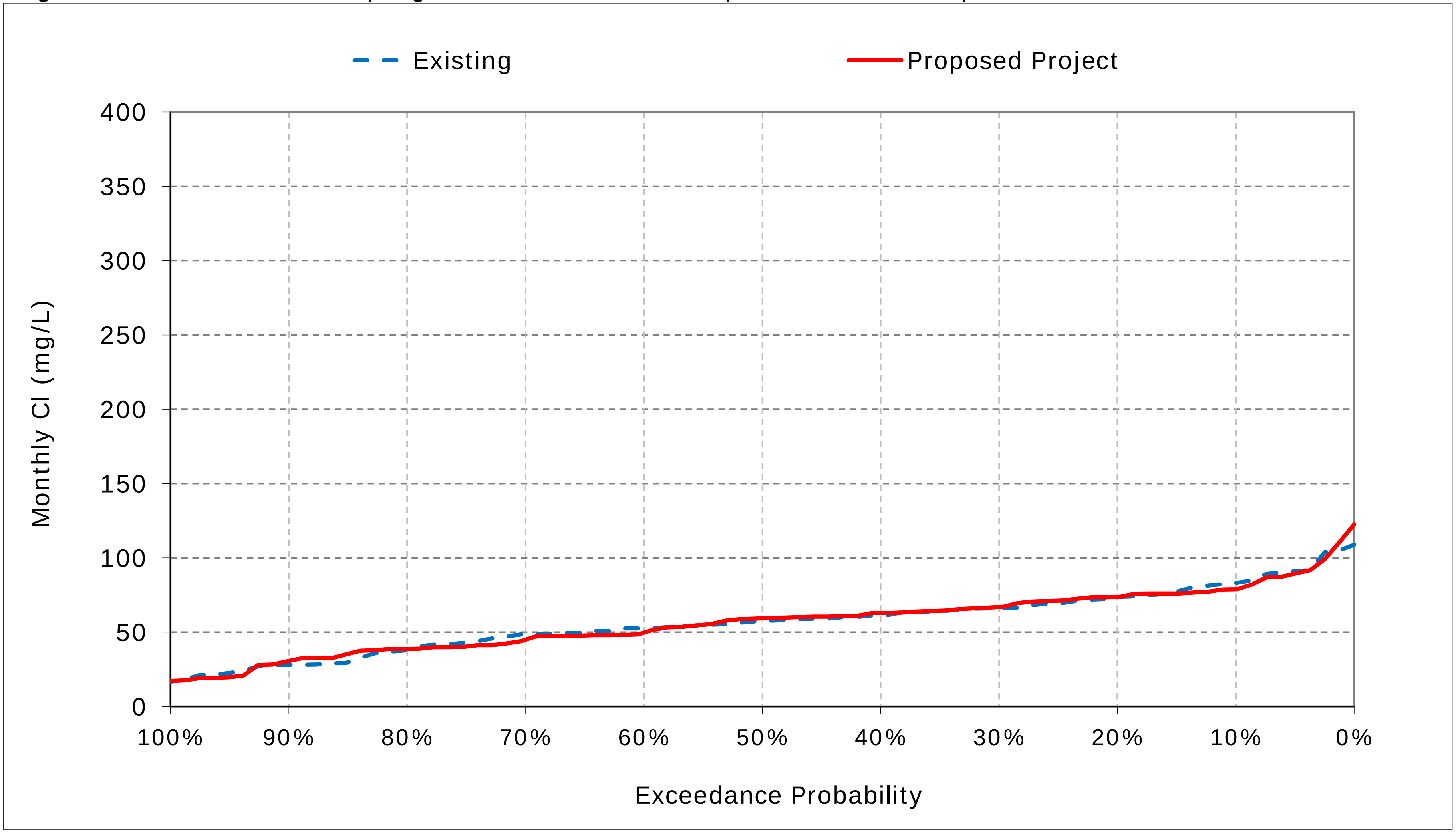


Figure 11-11. Banks Pumping Plant South Delta Exports Chloride, May Cl

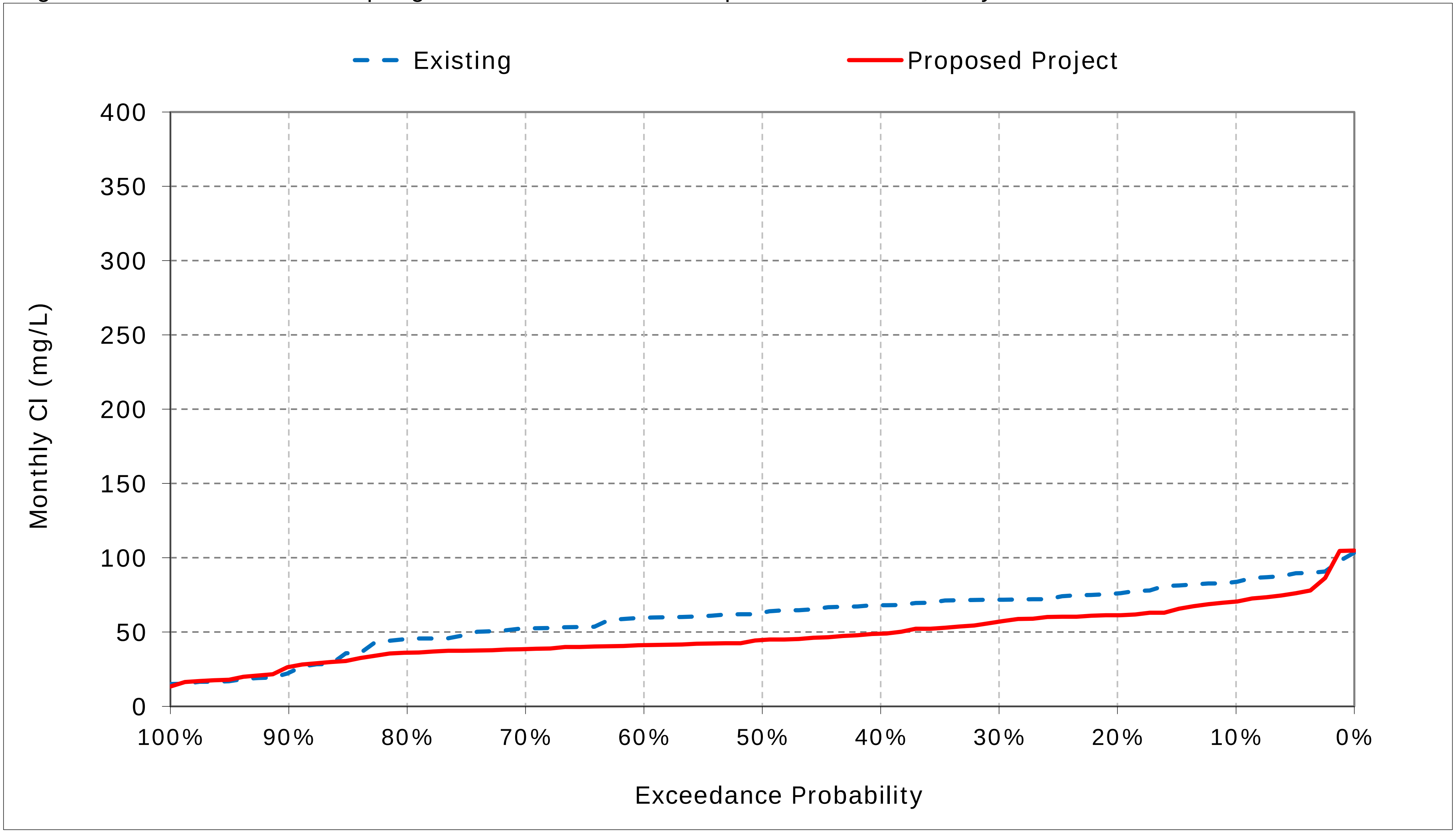


Figure 11-12. Banks Pumping Plant South Delta Exports Chloride, June Cl

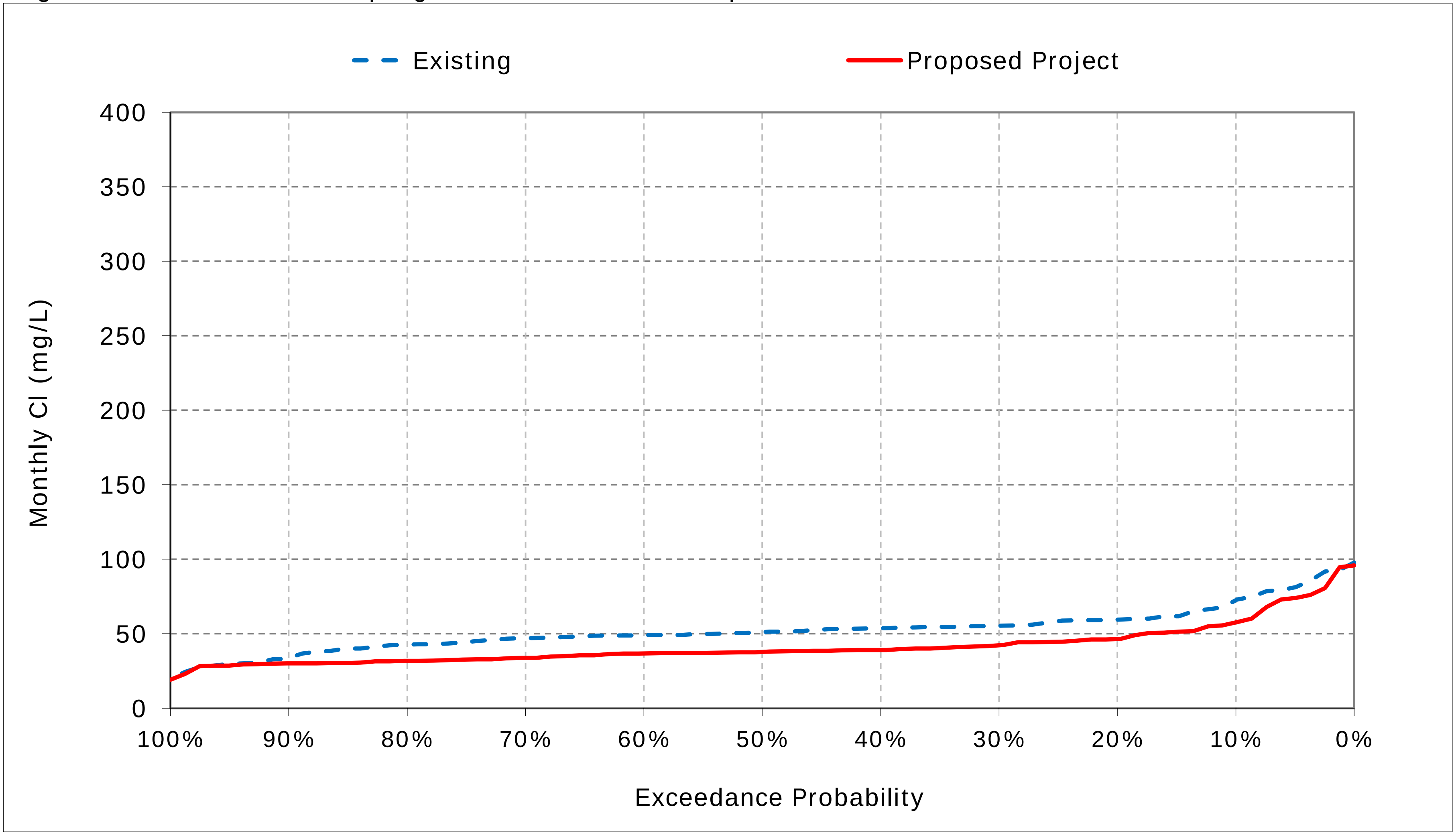


Figure 11-13. Banks Pumping Plant South Delta Exports Chloride, July Cl

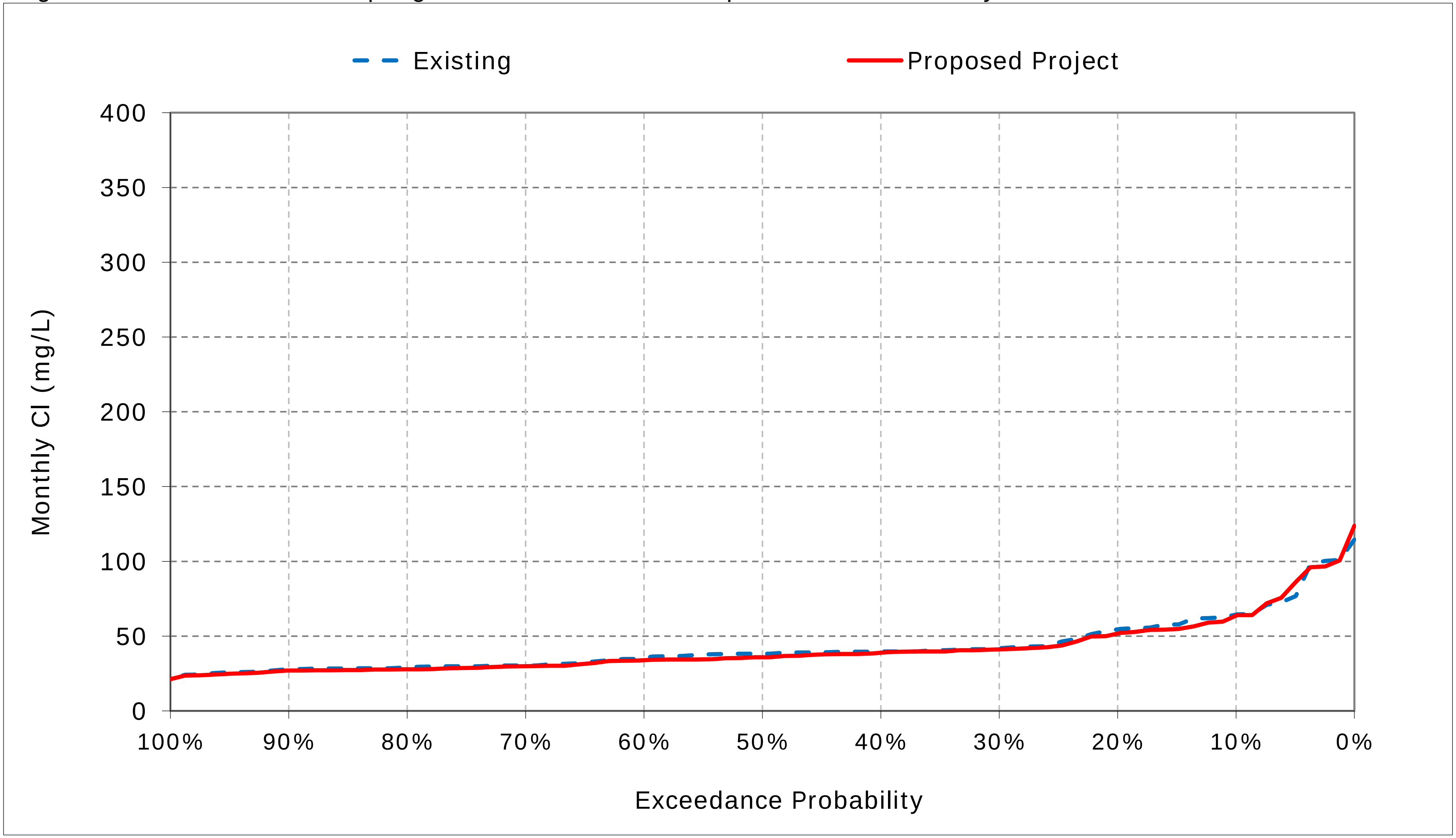


Figure 11-14. Banks Pumping Plant South Delta Exports Chloride, August Cl

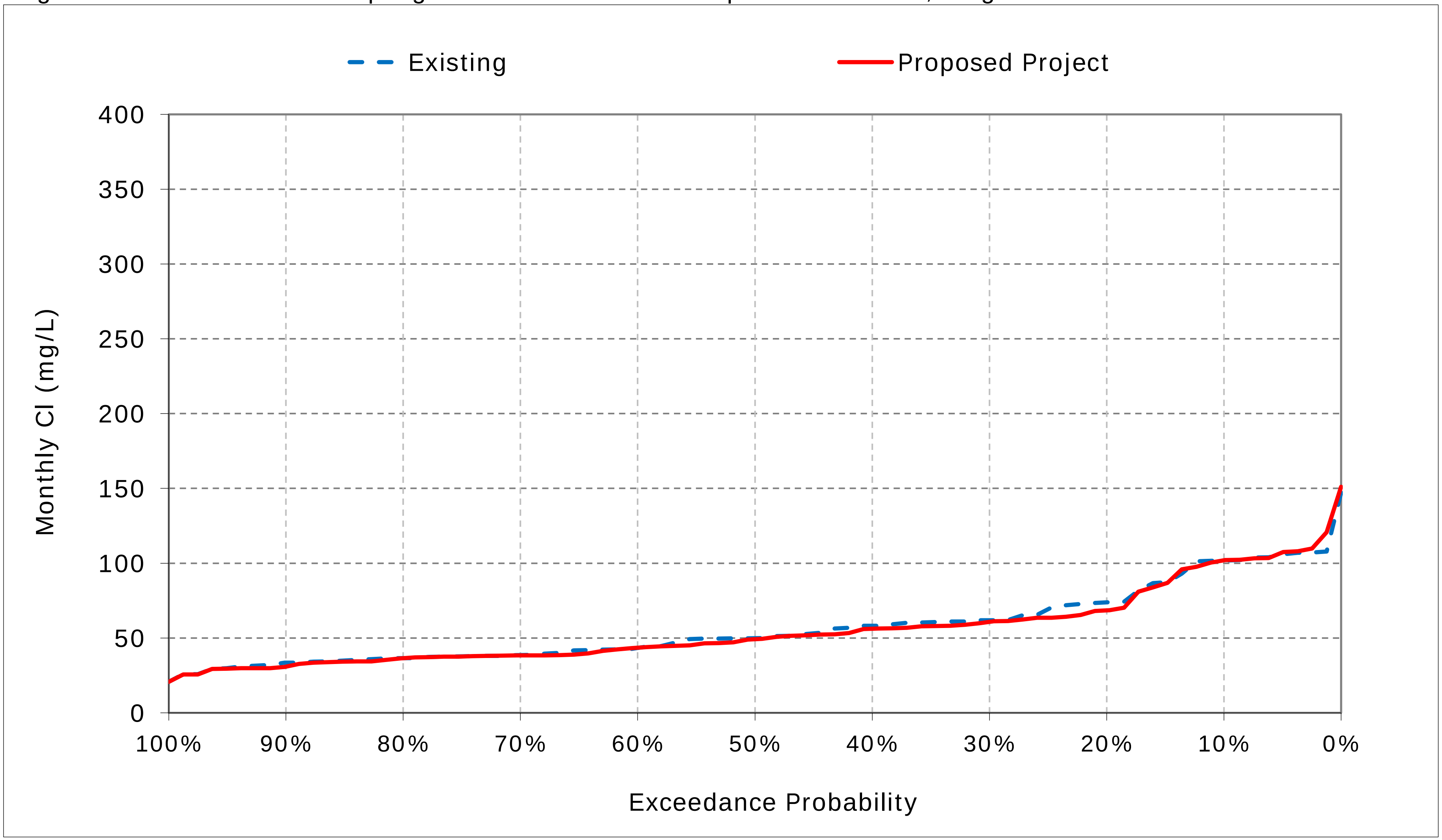


Figure 11-15. Banks Pumping Plant South Delta Exports Chloride, September Cl

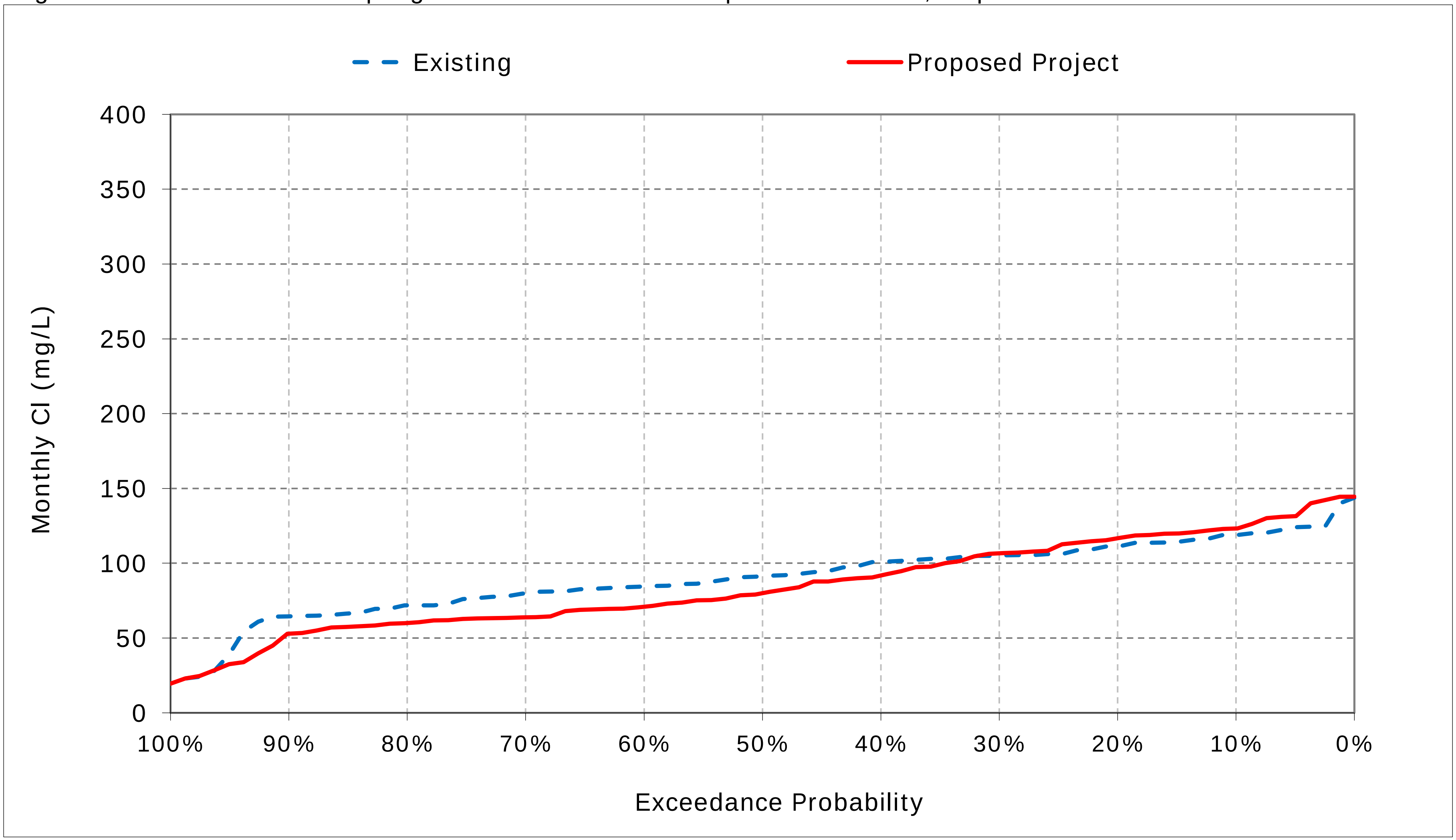


Figure 11-16. Banks Pumping Plant South Delta Exports Chloride, October Cl

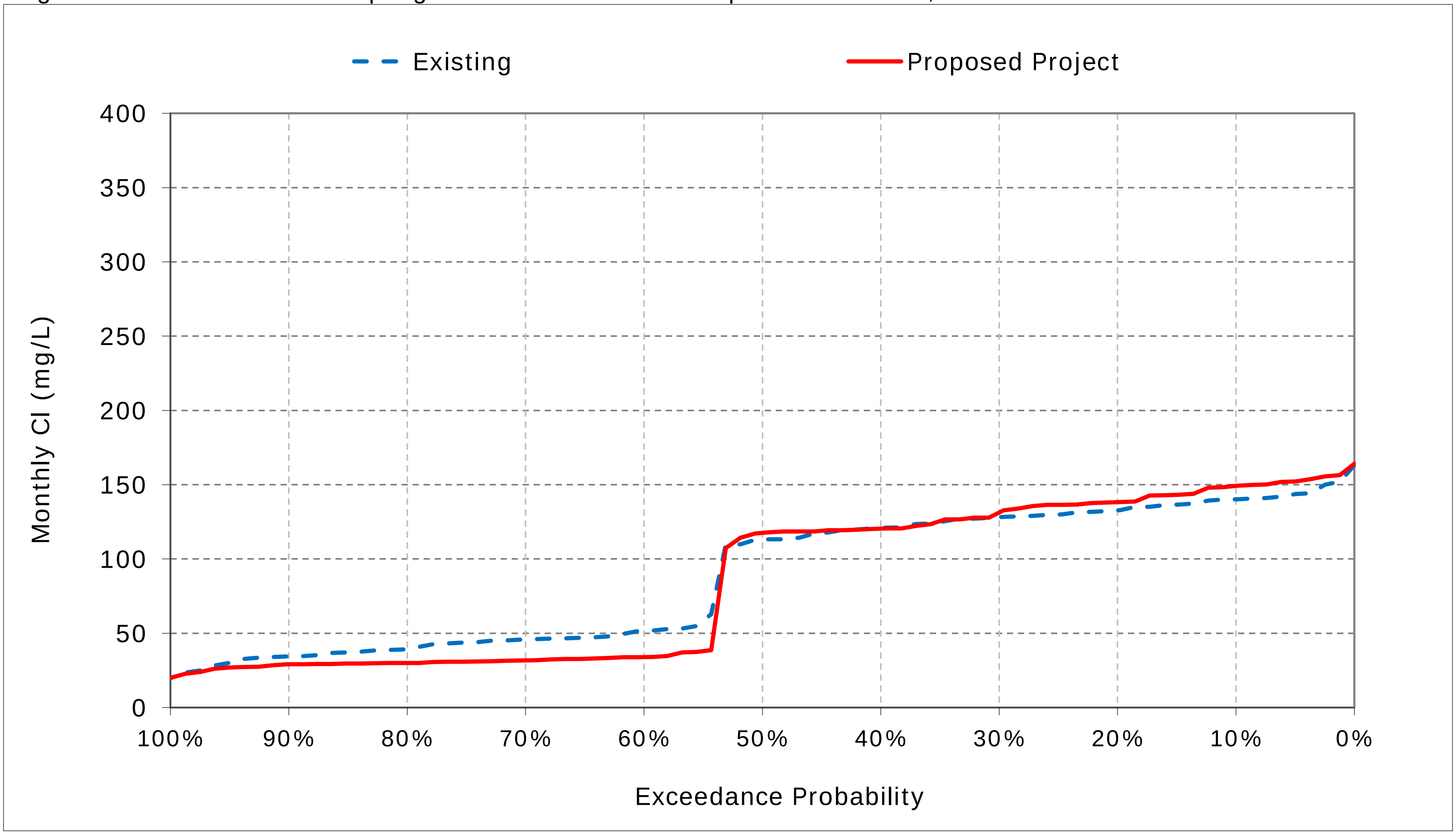


Figure 11-17. Banks Pumping Plant South Delta Exports Chloride, November Cl

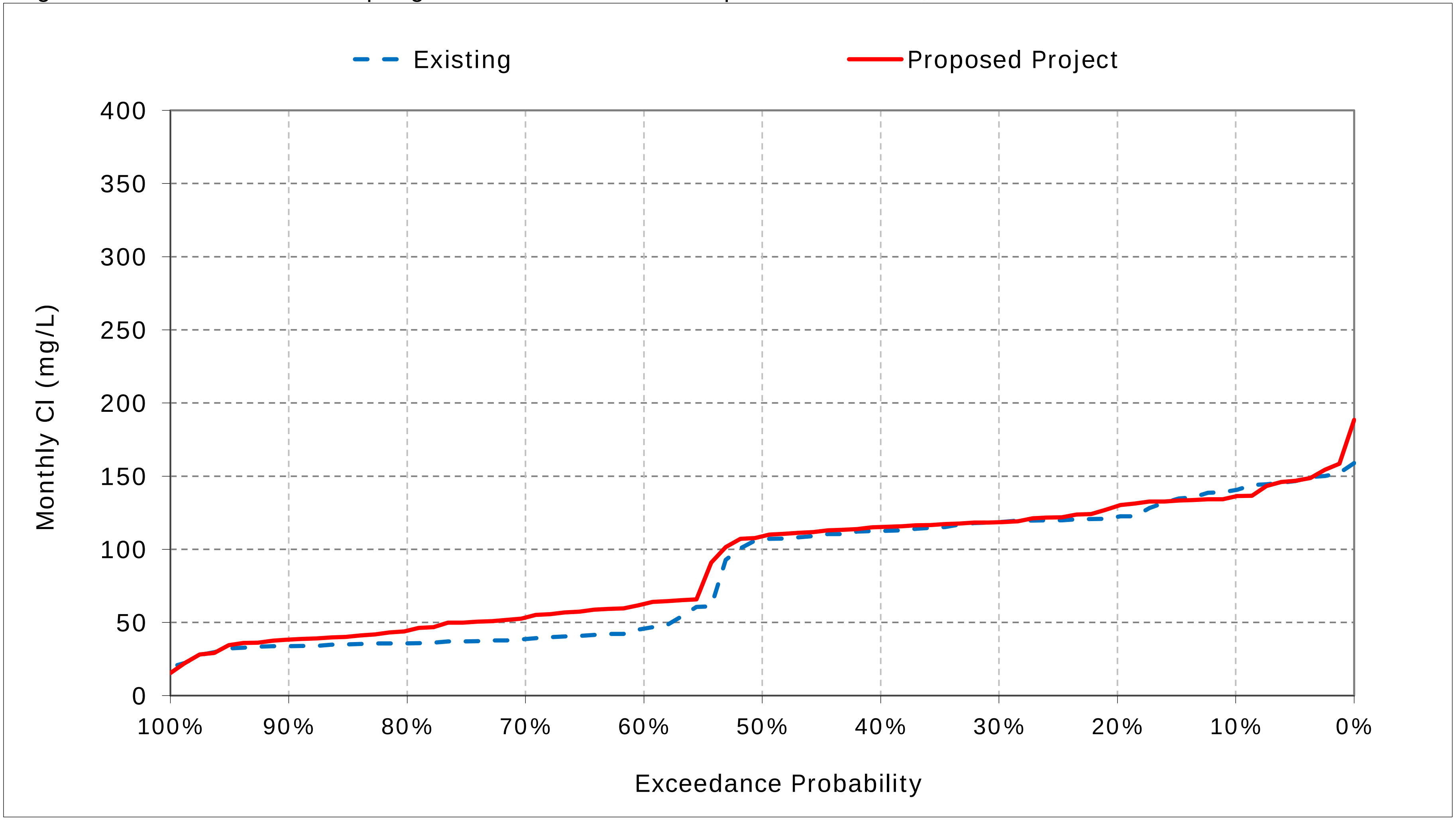


Figure 11-18. Banks Pumping Plant South Delta Exports Chloride, December Cl

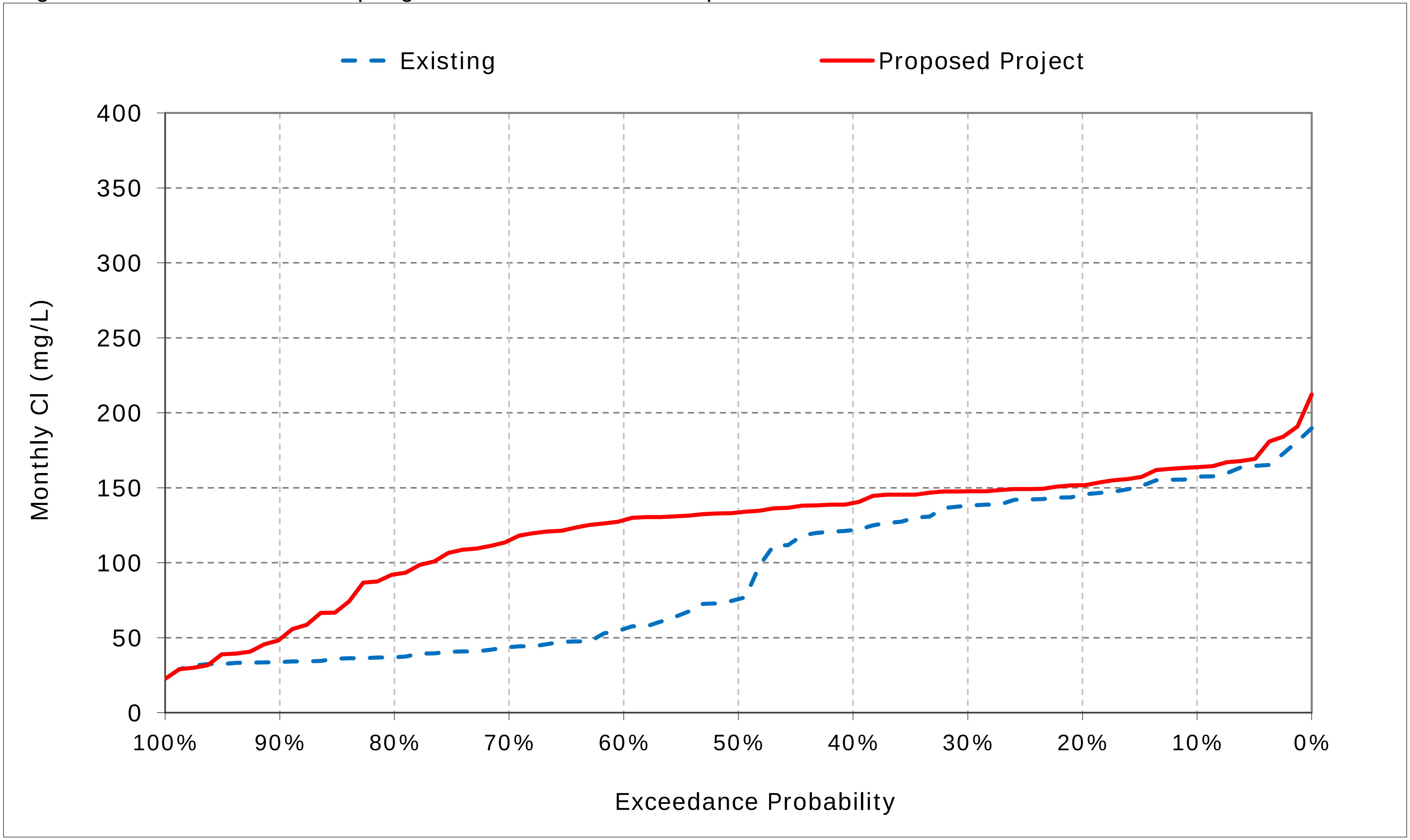


Table 12-1. Jones Pumping Plant South Delta Exports Chloride, Monthly Cl

Existing

Statistic	Monthly Cl (mg/L)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	136	138	168	171	144	126	96	82	67	68	103	120
20%	131	122	157	164	138	118	89	77	59	60	82	115
30%	126	119	149	142	126	107	81	73	57	57	71	108
40%	120	113	137	133	119	101	74	70	55	54	68	106
50%	111	106	105	125	112	90	65	62	54	48	62	97
60%	56	65	92	115	99	68	57	57	52	46	55	88
70%	52	52	79	106	84	53	47	53	51	42	49	80
80%	48	47	73	99	64	42	37	45	48	38	46	74
90%	44	44	71	72	44	35	26	22	44	33	44	65
Long Term												
Full Simulation Period[a]	90	90	114	125	103	85	63	60	55	52	65	93
Water Year Types[b]												
Wet (32%)	76	73	93	93	67	48	38	39	48	43	45	75
Above Normal (15%)	101	95	114	125	105	69	57	57	54	44	49	70
Below Normal (17%)	93	93	121	136	99	82	67	64	53	47	69	113
Dry (22%)	91	95	124	136	129	111	81	73	54	55	84	103
Critical (15%)	106	108	139	164	143	144	94	81	73	77	94	117

Proposed Project

Statistic	Monthly Cl (mg/L)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	139	136	171	193	159	142	113	92	60	68	105	127
20%	129	127	161	184	144	125	97	82	54	62	77	118
30%	124	120	157	169	131	115	84	72	50	58	71	111
40%	118	116	153	159	123	104	68	57	47	52	66	104
50%	112	111	148	139	110	95	58	51	45	46	60	89
60%	51	76	143	124	98	76	50	47	43	43	54	76
70%	47	68	130	108	81	54	45	45	41	40	49	70
80%	45	62	106	99	64	43	37	39	39	37	46	64
90%	43	52	83	72	46	34	25	21	34	32	40	58
Long Term												
Full Simulation Period[a]	88	96	137	138	105	90	65	57	47	51	64	89
Water Year Types[b]												
Wet (32%)	74	82	111	98	66	50	35	34	44	43	43	58
Above Normal (15%)	99	108	148	148	107	69	49	46	45	43	49	71
Below Normal (17%)	89	97	142	150	99	89	62	53	43	46	67	120
Dry (22%)	90	99	147	156	133	121	87	75	44	54	82	104
Critical (15%)	106	110	159	172	153	149	118	95	66	79	96	120

Proposed Project minus Existing

Statistic	Monthly Cl (mg/L)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	3	-2	3	21	16	16	18	10	-7	0	2	6
20%	-2	5	4	20	6	7	8	5	-5	2	-5	3
30%	-2	1	7	26	5	8	3	-1	-7	0	0	3
40%	-2	3	16	26	4	3	-6	-12	-9	-2	-1	-2
50%	0	5	43	15	-2	5	-7	-11	-9	-2	-2	-8
60%	-5	11	51	9	-2	8	-7	-10	-9	-3	-1	-12
70%	-5	16	51	2	-3	1	-3	-8	-10	-2	0	-10
80%	-2	15	33	0	0	1	0	-6	-9	-1	0	-9
90%	-1	9	12	0	1	-1	-1	-1	-9	-1	-4	-7
Long Term												
Full Simulation Period[a]	-2	7	22	13	2	5	2	-3	-8	0	-1	-4
Water Year Types[b]												
Wet (32%)	-2	9	18	4	-1	2	-3	-5	-4	0	-1	-17
Above Normal (15%)	-3	13	34	23	2	1	-8	-11	-10	-2	0	0
Below Normal (17%)	-4	5	21	14	0	7	-5	-10	-10	-1	-1	7
Dry (22%)	-1	4	23	20	4	9	6	1	-10	-1	-2	1
Critical (15%)	0	2	20	9	10	5	24	14	-7	1	3	3

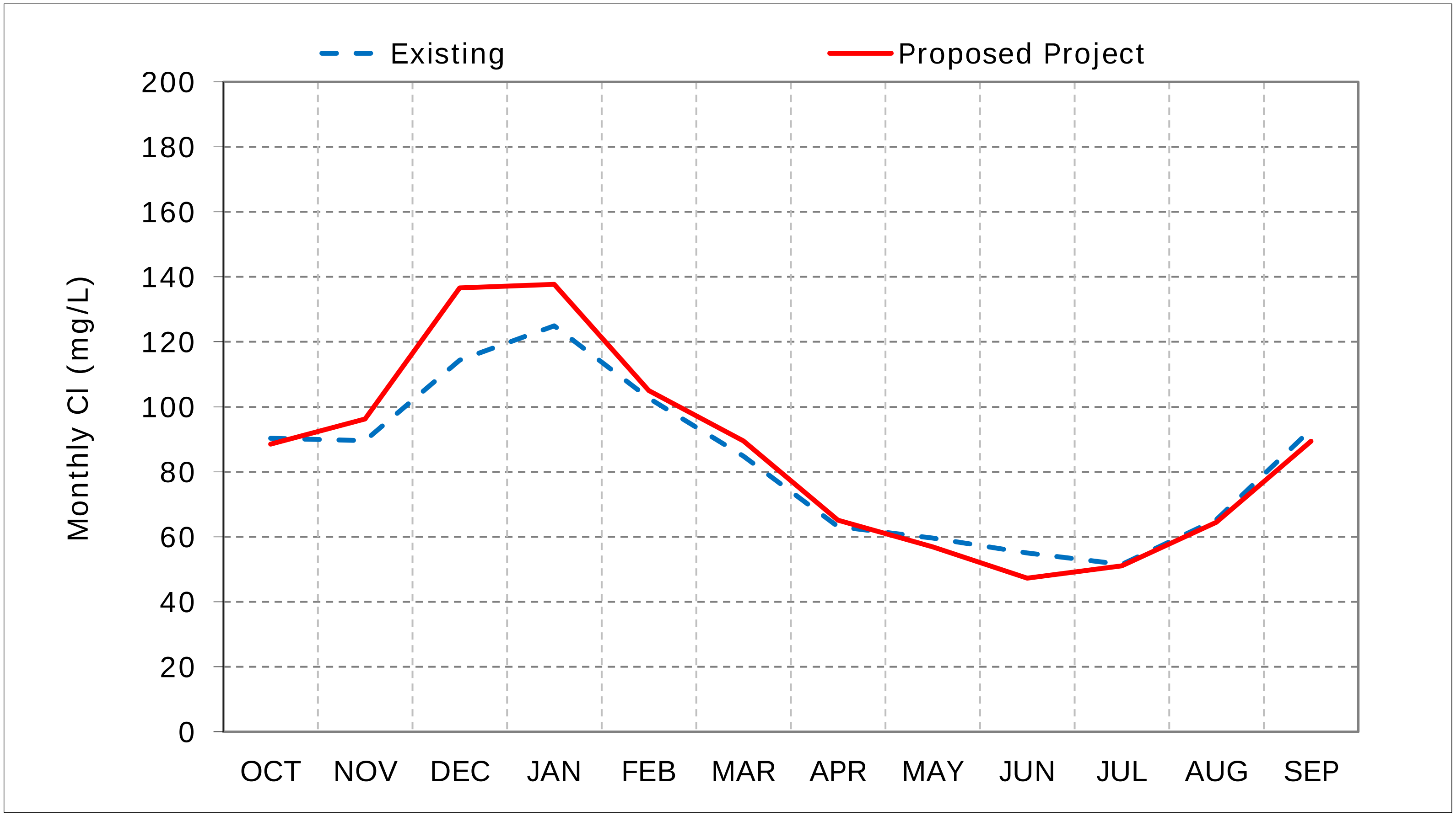
a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

c These results are displayed with water year - year type sorting.

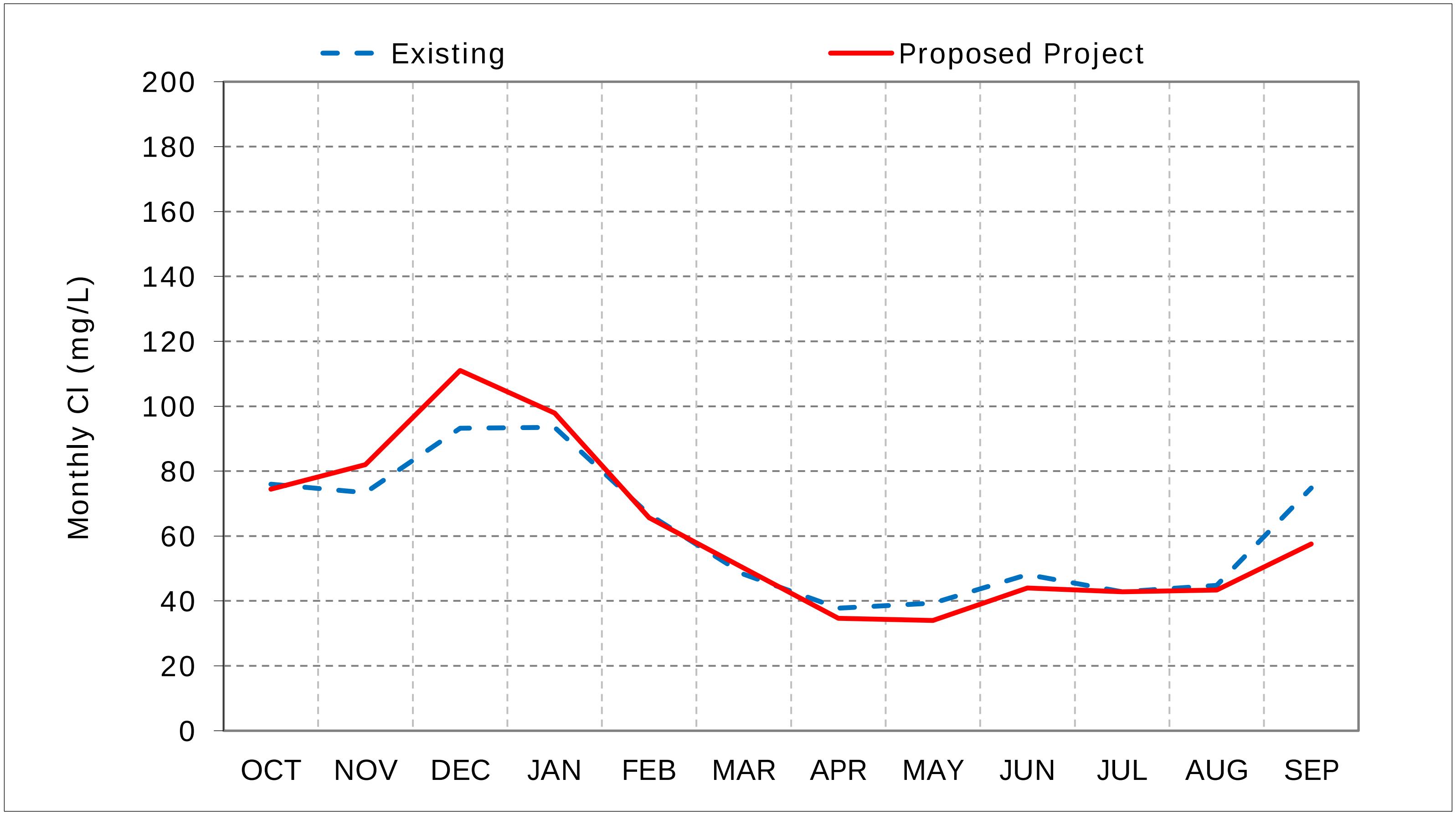
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 12-1. Jones Pumping Plant South Delta Exports Chloride, Long-Term Avera



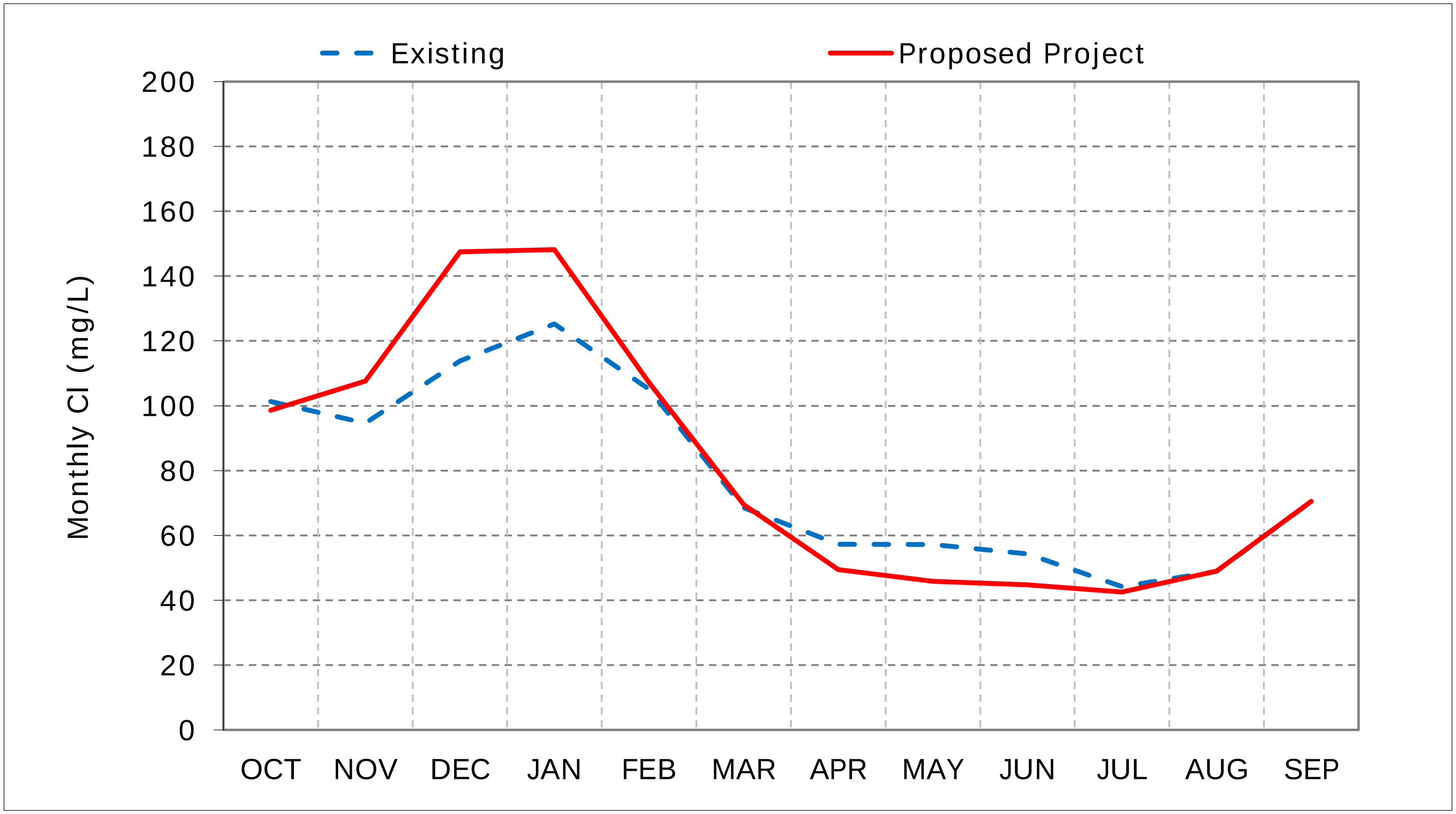
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 12-2. Jones Pumping Plant South Delta Exports Chloride, Wet Year Average



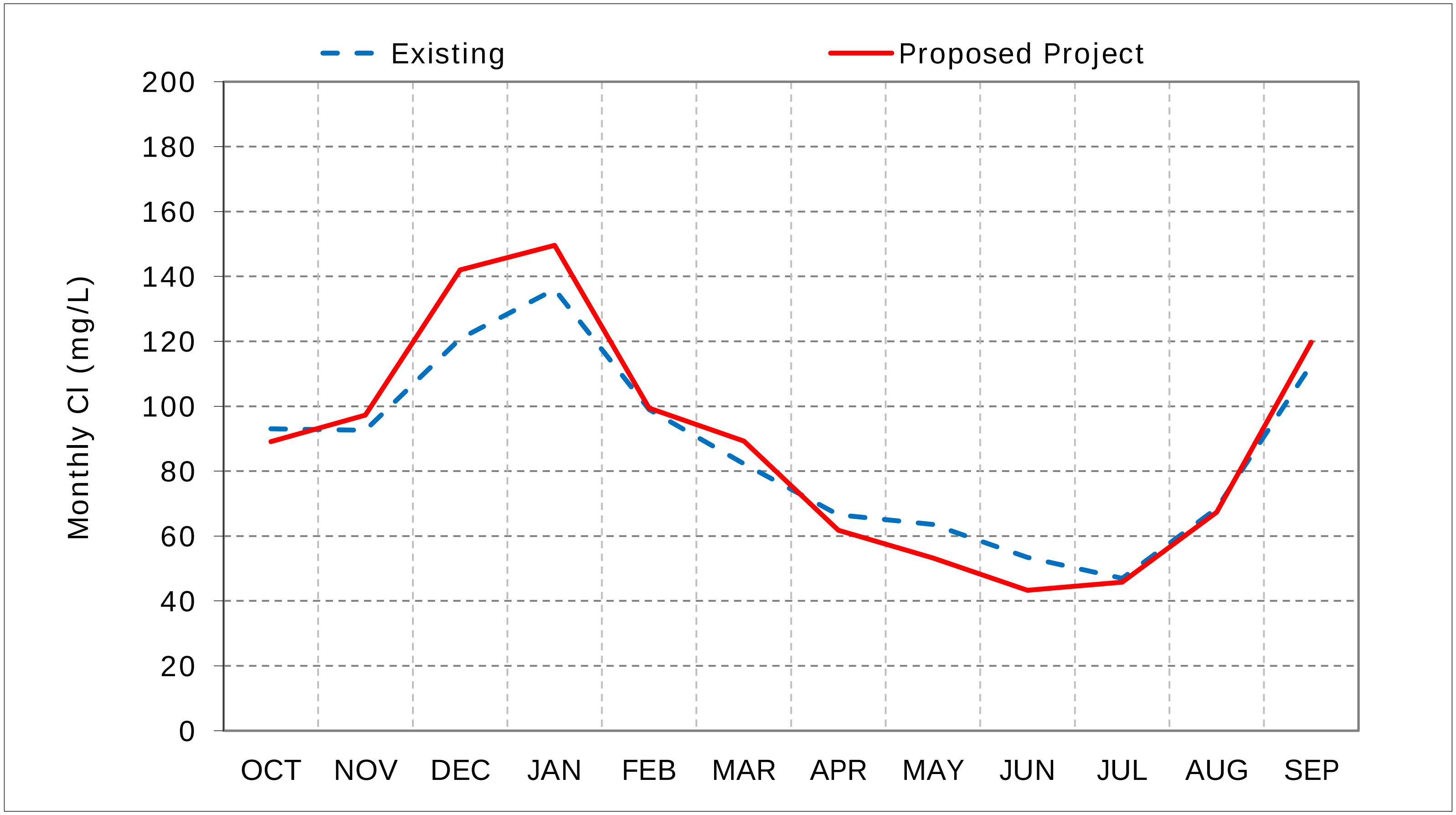
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 12-3. Jones Pumping Plant South Delta Exports Chloride, Above Normal Ye



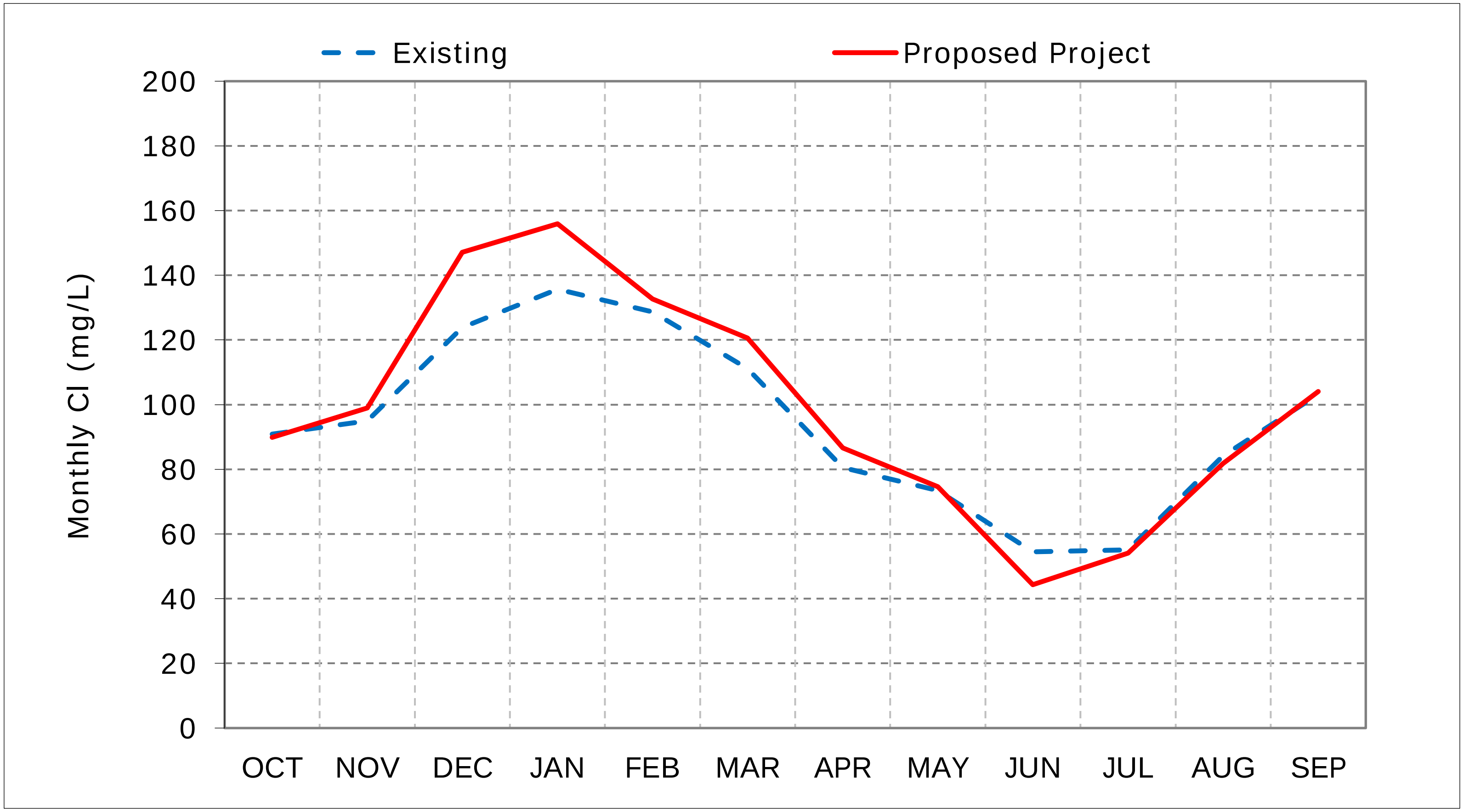
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 12-4. Jones Pumping Plant South Delta Exports Chloride, Below Normal Yea



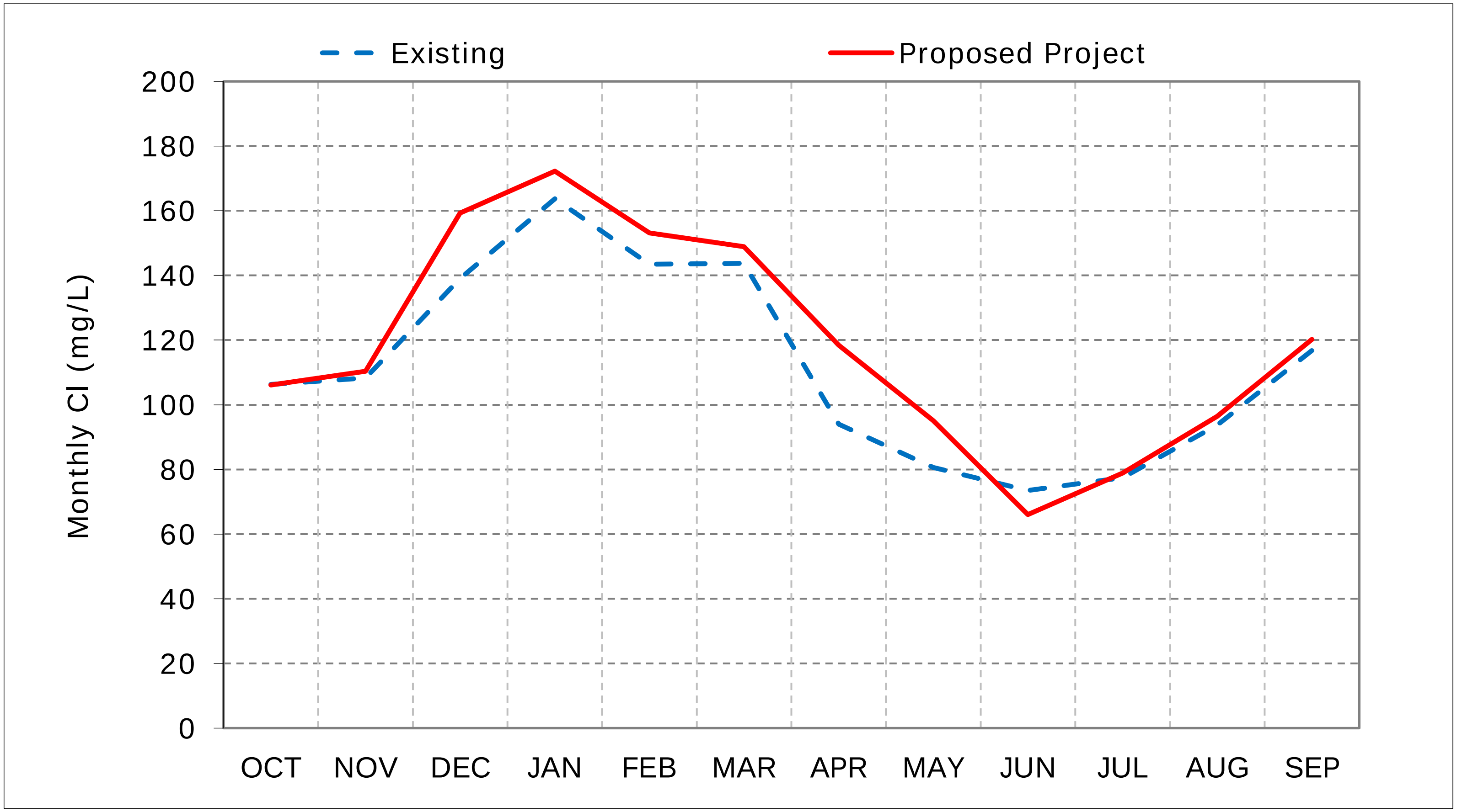
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 12-5. Jones Pumping Plant South Delta Exports Chloride, Dry Year Average



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 12-6. Jones Pumping Plant South Delta Exports Chloride, Critical Year Aver



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 12-7. Jones Pumping Plant South Delta Exports Chloride, January Cl

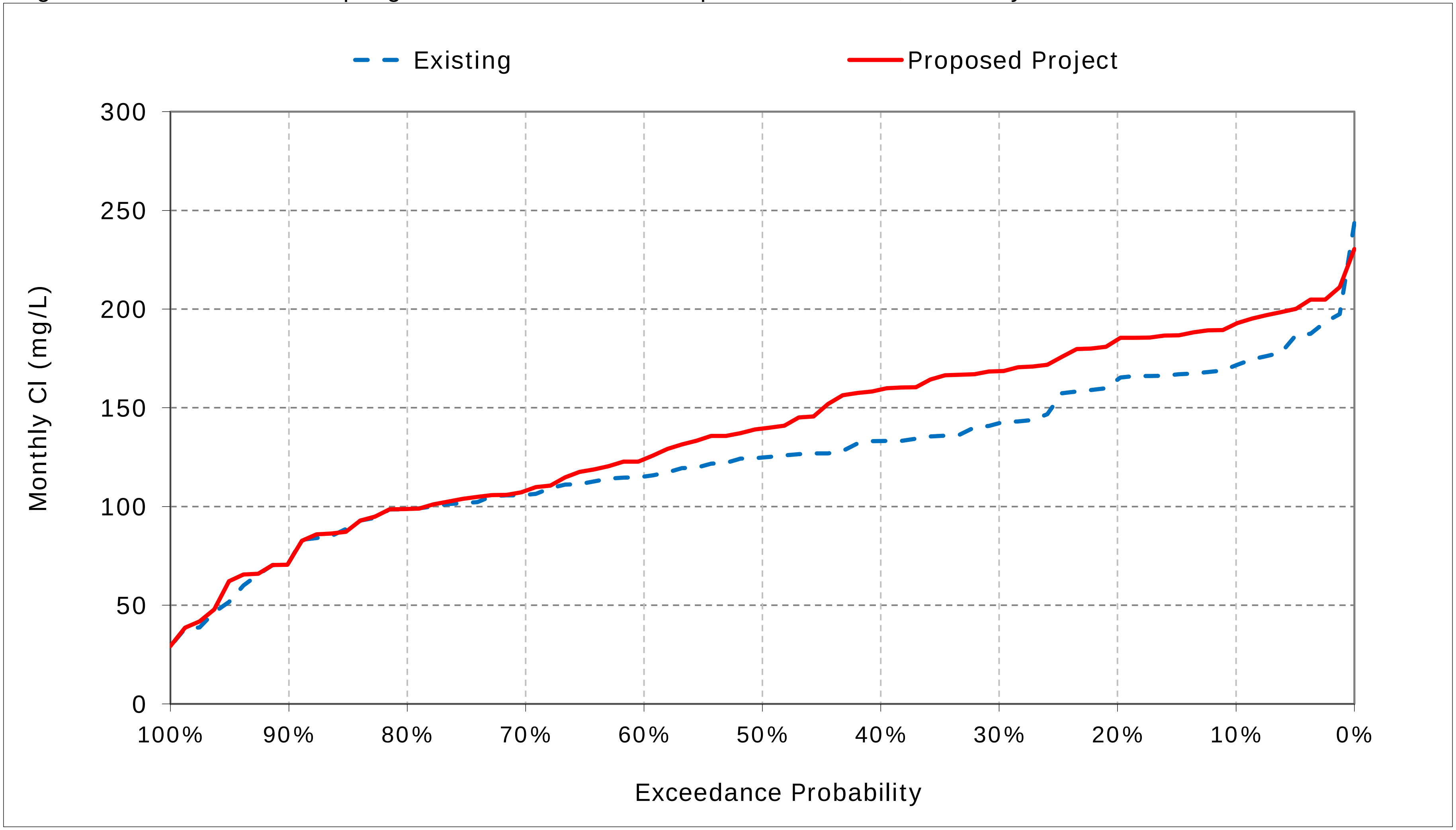


Figure 12-8. Jones Pumping Plant South Delta Exports Chloride, February Cl

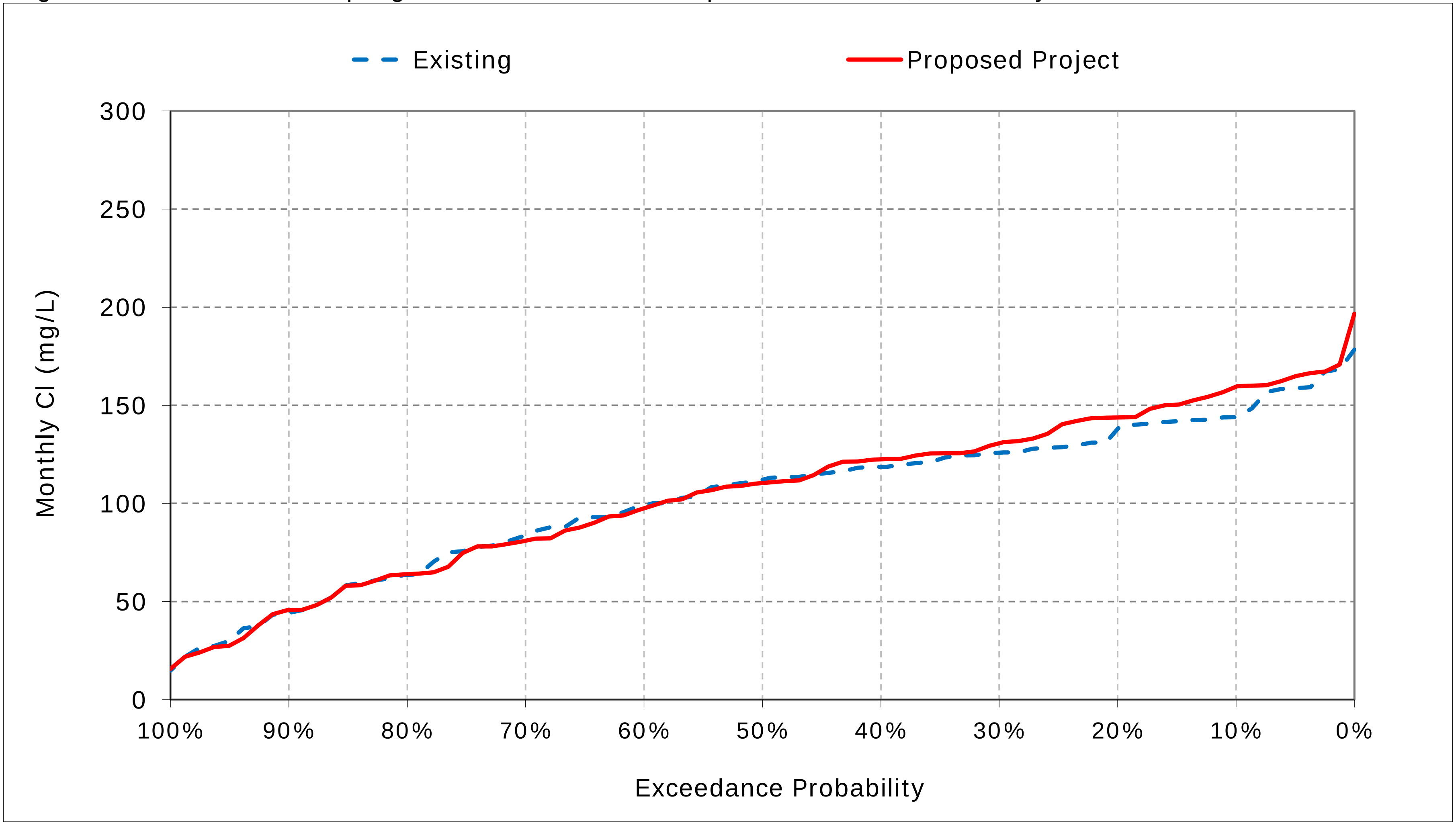


Figure 12-9. Jones Pumping Plant South Delta Exports Chloride, March Cl

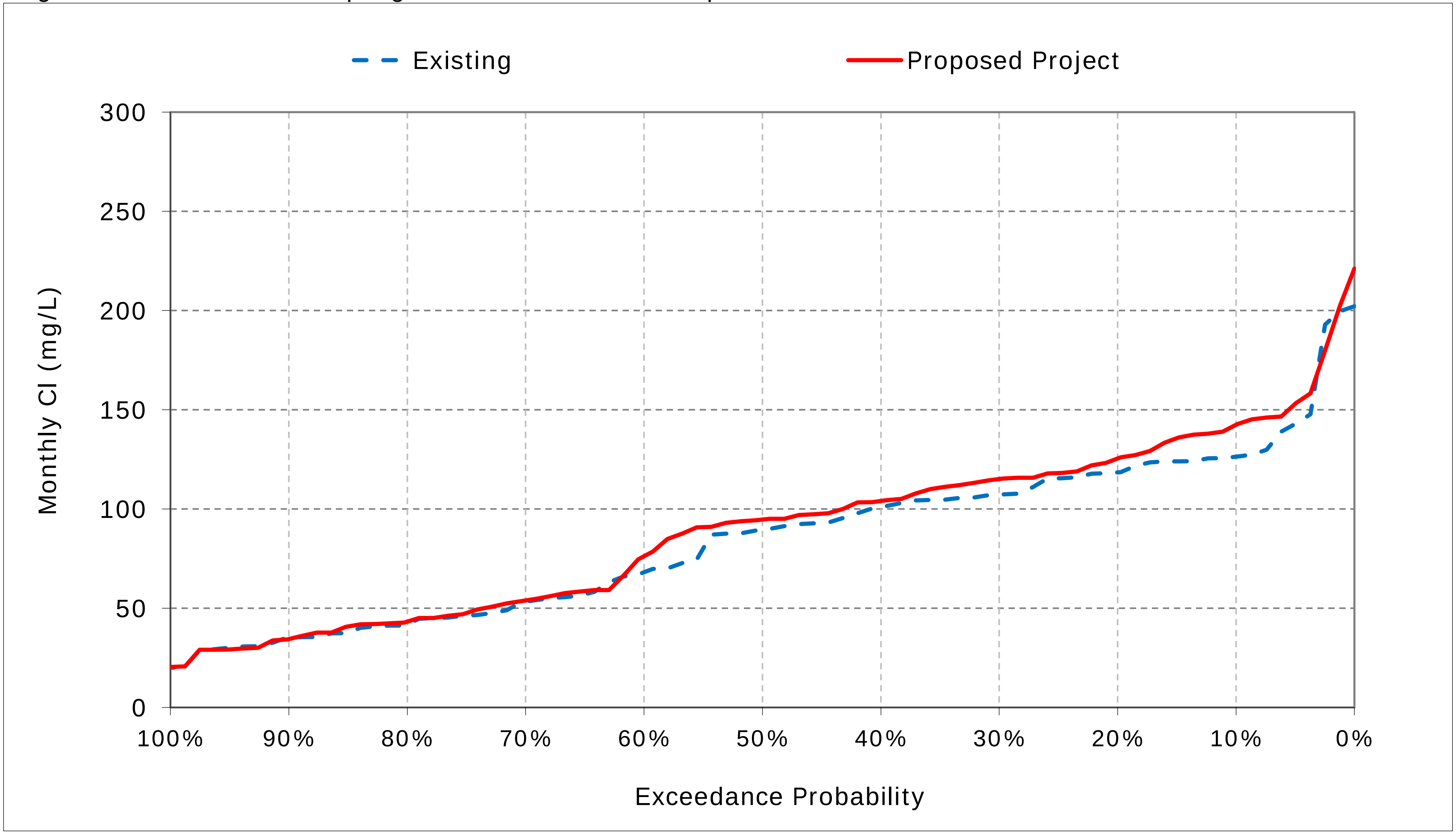


Figure 12-10. Jones Pumping Plant South Delta Exports Chloride, April Cl

Figure 12-11. Jones Pumping Plant South Delta Exports Chloride, May Cl

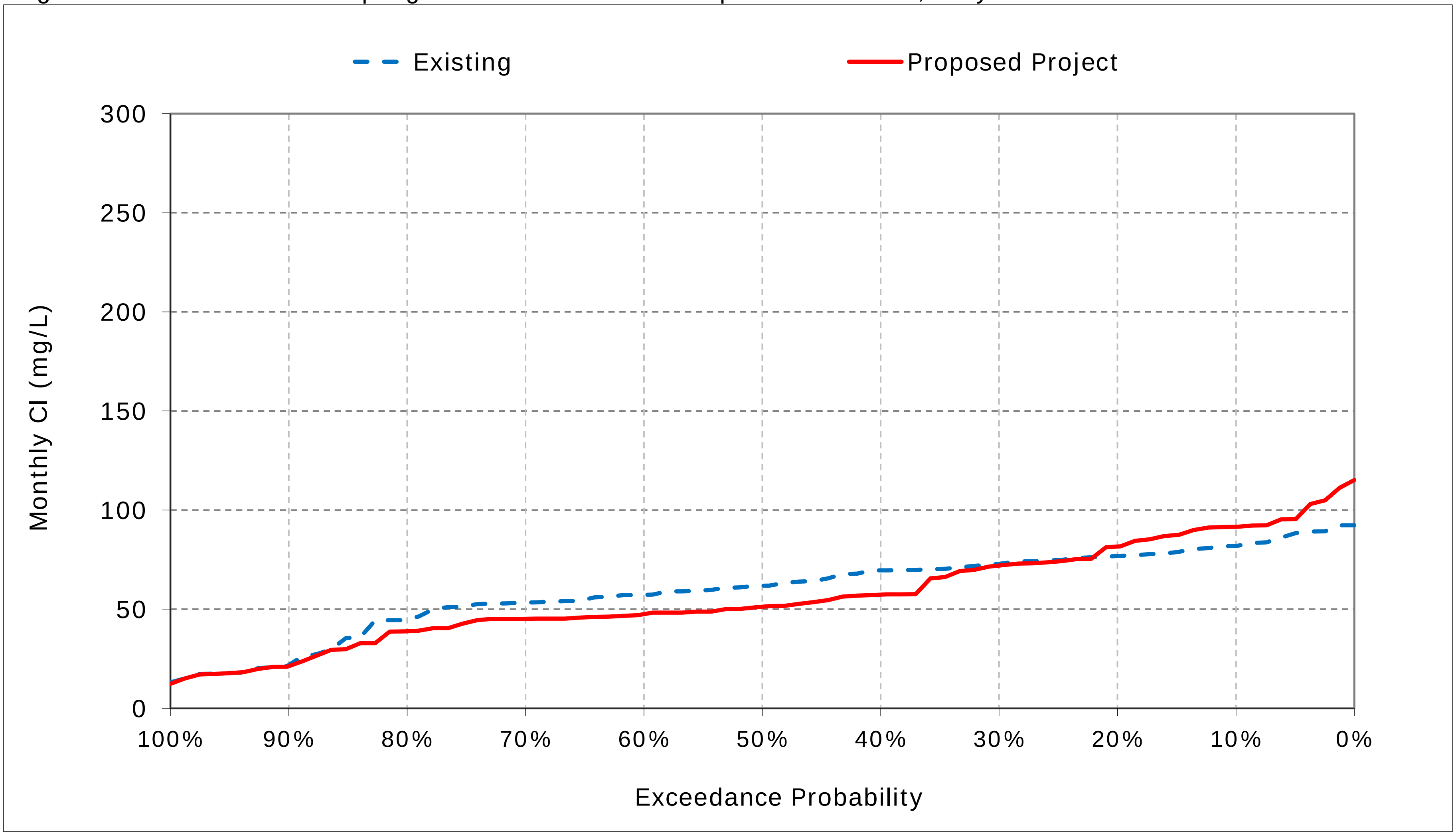


Figure 12-12. Jones Pumping Plant South Delta Exports Chloride, June Cl

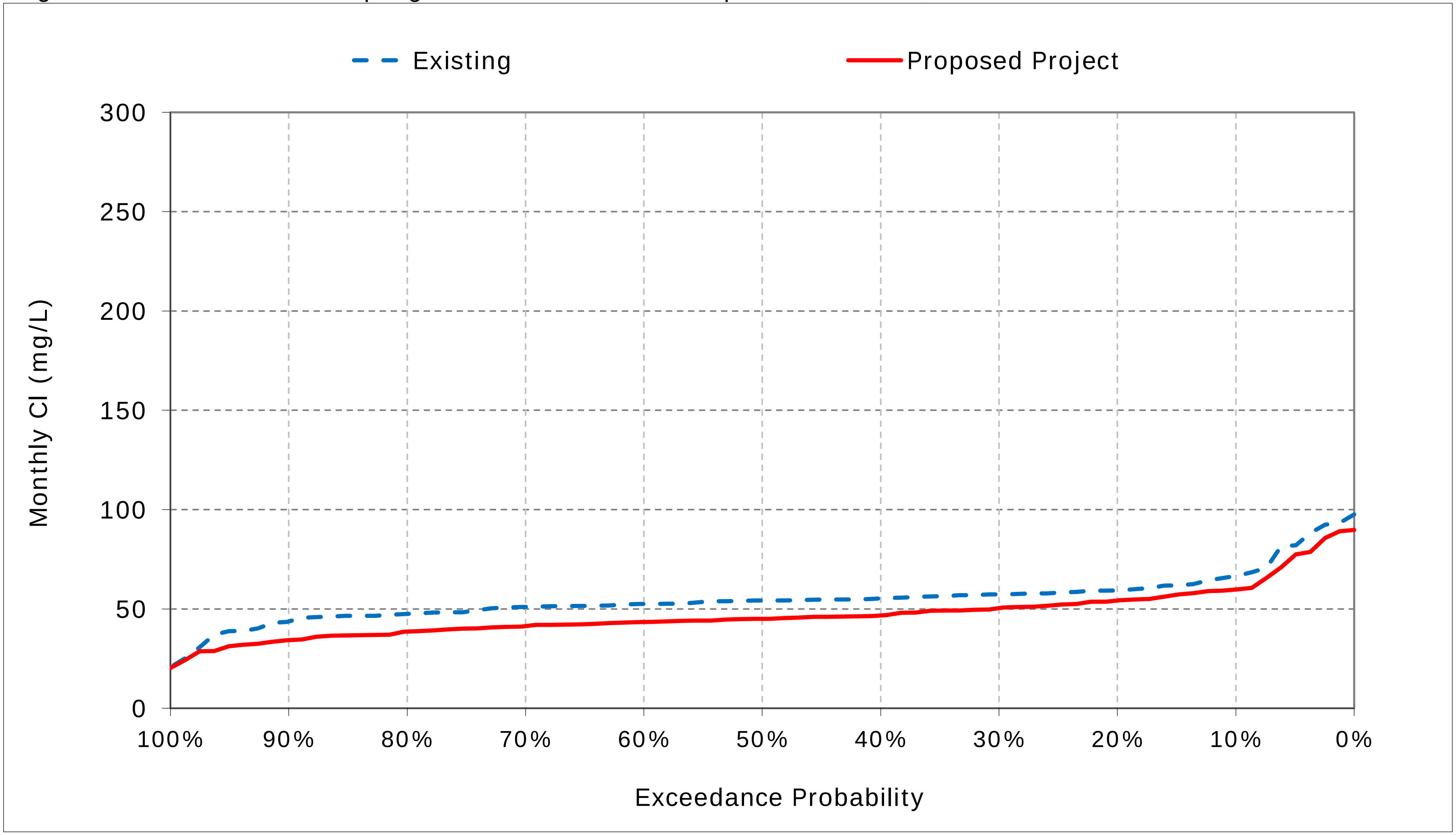


Figure 12-13. Jones Pumping Plant South Delta Exports Chloride, July Cl

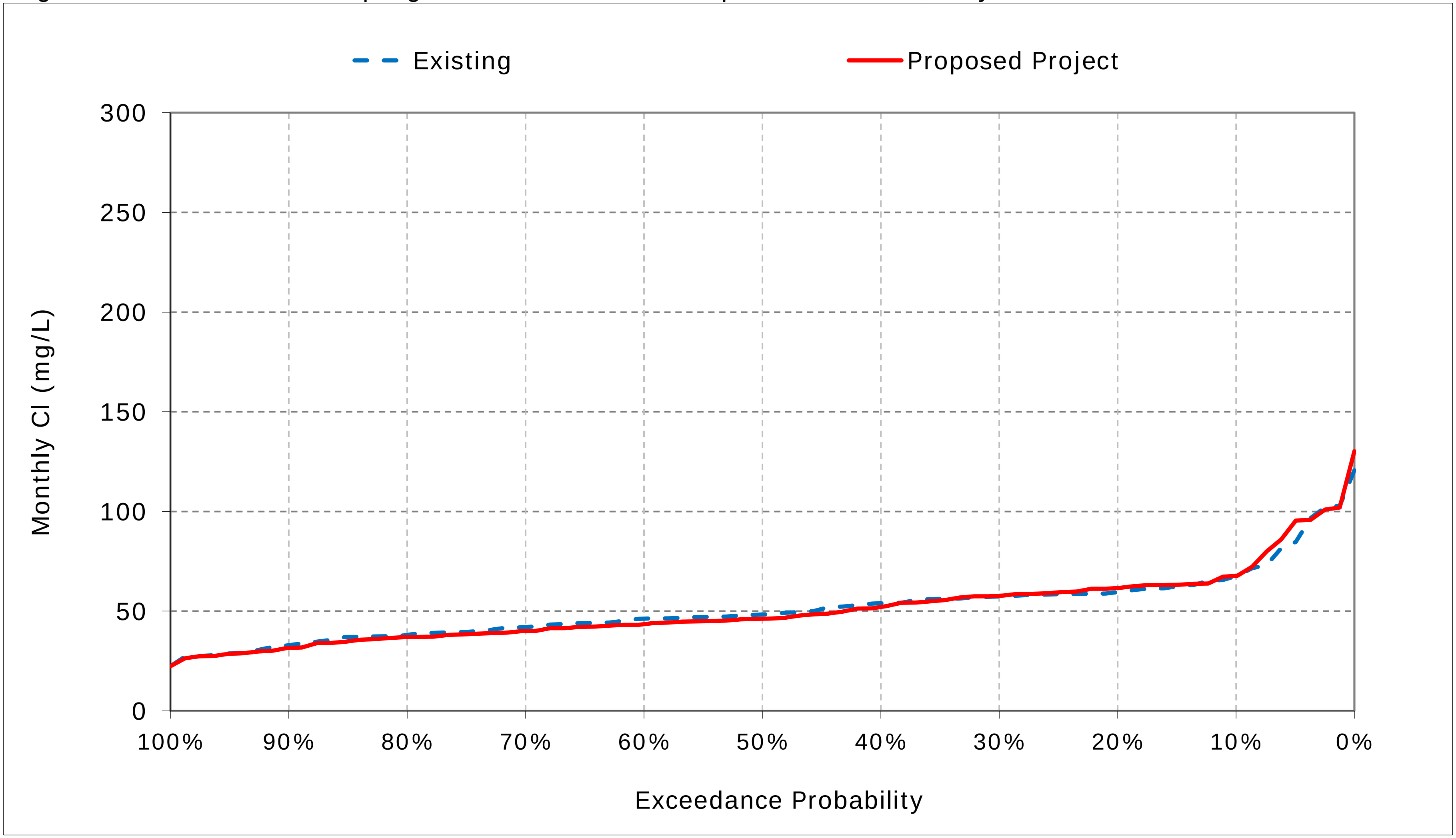


Figure 12-14. Jones Pumping Plant South Delta Exports Chloride, August Cl

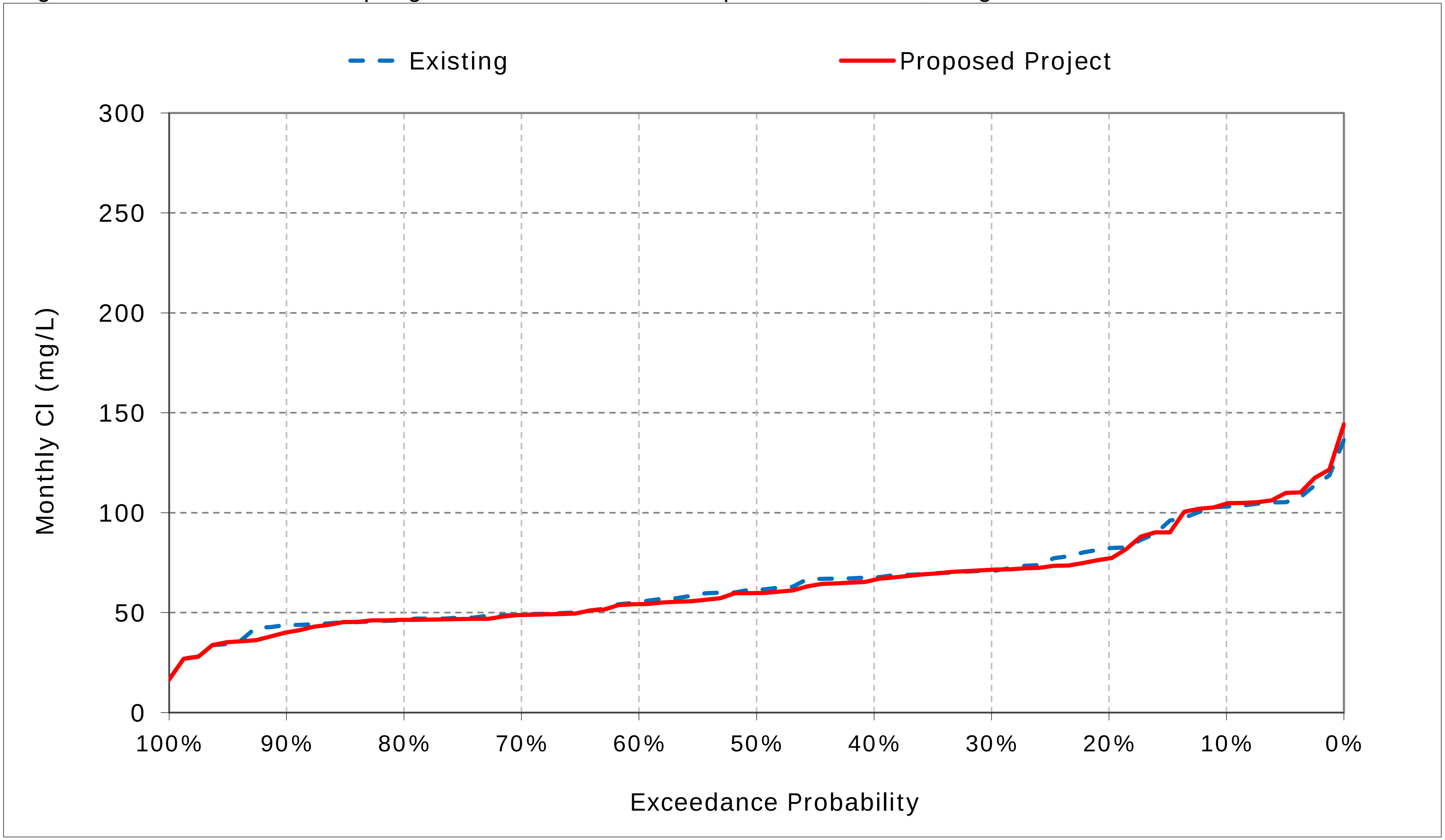


Figure 12-15. Jones Pumping Plant South Delta Exports Chloride, September Cl

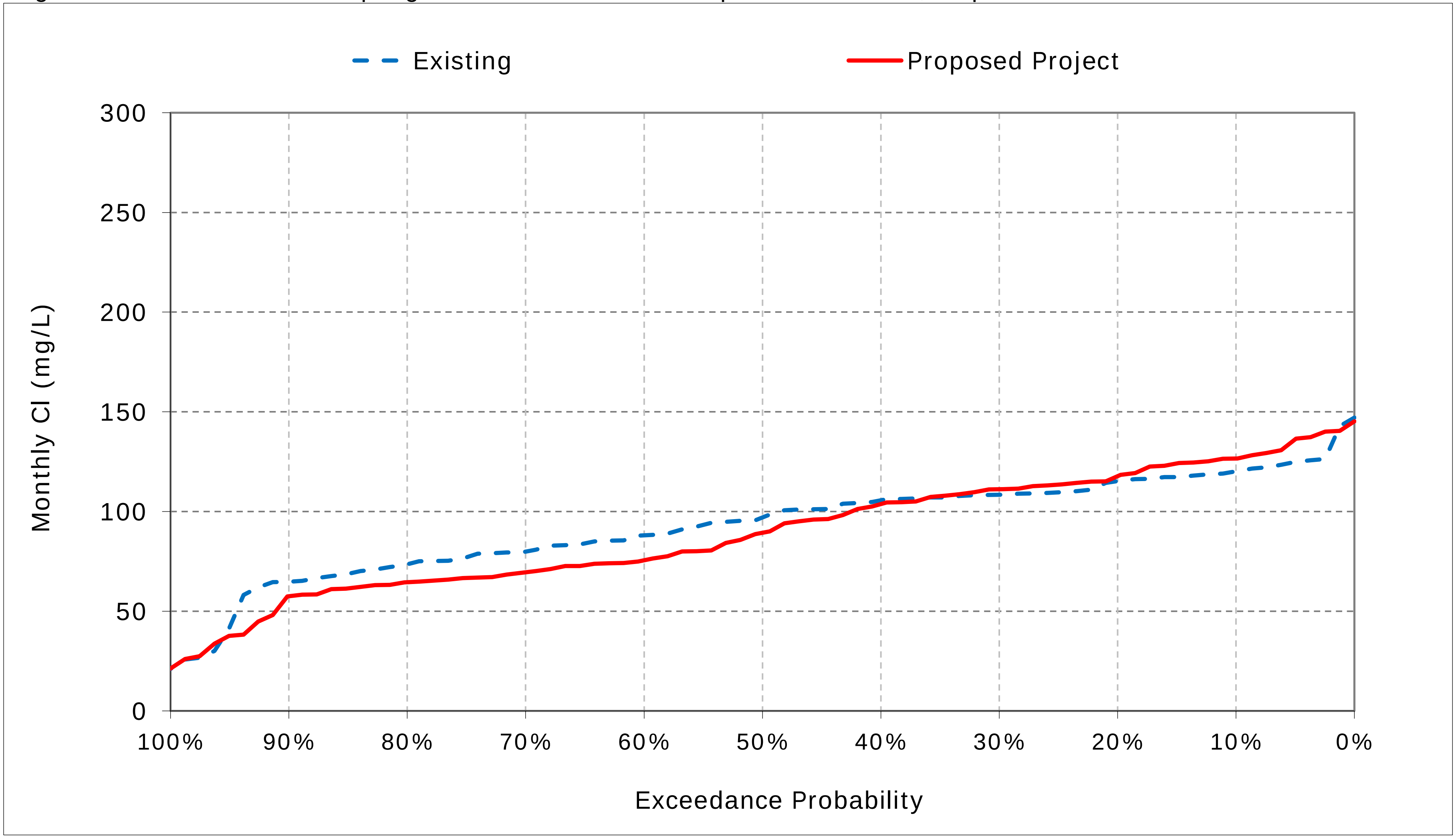


Figure 12-16. Jones Pumping Plant South Delta Exports Chloride, October Cl

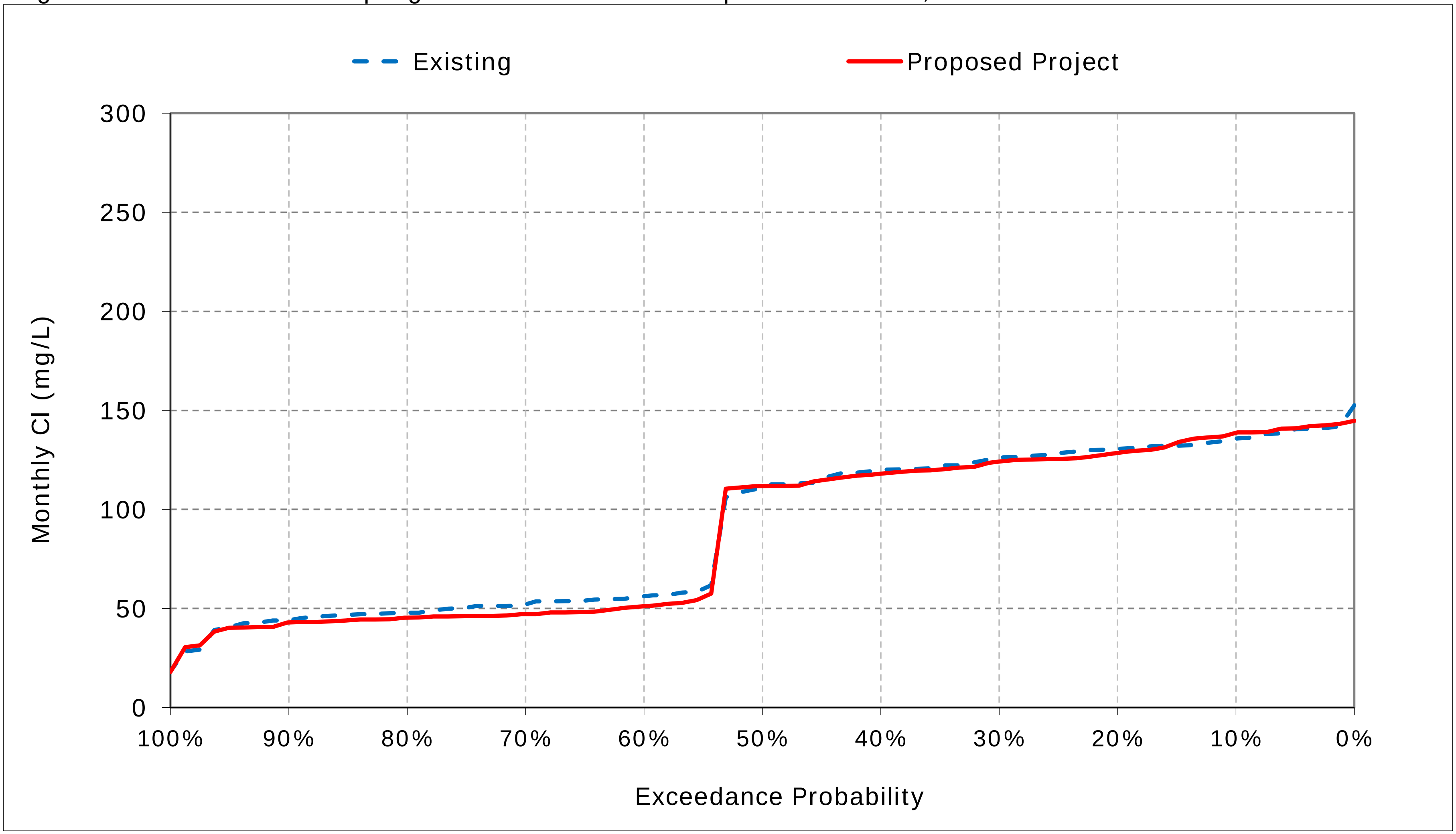


Figure 12-17. Jones Pumping Plant South Delta Exports Chloride, November Cl

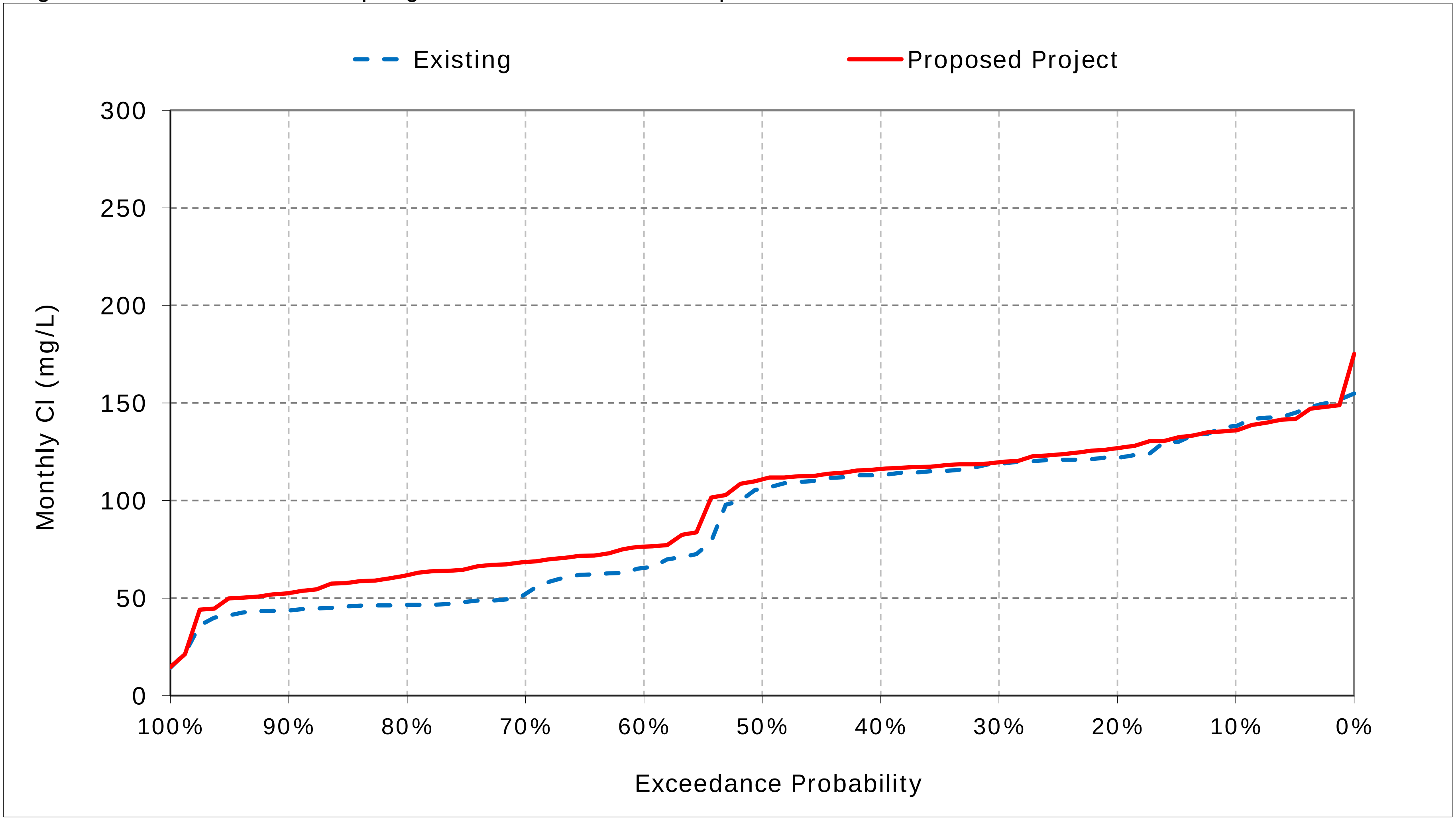


Figure 12-18. Jones Pumping Plant South Delta Exports Chloride, December Cl

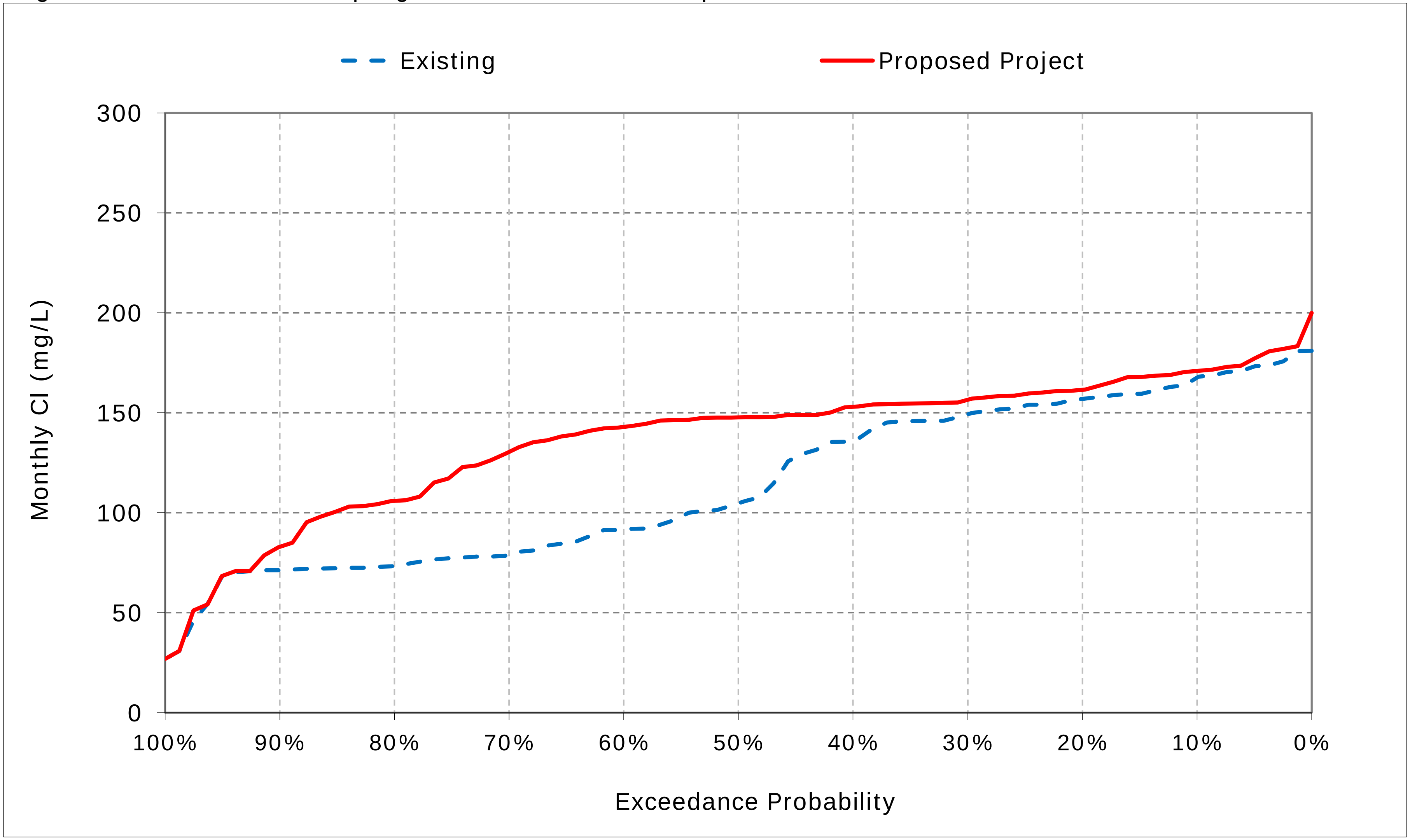


Table 13-1. Barker Slough at NBA Intake Chloride, Monthly Cl

Existing

Statistic	Monthly Cl (mg/L)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	18	18	19	23	25	23	21	19	18	18	18	18
20%	17	18	18	22	24	22	20	18	17	17	17	17
30%	17	17	18	21	23	21	19	18	17	17	16	17
40%	17	17	18	20	22	21	19	18	17	16	16	16
50%	16	17	17	19	21	20	19	17	17	16	16	16
60%	16	17	17	19	20	19	18	17	17	16	16	16
70%	16	16	17	18	20	19	18	17	17	16	16	16
80%	16	16	17	18	19	18	17	17	16	16	16	16
90%	16	16	16	18	19	18	17	16	16	16	16	16
Long Term												
Full Simulation Period[a]	17	17	18	20	22	20	19	18	17	17	16	17
Water Year Types[b]												
Wet (32%)	16	17	18	21	22	20	18	17	16	16	16	16
Above Normal (15%)	17	17	18	21	22	20	18	17	17	16	16	16
Below Normal (17%)	17	17	18	20	22	21	19	17	17	16	16	16
Dry (22%)	17	17	18	20	22	21	20	18	17	17	16	17
Critical (15%)	17	17	17	19	21	21	21	21	20	18	18	18

Proposed Project

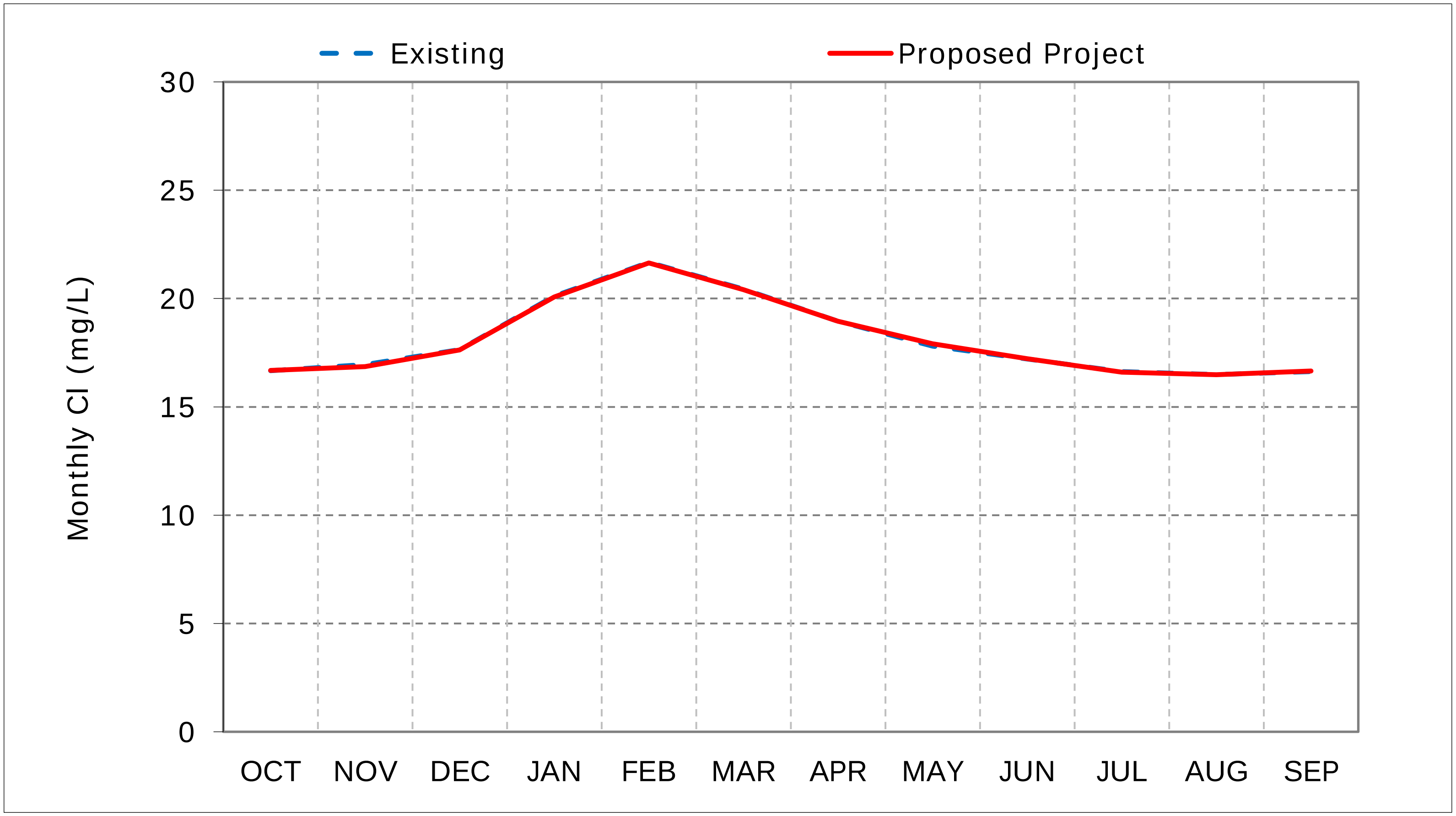
Statistic	Monthly Cl (mg/L)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	18	18	19	23	25	23	22	20	19	18	18	18
20%	17	18	18	22	24	23	20	19	17	17	17	17
30%	17	17	18	21	23	21	19	18	17	17	16	17
40%	17	17	18	20	22	20	19	17	17	16	16	16
50%	16	17	17	19	21	20	19	17	17	16	16	16
60%	16	16	17	19	20	19	18	17	17	16	16	16
70%	16	16	17	18	20	19	18	17	17	16	16	16
80%	16	16	16	18	19	18	17	17	16	16	16	16
90%	16	16	16	18	19	18	17	16	16	16	16	16
Long Term												
Full Simulation Period[a]	17	17	18	20	22	20	19	18	17	17	16	17
Water Year Types[b]												
Wet (32%)	16	17	18	20	22	20	18	17	16	16	16	16
Above Normal (15%)	16	17	18	21	22	20	18	17	17	16	16	16
Below Normal (17%)	17	17	18	20	22	20	19	17	17	16	16	16
Dry (22%)	17	17	18	20	22	21	20	18	17	17	16	17
Critical (15%)	17	17	17	19	21	21	21	21	20	18	18	18

Proposed Project minus Existing

Statistic	Monthly Cl (mg/L)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	0	0	0	0	0	0	0	1	1	0	0	0
20%	0	0	0	0	0	0	0	0	0	0	0	0
30%	0	0	0	0	0	0	0	0	0	0	0	0
40%	0	0	0	0	0	0	0	0	0	0	0	0
50%	0	0	0	0	0	0	0	0	0	0	0	0
60%	0	0	0	0	0	0	0	0	0	0	0	0
70%	0	0	0	0	0	0	0	0	0	0	0	0
80%	0	0	0	0	0	0	0	0	0	0	0	0
90%	0	0	0	0	0	0	0	0	0	0	0	0
Long Term												
Full Simulation Period[a]	0	0	0	0	0	0	0	0	0	0	0	0
Water Year Types[b]												
Wet (32%)	0	0	0	0	0	0	0	0	0	0	0	0
Above Normal (15%)	0	0	0	0	0	0	0	0	0	0	0	0
Below Normal (17%)	0	0	0	0	0	0	0	0	0	0	0	0
Dry (22%)	0	0	0	0	0	0	0	0	0	0	0	0
Critical (15%)	0	0	0	0	0	0	0	1	0	0	0	0

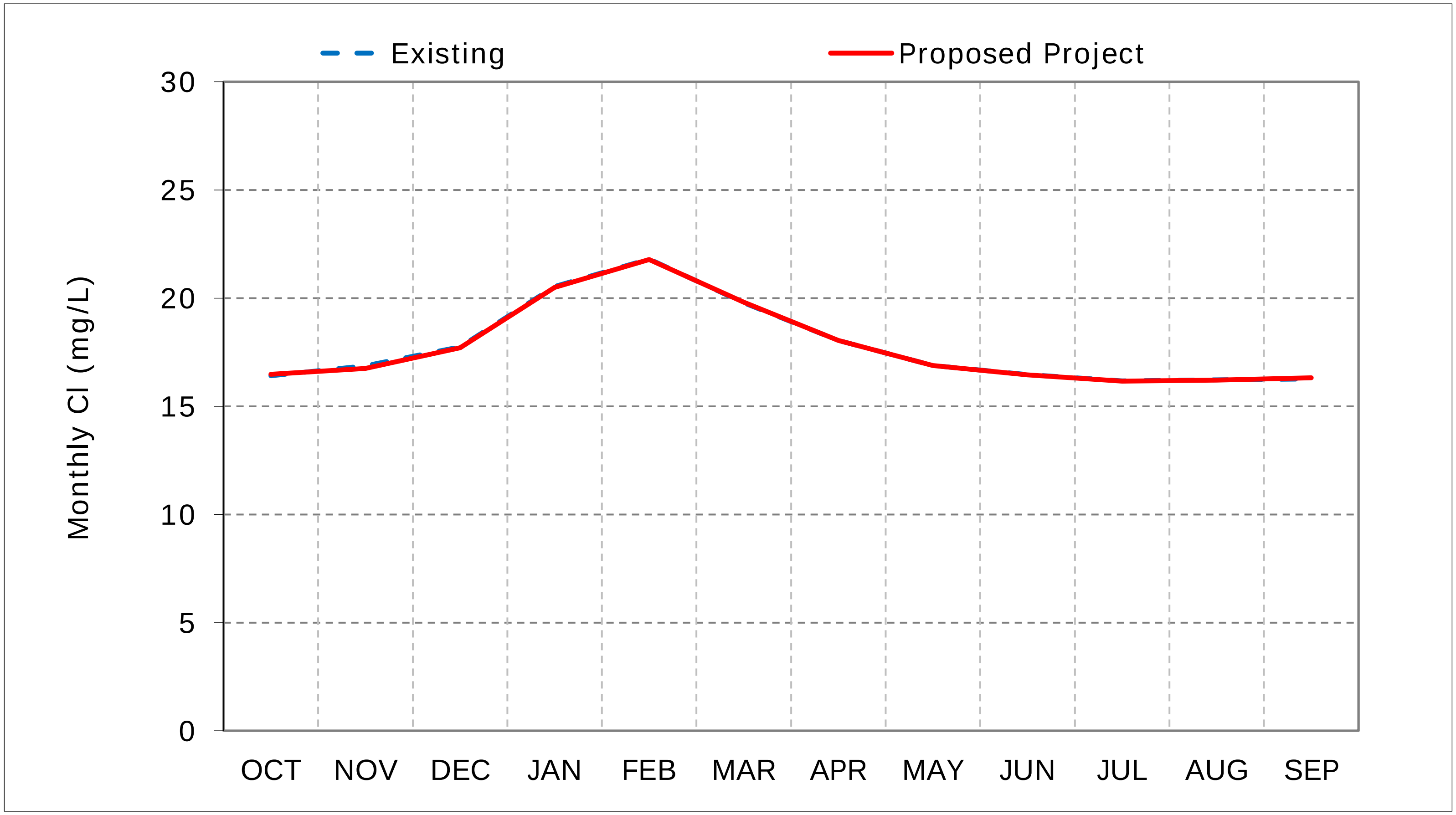
a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with water year - year type sorting.
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 13-1. Barker Slough at NBA Intake Chloride, Long-Term Average Cl



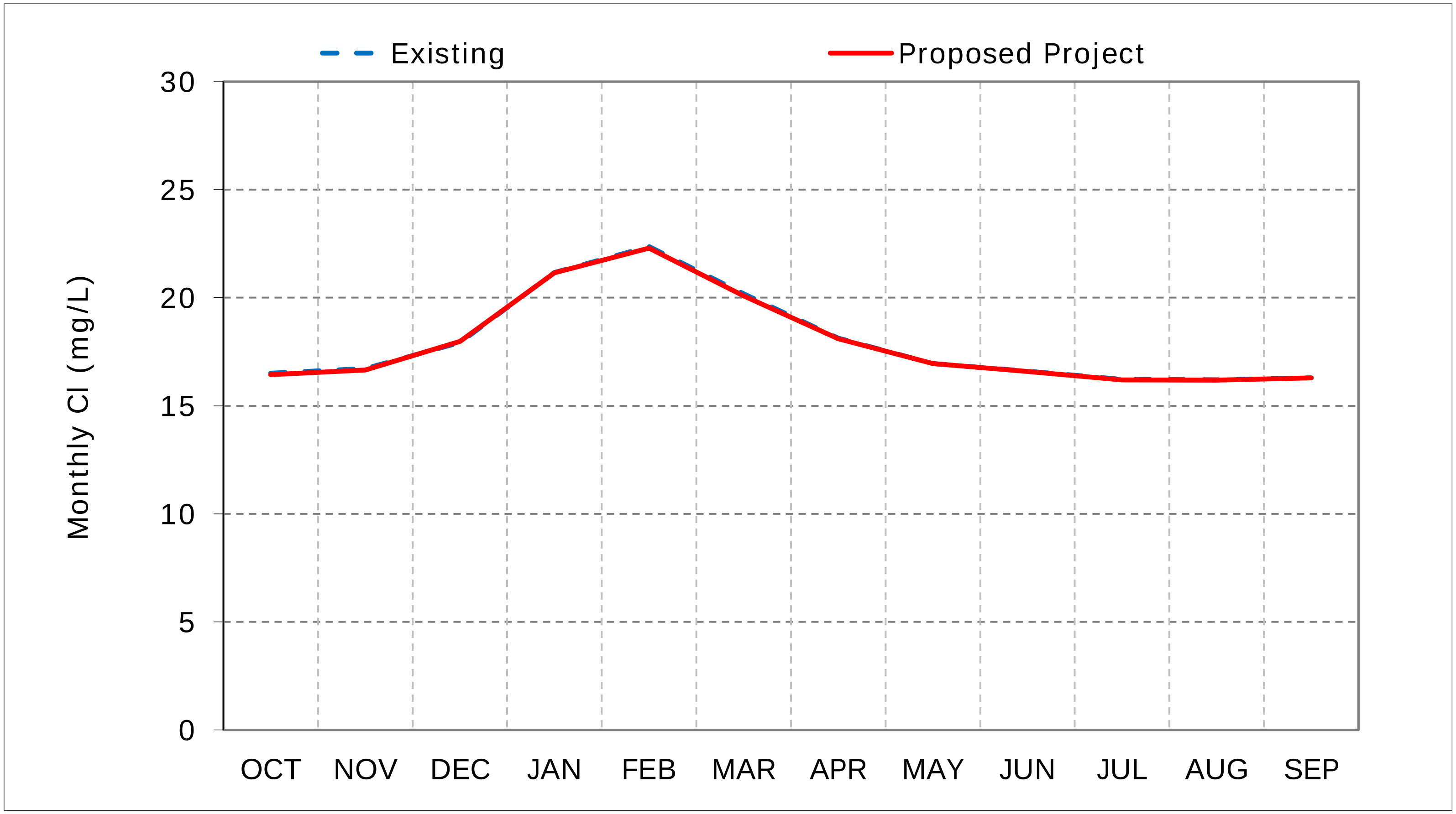
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 13-2. Barker Slough at NBA Intake Chloride, Wet Year Average Cl



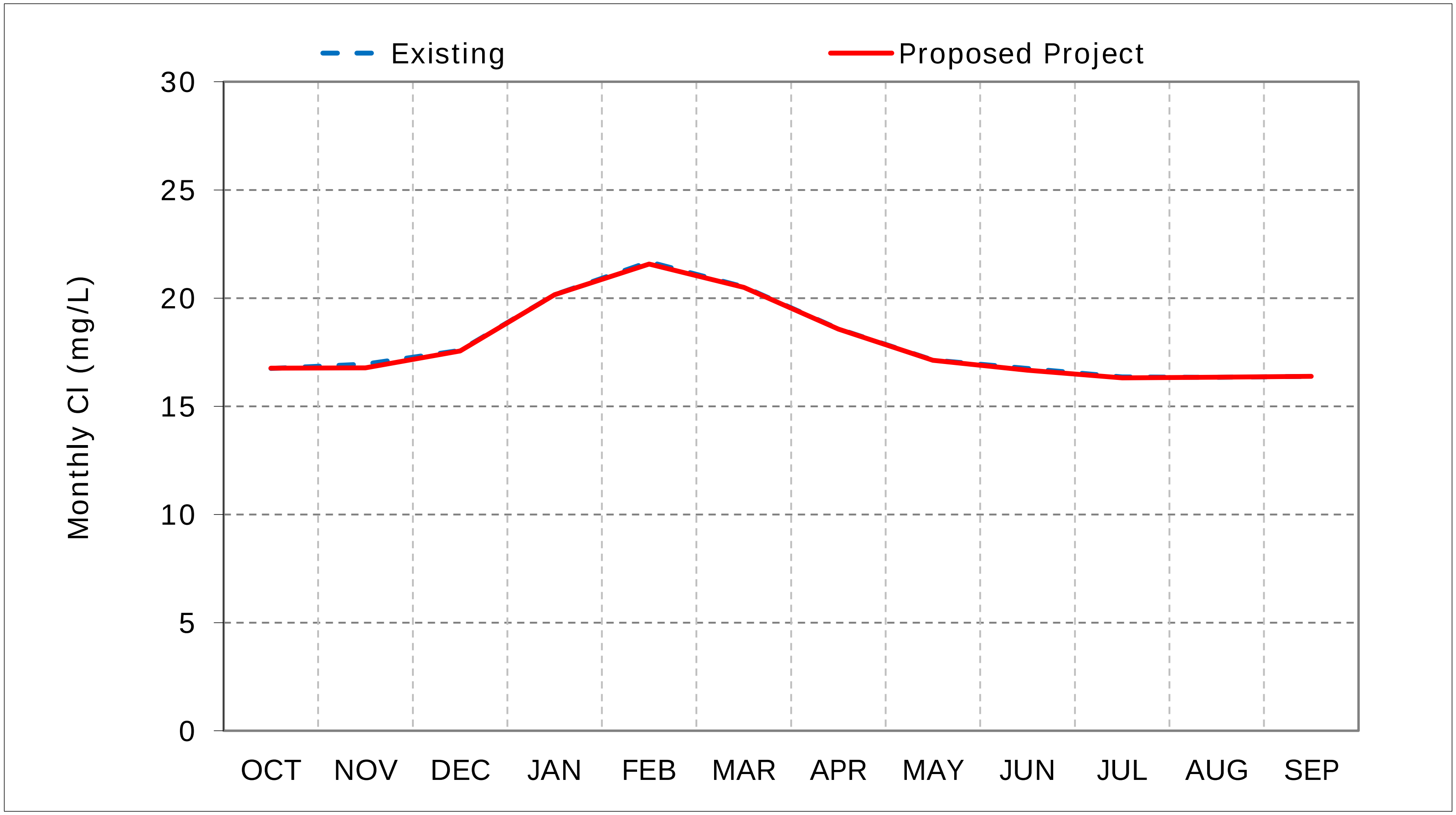
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 13-3. Barker Slough at NBA Intake Chloride, Above Normal Year Average C



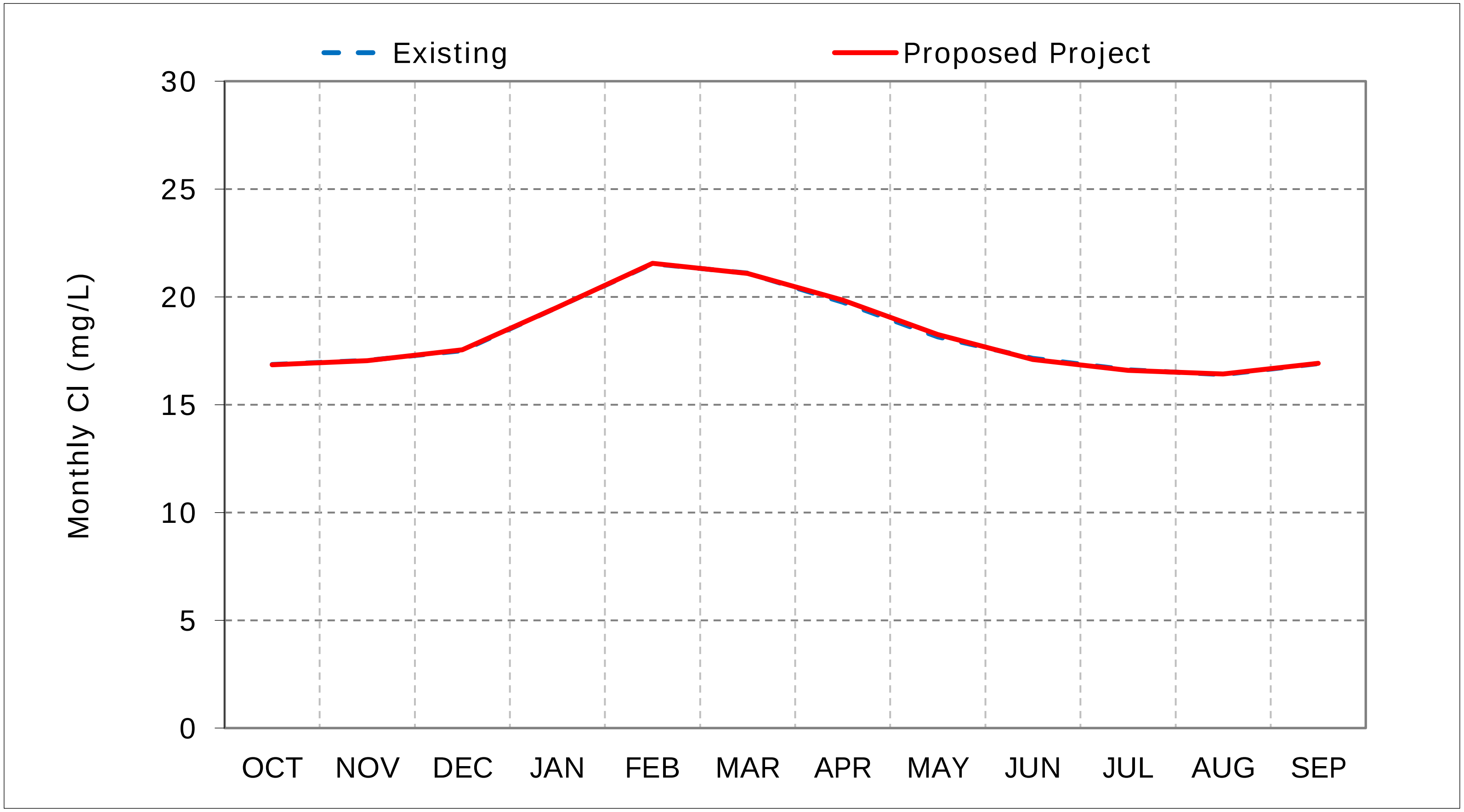
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 13-4. Barker Slough at NBA Intake Chloride, Below Normal Year Average C



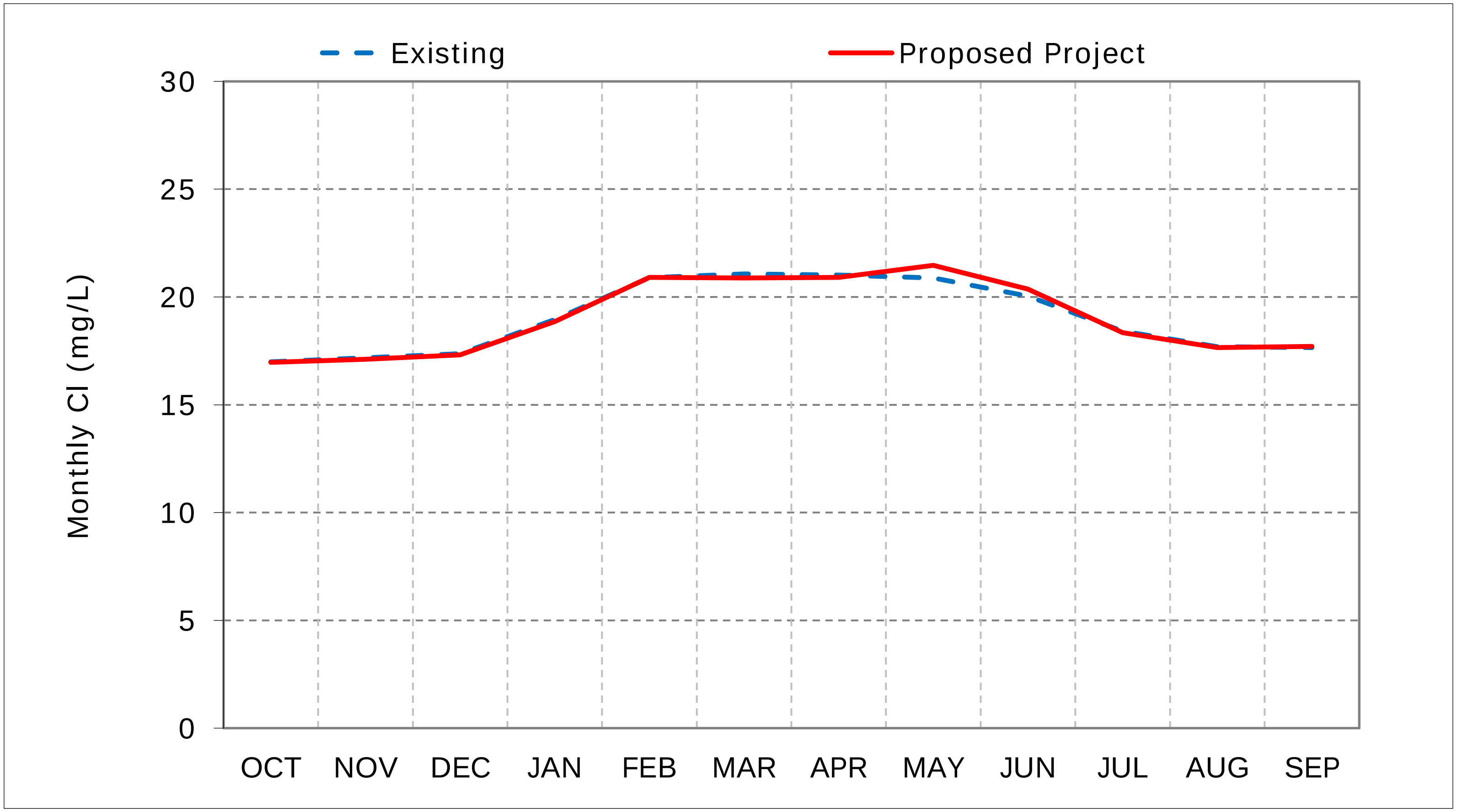
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 13-5. Barker Slough at NBA Intake Chloride, Dry Year Average Cl



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 13-6. Barker Slough at NBA Intake Chloride, Critical Year Average Cl



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 13-7. Barker Slough at NBA Intake Chloride, January Cl

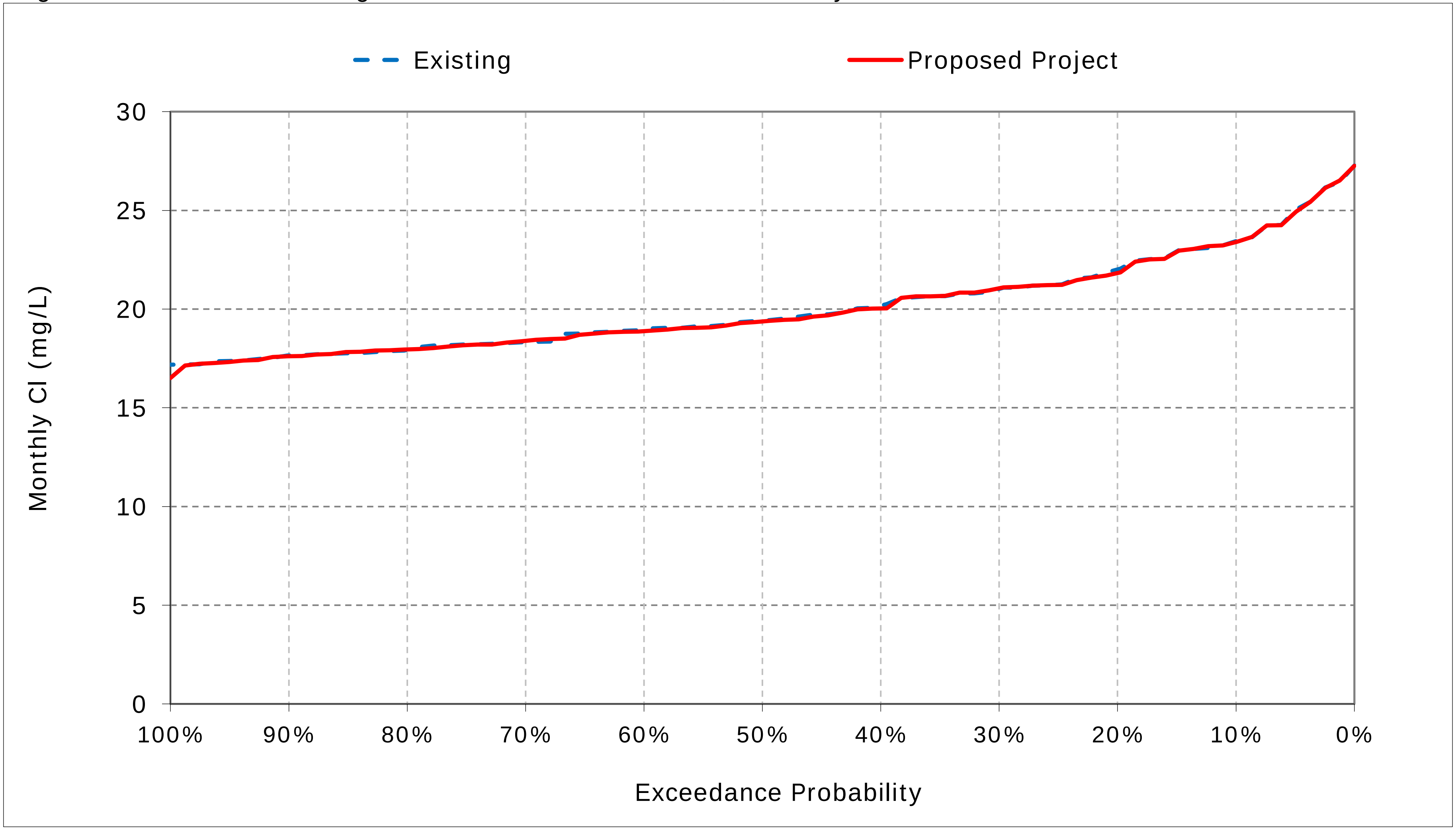


Figure 13-8. Barker Slough at NBA Intake Chloride, February Cl

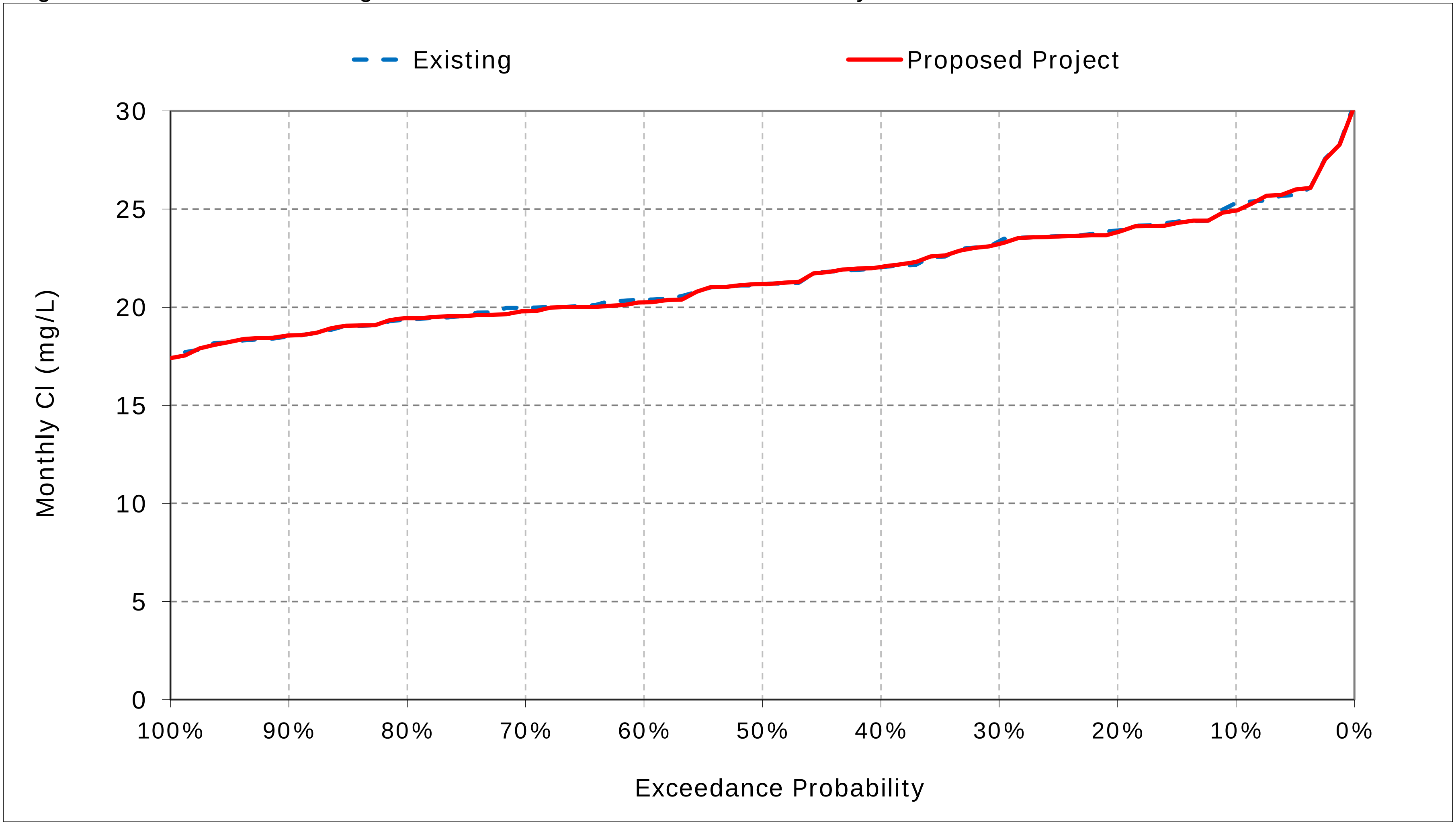


Figure 13-9. Barker Slough at NBA Intake Chloride, March Cl

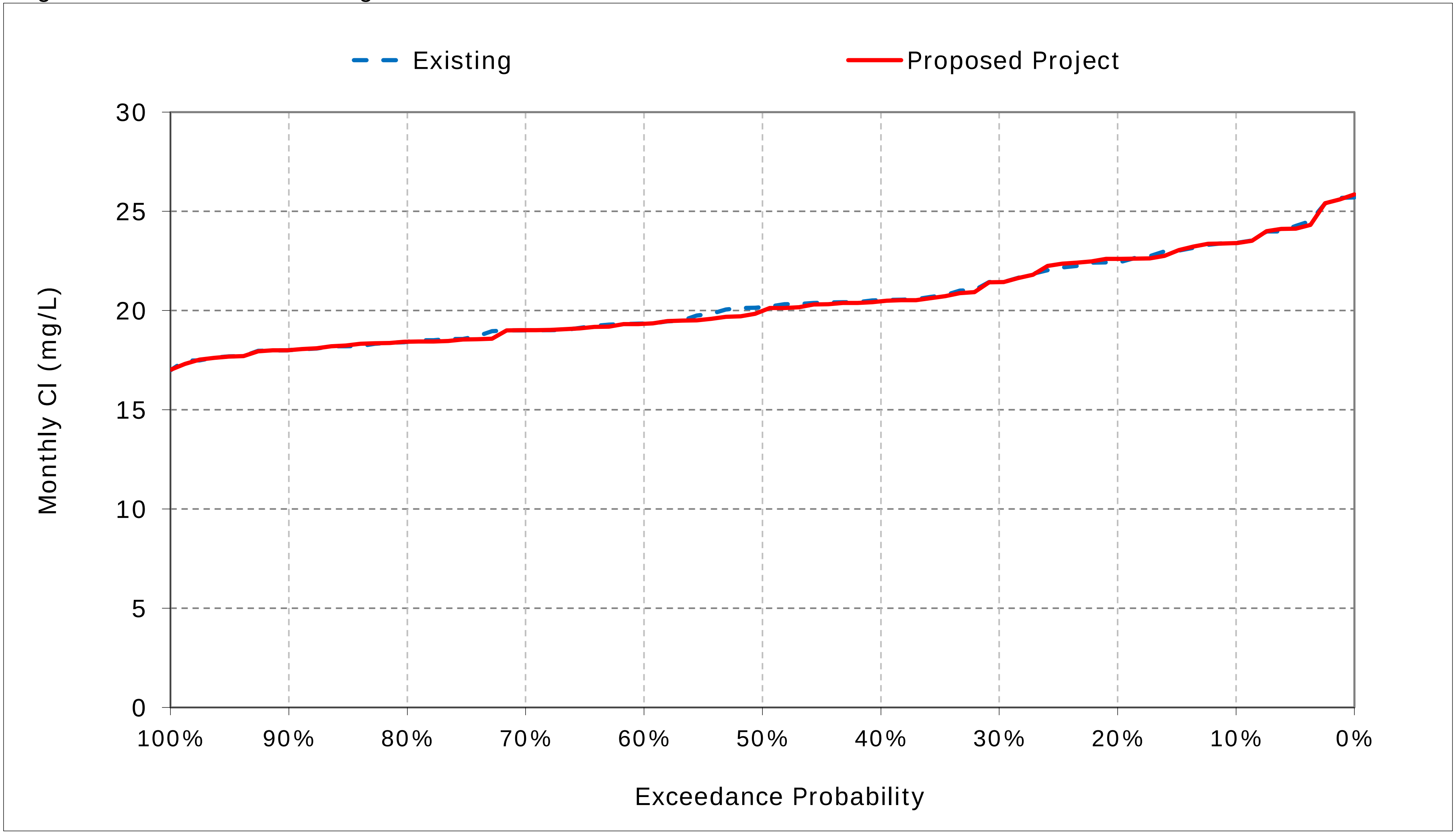


Figure 13-10. Barker Slough at NBA Intake Chloride, April Cl

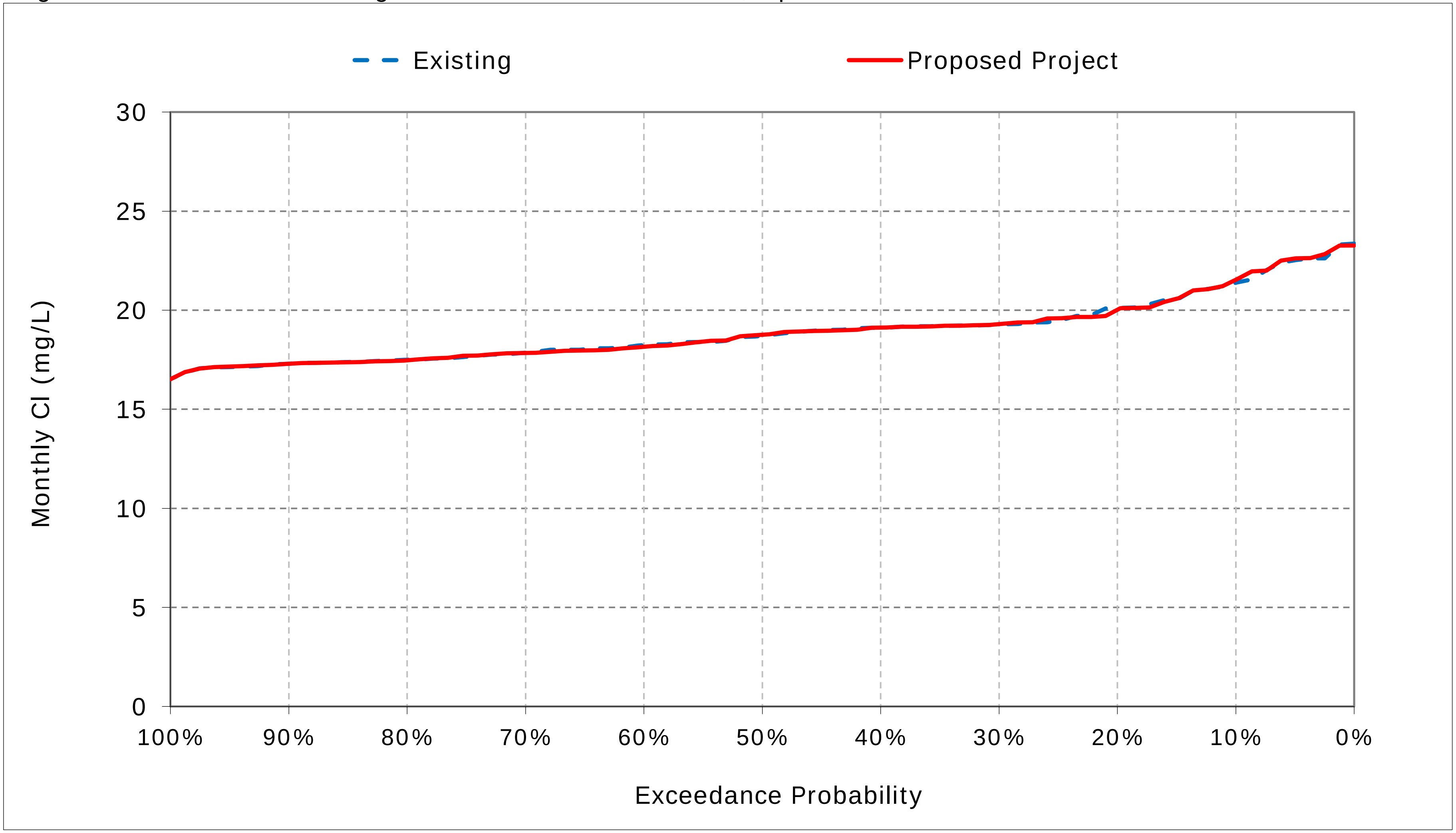


Figure 13-11. Barker Slough at NBA Intake Chloride, May Cl

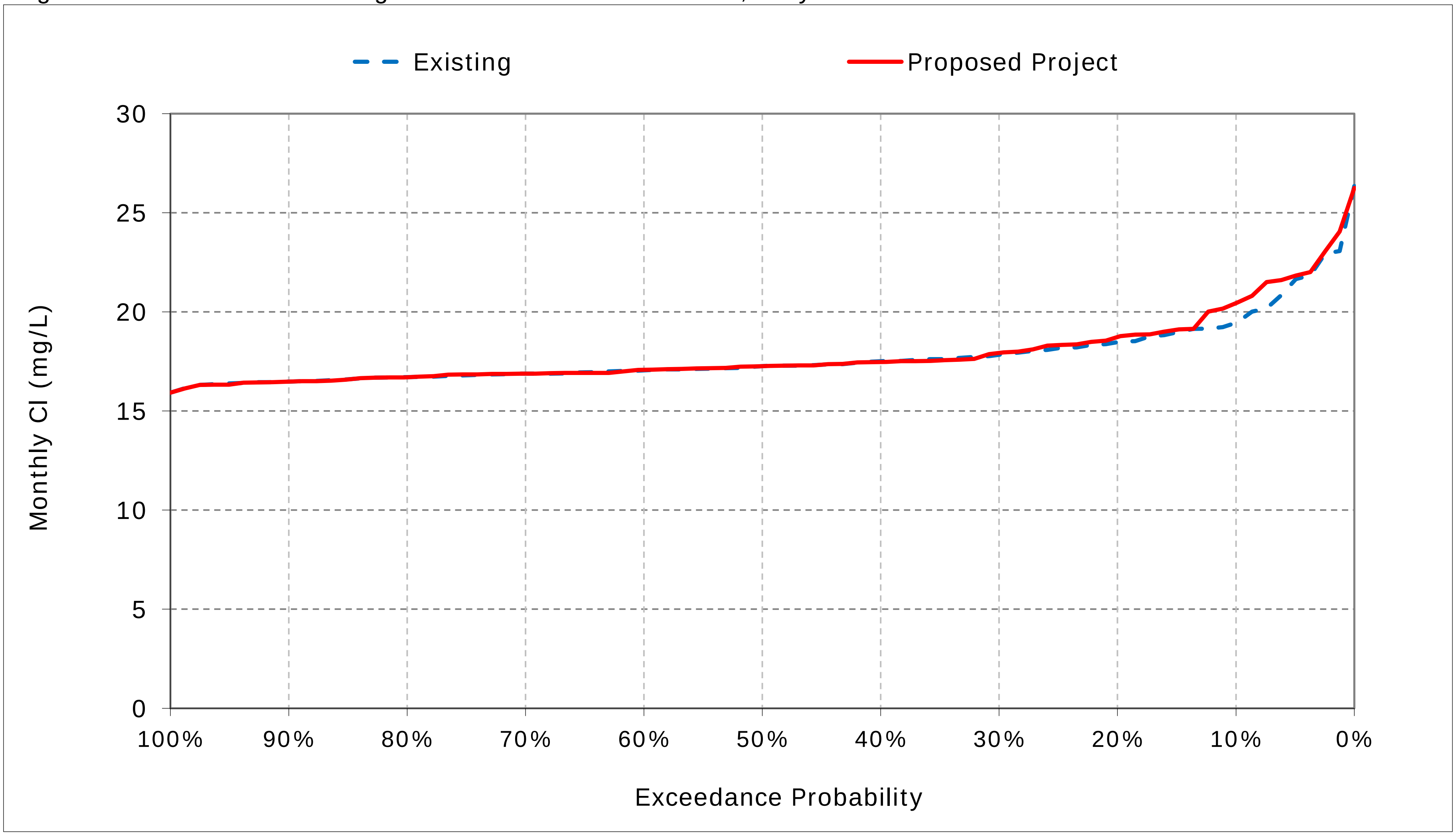


Figure 13-12. Barker Slough at NBA Intake Chloride, June Cl

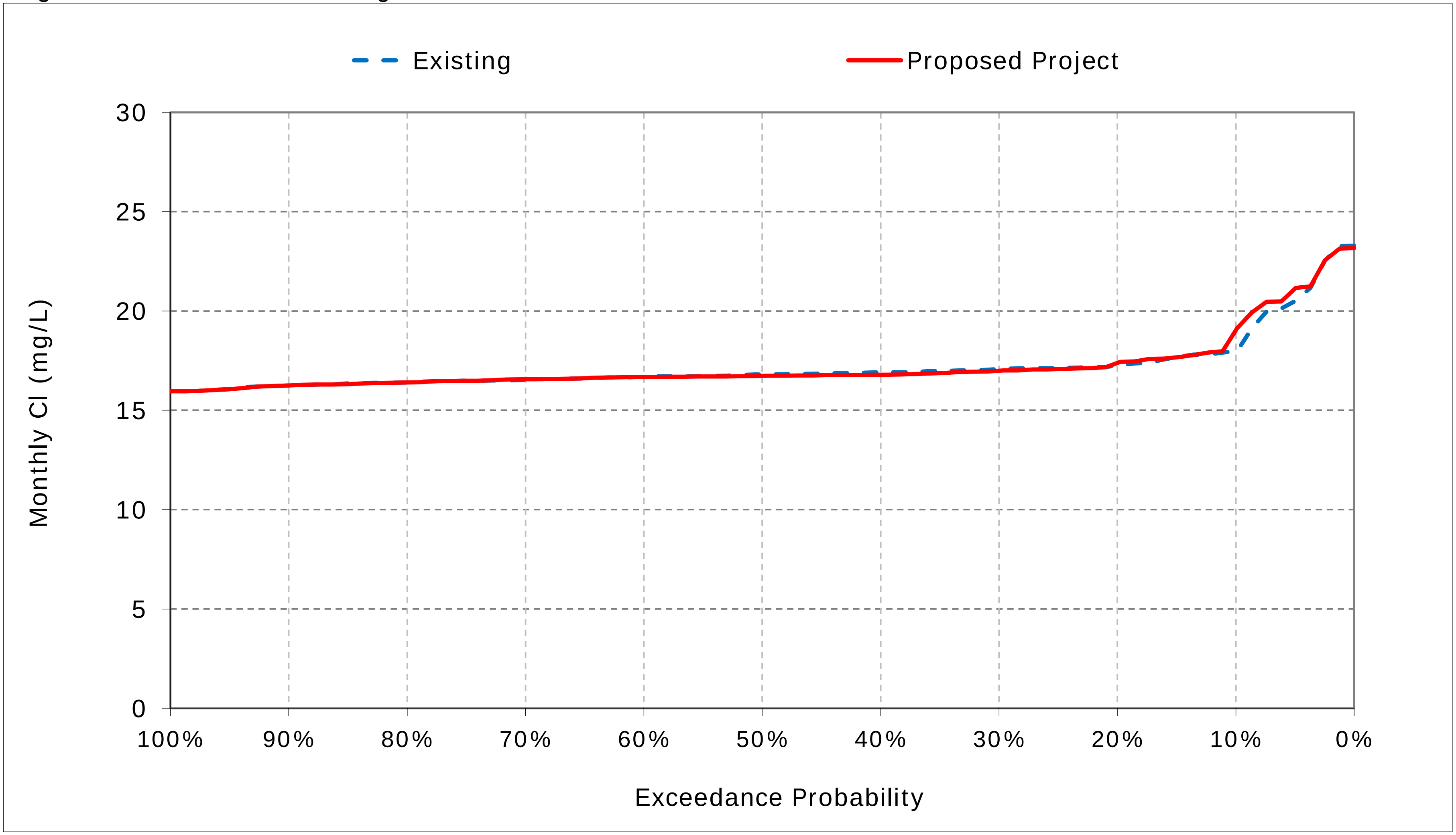


Figure 13-13. Barker Slough at NBA Intake Chloride, July Cl

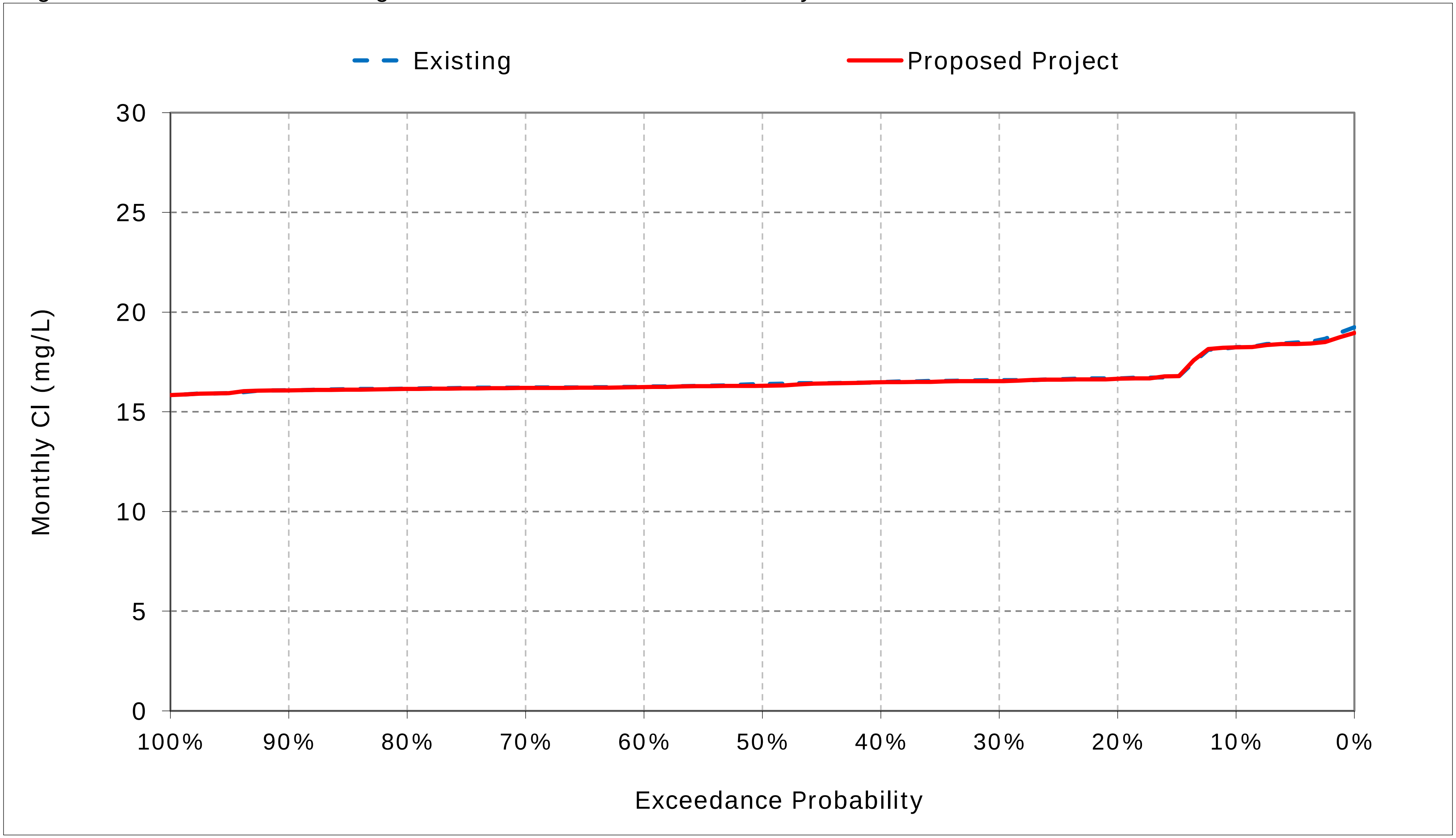


Figure 13-14. Barker Slough at NBA Intake Chloride, August Cl

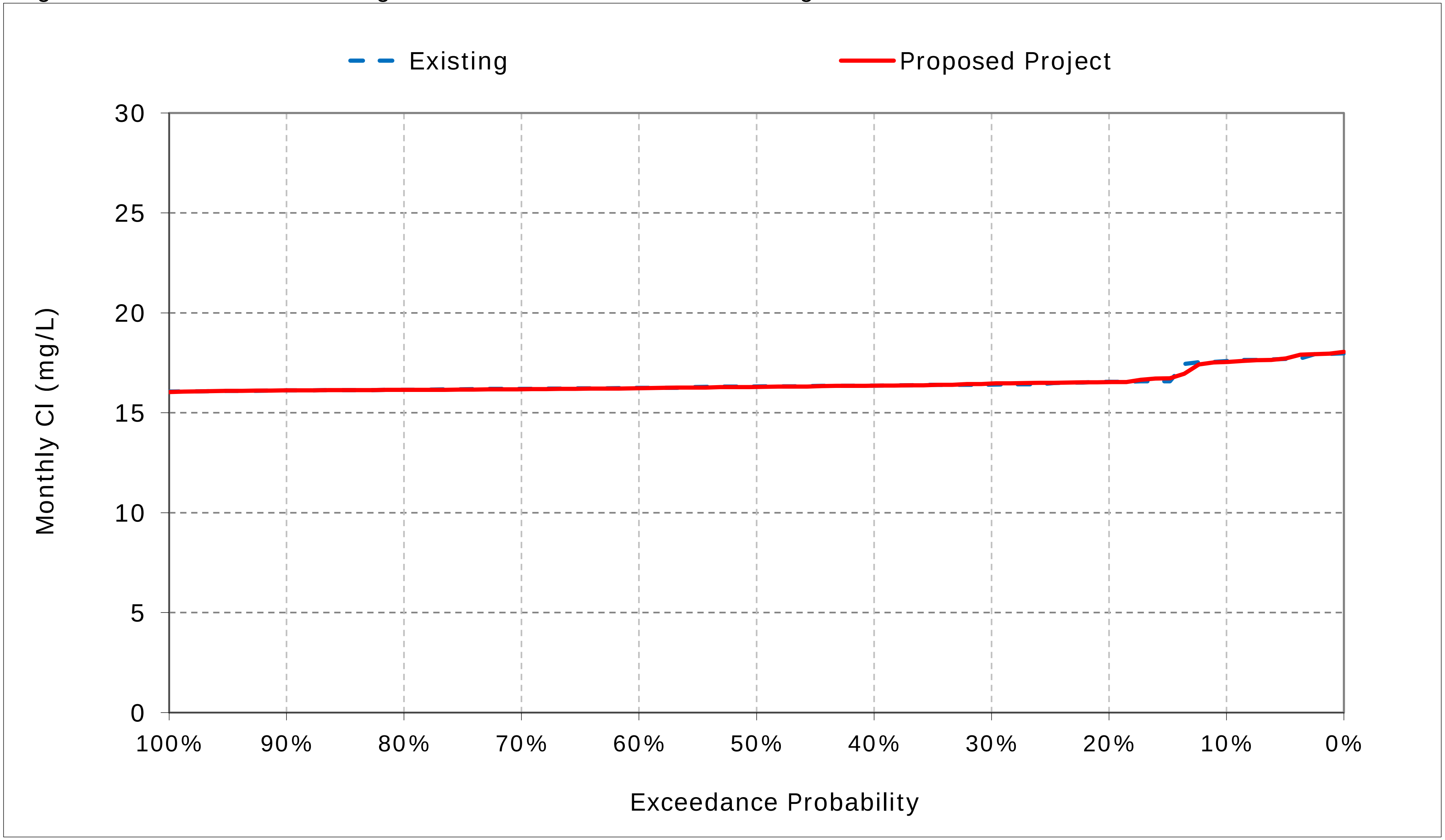


Figure 13-15. Barker Slough at NBA Intake Chloride, September Cl

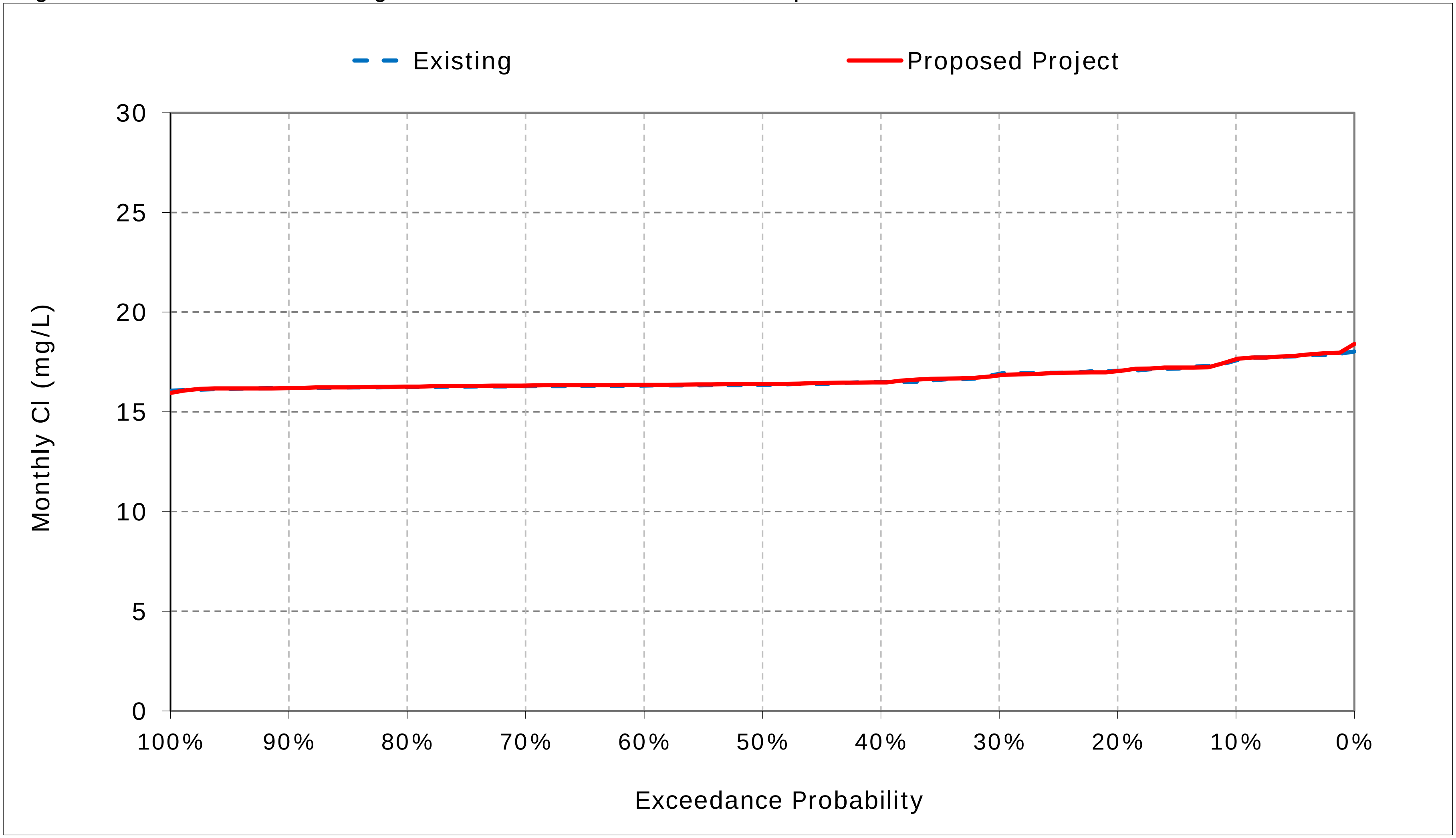


Figure 13-16. Barker Slough at NBA Intake Chloride, October Cl

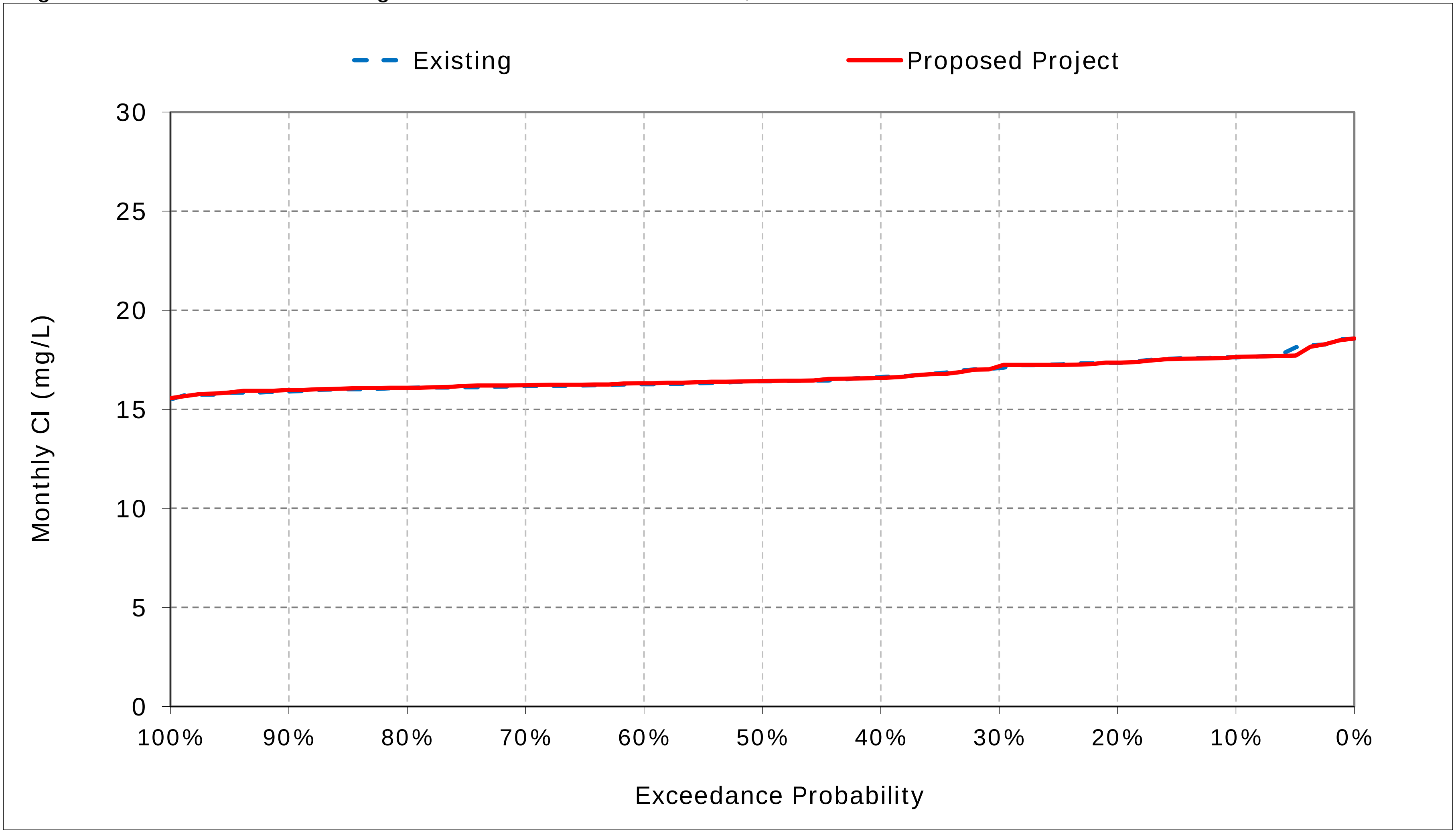


Figure 13-17. Barker Slough at NBA Intake Chloride, November Cl

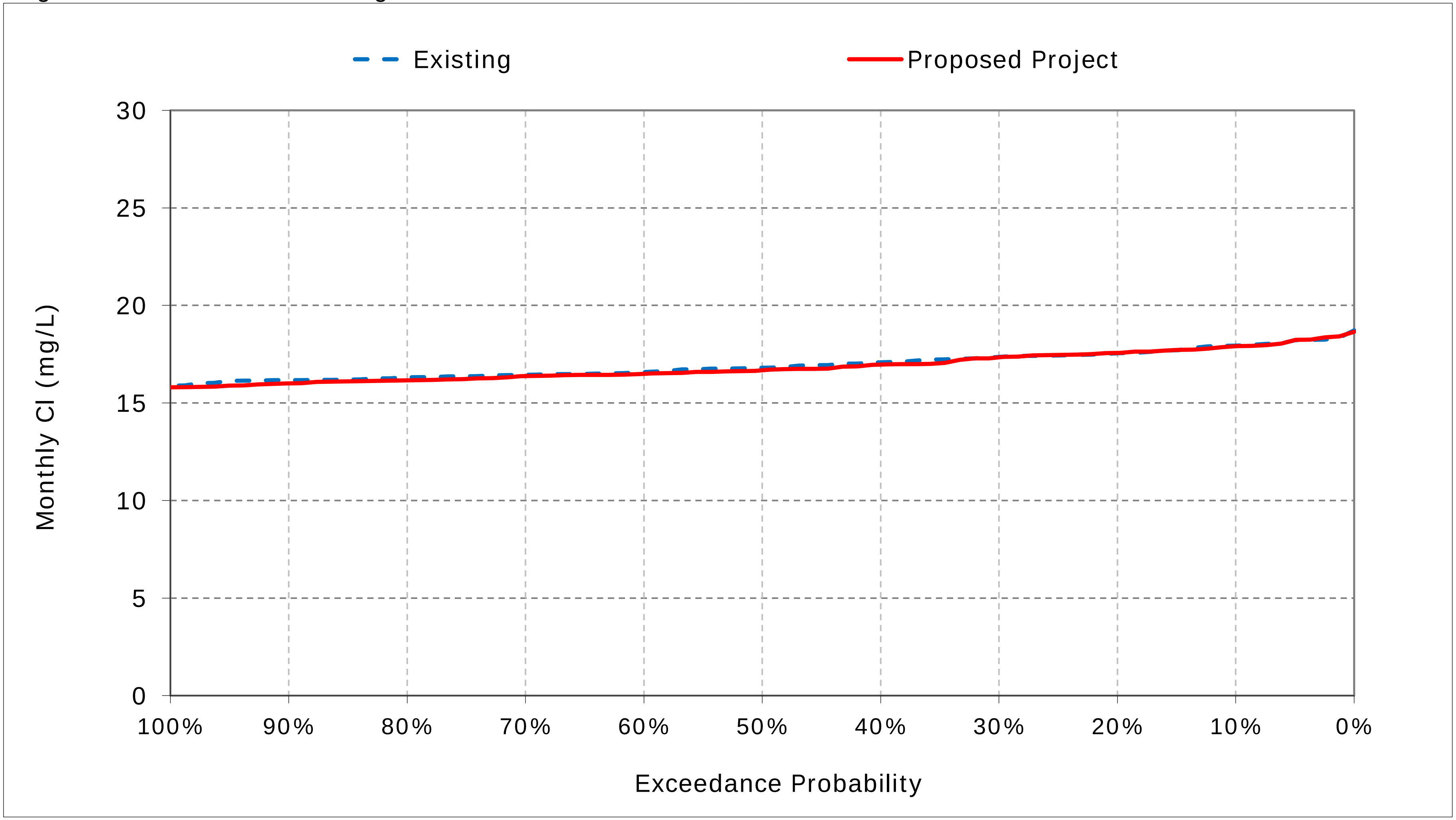
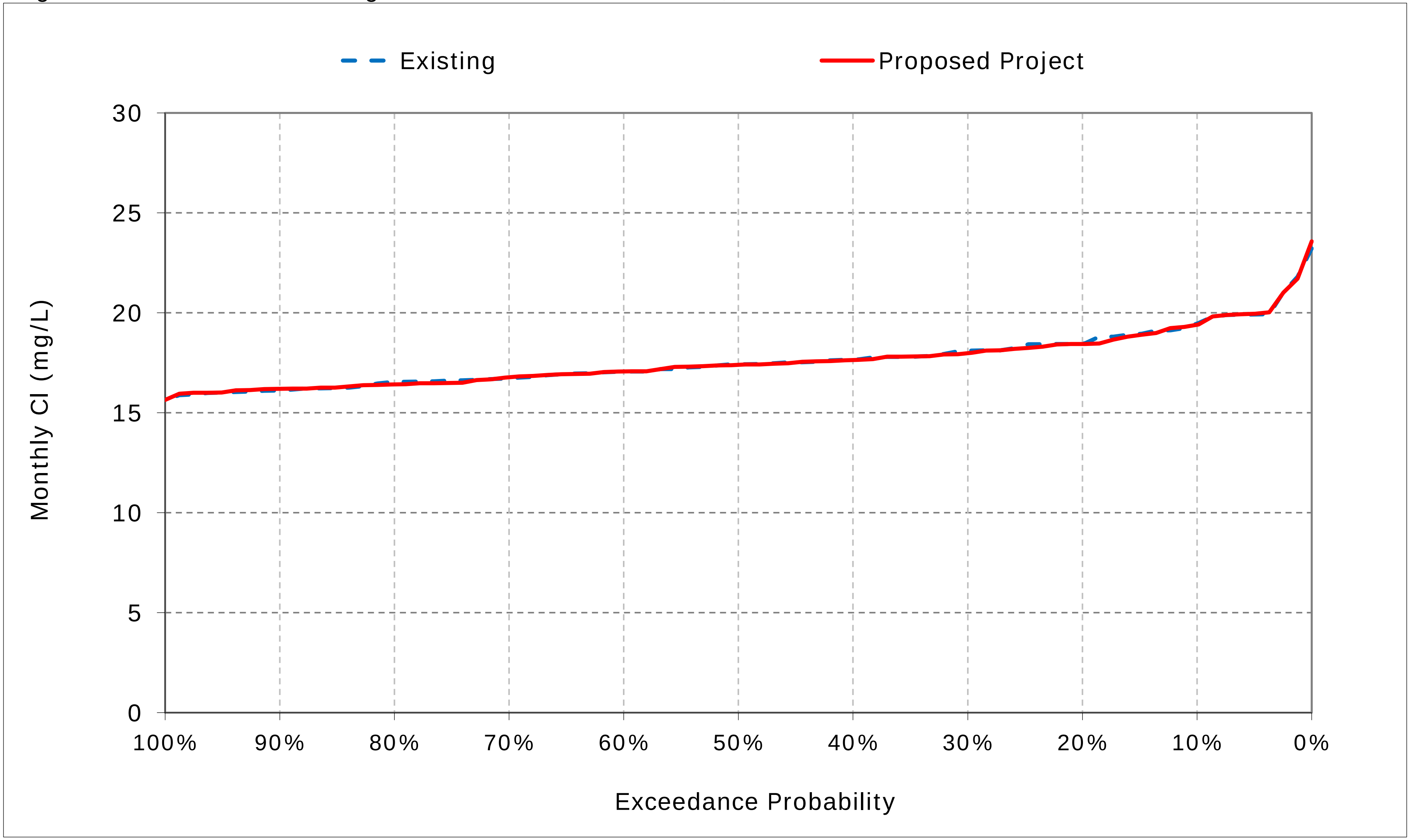


Figure 13-18. Barker Slough at NBA Intake Chloride, December Cl



Appendix C – Modeling

Attachment 2-9 – D1641 Compliance Results (DSM2-QUAL)

The following results of the DSM2-QUAL model are included for Delta compliance conditions for the following alternatives:

- Existing Conditions
- Proposed Project

Table 2-9.1. D1641 Compliance Results (DSM2-QUAL)

Title	Model Parameter	Table Numbers	Figure Numbers
D1641 AG West Canal at mouth of Clifton Court Forebay	CHWST000	NA	1-1
D1641 AG South Fork Mokelumne River at Terminus	RSMKL008	NA	2-1
D1641 AG Sacramento River at Emmaton	RSAC092	NA	3-1
D1641 AG San Joaquin River at Jersey Point	RSAN018	NA	4-1
D1641 AG San Joaquin River at San Andreas Landing	RSAN032	NA	5-1
D1641 AG Delta-Mendota Canal at Tracy Pumping Plant	CHDMC004	NA	6-1
D1641 FWS Chadbourne Slough at Sunrise Duck Club	SLCBN002	NA	7-1
D1641 FWS Montezuma Slough near Beldon Landing	SLMZU011	NA	8-1
D1641 FWS Montezuma Slough at National Steel	SLMZU025	NA	9-1
D1641 FWS Sacramento River at Collinsville	RSAC081	NA	10-1
D1641 FWS San Joaquin River at Jersey Point	RSAN018	NA	11-1
D1641 FWS San Joaquin River at Prisoners Point	RSAN037	NA	12-1
D1641 FWS Suisun Slough 300 ft south of Volanti Slough	SLSUS012	NA	13-1
D1641 MI Cache Slough at City of Vallejo Intake	SLCCH016	NA	14-1
D1641 MI West Canal at mouth of Clifton Court Forebay	CHWST000	NA	15-1
D1641 MI Contra Costa Canal at Pumping Plant #1	ROLD024	NA	16-1

Title	Model Parameter	Table Numbers	Figure Numbers
D1641 MI Delta-Mendota Canal at Tracy Pumping Plant	CHDMC004	NA	17-1
D1641 MI Barker Slough at North Bay Aqueduct Intake	SLBAR002	NA	18-1

Report formats

- Compliance exceedance charts including all scenarios

Figure 1 D1641 AG West Canal at mouth of Clifton Court Forebay Compliance Exceedance Plot

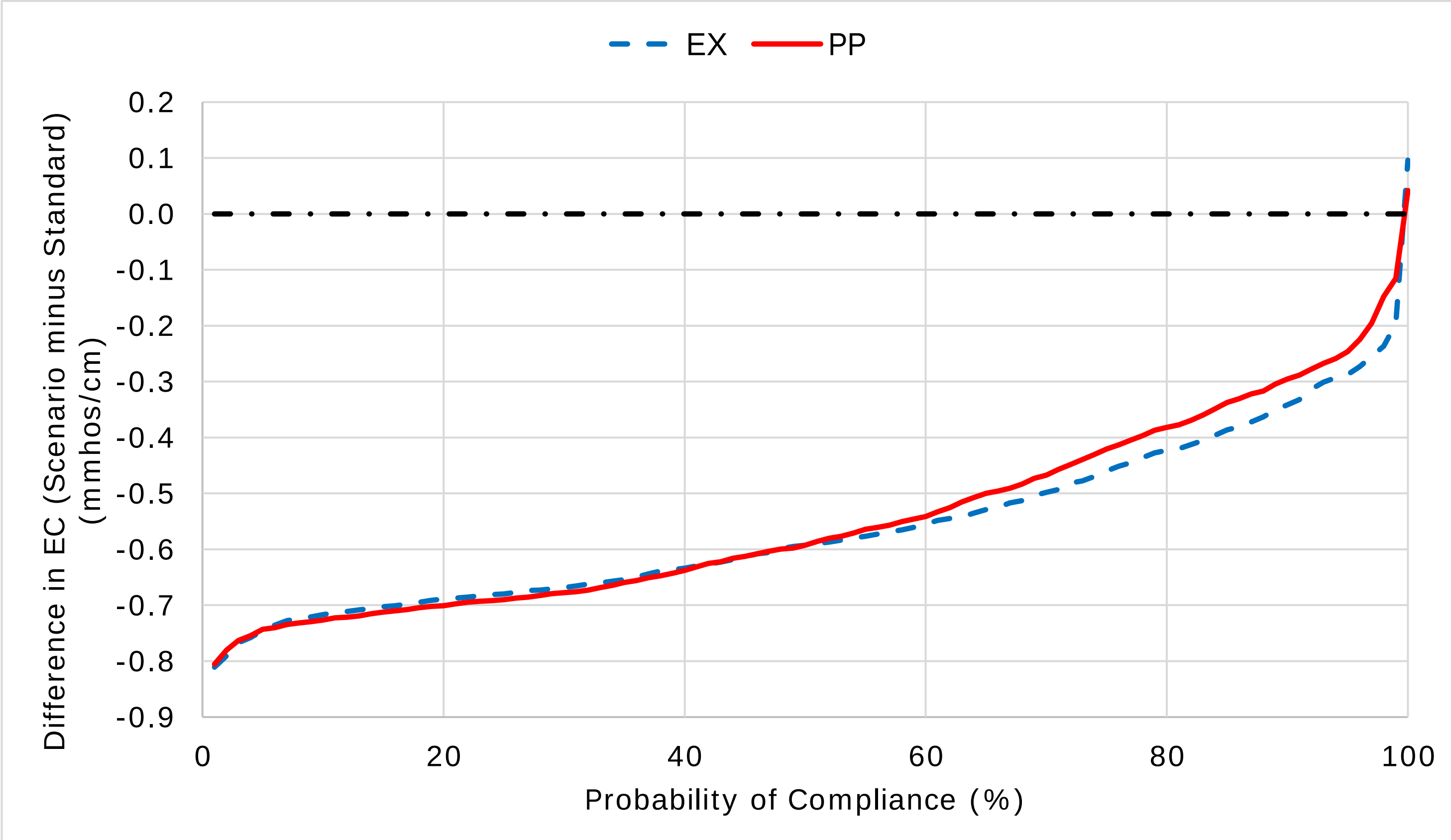


Figure 2 D1641 AG South Fork Mokelumne River at Terminus Compliance Exceedance Plot

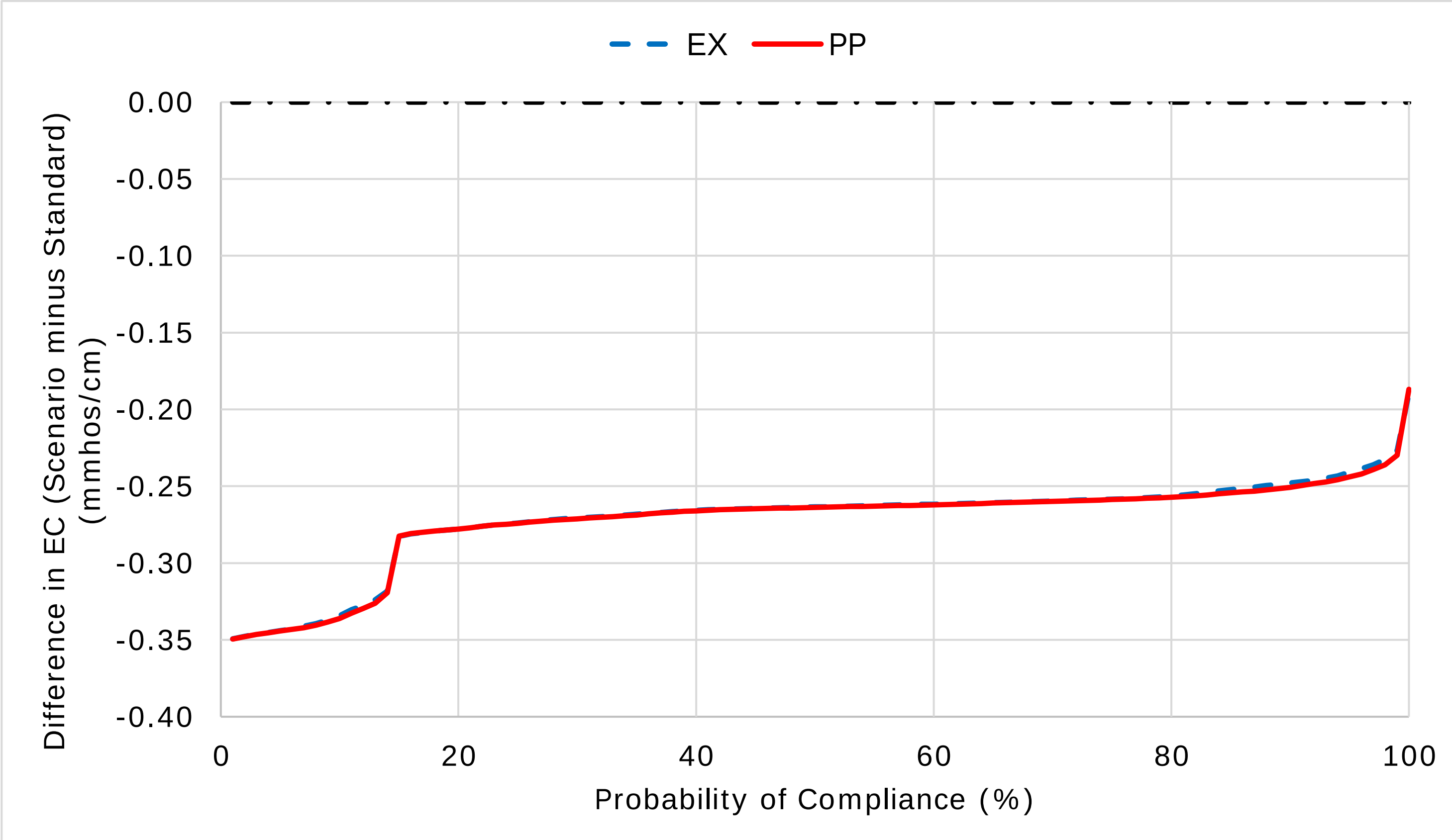


Figure 3 D1641 AG Sacramento River at Emmaton Compliance Exceedance Plot

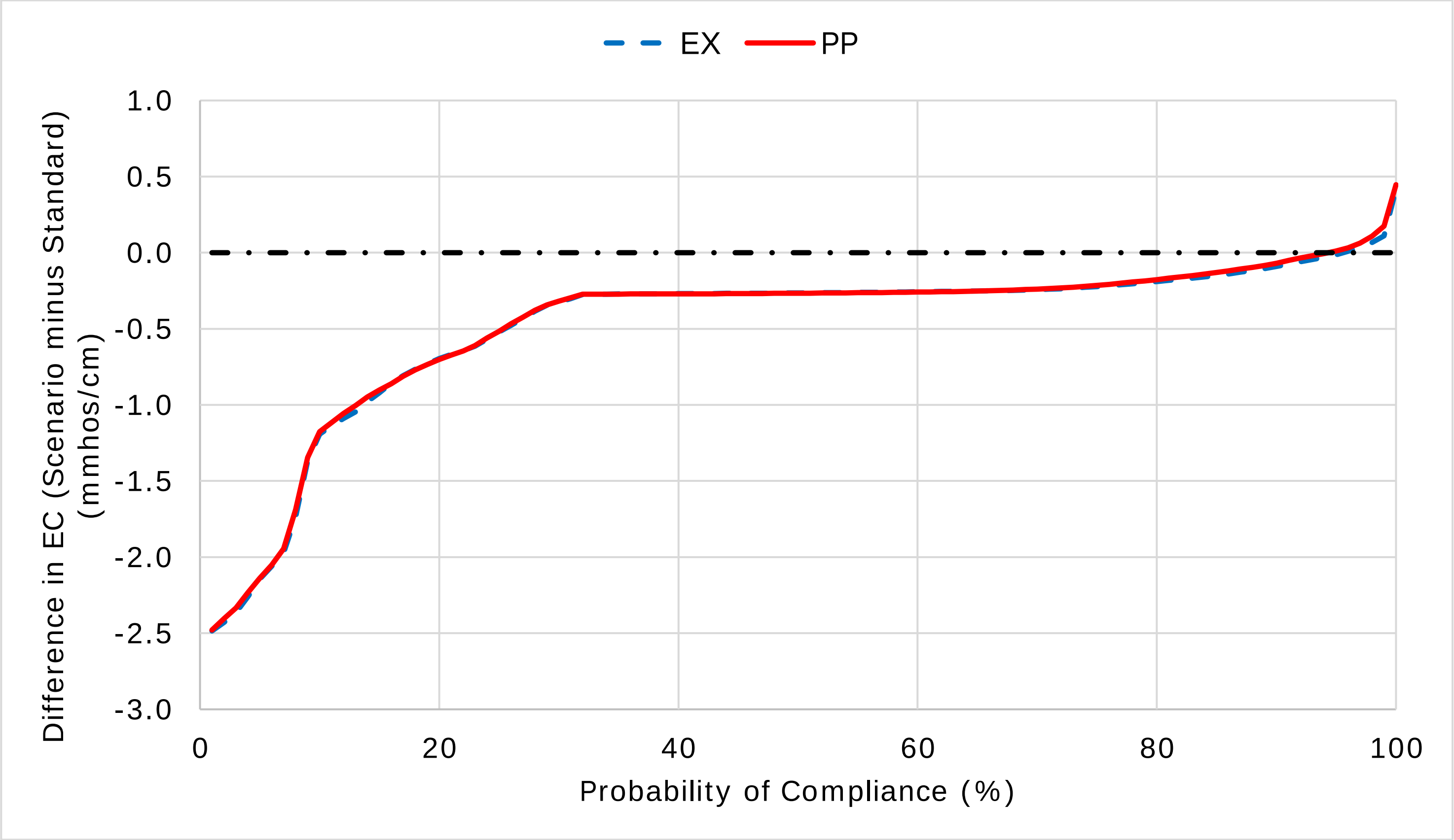


Figure 4 D1641 AG San Joaquin River at Jersey Point Compliance Exceedance Plot

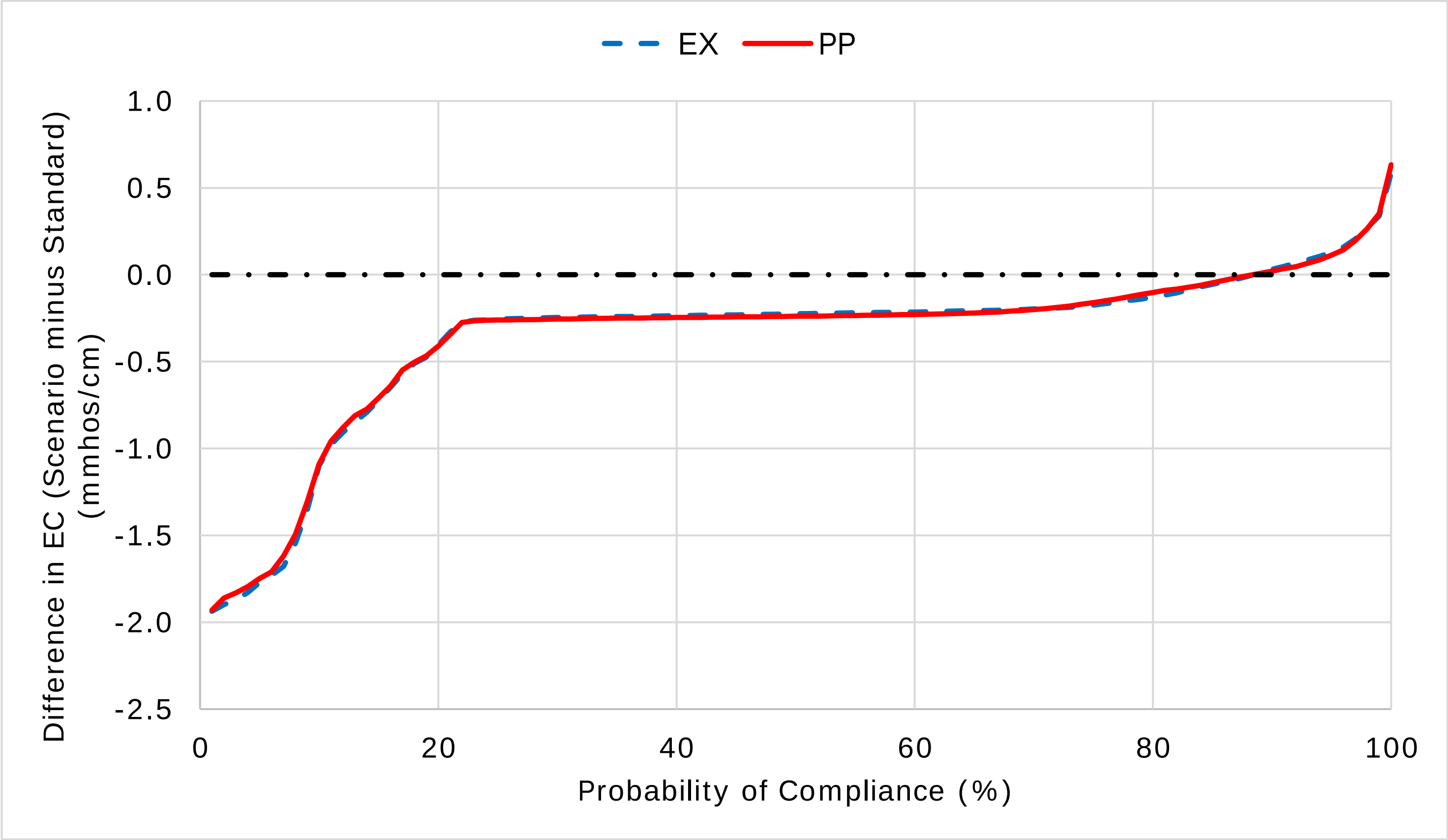


Figure 5 D1641 AG San Joaquin River at San Andreas Landing Compliance Exceedance Plot

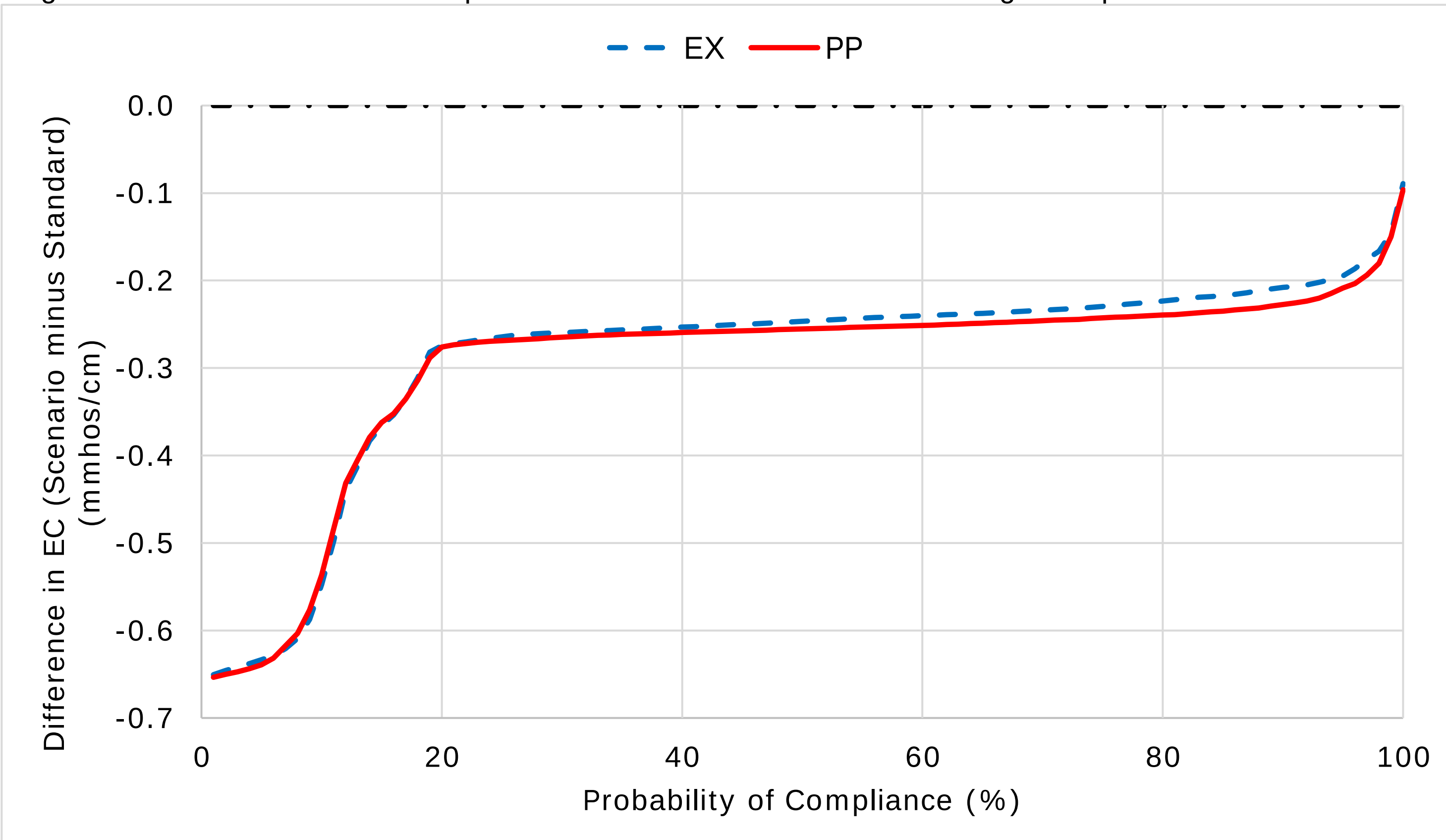


Figure 6 D1641 AG Delta-Mendota Canal at Tracy Pumping Plant Compliance Exceedance Plot

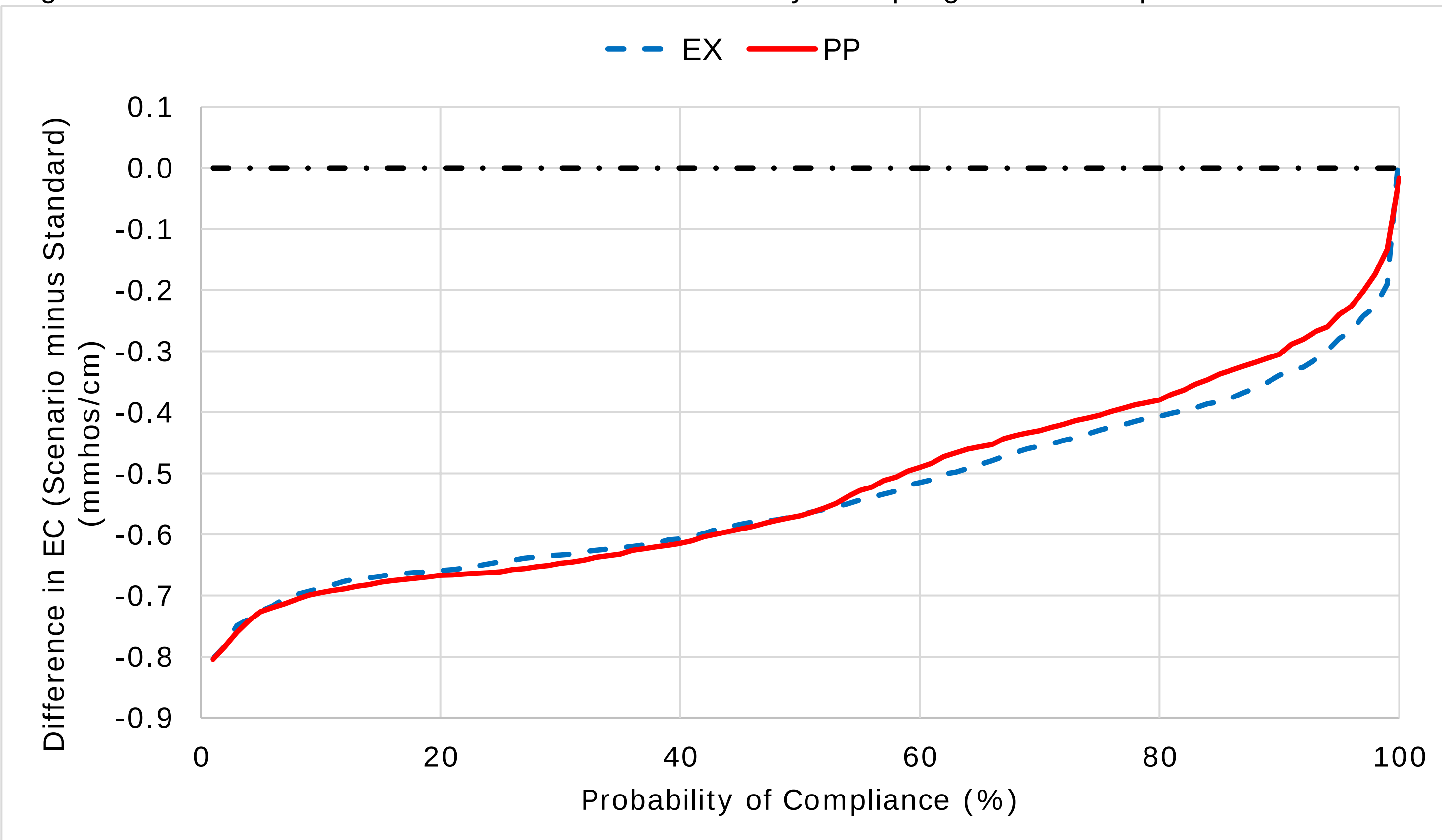


Figure 7 D1641 FWS Chadbourne Slough at Sunrise Duck Club Compliance Exceedance Plot

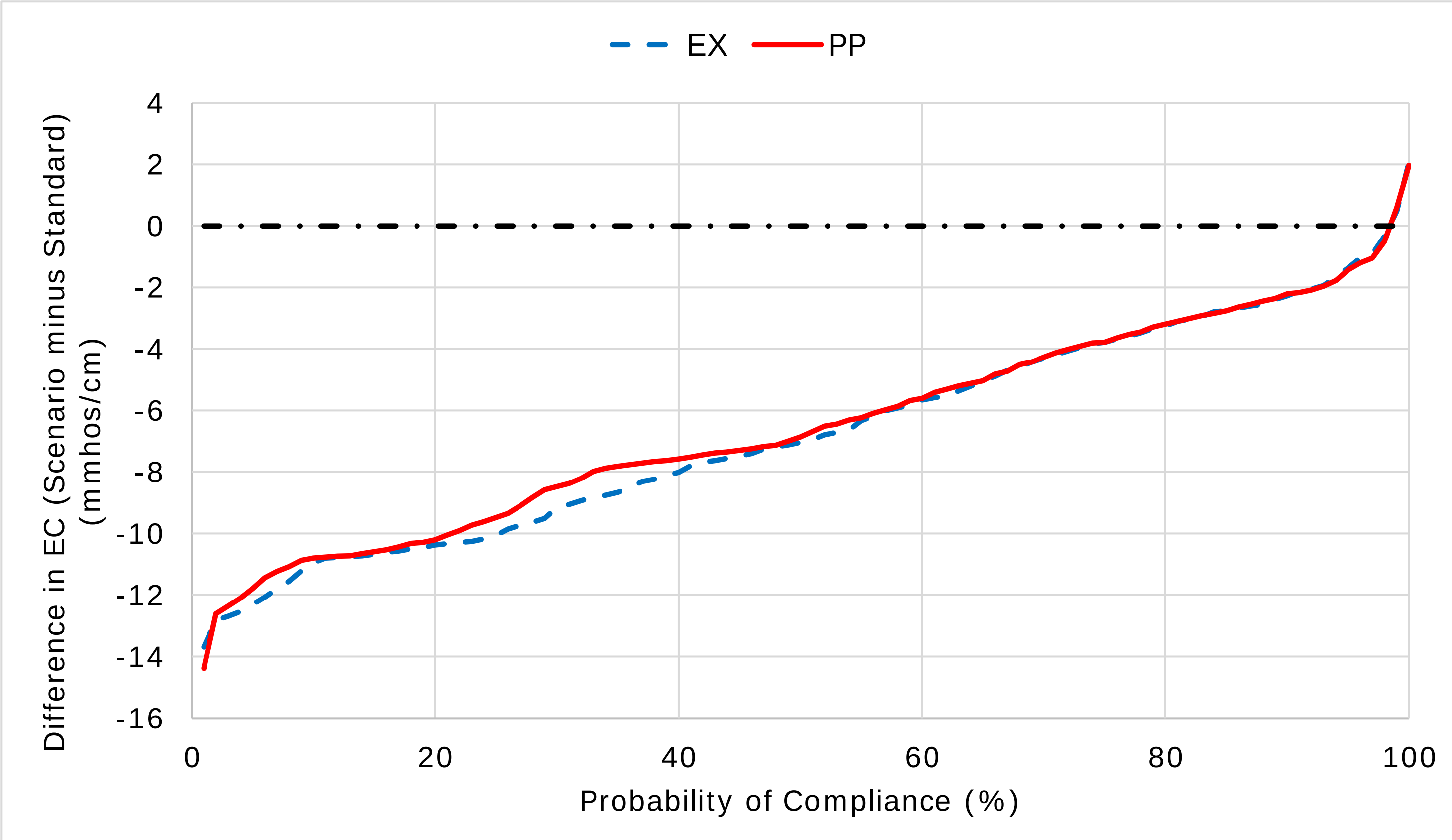


Figure 8 D1641 FWS Montezuma Slough near Beldons Landing Compliance Exceedance Plot

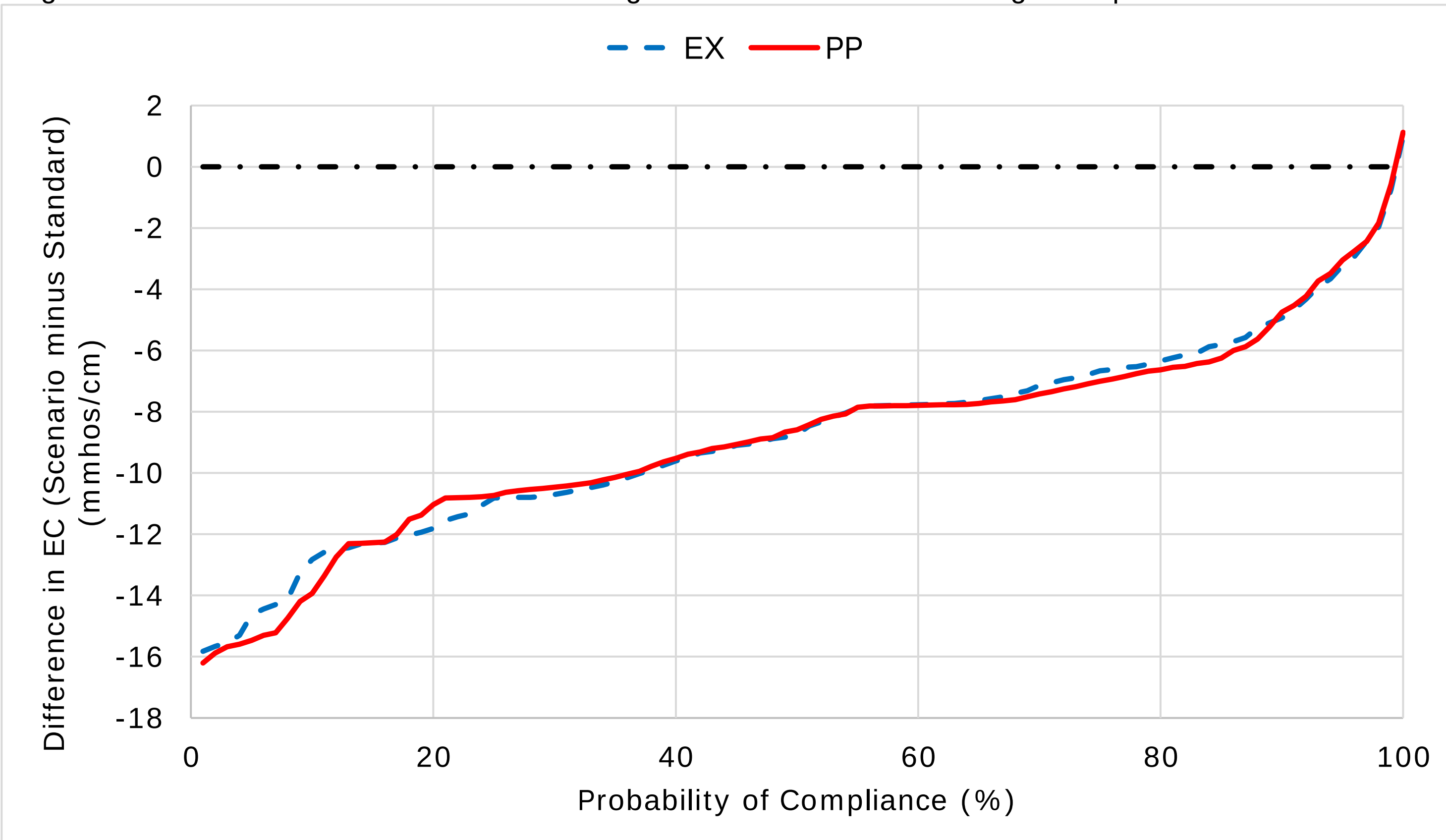


Figure 9 D1641 FWS Montezuma Slough at National Steel Compliance Exceedance Plot

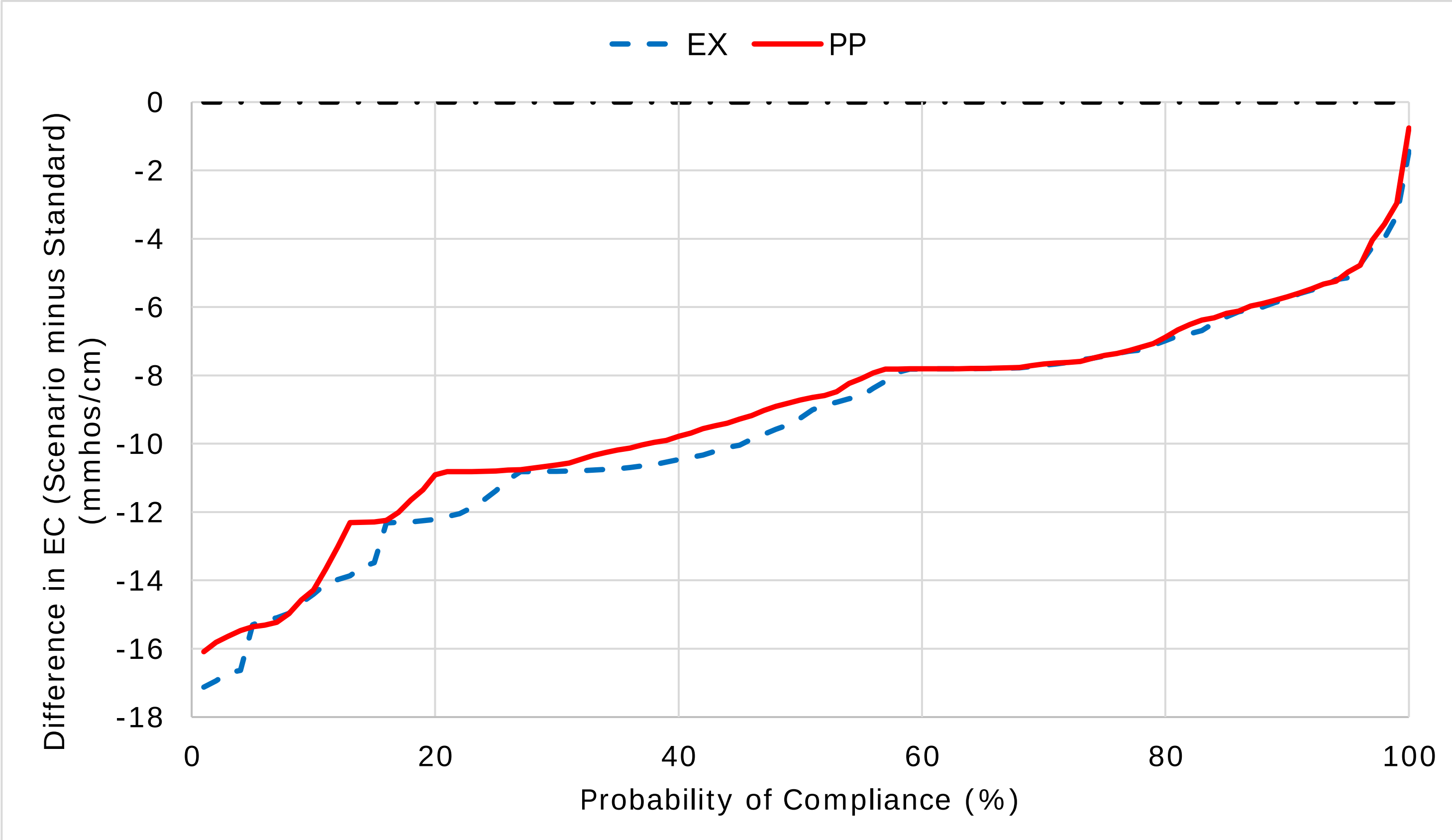


Figure 10 D1641 FWS Sacramento River at Collinsville Compliance Exceedance Plot

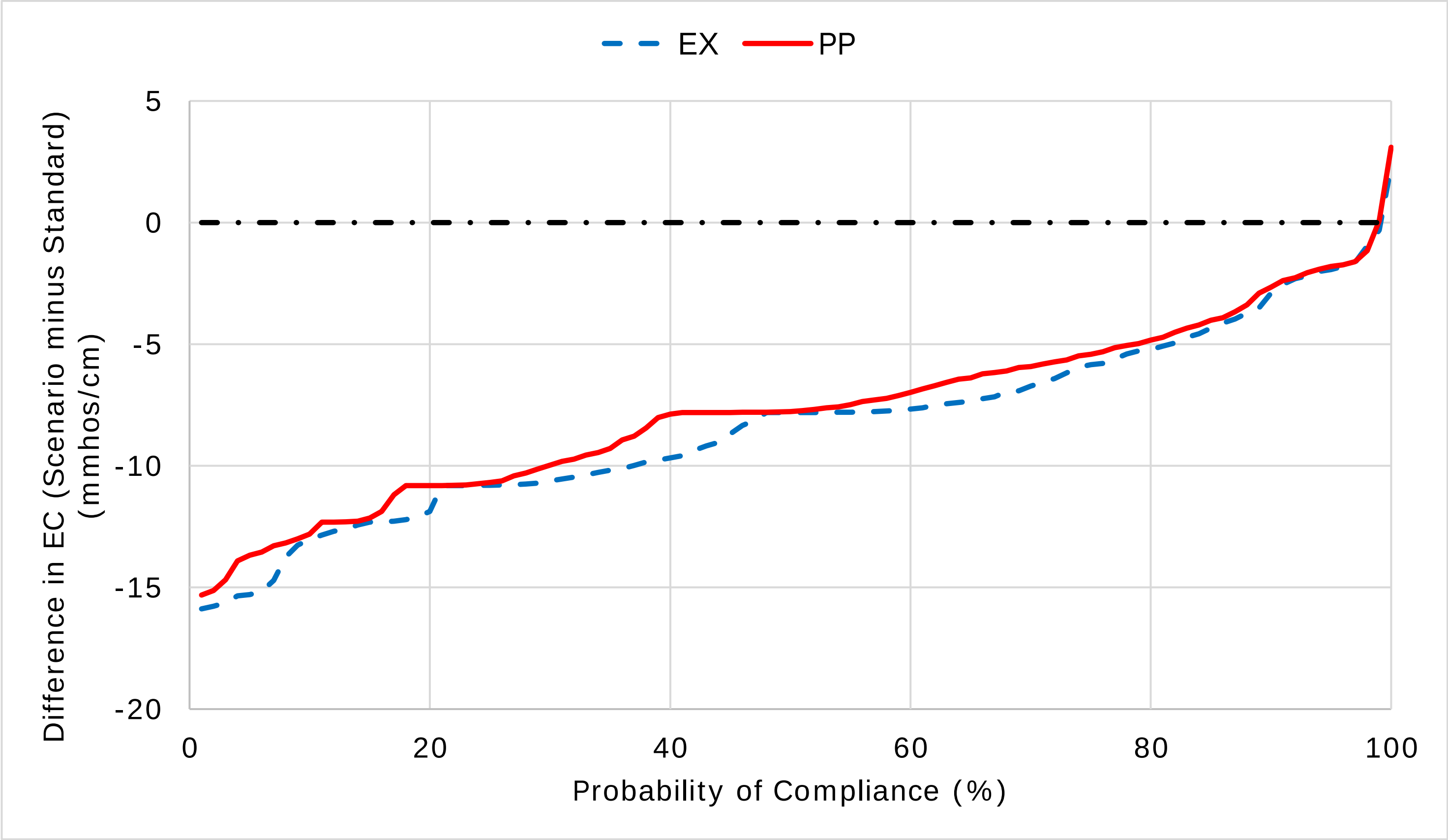


Figure 11 D1641 FWS San Joaquin River at Jersey Point Compliance Exceedance Plot

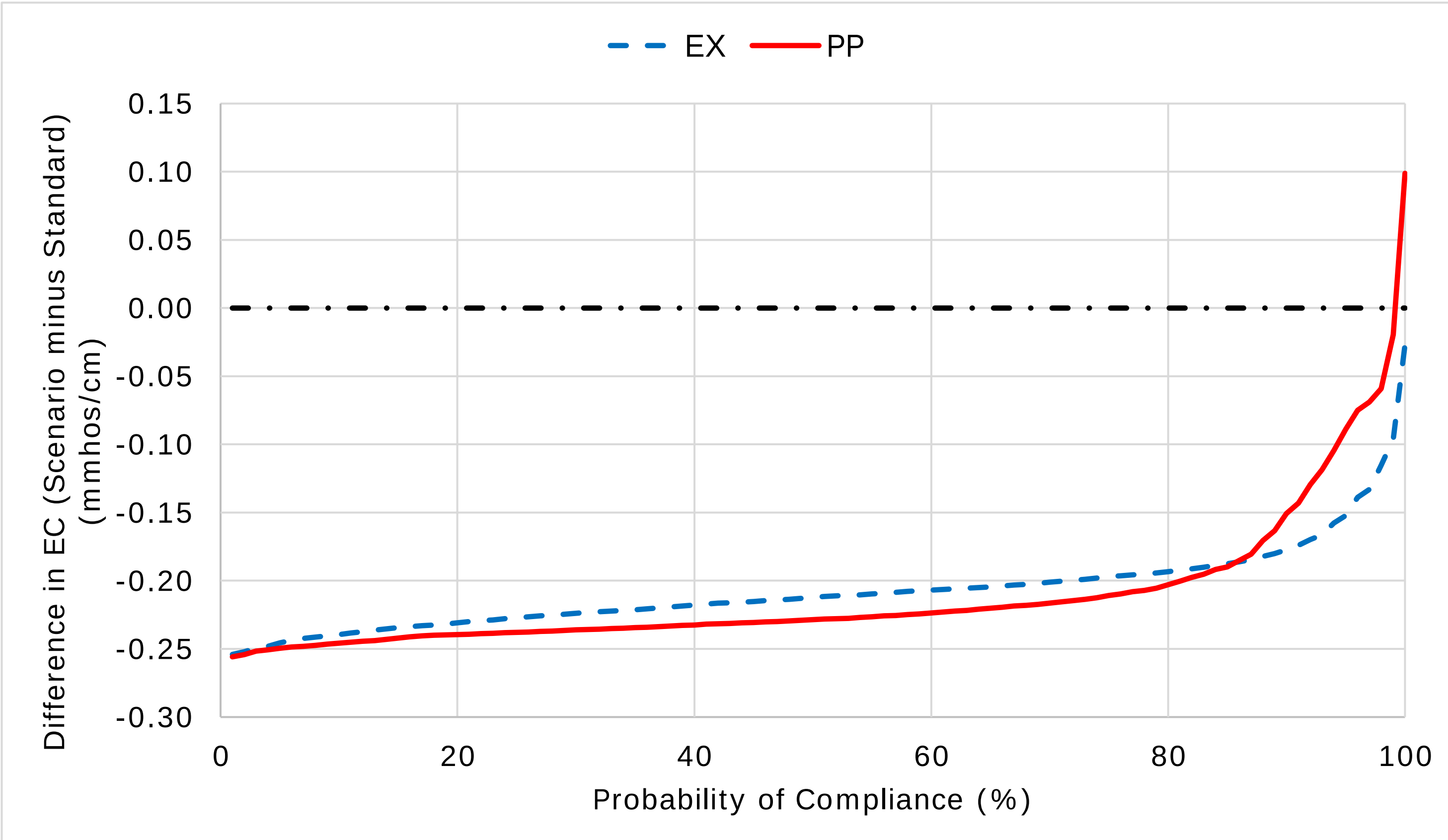


Figure 12 D1641 FWS San Joaquin River at Prisoners Point Compliance Exceedance Plot

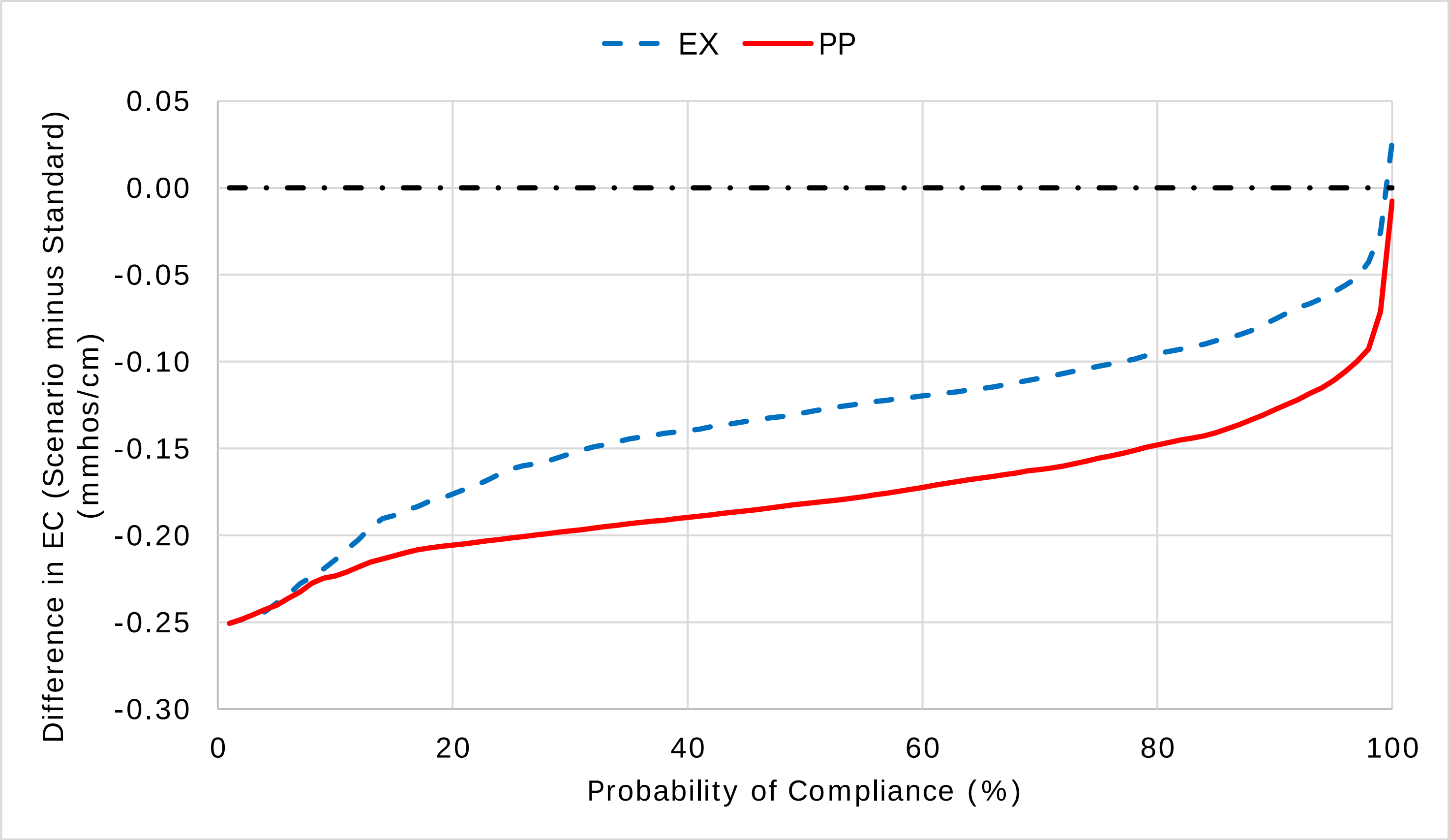


Figure 13 D1641 FWS Suisun Slough 300 ft south of Volanti Slough Compliance Exceedance Plot

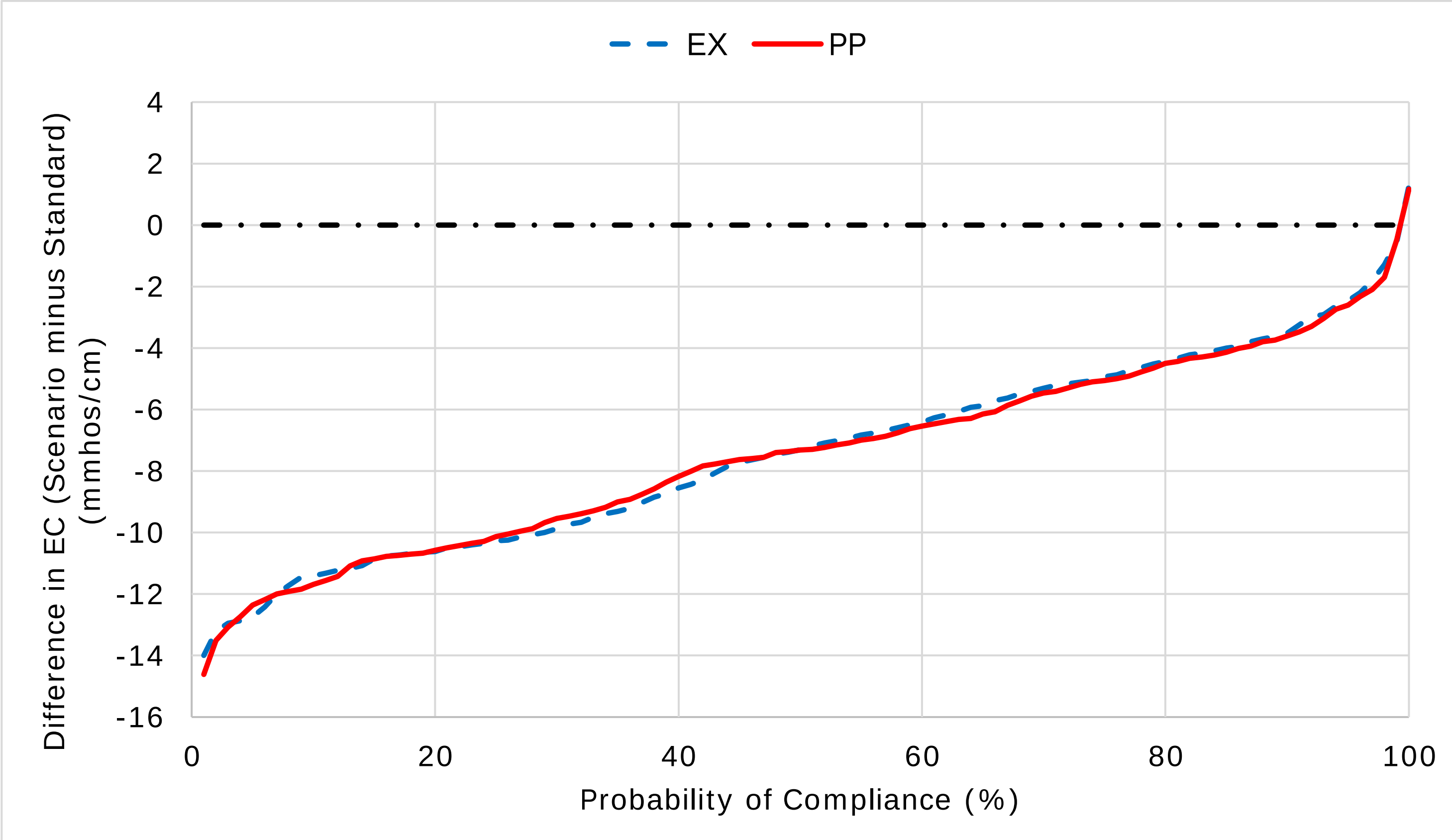


Figure 14 D1641 MI Cache Slough at City of Vallejo Intake Compliance Exceedance Plot

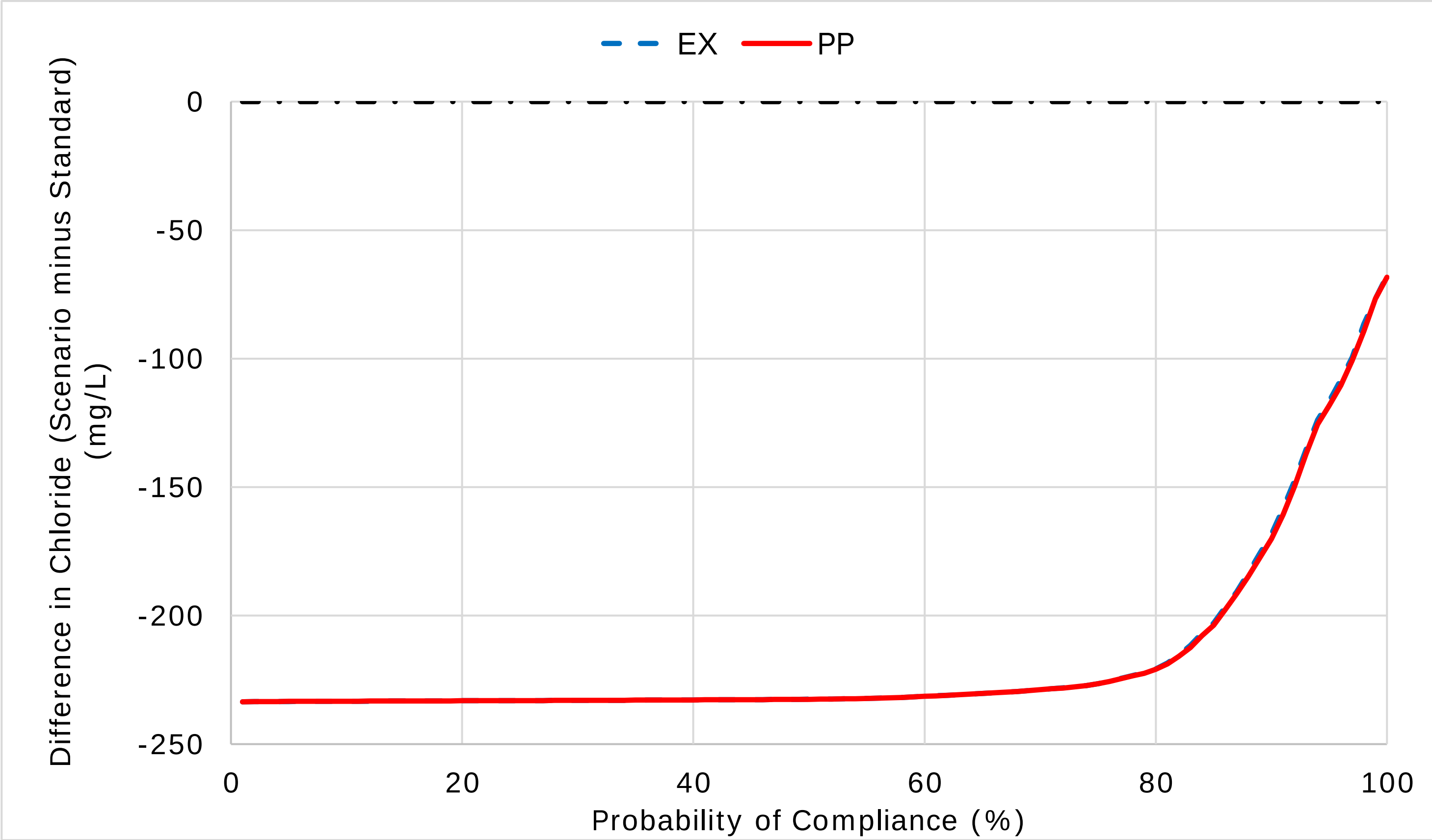


Figure 15 D1641 MI West Canal at mouth of Clifton Court Forebay Compliance Exceedance Plot

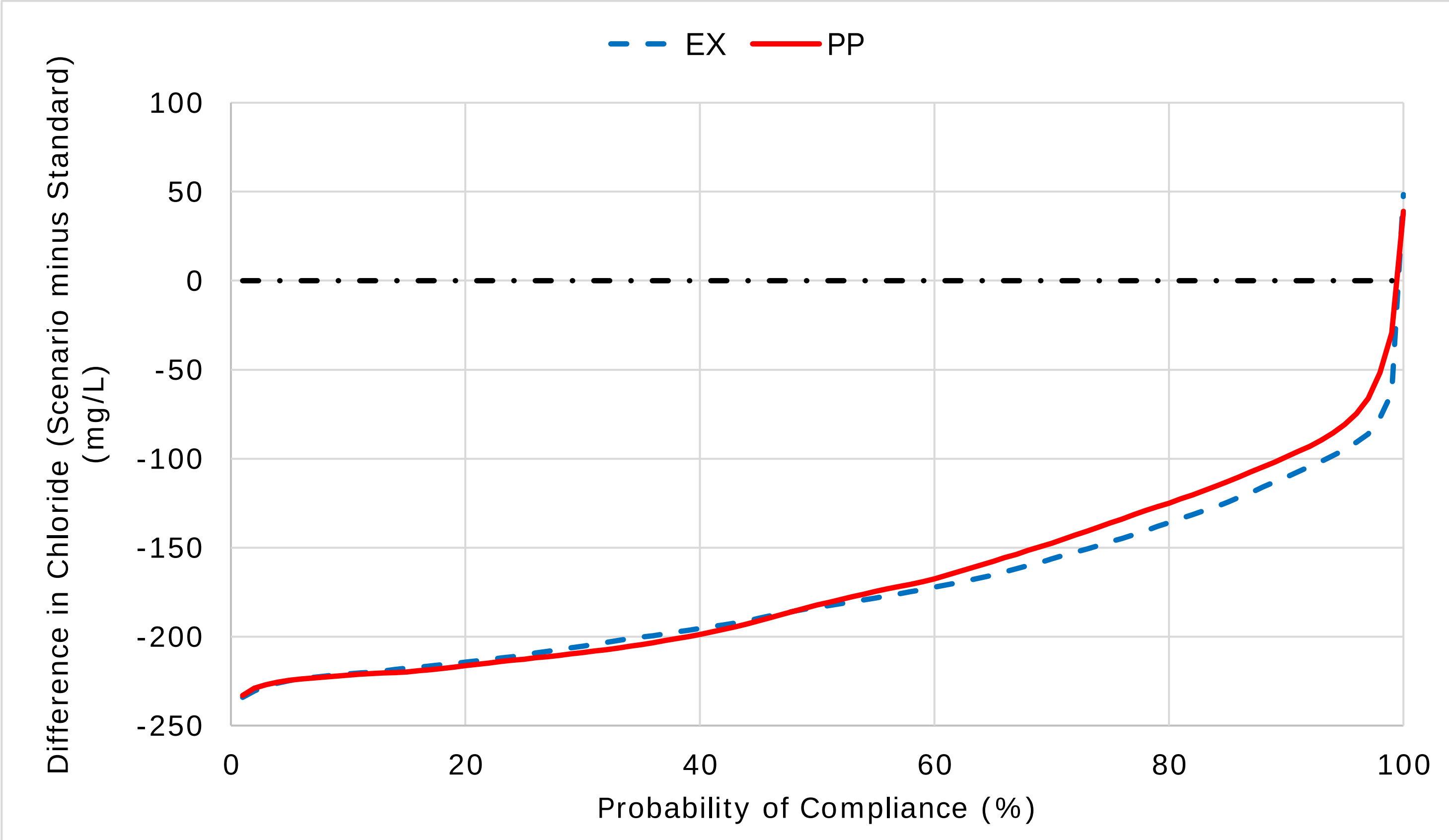


Figure 16 D1641 MI Contra Costa Canal at Pumping Plant #1 Compliance Exceedance Plot

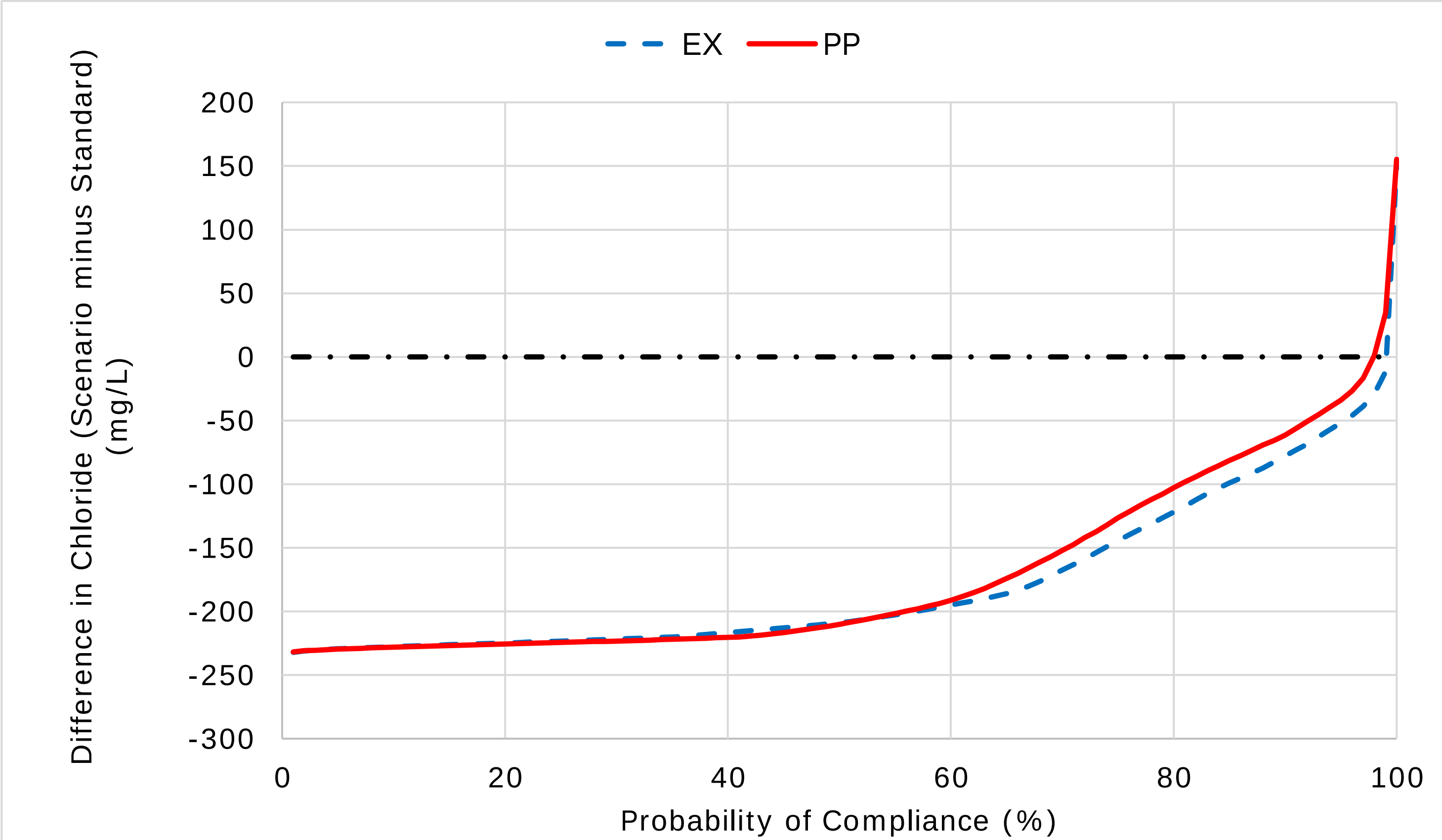


Figure 17 D1641 MI Delta-Mendota Canal at Tracy Pumping Plant Compliance Exceedance Plot

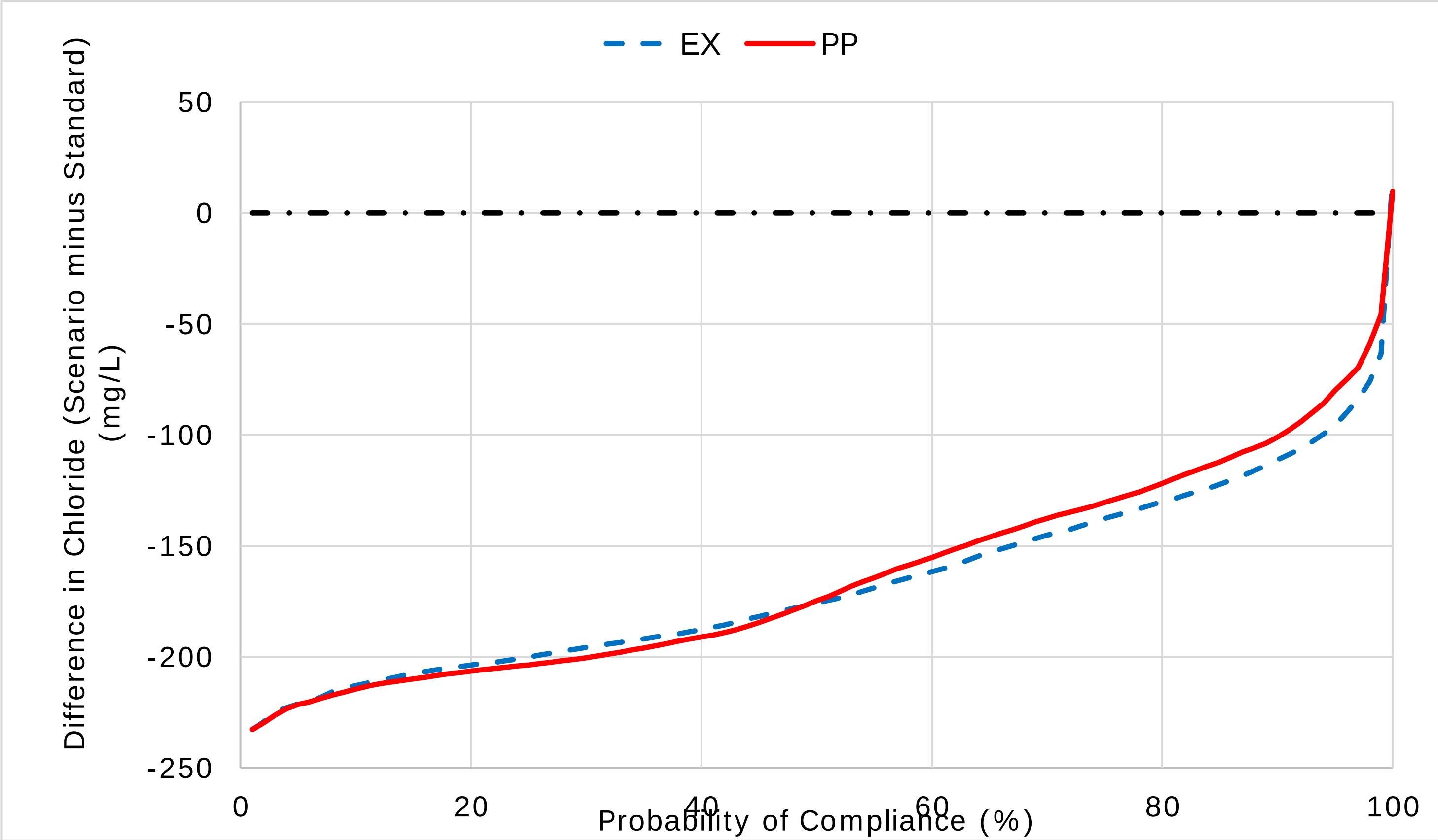
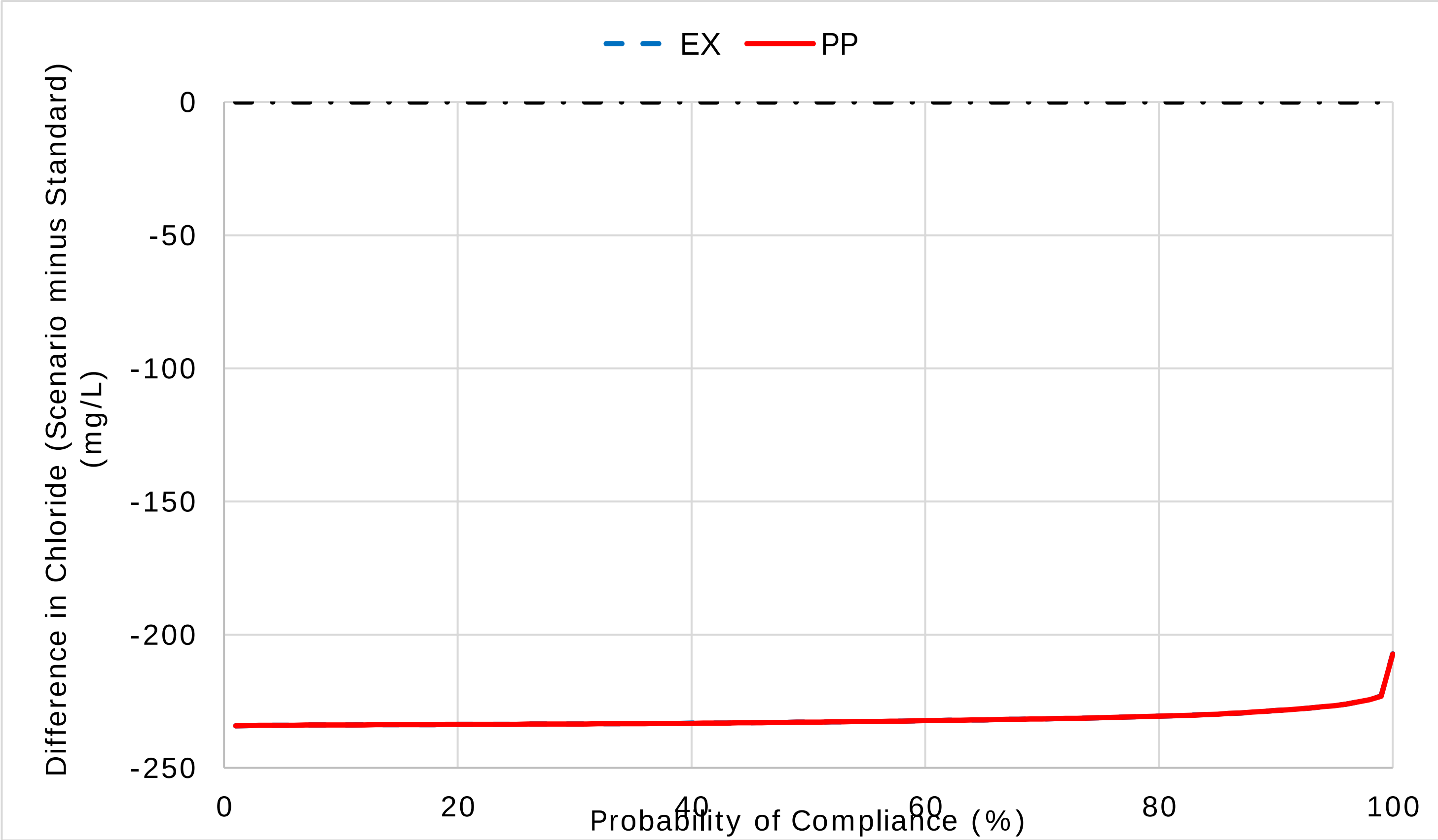


Figure 18 D1641 MI Barker Slough at North Bay Aqueduct Intake Compliance Exceedance Plot



Appendix C – Modeling

Attachment 2-10 – D1641 Compliance Results (CalSim II)

The following results of the CalSim II model are included for Delta compliance conditions for the following alternatives:

- Existing Conditions
- Proposed Project

Table 2-10.1. D1641 Compliance Results (CalSim II)

Title	Model Parameter	Table Numbers	Figure Numbers
D1641 MI Contra Costa Canal at Pumping Plant #1	NA	NA	1
D1641 AG San Joaquin River at Jersey Point	NA	NA	1
D1641 AG Sacramento River at Emmaton	NA	NA	1
D1641 FWS Spring X2	NA	NA	1

Report formats

- Compliance exceedance charts including all scenarios

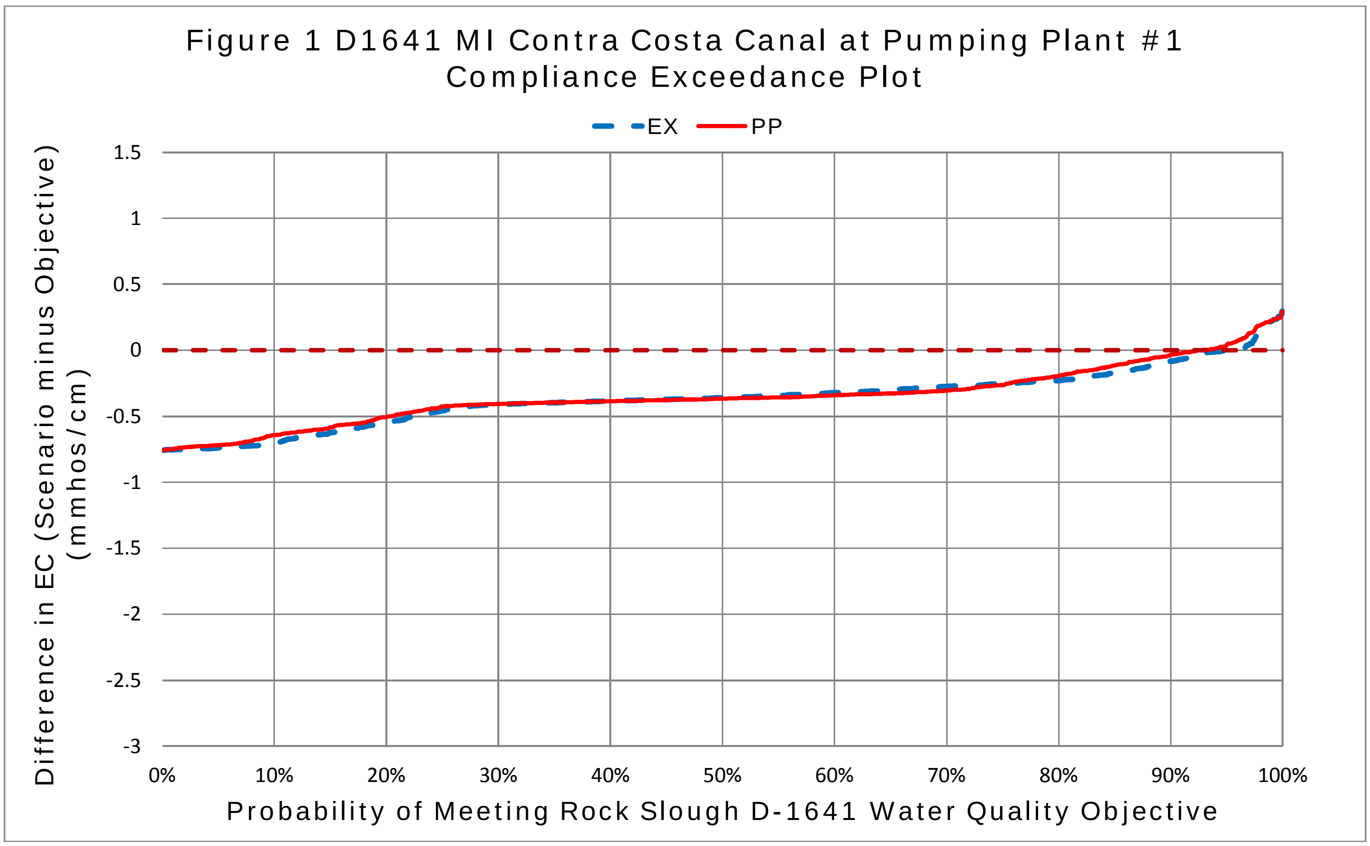


Figure 1 D1641 MI Contra Costa Canal at Pumping Plant #1
Compliance Exceedance Plot
EX
PP
Difference in EC (Scenario minus Objective) (mmhos/cm)
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
-3
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Probability of Meeting Rock Slough D-1641 Water Quality Objective

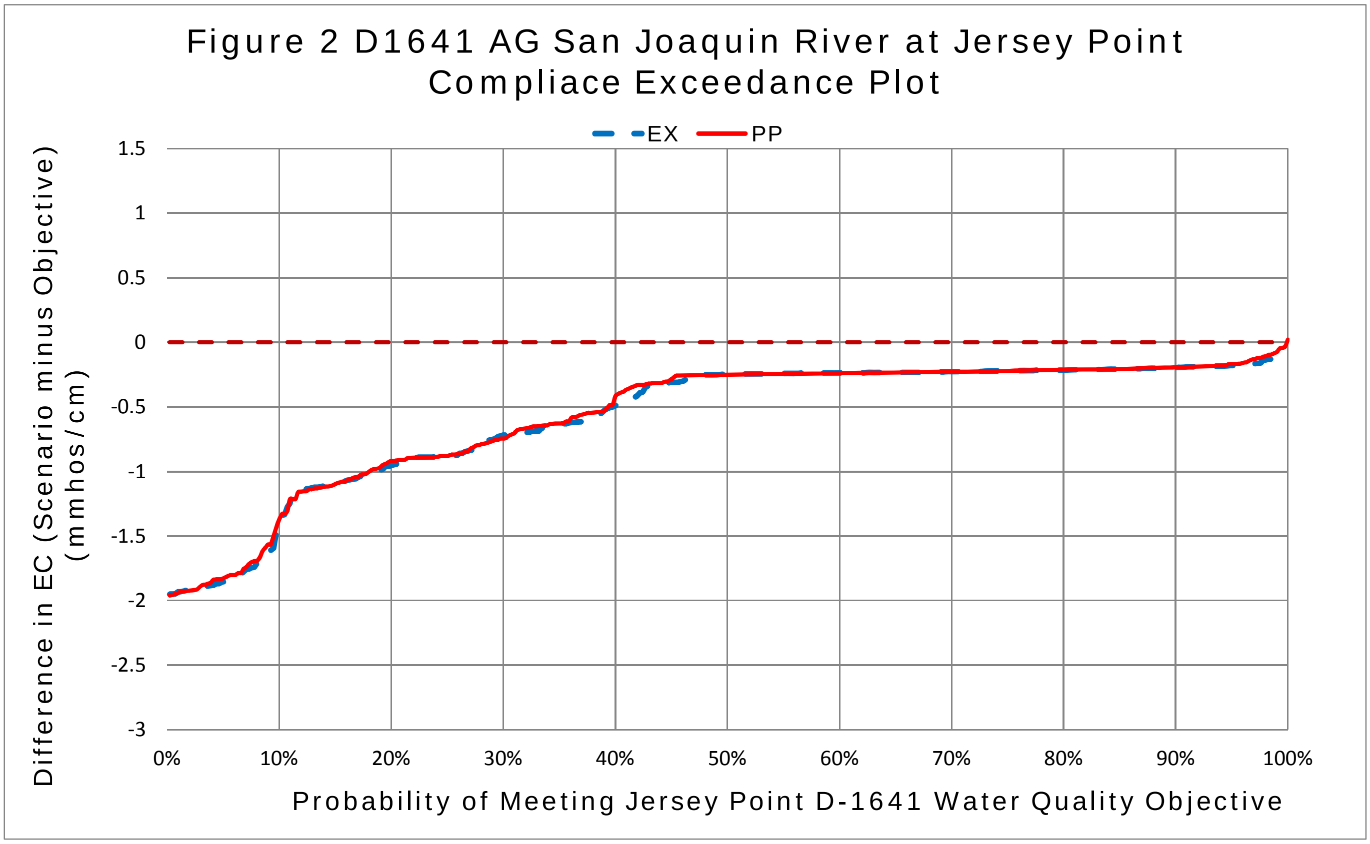


Figure 2 D1641 AG San Joaquin River at Jersey Point
Compliace Exceedance Plot
EX
PP
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
-3
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Difference in EC (Scenario minus Objective) (mmhos/cm)
Probability of Meeting Jersey Point D-1641 Water Quality Objective

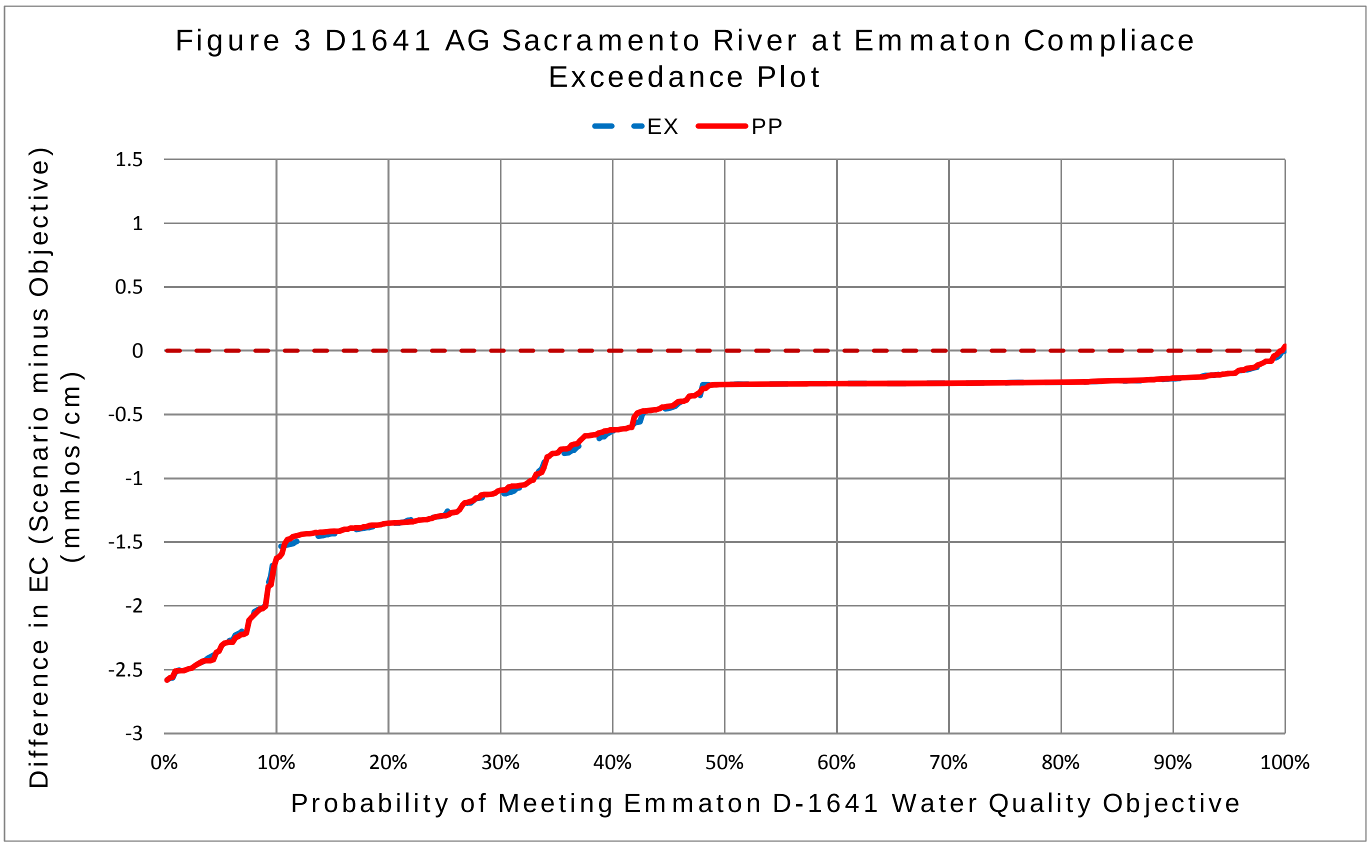


Figure 3 D1641 AG Sacramento River at Emmaton Compliace
Exceedance Plot
EX
PP
Difference in EC (Scenario minus Objective) (mmhos/cm)
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
-3
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Probability of Meeting Emmaton D-1641 Water Quality Objective

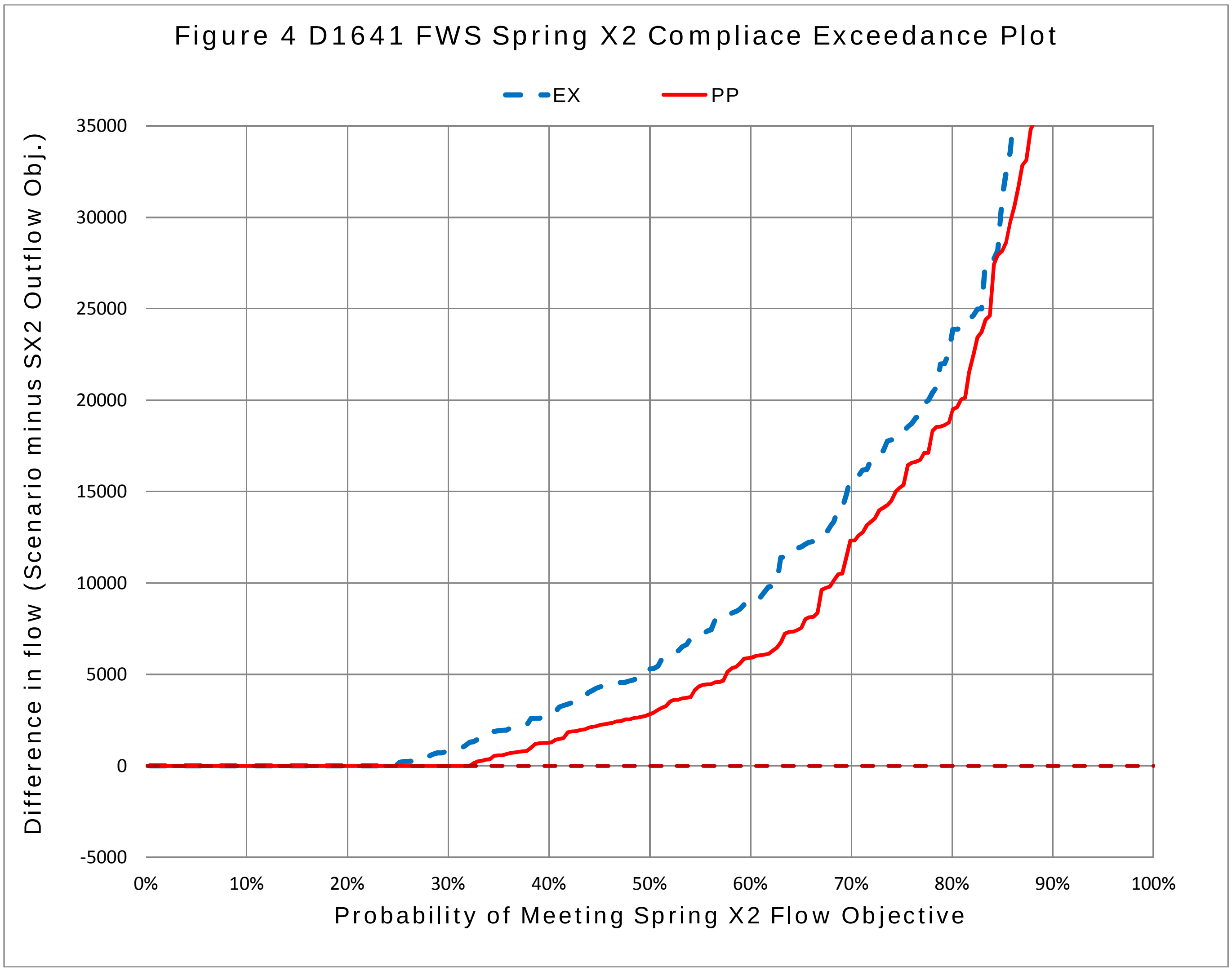


Figure 4 D1641 FWS Spring X2 Compliace Exceedance Plot
EX
PP
Difference in flow (Scenario minus SX2 Outflow Obj.)
35000
30000
25000
20000
15000
10000
5000
0
-5000
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Probability of Meeting Spring X2 Flow Objective

APPENDIX C

SCHISM Model Results

Table of Contents

Figures

Table

ACRONYMS AND OTHER ABBREVIATIONS

°C	degrees Celsius
CCF	Clifton Court Forebay
CDFW	California Department of Fish and Wildlife
cfs	cubic feet per second
CMOP	Coastal Margin Observation and Prediction
D-1641	State Water Resources Control Board Water Rights Decision 1641
DCC	Delta Cross Channel
DCD	Delta Channel Depletion
DES	Department of Environmental Services
DETAW	Delta Evapotranspiration of Applied Water
DWR	California Department of Water Resources
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
ELCIRC	Eulerian–Lagrangian algorithm
ELM	Eulerian-Lagrangian method
km	kilometer
LSC2	localized sigma coordinates with shaved cells
LSZ	low salinity zone
m	meter
mS/cm	milliSiemens per centimeter
NOAA	National Oceanic and Atmospheric Administration
psu	practical salinity units
SCHISM	Semi-Implicit Cross-scale Hydroscience Integrated System Model
SELFE	semi-implicit Eulerian-Lagrangian finite-element
SMSCG	Suisun Marsh Salinity Control Gate
SMSCG	Suisun Marsh Salinity Control Gate
SWRCB	State Water Resources Control Board
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

SCHISM MODEL RESULTS

INTRODUCTION: STUDY OBJECTIVE

This appendix section summarizes 3-D hydrodynamics modeling and analysis performed by the Bay-Delta Office of the California Department of Water Resources (DWR) to investigate the Suisun Marsh Salinity Control Gate (SMSCG) reoperation and flow augmentation components of the ITP Proposed Project.

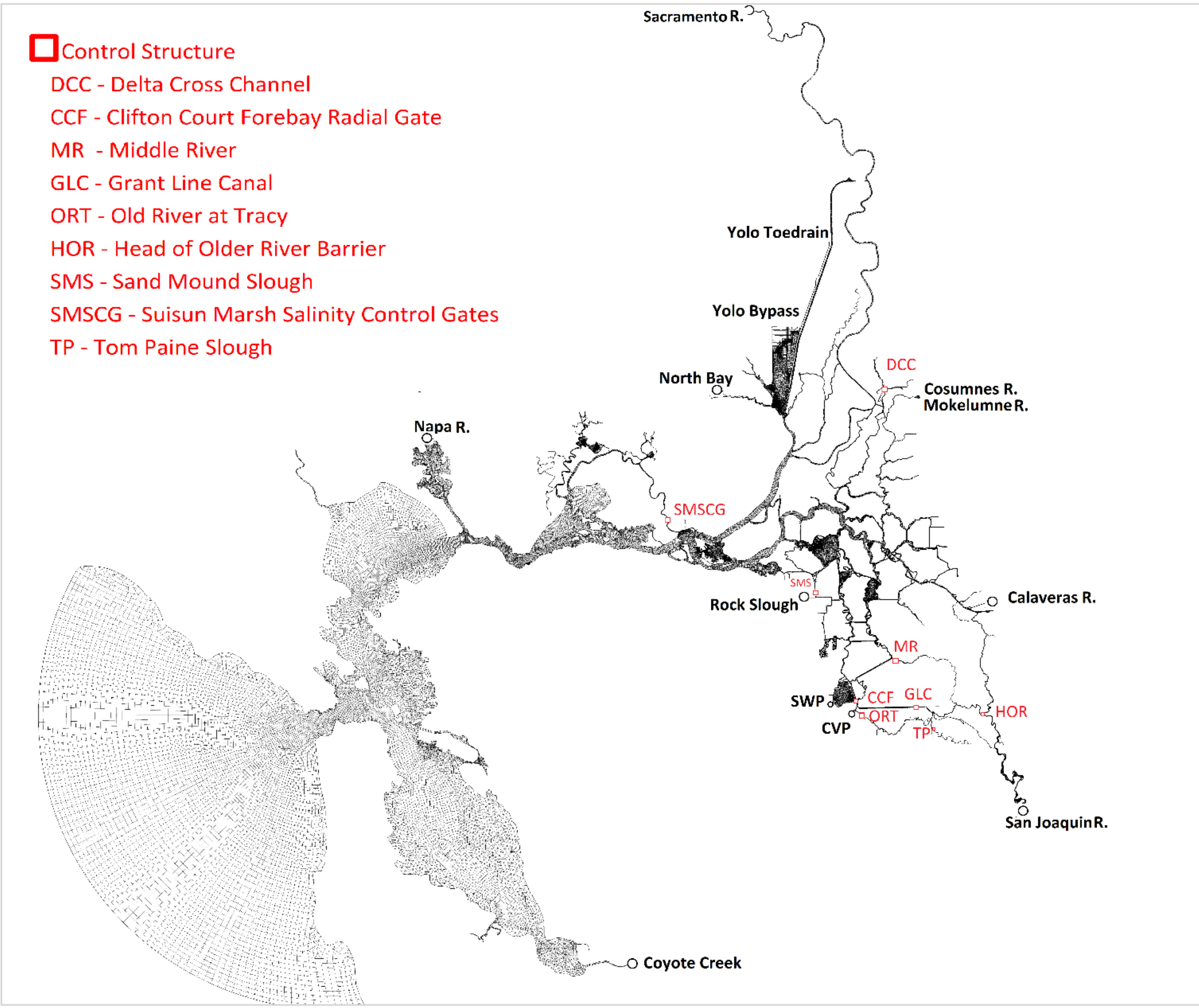
The focus of 3-D circulation modeling incorporated in the Incidental Take Permit (ITP) is to identify the habitat benefits of SMSCG operation and flow augmentation by mapping and computing low salinity zone and smelt habitat indices in various hydrologic and operational scenarios. Long-term water supply impacts of the proposed reoperation are incorporated in the CalSim and DSM2 modeling work described elsewhere.

SCHISM AND BAY-DELTA SCHISM BACKGROUND

The model used in this study is Bay-Delta SCHISM, which is based on the Semi-Implicit Cross-scale Hydroscience Integrated System Model (SCHISM, Zhang et al. 2016), which in turn is derived from the semi-implicit Eulerian-Lagrangian finite-element (SELFE) model (Zhang and Baptista 2008) SCHISM is an open-source community-supported modeling system, whose origins were to serve as a second-generation model (following ELCIRC, a Eulerian–Lagrangian algorithm used to solve shallow water equations) for use in the Columbia River estuary by the Center for Coastal Margin Observation and Prediction (CMOP). The model has subsequently been enhanced by the Virginia Institute of Marine Sciences and used in basins throughout the world in applications as diverse as reservoir temperature, estuarine transport of salinity, morphology, and near-coast tsunami response. The model has participated in numerous regional benchmark projects. A list of peer-review papers is maintained on the model website (http://ccrm.vims.edu/schismweb). The larger SCHISM suite includes modules for sediment transport, ecology/biology, wind-wave interaction, ice, oil spill, and marsh evolution.

The formulation of the core SCHISM hydrodynamic module is based on the 3-D hydrostatic Reynolds-averaged shallow water equations, including mass conservation, horizontal momentum conservation and salinity transport. The SCHISM hydrodynamic algorithm is based on mixed triangular-quadrangular unstructured grids in the horizontal and a flexible coordinate system in the vertical (localized sigma coordinates with shaved cells, or LSC2, Zhang et al. (2015)). The modeling system utilizes a semi-implicit finite-element/finite-volume method together with a Eulerian-Lagrangian method (ELM) for momentum advection to solve the Reynolds-averaged Navier-Stokes and transport equations at ocean to creek scales. It has both a hydrostatic and non-hydrostatic option, but as explained in MacWilliams et al. (2016) non-hydrostatic modeling is not feasible at field scale in the Bay-Delta because of the resolution required.

The DWR application of SCHISM to the Bay-Delta as well as a regional description of performance is described in Ateljevich et al (2014) and Ateljevich et al (2015). The mesh for the present model version 90e is shown in Figure 1 with model boundaries key hydraulic structures. The mesh contains 259,885 elements and 248,056 nodes, with length scales of the elements ranging from 1 kilometer (km) on the coast to 5m inland. The LSC2 vertical grid is terrain-conforming, but tapers in the number of vertical layers from 23 at the Farallon Islands to a single layer (2D horizontal) in the upstream reaches of the Sacramento River, Yolo Bypass and San Joaquin River. Near Suisun Bay and Marsh the mesh has 10-12 vertical layers, resulting in vertical resolution of 1m in the main ship channel and finer than 0.6 meter (m) in Suisun Bay and Montezuma Slough.



In addition, channel depletion sources from the Delta DCD model or similar methods are imposed throughout.

Figure 1: Bay-Delta SCHISM Mesh, Boundary Condition Location and Hydraulic Structure Locations

The Bay-Delta SCHISM model has been applied to study the performance of numerous operational and planning scenarios in the Bay-Delta, including the emergency Drought Barrier (MacWilliams 2016 and DWR efficacy report, in press), restoration of Franks Tract (Ateljevich, 2018), and hydrodynamic transit time through Clifton Court (Shu, 2018). The Franks Tract restoration study includes validation of performance in the western and middle Delta A Bay-only portion of SCHISM extended to Rio Vista is described and validated in Chao et al (2017a) for temperature as well as salinity and used to study a sea surface temperature anomaly in the Bay and near coast in Chao et al (2017b). The work of Cai

(2018) focused on the effects of submerged aquatic vegetation on flow physics and biogeochemistry in the Cache Complex.

Modeling assumptions and boundary conditions for the present study generally conform to the methods described by Ateljevich et al (2014). The mesh has been developed generally as part of the studies cited above and in response to improvements in bathymetry. For the present project, the mesh was modified to incorporate more marsh channels and marsh plains than previous versions of the Bay-Delta SCHISM mesh. Existing Montezuma Slough bathymetry was found to be insufficiently accurate for a focused study of the region and was resurveyed by the Bathymetry and Technical Support group at DWR. This work as well as single beam soundings upstream by UC Davis were incorporated into the latest (v4.1) modeling bathymetry map for modeling produced by DWR's Delta Modeling Section and were used in the current modeling; the production of the elevation model described by Wang (2018) and the elevations are available online in GeoTiff format in the Resources Agency Open Data Portal (DWR 2018).

The standard Bay-Delta SCHISM configuration incorporates approximations of numerous hydraulic structures in the Delta, including the Suisun Marsh Salinity Control Gate (SMSCG), Delta Cross Channel (DCC), and Clifton Court Forebay (CCF). All of which are modeled as radial gates using standard 1D approximations similar to those used in DSM2. No special configuration or recalibration was undertaken for the present work, but new periods of tidal operation were incorporated for SMSCG for some scenarios.

DWR consumptive use models do not account for evaporation and consumptive use in Suisun Marsh (including pond up of Duck Clubs and managed wetlands), and results in Grizzly Bay, the Marsh appear to be sensitive to this assumption. An estimate of evaporation from Suisun Bay and the marsh was included in the model, using a methodology similar to the Delta Evapotranspiration of Applied Water/Delta Channel Depletion (DETAW/DCD) land water balance technique (Liang, 2017) to arrive at an estimated peak total of 1,000-1,500 cubic feet per second (cfs) for July including bay evaporation in Grizzly and Honker Bay and evaporation on the marsh. Managed exports for duck clubs and wetlands were estimated by scaling volumes used by Research Management Associates for the Bay Delta Conservation Program Draft Environmental Impact Report (EIR)/Environmental Impact Statement (EIS) down by 60%, which gives good agreement at the one site in which short term monitoring and gate ratings were available at Roaring River intake. The assumption produces a peak pond-up flow in September that is similar to the peak evapotranspiration in June, consistent with the relatively constant rate of salinity intrusion across this transition.

SCENARIOS

DWR studied the proposed 60 days of additional tidal operation of the Suisun Marsh Salinity Control Gates in 2012 and 2017, two years representing different hydrologic, regulatory and antecedent salinity conditions. The scenarios are summarized in Table 1.

Table 1: Scenario Descriptions for SCHISM Modeling of ITP Proposed Operations for Suisun Marsh Habitat

Scenario Label	Year	SMSCG Gate operation	Flow
2012 Base	2012	Historical	Historical
2012 Gate (Jun)	2012	Historical + Tidal Op Jun 14, 60 days	Historical + Compensating
2012 Gate (Aug)	2012	Historical + Tidal Op Aug 14, 60 days	Historical + Compensating
2017 Base	2017	Historical	Historical
2017 Base No X2	2017	Historical	Base (modified historical)
2017 Gate (Sep)	2017	Historical + Tidal Op Sep 1, 60 days	Base (modified historical) + Compensating
2017 X2 80km	2017	Historical	Meet 80km X2 in Sep-Oct
2017 Gate (Sep) + X2 80km	2017	Historical + Tidal Op Sep 1, 60 days	Meet 80km-X2 in Sep-Oct + Compensating
2017 X2 74km	2017	Historical	Meet 74km X2 in Sep-Oct

Notes: km = kilometer
SMSCG = Suisun Marsh Salinity Control Gate
SCHISM = Semi-Implicit Cross-scale Hydroscience Integrated System Model
X2 = monthly averaged position of the 2.64 mS/cm isocontour of specific conductance at the surface (see caveats).

Two types of flow augmentation appear on this table. The term *X2 74km and X2 80km* refer to flow actions to provide habitat. The term *Compensating Flow* refers to additional flow used to maintain salinity at or below the level of the corresponding base case when the gate is tidally operated. Such compensating flow is required as the diversion of net flow to Montezuma Slough causes salinity on the main stem Sacramento and San Joaquin Rivers to increase. When the main action considered only includes tidal reoperation of the gate, the compensating flow is applied to maintain Jersey Point salinity. When the action includes both the X2 flow augmentation and the gate reoperation, the compensation maintains the X2 position.

Modified historical refers to historical inputs in which exports to achieve Fall X2 objectives have been eliminated. Operational constraints are instead provided by project capacity, State Water Resources Control Board (SWRCB) Water Rights Decision 1641 (D-1641) and upstream considerations such as reservoir drawdown. The reservoir drawdown in September was significant and to a certain extent releases were scheduled around X2, so increasing exports did not significantly change salinity conditions in September. In October, the modified historical scenario is significantly saltier. Finally, for the scenarios described as meeting X2 of 74km or 80km, Sacramento River flow was reduced to make this possible in September, ignoring some upstream constraints.

2012 was a year with Below Normal hydrological classification and is typical of an average operational situation in the Delta, with operations controlled by outflow in summer, D-1641 agricultural EC objectives in late summer through August 15 and informal guidance targets for the protection of mid-Delta water quality after August 15. In 2012, the historical hydrology was used unmodified as the base case.

The SMSCG was tidally operated historically starting October 15, 2012 and this historical operation is incorporated as part of the base case as well as the reoperation case. In the cases listed with additional August tidal gate operations in 2012, those operations begin on August 14, last 60 days, and transition immediately into the historical operation. Earlier gate operations were investigated on a screening basis, however, marsh salinity was not high enough in early-mid summer for tidal gate operations to have a large freshening effect.

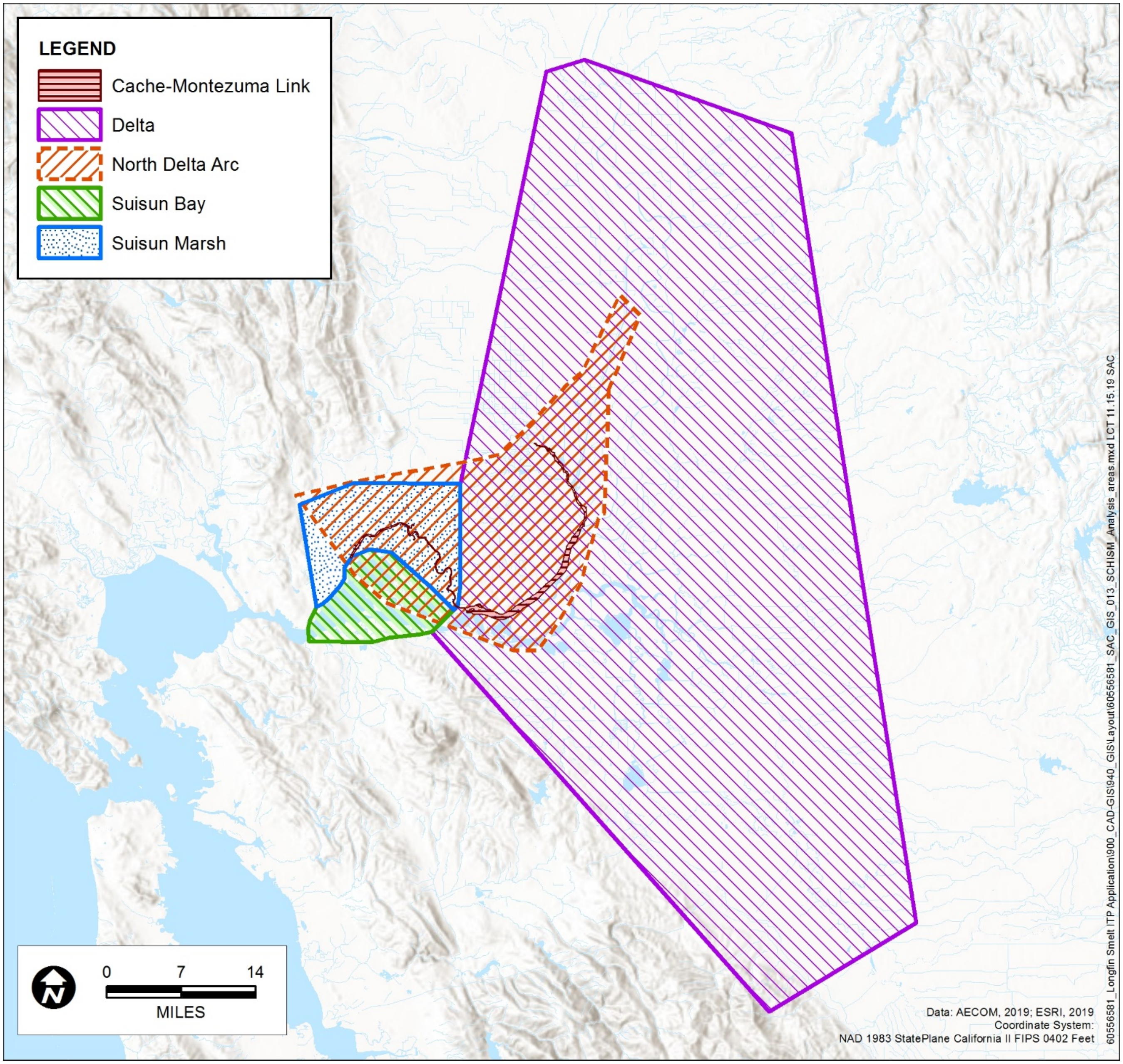
In contrast to 2012, 2017 was classified as a Wet year. Historical operations and water quality in the fall were controlled by a need to draw down upstream reservoirs and by a fall X2 objective that ranged between 74km and 79km based on coordination with U.S. Fish and Wildlife Service (USFWS) and California Department of Fish and Wildlife (CDFW). Water quality in the Suisun Marsh and even in Suisun Bay was fresh historically through most of October. For ease of modeling the proposed project X2 target of 80km, the base case for 2017 was modeled by backing out the component of outflow that was used to achieve fall X2 requirements in 2017. Historical exports and inflows were modified for this scenario. The primary mechanism was increased exports, as close to project capacity as possible. Inflow reduction was also used in September to achieve 80km in cases where this was not possible with export increases alone.

In the cases listed with additional September tidal gate operations in 2017, those operations begin on September 1 and last 60 days, and transition immediately into the historical operation. Earlier gate operations were not considered as the marsh salinity was not high enough in early-mid summer for tidal gate operations to have a large freshening effect. In the 2017 cases listed with X2 flow, the historical exports and inflows were modified to maintain X2 conditions at 80 km in September and October.

Two metrics of habitat were produced in this study. The first identified the spatial area and acreage of habitat that met a low salinity zone (LSZ) threshold of 6psu (practical salinity units or psu, ubiquitous in modeling, are used throughout this text; they are essentially interchangeable with parts per thousand). The second combined this threshold with a target Secchi disk depth of 0.5m or less (higher turbidity) and water temperature of 25C or lower. These were aggregated within the zones shown in Figure 2. Temperature was interpolated from a network of DWR Department of Environmental Services (DES), National Oceanic and Atmospheric Administration (NOAA) and U.S. Geological Survey (USGS) stations. Secchi Depth was interpolated from the entire network of CDFW Summer Townet and Fall Midwater Trawl sites. The latter provided coverage in much of the North Delta Arc, but less so in the upper reaches of the Sacramento and San Joaquin Rivers (often excluded based on water temperatures).

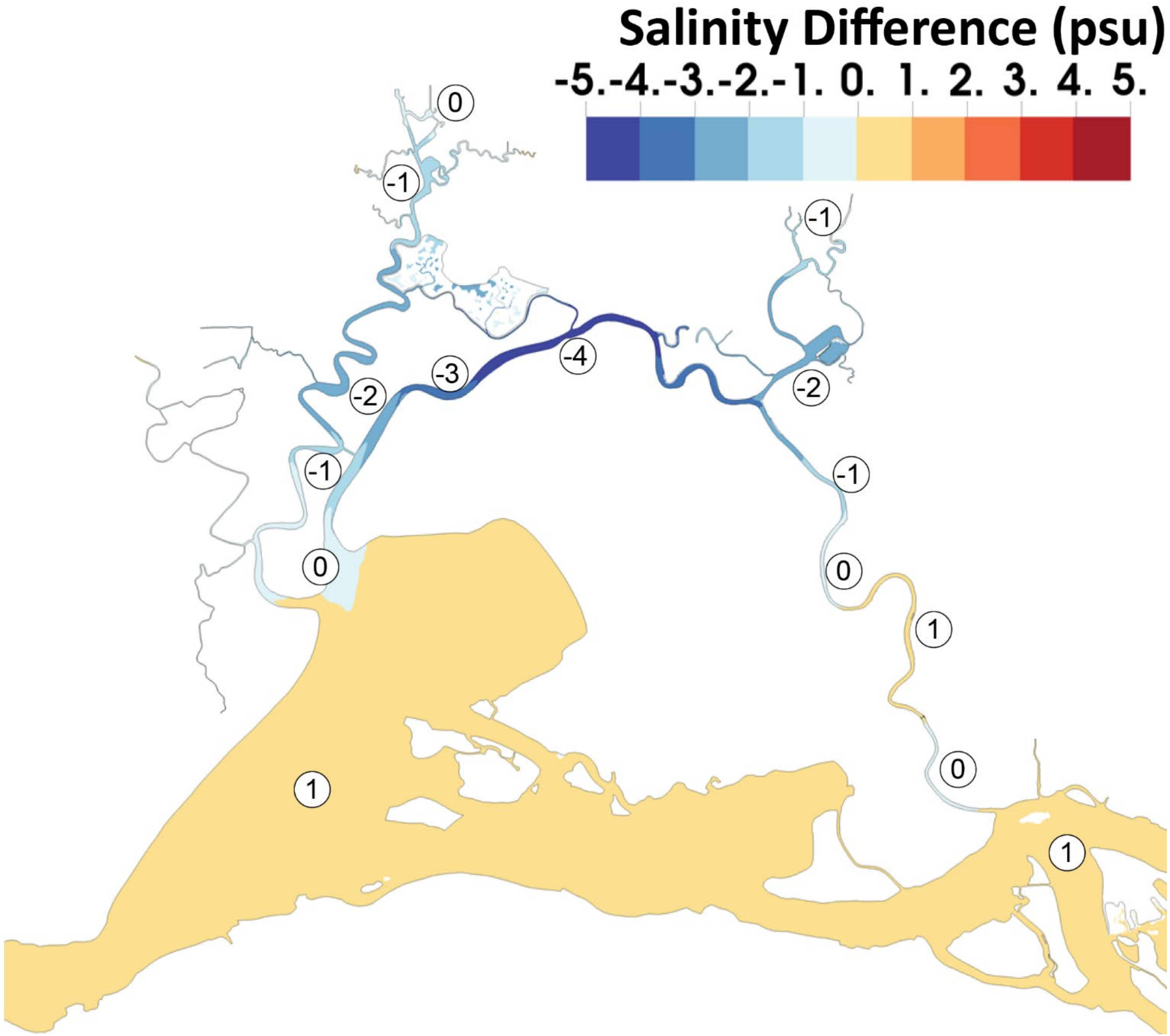
KEY RESULTS

The Suisun Marsh Salinity Control Structure is known to effectively freshen the marsh area. Figure 3 shows the change in salinity averaged over a fortnightly period in 2012 during operations. Tidal operation freshens the marsh with mild increases along the main stem of the estuary. Note that for 2012 approximately 550 cfs compensating flow has been applied (derived from DSM2 water cost studies), so that upstream at Jersey Point the salinity difference is zero – without this flow the increase in salinity on the main stem would be somewhat larger.



The category “All” represents the spatial union of areas in the legal Delta, Suisun Marsh and Suisun Bay.

Figure 2: Regions Used to Aggregate Low Salinity Zone and Habitat Suitability Indexes



The averaging period is August 29 – September 12, 2012.

Figure 3: Change in Fortnightly Salinity (in psu, equivalent to psu) in the Marsh Region Induced by Operating the Gates Tidally Starting August 14, 2012

Figure 6 and Figure 7 show time series of Low Salinity Zone and suitable habitat within zones under the gate actions in 2012. Figure 8 and Figure 9 show the same results for 2017. As demonstrated by these figures, SMSCG freshens the Suisun Marsh and has the potential to improve marsh habitat under some conditions. The potential increase in habitat from gate operations was most pronounced in the late August-September period in 2012 when external considerations such as the D-1641 agricultural standards do not incidentally freshen the marsh. Time continuity of habitat is also achievable for years such as 2012 if the gates are operated in August-September, bridging the period when LSZ habitat is protected by D-1641 objectives outside the marsh, with the period water quality is protected by standard tidal operation of the SMSCG radial gates typically starting mid-October. Such time continuity is evident in the LSZ acreage plot of Suisun Marsh in 2012. A sustained freshet peaking at a Net Delta

Outflow Index of 65,000 cfs coincides with the end of the habitat time series plot so the acreage at that time appears to represent habitat potential as represented by the model domain, slightly over 3,800 acres in the case of Suisun Marsh.

Similarly high flows predominated in 2017. Trivially, operation of the gate is not beneficial in the marsh under conditions that are already fresh, which continue to November. In fact, summer or fall tidal operation of the gate in very wet years such as 2017 improves water quality but does not create habitat as defined by the 6psu LSZ threshold. The tidal gate operation does, however, have a residual freshening effect in November that is visible in Figure 8. Additionally, during this November residual effect there seems to be a synergistic effect in the marsh between the 80km X2 flow augmentation and the tidal operation of the gate.

Fresh antecedent conditions would be expected in all Wet years through the August 15 end of the D-1641 agricultural objective. They would also hold under a Fall X2 requirement of 80km or better, or as a result of aggressive drawdown of reservoirs for flood control reasons that leads to high outflow. Low salinity does not otherwise seem to be a guaranteed consequence of a Wet year classification especially in drier fall months -- in some historical wetter years prior to the 2008/2009 biological opinions (e.g., 2000, which was regulated as Wet based on forecasts), fall salinity rose significantly enough that a gate action by itself might have been beneficial.

According to the modeling presented here, SMSCG tidal operation does not improve water quality over an appreciable acreage in Grizzly Bay during the operation period and in fact can rotate the salinity field in a way that slightly reduces LSZ habitat, as shown in Figure 3. The change is usually small (<1 psu) relative to the 6psu threshold for LSZ – for comparison, Beldons Landing salinity under these circumstances and averaging period decreases by 4.25psu from 7.29 to 3.04 psu.

The lack of LSZ habitat improvement in Grizzly Bay due to the gate action is visually important and represents a difference with prior results by AnchorQEA (2018) suggested freshening of 1-2psu over a substantial acreage in Grizzly Bay during a 2018 operational experiment. Field evidence on this point supports the position presented here, that Grizzly Bay is not freshened by tidal operation. Figure 4 shows the relationship between tidally averaged salinity at Collinsville and Grizzly Bay and, for comparison, at Hunter Cut. Points are colored by the gate operating regime. The colored dots represent 2008–2019 for Hunter Cut and the shorter 2016–2019 period of record for Grizzly Bay. The points have been filtered to eliminate periods of large flow transitions or Delta filling extremes (stage values far from 14-day average). The exception is the black dots, which represent the seven day transition (two before and five after) at the conclusion of the 2018 SMSCG field experiment. If Grizzly Bay were significantly freshened while Collinsville goes up as suggested by the AnchorQEA (2018) result, the scatter between Grizzly Bay and Collinsville when SMSCG is tidally operating, would shift compared to when SMSCG is open. Hunter Cut, which does exhibit this shift, is shown for contrast. Instead, Collinsville and Grizzly Bay seem to have the same relationship or only show minor differences regardless of the operating regime of the gate, suggesting that the SMSCG operation may have minimal effect on Grizzly Bay salinity conditions and that the salinity at Collinsville and Grizzly Bay would likely respond mostly to a common dynamic. In SCHISM results, this change is manifest as a mild increase in salinity at both locations when the SMSCG was tidally operating.

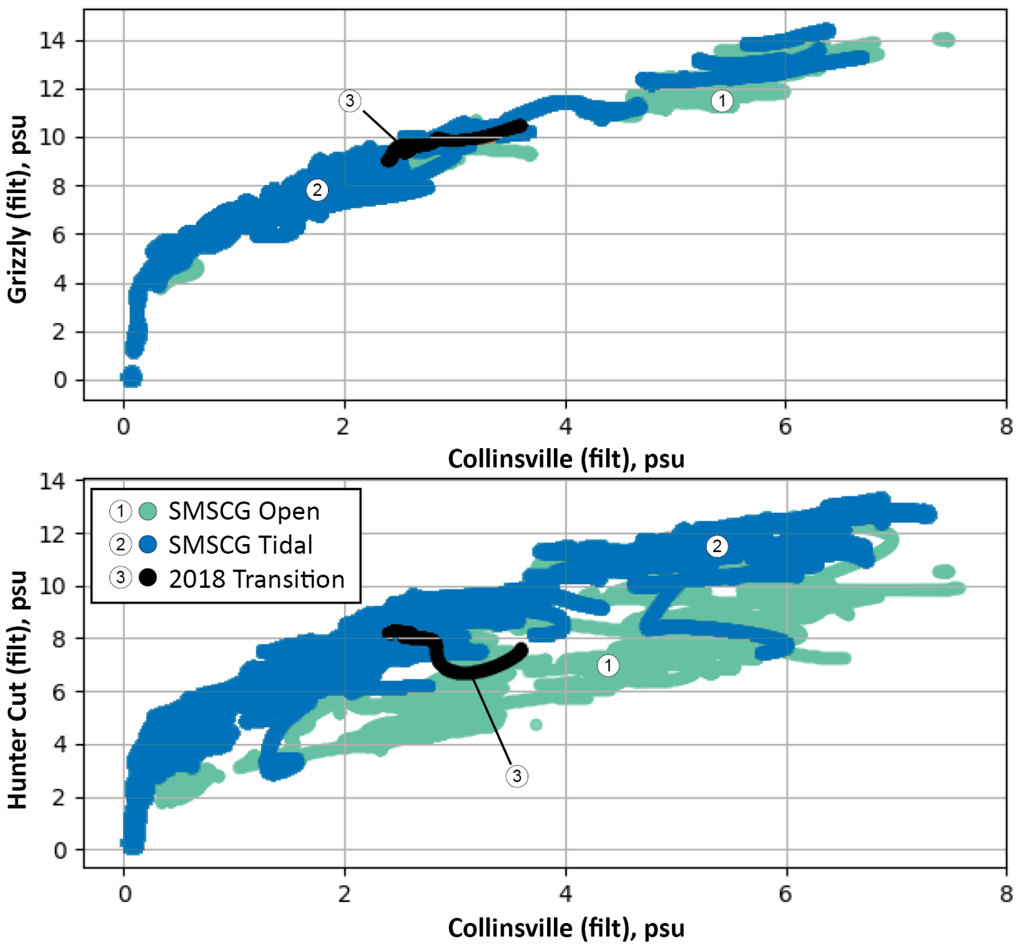
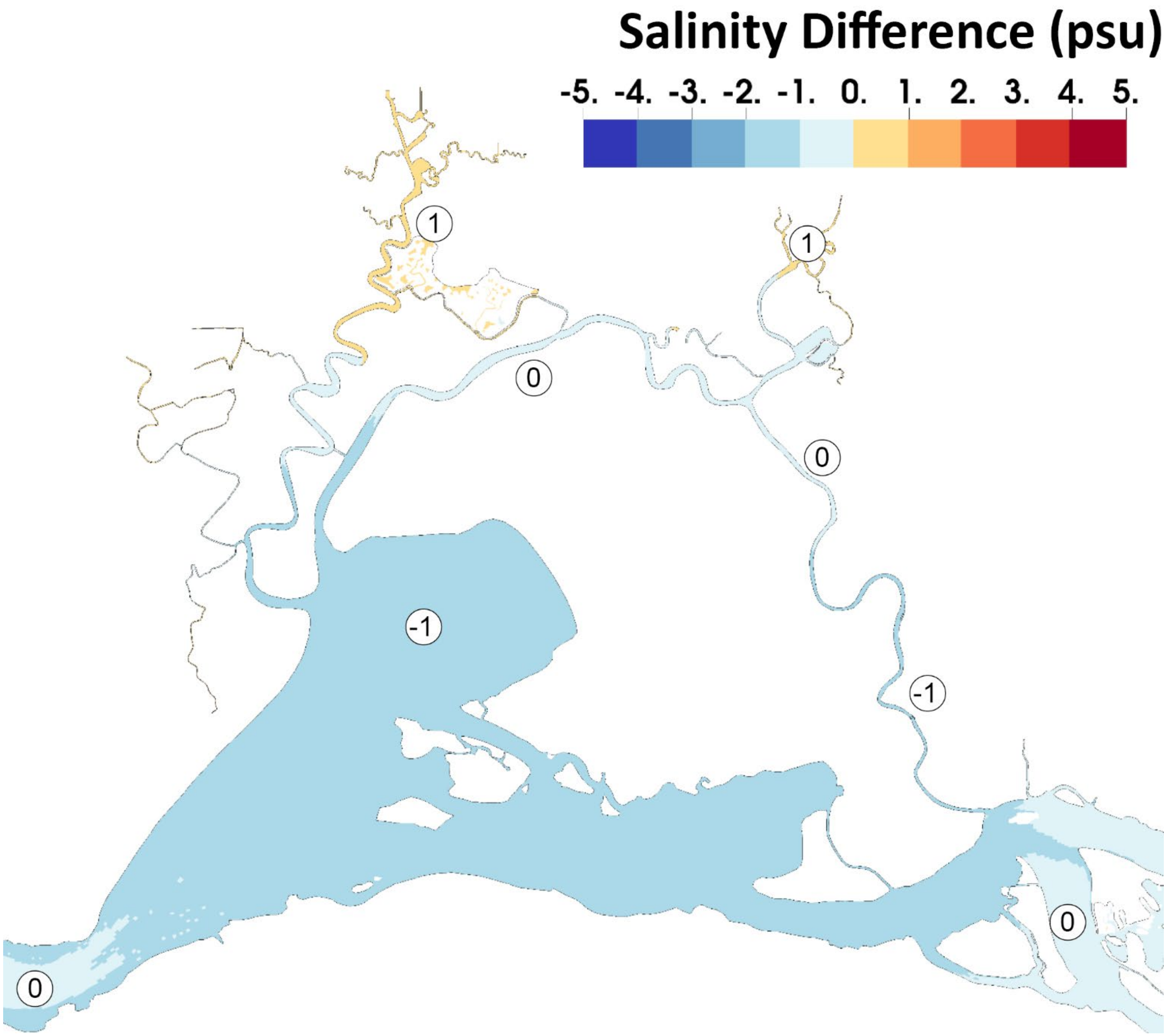


Figure 4: Comparison of Tidally Filtered Salinity at Collinsville (x-axis) Versus Grizzly Bay (CDEC GZB, top) and Hunter Cut (CDEC HUN, bottom)

Flow augmentation in fall 2017 targeting an X2 of 80km has little effect on LSZ of habitat in Grizzly Bay, particularly in October when it is very similar to the base condition. There is a decrease in LSZ habitat in parts of September, but this is because base September values are affected by reservoir drawdown so that X2 is lower in the base than in the action. The salinity change induced by this action relative to the No X2 case for that year is shown in Figure 5. Operating the gate tidally in addition to such a flow augmentation creates persistent habitat in November as noted above. The improved habitat conditions in November may be partly a result of the additional outflow needed to maintain the X2 at 80 km when gate is operating tidally. The gate action requires considerable compensating flow to maintain X2 at 80 km on the main stem, essentially supplementing the full 2,500 cfs net flow that is directed to Montezuma Slough with gate operations.

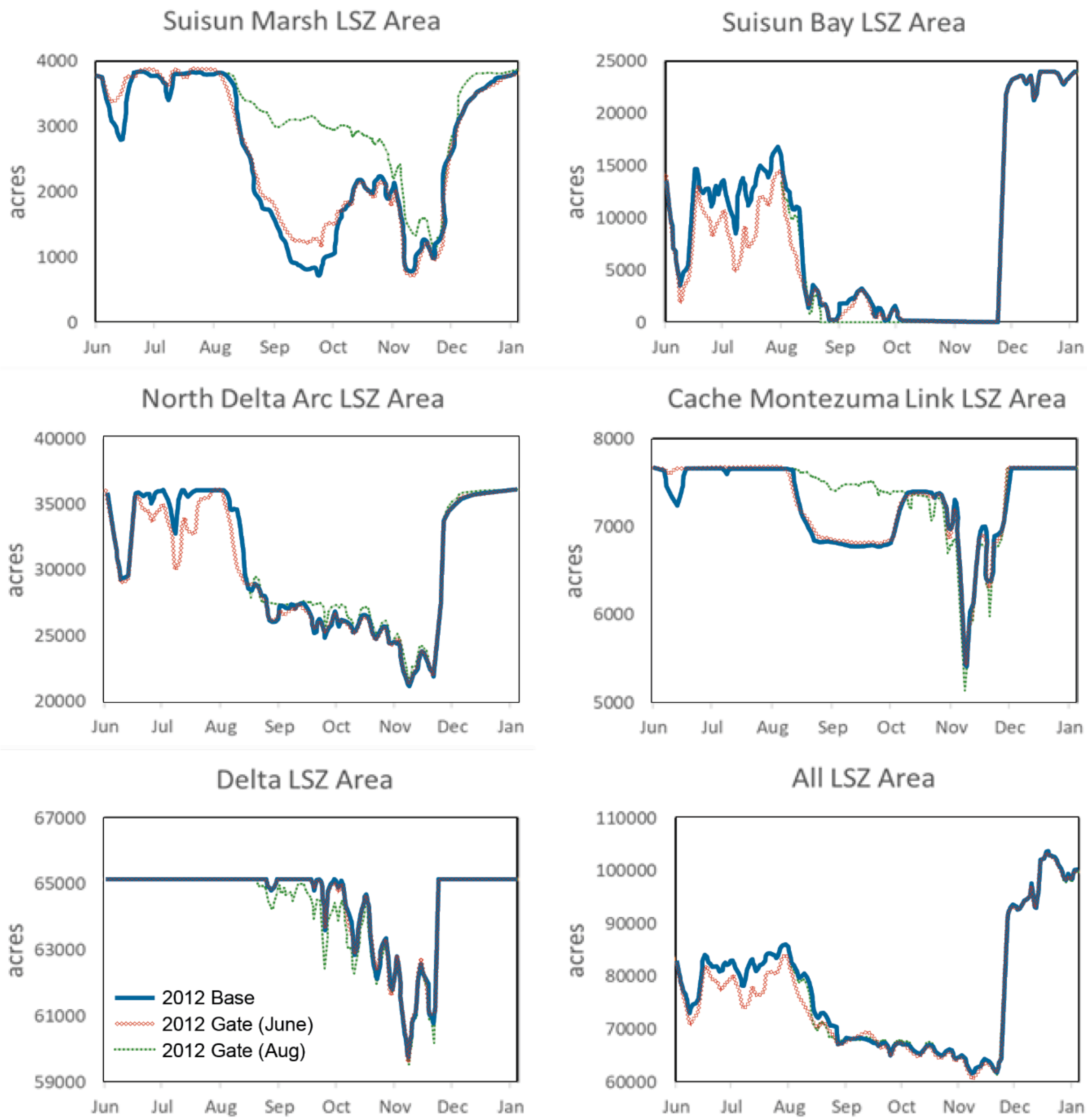
Flow augmentation in fall 2017 targeting a lower X2 value of 74km generates up to 11,000 acres of LSZ of habitat in Suisun Bay relative to the base case, with an improvement of 1000 acres or more persisting from October 9 to December 1.

When temperature (25 degrees Celsius [○C]) and Secchi Depth (0.5m) are considered in the three-variable habitat suitability index. The water clarity considerations (and to a lesser extent temperature) restrict candidate habitat considerably. This is particularly true when aggregated over large areas like the full statutory Delta, since water clarity or high temperatures excludes most of the interior Delta. Much of the remaining eligible habitat was in Suisun Bay and Marsh and the North Delta. However, one striking result in 2017 is that Suisun Bay LSZ habitat is greatly expanded but the three-variable habitat suitability index is not. This condition appears to be driven by water clarity, and a great deal more habitat would be available if the indexes were not binary (i.e., greater than >0.5 m Secchi not suitable versus <0.5 m suitable) and therefore brittle. In the present methodology, 6.1 psu is not habitat and 5.9 psu is.



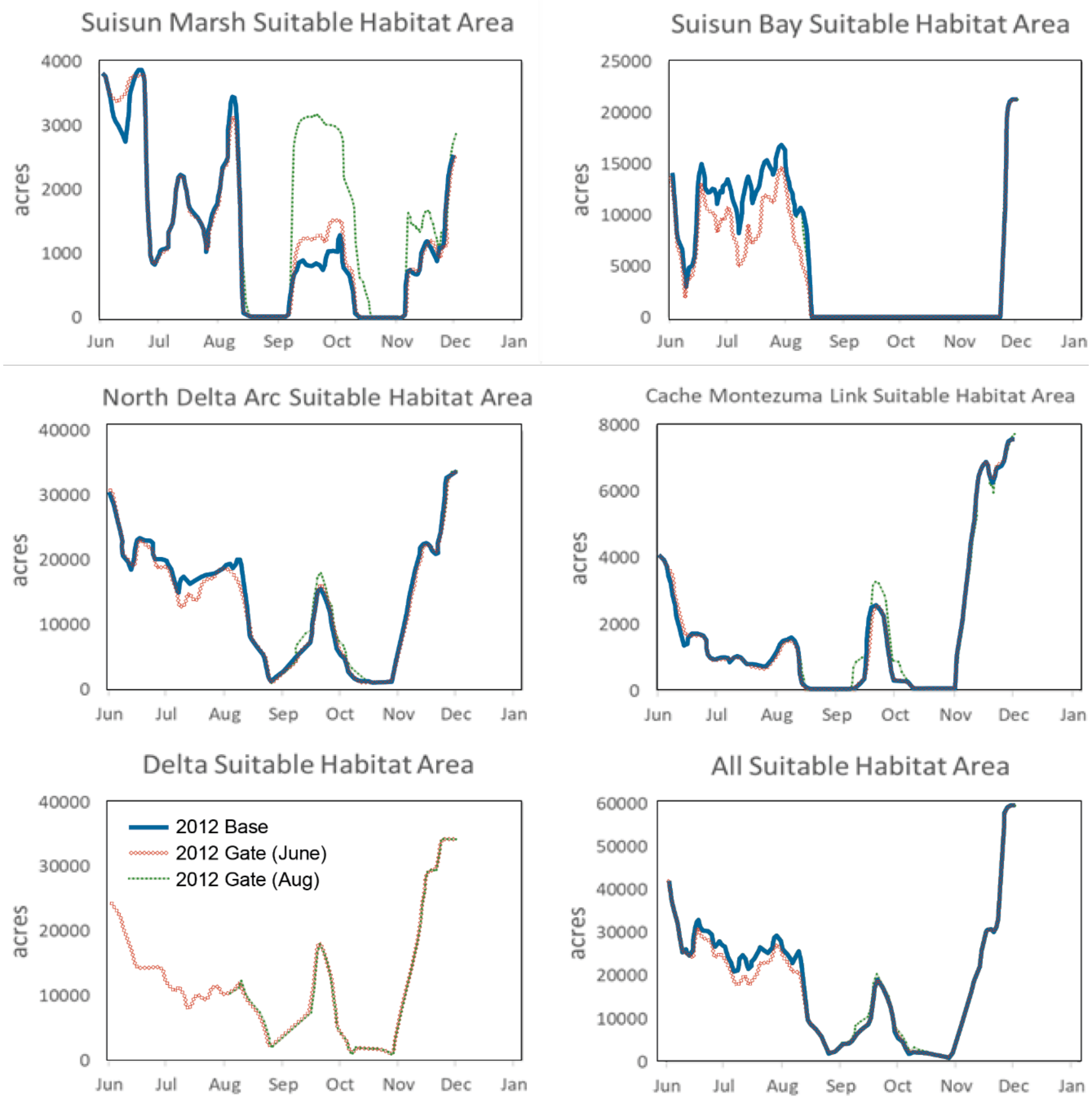
Averaging period was October 29 to November 12, 2017 (the largest effect happened slightly after the end of the action

Figure 5: Salinity Changed Induced by the 80km X2 Action in 2017 Relative to the No X2 Case Where the Historical 2017 fall X2 Action was Rolled Back to Conform to Other Regulatory Objectives and Obligations



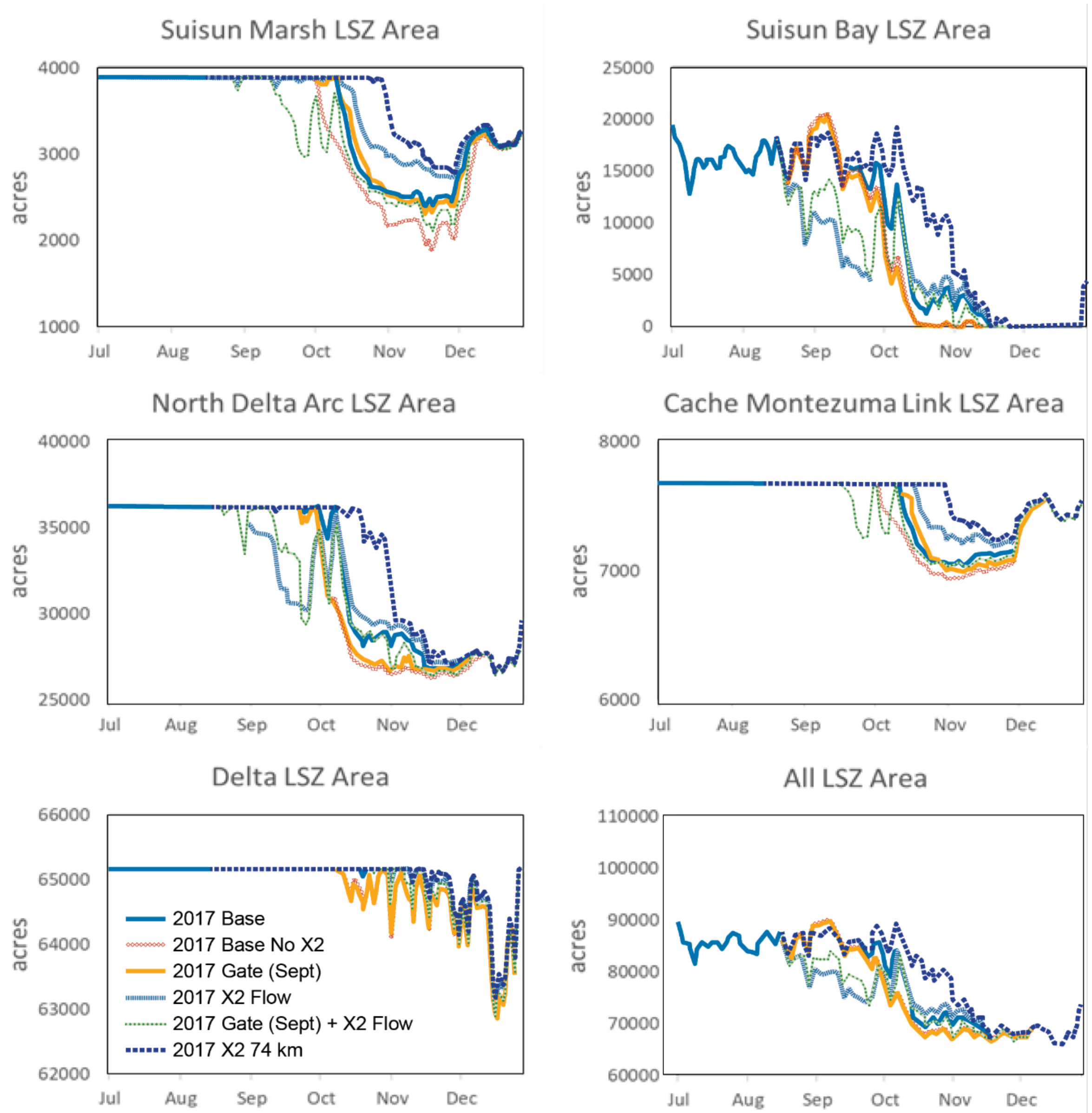
The base and two alternate gate timings are shown.

Figure 6: Low Salinity Zone Acreage in each of the Study Regions, Daily Averaged, for 2012



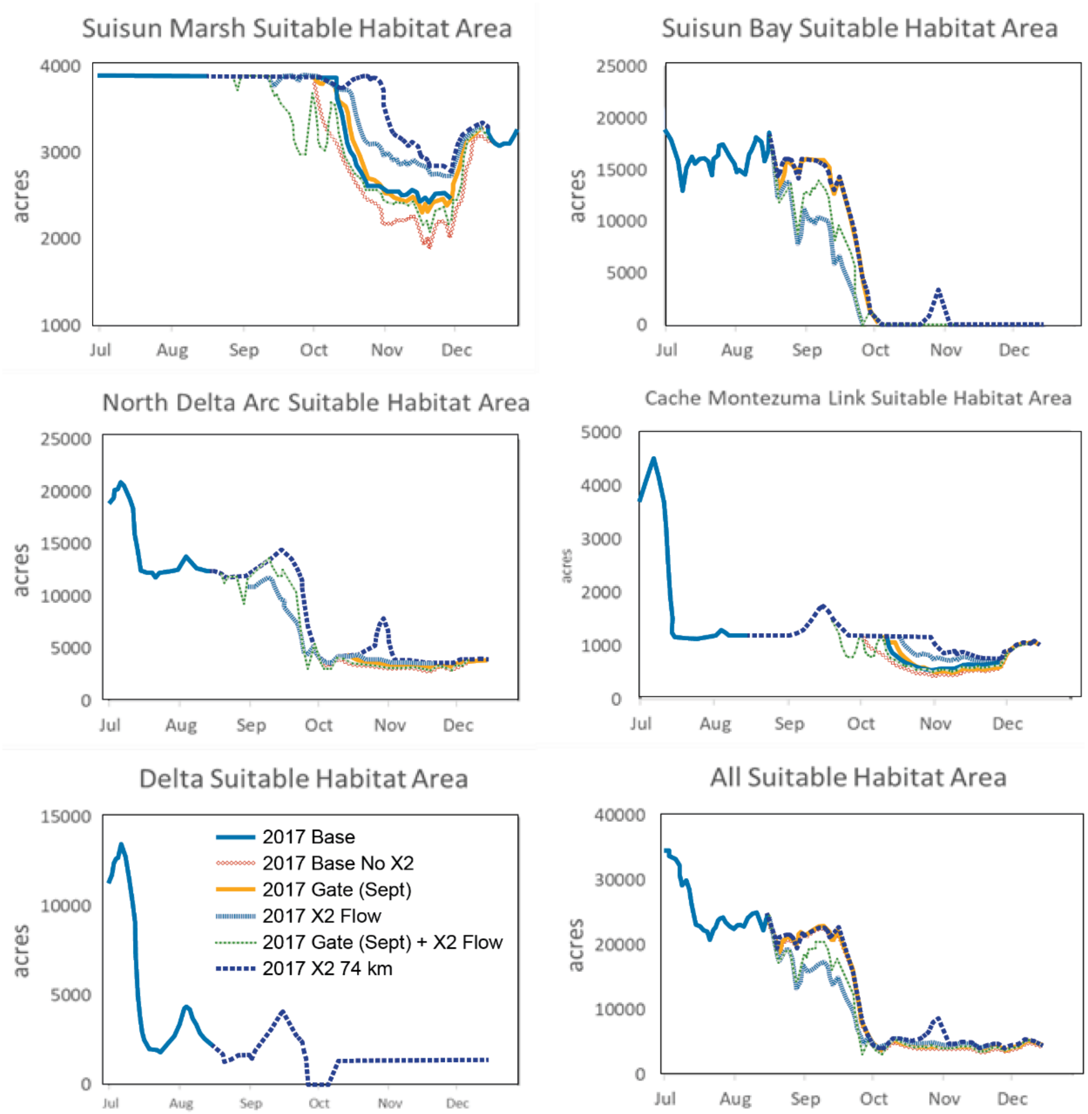
Areas are daily averaged.

Figure 7: Suitable Habitat Acreage within each of the Study Regions in 2012 using the Temperature, Seccchi Depth and Salinity Thresholds Described in the Text



The base, September gate operation, September-October 80 km X2, and both gate and 80 km X2 scenarios are shown.

Figure 8: Low Salinity Zone Acreage in each of the Study Regions, Daily Averaged, for 2017



Areas are daily averaged.

Figure 9: Suitable Habitat Acreage within each of the Study Regions in 2017 using the Temperature, Seccchi Depth and Salinity Thresholds Described in the Text

CONCLUSIONS

SMSCG tidal operation reliably freshens the marsh, but not Suisun Bay. The habitat benefits dependent on water clarity. Over a variety of year types, the most effective period for SMSCG tidal operations is after August 15 when mid-marsh salinity would otherwise rise steadily until any typical October action. When such SMSCG actions are followed by operations in October, considerable time continuity of the habitat can be achieved within the marsh. This seasonality is also largely predictable, which helps avoid thresholds which are hard to design in a way that they do not initiate the action too early.

Flow augmentation that maintains X2 at 80km appears to open up an additional 2,000–8,000 acres of LSZ habitat in Suisun Bay during the period of the action, as well as marsh habitat if the marsh is not so fresh as to render the action redundant. In 2017, this redundancy in the marsh was an issue through October. The flow and gate actions generated up to 500 acres (20%) extra LSZ habitat, but only as a residual improvement in November after the actions had already ended. Unlike the marsh, Suisun Bay LSZ habitat tends to respond to flow and gate interventions during higher flows.

One increment that may be of interest is the habitat difference between 74km and 80km X2. Comparison of the historical base run in 2017 (approximately 74km) and the 2017 X2 Flow run (80km) indicates that the LSZ habitat difference between these cases is approximately 5,000–6,000 acres (peaking at the end of September) in Suisun Bay. There is little change in the marsh because both X2 targets are sufficient to provide LSZ habitat there.

Even though there appears to be significant increase in low salinity habitat for some of the actions, the improvements in three-variable habitat index were muted, mainly due to the definition used for suitable water clarity. Tidal gate operations while holding 80km X2 requires an additional 2,500 cfs of additional flow beyond the 80km X2 action, which means that nearly all the flow diverted along Montezuma Slough must be compensated by releases or export reductions. It is not clear whether it is the flow or the gate operation provides the habitat benefit.

LIMITATIONS AND CAVEATS

Thresholds are sensitive: The threshold-based habitat metrics posed thus far are brittle for Suisun Marsh and Bay. 6psu is a common value for salinity in summer under the regulatory regime for many water types. A 0.1-0.4 psu variation would yield different significant area calculations. The same is true for the Secchi disk threshold of 0.5m, since at least in parts of 2012 and 2017 Suisun Bay hovered near this value. Although the study did not investigate either threshold in detail, it appears that values of 6.5 psu and 0.55m would more distinctly partition common operating regimes.

Turbidity is a sensitive component of habitat metric calculations limiting the habitat area severely in late summer and early fall outside of Suisun Marsh, Suisun Bay and parts of the North Delta. Temperature was less influential, except upstream on the San Joaquin River and in the South Delta where it excluded habitat.

Suisun Marsh Consumptive Use: Uncertainty over Suisun Marsh Consumptive Use was described in the modeling description. Work on marsh consumptive use is relatively recent. Progress has been made in estimating channel depletions and managed flows in the marsh in recent years. In the present study, uncertainty has been addressed with estimates that agree well with seasonality of flow and salinity measurements that are available and with reasonableness bounds imposed by evapotranspiration.

Definition of X2: Components of this study required that X2 be positioned at 80km. For these actions, the regulatory surrogate (2.64 milliSiemens per centimeter [mS/cm] surface EC) was used to position the salinity field, not the conceptual value of 2psu bottom salinity. The regulatory X2 represents the compliance method and has a higher outflow burden on the projects. The X2 surrogate used in compliance and the ecological literature is nearly always lower than conceptual X2 and therefore conservative. Stratification and shoal-channel differences do not completely explain the difference when X2 is near Collinsville. Figure 4 shows that salinity at Collinsville (81km) must be considerably fresher than 2psu for salinity at Grizzly Bay gage to fall below the 6 psu LSZ habitat threshold.

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APPENDIX D

Biological Modeling Methods and Selected Results

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ACRONYMS AND OTHER ABBREVIATIONS

AIC	Akaike's Information Criterion
AUC	area under the curve
AUCo	area under the curve overlapping portions
AUCt	total area under the curve
Banks pumping plant	Harvey O. Banks Pumping Plant
CAMT	Collaborative Adaptive Management Team
CDFW	California Department of Fish and Wildlife
cfs	cubic feet per second
COS	Continued Operations Scenario
CVP	Central Valley Project
CWT	coded wire tag
DCC	Delta Cross Channel
DFG	California Department of Fish and Game
DLO	driver-linkage-outcome
ESU	Evolutionarily Significant Unit
EXG	existing condition
FL	fork length
FMWT	Fall Mid-water Trawl
HOR	head of Old River
I-E	inflow-export ratio
ITP	Incidental Take Permit
km	kilometers
km/day	kilometers per day
LFS	Longfin Smelt
m^3/sec	cubic meters per second
mm	millimeter
MRV	Middle River
NAA	No Action Alternative
NBA	North Bay Aqueduct
OMR	Old and Middle River flows
ORV	Old River
PA	Proposed Action
PCA	principal components analysis
POD	Pelagic Organism Decline
PP	Proposed Project
PTM	particle tracking model

Skinner fish facility	John D. Skinner Delta Fish Protective Facility
SL	standard length
SLS	Smelt Larva Survey
SST	Salmonid Scoping Team
STARS	Survival, Travel Time, and Routing Analysis
SWP	State Water Project
taf	thousand acre feet
TL	total length
USFWS	U.S. Fish and Wildlife Service
WOA	Without Operations Scenario

APPENDIX D. BIOLOGICAL MODELING METHODS AND SELECTED RESULTS

D.1 INTRODUCTION

This appendix provides biological modeling methods and selected results for fish species for which quantitative modeling approaches are used. The appendix is divided into Section D.2 *Delta Smelt*, Section D.3 *Longfin Smelt*, and Section D.4 *Salmonids*, and Section D.5 *References*.

D.2 DELTA SMELT

D.2.1 PARTICLE TRACKING MODELING (LARVAL ENTRAINMENT)

For the present effects analysis, the most recent version of DSM2 particle tracking model (PTM) was used in the effects analysis to estimate the proportional entrainment of Delta Smelt larvae by various water diversions (i.e., the south Delta export facilities and the North Bay Aqueduct (NBA) Barker Slough Pumping Plant). This approach assumed that the susceptibility of Delta Smelt larvae can be represented by entrainment of passive particles, based on existing literature (Kimmerer 2008, 2011). Results of the PTM simulations do not represent the actual entrainment of larval Delta Smelt that may have occurred in the past or would occur in the future, but rather should be viewed as a comparative indicator of the relative risk of larval entrainment under Existing and Proposed Project (PP) scenarios. For purposes of this effects analysis, those particles that were estimated to have entered the various water diversion locations included in the PTM outputs (e.g., south Delta export facilities and NBA) are characterized as having been entrained. The latest version of DSM2-PTM allows agricultural diversions to be excluded as sources of entrainment (while still being included as water diversion sources): for this effects analysis, these agricultural diversions were excluded, given the relative coarseness of the assumptions related to specific locations of the agricultural diversions, the timing of water withdrawals by individual irrigators, and field observations that the density of young Delta Smelt entrained by these diversions is relatively low (Nobriga et al. 2004, Kimmerer 2008).

Delta smelt starting distributions used in the PTM larval entrainment analysis were based on the California Department of Fish and Wildlife (CDFW) 20 millimeter (mm) larval survey and were developed in association with M. Nobriga (USFWS Bay-Delta Office). This method paired observed Delta Smelt larval distributions from survey data with modeled hydraulic conditions from DSM2 PTM. Each pair was made by matching the observed Delta outflows of the first 20 mm survey that captured larval smelt (16 years of 20 mm surveys, 1995–2011) with the closest modeled mean monthly Delta outflow for the months of March to June in the 82 years of PTM simulations.

The 20 mm survey samples multiple stations throughout the Delta fortnightly. The average length of Delta Smelt caught during each survey was averaged across all stations (8–10 surveys per year) (Table D.2-1). The survey with mean fish length closest to 13 mm was chosen to represent the starting distribution of larval smelt in the Delta for that particular year (Table D.2-1). A length of 13 mm was chosen in order to represent a consistent period each year with respect to size/age of Delta Smelt larvae, while accounting for the mean size by survey across all years and the general pattern of more efficient capture with greater size. Catch efficiency changes rapidly for Delta Smelt larvae as they grow (see Figure 8 of Kimmerer 2008); the choice of 13 mm represents a compromise between larger larvae/early juveniles (e.g., ≥ 20 mm) that are captured more efficiently but which may have moved too far to accurately represent starting distribution and likely would be behaving less like passive particles, and smaller larvae (e.g., < 10 mm) that are not sampled efficiently enough to provide a reliable depiction of starting distribution. During the period included in the analysis (1995–2011), the fourth survey was selected most frequently (range between the first and fifth surveys).

Once a survey date was chosen for a given year, the actual Delta Smelt catch during this survey was examined by station number (Table D.2-1). Stations downstream of the confluence of the Sacramento and San Joaquin River confluence (in Suisun Bay and Suisun Marsh) were eliminated, as particles originating in these areas would not be subject to entrainment in the Delta and the PTM is better suited for the channels of the Delta than for the open-estuary environment of Suisun Bay. Several stations in the Cache Slough area also were not included as they were introduced in 2008 and did not have data for the entire period from which starting distributions are calculated. A list of stations and counts of Delta Smelt are provided in Table D.2-2, along with the fish count not used to calculate the starting distribution, as a percentage of total fish caught during a given survey. Note that the percentage of larvae collected downstream of the Sacramento–San Joaquin confluence varies from zero to almost 100%, depending on water year. For example, in 2002 (survey 4), with relatively low outflow of approximately 13,500 cubic feet per second (cfs), only 2.5% of larvae were downstream of the confluence (Table D.2-3). In contrast, over 70% of larvae were downstream in 1998 (survey 4), with outflow of nearly 70,000 cfs (Figure D.2-1). These percentages were used to adjust the percentage of particles (particles representing larvae) that would be considered susceptible to entrainment.

Delta smelt counts per station were then divided by the contributing area of a given station in acres (Table D.2-2), to remove spatial disparities, and percentages of the total number of Delta Smelt caught were calculated for each of the main areas included in the analysis. The final annual starting distributions then were established by evenly distributing assigned percentages to each DSM2 PTM node (i.e., model particle insertion points) in a given area.

Table D.2-1. Distribution of Larval Delta Smelt (Number of Smelt) in Selected Survey Period (Survey Number) – Table D.2-1 a – D.2-1 h

Table D.2-1 a. Distribution of Larval Delta Smelt (Number of Smelt) in Selected Survey Period (Survey Number) at West Delta/Lower Sacramento River Sampling Stations

Year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Survey Number	1	3	4	4	2	4	5	4	4	4	4	5	4	4	4	4	4
Average Monthly Outflow (cfs)2	90,837	46,021	12,257	67,612	35,509	22,057	9,612	13,483	41,877	12,354	29,876	82,004	11,235	9,482	11,944	25,102	84,981
Station No. 508	–	51	–	1	3	1	–	–	1	–	2	–	–	–	–	–	–
Station No. 513	–	110	3	–	1	18	1	–	1	7	7	–	–	–	–	2	–
Station No. 520	4	65	26	1	–	9	–	–	1	–	2	–	–	–	–	1	1
Station No. 801	–	41	2	–	8	18	–	–	2	13	1	–	–	1	–	1	–

Table D.2-1 b. Distribution of Larval Delta Smelt (Number of Smelt) in Selected Survey Period (Survey Number) at West Delta/ Sacramento–San Joaquin Confluence Sampling Stations

Year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Survey Number	1	3	4	4	2	4	5	4	4	4	4	5	4	4	4	4	4
Average Monthly Outflow (cfs)2	90,837	46,021	12,257	67,612	35,509	22,057	9,612	13,483	41,877	12,354	29,876	82,004	11,235	9,482	11,944	25,102	84,981
704	–	11	8	–	4	–	3	–	–	1	–	–	–	1	–	–	–
705	–	4	12	–	–	1	14	5	1	8	–	1	–	–	1	–	–
706	–	4	14	2	–	1	5	1	–	3	1	–	1	–	–	1	–
707	–	–	–	–	–	–	11	–	–	2	–	–	–	–	–	–	–

Table D.2-1 c. Distribution of Larval Delta Smelt (Number of Smelt) in Selected Survey Period (Survey Number) at Cache Slough and North Delta Sampling Stations

Year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Survey Number	1	3	4	4	2	4	5	4	4	4	4	5	4	4	4	4	4
Average Monthly Outflow (cfs)2	90,837	46,021	12,257	67,612	35,509	22,057	9,612	13,483	41,877	12,354	29,876	82,004	11,235	9,482	11,944	25,102	84,981
711	–	–	7	–	–	1	1	1	–	–	–	1	1	–	–	–	–
716	–	–	6	–	–	3	5	1	2	2	1	3	–	–	1	2	1
719	–	–	–	–	–	–	–	–	–	–	–	–	–	2	12	38	39

Table D.2-1 d. Distribution of Larval Delta Smelt (Number of Smelt) in Selected Survey Period (Survey Number) at West Delta/Lower San Joaquin River Sampling Stations

Year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Survey Number	1	3	4	4	2	4	5	4	4	4	4	5	4	4	4	4	4
Average Monthly Outflow (cfs)2	90,837	46,021	12,257	67,612	35,509	22,057	9,612	13,483	41,877	12,354	29,876	82,004	11,235	9,482	11,944	25,102	84,981
804	–	8	32	12	15	8	–	4	4	5	–	1	–	1	–	1	–
809	–	20	13	–	–	–	28	1	1	87	–	–	–	–	–	–	–
812	–	8	6	–	–	1	49	3	–	6	–	–	–	1	–	–	–
815	–	3	5	–	18	1	13	5	–	26	1	1	–	2	1	1	–
901	–	5	5	–	7	–	13	2	1	4	–	–	–	–	–	–	–

Table D.2-1 e. Distribution of Larval Delta Smelt (Number of Smelt) in Selected Survey Period (Survey Number) at South Delta Sampling Stations

Year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Survey Number	1	3	4	4	2	4	5	4	4	4	4	5	4	4	4	4	4
Average Monthly Outflow (cfs)2	90,837	46,021	12,257	67,612	35,509	22,057	9,612	13,483	41,877	12,354	29,876	82,004	11,235	9,482	11,944	25,102	84,981
902–915	–	0	4	–	45	18	11	14	8	3	2	–	–	3	2	1	–
918	–	1	–	–	–	21	1	1	–	2	1	–	–	–	–	–	–

Table D.2-1 f. Distribution of Larval Delta Smelt (Number of Smelt) in Selected Survey Period (Survey Number) at East Delta Sampling Stations

Year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Survey Number	1	3	4	4	2	4	5	4	4	4	4	5	4	4	4	4	4
Average Monthly Outflow (cfs)2	90,837	46,021	12,257	67,612	35,509	22,057	9,612	13,483	41,877	12,354	29,876	82,004	11,235	9,482	11,944	25,102	84,981
919	–	1	5	–	–	1	10	1	–	–	–	–	–	–	–	–	–

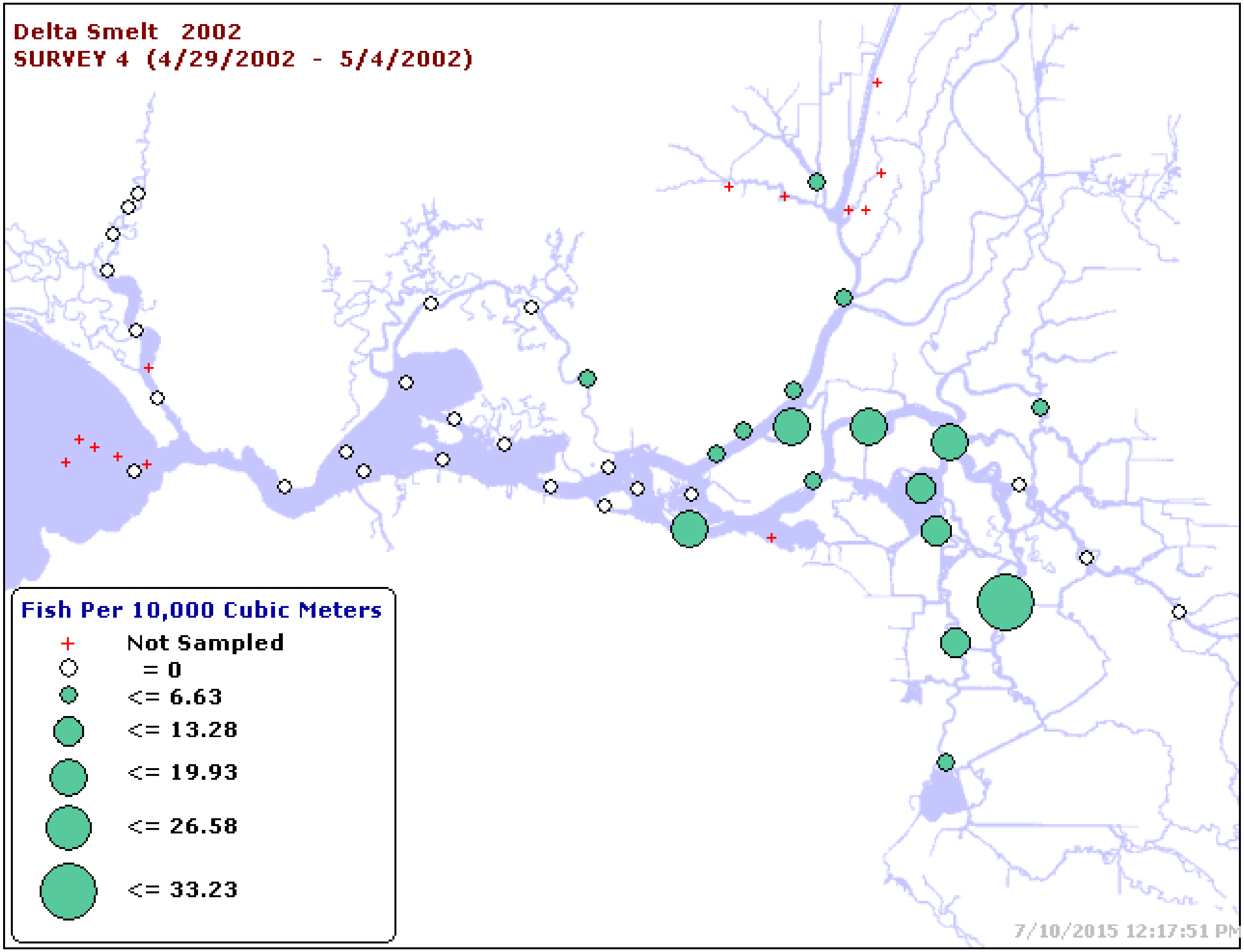
Table D.2-1 g. Distribution of Larval Delta Smelt (Number of Smelt) in Selected Survey Period (Survey Number) at Other Sampling Stations

Year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Survey Number	1	3	4	4	2	4	5	4	4	4	4	5	4	4	4	4	4
Average Monthly Outflow (cfs)2	90,837	46,021	12,257	67,612	35,509	22,057	9,612	13,483	41,877	12,354	29,876	82,004	11,235	9,482	11,944	25,102	84,981
Cache Slough Stations	0	0	0	0	0	0	0	0	0	0	0	0	0	10	4	16	4
Downstream of Confluence	7	567	66	43	127	46	8	1	7	20	50	242	1	0	1	4	120

Table D.2-1 h. Percentage of Total Larval Delta Smelt Count in Selected Survey Period (Survey Number) Not Considered for Starting Distribution

Year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Survey Number	1	3	4	4	2	4	5	4	4	4	4	5	4	4	4	4	4
Average Monthly Outflow (cfs)2	90,837	46,021	12,257	67,612	35,509	22,057	9,612	13,483	41,877	12,354	29,876	82,004	11,235	9,482	11,944	25,102	84,981
Cache Slough Stations	0	0	0	0	0	0	0	0	0	0	0	0	0	47.6	18.2	23.5	2.4
Downstream of Confluence	63.6	63.1	30.8	72.9	55.7	31.1	4.6	2.5	24.1	10.6	73.5	97.2	33.3	0	4.5	5.9	72.7

Note:
"–" indicates the cell is blank.



Source: http://www.dfg.ca.gov/delta/data/20mm/CPUE_map.asp. Accessed: July 10, 2015.

Figure D.2-1. Density of Delta Smelt from 20 mm Survey 4, 2002

Table D.2-2. Area of Water Represented by Each 20 mm Survey Station

Station	Area (acres)
508	2,296
513	1,703
520	438
801	2,226
704	605
705	277
706	931
707	1,859
711	1,994
716	3,110*
719	3,110*
804	1,195
809	1,392
812	1,767
815	4,023
901	3,822
902	1,744
906	1,780
910	1,925
912	1,225
914	1,554
915	1,146
918	1,601
919	2,043

Source: Saha 2008.
*Acreage for Station 716 was split between Stations 716 and 719

Each of the 328 months included in the PTM (i.e., March-June in 82 years) was matched to the closest starting distribution based on the average monthly Delta outflow. Average monthly Delta outflow for the months modeled by PTM hydro periods were based on CALSIM (Existing scenario) (Table D.2-1). Average monthly Delta outflow during the selected 20 mm survey period was calculated from DAYFLOW. If the selected survey period spanned two months (usually April–May), the applied outflow was for the month when most of the sampling occurred. The correspondence between the modeled Delta outflow and the applied starting distribution outflow from the 20 mm survey was reasonable: the mean difference was 4% (median = 1%), with a range from -221% (modeled Delta outflow of over 290,000 cfs in March 1983 matched with historical outflow of 90,837 cfs during survey 1 of 1995) to +58% (modeled Delta outflow of 4,000 cfs in several months matched with historical outflow of 9,482 cfs during survey 4 of 2008). Analysis of the PTM outputs was then done by multiplying the percentage of particles entrained from each release location by the applicable starting distribution percentage summarized in Table . Results were summarized for 30-day particle tracking periods as the percentage of particles being entrained at the south Delta exports (Clifton Court Forebay, with CVP considered separately for cumulative effects), or NBA. The total number of particles released at each location was 4,000. Note that a 30-day particle tracking period may result in relatively low fate resolution at low flows (Kimmerer and Nobriga 2008), but the relative differences between scenarios would be expected to be consistent, based on previous model comparisons of 30-day and 60-day fates.

Table D.2-3. Percentage of Particles at PTM Insertion Location Used as Starting Distributions in the Delta Smelt Particle Tracking Analysis - Table D.2-3 a - D.2-3 f

Table D.2-3 a. Percentage of Particles at PTM Insertion Locations in Sacramento–San Joaquin Confluence Area Used as Starting Distributions in the Delta Smelt Particle Tracking Analysis

Average Monthly Outflow in cfs:	9,482	9,612	11,235	11,944	12,257	12,354	13,483	22,057	25,102	29,876	35,509	46,021	67,612	82,004	84,891	90,837
Sacramento River at Sherman Lake	16.52	7.72	1.65	0	8.21	0	0.11	2.65	0	6.55	2.65	19.9	3.65	0	2.92	25.00
Sacramento River at Port Chicago	16.52	7.72	1.65	0	8.21	0	0.11	2.65	0	6.55	2.65	19.9	3.65	0	2.92	25.00
San Joaquin River downstream of Dutch Slough	16.52	7.72	1.65	0	8.21	0	0.11	2.65	0	6.55	2.65	19.9	3.65	0	2.92	25.00
Sacramento River at Pittsburg	16.52	7.72	1.65	0	8.21	0	0.11	2.65	0	6.55	2.65	19.9	3.65	0	2.92	25.00

Table D.2-3 b. Percentage of Particles at PTM Insertion Locations in Lower Sacramento River Area Used as Starting Distributions in the Delta Smelt Particle Tracking Analysis

Average Monthly Outflow in cfs:	9,482	9,612	11,235	11,944	12,257	12,354	13,483	22,057	25,102	29,876	35,509	46,021	67,612	82,004	84,891	90,837
Threemile Slough	1.30	0.67	4.24	8.76	6.96	10.64	9.10	2.35	6.00	4.13	2.35	2.13	2.12	8.76	0	0
Sacramento River at Rio Vista	1.30	0.67	4.24	8.76	6.96	10.64	9.10	2.35	6.00	4.13	2.35	2.13	2.12	8.76	0	0
Sacramento River downstream of Decker Island	1.30	0.67	4.24	8.76	6.96	10.64	9.10	2.35	6.00	4.13	2.35	2.13	2.12	8.76	0	0

Table D.2-3 c. Percentage of Particles at PTM Insertion Locations in Cache Slough and North Delta Area Used as Starting Distributions in the Delta Smelt Particle Tracking Analysis

Average Monthly Outflow in cfs:	9,482	9,612	11,235	11,944	12,257	12,354	13,483	22,057	25,102	29,876	35,509	46,021	67,612	82,004	84,891	90,837
Miner Slough	0.32	0.35	0.06	5.86	1.26	1.05	0.40	0	9.11	0.60	0	0	0	5.86	9.82	0
Sacramento Deep Water Ship Channel	0.32	0.35	0.06	5.86	1.26	1.05	0.40	0	9.11	0.60	0	0	0	5.86	9.82	0
Cache Slough at Shag Slough	0.32	0.35	0.06	5.86	1.26	1.05	0.40	0	9.11	0.60	0	0	0	5.86	9.82	0
Cache Slough at Liberty Island	0.32	0.35	0.06	5.86	1.26	1.05	0.40	0	9.11	0.60	0	0	0	5.86	9.82	0
Lindsey Slough at Barker Slough	0.32	0.35	0.06	5.86	1.26	1.05	0.40	0	9.11	0.60	0	0	0	5.86	9.82	0
Sacramento River at Sacramento	0.32	0.35	0.06	5.86	1.26	1.05	0.40	0	9.11	0.60	0	0	0	5.86	9.82	0
Sacramento River at Sutter Slough	0.32	0.35	0.06	5.86	1.26	1.05	0.40	0	9.11	0.60	0	0	0	5.86	9.82	0
Sacramento River at Ryde	0.32	0.35	0.06	5.86	1.26	1.05	0.40	0	9.11	0.60	0	0	0	5.86	9.82	0
Sacramento River near Cache Slough confluence	0.32	0.35	0.06	5.86	1.26	1.05	0.40	0	9.11	0.60	0	0	0	5.86	9.82	0

Table D.2-3 d. Percentage of Particles at PTM Insertion Locations in West Delta/San Joaquin River Area Used as Starting Distributions in the Delta Smelt Particle Tracking Analysis

Average Monthly Outflow in cfs:	9,482	9,612	11,235	11,944	12,257	12,354	13,483	22,057	25,102	29,876	35,509	46,021	67,612	82,004	84,891	90,837
San Joaquin River at Potato Slough	0.80	2.86	25.12	7.00	10.87	11.13	19.73	17.80	0	13.16	17.80	4.24	26.34	7.00	0	0
San Joaquin River at Twitchell Island	0.80	2.86	25.12	7.00	10.87	11.13	19.73	17.80	0	13.16	17.80	4.24	26.34	7.00	0	0
San Joaquin River near Jersey Point	0.80	2.86	25.12	7.00	10.87	11.13	19.73	17.80	0	13.16	17.80	4.24	26.34	7.00	0	0

Table D.2-3 e. Percentage of Particles at PTM Insertion Locations in Central/South Delta Area Used as Starting Distributions in the Delta Smelt Particle Tracking Analysis

Average Monthly Outflow in cfs:	9,482	9,612	11,235	11,944	12,257	12,354	13,483	22,057	25,102	29,876	35,509	46,021	67,612	82,004	84,891	90,837
San Joaquin River downstream of Rough and Ready Island	2.47	5.50	0.47	0	0.07	2.34	0.50	2.89	0	1.66	2.89	0.10	0	0	0	0
San Joaquin River at Buckley Cove	2.47	5.50	0.47	0	0.07	2.34	0.50	2.89	0	1.66	2.89	0.10	0	0	0	0
San Joaquin River near Medford Island	2.47	5.50	0.47	0	0.07	2.34	0.50	2.89	0	1.66	2.89	0.10	0	0	0	0
Old River near Victoria Canal	2.47	5.50	0.47	0	0.07	2.34	0.50	2.89	0	1.66	2.89	0.10	0	0	0	0
Old River at Railroad Cut	2.47	5.50	0.47	0	0.07	2.34	0.50	2.89	0	1.66	2.89	0.10	0	0	0	0
Old River near Quimby Island	2.47	5.50	0.47	0	0.07	2.34	0.50	2.89	0	1.66	2.89	0.10	0	0	0	0
Middle River at Victoria Canal	2.47	5.50	0.47	0	0.07	2.34	0.50	2.89	0	1.66	2.89	0.10	0	0	0	0
Middle River u/s of Mildred Island	2.47	5.50	0.47	0	0.07	2.34	0.50	2.89	0	1.66	2.89	0.10	0	0	0	0
Grant Line Canal	2.47	5.50	0.47	0	0.07	2.34	0.50	2.89	0	1.66	2.89	0.10	0	0	0	0
Frank's Tract East	2.47	5.50	0.47	0	0.07	2.34	0.50	2.89	0	1.66	2.89	0.10	0	0	0	0

Table D.2-3 f. Percentage of Particles at PTM Insertion Locations in East Delta Area Used as Starting Distributions in the Delta Smelt Particle Tracking Analysis

Average Monthly Outflow in cfs:	9,482	9,612	11,235	11,944	12,257	12,354	13,483	22,057	25,102	29,876	35,509	46,021	67,612	82,004	84,891	90,837
Little Potato Slough	0	0.08	0	0	0.26	0.30	0.74	0.00	0	0	0	0.03	0	0	0	0
Mokelumne River downstream of Cosumnes confluence	0	0.08	0	0	0.26	0.30	0.74	0.00	0	0	0	0.03	0	0	0	0
South Fork Mokelumne	0	0.08	0	0	0.26	0.30	0.74	0.00	0	0	0	0.03	0	0	0	0
Mokelumne River downstream of Georgiana confluence	0	0.08	0	0	0.26	0.30	0.74	0.00	0	0	0	0.03	0	0	0	0
North Fork Mokelumne	0	0.08	0	0	0.26	0.30	0.74	0	0	0	0	0.03	0	0	0	0
Georgiana Slough	0	0.08	0	0	0.26	0.30	0.74	0	0	0	0	0.03	0	0	0	0

D.2.2 *EURYTEMORA AFFINIS*-X2 ANALYSIS

This analysis followed Kimmerer's (2002) methods to conduct an analysis of the relationship between *Eurytemora affinis* and spring (March–May) X2 for the period from 1980 to 2017, as described by Greenwood (2018). The main steps in preparing the data for analysis were as follows:

1. Historical zooplankton data were obtained from ftp://ftp.dfg.ca.gov/IEP_Zooplankton/1972-2017CBMatrix.xlsx
    a. Data were subsetted to only include surveys 3, 4, and 5 (March-May).
    b. Specific conductance was converted to salinity by applying Schemel's (2001) method, then only samples within the low salinity zone (salinity = 0.5-6) were selected.
    c. A constant of 10 was added to *D. affinis* adult catch per unit effort (number per cubic meter) in each sample, then the resulting value was $\log_{10}$-transformed.
    d. The $\log_{10}$-transformed values were averaged first by month, and then by year.
2. Historical X2 data were obtained from DAYFLOW (https://www.water.ca.gov/Programs/Environmental-Services/Compliance-Monitoring-And-Assessment/Dayflow-Data)
    a. For years prior to water year 1997 (which is the year DAYFLOW X2 values began to be provided), the DAYFLOW daily predictive equation for X2 was used, based on a starting value from Anke Mueller-Solger (see Greenwood 2018 for details).
    b. The mean March-May X2 was calculated for each year.

Similar to Kimmerer (2002), a general linear model was used to regress mean annual $\log_{10}$-transformed *D. affinis* catch per unit effort against mean March-May X2, including a step change between 1987 and 1988 to reflect the *Potamocorbula amurensis* clam invasion and a step change between 2002 and 2003 to reflect the onset of the Pelagic Organism Decline (POD; Thomson et al. 2010). The interaction of X2 and the step change was included in a full model, but the interaction was not statistically significant, so the model was re-run with only X2 and the step changes included. These analyses were conducted in SAS 9.4 software. The statistical outputs indicate that there is little difference in the coefficients for the post-*Potamocorbula* and POD step changes, whereas both coefficients were significantly less than the coefficient for the pre-*Potamocorbula* period. Regression coefficients from the model were stored for prediction of *D. affinis* relative abundance for the Existing and PP scenarios.

The stored regression coefficients from the regression of historical *D. affinis* catch per unit effort vs. X2 and step changes were then applied to the Existing and PP X2 inputs using PROC PLM in SAS 9.4 software. The basic regression model being applied was:

$$\log_{10}(\textit{D. affinis}\text{ catch per unit effort}) = 3.9404 - 0.0152\ (\text{mean March-May X2}) - 0.7863$$

where 3.9404 is the intercept and -0.7863 is the coefficient for the POD step change. Predictions were back-transformed to the original measurement scale (catch per unit effort, number per cubic meter) for summary of results.

D.3 LONGFIN SMELT

D.3.1 Particle Tracking Modeling (Larval Entrainment)

D.3.1.1 Derivation of Larval Longfin Smelt Hatching Locations

The potential effect of the PP on larval Longfin Smelt entrainment in the Delta and Suisun Marsh was evaluated through a PTM of neutrally buoyant particles representing newly hatched larvae inserted at various locations in the Delta. The first step in the analysis involved determining appropriate weights for particle insertion points to reflect the hatching locations of larval Longfin Smelt. Injection points for comparisons of Existing to PP effects were determined through examination of the spatial distributions of larvae observed in the Smelt Larva Survey (SLS) from 2009 to 2014. This methodology is consistent with the approach used by California Department of Fish and Game (DFG) in its effects and Incidental Take Permit (ITP) analysis for State Water Project (SWP) and Central Valley Project (CVP) Data (California Department of Fish and Game 2009a). Data were obtained from the CDFW website (ftp://ftp.delta.dfg.ca.gov/Delta%20Smelt/SLS.mdb). For most of this time period, the SLS generally included 5-6 surveys at 35 stations in the Delta and Suisun Marsh and Bay during January-March; stations 323 to 343 in the Napa River were added in 2014, but are not considered in the present analysis because there is only one year of data. Data were filtered to include Longfin Smelt larvae ≤ 6-mm total length (TL), which represents mostly newly hatched larvae, but includes some larvae up to 8 days old, assuming conservative hatch lengths as low of 4-mm standard length (SL) and growth rate of 0.25 mm d^{-1} (California Department of Fish and Game 2009b). Inspection of size distribution and presence of yolk-sacs of the larval Longfin Smelt catch from the SLS data suggest that most newly hatched larvae are around 6-mm TL (Figure D.3-1), which is consistent with the presumed range of 4- to 8-mm SL (Wang 2007; California Department of Fish and Game 2009b).

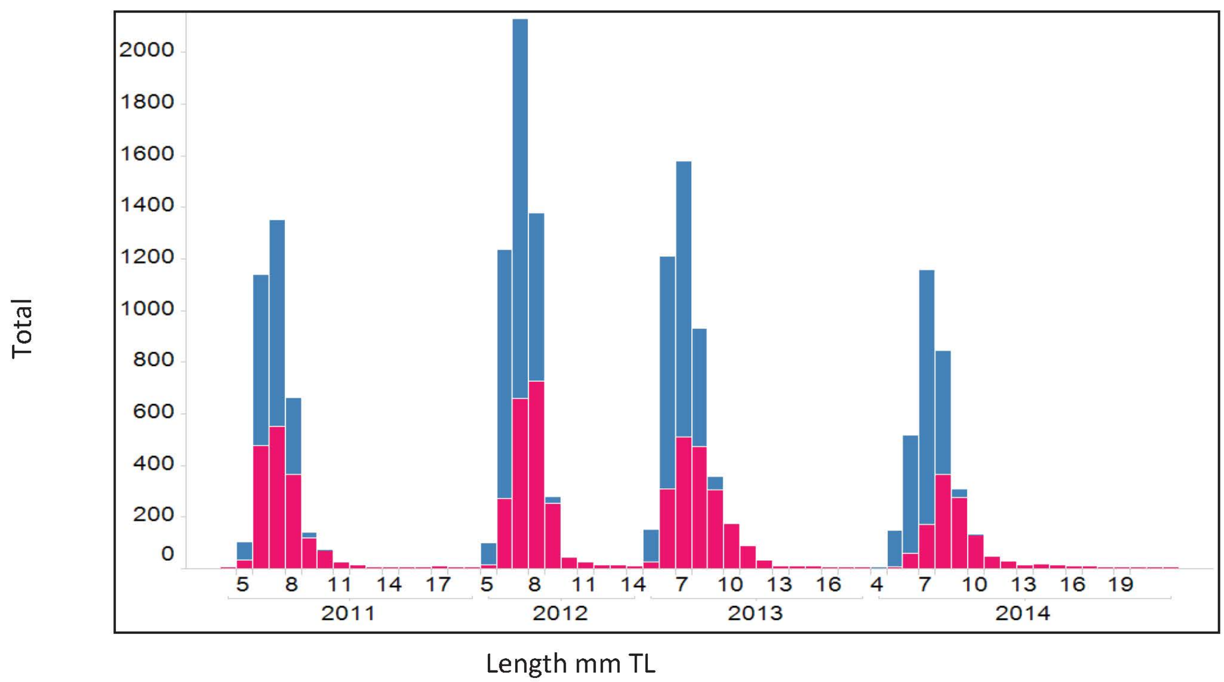


Figure D.3-1. Length-frequency histogram of Longfin Smelt larvae collected in the SLS. Larvae with yolk-sacs are represented by blue bars. DFG did not distinguish yolk sac larvae in 2009 and 2010

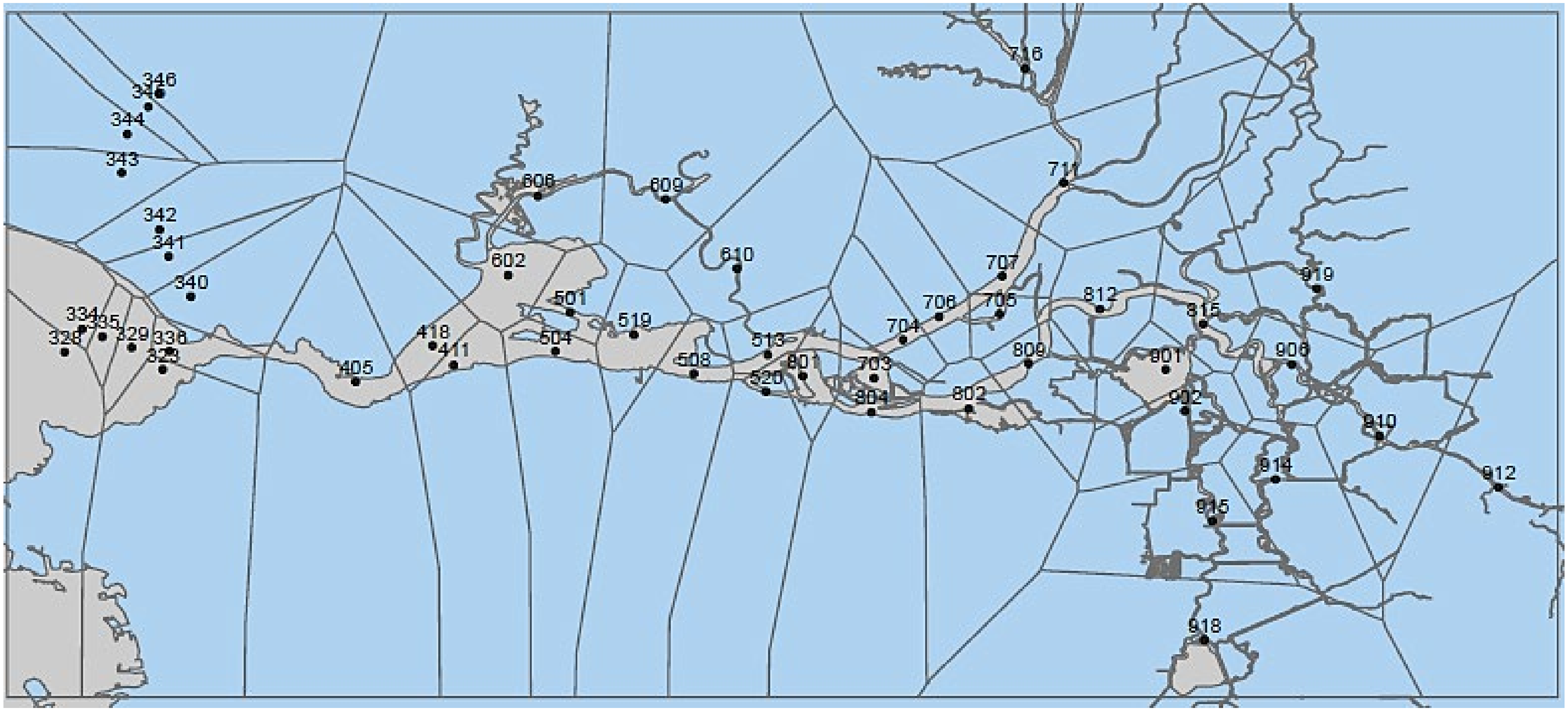
The density of larvae (≤ 6 mm TL) per cubic meter sampled at each station was calculated as:

Density = Number of larvae/(0.37*(26873+99999)*Net meter reading),

where the conversion factor derives from calibration of the net flow meter used during SLS sampling.[1]

The SLS includes a subset of the stations that are used for the March-June 20-mm survey for larval/juvenile delta smelt. Saha (2008) estimated the areas and volumes that each of the 20-mm stations represents within the Delta and Suisun Marsh and Bay using a Voronoi diagram (Figure D.3-2). There is a station (723) that was not part of the 20-mm Survey when Saha (2008) made the area and volume calculations; this station is close to station 716, so the area and volume represented by station 716 were halved for the present analysis, with the other half being considered to be the area and volume represented by station 723 (Table D.3-1).

[1] See Eijkelkamp Agrisearch Equipment (no date) for further details.



Source: Saha (2008).

Figure D.3-2. Division of the Delta and Suisun Marsh and Bay Around 20-mm Survey Stations With a Voronoi Diagram

Table D.3-1. Area and Volume Represented by Smelt Larval Survey Stations

Station	Area (ac)	Volume (ac-ft)	Area (m2)	Volume (m3)
405	3,547	139,804	14,354,198	172,445,718
411	2,119	37,344	8,575,288	46,063,152
418	2,756	63,186	11,153,135	77,938,794
501	3,692	36,856	14,940,992	45,461,213
504	2,403	44,046	9,724,595	54,329,948
508	2,296	53,344	9,291,581	65,798,864
513	1,703	41,921	6,891,796	51,708,799
519	4,101	67,942	16,596,156	83,805,234
520	438	12,130	1,772,523	14,962,137
602	7,361	72,852	29,788,907	89,861,631
606	1,332	17,685	5,390,412	21,814,129
609	727	8,114	2,942,064	10,008,473
610	259	3,156	1,048,136	3,892,869
703	2,091	25,853	8,461,976	31,889,210
704	605	15,952	2,448,348	19,676,505
705	277	3,741	1,120,979	4,614,456
706	931	24,539	3,767,623	30,268,415
707	1,859	37,076	7,523,105	45,732,579
711	1,994	39,391	8,069,431	48,588,089
716*	3,110	51,796	12,583,699	63,889,434
723*	3,110	51,796	12,583,699	63,889,434
801	2,226	45,662	9,008,301	56,323,255
802	3,546	45,094	14,350,151	55,622,637
804	1,195	32,119	4,835,993	39,618,208
809	1,392	33,562	5,633,224	41,398,123
812	1,767	43,810	7,150,795	54,038,846
815	4023	72053	16,280,502	88,876,079
901	3,822	33,855	15,467,084	41,759,533
902	1,744	22,095	7,057,717	27,253,785
906	1,780	32,694	7,203,404	40,327,461
910	1,925	25,760	7,790,198	31,774,496
912	1,225	13,747	4,957,399	16,956,677
914	1,554	23,552	6,288,814	29,050,968
915	1,146	13,302	4,637,697	16,407,778
918	1601	14,685	6,479,016	18,113,683
919	2,043	20,702	8,267,727	25,535,544

Source: Saha (2008)

*See text for discussion of values for stations 716 and 723.

The total number of Longfin Smelt larvae ≤ 6 mm in the volume of water represented by each station (Table D.3-1) was calculated by multiplying the density of larvae by the volume of each station.[2] The proportion of larvae in the volume of water represented by each SLS station was calculated for each survey as the number of larvae per station divided by the total sum of larvae across all stations (Table D.3-2).

There was little evidence that the general distribution of Longfin Smelt larvae from the SLS varied by year in relation to hydrological conditions, at least for the groups of stations examined herein[3] (Table D.3-3). Therefore an overall mean distribution was used to weigh the results of the DSM2-PTM analysis, based on the mean proportion by station from all surveys during 2009–2014.

D.3.1.2 DSM2-PTM Runs

Sixty-day-long DSM2-PTM runs were undertaken for the Existing and PP scenarios at 39 particle injection locations in the Delta and Suisun Marsh and Bay (Table D.3-4) during January, February, and March in 1922–2003. The particle injection locations were chosen to provide a representative variety of locations generally associated with SLS stations, with particular emphasis on the Delta. For each run, 4,000 neutrally buoyant passive particles were injected evenly every hour (i.e., about 160 particles per hour) over a 24.75-hour period at the beginning of the month. The fate of the particles was output at forty-five days, which was assumed to represent the duration that newly hatched larvae could be considered to act as neutrally buoyant particles with relatively poor swimming ability, and would therefore be susceptible to movement by prevailing channel currents, including entrainment. By the time larvae develop air bladders at around 12-mm TL, they are able to manipulate their position in the water column (Bennett et al. 2002), although they are still susceptible to entrainment, which is not represented by the tracking of particles for 45 days in the present analysis. For consistency with the analysis conducted by DFG (2009a), runs were also undertaken with surface (top 10% of water column) orientation of particles.

[2] For reference, the overall estimated number of larvae across all stations ranged from around 600,000 (survey 6 in 2014) to around 160,000,000 (survey 4 in 2009). Dividing these estimates by fecundity of 7,500 (California Department of Fish and Game 2009b: Figure 3) for a 2-year-old female and multiplying by 2 (under the assumption of a 1:1 sex ratio) gives an estimate of adult Longfin Smelt abundance, assuming 100% survival from eggs to larvae . Applying 10%, 50%, and 90% survival from eggs to larvae gives estimates of adult population size of around 500-2,300 (survey 6 in 2014) to 130,000-650,000 (survey 4 in 2009). These estimates bracket the "tens of thousands" of adults suggested by Newman (pers. comm. to California Department of Fish and Game 2009b), perhaps providing some indication that the numbers are of a reasonable order of magnitude for the purposes of the present analysis. Note, however, that the analysis is not dependent on absolute numbers of larvae to be accurately represented, as gear efficiency for smaller stages would need to be refined.

[3] This does not preclude the possibility of a considerable proportion of the population occurring downstream of the SLS sampling area during wet years, for example.

Table D.3-2. Volume-Weighted Proportion of Longfin Smelt Larvae ≤ 6 mm By Station, 2009-2014

Year	Survey	405	411	418	501	504	508	513	519	520	602	606	609	610	703	704	705	706	707	711	716	723	801	804	809	812	815	901	902	906	910	912	914	915	918	919
2009	1	0.0466	0.0000	0.0000	0.0118	0.0000	0.0151	0.2600	0.0217	0.0079	0.0000	0.0164	0.0000	0.0000	0.0164	0.0173	0.0104	0.2071	0.0365	0.0504	0.0161	0.0470	0.1693	0.0089	0.0193	0.0000	0.0000	0.0110	0.0000	0.0106	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2009	2	0.0000	0.0000	0.0000	0.0034	0.0000	0.1338	0.0993	0.0057	0.0227	0.0142	0.0015	0.0014	0.0033	0.0144	0.0771	0.0221	0.0779	0.2020	0.0296	0.0254	0.0045	0.0437	0.0848	0.0651	0.0150	0.0179	0.0324	0.0000	0.0000	0.0000	0.0000	0.0000	0.0027	0.0000	0.0000
2009	3	0.0000	0.0000	0.0000	0.0035	0.0021	0.0479	0.0019	0.0099	0.0099	0.0029	0.0083	0.0037	0.0009	0.0774	0.0369	0.0125	0.1055	0.1392	0.0355	0.1416	0.1250	0.0784	0.0316	0.0437	0.0632	0.0124	0.0056	0.0000	0.0000	0.0000	0.0000	0.0000	0.0006	0.0000	0.0000
2009	4	0.1055	0.0222	0.0320	0.0052	0.0016	0.0773	0.2536	0.0267	0.0164	0.0827	0.0007	0.0013	0.0005	0.0126	0.0231	0.0027	0.0101	0.0309	0.0000	0.0305	0.0302	0.1554	0.0467	0.0209	0.0016	0.0028	0.0050	0.0008	0.0000	0.0000	0.0000	0.0008	0.0005	0.0000	0.0000
2009	5	0.0152	0.0190	0.0447	0.1238	0.0582	0.2174	0.1067	0.0734	0.0199	0.0931	0.0095	0.0012	0.0002	0.0129	0.0052	0.0015	0.0062	0.0139	0.0000	0.0178	0.0185	0.0587	0.0543	0.0047	0.0084	0.0064	0.0090	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2010	1	0.0130	0.0118	0.0218	0.0429	0.0161	0.1210	0.0807	0.0456	0.0451	0.0300	0.0000	0.0014	0.0006	0.0048	0.0105	0.0078	0.0526	0.1396	0.0035	0.0639	0.0745	0.0257	0.0383	0.0734	0.0421	0.0000	0.0272	0.0038	0.0000	0.0000	0.0000	0.0021	0.0000	0.0000	0.0000
2010	4	0.0506	0.0167	0.0480	0.0663	0.1274	0.0574	0.0304	0.0226	0.0283	0.0371	0.0000	0.0019	0.0033	0.0086	0.0753	0.0031	0.0841	0.1396	0.0038	0.0225	0.0094	0.0457	0.0631	0.0208	0.0095	0.0133	0.0097	0.0019	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2010	5	0.0670	0.1457	0.0848	0.1239	0.0744	0.0428	0.0147	0.0515	0.0162	0.0436	0.0000	0.0011	0.0000	0.0280	0.0164	0.0038	0.0361	0.0436	0.0106	0.0197	0.0534	0.0400	0.0274	0.0283	0.0175	0.0000	0.0071	0.0016	0.0000	0.0000	0.0000	0.0000	0.0000	0.0011	0.0000
2010	6	0.0171	0.0000	0.0000	0.0000	0.0106	0.1488	0.3585	0.0163	0.0095	0.0103	0.0095	0.0000	0.0005	0.0143	0.0479	0.0000	0.1063	0.0431	0.0167	0.0220	0.1016	0.0112	0.0161	0.0120	0.0138	0.0000	0.0088	0.0000	0.0000	0.0000	0.0000	0.0000	0.0022	0.0000	0.0029
2011	1	0.0130	0.0110	0.0187	0.0146	0.0212	0.1665	0.0837	0.2172	0.0349	0.0542	0.0204	0.0008	0.0006	0.0159	0.0576	0.0030	0.0682	0.1289	0.0000	0.0096	0.0102	0.0034	0.0278	0.0186	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2011	2	0.0336	0.0024	0.0307	0.0287	0.0181	0.0758	0.0363	0.0819	0.0251	0.0191	0.0053	0.0005	0.0044	0.0029	0.0314	0.0042	0.0487	0.0846	0.0193	0.0785	0.1454	0.0624	0.0531	0.0296	0.0137	0.0134	0.0490	0.0013	0.0000	0.0000	0.0008	0.0000	0.0000	0.0000	0.0000
2011	3	0.0000	0.0079	0.0062	0.0150	0.0301	0.0522	0.0043	0.0143	0.0067	0.0000	0.0000	0.0009	0.0010	0.0725	0.0207	0.0069	0.0611	0.1476	0.0775	0.2083	0.1842	0.0000	0.0228	0.0259	0.0190	0.0075	0.0075	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2011	4	0.0000	0.0038	0.0000	0.0916	0.1170	0.2984	0.0612	0.0802	0.0198	0.0184	0.0000	0.0000	0.0005	0.0113	0.0252	0.0030	0.0097	0.1250	0.0144	0.0057	0.0846	0.0128	0.0044	0.0000	0.0050	0.0000	0.0049	0.0031	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2011	5	0.2285	0.0972	0.0192	0.0641	0.1032	0.0171	0.0000	0.0814	0.0078	0.2402	0.0000	0.0000	0.0009	0.0236	0.0183	0.0012	0.0000	0.0000	0.0124	0.0000	0.0289	0.0000	0.0100	0.0096	0.0259	0.0000	0.0106	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2012	1	0.0000	0.0000	0.0127	0.0206	0.0000	0.1460	0.1212	0.0000	0.0075	0.0282	0.0017	0.0022	0.0000	0.0224	0.0130	0.0028	0.0766	0.1361	0.0000	0.1099	0.1076	0.0275	0.0437	0.0819	0.0196	0.0189	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2012	2	0.2521	0.0066	0.0415	0.0310	0.0193	0.0884	0.0153	0.0077	0.0072	0.0519	0.0029	0.0010	0.0009	0.0301	0.0301	0.0011	0.0460	0.0765	0.0000	0.0543	0.0935	0.0384	0.0047	0.0355	0.0373	0.0000	0.0203	0.0035	0.0019	0.0000	0.0000	0.0000	0.0000	0.0000	0.0012
2012	3	0.0000	0.0000	0.0143	0.0081	0.0000	0.1628	0.0815	0.0082	0.0225	0.0258	0.0000	0.0009	0.0024	0.0026	0.0182	0.0024	0.0551	0.1591	0.0164	0.1159	0.1445	0.0047	0.0522	0.0050	0.0373	0.0508	0.0095	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2012	4	0.0593	0.0053	0.0236	0.0390	0.0248	0.0813	0.0322	0.1418	0.0230	0.0000	0.0000	0.0011	0.0000	0.0099	0.0250	0.0015	0.0829	0.1637	0.0168	0.0388	0.1124	0.0754	0.0192	0.0043	0.0000	0.0000	0.0102	0.0063	0.0000	0.0000	0.0000	0.0000	0.0000	0.0019	0.0000
2012	6	0.0894	0.0469	0.0522	0.0211	0.2308	0.1499	0.0583	0.0204	0.0683	0.1683	0.0000	0.0000	0.0048	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0151	0.0000	0.0392	0.0082	0.0000	0.0274	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2013	1	0.1422	0.0980	0.0000	0.0635	0.1968	0.0000	0.2731	0.0000	0.0000	0.1031	0.0000	0.0000	0.0000	0.0000	0.0078	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0208	0.0000	0.0141	0.0192	0.0000	0.0614	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2013	2	0.0124	0.0147	0.1148	0.0597	0.0858	0.0918	0.0308	0.1344	0.0087	0.1266	0.0000	0.0000	0.0000	0.0330	0.0013	0.0009	0.0704	0.0787	0.0034	0.0423	0.0280	0.0224	0.0202	0.0117	0.0000	0.0000	0.0079	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2013	3	0.0440	0.0000	0.0713	0.0527	0.0554	0.0301	0.0232	0.0568	0.0187	0.0499	0.0000	0.0000	0.0000	0.0514	0.0289	0.0037	0.0223	0.0807	0.0462	0.0927	0.1084	0.0435	0.0099	0.0472	0.0098	0.0164	0.0348	0.0000	0.0018	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2013	4	0.0000	0.0548	0.0103	0.0188	0.0253	0.0369	0.0194	0.0912	0.0116	0.0510	0.0000	0.0000	0.0000	0.0045	0.0296	0.0035	0.0585	0.1107	0.0934	0.1044	0.1985	0.0276	0.0201	0.0110	0.0036	0.0000	0.0134	0.0017	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2013	5	0.0689	0.0000	0.0506	0.0253	0.0280	0.1278	0.0172	0.0957	0.0245	0.0084	0.0000	0.0000	0.0000	0.0083	0.0134	0.0029	0.0422	0.1206	0.0498	0.0531	0.1243	0.0666	0.0384	0.0192	0.0115	0.0000	0.0034	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2013	6	0.0000	0.0680	0.0000	0.0000	0.0000	0.0000	0.1270	0.0000	0.0550	0.0000	0.0000	0.0000	0.0000	0.0411	0.0000	0.0000	0.3130	0.0000	0.0000	0.0000	0.0000	0.0000	0.3286	0.0000	0.0000	0.0000	0.0673	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2014	1	0.0000	0.0000	0.0190	0.0094	0.0000	0.2113	0.2272	0.0000	0.0332	0.0382	0.0053	0.0022	0.0100	0.0320	0.0287	0.0008	0.0131	0.0197	0.0276	0.0126	0.0259	0.0814	0.0425	0.0773	0.0467	0.0175	0.0183	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2014	2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0494	0.0598	0.0291	0.0171	0.0373	0.0020	0.0009	0.0007	0.0137	0.0079	0.0021	0.0095	0.0501	0.0446	0.2024	0.2176	0.0570	0.0096	0.0156	0.1374	0.0143	0.0162	0.0057	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2014	3	0.0000	0.0168	0.0415	0.0223	0.0137	0.0434	0.0381	0.0462	0.0159	0.0413	0.0000	0.0042	0.0000	0.0148	0.0024	0.0046	0.0042	0.0230	0.0367	0.2676	0.1165	0.1119	0.0160	0.0664	0.0324	0.0000	0.0201	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2014	4	0.0000	0.0000	0.0000	0.0000	0.0098	0.0124	0.0606	0.1058	0.0194	0.0000	0.0000	0.0018	0.0014	0.0208	0.0358	0.0000	0.0762	0.1184	0.0000	0.0980	0.2803	0.1038	0.0000	0.0280	0.0207	0.0000	0.0070	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2014	5	0.0000	0.0000	0.2679	0.0000	0.1638	0.0460	0.0423	0.0652	0.0338	0.0000	0.0000	0.0000	0.0105	0.0000	0.0000	0.0000	0.0221	0.0000	0.0000	0.0000	0.0000	0.0900	0.1203	0.0316	0.0391	0.0000	0.0673	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2014	6	0.0000	0.0000	0.0000	0.0000	0.3797	0.0000	0.0000	0.0000	0.1078	0.0000	0.0000	0.0000	0.0338	0.0000	0.0000	0.0000	0.4788	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Note: Surveys 2 and 3 in 2010 and 5 in 2012 had missing data and were excluded from the analysis.

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Table D.3-3. Mean Proportion of Longfin Smelt Larvae In Each Group of SLS Stations

Year	Mean Dec.-Mar. Delta Outflow (cfs)	400s	500s	600s	700s	800s	900s
2009	13,808	0.06	0.33	0.05	0.35	0.20	0.02
2010	19,863	0.12	0.39	0.03	0.32	0.12	0.02
2011	55,663	0.09	0.37	0.07	0.37	0.07	0.02
2012	11,946	0.12	0.33	0.06	0.36	0.13	0.01
2013	23,600	0.13	0.31	0.06	0.35	0.13	0.03
2014	8,331	0.06	0.31	0.03	0.38	0.19	0.02
Mean	**–**	**0.09**	**0.34**	**0.05**	**0.36**	**0.14**	**0.02**

Note:
"–" indicates the cell is blank.

Each particle injection location was assigned to one or more SLS stations, and some SLS stations had multiple particle injection locations assigned to them, reflecting the relative distribution of the nearest SLS station to particle injection locations (e.g., station 919 had five injection locations assigned to it, whereas station 901 had one injection location assigned to it; Table D.3-4). The weight assigned to the particles injected at each PTM injection location reflected the mean proportion of larvae captured at the associated SLS station (Table D.3-2) divided by the number of injection locations at a given station. As an example, station 707 was assigned two particle injection locations: Threemile Slough (location no. 15) and Sacramento River at Rio Vista (location no. 31) (Table D.3-4). The overall mean proportion of larval Longfin Smelt at station 707 across all surveys in 2009–2014 was 0.078 (mean of values in the 707 column of Table D.3-2 This 0.078 (i.e., 7.8% of larvae) was then divided equally among the two particle injection locations assigned to SLS station 707, giving a weight of 0.039 (i.e., 3.9% of larvae) for the particles injected at both locations (Table D.3-4). Professional judgement was used to assign representative weights in situations where a broader area needed to be represented by relatively few stations (e.g., Cache Slough Complex stations 22–26 represented by SLS stations 716 and 713).

Table D.3-4. Particle Injection Locations, Associated SLS Stations, and Location Weight for the DSM2-PTM Analysis of Potential Larval Longfin Smelt Entrainment

PTM Injection Location Number	PTM Injection Location Name	SLS Station	Weight
1	San Joaquin River at Vernalis	912	0.000014
2	San Joaquin River at Mossdale	912	0.000014
3	San Joaquin River D/S of Rough and Ready Island	910	0.000000
4	San Joaquin River at Buckley Cove	910	0.000000
5	San Joaquin River near Medford Island	906	0.000463
6	San Joaquin River at Potato Slough	815	0.003088
7	San Joaquin River at Twitchell Island	812	0.021832
8	Old River near Victoria Canal	918	0.000032
9	Old River at Railroad Cut	915	0.000191
10	Old River near Quimby Island	902	0.000957
11	Middle River at Victoria Canal	918	0.000032
12	Middle River u/s of Mildred Island	914	0.000094
13	Grant Line Canal	918	0.000032
14	Frank's Tract East	901	0.017578
15	Threemile Slough	707	0.038899
16	Little Potato Slough	919	0.000026
17	Mokelumne River d/s of Cosumnes confluence	919	0.000026
18	South Fork Mokelumne	919	0.000026
19	Mokelumne River d/s of Georgiana confluence	815	0.003088

PTM Injection Location Number	PTM Injection Location Name	SLS Station	Weight
20	North Fork Mokelumne	919	0.000026
21	Georgiana Slough	919	0.000026
22	Miner Slough	716+723	0.028025
23	Sacramento Deep Water Ship Channel	716+723	0.028025
24	Cache Slough at Shag Slough	716+723	0.028025
25	Cache Slough at Liberty Island	716+723	0.028025
26	Cache Slough near Lindsey Slough	716+723	0.028025
27	Sacramento River at Sacramento	upstream	0.000000
28	Sacramento River at Sutter Slough	upstream	0.000000
29	Sacramento River at Ryde	711	0.009815
30	Sacramento River near Cache Slough confluence	711	0.009815
31	Sacramento River at Rio Vista	707	0.038899
32	Sacramento River d/s of Decker Island	705+706	0.075899
33	Sacramento River at Sherman Lake	704	0.022743
34	Sacramento River at Port Chicago	downstream	0.000000
35	Montezuma Slough near National Steel	downstream	0.000000
36	Montezuma Slough at Suisun Slough	downstream	0.000000
37	San Joaquin River d/s of Dutch Slough	703+804	0.058814
38	Sacramento River at Pittsburg	801	0.048938
39	San Joaquin River near Jersey Point	809	0.026464

SLS stations downstream of the Sacramento-San Joaquin river confluence (i.e., stations numbered 400s to 600s) were considered to be downstream of the influence of the SWP/CVP export facilities, and so were not included in the PTM analysis (but were used in the calculation of proportions; see Table D.3-2). Similarly, PTM injection locations downstream of the confluence were assigned zero weight[4], because these particles would not be susceptible to entrainment at the locations of interest. In addition, particles injected in the Sacramento River at Sacramento and Sutter Slough were assigned zero weight because they are upstream of the range of the SLS (suggesting that this portion of the river is of minor concern for Longfin Smelt management). The summed weight of all the PTM injection locations in the analysis was 0.52, reflecting that 0.48 of the larval population was assumed to be downstream of the confluence and therefore not susceptible to entrainment in the Delta (see sum of the 400s, 500s, and 600s stations in Table D.3-3). As discussed further in Section D.3.1.3 *Note on Proportion of Larval Population Outside the Delta and Suisun Marsh and Bay*, the spatial extent of the SLS data used in the present analysis includes only the Delta and Suisun Marsh and Bay, but the full extent of the distribution of larval Longfin Smelt may be considerably greater.

For each simulated month in the DSM2-PTM analysis, the percentage of particles from each particle injection location was output for several fates: entrainment (the SWP's Clifton Court Forebay, the CVP's Jones Pumping Plant, and the NBA Barker Slough Pumping Plant), and passing Chipps Island. These percentages were multiplied by the weight for each particle injection location (Table D.3-4), and then summed across all injection locations to give a relative comparison of the overall percentage of larvae that would have been entrained or entered the south Delta under the Existing and PP scenarios. Note that these percentages are not intended to represent an absolute estimate of the actual

[4] PTM results for injection locations assigned zero weight are available upon request.

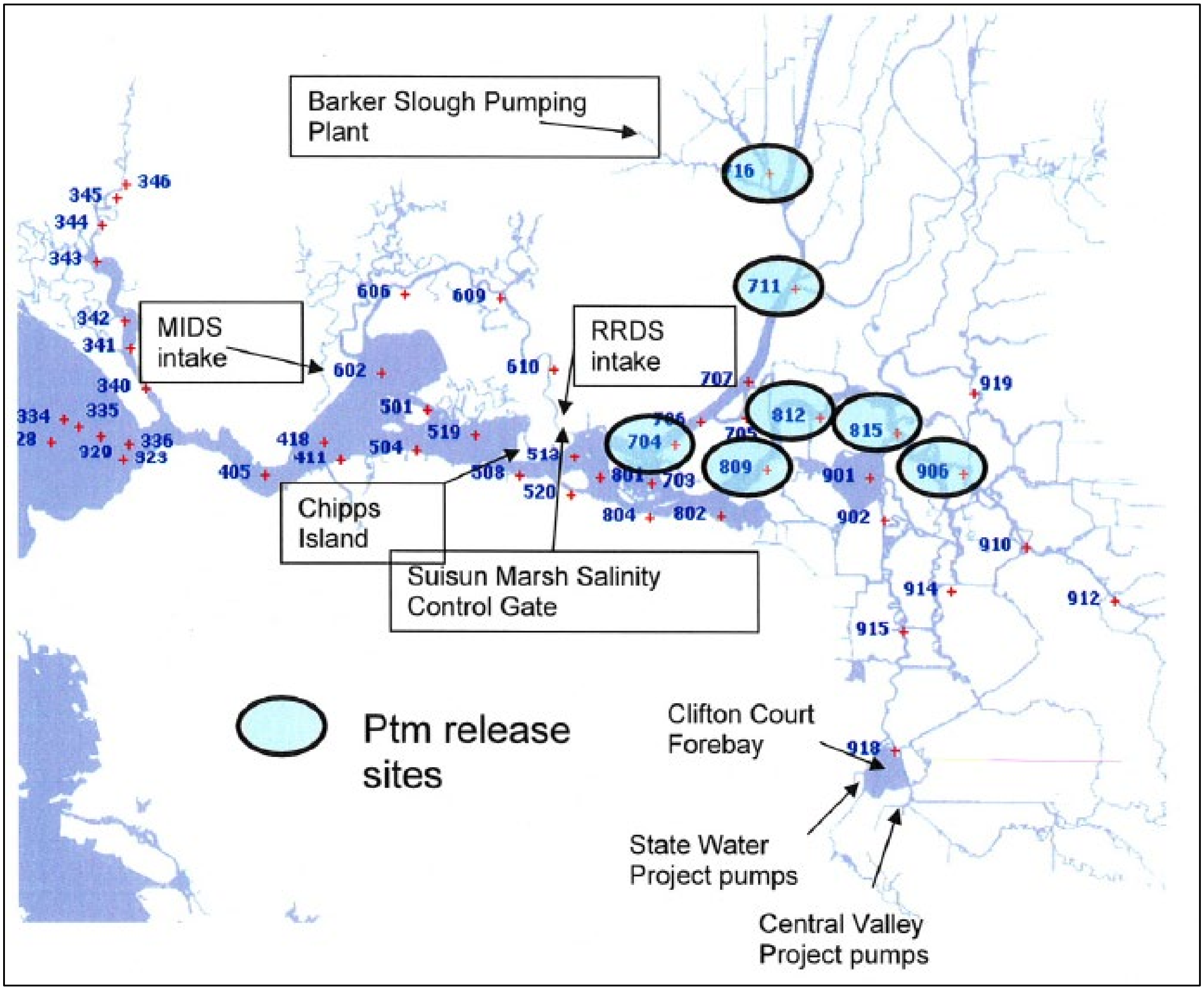
percentage of larvae that would be entrained, and should be interpreted only as a comparison of two operational scenarios (Existing and PP). The latest version of DSM2-PTM allows the user to not allow particles to be entrained into small agricultural diversions; this option was used for the present analysis in order to represent the hypothesis that such losses may not be substantial for Longfin Smelt (based on observations for delta smelt; Nobriga et al. 2004) and because losses at agricultural diversions were not the focus of the present analysis. In addition to reporting of the above fates, the percentage of particles remaining in the DSM2-PTM modeling domain after 45 days (i.e., neither entrained nor having left the domain) was also calculated.

D.3.1.3 NOTE ON PROPORTION OF LARVAL POPULATION OUTSIDE THE DELTA AND SUISUN MARSH AND BAY

The spatial distribution of newly hatched larvae determined from the SLS is likely much broader than observed, especially during wet years. Grimaldo et al. (2014) recently showed that larval Longfin Smelt are hatching in shallow water and tidal marsh habitats in salinities up to 8 parts per thousand (ppt). Previously thought to concentrate spawning in freshwater (Rosenfield and Baxter 2007; California Department of Fish and Game 2009a,b; Kimmerer et al. 2009), the analysis presented here and work by Grimaldo et al. (2014) shows that Longfin Smelt hatching is broadly distributed throughout Suisun Bay in most years (Table D.3-2). The proportion of newly hatched larvae from Delta stations was consistently lower than densities observed in Suisun Bay. Further, because overall larval Longfin Smelt abundance in the SLS is lowest during wet years, it is likely that spawning and hatching is occurring in San Pablo Bay and adjacent tributaries (e.g., Napa River, Petaluma River) when the area becomes suitable for spawning. Ultimately, this does not affect interpretation of results presented here because relative comparisons of Existing and PP were made using data for observations of larvae. The potential effects of survey bias would be more relevant for real-time operations where interpretation of proportional losses are likely to be affected by the observed versus actual distribution of larvae in the SLS survey.

D.3.1.4 DETAILED RESULTS FOR DFG (2009A) STATIONS OF INTEREST

To supplement the above analysis and provide some comparability with the DFG (2009a) effects analysis, PTM results were summarized for the seven particle injection stations analyzed by DFG (2009; Figure D.3-3). The results are presented below in Tables D.3-5, D.3-6, D.3-7, D.3-8, D.3-9, D.3-10, D.3-11, D.3-12, D.3-13, D.3-14, D.3-15, D.3-16, D.3-17, and D.3-18. Note that these are 'raw' results, with no weighting as undertaken by DFG (2009a).



Source: DFG (2009a).

Figure D.3-3. Particle Tracking Injection (Release) Locations Used by DFG (2009a)

Table D.3-5. Percentage of Neutrally Buoyant Particles Injected at Station 716 (Cache Slough at Liberty Island) That Were Entrained Over 45 Days into Clifton Court Forebay, Central Valley Project (Jones Pumping Plant), and Barker Slough Pumping Plant; or That Passed Chipps Island - Table D.3-5 a - D.3-5 d

Table D.3-5 b. Percentage of Neutrally Buoyant Particles Injected at Station 716 (Cache Slough at Liberty Island) That Were Entrained Over 45 Days into Clifton Court Forebay

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	0.33	0.35	0.02 (6%)
January	Above Normal	0.86	0.85	-0.01 (-2%)
January	Below Normal	1.90	1.84	-0.06 (-3%)
January	Dry	3.01	3.59	0.58 (19%)
January	Critical	3.32	3.55	0.23 (7%)
February	Wet	0.06	0.09	0.02 (36%)
February	Above Normal	0.29	0.24	-0.05 (-18%)
February	Below Normal	0.68	0.69	0.01 (2%)
February	Dry	1.39	1.58	0.19 (14%)
February	Critical	2.21	2.25	0.04 (2%)
March	Wet	0.09	0.06	-0.03 (-31%)
March	Above Normal	0.10	0.08	-0.03 (-26%)
March	Below Normal	0.51	0.38	-0.13 (-25%)
March	Dry	0.72	0.61	-0.11 (-15%)
March	Critical	0.97	1.19	0.23 (23%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_20191030.dat

Table D.3-5 b. Percentage of Neutrally Buoyant Particles Injected at Station 716 (Cache Slough at Liberty Island) That Were Entrained Over 45 Days into Central Valley Project (Jones Pumping Plant).

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	0.27	0.21	-0.06 (-24%)
January	Above Normal	0.75	0.84	0.09 (12%)
January	Below Normal	1.53	1.56	0.03 (2%)
January	Dry	2.92	3.23	0.31 (10%)
January	Critical	3.56	3.79	0.23 (7%)
February	Wet	0.06	0.05	-0.01 (-16%)
February	Above Normal	0.26	0.22	-0.04 (-15%)
February	Below Normal	0.56	0.57	0.01 (2%)
February	Dry	1.29	1.37	0.08 (6%)
February	Critical	2.38	2.54	0.16 (7%)
March	Wet	0.05	0.04	-0.01 (-25%)
March	Above Normal	0.06	0.06	-0.01 (-10%)
March	Below Normal	0.42	0.27	-0.15 (-36%)
March	Dry	0.75	0.49	-0.26 (-35%)
March	Critical	0.93	1.12	0.19 (20%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_20191030.dat

Table D.3-5 c. Percentage of Neutrally Buoyant Particles Injected at Station 716 (Cache Slough at Liberty Island) That Were Entrained Over 45 Days into Barker Slough Pumping Plant

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	1.54	1.53	-0.01 (-1%)
January	Above Normal	1.61	1.54	-0.07 (-5%)
January	Below Normal	1.91	1.78	-0.13 (-7%)
January	Dry	2.09	2.15	0.07 (3%)
January	Critical	1.74	1.69	-0.05 (-3%)
February	Wet	1.54	1.55	0.01 (1%)
February	Above Normal	1.58	1.50	-0.08 (-5%)
February	Below Normal	1.78	1.67	-0.11 (-6%)
February	Dry	1.44	1.44	0.00 (0%)
February	Critical	1.30	1.33	0.03 (3%)
March	Wet	1.47	1.46	-0.01 (-1%)
March	Above Normal	1.68	1.61	-0.07 (-4%)
March	Below Normal	2.08	2.07	-0.01 (0%)
March	Dry	1.52	1.45	-0.06 (-4%)
March	Critical	0.79	0.84	0.04 (6%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_20191030.dat

Table D.3-5 d. Percentage of Neutrally Buoyant Particles Injected at Station 716 (Cache Slough at Liberty Island) That Passed Chipps Island.

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	92.34	92.55	0.21 (0%)
January	Above Normal	86.53	87.23	0.70 (1%)
January	Below Normal	80.40	81.17	0.77 (1%)
January	Dry	68.70	66.79	-1.91 (-3%)
January	Critical	62.09	60.02	-2.08 (-3%)
February	Wet	93.90	93.89	-0.01 (0%)
February	Above Normal	91.41	91.86	0.46 (0%)
February	Below Normal	86.16	86.56	0.40 (0%)
February	Dry	79.71	79.43	-0.28 (0%)
February	Critical	67.77	67.99	0.22 (0%)
March	Wet	96.16	96.24	0.08 (0%)
March	Above Normal	95.87	95.88	0.00 (0%)
March	Below Normal	91.56	92.10	0.54 (1%)
March	Dry	86.49	87.15	0.66 (1%)
March	Critical	75.64	73.82	-1.82 (-2%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_20191030.dat

Table D.3-6. Percentage of Surface-Oriented Particles Injected at Station 716 (Cache Slough at Liberty Island) That Were Entrained Over 45 Days into Clifton Court Forebay, Central Valley Project (Jones Pumping Plant), and Barker Slough Pumping Plant; or That Passed Chipps Island - Table D.3-6 c - D.3-6 d

Table D.3-6 d. Percentage of Surface-Oriented Particles Injected at Station 716 (Cache Slough at Liberty Island) That Were Entrained Over 45 Days into Clifton Court Forebay

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	1.02	1.01	-0.01 (-1%)
January	Above Normal	0.98	1.03	0.05 (5%)
January	Below Normal	0.99	1.08	0.08 (8%)
January	Dry	0.37	0.38	0.01 (3%)
January	Critical	0.31	0.35	0.04 (12%)
February	Wet	0.76	0.56	-0.20 (-26%)
February	Above Normal	1.33	1.15	-0.17 (-13%)
February	Below Normal	1.20	1.10	-0.10 (-8%)
February	Dry	0.50	0.40	-0.10 (-20%)
February	Critical	0.24	0.21	-0.03 (-12%)
March	Wet	0.38	0.43	0.05 (12%)
March	Above Normal	0.48	0.48	0.00 (0%)
March	Below Normal	0.22	0.24	0.02 (7%)
March	Dry	0.24	0.23	-0.01 (-5%)
March	Critical	0.09	0.07	-0.01 (-15%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_BHV_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_BHV_20191030.dat

Table D.3-6 b. Percentage of Surface-Oriented Particles Injected at Station 716 (Cache Slough at Liberty Island) That Were Entrained Over 45 Days into Central Valley Project (Jones Pumping Plant).

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	0.87	0.78	-0.09 (-10%)
January	Above Normal	0.90	1.00	0.10 (11%)
January	Below Normal	0.85	1.10	0.24 (28%)
January	Dry	0.49	0.48	-0.01 (-3%)
January	Critical	0.45	0.44	-0.02 (-4%)
February	Wet	0.42	0.39	-0.03 (-7%)
February	Above Normal	1.10	1.15	0.04 (4%)
February	Below Normal	1.16	0.86	-0.30 (-26%)
February	Dry	0.79	0.73	-0.06 (-8%)
February	Critical	0.37	0.36	-0.01 (-4%)
March	Wet	0.21	0.27	0.06 (28%)
March	Above Normal	0.35	0.30	-0.05 (-13%)
March	Below Normal	0.22	0.19	-0.03 (-14%)
March	Dry	0.23	0.20	-0.03 (-12%)
March	Critical	0.09	0.16	0.08 (88%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_BHV_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_BHV_20191030.dat

Table D.3-6 c. Percentage of Surface-Oriented Particles Injected at Station 716 (Cache Slough at Liberty Island) That Were Entrained Over 45 Days into Barker Slough Pumping Plant

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	1.96	1.92	-0.04 (-2%)
January	Above Normal	2.77	2.59	-0.18 (-6%)
January	Below Normal	3.54	3.33	-0.21 (-6%)
January	Dry	2.90	2.90	0.00 (0%)
January	Critical	1.72	1.79	0.08 (4%)
February	Wet	1.77	1.72	-0.06 (-3%)
February	Above Normal	2.50	2.51	0.02 (1%)
February	Below Normal	3.01	2.92	-0.10 (-3%)
February	Dry	0.79	0.84	0.05 (6%)
February	Critical	0.35	0.54	0.19 (55%)
March	Wet	2.54	2.41	-0.13 (-5%)
March	Above Normal	3.28	3.08	-0.20 (-6%)
March	Below Normal	4.94	5.00	0.06 (1%)
March	Dry	1.25	1.26	0.01 (1%)
March	Critical	0.28	0.22	-0.06 (-20%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_BHV_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_BHV_20191030.dat

Table D.3-6 d. Percentage of Surface-Oriented Particles Injected at Station 716 (Cache Slough at Liberty Island) That Passed Chipps Island.

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	73.50	74.51	1.02 (1%)
January	Above Normal	49.84	50.25	0.41 (1%)
January	Below Normal	11.72	13.57	1.86 (16%)
January	Dry	5.31	5.36	0.05 (1%)
January	Critical	0.10	0.14	0.04 (40%)
February	Wet	75.05	75.92	0.87 (1%)
February	Above Normal	57.91	59.16	1.25 (2%)
February	Below Normal	25.76	29.46	3.70 (14%)
February	Dry	8.62	8.95	0.33 (4%)
February	Critical	0.94	0.82	-0.11 (-12%)
March	Wet	61.93	62.46	0.53 (1%)
March	Above Normal	45.26	46.46	1.20 (3%)
March	Below Normal	4.23	4.21	-0.02 (-1%)
March	Dry	4.45	5.02	0.57 (13%)
March	Critical	0.80	0.64	-0.17 (-21%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_BHV_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_BHV_20191030.dat

Table D.3-7. Percentage of Neutrally Buoyant Particles Injected at Station 711 (Sacramento River near Cache Slough confluence) That Were Entrained Over 45 Days into Clifton Court Forebay, Central Valley Project (Jones Pumping Plant), and Barker Slough Pumping Plant; or That Passed Chipps Island - Table D.3-7 e - D.3-7 d

Table D.3-7 f. Percentage of Neutrally Buoyant Particles Injected at Station 711 (Sacramento River near Cache Slough confluence) That Were Entrained Over 45 Days into Clifton Court Forebay

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	0.42	0.39	-0.03 (-7%)
January	Above Normal	0.93	1.01	0.08 (8%)
January	Below Normal	2.39	2.46	0.07 (3%)
January	Dry	3.61	4.44	0.83 (23%)
January	Critical	4.02	4.46	0.44 (11%)
February	Wet	0.06	0.06	0.00 (8%)
February	Above Normal	0.35	0.28	-0.07 (-19%)
February	Below Normal	0.90	0.95	0.05 (6%)
February	Dry	1.81	1.94	0.13 (7%)
February	Critical	2.89	2.92	0.03 (1%)
March	Wet	0.10	0.06	-0.04 (-41%)
March	Above Normal	0.12	0.09	-0.03 (-27%)
March	Below Normal	0.67	0.40	-0.27 (-41%)
March	Dry	0.99	0.83	-0.16 (-16%)
March	Critical	1.20	1.78	0.57 (48%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_20191030.dat

Table D.3-7 b. Percentage of Neutrally Buoyant Particles Injected at Station 711 (Sacramento River near Cache Slough confluence) That Were Entrained Over 45 Days into Central Valley Project (Jones Pumping Plant).

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	0.35	0.27	-0.08 (-23%)
January	Above Normal	0.89	0.93	0.04 (5%)
January	Below Normal	1.97	2.12	0.16 (8%)
January	Dry	3.51	3.71	0.19 (5%)
January	Critical	4.28	4.51	0.23 (5%)
February	Wet	0.06	0.04	-0.02 (-36%)
February	Above Normal	0.28	0.22	-0.06 (-22%)
February	Below Normal	0.81	0.79	-0.01 (-2%)
February	Dry	1.66	1.83	0.17 (10%)
February	Critical	3.16	3.24	0.08 (2%)
March	Wet	0.06	0.04	-0.03 (-43%)
March	Above Normal	0.09	0.06	-0.03 (-34%)
March	Below Normal	0.51	0.27	-0.24 (-47%)
March	Dry	0.96	0.67	-0.29 (-31%)
March	Critical	1.45	1.55	0.10 (7%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_20191030.dat

Table D.3-7 c. Percentage of Neutrally Buoyant Particles Injected at Station 711 (Sacramento River near Cache Slough confluence) That Were Entrained Over 45 Days into Barker Slough Pumping Plant

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	0.11	0.10	-0.02 (-14%)
January	Above Normal	0.26	0.24	-0.02 (-7%)
January	Below Normal	0.35	0.34	-0.01 (-2%)
January	Dry	0.40	0.45	0.05 (12%)
January	Critical	0.39	0.40	0.01 (2%)
February	Wet	0.05	0.05	0.00 (-2%)
February	Above Normal	0.12	0.12	0.00 (-2%)
February	Below Normal	0.27	0.25	-0.02 (-8%)
February	Dry	0.29	0.29	0.00 (1%)
February	Critical	0.24	0.29	0.05 (23%)
March	Wet	0.08	0.09	0.01 (11%)
March	Above Normal	0.11	0.11	0.00 (-2%)
March	Below Normal	0.36	0.36	0.00 (0%)
March	Dry	0.28	0.28	0.00 (0%)
March	Critical	0.17	0.18	0.02 (10%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_20191030.dat

Table D.3-7 d. Percentage of Neutrally Buoyant Particles Injected at Station 711 (Sacramento River near Cache Slough confluence) That Passed Chipps Island.

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	93.51	93.83	0.32 (0%)
January	Above Normal	88.03	88.57	0.54 (1%)
January	Below Normal	81.30	81.42	0.11 (0%)
January	Dry	70.49	68.92	-1.56 (-2%)
January	Critical	64.71	62.78	-1.93 (-3%)
February	Wet	95.62	95.68	0.06 (0%)
February	Above Normal	93.12	93.61	0.49 (1%)
February	Below Normal	88.05	88.19	0.14 (0%)
February	Dry	81.42	81.21	-0.21 (0%)
February	Critical	70.65	70.81	0.16 (0%)
March	Wet	98.38	98.39	0.02 (0%)
March	Above Normal	98.14	98.28	0.14 (0%)
March	Below Normal	95.73	96.58	0.85 (1%)
March	Dry	92.33	92.97	0.64 (1%)
March	Critical	84.48	82.83	-1.65 (-2%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_20191030.dat

Table D.3-8. Percentage of Surface-Oriented Particles Injected at Station 711 (Sacramento River near Cache Slough confluence) That Were Entrained Over 45 Days into Clifton Court Forebay, Central Valley Project (Jones Pumping Plant), and Barker Slough Pumping Plant; or That Passed Chipps Island – Table D.3-8 a - d

Table D.3-8 g. Percentage of Surface-Oriented Particles Injected at Station 711 (Sacramento River near Cache Slough confluence) That Were Entrained Over 45 Days into Clifton Court Forebay

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	4.44	4.46	0.02 (0%)
January	Above Normal	9.64	8.96	-0.69 (-7%)
January	Below Normal	14.73	15.18	0.45 (3%)
January	Dry	12.66	12.43	-0.24 (-2%)
January	Critical	10.36	9.99	-0.37 (-4%)
February	Wet	2.88	2.59	-0.29 (-10%)
February	Above Normal	6.62	6.15	-0.47 (-7%)
February	Below Normal	10.29	9.52	-0.77 (-7%)
February	Dry	12.98	12.61	-0.37 (-3%)
February	Critical	11.22	11.64	0.41 (4%)
March	Wet	3.04	3.42	0.38 (13%)
March	Above Normal	3.90	3.84	-0.06 (-2%)
March	Below Normal	9.38	10.26	0.88 (9%)
March	Dry	8.92	9.71	0.80 (9%)
March	Critical	5.55	7.37	1.81 (33%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_BHV_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_BHV_20191030.dat

Table D.3-8 b. Percentage of Surface-Oriented Particles Injected at Station 711 (Sacramento River near Cache Slough confluence) That Were Entrained Over 45 Days into Central Valley Project (Jones Pumping Plant).

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	3.76	3.71	-0.05 (-1%)
January	Above Normal	9.21	8.97	-0.24 (-3%)
January	Below Normal	13.56	13.18	-0.38 (-3%)
January	Dry	14.75	14.29	-0.46 (-3%)
January	Critical	14.62	12.24	-2.39 (-16%)
February	Wet	2.09	1.79	-0.30 (-14%)
February	Above Normal	6.14	5.59	-0.54 (-9%)
February	Below Normal	8.65	8.32	-0.33 (-4%)
February	Dry	13.83	13.59	-0.25 (-2%)
February	Critical	14.04	15.00	0.96 (7%)
March	Wet	2.03	2.00	-0.04 (-2%)
March	Above Normal	3.12	2.70	-0.42 (-13%)
March	Below Normal	8.03	6.97	-1.06 (-13%)
March	Dry	10.85	9.40	-1.45 (-13%)
March	Critical	7.06	7.18	0.12 (2%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_BHV_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_BHV_20191030.dat

Table D.3-8 c. Percentage of Surface-Oriented Particles Injected at Station 711 (Sacramento River near Cache Slough confluence) That Were Entrained Over 45 Days into Barker Slough Pumping Plant

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	0.36	0.33	-0.03 (-8%)
January	Above Normal	0.94	0.77	-0.17 (-19%)
January	Below Normal	1.20	0.99	-0.21 (-18%)
January	Dry	1.38	1.40	0.02 (2%)
January	Critical	1.06	1.05	-0.01 (-1%)
February	Wet	0.08	0.09	0.00 (6%)
February	Above Normal	0.35	0.25	-0.10 (-29%)
February	Below Normal	0.72	0.63	-0.10 (-14%)
February	Dry	0.26	0.26	0.00 (1%)
February	Critical	0.12	0.20	0.07 (62%)
March	Wet	0.28	0.24	-0.04 (-15%)
March	Above Normal	0.34	0.38	0.04 (11%)
March	Below Normal	1.58	1.44	-0.14 (-9%)
March	Dry	0.48	0.39	-0.08 (-18%)
March	Critical	0.11	0.09	-0.02 (-16%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_BHV_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_BHV_20191030.dat

Table D.3-8 d. Percentage of Surface-Oriented Particles Injected at Station 711 (Sacramento River near Cache Slough confluence) That Passed Chipps Island

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	77.16	78.06	0.90 (1%)
January	Above Normal	51.37	52.42	1.05 (2%)
January	Below Normal	17.27	19.44	2.17 (13%)
January	Dry	6.41	6.26	-0.15 (-2%)
January	Critical	0.43	0.60	0.18 (41%)
February	Wet	83.65	84.15	0.51 (1%)
February	Above Normal	64.73	65.66	0.94 (1%)
February	Below Normal	40.83	43.19	2.36 (6%)
February	Dry	14.97	15.18	0.20 (1%)
February	Critical	2.63	2.68	0.05 (2%)
March	Wet	78.34	79.33	1.00 (1%)
March	Above Normal	69.90	72.93	3.03 (4%)
March	Below Normal	23.04	25.63	2.59 (11%)
March	Dry	11.47	12.57	1.10 (10%)
March	Critical	3.72	3.54	-0.18 (-5%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_BHV_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_BHV_20191030.dat

Table D.3-9. Percentage of Neutrally Buoyant Particles Injected at Station 704 (Sacramento River at Sherman Lake) That Were Entrained Over 45 Days into Clifton Court Forebay, Central Valley Project (Jones Pumping Plant), and Barker Slough Pumping Plant; or That Passed Chipps Island – Table D.3-9 a - D.3-9 d

Table D.3-9 h. Percentage of Neutrally Buoyant Particles Injected at Station 704 (Sacramento River at Sherman Lake) That Were Entrained Over 45 Days into Clifton Court Forebay

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	0.01	0.01	0.00 (8%)
January	Above Normal	0.04	0.05	0.01 (41%)
January	Below Normal	0.12	0.15	0.02 (17%)
January	Dry	0.16	0.22	0.06 (38%)
January	Critical	0.21	0.22	0.01 (4%)
February	Wet	0.00	0.00	0.00 (0%)
February	Above Normal	0.00	0.01	0.00 (50%)
February	Below Normal	0.02	0.02	0.00 (-10%)
February	Dry	0.04	0.06	0.02 (43%)
February	Critical	0.10	0.10	0.00 (-4%)
March	Wet	0.00	0.00	0.00 (-100%)
March	Above Normal	0.00	0.00	0.00 (-100%)
March	Below Normal	0.01	0.01	0.00 (-40%)
March	Dry	0.02	0.02	0.00 (-20%)
March	Critical	0.03	0.05	0.02 (63%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_20191030.dat

Table D.3-9 b. Percentage of Neutrally Buoyant Particles Injected at Station 704 (Sacramento River at Sherman Lake) That Were Entrained Over 45 Days into Central Valley Project (Jones Pumping Plant).

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	0.02	0.01	-0.01 (-35%)
January	Above Normal	0.03	0.05	0.03 (108%)
January	Below Normal	0.10	0.12	0.02 (24%)
January	Dry	0.17	0.24	0.07 (39%)
January	Critical	0.24	0.32	0.08 (32%)
February	Wet	0.00	0.00	0.00 (0%)
February	Above Normal	0.00	0.00	0.00 (0%)
February	Below Normal	0.01	0.02	0.01 (71%)
February	Dry	0.04	0.06	0.02 (56%)
February	Critical	0.15	0.12	-0.03 (-22%)
March	Wet	0.00	0.00	0.00 (0%)
March	Above Normal	0.00	0.00	0.00 (0%)
March	Below Normal	0.01	0.00	-0.01 (-80%)
March	Dry	0.02	0.01	-0.01 (-64%)
March	Critical	0.03	0.04	0.01 (19%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_20191030.dat

Table D.3-9 c. Percentage of Neutrally Buoyant Particles Injected at Station 704 (Sacramento River at Sherman Lake) That Were Entrained Over 45 Days into Barker Slough Pumping Plant

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	0.00	0.00	0.00 (0%)
anuary	Above Normal	0.00	0.00	0.00 (0%)
January	Below Normal	0.00	0.00	0.00 (0%)
January	Dry	0.00	0.00	0.00 (0%)
January	Critical	0.00	0.00	0.00 (0%)
February	Wet	0.00	0.00	0.00 (0%)
February	Above Normal	0.00	0.00	0.00 (0%)
February	Below Normal	0.00	0.00	0.00 (0%)
February	Dry	0.00	0.00	0.00 (0%)
February	Critical	0.00	0.00	0.00 (0%)
March	Wet	0.00	0.00	0.00 (0%)
March	Above Normal	0.00	0.00	0.00 (0%)
March	Below Normal	0.00	0.00	0.00 (0%)
March	Dry	0.00	0.00	0.00 (0%)
March	Critical	0.00	0.00	0.00 (0%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_20191030.dat

Table D.3-9 d. Percentage of Neutrally Buoyant Particles Injected at Station 704 (Sacramento River at Sherman Lake) That Passed Chipps Island.

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	94.87	95.04	0.17 (0%)
January	Above Normal	91.45	91.68	0.23 (0%)
January	Below Normal	86.50	86.74	0.24 (0%)
January	Dry	81.15	80.47	-0.68 (-1%)
January	Critical	78.49	76.51	-1.98 (-3%)
February	Wet	96.63	96.65	0.02 (0%)
February	Above Normal	94.68	95.07	0.39 (0%)
February	Below Normal	91.55	91.73	0.18 (0%)
February	Dry	87.77	87.71	-0.06 (0%)
February	Critical	81.69	81.90	0.21 (0%)
March	Wet	98.61	98.61	0.00 (0%)
March	Above Normal	98.65	98.60	-0.04 (0%)
March	Below Normal	99.17	99.17	0.01 (0%)
March	Dry	99.07	98.95	-0.13 (0%)
March	Critical	98.09	97.88	-0.21 (0%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_20191030.dat

Table D.3-10. Percentage of Surface-Oriented Particles Injected at Station 704 (Sacramento River at Sherman Lake) That Were Entrained Over 45 Days into Clifton Court Forebay, Central Valley Project (Jones Pumping Plant), and Barker Slough Pumping Plant; or That Passed Chipps Island – Table D.3-10 a - D.3-10 d

Table D.3-10 i. Percentage of Surface-Oriented Particles Injected at Station 704 (Sacramento River at Sherman Lake) That Were Entrained Over 45 Days into Clifton Court Forebay

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	3.16	2.70	-0.47 (-15%)
January	Above Normal	8.10	7.54	-0.56 (-7%)
January	Below Normal	15.90	16.41	0.51 (3%)
January	Dry	21.30	22.92	1.62 (8%)
January	Critical	21.36	21.80	0.44 (2%)
February	Wet	0.89	0.81	-0.08 (-9%)
February	Above Normal	3.93	3.10	-0.83 (-21%)
February	Below Normal	9.23	7.53	-1.70 (-18%)
February	Dry	14.24	13.41	-0.83 (-6%)
February	Critical	15.00	15.22	0.22 (1%)
March	Wet	0.77	1.20	0.43 (56%)
March	Above Normal	0.80	0.89	0.09 (11%)
March	Below Normal	4.93	7.86	2.92 (59%)
March	Dry	7.64	10.07	2.43 (32%)
March	Critical	9.31	12.14	2.82 (30%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_BHV_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_BHV_20191030.dat

Table D.3-10 b. Percentage of Surface-Oriented Particles Injected at Station 704 (Sacramento River at Sherman Lake) That Were Entrained Over 45 Days into Central Valley Project (Jones Pumping Plant).

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	2.55	2.19	-0.37 (-14%)
January	Above Normal	7.48	7.57	0.09 (1%)
January	Below Normal	14.41	14.17	-0.24 (-2%)
January	Dry	24.50	25.08	0.58 (2%)
January	Critical	28.37	27.17	-1.20 (-4%)
February	Wet	0.84	0.54	-0.30 (-35%)
February	Above Normal	3.59	2.84	-0.75 (-21%)
February	Below Normal	6.82	6.60	-0.22 (-3%)
February	Dry	14.80	13.71	-1.09 (-7%)
February	Critical	19.48	20.42	0.94 (5%)
March	Wet	0.66	0.75	0.09 (13%)
March	Above Normal	0.87	0.78	-0.09 (-11%)
March	Below Normal	5.06	4.97	-0.10 (-2%)
March	Dry	10.03	7.95	-2.08 (-21%)
March	Critical	11.88	12.32	0.44 (4%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_BHV_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_BHV_20191030.dat

Table D.3-10 c. Percentage of Surface-Oriented Particles Injected at Station 704 (Sacramento River at Sherman Lake) That Were Entrained Over 45 Days into Barker Slough Pumping Plant

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	0.00	0.00	0.00 (-100%)
January	Above Normal	0.00	0.00	0.00 (0%)
January	Below Normal	0.00	0.00	0.00 (-100%)
January	Dry	0.00	0.01	0.01 (600%)
January	Critical	0.01	0.00	-0.01 (-100%)
February	Wet	0.00	0.00	0.00 (0%)
February	Above Normal	0.00	0.00	0.00 (0%)
February	Below Normal	0.00	0.00	0.00 (0%)
February	Dry	0.00	0.00	0.00 (0%)
February	Critical	0.00	0.00	0.00 (0%)
March	Wet	0.00	0.00	0.00 (0%)
March	Above Normal	0.00	0.00	0.00 (0%)
March	Below Normal	0.01	0.00	0.00 (-67%)
March	Dry	0.00	0.00	0.00 (0%)
March	Critical	0.00	0.00	0.00 (0%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_BHV_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_BHV_20191030.dat

Table D.3-10 d. Percentage of Surface-Oriented Particles Injected at Station 704 (Sacramento River at Sherman Lake) That Passed Chipps Island.

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	82.10	82.92	0.82 (1%)
January	Above Normal	56.95	59.00	2.06 (4%)
January	Below Normal	22.70	24.98	2.29 (10%)
January	Dry	6.46	6.41	-0.05 (-1%)
January	Critical	0.83	1.19	0.35 (43%)
February	Wet	88.98	89.12	0.15 (0%)
February	Above Normal	73.33	74.77	1.45 (2%)
February	Below Normal	49.97	51.99	2.02 (4%)
February	Dry	20.67	20.91	0.23 (1%)
February	Critical	3.80	4.10	0.29 (8%)
March	Wet	86.52	87.19	0.67 (1%)
March	Above Normal	84.57	86.75	2.18 (3%)
March	Below Normal	37.35	41.07	3.72 (10%)
March	Dry	17.83	20.73	2.90 (16%)
March	Critical	6.53	6.36	-0.17 (-3%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_BHV_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_BHV_20191030.dat

Table D.3-11. Percentage of Neutrally Buoyant Particles Injected at Station 809 (San Joaquin River near Jersey Point) That Were Entrained Over 45 Days into Clifton Court Forebay, Central Valley Project (Jones Pumping Plant), and Barker Slough Pumping Plant; or That Passed Chipps Island - Table D.3-11 j - D.3-11 d

Table D.3-11 k. Percentage of Neutrally Buoyant Particles Injected at Station 809 (San Joaquin River near Jersey Point) That Were Entrained Over 45 Days into Clifton Court Forebay

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	0.96	0.89	-0.06 (-7%)
January	Above Normal	1.99	2.15	0.16 (8%)
January	Below Normal	4.35	4.57	0.22 (5%)
January	Dry	6.86	7.98	1.12 (16%)
January	Critical	6.85	7.22	0.37 (5%)
February	Wet	0.22	0.22	0.01 (3%)
February	Above Normal	0.97	0.86	-0.11 (-12%)
February	Below Normal	2.01	2.06	0.06 (3%)
February	Dry	4.00	4.22	0.22 (5%)
February	Critical	5.68	5.84	0.16 (3%)
March	Wet	0.26	0.17	-0.09 (-34%)
March	Above Normal	0.37	0.24	-0.12 (-34%)
March	Below Normal	1.53	1.01	-0.52 (-34%)
March	Dry	2.11	1.61	-0.50 (-24%)
March	Critical	2.43	3.19	0.76 (31%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_20191030.dat

Table D.3-11 b. Percentage of Neutrally Buoyant Particles Injected at Station 809 (San Joaquin River near Jersey Point) That Were Entrained Over 45 Days into Central Valley Project (Jones Pumping Plant).

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	0.77	0.70	-0.08 (-10%)
January	Above Normal	1.81	2.17	0.35 (20%)
January	Below Normal	3.85	4.08	0.23 (6%)
January	Dry	6.51	6.95	0.44 (7%)
January	Critical	7.34	7.34	0.00 (0%)
February	Wet	0.15	0.14	-0.02 (-11%)
February	Above Normal	0.81	0.78	-0.03 (-4%)
February	Below Normal	1.71	1.87	0.15 (9%)
February	Dry	3.51	3.85	0.34 (10%)
February	Critical	5.87	6.25	0.38 (6%)
March	Wet	0.17	0.10	-0.07 (-39%)
March	Above Normal	0.26	0.13	-0.13 (-50%)
March	Below Normal	1.16	0.72	-0.43 (-37%)
March	Dry	2.04	1.38	-0.67 (-33%)
March	Critical	2.56	2.92	0.36 (14%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_20191030.dat

Table D.3-11 c. Percentage of Neutrally Buoyant Particles Injected at Station 809 (San Joaquin River near Jersey Point) That Were Entrained Over 45 Days into Barker Slough Pumping Plant

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	0.00	0.00	0.00 (0%)
January	Above Normal	0.00	0.00	0.00 (0%)
January	Below Normal	0.00	0.00	0.00 (0%)
January	Dry	0.00	0.00	0.00 (0%)
January	Critical	0.00	0.00	0.00 (0%)
February	Wet	0.00	0.00	0.00 (0%)
February	Above Normal	0.00	0.00	0.00 (0%)
February	Below Normal	0.00	0.00	0.00 (0%)
February	Dry	0.00	0.00	0.00 (0%)
February	Critical	0.00	0.00	0.00 (0%)
March	Wet	0.00	0.00	0.00 (0%)
March	Above Normal	0.00	0.00	0.00 (0%)
March	Below Normal	0.00	0.00	0.00 (0%)
March	Dry	0.00	0.00	0.00 (0%)
March	Critical	0.00	0.00	0.00 (0%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_20191030.dat

Table D.3-11 d. Percentage of Neutrally Buoyant Particles Injected at Station 809 (San Joaquin River near Jersey Point) That Passed Chipps Island.

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	93.10	93.42	0.32 (0%)
January	Above Normal	86.18	86.39	0.21 (0%)
January	Below Normal	77.81	78.24	0.43 (1%)
January	Dry	64.65	62.47	-2.18 (-3%)
January	Critical	59.64	57.83	-1.81 (-3%)
February	Wet	95.87	96.01	0.14 (0%)
February	Above Normal	91.84	92.50	0.67 (1%)
February	Below Normal	86.08	86.16	0.08 (0%)
February	Dry	77.42	76.98	-0.44 (-1%)
February	Critical	64.72	64.28	-0.44 (-1%)
March	Wet	98.38	98.58	0.20 (0%)
March	Above Normal	97.95	98.28	0.33 (0%)
March	Below Normal	94.37	95.99	1.62 (2%)
March	Dry	89.18	91.17	1.98 (2%)
March	Critical	81.11	78.27	-2.84 (-4%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_20191030.dat

Table D.3-12. Percentage of Surface-Oriented Particles Injected at Station 809 (San Joaquin River near Jersey Point) That Were Entrained Over 45 Days into Clifton Court Forebay, Central Valley Project (Jones Pumping Plant), and Barker Slough Pumping Plant; or That Passed Chipps Island - Table D.3-12 l - D.3-12 h

Table D.3-12 m. Percentage of Surface-Oriented Particles Injected at Station 809 (San Joaquin River near Jersey Point) That Were Entrained Over 45 Days into Clifton Court Forebay

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	13.49	13.39	-0.10 (-1%)
January	Above Normal	23.36	23.49	0.13 (1%)
January	Below Normal	37.59	38.78	1.18 (3%)
January	Dry	37.53	39.73	2.21 (6%)
January	Critical	34.41	36.73	2.32 (7%)
February	Wet	8.50	7.62	-0.88 (-10%)
February	Above Normal	18.99	17.61	-1.38 (-7%)
February	Below Normal	28.53	26.42	-2.12 (-7%)
February	Dry	34.66	34.40	-0.27 (-1%)
February	Critical	33.24	33.50	0.26 (1%)
March	Wet	9.05	9.78	0.73 (8%)
March	Above Normal	12.68	12.21	-0.47 (-4%)
March	Below Normal	26.79	30.06	3.27 (12%)
March	Dry	29.40	30.84	1.44 (5%)
March	Critical	22.12	26.04	3.92 (18%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_BHV_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_BHV_20191030.dat

Table D.3-12 b. Percentage of Surface-Oriented Particles Injected at Station 809 (San Joaquin River near Jersey Point) That Were Entrained Over 45 Days into Central Valley Project (Jones Pumping Plant).

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	11.54	10.74	-0.80 (-7%)
January	Above Normal	23.63	23.60	-0.03 (0%)
January	Below Normal	36.47	35.45	-1.01 (-3%)
January	Dry	43.67	42.91	-0.76 (-2%)
January	Critical	47.84	44.31	-3.53 (-7%)
February	Wet	6.05	5.14	-0.91 (-15%)
February	Above Normal	16.51	15.15	-1.36 (-8%)
February	Below Normal	25.05	23.41	-1.64 (-7%)
February	Dry	38.72	38.03	-0.69 (-2%)
February	Critical	42.67	43.76	1.09 (3%)
March	Wet	5.79	5.75	-0.04 (-1%)
March	Above Normal	10.08	7.82	-2.26 (-22%)
March	Below Normal	22.04	19.37	-2.67 (-12%)
March	Dry	33.57	29.03	-4.54 (-14%)
March	Critical	31.73	32.54	0.81 (3%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_BHV_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_BHV_20191030.dat

Table D.3-12 c. Percentage of Surface-Oriented Particles Injected at Station 809 (San Joaquin River near Jersey Point) That Were Entrained Over 45 Days into Barker Slough Pumping Plant

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	0.00	0.00	0.00 (-100%)
January	Above Normal	0.00	0.00	0.00 (0%)
January	Below Normal	0.00	0.01	0.00 (50%)
January	Dry	0.01	0.01	0.00 (0%)
January	Critical	0.00	0.00	0.00 (-100%)
February	Wet	0.00	0.00	0.00 (0%)
February	Above Normal	0.00	0.00	0.00 (0%)
February	Below Normal	0.00	0.00	0.00 (0%)
February	Dry	0.00	0.00	0.00 (-100%)
February	Critical	0.00	0.00	0.00 (0%)
March	Wet	0.00	0.00	0.00 (0%)
March	Above Normal	0.00	0.00	0.00 (0%)
March	Below Normal	0.01	0.01	-0.01 (-38%)
March	Dry	0.00	0.00	0.00 (50%)
March	Critical	0.00	0.00	0.00 (0%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_BHV_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_BHV_20191030.dat

Table D.3-12 d. Percentage of Surface-Oriented Particles Injected at Station 809 (San Joaquin River near Jersey Point) That Passed Chipps Island.

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	63.60	64.38	0.78 (1%)
January	Above Normal	35.21	35.65	0.44 (1%)
January	Below Normal	5.17	5.42	0.24 (5%)
January	Dry	1.15	1.12	-0.03 (-3%)
January	Critical	0.08	0.10	0.02 (24%)
February	Wet	74.93	76.17	1.23 (2%)
February	Above Normal	46.38	46.88	0.50 (1%)
February	Below Normal	23.16	25.54	2.38 (10%)
February	Dry	4.13	3.57	-0.56 (-13%)
February	Critical	0.44	0.50	0.06 (15%)
March	Wet	64.99	66.54	1.54 (2%)
March	Above Normal	48.39	54.24	5.85 (12%)
March	Below Normal	9.62	11.94	2.32 (24%)
March	Dry	2.08	3.03	0.95 (46%)
March	Critical	0.70	0.59	-0.11 (-16%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_BHV_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_BHV_20191030.dat

Table D.3-13. Percentage of Neutrally Buoyant Particles Injected at Station 812 (San Joaquin River at Twitchell Island) That Were Entrained Over 45 Days into Clifton Court Forebay, Central Valley Project (Jones Pumping Plant), and Barker Slough Pumping Plant; or That Passed Chipps Island - Table D.3-13 n - D.3-13 d

Table D.3-13 o. Percentage of Neutrally Buoyant Particles Injected at Station 812 (San Joaquin River at Twitchell Island) That Were Entrained Over 45 Days into Clifton Court Forebay

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	5.86	5.79	-0.07 (-1%)
January	Above Normal	11.13	11.31	0.18 (2%)
January	Below Normal	19.01	19.51	0.50 (3%)
January	Dry	25.27	27.88	2.61 (10%)
January	Critical	24.64	26.25	1.61 (7%)
February	Wet	3.37	3.22	-0.15 (-4%)
February	Above Normal	7.90	7.52	-0.38 (-5%)
February	Below Normal	11.82	11.91	0.09 (1%)
February	Dry	19.67	20.61	0.94 (5%)
February	Critical	22.67	23.41	0.74 (3%)
March	Wet	3.24	2.13	-1.12 (-34%)
March	Above Normal	4.80	2.86	-1.94 (-40%)
March	Below Normal	11.17	7.88	-3.29 (-29%)
March	Dry	14.17	10.61	-3.55 (-25%)
March	Critical	12.30	15.02	2.72 (22%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_20191030.dat

Table D.3-13 b. Percentage of Neutrally Buoyant Particles Injected at Station 812 (San Joaquin River at Twitchell Island) That Were Entrained Over 45 Days into Central Valley Project (Jones Pumping Plant).

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	4.52	4.30	-0.21 (-5%)
January	Above Normal	9.55	9.68	0.12 (1%)
January	Below Normal	15.97	15.99	0.03 (0%)
January	Dry	23.43	24.19	0.76 (3%)
January	Critical	26.37	25.15	-1.22 (-5%)
February	Wet	2.19	1.89	-0.30 (-14%)
February	Above Normal	6.11	5.99	-0.11 (-2%)
February	Below Normal	9.38	9.43	0.05 (1%)
February	Dry	17.16	17.75	0.59 (3%)
February	Critical	23.38	23.66	0.28 (1%)
March	Wet	1.66	1.03	-0.63 (-38%)
March	Above Normal	3.15	1.74	-1.41 (-45%)
March	Below Normal	7.79	4.85	-2.93 (-38%)
March	Dry	12.89	8.82	-4.07 (-32%)
March	Critical	12.85	14.38	1.53 (12%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_20191030.dat

Table D.3-13 c. Percentage of Neutrally Buoyant Particles Injected at Station 812 (San Joaquin River at Twitchell Island) That Were Entrained Over 45 Days into Barker Slough Pumping Plant

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	0.00	0.00	0.00 (0%)
January	Above Normal	0.00	0.00	0.00 (0%)
January	Below Normal	0.00	0.00	0.00 (0%)
January	Dry	0.00	0.00	0.00 (0%)
January	Critical	0.00	0.00	0.00 (0%)
February	Wet	0.00	0.00	0.00 (0%)
February	Above Normal	0.00	0.00	0.00 (0%)
February	Below Normal	0.00	0.00	0.00 (0%)
February	Dry	0.00	0.00	0.00 (0%)
February	Critical	0.00	0.00	0.00 (0%)
March	Wet	0.00	0.00	0.00 (0%)
March	Above Normal	0.00	0.00	0.00 (0%)
March	Below Normal	0.00	0.00	0.00 (0%)
March	Dry	0.00	0.00	0.00 (0%)
March	Critical	0.00	0.00	0.00 (0%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_20191030.dat

Table D.3-13 d. Percentage of Neutrally Buoyant Particles Injected at Station 812 (San Joaquin River at Twitchell Island) That Passed Chipps Island.

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	84.70	84.90	0.20 (0%)
January	Above Normal	69.76	69.96	0.20 (0%)
January	Below Normal	51.08	51.50	0.42 (1%)
January	Dry	30.00	27.74	-2.26 (-8%)
January	Critical	22.89	23.22	0.33 (1%)
February	Wet	90.30	90.79	0.49 (1%)
February	Above Normal	79.31	80.01	0.71 (1%)
February	Below Normal	66.57	66.76	0.20 (0%)
February	Dry	44.38	43.28	-1.10 (-2%)
February	Critical	26.43	26.40	-0.02 (0%)
March	Wet	92.89	94.74	1.85 (2%)
March	Above Normal	88.53	92.27	3.74 (4%)
March	Below Normal	68.22	75.35	7.14 (10%)
March	Dry	48.74	56.86	8.13 (17%)
March	Critical	35.72	32.15	-3.56 (-10%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_20191030.dat

Table D.3-14. Percentage of Surface-Oriented Particles Injected at Station 812 (San Joaquin River at Twitchell Island) That Were Entrained Over 45 Days into Clifton Court Forebay, Central Valley Project (Jones Pumping Plant), and Barker Slough Pumping Plant; or That Passed Chipps Island - Table D.3-14 p - D.3-14 d

Table D.3-14 q. Percentage of Surface-Oriented Particles Injected at Station 812 (San Joaquin River at Twitchell Island) That Were Entrained Over 45 Days into Clifton Court Forebay

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	27.52	28.22	0.70 (3%)
January	Above Normal	35.75	35.86	0.11 (0%)
January	Below Normal	44.07	45.30	1.23 (3%)
January	Dry	41.57	43.84	2.27 (5%)
January	Critical	36.92	40.56	3.64 (10%)
February	Wet	24.75	22.78	-1.97 (-8%)
February	Above Normal	35.94	34.19	-1.75 (-5%)
February	Below Normal	41.13	40.69	-0.44 (-1%)
February	Dry	41.31	40.94	-0.37 (-1%)
February	Critical	37.44	37.65	0.21 (1%)
March	Wet	23.36	22.69	-0.67 (-3%)
March	Above Normal	31.33	30.93	-0.40 (-1%)
March	Below Normal	41.44	43.47	2.03 (5%)
March	Dry	37.84	39.04	1.21 (3%)
March	Critical	27.63	30.91	3.28 (12%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_BHV_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_BHV_20191030.dat

Table D.3-14 b. Percentage of Surface-Oriented Particles Injected at Station 812 (San Joaquin River at Twitchell Island) That Were Entrained Over 45 Days into Central Valley Project (Jones Pumping Plant).

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	22.36	20.65	-1.71 (-8%)
January	Above Normal	35.83	35.77	-0.06 (0%)
January	Below Normal	43.55	42.99	-0.56 (-1%)
January	Dry	48.32	46.85	-1.47 (-3%)
January	Critical	52.50	48.43	-4.07 (-8%)
February	Wet	14.57	13.31	-1.25 (-9%)
February	Above Normal	27.66	27.39	-0.26 (-1%)
February	Below Normal	33.57	32.28	-1.29 (-4%)
February	Dry	45.95	45.79	-0.16 (0%)
February	Critical	48.36	49.10	0.74 (2%)
March	Wet	11.31	11.33	0.03 (0%)
March	Above Normal	20.77	18.79	-1.98 (-10%)
March	Below Normal	30.30	27.36	-2.94 (-10%)
March	Dry	41.88	38.35	-3.53 (-8%)
March	Critical	39.06	40.33	1.26 (3%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_BHV_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_BHV_20191030.dat

Table D.3-14 c. Percentage of Surface-Oriented Particles Injected at Station 812 (San Joaquin River at Twitchell Island) That Were Entrained Over 45 Days into Barker Slough Pumping Plant

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	0.00	0.00	0.00 (0%)
January	Above Normal	0.00	0.00	0.00 (0%)
January	Below Normal	0.00	0.00	0.00 (0%)
January	Dry	0.00	0.00	0.00 (0%)
January	Critical	0.00	0.00	0.00 (0%)
February	Wet	0.00	0.00	0.00 (0%)
February	Above Normal	0.00	0.00	0.00 (0%)
February	Below Normal	0.00	0.00	0.00 (0%)
February	Dry	0.00	0.00	0.00 (0%)
February	Critical	0.00	0.00	0.00 (0%)
March	Wet	0.00	0.00	0.00 (0%)
March	Above Normal	0.00	0.00	0.00 (0%)
March	Below Normal	0.00	0.00	0.00 (0%)
March	Dry	0.00	0.00	0.00 (0%)
March	Critical	0.00	0.00	0.00 (0%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_BHV_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_BHV_20191030.dat

Table D.3-14 d. Percentage of Surface-Oriented Particles Injected at Station 812 (San Joaquin River at Twitchell Island) That Passed Chipps Island.

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	37.69	38.35	0.66 (2%)
January	Above Normal	14.72	14.45	-0.27 (-2%)
January	Below Normal	0.50	0.60	0.09 (19%)
January	Dry	0.04	0.06	0.02 (67%)
January	Critical	0.00	0.00	0.00 (-100%)
February	Wet	46.73	48.53	1.79 (4%)
February	Above Normal	20.70	21.47	0.76 (4%)
February	Below Normal	8.44	8.88	0.44 (5%)
February	Dry	0.21	0.20	-0.01 (-6%)
February	Critical	0.02	0.02	0.00 (-10%)
March	Wet	45.01	47.48	2.47 (5%)
March	Above Normal	20.38	23.49	3.12 (15%)
March	Below Normal	0.96	1.66	0.70 (72%)
March	Dry	0.15	0.26	0.10 (66%)
March	Critical	0.02	0.01	-0.01 (-50%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_BHV_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_BHV_20191030.dat

Table D.3-15. Percentage of Neutrally Buoyant Particles Injected at Station 815 (San Joaquin River at Potato Slough) That Were Entrained Over 45 Days into Clifton Court Forebay, Central Valley Project (Jones Pumping Plant), and Barker Slough Pumping Plant; or That Passed Chipps Island - Table D.3-15 r - D.3-15 d

Table D.3-15 s. Percentage of Neutrally Buoyant Particles Injected at Station 815 (San Joaquin River at Potato Slough) That Were Entrained Over 45 Days into Clifton Court Forebay

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	10.50	10.56	0.07 (1%)
January	Above Normal	16.79	16.76	-0.03 (0%)
January	Below Normal	24.77	25.68	0.91 (4%)
January	Dry	30.69	33.07	2.38 (8%)
January	Critical	29.09	30.61	1.53 (5%)
February	Wet	7.76	7.41	-0.36 (-5%)
February	Above Normal	13.66	13.10	-0.55 (-4%)
February	Below Normal	18.34	18.10	-0.24 (-1%)
February	Dry	25.23	26.77	1.53 (6%)
February	Critical	27.50	28.23	0.73 (3%)
March	Wet	7.57	5.04	-2.53 (-33%)
March	Above Normal	10.56	6.88	-3.68 (-35%)
March	Below Normal	17.83	13.06	-4.77 (-27%)
March	Dry	20.72	16.53	-4.19 (-20%)
March	Critical	15.85	18.83	2.98 (19%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_20191030.dat

Table D.3-15 b. Percentage of Neutrally Buoyant Particles Injected at Station 815 (San Joaquin River at Potato Slough) That Were Entrained Over 45 Days into Central Valley Project (Jones Pumping Plant).

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	7.41	7.19	-0.22 (-3%)
January	Above Normal	13.71	14.29	0.58 (4%)
January	Below Normal	20.96	20.51	-0.45 (-2%)
January	Dry	28.27	28.71	0.43 (2%)
January	Critical	31.27	28.84	-2.42 (-8%)
February	Wet	4.38	4.00	-0.38 (-9%)
February	Above Normal	9.65	9.64	-0.01 (0%)
February	Below Normal	13.26	13.80	0.54 (4%)
February	Dry	22.80	23.26	0.46 (2%)
February	Critical	28.08	28.73	0.65 (2%)
March	Wet	3.46	2.24	-1.22 (-35%)
March	Above Normal	6.16	3.86	-2.30 (-37%)
March	Below Normal	11.99	7.97	-4.02 (-34%)
March	Dry	18.76	13.26	-5.50 (-29%)
March	Critical	16.66	18.57	1.91 (11%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_20191030.dat

Table D.3-15 c. Percentage of Neutrally Buoyant Particles Injected at Station 815 (San Joaquin River at Potato Slough) That Were Entrained Over 45 Days into Barker Slough Pumping Plant

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	0.00	0.00	0.00 (0%)
January	Above Normal	0.00	0.00	0.00 (0%)
January	Below Normal	0.00	0.00	0.00 (0%)
January	Dry	0.00	0.00	0.00 (0%)
January	Critical	0.00	0.00	0.00 (0%)
February	Wet	0.00	0.00	0.00 (0%)
February	Above Normal	0.00	0.00	0.00 (0%)
February	Below Normal	0.00	0.00	0.00 (0%)
February	Dry	0.00	0.00	0.00 (0%)
February	Critical	0.00	0.00	0.00 (0%)
March	Wet	0.00	0.00	0.00 (0%)
March	Above Normal	0.00	0.00	0.00 (0%)
March	Below Normal	0.00	0.00	0.00 (0%)
March	Dry	0.00	0.00	0.00 (0%)
March	Critical	0.00	0.00	0.00 (0%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_20191030.dat

Table D.3-15 d. Percentage of Neutrally Buoyant Particles Injected at Station 815 (San Joaquin River at Potato Slough) That Passed Chipps Island.

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	77.07	77.33	0.25 (0%)
January	Above Normal	60.64	60.59	-0.05 (0%)
January	Below Normal	42.34	42.76	0.42 (1%)
January	Dry	24.18	22.41	-1.77 (-7%)
January	Critical	18.78	19.94	1.16 (6%)
February	Wet	83.59	84.36	0.76 (1%)
February	Above Normal	70.48	71.05	0.58 (1%)
February	Below Normal	57.21	57.46	0.26 (0%)
February	Dry	36.41	34.70	-1.72 (-5%)
February	Critical	22.07	21.94	-0.13 (-1%)
March	Wet	86.43	90.30	3.87 (4%)
March	Above Normal	79.51	85.81	6.29 (8%)
March	Below Normal	58.72	67.13	8.41 (14%)
March	Dry	40.96	49.58	8.63 (21%)
March	Critical	33.43	29.57	-3.85 (-12%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_20191030.dat

Table D.3-16. Percentage of Surface-Oriented Particles Injected at Station 815 (San Joaquin River at Potato Slough) That Were Entrained Over 45 Days into Clifton Court Forebay, Central Valley Project (Jones Pumping Plant), and Barker Slough Pumping Plant; or That Passed Chipps Island - Table D.3-16 t - D.3-16 d

Table D.3-16 u. Percentage of Surface-Oriented Particles Injected at Station 815 (San Joaquin River at Potato Slough) That Were Entrained Over 45 Days into Clifton Court Forebay

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	31.93	32.48	0.55 (2%)
January	Above Normal	38.64	39.35	0.70 (2%)
January	Below Normal	44.37	46.03	1.66 (4%)
January	Dry	41.76	44.49	2.73 (7%)
January	Critical	37.28	41.25	3.97 (11%)
February	Wet	30.86	29.30	-1.56 (-5%)
February	Above Normal	39.82	38.15	-1.67 (-4%)
February	Below Normal	44.31	43.77	-0.54 (-1%)
February	Dry	42.03	41.80	-0.23 (-1%)
February	Critical	38.20	38.47	0.27 (1%)
March	Wet	30.29	28.31	-1.98 (-7%)
March	Above Normal	36.59	35.40	-1.19 (-3%)
March	Below Normal	44.56	46.08	1.52 (3%)
March	Dry	39.14	40.51	1.37 (4%)
March	Critical	28.69	31.70	3.01 (10%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_BHV_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_BHV_20191030.dat

Table D.3-16 b. Percentage of Surface-Oriented Particles Injected at Station 815 (San Joaquin River at Potato Slough) That Were Entrained Over 45 Days into Central Valley Project (Jones Pumping Plant).

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	24.92	23.34	-1.58 (-6%)
January	Above Normal	37.68	37.45	-0.23 (-1%)
January	Below Normal	44.49	43.48	-1.01 (-2%)
January	Dry	49.38	47.42	-1.95 (-4%)
January	Critical	53.48	48.65	-4.83 (-9%)
February	Wet	17.04	15.39	-1.65 (-10%)
February	Above Normal	29.33	28.77	-0.55 (-2%)
February	Below Normal	34.62	33.71	-0.91 (-3%)
February	Dry	47.01	46.94	-0.07 (0%)
February	Critical	49.47	50.00	0.53 (1%)
March	Wet	12.93	12.67	-0.26 (-2%)
March	Above Normal	22.68	20.64	-2.04 (-9%)
March	Below Normal	31.32	28.40	-2.93 (-9%)
March	Dry	43.37	39.86	-3.51 (-8%)
March	Critical	40.29	41.57	1.27 (3%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_BHV_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_BHV_20191030.dat

Table D.3-16 c. Percentage of Surface-Oriented Particles Injected at Station 815 (San Joaquin River at Potato Slough) That Were Entrained Over 45 Days into Barker Slough Pumping Plant

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	0.00	0.00	0.00 (0%)
January	Above Normal	0.00	0.00	0.00 (0%)
January	Below Normal	0.00	0.00	0.00 (0%)
January	Dry	0.00	0.00	0.00 (0%)
January	Critical	0.00	0.00	0.00 (0%)
February	Wet	0.00	0.00	0.00 (0%)
February	Above Normal	0.00	0.00	0.00 (0%)
February	Below Normal	0.00	0.00	0.00 (0%)
February	Dry	0.00	0.00	0.00 (0%)
February	Critical	0.00	0.00	0.00 (0%)
March	Wet	0.00	0.00	0.00 (0%)
March	Above Normal	0.00	0.00	0.00 (0%)
March	Below Normal	0.00	0.00	0.00 (0%)
March	Dry	0.00	0.00	0.00 (0%)
March	Critical	0.00	0.00	0.00 (0%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_BHV_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_BHV_20191030.dat

Table D.3-16 d. Percentage of Surface-Oriented Particles Injected at Station 815 (San Joaquin River at Potato Slough) That Passed Chipps Island.

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	32.66	33.54	0.88 (3%)
January	Above Normal	12.21	11.88	-0.33 (-3%)
January	Below Normal	0.47	0.48	0.01 (2%)
January	Dry	0.05	0.05	0.00 (-8%)
January	Critical	0.00	0.00	0.00 (0%)
February	Wet	40.61	42.63	2.02 (5%)
February	Above Normal	17.95	19.15	1.19 (7%)
February	Below Normal	7.32	7.79	0.47 (6%)
February	Dry	0.24	0.17	-0.06 (-26%)
February	Critical	0.02	0.01	-0.01 (-64%)
March	Wet	40.15	43.38	3.23 (8%)
March	Above Normal	17.53	20.71	3.18 (18%)
March	Below Normal	1.00	1.86	0.86 (86%)
March	Dry	0.12	0.18	0.06 (48%)
March	Critical	0.02	0.02	0.00 (0%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_BHV_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_BHV_20191030.dat

Table D.3-17. Percentage of Neutrally Buoyant Particles Injected at Station 906 (San Joaquin River near Medford Island) That Were Entrained Over 45 Days into Clifton Court Forebay, Central Valley Project (Jones Pumping Plant), and Barker Slough Pumping Plant; or That Passed Chipps Island - Table D.3-17 v - D.3-17 d

Table D.3-17 w. Percentage of Neutrally Buoyant Particles Injected at Station 906 (San Joaquin River near Medford Island) That Were Entrained Over 45 Days into Clifton Court Forebay

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	28.64	28.61	-0.03 (0%)
January	Above Normal	37.74	38.20	0.46 (1%)
January	Below Normal	44.61	45.81	1.20 (3%)
January	Dry	47.66	50.32	2.66 (6%)
January	Critical	42.85	46.20	3.35 (8%)
February	Wet	24.46	23.40	-1.06 (-4%)
February	Above Normal	33.36	33.35	-0.01 (0%)
February	Below Normal	39.56	40.07	0.51 (1%)
February	Dry	46.52	46.70	0.18 (0%)
February	Critical	44.61	45.08	0.47 (1%)
March	Wet	22.38	17.07	-5.31 (-24%)
March	Above Normal	29.93	22.72	-7.21 (-24%)
March	Below Normal	39.47	34.50	-4.97 (-13%)
March	Dry	42.91	39.14	-3.77 (-9%)
March	Critical	31.15	34.07	2.92 (9%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_20191030.dat

Table D.3-17 b. Percentage of Neutrally Buoyant Particles Injected at Station 906 (San Joaquin River near Medford Island) That Were Entrained Over 45 Days into Central Valley Project (Jones Pumping Plant).

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	19.13	18.19	-0.94 (-5%)
January	Above Normal	29.91	30.38	0.48 (2%)
January	Below Normal	36.99	36.63	-0.36 (-1%)
January	Dry	43.60	42.31	-1.29 (-3%)
January	Critical	46.92	42.01	-4.91 (-10%)
February	Wet	12.79	11.81	-0.98 (-8%)
February	Above Normal	22.62	22.59	-0.04 (0%)
February	Below Normal	28.39	27.78	-0.61 (-2%)
February	Dry	41.41	42.35	0.94 (2%)
February	Critical	45.54	45.47	-0.07 (0%)
March	Wet	9.08	7.22	-1.86 (-20%)
March	Above Normal	16.64	12.01	-4.62 (-28%)
March	Below Normal	25.32	19.85	-5.48 (-22%)
March	Dry	37.94	32.21	-5.73 (-15%)
March	Critical	33.77	35.45	1.68 (5%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_20191030.dat

Table D.3-17 c. Percentage of Neutrally Buoyant Particles Injected at Station 906 (San Joaquin River near Medford Island) That Were Entrained Over 45 Days into Barker Slough Pumping Plant

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	0.00	0.00	0.00 (0%)
January	Above Normal	0.00	0.00	0.00 (0%)
January	Below Normal	0.00	0.00	0.00 (0%)
January	Dry	0.00	0.00	0.00 (0%)
January	Critical	0.00	0.00	0.00 (0%)
February	Wet	0.00	0.00	0.00 (0%)
February	Above Normal	0.00	0.00	0.00 (0%)
February	Below Normal	0.00	0.00	0.00 (0%)
February	Dry	0.00	0.00	0.00 (0%)
February	Critical	0.00	0.00	0.00 (0%)
March	Wet	0.00	0.00	0.00 (0%)
March	Above Normal	0.00	0.00	0.00 (0%)
March	Below Normal	0.00	0.00	0.00 (0%)
March	Dry	0.00	0.00	0.00 (0%)
March	Critical	0.00	0.00	0.00 (0%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_20191030.dat

Table D.3-17 d. Percentage of Neutrally Buoyant Particles Injected at Station 906 (San Joaquin River near Medford Island) That Passed Chipps Island.

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	47.95	48.93	0.98 (2%)
January	Above Normal	26.91	26.20	-0.71 (-3%)
January	Below Normal	11.24	10.91	-0.33 (-3%)
January	Dry	2.82	2.45	-0.38 (-13%)
January	Critical	1.82	2.98	1.16 (63%)
February	Wet	58.82	60.70	1.87 (3%)
February	Above Normal	39.47	39.53	0.06 (0%)
February	Below Normal	25.86	25.82	-0.04 (0%)
February	Dry	5.65	4.73	-0.92 (-16%)
February	Critical	2.06	2.01	-0.05 (-2%)
March	Wet	64.79	72.08	7.29 (11%)
March	Above Normal	47.99	59.81	11.82 (25%)
March	Below Normal	25.84	33.67	7.83 (30%)
March	Dry	6.47	11.77	5.31 (82%)
March	Critical	7.47	5.49	-1.98 (-27%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_20191030.dat

Table D.3-18. Percentage of Surface-Oriented Particles Injected at Station 906 (San Joaquin River near Medford Island) That Were Entrained Over 45 Days into Clifton Court Forebay, Central Valley Project (Jones Pumping Plant), and Barker Slough Pumping Plant; or That Passed Chipps Island - Table D.3-18 x - D.3-18 d

Table D.3-18 y. Percentage of Surface-Oriented Particles Injected at Station 906 (San Joaquin River near Medford Island) That Were Entrained Over 45 Days into Clifton Court Forebay

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	42.84	42.95	0.11 (0%)
January	Above Normal	47.30	47.00	-0.30 (-1%)
January	Below Normal	46.25	47.74	1.49 (3%)
January	Dry	43.19	46.29	3.10 (7%)
January	Critical	37.85	42.56	4.71 (12%)
February	Wet	43.95	42.07	-1.88 (-4%)
February	Above Normal	49.26	48.23	-1.03 (-2%)
February	Below Normal	51.22	51.21	-0.01 (0%)
February	Dry	44.28	44.17	-0.11 (0%)
February	Critical	40.14	40.51	0.37 (1%)
March	Wet	43.50	40.92	-2.58 (-6%)
March	Above Normal	50.03	50.34	0.31 (1%)
March	Below Normal	52.20	53.97	1.77 (3%)
March	Dry	42.98	44.30	1.32 (3%)
March	Critical	32.22	34.48	2.26 (7%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_BHV_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_BHV_20191030.dat

Table D.3-18 b. Percentage of Surface-Oriented Particles Injected at Station 906 (San Joaquin River near Medford Island) That Were Entrained Over 45 Days into Central Valley Project (Jones Pumping Plant).

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	32.30	30.85	-1.45 (-5%)
January	Above Normal	43.51	43.57	0.06 (0%)
January	Below Normal	46.74	45.69	-1.05 (-2%)
January	Dry	50.53	48.25	-2.28 (-5%)
January	Critical	55.34	49.81	-5.53 (-10%)
February	Wet	23.02	21.17	-1.85 (-8%)
February	Above Normal	35.54	35.53	-0.01 (0%)
February	Below Normal	38.54	38.11	-0.43 (-1%)
February	Dry	49.94	50.08	0.14 (0%)
February	Critical	52.52	53.27	0.75 (1%)
March	Wet	16.71	16.24	-0.47 (-3%)
March	Above Normal	29.72	28.46	-1.26 (-4%)
March	Below Normal	36.15	32.62	-3.53 (-10%)
March	Dry	46.77	44.21	-2.55 (-5%)
March	Critical	44.07	45.98	1.91 (4%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_BHV_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_BHV_20191030.dat

Table D.3-18 c. Percentage of Surface-Oriented Particles Injected at Station 906 (San Joaquin River near Medford Island) That Were Entrained Over 45 Days into Barker Slough Pumping Plant

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	0.00	0.00	0.00 (0%)
January	Above Normal	0.00	0.00	0.00 (0%)
January	Below Normal	0.00	0.00	0.00 (0%)
January	Dry	0.00	0.00	0.00 (0%)
January	Critical	0.00	0.00	0.00 (0%)
February	Wet	0.00	0.00	0.00 (0%)
February	Above Normal	0.00	0.00	0.00 (0%)
February	Below Normal	0.00	0.00	0.00 (0%)
February	Dry	0.00	0.00	0.00 (0%)
February	Critical	0.00	0.00	0.00 (0%)
March	Wet	0.00	0.00	0.00 (0%)
March	Above Normal	0.00	0.00	0.00 (0%)
March	Below Normal	0.00	0.00	0.00 (0%)
March	Dry	0.00	0.00	0.00 (0%)
March	Critical	0.00	0.00	0.00 (0%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_BHV_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_BHV_20191030.dat

Table D.3-18 d. Percentage of Surface-Oriented Particles Injected at Station 906 (San Joaquin River near Medford Island) That Passed Chipps Island.

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	18.47	19.63	1.16 (6%)
January	Above Normal	3.87	3.85	-0.02 (-1%)
January	Below Normal	0.00	0.00	0.00 (0%)
January	Dry	0.00	0.00	0.00 (0%)
January	Critical	0.00	0.00	0.00 (0%)
February	Wet	26.10	28.71	2.61 (10%)
February	Above Normal	9.70	11.29	1.59 (16%)
February	Below Normal	3.27	3.54	0.27 (8%)
February	Dry	0.00	0.00	0.00 (0%)
February	Critical	0.00	0.00	0.00 (0%)
March	Wet	29.60	32.61	3.01 (10%)
March	Above Normal	8.65	8.90	0.25 (3%)
March	Below Normal	0.16	1.04	0.88 (536%)
March	Dry	0.00	0.00	0.00 (0%)
March	Critical	0.00	0.00	0.00 (0%)

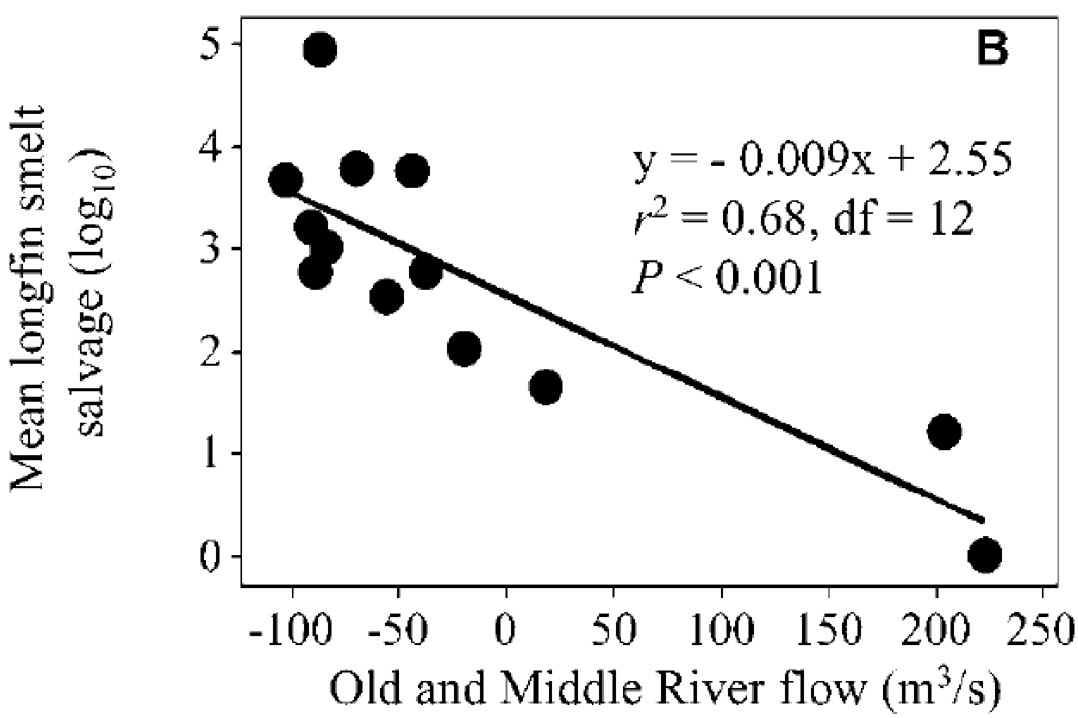
Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_BHV_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_BHV_20191030.dat

D.3.2 SALVAGE-OLD AND MIDDLE RIVER FLOW ANALYSIS (BASED ON GRIMALDO ET AL. 2009)

Grimaldo et al. (2009: their Figure 7B) found a significant relationship between juvenile Longfin Smelt salvage in April and May as a function of mean April–May Old and Middle River flows. In order to assess potential differences in salvage between Existing and PP scenarios, the regression of Grimaldo et al. (2009) was recreated in order to be able to fully account for sources of error in the predictions; this allowed calculation of prediction intervals from CalSim-derived estimates of Old and Middle River flows for Existing and PP scenarios, as recommended by Simenstad et al. (2016).

Longfin Smelt salvage data for April and May 1993–2005 were obtained from the DFW salvage monitoring website[5]. Consistent with Grimaldo et al. (2009), a record of 616 Longfin Smelt salvaged on April 7, 1998, was assumed to be in error, and was converted to zero for the analysis. Old and Middle River flow data were provided by Smith (pers. comm.). Following Grimaldo et al. (2009), $\log_{10}$(total salvage) was regressed against mean April–May Old and Middle River flow (converted to cubic meters/second). The resulting regression equation was very similar to that obtained by Grimaldo et al. (2009; Figure D.3-4):

> Log_{10}(April–May total Longfin Smelt salvage) = 2.5454 (± 0.2072 SE) – 0.0100 (± 0.0020 SE)*(Mean April–May Old and Middle River flow); r^2 = 0.70, 12 degrees of freedom.



Source: Grimaldo et al. (2009)

Figure D.3-4. Regression of April–May Longfin Smelt Salvage as a Function of Old and Middle River Flow

[5] http://www.dfg.ca.gov/delta/apps/salvage/SalvageExportChart.aspx?Species=1&SampleDate=1%2f22%2f2016&Facility=1, accessed January 1, 2016, and August 17, 2016 (salvage for Longfin Smelt at both facilities was selected).

For the comparison of Existing and PP scenarios, CalSim data outputs were used to calculate mean April–May Old and Middle River flows for each year of the 1922–2003 simulation. The salvage-Old and Middle River flow regression calculated as above was used to estimate salvage for the Existing and PP scenarios. The log-transformed salvage estimates were back-transformed to a linear scale for comparison of Existing and PP. In order to illustrate the variability in predictions from the salvage-Old and Middle River flow regression, annual estimates were made for the mean and upper and lower 95% prediction limits of the salvage estimates, as recommended by Simenstad et al. (2016). Means and predictions limits giving negative estimates of salvage were converted to zero before statistical summary. Statistical analyses were conducted with PROC GLM and PROC PLM in SAS/STAT software, Version 9.4 of the SAS System for Windows.[6]

D.3.3 Delta Outflow-Abundance Analysis (Based on Nobriga and Rosenfield 2016)

This analysis used the Nobriga and Rosenfield (2016) Longfin Smelt population dynamics model to assess potential effects of the PP as a function of changes in winter/spring outflow.

D.3.3.1 Reproduction of Nobriga and Rosenfield (2016) Model

This analysis reproduced the methods described in Nobriga and Rosenfield (2016) for calculation of the two-life-stage model referred to as the “2abc” model, which includes the embedded hypotheses that understanding the trend in age-0 LFS relative abundance requires explicit modeling of spawning and recruit relative abundance; that the production of age-0 fish is density dependent; and that juvenile survival from age 0 to age 2 has changed over time. For purposes of this effects analysis, the “2abc” model was selected because its median predictions visually fit recent years of empirical data better than the other model evaluated (Figure D.3-5).

Model input data used to reproduce the “2abc” model were as provided in Table 2 of Nobriga and Rosenfield (2016). The input data are provided in Appendix A of Greenwood and Phillis (2018). The analyses were run in R software (R Core Team 2016).

Graphical comparison of the reproduction of the “2abc” model to the original Nobriga and Rosenfield (2016) “2abc” model (Figure D.3-5) suggests that the reproduced model was a reasonable approximation of the original model (i.e., the reproduction of the method was reasonably successful). It should be noted that the original “2abc” model 95% confidence intervals are wider than the reproduction utilized in this analysis. However, the model coefficients and standard errors are identical between the original and reproduced models. Therefore, the reproduced “2abc” model utilized in this analysis is considered appropriate, and the differences in 95% confidence intervals among the original and reproduced models do not affect the comparison of the scenarios discussed below.

[6] Copyright 2002–2010, SAS Institute Inc. SAS and all other SAS Institute Inc. product or service names are registered trademarks or trademarks of SAS Institute Inc., Cary, NC, USA

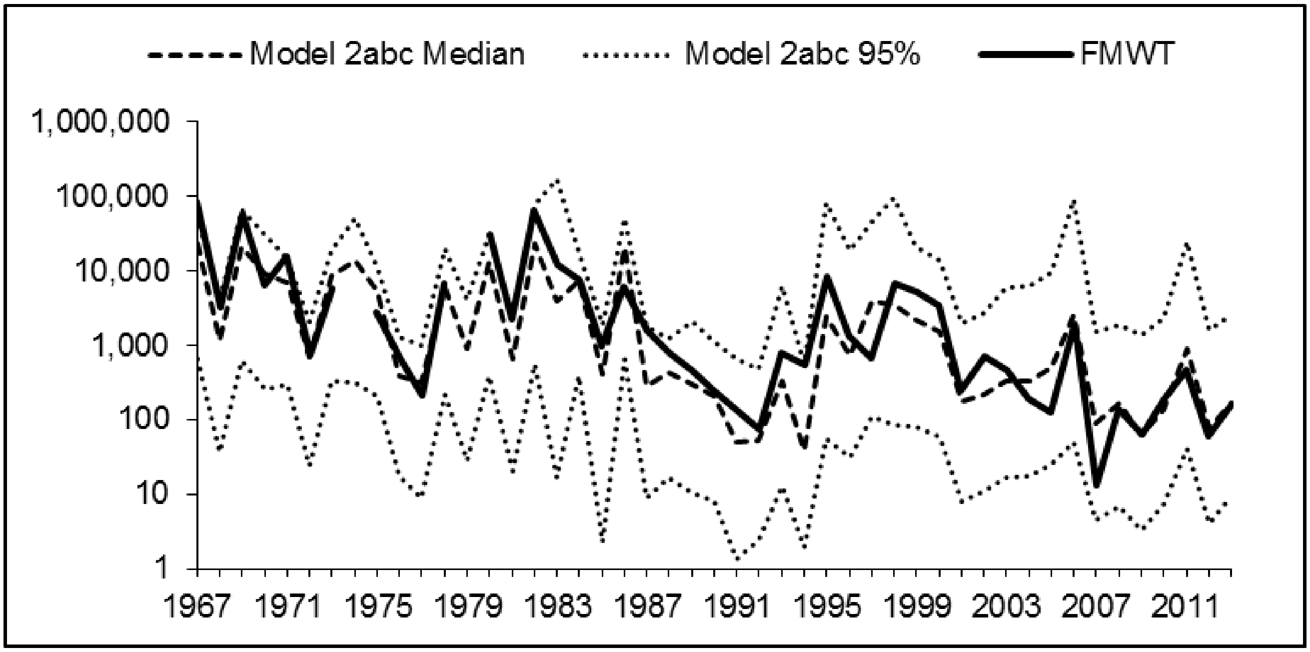


Figure D.3-5 a. Reproduction of Nobriga and Rosenfield (2016) 2abc Model Predictions Compared to Historical Fall Midwater Trawl Survey Longfin Smelt Abundance Index.

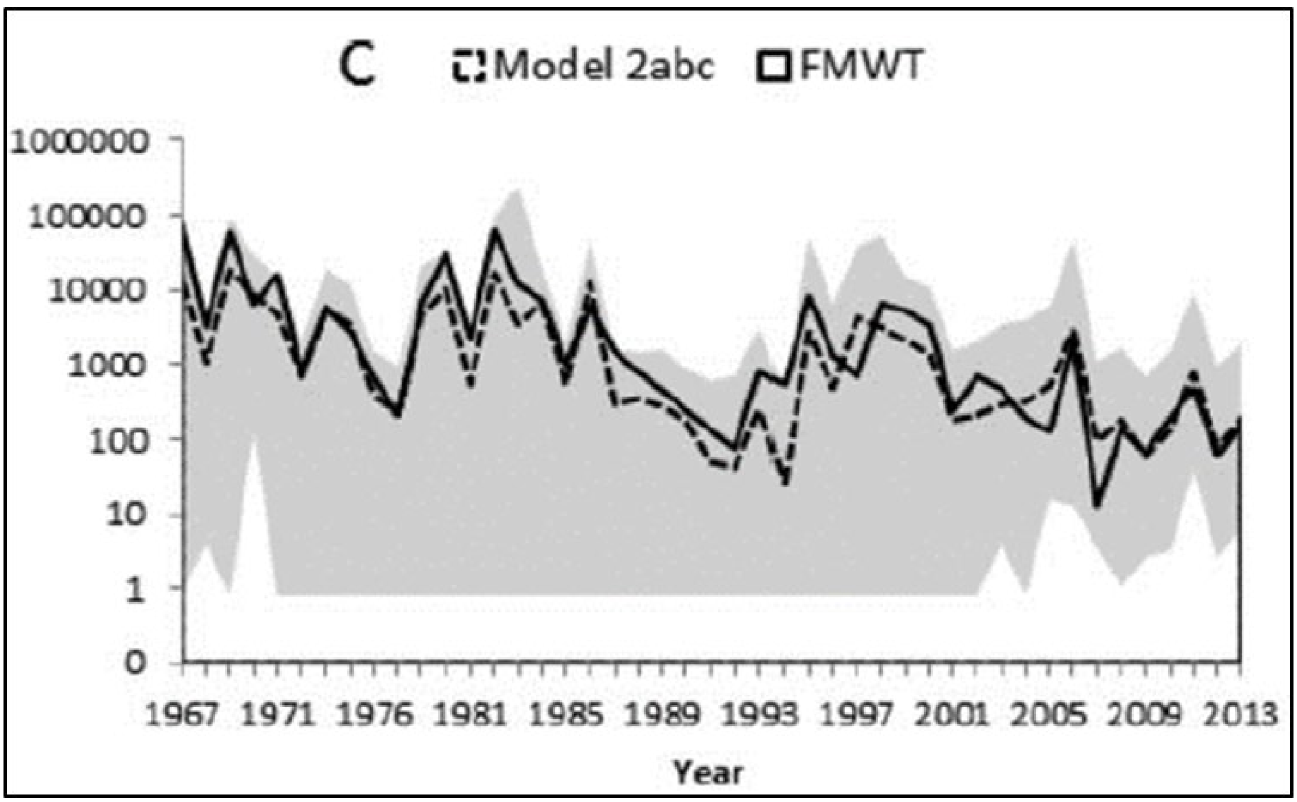


Figure D.3-5 b. Original (Figure 6c of Nobriga and Rosenfield 2016) 2abc Model Predictions Compared to Historical Fall Midwater Trawl Survey Longfin Smelt Abundance Index. Grey shading indicates 95% interval.

D.3.3.2 CALCULATION OF DELTA OUTFLOW MODEL INPUTS FOR SCENARIO COMPARISON

To obtain the required first principal component (PC1) model inputs for comparison of the PP and Existing scenarios, it was first necessary to reproduce the principal components analysis (PCA). Following Nobriga and Rosenfield (2016), historical daily Delta outflow data were acquired from the DAYFLOW database[7]. Flow data were averaged for December to May by month and year and the Principal Component Analysis was conducted using the 'PCA' function in the R package FactoMineR (Le et al. 2008) on water years 1956-2013. The resulting PC1 outputs were very similar to the original values computed by Nobriga and Rosenfield (2016), suggesting that the reported method had been successfully reproduced[8]. The 'predict PCA' function was then used to predict PC1 values for the PP and Existing scenarios for water years 1956-2017 on the same projection as the PCA. The resulting PC1 values were used as the input for the model simulation of the flow scenarios described in the next section.

D.3.3.3 MODEL SIMULATION TO COMPARE SCENARIOS

Model simulation to compare the Existing Conditions, Proposed Project, Alternative 2a, Alternative 2b, and Alternative 3 scenarios used the PC1 flow inputs. To produce a simulation for the 1922-2003 time series, and consistent with Nobriga and Rosenfield (2016), the model was initiated with 2 years (i.e., years 1922 and 1923) of Fall Mid-water Trawl (FMWT) indices equal to 798, which represents the median observed FMWT index from 1967 to 2013. The simulation was conducted for two juvenile survival functions:

- 'good', which used the pre-1991 relatively high survival for simulation over the full 1922-2003 time series;
- 'poor', which used the post-1991 relatively low survival for simulation over the full 1922-2003 simulation time series.

Following Nobriga and Rosenfield (2016), 1,000 stochastic simulations were conducted in which random draws were made based on the mean and standard error of the model parameters. Consistent with Nobriga and Rosenfield (2016), the variability among the estimates was examined using the 95% intervals. Violin plots were used to illustrate the distribution of simulated FMWT indices.

D.4 SALMONIDS

D.4.1 SALVAGE-DENSITY METHOD

The basic procedure used for the salvage-density method for Winter-run and Spring-run Chinook Salmon was an update of previous methods, such as that used in the California WaterFix ITP Application. The updated method reflected more recently available data and was as follows:

[7] https://www.water.ca.gov/Programs/Environmental-Services/Compliance-Monitoring-And-Assessment/Dayflow-Data

[8] The small differences may have arisen because of varying PCA algorithms in different statistical software packages, for example.

- All data were downloaded from https://apps.wildlife.ca.gov/Salvage[9];
- Water years 1994–2018 were included as these water years were complete and the water year type was known (http://cdec.water.ca.gov/reportapp/javareports?name=WSIHIST);
- Fish with clipped and unclipped adipose fins were included, as together they represent hatchery-origin and wild fish that are all part of the Evolutionary Significant Unit (ESU);
- Daily loss density (fish per thousand acre feet (taf) of water exported) was calculated for the SWP south Delta export facility (Clifton Court Forebay, Skinner fish facility, and Banks pumping plant)[10], month, and water year type;

The daily loss density values for each month, facility, and water year type were multiplied by the CalSim-modeled exports for the Existing and PP scenarios to give estimates of fish loss.

[9] This website includes salvage density for all species, and loss density for salmonids; the latter was used in this analysis.

[10] Loss density was also calculated for the CVP Jones Pumping Plant in consideration of cumulative effects.

D.4.2 SALVAGE ANALYSIS (BASED ON ZEUG AND CAVALLO 2014)

An analysis to evaluate differences in entrainment (salvage) at the south Delta export facilities between the existing condition (EXG) and the PP was done following the statistical models of salvage of marked (coded wire tags) hatchery-reared Chinook salmon published by Zeug and Cavallo (2014). This analysis focused on winter-run Chinook salmon; spring-run Chinook salmon were not included because very few marked individuals were salvaged and the statistical models could not be fit successfully (Zeug and Cavallo 2014). Several modifications to the methods of Zeug and Cavallo (2014) were employed to focus on relevant model predictors. First, statistical models of the empirical data were constructed using only releases of winter-run Chinook salmon raised at the Livingston Stone Hatchery. Second, salvage at the SWP south Delta export facilities and SWP-specific exports were modeled in addition to combined values from both the SWP and CVP facilities. This was done to focus on effects of the SWP to the greatest extent possible and provide context with total salvage. Some variables were excluded from the statistical models because they were not significant in the original analysis or they were not relevant in this context. For example, the original analysis used the variable “distance of release from the facilities”. However, winter-run Chinook salmon were only released from a single location, making this predictor irrelevant. Finally, to determine which hydrologic variables were the best predictors of salvage, a model selection exercise was performed using the original data from Zeug and Cavallo (2014). The model selection exercise included five potential hydrologic predictor variables including; Old and Middle River flows (OMR), inflow-export ratio (I-E), total south Delta exports, San Joaquin River flow, Sacramento River flow and one biological variable (mean fork length at release). Most of these variables were strongly correlated so models were constructed only with variables that had correlation coefficients $<|0.70|$. One million individuals were used as the total release size (offset variable) for each candidate model with standardized predictors for both the count and zero-inflation portion of the models. To select the best approximating model, Akaike’s Information Criterion (AIC) was calculated for each model. The model with the lowest AIC value was identified as the best approximating model. The AIC value of all other models was subtracted from the value of the best approximating model to calculate the ΔAIC. Any model that had a ΔAIC value ≤ 2.0 was considered a competing model with the best approximating model.

A single best model of salvage was selected with no other model having a ΔAIC <2.8. This model had three predictor variables for the count model and zero inflation models including mean fork length of fish at release, Sacramento River flow, and total exports. The final count model indicated that non-zero salvage was greater when fish were released at a larger size, flow in the Sacramento River was higher, and exports were higher. For the zero inflation model, coefficients indicated zero salvage was more likely when fish were released at a smaller size, Sacramento River flow was higher, and exports were lower.

To predict salvage under the existing condition and the Proposed Project scenarios, daily flow and export data from DSM2 output was aggregated into 7-day running means and standardized to the same scale as the empirical data. This was done to mimic the way data were aggregated in the original publication (7-day means) and the winter-run specific models described above. A 7-day mean was used because an acoustic tagging study revealed that was the approximate mean time Chinook salmon smolts spent transiting through the Delta (Zeug and Cavallo 2014). The total number of fish entering the Delta in a season was then multiplied by the daily entry proportion defined by the same distribution used in the Delta Passage Model. The log-transformed product of this calculation was used as the offset on each day. The distribution did not weight the result but simply distributed the fish over time.

The values described above (DSM2 data, offset, fish fork length) are used as inputs in the ZINB model to predict the mean salvage for each day. The size of fish entering the delta was set as the midpoint size on the 15th of each month using the Delta length-at-date model. After January, the midpoint value was higher than the observed sizes at release and the model was set to the maximum observed fork length from February–June (95 mm). However, it should be noted that the statistical model uses size at release in the Sacramento River near Redding, CA, and fish are assumed to grow between release and the salvage facilities. The mean daily salvage values were then summarized by month and reported as the proportion of total annual salvage observed in each month. Additionally, the annual predicted value of salvage in each of the 82 water years was plotted for the Existing and PP scenarios.

D.4.3 Delta Hydrodynamic Assessment and Junction Routing Analysis

D.4.3.1 Velocity Assessment

Hydrodynamic changes associated with river inflows and South Delta exports have been suggested to adversely affect juvenile Chinook Salmon in two distinct ways: 1) "near-field" mortality associated with entrainment to the export facilities, and 2) "far-field" mortality resulting from altered hydrodynamics. Near-field or entrainment effects of proposed seasonal operations can be assessed by examining patterns of proportional population entrainment available from decades of coded wire tag studies (e.g., Zeug and Cavallo 2014). A foundation for assessing far-field effects has been provided by work of the Collaborative Adaptive Management Team's (CAMT) Salmonid Scoping Team (SST). The SST completed a thorough review of this subject and defined a driver-linkage-outcome (DLO) framework for specifying how water project operations (the "driver") can influence juvenile salmonid behavior (the "linkage") and potentially cause changes in survival or routing (the "outcome"). The SST concluded altered "Channel Velocity" and altered "Flow Direction" were the only two hydrodynamic mechanisms by which exports and river inflows could affect juvenile salmonids in the Delta. Figure D.4-3 provides a simplified conceptual model of the DLO defined by the CAMT SST.

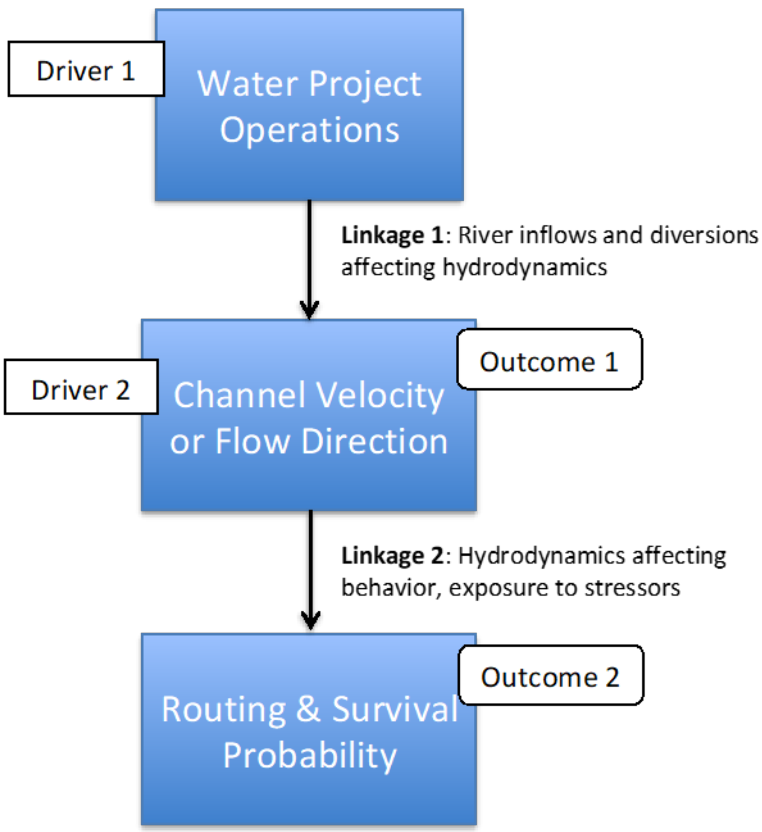


Figure D.4-3. Conceptual Model for Far-field Effects of Water Project Operations on Juvenile Salmonids in the Delta. This CM is a Simplified Version of the Information Provided by the CAMT SST

In order to assess the potential for water project operations to influence survival and routing, Delta hydrodynamic conditions were analyzed by creating maps from DSM2 Hydro modeling. The maps are based on a comparative metric, proportion overlap (more below), to capture channel-level hydrodynamic details as a single number for color-scale mapping of Delta channels.

The objective of the comparative metric is to summarize the water velocity time series for each channel and scenario such the channel-level comparison is captured in a single number. For the proportion overlap metric, kernel density estimates are calculated on each time series. The kernel density estimates represent a non-parametric smoothing of the empirical distribution of time series values. The proportion overlap of two kernel density estimates is calculated with the following steps: 1) calculate the total area under the curve (AUC_t) as the sum of the AUC for each density estimate, 2) calculate the AUC of the overlapping portions (AUC_o) of the two density distributions being compared, and 3) calculate the overlapping proportion of the density distributions as AUC_o/AUC_t. Proportion overlap is naturally bound by zero and one; a value of zero indicates no overlap and a value of one indicates complete overlap. Lower values of proportion overlap identify channels demonstrating larger differences in a scenario comparison.

The proportion overlap metric is best applied over relatively short time periods because seasonal and annual variation in water velocity can overwhelm differences between scenarios. Thus, the proportion overlap for every DSM2 channel for two seasons (December-February, March-May) in each water year (1922-2003) was calculated. DSM2 output was excluded from water year 1921 to allow for an extensive burn-in period. The proportion overlap was calculated based on hourly DSM2 output. Because each season was roughly 90 days, each comparison involved roughly 4,300 DSM2 values (2 scenarios * 24 hours * 90 days) for each channel.

Because the proportion overlap was calculated for each channel in each water year, the proportion overlap values were summarized prior to mapping (i.e., not feasible to map proportion overlap for every comparison in every water year). To summarize, the minimum and median proportion overlap for each channel for each water year type for each comparison was found. The minimum values represent the maximum expected effect. The median values represent the average expected effect. Note that the year with the minimum (or median) proportion overlap for one channel might not be the same year as for another channel.

D.4.3.2 Routing Analysis

Many routes can potentially be used by fish migrating through the Delta and survival through these routes can be significantly different (Newman 2008; Perry et al. 2010). Thus, routing of fish at junctions and how routing could be affected by project operations has the potential to influence through-Delta survival. In general, routes that keep fish in the mainstem Sacramento and San Joaquin Rivers are superior to routes leading into the interior Delta (Hankin et al. 2010; Perry et al. 2010), although some recent findings for the San Joaquin River have not supported this generality (Buchanan et al. 2013). Perry (2010) found that the routing of fish into the interior delta through the combined junction of Georgiana Slough and the Delta Cross Channel was a function of the total flow entering the interior delta through both of those junctions. This is the function represented in Figure 6.7 within Perry (2010). This function indicated that the slope of the relationship was less than 1.

Cavallo et al. (2015) performed a meta-analysis of routing at 6 Delta junctions and found that the proportion of flow entering a junction explained 70% of the variation in routing. Similar to the Perry (2010) study, the slope of this relationship was less than 1 suggesting fish move into junctions at a rate less than the proportion of flow. Both of these studies present strong evidence that routing at junctions is a function of the proportion of flow into that junction.

For the present analysis of the PP, flow routing into the Head of Old River junction was based on the proportion of flow entering a junction away from the main stem, from DSM2-HYDRO outputs. Fifteen-minute data were used to calculate the daily proportion of flow that enters the junction, following the methods of Cavallo et al. (2015). Similar to the analysis of velocity described previously, the daily value calculated from the 15-minute data was used to calculate summary statistics (box plots) for each month (December–June) and water year-type. If the median entrainment values under Existing Conditions and Proposed Project scenarios differed by ≥ 5% for any month, greater detail in the description of results was provided, based on a comparison of minimum values, maximum values, 25th quantile, 75th quantile, and median values.

Flow into the head of Old River (HOR) was examined in the routing analysis (Figure D.4-4).

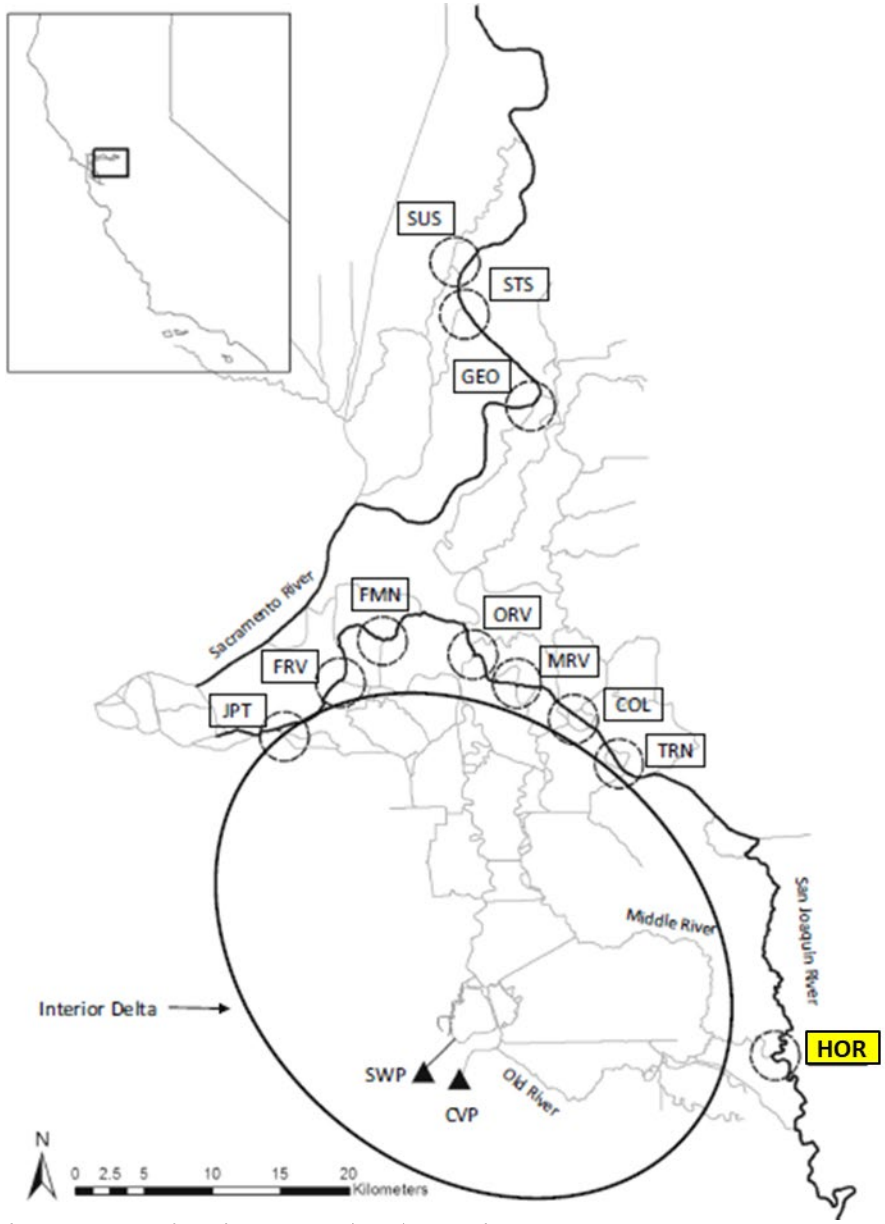
The combined evidence from the literature strongly indicates routing is a function of flow. Thus, it can be assumed routing of fish toward the interior delta will increase as the proportion of flow entering the junction increases. However, the slope of the relationship will be less than 1.

D.4.4 Delta Passage Model

D.4.4.1 Introduction

The DPM simulates migration of Chinook salmon smolts entering the Delta from the Sacramento River basin and estimates survival to Chipps Island. The DPM uses available time-series data and values taken from empirical studies or other sources to parameterize model relationships and inform uncertainty, thereby using the greatest amount of data available to dynamically simulate responses of smolt survival to changes in water management. Although the DPM is based primarily on studies of winter-run Chinook salmon smolt surrogates (late fall–run Chinook salmon), it is applied here for winter-run and spring-run Chinook salmon from the Sacramento River basin[11] by adjusting emigration timing and assuming that all migrating Chinook salmon smolts will respond similarly to Delta conditions. The DPM results presented here reflect the current version of the model, which continues to be reviewed and refined, and for which a sensitivity analysis has been completed to examine various aspects of uncertainty related to the model's inputs and parameters.

[11] Note that some methods described below may pertain more to runs from basins other than the Sacramento.



Source: Adapted from Cavallo et al. (2015). Note: Only the highlighted junction was examined in this analysis, i.e., HOR (head of Old River).

Figure D.4-4. Highlighted Junction Examined in the Routing Analysis

Although studies have shown considerable variation in emigrant size, with Central Valley Chinook salmon migrating as fry, parr, or smolts (Brandes and McLain 2001; Williams 2001), the DPM relies predominantly on data from acoustic-tagging studies of large (>140 mm) smolts, and therefore should be applied very cautiously to pre-smolt migrants. Salmon juveniles less than 70 mm are more likely to exhibit rearing behavior in the Delta (Moyle 2002) and thus likely will be represented poorly by the DPM. It has been assumed that the downstream emigration of fry, when spawning grounds are well upstream, is probably a dispersal mechanism that helps distribute fry among suitable rearing habitats. However, even when rearing habitat does not appear to be a limiting factor, downstream movement of fry still may be observed, suggesting that fry emigration is a viable alternative life-history strategy (Healy 1980; Healey and Jordan 1982; Miller et al. 2010). Unfortunately, survival data are lacking for small (fry-sized) juvenile emigrants because of the difficulty of tagging such small individuals. Therefore, the DPM should be viewed as a smolt survival model only, with its survival relationships generally having been derived from larger smolts (>140 mm), with the fate of pre-smolt emigrants not incorporated into model results.

The DPM has undergone substantial revisions based on comments received through the Bay Delta Conservation Plan preliminary proposal anadromous team meetings and in particular through feedback received during a workshop held on August 24, 2010, a 2-day workshop held June 23–24, 2011, and since then from various meetings of a workgroup consisting of agency biologists and consultants during preparation of the California WaterFix Biological Assessment. This effects analysis uses the most recent version of the DPM as of September 2015, with updates as noted below. The DPM is viewed as a simulation framework that can be changed as more data or new hypotheses regarding smolt migration and survival become available. The results are based on these revisions.

Survival estimates generated by the DPM are not intended to predict future outcomes. Instead, the DPM provides a simulation tool that compares the effects of different water management options on smolt migration survival, with accompanying estimates of uncertainty. The DPM was used to evaluate overall through-Delta survival for the Existing Conditions and Proposed Project scenarios. Note that the DPM is a tool to compare different scenarios and is not intended to predict actual through-Delta survival under current or future conditions. In keeping with other methods found in the effects analysis, it is possible that underlying relationships (e.g., flow-survival) that are used to inform the DPM will change in the future; there is an assumption of stationarity of these basic relationships to allow scenarios to be compared for the current analysis, recognizing that it may be necessary to re-examine the relationships as new information becomes available.

D.4.4.2 Model Overview

The DPM is based on a detailed accounting of migratory pathways and reach-specific mortality as Chinook salmon smolts travel through a simplified network of reaches and junctions. The biological functionality of the DPM is based on the foundation provided by Perry et al. (2010) as well as other acoustic tagging–based studies (San Joaquin River Group Authority 2008, 2010; Holbrook et al. 2009) and coded wire tag (CWT)–based studies (Newman and Brandes 2010; Newman 2008). Uncertainty is explicitly modeled in the DPM by incorporating environmental stochasticity and estimation error whenever available.

The major model functions in the DPM are as follows.

1. Delta Entry Timing, which models the temporal distribution of smolts entering the Delta for each race of Chinook salmon.
2. Fish Behavior at Junctions, which models fish movement as they approach river junctions.
3. Migration Speed, which models reach-specific smolt migration speed and travel time.
4. Route-Specific Survival, which models route-specific survival response to non-flow factors.
5. Flow-Dependent Survival, which models reach-specific survival response to flow.
6. Export-Dependent Survival, which models survival response to water export levels in the Interior Delta reach (see Table D.4-6 for reach description).

Functional relationships are described in detail in the Section discussing *Model Functions*.

Model Time Step

The DPM operates on a daily time step using simulated daily average flows and Delta exports as model inputs. The DPM does not attempt to represent sub-daily flows or diel salmon smolt behavior in response to the interaction of tides, flows, and specific channel features. The DPM is intended to represent the net outcome of migration and mortality occurring over days, not three dimensional movements occurring over minutes or hours (e.g., Blake and Horn 2003). It is acknowledged that finer scale modeling with a shorter time step may match the biological processes governing fish movement better than a daily time step (e.g., because of diel activity patterns; Plumb et al. 2015) and that sub-daily differences in flow proportions into junctions make daily estimates somewhat coarse (Cavallo et al. 2015).

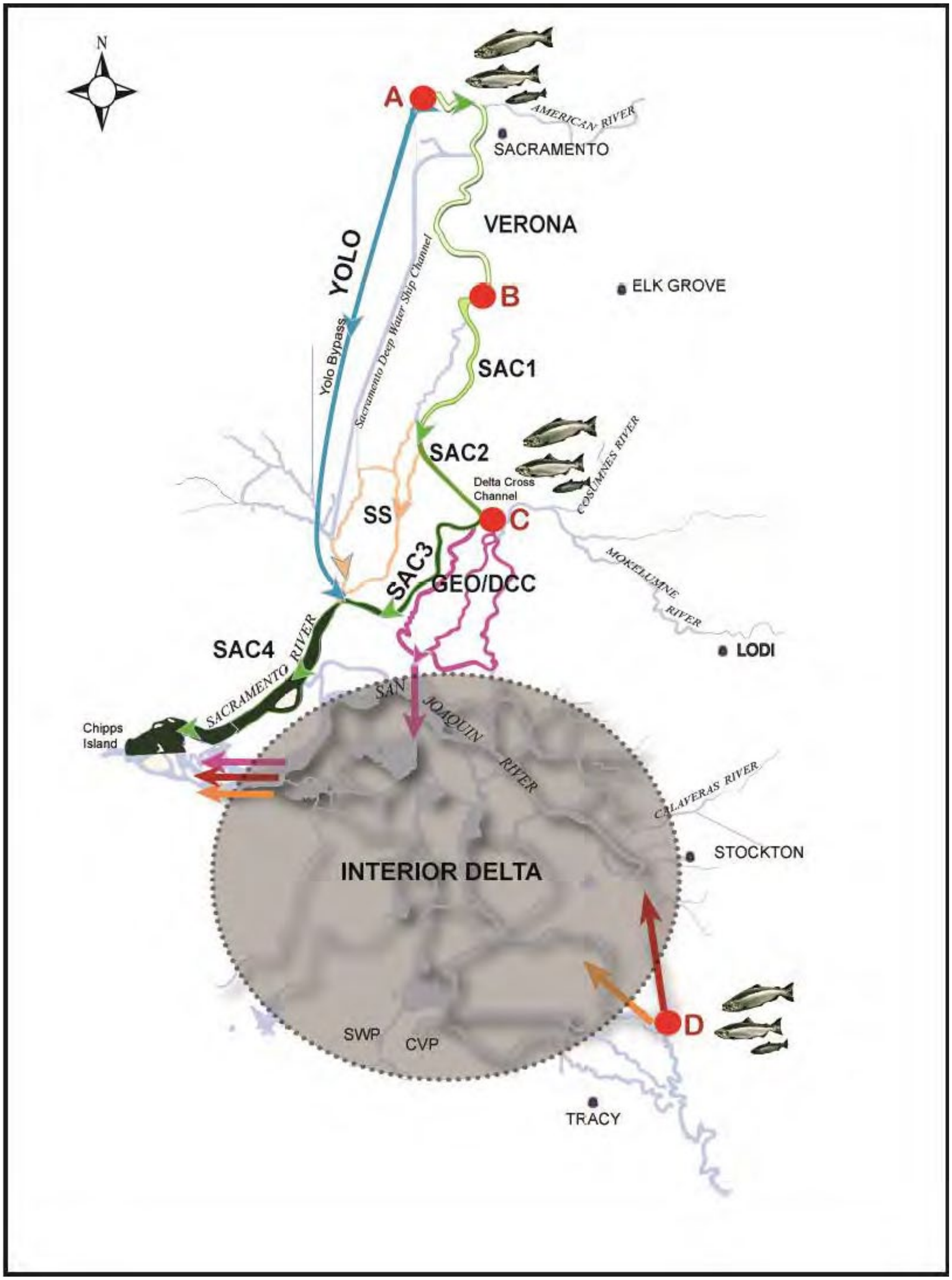
Spatial Framework

The DPM is composed of nine reaches and four junctions (Figure D.4-5; Table D.4-6) selected to represent primary salmonid migration corridors where high-quality data were available for fish and hydrodynamics. For simplification, Sutter Slough and Steamboat Slough are combined as the reach SS; and Georgiana Slough, the Delta Cross Channel (DCC), and the forks of the Mokelumne River to which the DCC leads are combined as Geo/DCC. The Geo/DCC reach can be entered by Sacramento runs through the combined junction of Georgiana Slough and DCC (Junction C). The Interior Delta reach can be entered from Geo/DCC. The entire Interior Delta region is treated as a single model reach3. The four distributary junctions (channel splits) depicted in the DPM are (A) Sacramento River at Fremont Weir (head of Yolo Bypass), (B) Sacramento River at head of Sutter and Steamboat Sloughs, and (C) Sacramento River at the combined junction with Georgiana Slough and DCC (Figure D.4-5, Table D.4-6).

Table D.4-6. Description of Modeled Reaches and Junctions in the Delta Passage Model

Reach/ Junction	Description	Reach Length (km)
Sac1	Sacramento River from Freeport to junction with Sutter/Steamboat Sloughs	19.33
Sac2	Sacramento River from Sutter/Steamboat Sloughs junction to junction with Delta Cross Channel/Georgiana Slough	10.78
Sac3	Sacramento River from Delta Cross Channel junction to Rio Vista, California	22.37
Sac4	Sacramento River from Rio Vista, California to Chipps Island	23.98
Yolo	Yolo Bypass from entrance at Fremont Weir to Rio Vista, California	NA[a]
Verona	Fremont Weir to Freeport	57
SS	Combined reach of Sutter Slough and Steamboat Slough ending at Rio Vista, California	26.72
Geo/DCC	Combined reach of Georgiana Slough, Delta Cross Channel, and South and North Forks of the Mokelumne River ending at confluence with the San Joaquin River in the Interior Delta	25.59
Interior Delta	Begins at end of reach Geo/DCC, San Joaquin River via Junction D, or Old River via Junction D, and ends at Chipps Island	NAb
A	Junction of the Yolo Bypass[c] and the Sacramento River	NA
B	Combined junction of Sutter Slough and Steamboat Slough with the Sacramento River	NA
C	Combined junction of the Delta Cross Channel and Georgiana Slough with the Sacramento River	NA

[a] Reach length for Yolo Bypass is undefined because reach length currently is not used to calculate Yolo Bypass speed and ultimate travel time.
[b] Reach length for the Interior Delta is undefined because salmon can take multiple pathways. Also, timing through the Interior Delta does not affect Delta survival because there are no Delta reaches located downstream of the Interior Delta.
[c] Flow into the Yolo Bypass is primarily via the Fremont Weir but flow via Sacramento Weir is also included.



Bold headings label modeled reaches, and red circles indicate model junctions. Salmonid icons indicate locations where smolts enter the Delta in the DPM. Smolts enter the Interior Delta from the Geo/DCC reach. Because of the lack of data informing specific routes through the Interior Delta, and tributary specific survival, the entire Interior Delta region is treated as a single model reach. Note that junction D is not modeled for fish entering the Delta from the Sacramento River basin, as in this analysis.

Figure D.4-5. Map of the Sacramento–San Joaquin River Delta Showing the Modeled Reaches and Junctions of the Delta Applied in the Delta Passage Model

Flow Input Data

Water movement through the Delta as input to the DPM is derived from daily (tidally averaged) flow output produced by the hydrology module of the Delta Simulation Model II (DSM2- HYDRO; <http://baydeltaoffice.water.ca.gov/modeling/deltamodeling/>) or from CALSIM-II.

The nodes in the DSM2-HYDRO and CALSIM II models that were used to provide flow for specific reaches in the DPM are shown in Table D.4-7.

Table D.4-7. Delta Passage Model Reaches and Associated Output Locations from DSM2-HYDRO and CALSIM II Models

DPM Reach or Model Component	DSM2 Output Locations	CALSIM Node
Sac1	rsac155	--
Sac2	rsac128	--
Sac3	rsac123	--
Sac4	rsac101	--
Yolo	--	d160a+d166aa
Verona	--	C160a
SS	slsbt011	--
Geo/DCC	dcc+georg_sl	--
South Delta Export Flow	Clifton Court Forebay + Delta Mendota Canal	--
Sacramento River flow at Fremont Weir	--	C129a

Note:
"–" indicates the cell is blank.

D.4.4.3 MODEL FUNCTIONS

Delta Entry Timing

Recent sampling data on Delta entry timing of emigrating juvenile smolts for six Central Valley Chinook salmon runs were used to inform the daily proportion of juveniles entering the Delta for each run (Table D.4-8). Because the DPM models the survival of smolt-sized juvenile salmon, pre-smolts were removed from catch data before creating entry timing distributions. The lower 95th percentile of the range of salmon fork lengths visually identified as smolts by the USFWS in Sacramento trawls was used to determine the lower length cutoff for smolts. A lower fork length cutoff of 70 mm for smolts was applied, and all catch data of fish smaller than 70 mm were eliminated. To isolate wild production, all fish identified as having an adipose-fin clip (hatchery production) were eliminated, recognizing that most of the fall-run hatchery fish released upstream of Sacramento are not marked. Daily catch data for each brood year were divided by total annual catch to determine the daily proportion of smolts entering the Delta for each brood year. Sampling was not conducted daily at most stations and catch was not expanded for fish caught but not measured. Finally, the daily proportions for all brood years were plotted for each race, and a normal distribution was visually approximated to obtain the daily proportion of smolts entering the DPM for each run (Figure D.4-6). Because a bi-modal distribution appeared evident for winter-run entry timing, a generic probability density function was fit to the winter-run daily proportion data using the package "sm" in R software (R Core Team 2012). The R fitting procedure estimated the best-fit probability distribution of the daily proportion of fish entering the DPM for winter-run. A sensitivity analysis of this assumption was undertaken and showed that patterns in results would be expected to be similar for a range of entry distribution assumptions.

For the current analysis, the most recent data from the Sacramento Trawl survey was added to the previous data to determine if entry distributions had shifted since the original fitting. Only late fall Chinook Salmon exhibited substantial change from the original fit and the entry distribution for that race was updated (Figure D.4-6).

Table D.4-8. Sampling Gear Used to Create Juvenile Delta Entry Timing Distributions for Each Central Valley Run of Chinook Salmon

Chinook Salmon Run	Gear	Agency	Brood Years
Sacramento River Winter Run	Trawls at Sacramento	USFWS	1995–2009
Sacramento River Spring Run	Trawls at Sacramento	USFWS	1995–2005

Agencies that conducted sampling are listed: USFWS = U.S. Fish and Wildlife Service.

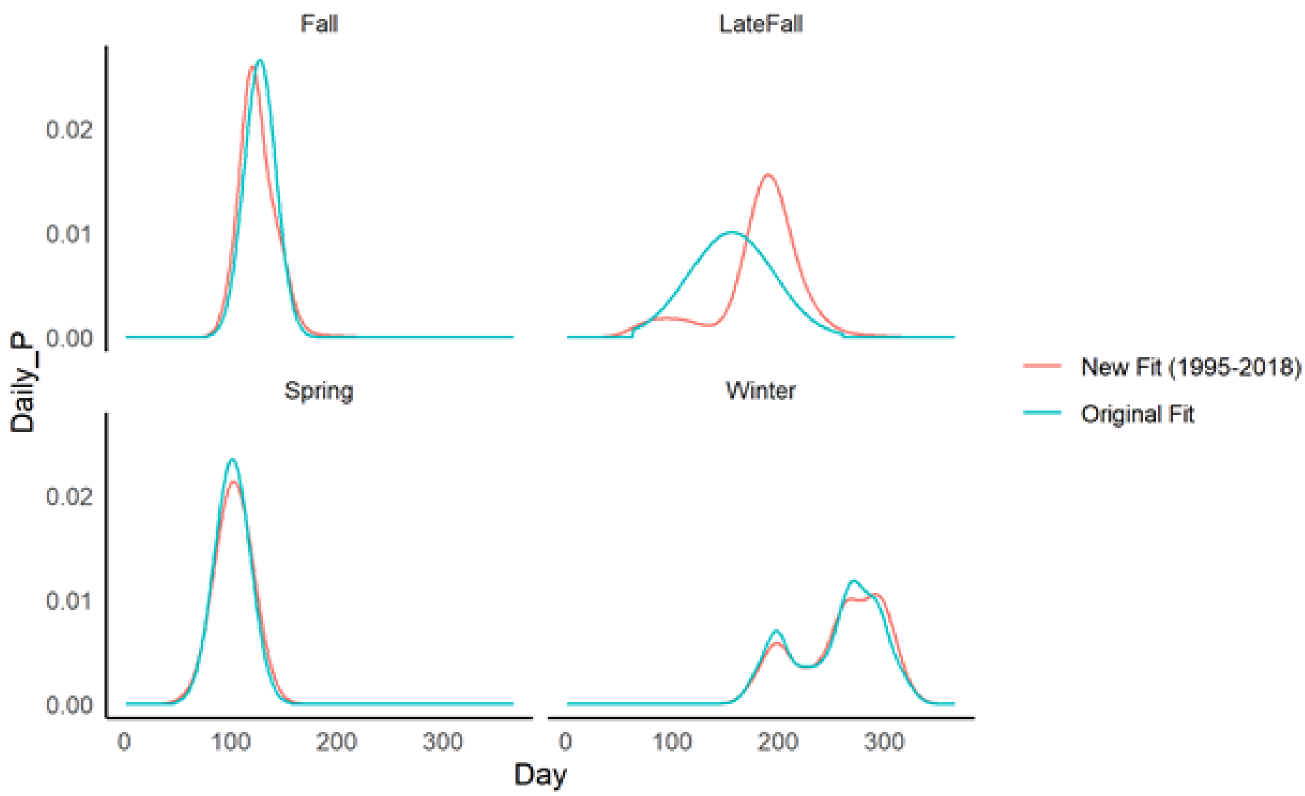


Figure D.4-6. Delta Entry Distributions for Chinook Salmon Smolts Applied in the Delta Passage Model for Sacramento River Winter-Run, Central Valley Spring-Run (from the Sacramento River basin), Central Valley Fall-Run (from the Sacramento River basin), and Central Valley Late Fall–Run[12]

Migration Speed

The DPM assumes a net daily movement of smolts in the downstream direction. The rate of smolt movement in the DPM affects the timing of arrival at Delta junctions and reaches, which can affect route selection and survival as flow conditions or water project operations change.

[12] As previously noted, only Winter-run and Spring-run Chinook Salmon were included in this implementation of the DPM.

Smolt movement in all reaches except Yolo Bypass and the Interior Delta is a function of reach-specific length and migration speed as observed from acoustic-tagging results. Reach-specific length (kilometers [km]) (Table D.4-6) is divided by reach migration speed (km/day) the day smolts enter the reach to calculate the number of days smolts will take to travel through the reach.

For north Delta reaches Verona, Sac1, Sac2, SS, and Geo/DCC, mean migration speed through the reach is predicted as a function of flow. Many studies have found a positive relationship between juvenile Chinook salmon migration rate and flow in the Columbia River Basin (Raymond 1968; Berggren and Filardo 1993; Schreck et al. 1994), with Berggren and Filardo (1993) finding a logarithmic relationship for Snake River yearling Chinook salmon. Ordinary least squares regression was used to test for a logarithmic relationship between reach-specific migration speed (km/day) and average daily reach-specific flow (cubic meters per second [m3/sec]) for the first day smolts entered a particular reach for reaches where acoustic-tagging data was available (Sac1, Sac2, Sac3, Sac4, Geo/DCC, and SS):

$$Speed = \beta_0 \ln(flow) + \beta_1$$

Where β_0 is the slope parameter and β_1 is the intercept.

Individual smolt reach-specific travel times were calculated from detection histories of releases of acoustically tagged smolts conducted in December and January for three consecutive winters (2006/2007, 2007/2008, and 2008/2009) (Perry 2010). Reach-specific migration speed (km/day) for each smolt was calculated by dividing reach length by travel days (Table). Flow data was queried from the California Department of Water Resources (DWR's) California Data Exchange website (<http://cdec.water.ca.gov/>).

Table D.4-9. Reach-Specific Migration Speed and Sample Size of Acoustically-Tagged Smolts Released during December and January for Three Consecutive Winters (2006/2007, 2007/2008, and 2008/2009)

Reach	Gauging Station ID	Release Dates	Sample Size	Avg Speed (km/day)	Min Speed (km/day)	Max Speed (km/day)	SD Speed (km/day)
Sac1	FPT	12/05/06–12/06/06, 1/17/07–1/18/07, 12/04/07–12/07/07, 1/15/08–1/18/08, 11/30/08–12/06/08, 1/13/09–1/19/09	452	13.32	0.54	41.04	9.29
Sac2	SDC	1/17/07–1/18/07, 1/15/08–1/18/08, 11/30/08–12/06/08, 1/13/09–1/19/09	294	9.29	0.34	10.78	3.09
Sac3	GES	12/05/06–12/06/06, 1/17/07–1/18/07, 12/04/07–12/07/07, 1/15/08–1/18/08, 11/30/08–12/06/08, 1/13/09–1/19/09	102	9.24	0.37	22.37	7.33
Sac4	GES[a]	12/05/06–12/06/06, 1/17/07–1/18/07, 12/04/07–12/07/07, 1/15/08–1/18/08, 11/30/08–12/06/08, 1/13/09–1/19/09	62	8.60	0.36	23.98	6.79
Geo/DCC	GSS	12/05/06–12/06/06, 1/17/07–1/18/07, 12/04/07–12/07/07, 1/15/08–1/18/08, 11/30/08–12/06/08, 1/13/09–1/19/09	86	14.20	0.34	25.59	8.66
SS	FPT-SDC[b]	12/05/06–12/06/06, 12/04/07–12/07/07, 1/15/08–1/18/08, 11/30/08–12/06/08, 1/13/09–1/19/09	30	9.41	0.56	26.72	7.42

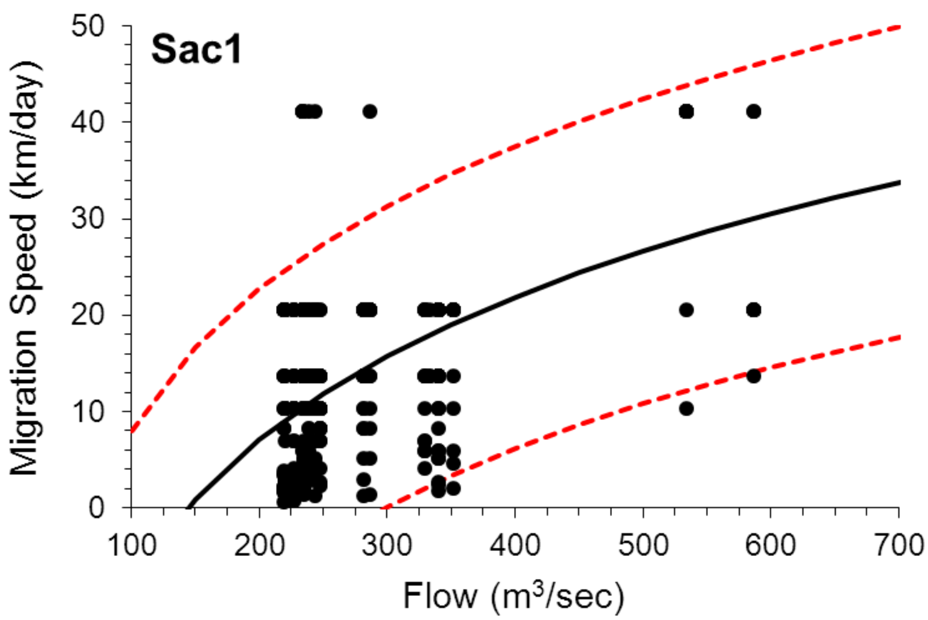
[a] Sac3 flow is used for Sac4 because no flow gauging station is available for Sac4.

[b] SS flow is calculated by subtracting Sac2 flow (SDC) from Sac1 flow (FPT).

Migration speed was significantly related to flow for reaches Sac1 (df = 450, F = 164.36, P < 0.001), Sac2 (df = 292, F = 4.17, P = 0.042), and Geo/DCC (df = 84, F = 13.74, P <0.001). Migration speed increased as flow increased for all three reaches (Table D.4-10, Figure D.4-7). Therefore, for reaches Sac1, Sac2, and Geo/DCC, the regression coefficients shown in Table D.4-10 are used to calculate the expected average migration rate given the input flow for the reach and the associated standard error of the regressions is used to inform a normal probability distribution that is sampled from the day smolts enter the reach to determine their migration speed throughout the reach. The minimum migration speed for each reach is set at the minimum reach-specific migration speed observed from the acoustic-tagging data (Table D.4-4). The flow-migration rate relationship that was used for Sac1 also was applied for the Verona reach.

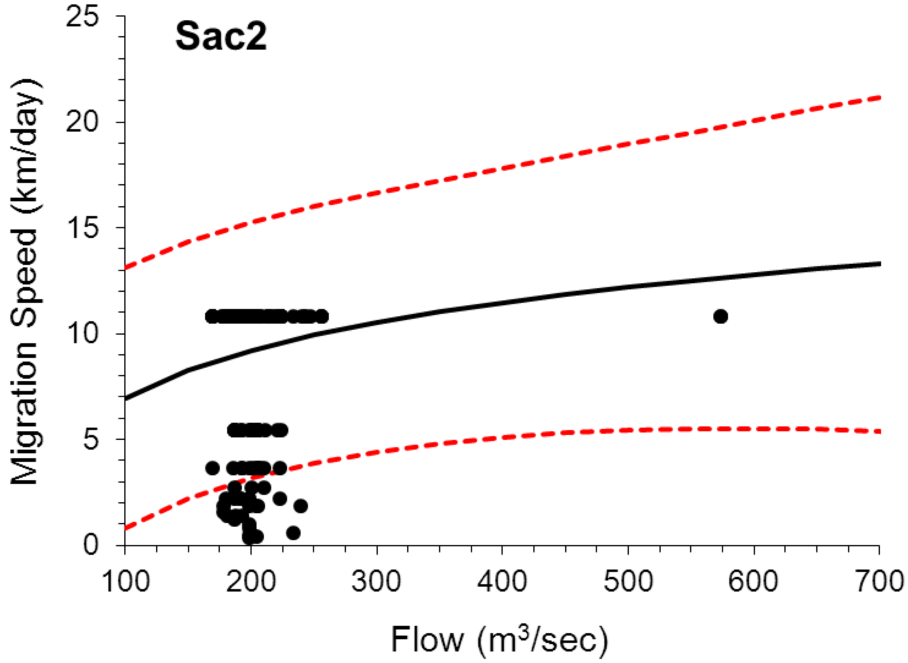
Table D.4-10. Sample Size (N) and Slope (β0) and Intercept (β1) Parameter Estimates with Associated Standard Error (in Parenthesis) for the Relationship between Migration Speed and Flow for Reaches Sac1, Sac2, and Geo/DCC

Reach	Sample Size (N)	Slope [β_0] (with standard error)	Intercept [β_1] (with standard error)
Sac1	452	21.34 (1.66)	-105.98 (9.31)
Sac2	294	3.25 (1.59)	-8.00 (8.46)
Geo/DCC	86	11.08 (2.99)	-33.52 (12.90)



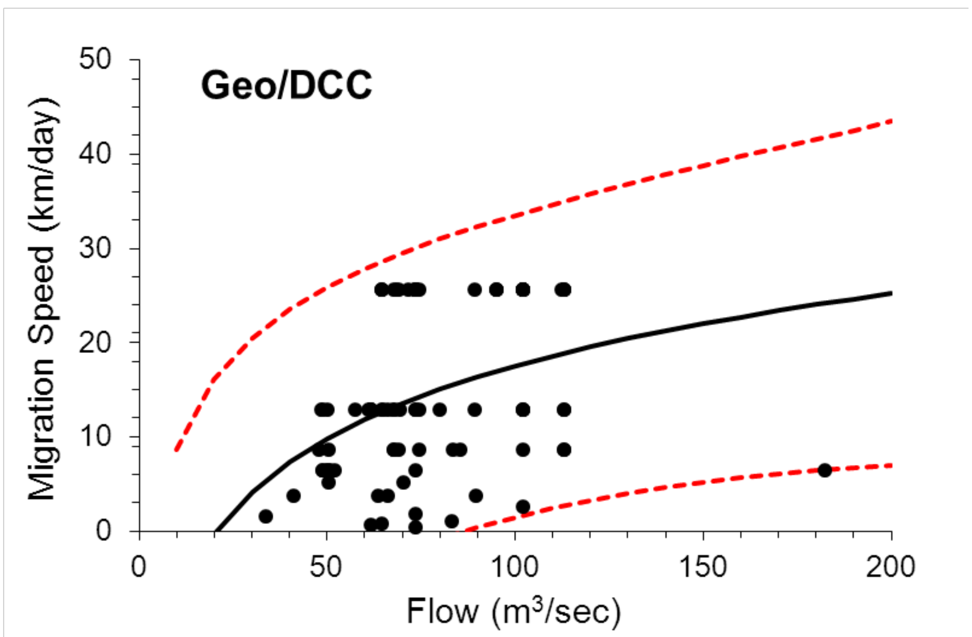
Circles are observed migration speeds of acoustically tagged smolts from acoustic-tagging studies from Perry (2010), solid lines are predicted mean migration speed, and dotted lines are 95% prediction intervals used to inform uncertainty.

Figure D.4-7 a. Reach-Specific Migration Speed (km/day) as a Function of Flow (m^3/sec) Applied in Reach Sac1



Circles are observed migration speeds of acoustically tagged smolts from acoustic-tagging studies from Perry (2010), solid lines are predicted mean reach survival curves, and dotted lines are 95% prediction intervals used to inform uncertainty.

Figure D.4-7 b. Reach-Specific Migration Speed (km/day) as a Function of Flow (m^3/sec) Applied in Reach Sac2



Circles are observed migration speeds of acoustically tagged smolts from acoustic-tagging studies from Perry (2010), solid lines are predicted mean reach survival curves, and dotted lines are 95% prediction intervals used to inform uncertainty.

Figure D.4-7 c. Reach-Specific Migration Speed (km/day) as a Function of Flow (m^3/sec) Applied in Reach Geo/DCC

No significant relationship between migration speed and flow was found for reaches Sac3 (df = 100, F = 1.13, P =0.29), Sac4 (df = 60, F = 0.33, P = 0.57), and SS (df = 28, F = 0.86, P = 0.36). Therefore, for these reaches the observed mean migration speed and associated standard deviation (Table D.4-9) is used to inform a normal probability distribution that is sampled from the day smolts enter the reach to determine their migration speed throughout the reach. As applied for reaches Sac1, Sac2, and Geo/DCC, the minimum migration speed for reaches Sac3, Sac4, and SS is set at the minimum reach-specific migration speed observed from the acoustic-tagging data (Table D.4-9).

Yolo Bypass travel time data from Sommer et al. (2005) for acoustic-tagged, fry-sized (mean size = 57 mm fork length [FL]) Chinook salmon were used to inform travel time through the Yolo Bypass in the DPM. Because the DPM models the migration and survival of smolt-sized juveniles, the range of the shortest travel times observed across all three years (1998–2000) by Sommer et al. (2005) was used to inform the bounds of a uniform distribution of travel times (range = 4–28 days), on the assumption that smolts would spend less time rearing, and would travel faster than fry. On the day smolts enter the Yolo Bypass, their travel time through the reach is calculated by sampling from this uniform distribution of travel times.

The travel time of smolts migrating through the Interior Delta in the DPM is informed by observed mean travel time (7.95 days) and associated standard deviation (6.74) from North Delta acoustic-tagging studies (Perry 2010). However, the timing of smolt passage through the Interior Delta does not affect Delta survival because there are no Delta reaches located downstream of the Interior Delta.

Fish Behavior at Junctions (Channel Splits)

Perry et al. (2010) found that acoustically-tagged smolts arriving at Delta junctions exhibited inconsistent movement patterns in relation to the flow being diverted. For Junction A (entry into the Yolo Bypass at Fremont Weir), the following relationships were used.

- Proportion of smolts entering Yolo Bypass = Fremont Weir spill[13] / (Fremont Weir spill + Sacramento River at Verona flows).

As noted above in *Flow Input Data*, the flow data informing Yolo Bypass entry were obtained by disaggregating CALSIM estimates using historical daily patterns of variability because DSM2 does not provide daily flow data for these locations.

For Junction B (Sacramento River-Sutter/Steamboat Sloughs), Perry et al. (2010) found that smolts consistently entered downstream reaches in proportion to the flow being diverted. Therefore, smolts arriving at Junction B in the model were assumed to move proportionally with flow. Similarly, with data lacking to inform the nature of the relationship, a proportional relationship between flow and fish movement for Junction D (San Joaquin River–Old River) also was applied. Note that the operation of the Head of Old River gate proposed under the PA is accounted for in the DSM2 flow input data (i.e., with a closed gate, relatively more flow [and therefore smolts] remains in the San Joaquin River).

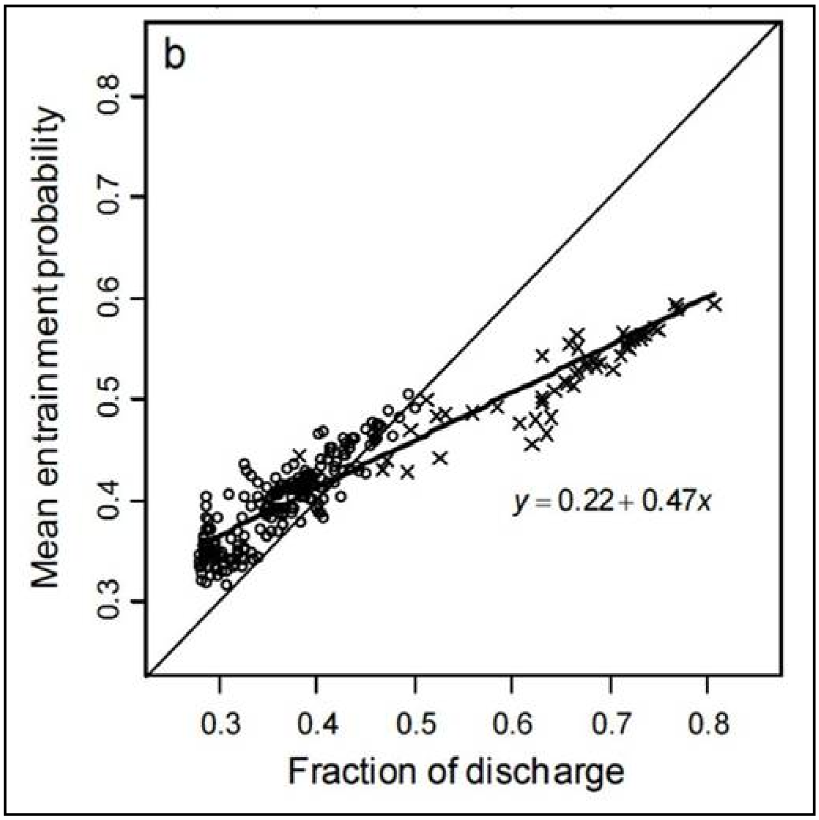
[13] As noted in Table DPM2, Yolo Bypass flow includes spill from both Fremont Weir and Sacramento Weir. The DPM simplifies the occasional entry of fish via Sacramento Weir by adding Sacramento Weir spill to Fremont Weir spill.

For Junction C (Sacramento River–Georgiana Slough/DCC), Perry (2010) found a linear, nonproportional relationship between flow and fish movement. This relationship for Junction C was applied in the DPM:

$$y = 0.22 + 0.47x;$$

where *y* is the proportion of fish diverted into Geo/DCC and *x* is the proportion of flow diverted into Geo/DCC (Figure).

In the DPM, this linear function is applied to predict the daily proportion of fish movement into Geo/DCC as a function of the proportion of flow into Geo/DCC.



Note: Circles Depict DCC Gates Closed, Crosses Depict DCC Gates Open.

Figure D.4-8. Figure from Perry (2010) Depicting the Mean Entrainment Probability (Proportion of Fish Being Diverted into Reach Geo/DCC) as a Function of Fraction of Discharge (Proportion of Flow Entering Reach Geo/DCC)

Route-Specific Survival

Survival through a given route (individual reach or several reaches combined) is calculated and applied the first day smolts enter the reach. For reaches where literature showed support for reach-level responses to environmental variables, survival is influenced by flow (Sac1, Sac2, Sac3 and Sac4 combined, SS and Sac 4 combined, Interior Delta via San Joaquin River, and Interior Delta via Old River) or south Delta water exports (Interior Delta via Geo/DCC). For these reaches, daily flow or exports occurring the day of reach entry are used to predict reach survival during the entire migration period through the reach (Table D.4-11). For all other reaches (Geo/DCC and Yolo), reach survival is assumed to be unaffected by Delta conditions and is informed by means and standard deviations of survival from acoustic-tagging studies.

Table D.4-11. Route-Specific Survival and Parameters Defining Functional Relationships or Probability Distributions for Each Chinook Salmon Run and Methods Section Where Relationship is Described

Route	Chinook Salmon Run	Survival[a]	Methods Section Description
Verona	All Sacramento runs	0.931 (0.02)	This section
Sac1	All Sacramento runs	Function of flow	Flow-Dependent Survival
Sac2	All Sacramento runs	Function of flow	Flow-Dependent Survival
Sac3 and Sac4 combined	All Sacramento runs	Function of flow	Flow-Dependent Survival
Yolo	All Sacramento runs	Various	This section
Sac4 via Yolo[b]	All Sacramento runs	0.698 (0.153)	This section
SS and Sac4 combined	All Sacramento runs	Function of flow	Flow-Dependent Survival
Geo/DCC	All Sacramento runs	0.65 (0.126)	This section
Interior Delta	All Sacramento runs	Function of exports	Export-Dependent Survival
Interior Delta	San Joaquin fall-run via Old River	Function of flow	Flow-Dependent Survival
Interior Delta	San Joaquin fall-run via San Joaquin River	Function of flow	Flow-Dependent Survival

[a] For routes where survival is uninfluenced by Delta conditions, mean survival and associated standard deviation (in parentheses) observed during acoustic-tagging studies (Michel 2010; Perry 2010) are used to define a normal probability distribution that is sampled from the day smolts enter a reach to calculate reach survival.

[b] Although flow influences survival of fish migrating through the combined routes of SS–Sac4 and Sac3–Sac4, flow does not influence Sac4 survival for fish arriving from Yolo.

For reaches Geo/DCC, Yolo, and Sac4 via Yolo, no empirical data were available to support a relationship between survival and Delta flow conditions (channel flow, exports). Therefore, for these reaches mean reach survival is used along with reach-specific standard deviation to define a normal probability distribution that is sampled from when smolts enter the reach to determine reach survival (Table D.4-11).

Mean reach survival and associated standard deviation for Geo/DCC are informed by survival data from smolt acoustic-tagging studies from Perry (2010; Table D.4-12). Smolts migrating down the Sacramento River during the acoustic-tagging studies could enter the DCC or Georgiana Slough when the DCC was open (December releases), therefore, group survivals for both routes are used to inform the mean survival and associated standard deviation for the Geo/DCC reach for Sacramento River runs.

Smolt survival data for the Yolo Bypass were obtained from the UC Davis Biotelemetry Laboratory (M. Johnston pers. comm.). These data included survival estimates for five reaches from release near the head of the bypass to the base of the bypass. The means (and standard errors) of these estimates defined normal probability distributions from which daily value for the DPM were drawn, and were as follows: reach 1 (release site): 1.00; reach 2 (release site to I-80): 0.96 (SE = 0.059); reach 3 (I-80 to screw trap): 0.96 (0.064); reach 4 (screw trap to base of Toe Drain): 0.94 (0.107); reach 5 (base of Toe Drain to base of Bypass): 0.88 (0.064). Fish leaving the Yolo reach in the model then entered Sac4 and were subject to survival at the rate shown in Table D.4-11.

Mean survival and associated standard deviation for the Verona reach between Fremont Weir and Yolo Bypass were derived from the 2007–2009 acoustic-tag study reported by Michel (2010), who did not find a flow-survival relationship for that reach.

Table D.4-12. Individual Release-Group Survival Estimates, Release Dates, Data Sources, and Associated Calculations Used to Inform Reach-Specific Mean Survivals and Standard Deviations Used in the Delta Passage Model for Reaches Where Survival Is Uninfluenced by Delta Conditions - Table D.4-12 a - D.4-12 b

Table D.4-12 a. Individual Release-Group Survival Estimates, Release Dates, Data Sources, and Associated Calculations Used to Inform Reach-Specific Mean Survivals and Standard Deviations Used in the Delta Passage Model for Reaches Where Survival Is Uninfluenced by Delta Conditions - Geo/DCC via Sacramento River

Survival	Release Dates	Survival Calculation	Mean	Standard Deviation
0.648	12/05/06	S_{D1}	0.559	0.194
0.600	12/04/07–12/06/07	$S_{D1,SAC}$*S_{D2}	0.559	0.194
0.762	1/15/08–1/17/08	$S_{D1,SAC}$*S_{D2}	0.559	0.194
0.774	11/31/08–12/06/08	$S_{D1,SAC}$*S_{D2}	0.559	0.194
0.467	1/13/08–1/19/09	$S_{D1,SAC}$*S_{D2}	0.559	0.194
0.648	12/05/06	S_{C1}* S_{C2}	0.559	0.194
0.286	12/04/07–12/06/07	S_{C1}	0.559	0.194
0.286	11/31/08–12/06/08	S_{C1}	0.559	0.194

Source: Perry 2010.

Table D.4-12 b. Individual Release-Group Survival Estimates, Release Dates, Data Sources, and Associated Calculations Used to Inform Reach-Specific Mean Survivals and Standard Deviations Used in the Delta Passage Model for Reaches Where Survival Is Uninfluenced by Delta Conditions - Sac4 via Yolo

Survival	Release Dates	Survival Calculation	Mean	Standard Deviation
0.714	12/5/2006	S_{A6}*S_{A7}	0.698	0.153
0.858	1/17/2007	S_{A6}*S_{A7}	0.698	0.153
0.548	12/4/07-12/6/07	S_{A7}*S_{A8}	0.698	0.153
0.488	1/15/08-1/17/08	S_{A7}*S_{A8}	0.698	0.153
0.731	11/31/08-12/06/08	S_{A7}*S_{A8}	0.698	0.153
0.851	1/13/09-1/19/09	S_{A7}*S_{A8}	0.698	0.153

Source: Perry 2010.

Flow-Dependent Survival

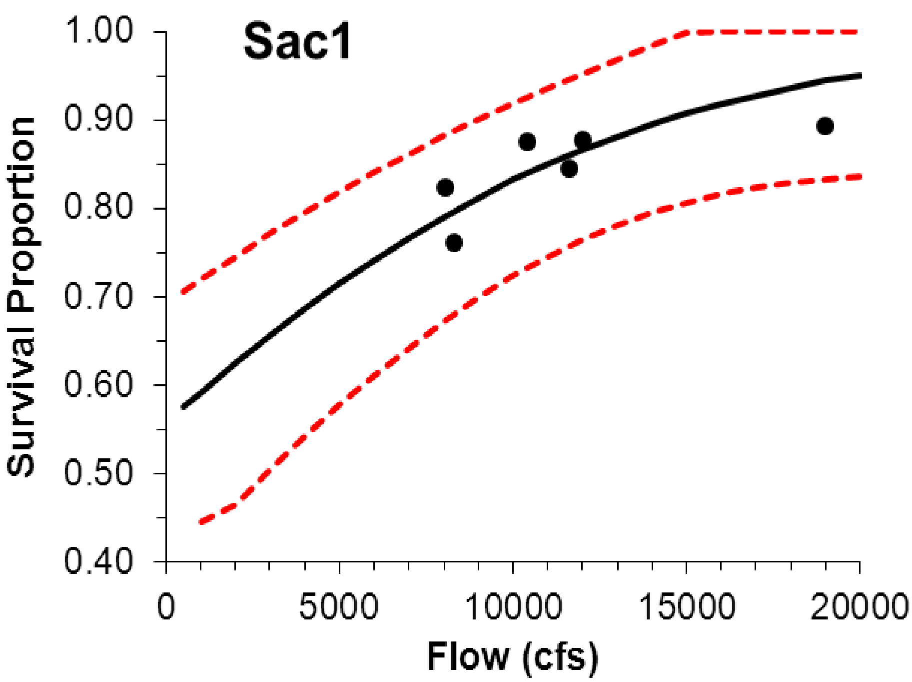
For reaches Sac1, Sac2, Sac3 and Sac4 combined, and SS and Sac4 combined, flow values on the day of route entry are used to predict route survival (Figure D.4-9). Perry (2010) evaluated the relationship between survival among acoustically-tagged Sacramento River smolts and Sacramento River flow measured below Georgiana Slough (DPM reach Sac3) and found a significant relationship between survival and flow during the migration period for smolts that migrated through Sutter and Steamboat Sloughs to Chipps Island (Sutter and Steamboat route; SS and Sac4 combined) and smolts that migrated from the junction with Georgiana Slough to Chipps Island (Sacramento River route; Sac3 and Sac4 combined). Therefore, for route Sac3 and Sac4 combined and route SS and Sac4 combined, the logit survival function from Perry (2010) was used to predict mean reach survival (S) from reach flow (flow):

$$S = \frac{e^{(\beta_0 + \beta_1 flow)}}{1 + e^{(\beta_0 + \beta_1 flow)}}$$

where β_0 (SS and Sac4 = -0.175, Sac3 and Sac4 = -0.121) is the reach coefficient and β_1 (0.26) is the flow coefficient, and *flow* is average Sacramento River flow in reach Sac3 during the experiment standardized to a mean of 0 and standard deviation of 1.

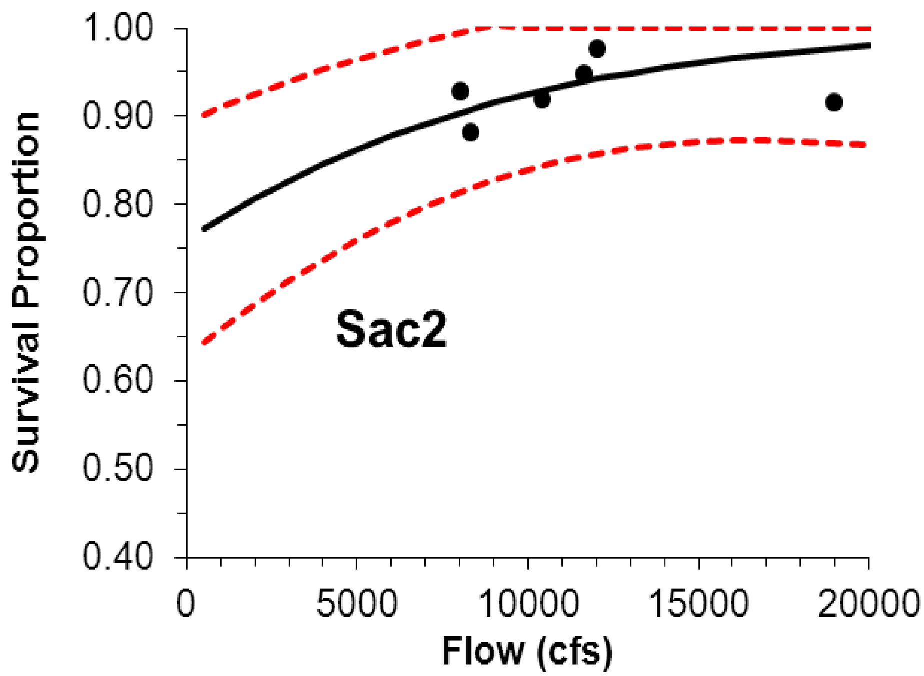
Perry (2010) estimated the global flow coefficient for the Sutter Steamboat route and Sacramento River route as 0.52. For the Sac3 and Sac4 combined route and the SS and Sac4 combined route, mean survival and associated standard error predicted from each flow-survival relationship is used to inform a normal probability distribution that is sampled from the day smolts enter the route to determine their route survival.

With a flow-survival relationship appearing evident for group survival data of acoustically-tagged smolts in reaches Sac1 and Sac2, Perry's (2010) relationship was applied to Sac1 and Sac2 while adjusting for the mean reach-specific survivals for Sac1 and Sac2 observed during the acoustic-tagging studies (Figure E4.-9; Table D.4-13). The flow coefficient was held constant at 0.52 and the residual sum of squares of the logit model was minimized about the observed Sac1 and Sac2 group survivals, respectively, while varying the reach coefficient. The resulting reach coefficients for Sac1 and Sac2 were 1.27 and 2.16, respectively. Mean survival and associated standard error predicted from the flow-survival relationship is used to inform a normal probability distribution that is sampled from the day smolts enter the reach to determining Sac1 and Sac2 reach survival.



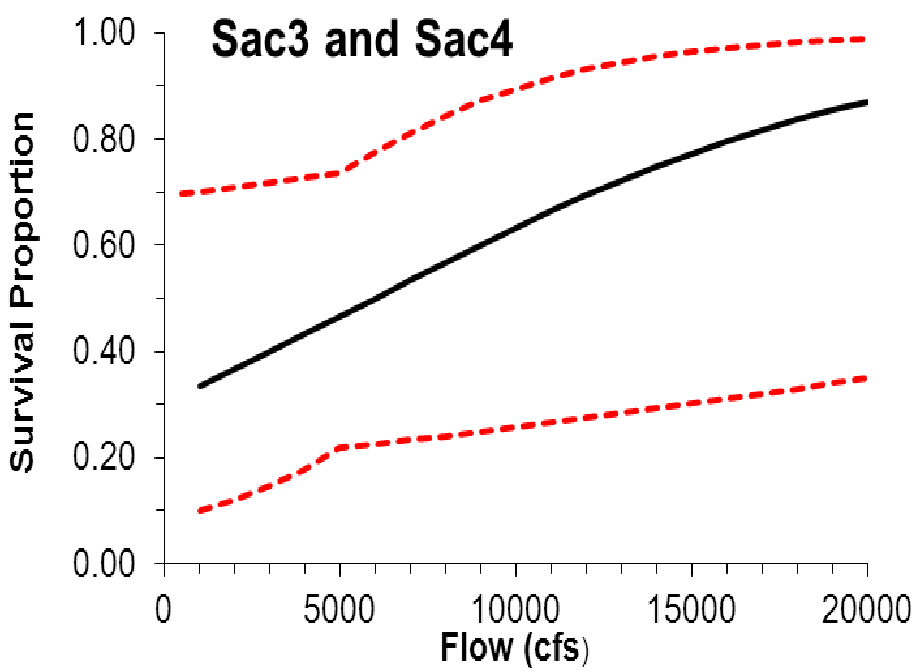
Circles are observed group survivals from acoustic-tagging studies from Perry (2010). Solid lines are predicted mean route survival curves, and dotted lines are 95% confidence bands used to inform uncertainty.

Figure D.4-9 a. Route Survival as a Function of Flow Applied in Sac 1 Reach.



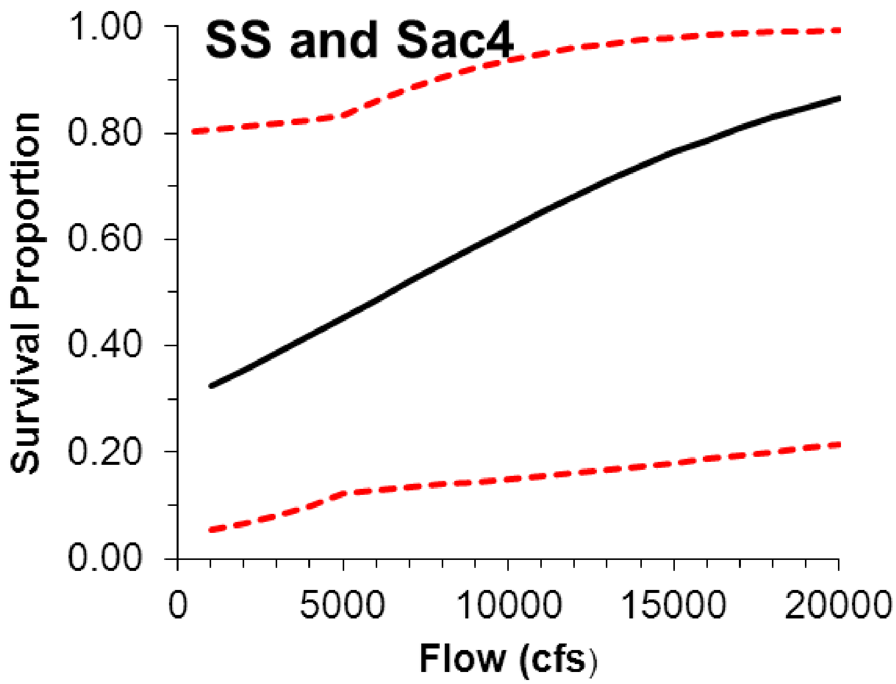
Circles are observed group survivals from acoustic-tagging studies from Perry (2010). Solid lines are predicted mean route survival curves, and dotted lines are 95% confidence bands used to inform uncertainty.

Figure D.4-9 b. Route Survival as a Function of Flow Applied in Sac 2 Reach.



Solid lines are predicted mean route survival curves, and dotted lines are 95% confidence bands used to inform uncertainty.

Figure D.4-9 c. Route Survival as a Function of Flow Applied in combined Sac3 and Sac4 Reach.



Solid lines are predicted mean route survival curves, and dotted lines are 95% confidence bands used to inform uncertainty.

Figure D.4-9 d. Route Survival as a Function of Flow Applied in combined SS and Sac4 reach.

Table D.4-13. Group Survival Estimates of Acoustically-Tagged Chinook Salmon Smolts from Perry (2010) and Associated Calculations Used to Inform Flow-Dependent Survival Relationships for Reaches Sac1 and Sac2

DPM Reach	Survival	Release Dates	Survival Calculation
Sac1	0.844	12/5/06	SA1 *SA2
Sac1	0.876	1/17/07	SA1 *SA2
Sac1	0.874	12/4/07-12/6/07	SA1 *SA2
Sac1	0.892	1/15/08-1/17/08	SA1 *SA2
Sac1	0.822	11/31/08-12/06/08	SA1 *SA2
Sac1	0.760	1/13/09-1/19/09	SA1 *SA2
Sac2	0.947	12/5/06	SA3
Sac2	0.976	1/17/07	SA3
Sac2	0.919	12/4/07-12/6/07	SA3
Sac2	0.915	1/15/08-1/17/08	SA3
Sac2	0.928	11/31/08-12/06/08	SA3
Sac2	0.881	1/13/09-1/19/09	SA3

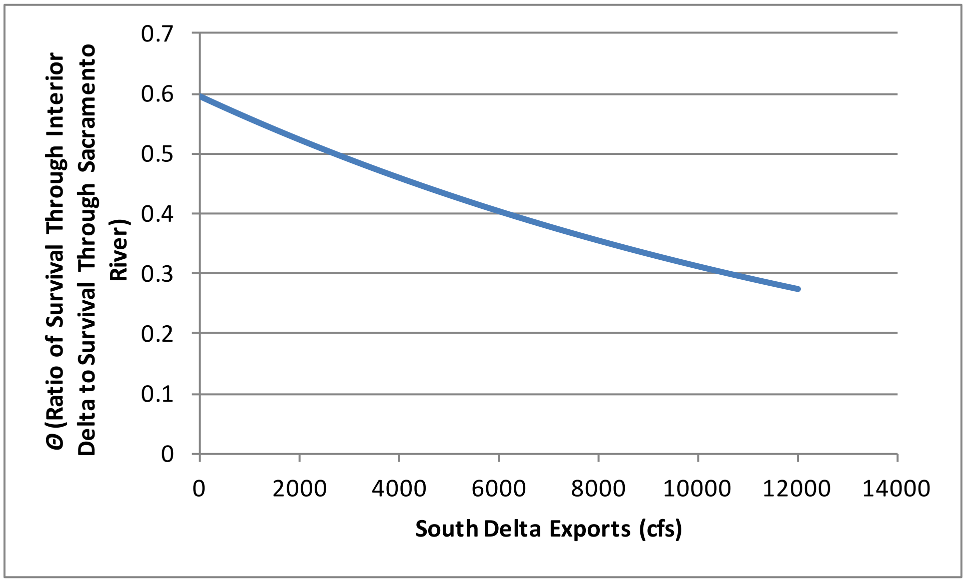
Source: Perry 2010.

Export-Dependent Survival

As migratory juvenile salmon enter the Interior Delta from Geo/DCC for Sacramento River Chinook Salmon, they transition to an area strongly influenced by tides and where south Delta water exports may influence survival. The export–survival relationship described by Newman and Brandes (2010) was applied as follows:

$$\theta = 0.5948 * e^{(-0.000065 * Total\_Exports)}$$

where ϑ is the ratio of survival between coded wire tagged smolts released into Georgiana Slough and smolts released into the Sacramento River and Total Exports is the flow of water (cfs) pumped from the Delta from the State and Federal facilities. ϑ is a ratio and ranges from just under 0.6 at zero south Delta exports to ~0.27 at 12,000-cfs south Delta exports (D.4-6).



Source: Newman and Brandes 2010

Figure D.4-10. Relationship between θ (Ratio of Survival through the Interior Delta to Survival through Sacramento River) and South Delta Export Flows

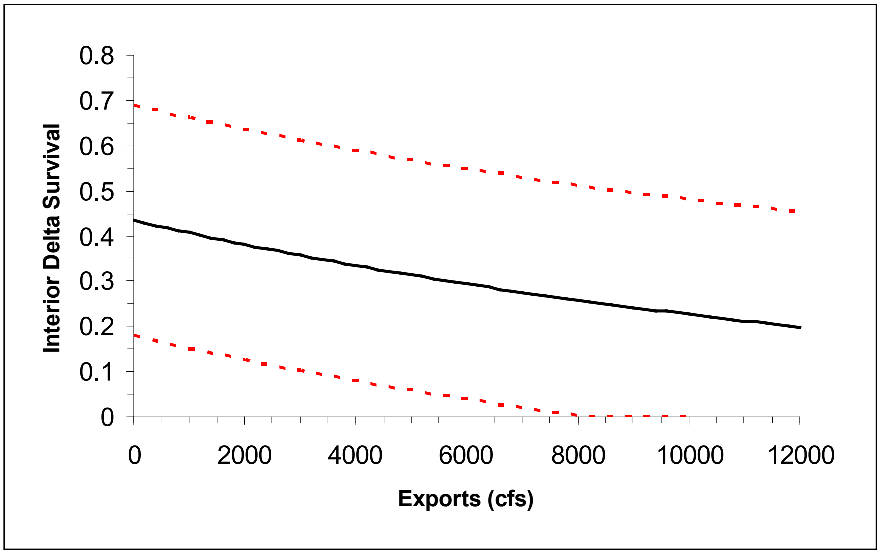
ϑ was converted from a ratio into a value of survival through the Interior Delta using the equation:

$$S_{ID} = \frac{\theta}{S_{Geo/DCC}} * (S_{Sac3} * S_{Sac4})$$

where S_{ID} is survival through the Interior Delta, ϑ is the ratio of survival between Georgiana Slough and Sacramento River smolt releases, $S_{Geo/DCC}$ is the survival of smolts in the Georgiana Slough/Delta Cross Channel reach, S_{Sac3} * S_{Sac4} is the combined survival in reaches Sac 3 and Sac 4 (Figure)[14].

Uncertainty is represented in this relationship by using the estimated value of θ and the standard error of the equation to define a normal distribution bounded by the 95% prediction interval of the model that is then re-sampled each day to determine the value of θ.

[14] Although daily survivals in Sac3/Sac4 are used to calculate Sacramento River survival for Sacramento River runs (winter-run, spring-run, Sacramento fall-run, and late fall–run), the combined Sac3/Sac4 survival used to calculate Sacramento River survival would be slightly different than that used to calculate interior Delta survival because of the travel time required for smolts to reach the interior Delta via Geo/DCC.



Survival values in reaches Sac3, Sac4, and Geo/DCC were held at mean values observed during acoustic-tag studies (Perry 2010) to depict export effect on Interior Delta survival in this plot. Dashed lines are 95% prediction bands used to inform uncertainty in the relationship.

Figure D.4-11. Interior Delta Survival as a Function of Delta Exports (Newman and Brandes 2010) as Applied for Sacramento Races of Chinook Salmon Smolts Migrating through the Interior Delta via Reach Geo/DCC

D.4.5 Structured Decision Model (Chinook Salmon Routing Application)

The Delta Structured Decision Model Chinook Salmon Routing Application was developed by the Central Valley Project Improvement Act Science Integration Team to evaluate the effect of different management decisions on the survival and routing of juvenile Fall-Run Chinook Salmon. The model relies on survival-environment relationships and routing-environment relationships from acoustic studies conducted in the Sacramento and San Joaquin Rivers and at the state and federal south Delta export facilities. Here only the results from the San Joaquin River sub model were reported, with separate analyses conducted for Fall-Run and Spring-Run Chinook Salmon. The model and documentation has not been finalized and the code for the most recent model version used here used was accessed at https://github.com/FlowWest/chinookRoutingApp. Total South Delta Survival probability was unmodified from the Routing Application's original "SouFish" equation, which defines survival to Chipps Island for South Delta-routed fish as:

SouFish =

(S_prea * psi_sjr1 * S_a * psi_sjr2 * S_bc) + (S_prea * psi_sjr1 * S_a * psi_TC * S_efc) +

(S_prea * psi_OR * S_d * psi_ORN * S_efc) + (S_prea * psi_OR * S_d * psi_CVP * S_CVP) +

(S_prea * psi_OR * S_d * psi_SWP * S_SWP).

Model functions, parameters, and inputs used for this analysis are described in Table D.4-14. Where inputs were not available, they were assumed to be the mean values for the studies used to establish the model parameters. For implementation of the effects analysis, the model was run using DPM Delta entry weightings for Fall-Run Chinook Salmon from the San Joaquin River basin; Delta entry weightings for Spring-Run Chinook Salmon from the Sacramento River basin were assumed to be representative of daily weightings of Spring-Run Chinook Salmon from the San Joaquin River basin.

Table D.4-14. Functions, Parameter Calculations, and Inputs Used in the Structured Decision Model Chinook Salmon Routing Application San Joaquin Sub Model

Function	Parameters	Inputs
S_prea = survival through the tributaries to the Head of Old River (HOR)	inv.logit(5.77500 + 0.00706 * Q_vern - 0.32810 * Temp_vern + 0.152 *(FL-155.1) / 21.6)	Q_vern (Flow at Vernalis): DSM2 Temp_vern (Temperature at Vernalis): 16.7C FL (Fork length): 120mm
psi_sjr1 = probability of remaining in SJR at HOR	inv.logit(-0.75908 + 1.72020 * hor_barr + 0.00361 * Q_vern + 0.02718 * hor_barr * Q_vern)	hor_barr (Head of Old River barrier): DSM2 (Existing), 0 (Proposed) Q_vern: DSM2
S_a = survival from the HOR to Turner Cut	inv.logit(-2.90330 + 0.01059 * Q_vern + 0.152 * (FL - 155.1) / 21.6)	Q_vern: DSM2 FL: 120mm
psi_sjr2 = the probability of remaining in SJR at Turner Cut	inv.logit(5.83131 - 0.037708993 * Q_stck)	Q_stck (Flow at Stockton): DSM2
S_bc = survival from SJR Turner Cut to Chipps	inv.logit(13.41840 - 0.90070 * Temp_pp + 0.152 * (FL - 155.1) / 21.6)	Temp_pp: 17.8C FL: 120mm
psi_TC = probability of taking Turner Cut	psi_TC <- 1 - psi_sjr2	See psi_sjr2 above
psi_OR = probability of entering Old River	1 - psi_sjr1	See psi_sjr1 above
S_d = Survival down OR to HOR to CVP	inv.logit(2.16030 - 0.20500 * Temp_vern + 0.152 * (FL - 155.1)/21.6)	Temp_vern: 16.7C FL: 120mm
psi_ORN = probability of remaining in Old River North	1 - psi_CVP - psi_SWP	See psi_CVP and psi_SWP, below
S_efc = Survival from Old River North to Chipps Island (San Joaquin River Group Authority)	0.01	0.01
psi_CVP = probability of entrainment at CVP	inv.logit(-3.9435 + 2.9025 * no.pump - 0.3771 * no.pump ^ 2)	no.pump (Number of CVP pumps in operation): DSM2*
psi_SWP = probability of entrainment at SWP	(1 - psi_CVP) * inv.logit(-1.48969 + 0.016459209 * SWP_exp)	SWP_exp (SWP exports): DSM2
S_CVP = survival through CVP (Karp et al. 2017)	inv.logit(-3.0771 + 1.8561 * no.pump - 0.2284 * no.pump ^ 2)	no.pump: DSM2*
S_SWP = survival through SWP (Gingras 1997)	0.1325	0.1325

*The model calculates the number of pumps based on DSM2 export inputs (cfs)

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APPENDIX E

CalSim II and DSM2 Model Descriptions and Assumptions

Appendix E

E.1 Introduction

The results of model simulations are provided for informational purposes. Please do not use any information contained in these products for any purpose other than this ITP Application process. If there are any questions regarding the results of these model simulations, please contact DWR.

Any use of results of model simulations should observe limitations of the models used as well as the limitations to the modeled alternatives. These results should only be used for comparative purposes. More information regarding limitations of the models used as well as the limitations to the modeled alternatives is included Appendix E Attachment 1-7 Model Limitations.

E.2 Modeled Alternatives

The following alternatives were prepared:

- Existing Conditions (EX)
- Proposed Project (PP)

The assumptions used for each alternative and each model listed above are documented in the following attachments:

- Appendix E Attachment 1-1 Model Assumptions
- Appendix E Attachment 1-2 CalSim II Model Assumptions Callouts
- Appendix E Attachment 1-3 DSM2 Model Assumptions Callouts

The following attachments contain documentation of model assumptions and limitations:

- Appendix E Attachment 1-4 Scenario Related Changes to CalSim II and DSM2
- Appendix E Attachment 1-5 SWP Contribution
- Appendix E Attachment 1-6 DSM2-PTM
- Appendix E Attachment 1-7 Model Limitations
- Appendix E Attachment 1-8 CalSim II Assumptions and Real Time Operations
- Appendix E Attachment 1-9 Hydrology Analysis for Spring Outflow Scenario

The following is a summary of the alternatives and the models used.

Existing Conditions

The Existing Conditions represents CVP and SWP operations to comply with the "current" regulatory environment as of (April 22, 2019). The Existing Conditions assumptions include existing facilities and ongoing programs that existed as of April 22, 2019- publication date of the Notice of Preparation (NOP). The Existing Conditions assumptions also include facilities and programs that received approvals and permits by April, 2019 because those programs were consistent with existing management direction as of the NOP.

Proposed Project

The proposed project is the DWR on-going long-term operation of the State Water Project (SWP) consistent with existing regulatory requirements that address water rights, water quality, and the protection and conservation of designated species in compliance with California Endangered Species Act (CESA). The goal of the proposed project is to continue the long-term operation of the SWP for water supply and power generation, consistent with applicable laws, contractual obligations, and agreements, and to increase operational flexibility by focusing on nonoperational measures to avoid significant adverse effects. DWR proposes to store, divert, and convey water in accordance with existing water contracts and agreements up to full contract amounts and other deliveries, consistent with water rights and applicable laws and regulations.

The following model simulations were prepared for each alternative:

- CalSim II
- DSM2

E.3 CalSim II

Reclamation / DWR CalSim II planning model was used to simulate the coordinated operation of the CVP and SWP over a range of hydrologic conditions. CalSim II is a generalized reservoir-river basin simulation model that allows for specification and achievement of user-specified allocation targets, or goals (Draper et al. 2004). CalSim II represents the best available planning model for CVP and SWP system operations and has been used in previous system-wide evaluations of CVP and SWP operations (U.S. Bureau of Reclamation 2015).

Salinity in the Sacramento-San Joaquin Delta is critical to project and ecosystem management. Operation of CVP/SWP facilities and management of Delta flows often depends on salinity standards. An Artificial Neural Network (ANN) was developed (Sandhu et al. 1999) to estimate flow – salinity relationships modeled by DSM2 (described below). The ANN is utilized in CalSim II to ensure upstream reservoir operations and Delta exports meet select D1641 salinity requirements in the Delta. More details regarding the ANN and its implementation in CalSim II can be found in Wilbur and Munévar (2001).

E.4 DSM2

DSM2 is a one-dimensional hydrodynamic and water quality simulation model used to simulate hydrodynamics, water quality, and particle tracking in the Sacramento-San Joaquin Delta (DWR, 2019). DSM2 represents the best available planning model for Delta tidal hydraulic and salinity modeling. It is appropriate for describing the existing conditions in the Delta, as well as performing simulations for the assessment of incremental environmental impacts caused by future facilities and operations (U.S. Bureau of Reclamation 2015).

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Attachment 1-1 Model Assumptions

1 Introduction

The following model simulations were prepared to evaluate the impacts of different project:

- Existing Conditions (EX)
- Proposed Project (PP)

Sections 2 and 3 describe the assumptions used for each model simulation. Section 4 lists references cited.

The assumptions for all model simulations are also summarized in table format in the following attachments:

- Appendix E Attachment 1-2 CalSim II Model Assumptions Callouts
- Appendix E Attachment 1-3 DSM2 Model Assumptions Callouts
- Appendix E Attachment 1-4 Scenario Related Changes to CalSim II and DSM2
- Appendix E Attachment 1-5 SWP Contribution
- Appendix E Attachment 1-6 DSM2 – PTM
- Appendix E Attachment 1-7 Model Limitations
- Appendix E Attachment 1-8 CalSim II Assumptions and Real Time Operations
- Appendix E Attachment 1-9 Hydrology Analysis for Spring Outflow Scenario

Any use of results of model simulations should observe limitations of the models used as well as the limitations to the modeled alternatives. These results should only be used for comparative purposes. More information regarding limitations of the models used is included Appendix E Attachment 1-7 Model Limitations.

2 Assumptions for the Existing Conditions

This section presents the assumptions used in developing the CalSim II and DSM2, Model simulations of the Existing Conditions considered for the EIR.

The Existing Conditions represents SWP operations to comply with the “current” regulatory environment as of (2019). The Existing Conditions assumptions include existing facilities and ongoing programs that existed as of April 22, 2019- publication date of the Notice of Preparation (NOP).

The Existing Conditions assumptions also include facilities and programs that received approvals and permits by April, 2019 because those programs were consistent with existing management direction as of the NOP.

2.1 CalSim II Assumptions for the Existing Conditions

The following is a description of the assumptions tabulated in Appendix E Attachment 1-2 CalSim II Model Assumptions Callouts.

Hydrology

Inflows/Supplies

The CalSim II model includes the historical hydrology.

Level of Development

CalSim II uses a hydrology which is the result of an analysis of agricultural and urban land use and population estimates. The assumptions used for Sacramento Valley land use result from aggregation of historical survey and projected data developed for the California Water Plan Update (Bulletin 160-98). Generally, land use projections are based on Year 2020 estimates (hydrology serial number 2020D09E), however the San Joaquin Valley hydrology reflects draft 2030 land use assumptions developed by Reclamation. Where appropriate Year 2020 projections of demands associated with water rights and CVP and SWP water service contracts have been included. Specifically, projections of full build out are used to describe the American River region demands for water rights and CVP contract supplies, and California Aqueduct and the Delta Mendota Canal SWP/CVP contractor demands are set to full contract amounts.

CVP Settlement Contractor Consumptive Use of Applied Water (CUAW) Demands are modified to match historical annual volumes and monthly distributions, based on historical data from 2000 – 2016. The monthly distributions of annual contract amounts were also modified to match the distributions of CUAW demand.

Demands, Water Rights, CVP/SWP Contracts

CalSim II demand inputs are preprocessed monthly time series for a specified level of development (e.g. 2020) and according to hydrologic conditions. Demands are classified as CVP project, SWP project, local project or non-project. CVP and SWP demands are separated into different classes based on the contract type. A description of various demands and classifications included in CalSim II is provided in the 2008 OCAP BA Appendix D (USBR, 2008a).

The detailed listing of CVP and SWP contract amounts and other water rights assumptions are included in the delivery specification tables in Appendix E Attachment 1-2 CalSim II Model Assumptions Callouts.

Facilities

All CVP-SWP existing facilities are simulated based on operations criteria under current regulatory environment.

CalSim II includes representation of all the existing CVP and SWP storage and conveyance facilities. Assumptions regarding selected key facilities are included in the callout tables in Appendix E Attachment 1-2 CalSim II Model Assumptions Callouts.

CalSim II also represents the flood control weirs such as the Fremont Weir located along the Sacramento River at the upstream end of the Yolo Bypass (Reclamation, 2017).

The Existing Conditions also includes the Freeport Regional Water Project, located along the Sacramento River near Freeport and the City of Stockton Delta Water Supply Project (30 mgd capacity).

A brief description of the key export facilities that are located in the Delta and included under the Existing Conditions run is provided below.

The Delta serves as a natural system of channels to transport river flows and reservoir storage to the CVP and SWP facilities in the south Delta, which export water to the projects' contractors through two pumping plants: CVP's C.W. Jones Pumping Plant and SWP's Harvey O. Banks Pumping Plant. Jones and Banks Pumping Plants supply water to agricultural and urban users throughout parts of the San Joaquin Valley, South Lahontan, Southern California, Central Coast, and South San Francisco Bay Area regions.

The Contra Costa Canal and the North Bay Aqueduct supply water to users in the northeastern San Francisco Bay and Napa Valley areas.

Fremont Weir

Fremont Weir is a flood control structure located along the Sacramento River at the head of the Yolo Bypass.

CVP C.W. Bill Jones Pumping Plant (Tracy PP) Capacity

The Jones Pumping Plant consists of six pumps including one rated at 800 cfs, two at 850 cfs, and three at 950 cfs. Maximum pumping capacity is assumed to be 4,600 cfs with the 400 cfs Delta Mendota Canal (DMC) –California Aqueduct Intertie that became operational in July 2012.

SWP Banks Pumping Plant Capacity

SWP Banks pumping plant has an installed capacity of about 10,300 cfs. The SWP water rights for diversions specify a maximum of 10,300 cfs, but the U. S. Army Corps' of Engineers (ACOE) permit for SWP Banks Pumping Plant allows a maximum pumping of 6,680 cfs. With additional diversions depending on Vernalis flows the total diversion can go up to 10,300 cfs during December 15 – March 15. Additional capacity of 500 cfs (pumping limit up to 7,180 cfs) is allowed to reduce impact of NMFS BO Action IV.2.1 on the SWP.

CCWD Intakes

The Contra Costa Canal originates at Rock Slough, about four miles southeast of Oakley, and terminates after 47.7 miles at Martinez Reservoir. Historically, diversions at the unscreened Rock Slough facility (Contra Costa Canal Pumping Plant No. 1) have ranged from about 50 to 250 cfs. The canal and associated facilities are part of the CVP; but are operated and maintained by the Contra Costa Water District (CCWD). CCWD also operates a diversion on Old River and the Alternative Intake Project (AIP), the new drinking water intake at Victoria Canal, about 2.5 miles east of Contra Costa Water District's (CCWD) intake on the Old River. CCWD can divert water to the Los Vaqueros Reservoir to store good quality water when available and supply to its customers.

Regulatory Standards

The regulatory standards that govern the operations of the CVP and SWP facilities under the Existing Conditions are briefly described below. Specific assumptions related to key regulatory standards are also outlined below.

D-1641 Operations

The SWRCB Water Quality Control Plan (WQCP) and other applicable water rights decisions, as well as other agreements are important factors in determining the operations of both the Central Valley Project (CVP) and the State Water Project (SWP).

The December 1994 Accord committed the CVP and SWP to a set of Delta habitat protective objectives that were incorporated into the 1995 WQCP and later, were implemented by D-1641. Significant elements in D-1641 include X2 standards, export/inflow (E/I) ratios, Delta water quality standards, real-time Delta Cross Channel operation, and San Joaquin flow standards.

Coordinated Operations Agreement (COA)

The CVP and SWP use a common water supply in the Central Valley of California. Reclamation and DWR have built water conservation and water delivery facilities in the Central Valley in order to deliver water supplies to project contractors. The water rights of the projects are conditioned by the SWRCB to protect the beneficial uses of water within each respective project and jointly for the protection of beneficial uses in the Sacramento Valley and the Sacramento-San Joaquin Delta Estuary. The agencies coordinate and operate the CVP and SWP to meet the joint water right requirements in the Delta.

The Coordinated Operations Agreement (COA), signed in 1986, defines the project facilities and their water supplies, sets forth procedures for coordination of operations, identifies formulas for sharing joint responsibilities for meeting Delta standards as they existed in SWRCB Decision 1485 (D-1485), identifies how unstored flow will be shared, sets up a framework for exchange of water and services between the Projects, and provides for periodic review of the agreement.

DWR and Reclamation re-negotiated COA in 2018. The amendment stipulates a change in responsibility for making storage withdrawals to meet in-basin use (as noted in Table 1) and a change in export capacity when exports are constrained (Table 2).

Table 1. Sharing of Responsibility for Meeting In-basin Use

–	**CVP**	**SWP**
W	80%	20%
AN	80%	20%
BN	75%	25%
D	65%	35%
C	60%	40%

Note:

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Table 2. Sharing of Applicable Export Capacity When Exports Are Constrained

–	CVP	SWP
Balanced Water Conditions	65%	35%
Excess Water Conditions	60%	40%

Note:
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CVPIA (b)(2) Assumptions

The Existing Conditions includes a dynamic representation of the Central Valley Project Improvement Act (CVPIA) 3406(b)(2) water allocation, management and related actions (B2). The selection of discretionary actions for use of B2 water in each year was based on a May 2003 Department of the Interior policy decision. The use of B2 water is assumed to continue in conjunction with the USFWS and NMFS BO RPA actions. CalSim II does not dynamically account for the use of (b)(2) water, but rather assumes pre-determined upstream fish objectives for Clear Creek. Other (b)(2) actions are assumed to be accommodated by USFWS and NMFS BiOp RPA actions.

Continued CALFED Agreements

The Environmental Water Account (EWA) was established in 2000 by the CALFED Record of Decision (ROD). The EWA was initially identified as a 4-year cooperative effort intended to operate from 2001 through 2004 but was extended through 2007 by agreement between the EWA agencies. It is uncertain, however, whether the EWA will be in place in the future and what actions and assets it may include. Because of this uncertainty, the EWA has not been included in the current CalSim II implementation.

One element of the EWA available assets is the Lower Yuba River Accord (LYRA) Component 1 water. In the absence of the EWA and implementation in CalSim II, the LYRA Component 1 water is assumed to be transferred to South of Delta (SOD) State Water Project (SWP) contractors to help mitigate the impact of the NMFS BO and D1641 on SWP exports during April and May. An additional 500 cfs of capacity is permitted at Banks Pumping Plant from July through September to export this transferred water.

USFWS Delta Smelt BO Actions

The USFWS Delta Smelt BO was released on December 15, 2008, in response to Reclamation’s request for formal consultation with the USFWS on the coordinated operations of the Central Valley Project (CVP) and State Water Project (SWP) in California. To develop CalSim II modeling assumptions for the RPA documented in this BO, DWR led a series of meetings that involved members of fisheries and project agencies. This group has prepared the assumptions and CalSim II implementations to represent the RPA in the CalSim II model. The following actions of the USFWS BO RPA have been included in the Existing Conditions CalSim II model simulation:

- Action 1: Adult Delta smelt migration and entrainment (RPA Component 1, Action 1 – First Flush)
- Action 2: Adult Delta smelt migration and entrainment (RPA Component 1, Action 2)
- Action 3: Entrainment protection of larval and juvenile Delta smelt (RPA Component 2)
- Action 4: Estuarine habitat during Fall (RPA Component 3)

- Action 5: Temporary spring head of Old River barrier and the Temporary Barrier Project (RPA Component 2)

A detailed description of the assumptions that have been used to model each action is included in the technical memorandum "Representation of U.S. Fish and Wildlife Service Biological Opinion Reasonable and Prudent Alternative Actions for CalSim II Planning Studies", prepared by an interagency working group under the direction of the lead agencies. This technical memorandum is included in the Appendix 5A of the LTO EIS (Reclamation 2015b).

NMFS BO Salmon Actions

The NMFS Salmon BO on long-term operations of the CVP and SWP was released on June 4, 2009. To develop CalSim II modeling assumptions for the RPA's documented in this BO, DWR led a series of meetings that involved members of fisheries and project agencies. This group has prepared the assumptions and CalSim II implementations to represent the RPA in the CalSim II model for future planning studies. The following NMFS BO RPA's have been included in the Existing Conditions CalSim II model simulation:

- Action I.1.1: Clear Creek spring attraction flows
- Action I.4: Wilkins Slough operations
- Action II.1: Lower American River flow management
- Action III.1.3: Stanislaus River flows below Goodwin Dam
- Action IV.1.2: Delta Cross Channel gate operations
- Action IV.2.1: San Joaquin River flow requirements at Vernalis and Delta export restrictions
- Action IV.2.3: Old and Middle River flow management

For Action I.2.1, which calls for a percentage of years that meet certain specified end-of-September and end-of-April storage and temperature criteria resulting from the operation of Lake Shasta, no specific CalSim II modeling code is implemented to simulate the performance measures identified.

A detailed description of the assumptions that have been used to model each action is included in the technical memorandum "Representation of National Marine Fisheries Service Biological Opinion Reasonable and Prudent Alternative Actions for CalSim II Planning Studies", prepared by an interagency working group under the direction of the lead agencies. This technical memorandum is included in the in Appendix 5A of the LTO EIS (Reclamation 2015c) and is incorporated here by reference.

Water Transfers

Lower Yuba River Accord (LYRA)

Acquisitions of Component 1 water under the Lower Yuba River Accord, and use of 500 cfs dedicated capacity at Banks PP during July – September, are assumed to be used to reduce as much of the impact of the Apr – May Delta export actions on SWP contractors as possible.

Phase 8 transfers

Phase 8 transfers are not included in the Existing Conditions simulation.

Short-term or Temporary Water Transfers

Short term or temporary transfers such as Sacramento Valley acquisitions conveyed through Banks PP are not included in the Existing Conditions simulation.

Specific Regulatory Assumptions

Upper Sacramento Flow Management

Model includes SWRCB WR 90-5 and NMFS BO (Jun 2009) Action I.2.2 achieved as possible through other modeled actions.

Lower Feather Flow Management

Model includes 1983 DWR, DFG Agreement (minimum flow 750 – 1,700 cfs, depending on runoff and month).

Lower American Flow Management

The 2006 American River Flow Management Standard (ARFMS) is included in the Existing Conditions.

The flow requirements of ARFMS are further described in Reclamation 2006.

Delta Outflow (Flow and Salinity)

SWRCB D-1641:

All Delta outflow requirements per SWRCB D-1641 are included in the Existing Conditions simulation. Similarly, for the February through June period the X2 standard is included in the Existing Conditions simulation.

USFWS BO (December, 2008) Action 4:

USFWS BO Action 4 requires additional Delta outflow to manage X2 in the fall months following wet and above normal years to maintain an average X2 for September and October no greater (more eastward) than 74 kilometers following wet years and 81 kilometers following above normal years. In November, the inflow to CVP/SWP reservoirs in the Sacramento Basin should be added to reservoir releases to provide an added increment of Delta inflow and to augment Delta outflow up to the fall X2 target. This action is included in the Existing Conditions simulation.

Combined Old and Middle River Flows

USFWS BO restricts south Delta pumping to preserve certain OMR flows in three of its Actions: Action 1 to protect pre-spawning adult Delta smelt from entrainment during the first flush, Action 2 to protect pre-spawning adults from entrainment and from adverse hydrodynamic conditions, and Action 3 to protect larval Delta smelt from entrainment. CalSim II simulates these actions to a limited extent.

Brief description of USFWS BO Actions 1-3 implementations in CalSim is as follows: Action 1 is onset based on a turbidity trigger that takes place during or after December. This action requires limit on exports so that the average daily OMR flow is no more negative than -2,000 cfs for a total duration of 14 days, with a 5-day running average no more negative than -2,500 cfs (within 25 percent of the monthly criteria). Action 1 ends after 14 days of duration or when Action 3 is triggered based on a temperature criterion. Action 2 starts immediately after Action 1 and requires a range of net daily OMR flows to be no more negative than -1,250 to -5,000 cfs (with a 5-day running average within 25 percent of the monthly criteria). The Action continues until Action 3 is triggered. Action 3 also requires net daily OMR flow to be no more negative than -1,250 to -5,000 cfs based on a 14-day running average (with a simultaneous 5-day running average within 25 percent). Although the range is similar to Action 2, the Action implementation is different. Action 3 continues until June 30 or when water temperature reaches a certain threshold. A more detailed description is included in the Appendix 5A of the LTO EIS (Reclamation 2015b).

NMFS BO Action 4.2.3 requires OMR flow management to protect emigrating juvenile winter-run, yearling spring-run, and Central Valley steelhead within the lower Sacramento and San Joaquin rivers from entrainment into south Delta channels and at the export facilities in the south Delta. This action requires reducing exports from January 1 through June 15 to limit negative OMR flows to -2,500 to -5,000 cfs. CalSim II assumes OMR flows required in NMFS BO are covered by OMR flow requirements developed for actions 1 through 3 of the USFWS BO as described in the Appendix 5A of the LTO EIS (Reclamation 2015c).

South Delta Export-San Joaquin River Inflow Ratio

NMFS BO Action 4.2.1 requires exports to be capped at a certain fraction of San Joaquin River flow at Vernalis during April and May while maintaining a health and safety pumping of 1,500 cfs.

Exports at the South Delta Intakes

Exports at Jones and Banks Pumping Plant are restricted to their permitted capacities per SWRCB D-1641 requirements. In addition, the south Delta exports are subjected to Vernalis flow-based export limits during April and May as required by Action 4.2.1. Additional 500 cfs pumping is allowed to reduce impact of NMFS BO Action 4.2.1 and D1641 on SWP during the July through September period.

Under D-1641 the combined export of the CVP Tracy Pumping Plant and SWP Banks Pumping Plant is limited to a percentage of Delta inflow. The percentage ranges from 35 to 45 percent during February depending on the January eight river index and is 35 percent during March through June months. For the rest of the months 65 percent of the Delta inflow is allowed to be exported.

A minimum health and safety pumping of 1,500 cfs is assumed from January through June.

Delta Water Quality

The Existing Conditions simulation includes SWRCB D-1641 salinity requirements. However, not all salinity requirements are included as CalSim II is not capable of predicting salinities in the Delta. Instead, empirically based equations and models are used to relate interior salinity conditions with the flow conditions. DWR's Artificial Neural Network (ANN) trained for salinity is used to predict and interpret salinity conditions at the Emmaton, Jersey Point, and Rock Slough stations. Emmaton and Jersey Point standards are for protecting water quality conditions for agricultural use in the western Delta and they are in effect from April 1 to August 15. The EC requirement at Emmaton varies from 0.45 mmhos/cm to 2.78 mmhos/cm, depending on the water year type. The EC requirement at Jersey Point varies from 0.45 to 2.20 mmhos/cm, depending on the water year type. The Rock Slough standard is for protecting water quality conditions for M&I use for water exported through the Contra Costa Canal. It is a year-round standard that requires a certain number of days in a year with chloride concentration less than 150 mg/L. The number of days requirement is dependent upon the water year type.

San Joaquin River Restoration Program

Friant Dam releases required by the San Joaquin River Restoration Program are included in the Existing Conditions. More detailed description of the San Joaquin River Restoration Program is presented in the Appendix 3A "*No Action Alternative: Central Valley Project and State Water Project Operations*" of the LTO EIS (Reclamation 2015a).

Operations Criteria

Delta Cross Channel Gate Operations

SWRCB D-1641 DCC standards provide for closure of the DCC gates for fisheries protection at certain times of the year. From November through January, the DCC may be closed for up to 45 days. From February 1 through May 20, the gates are closed every day. The gates may also be closed for 14 days during the May 21 through June 15 time period. Reclamation determines the timing and duration of the closures after discussion with USFWS, CDFW, and NMFS.

NMFS BO Action 4.1.2 requires gates to be operated as described in the BO based on the presence of salmonids and water quality from October 1 through December 14; and gates to be closed from December 15 to January 31, except for short-term operations to maintain water quality. CalSim II includes the NMFS BO DCC gate operations in addition to the D-1641 gate operations. When the daily flows in the Sacramento River at Wilkins Slough exceed 7,500 cfs (flow assumed to flush salmon into the Delta), DCC is closed for a certain number of days in a month as described in Appendix 5A of the LTO EIS (Reclamation 2015b). During October 1 – December 14, if the flow trigger condition is such that additional days of DCC gates closure is called for, however water quality conditions are a concern and the DCC gates remain open, then Delta exports are limited to 2,000 cfs for each day in question.

Allocation Decisions

CalSim II includes allocation logic for determining deliveries to north-of-Delta and south-of-Delta CVP and SWP contractors. The delivery logic uses runoff forecast information, which incorporates uncertainty in the hydrology, and standardized rule curves (i.e. Water Supply Index versus Demand Index Curve). The rule curves relate forecasted water supplies to deliverable "demand," and then use deliverable "demand" to assign subsequent delivery levels to estimate the water available for delivery and carryover storage. Updates of delivery levels occur monthly from January 1 through May 1 for the SWP and March 1 through May 1 for the CVP as runoff forecasts become more certain. The south-of-Delta SWP delivery is determined based on water supply parameters and operational constraints. The CVP system wide delivery and south-of-Delta delivery are determined similarly upon water supply parameters and operational constraints with specific consideration for export constraints.

San Luis Operations

CalSim II sets targets for San Luis storage each month that are dependent on the current South-of-Delta allocation and upstream reservoir storage. When upstream reservoir storage is high, allocations and San Luis fill targets are increased. During a prolonged drought when upstream storage is low, allocations and fill targets are correspondingly low. For the Existing Conditions simulation, the San Luis rule curve is managed to minimize situations in which shortages may occur due to lack of storage or exports.

New Melones Operations

In addition to flood control, New Melones is operated for four different purposes: fishery flows, water quality, Bay-Delta flow, and water supply.

Fishery

In the Existing Conditions, fishery flows refer to flow requirements of the 2009 NMFS BO Action III.1.3 (NMFS 2009). These flows are patterned to provide fall attraction flows in October and outmigration pulse flows in spring months (April 15 through May 15 in all years) and total up to 98.9 TAF to 589.5 TAF annually depending on the hydrological conditions based on the New Melones water supply forecast (the end-of-February New Melones Storage, plus the March - September forecast of inflow to the reservoir) (Tables 3 through 5).

Table 3. Annual Fishery Flow Allocation in New Melones

New Melones Water Supply Forecast (TAF)	Fishery Flows (TAF)
0 to 1,399.9	185.3
1,400 to 1,999.9	234.1
2,000 to 2,499.9	346.7
2,500 to 2,999.9	483.7
≥3,000	589.5

Table 4. Monthly "Base" Flows for Fisheries Purposes Based on the Annual Fishery Volume

Annual Fishery Flow Volume (TAF)	Base Flow (CFS) for Oct	Base Flow (CFS) for Nov	Base Flow (CFS) for Dec	Base Flow (CFS) for Jan	Base Flow (CFS) for Feb	Base Flow (CFS) for Mar	Base Flow (CFS) for Apr 1–15	Base Flow (CFS) for May 16–31	Base Flow (CFS) for Jun	Base Flow (CFS) for Jul	Base Flow (CFS) for Aug	Base Flow (CFS) for Sep
98.9	110	200	200	125	125	125	250	250	0	0	0	0
185.3	577.4	200	200	212.9	214.3	200	200	150	150	150	150	150
234.1	635.5	200	200	219.4	221.4	200	500	284.4	200	200	200	200
346.7	774.2	200	200	225.8	228.6	200	1,471.4	1,031.3	363.3	250	250	250
483.7	796.8	200	200	232.3	235.7	1,521	1,614.3	1,200	940	300	300	300
589.5	841.9	300	300	358.1	364.3	1,648.4	2,442.9	1,725	1,100	429	400	400

Table 5. April 15 through May 15 "Pulse" Flows for Fisheries Purposes Based on the Annual Fishery Volume

Annual Fishery Flow Volume (TAF)	Fishery Pulse Flows (CFS) April 15–30	Fishery Pulse Flows (CFS) May 1–15
185.3	687.5	666.7
234.1	1,000.0	1,000.0
346.7	1,625.0	1,466.7
483.7	1,212.5	1,933.3
589.5	925.0	2,206.7

Water Quality

Water quality releases include releases to meet the State Water Resources Control Board (SWRCB) Decision 1641 (D-1641) salinity objectives at Vernalis and the Decision 1422 (D-1422) dissolved oxygen objectives at Ripon. The Vernalis water quality requirement (SWRCB D-1641) is an electrical conductivity (EC) requirement of 700 and 1000 micromhos/cm for the irrigation (Apr-Aug) and non-irrigation (Sep-Mar) seasons, respectively.

Additional releases are made to the Stanislaus River below Goodwin Dam if necessary, to meet the D-1422 dissolved oxygen content objective. Surrogate flows representing releases for DO requirement in CalSim II are presented in Table 6. The surrogate flows are reduced for critical years where New Melones water supply forecast (the end-of-February New Melones Storage, plus the March - September forecast of inflow to the reservoir) is less than 940 TAF. These flows are met through releases from New Melones without any annual volumetric limit.

Table 6. Surrogate flows for D1422 DO requirement at Vernalis (TAF)

--	Non-Critical Years	Critical Years
January	0.0	0.0
February	0.0	0.0
March	0.0	0.0
April	0.0	0.0
May	0.0	0.0
June	15.2	11.9
July	16.3	12.3
August	17.4	12.3
September	14.8	11.9
October	0.0	0.0
November	0.0	0.0
December	0.0	0.0

Notes:

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Bay-Delta Flows

Bay-Delta flow requirements are defined by D-1641 flow requirements at Vernalis (not including pulse flows during the April 15 - May 16 period). These flows are met through releases from New Melones without any annual volumetric limit. D-1641 requires the flow at Vernalis to be maintained during the February through June period. The flow requirement is based on the required location of “X2” and the San Joaquin Valley water year hydrologic classification (60-20-20 Index) as summarized in Table 7.

Table 7. Bay-Delta Vernalis Flow Objectives (average monthly cfs)

60-20-20 Index	Flow Required if X2 is West of Chipps Island	Flow required if X2 is East of Chipps Island
Wet	3,420	2,130
Above Normal	3,420	2,130
Below Normal	2,280	1,420
Dry	2,280	1,420
Critical	1,140	710

Water Supply

Water supply refers to deliveries from New Melones to water rights holders (Oakdale Irrigation District and South San Joaquin Irrigation District) and CVP eastside contractors (Stockton East Water District and Central San Joaquin Water Control District). Water is provided to Oakdale ID and South San Joaquin ID in accordance with their 1988 Settlement Agreement with Reclamation (up to 600 TAF based on hydrologic conditions), limited by consumptive use. The conservation account of up to 200 TAF storage capacity defined under this agreement is not modeled in CalSim II.

Water Supply-CVP Eastside Contractors

Annual allocations are determined using New Melones water supply forecast (the end-of- February New Melones Storage, plus the March - September forecast of inflow to the reservoir) for Stockton East WD and Central San Joaquin WCD (Table 8) and are distributed throughout a year using monthly patterns.

Table 8. CVP Contractor Allocations

New Melones Water Supply Forecast (TAF)	CVP Contractor Allocation (TAF)
<1,400	0
1,400 to 1,800	49
>1,800	155

2.2 DSM2 Assumptions for Existing Conditions

The following is a description of the assumptions listed in Appendix E Attachment 1-3 DSM2 Model Assumptions Callouts.

River Flows

For DSM2 simulation, the river flows at the DSM2 boundaries are based on the monthly flow time series from CalSim II.

Tidal Boundary

The tidal boundary condition at Martinez is based on an adjusted astronomical tide normalized for sea level rise (Ateljevich and Yu, 2007).

Water Quality

Martinez EC

The Martinez EC boundary condition in the DSM2 planning simulation is estimated using the G-model based on the net Delta outflow simulated in CalSim II and the pure astronomical tide (Ateljevich, 2001), as modified to account for the salinity changes related to the sea level rise using the correlations derived based on the three-dimensional (UnTRIM) modeling of the Bay-Delta with sea level rise at Year 2030.

Vernalis EC

For the DSM2 simulation, the Vernalis EC boundary condition is based on the monthly San Joaquin EC time series estimated in CalSim II.

Morphological Changes

No additional morphological changes were assumed as part of the Existing Conditions. The DSM2 model and grid developed as part of the 2009 recalibration effort (CH2M HILL, 2009) was used for modeling.

Facilities

Delta Cross Channel

Delta Cross Channel gate operations are modeled in DSM2. The number of days in a month the DCC gates are open is based on the monthly time series from CalSim II.

South Delta Temporary Barriers

South Delta Temporary Barriers are included in the Existing Conditions simulation. The three agricultural temporary barriers located on Old River, Middle River and Grant Line Canal are included in the model. The fish barrier located at the Head of Old River is also included in the model.

Clifton Court Forebay Gates

Clifton Court Forebay gates are operated based on the Priority 3 operation, where the gate operations are synchronized with the incoming tide to minimize the impacts to low water levels in nearby channels. The Priority 3 operation is described in the 2008 OCAP BA Appendix F Section 5.2 (USBR, 2008b).

Operations Criteria

South Delta Temporary Barriers

South Delta Temporary Barriers are operated based on San Joaquin flow conditions. Head of Old River Barrier is assumed to be installed in both the spring and fall months from April 1 to May 31 and September 16 to November 30. The agricultural barriers on Old and Middle Rivers are assumed to be installed starting from May 16 and the one on Grant Line Canal from June 1. All three agricultural barriers are allowed to operate until November 30. The tidal gates on Old and Middle River agricultural barriers are assumed to be tied open from May 16 to May 31.

Suisan Marsh Salinity Control Gate

The radial gates in the Montezuma Slough Salinity Control Gate Structure are assumed to be tidally operating from October through February each year, to minimize propagation of high salinity conditions into the interior Delta.

3 Assumptions for Proposed Project

This section presents the assumptions used in developing the CalSim II, and DSM2 simulations of Proposed Project.

3.1 CalSim II Assumptions for Proposed Project

The following is a description of the assumptions listed in Appendix E Attachment 1-2 CalSim II Model Assumptions Callouts.

Hydrology

Inflows/Supplies

Same as the Existing Conditions.

Level of Development

Same as the Existing Conditions.

Demands, Water Rights, CVP/SWP Contracts

Same as the Existing Conditions.

Facilities

Same as the Existing Conditions.

Fremont Weir

Same as the Existing Conditions.

CVP C.W. Bill Jones Pumping Plant (Tracy PP) Capacity

Same as the Existing Conditions.

SWP Banks Pumping Plant Capacity

Same as the Existing Conditions.

CCWD Intakes

Same as the Existing Conditions.

Regulatory Standards

The regulatory standards that govern the operations of the CVP and SWP facilities are briefly described below. Specific assumptions related to key regulatory standards are also outlined below.

D-1641 Operations

Same as the Existing Conditions.

Coordinated Operations Agreement (COA)

Same as the Existing Conditions.

CVPIA (b)(2) Assumptions

Same as the Existing Conditions.

Clear Creek Flows

Same as the Existing Conditions.

Continued CALFED Agreements

Same as the Existing Conditions.

USFWS Delta Smelt BO Actions

The USFWS Delta Smelt BO RPA actions are replaced with actions developed for Proposed Project as summarized below and described further in this document.

NMFS BO Salmon Actions

The NMFS Salmon BO RPA actions are replaced with actions developed for Proposed Project as summarized below and described further in this document.

Water Transfers

Same as the Existing Conditions.

Specific Regulatory Assumptions

Upper Sacramento Flow Management

Same as the Existing Conditions.

Lower Feather Flow Management

Same as the Existing Conditions.

Lower American Flow Management

Model includes Water Forum's 2017 Lower American Flow Management Standard where the flows range from 500 to 2000 cfs based on time of year and annual hydrology. Planning minimum storage is represented in CalSim with a 275 taf end-of September storage target in Folsom.

Delta Outflow (Flow and Salinity)

SWRCB D-1641:

Same as the Existing Conditions.

Combined Old and Middle River Flows

Reclamation and DWR propose to operate the CVP and SWP in a manner that maximizes exports while minimizing entrainment of fish and protecting critical habitat.

Proposed OMR management is modeled as follows:

Projects operate to an OMR index no more negative than a 14-day moving average of -5,000 cfs between January 1 and June 30 except for the following conditions:

- Integrated Early Winter Pulse Protection: After December 1, and when the 3-day average turbidity is 50 NTU or greater at Sacramento River at Freeport and Sacramento River at Freeport Flow is 25,000 cfs or greater, Reclamation and DWR propose to operate to -2,000 cfs of the 14-day average OMR index for 14 days. The same model index of SAC_RI developed for the USFWS RPA Action I representation is used in the model to determine when the turbidity exceeds 50 NTU.
- Turbidity Bridge Avoidance: For January and February in any water year type, if the Turbidity trigger is reached (SAC_RI greater than or equal to 20,000 cfs), Projects operate to 14-day average OMR Index if -2000 cfs for five days. For March through June of Wet and Above Normal years, it is assumed that there will be one event of turbidity bridge avoidance in each month (-2000 cfs for five days).
- OMR Flexibility: It is assumed that there may be storm-related OMR management flexibility in January and February. In wet years, it is assumed that storm events will coincide with turbidity bridge events and no OMR flexibility is modeled. In Above Normal and Below Normal years, it is assumed that there will be one opportunity in January and one opportunity in February to operate to a more negative OMR index than -6,000 cfs. This is modeled as 14-day OMR index of -6,000 cfs for 7 days in each month. In dry years, it is assumed that one opportunity occurs either in January or February but not both months.
- Species-specific single-year loss threshold: Even though salvage or loss cannot be modeled using CalSim, it is assumed that this threshold would be reached by March and April of wet, above normal, below normal, and dry years and species-specific offramp would be met by June. The OMR restriction for this condition is modeled as a 14-day average OMR index of -3,500 cfs in March and April of all wet, above normal, below normal, and dry year-types.
- Adult Longfin Smelt Entrainment Protection - This action was not modeled in CalSim II due to the lack of data needed to develop a simplifying assumption, however it is conceivable that this action could result in a significant range of required OMR. The tools and processes described in

Section 3.3.1 are new and it is uncertain as to what level of OMR restriction would result from those tools and processes.

- Larval and Juvenile Longfin Smelt Criteria – This action was not modeled in CalSim II due to the lack of data needed to develop a simplifying assumption, however it is conceivable that this action could result in a significant range of required OMR. The tools and processes described in Section 3.3.1 are new and it is uncertain as to what level of OMR restriction would result from those tools and processes.
- Delta Smelt Larval – This action was not modeled in CalSim II due to the lack of data needed to develop a simplifying assumption, however it is conceivable that this action could result in a significant range of required OMR. The tools and processes described in Section 3.3.1 are new and it is uncertain as to what level of OMR restriction would result from those tools and processes.

South Delta Export-San Joaquin River Inflow Ratio

NMFS BO Action 4.2.1 would not be implemented under this alternative.

Exports at the South Delta Intakes

Same as the Existing Conditions.

Delta Water Quality

Same as the Existing Conditions.

San Joaquin River Restoration Program

Same as the Existing Conditions.

Operations Criteria

Fremont Weir Operations

Same as the Existing Conditions.

Delta Cross Channel Gate Operations

Same as the Existing Conditions.

Allocation Decisions

Same as the Existing Conditions.

San Luis Operations

Same as the Existing Conditions.

New Melones Operations

In addition to flood control, New Melones is operated for three different purposes: fishery flows, water quality, and water supply.

Fishery

These flows are patterned to provide fall attraction flows in October and outmigration pulse flows in spring months (April 15 through May 15 in all years), and total up to 98.9 TAF to 483.7 TAF annually depending on the hydrological conditions based on the San Joaquin 60-20-20 Index (Tables 9 through 11).

Table 9. Annual Fishery Flow Allocation

60-20-20 Index	Fishery Flows (TAF)
Critical	185.3
Dry	234.1
Below Normal	346.7
Above Normal	346.7
Wet	483.7

Table 10. Monthly "Base" Flows for Fishery Purposes Based on the Annual Fishery Volume

Annual Fishery Flow Volume (TAF)	Base Flow (CFS) for Oct.	Base Flow (CFS) for Nov.	Base Flow (CFS) for Dec.	Base Flow (CFS) for Jan.	Base Flow (CFS) for Feb.	Base Flow (CFS) for Mar.	Base Flow (CFS) for Apr. 1–14	Base Flow (CFS) for May 16–31	Base Flow (CFS) for June	Base Flow (CFS) for July	Base Flow (CFS) for Aug.	Base Flow (CFS) for Sept.
185.3	577.4	200	200	212.9	214.3	200	200	150	150	150	150	150
234.1	635.5	200	200	219.4	221.4	200	500	284.4	200	200	200	200
346.7	774.2	200	200	225.8	228.6	200	1,471.4	1,031.3	363.3	250	250	250
483.7	796.8	200	200	232.3	235.7	1,521	1,614.3	1,200	940	300	300	300

Table 11. April 15 through May 15 "Pulse" Flows for Fishery Purposes Based on the Annual Fishery Volume

Annual Fishery Flow Volume (TAF)	Fishery Pulse Flows (CFS) April 15–30	Fishery Pulse Flows (CFS) May 1–15
185.3	687.5	666.7
234.1	1,000.0	1,000.0
346.7	1,625.0	1,466.7
483.7	1,212.5	1,933.3

Water Quality

Releases are made to the Stanislaus River below Goodwin Dam to meet the D-1422 dissolved oxygen content objective. Surrogate flows representing releases for dissolved oxygen requirement in CalSim II are presented in Table 12. The surrogate flows are reduced for critical years under the San Joaquin 60-20-20 Index. These flows are met through releases from New Melones without any annual volumetric limit.

Table 12. Surrogate flows representing releases for dissolved oxygen requirement in CalSim II

–	Non-Critical Years	Critical Years
January	0.0	0.0
February	0.0	0.0
March	0.0	0.0
April	0.0	0.0
May	15.2	11.9
June	16.3	12.3
July	17.4	12.3
August	14.8	11.9
September	0.0	0.0
October	0.0	0.0
November	0.0	0.0
December	0.0	0.0

Notes:

– = This cell is empty.

Water Supply

Water supply refers to deliveries from New Melones to water rights holders (Oakdale Irrigation District [ID] and South San Joaquin ID) and CVP eastside contractors (Stockton East Water District [WD] and Central San Joaquin Water Control District [WCD]).

Water is provided to Oakdale ID and South San Joaquin ID in accordance with their 1988 Settlement Agreement with Reclamation (up to 600 TAF based on hydrologic conditions), limited by consumptive use. The conservation account of up to 200 TAF storage capacity defined under this agreement is not modeled in CalSim II.

Water Supply-CVP Eastside Contractors

Annual allocations are determined using the San Joaquin 60-20-20 Index for Stockton East WD and Central San Joaquin WCD (Table 13) and are distributed throughout 1 year using monthly patterns.

Table 13. Annual allocations for Stockton East WD and Central San Joaquin WCD

60-20-20 Index	CVP Contractor Allocation (TAF)
Critical	0
Dry	49
Below Normal, Above Normal, and Wet	155

3.2 DSM2 Assumptions for Proposed Project

The following is a description of the assumptions listed in Appendix E Attachment 1-3 DSM2 Model Assumptions Callouts.

River Flows

Same as the Existing Conditions.

Tidal Boundary

Same as the Existing Conditions.

Water Quality

Martinez EC

Same as the Existing Conditions.

Vernalis EC

Same as the Existing Conditions.

Morphological Changes

Same as the Existing Conditions.

Facilities

Delta Cross Channel

Same as the Existing Conditions.

South Delta Temporary Barriers

The three agricultural temporary barriers located on Old River, Middle River and Grant Line Canal are included in the model; however, the fish barrier located at the Head of Old River is not included in the model.

Clifton Court Forebay Gates

Same as the Existing Conditions.

Operations Criteria

South Delta Temporary Barriers

South Delta Temporary Barriers are operated based on San Joaquin flow conditions. The agricultural barriers on Old and Middle Rivers are assumed to be installed starting from May 16 and the one on Grant Line Canal from June 1. All three agricultural barriers are allowed to operate until November 30. The tidal gates on Old and Middle River agricultural barriers are assumed to be tied open from May 16 to May 31. Head of Old River Barrier would not be installed.

Suisan Marsh Salinity Control Gate

The radial gates in the Suisan Marsh Salinity Control Gate Structure are assumed to be tidally operating from October through February each year and from July through August during Below Normal years, to minimize propagation of high salinity conditions into the interior Delta.

Gate operations occur in October through February. Gates open when upstream water level is 0.3 ft above downstream water level. Gates close when current is less than -0.1 fps. Gates are open in March through September.

DWR proposes Suisun Marsh Salinity Control Gates operations in July and August of Below Normal Water year types.

4 References

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Attachment 1-2 CalSim II Model Assumptions Callouts

1 Introduction

The assumptions for all model simulations are summarized in Appendix E Attachment 1-1 Model Assumptions.

2 CalSim II Modeling Assumptions Callouts

The following matrix summarizes the assumptions used for the CalSim II models:

- Existing Condition[1]
- Proposed Project

Table 2-1. Summary of Assumptions used for CalSim II Models - Tables 2-1a through 2-1v

Table 2-1 a. General

–	Existing	Proposed Project
Planning horizon	Year 2030	Same
Period of simulation	82 years (1922-2003)	Same

Notes for Tables 2-1 a through Table 2-1 v are provided following Table 2-1 v.

Table 2-1 b. Hydrology

–	Existing	Proposed Project
Inflows/Supplies	Inflows based on Historical Hydrology[23, 25]	Same
Level of development	2030 level[2]	Same

Notes for Tables 2-1 a through Table 2-1 v are provided following Table 2-1 v.

Table 2-1 c. Demands, Water Rights, and CVP/SWP Contracts: Sacramento River Region (excluding American River)

–	Existing	Proposed Project
CVP[3]	Land-use based, full build-out of contract amounts, except for Settlement Contractors represented with historical diversions.	Same
SWP (FRSA)	Land-use based, limited by contract amounts[4,7]	Same
Non-project	Land use based, limited by water rights and SWRCB Decisions for Existing Facilities	Same
Antioch Water Works	Pre-1914 water right	Same
Federal refuges	Firm Level 2 water supply needs[5]	Same

Notes for Tables 2-1 a through Table 2-1 v are provided following Table 2-1 v.

Table 2-1 d. Demands, Water Rights, and CVP/SWP Contracts: Sacramento River Region - American River

–	Existing	Proposed Project
Water rights	Year 2025, full water rights[6]	Same
CVP	Year 2025, full contracts except for Settlement Contractors at historical diversions, including Freeport Regional Water Project[6]	Same

Notes for Tables 2-1 a through Table 2-1 v are provided following Table 2-1 v.

Table 2-1 e. Demands, Water Rights, and CVP/SWP Contracts: San Joaquin River Region

–	Existing	Proposed Project
Friant Unit	Limited by contract amounts, based on current allocation policy[26]	Same
Lower Basin	Land-use based, based on district level operations and constraints[24]	Same
Stanislaus River[9, 17]	Land-use based, Revised Operations Plan (2008 model assumptions) and NMFS BO (Jun 2009) Actions III.1.2 and III.1.3	Land-use based, Stepped Release Plan (SRP)

Notes for Tables 2-1 a through Table 2-1 v are provided following Table 2-1 v.

Table 2-1 f. Demands, Water Rights, and CVP/SWP Contracts: San Francisco Bay, Central Coast, Tulare Lake and South Coast Regions (CVP/SWP project facilities)

–	Existing	Proposed Project
CVP	Demand based on contract amounts[3]	Same
CCWD	195 TAF/yr CVP contract supply and water rights.[10] Modified the hydrology in the Los Vaqueros watershed as well as CCWD's operations to reflect the most recent studies and operational agreements	Same
SWP[4,11]	Demand based on full Table A amounts	Same
Article 56	Based on 2001-08 contractor requests	Same
Article 21	MWD demand up to 200 TAF/month (December to March) subject to conveyance capacity, KCWA demand up to 180 TAF/month and other contractor demands up to 34 TAF/month in all months, subject to conveyance capacity	Same
North Bay Aqueduct (NBA)	77 TAF/yr demand under SWP contracts. Up to 2.635 TAF/mon of excess flow (i.e. when Standard Water Right Term 91 is not in effect, UWFE used as surrogate) under Fairfield, Vacaville and Benecia Settlement Agreement. NOD Allocation Settlement Agreement terms for Napa and Solano[15]	Same
Federal refuges	Firm Level 2 water needs[5]	Same

Notes for Tables 2-1 a through Table 2-1 v are provided following Table 2-1 v.

Table 2-1 g. Facilities: System-Wide

–	Existing	Proposed Project
Systemwide	Existing facilities	Same

Notes for Tables 2-1 a through Table 2-1 v are provided following Table 2-1 v.

Table 2-1 h. Facilities: Sacramento River Region

–	Existing	Proposed Project
Shasta Lake	Existing, 4,552 TAF capacity	Same
Red Bluff Diversion Dam	Diversion dam gates out all year, Pumping Plant operated to deliver CVP water	Same
Fremont Weir	Existing weir	Same
Colusa Basin	Existing conveyance and storage facilities	Same
Lower American River	Hodge criteria for diversion at Fairbairn	Same
Upper American River[6,22]	PCWA American River Pump Station	Same
Lower Sacramento River	Freeport Regional Water Project[12]	Same

Notes for Tables 2-1 a through Table 2-1 v are provided following Table 2-1 v.

Table 2-1 i. Facilities: San Joaquin River Region

–	Existing	Proposed Project
Millerton Lake (Friant Dam)	Existing, 524 TAF capacity	Same
Lower San Joaquin River	City of Stockton Delta Water Supply Project, 30-mgd capacity	Same
SWP Banks Pumping Plant (South Delta)	Physical capacity is 10,300 cfs but 6,680 cfs permitted capacity in all months. Pumping can be up to 10,300 cfs during Dec 15 – Mar 15 depending on Vernalis flow conditions[18]; additional capacity of 500 cfs (up to 7,180 cfs) allowed Jul – Sep for reducing impact of NMFS BO (Jun 2009) Action IV.2.1 Phase II on SWP[19]	Same
CVP C.W. "Bill" Jones Pumping Plant (formerly Tracy PP)	Permit capacity is 4,600 cfs in all months (allowed for by the Delta-Mendota Canal–California Aqueduct Intertie)	Same
Upper Delta-Mendota Canal Capacity	Existing plus 400 cfs Delta-Mendota Canal–California Aqueduct Intertie	Same
CCWD Intakes	Los Vaqueros existing storage capacity, 160 TAF, existing pump locations, Alternative Intake Project (AIP) included[13]	Same
Head of Old River Barrier (HORB)	Temporary Barrier Project operated based on San Joaquin River flow time series from CalSim II output HORB installed in Fall (Sep 16 – Nov 30) HORB also installed in Spring (April 1 – May 31) when SJR flow is less than 5,000 cfs	Not installed

Notes for Tables 2-1 a through Table 2-1 v are provided following Table 2-1 v.

Table 2-1 j. Facilities: San Francisco Bay Region

–	Existing	Proposed Project
South Bay Aqueduct (SBA)	SBA rehabilitation, 430 cfs capacity from junction with California Aqueduct to Alameda County FC&WSD Zone 7 diversion point	Same

Notes for Tables 2-1 a through Table 2-1 v are provided following Table 2-1 v.

Table 2-1 k. Facilities: South Coast Region

–	Existing	Proposed Project
California Aqueduct East Branch	Existing capacity	Same

Notes for Tables 2-1 a through Table 2-1 v are provided following Table 2-1 v.

Table 2-1 l. Regulatory Standards: North Coast Region

–	Existing	Proposed Project
Trinity River	–	–
Minimum flow below Lewiston Dam	Trinity EIS Preferred Alternative (369-815 TAF/yr)	Same
Trinity River Fall Augmentation Flows	420 cfs August 1 through September 30 in all but very wet years	Same
Trinity Reservoir end-of-September minimum storage	Trinity EIS Preferred Alternative (600 TAF as able)	Same

Notes for Tables 2-1 a through Table 2-1 v are provided following Table 2-1 v.

Table 2-1 m. Regulatory Standards: Sacramento River Region

–	Existing	Proposed Project
Clear Creek	-	-
Minimum flow below Whiskeytown Dam	Downstream water rights, 1963 Reclamation Proposal to USFWS and NPS, predetermined CVPIA 3406(b)(2) flows[20], and NMFS BO (Jun 2009) Action I.1.1[17]	Same
Upper Sacramento River	-	-
Shasta Lake end-of-September minimum storage	NMFS 2004 Winter-run Biological Opinion, (1900 TAF in non-critically dry years), and NMFS BO (Jun 2009) Action I.2.1[17] (NMFS BiOp storage objectives not explicitly modeled; achieved through project allocation procedures when hydrologically possible)	1900 TAF in non-critically dry years (not explicitly modeled - achieved through project allocation profiles when hydrologically possible)
Minimum flow below Keswick Dam	SWRCB WR 90-5, NMFS BO (Jun 2009) Action I.2.2 achieved as possible through other modeled actions[17]	Same
Feather River	-	-
Minimum flow below Thermalito Diversion Dam	2006 Settlement Agreement (700 / 800 cfs)	Same
Minimum flow below Thermalito Afterbay outlet	1983 DWR, DFG Agreement (750-1,700 cfs)	Same
Yuba River	-	-
Minimum flow below Daguerre Point Dam	D-1644 Operations (Lower Yuba River Accord)[14]	Same
American River	-	-
Minimum flow below Nimbus Dam	American River Flow Management (2006) as required by NMFS BO (Jun 2009) Action II.1[17]	American River Flow Management Standard, per 2017 Water Forum Agreement with a planning minimum end of September storage target of 275 TAF
Minimum Flow at H Street Bridge	SWRCB D-893	Same

–	Existing	Proposed Project
Lower Sacramento River	-	-
Minimum flow near Rio Vista	SWRCB D-1641	Same

Notes for Tables 2-1 a through Table 2-1 v are provided following Table 2-1 v.

Table 2-1 n. Regulatory Standards: San Joaquin River Region

–	Existing	Proposed Project
Mokelumne River	-	-
Minimum flow below Camanche Dam	FERC 2916-029[12], 1996 (Joint Settlement Agreement) (100-325 cfs)	Same
Minimum flow below Woodbridge Diversion Dam	FERC 2916-029[12], 1996 (Joint Settlement Agreement) (25-300 cfs)	Same
Stanislaus River	-	-
Minimum flow below Goodwin Dam	1987 Reclamation, CDFW agreement, and flows required for NMFS BO (Jun 2009) Action III.1.2 and III.1.3[17]	Flows per New Melones SRP
Minimum dissolved oxygen	SWRCB D-1422	Same
Merced River	-	-
Minimum flow below Crocker-Huffman Diversion Dam	Davis-Grunsky (180-220 cfs, Nov-Mar), and Cowell Agreement	Same
Minimum flow at Shaffer Bridge	FERC 2179 (25-100 cfs)	Same
Tuolumne River	-	-
Minimum flow at Lagrange Bridge	FERC 2299-024, 1995 (Settlement Agreement) (94-301 TAF/yr)	Same
San Joaquin River	-	-
San Joaquin River below Friant Dam/ Mendota Pool	San Joaquin River Restoration-full flows not included[26]	Same
Maximum salinity near Vernalis	SWRCB D-1641	Stanislaus contribution per New Melones SRP
Minimum flow near Vernalis	SWRCB D-1641. VAMP is turned off since the San Joaquin River Agreement has expired[16]. NMFS BO (Jun 2009) Action IV.2.1[17] Phase II flows not provided due to lack of agreement for purchasing water.	Stanislaus contribution per New Melones SRP

Notes for Tables 2-1 a through Table 2-1 v are provided following Table 2-1 v.

Table 2-1 o. Regulatory Standards: Sacramento River/San Joaquin Delta Region

–	Existing	Proposed Project
Delta Outflow Index (flow and salinity)	SWRCB D-1641 and FWS BO (Dec 2008) Action 4[17]	SWRCB D-1641; X2 of 80 km in September and October of wet and above normal years.
Delta Cross Channel gate operation	SRWCB D-1641 with additional days closed from Oct 1 – Jan 31 based on NMFS BO (Jun 2009) Action IV.1.2[17] (closed during flushing flows from Oct 1 – Dec 14 unless adverse water quality conditions)	Same

–	Existing	Proposed Project
South Delta export limits (Jones PP and Banks PP)	SWRCB D-1641, Vernalis flow-based export limits Apr 1 – May 31 as required by NMFS BO (Jun, 2009) Action IV.2.1[17] (additional 500 cfs allowed for Jul – Sep for reducing impact on SWP)	SWRCB D-1641 (additional 500 cfs allowed for Jul – Sep for reducing impact on SWP)[19]
Combined Flow in Old and Middle River (OMR)	Adult Longfin Smelt Entrainment Protection Not explicitly modeled Adult Delta Smelt (First Flush) Trigger: 3 station avg > 12 NTU Period: December 1 to January 31 CalSim assumption: Sacrament River Runoff > 20,000 then OMR = -2,000 cfs for 14 days Adult Delta Smelt (Turbidity Bridge) January to March & Sacramento River Runoff > 20,000 OMR = -2,000 cfs for 5 days Larval and Juvenile Delta & Longfin Smelt Not explicitly modeled Winter Run/Steelhead January 1 to June 30 OMR > -5,000 cfs Salvage Density (based on 2008-2018 historic data) March: OMR = 3 days at -3,500 cfs, 5 days at -2,500 cfs April: OMR – 9 days at -3,500 cfs May: OMR – 5 days at -3,500 cfs OMR Flex (storm flex) No Flex	Adult Longfin Smelt Entrainment Protection Not explicitly modeled Adult Delta Smelt (First Flush) Trigger: Freeport > 50 NTU & Freeport > 25,000 cfs Period: December 1 to January 31 CalSim assumption: Sacrament River Runoff > 20,000 then OMR = -2,000 cfs for 14 days Adult Delta Smelt (Turbidity Bridge) January to March & Sacramento River Runoff > 20,000 OMR = -2,000 cfs for 5 days Larval and Juvenile Delta & Longfin Smelt Not explicitly modeled Winter Run/Steelhead January 1 to June 30 OMR > -5,000 cfs Salvage Threshold (assume triggering 50% single year loss thresholds in Wet, Above Normal, Below Normal, and Dry Years) March: OMR = -3,500 cfs April: OMR = -3,500 cfs OMR Flex (storm flex) If first flush or turbidity bridge are not triggered, then January: OMR = 7 days at OMR -6,000 cfs (AN and BN years) February: OMR = 7 days at OMR -6,000 cfs (AN and BN years) Once in January or February: OMR = 7 days at -6,000 cfs (D)
Water Quality (EC) Standards	SWRCB D-1641	Same
SJR Inflow to Export Ratio	April to May when SJR < 21,750 cfs Wet and Above Normal: SJR IE = 4:1 Below Normal: SJR IE = 3:1 Dry: SJR IE = 2:1 Critical: SJR IE = 1:1	Not implemented

–	Existing	Proposed Project
Summer/Fall Habitat (Fall X2)	September to November Wet years = 74 km Above Normal years = 81 km	September to October Wet and Above Normal years = 80 KM X2 Below Normal = SMSCG operations for 60 days in July and August Salinity requirements adjusted in Below Normal Years to account for the effect of Suisun Marsh Salinity Control Gates (SMSCG) operations for 60 days Emmaton (Jul - Aug, BN only) Jersey Point (Jul - Aug, BN only)

Notes for Tables 2-1 a through Table 2-1 v are provided following Table 2-1 v.

Table 2-1 p. Operations Criteria: Sacramento River Region

–	Existing	Proposed Project
Upper Sacramento River: Flow objective for navigation (Wilkins Slough)	Revised flow objective for Wilkins Slough. Flow objective for Wilkins Slough based on month, CVP allocation, and Shasta storage condition to reflect CVP operations for local delivery	Same
American River: Folsom Dam flood control	Variable 400/600 flood control diagram (without outlet modifications)	Same
Feather River: Flow at Mouth of Feather River (above Verona)	Maintain the CDFW /DWR flow target of 2,800 cfs for Apr - Sep dependent on Oroville inflow and FRSA allocation	Same

Notes for Tables 2-1 a through Table 2-1 v are provided following Table 2-1 v.

Table 2-1 q. Operations Criteria: San Joaquin River Region

–	Existing	Proposed Project
Stanislaus River: Flow below Goodwin Dam	1987 USBR, CDFW agreement, and flows required for NMFS BO (Jun 2009) Action III.1.2 and III.1.3[17]	Flows per New Melones SRP
San Joaquin River: Salinity at Vernalis	Grasslands Bypass Project (full implementation)	Same

Notes for Tables 2-1 a through Table 2-1 v are provided following Table 2-1 v.

Table 2-1 r. Operations Criteria: Systemwide – CVP Water Allocation

–	Existing	Proposed Project
Settlement / Exchange	100% (75% in Shasta critical years)	Same
Refuges	100% (75% in Shasta critical years)	Same
Agriculture Service	100% - 0% based on supply. South-of-Delta allocations are additionally limited due to D-1641, FWS BO (Dec 2008), and NMFS BO (Jun 2009) export restrictions[17]	Same
Municipal & Industrial Service	100% - 50% based on supply. South-of-Delta allocations are additionally limited due to D-1641, FWS BO (Dec 2008), and NMFS BO (Jun 2009) export restrictions[17]	Same

Notes for Tables 2-1 a through Table 2-1 v are provided following Table 2-1 v.

Table 2-1 s. Operations Criteria: Systemwide – SWP Water Allocation

–	Existing	Proposed Project
North of Delta (FRSA)	Contract-specific NOD Allocation Settlement Agreement terms for Napa and Solano[15]	Same

–	Existing	Proposed Project
South of Delta (including North Bay Aqueduct)	Based on supply; equal prioritization between Ag and M&I based on Monterey Agreement; allocations are limited due to D-1641, FWS BO (Dec 2008), and NMFS BO (Jun 2009) export restrictions[27,17] NOD Allocation Settlement Agreement terms for Napa and Solano[15]	Same

Notes for Tables 2-1 a through Table 2-1 v are provided following Table 2-1 v.

Table 2-1 t. Operations Criteria: Systemwide – CVP-SWP Coordinated Operations

–	Existing	Proposed Project
Sharing of responsibility for in-basin-use	According to Coordinated Operations Agreement (2018), sharing responsibility for meeting Sacramento Valley In-basin use during balance condition with water year type in percentage for CVP and SWP, respectively are: 80/20 in AN and W 75/25 in BN 65/35 in D 60/40 in C As per NAPA agreement, FRWP and EBMUD 2/3 of the North Bay Aqueduct diversions are considered as Delta export, 1/3 of the North Bay Aqueduct diversion is considered as in-basin use	Same
Sharing of surplus flows	According to Coordinated Operations Agreement (2018), CVP and SWP sharing responsibility during Unstored Water for Export (UWFE) during balanced condition for all year type is 55% and 45%, respectively.	Same
Sharing of restricted export capacity for project- specific priority pumping	The percentage sharing of export capacity under export limits due to (1) SWRCB D-1641 (export/inflow ratio, Vernalis 1:1), (2) 2008 USFWS and 2009 NMFS biological opinions Old and Middle River flow requirements, or (3) 2009 NMFS biological opinion San Joaquin River i:e ratio[27, 17] 60/40 CVP/SWP during excess conditions 65/35 CVP/SWP during balanced conditions No restrictions on Inter-tie use to meet these shares	Same
Water transfers	Acquisitions by SWP contractors are wheeled at priority in Banks Pumping Plant over non-SWP users; LYRA included for SWP contractors[19]	Same
Sharing of export capacity for lesser priority and wheeling-related pumping	Cross Valley Canal wheeling (max of 128 TAF/yr), CALFED ROD defined Joint Point of Diversion (JPOD)	Same
San Luis Reservoir	San Luis Reservoir is allowed to operate to a minimum storage of 100 TAF	Same

Notes for Tables 2-1 a through Table 2-1 v are provided following Table 2-1 v.

Table 2-1 u. Operations Criteria: Systemwide – CVPIA 3406(b)(2)

–	Existing	Proposed Project
Policy Decision	Per May 2003 Dept. of Interior decision	Same
Allocation	800 TAF, 700 TAF in 40-30-30 dry years, and 600 TAF in 40-30-30 critical years as a function of Ag allocation	Same
Actions	Pre-determined upstream fish flow objectives below Whiskeytown Dams, non-discretionary NMFS BO (Jun 2009) actions for the American and Stanislaus Rivers, and NMFS BO (Jun 2009) and FWS BO (Dec 2008) actions leading to export restrictions[17]	Same
Accounting Adjustments	Releases for non-discretionary FWS BO (Dec 2008) and NMFS BO (Jun 2009)[17] actions may or may not always be deemed (b)(2) actions; in general, it is anticipated, that accounting of these actions using (b)(2) metrics, the sum would exceed the (b)(2) allocation in many years; therefore no additional actions are considered and no accounting logic is included in the model	Same

Notes for Tables 2-1 a through Table 2-1 v are provided following Table 2-1 v.

Table 2-1 v. Operations Criteria: Systemwide – Water Management Actions: Water Transfer Supplies (long term programs)

–	Existing	Proposed Project
Lower Yuba River Accord[19,25]	Yuba River acquisitions for reducing impact of NMFS BO export restrictions[17] on SWP	Same
Phase 8	None	Same

Notes for Table 2-1 (Tables 2-1 a through 2-1 v)
"-" indicates blank cell.

[1] These assumptions have been developed under the direction of the Department of Water Resources team for the Voluntary Settlement Agreement (VA) of the Central Valley Project (CVP) and State Water Project (SWP).

[2] The Sacramento Valley hydrology used in the Future Conditions CALSIM II model reflects 2020 land-use assumptions associated with Bulletin 160-98. The San Joaquin Valley hydrology reflects draft 2030 land-use assumptions developed by Reclamation. Development of Future-level projected land-use are being coordinated with the California Water Plan Update for future models.

[3] CVP contract amounts have been reviewed and updated according to existing and amended contracts, as appropriate. Assumptions regarding CVP agricultural and M&I service contracts and Settlement Contract amounts are listed in table 1, table 2 and table 3 in respect of NOD, American River and SOD accordingly. Summary of CVP contract amounts are tabulated below.

Project Contractor Type	North-of-the-Delta (TAF)	South-of-the-Delta (TAF)
CVP Contractors		
Settlement/Exchanges	2291	840
Water Service Contractor		
Agriculture	358	1937
M&I	360	164
Refuges	191	281

[4] SWP contract amounts have been updated as appropriate based on recent Table A transfers/agreements. The contractors' table A entitlement is obtained from Bulletin 132. Assumptions regarding SWP agricultural and M&I contract amounts are listed in table 4, table 5 and table 6 in respect of NOD, Delta and SOD accordingly. Summary of SWP contract amounts are tabulated below.

Project Contractor Type	North-of-the-Delta (TAF)	South-of-the-Delta (TAF)
SWP Contractors		
Feather River Area + Delta	1087	0
Table A	114	4056
Agriculture	0	1012
M&I	114	3044

[5] Water needs for Federal refuges have been reviewed and updated, as appropriate. Assumptions regarding firm Level 2 refuge water are listed in table 1 and table 3. Refuge Level 4 (and incremental Level 4) water is not included.

[6] Assumptions regarding American River water rights and CVP contracts with the Sacramento River Water Reliability Project are listed in table 2. The Sacramento Area Water Forum agreement, its dry year diversion reductions, Middle Fork Project operations and water is not included.

[7] Demand for rice straw decomposition water from Thermalito Afterbay was added to the model and updated to reflect historical diversion from Thermalito in the October through January period.

[8] The new CalSim-II representation of the San Joaquin River has been included in this model package (CalSim-II San Joaquin River Model, Reclamation, 2005). Updates to the San Joaquin River have been included since the preliminary model release in August 2005. The model reflects the difficulties of on-going groundwater overdraft problems. The 2030 level of development representation of the San Joaquin River Basin does not make any attempt to offer solutions to groundwater overdraft problems. In addition, a dynamic groundwater simulation is not yet developed for the San Joaquin River Valley. Groundwater extraction/ recharge and stream-groundwater interaction are static assumptions and may not accurately reflect a response to simulated actions. These limitations should be considered in the analysis of result

[9] The CALSIM II model representation for the Stanislaus River does not necessarily represent Reclamation's current or future operational policies. A suitable plan for supporting flows has not been developed for NMFS BO (Jun 2009) Action III.1.3.

[10] The actual amount diverted is operated in conjunction with supplies from the Los Vaqueros project. The existing Los Vaqueros storage capacity is 160 TAF. Associated water rights to fill Los Vaqueros with Delta excess flows are included, but CCWD's water right permit and water right license on Mallard Slough are not included.

[11] It is assumed that SWP Contractors can take delivery of all Table A allocations and Article 21 supplies. Article 56 provisions are assumed and allow for SWP Contractors to manage storage and delivery conditions such that full Table A allocations can be delivered. Detailed analysis of the South Coast and Tulare regions support these assumptions. NBA Article 21 deliveries are dependent on excess conditions only, all other Article 21 deliveries also require that San Luis Reservoir be at capacity and that Banks PP and the California Aqueduct has available capacity to divert from the Delta for direct delivery.

[12] Mokelumne River flows are modified to reflect modified operations associated with EBMUD supplies from the Freeport Regional Water Project.

[13] The CCWD Alternate Intake Project, an intake at Victoria Canal, which operates as an alternate Delta diversion for Los Vaqueros Reservoir.

[14] D-1644 and the Lower Yuba River Accord is assumed to be implemented. The Yuba River is not dynamically modeled in CALSIM II. Yuba River hydrology and availability of water acquisitions under the Lower Yuba River Accord are based on modeling performed and the Lower Yuba River Accord EIS/EIR study team.

[15] This includes draft logic for the updated Allocation Settlement Agreement for four NOD contractors: Butte, Yuba, Napa and Solano.

[16] It is assumed that D-1641 requirements will be in place in 2030, and VAMP is turned off.

[17] In cooperation with Reclamation, National Marine Fisheries Service, Fish and Wildlife Service, and CA Department of Fish and Game, the CA Department of Water Resources has developed assumptions for implementation of the FWS BO (Dec 15th 2008) and NMFS BO (June 4th 2009) in CALSIM II. The FWS BO and NMFS BO assumptions are documented in the Appendix 5A of the LTO EIS (Reclamation 2015b).

[18] Current ACOE permit for Banks PP allows for an average diversion rate of 6,680 cfs in all months. Diversion rate can increase up to 1/3 of the rate of San Joaquin River flow at Vernalis during Dec 15th – Mar 15th up to a maximum diversion of 10,300 cfs, if Vernalis flow exceeds 1,000 cfs.

[19] Acquisitions of Component 1 water under the Lower Yuba River Accord and use of 500 cfs dedicated capacity at Banks PP during Jul – Sep, are assumed to be used to reduce as much of the impact of the Apr-May fish related Delta export restrictions on SWP contractors as possible.

[20] Delta actions, under USFWS discretionary use of CVPIA 3406(b)(2) allocations, are no longer dynamically operated and accounted for in the CALSIM II model. The Combined Old and Middle River Flow and Delta Export restrictions under the FWS BO (Dec 15th 2008) and the NMFS BO (June 4th 2009) severely limit any discretion that would have been otherwise assumed in selecting Delta actions under the CVPIA 3406(b)(2) accounting criteria. Therefore, it is anticipated that CVPIA 3406(b)(2) account availability for upstream river flows below Whiskeytown, Keswick and Nimbus Dams would be very limited. It appears the integration of BO RPA actions will likely exceed the 3406(b)(2) allocation in all water year types. For these baseline simulations, upstream flows on the Clear Creek and Sacramento River are pre-determined based on CVPIA 3406(b)(2) based operations from the Aug 2008 BA Study 7.0 and Study 8.0 for Existing and Future No Action baselines respectively. The procedures for dynamic operation and accounting of CVPIA 3406(b)(2) are not included in the CALSIM II model.

[21] Only acquisitions of Lower Yuba River Accord Component 1 water are included.

[22] PCWA American River pumping facility upstream of Folsom Lake is included.

[23] Since the release of DCR 2017, EBMUD has replaced their monthly timestep planning model with a physically based, daily timestep model. To be consistent with EBMUD's planning model, the CalSim II inputs related to the EBMUD operations – Mokelumne River inflow into Delta and allocations from the Freeport Regional Water Project – are updated to match the outputs from Model Run #8079. Key modeling assumptions include: projected 2040 level of development; average demand of 230 MGD; and FWRP operations based on the 2016 Drought Management Program Guidelines.

[24] For consistency, the CalSim II Tuolumne River operations – New Don Pedro storage along with diversions and channel flows downstream of the New Don Pedro dam – are fixed to the Tuolumne operations modeled in the Water Supply Effect (WSE) spreadsheet model of the State Water Resource Control Board (SWRCB). The model inputs to the WSE model were developed from DCR 2017existing conditions CalSim II model run.

[25] Yuba Water Agency (YWA) has recently converted their operations model from a monthly timestep to daily timestep as part of their FERC Relicensing process for a more accurate representation of Yuba River Development Project (YRDP) operations. To be consistent with YWA's planning model, Yuba River Development Project Model (YRDPM), the CalSim II inputs related to the Yuba River operations have been updated, including Yuba River flow above Daguerre Point Dam and Daguerre Point Dam diversion, and the Yuba River transfer operations.

[26] The SJRR flows represented in the CalSim II model so far reflected the long-term flow schedule. A timeseries that reflects the near-term flows is being developed. The near-term SJRR flows can be recaptured using the current facilities before reaching the Delta, which is closer to a CalSim II model run without SJRR flows in terms of the Delta flow and salinity conditions as well as the Delta outflow. As a result, San Joaquin River Restoration flows are turned off.

[27] Fall X2 is considered in-basin-use (IBU) even the Delta outflow requirement under X2 condition is met though export restriction.

3 CalSim II Model Delivery Specifications

This compilation of delivery specifications for the CalSim II model provides additional detail in support of Attachment 1-1.

The delivery specifications for the CalSim II model include Central Valley Project (CVP) and State Water Project (SWP) contract amounts and other water rights assumptions used. These specifications are detailed in the following tables:

- Tables 1a through 1d. CVP North-of-the-Delta – Future Conditions
- Tables 2a and 2b. CVP American River – Future Conditions
- Table 3. CVP Delta – Future Conditions
- Tables 4a through 4e. CVP South-of-the-Delta – Future Conditions
- Table 5. SWP North-of-the-Delta – Future Conditions
- Tables 6a and 6b. SWP South-of-the-Delta – Future Conditions

Table 1a. CVP North-of-the-Delta

CVP Contractor	Geographic Location	CVP Water Service Contracts: AG (TAF/yr)	CVP Water Service Contracts: M&I (TAF/yr)	Settlement / Exchange Contractor (TAF/yr)	Water Rights / Non CVP (TAF/yr)	Level 2 Refugees[1] (TAF/yr)
Anderson Cottonwood ID	Sacramento River Redding Subbasin	-	-	128.0	-	-
Clear Creek CSD	Sacramento River Redding Subbasin	13.8	1.5	-	-	-
Bella Vista WD	Sacramento River Redding Subbasin	22.1	2.4	-	-	-
Shasta CSD	Sacramento River Redding Subbasin	-	1.0	-	-	-
Sac R. Misc. Users	Sacramento River Redding Subbasin	-	-	3.4	-	-
Redding, City of	Sacramento River Redding Subbasin	-	-	21.0	-	-
City of Shasta Lake	Sacramento River Redding Subbasin	2.5	0.3	-	-	-
Mountain Gate CSD	Sacramento River Redding Subbasin	-	0.4	-	-	-
Shasta County Water Agency	Sacramento River Redding Subbasin	0.5	0.5	-	-	-
Redding, City of/Buckeye	Sacramento River Redding Subbasin	-	6.1	-	-	-
Total	**Sacramento River Redding Subbasin**	**38.9**	**12.2**	**152.4**	**-**	**0.0**
Corning WD	Corning Canal	23.0	-	-	-	-
Proberta WD	Corning Canal	3.5	-	-	-	-
Thomes Creek WD	Corning Canal	6.4	-	-	-	-
Total	**Corning Canal**	**32.9**	**0.0**	**0.0**	**-**	**0.0**

Notes:
"-" indicates blank cell
1. Level 4 Refuge water needs are not included.

Table 1b. CVP North-of-the-Delta

CVP Contractor	Geographic Location	CVP Water Service Contracts: AG (TAF/yr)	CVP Water Service Contracts: M&I (TAF/yr)	Settlement / Exchange Contractor (TAF/yr)	Water Rights / Non CVP (TAF/yr)	Level 2 Refugees[1] (TAF/yr)
Kirkwood WD	Tehama-Colusa Canal	2.1	-	-	-	-
Glide WD	Tehama-Colusa Canal	10.5	-	-	-	-
Kanawha WD	Tehama-Colusa Canal	45.0	-	-	-	-
Orland-Artois WD	Tehama-Colusa Canal	53.0	-	-	-	-
Colusa, County of	Tehama-Colusa Canal	20.0	-	-	-	-
Colusa County WD	Tehama-Colusa Canal	62.2	-	-	-	-
Davis WD	Tehama-Colusa Canal	4.0	-	-	-	-
Dunnigan WD	Tehama-Colusa Canal	19.0	-	-	-	-
La Grande WD	Tehama-Colusa Canal	5.0	-	-	-	-
Westside WD	Tehama-Colusa Canal	65.0	-	-	-	-
Total	**Tehama-Colusa Canal**	**285.8**	**0.0**	**0.0**	**-**	**0.0**
Sac. R. Misc. Users[2]	Sacramento River	-	-	1.5	-	-
Glenn Colusa ID	Glenn-Colusa Canal	-	-	441.5	-	-
Glenn Colusa ID	Glenn-Colusa Canal	-	-	383.5	-	-
Sacramento NWR	Glenn-Colusa Canal	-	-	-	-	54.5
Delevan NWR	Glenn-Colusa Canal	-	-	-	-	24.6
Colusa NWR	Glenn-Colusa Canal	-	-	-	-	29.3
Colusa Drain M.W.C.	Colusa Basin Drain	-	-	7.7	-	-
Colusa Drain M.W.C.	Colusa Basin Drain	**-**	**-**	62.3	**-**	**-**
Total	**-**	**0.0**	**0.0**	**895.0**		**108.4**

Notes:
"-" indicates blank cell
1. Level 4 Refuge water needs are not included.

Table 1c. CVP North-of-the-Delta

CVP Contractor	Geographic Location	CVP Water Service Contracts: AG (TAF/yr)	CVP Water Service Contracts: M&I (TAF/yr)	Settlement / Exchange Contractor (TAF/yr)	Water Rights / Non CVP (TAF/yr)	Level 2 Refugees[1] (TAF/yr)
Princeton-Cordova-Glenn ID	Sacramento River	-	-	67.8	-	-
Provident ID	Sacramento River	-	-	54.7	-	-
Maxwell ID	Sacramento River	-	-	1.8	-	-
Maxwell ID	Sacramento River	-	-	16.2	-	-
Sycamore Family Trust	Sacramento River	-	-	31.8	-	-
Roberts Ditch IC	Sacramento River	-	-	4.4	-	-
Sac R. Misc. Users[2]	Sacramento River	-	-	4.9	-	-
Sac R. Misc. Users[2]	Sacramento River	-	-	9.5	-	-
Total	**Sacramento River**	**0.0**	**0.0**	**191.2**	**-**	**0.0**
Reclamation District 108	Sacramento River	-	-	12.9	-	-
Reclamation District 108	Sacramento River	-	-	219.1	-	-
River Garden Farms	Sacramento River	-	-	29.8	-	-
Meridian Farms WC	Sacramento River	-	-	35.0	-	-
Pelger Mutual WC	Sacramento River	-	-	8.9	-	-
Reclamation District 1004	Sacramento River	-	-	71.4	-	-
Carter MWC	Sacramento River	-	-	4.7	-	-
Sutter MWC	Sacramento River	-	-	226.0	-	-
Tisdale Irrigation & Drainage Co.	Sacramento River	-	-	9.9	-	-
Sac R. Misc. Users[2]	Sacramento River	-	-	103.4	-	-
Sac R. Misc. Users[2]	Sacramento River	-	-	0.9	-	-
Feather River WD export	Sacramento River	20.0	-	-	-	-
Total	**Sacramento River**	**20.0**	**0.0**	**722.1**	**-**	**0.0**

Notes:
"-" indicates blank cell
1. Level 4 Refuge water needs are not included.

Table 1d. CVP North-of-the-Delta

CVP Contractor	Geographic Location	CVP Water Service Contracts: AG (TAF/yr)	CVP Water Service Contracts: M&I (TAF/yr)	Settlement / Exchange Contractor (TAF/yr)	Water Rights / Non CVP (TAF/yr)	Level 2 Refugees[1] (TAF/yr)
Sutter NWR	Sutter bypass water for Sutter NWR	-	-	-	-	25.7
Gray Lodge WMA	Feather River	-	-	-	-	41.3
Butte Sink Duck Clubs	Feather River	-	-	-	-	15.6
Total	Feather River	0.0	0.0	0.0	-	82.6
Sac. R. Misc. Users[2]	Sacramento River DSA 65	-	-	56.8	-	-
City of West Sacramento	Sacramento River DSA 65	-	-	23.6	-	-
Davis-Woodland Water Supply Project	Sacramento River DSA 65	-	-	-	-	-
Total	**Sacramento River DSA 65**	**0.0**	**0.0**	**80.4**	-	**0.0**
Sac R. Misc. Users	Lower Sacramento River	-	-	4.8	-	-
Natomas Central MWC	Lower Sacramento River	-	-	120.2	-	-
Pleasant Grove-Verona MWC	Lower Sacramento River	-	-	26.3	-	-
City of Sacramento (PCWA)	Lower Sacramento River	-	0.0	-	0.0	-
PCWA (Water Rights)	Lower Sacramento River	-	0.0	-	0.0	-
Total	**Lower Sacramento River**	**0.0**	**0.0**	**151.3**	**0.0**	**-**
Total CVP North-of-Delta	**-**	**377.6**	**12.2**	**2193.8**	**0.0**	**191.0**

Notes:
1. Level 4 Refuge water needs are not included.
"-" indicates blank cell

Table 2a. American River

–	Diversion Location	CVP M&I[1] Contracts (maximum[1])	Water Rights (maximum)	Diversion Limit (maximum capacity)
Placer County Water Agency	Auburn Dam Site	-	65.0	65.0
Total	**Auburn Dam Site**	**0**	**65.0**	**65.0**
Sacramento Suburban Water District[2]	Folsom Reservoir	-	0	0
City of Folsom - includes P.L. 101-514	Folsom Reservoir	7	27	34
Folsom Prison	Folsom Reservoir	-	5	5
San Juan Water District (Placer County)	Folsom Reservoir	-	25	25
San Juan Water District (Sac County) - includes P.L. 101-514	Folsom Reservoir	24.2	33	57.2
El Dorado Irrigation District	Folsom Reservoir	7.55	17	24.55
City of Roseville	Folsom Reservoir	32	30	62.0
Placer County Water Agency	Folsom Reservoir	35	-	35
El Dorado County - P.L.101-514	Folsom Reservoir	15	-	15
Total	**Folsom Reservoir**	**120.75**	**137.0**	**257.75**
So. Cal WC/Arden Cordova WC	Folsom South Canal	-	5	5
California Parks and Recreation	Folsom South Canal	5	-	5
SMUD	Folsom South Canal	30	15	45
Canal Losses	Folsom South Canal	-	1	1
Total	**Folsom South Canal**	**35**	**21**	**56**
City of Sacramento[3]	Lower American River	-	230	230
Carmichael Water District	Lower American River	-	12	12
Total	**Lower American River**	**0**	**242**	**242**
Total American River Diversions	**-**	**155.75**	**465**	**620.75**

Notes for Tables 3-2a and 3-2b are provided after Table 3-2b.
“-“ indicates blank cell

Table 2b. American River

–	Diversion Location	CVP M&I[1] Contracts (maximum[1])	Water Rights (maximum)	Diversion Limit (maximum capacity)
City of Sacramento	Lower Sacramento River	-	81.8	81.8
Sacramento County Water Agency	Lower Sacramento River	10	-	10
Sacramento County Water Agency - P.L. 101-514 / FRWP	Lower Sacramento River	35	-	35
Sacramento County Water Agency - water rights and acquisitions	Lower Sacramento River	-	varies[4], average ~32	varies[4], average ~32
East Bay Municipal Utilities District	Lower Sacramento River	133	-	varies[5], average 14.6
Total Sacramento River Diversions	**-**	**178**	**113.8**	**173.4**
Total	**-**	**333.75**	**578.8**	**794.15**

Notes for Tables 3-2a and 3-2b:

"-" indicates blank cell

1 When the CVP Contract quantity exceeds the quantity of the Diversion Limit minus the Water Right (if any), the diversion modeled is the quantity allocated to the CVP Contract (based on the CVP contract quantity shown times the CVP M&I allocation percentage) plus the Water Right (if any), but with the sum limited to the quantity of the Diversion Limit

2 Diversion is only allowed if and when Mar-Nov Folsom Unimpaired Inflow (FUI) exceeds 1600 TAF

3 When the Hodge single dry year criteria is triggered, Mar-Nov FUI falls below 400 TAF, diversion on the American River is limited to 50 TAF/yr; based on monthly Hodge flow limits assumed for the American, diversion on the Sacramento River may be increased to 223 TAF due to reductions of diversions on American River

4 SCWA targets 68 TAF of surface water supplies annually. The portion unmet by CVP contract water is assumed to come from two sources:
  - (1) Delta "excess" water- averages 17.5 TAF annually, but varies according to availability. SCWA is assumed to divert excess flow when it is available, and when there is available pumping capacity.
  - (2) "Other" water- derived from transfers and/or other appropriated water, averaging 14.5 TAF annually but varying according remaining unmet demand.

5 EBMUD CVP diversions are governed by the Amendatory Contract, stipulating:
  - (1) 133 TAF maximum diversion in any given year
  - (2) 165 TAF maximum diversion amount over any 3 year period
  - (3) Diversions allowed only when EBMUD total storage drops below 500 TAF
  - (4) 155 cfs maximum diversion rate

Table 3. Delta

CVP/ SWP Contractor	Area	Geographic Location	Water Right (TAF/yr)	SWP Table A Amount AG (TAF)	SWP Table A Amount M&I (TAF)	SWP Article 21 Demand (TAF/mon)	CVP Water Service Contracts AG (TAF/yr)	CVP Water Service Contracts M&I (TAF/yr)
City of Vallejo	North Delta	City of Vallejo	-	-	-	-	-	16.0
CCWD[1]	North Delta	Contra Costa County	-	-	-	-	-	195.0
Napa County FC&WCD	North Delta	North Bay Aqueduct	-	-	29.03	1.0	-	-
Solano County WA	North Delta	North Bay Aqueduct	-	-	47.76	1.0	-	-
Fairfield, Vacaville and Benicia Agreement	North Delta	North Bay Aqueduct	31.60	-	-	-	-	-
City of Antioch	North Delta	City of Antioch	18.0	-	-	-	-	-
Total North Delta	**North Delta**	**-**	**49.6**	**0.0**	**76.79**	**2.0**	**0.0**	**211.0**
Delta Water Supply Project	South Delta	City of Stockton	32.4					
Total South Delta	**South Delta**	**-**	**32.4**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Total	**North and South Delta**	**-**	**82.0**	**0.0**	**76.79**	**2.0**	**0.0**	**211.0**

Notes:
“-“ indicates blank cell
1. The Los Vaqueros module in CalSim II is used to determine the range of demands that are met by CVP contracts or other water rights

Table 4a. CVP South-of-the-Delta

CVP Contractor	Geographic Location	CVP Water Service Contracts AG (TAF/yr)	CVP Water Service Contracts M&I (TAF/yr)	Settlement/ Exchange Contractor (TAF/yr)	Water Rights/ Non-CVP (TAF/yr)	Level 2 Refuges[1] (TAF/yr)	Losses (TAF/yr)
Byron-Bethany ID	Upper DMC	20.6	-	-	-	-	-
Tracy, City of	Upper DMC	-	10.0	-	-	-	-
Tracy, City of	Upper DMC	-	5.0	-	-	-	-
Tracy, City of	Upper DMC	-	5.0	-	-	-	-
Banta Carbona ID	Upper DMC	20.0	-	-	-	-	-
Total	**Upper DMC**	**40.6**	**20.0**	**0.0**	**0.0**	**0.0**	**0.0**
Del Puerto WD	Upper DMC	12.1	-	-	-	-	-
Davis WD	Upper DMC	5.4	-	-	-	-	-
Foothill WD	Upper DMC	10.8	-	-	-	-	-
Hospital WD	Upper DMC	34.1	-	-	-	-	-
Kern Canon WD	Upper DMC	7.7	-	-	-	-	-
Mustang WD	Upper DMC	14.7	-	-	-	-	-
Orestimba WD	Upper DMC	15.9	-	-	-	-	-
Quinto WD	Upper DMC	8.6	-	-	-	-	-
Romero WD	Upper DMC	5.2	-	-	-	-	-
Salado WD	Upper DMC	9.1	-	-	-	-	-
Sunflower WD	Upper DMC	16.6	-	-	-	-	-
West Stanislaus WD	Upper DMC	50.0	-	-	-	-	-
Patterson WD	Upper DMC	16.5	-	-	6.0	-	-
Total	**Upper DMC**	**206.7**	**0.0**	**0.0**	**6.0**	**0.0**	**0.0**

Notes for Tables 3-4a and 3-4e are provided after Table 3-4e.

Table 4b. CVP South-of-the-Delta

CVP Contractor	Geographic Location	CVP Water Service Contracts AG (TAF/yr)	CVP Water Service Contracts M&I (TAF/yr)	Settlement/ Exchange Contractor (TAF/yr)	Water Rights/ Non-CVP (TAF/yr)	Level 2 Refuges[1] (TAF/yr)	Losses (TAF/yr)
Upper DMC Loss	Upper DMC	-	-	-	-	-	18.5
Panoche WD	Lower DMC Volta	6.6	-	-	-	-	-
San Luis WD	Lower DMC Volta	65.0	-	-	-	-	-
Laguna WD	Lower DMC Volta	0.8	-	-	-	-	-
Eagle Field WD	Lower DMC Volta	4.6	-	-	-	-	-
Mercy Springs WD	Lower DMC Volta	2.8	-	-	-	-	-
Oro Loma WD	Lower DMC Volta	4.6	-	-	-	-	-
Total	**Lower DMC Volta**	**84.4**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Central California ID	Lower DMC Volta	-	-	140.0	-	-	-
Grasslands via CCID	Lower DMC Volta	-	-	-	-	81.8	-
Los Banos WMA	Lower DMC Volta	-	-	-	-	11.2	-
Kesterson NWR	Lower DMC Volta	-	-	-	-	10.5	-
Freitas - SJBAP	Lower DMC Volta	-	-	-	-	6.3	-
Salt Slough - SJBAP	Lower DMC Volta	-	-	-	-	8.6	-
China Island - SJBAP	Lower DMC Volta	-	-	-	-	7.0	-
Volta WMA	Lower DMC Volta	-	-	-	-	13.0	-
Grassland via Volta Wasteway	Lower DMC Volta	-	-	-	-	23.2	-
Total	**Lower DMC Volta**	**0.0**	**0.0**	**140.0**	**0.0**	**161.5**	**0.0**

Notes for Tables 3-4a and 3-4e are provided after Table 3-4e.

Table 4c. CVP South-of-the-Delta

CVP Contractor	Geographic Location	CVP Water Service Contracts AG (TAF/yr)	CVP Water Service Contracts M&I (TAF/yr)	Settlement/ Exchange Contractor (TAF/yr)	Water Rights/ Non-CVP (TAF/yr)	Level 2 Refuges[1] (TAF/yr)	Losses (TAF/yr)
Fresno Slough WD	San Joaquin River at Mendota Pool	4.0	-	-	0.9	-	-
James ID	San Joaquin River at Mendota Pool	35.3	-	-	9.7	-	-
Coelho Family Trust	San Joaquin River at Mendota Pool	2.1	-	-	1.3	-	-
Tranquillity ID	San Joaquin River at Mendota Pool	13.8	-	-	20.2	-	-
Tranquillity PUD	San Joaquin River at Mendota Pool	0.1	-	-	0.1	-	-
Reclamation District 1606	San Joaquin River at Mendota Pool	0.2	-	-	0.3	-	-
Central California ID	San Joaquin River at Mendota Pool	-	-	392.4	-	-	-
Columbia Canal Co.	San Joaquin River at Mendota Pool	-	-	59.0	-	-	-
Firebaugh Canal Co.	San Joaquin River at Mendota Pool	-	-	85.0	-	-	-
San Luis Canal Co.	San Joaquin River at Mendota Pool	-	-	23.6	-	-	-
M.L. Dudley Company	San Joaquin River at Mendota Pool	-	-	-	2.3	-	-
Grasslands WD	San Joaquin River at Mendota Pool	-	-	-	-	29.0	-
Mendota WMA	San Joaquin River at Mendota Pool	-	-	-	-	27.6	-
Losses	San Joaquin River at Mendota Pool	-	-	-	-	-	101.5
Total	**San Joaquin River at Mendota Pool**	**55.5**	**0.0**	**560.0**	**34.8**	**56.6**	**101.5**
San Luis Canal Co.	-	-	-	140.0	-	-	-
Grasslands WD	-	-	-	-	-	2.3	-
Los Banos WMA	-	-	-	-	-	12.4	-
San Luis NWR	-	-	-	-	-	19.5	-
West Bear Creek NWR	-	-	-	-	-	7.5	-
East Bear Creek NWR	-	-	-	-	-	8.9	-
Total	-	**0.0**	**0.0**	**140.0**	**0.0**	**50.6**	**0.0**

Notes for Tables 3-4a and 3-4e are provided after Table 3-4e.

Table 4d. CVP South-of-the-Delta

CVP Contractor	Geographic Location	CVP Water Service Contracts AG (TAF/yr)	CVP Water Service Contracts M&I (TAF/yr)	Settlement/ Exchange Contractor (TAF/yr)	Water Rights/ Non-CVP (TAF/yr)	Level 2 Refuges[1] (TAF/yr)	Losses (TAF/yr)
San Benito County WD (Ag)	San Felipe Aqueduct	35.6	-	-	-	-	-
Santa Clara Valley WD (Ag)	San Felipe Aqueduct	33.1	-	-	-	-	-
Pajaro Valley WD	San Felipe Aqueduct	6.3	-	-	-	-	-
San Benito County WD (M&I)	San Felipe Aqueduct	-	8.3	-	-	-	-
Santa Clara Valley WD (M&I)	San Felipe Aqueduct	-	119.4	-	-	-	-
Total	**San Felipe Aqueduct**	**74.9**	**127.7**	**0.0**	**0.0**	**0.0**	**0.0**
San Luis WD	CA reach 3	60.1	-	-	-	-	-
CA, State Parks and Rec	CA reach 3	2.3	-	-	-	-	-
Affonso/Los Banos Gravel Co.	CA reach 3	0.3	-	-	-	-	-
Total	**CA reach 3**	**62.6**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Panoche WD	CVP Dos Amigos PP/ CA reach 4	87.4	-	-	-	-	-
Pacheco WD	CVP Dos Amigos PP/ CA reach 4	10.1	-	-	-	-	-
Total	**CVP Dos Amigos PP/ CA reach 4**	**97.5**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Westlands WD (Centinella)	CA reach 4	2.5	-	-	-	-	-
Westlands WD (Broadview WD)	CA reach 4	27.0	-	-	-	-	-
Westlands WD (Mercy Springs WD)	CA reach 4	4.2	-	-	-	-	-
Westlands WD (Widern WD)	CA reach 4	3.0	-	-	-	-	-
Total	**CA reach 4**	**36.7**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Westlands WD: CA Joint Reach 4	CA reach 4	219.0	-	-	-	-	-
Westlands WD: CA Joint Reach 5	CA reach 5	570.0	-	-	-	-	-
Westlands WD: CA Joint Reach 6	CA reach 6	219.0	-	-	-	-	-
Westlands WD: CA Joint Reach 7	CA reach 7	142.0	-	-	-	-	-
Total	**-**	**1150.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**

Notes for Tables 3-4a and 3-4e are provided after Table 3-4e.

Table 4e. CVP South-of-the-Delta

CVP Contractor	Geographic Location	CVP Water Service Contracts AG (TAF/yr)	CVP Water Service Contracts M&I (TAF/yr)	Settlement/ Exchange Contractor (TAF/yr)	Water Rights/ Non-CVP (TAF/yr)	Level 2 Refuges[1] (TAF/yr)	Losses (TAF/yr)
Avenal, City of	CA reach 7	-	3.5	-	3.5	-	-
Coalinga, City of	CA reach 7	-	10.0	-	-	-	-
Huron, City of	CA reach 7	-	3.0	-	-	-	-
Total	**CA reach 7**	**0.0**	**16.5**	**0.0**	**3.5**	**0.0**	**0.0**
CA Joint Reach 3 - Loss	CVP Dos Amigos PP/CA reach 3	-	-	-	-	-	2.5
CA Joint Reach 4 - Loss	CA reach 4	-	-	-	-	-	10.1
CA Joint Reach 5 - Loss	CA reach 5	-	-	-	-	-	30.1
CA Joint Reach 6 - Loss	CA reach 6	-	-	-	-	-	12.5
CA Joint Reach 7 - Loss	CA reach 7	-	-	-	-	-	8.5
Total	**-**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**63.7**
Cross Valley Canal - CVP	CA reach 14	-	-	-	-	-	-
Fresno, County of	CA reach 14	3.0	-	-	-	-	-
Hills Valley ID-Amendatory	CA reach 14	3.3	-	-	-	-	-
Kern-Tulare WD	CA reach 14	40.0	-	-	-	-	-
Lower Tule River ID	CA reach 14	31.1	-	-	-	-	-
Pixley ID	CA reach 14	31.1	-	-	-	-	-
Rag Gulch WD	CA reach 14	13.3	-	-	-	-	-
Tri-Valley WD	CA reach 14	1.1	-	-	-	-	-
Tulare, County of	CA reach 14	5.3	-	-	-	-	-
Kern NWR	CA reach 14	-	-	-	-	11.0	-
Pixley NWR	CA reach 14	-	-	-	-	1.3	-
Total	**CA reach 14**	**128.3**	**0.0**	**0.0**	**0.0**	**12.3**	**0.0**
Total CVP South-of-Delta	**-**	**1937.1**	**164.2**	**840.0**	**44.3**	**281.0**	**183.7**

Notes for Tables 3-4a and 3-4e:
"-" indicates blank cell
1. Level 4 Refuge water needs are not included.

Table 5. SWP North-of-the-Delta

SWP CONTRACTOR	Geographic Location	FRSA Amount (TAF)	Water Right (TAF/yr)	Table A Amount Ag (TAF)	Table A Amount M&I (TAF)	Article 21 Demand (TAF/mon)	Other (TAF/yr)
Palermo	FRSA	-	17.6	-	-	-	-
County of Butte	Feather River	-	-	-	27.5		
Thermalito	FRSA	-	8.0	-	-	-	-
Western Canal	FRSA	150.0	145.0	-	-	-	-
Joint Board	FRSA	550.0	5.0	-	-	-	-
City of Yuba City	Feather River	-	-	-	9.6	-	-
Feather WD	FRSA	17.0	-	-	-	-	-
Garden, Oswald, Joint Board	FRSA	-	-	-	-	-	-
Garden	FRSA	12.9	5.1	-	-	-	-
Oswald	FRSA	2.9	-	-	-	-	-
Joint Board	FRSA	50.0	-	-	-	-	-
Plumas, Tudor	FRSA	-	-	-	-	-	-
Plumas	FRSA	8.0	6.0	-	-	-	-
Tudor	FRSA	5.1	0.2	-	-	-	-
Total Feather River Area	**-**	**795.8**	**186.9**	**0.0**	**37.1**	-	-
Yuba County Water Agency	Yuba River	-	-	-	-	-	Variable
Yuba County Water Agency	Yuba River	-	-	-	-	-	333.6
Camp Far West ID	Yuba River	-	-	-	-	-	12.6
Bear River Exports	American R/DSA70	-	-	-	-	-	Variable
Bear River Exports	American R/DSA70	-	-	-	-	-	95.2
Feather River Exports to American River (left bank to DSA70)	American R/DSA70	-	11.0	-	-	-	-

Notes:
"-" indicates blank cell

Table 6a. SWP South-of-the-Delta –Future Conditions

SWP Contractor	Geographic Location	Table A Amount Ag (TAF)	Table A Amount M&I (TAF)	Article 21 Demand (TAF/mon)	Losses (TAF/yr)
Alameda Co. FC&WCD, Zone 7	SBA reaches 1-4	-	43.98	1.00	-
Alameda Co. FC&WCD, Zone 7	SBA reaches 5-6	-	36.64	None	-
Alameda Co. FC&WCD, Zone 7	**Total**	-	**80.62**	**1.00**	-
Alameda County WD	SBA reaches 7-8	-	42.00	1.00	-
Santa Clara Valley WD	SBA reach 9	-	100.00	4.00	-
Oak Flat WD	CA reach 2A	5.70	-	None	-
County of Kings	CA reach 8C	9.31	-	None	-
Dudley Ridge WD	CA reach 8D	45.35	-	1.00	-
Empire West Side ID	CA reach 8C	3.00	-	1.00	-
Kern County Water Agency	CA reaches 3, 9-13B	608.86	134.60	None	-
Kern County Water Agency	CA reaches 14A-C	99.20	-	180.00	-
Kern County Water Agency	CA reaches 15A-16A	59.40	-	None	-
Kern County Water Agency	CA reach 31A	80.67	-	None	-
Kern County Water Agency	**Total**	**848.13**	**134.60**	**180.00**	-
Tulare Lake Basin WSD	CA reaches 8C-8D	87.47	-	15.00	-
San Luis Obispo Co. FC&WCD	CA reaches 33A-35	-	25.00	None	-
Santa Barbara Co. FC&WCD	CA reach 35	-	45.49	None	-
Antelope Valley-East Kern WA	CA reaches 19-20B, 22A-B	-	144.84	1.00	-
Castaic Lake WA	CA reach 31A	12.70	-	1.00	-
Castaic Lake WA	CA reach 30	-	82.50	None	-
Castaic Lake WA	**Total**	**12.70**	**82.50**	**1.00**	-
Coachella Valley WD	CA reach 26A	-	138.35	2.00	-
Crestline-Lake Arrowhead WA	CA reach 24	-	5.80	None	-
Desert WA	CA reach 26A	-	55.75	5.00	-
Littlerock Creek ID	CA reach 21	-	2.30	None	-
Mojave WA	CA reaches 19, 22B-23	-	85.80	None	-

SWP Contractor	Geographic Location	Table A Amount Ag (TAF)	Table A Amount M&I (TAF)	Article 21 Demand (TAF/mon)	Losses (TAF/yr)
Metropolitan WDSC	CA reach 26A	-	148.67	90.70	-
Metropolitan WDSC	CA reach 30	-	756.69	74.80	-
Metropolitan WDSC	CA reaches 28G-H	-	102.71	27.60	-
Metropolitan WDSC	CA reach 28J	-	903.43	6.90	-
Metropolitan WDSC	**Total**	-	**1911.50**	**200.00**	-

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Table 6b. SWP South-of-the-Delta

SWP Contractor	Geographic Location	Table A Amount Ag (TAF)	Table A Amount M&I (TAF)	Article 21 Demand (TAF/mon)	Losses (TAF/yr)
Palmdale WD	CA reaches 20A-B	-	21.30	None	-
San Bernardino Valley MWD	CA reach 26A	-	102.60	None	-
San Gabriel Valley MWD	CA reach 26A	-	28.80	None	-
San Gorgonio Pass WA	CA reach 26A	-	17.30	None	-
Ventura County FCD	CA reach 29H	-	3.15	None	-
Ventura County FCD	CA reach 30	-	16.85	None	-
Ventura County FCD	**Total**	**-**	**20.00**	**-**	**-**
SWP Losses	CA reaches 1-2	-	-	-	7.70
SWP Losses	SBA reaches 1-9	-	-	-	0.60
SWP Losses	CA reach 3	-	-	-	10.80
SWP Losses	CA reach 4	-	-	-	2.60
SWP Losses	CA reach 5	-	-	-	3.90
SWP Losses	CA reach 6	-	-	-	1.20
SWP Losses	CA reach 7	-	-	-	1.60
SWP Losses	CA reaches 8C-13B	-	-	-	11.90
SWP Losses	Wheeler Ridge PP and CA reaches 14A-C	-	-	-	3.60
SWP Losses	Chrisman PP and CA reaches 15A-18A	-	-	-	1.80
SWP Losses	Pearblossom PP and CA reaches 17-21	-	-	-	5.10
SWP Losses	Mojave PP and CA reaches 22A-23	-	-	-	4.00
SWP Losses	REC and CA reaches 24-28J	-	-	-	1.40
SWP Losses	CA reaches 29A-29F	-	-	-	1.90
SWP Losses	Castaic PWP and CA reach 29H	-	-	-	3.10
SWP Losses	REC and CA reach 30	-	-	-	2.40
SWP Losses	**Total**	**-**	**-**	**-**	**63.60**
Total	**-**	**1011.66**	**3044.55**	**412.00**	**63.60**

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Attachment 1-3 DSM2 Model Assumptions Callouts

1 Introduction

The assumptions for all model simulations in this study are summarized in Appendix E Attachment 1-1 Model Assumptions.

2 DSM2 Modeling Assumptions Callouts

The following matrix summarizes the assumptions used for the DSM2 models:

- Existing Conditions (EX)
- Proposed Project (PP)

Table 1a. Boundary Conditions

–	Existing Conditions (EX)	Proposed Project (PP)
Period of simulation	82 years (1922-2003)[1]	Same as EX
Boundary flows	Monthly timeseries from CalSim II output (at Sacramento River, East Side Streams, San Joaquin River, as well as Delta exports and diversions)[3]	Same as EX
Ag flows (DICU)	2020 Level, DWR Bulletin 160-98[4]	Same as EX
Martinez stage	15-minute adjusted astronomical tide[1]	Same as EX
Vernalis EC	Monthly time series from CalSim II output[5]	Same as EX
Agricultural Return EC	Municipal Water Quality Investigation Program analysis	Same as EX
Martinez EC	Monthly net Delta Outflow from CalSim output & G-model[6]	Same as EX

Notes for Table 1a and 1b are provided after Table 1b.

Table 1b. Facilities

–	Existing Conditions (EX)	Proposed Project (PP)
Period of simulation	82 years (1922-2003)[1]	Same as EX
Freeport Regional Water Project	Monthly output from CalSim II	Same as EX
Delta Cross Channel	Monthly time series of number of days open from CalSim II output[8]	Same as EX
Stockton Delta Water Supply Project	Monthly output from CalSim II	Same as EX
Delta Habitat Improvements	None	Same as EX
Veale Tract Drainage Relocation	The Veale Tract Water Quality Improvement Project, funded by CALFED, relocates the agricultural drainage outlet was relocated from Rock Slough channel to the southern end of Veale Tract, on Indian Slough[7]	Same as EX
Clifton Court Forebay	Priority 3, gate operations synchronized with incoming tide to minimize impacts to low water levels in nearby channels	Same as EX
Contra Costa Water District Delta Intakes	Rock Slough Pumping Plant, Old River at Highway 4 Intake and Alternate Improvement Project Intake on Victoria Canal	Same as EX

–	Existing Conditions (EX)	Proposed Project (PP)
South Delta barriers	Temporary Barriers Project operated based on San Joaquin River flow time series from CalSim II output; HORB installed Apr 1– May 31 and Sep 16 – Nov 30; Agricultural barriers on Old and Middle Rivers are assumed to be installed starting from May 16 and on Grant Line Canal from June 1; All three barriers are allowed to be operated until November 30; May 16 to May 31; the tidal gates are assumed to be tied open for the barriers on Old and Middle Rivers.	Temporary Barriers Project operated based on San Joaquin River flow time series from CalSim II output; HORB is not installed; Agricultural barriers on Old and Middle Rivers are assumed to be installed starting from May 16 and on Grant Line Canal from June 1; All three barriers are allowed to be operated until November 30; May 16 to May 31; the tidal gates are assumed to be tied open for the barriers on Old and Middle Rivers.
Antioch Water Works	Monthly output from CalSim II	Same as EX
Suisun Marsh Salinity Control Gates	Gate operations occur in October through February. Gates open when upstream water level is 0.3 ft above downstream water level. Gates close when current is less than -0.1 fps. Gates are open in March through September.	Gate operations occur in October through February in all years, and July through August during Below Normal water years. Gates open when upstream water level is 0.3 ft above downstream water level. Gates close when current is less than -0.1 fps. In Below Normal years, gates are open in March through June. In all other water years, gates are open in March through September.

Notes for Table 1a and 1b:

"–" indicates a cell is blank.

1 Adjusted astronomical tide for use in DSM2 planning studies has been developed by DWR's Bay Delta Office Modeling Support Branch Delta Modeling Section in cooperation with the Common Assumptions workgroup. This tide is based on a more extensive observed dataset and covers the entire 82-year period of record.

2 Footnote not used

3 Although monthly CalSim output was used as the DSM2-HYDRO input, the Sacramento and San Joaquin rivers were interpolated to daily values in order to smooth the transition at the month transitions. DSM2 then uses the daily flow values along with a 15-minute adjusted astronomical tide to simulate effect of the spring and neap tides.

4 The Delta Island Consumptive Use (DICU) model is used to calculate diversions and return flows for all Delta islands based on the level of development assumed. The projected 2020 land-use assumptions are found in Bulletin 160-98.

5 CalSim II calculates monthly EC for the San Joaquin Riverm, which are then represented at a daily interval. Daily EC timeseries data are constant across each month. Fixed concentrations of 150, 175, and 125 µmhos/cm were assumed for the Sacramento River, Yolo Bypass, and eastside streams, respectively.

6 Net Delta outflow based on the CalSim II flows was used with an updated G-model to calculate Martinez EC.

7 Information was obtained based on the information from the draft final “Delta Region Drinking Water Quality Management Plan” dated June 2005 prepared under the CALFED Water Quality Program and a presentation by David Briggs at SWRCB public workshop for periodic review. The presentation “Compliance location at Contra Costa Canal at Pumping Plant #1 – Addressing Local Degradation” notes that the Veale Tract drainage relocation project will be operational in June 2005. The DICU drainage currently simulated at node 204 is moved to node 202 in DSM2.

8 CalSim II calculates number of days DCC gates are open in a given month. For implementation in DSM2, it is assumed the number of days open are the first series of days in that month. For example, if CalSim II output indicates DCC gates are open for 5 days in a given month, DCC gates will be open for the first five days of that month in DSM2.

Attachment 1-4 Scenario Related Changes to CalSim II and DSM2

1 Introduction

This document describes assumptions for scenario related changes to CalSim II and DSM2 utilized in this EIR. Scenario related changes include:

- Application of Summer/Fall Suisun Marsh Salinity Control Gate (SMSCG) Operations
- Old and Middle River flows

2 Application of Summer/Fall SMSCG Operations

The proposed project Summer/Fall Delta Smelt Habitat Action includes a measure to operate SMSCG for up to 60 days in June – October of below normal, above normal years, and, possibly wet years. For more detailed description of the action, see Section 3.3 of the main document. This document describes the changes to CalSim II and DSM2 to model effect of proposed project SMSCG operations.

2.1 Representation in CalSim II

CalSim II uses artificial neural networks (ANNs) to calculate the salinity at select compliance locations in the Delta. However, the CalSim II ANNs do not account for effect SMSCG operations, which increase salinity intrusion in the Sacramento and San Joaquin Rivers. To ensure modeled operations from CalSim II meet D1641 water quality standards, a buffer was applied to the compliance threshold.

Therefore, CalSim II was adjusted to meet water quality standards in the Delta. To model the effect of gate operations, a buffer to D1641 water quality standards at Sacramento River at Emmaton and San Joaquin River at Jersey Point during assumed periods of SMSCG operations. The buffer value represents the increase in Delta Outflow required meet water quality standards when SMSCG are operating. Therefore, operating to a salinity buffer would provide the same operational response as would a simulation that included SMSCG operations explicitly. Methodology for determining CalSim II buffer values is described in Section 2.3.

2.2 Representation in DSM2

DSM2 dynamically models SMSCG operations. Therefore, DSM2 model input were adjusted to match description in proposed project.

2.3 Calculation of CalSim II Buffer

Impact of SMSCG operations on salinity at select compliance locations was studied using the DSM2. DSM2 was run with and without July – August SMSCG operations. Tidally averaged salinity results were then compared at D-1641 regulation stations modeled in CalSim II. Scatter plots, of tidally averaged monthly salinity with and without July – August SMSCG operations are presented in Figure 1. Salinity during the months of January – June and November – December, when modeled SMSCG operations are consistent, are shown in blue. The blue scatter points make a 1:1 line, indicating salinity results during these months are equal. Salinity during the months of July and August are shown in orange. As these points are above the 1:1 line (in blue), monthly average July and August salinity at these locations increases. Salinity results during September and October are represented as grey point. Even though SMSCG are not operating, the salinity impact of July – August operations require about two months to disperse. As changes to salinity follow a linear trend, salinity impacts of SMSCG operations are estimated with a linear regression.

The result of applying linear regressions for the month of July-September at the major regulatory locations (Jersey Point, Emmaton, Contra Costa Canal and Clifton Court) are summarized in Table 1.

Table 1. Regression Coefficients Representing Salinity Effects of SMSCG Operations

–	*Jersey Point*	*Emmaton*	*Old River at Rock Slough*	*Clifton Court Forebay*
Intercept	24.0	32.3	-46.8	-60.6
Slope	1.12	1.09	1.20	1.22

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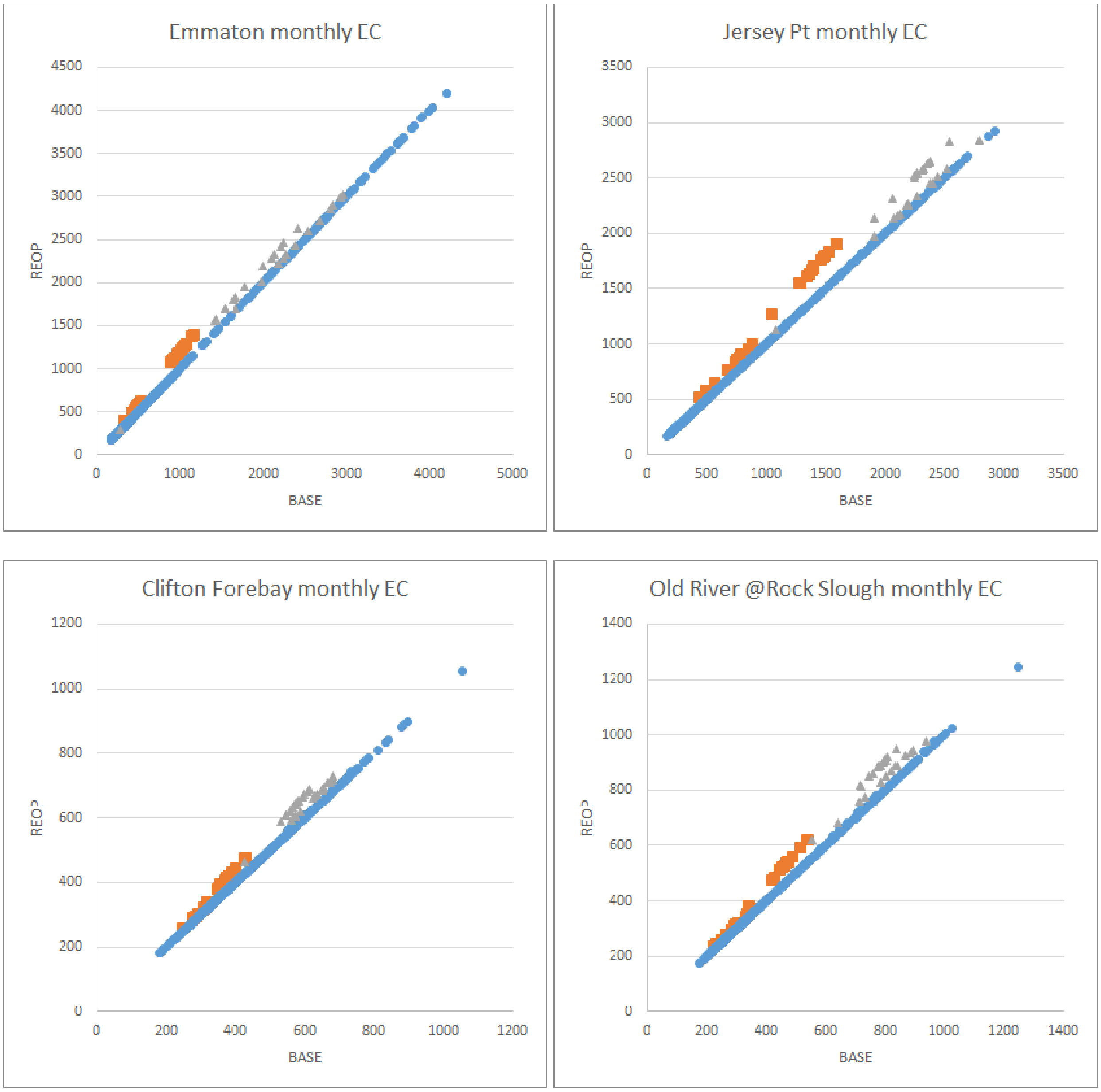

Figure 1. Scatter Plot of With and Without SMSCG Operations, Monthly Averaged EC

- **orange** square is for Jul-Aug, the SMSCG summer re-operation time
- **grey** triangle is for Sep-Oct, to show the lingering effect
- **blue** circles is for all the other months, when both scenarios are almost identical

3 Old and Middle River Flows

3.1 Existing

Calculations of the Net Tidal Flow in Old and Middle River (OMR) have been used in recent years as a surrogate for determining the relative influence of water project export rates on Bay-Delta aquatic species listed for Endangered Species Act protection under both Federal and State law.

The U.S. Fish and Wildlife Service and National Marine Fisheries Service issued Biological Opinions for Delta smelt and Central Valley salmonids in 2008 and 2009 (08/09 BiOps), respectively. The 08/09 BiOps included OMR restrictions to minimize potential loss of sensitive fish species due to the water project exports.

PREVIOUS APPROACH USED FOR CALSIM STUDIES (2009 CalSim II Assumptions)

After the issuance of the 08/09 BiOps, there was a multi-agency effort to develop representations of these new criteria in CalSim II for the purpose of estimating the operations of the SWP and CVP for water supply and CECA/NEPA processes. Many of the assumptions were based on best guesses and limited data at the time. At the time of development, it was expected that the Delta smelt would be the primary driver in the determination of the OMR for the export operations. Salmonids were expected to provide a consistent timing with the explicit onset starting January 1, but otherwise expected to be covered by the Delta smelt criteria.

The methods used in estimating the OMR requirements are detailed in “Representation of U.S. Fish and Wildlife USFWS Biological Opinion Reasonable and Prudent Alternative Actions for CalSim II Planning Studies” and “Representation of National Marine Fisheries Service Biological Opinion Reasonable and Prudent Alternative Actions for CalSim II Planning Studies” included at the end of Appendix E Attachment 1-4 Scenario Related Changes to CalSim II and DSM2.

PROPOSED NEW APPROACH FOR CALSIM STUDIES

As part of the development of the baseline assumptions for the proposed project, previous assumptions that were developed almost 10 years ago prior to the implementation of the 08/09 BiOps, were reevaluated for consistency with current understanding of OMR management. This review is especially necessary considering a known shift in how OMR is determined in real-time for Delta smelt and a recognition that Salmonid protections have been the determining factor on setting OMR more often than originally expected.

Historical OMR determinations, as shown in Figure 2, were used to assess the general representation of the OMR in CalSim II based on assumptions developed roughly 10 years ago. As shown in the figure, there are periods with significant deviations. This comparison demonstrates the need for updated OMR assumptions for appropriate reflection of the existing conditions in the CalSim II model.

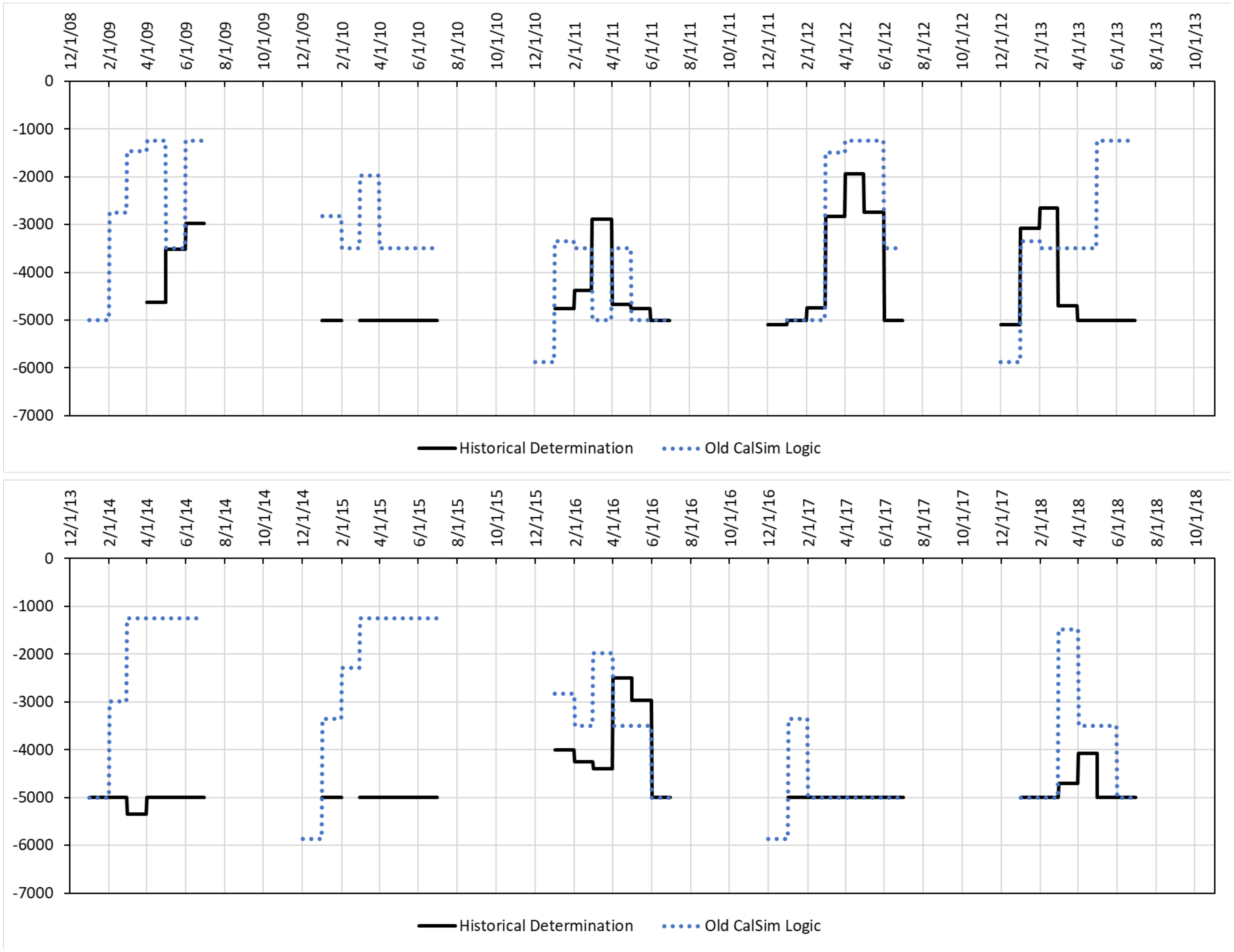

Figure 2: Comparison of the Old CalSim logic to the actual historical OMR determinations.

Method for Estimating the First Flush in CalSim for the Baseline

In modeling the existing condition, 2008 USFWS BiOp Action 1 or "First Flush" was assumed to be implemented under the following conditions:

- December when the unimpaired Sacramento River Runoff (SRR) is greater than 20,000 cfs,
- January if no First Flush occurred in December and when the SRR is greater than 20,000 cfs

This action is consistent with the methodology used in the 2009 CalSim II assumptions, but reduces the timeframe during which this action trigger in the model to December and January. This reduction in timeframe was based on the general understanding that the action would likely not occur after January.

Method for Estimating the Calendar based 2009 NMFS BiOp Action 4.2.3

The implementation of the 2009 NMFS BiOp Action 4.2.3 is a calendar-based OMR that begins on January 1 and ends June 30. An OMR restriction of -5,000 cfs is applied as a background level for this period.

Method for Estimating OMR for Smelt Entrainment Protection in CalSim

The 2008 USFWS BiOp Action 2 CalSim assumptions were updated from using an X2 based measure in the 2009 implementation to a turbidity-based protection measure reflecting the recent OMR determinations. As mentioned above, most recent historical OMR determinations have been based on turbidity-based indicators, rather than strictly fish presence. Instead of an X2 surrogate, this action uses a flow surrogate to indicate central Delta turbidity triggering an Adult Delta smelt entrainment protective OMR action. Old River at Bacon Island (OBI) was chosen to represent the southern part of the central Delta and to trigger an entrainment protection action.

When triggered the modeling assumes a -2000 cfs for 5 days when the following conditions occur:

- Timeframe under which a turbidity avoidance action may occur
  - January to March – if First Flush occurs in December,
  - February to March – if First Flush occurs in January or not at all,
- SRR > 20,000 cfs

Like other turbidity related actions, this one requires the use of a surrogate to determine when an action is triggered. The turbidity station at OBI is in the interior Delta south of the San Joaquin River, which makes it difficult to predict with any great accuracy. However, the SRR is and has been used as a surrogate for other turbidity-based actions in CalSim II. To determine an appropriate flow level, number of days with historical daily average OBI data above 12 NTU, from 2008 to 2019, were summed for each month from January to March. The resulting number of days per month exceeding 12 NTU were compared to the SRR for the same month (Figure 3). The red line indicates the SRR value that captures most instances when daily average OBI turbidity greater than 12 NTU.

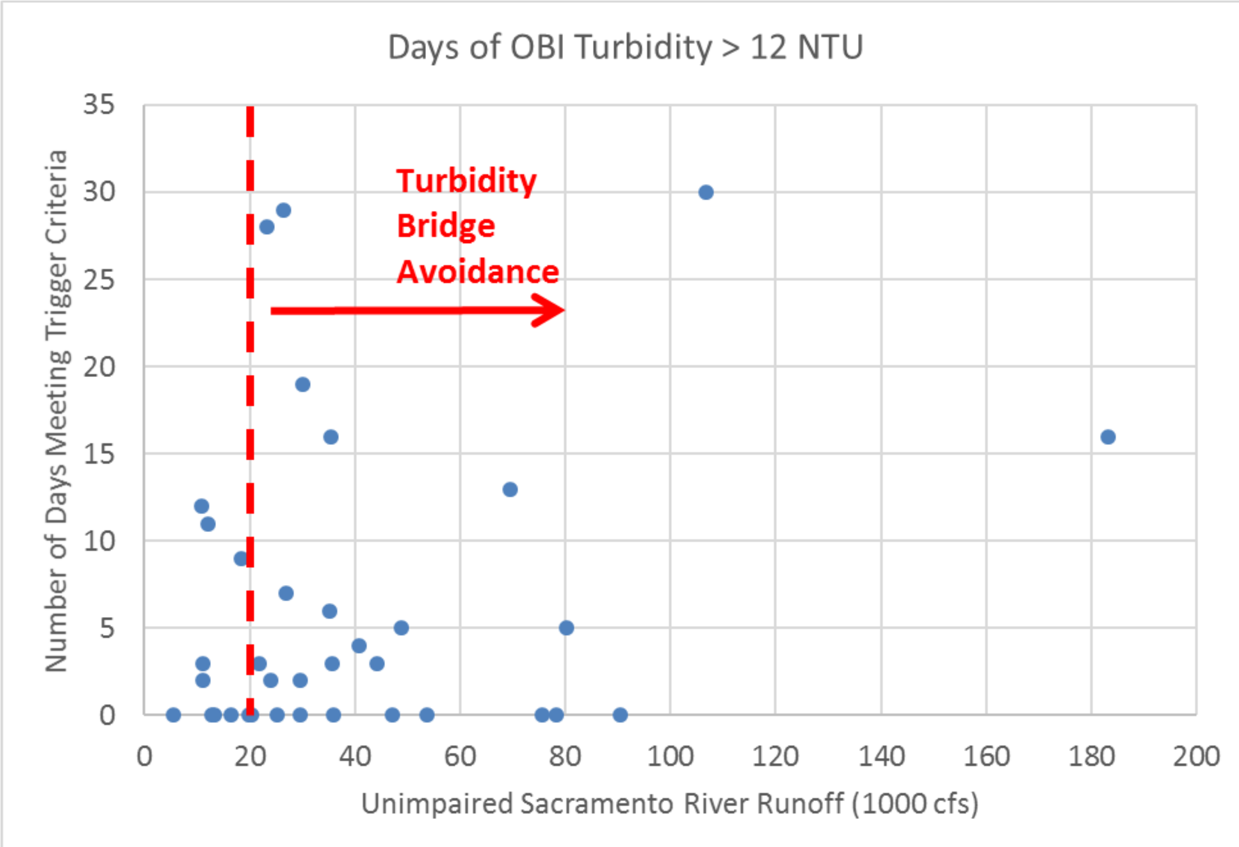

Figure 3: Relationship between Sacramento River Runoff and the number of days of turbidity at Old River at Bacon Island exceeding 12 NTU. Where the red line at a SRR of 20,000 cfs shows the rough transition point of the data.

This relationship could be stronger, but it should be recognized that because of its location, OBI turbidity is subject to many variables, including but not limited to wind driven turbidity and lower turbidity due to proactive Project operations that is embedded in the OBI turbidity data presented here, and may not be representing a true turbidity bridge formation. In general, the historic OBI turbidity data resulted in a 72% frequency of triggering an event. Using an SRR surrogate of 20,000 cfs results in a 61% triggering frequency. Given that in CalSim II the OMR requirements are applied on a monthly timestep, this is a reasonable surrogate for reflecting potential duration of this OMR action in CalSim II.

Representation of OMR due to Salvage Density in CalSim

As described above, the existing conditions modeling was updated to estimate the OMR restrictions based more on the Salmon and Steelhead density triggers rather than the larval and juvenile smelt using the location of X2 consistent with recent historical operations. Based on the historical salvage data a generalized relationship was developed and applied in all year types where:

- March assumed 3 days at Stage 1 (OMR = -3,500 cfs), and 5 days at Stage 2 (OMR = -2,500 cfs)
- April assumed 9 days at Stage 1 (OMR = -3,500 cfs)
- May assumed 5 days at Stage 1 (OMR = -3,500 cfs)

The number of days at each *Stage* were determined using salvage data for winter run, based on length at date, and for steelhead from 2010 to 2019. Daily density was determined for each species by dividing the daily fish loss by the volume of pumping at the SWP and CVP export facilities. Calculated daily densities were then compared to triggers levels, which are determined at the beginning of each year for winter run. Historical winter run trigger levels have ranged 2.5 fish/TAF to 12 fish/TAF for Stage 1 and 5 fish/TAF to 24 fish/TAF for Stage 2. Steelhead triggers were consistently 8 fish/TAF for Stage 1 and 12 fish/TAF for Stage 2.

For each triggering event, a minimum of 5 days of required OMR was assumed, but, if an event continues or another event is triggered immediately, the number of days at a specific OMR level could be greater, or could transition to another *Stage.* Table 2 reports the total number of days determined by the historic data that resulted in Stage 1, and Table 3 reports the total number of days at Stage 2.

Table 2: Number of days of OMR at Stage 1 levels based on historical salvage that exceeded the fish density triggers for Stage 1 for winter run and steelhead.

–	Jan	Feb	Mar	Apr	May	Jun
2010	0	5	0	5	2	0
2011	5	1	3	5	10	10
2012	0	5	5	10	5	0
2013	0	0	12	13	5	0
2014	0	0	0	0	0	0
2015	0	5	0	0	0	0
2016	0	0	0	0	0	0
2017	0	0	0	0	0	0
2018	0	0	5	15	11	0
2019	0	0	0	11	0	0
Average	1	2	3	6	3	1

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Table 3: Number of days of OMR at Stage 2 levels based on historical salvage that exceeded the fish density triggers for Stage 2 for winter run and steelhead.

–	Jan	Feb	Mar	Apr	May	Jun
2010	0	0	0	0	0	5
2011	0	10	28	2	0	0
2012	0	7	26	6	0	0
2013	0	0	0	12	10	0
2014	0	0	0	0	0	0
2015	0	0	0	0	0	0
2016	0	0	0	0	0	0
2017	0	0	0	0	0	0
2018	0	0	0	5	5	0
2019	0	0	0	0	0	0
Average	0	2	5	3	2	1

Note:
" –" indicates this cell is blank.

For implementation in CalSim, the combined monthly averages for Stage 1 and Stage 2 were used to determine months with an average of 5 more days, which would indicate on average one or more triggering events occurred. Only months with combined averages over 5 were assumed in development of OMR restrictions based on salvage density. Table 4 shows the number of days assumed in the CalSim II logic for Stage 1 and Stage 2 salvage density salmonid protections.

Table 4: Resulting number of days for each trigger stage assumed in the CalSim model under Existing Conditions.

–	Jan	Feb	Mar	Apr	May	Jun
Stage 1 (-3,500 cfs)	0	0	3	9	5	0
Stage 2 (-2,500 cfs)	0	0	5	0	0	0

Note:
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Rollup of OMR Methodology in CalSim

Implementation of the updated assumptions in CalSim, as described above, better represent both the fish species that has been dictating the OMR requirements as well as the restriction level under the recent historic conditions. Figure 4 compares the updated CalSim assumptions to both the historical OMR requirements and the previous (old) CalSim assumptions used in CalSim, where the updated logic appears to better represent the actual historical determinations better.

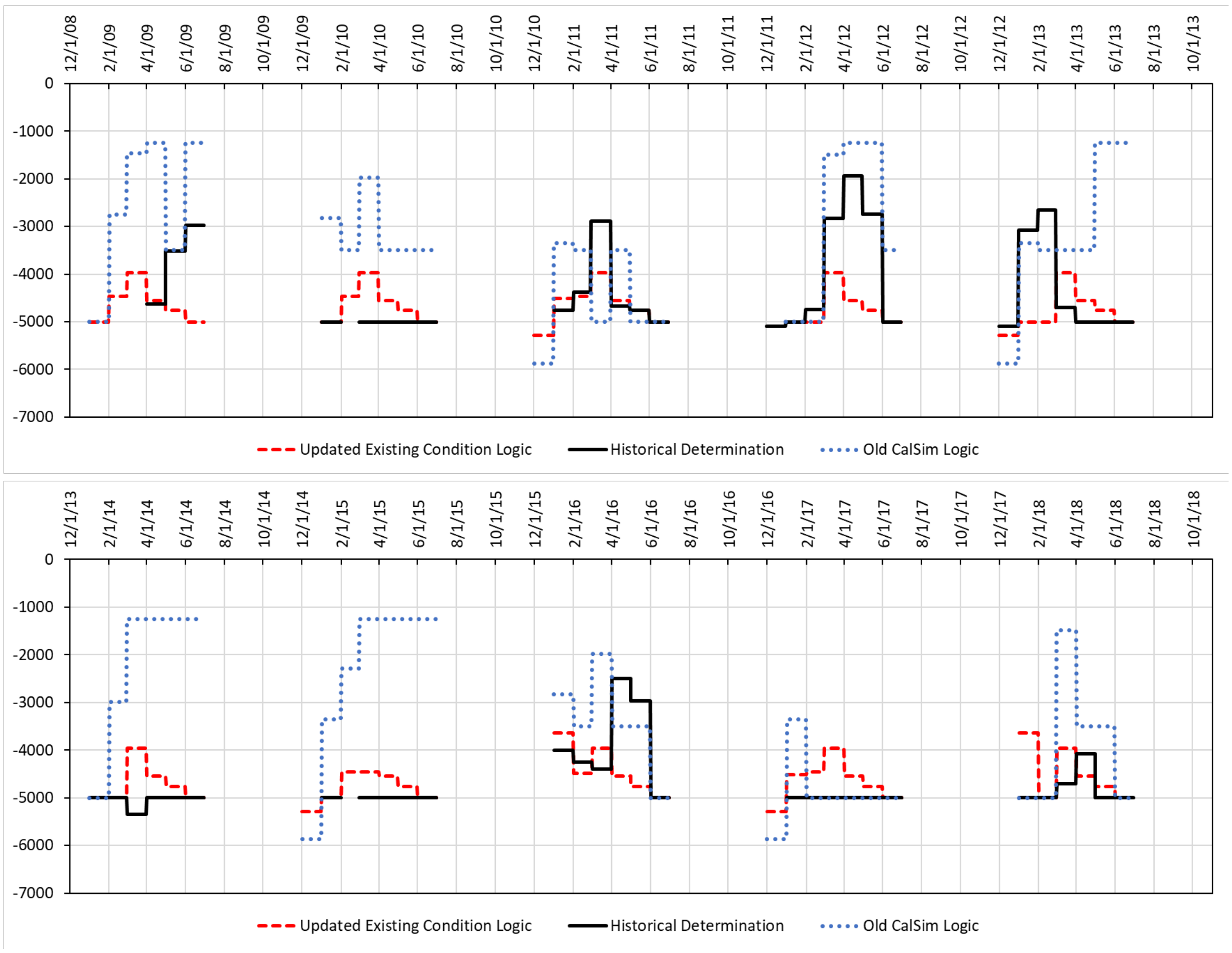

Figure 4: Comparison of the Updated CalSim logic to the actual historical OMR determinations and the Old CalSim logic.

3.2 Proposed Project

The following OMR criteria were implemented in the Proposed Project CalSim II model.

Integrated Early Winter Pulse Protection (First Flush) Trigger and Criteria

In modeling the proposed project, the Integrated Early Winter Pulse Protection or "First Flush" (described in Section 3.3.1 of the main document) was assumed to be implemented under the following conditions:

- December when the unimpaired Sacramento River Runoff (SRR) is greater than 20,000 cfs,
- January if no First Flush occurred in December and when the SRR is greater than 20,000 cfs

The First Flush action is assumed to restrict OMR to -2,000 cfs for 14 days. Since CalSim utilizes a monthly timestep this 14 day action is implemented using a weighted average with a background level. For December the background level is -8,000 cfs and for January the background level is -5,000 cfs.

These assumptions were developed using Sacramento River at Freeport flow and turbidity data from 2008 to 2019. In addition, turbidity data from Sacramento River at Hood was used to fill-in and confirm turbidity data at Freeport. Since the first flush is limited to the December to January period, the data analyzed was also limited to this timeframe. Turbidity is a parameter that is not simulated in CalSim, and so a flow surrogate was used and consistent with past practice. The SRR represents the unimpaired flow from the major tributaries to the Sacramento River. As shown in Figure 5 the approximate transition where Freeport flow and turbidity levels would trigger a first flush is around an SRR of about 20,000 cfs.

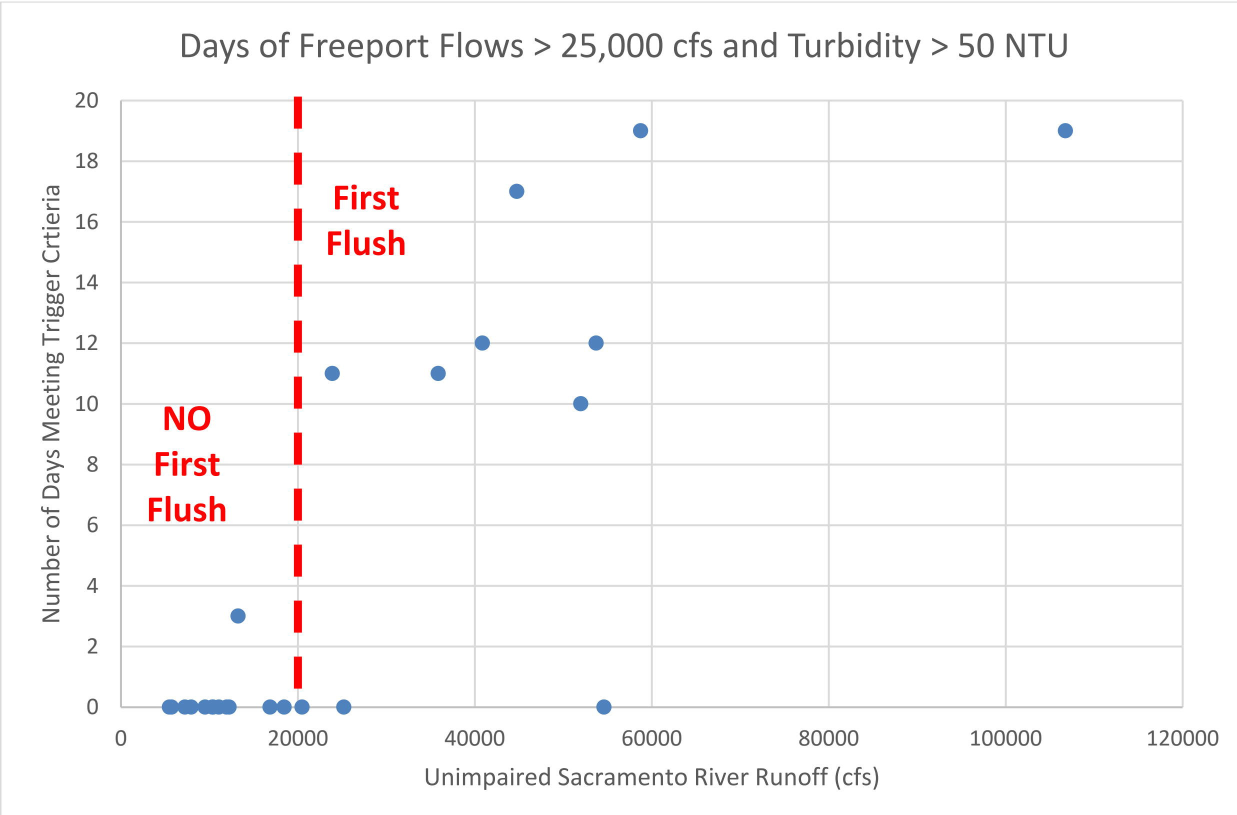

Figure 5: Relationship between Sacramento River Runoff and the flow and turbidity at Freeport exceeding 25,000 cfs and 50 NTU.

Using the SRR is consistent with what was used in the modeling of the Existing Condition which represents a different triggering criterion – Section 3.1 of this attachment describes how the assumptions for the Existing Conditions were developed). As described, the Existing Condition modeling uses an SRR of 20,000 cfs as a surrogate of reaching 12 NTU in the interior Delta. Even though these separate analyses have indicated similar levels of SRR to represent the triggering of the First Flush, the action in the Proposed Project is expected to be triggered more often. Evaluating the historical First Flush actions from the 2008/2009 BiOps (water years 2009 to 2019) has shown that the action was only triggered once, in 2013. However, there was an additional period where the Projects proactively took an action before a trigger could occur, and so in the 11 years of historical operations, the First Flush conditions, as described by the action in the Existing Conditions, occurred twice. Under the newer definition using flow and turbidity at Freeport, this would occur much more frequently. Figure 6 shows that the frequency of the First Flush occurring increases from roughly 20% under Existing Conditions to over 70% with the Proposed Project.

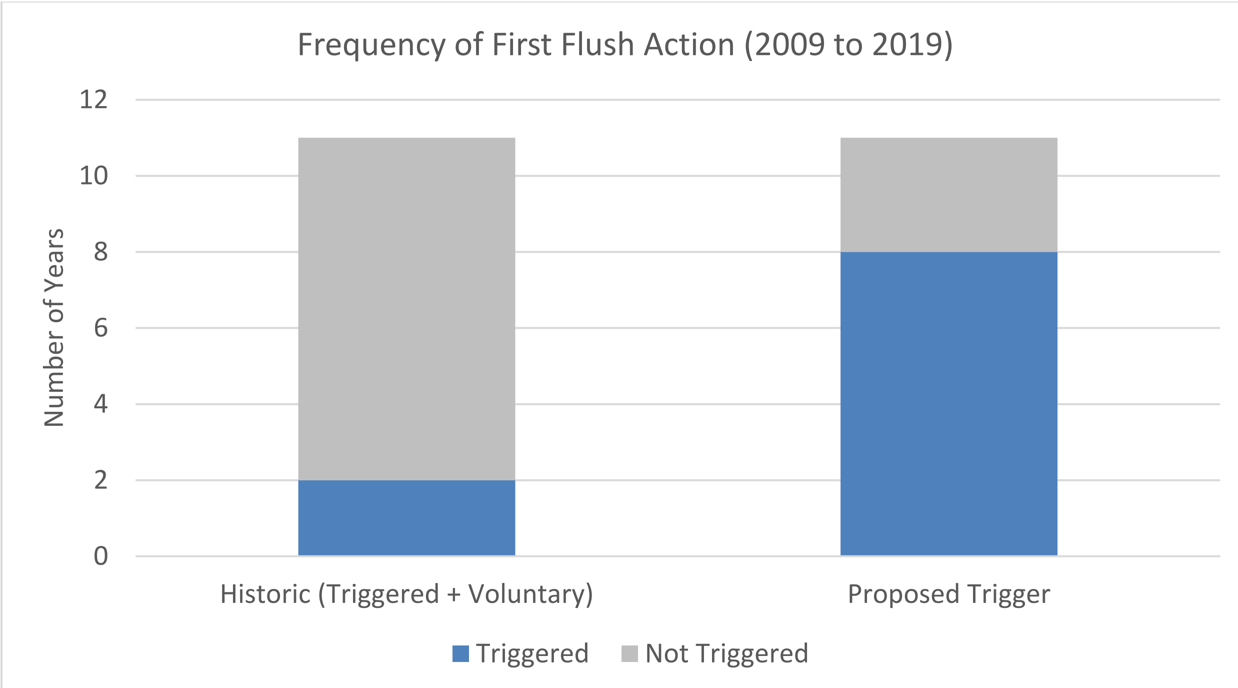

Figure 6: Comparison of the historical triggering of the First Flush action under the 2008/2009 BiOps and the new proposed triggering under the Proposed Project.

It is important to note, that the CalSim assumptions between the Existing Condition and the Proposed Project are the same, however as shown in Figure 6, the frequency of triggering the First Flush action is expected to be higher under the Proposed Project.

Turbidity Bridge Avoidance Trigger and Criteria

In modeling the proposed project, the turbidity bridge avoidance (described in Section 3.3.1 of the main document) was assumed to apply an additional OMR requirement of -2,000 cfs for 5 days when the following conditions occur:

- Timeframe under which a turbidity avoidance action may occur
  - January to March – if First Flush occurs in December,
  - February to March – if First Flush occurs in January or not at all,
- SRR > 20,000 cfs

Like other turbidity related actions, this one requires the use of a surrogate to determine when an action is triggered. The turbidity station at Old River at Bacon Island (OBI) is in the interior Delta south of the San Joaquin River, which makes it difficult to predict with any great accuracy. However, the SRR is and has been used for other turbidity based actions. Using historical OBI data from 2008 to 2019, daily average values above 12 NTU were summed for months January to March. The resulting number of days per month exceeding 12 NTU were compared to the SRR for the same month (Figure 7). The red line indicates the rough transition point using the SRR.

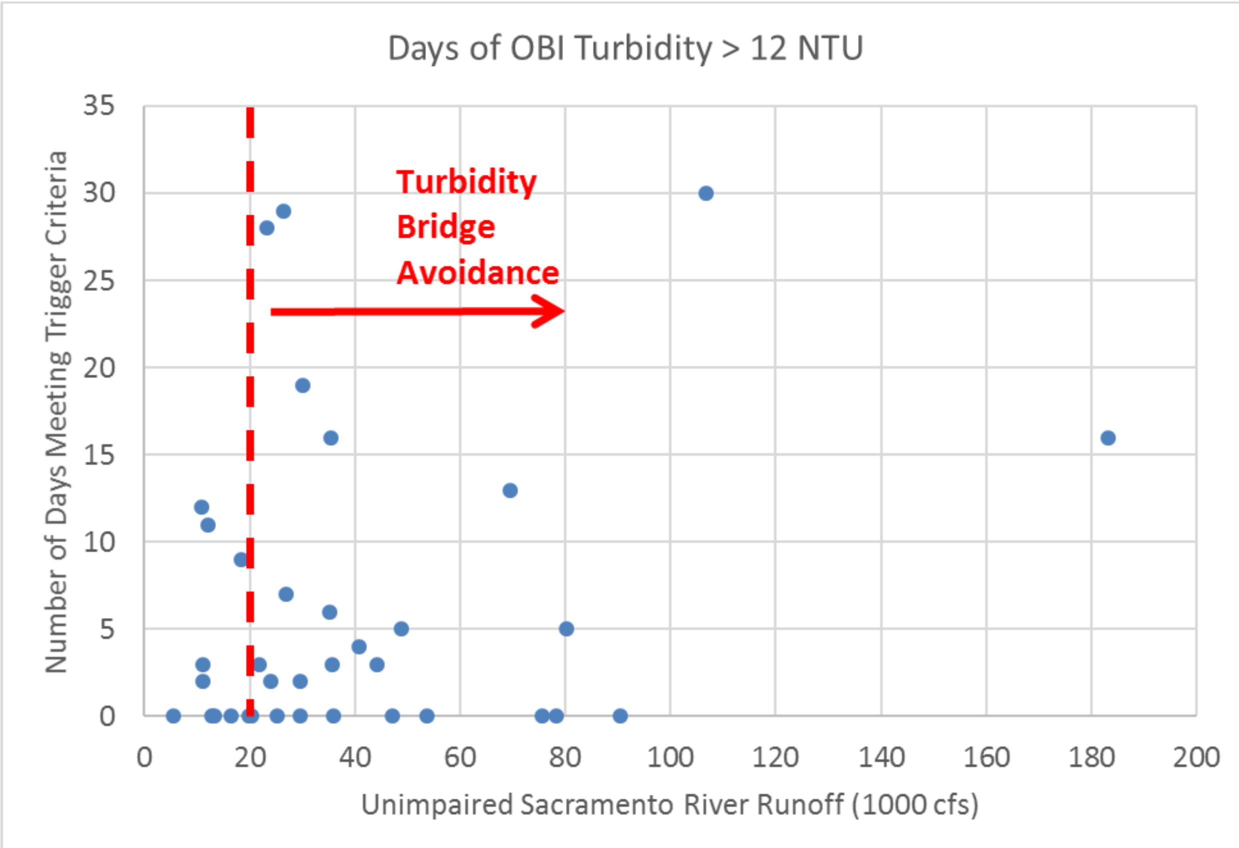

Figure 7: Monthly Comparison of Number of Days in Month Exceeding 12 NTU at OBI and SRR

This relationship could be stronger, but it should be recognized that because of its location, OBI, is subject to many variables, including but not limited to wind driven turbidity and lower turbidity due to proactive Project operations that is embedded in the data. In general, the historic data resulted in a 72% frequency of a triggering event. Using an SRR surrogate of 20,000 cfs results in a 61% triggering frequency.

OMR Flex Trigger and Criteria

In modeling the proposed project, OMR Flex (described in Section 3.3.1 of the main document) was assumed to be implemented under the following conditions:

- Wet water years – no OMR flex was assumed,
- Above normal and below normal water years – 7 days at -6,000 cfs in January and February,
- Dry water years – 7 days at -6,000 cfs in either January or February, and
- Critical water years – no OMR flex was assumed.

These assumptions were developed using historical data from 2009 to 2018 were used to develop a generalized OMR flex implementation in the CalSim model. There are many conditions which need to be met before an OMR flex can occur, however not all conditions are available in the historical data. For estimating the OMR flex in the model the following data and conditions were used:

- Excess condition – Daily historical determinations of excess conditions was used to indicate periods where the first condition under which OMR flex may occur,
- First Flush not occurring – the method for estimating first flush in CalSim (described above) was used to determine periods where a first flush was not occurring,
- Turbidity bridge avoidance not occurring – the method for estimating turbidity avoidance in CalSim (described above was used to determine periods where a turbidity bridge avoidance action was not occurring.
- Salvage threshold not occurring – the method for estimating salvage threshold triggers in CalSim (described above) was used to determine periods when a salvage threshold trigger would not have been active.
- No other risk fishery related concerns – to address the potential for other fishery related concerns, the historical OMR level more negative than -4,000 cfs was assumed, for this purpose, to indicate the low general risk to fish and capture the other conditions described in described in Section 3.3.1 of the main document.

If all conditions above were met, then OMR flex was assumed to be possible. Table 5 reports the number of days that were determined to have potential for OMR flex using the method described.

Table 5: Number of days in each month and water year that had the potential for OMR flex.

Year	Dec	Jan	Feb	Mar	Apr	May	Jun
2009	0	0	7	20	2	0	0
2010	0	1	0	0	0	3	28
2011	17	22	8	0	0	0	23
2012	0	24	0	0	0	14	0
2013	2	3	6	12	0	0	0
2014	0	0	6	13	11	0	0
2015	5	3	15	5	0	0	0
2016	0	9	9	23	0	0	0
2017	8	1	5	0	0	0	23
2018	0	31	11	6	0	0	0

Further aggregating the estimated OMR flex days into a generalized CalSim representation, the water years were consolidated into two groups of 1) wet, above normal, and below normal, and 2) dry and critical. These groups roughly split the available water years into 6 samples and 4 samples respectively. Table 6 shows the results of the water year grouping.

Table 6: Average number of days with potential OMR flex, grouped by critical and dry water years and wet, above normal, and below normal water years. Based on historical analysis of water years 2009 to 2018.

Condition	Dec	Jan	Feb	Mar	Apr	May	Jun
C & D	2	2	9	13	3	0	0
W, AN & BN	4	15	6	5	0	3	12

Table 6 was used to further develop the generalized assumptions for CalSim. The timeframe of OMR flex for modeling purposes was limited to January and February because December in the model would only be activated with a first flush event which would eliminate the ability for OMR flex. Months later in the spring were also not included because of the potential for additional OMR due to larval and juvenile Delta smelt and longfin smelt. In addition, as Table 5 (the annual one) indicates, there is considerable variability in the potential OMR flex days and so for the CalSim implementation only above normal, below normal and dry years were assumed to utilize OMR flex.

Salvage Loss Thresholds Trigger and Criteria

The Proposed Project includes real-time OMR management actions based on percent of Winter-Run Chinook Salmon and Central valley Steelhead salvaged relative to proposed Single Year Loss Thresholds (described in Section 3.3.1 of the main document). The proposed Single Year Loss Thresholds were based on the 90% of the greatest loss observed for each species during water years 2010 through 2018. For Winter-Run loss thresholds were identified for Dec – Mar period. For steelhead, separate loss thresholds were identified for Dec – Mar and Apr – Jun. In modeling the proposed project, the real-time OMR management based on Single Year Loss Thresholds was assumed to be implemented as follows:

- In March and April of wet, above-normal, below-normal and dry years, it is assumed that the 50% of the proposed single year loss thresholds for one or more of the species will be exceeded, which triggers an OMR flow requirement of -3,500 cfs.

Historic salvage data at the fish facilities at Banks and Jones Pumping Plants and fish catch data at Chipps Island trawl during water years 2010 – 2018 were analyzed. Historic salvage data provides the potential timing of triggering the 50% and 75% levels of the proposed single year loss thresholds. The Chipps Island catch data provides the migration timing and estimates for when the 95% of Winter-Run and Steelhead have migrated out of the Delta, which is the proposed offramp for the real-time OMR management for these species.

Figures 8, 9 and 10 show the historical loss of Winter-Run, Steelhead for Dec – Mar and Steelhead for April – Jun, respectively. The historical loss in the figures is expressed as a percent of the proposed single year loss threshold values. Figure 11 and 12 show the migration timing based on the fish catch data at the Chipps Island trawls for Winter-Run and Steelhead. Information from Figures 8 through 12 is summarized below in Table 7, which shows the timing of when 50% and 75% of the proposed loss thresholds are triggered for water years 2010 through 2018, and when 95% of listed salmonid species are estimated to leave the Delta.

The information summarized in Table 7 was used to select the generalized assumptions for implementation of real-time management based on Single Year Loss Thresholds CalSim. It is important to recognize that the historical salvage and fish distribution data are reflective historical hydrologic and environmental conditions and not necessarily reflect of future conditions. However, since the proposed operations are tied to the historical loss at the SWP and CVP pumping facilities, it is appropriate to use historical data to estimate the generalized assumptions for use in CalSim in this case.

Table 7: Historical timing of natural Winter-Run and Steelhead loss at SWP and CVP south Delta pumping facilities. 50% and 75% losses are percentages of "90% of maximum annual loss during 2010-2018 period" – Table 7a – 7b.

Table 7a: Historical timing of natural Winter-Run at SWP and CVP south Delta pumping facilities. 50% and 75% losses are percentages of "90% of maximum annual loss during 2010-2018 period".

WY	WYT	50% Dec-Mar Loss Timing	75% Dec-Mar Loss Timing	95% past Chipps
2010	BN	--	--	May
2011	W	Feb 16 - 28	Mar 1 - 15	May
2012	BN	Mar 1 - 15	Mar 16 - 31	May
2013	D	--	--	May
2014	C	--	--	May
2015	C	--	--	May
2016	BN	--	--	May
2017	W	--	--	May
2018	BN	--	--	May

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Table 7b: Historical timing of natural Steelhead loss at SWP and CVP south Delta pumping facilities. 50% and 75% losses are percentages of "90% of maximum annual loss during 2010-2018 period".

WY	WYT	50% Dec-Mar Loss Timing	75% Dec-Mar Loss Timing	50% Apr-Jun Loss Timing	75% Apr-Jun Loss Timing	95% past Chipps
2010	BN	Feb	Mar	--	--	May
2011	W	Mar	--	May	Jun	Apr
2012	BN	Mar	--	--	--	Apr
2013	D	Mar	--	May	Jun	Apr
2014	C	--	--	--	--	May
2015	C	--	--	--	--	Apr
2016	BN	--	--	--	--	Mar
2017	W	--	--	--	--	Apr
2018	BN	Mar	Mar	Apr	Apr	May

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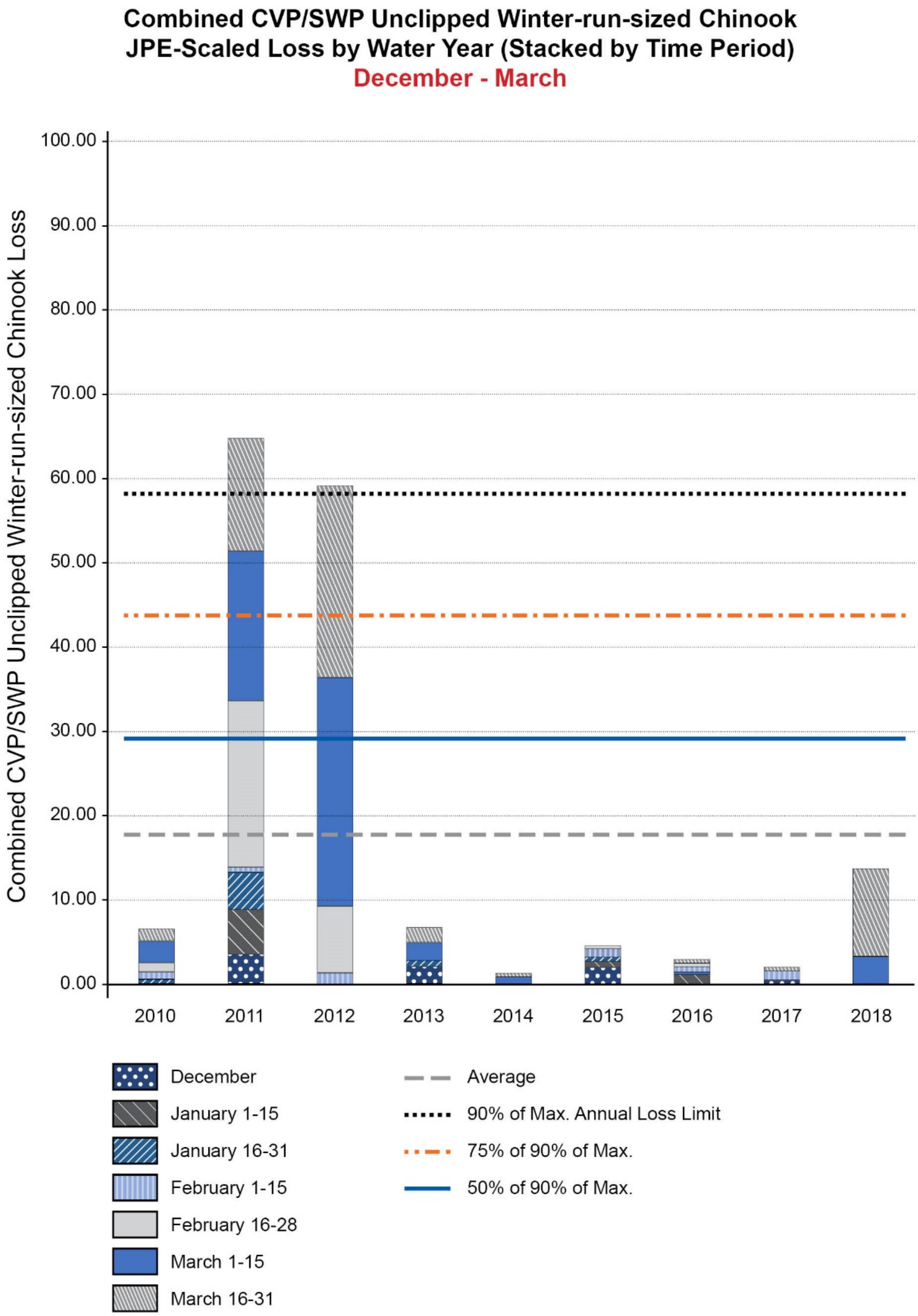

Figure 8: Combined CVP/SWP unclipped winter-run-sized Chinook loss, as a percentage of the winter-run Juvenile Production Estimate (JPE), for WY 2010 through WY 2018. Bars represent cumulative loss from December through March, stacked by month. Horizontal reference lines indicate the loss thresholds relevant for OMR management. (Source: July 2019 ROC Peer Review Draft NMFS Biological Opinion)

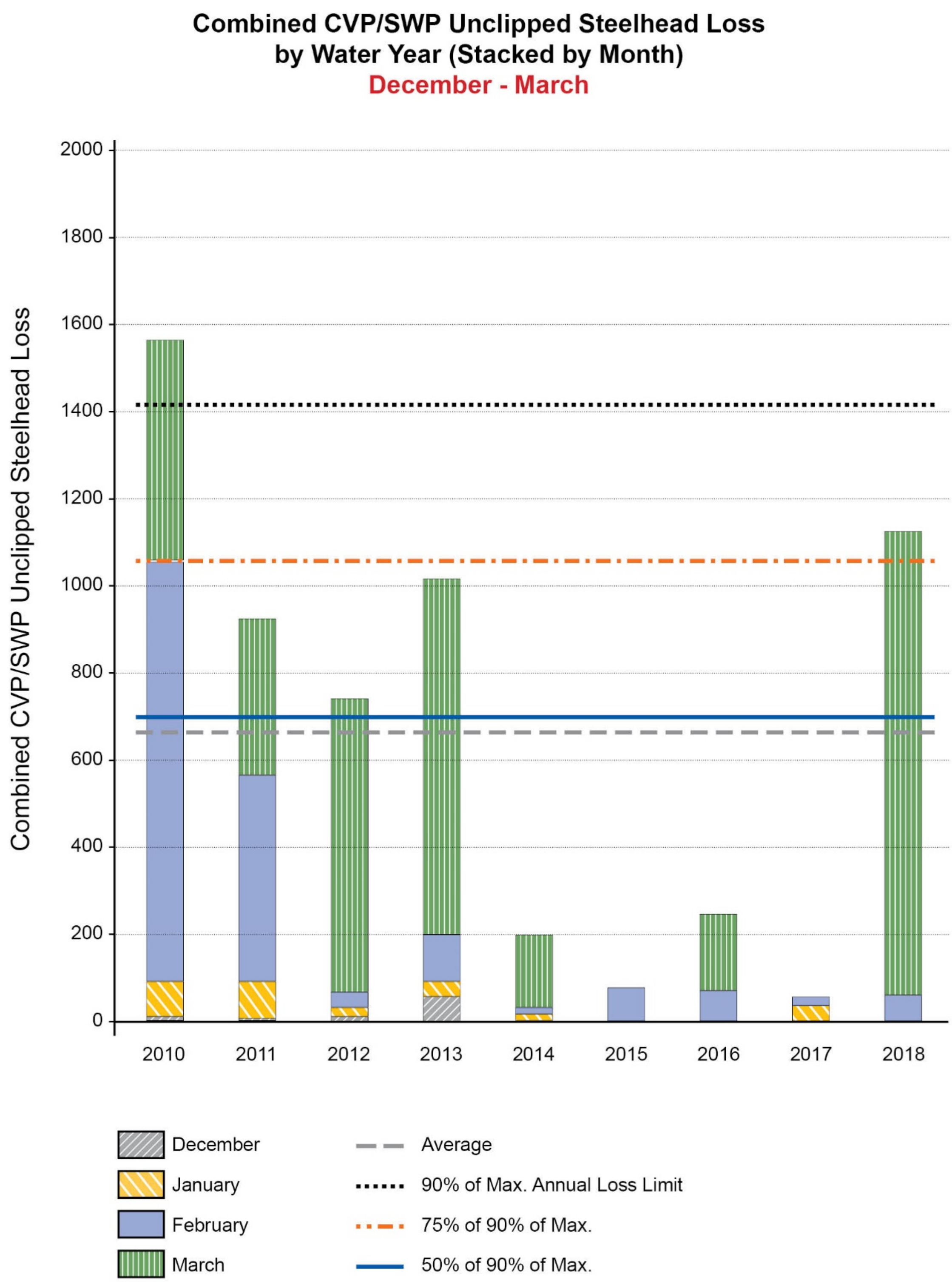

Figure 9: Combined CVP/SWP wild steelhead loss for WY 2010 through WY 2018. Bars represent cumulative loss from December through March, stacked by month. Horizontal reference lines indicate the loss thresholds relevant for OMR management. (Source: July 2019 ROC Peer Review Draft NMFS Biological Opinion)

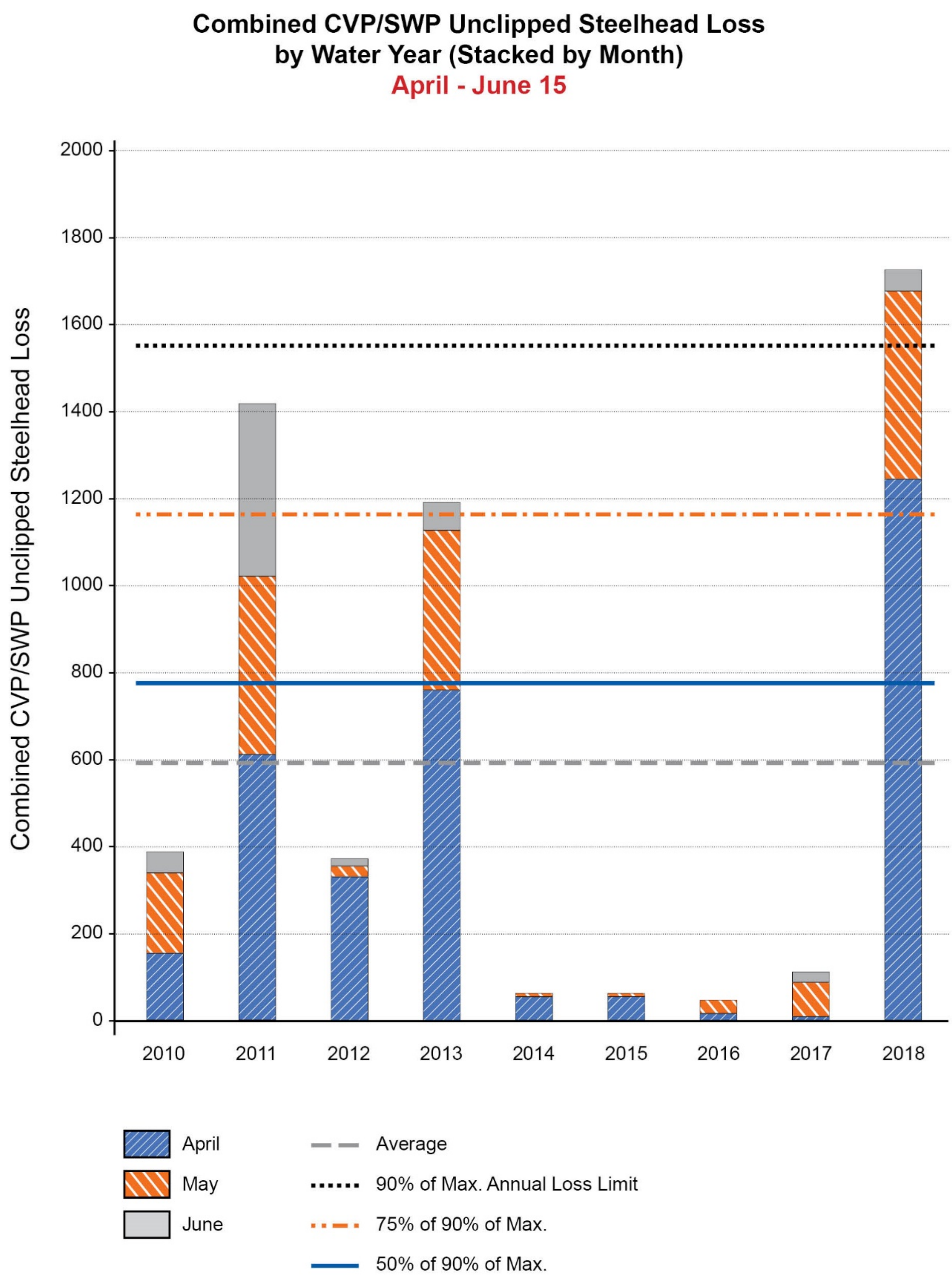

Figure 10: Combined CVP/SWP wild steelhead loss for WY 2010 through WY 2018. Bars represent cumulative loss from April through June 15, stacked by month. Horizontal reference lines indicate the loss thresholds relevant for OMR management. (Source: July 2019 ROC Peer Review Draft NMFS Biological Opinion)

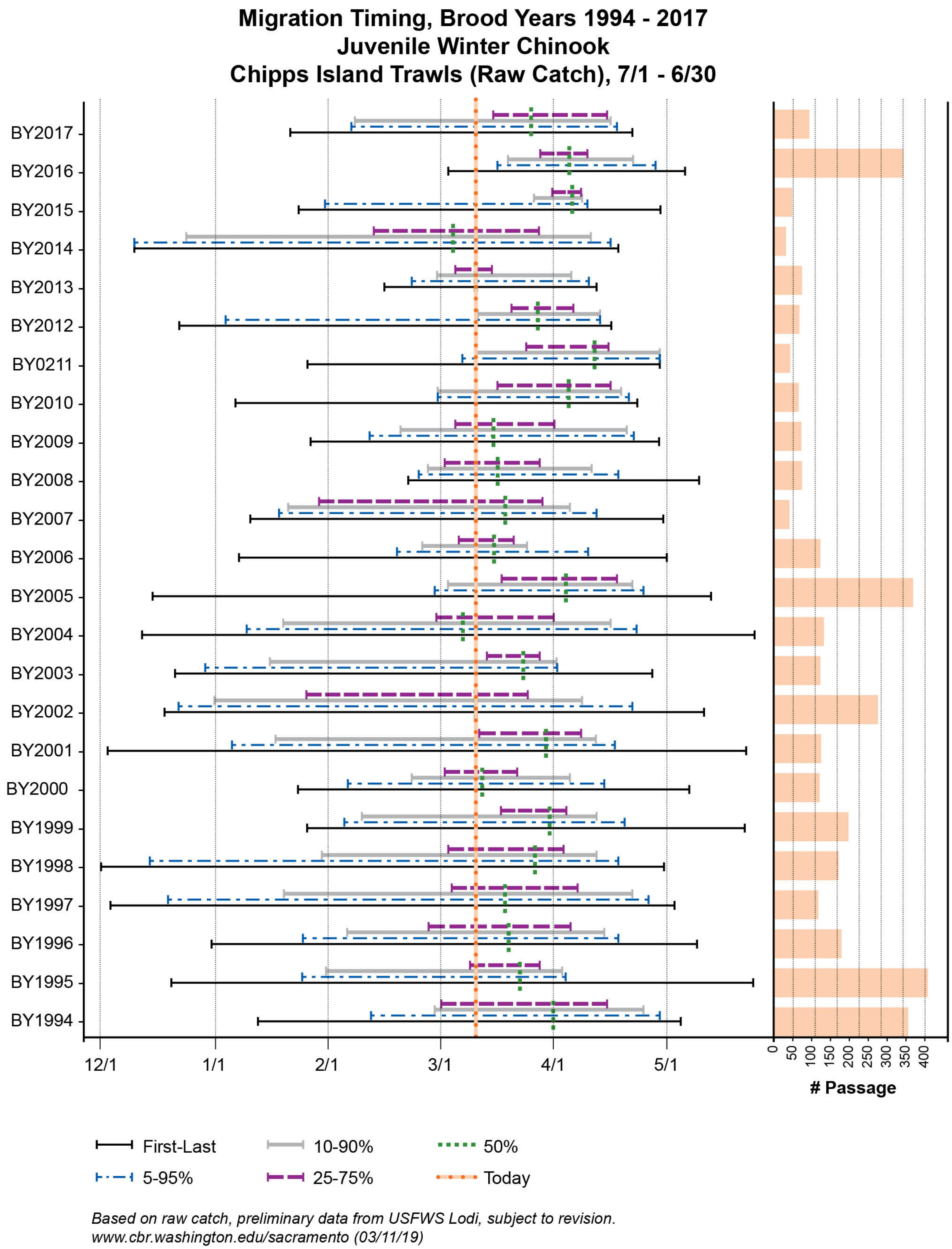

Figure 11: Juvenile winter-run Chinook salmon migration timing past the Chipps Island Trawl location for Brood Years 1994-2017 or Water Years 1995-2018. (Source: January 2019 ROC BA Appendix F)

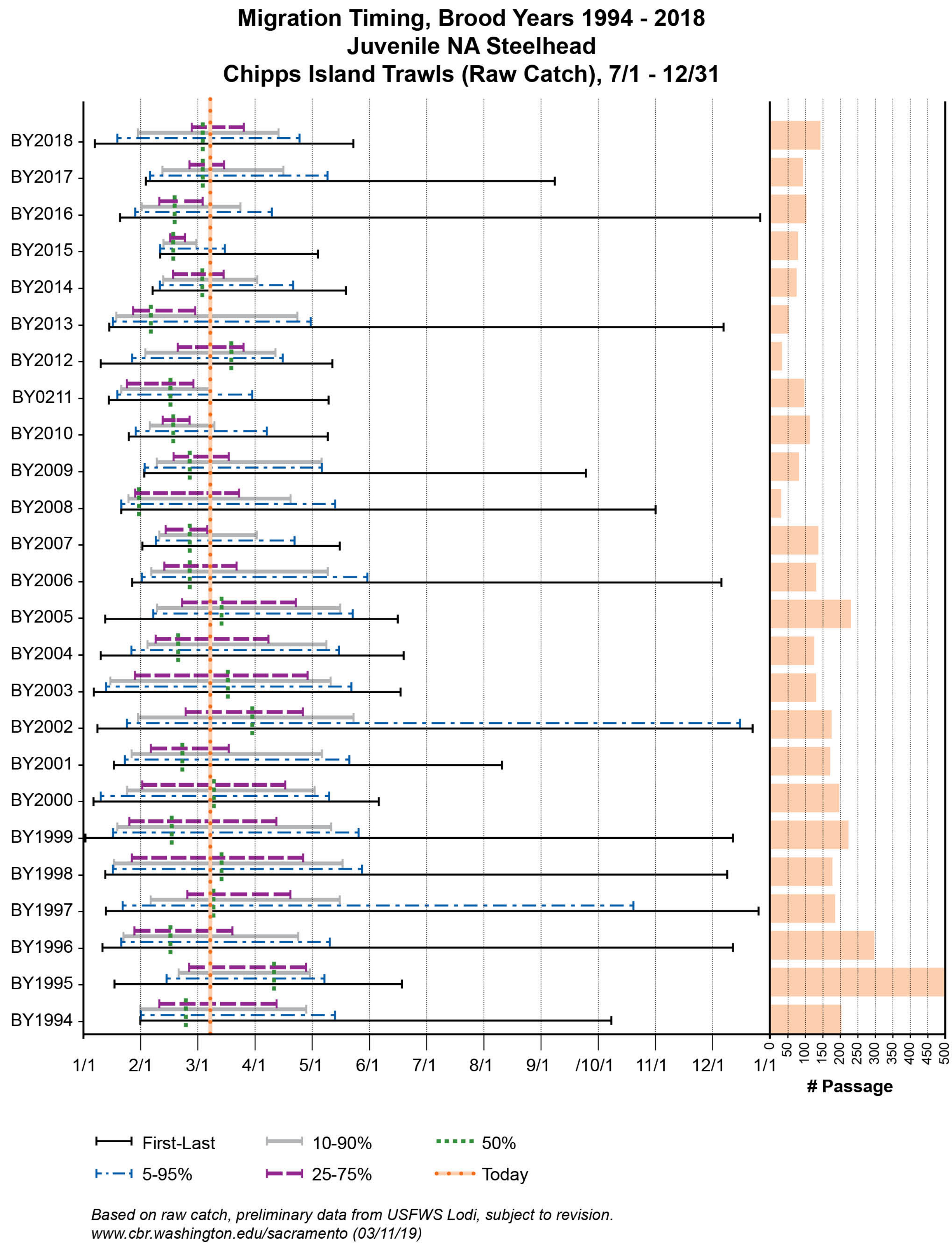

Figure 12: Juvenile unclipped CCV steelhead migration timing past the Chipps Island Trawl location for Brood Years 1994-2017 or Water Years 1995-2018. (Source: January 2019 ROC BA Appendix F)

4 Referenced Material

Representation of U.S. Fish and Wildlife USFWS Biological Opinion Reasonable and Prudent Alternative Actions for CalSim II Planning Studies

The U.S. Fish and Wildlife Services's (USFWS) Delta Smelt Biological Opinion (BiOp) was released on December 15, 2008, in response to the U.S. Bureau of Reclamation's (Reclamation) request for formal consultation with the USFWS on the coordinated operations of the Central Valley Project (CVP) and State Water Project (SWP) in California.

To develop CalSim II modeling assumptions for reasonable and prudent alternative actions (RPA) documented in this BiOp, the California Department of Water Resources (DWR) led a series of meetings that involved members of fisheries and project agencies. The purpose for establishing this group was to prepare the assumptions and CalSim II implementations to represent the RPAs in Existing and Future Condition CalSim II simulations for future planning studies.

This memorandum summarizes the approach that resulted from these meetings and the modeling assumptions that were laid out by the group. The scope of this memorandum is limited to the December 15, 2008 BiOp. Unless otherwise indicated, all descriptive information of the RPAs is taken from Appendix B of the BiOp.

Table 5.A.A.6-1 lists the participants that contributed to the meetings and information summarized in this document.

The RPAs in the USFWS's BiOp are based on physical and biological phenomena that do not lend themselves to simulations using a monthly time step. Much scientific and modeling judgment has been employed to represent the implementation of the RPAs. The group believes the logic put into CalSim II represents the RPAs as best as possible at this time, given the scientific understanding of environmental factors enumerated in the BiOp and the limited historical data for some of these factors.

Table 5.A.A.6-1 Meeting Participants

Name of Participant	Agency
Aaron Miller	Department of Water Resources, State of Californi (DWR)
Steve Ford	DWR
Randi Field	Reclamation
Gene Lee	Reclamation
Lenny Grimaldo	Reclamation
Parviz Nader-Tehrani	DWR
Erik Reyes	DWR
Sean Sou	DWR
Derek Hilts	United States Fish and Wildlife Service (USFWS)
Steve Detwiler	USFWS
Matt Nobriga	California Department of Fish and Wildlife (CDFW)
Jim White	CDFW
Craig Anderson	National Marine Fisheries (NMFS)
Robert Leaf	CH2M HILL
Derya Sumer	CH2M HILL

The simulated Old and Middle River (OMR) flow conditions and CVP/SWP Delta export operations, resulting from these assumptions, are believed to be a reasonable representation of conditions expected to prevail under the RPAs over large spans of years (refer to CalSim II modeling results for more details on simulated operations). Actual OMR flow conditions and Delta export operations will differ from simulated operations for numerous reasons, including having near real-time knowledge and/or estimates of turbidity, temperature, and fish spatial distribution that are unavailable for use in CalSim II over a long period of record. Because these factors and others are believed to be critical for smelt entrainment risk management, the USFWS adopted an adaptive process in defining the RPAs. Given the relatively generalized representation of the RPAs, assumed for CalSim II modeling, much caution is required when interpreting outputs from the model.

Action 1: Adult Delta Smelt Migration and Entrainment (RPA Component 1, Action 1 –First Flush)

Action 1 Summary:

Objective: A fixed duration action to protect pre-spawning adult delta smelt from entrainment during the first flush, and to provide advantageous hydrodynamic conditions early in the migration period.

Action: Limit exports so that the average daily Combined OMR flow is no more negative than -2,000 cubic feet per second (cfs) for a total duration of 14 days, with a 5-day running average no more negative than -2,500 cfs (within 25%).

Timing:

Part A: December 1 to December 20 – Based upon an examination of turbidity data from Prisoner's Point, Holland Cut, and Victoria Canal and salvage data from CVP/SWP (see below), and other parameters important to the protection of delta smelt including, but not limited to, preceding conditions of X2, the Fall Midwater Trawl Survey (FMWT), and river flows; the Smelt Working Group (SWG) may recommend a start date to the USFWS. The USFWS will make the final determination.

Part B: After December 20 – The action will begin if the 3-day average turbidity at Prisoner's Point, Holland Cut, and Victoria Canal exceeds 12 nephelometric turbidity units (NTU). However the SWG can recommend a delayed start or interruption based on other conditions such as Delta inflow that may affect vulnerability to entrainment.

Triggers (Part B):

<u>Turbidity:</u> Three-day average of 12 NTU or greater at all three turbidity stations: Prisoner's Point, Holland Cut, and Victoria Canal.

OR

<u>Salvage:</u> Three days of delta smelt salvage after December 20 at either facility or cumulative daily salvage count that is above a risk threshold based upon the "daily salvage index" approach reflected in a daily salvage index value ≥ 0.5 (daily delta smelt salvage > one-half prior year FMWT index value).

The window for triggering Action 1 concludes when either off-ramp condition described below is met. These off-ramp conditions may occur without Action 1 ever being triggered. If this occurs, then Action 3 is triggered, unless the USFWS concludes on the basis of the totality of available information that Action 2 should be implemented instead.

Off-ramps:

Temperature: Water temperature reaches 12 degrees Celsius (°C) based on a three station daily mean at the temperature stations: Mossdale, Antioch, and Rio Vista

OR

Biological: Onset of spawning (presence of spent females in the Spring Kodiak Trawl Survey [SKT] or at Banks or Jones).

Action 1 Assumptions for CalSim II Modeling Purposes:

An approach was selected based on hydrologic and assumed turbidity conditions. Under this general assumption, Part A of the action was never assumed because, on the basis of historical salvage data, it was considered unlikely or rarely to occur. Part B of the action was assumed to occur if triggered by turbidity conditions. This approach was believed to tend to a more conservative interpretation of the frequency, timing, and extent of this action. The assumptions used for modeling are as follows:

Action: Limit exports so that the average daily OMR flow is no more negative than -2,000 cfs for a total duration of 14 days, with a 5-day running average no more negative than -2,500 cfs (within 25% of the monthly criteria).

Timing: If turbidity-trigger conditions first occur in December, then the action starts on December 21; if turbidity-trigger conditions first occur in January, then the action starts on January 1; if turbidity-trigger conditions first occur in February, then the action starts on February 1; and if turbidity-trigger conditions first occur in March, then the action starts on March 1. It is assumed that once the action is triggered, it continues for 14 days.

Triggers: Only an assumed turbidity trigger that is based on hydrologic outputs was considered. A surrogate salvage trigger or indicator was not included because there was no way to model it.

Turbidity: If the monthly average unimpaired Sacramento River Index (four-river index: sum of Sacramento, Yuba, Feather, and American Rivers) exceeds 20,000 cfs, then it is assumed that an event, in which the 3-day average turbidity at Hood exceeds 12 NTU, has occurred within the month. It is assumed that an event at Sacramento River is a reasonable indicator of this condition occurring, within the month, at all three turbidity stations: Prisoner's Point, Holland Cut, and Victoria Canal.

A chart showing the relationship between turbidity at Hood (number of days with turbidity is greater than 12 NTU) and Sacramento River Index (sum of monthly flow at four stations on the Sacramento, Feather, Yuba and American Rivers, from 2003 to 2006) is shown on Figure 5.A.A.6-1. For months when average Sacramento River Index is between 20,000 cfs and 25,000 cfs a transition is observed in number of days with Hood turbidity greater than 12 NTU. For months when average Sacramento River Index is above 25,000 cfs, Hood turbidity was always greater than 12 NTU for as many as 5 days or more within the month in which the flow occurred. For a conservative approach, 20,000 cfs is used as the threshold value.

Salvage: It is assumed that salvage would occur when first flush occurs.

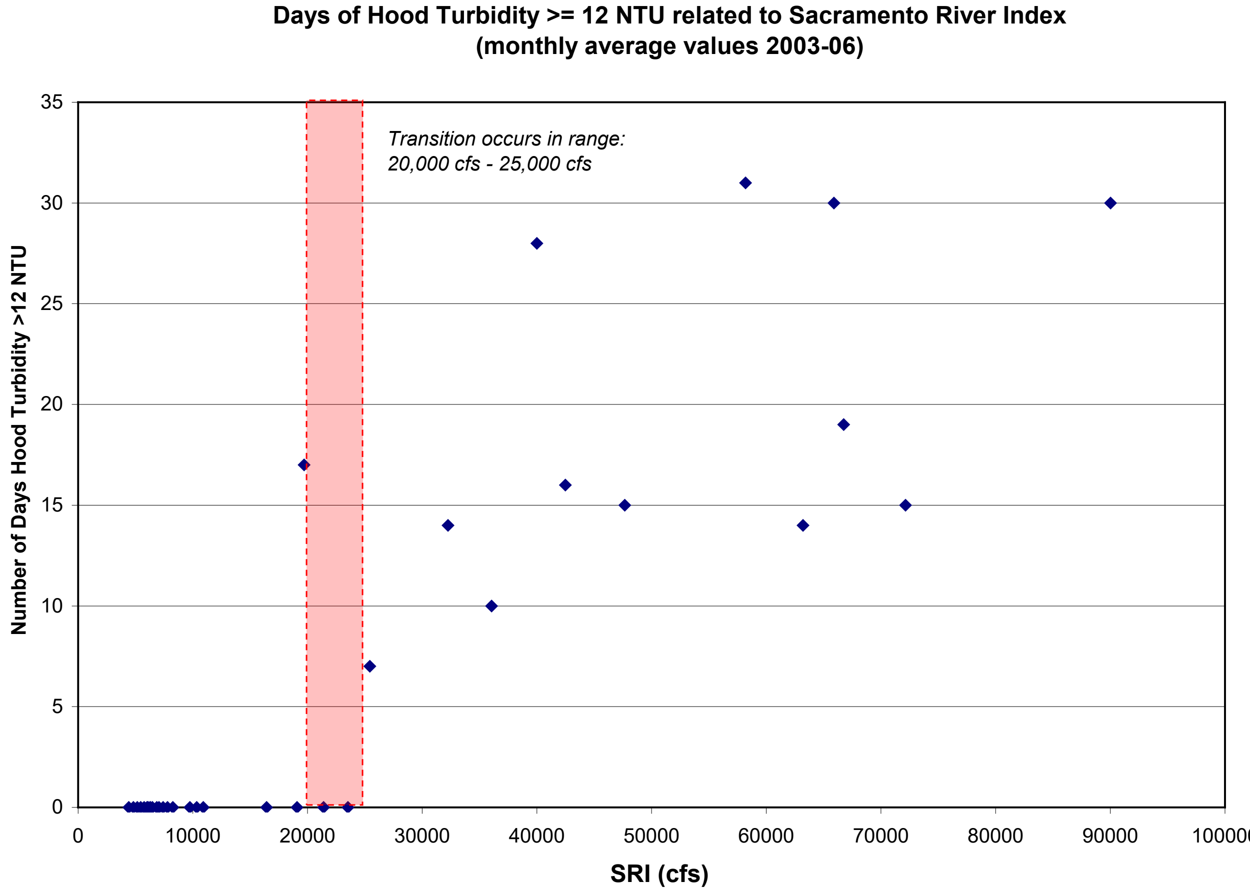

Figure 5.A.A.6-1 Relationship between Turbidity at Hood and Sacramento River Index

Off-ramps: Only temperature-based off-ramping is considered. A surrogate biological off-ramp indicator was not included.

Temperature: Because the water temperature data at the three temperature stations (Antioch, Mossdale, and Rio Vista) are only available for years after 1984, another parameter was sought for use as an alternative indicator. It is observed that monthly average air temperature at Sacramento Executive Airport generally trends with the three-station average water temperature (see Figure 5.A.A.6-2). Using this alternative indicator, monthly average air temperature is assumed to occur in the middle of the month, and values are interpolated on a daily basis to obtain daily average water temperature. Using the correlation between air and water temperature, estimated daily water temperatures are estimated from the 82-year monthly average air temperature. Dates when the three-station average temperature reaches 12°C are recorded and used as input in CalSim. A 1:1 correlation was used for simplicity instead of using the trend line equation illustrated on Figure 5.A.A.6-2.

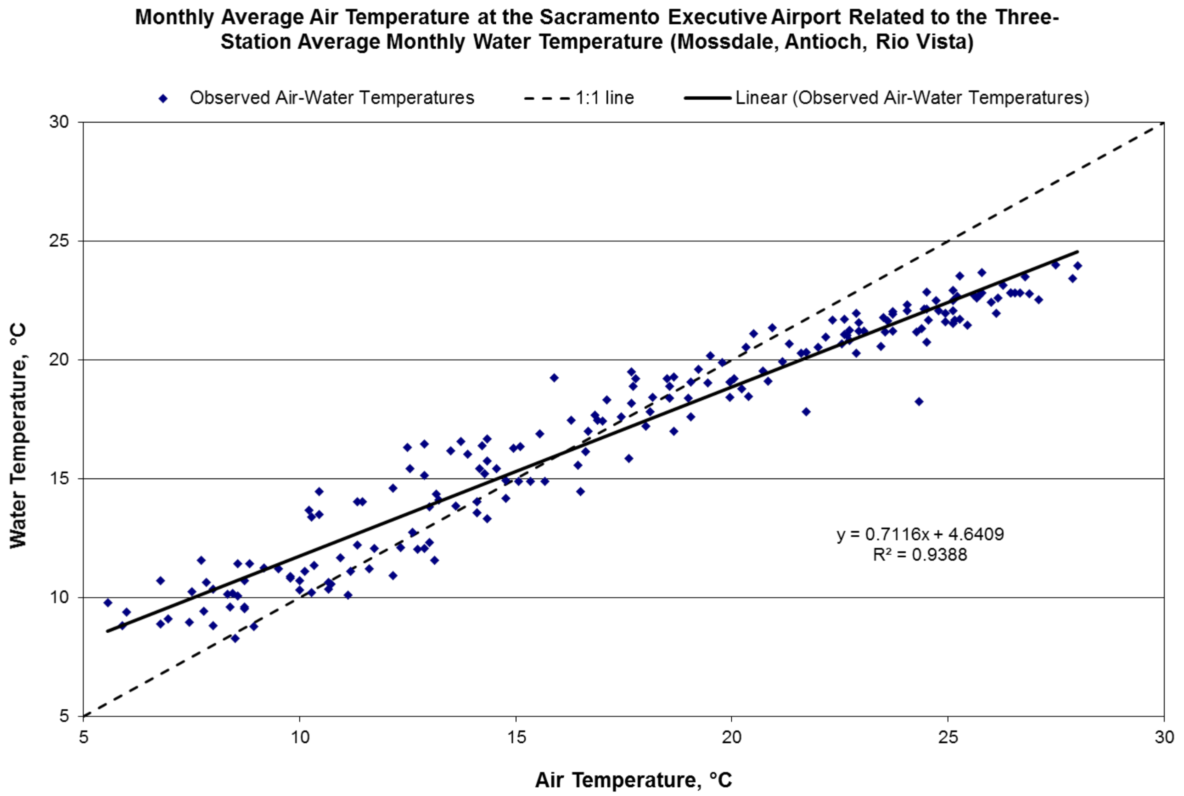

Figure 5.A.A.6-2 Relationship between Monthly Average Air Temperature at the Sacramento Executive Airport and the Three-station Average Monthly Water Temperature

Other Modeling Considerations:

In the month of December in which Action 1 does not begin until December 21, for monthly analysis, a background OMR flow must be assumed for the purpose of calculating a day-weighted average for implementing a partial-month action condition. When necessary, the background OMR flow for December was assumed to be -8,000 cfs.

For the additional condition to meet a 5-day running average no more negative than -2,500 cfs (within 25%), Paul Hutton's equation[1] is used. Hutton concluded that with stringent OMR standards (1,250 to 2,500 cfs), the 5-day average would control more frequently than the 14-day average, but it is less likely to control at higher flows. Therefore, the CalSim II implementation includes both a 14-day (approximately monthly average) and a 5-day average flow criteria based on Hutton's methodology (see Attachment 1).

Rationale: The following is an overall summary of the rationale for the preceding interpretation of RPA Action 1.

[1]Hutton, Paul/Metropolitan Water District of Southern California (MWDSC). Water Supply Impact Analysis of December 2008 Delta Smelt Biological Opinion, Appendix 5. February.

December 1 to December 20 for initiating Action 1 is not considered because seasonal peaks of delta smelt salvage are rare prior to December 20. Adult delta smelt spawning migrations often begin following large precipitation events that happen after mid-December.

Salvage of adult delta smelt often corresponds with increases in turbidity and exports. On the basis of the above discussion and Figure B-2, Sacramento River Index greater than 25,000 cfs is assumed to be an indicator of turbidity trigger being reached at all three turbidity stations: Prisoner's Point, Holland Cut, and Victoria Canal. Most sediment enters the Delta from the Sacramento River during flow pulses; therefore, a flow indicator based on only Sacramento River flow is used.

The 12°C threshold for the off-ramp criterion is a conservative estimate of when delta smelt larvae begin successfully hatching. Once hatched, the larvae move into the water column where they are potentially vulnerable to entrainment.

Results: Using these assumptions, in a typical CalSim II 82-year simulation (1922 through 2003 hydrologic conditions), Action 1 will occur 29 times in the December 21 to January 3 period, 14 times in the January 1 to January 14 period, 13 times in the February 1 to February 14 period, and 17 times in the March 1 to March 14 period. In 3 of these 17 occurrences (1934, 1991, and 2001), Action 3 is triggered before Action 1 and therefore Action 1 is bypassed. Action 1 is not triggered in 9 of the 82 years (1924, 1929, 1931, 1955, 1964, 1976, 1977, 1985, and 1994), typically critically dry years. Refer to CalSim II modeling results for more details on simulated operations of OMR, Delta exports and other parameters of interest.

Action 2: Adult Delta Smelt Migration and Entrainment (RPA Component 1, Action 2)

Action 2 Summary:

Objective: An action implemented using an adaptive process to tailor protection to changing environmental conditions after Action 1. As in Action 1, the intent is to protect pre-spawning adults from entrainment and, to the extent possible, from adverse hydrodynamic conditions.

Action: The range of net daily OMR flows will be no more negative than -1,250 to -5,000 cfs. Depending on extant conditions (and the general guidelines below), specific OMR flows within this range are recommended by the USFWS's Smelt Working Group (SWG) from the onset of Action 2 through its termination (see Adaptive Process description in the BiOp). The SWG would provide weekly recommendations based upon review of the sampling data, from real-time salvage data at the CVP/SWP, and utilizing most up-to-date technological expertise and knowledge relating population status and predicted distribution to monitored physical variables of flow and turbidity. The USFWS will make the final determination.

Timing: Beginning immediately after Action 1. Before this date (in time for operators to implement the flow requirement) the SWG will recommend specific requirement OMR flows based on salvage and on physical and biological data on an ongoing basis. If Action 1 is not implemented, the SWG may recommend a start date for the implementation of Action 2 to protect adult delta smelt.

Suspension of Action:

Flow: OMR flow requirements do not apply whenever a 3-day flow average is greater than or equal to 90,000 cfs in Sacramento River at Rio Vista and 10,000 cfs in San Joaquin River at Vernalis. Once such flows have abated, the OMR flow requirements of the Action are again in place.

Off-ramps:

Temperature: Water temperature reaches 12°C based on a three-station daily average at the temperature stations: Rio Vista, Antioch, and Mossdale.

OR

Biological: Onset of spawning (presence of a spent female in SKT or at either facility).

Action 2 Assumptions for CalSim II Modeling Purposes:

An approach was selected based on the occurrence of Action 1 and X2 salinity conditions. This approach selects from between two OMR flow tiers depending on the previous month's X2 position, and is never more constraining than an OMR criterion of -3,500 cfs. The assumptions used for modeling are as follows:

Action: Limit exports so that the average daily OMR flow is no more negative than -3,500 or -5,000 cfs depending on the previous month's ending X2 location (-3,500 cfs if X2 is east of Roe Island, or -5,000 cfs if X2 is west of Roe Island), with a 5-day running average within 25% of the monthly criteria (no more negative than -4,375 cfs if X2 is east of Roe Island, or -6,250 cfs if X2 is west of Roe Island).

Timing: Begins immediately after Action 1 and continues until initiation of Action 3.

In a typical CalSim II 82-year simulation, Action 1 was not triggered in 9 of the 82 years. In these conditions it is assumed that OMR flow should be maintained no more negative than -5,000 cfs.

Suspension of Action: A flow peaking analysis, developed by Paul Hutton[2], is used to determine the likelihood of a 3-day flow average greater than or equal to 90,000 cfs in Sacramento River at Rio Vista and a 3-day flow average greater than or equal to 10,000 cfs in San Joaquin River at Vernalis occurring within the month. It is assumed that when the likelihood of these conditions occurring exceeds 50%, Action 2 is suspended for the full month, and OMR flow requirements do not apply. The likelihood of these conditions occurring is evaluated each month, and Action 2 is suspended for one month at a time whenever both of these conditions occur.

[2] Hutton, Paul/MWDSC. 2009. Water Supply Impact Analysis of December 2008 Delta Smelt Biological Opinion, Appendix 4. February.

The equations for likelihood (frequency of occurrence) are as follows:

Frequency of Rio Vista 3-day flow average > 90,000 cfs:

> 0% when Freeport monthly flow < 50,000 cfs, OR
>
> (0.00289 × Freeport monthly flow – 146)% when 50,000 cfs ≤ Freeport plus Yolo Bypass monthly flow ≤ 85,000 cfs, OR
>
> 100% when Freeport monthly flow >85,000 cfs

Frequency of Vernalis 3-day flow average > 10,000 cfs:

> 0% when Vernalis monthly flow < 6,000 cfs, OR
>
> (0.00901 × Vernalis monthly flow – 49)% when 6,000 cfs ≤ Vernalis monthly flow ≤ 16,000 cfs, OR
>
> 100% when Vernalis monthly flow >16,000 cfs

Frequency of Rio Vista 3-day flow average > 90,000 cfs equals 50% when Freeport plus Yolo Bypass monthly flow is 67,820 cfs and the frequency of Vernalis 3-day flow average > 10,000 cfs equals 50% Vernalis monthly flow is 10,988 cfs. Therefore these two flow values are used as thresholds in the model.

Off-ramps: Only temperature-based off-ramping is considered. A surrogate biological off-ramp indicator was not included.

Temperature: Because the water temperature data at the three temperature stations (Antioch, Mossdale, and Rio Vista) are only available for years after 1984, another parameter was sought for use as an alternative indicator. It is observed that monthly average air temperature at Sacramento Executive Airport generally trends with the three-station average water temperature (Figure 5.A.A.6-2). Using this alternative indicator, monthly average air temperature is assumed to occur in the middle of the month, and values are interpolated on a daily basis to obtain daily average water temperature. Using the correlation between air and water temperature, daily water temperatures are estimated from the 82-year monthly average air temperature. Dates when the three-station average temperature reaches 12°C are recorded and used as input in CalSim II. A 1:1 correlation was used for simplicity instead of using the trend line equation illustrated on Figure 5.A.A.6-2.

Rationale: The following is an overall summary of the rationale for the preceding interpretation of RPA Action 2.

Action 2 requirements are based on X2 location that is dependent on the Delta outflow. If outflows are very high, fewer delta smelt will spawn east of Sherman Lake; therefore, the need for OMR restrictions is lessened.

In the case of Action 1 not being triggered, CDFW suggested OMR > -5,000 cfs, following the actual implementation of the BiOp in winter 2009, because some adult delta smelt might move into the Central Delta without a turbidity event.

Action 2 is suspended when the likelihood of a 3-day flow average greater than or equal to 90,000 cfs in Sacramento River at Rio Vista and a 3-day flow average greater than or equal to 10,000 cfs in San Joaquin River at Vernalis occurring concurrently within the month exceeds 50%, because at extreme high flows the majority of adult delta smelt will be distributed downstream of the Delta, and entrainment concerns will be very low.

The 12°C threshold for the off-ramp criterion is a conservative estimate of when delta smelt larvae begin successfully hatching. Once hatched, the larvae move into the water column where they are potentially vulnerable to entrainment.

Results: Using these assumptions, in a typical CalSim II 82-year simulation (1922 through 2003 hydrologic conditions), Action 1, and therefore Action 2, does not occur in 11 of the 82 years (1924, 1929, 1931, 1934, 1955, 1964, 1976, 1977, 1985, 1991, 1994, and 2001), typically critically dry years. The criteria for suspension of OMR minimum flow requirements, described above, results in potential suspension of Action 2 (if Action 2 is active) 6 times in January, 11 times in February, 6 times in March (however Action 2 was not active in 3 of these 6 times), and 2 times in April. The result is that Action 2 is in effect 37 times in January (with OMR at -3,500 cfs 29 times, and at -5,000 cfs 8 times), 43 times in February (with OMR at -3,500 cfs 25 times, and at -5,000 cfs 18 times), 31 times in March (with OMR at -3,500 cfs 14 times, and at -5,000 cfs 17 times), and 80 times in April (with OMR at -3,500 cfs 46 times, and at -5,000 cfs 34 times). The frequency each month is a cumulative result of the action being triggered in the current or prior months. Refer to CalSim II modeling results for more details on simulated operations of OMR, Delta exports and other parameters of interest.

Action 3: Entrainment Protection of Larval and Juvenile Delta Smelt (RPA Component 2)

Action 3 Summary:

Objective: Minimize the number of larval delta smelt entrained at the facilities by managing the hydrodynamics in the Central Delta flow levels pumping rates spanning a time sufficient for protection of larval delta smelt, e.g., by using a VAMP-like action. Because protective OMR flow requirements vary over time (especially between years), the action is adaptive and flexible within appropriate constraints.

Action: Net daily OMR flow will be no more negative than -1,250 to -5,000 cfs based on a 14-day running average with a simultaneous 5-day running average within 25% of the applicable requirement for OMR. Depending on extant conditions (and the general guidelines below), specific OMR flows within this range are recommended by the SWG from the onset of Action 3 through its termination (see Adaptive Process in Introduction). The SWG would provide these recommendations based upon weekly review of sampling data, from real-time salvage data at the CVP/SWP, and expertise and knowledge relating population status and predicted distribution to monitored physical variables of flow and turbidity. The USFWS will make the final determination.

Timing: Initiate the action after reaching the triggers below, which are indicative of spawning activity and the probable presence of larval delta smelt in the South and Central Delta. Based upon daily salvage data, the SWG may recommend an earlier start to Action 3. The USFWS will make the final determination.

Triggers:

Temperature: When temperature reaches 12°C based on a three-station average at the temperature stations: Mossdale, Antioch, and Rio Vista.

OR

Biological: Onset of spawning (presence of spent females in SKT or at either facility).

Off-ramps:

Temporal: June 30;

OR

Temperature: Water temperature reaches a daily average of 25°C for three consecutive days at Clifton Court Forebay.

Action 3 Assumptions for CalSim II Modeling Purposes:

An approach was selected based on assumed temperature and X2 salinity conditions. This approach selects from among three OMR flow tiers depending on the previous month's X2 position and ranges from an OMR criteria of -1,250 to -5,000 cfs. Because of the potential low export conditions that could occur at an OMR criterion of -1,250 cfs, a criterion for minimum exports for health and safety is also assumed. The assumptions used for modeling are as follows:

Action: Limit exports so that the average daily OMR flow is no more negative than -1,250, -3,500, or -5,000 cfs, depending on the previous month's ending X2 location (-1,250 cfs if X2 is east of Chipps Island, -5,000 cfs if X2 is west of Roe Island, or -3,500 cfs if X2 is between Chipps and Roe Island, inclusively), with a 5-day running average within 25% of the monthly criteria (no more negative than -1,562 cfs if X2 is east of Chipps Island, -6,250 cfs if X2 is west of Roe Island, or -4,375 cfs if X2 is between Chipps and Roe Island). The more constraining of this OMR requirement or the VAMP requirement will be selected during the VAMP period (April 15 to May 15). Additionally, in the case of the month of June, the OMR criterion from May is maintained through June (it is assumed that June OMR should not be more constraining than May).

Timing: Begins immediately upon temperature trigger conditions and continues until off-ramp conditions are met.

Triggers: Only temperature trigger conditions are considered. A surrogate biological trigger was included.

Temperature: Because the water temperature data at the three temperature stations (Antioch, Mossdale, and Rio Vista) are only available for years after 1984, another parameter was sought to be used as an alternative indicator. It is observed that monthly average air temperature at Sacramento Executive Airport generally trends with the three-station average water temperature (Figure 5.A.A.6-2). Using this alternative indicator, monthly average air temperature is assumed to occur in the middle of the month, and values are interpolated on a daily basis to obtain daily average water temperature. Using the correlation between air and water temperature, estimated daily water temperatures are estimated from the 82-year monthly average air temperature. Dates when the three-station average temperature reaches 12°C are recorded and used as input in CalSim. A 1:1 correlation was used for simplicity instead of using the trend line equation illustrated on Figure 5.A.A.6-2.

Biological: Onset of spawning is assumed to occur no later than *May* 30.

Clarification Note: This text previously read “Onset of spawning is assumed to occur no later than April 30”, where the CalSim II lookup table has May 30 as the date. Based on RPA team discussions in August 2009, it was agreed upon that onset of spawning could not be modeled in CalSim. This trigger was actually coded as a placeholder in case in future this trigger was to be used; and the date was selected purposefully in a way that it wouldn’t affect modeling results. Temperature trigger for Action 3 does occur before end of April. Therefore it does not matter whether the document is corrected to read May 30 or the model lookup table is changed to April 30.

Off-ramps:

Temporal: It is assumed that the ending date of the action would be no later than June 30.

OR

Temperature: Only 17 years of data are available for Clifton Court water temperature. A similar approach as used in the temperature trigger was considered. However, because 3 consecutive days of water temperature greater than or equal to 25°C is required, a correlation between air temperature and water temperature did not work well for this off-ramp criterion. Out of the 17 recorded years, in one year the criterion was triggered in May (May 31), and in 3 years it was triggered in June (June 3, 21, and 27). In all other years it was observed in July or later. With only four data points before July, it was not possible to generate a rule based on statistics. Therefore, temporal off-ramp criterion (June 30) is used for all years.

Health and Safety: In CalSim II, a minimum monthly Delta export criterion of 300 cfs for SWP and 600 cfs (or 800 cfs depending on Shasta storage) for CVP is assumed. This assumption is suitable for dry-year conditions when allocations are low and storage releases are limited; however, minimum monthly exports need to be made for protection of public health and safety (health and safety deliveries upstream of San Luis Reservoir).

In consideration of the severe export restrictions associated with the OMR criteria established in the RPAs, an additional set of health and safety criterion is assumed. These export restrictions could lead to a situation in which supplies are available and allocated; however, exports are curtailed forcing San Luis to have an accelerated drawdown rate. For dam safety at San Luis Reservoir, 2 feet per day is the maximum acceptable drawdown rate. Drawdown occurs faster in summer months and peaks in June when the agricultural demands increase. To avoid rapid drawdown in San Luis Reservoir, a relaxation of OMR is allowed so that exports can be maintained at 1,500 cfs in all months if needed.

This modeling approach may not fit the real-life circumstances. In summer months, especially in June, the assumed 1,500 cfs for health and safety may not be sufficient to keep San Luis drawdown below a safe 2 ft/day; and under such circumstances the projects would be required to increase pumping in order to maintain dam safety.

Rationale: The following is an overall summary of the rationale for the preceding interpretation of RPA Action 3.

The geographic distribution of larval and juvenile delta smelt is tightly linked to X2 (or Delta outflow). Therefore, the percentage of the population likely to be found east of Sherman Lake is also influenced by the location of X2. The X2-based OMR criteria were intended to model an expected management response to the general increase in delta smelt's risk of entrainment as a function of increasing X2.

The 12°C threshold for the trigger criterion is a conservative estimate of when delta smelt larvae begin successfully hatching. Once hatched, the larvae move into the water column where they are potentially vulnerable to entrainment.

The annual salvage "season" for delta smelt typically ends as South Delta water temperatures warm to lethal levels during summer. This usually occurs in late June or early July. The laboratory-derived upper lethal temperature for delta smelt is 25.4°C.

Results: Action 3 occurs 30 times in February (with OMR at -1,250 cfs 9 times, at -3,500 cfs 11 times, and at -5,000 cfs 10 times), 76 times in March (with OMR at -1,250 cfs 15 times, at -3,500 cfs 27 times, and at -5,000 cfs 34 times), all times (82) in April (with OMR at -1,250 cfs 17 times, at -3,500 cfs 29 times, and at -5,000 cfs 35 times), all times (82) in May (with OMR at -1,250 cfs 19 times, at -3,500 cfs 37 times, and at -5,000 cfs 26 times), and 70 times in June (with OMR at -1,250 cfs 7 times, at -3,500 cfs 37 times, and at -5,000 cfs 26 times). Refer to CalSim II modeling results for more details on simulated operations of OMR, Delta exports and other parameters of interest. (Note: The above information is based on the August 2009 version of the model and documents the development process, more recent versions of the model may have different results.)

Action 4: Estuarine Habitat During Fall (RPA Component 3)

Action 4 Summary:

Objective: Improve fall habitat for delta smelt by managing of X2 through increasing Delta outflow during fall when the preceding water year was wetter than normal. This will help return ecological conditions of the estuary to that which occurred in the late 1990s when smelt populations were much larger. Flows provided by this action are expected to provide direct and indirect benefits to delta smelt. Both the direct and indirect benefits to delta smelt are considered equally important to minimize adverse effects.

Action: Subject to adaptive management as described below, provide sufficient Delta outflow to maintain average X2 for September and October no greater (more eastward) than 74 kilometers in the fall following wet years and 81 kilometers in the fall following above normal years. The monthly average X2 position is to be maintained at or seaward of these location for each individual month and not averaged over the two month period. In November, the inflow to CVP/SWP reservoirs in the Sacramento Basin will be added to reservoir releases to provide an added increment of Delta inflow and to augment Delta outflow up to the fall X2 target. The action will be evaluated and may be modified or terminated as determined by the USFWS.

Timing:

September 1 to November 30.

Triggers:

Wet and above normal water-year type classification from the 1995 Water Quality Control Plan that is used to implement D-1641.

Action 4 Assumptions for CalSim II Modeling Purposes:

Model is modified to increase Delta outflow to meet monthly average X2 requirements for September and October and subsequent November reservoir release actions in Wet and Above Normal years. No off-ramps are considered for reservoir release capacity constraints. Delta exports may or may not be reduced as part of reservoir operations to meet this action. The Action is summarized in Table 5.A.A.6-2.

Table 5.A.A.6-2. Summary of Action 4 implementation in CalSim II

Fall Months following Wet or Above Normal Years	Action Implementation
September	Meet monthly average X2 requirement (74 km in Wet years, 81 km in Above Normal years)
October	Meet monthly average X2 requirement (74 km in Wet years, 81 km in Above Normal years)
November	Add reservoir releases up to natural inflow as needed to continue to meet monthly average X2 requirement (74 km in Wet years, 81 km in Above Normal years)

Rationale: Action 4 requirements are based on determining X2 location. Adjustment and retraining of the ANN was also completed to address numerical sensitivity concerns.

Results: There are 38 September and 37 October months that the Action is triggered over the 82-year simulation period.

Action 5: Temporary Spring Head of Old River Barrier and the Temporary Barrier Project (RPA Component 2)

Action 5 Summary:

Objective: To minimize entrainment of larval and juvenile delta smelt at Banks and Jones or from being transported into the South and Central Delta, where they could later become entrained.

Action: Do not install the Spring Head of Old River Barrier (HORB) if delta smelt entrainment is a concern. If installation of the HORB is not allowed, the agricultural barriers would be installed as described in the Project Description. If installation of the HORB is allowed, the Temporary Barrier Project (TBP) flap gates would be tied in the open position until May 15.

Timing: The timing of the action would vary depending on the conditions. The normal installation of the spring temporary HORB and the TBP is in April.

Triggers: For delta smelt, installation of the HORB will only occur when particle tracking modeling results show that entrainment levels of delta smelt will not increase beyond 1% at Station 815 as a result of installing the HORB.

Off-ramps: If Action 3 ends or May 15, whichever comes first.

Action 5 Assumptions for CalSim II and DSM2 Modeling Purposes:

The South Delta Improvement Program (SDIP) Stage 1 is not included in the Existing and Future Condition assumptions being used for CalSim II and DSM2 baselines. The TBP is assumed instead. The TBP specifies that HORB be installed and operated during April 1 through May 31 and September 16 through November 30. In response to the USFWS BiOp, Action 5, the HORB is assumed to not be installed during April 1 through May 31.

Appendix 4: Approach to Suspend Actions During High Flows

MEMO

Date: December 16, 2008

To: File

From: Paul Hutton

Subject: Modeling Delta Smelt High Flow Action Temporary Suspensions

This memo summarizes an approach that was developed to represent high flow periods when Delta smelt flow actions are temporarily suspended. The actions of interest include the following:

- Wanger Actions – The winter pulse flow action (on or after December 25) is temporarily suspended if the 3-day average flow at Freeport exceeds 80,000 cfs. Similarly, the pre-spawning adult flow action (January and February) is temporarily suspended if the 3-day average flow at Freeport exceeds 80,000 cfs.

- Delta Smelt Biological Opinion Actions – Action 2 is temporarily suspended if the 3-day average flows at Rio Vista and Vernalis exceed 90,000 cfs and 10,000 cfs, respectively.

Methodology

Given that (1) the actions are written in terms of 3-day flow averages and (2) typical water supply impact analyses are conducted assuming monthly average flows, a method is needed to characterize the action in terms of monthly average flows. Historical flows information from DAYFLOW was used to characterize relationships between 3-day flows and monthly flows. The desired product is to determine a frequency of exceeding the 3-day flow target as a function of a monthly flow value. This frequency will be used to proportionally reduce calculated water supply impacts in high flow months.

Results for Wanger Actions

Figure 4-1 plots the frequency that 3-day Freeport flows exceed 80,000 cfs as a function of monthly average Freeport flows (Q_F). The resulting mathematical frequency relationship (in percent units) is as follows:

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0% when $Q_F < 50{,}000$ cfs

0.0126 * exp (0.000105*Q_F) when 50,000 cfs ≤ Q_F ≤ 85,000 cfs

100% when Q_F > 85,000 cfs

Results for BO Actions

Figure 4-2 plots the frequency that 3-day Rio Vista flows exceed 90,000 cfs as a function of monthly average Freeport flows (Q_F). The resulting mathematical frequency relationship (in percent units) is as follows:

0% when $Q_F < 50{,}000$ cfs

-146 + 0.00289*Q_F when 50,000 cfs ≤ Q_F ≤ 85,000 cfs

100% when Q_F > 85,000 cfs

Figure 4-3 plots the frequency that 3-day Vernalis flows exceed 10,000 cfs as a function of monthly average Vernalis flows (Q_V). The resulting mathematical frequency relationship (in percent units) is as follows:

0% when $Q_V < 6{,}000$ cfs

-49 + 0.00901*Q_V when 6,000 cfs ≤ Q_V ≤ 16,000 cfs

100% when Q_V > 16,000 cfs

The BO requires Rio Vista and Vernalis flows to simultaneously exceed the targets to temporarily suspend the flow action. For modeling purposes, it is assumed that these flows are statistically independent. Hence, the suspension frequency is calculated as the product of the individual frequencies. Since Rio Vista and Vernalis flows are modestly correlated, the proposed approach may somewhat understate the true suspension frequency. However, a cursory paired data evaluation suggested that the assumption will provide reasonable results.

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Figure 4-1. Frequency of Wanger Freeport Flow Trigger as a Function of Monthly Freeport Flow

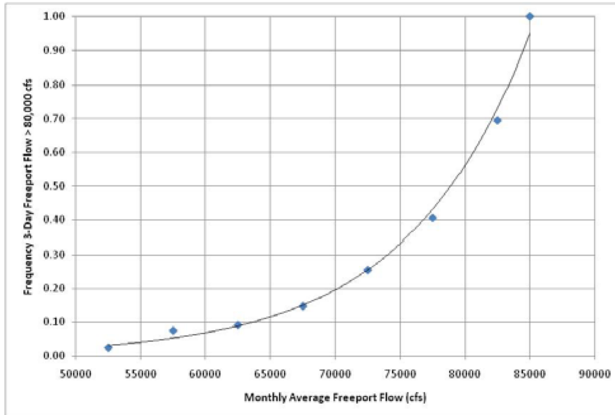


Figure 4-2. Frequency of BO Rio Vista Flow Trigger as a Function of Monthly Freeport Flow

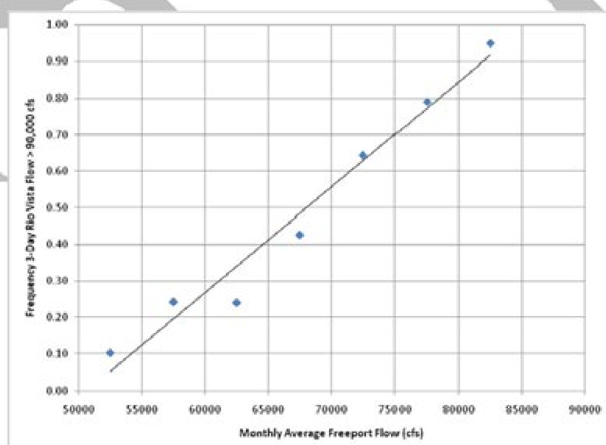
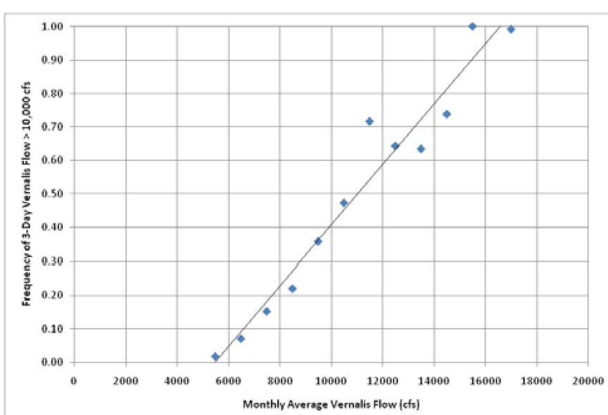


Figure 4-3. Frequency of BO Vernalis Flow Trigger as a Function of Monthly Vernalis Flow



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Appendix 5: Approach to Relate 5-Day & 14-Day OMR Flows

MEMO

Date: January 2, 2009

To: File

From: Paul Hutton

Subject: How Frequently Will 5-Day OMR Flows (Rather than 14-Day OMR Flows) Control Project Operations Under New Delta Smelt Biological Opinion?

Background

Several flow actions specified in the December 2008 Delta Smelt biological opinion place limits on reverse flows in Old and Middle Rivers. Limits are given as 14-day averages, but the simultaneous 5-day averages are to be within 25% of the 14-day averages. This memo summarizes an investigation to answer the question "How frequently will 5-day OMR flows, rather than 14-day OMR flows, control project operations under the new Delta smelt biological opinion?"

Water supply impact studies assume the 14-day average flow controls. Such an approach would not be conservative if 5-day flows frequently control project operations. Based upon a recent meeting with SWP and CVP operators, the CVP operators believe that fishery agencies will accept violations of the 5-day flow limit provided that project operators maintain relatively stable pumping operations. Is this belief that 5-day flows will not control operations valid? Will the courts or environmental groups accept such an operation? An investigation into the potential frequency of 5-day flow control seems prudent, given that we don't know the answers to such questions.

Methods

The following methods were employed:

- Review historical Delta flow and operations data for the period between January 1990 and May 2008.
- Identify periods when (1) pumping operations were relatively stable and (2) 5-day OMR flows were more negative than 14-day OMR flows. For periods prior to

5-day OMR flows are more negative than 14-day OMR flows by nearly 1000 cfs (679 cfs + 297 cfs = 976 cfs). At two standard errors, or about 95% confidence, 5-day OMR flows are more negative than 14-day OMR flows by nearly 1300 cfs (679 cfs + 2*297 cfs = 1273 cfs).

By solving the Figure 5-1 regression equation for a condition when the 5-day OMR flow is 25% more negative than the 14-day OMR flow, the following limits are identified when 5-day OMR flows will control:

14-day OMR flow = -2980 cfs at a 50% confidence interval

-4280 cfs at a 67% confidence interval

-5580 cfs at a 95% confidence interval

Conclusions

This memo summarizes an investigation to answer the question "How frequently will 5-day OMR flows, rather than 14-day OMR flows, control project operations under the new Delta smelt biological opinion?" An analysis of historical flow and project operations data suggests that 5-day OMR flows will often control operations when the 14-day flow target is in the most stringent range of -1500 cfs to -2500 cfs. When the projects are operating to less stringent OMR flows in the range of -3000 cfs to -5000 cfs, 5-day OMR flows will occasionally be at least 25% more negative than 14-day OMR flows and might control project operations.

If the projects are required to strictly meet the 5-day OMR flow criteria, (1) the current water supply impact assumption of 14-day OMR flow control is not conservative and (2) it would be prudent to incorporate a factor of safety to address the 5-day flow criteria.

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Figure 5-1. Average 5d OMR flows as a function of average 14d OMR flows during periods when pumping operations were stable and 5d flows were more negative than 14d flows.

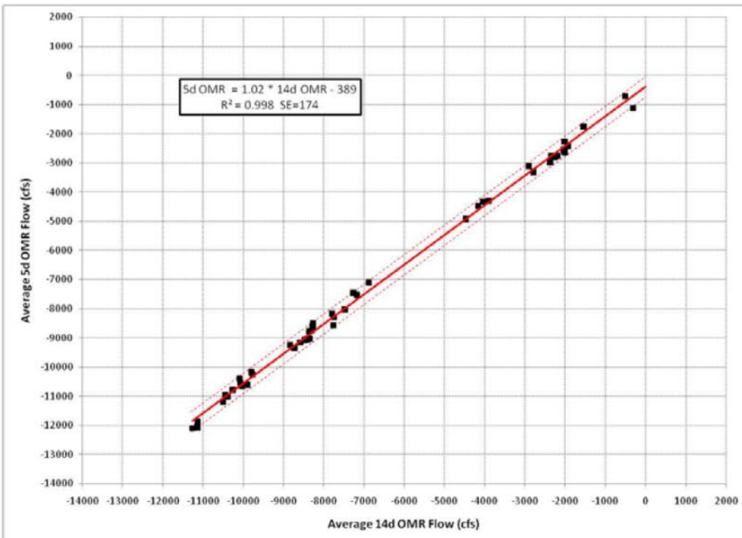

Figure 5-2. Peak 5d OMR flows as a function of peak 14d OMR flows during periods when pumping operations were stable and 5d flows were more negative than 14d flows.

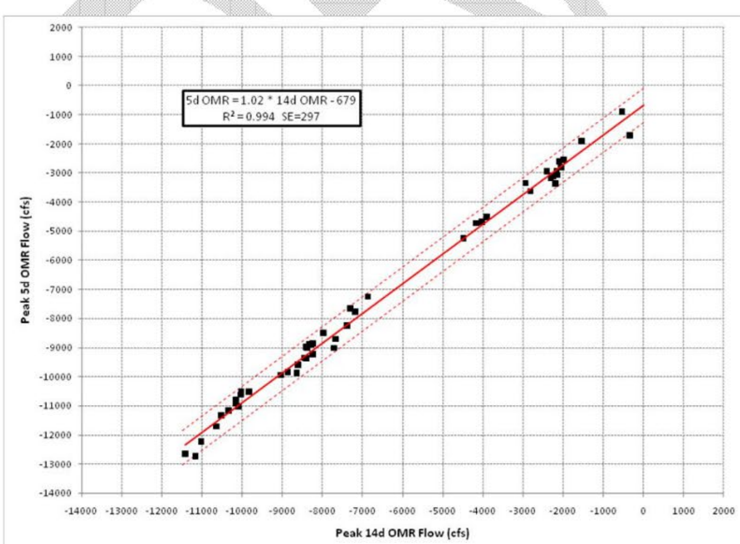

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Table 5-1. Fifty periods were identified when pumping operations were relatively stable and 5-day OMR flows were more negative than 14-day OMR flows.

Period			Daily Export Range (cfs)			14d Export Range (cfs)			Average OMR Difference (cfs)				Peak OMR Difference (cfs)				
Start Date	End Date	Duration (days)	Min	Max	Range	Min	Max	Range	14d	5d	Diff	%Diff	Date	14d	5d	Diff	%Diff
24-Jan-90	1-Feb-90	9	10000	10700	700	10400	10500	100	-8300	-8760	-460	6%	30-Jan-90	-8390	-9010	-620	7%
9-Feb-90	17-Feb-90	9	9900	10600	700	10400	10400	0	-8270	-8590	-320	4%	12-Feb-90	-8280	-8900	-620	7%
24-Feb-90	3-Mar-90	8	10000	10600	600	10400	10500	100	-8270	-8690	-420	5%	27-Feb-90	-8240	-8870	-630	8%
10-Mar-90	19-Mar-90	10	10000	10800	800	10300	10400	100	-8260	-8510	-250	3%	18-Mar-90	-8340	-8890	-550	7%
24-Mar-90	1-Apr-90	9	10300	10600	300	10300	10500	200	-8830	-9250	-420	5%	31-Mar-90	-9040	-9950	-910	10%
1-Apr-91	8-Apr-91	8	9300	10200	900	10200	10300	100	-7470	-8020	-550	7%	4-Apr-91	-7390	-8260	-870	12%
16-Mar-92	24-Mar-92	9	10000	10700	700	10300	10400	100	-8410	-9060	-650	8%	22-Mar-92	-8640	-9880	-1240	14%
20-Aug-93	27-Aug-93	8	10400	10900	500	10600	10700	100	-8730	-9350	-620	7%	24-Aug-93	-8870	-9850	-980	11%
4-Sep-93	10-Sep-93	7	10900	10900	0	10600	10700	100	-8360	-8790	-430	5%	9-Sep-93	-8420	-8990	-570	7%
18-Sep-93	23-Sep-93	6	10300	10900	600	10800	10900	100	-8370	-9030	-660	8%	20-Sep-93	-8450	-9360	-910	11%
1-Oct-93	9-Oct-93	9	10800	11100	300	10600	10900	300	-8340	-9040	-700	8%	3-Oct-93	-8240	-9240	-1000	12%
17-Oct-93	22-Oct-93	6	10800	10900	100	10900	10900	0	-7790	-8170	-380	5%	18-Oct-93	-7980	-8500	-520	7%
22-Nov-95	30-Nov-95	9	4300	4800	500	4400	4400	0	-2780	-3300	-520	19%	25-Nov-95	-2810	-3640	-830	30%
7-Dec-95	13-Dec-95	7	4200	4400	200	4300	4400	100	-2900	-3100	-200	7%	12-Dec-95	-2930	-3360	-430	15%
22-Dec-95	28-Dec-95	7	4200	4400	200	4200	4300	100	-2370	-2980	-610	26%	26-Dec-95	-2250	-3130	-880	39%
12-Aug-99	22-Aug-99	11	8700	11600	2900	10900	11300	400	-9800	-10180	-380	4%	20-Aug-99	-10040	-10630	-590	6%
28-Aug-99	5-Sep-99	9	10900	11600	700	11100	11400	300	-10260	-10790	-530	5%	1-Sep-99	-10350	-11180	-830	8%
13-Sep-99	19-Sep-99	7	11400	11500	100	11500	11500	0	-10090	-10390	-300	3%	17-Sep-99	-10030	-10530	-500	5%
3-May-00	9-May-00	7	1700	2200	500	2100	2300	200	-1930	-2410	-480	25%	8-May-00	-1980	-2560	-580	29%
5-May-01	13-May-01	9	1500	1700	200	1500	1500	0	-2000	-2630	-630	32%	11-May-01	-2190	-3380	-1190	54%
22-May-01	29-May-01	8	800	1600	800	1500	1500	0	-2020	-2590	-570	28%	27-May-01	-2140	-3080	-940	44%
22-Jul-01	29-Jul-01	8	7900	8800	900	8100	8300	200	-8580	-9160	-580	7%	25-Jul-01	-8610	-9610	-1000	12%
20-Aug-01	26-Aug-01	7	7700	8900	1200	8100	8400	300	-8470	-9080	-610	7%	23-Aug-01	-8410	-9370	-960	11%
6-Sep-01	12-Sep-01	7	7200	8300	1100	7500	7600	100	-7760	-8580	-820	11%	8-Sep-01	-7720	-9030	-1310	17%
19-Sep-01	25-Sep-01	7	7200	8200	1000	7700	7800	100	-7750	-8310	-560	7%	22-Sep-01	-7680	-8720	-1040	14%
27-Apr-02	3-May-02	7	1400	1500	100	1500	2000	500	-2190	-2750	-560	26%	30-Apr-02	-2160	-2960	-800	37%
12-May-02	18-May-02	7	1500	1500	0	1500	1500	0	-2030	-2540	-510	25%	16-May-02	-2040	-2810	-770	38%
26-May-02	31-May-02	6	1600	1600	0	1600	1600	0	-2010	-2260	-250	12%	31-May-02	-2100	-2620	-520	25%
1-May-03	7-May-03	7	1400	1500	100	1500	1500	0	-2340	-2760	-420	18%	3-May-03	-2400	-2950	-550	23%
15-May-03	22-May-03	8	1500	2300	800	1400	1700	300	-2250	-2800	-550	24%	20-May-03	-2300	-3190	-890	39%
15-Aug-03	22-Aug-03	8	11300	11600	300	11200	11400	200	-11260	-12100	-840	7%	20-Aug-03	-11430	-12670	-1240	11%
31-Aug-03	6-Sep-03	7	11200	11500	300	11400	11500	100	-11140	-12070	-930	8%	3-Sep-03	-11170	-12750	-1580	14%
13-Sep-03	21-Sep-03	9	10000	11600	1600	11200	11400	200	-11130	-11880	-750	7%	16-Sep-03	-11030	-12240	-1210	11%
25-Jul-05	31-Jul-05	7	11500	11600	100	11500	11500	0	-10020	-10670	-650	6%	28-Jul-05	-10110	-11040	-930	9%
7-Aug-05	15-Aug-05	9	10900	11700	800	11500	11600	100	-10390	-11020	-630	6%	13-Aug-05	-10530	-11350	-820	8%
22-Aug-05	28-Aug-05	7	11600	11700	100	11500	11600	100	-10500	-11190	-690	7%	25-Aug-05	-10650	-11720	-1070	10%
13-Aug-06	18-Aug-06	6	11500	11600	100	11500	11600	100	-10070	-10560	-490	5%	15-Aug-06	-10170	-10930	-760	7%
26-Aug-06	3-Sep-06	9	11300	11600	300	11500	11500	0	-9760	-10260	-500	5%	1-Sep-06	-9840	-10520	-680	7%
10-Sep-06	16-Sep-06	7	11000	11600	600	11500	11600	100	-9900	-10610	-710	7%	14-Sep-06	-10090	-11040	-950	9%
5-Nov-06	13-Nov-06	9	8600	10000	1400	9200	9400	200	-6880	-7100	-220	3%	7-Nov-06	-6870	-7260	-390	6%
15-Nov-06	23-Nov-06	9	9200	10000	800	9200	9500	300	-7260	-7460	-200	3%	20-Nov-06	-7310	-7660	-350	5%
2-Dec-06	6-Dec-06	5	8400	10200	1800	9600	9800	200	-7170	-7530	-360	5%	4-Dec-06	-7180	-7780	-600	8%
27-Jan-07	1-Feb-07	6	6300	6900	600	6500	6800	300	-3890	-4300	-410	11%	28-Jan-07	-3900	-4530	-630	16%
7-Feb-07	13-Feb-07	7	6400	6900	500	6800	6800	0	-4160	-4490	-330	8%	10-Feb-07	-4170	-4730	-560	13%
22-Feb-07	28-Feb-07	7	6600	6900	300	6800	6900	100	-4030	-4330	-300	7%	25-Feb-07	-4020	-4700	-680	17%
3-Apr-07	9-Apr-07	7	5600	7100	1500	6200	6600	400	-4460	-4920	-460	10%	7-Apr-07	-4480	-5250	-770	17%
15-May-07	20-May-07	6	1200	1500	300	1400	1500	100	-1540	-1750	-210	14%	18-May-07	-1540	-1920	-380	25%
14-Aug-07	24-Aug-07	11	11600	11600	0	11500	11600	100	-10450	-10960	-510	5%	17-Aug-07	-10160	-10810	-650	6%
3-May-08	9-May-08	7	1500	1500	0	1500	1600	100	-310	-1110	-800	258%	6-May-08	-330	-1720	-1390	421%
18-May-08	22-May-08	5	1400	1700	300	1500	1500	0	-500	-710	-210	42%	20-May-08	-530	-900	-370	70%

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4.1 Representation of National Marine Fisheries Service Biological Opinion Reasonable and Prudent Alternative Actions for CalSim II Planning Studies

The National Marine Fisheries Service's (NMFS) Biological Opinion (BiOp) on the Long-term Operations of the Central Valley Project and State Water Project was released on June 4, 2009.

To develop CalSim II modeling assumptions to represent the operations related reasonable and prudent alternative actions (RPA) required by this BiOp, the California Department of Water Resources (DWR) led a series of meetings that involved members of fisheries and project agencies. The purpose for establishing this group was to prepare the assumptions and CalSim II implementations to represent the RPAs in both Existing- and Future-Condition CalSim II simulations for future planning studies.

This memorandum summarizes the approach that resulted from these meetings and the modeling assumptions that were laid out by the group. The scope of this memorandum is limited to the June 4, 2009 BiOp. All descriptive information of the RPAs is taken from the BiOp.

Table 5.A.A.6-1 lists the participants that contributed to the meetings and information summarized in this document.

The RPAs in NMFS's BiOp are based on physical and biological processes that do not lend themselves to simulations using a monthly time step. Much scientific and modeling judgment has been employed to represent the implementation of the RPAs. The group believes the logic put into CalSim II represents the RPAs as best as possible at this time, given the scientific understanding of environmental factors enumerated in the BiOp and the limited historical data for some of these factors.

Given the relatively generalized representation of the RPAs assumed for CalSim II modeling, much caution is required when interpreting outputs from the model.

Table 5.A.A.7-1 Meeting Participants

Name of Participant	Agency
Aaron Miller	Department of Water Resources, State of California (DWR)
Randi Field	Reclamation
Lenny Grimaldo	Reclamation
Henry Wong	Reclamation
Parviz Nader-Tehrani	DWR
Erik Reyes	DWR
Sean Sou	DWR
Paul A. Marshall	DWR
Ming-Yen Tu	DWR
Xiaochun Wang	DWR
Derek Hilts	United States Fish and Wildlife Service (USFWS)
Roger Guinee	USFWS
Matt Nobriga	California Department of Fish and Wildlife (CDFW)
Bruce Oppenheim	National Marine Fisheries Service (NMFS)
Robert Leaf	CH2M HILL
Derya Sumer	CH2M HILL

4.2 Action Suite 1.1 Clear Creek

Suite Objective: The RPA actions described below were developed based on a careful review of past flow studies, current operations, and future climate change scenarios. These actions are necessary to address adverse project effects on flow and water temperature that reduce the viability of spring-run and CV steelhead in Clear Creek.

Action 1.1.1 Spring Attraction Flows

Objective: Encourage spring-run movement to upstream Clear Creek habitat for spawning.

Action: Reclamation shall annually conduct at least two pulse flows in Clear Creek in May and June of at least 600 cfs for at least three days for each pulse, to attract adult spring-run holding in the Sacramento River main stem.

Action 1.1.1 Assumptions for CalSim II Modeling Purposes

Action: Model is modified to meet 600 cfs for 3 days twice in May. In the CalSim II analysis, Flows sufficient to increase flow up to 600 cfs for a total of 6 days are added to the flows that would have otherwise occurred in Clear Creek.

Rationale: CalSim II is a monthly model. The monthly flow in Clear Creek is an underestimate of the actual flows that would occur subject to daily operational constraints at Whiskeytown Reservoir. The additional flow to meet 600 cfs for a total of 6 days was added to the monthly average flow modeled.

Action 1.1.5. Thermal Stress Reduction

Objective: To reduce thermal stress to over-summering steelhead and spring-run during holding, spawning, and embryo incubation.

Action: Reclamation shall manage Whiskeytown releases to meet a daily water temperature of: (1) 60°F at the Igo gauge from June 1 through September 15; and (2) 56°F at the Igo gauge from September 15 to October 31.

Action 1.1.5 Assumptions for CalSim II Modeling Purposes

Action: It is assumed that temperature operations can perform reasonably well with flows included in model.

Rationale: A temperature model of Whiskeytown Reservoir has been developed by Reclamation. Further analysis using this or other temperature model is required to verify the statement that temperature operations can perform reasonably well with flows included in model.

4.3 Action Suite 1.2 Shasta Operations

Objectives: To address the avoidable and unavoidable adverse effects of Shasta operations on winter-run and spring-run:

- Ensure a sufficient cold water pool to provide suitable temperatures for winter-run spawning between Balls Ferry and Bend Bridge in most years, without sacrificing the potential for cold water management in a subsequent year. Additional actions to those in the 2004 CVP/SWP operations Opinion are needed, due to increased vulnerability of the population to temperature effects attributable to changes in Trinity River ROD operations, projected climate change hydrology, and increased water demands in the Sacramento River system.
- Ensure suitable spring-run temperature regimes, especially in September and October. Suitable spring-run temperatures will also partially minimize temperature effects to naturally-spawning, non-listed Sacramento River fall-run, an important prey base for endangered Southern Residents.
- Establish a second population of winter-run in Battle Creek as soon as possible, to partially compensate for unavoidable project-related effects on the one remaining population.
- Restore passage at Shasta Reservoir with experimental reintroductions of winter-run to the upper Sacramento and/or McCloud rivers, to partially compensate for unavoidable project-related effects on the remaining population.

Action 1.2.1 Performance Measures

Objective: To establish and operate to a set of performance measures for temperature compliance points and End-of-September (EOS) carryover storage, enabling Reclamation and NMFS to assess the effectiveness of this suite of actions over time. Performance measures will help to ensure that the beneficial variability of the system from changes in hydrology will be measured and maintained.

Action: To ensure a sufficient cold water pool to provide suitable temperatures, long-term performance measures for temperature compliance points and EOS carryover storage at Shasta Reservoir shall be attained. Performance measures for EOS carryover storage at Shasta Reservoir are as follows:

- 87% of years: Minimum EOS storage of 2.2 MAF
- 82% of years: Minimum EOS storage of 2.2 MAF and end-of-April storage of 3.8 MAF in following year (to maintain potential to meet Balls Ferry compliance point)
- 40% of years: Minimum EOS storage 3.2 MAF (to maintain potential to meet Jelly’s Ferry compliance point in following year)

Performance measures (measured as a 10-year running average) for temperature compliance points during summer season are:

- Meet Clear Creek Compliance point 95% of time
- Meet Balls Ferry Compliance point 85% of time
- Meet Jelly’s Ferry Compliance point 40% of time
- Meet Bend Bridge Compliance point 15% of time

Action 1.2.1 Assumptions for CalSim II Modeling Purposes

Action: No specific CalSim II modeling code is implemented to simulate the performance measures identified. System performance will be assessed and evaluated through post-processing of various model results.

Rationale: Given that the performance criteria are based on the CalSim II modeling data used in preparation of the Biological Assessment, the system performance after application of the RPAs should be similar as a percentage of years that the end-of-April storage and temperature compliance requirements are met over the simulation period. Post-processing of modeling results will be compared to various new operating scenarios as needed to evaluate performance criteria and appropriateness of the rules developed.

Action 1.2.2 November through February Keswick Release Schedule (Fall Actions)

Objective: Minimize impacts to listed species and naturally spawning non-listed fall-run from high water temperatures by implementing standard procedures for release of cold water from Shasta Reservoir.

Action: Depending on EOS carryover storage and hydrology, Reclamation shall develop and implement a Keswick release schedule, and reduce deliveries and exports as needed to achieve performance measures.

Action 1.2.2 Assumptions for CalSim II Modeling Purposes

Action: No specific CalSim II modeling code is implemented to simulate the Performance measures identified. Keswick flows based on operation of 3406(b)(2) releases in OCAP Study 7.1 (for Existing) and Study 8 (for Future) are used in CalSim II. These flows will be reviewed for appropriateness under this action. A post-process based evaluation similar to what has been explained in Action 1.2.1 will be conducted.

Rationale: Performance measures are set as percentage of years that the end-of-September and temperature compliance requirements are met over the simulation period. Post-processing of modeling results will be compared to various new operating scenarios as needed to evaluate performance criteria and appropriateness of the rules developed.

Action 1.2.3 February Forecast; March – May 14 Keswick Release Schedule (Spring Actions)

Objective: To conserve water in Shasta Reservoir in the spring in order to provide sufficient water to reduce adverse effects of high water temperature in the summer months for winter-run, without sacrificing carryover storage in the fall.

Action:

- Reclamation shall make its February forecast of deliverable water based on an estimate of precipitation and runoff within the Sacramento River basin at least as conservative as the 90% probability of exceedance. Subsequent updates of water delivery commitments must be based on monthly forecasts at least as conservative as the 90% probability of exceedance.
- Reclamation shall make releases to maintain a temperature compliance point not in excess of 56 degrees between Balls Ferry and Bend Bridge from April 15 through May 15.

Action 1.2.3 Assumptions for CalSim II Modeling Purposes

Action: No specific CalSim II modeling code is implemented to simulate the Performance measures identified. It is assumed that temperature operations can perform reasonably well with flows included in model.

Rationale: Temperature models of Shasta Lake and the Sacramento River have been developed by Reclamation. This modeling reflects current facilities for temperature controlled releases. Further analysis using this or another temperature model can further verify that temperature operations can perform reasonably well with flows included in model and temperatures are met reliably at each of the compliance points. In the future, it may be that adjusted flow schedules may need to be developed based on development of temperature model runs in conjunction with CalSim II modeled operations.

Action 1.2.4 May 15 through October Keswick Release Schedule (Summer Action)

Objective: To manage the cold water storage within Shasta Reservoir and make cold water releases from Shasta Reservoir to provide suitable habitat temperatures for winter-run, spring-run, CV steelhead, and Southern DPS of green sturgeon in the Sacramento River between Keswick Dam and Bend Bridge, while retaining sufficient carryover storage to manage for next year's cohorts. To the extent feasible, manage for suitable temperatures for naturally spawning fall-run.

Action: Reclamation shall manage operations to achieve daily average water temperatures in the Sacramento River between Keswick Dam and Bend Bridge as follows:

- Not in excess of 56°F at compliance locations between Balls Ferry and Bend Bridge from May 15 through September 30 for protection of winter-run, and not in excess of 56°F at the same compliance locations between Balls Ferry and Bend Bridge from October 1 through October 31 for protection of mainstem spring run, whenever possible.
- Reclamation shall operate to a final Temperature Management Plan starting May 15 and ending October 31.

Action 1.2.4 Assumptions for CalSim II Modeling Purposes

Action: No specific CalSim II modeling code is implemented to simulate the Performance measures identified. It is assumed that temperature operations can perform reasonably well with flows included in model. During the detailed effects analysis, temperature modeling and post-processing will be used to verify temperatures are met at the compliance points. In the long-term approach, for a complete interpretation of the action, development of temperature model runs are needed to develop flow schedules if needed for implementation into CalSim II.

Rationale: Temperature models of Shasta Lake and the Sacramento River have been developed by Reclamation. This modeling reflects current facilities for temperature controlled releases. Further analysis using this or another temperature model is required to verify the statement that temperature operations can perform reasonably well with flows included in model and temperatures are met reliably at each of the compliance points. It may be that alternative flow schedules may need to be developed based on development of temperature model runs in conjunction with CalSim II modeled operations.

4.4 Action Suite 1.3 Red Bluff Diversion Dam (RBDD) Operations

Objectives: Reduce mortality and delay of adult and juvenile migration of winter-run, spring-run, CV steelhead, and Southern DPS of green sturgeon caused by the presence of the diversion dam and the configuration of the operable gates. Reduce adverse modification of the passage element of critical habitat for these species. Provide unimpeded upstream and downstream fish passage in the long term by raising the gates year-round, and minimize adverse effects of continuing dam operations, while pumps are constructed replace the loss of the diversion structure.

Action 1.3.1 Operations after May 14, 2012: Operate RBDD with Gates Out

Action: No later than May 15, 2012, Reclamation shall operate RBDD with gates out all year to allow unimpeded passage for listed anadromous fish.

Action 1.3.1 Assumptions for CalSim II Modeling Purposes

Action: Adequate permanent facilities for diversion are assumed; therefore no constraint on diversion schedules is included in the Future condition modeling.

Action 1.3.2 Interim Operations

Action: Until May 14, 2012, Reclamation shall operate RBDD according to the following schedule:

•September 1 - June 14: Gates open. No emergency closures of gates are allowed.

•June 15 - August 31: Gates may be closed at Reclamation's discretion, if necessary to deliver water to TCCA.

Action 1.3.2 Assumptions for CalSim II Modeling Purposes

Action: Adequate interim/temporary facilities for diversion are assumed; therefore no constraint on diversion schedules is included in the No Action Alternative modeling.

4.5 Action 1.4 Wilkins Slough Operations

Objective: Enhance the ability to manage temperatures for anadromous fish below Shasta Dam by operating Wilkins Slough in the manner that best conserves the dam's cold water pool for summer releases.

Action: The Sacramento River Temperature Task Group (SRTTG) shall make recommendations for Wilkins Slough minimum flows for anadromous fish in critically dry years, in lieu of the current 5,000 cfs navigation criterion to NMFS by December 1, 2009. In critically dry years, the SRTTG will make a recommendation.

Action 1.4 Assumptions for CalSim II Modeling Purposes

Action: Current rules for relaxation of NCP in CalSim II (based on BA models) will be used. In CalSim II, NCP flows are relaxed depending on allocations for agricultural contractors. Table 5.A.A.7-2 is used to determine the relaxation.

Table 5.A.A.7-2 NCP Flow Schedule with Relaxation

CVP AG Allocation (%)	NCP Flow (cfs)
<10	3,250
10–25	3,500
25–40	4,000
40–65	4,500
>65	5,000

Rationale: The allocation-flow criteria have been used in the CalSim II model for many years. The low allocation year relaxations were added to improve operations of Shasta Lake subject to 1.9 MAF carryover target storage. These criteria may be reevaluated subject to the requirements of Action 1.2.1

4.6 Action 2.1 Lower American River Flow Management

Objective: To provide minimum flows for all steelhead life stages.

Action: Implement the flow schedule specified in the Water Forum's Flow Management Standard (FMS), which is summarized in Appendix 2-D of the NMFS BiOp.

Action 2.1 Assumptions for CalSim II Modeling Purposes

Action: The AFRMP Minimum Release Requirements (MRR) range from 800 to 2,000 cfs based on a sequence of seasonal indices and adjustments. The minimum Nimbus Dam release requirement is determined by applying the appropriate water availability index (Index Flow). Three water availability indices (i.e., Four Reservoir Index (FRI), Sacramento River Index (SRI), and the Impaired Folsom Inflow Index (IFII)) are applied during different times of the year, which provides adaptive flexibility in response to changing hydrological and operational conditions.

During some months, Prescriptive Adjustments may be applied to the Index Flow, resulting in the MRR. If there is no Prescriptive Adjustment, the MRR is equal to the Index Flow.

Discretionary Adjustments for water conservation or fish protection may be applied during the period extending from June through October. If Discretionary Adjustments are applied, then the resultant flows are referred to as the Adjusted Minimum Release Requirement (Adjusted MRR).

The MRR and Adjusted MRR may be suspended in the event of extremely dry conditions, represented by "conference years" or "off-ramp criteria". Conference years are defined when the projected March through November unimpaired inflow into Folsom Reservoir is less than 400,000 acre-feet. Off-ramp criteria are triggered if forecasted Folsom Reservoir storage at any time during the next twelve months is less than 200,000 acre-feet.

Rationale: Minimum instream flow schedule specified in the Water Forum's Flow Management Standard (FMS) is implemented in the model.

Action 2.2 Lower American River Temperature Management

Objective: Maintain suitable temperatures to support over-summer rearing of juvenile steelhead in the lower American River.

Action: Reclamation shall develop a temperature management plan that contains: (1) forecasts of hydrology and storage; (2) a modeling run or runs, using these forecasts, demonstrating that the temperature compliance point can be attained (see Coldwater Management Pool Model approach in Appendix 2-D); (3) a plan of operation based on this modeling run that demonstrates that all other non-discretionary requirements are met; and (4) allocations for discretionary deliveries that conform to the plan of operation.

Action 2.2 Assumptions for CalSim II Modeling Purposes

Action: The flows in the model reflect the FMS implemented under Action 2.1. It is assumed that temperature operations can perform reasonably well with flows included in model.

Rationale: Temperature models of Folsom Lake and the American River were developed in the 1990's. Model development for long range planning purposes may be required. Further analysis using a verified long range planning level temperature model is required to verify the statement that temperature operations can perform reasonably well with flows included in model and temperatures are met reliably

4.7 Action Suite 3.1 Stanislaus River / Eastside Division Actions

Overall Objectives: (1) Provide sufficient definition of operational criteria for Eastside Division to ensure viability of the steelhead population on the Stanislaus River, including freshwater migration routes to and from the Delta; and (2) halt or reverse adverse modification of steelhead critical habitat.

Action 3.1.2 Provide Cold Water Releases to Maintain Suitable Steelhead Temperatures

Action: Reclamation shall manage the cold water supply within New Melones Reservoir and make cold water releases from New Melones Reservoir to provide suitable temperatures for CV steelhead rearing, spawning, egg incubation smoltification, and adult migration in the Stanislaus River downstream of Goodwin Dam.

Action 3.1.2 Assumptions for CalSim II Modeling Purposes

Action: No specific CalSim II modeling code is implemented to simulate the Performance measures identified. It is assumed that temperature operations can perform reasonably well with flow operations resulting from the minimum flow requirements described in action 3.1.3.

Rationale: Temperature models of New Melones Lake and the Stanislaus River have been developed by Reclamation. Further analysis using this or another temperature model can further verify that temperature operations perform reasonably well with flows included in model and temperatures are met reliably. Development of temperature model runs is needed to refine the flow schedules assumed.

Action 3.1.3 Operate the East Side Division Dams to Meet the Minimum Flows, as Measured at Goodwin Dam

Objective: To maintain minimum base flows to optimize CV steelhead habitat for all life history stages and to incorporate habitat maintaining geomorphic flows in a flow pattern that will provide migratory cues to smolts and facilitate out-migrant smolt movement on declining limb of pulse.

Action: Reclamation shall operate releases from the East Side Division reservoirs to achieve a minimum flow schedule as prescribed in NMFS BiOp Appendix 2-E and generally described in figure 11-1. When operating at higher flows than specified, Reclamation shall implement ramping rates for flow changes that will avoid stranding and other adverse effects on CV steelhead.

Action 3.1.3 Assumptions for CalSim II Modeling Purposes

Action: Minimum flows based on Appendix 2-E flows (presented in Figure 5.A.A.7-1) are assumed consistent to what was modeled by NMFS (5/14/09 and 5/15/09 CalSim II models provided by NMFS; relevant logic merged into baselines models).

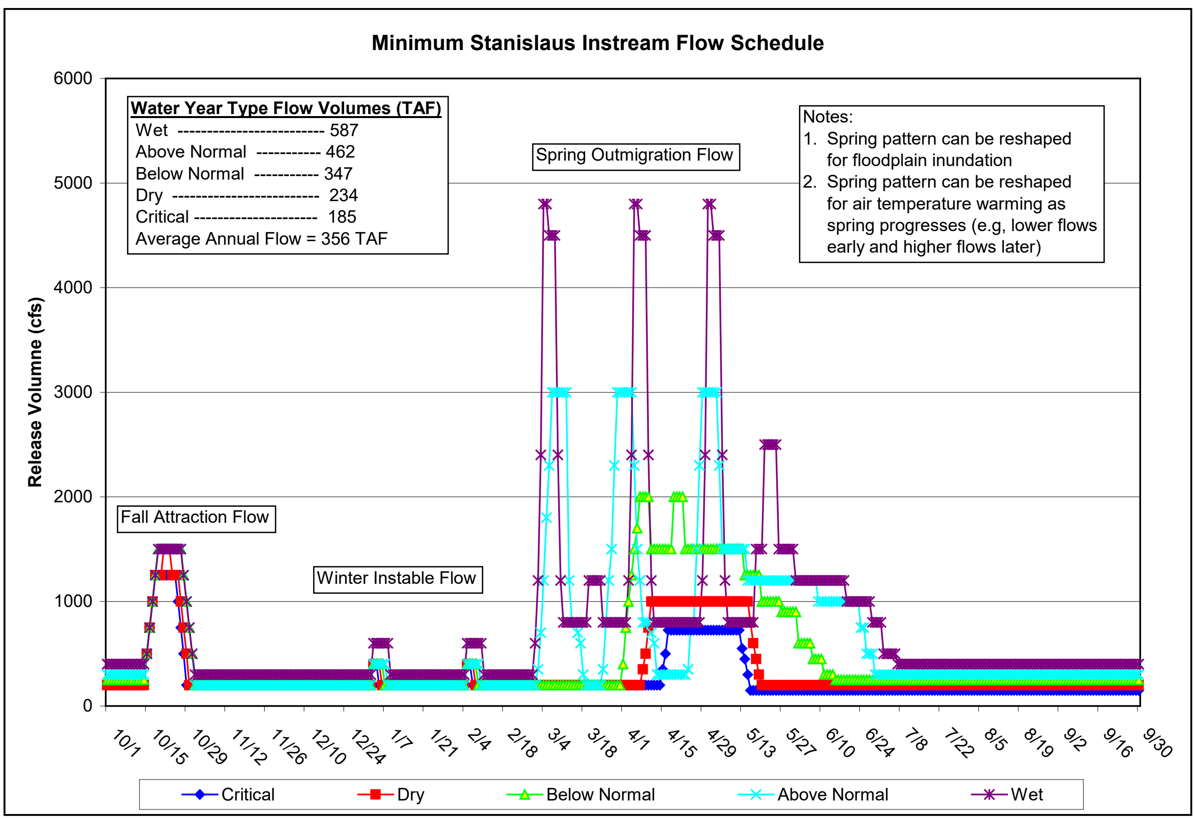

Figure 5.A.A.7-1 Minimum Stanislaus instream flow schedule as prescribed in Appendix 2-E of the NMFS BiOp (06/04/09)

Annual allocation in New Melones is modeled to ensure availability of required instream flows (Table 5.A.A.7-3) based on a water supply forecast that is comprised of end-of-February New Melones storage (in TAF) plus forecasted inflow to New Melones from March 1 to September 30 (in TAF). The “forecasted inflow” is calculated using perfect foresight in the model. Allocated volume of water is released according to water year type following the monthly flow schedule illustrated in Figure 5.A.A.7-1.

Table 5.A.A.7-3 New Melones Allocations to Meet Minimum Instream Flow Requirements

New Melones index (TAF)	Annual Allocation Required for Instream Flows (TAF)
< 1000	0 to 98.9
1,000 to 1,399	98.9
1,400 to 1,724	185.3
1,725 to 2,177	234.1
2,178 to 2,386	346.7
2,387 to 2,761	461.7
2,762 to 6,000	586.9

Rationale: This approach was reviewed by NOAA fisheries and verified that the year typing and New Melones allocation scheme are consistent with the modeling prepared for the BiOp.

4.8 Action Suite 4.1 Delta Cross Channel (DCC) Gate Operation, and Engineering Studies of Methods to Reduce Loss of Salmonids in Georgiana Slough and Interior Delta

Action 4.1.2 DCC Gate Operation

Objective: Modify DCC gate operation to reduce direct and indirect mortality of emigrating juvenile salmonids and green sturgeon in November, December, and January.

Action: During the period between November 1 and June 15, DCC gate operations will be modified from the proposed action to reduce loss of emigrating salmonids and green sturgeon. From December 1 to January 31, the gates will remain closed, except as operations are allowed using the implementation procedures/modified Salmon Decision Tree.

Timing: November 1 through June 15.

Triggers: Action triggers and description of action as defined in NMFS BiOp are presented in Table 5.A.A.7-4.

Table 5.A.A.7-4 NMFS BiOp DCC Gate Operation Triggers and Actions

Date	Action Triggers	Action Responses
October 1 – November 30	Water quality criteria per D-1641 are met and either the Knights Landing Catch Index (KLCI) or the Sacramento Catch Index (SCI) are greater than 3 fish per day but less than or equal to 5 fish per day.	Within 24 hours of trigger, DCC gates are closed. Gates will remain closed for 3 days.
October 1 – November 30	Water quality criteria per D-1641 are met and either the KLCI or SCI is greater than 5 fish per day	Within 24 hours, close the DCC gates and keep closed until the catch index is less than 3 fish per day at both the Knights Landing and Sacramento monitoring sites.
October 1 – November 30	The KLCI or SCI triggers are met but water quality criteria are not met per D-1641 criteria.	DOSS reviews monitoring data and makes recommendation to NMFS and WOMT per procedures in Action IV.5.
December 1 – December 14	Water quality criteria are met per D-1641.	DCC gates are closed. If Chinook salmon migration experiments are conducted during this time period (e.g., Delta Action 8 or similar studies), the DCC gates may be opened according to the experimental design, with NMFS' prior approval of the study.
December 1 – December 14	Water quality criteria are not met but both the KLCI and SCI are less than 3 fish per day.	DCC gates may be opened until the water quality criteria are met. Once water quality criteria are met, the DCC gates will be closed within 24 hours of compliance.
December 1 – December 14	Water quality criteria are not met but either of the KLCI or SCI is greater than 3 fish per day.	DOSS reviews monitoring data and makes recommendation to NMFS and WOMT per procedures in Action IV.5
December 15 – January 31	December 15 – January 31	DCC Gates Closed.
December 15 – January 31	NMFS-approved experiments are being conducted.	Agency sponsoring the experiment may request gate opening for up to 5 days; NMFS will determine whether opening is consistent with ESA obligations.
December 15 – January 31	One-time event between December 15 to January 5, when necessary to maintain Delta water quality in response to the astronomical high tide, coupled with low inflow conditions.	Upon concurrence of NMFS, DCC Gates may be opened one hour after sunrise to one hour before sunset, for up to 3 days, then return to full closure. Reclamation and DWR will also reduce Delta exports down to a health and safety level during the period of this action.
February 1 – May 15	D-1641 mandatory gate closure.	Gates closed, per WQCP criteria
May 16 – June 15	D-1641 gate operations criteria	DCC gates may be closed for up to 14 days during this period, per 2006 WQCP, if NMFS determines it is necessary.

Action 4.1.2 Assumptions for CalSim II Modeling Purposes

Action: The DCC gate operations for October 1 through January 31 were layered on top of the D-1641 gate operations already included in the CalSim II model. The general assumptions regarding the NMFS DCC operations are summarized in Table 5.A.A.7-5.

Timing: October 1 through January 31.

Table 5.A.A.7-5 DCC Gate Operation Triggers and Actions as Modeled in CalSim II

Date	Modeled Action Triggers	Modeled Action Responses
October 1 – December 14	Sacramento River daily flow at Wilkins Slough exceeding 7,500 cfs; flow assumed to flush salmon into the Delta	Each month, the DCC gates are closed for number of days estimated to exceed the threshold value.
October 1 – December 14	Water quality conditions at Rock Slough subject to D-1641 standards	Each month, the DCC gates are not closed if it results in violation of the D-1641 standard for Rock Slough; if DCC gates are not closed due to water quality conditions, exports during the days in question are restricted to 2,000 cfs.
December 15 – January 31	December 15-January 31	DCC Gates Closed.

Flow Trigger: It is assumed that during October 1 – December 14, the DCC will be closed if Sacramento River daily flow at Wilkins Slough exceeds 7,500 cfs. Using historical data (1945 through 2003, USGS gauge 11390500 “Sacramento River below Wilkins Slough near Grimes, CA”), a linear relationship is obtained between average monthly flow at Wilkins Slough and the number of days in month where the flow exceeds 7,500 cfs. This relation is then used to estimate the number of days of DCC closure for the October 1 – December 14 time period (Figure 5.A.A.7-2).

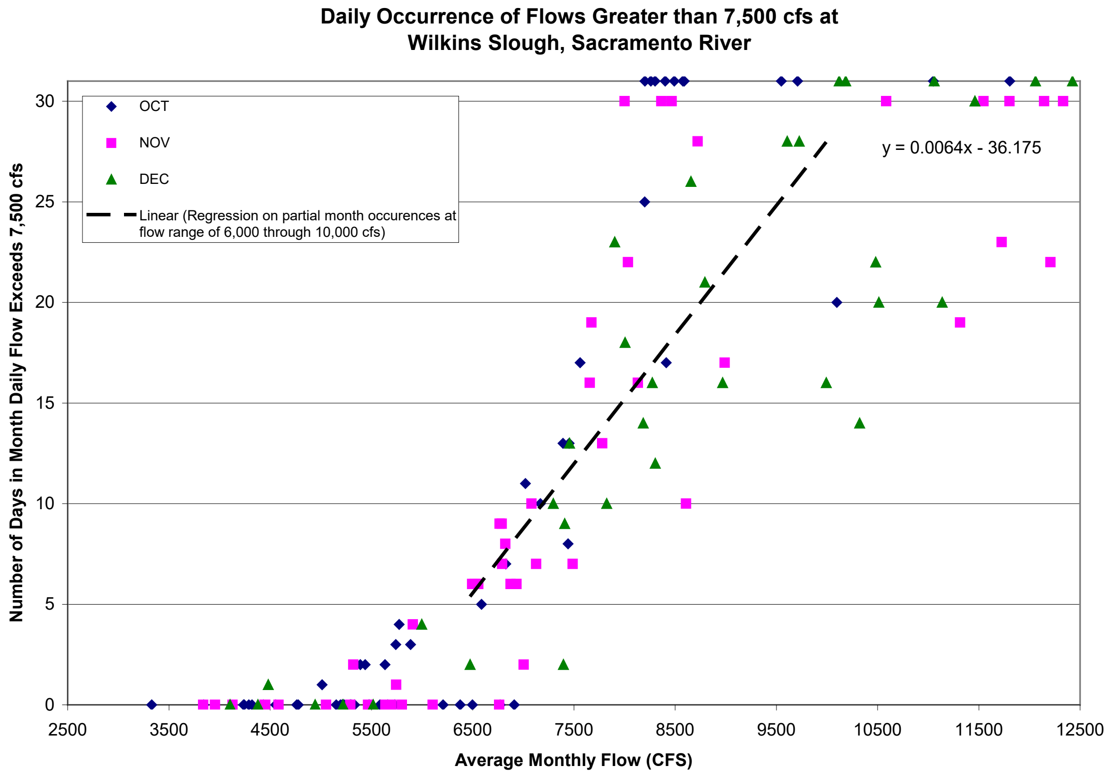

Figure 5.A.A.7-2 Relationship between monthly averages of Sacramento River flows and number of days that daily flow exceeds 7,500 cfs in a month at Wilkins Slough

It is assumed that during December 15 through January 31 that the DCC gates are closed under all flow conditions.

Water Quality: It is assumed that during October 1 – December 14 the DCC gates may remain open if water quality is a concern. Using the CalSim II-ANN flow-salinity model for Rock Slough, current month's chloride level at Rock Slough is estimated assuming DCC closure per NMFS BiOp. The estimated chloride level is compared against the Rock Slough chloride standard (monthly average). If estimated chloride level exceeds the standard, the gate closure is modeled per D1641 schedule (for the entire month).

It is assumed that during December 15 through January 31 that the DCC gates are closed under all water quality conditions.

Export Restriction: During October 1 – December 14 period, if the flow trigger condition is such that additional days of DCC gates closed is called for, however water quality conditions are a concern and the DCC gates remain open, then Delta exports are limited to 2,000 cfs for each day in question. A monthly Delta export restriction is calculated based on the trigger and water quality conditions described above.

Rationale: The proposed representation in CalSim II should adequately represent the limited water quality concerns were Sacramento River flows are low during the extreme high tides of December.

4.9 Action Suite 4.2 Delta Flow Management

Action 4.2.1 San Joaquin River Inflow to Export Ratio

Objectives: To reduce the vulnerability of emigrating CV steelhead within the lower San Joaquin River to entrainment into the channels of the South Delta and at the pumps due to the diversion of water by the export facilities in the South Delta, by increasing the inflow to export ratio. To enhance the likelihood of salmonids successfully exiting the Delta at Chipps Island by creating more suitable hydraulic conditions in the main stem of the San Joaquin River for emigrating fish, including greater net downstream flows.

Action: For CVP and SWP operations under this action, "The Phase II: Operations beginning is 2012" is assumed. From April 1 through May 31, 1) Reclamation shall continue to implement the Goodwin flow schedule for the Stanislaus River prescribed in Action 3.1.3 and Appendix 2-E of the NMFS BiOp); and 2) Combined CVP and SWP exports shall be restricted to the ratio depicted in table B-44 below based on the applicable San Joaquin River Index, but will be no less than 1,500 cfs (consistent with the health and safety provision governing this action.)

Action 4.2.1 Assumptions for CalSim II Modeling Purposes

Action: Flows at Vernalis during April and May will be based on the Stanislaus River flow prescribed in Action 3.1.3 and the flow contributions from the rest of the San Joaquin River basin consistent with the representation of VAMP contained in the BA modeling. In many years this flow may be less than the minimum Vernalis flow identified in the NOAA BiOp.

Exports are restricted as illustrated in Table 5.A.A.7-6.

Table 5.A.A.7-6. Maximum Combined CVP and SWP Export during April and May

San Joaquin River Index	Combined CVP and SWP Export Ratio
Critically dry	1:1
Dry	2:1
Below normal	3:1
Above normal	4:1
Wet	4:1

Rationale: Although the described model representation does not produce the full Vernalis flow objective outlined in the NOAA BiOp, it does include the elements that are within the control of the CVP and SWP, and that are reasonably certain to occur for the purpose of the EIS/EIR modeling.

In the long-term, a future SWRCB flow standard at Vernalis may potentially incorporate the full flow objective identified in the BiOp; and the Merced and Tuolumne flows would be based on the outcome of the current SWRCB and FERC processes that are underway.

Action 4.2.3 Old and Middle River Flow Management

Objective: Reduce the vulnerability of emigrating juvenile winter-run, yearling spring-run, and CV steelhead within the lower Sacramento and San Joaquin rivers to entrainment into the channels of the South Delta and at the pumps due to the diversion of water by the export facilities in the South Delta. Enhance the likelihood of salmonids successfully exiting the Delta at Chipps Island by creating more suitable hydraulic conditions in the mainstem of the San Joaquin River for emigrating fish, including greater net downstream flows.

Action: From January 1 through June 15, reduce exports, as necessary, to limit negative flows to -2,500 to -5,000 cfs in Old and Middle Rivers, depending on the presence of salmonids. The reverse flow will be managed within this range to reduce flows toward the pumps during periods of increased salmonid presence. Refer to NMFS BiOp document for the negative flow objective decision tree.

Action 4.2.3 Assumptions for CalSim II Modeling Purposes

Action: Old and Middle River flows required in this BiOp are assumed to be covered by OMR flow requirements developed for actions 1 through 3 of the FWS BiOp Most Likely scenario (Representation of U.S. Fish and Wildlife Service Biological Opinion Reasonable and Prudent Alternative Actions for CalSim II Planning Studies – DRAFT, 6/10/09).

Rationale: Based on a review of available data, it appears that implementation of actions 1 through 3 of the FWS RPA, and action 4.2.1 of the NOAA RPA will adequately cover this action within the CalSim II simulation. If necessary, additional post-processing of results could be conducted to verify this assumption.

4.10 References

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Attachment 1-5 Estimation of SWP Proportion of Effects

The scope of current project is to secure coverage for the long-term operations of the SWP under CESA. The CalSim modeling performed to analyze the proposed long-term SWP operations simulate the joint SWP and CVP operations. Therefore, following approach was used to isolate potential SWP proportion of any effects that may be a result of joint operation of SWP and CVP.

The approach is based on premise that under excess Delta conditions the joint operations are typically governed by the exports at the SWP and CVP pumping facilities, and under balanced conditions the SWP and CVP responsibility are defined in the Coordinated Operations Agreement (COA). COA identifies two types of balanced conditions: In basin use (IBU) and Unstored water for export (UWFE). In estimating the SWP proportion of effects, following principles were used:

- For months with IBU balanced conditions, the sharing ratio assigned to SWP in the COA is the SWP's proportion of an effect.
- For months with UWFE balanced conditions and excess conditions, the proportion of exports at Banks Pumping Plant of the total exports at Banks and Jones Pumping Plants is the SWP's proportion of an effect. All exports including any CVP wheeling and water transfers at the Banks Pumping Plant are used in this estimation.

These principles were applied to each month in the 82-year CalSim simulation period, and the SWP's proportions were identified for each month. The monthly proportions were averaged by Sacramento 40-30-30 water year types and long-term. Table 1 shows the estimated SWP proportion of an effect that is a result of joint operations of SWP and CVP. The proportions shown in Table 1 are based on the proposed project CalSim modeling performed to support the effects analysis. These proportions are only for use in the effects analysis included in the current project.

Table 1: Estimated SWP proportion of an effect that may be a result of joint operation of SWP and CVP. The proportions presented are averaged by water year type and long-term by month.

Month	Wet	Above-Normal	Below-Normal	Dry	Critical	Long-term Average
OCT	49%	47%	44%	43%	42%	45%
NOV	64%	51%	57%	54%	48%	56%
DEC	50%	56%	56%	54%	49%	53%
JAN	50%	43%	43%	44%	43%	45%
FEB	56%	48%	46%	41%	40%	48%
MAR	57%	46%	49%	41%	39%	48%
APR	49%	47%	51%	45%	47%	48%
MAY	46%	44%	40%	37%	37%	42%
JUN	42%	31%	29%	35%	40%	36%
JUL	39%	20%	25%	35%	40%	33%
AUG	43%	20%	25%	30%	36%	33%
SEP	28%	23%	52%	40%	39%	36%
Annual Average	48%	40%	43%	42%	42%	44%

Attachment 1-6 Delta Particle Tracking Modeling

Particle tracking models (PTM) are excellent tools to visualize and summarize the impacts of modified hydrodynamics in the Delta. These tools can simulate the movement of passive particles or particles with behavior representing either larval or adult fish through the Delta. The PTM tools can provide important information relating hydrodynamic results to the analysis needs of biologists that are essential in assessing the impacts to the habitat in the Delta.

1.1 DSM2 - PTM

DSM2-PTM simulates pseudo 3-D transport of neutrally buoyant particles based on the flow field simulated by HYDRO. The PTM module simulates the transport and fate of individual particles traveling throughout the Delta. The model uses geometry files, velocity, flow, and stage output from the HYDRO module to monitor the location of each individual particle using assumed vertical and lateral velocity profiles and specified random movement to simulate mixing. The location of a particle in a channel is determined as the distance from the downstream end of the channel segment (x), the distance from the centerline of the channel (y), and the distance above the channel bottom (z). PTM has multiple applications ranging from visualization of flow patterns to simulation of discrete organisms such as fish eggs and larvae.

The longitudinal distance traveled by a particle is determined from a combination of the lateral and vertical velocity profiles in each channel. The transverse velocity profile simulates the effects of channel shear that occurs along the sides of a channel. The result is varying velocities across the width of the channel. The average cross-sectional velocity is multiplied by a factor based on the particle’s transverse location in the channel. The model uses a fourth order polynomial to represent the velocity profile. The vertical velocity profile shows that particles located near the bottom of the channel move more slowly than particles located near the surface. The model uses the Von Karman logarithmic profile to create the velocity profile. Particles also move because of random mixing. The mixing rates (i.e., distances) are a function of the water depth and the velocity in the channel. High velocities and deeper water result in greater mixing.

At a junction the path of a particle is determined randomly based on the proportion of flow. The proportion of flow determines the probability of movement into each reach. A random number based on this determined probability then determines where the particle will go. A particle that moves into an open water area, such as a reservoir, no longer retains its position information. A DSM2 open water area is considered a fully mixed reactor. The path out of the open water area is a decision based on the volume in the open water area, the time step, and the flow out of the area. At the beginning of a time step the volume of the open water area the volume of water leaving at each opening of the open water area is determined. From that the probability of the particle leaving the open water area is calculated. Particles entering exports or agricultural diversions are considered "lost" from the system.

Their final destination is recorded. Once particles pass the Martinez boundary, they have no opportunity to return to the Delta. (Smith, 1998, Wilbur, 2001, Miller, 2002)

1.2 DSM2 – PTM METRICS

Fate Mapping – an indicator of entrainment. It is the percent of particles that go past various exit points in the system at the end of a given number of days after insertion.

1.3 PTM PERIOD SELECTION

PTM simulation periods for the fate computations were in December through June of the entire 82-year planning simulation period.

1.4 PTM SIMULATIONS

PTM simulations are performed to derive the metrics described above. The particles are inserted at the 39 locations listed in Table 1. The locations were identified based on the 20mm Delta Smelt Survey Stations. 20 mm Deta Smelt Survey Stations and particle insertion locations are display in Figure 1.

A total of 39 PTM simulations are performed in a batch mode for each insertion period. For each insertion period, 4000 particles are inserted at the identified locations over a 24.75-hour period, starting on the 1st of the selected month. The fate of the inserted particles is tracked continuously over a 120-day simulation period. The particle flux is tracked at the key exit locations – exports, Delta agricultural intakes, past Chipps Island, to Suisun Marsh and past Martinez and at several internal tracking locations. Generally, the fate of particles at the end of 30 days, 60 days, 90 days and 120 days after insertion is computed for the fate mapping analysis.

Table 1: List of Particle Insertion Locations for Residence Time and Fate Computations

Location	DSM2 Node
San Joaquin River at Vernalis	1
San Joaquin River at Mossdale	7
San Joaquin River D/S of Rough and Ready Island	21
San Joaquin River at Buckley Cove	25
San Joaquin River near Medford Island	34
San Joaquin River at Potato Slough	39
San Joaquin River at Twitchell Island	41
Old River near Victoria Canal	75
Old River at Railroad Cut	86
Old River near Quimby Island	99
Middle River at Victoria Canal	113
Middle River u/s of Mildred Island	145
Grant Line Canal	174
Frank's Tract East	232
Threemile Slough	240
Little Potato Slough	249

Location	DSM2 Node
Mokelumne River d/s of Cosumnes confluence	258
South Fork Mokelumne	261
Mokelumne River d/s of Georgiana confluence	272
North Fork Mokelumne	281
Georgiana Slough	291
Miner Slough	307
Sacramento Deep Water Ship Channel	314
Cache Slough at Shag Slough	321
Cache Slough at Liberty Island	323
Lindsey slough at Barker Slough	322
Sacramento River at Sacramento	330
Sacramento River at Sutter Slough	339
Sacramento River at Ryde	344
Sacramento River near Cache Slough confluence	350
Sacramento River at Rio Vista	351
Sacramento River d/s of Decker Island	353
Sacramento River at Sherman Lake	354
Sacramento River at Port Chicago	359
Montezuma Slough at Head	418
Montezuma Slough at Suisun Slough	428
San Joaquin River d/s of Dutch Slough	461
Sacramento River at Pittsburg	465
San Joaquin River near Jersey Point	469

1.5 OUTPUT PARAMETERS

The particle tracking models can be used to assist in understanding passive fate and transport, or through consideration of behavior or residence time. In, general the following outputs are generated:

- Fate of particles and cut lines or regions
- Time of travel breakthrough curves
- Residence time

For the purposes of this EIR, only particle fate outputs were assessed.

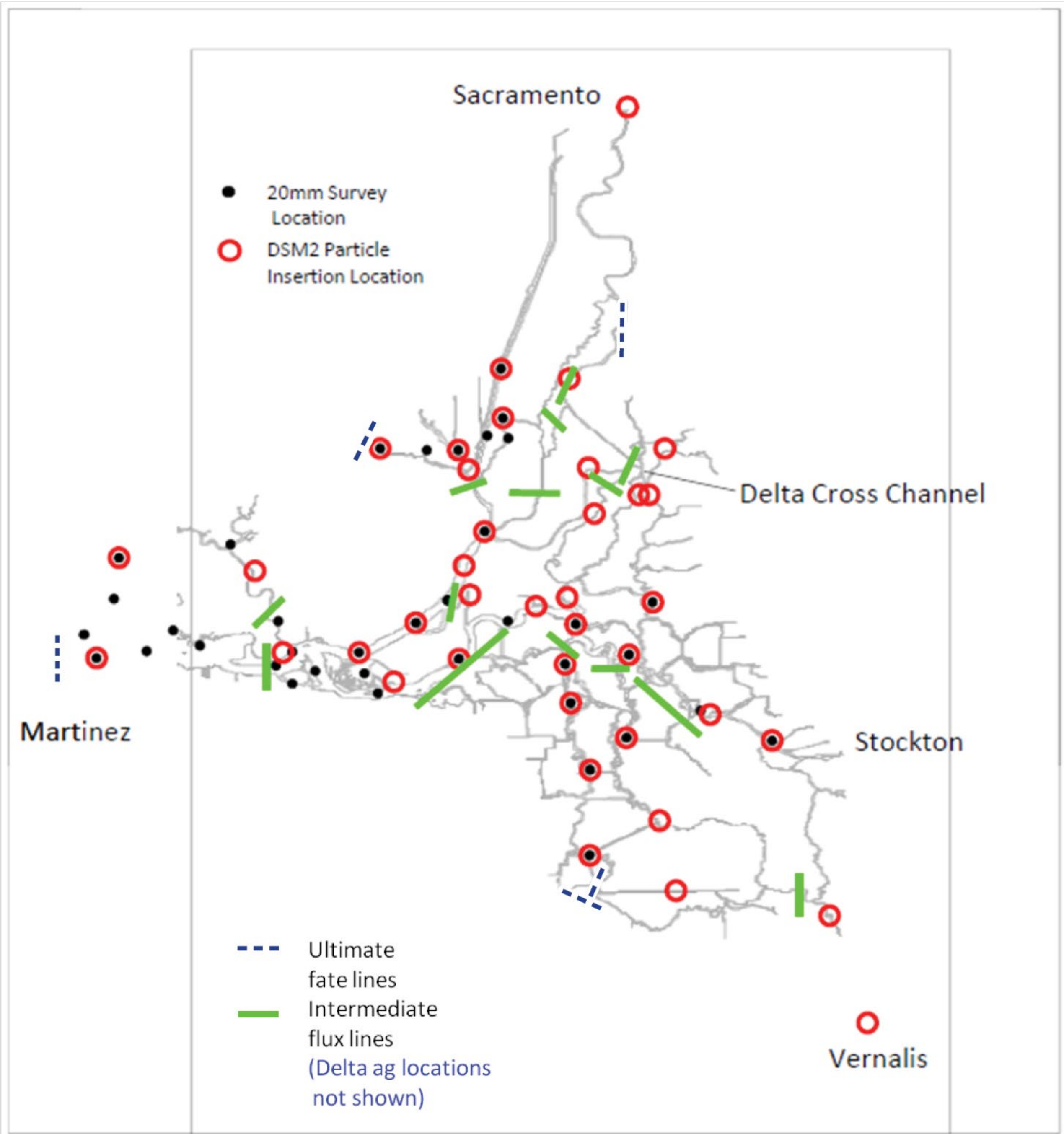

Figure 1. Particle insertion locations for fate computations

Attachment 1-7 Model Limitations

1 Introduction

Models are commonly used to evaluate changes in the management and operations of water resources systems. These models are computer based and use mathematical expressions, methods and input data to represent hydrologic, physical, environmental, operational, and institutional aspects of the water resources systems. As complex as water resources systems are, the representation of the water resources system in input data, calculations and model outputs is understood to be simplified and generalized in comparison to what is observed in the historical records and documents that describe the real-world water resources system. Even so, models are useful tools in assessing historical, current and future projected conditions of the water resources system. These conditions are described by models based on assumptions that are captured in the data and calculations used.

Even though the models used in this document are the best available tools, because the representation of the water resources system in models is understood to be simplified and generalized in comparison to what is observed in the historical records and documents, the use of model results should be subject to a set of agreed upon limitations and subsequent analysis of results is thereby limited. The developers and expert users of the models in question should be consulted in regard to these limitations. The following is a presentation of information that the team of modelers relevant to the limitations of the models. This information should be considered in use of the model results and any subsequent analysis derived from these model results.

2 General Limitations of Models Used

2.1 CalSim II

CalSim II is a monthly model developed for planning level analyses. The model is run for an 82-year historical hydrologic period, at a projected level of hydrology and demands; and under an assumed framework of regulations. Therefore the 82-year simulation does not provide information about historical conditions, but it does provide information about variability of conditions that would occur at the assumed level of hydrology and demand with the assumed operations, under the same historical hydrologic sequence. Because it is not a physically based model, CalSim II is not calibrated and cannot be used in a predictive manner. CalSim II is intended to be used in a comparative manner; which is appropriate for CESA analysis.

In CalSim II, operational decisions are made on a monthly basis, based on a set of pre-defined rules that represent the assumed regulations. Modifications by the model user would be required to allow for variation in these rules based on a sequence of hydrologic events such as a prolonged drought, or statistical performance criteria such as meeting a storage target in an assumed percentage of years.

While there are certain components in the model that are downscaled to a daily time step (simulated or approximated hydrology), such as an air-temperature based trigger for a fisheries action, the results of those daily conditions are always averaged to a monthly time step. For example, a certain number of days with and without the action is calculated and the monthly result is calculated using a day-weighted average based on the total number of days in that month. Operational decisions based on those components are again made on a monthly basis. Any reporting or use of sub-monthly results from CalSim II should include disaggregation methods that are appropriate for the given application, report, or subsequent model.

Appropriate use of model results is important. Despite detailed model inputs and assumptions, the CalSim II results differ from real-time operations under stressed water supply conditions. Such model results occur due to the inability of the model to make unique real-time policy decisions under extreme circumstances, as the actual (human) operators must do. Therefore, results which indicate severely low storage, or inability to meet flow requirements or senior water rights should only be considered an indicator of stressed water supply conditions under that alternative, and should not necessarily be understood to reflect literally what would occur in the future under that alternative. These conditions, in real-time operations, would be avoided by making policy decisions on other requirements in prior months. In actual future operations, as has always been the case in the past, the project operators would work in real time to satisfy legal and contractual obligations given then current conditions and hydrologic constraints.

Reclamation's 2008 BA on the coordinated long-term operations Appendix W (Reclamation 2008) included a comprehensive sensitivity and uncertainty analysis of CalSim II results relative to the uncertainty in the inputs. This appendix provides a good summary of the key inputs that are critical to the largest changes in several operational outputs. Understanding the findings from this appendix may help in better understanding of the alternatives.

2.2 DSM2

DSM2 is a one-dimensional model with inherent limitations in simulating hydrodynamic and transport processes in a complex estuarine environment such as the Sacramento – San Joaquin Delta. DSM2 assumes that velocity in a channel can be adequately represented by a single average velocity over the channel cross-section, meaning that variations both across the width of the channel and through the water column are negligible. DSM2 does not have the ability to model short-circuiting of flow through a reach, where a majority of the flow in a cross-section is confined to a small portion of the cross-section. DSM2 does not conserve momentum at the channel junctions and does not model the secondary currents in a channel. DSM2 also does not explicitly account for dispersion due to flow accelerating through channel bends. It cannot model the vertical salinity stratification in the channels.

It has inherent limitations in simulating the hydrodynamics related to the open water areas. Since an open water surface area (represented with a reservoir in the model) is constant in DSM2, it impacts the stage in the reservoir and thereby impacts the flow exchange with the adjoining channel. Due to the inability to change the cross-sectional area of the reservoir inlets with changing water surface elevation, the final entrance and exit coefficients were fine tuned to match a median flow range. This causes errors in the flow exchange at breaches (levee openings) during the extreme spring and neap tides. Using an arbitrary bottom elevation value for the reservoirs representing the proposed marsh areas to get around the wetting-drying limitation of DSM2 may increase the dilution of salinity in the reservoirs.

For open water bodies DSM2 assumes uniform and instantaneous mixing over entire open water area. Thus it does not account for the any salinity gradients that may exist within the open water bodies. Significant uncertainty exists in flow and EC input data related to in-Delta agriculture, which leads to uncertainty in the simulated EC values. Caution needs to be exercised when using EC outputs on a sub-monthly scale, and therefore results are only presented at the monthly scale. Water quality results inside the water bodies representing the tidal marsh areas were not validated specifically and because of the bottom elevation assumptions, preferably should not be used for analysis.

3 Appropriate Use of CalSim II and DSM2 Model Results

The modeling conducted to evaluate Existing Conditions and Proposed Project scenarios is a planning analysis. A planning analysis is conducted to understand long-term changes in the Central Valley Project (CVP) and State Water Project (SWP) system due to a proposed change. The models developed and applied in planning analysis are generalized and simplified representations of a complex water resources system. Even so, the models used are informative and helpful in understanding the performance and potential effects (both positive and negative) of the operation of a project and its interaction with the water resources system under consideration. Even though some of the models used in this planning analysis such as DSM2 are calibrated and validated to represent physical processes, given the nature of the boundary conditions used (derived from CalSim II, a generalized system model), DSM2 results would only tend to represent generalized long-term trends. Note that level of confidence, in the results of any well calibrated predictive model is only as good as the level of confidence in the input boundary conditions used. Given the limitations of the planning analysis, a brief description of appropriate use of the model results to compare two scenarios or to compare against threshold values or standards is presented below.

3.1 Absolute Versus Relative Use of the Model Results

The CalSim II and DSM2 results in a planning analysis are appropriately used as “comparative tools” to assess relative changes between Existing Conditions and Proposed Project. In a planning analysis, models used are not predictive models and therefore the results cannot be considered as absolute with a quantifiable confidence interval. The model results are only useful in a comparative analysis and can only serve as an indicator of condition (e.g. compliance with a standard) and of trend or tendency (e.g. generalized impacts). Because CalSim II relies on generalized rules, a coarse representation of project operations, adjusted hydrologic conditions to reflect future demands and land use, and no specific operations in response to extreme events, results should not be expected to reflect what operators might do in real time operations on a specific day, month or year within the simulation period. In reality, the operators would be informed by numerous real-time considerations such as salinity monitoring.

3.2 Appropriate Reporting Time-Step

Due to the assumptions involved in the input data sets and model logic, care must be taken to select the most appropriate time-step for the reporting of model results. Sub-monthly (e.g. weekly or daily) reporting of model results are generally inappropriate for both models and the results should be presented on a monthly basis. There may be exceptions to this, and selected model results can be reported on a sub-monthly basis with adequate caution. An understanding of validity of the underlying operational conditions is critical in interpreting a sub-monthly result.

3.3 Appropriate Reporting Locations

Due to the assumptions involved in the input data sets and model logic, care must be taken to select the most appropriate reference locations (and/or boundaries) for the reporting of model results. Each model assumes a simplified spatial representation of the water resource system and sub-systems. Reporting of model results inconsistent with the spatial representation of the model is inappropriate. Care must be taken in selecting the locations desired for reporting model results and whether or not the models are adequate for that purpose.

3.4 Statistical Comparisons are Preferred

Absolute differences computed at a point in time between model results from an alternative and a baseline to evaluate impacts is an inappropriate use of model results (e.g. computing differences between the results from a baseline and an alternative for a particular day or month and year within the period of record of simulation). Likewise, computing absolute differences between an alternative (or a baseline) and a specific threshold value or standard is an inappropriate use of model results. Statistics based on the absolute differences at a point in time (e.g. maximum of monthly differences) are an inappropriate use of model results. By computing the absolute differences in this way, an analysis disregards the changes in antecedent conditions between individual scenarios and distorts the evaluation of impacts of a specific action (e.g. project).

Reporting seasonal patterns from long-term averages and water year type averages is appropriate. Statistics based on long-term and water year type averages are an appropriate use of model results. Computing differences between long-term or water year type averages of model results from two scenarios is appropriate. Care should be taken to use the appropriate water year type for presenting water year type average statistics of model results (e.g. D1641 Sacramento River 40-30-30 or San Joaquin River 60-20-20, and with or without climate modified conditions).

The most appropriate presentation of monthly and annual model results is in the form of probability distributions and comparisons of probability distributions (e.g. cumulative probabilities). If necessary, comparisons of model results against threshold or standard values should be limited to comparisons based on cumulative probability distributions. Information specific to a model calibration (should be considered in using these types of comparisons.

3.5 Suggested Formats for Presentation of Model Results

The most appropriate format to present model results is:

- Long term average summary and year type based summary tables and graphics showing monthly and/or annual statistics derived from the model results
- Cumulative exceedance probability monthly and/or annual model results shown only by rank/order or only by probability statistic

Comparative statistics based on these two types of presentations are generally acceptable.

4 Model Specific Considerations

As stated earlier, the models developed and applied in planning analysis are generalized and simplified representations of a complex water resources system, which means they are limited in some way. The following is a description of considerations specific to each model.

4.1 CalSim II

CalSim II is a monthly time-step model. It represents projected conditions under current or future regulatory and operational regimes. The operational decisions in CalSim II (e.g. determining the flow needed to meet a salinity standard in the Delta) are on a monthly time-step which does not consider operational responses to changes that are on a sub-monthly timescale. Results for an individual parameter are either a monthly average or an end-of-month condition.

A few specific concerns regarding CalSim II model results include the following:

- Storage results from CalSim II reflect end-of-month conditions and not monthly-average conditions. Therefore, any attributes derived from storage results such as littoral area or water surface elevation in the reservoir reflect end-of-month values.

- CalSim II operates to a monthly approximation of compliance to selected Delta standards. CalSim II monthly average salinity and X2 location outputs are ANN-based. (note that ANN outputs are lagged by one month). Following are some more details on CalSim II D1641 compliance limitations:

    - Even though additional standards are identified in SWRCB D-1641, CalSim II only recognizes five stations for compliance with a salinity standard:

        - Sacramento River at Emmaton
        - San Joaquin River at Jersey Point
        - Old River at Rock Slough
        - Sacramento River at Collinsville
        - Sacramento River at Chipps Island

    - Some standards in SWRCB D-1641 require compliance for a specified number of days in a year (e.g. CCWD 150mg/L Chloride Standard). In such cases, CalSim II does not have any discretion on which days the standards are met, but rather depends on a predetermined schedule, which cannot be altered dynamically.

    - Some of the standards modeled in CalSim II may not match exactly with the values specified in the SWRCB D-1641. Modeled standards may be more constrained ("ramped") to make operations more responsive to comply with a standard over the season.

    - Under extreme operational conditions, CalSim II may fail to comply with D1641 and other standards. This situation occurs rarely and is needed to maintain feasibility of the model solution.

- San Luis Storage operations in CalSim II are simplified compared to real time operations. The results are uncertain and prone to reflect how CalSim II represents CVP and SWP operations. This is due to the relatively coarse SWP/CVP allocation decisions (e.g. no updates after May) used in the model and uncertainty in the model's capability to forecast export capabilities.

4.2 DSM2

In a planning analysis, the flow boundary conditions that drive DSM2 are obtained from the monthly CalSim II model. The agricultural diversions, return flows and associated salinities used in DSM2 are on a monthly time step. The implementation of Delta Cross Channel gate operations in DSM2 assumes that the gates are open from the beginning of a given month, irrespective of the water quality needs in the South Delta.

A few specific concerns regarding DSM2 model results include the following:

- Even though CalSim II releases sufficient flow to meet the standards on a monthly average basis, the resulting EC from DSM2 may exceed the standard for part of a month while complying with the standard for the remainder of the month, depending on the spring/neap tide and other factors (e.g. simplification of operations). It is appropriate to present the results on a monthly basis. Frequency of compliance with a criterion should be computed based on monthly average results. Averaging on a sub-monthly (14-day or more) scale may be appropriate as long as the limitations with respect to the compliance of the baseline model are described in detail and the alternative results are presented as an incremental change from the baseline model.

- In general, it is appropriate to present DSM2 QUAL results including EC, DOC, volumetric fingerprinting and constituent fingerprinting on a monthly time step. When comparing results from two scenarios, computing differences based on these mean monthly statistics would be appropriate.

5 Extreme Operational Conditions under Regulatory Uncertainty

Continuing uncertainty in the regulatory environment makes the long-term planning of CVP and SWP operations challenging. The Existing Conditions CalSim II model used to establish the modeling of the Proposed Project scenario assumes the full implementation of the operational actions of the 2008 USFWS and 2009 NMFS BiOp. However, under full implementation of the BiOps, not all conditions of the BiOps may be met in a given month due to competing hydrologic, operational, and regulatory requirements. As a result the simulation provides what is referred to as “extreme operational conditions”. Frequency of such conditions can increase in the future with climate change, if the hydrology is drier or occurrence of sea level rise, without changes in the existing obligations of CVP-SWP.

Extreme operational conditions are defined as simulated occurrences of storage conditions at CVP and SWP reservoirs in which storage is at “dead pool” levels. Reservoir storage at or below the elevation of the lowest outlet is considered to be at dead pool level.

Under extreme operational conditions, CalSim II will utilize a series of rules within the specified priority to reach a numerically feasible solution to allow for the continuation of the simulation. The outcome of these types of solutions in CalSim II may vary greatly depending upon the antecedent conditions from the previous time-step result. The model may reach a numerical solution, but the results of the simulation may not reflect a reasonably expected outcome (i.e. an outcome which would require negotiation). In such cases, flows may fall short of minimum flow criteria, salinities may exceed standards, diversions may fall short of allocated volumes and operating agreements may not be met, indicating a stressed water supply condition.

6 Limitations of the Delta Salinity Modeling Approach

Delta salinity changes were analyzed based on the modeling results from CalSim II and DSM2 simulations of the Existing Conditions and Proposed Project scenarios. DSM2 salinity results indicated exceedances of a few salinity requirements. This section provides background on the models and examines three types of modeling limitations that could have resulted in exceedances.

CalSim II is a water operations model that simulates Delta flows for regulatory and operational criteria assumed under the scenarios on a monthly time step. The model simulates compliance with salinity standards in the Delta. CalSim II relies on an Artificial Neural Network (ANN) for monthly averaged flow verses salinity relationships in the Delta. ANN emulates flow-salinity relationships derived from DSM2 for a given Delta channel configuration and sea level rise condition.

DSM2 application for analyzing Existing Conditions and Proposed Project scenarios uses the monthly CalSim II Delta inflows and diversions/exports results, and simulates Delta hydrodynamics and salinity from the water year 1922 to water year 2003, on a 15-minute time step. Flow inputs assumed in DSM2 modeling are based on monthly CalSim II outputs. The DSM2 inflows do not represent any sub-monthly operational adjustments that could occur to address any potential issues with salinity control in the Delta.

Monthly CalSim II salinity outputs and daily averaged salinity outputs from DSM2 simulations were used to evaluate compliance with D-1641 salinity requirements. DSM2 salinity results indicated exceedances of a few salinity requirements. The modeling limitations that could have resulted in exceedances are listed below:

a. CalSim II is a monthly model – some salinity standards are partial month
b. CalSim II flow-salinity ANN

6.1 CalSim II is a Monthly Model – Some Salinity Standards Are Partial Month

Since CalSim II is a model with a monthly time-step and a number of daily D-1641 salinity standards are active during only portions of a month (ex: April 1 – June 20 and June 20 to August 15), D-1641 standards are calculated as a monthly weighted average in the model. The model attempts to meet these objectives on a monthly average basis, even though the objectives themselves are often transitioning within a month from one value to the other, and may start or end in the middle of a month. When the monthly weighted average standards calculated for CalSim II are less stringent than the daily D-1641 EC standards, CalSim II adjusts SWP and CVP operations to release less flow to meet monthly weighted average EC standards instead of the flow needed to meet higher daily D-1641 EC standards. Figure 1 “Sacramento River at Emmaton” below shows the difference between daily D-1641 EC standards and the monthly weighted average EC standards modeled in CalSim II, for reference. Therefore, within the months where the salinity standard is transitioning, there may be days where DSM2 inflows are less than the required flow to comply with the salinity standard, and more flow on other days. This results in a few days within such months where the modeled salinity exceeds the compliance standard. Importantly, however, in reality the CVP and SWP operations will be adjusted on day-to-day basis to meet the Delta standards.

6.2 CalSim II Flow-Salinity ANN

In CalSim II, the reservoirs and facilities of the SWP and CVP are operated to assure the flow and water quality requirements for these systems are met. Meeting regulatory requirements, including Delta water quality objectives, is the highest operational priority in CalSim II. CalSim II uses the ANN to configure system operations to meet salinity objectives. Because meeting the objectives is the highest priority in CalSim II, the model attempts to meet the applicable water quality objectives on a monthly average basis according to the ANN, unless there is no feasible way to meet the objective (i.e., upstream reservoirs at dead pool conditions). In some cases, even though the ANN predicts that the objective would be met on a monthly average basis, it can be an imperfect predictor of compliance on the time-step appropriate for a given standard (e.g daily standard) and averaging basis (e.g. 14-day running average) that these objectives need to be met. Thus when using the CalSim II results in such cases, the DSM2 results may indicate an exceedance of a salinity standard, when CalSim II does not.

6.3 Stressed CVP-SWP System Under Extreme Operational Conditions

Existing obligations on the CVP-SWP system (hydrology, water demands, biological opinions and other regulatory requirements) may result in extreme operational conditions. Under such extreme operational conditions, flows may fall short of minimum flow criteria, salinities may exceed standards, diversions may fall short of allocated volumes and operating agreements may not be met in CalSim II simulations. In some months, unavailability of the flow to meet the salinity standards in the Delta when upstream storage is at dead pool conditions can be a factor for the modeled exceedances of the standards. In such cases any salinity standard exceedances are reflections of the system operations in the CalSim II model which does not always recognize the operational flexibility, and adhere to the rigid criteria set forth in the model.

6.4 Modeling Exceedances

CalSim II and DSM2 modeling presented in this document may indicate a few modeled exceedances of the D1641 salinity standards. As noted above the exceedances are mostly a result of limitations in the modeling process. In reality, DWR and Reclamation staff constantly monitor Delta water quality conditions and adjust operations of the SWP and CVP in real time as necessary to meet water quality objectives. These decisions take into account real-time conditions and are able to account for many factors that the best available models cannot simulate. At times, under extreme conditions, negotiations with the State Water Resources Control Board occur in order to effectively maximize and balance protection of beneficial uses and water rights, which cannot be modeled.

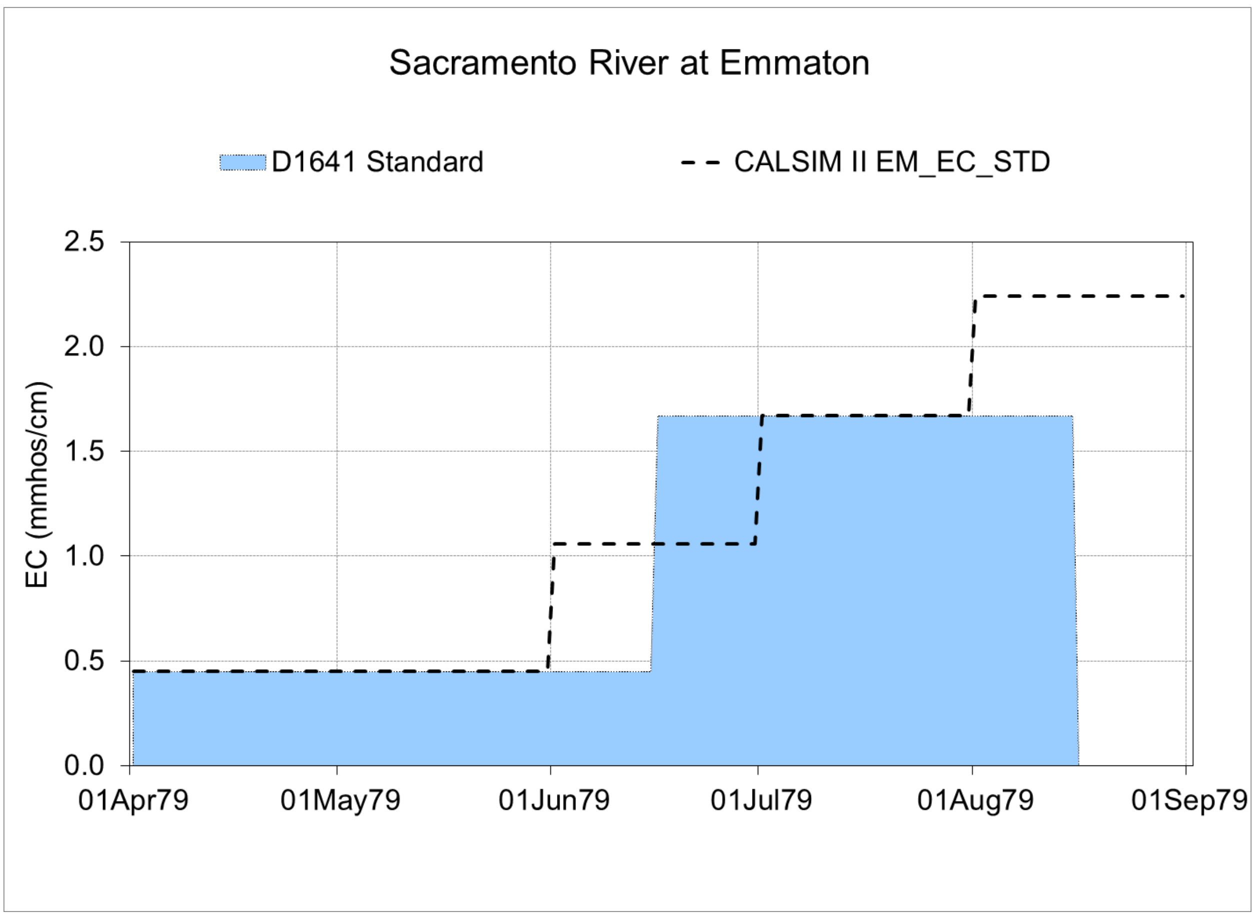

Figure 1. D-1641 Salinity Control Requirement at Emmaton as Simulated in CalSim II

7 References

U. S. Bureau of Reclamation, 2008. Biological Assessment on the Continued Long-term Operations of the Central Valley Project and State Water Project, Appendix W Sensitivity and Uncertainty Analysis, August 2008.

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Attachment 1-8 CalSim II Assumptions and Real-Time Operations

1 Introduction

The purpose of this attachment is to describe some of the limits of the CalSim II model as it relates to simulating real-time project operations, that is, the daily management of the SWP to a variety of conditions. In addition to the uncertainty inherent in attempting to mimic real-time operations with a model, this section explains that future actual operations of the SWP and CVP, themselves, in the Delta cannot be described with certainty because multiple regulatory conditions govern the operations, calling for potentially different protective actions in any given set of circumstances.

2 Modeling Assumptions

The CalSim II model was used to evaluate the Long Term Operations (LTO) of the SWP. CalSim II simulates the operations of the SWP and CVP over 82 years of hydrology. The model simulates water volumes, flows, and water quality, and does not have the capability to simulate fish or turbidity. However, fish presence and turbidity are the primary factors in determining the OMR (permissible Old and Middle River flow direction and magnitude) which at times (January through mid-June) acts as a constraint on export levels in real-time operations. To represent operations governed by fish presence or other real-time variable, simplifying assumptions are made. As described in Appendix E Attachment 1-4 Scenario Related Changes to CalSim II and DSM2, assumptions were developed using historical data and generalized for application in the model. Generalizing historical data for use in models is a common practice especially with representing fishery-based actions. Some of the assumptions and potential uncertainty in the CalSim II implementation of the fishery protection actions are:

- **Adult LFS entrainment protection** – This action was not modeled in CalSim II due to the lack of data needed to develop a simplifying assumption. However, in reality adult LFS entrainment has the potential to trigger an OMR requirement of ‘no more negative than -5,000 cfs’ as early as December 1.
- **Larval and Juvenile LFS entrainment protection** – This action was not modeled in CalSim II due to the lack of data needed to develop a simplifying assumption. However, it is conceivable that this action could result in a significant range of required OMR. The tools and processes described in Section 3.3.1.2 are new and it is uncertain as to what level of OMR restriction would result from those tools and processes.
- **Onset of OMR** – As described in Appendix E Attachment 1-4 Scenario Related Changes to CalSim II and DSM2, this is modeled as starting as early as December 17 or as late as January 1 depending on triggering the “First Flush” action. However, past historical data indicates a triggering event would have occurred as early as December 3rd in 2013. It is conceivable that under actual real time operations this action could start as early as December 1 and as late as January 31 as described in Section 3.3.1.1.
- **Turbidity Bridge Avoidance (DS)** – As described in Appendix E Attachment 1-4 Scenario Related Changes to CalSim II and DSM2, this action is modeled as a variable action based a flow

surrogate which triggers the turbidity bridge avoidance action. The modeling assumed that when triggered, the action would apply an additional OMR requirement for 5 days at -2,000 cfs. However, historical data indicates that turbidity levels could persist and with protective risk assessments for Delta smelt, could extend additional OMR action well beyond the 5-day period assumed. Turbidity data in some years can persist for multiple months.

- **Larval and Juvenile DS entrainment protection** – This action was not modeled in CalSim II due to the lack of data needed to develop a simplifying assumption, however it is conceivable that this action could result in a significant range of required OMR. The tools and processes described in Section 3.3.1.1 are new and it is uncertain as to what level of OMR restriction would result from those tools and processes.
- **Salmon and Steelhead Salvage Thresholds** – As described in Appendix E Attachment 1-4 Scenario Related Changes to CalSim II and DSM2, this action is modeled as reaching the 50% salvage threshold in March of wet, above normal, below normal, and dry years and extending through April with 95% of salmonids exiting the Delta. The resulting additional OMR requirement for that period is -3,500 cfs. The assumption was developed using a generalization of the historical salvage. In actual real time operations, the salvage can vary. The historical data indicates that this action could occur as early as February, extend through May, and be as low as -2,500 cfs. In addition, if population levels were to increase, it could result in this action triggering more often with the potential for greater OMR restriction.

3 Potential Differences Between SWP LTO and CVP LTO Criteria

The modeling completed for this CEQA/CESA process assumes that the SWP and CVP operate to consistent regulatory criteria, i.e., the resulting OMR would be the same requirement for the SWP as for the CVP. The modeling assumes the Projects jointly operate to consistent criteria and split responsibilities for Delta inflows and opportunities for Delta export based on the provisions in the COA. As described below, however, there is the potential for the SWP to have more restrictive criteria than the CVP, where the OMR requirement could potentially vary by 3,000 cfs, with the SWP subject to -2,000 cfs and CVP subject to -5,000 cfs OMR flows. If the SWP were required to meet a different regulatory requirement than the CVP, as a result of additional DFW oversight for CESA purposes, the SWP will meet its proportion of the OMR requirement.

As described in Project Description, there are differences in the federal LTO and state LTO processes that could result in different operating criteria between the SWP and CVP. There are several areas within the Federal LTO and State LTO where criteria could deviate, making the SWP be required to operate to a different criterion than the CVP. Different operating criteria could occur under at least two situations: 1) Longfin Smelt action, and 2) risk assessments for off-ramping additional OMR criteria.

3.1 Longfin Smelt Actions

Longfin Smelt (LFS) are a state listed species and are protected by state law, however they are not federally listed and therefore not covered by the federal endangered species act. The State LTO includes specific actions for the protection of longfin that can begin as early as December 1 and includes entrainment protections for Adult LFS, and Larval and Juvenile LFS. These actions could potentially require SWP to operate to criteria that are in addition to the requirements incumbent on the CVP. Specifically, LFS actions that could require OMR requirements different from the CVP requirements include:

- **Adult LFS entrainment protection** – This can begin as early as December 1 based on salvage of longfin at SWP and CVP export facilities. There is a potential for this action to occur before the Delta smelt "First Flush" action. If triggered before the "First Flush", the Adult LFS protection would require an OMR less negative than -5,000 cfs for the SWP. At the same time, the CVP would be operating without any OMR requirement.
- **Larval and Juvenile LFS protection** – This can begin as early as January and would likely coincide with an OMR requirement for other species through the federal LTO with a standard OMR requirement of -5,000 cfs. However, there is a potential for significant differences in the required OMR. An appropriate action is dependent on real-time monitoring, simulation models, and coordination and concurrence with CDFW. A final OMR determination from a real-time assessment could easily be close to -2,000 cfs (i.e. considerably more restrictive for SWP). If situationally the CVP concluded that storm flexibility were available, the SWP could be required to operate to an OMR that is even more than 3,000 cfs more positive (effectively more restrictive to exports) than the CVP requirement.

3.2 Potential for different Risk Assessments and determination of species protection

After the onset of OMR management, there are several prescriptive actions that can trigger additional OMR restrictions based on real-time data. These additional restrictions can require the SWP and CVP to manage to OMR no more negative than -2,000 cfs. However, if DWR and Reclamation determine that the additional actions are no longer warranted for species protection, through an assessment of conditions and risk to species, then the additional restrictions may be lifted. However, CDFW may object to DWR's assessment and planned operations, in which case SWP may be required to operate to a more restrictive OMR than the CVP, and as described above, SWP will meet its proportional share. It is reasonable to assume that there will be situations where the federal and state assessments differ, but too speculative for modeling purposes.

The following species protections allow the projects to evaluate risk to species and potentially offramp from a specific measure if the risk is low enough. If CDFW disagrees with DWR's assessment, CDFW can ultimately require SWP to manage to a different criterion than the CVP.

- **Turbidity Bridge Avoidance** – Requires the Projects to manage to an OMR of -2,000 cfs when the turbidity at CDEC station OBI becomes greater than 12 NTU. However, there are conditions (e.g. bad data, localized event, or inability to control bridge formation) where the Projects could identify a "false" turbidity bridge avoidance event or determine a more appropriate OMR level that would continue to be protective and based on real-time data. The offramp could result in an OMR requirement no more negative than -5,000 cfs. CDFW can object to the Projects conclusions and require DWR to operate to as restrictive as -2,000 cfs OMR. Therefore, the difference between the CVP and SWP criteria could be up to 3,000 cfs, where SWP could be required to meet -2,000 cfs OMR with the CVP allowed to meet -5,000 cfs OMR. Under this condition SWP would meet its proportional share.
- **Larval and Juvenile Delta Smelt Protection** – Requires the Projects to determine a protective OMR for the protection of larval and juvenile Delta smelt. An entrainment assessment for Delta Smelt will occur on or after March 15 when Q-west is negative and larval and juveniles Delta smelt are detected in the OMR corridor. A protective OMR is to be determined by the Projects using the best available models and science. This protective action is open to many possible ways to determine a what an appropriate OMR level should be and therefore has the potential to result in different criteria. However, determining a reasonable range would be too speculative.
- **Cumulative Loss Thresholds** – Designed to meter the long-term salvage by applying a total salvage limit on the next 4 and 10 years of operations. If salvage levels reach those thresholds, then the Projects will coordinate on future actions to limit take. Though this should be a

cooperative process, there is some potential for differences in strategy that may result in different criteria. However, determining a reasonable range would be too speculative.

- **Single-Year Loss Thresholds** – A prescriptive OMR requirement based on the salvage of listed species. Additional OMR criteria is imposed when the SWP and CVP reach 50% and 75% of the loss threshold. These thresholds represent an additional OMR requirement of -3,500 cfs and -2,500 cfs respectively. Once a threshold is reached, that OMR restriction would remain in effect until the end of the season. The Projects can, through a risk assessment, determine an OMR restriction that is still protective to the species. CDFW has the ability to object to DWR's risk assessment and require SWP to continue with an additional OMR requirement defined by the salvage loss threshold. At most, this could require SWP to operate to an OMR requirement of -2,500 cfs, with the CVP operating to -5,000 cfs. This is a potential difference that could have SWP operating to a 2,500 cfs more restrictive OMR requirement.
- **OMR Flexibility During Excess Flow Conditions** – Allow for the Projects to operate to more negative OMR when risk to listed species is low. There are many conditions that have to be met before the projects can flex the OMR to something more negative than -5,000 cfs including insuring that no other OMR action has been triggered, as well as evaluating if OMR flexing would exacerbate the need for additional OMR requirements in the near future. In this aspect there is again the potential for the CVP and SWP to each be left operating to a different standard, the potential range of which is speculative.

As explained above, the CalSim II model does not—and cannot--represent real-time operations perfectly. CalSim II incorporates assumptions to provide for general operating conditions, but actual operations can vary and the general operating conditions do not represent extreme possibilities associated with fishery-based regulatory criteria.

Additionally, several conditions could require the CVP and the SWP to operate to different regulatory requirements associated with additional CDFW authority over SWP operations. However, it is too speculative to assume such conditions in the modeling analysis.

Despite CalSim II's limitations, CalSim II offers the best tool available to simulate SWP and CVP potential operational alternatives over a range of hydrologic conditions. Comparison of analysis of different operational regimes (including regulatory conditions) allows reasonable inference of how differently the projects might perform under the differing conditions.

Attachment 1-9 Hydrology Analysis for Spring Outflow Scenario

Spring Outflow Scenario (aka "Alternative 2b" or "PP-Spring"): This scenario considers the Proposed Project with additional spring outflow contribution from SWP. It represents the upper bound of the SWP's contribution under the adaptive management for spring Delta outflow. The San Joaquin River I:E ratio is assumed to be implemented in all water year types in this scenario, unless Delta outflow is greater than 44,500-cfs, and includes dedication of instream flow.

1.1 Approach to Analysis

The analyses herein are based on a simplified post-processing of the Proposed Project CalSim II outputs that focuses on changes to the April and May time period. The CalSim II output for the Proposed Project were used as the basis for comparison where simplified assumptions were used to estimate changes in Delta outflow, Old and Middle River (OMR) flows and Exports for both CVP and SWP. This was a Delta-centric analysis where the following assumptions were used in developing these estimates:

- Only export changes were assumed while analyzing these alternatives,
- Only export changes during excess conditions[1] were assumed to have a resulting one-for-one increase or decrease in Delta outflow,
- Any water quality changes were assumed to be insignificant.

1.2 Method

Under this scenario it is assumed that the water from SWP export curtailments would be dedicated to outflow for the term of the permit, by pursuing an instream flow dedication under Section 1707 of the California Water Code as well as agreements for the protection of this flow from other diverters. To estimate the reduction in the SWP exports at the Banks Pumping Plant, the resulting change to OMR, and the increase in Delta outflow, the following method was employed in April and May:

[1] Excess conditions are periods when the amount of water in the Delta is above what is needed to meet the water quality and flow requirements in D1641. During these conditions reservoir releases are controlled by upstream requirements (i.e. minimum releases or flood control).

1) The SWP export was limited to 40% of the available exports under the 2009 NMFS BiOp San Joaquin River inflow to export ratio constraint, unless Delta outflow was greater than 44,500 cfs.
2) The SWP exports were limited to a minimum of 600 cfs for its Health and Safety needs.
3) The change in exports was used to determine the change in OMR flow and the increase in Delta Outflow.

Figures 11 to 20 and Tables 21 to 40 illustrate the results of Alternative 2b for Delta outflow, OMR, total exports, Jones exports, and Banks exports in comparison to the Existing Conditions and the Proposed Project.

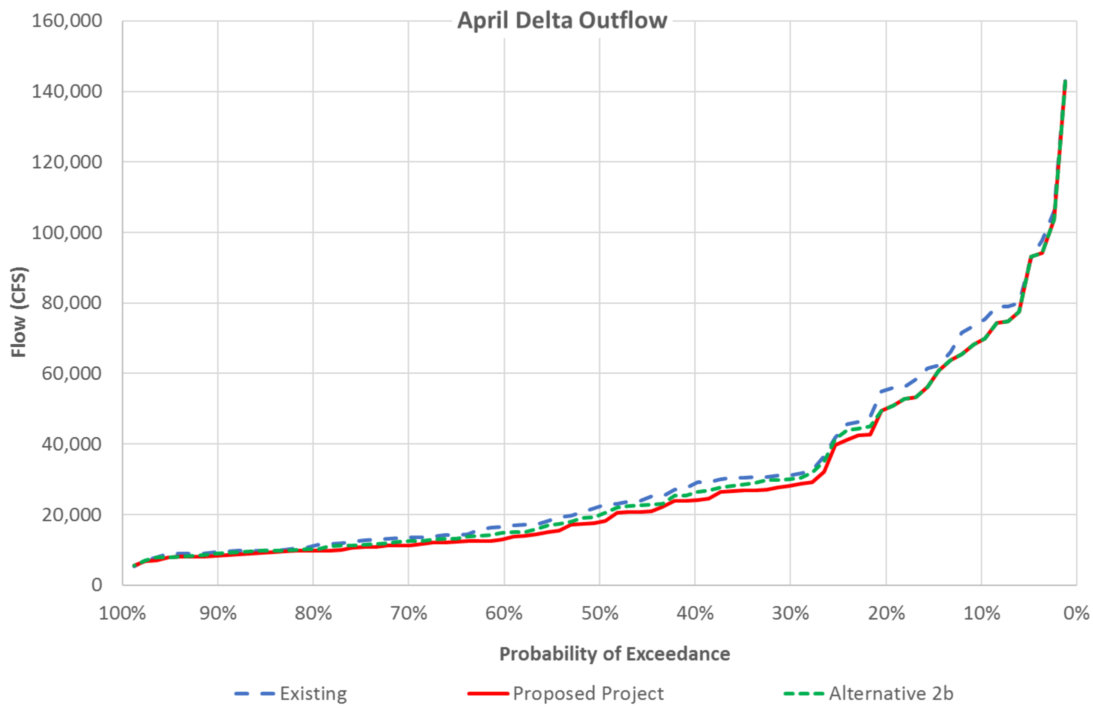

Figure 1: Probability of exceedance of Delta outflow in April

Table 1: Average Delta outflow in April

Water Year Type	Existing	Proposed Project	Alternative 2b	Existing vs. Alternative 2b	Proposed Project vs. Alternative 2b
W	56933	53084	53921	-3012 (-5%)	837 (2%)
AN	33562	29851	31606	-1956 (-6%)	1756 (6%)
BN	23217	20278	21931	-1286 (-6%)	1653 (8%)
D	15097	13225	14019	-1078 (-7%)	795 (6%)
C	9410	8916	9172	-238 (-3%)	256 (3%)
Average	31618	28870	29886	-1732 (-5%)	1017 (4%)

Table 2: Probability of Exceedance of Delta outflow in April

Probability of Exceedance	Existing	Proposed Project	Alternative 2b	Existing vs. Alternative 2b	Proposed Project vs. Alternative 2b
10%	74775	69331	69331	-5444 (-7%)	0 (0%)
20%	55367	49987	49987	-5381 (-10%)	0 (0%)
30%	31129	28197	30110	-1018 (-3%)	1913 (7%)
40%	28790	23989	26177	-2613 (-9%)	2188 (9%)
50%	22248	17845	19860	-2388 (-11%)	2015 (11%)
60%	16523	13030	14915	-1609 (-10%)	1885 (14%)
70%	13456	11221	12410	-1046 (-8%)	1189 (11%)
80%	11145	9673	10168	-977 (-9%)	494 (5%)
90%	9317	8280	8921	-396 (-4%)	641 (8%)

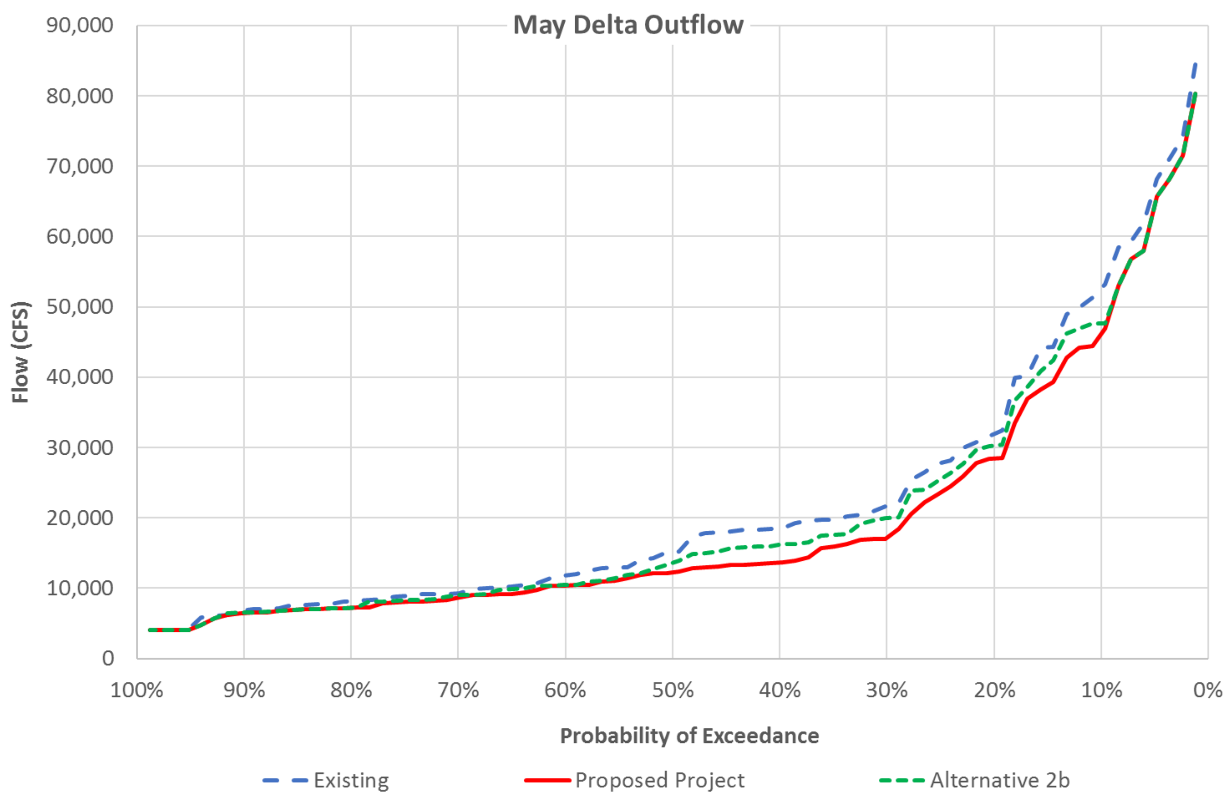

Figure 2: Probability of exceedance of Delta outflow in May

Table 3: Average Delta outflow in May

Water Year Type	Existing	Proposed Project	Alternative 2b	Existing vs. Alternative 2b	Proposed Project vs. Alternative 2b
W	39709	35402	37011	-2698 (-7%)	1610 (5%)
AN	24582	20521	22247	-2335 (-9%)	1726 (8%)
BN	15806	13073	14331	-1475 (-9%)	1258 (10%)
D	9920	8909	9205	-715 (-7%)	296 (3%)
C	5821	5628	5671	-150 (-3%)	44 (1%)
Average	21916	19239	20288	-1628 (-7%)	1049 (5%)

Table 4: Probability of Exceedance of Delta outflow in May

Probability of Exceedance	Existing	Proposed Project	Alternative 2b	Existing vs. Alternative 2b	Proposed Project vs. Alternative 2b
10%	52644	46156	47677	-4967 (-9%)	1521 (3%)
20%	31925	28454	30297	-1628 (-5%)	1843 (6%)
30%	21645	17182	20007	-1639 (-8%)	2825 (16%)
40%	18496	13649	16218	-2278 (-12%)	2569 (19%)
50%	15195	12246	13580	-1615 (-11%)	1334 (11%)
60%	11871	10365	10470	-1401 (-12%)	105 (1%)
70%	9237	8661	8992	-245 (-3%)	330 (4%)
80%	8154	7188	7188	-967 (-12%)	0 (0%)
90%	6815	6451	6554	-261 (-4%)	103 (2%)

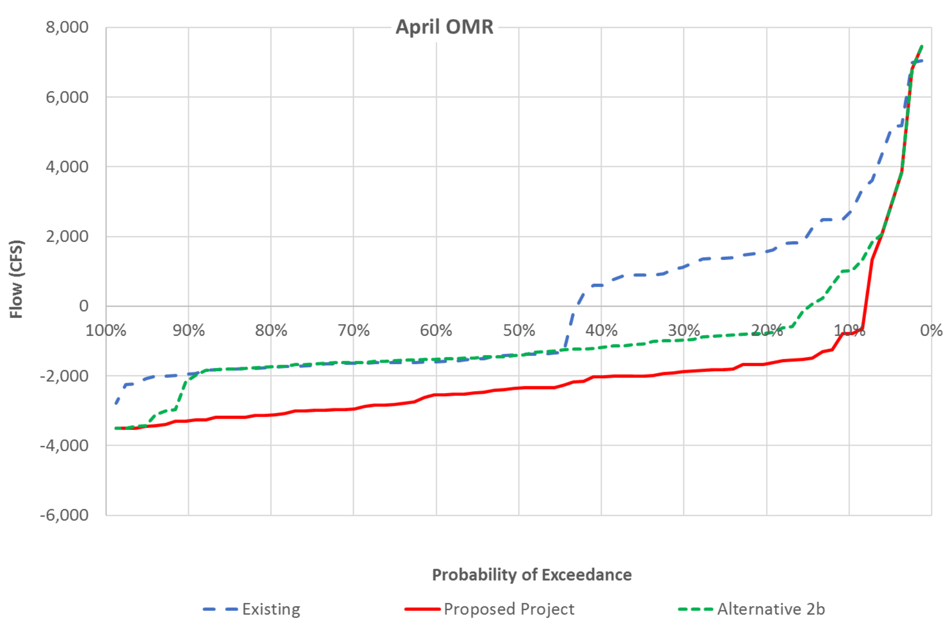

Figure 3: Probability of exceedance of OMR flow in April

Table 5: Average OMR flow in April

Water Year Type	Existing	Proposed Project	Alternative 2b	Existing vs. Alternative 2b	Proposed Project vs. Alternative 2b
W	1945	-1208	-446	-2391 (-123%)	763 (63%)
AN	104	-2740	-1140	-1245 (-1191%)	1600 (58%)
BN	-415	-2495	-989	-574 (-138%)	1506 (60%)
D	-1586	-2300	-1394	192 (12%)	906 (39%)
C	-1748	-1592	-1183	565 (32%)	409 (26%)
Average	-43	-1948	-956	-913 (-2135%)	992 (51%)

Table 6: Probability of exceedance of OMR flow in April

Probability of Exceedance	Existing	Proposed Project	Alternative 2b	Existing vs. Alternative 2b	Proposed Project vs. Alternative 2b
10%	2669	-789	1018	-1651 (-62%)	1807 (229%)
20%	1567	-1652	-772	-2339 (-149%)	880 (53%)
30%	1136	-1875	-975	-2111 (-186%)	900 (48%)
40%	595	-2024	-1177	-1772 (-298%)	847 (42%)
50%	-1385	-2352	-1413	-28 (-2%)	938 (40%)
60%	-1593	-2538	-1517	76 (5%)	1021 (40%)
70%	-1637	-2951	-1620	18 (1%)	1331 (45%)
80%	-1753	-3125	-1739	14 (1%)	1386 (44%)
90%	-1951	-3289	-2122	-170 (-9%)	1168 (36%)

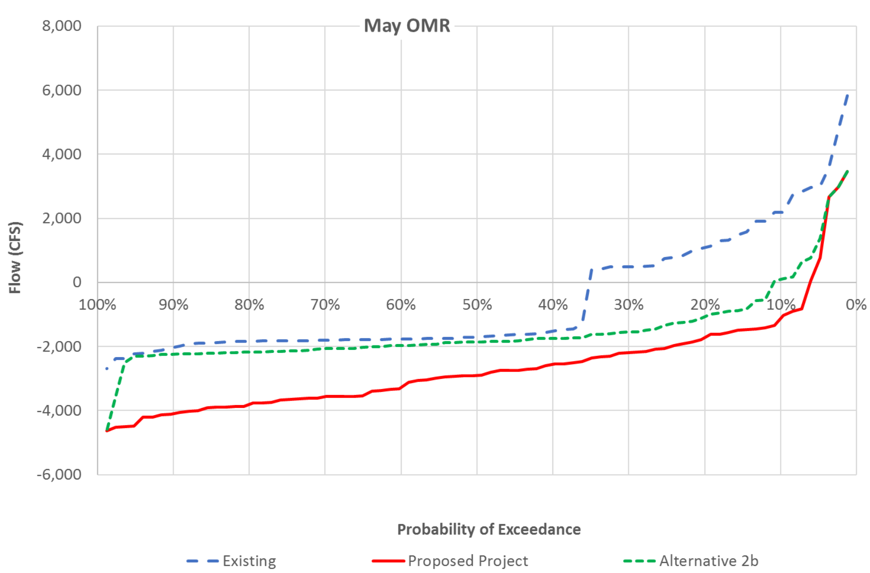

Figure 4: Probability of exceedance of OMR flow in May

Table 7: Average OMR flow in May

Water Year Type	Existing	Proposed Project	Alternative 2b	Existing vs. Alternative 2b	Proposed Project vs. Alternative 2b
W	812	-2388	-922	-1734 (-214%)	1466 (61%)
AN	-383	-3585	-1945	-1562 (-407%)	1640 (46%)
BN	-695	-3268	-1826	-1131 (-163%)	1442 (44%)
D	-1773	-2548	-1891	-118 (-7%)	657 (26%)
C	-1881	-1522	-1412	469 (25%)	110 (7%)
Average	-582	-2622	-1510	-929 (-160%)	1112 (42%)

Table 8: Probability of exceedance of OMR flow in May

Probability of Exceedance	Existing	Proposed Project	Alternative 2b	Existing vs. Alternative 2b	Proposed Project vs. Alternative 2b
10%	2194	-1126	91	-2104 (-96%)	1217 (108%)
20%	1088	-1711	-1072	-2159 (-199%)	640 (37%)
30%	488	-2189	-1554	-2042 (-419%)	635 (29%)
40%	-1517	-2560	-1754	-238 (-16%)	806 (31%)
50%	-1706	-2897	-1853	-148 (-9%)	1044 (36%)
60%	-1767	-3284	-1972	-205 (-12%)	1312 (40%)
70%	-1797	-3564	-2058	-261 (-15%)	1506 (42%)
80%	-1835	-3806	-2176	-341 (-19%)	1629 (43%)
90%	-2022	-4102	-2237	-215 (-11%)	1864 (45%)

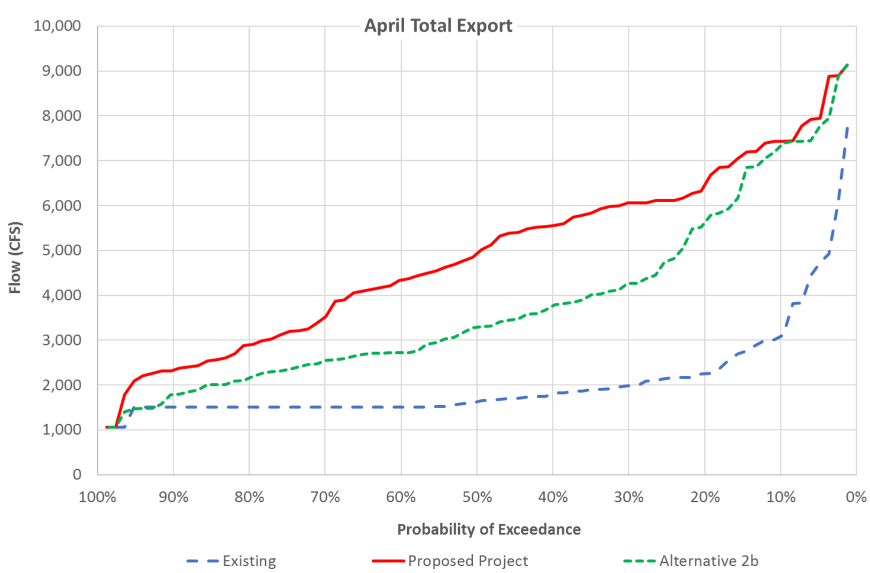

Figure 5: Probability of exceedance of total exports in April

Table 9: Average exports in April

Water Year Type	Existing	Proposed Project	Alternative 2b	Existing vs. Alternative 2b	Proposed Project vs. Alternative 2b
W	2791	6606	5768	2977 (107%)	-837 (-13%)
AN	1765	5702	3946	2181 (124%)	-1756 (-31%)
BN	1651	4931	3278	1627 (98%)	-1653 (-34%)
D	1813	3643	2648	836 (46%)	-994 (-27%)
C	1570	2121	1672	101 (6%)	-449 (-21%)
Average	2053	4881	3792	1739 (85%)	-1089 (-22%)

Table 10: Probability of exceedance of total exports in April

Probability of Exceedance	Existing	Proposed Project	Alternative 2b	Existing vs. Alternative 2b	Proposed Project vs. Alternative 2b
10%	3080	7432	7326	4247 (138%)	-106 (-1%)
20%	2250	6465	5625	3375 (150%)	-839 (-13%)
30%	1978	6054	4263	2285 (116%)	-1791 (-30%)
40%	1804	5547	3765	1960 (109%)	-1783 (-32%)
50%	1625	4929	3285	1660 (102%)	-1644 (-33%)
60%	1500	4339	2723	1223 (82%)	-1616 (-37%)
70%	1500	3507	2541	1041 (69%)	-966 (-28%)
80%	1500	2898	2156	656 (44%)	-742 (-26%)
90%	1500	2332	1787	287 (19%)	-545 (-23%)

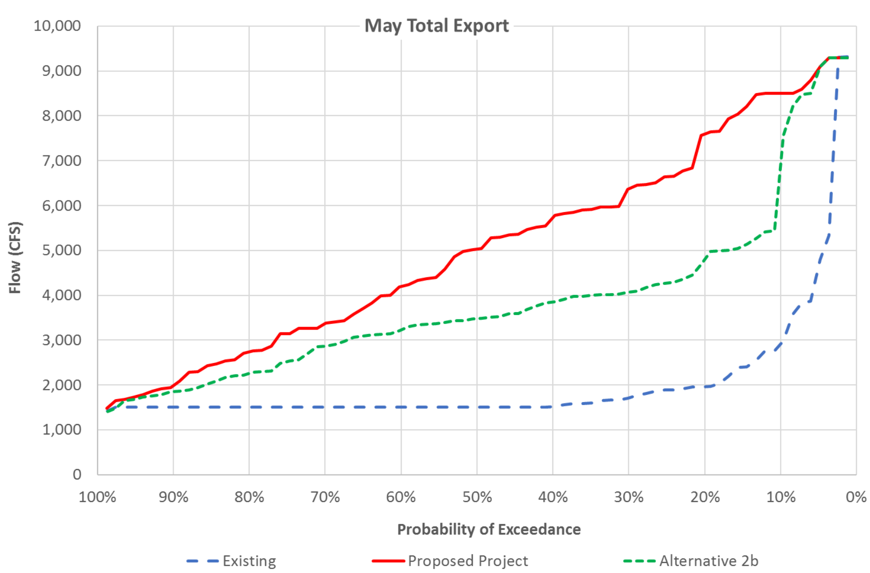

Figure 6: Probability of exceedance of total exports in May

Table 11: Average exports in May

Water Year Type	Existing	Proposed Project	Alternative 2b	Existing vs. Alternative 2b	Proposed Project vs. Alternative 2b
W	2861	7027	5417	2556 (89%)	-1610 (-23%)
AN	1639	5966	4165	2526 (154%)	-1801 (-30%)
BN	1580	5258	3675	2096 (133%)	-1583 (-30%)
D	1621	3495	2773	1153 (71%)	-721 (-21%)
C	1644	1996	1875	231 (14%)	-121 (-6%)
Average	2013	5058	3838	1825 (91%)	-1220 (-24%)

Table 12: Probability of exceedance of total exports in May

Probability of Exceedance	Existing	Proposed Project	Alternative 2b	Existing vs. Alternative 2b	Proposed Project vs. Alternative 2b
10%	2917	8502	6925	4008 (137%)	-1577 (-19%)
20%	1961	7591	4802	2842 (145%)	-2789 (-37%)
30%	1716	6372	4073	2357 (137%)	-2298 (-36%)
40%	1517	5731	3846	2329 (154%)	-1886 (-33%)
50%	1500	5029	3479	1979 (132%)	-1550 (-31%)
60%	1500	4201	3231	1731 (115%)	-970 (-23%)
70%	1500	3363	2864	1364 (91%)	-499 (-15%)
80%	1500	2739	2260	760 (51%)	-480 (-18%)
90%	1500	1987	1853	353 (24%)	-134 (-7%)

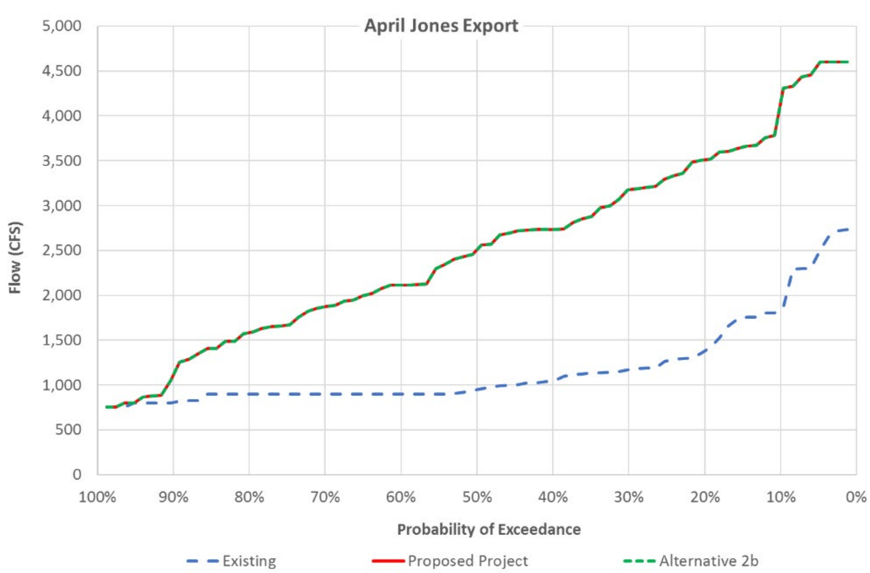

Figure 7: Probability of exceedance of Jones export in April

Table 13: Average Jones export in April

Water Year Type	Existing	Proposed Project	Alternative 2b	Existing vs. Alternative 2b	Proposed Project vs. Alternative 2b
W	1527	3364	3364	1837 (120%)	0 (0%)
AN	1059	3033	3033	1974 (186%)	0 (0%)
BN	980	2416	2416	1436 (147%)	0 (0%)
D	1118	2007	2007	889 (80%)	0 (0%)
C	878	1122	1122	244 (28%)	0 (0%)
Average	1180	2528	2528	1347 (114%)	0 (0%)

Table 14: Probability of exceedance of Jones export in April

Probability of Exceedance	Existing	Proposed Project	Alternative 2b	Existing vs. Alternative 2b	Proposed Project vs. Alternative 2b
10%	1848	4152	4152	2304 (125%)	0 (0%)
20%	1379	3510	3510	2132 (155%)	0 (0%)
30%	1173	3176	3176	2003 (171%)	0 (0%)
40%	1046	2733	2733	1687 (161%)	0 (0%)
50%	948	2511	2511	1562 (165%)	0 (0%)
60%	900	2114	2114	1214 (135%)	0 (0%)
70%	900	1871	1871	971 (108%)	0 (0%)
80%	900	1584	1584	684 (76%)	0 (0%)
90%	806	1113	1113	307 (38%)	0 (0%)

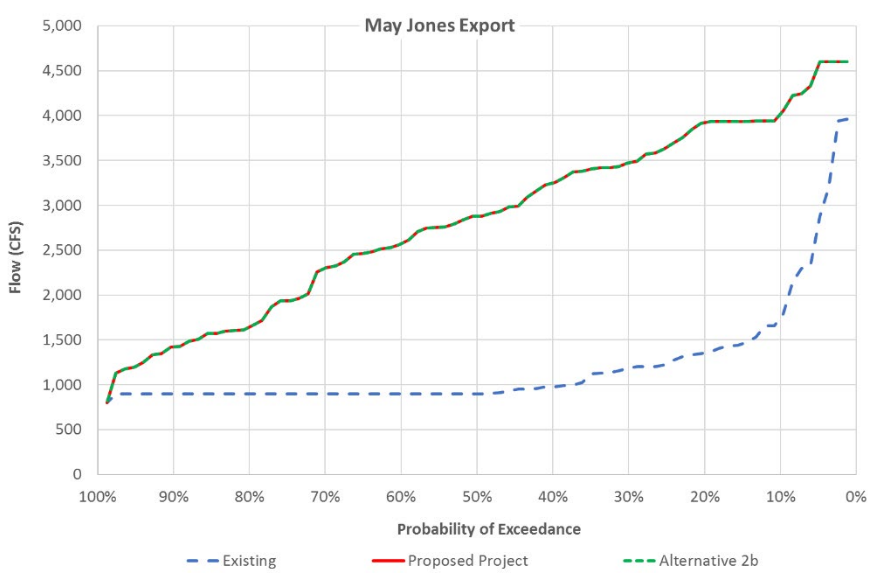

Figure 8: Probability of exceedance of Jones export in May

Table 15: Average Jones export in May

Water Year Type	Existing	Proposed Project	Alternative 2b	Existing vs. Alternative 2b	Proposed Project vs. Alternative 2b
W	1591	3634	3634	2043 (128%)	0 (0%)
AN	984	3264	3264	2281 (232%)	0 (0%)
BN	948	3037	3037	2089 (220%)	0 (0%)
D	992	2161	2161	1168 (118%)	0 (0%)
C	1190	1436	1436	246 (21%)	0 (0%)
Average	1202	2833	2833	1631 (136%)	0 (0%)

Table 16: Probability of exceedance of Jones export in May

Probability of Exceedance	Existing	Proposed Project	Alternative 2b	Existing vs. Alternative 2b	Proposed Project vs. Alternative 2b
10%	1750	4019	4019	2269 (130%)	0 (0%)
20%	1357	3921	3921	2564 (189%)	0 (0%)
30%	1183	3473	3473	2291 (194%)	0 (0%)
40%	975	3246	3246	2271 (233%)	0 (0%)
50%	900	2879	2879	1979 (220%)	0 (0%)
60%	900	2570	2570	1670 (186%)	0 (0%)
70%	900	2299	2299	1399 (155%)	0 (0%)
80%	900	1644	1644	744 (83%)	0 (0%)
90%	900	1421	1421	521 (58%)	0 (0%)

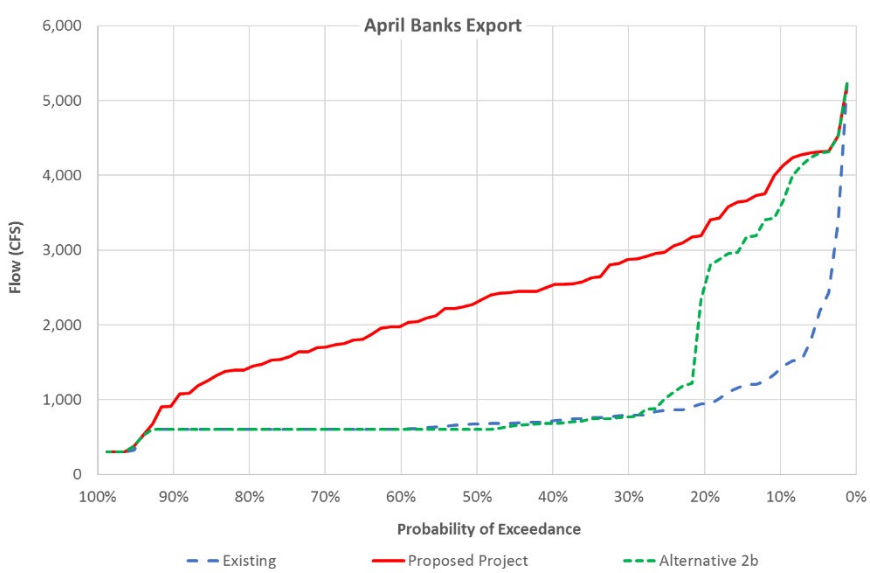

Figure 9: Probability of exceedance of Banks export in April

Table 17: Average Banks export in April

Water Year Type	Existing	Proposed Project	Alternative 2b	Existing vs. Alternative 2b	Proposed Project vs. Alternative 2b
W	1264	3241	2404	1140 (90%)	-837 (-26%)
AN	706	2669	914	207 (29%)	-1756 (-66%)
BN	672	2515	862	190 (28%)	-1653 (-66%)
D	695	1636	642	-53 (-8%)	-994 (-61%)
C	692	999	550	-143 (-21%)	-449 (-45%)
Average	873	2353	1264	392 (45%)	-1089 (-46%)

Table 18: Probability of exceedance of Banks export in April

Probability of Exceedance	Existing	Proposed Project	Alternative 2b	Existing vs. Alternative 2b	Proposed Project vs. Alternative 2b
10%	1415	4093	3591	2176 (154%)	-501 (-12%)
20%	945	3277	2522	1577 (167%)	-755 (-23%)
30%	790	2878	767	-23 (-3%)	-2111 (-73%)
40%	716	2532	684	-33 (-5%)	-1848 (-73%)
50%	673	2305	603	-70 (-10%)	-1703 (-74%)
60%	604	1988	600	-4 (-1%)	-1388 (-70%)
70%	600	1703	600	0 (0%)	-1103 (-65%)
80%	600	1429	600	0 (0%)	-829 (-58%)
90%	600	963	600	0 (0%)	-363 (-38%)

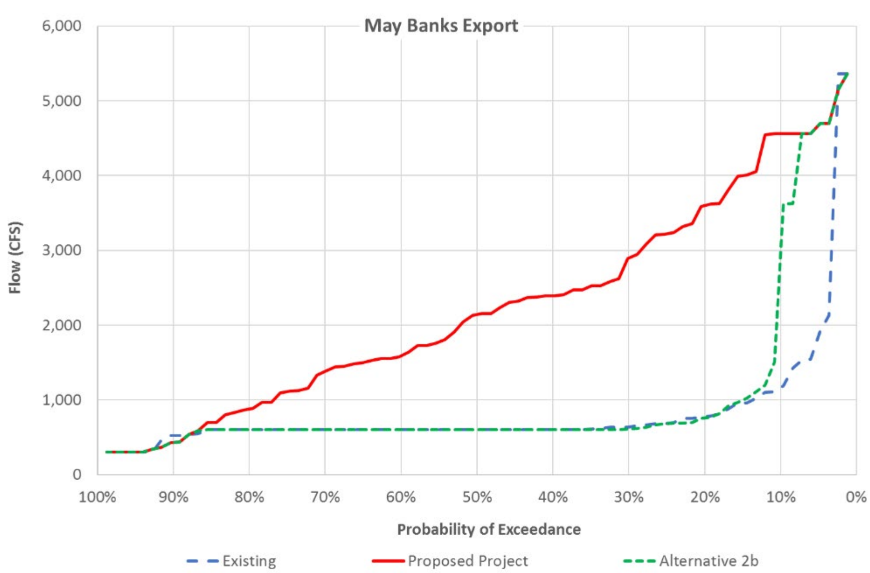

Figure 10: Probability of exceedance of Banks export in May

Table 19: Average Banks export in May

Water Year Type	Existing	Proposed Project	Alternative 2b	Existing vs. Alternative 2b	Proposed Project vs. Alternative 2b
W	1270	3393	1784	514 (40%)	-1610 (-47%)
AN	656	2702	901	245 (37%)	-1801 (-67%)
BN	632	2221	638	7 (1%)	-1583 (-71%)
D	628	1334	612	-16 (-3%)	-721 (-54%)
C	454	559	439	-16 (-3%)	-121 (-22%)
Average	811	2225	1005	194 (24%)	-1220 (-55%)

Table 20: Probability of exceedance of Banks export in May

Probability of Exceedance	Existing	Proposed Project	Alternative 2b	Existing vs. Alternative 2b	Proposed Project vs. Alternative 2b
10%	1167	4562	2983	1816 (156%)	-1579 (-35%)
20%	776	3597	760	-16 (-2%)	-2837 (-79%)
30%	640	2897	609	-31 (-5%)	-2287 (-79%)
40%	600	2390	600	0 (0%)	-1790 (-75%)
50%	600	2144	600	0 (0%)	-1544 (-72%)
60%	600	1591	600	0 (0%)	-991 (-62%)
70%	600	1384	600	0 (0%)	-784 (-57%)
80%	600	880	600	0 (0%)	-280 (-32%)
90%	525	433	433	-92 (-18%)	0 (0%)

APPENDIX F

Analysis with X2-Longfin Smelt Abundance Index Relationship

PURPOSE OF THIS MEMORANDUM

California Department of Fish and Wildlife (CDFW) representatives have requested that the California Department of Water Resources (DWR) undertake additional analysis of Longfin Smelt abundance for inclusion in the Incidental Take Permit (ITP) Application and in the Final Environmental Impact Report (EIR). Specifically, CDFW requested that DWR undertake a "Kimmerer regression to analyze the relationship between X2 and Longfin smelt abundance." In the spirit of cooperation, DWR has undertaken the requested analysis with respect to the Proposed Project and flow-based minimization/mitigation measures identified in the ITP application. By undertaking the "Kimmerer regression"[1], DWR does not agree that the "Kimmerer regression" is the best available science or that any decisions should be made based on the "Kimmerer regressions" as further explained below:

1. DWR has already completed a robust abundance analysis based on a 2016 Longfin Smelt population dynamics modeling study by Nobriga and Rosenfield (2016). Nobriga and Rosenfeld (2016) represents the best available science for this type of analysis and presents the best fit, based on current information, for analyzing Longfin Smelt abundance under the Proposed Project and applicable mitigation measures. The "Kimmerer regression" approach does not take into account stock size of the Longfin Smelt population; whereas the Nobriga and Rosenfield (2016) approach does so, and therefore more accurately reflects how this species will respond to different conditions.
2. The results from the Nobriga and Rosenfield (2016) approach show the same general differences and level of uncertainty between the different alternatives as the "Kimmerer regression" approach. Hence, DWR considers that the "Kimmerer regression" analysis does not add value to the comparison of alternatives.

This memo presents the results of the "Kimmerer regression" approach for the Proposed Project, Existing Conditions, and Proposed Project with additional spring outflow as minimization/mitigation[2].

Methods

The method is the same as that used in the California WaterFix (CWF) Incidental Take Permit (ITP) Application (ICF International 2016). The methods described herein are the same as those used in that application; the methods description below was adapted from ICF International (2016).

The analysis essentially updated previously described X2-abundance index regressions (Kimmerer et al. 2009; Mount et al. 2013) by adding additional years of data. Updating the analysis allowed full accounting of sources of error in the predictions, allowing calculation of prediction intervals from

[1] The origin of the term "Kimmerer regression" reflects previous analyses, e.g., Kimmerer (2002) and Kimmerer et al. (2009); the approach is technically a general linear model, as described later in this memo.

[2] The scenario representing Proposed Project with additional spring outflow represents the upper bound of the adaptive management of spring Delta outflow, i.e., with San Joaquin River I:E ratio implemented in all water year types, 44,500-cfs offramp, and dedication of instream flow, as described in Section 3.3.16.1 *Adaptive Management Across Wetter And Drier Years*.

estimates of X2, as recommended by Simenstad et al. (2016), for the Existing Conditions ('Existing'), Proposed Project ('PP'), and PP with additional spring outflow ('PP–spring') scenarios.

Longfin Smelt fall-mid-water trawl index data were obtained (http://www.dfg.ca.gov/delta/data/fmwt/indices.asp?view=single), including indices for 1967–2014 (excluding 1974 and 1979, when there was no sampling). For each index year, mean X2 during January–June was calculated based on X2 from the DAYFLOW database (https://data.cnra.ca.gov/dataset/dayflow), in addition to calculated X2 for earlier years[3].

Similar to Mount et al. (2013), GLMs were run, predicting Longfin Smelt fall midwater trawl relative abundance index as a function of X2 and step changes in 1987/1988 and 2002/2003:

$$\text{Log}_{10}(\text{FMWT index}_y) = a + b\cdot(\text{mean X2}_y) + c\cdot\text{period}_y$$

Where *y* indicates year, *a* is the intercept, *b* is the coefficient applied to the mean Delta outflow, and *c* takes one of three values for period: 0 for the Pre-*Potamocorbula* period (1967–1987), and values to be estimated for Post-*Potamocorbula* (1988–2002) and Pelagic Organism Decline (POD; 2003–2014) periods.

Regarding the months used for mean X2, Mount et al. (2013: 67) noted the following:

> The months selected in the original analysis [by Jassby et al. 1995] were based on the assumption that the (unknown) X2 mechanism operated during early life history of Longfin Smelt, which smelt experts linked to this period. Autocorrelation in the X2 values through months means that statistical analysis provides little guidance for improving the selection of months. A better understanding of the mechanism(s) underlying the relationship would probably allow this period to be narrowed and focused, but for now there is little basis for selecting a narrower period for averaging X2.

Mount et al. (2013) compared the fit of X2 averaging periods for January–June (i.e., the original period used by Jassby et al. 1995, also used by Kimmerer et al. 2009) and March–May; they selected the former because the fit to the empirical data was slightly superior. In the present analysis, both the January–June and March–May averaging periods were compared for their adequacy of fit, using standard criteria (Akaike's Information Criterion adjusted for small sample sizes, AIC_c; and variation explained, r^2). This showed that the January–June X2 averaging period was better supported in terms of explaining variability in the FWMT index (Table F-1; Figure F-1), so this averaging period was used in the subsequent comparison of the Existing, PP, and PP-spring scenarios based on CalSim outputs.

[3] DAYFLOW provides X2 estimates from water year 1997 onwards, so the DAYFLOW equation (X2(t) = 10.16 + 0.945*X2(t-1) – 1.487log(QOUT(t))) was used to provide X2 for earlier years, based on a starting unpublished estimate of X2 (Mueller-Solger 2012).

Table F-1a. Parameter Coefficients for General Linear Models Explaining Longfin Smelt Fall Midwater Trawl Index as a Function of Mean January–June X2 and Step Changes in 1987/1988 (Potamocorbula Invasion) and 2002/2003 (Pelagic Organism Decline).

Parameter	Estimate	Standard Error	P	Fit
a (Intercept)	7.3059	0.3299	< 0.0001	–
b (X2)	-0.0542	0.0049	< 0.0001	–
c (Period: Post-Potamocorbula)	-0.5704	0.1174	< 0.0001	–
c (Period: POD)	-1.4067	0.1244	< 0.0001	–
AICc1	–	–	–	-47.4904
r2	–	–	–	0.8666

Notes:

1 The difference of ~8 AIC_c units between the two GLMs indicates that the January–June mean X2 GLM is better supported in terms of explaining the patterns in the data (Burnham et al. 2011).

2 A dash ("– ") indicates a blank cell or N/A

Table F-1b. Parameter Coefficients for General Linear Models Explaining Longfin Smelt Fall Midwater Trawl Index as a Function of Mean March–May X2 and Step Changes in 1987/1988 (Potamocorbula Invasion) and 2002/2003 (Pelagic Organism Decline).

Parameter	Estimate	Standard Error	P	Fit
a (Intercept)	6.8100	0.3224	< 0.0001	–
b (X2)	-0.0475	0.0047	< 0.0001	–
c (Period: Post-Potamocorbula)	-0.6368	0.1271	< 0.0001	–
c (Period: POD)	-1.4581	0.1351	< 0.0001	–
AICc1	–	–	–	-39.5492
r2	–	–	–	0.8414

Notes:

1 The difference of ~8 AIC_c units between the two GLMs indicates that the January–June mean X2 GLM is better supported in terms of explaining the patterns in the data (Burnham et al. 2011).

2 A dash ("– ") indicates a blank cell or N/A

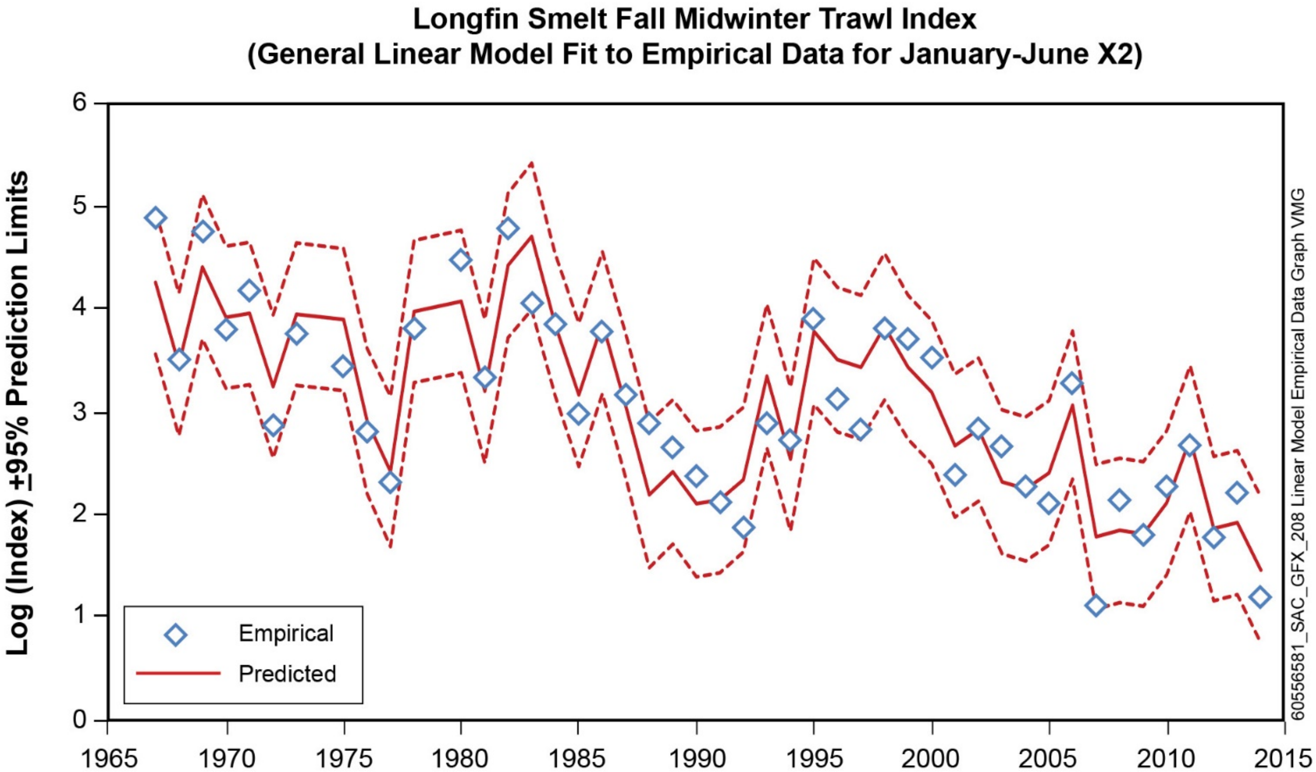

Figure F-1. Fit to Empirical Data of General Linear Model Predicting Longfin Smelt Fall Midwater Trawl Relative Abundance Index as a Function of Mean January–June X2 and Step Changes for *Potamocorbula* and Pelagic Organism Decline.

For the comparison of Existing, PP, and PP-spring scenarios, mean January–June X2 was calculated for each year of the 1922–2003 simulation. Because CalSim modeling was not available for all scenarios, X2 was estimated based on Delta outflow and the previous month's X2, using a starting value of X2 = 80 km to initiate the calculations, using the equation similar of Kimmerer and Monismith (see p.A-8 of Appendix A of Schubel 1993):

$$X2 = 122.2 + 0.3278*(X2 \text{ during previous month}) - 17.65*\log(\text{Delta outflow})$$

The X2-abundance index GLM calculated as above was used to estimate abundance index for the scenarios, based on the POD period coefficient in addition to the intercept and X2 slope terms. The basic equation used was (see also Table F-1):

$$\log_{10}(\text{Longfin Smelt FMWT index}) = 7.3059 - 0.0542*(\text{January-June X2}) - 1.4067$$

The log-transformed abundance indices were back-transformed to a linear scale for comparison of scenarios. In order to illustrate the variability in predictions from the X2-abundance index GLM, annual estimates were made for the mean and upper and lower 95% prediction limits of the abundance indices, as recommended by Simenstad et al. (2016). Statistical analyses were conducted with PROC GLM and PROC PLM in SAS/STAT software, Version 9.4 of the SAS System for Windows.[4]

[4] Copyright 2002–2010, SAS Institute Inc. SAS and all other SAS Institute Inc. product or service names are registered trademarks or trademarks of SAS Institute Inc., Cary, NC, USA

Results

There was considerable overlap in predictions of Longfin Smelt fall midwater trawl index between scenarios (Figures F-2, F-3, F-4, and F-5). There was a smaller difference between Existing and PP-spring than between Existing and PP, although the differences were small in all cases, particularly when accounting for the signal to noise in the estimates (Table F-2).

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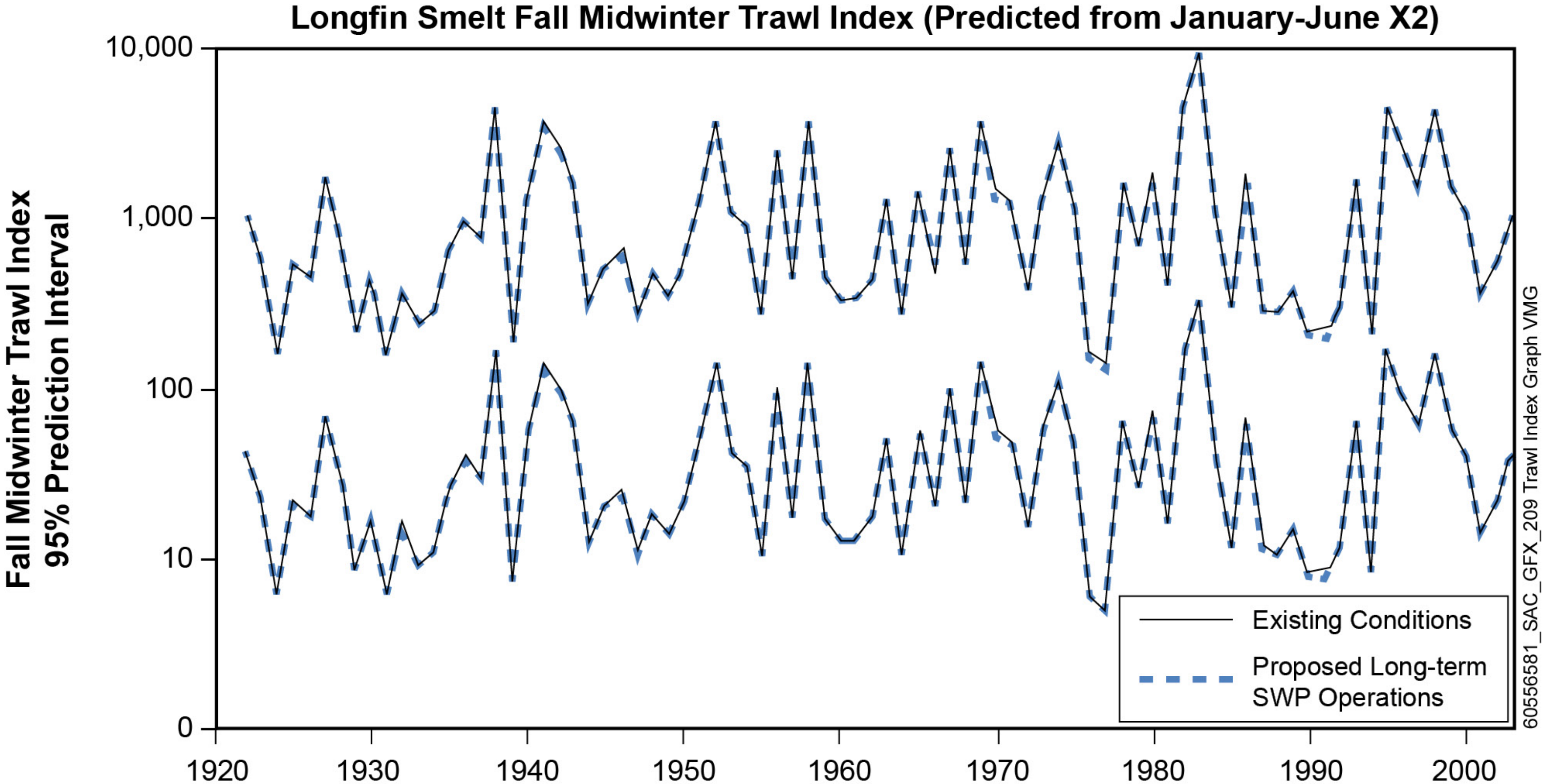


Figure F-2a. Time Series of 95% Prediction Interval Longfin Smelt Bay Midwater Trawl Index, from the General Linear Model Including Mean January–June X2, Comparing Existing and Proposed Project (PP) Scenarios.

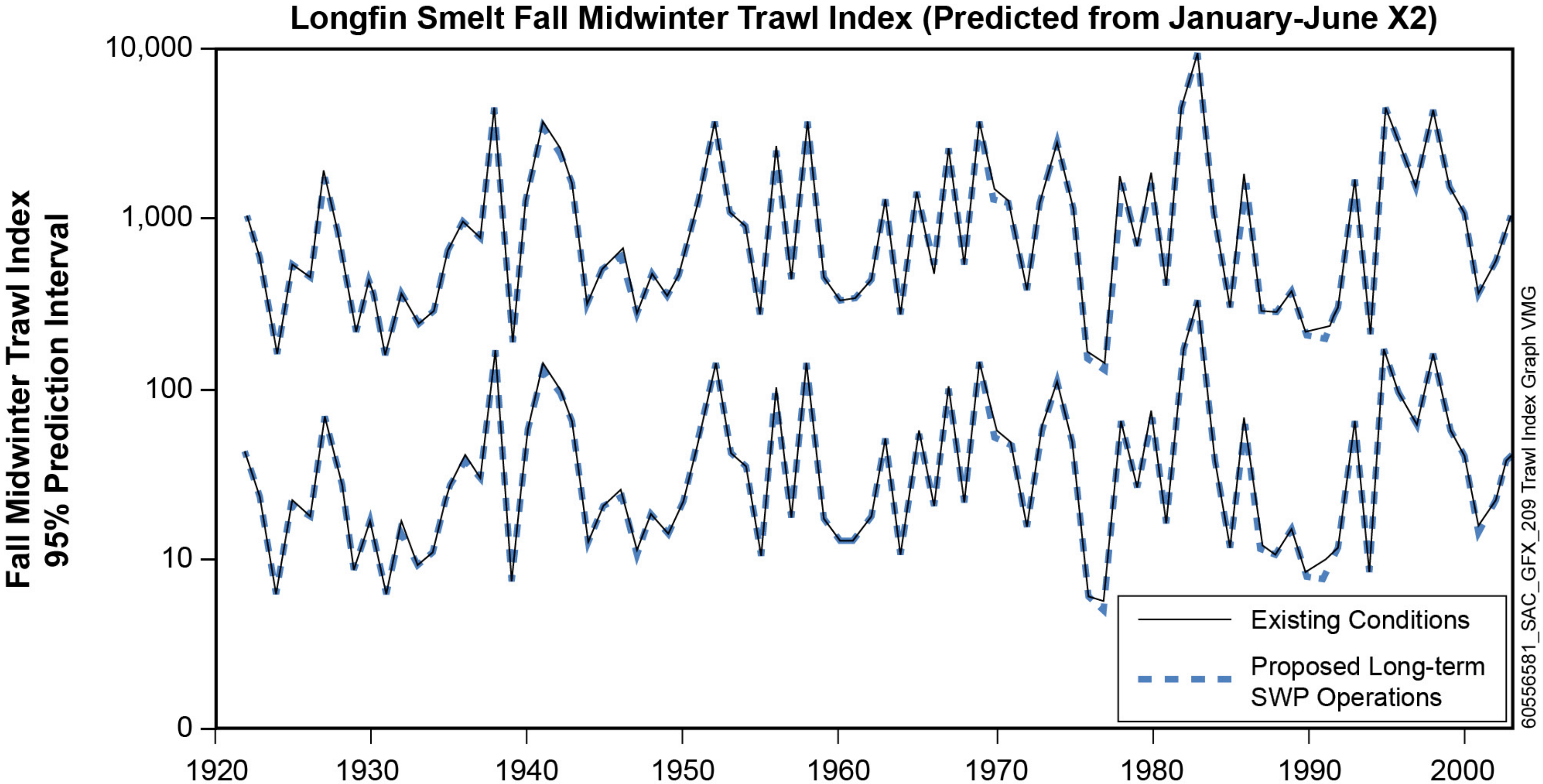
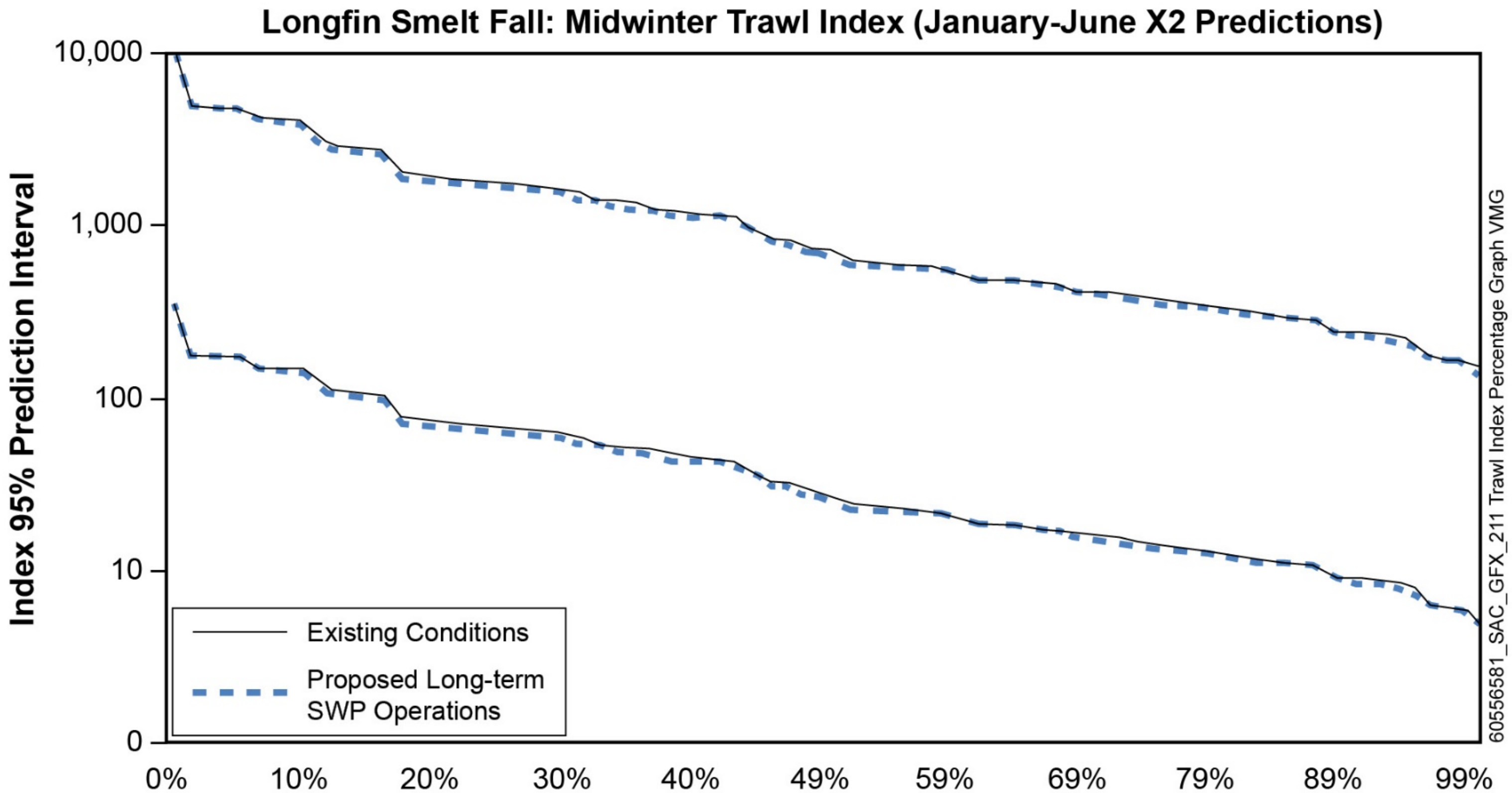
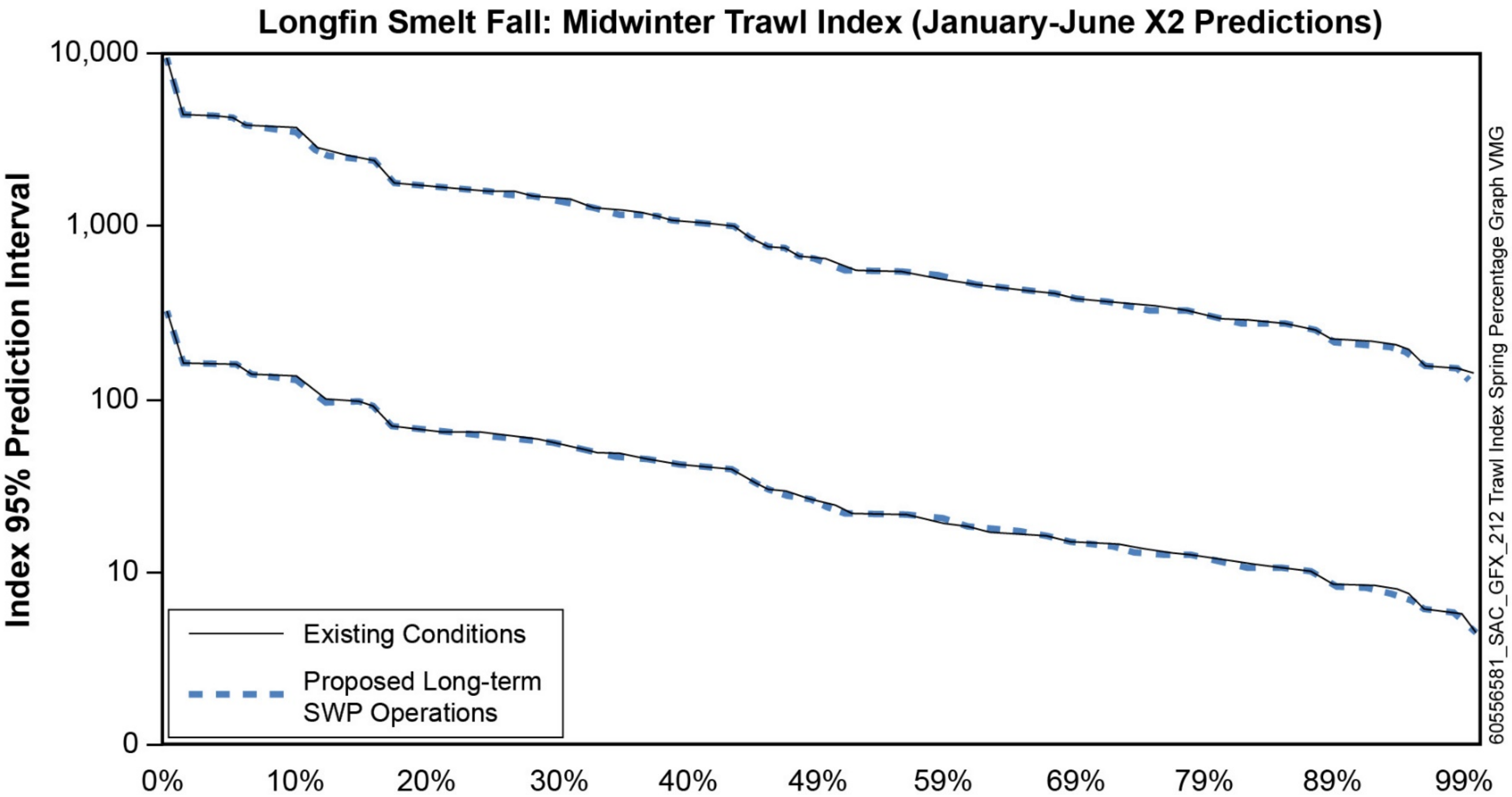


Figure F-2b. Time Series of 95% Prediction Interval Longfin Smelt Bay Midwater Trawl Index, from the General Linear Model Including Mean January–June X2, Comparing Existing and Proposed Project with Additional Spring Delta Outflow (PP-spring) Scenarios.



Note: Data are sorted by mean estimate, with only 95% prediction intervals shown.

Figure F-3. Exceedance Plot of Longfin Smelt Fall Midwater Trawl Relative Abundance Index, Estimated from the General Linear Model Including Mean January–June X2, Comparing Existing and Proposed Project (PP) Scenarios.



Note: Data are sorted by mean estimate, with only 95% prediction intervals shown.

Figure F-4. Exceedance Plot of Longfin Smelt Fall Midwater Trawl Relative Abundance Index, Estimated from the General Linear Model Including Mean January–June X2, Comparing Existing and Proposed Project with Additional Spring Delta Outflow (PP-spring) Scenarios.

Table F-2. Predicted Mean Longfin Smelt Fall Midwater Trawl Index Averaged by Water Year Type, Based on General Linear Model Including Mean January–June X2, Comparing Existing and Proposed Project with Additional Spring Delta Outflow (PP-spring) Scenarios.

	Existing	PP	PP-spring	PP vs. Existing[1]	PP vs. Existing[2]	PP-spring vs. Existing[1]	PP-spring vs. Existing[2]
Wet Year	550	530	538	-20 (-4%)	-20 (0%)	-11 (-2%)	-11 (0%)
Above Normal Year	249	236	246	-13 (-5%)	-13 (0%)	-3 (-1%)	-3 (0%)
Below Normal Year	119	114	119	-5 (-4%)	-5 (0%)	0 (0%)	0 (0%)
Dry Year	74	70	72	-4 (-5%)	-4 (0%)	-2 (-3%)	-2 (0%)
Critical Year	43	41	42	-1 (-3%)	-1 (0%)	-1 (-2%)	-1 (0%)

Notes: [1] Difference is absolute difference between mean estimates, with values in parentheses representing % difference in mean. Equivalent comparisons are shown with gray shading.
[2] Difference is absolute difference between mean estimates, with values in parentheses representing mean % difference based on difference between Proposed Project scenarios and Existing, divided by the mean Existing 95% confidence interval, which is an indicator of signal to noise. Equivalent comparisons are shown with blue shading.

APPENDIX G

CLIMATE CHANGE SENSITIVITY ANALYSIS

OPERATIONS SENSITIVITY TO CLIMATE CHANGE PROJECTIONS

This appendix summarizes key findings from a sensitivity analysis of operational changes to existing conditions and proposed project under climate change and sea level rise conditions. The existing conditions and the proposed project for this Incidental Take Permit Application (ITPA) were simulated using CalSim II under the current climate. For this sensitivity analysis, the existing conditions and the proposed project were modeled using climate centered around year 2035 with 15 centimeters (cm) of sea level rise, and climate centered around year 2035 with 45 cm of sea level rise. The climate projections for 2035 conditions were derived from the ensemble of 20 Coupled Model Intercomparison Project 5 (CMIP5) global climate projections selected by the California Department of Water Resources (DWR) Climate Change Technical Advisory Group (CCTAG) as the most appropriate projections for California water resources evaluation and planning (DWR CCTAG, 2015). The 20 climate projections, selected by CCTAG, were generated from 10 global climate models run with two emission scenarios, one optimistic (Representative Concentration Pathway [RCP] 4.5) and one pessimistic (RCP 8.5), identified by the Intergovernmental Panel on Climate Change (IPCC) for the Fifth Assessment Report (AR5) (2014). Consistent with the Bay-Delta Conservation Plan/California WaterFix Analyses (ICF, 2016), historical temperature and precipitation were adjusted to represent future conditions with the quantile mapping approach. Adjustments to temperature and precipitation were calculated with cumulative distribution functions mapped with the 20 downscaled global climate model projections from the CMIP5 (Taylor et al., 2012).

The selected period for the climate change projections reflect the expected duration of the SWP permit. The two considered sea-level rise scenarios reflect the range of projected sea level values identified in the latest Ocean Protection Council Sea-Level Rise Guidance released in 2018 (OPC, 2018). The operations results from these simulations were analyzed to understand if the incremental changes between the existing conditions and the proposed project remain similar with and without climate change. This section summarizes key CalSim II results for the existing conditions and the proposed project under the three climate and sea level rise scenarios. The Attachment 1 includes detailed information about the climate change projections and the necessary changes to CalSim II inputs to reflect the projected hydrology and sea level changes.

Study Objectives

The CalSim II model was applied to evaluate the sensitivity of the existing conditions and proposed project to the future climate and sea level rise conditions described above. The CalSim II model was used for quantifying the changes in river flows, delta channel flows, exports, and water deliveries. Key output parameters from this analysis are shown in Figures 1 through 9. Effects of climate change and sea level rise are summarized below.

Climate Sensitivity Analyses

The existing conditions and proposed project simulations described in the ITPA were modeled under current or historic climate and sea level conditions. For this sensitivity analysis, the existing conditions and proposed project models were generated using the modified hydrologic inputs based on the projected runoff changes under near future climate scenario centered around 2035. The scenarios with historical climate did not include any sea level rise reflecting the historical conditions centered around 1995. The CalSim II simulations in this sensitivity analysis only differ in the hydrology inputs depending on the climate scenario considered and sea level rise effect. None of the other system parameters have been changed.

The purpose of conducting these simulations is to help describe the sensitivity in projected Central Valley Project (CVP)/State Water Project (SWP) system operations under existing conditions and proposed project with respect to climate change and sea level rise. The incremental changes between existing conditions and proposed project with the historical hydrologic conditions (used in the ITPA) were compared to the incremental changes under the projected climate change conditions.

Figures 1 through 9 show the system responses for historical climate (black lines), 2035 future climate scenario with 15 cm of sea level rise (green lines), and 2035 future climate scenario with 45 cm of sea level rise (purple lines). For each climate scenario, the dashed line represents the existing condition and the solid line represents the proposed project. Each plot includes results from the CalSim II simulations for the existing conditions and the proposed project under the above climate scenarios. The plots presented in this document are relevant to assessing whether the hydrology, water quality and aquatic biological resource conclusions analyzed in the ITPA are consistent with the projected climate change conditions. Several key observations can be made based on these simulations:

- Under all climate and sea level rise scenarios, Sacramento River flow at Freeport for existing conditions and proposed project remains similar. Consistent with the current climate, the proposed project flow would be less than existing conditions flow in September (wet years) and November (following wet and above normal years) as a result of the proposed Summer/Fall Delta Smelt Habitat action.
- Yolo Bypass flows are higher during December through March under the future climate projection considered in this analysis relative to the historical climate modeled in the ITPA. However, flows under the proposed project and existing conditions are nearly identical when comparing to the conditions with the same climate and sea level rise assumptions consistent with the findings in the ITPA.
- Incremental changes in flows between proposed project and existing conditions at Georgiana Slough and Delta Cross Channel (DCC) are similar under all climate and sea level rise conditions. These flows reflect the changes in Sacramento River flow at Freeport due to climate change and sea level rise influence on tidal conditions in the estuary. Georgiana Slough flow under proposed project is lower in September (wet years) and November (following wet and above normal years) similar to the Sacramento River flow at Freeport. Whereas, DCC flow under proposed project is greater in September (wet years) and November (following wet and above normal years), likely a result of reduction in DCC gates closure associated with scour concerns.
- Incremental changes in QWEST flows due to the proposed project compared to existing conditions are consistent across the climate change scenarios evaluated. Proposed project operations result in lower Qwest flows in April and May compared to existing conditions, and slightly lower flows in fall

months, with slightly greater flows in winter and summer months under all climate and sea level rise scenarios.

- Incremental changes in Sacramento–San Joaquin Delta (Delta) outflow due to the proposed project operations compared to existing conditions under all climate and sea level scenarios are larger in January, February, and March as compared to current climate and sea level scenario. Under all climate and sea level rise scenarios, Delta outflow is lower in April, May, September (wet years) and November (following wet and above normal years) under the proposed project as compared to the existing conditions.
- Old and Middle River (OMR) flow incremental changes under proposed project compared to existing conditions during December – June are consistent across all climate and sea level scenarios. OMR flow under the proposed project remains similar or slightly greater than OMR flow under existing conditions during December – March and June. OMR is lower in April – May.
- Simulated exports are most sensitive to the climate and sea level rise scenarios in the summer and fall reflecting the changes in available water supply for south-of-Delta SWP and CVP deliveries. With warming climate and salinity intrusion associated with sea level rise, available water supply and exports under existing conditions and proposed project decrease. Exports in the months that are significantly constrained (February through June) are not as sensitive to climate change and sea level rise.

Overall the relative incremental changes due to the proposed project as compared to the existing conditions under the future climate and sea level rise scenarios are similar to that described under the current climate scenario in the ITPA. While future climate and sea level rise will alter some of the magnitude of flows, the relative incremental changes due to the proposed project are similar when compared to existing conditions.

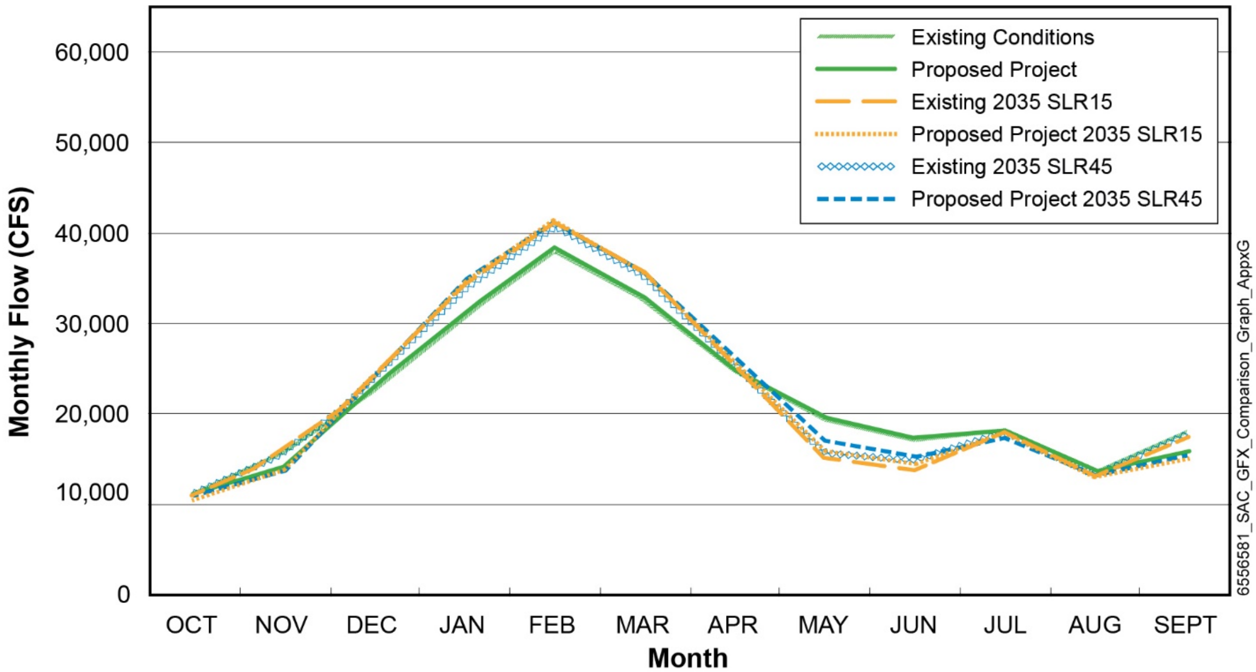


Figure 1 Sacramento River at Freeport Monthly Flow for the existing conditions and proposed project under current climate and near future climate centered around year 2035 with 15 cm and 45 cm of sea level rise

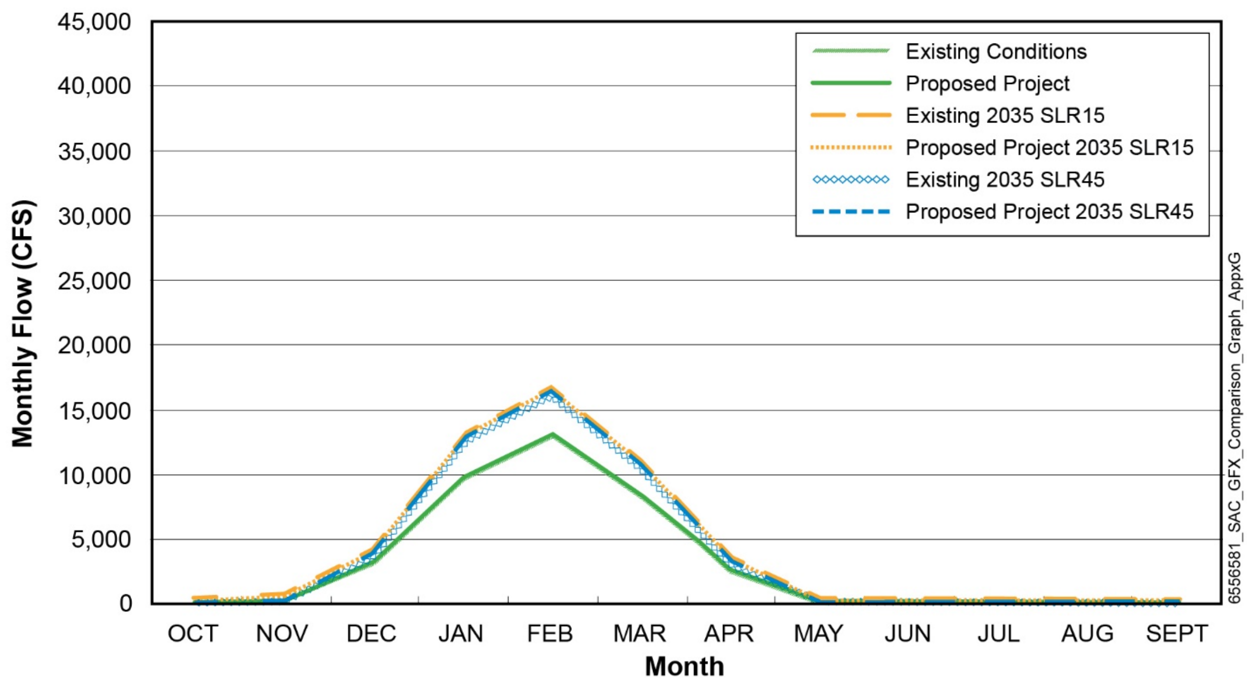


Figure 2 Monthly Yolo Bypass Flow for the existing conditions and proposed project under current climate and near future climate centered around year 2035 with 15 cm and 45 cm of sea level rise

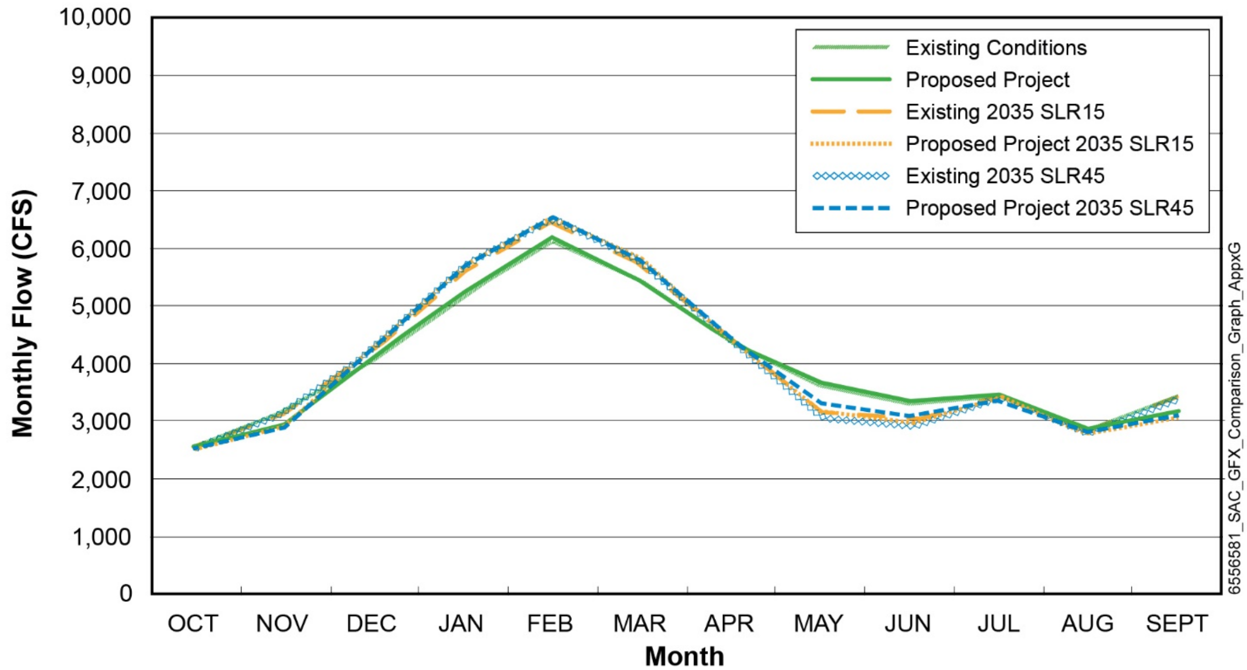


Figure 3 Monthly Georgiana Slough Flow for the existing conditions and proposed project under current climate and near future climate centered around year 2035 with 15 cm and 45 cm of sea level rise

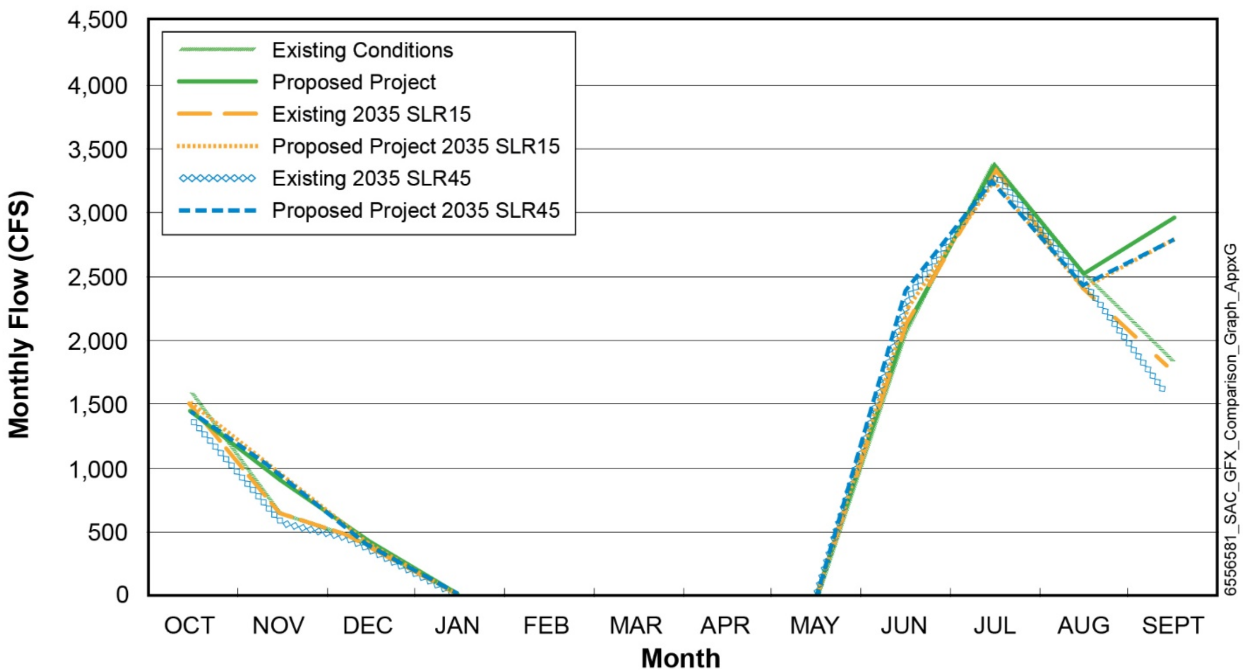


Figure 4 Monthly DCC Flow for the existing conditions and proposed project under current climate and near future climate centered around year 2035 with 15 cm and 45 cm of sea level rise

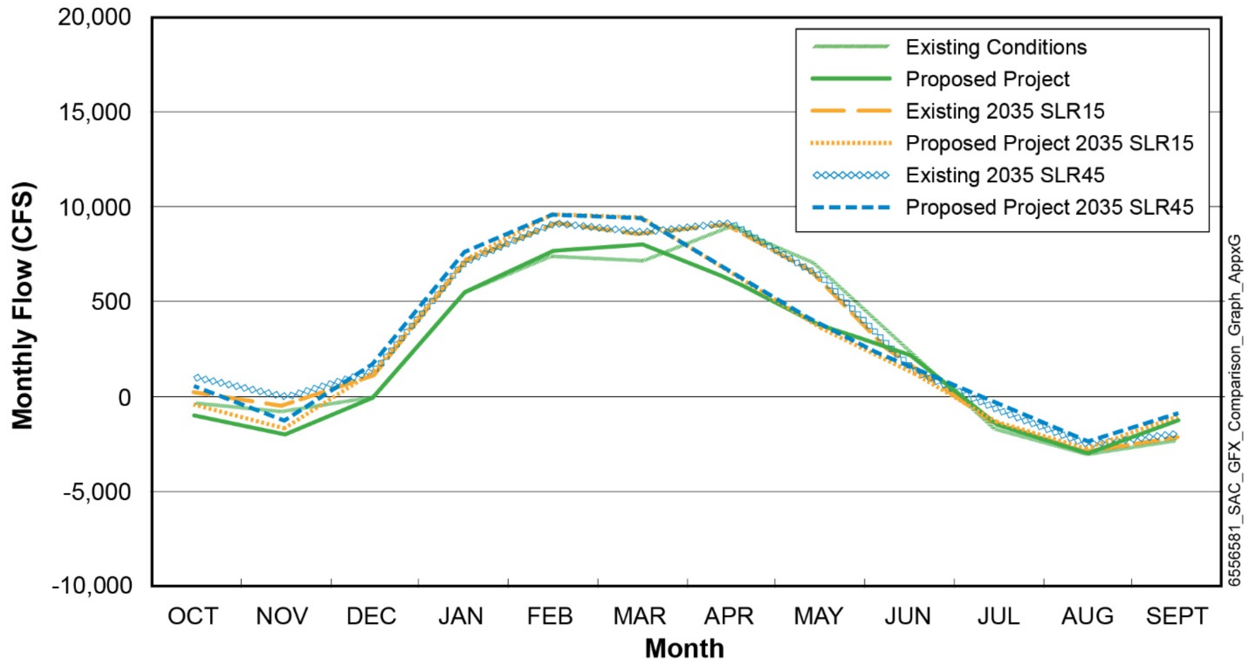


Figure 5 Monthly Qwest Flow for the existing conditions and proposed project under current climate and near future climate centered around year 2035 with 15 cm and 45 cm of sea level rise

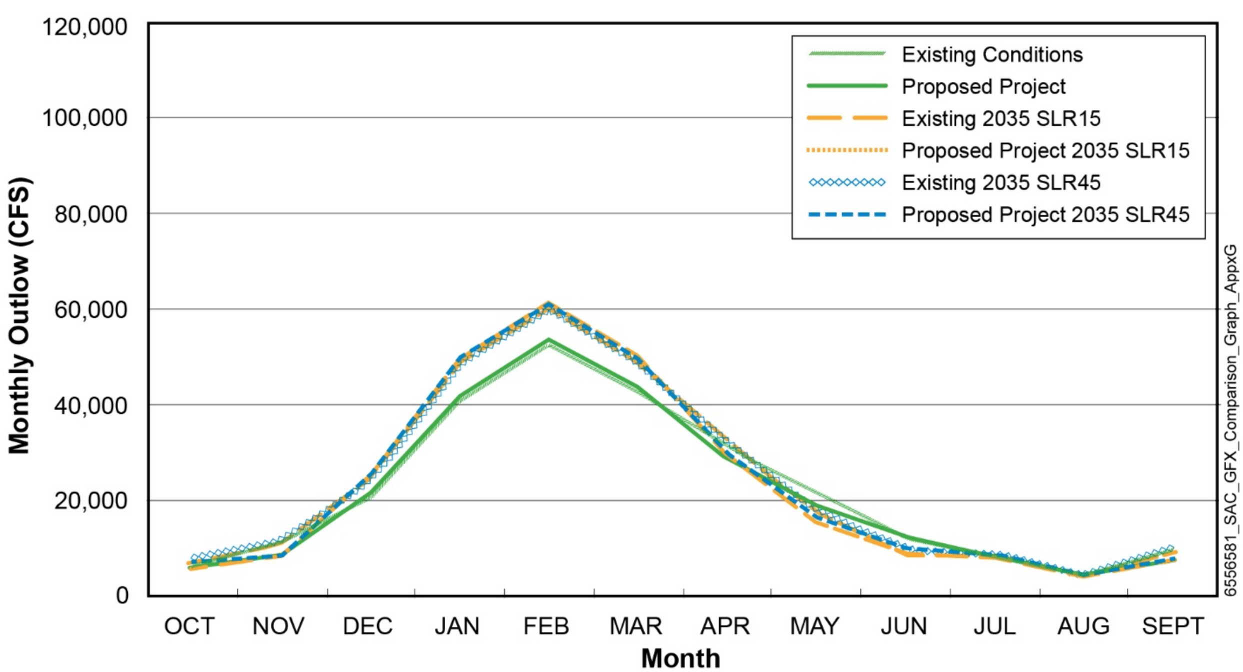


Figure 6 Monthly Delta Outflow for the existing conditions and proposed project under current climate and near future climate centered around year 2035 with 15 cm and 45 cm of sea level rise

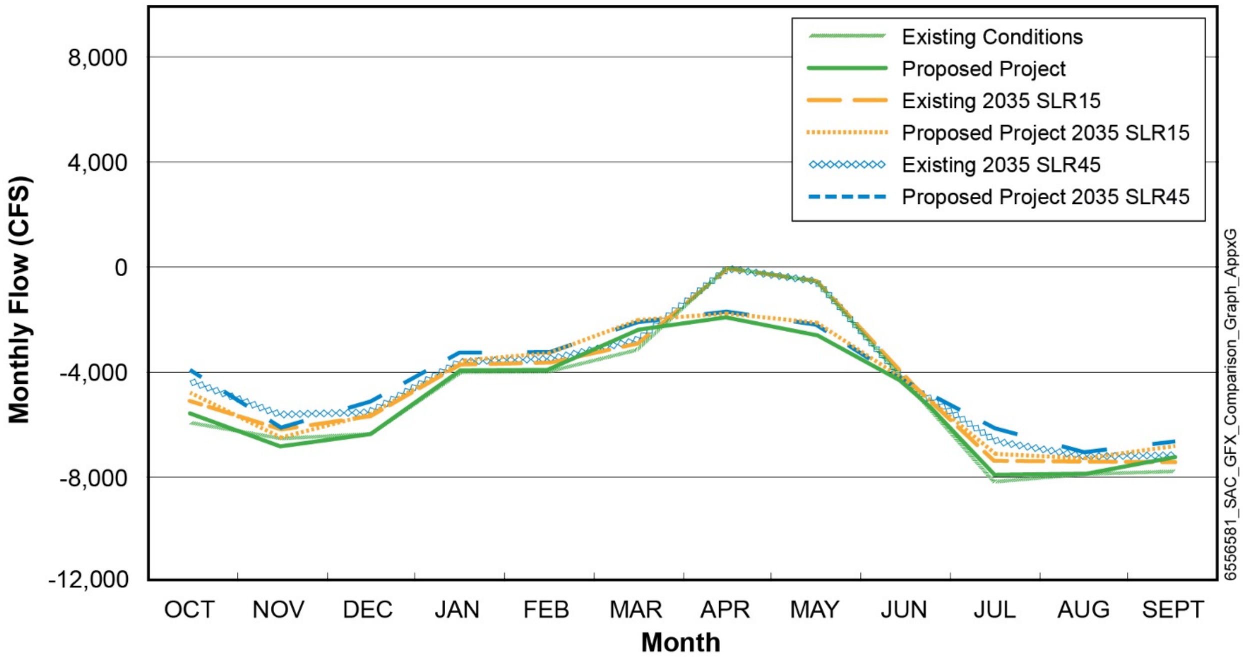


Figure 7 Combined Old and Middle River Monthly Flow for the existing conditions and proposed project under current climate and near future climate centered around year 2035 with 15 cm and 45 cm of sea level rise

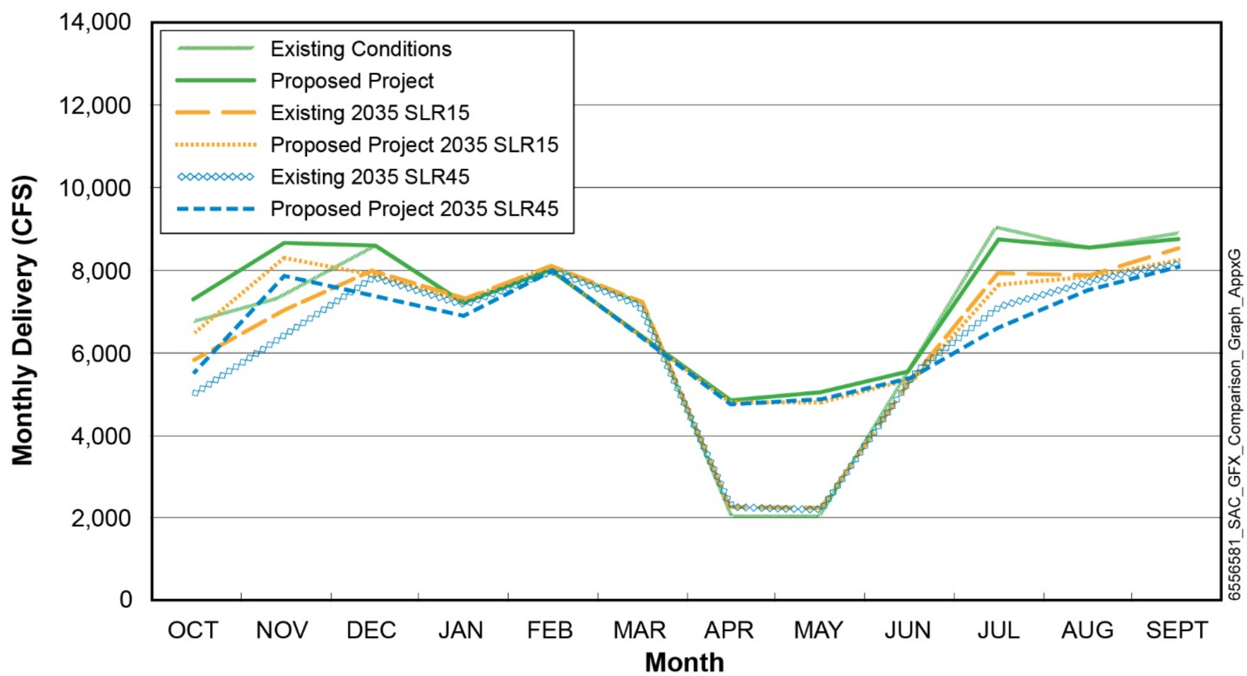


Figure 8 Monthly Delta Exports for the existing conditions and proposed project under current climate and near future climate centered around year 2035 with 15 cm and 45 cm of sea level rise

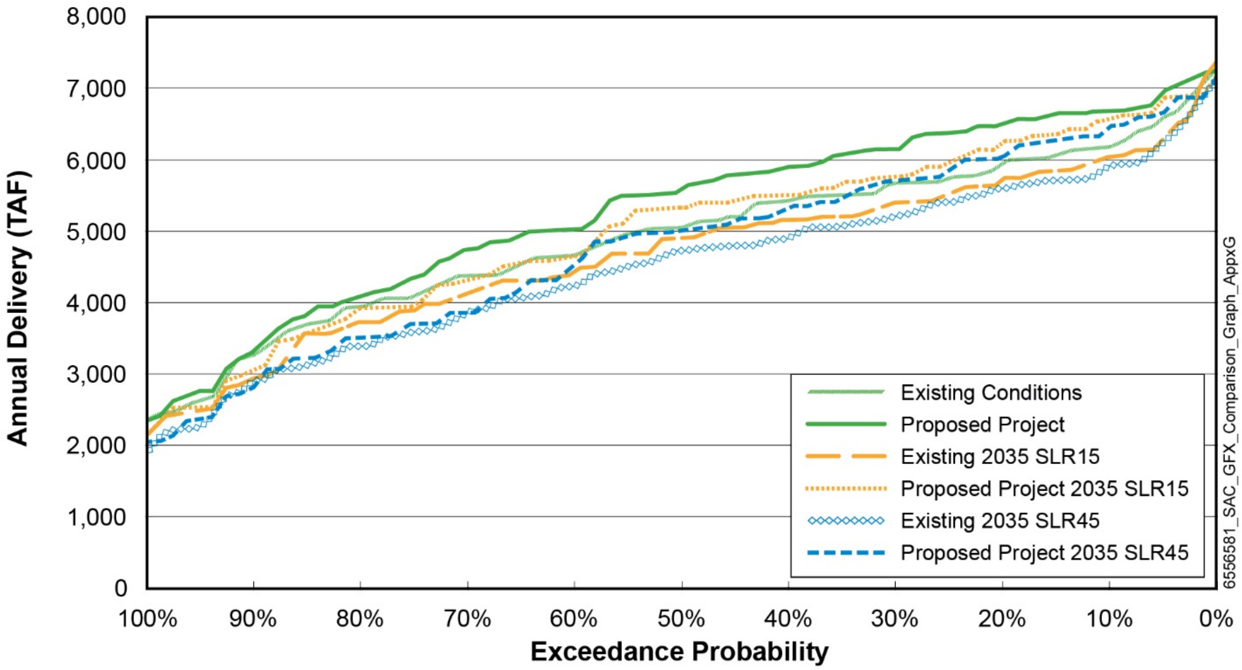


Figure 9 Annual Delta Exports for the existing conditions and proposed project under current climate and near future climate centered around year 2035 with 15 cm and 45 cm of sea level rise

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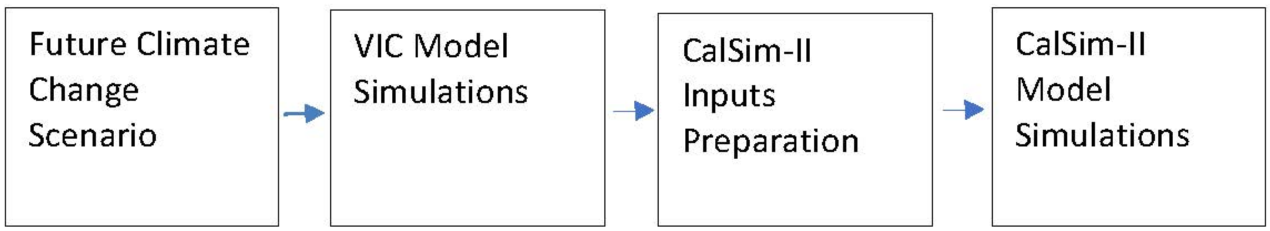
Attachment 1

The purpose of this attachment is to detail the steps in developing climate change boundary conditions for the CalSim II model. Figure 1 shows the dataset development and modeling sequence.

Figure 1 Dataset Development and Modeling Sequence



Historical Observed Meteorological Data

Livneh et al. (2013) daily historical meteorology data at 1/16th degree (~6 kilometers [km]) (~3.75 miles) spatial resolution over the period 1915 through 2011 was used to develop historical Variable Infiltration Capacity (VIC) simulation and future climate change scenarios based on quantile mapping approach. These historical data were adjusted based on PRISM data (Daly et al., 1994) to correct biases found in the pre-1950 period. These datasets have already been reviewed under the Sacramento – San Joaquin River Basins Study, Central Valley Flood Protection Plan (CVFPP) 2017 Update, and Water Storage Investment Program (WSIP).

Future Climate Change Scenario

The climate change scenario centered around 2035 (2020–2049) was developed with the ensemble informed climate change scenarios method, using the 20 Coupled Model Intercomparison Project 5 (CMIP5) global climate model projections. These projections were downscaled using the localized constructed analog (LOCA) method at 1/16th degree (approximately 6 km, or approximately 3.75 miles) spatial resolution (Pierce et al., 2014). The LOCA method is a statistical scheme that uses future climate projections combined with historical analog events to produce daily downscaled precipitation, and maximum and minimum temperature time series data. Further details on the LOCA downscaling can be found in WSIP Technical Reference Document Appendix A (CWC, 2017).

The 20 CMIP5 global climate projections were selected by the California Department of Water Resources (DWR) Climate Change Technical Advisory Group (CCTAG) as the most appropriate projections for California water resources evaluation and planning (DWR CCTAG, 2015) (Table 1). The climate model projections were generated with two emission scenarios, one optimistic (Representative Concentration Pathway [RCP] 4.5) and one pessimistic (RCP 8.5), identified by the IPCC for the Fifth Assessment Report (AR5) (IPCC, 2013).

Table 1. CCTAG Recommended Climate Models

Model Number	Model Name	Model Institution	Model Resolution[a]
1	ACCESS-1.0	Commonwealth Scientific and Industrial Research Organisation and Bureau of Meteorology	192 x 145 (165 km)
2	CCSM4	National Center for Atmospheric Research	288 x 192 (110 km)
3	CESM1-BGC	National Science Foundation, Department of Energy, National Center for Atmospheric Research	288 x 192 (110 km)
4	CMCC-CMS	Centro Euro-Mediterraneo per I Cambiamenti Climatici	192 x 96 (165 km)
5	CNRM-CM5	Centre National de Recherches Météorologiques, Centre Européen de Recherche et Formation Avancées en Calcul Scientifique	256 x 128 (123 km)
6	CanESM2	Canadian Centre for Climate Modeling and Analysis	128 x 64 (247 km)
7	GFDL-CM3	Geophysical Fluid Dynamics Laboratory	144 x 90 (219 km)
8	HadGEM2-CC	Met Office Hadley Centre	192 x 145 (165 km)
9	HadGEM2-ES	Met Office Hadley Centre; additional HadGEM2-ES realizations contributed by Instituto Nacional de Pesquisas Espaciais	192 x 145 (165 km)
10	MIROC5	Atmosphere and Ocean Research Institute at the University of Tokyo, National Institute for Environmental Studies, and Japan Agency for Marine-Earth Science and Technology	256 x 128 (123 km)

Table Notes:
CCTAG = Climate Change Technical Advisory Group
km = kilometers
Models are listed alphabetically.
a Size of the model's atmospheric grid (number of longitudes by number of latitudes)
Consistent with the Bay-Delta Conservation Plan/California WaterFix Analyses (ICF, 2016), historical temperature and precipitation were adjusted to represent future conditions with the quantile mapping approach. Adjustments to temperature and precipitation were calculated with cumulative distribution functions mapped with the 20 downscaled global climate model projections from the CMIP5 (Taylor et al., 2012).

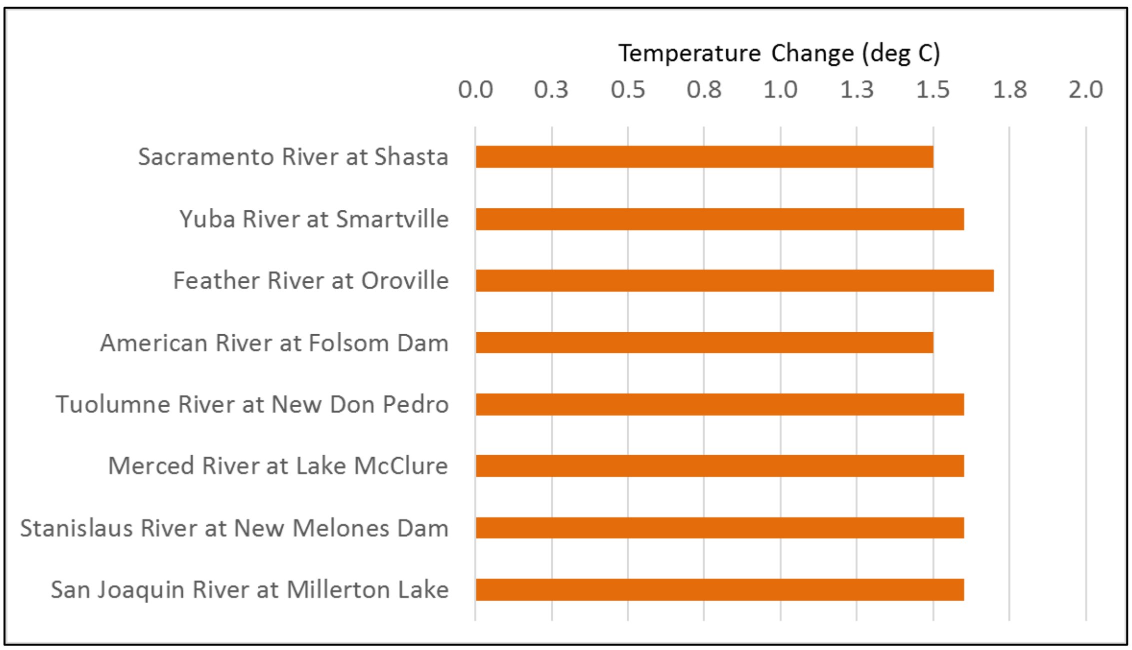
The quantile mapping approach involves the following steps:

- Extract a 30-year slice of climate model data (precipitation, and maximum and minimum temperatures) from downscaled ensemble climate projection centered on reference (1995: 1980–2009) and future periods (2035: 2020–2049).
- For each calendar month (e.g., January) of the future period, calculate cumulative distribution function (CDF) of temperature and precipitation at each grid cell.
- For each calendar month of the model simulated reference period (1980–2009), calculate CDFs of temperature and precipitation at each grid cell.
- Calculate the ratio (future period divided by reference period) for precipitation and 'deltas' (future period minus reference period) for each quantile from the reference and future period CDFs.

- Apply these ratios and deltas to develop a monthly time series of temperature and precipitation at 1/16th degree (~6 km) (~3.75 miles) over the period 1915–2011 that incorporates the climate shift of the future period.
- Convert monthly time series to a daily time series by scaling monthly values to daily sequence found in the observed record.

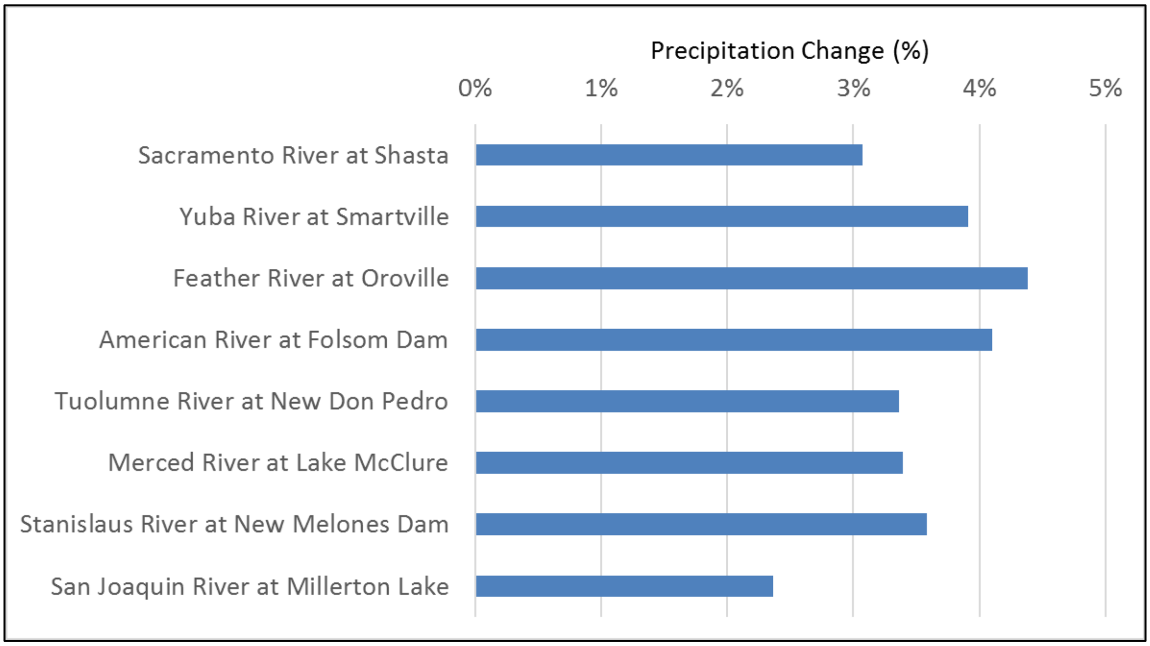
Figure 2 shows the projected change in long-term average temperature for the major watersheds in the Sacramento and San Joaquin River Basins using the climate change scenario for 2035 future conditions. Compared to the reference period (1995), average temperature is projected to increase by at least 1.5 degrees Celsius (°C) in all major watersheds. The highest temperature increases in the Sacramento River Basin occur in the Yuba River (1.6°C) and Feather River (1.7°C) watersheds. All major San Joaquin River Basin watersheds are expected to increase by 1.6°C.

Figure 2. Projected Change in Average Temperature for Major Watersheds in the Sacramento and San Joaquin River Basins



Projected change in long-term average precipitation for major watersheds in the Sacramento and San Joaquin River Basins are presented in Figure 3. Overall, all major watersheds are projected to be wetter, with average precipitation increases of 2.4% to 4.4%. Sacramento River Basin is projected to experience a higher increase in long-term average precipitation than the San Joaquin River Basin.

Figure 3. Projected Change in Precipitation for Major Watersheds in the Sacramento and San Joaquin River Basins



Projected streamflow data were generated by inputting adjusted temperature and precipitation time series data for 2035 conditions into the Variable Infiltration Capacity (VIC) hydrologic model.

VIC Model Simulations

Historical and projected surface runoff and baseflow at 1/16th degree (approximately 6 km, or 3.75 miles) were generated by inputting historical and projected meteorological data into the VIC model. The VIC Model (Liang et al., 1994, 1996; Nijssen et al., 1997) simulates land-surface-atmosphere exchanges of moisture and energy at each model grid cell. The VIC Model incorporates spatially distributed parameters describing topography, soils, land use, and vegetation classes.

VIC simulated surface runoff and baseflow were used to produce routed streamflows at several locations in the Sacramento and San Joaquin River Basin. VIC model and routing model network are consistent with modeling conducted in the WSIP. Further details on the VIC model and routing model can be found in WSIP Technical Reference Document Appendix A (CWC, 2017).

Sea Level Rise Scenarios

For this analysis, the existing conditions and the proposed project were modeled using climate centered around year 2035 with 15 cm of Sea Level Rise (SLR), and climate centered around year 2035 with 45 cm of SLR. The two considered SLR scenarios reflect the range of projected sea level values identified in the latest Ocean Protection Council Sea-Level Rise Guidance released in 2018 (OPC, 2018).

CalSim-II Inputs Preparation

Climate and sea-level change are incorporated into CalSim-II in two ways: changes to the input hydrology, and changes to the flow-salinity relationship in the Delta due to SLR.

The following methods were used to calculate projected CalSim-II inflow data:

1. For larger and smaller watersheds, simulated changes in streamflows (simulated future streamflows divided by historical simulated streamflows) were applied to the CalSim-II inflows. These fractional changes were first applied for every month of the 82-year period consistent with the VIC Model simulated patterns. A second order correction was then applied to confirm that the annual shifts in runoff at each location were consistent with that generated from the VIC Model. Similarly, fractional changes were also used to simulate change in precipitation and temperature as needed for calculation of certain parameters used in CalSim-II. This approach is consistent with the approach used in the Bay Delta Conservation Plan (BDCP)/California WaterFix (CA Water) Fix modeling.
2. For larger watersheds where streamflows are heavily impaired, a process was implemented by calculating historical impairment based on observed data, and adding that impairment back onto the VIC Model simulated flows at a location upstream of the impairment. This approach is consistent with the approach used in the WSIP CalSim-II modeling under future conditions.
3. Water year types and other indices used in system operation decisions by CalSim II were regenerated using adjusted flows, precipitation, or temperature as needed in their respective methods.
4. SLR effects on the flow-salinity response in CalSim-II were incorporated by a separate Artificial Neural Network (ANN) for future climate condition.
5. SLR effects were used in the regression equations to estimate the flow split between the Sacramento River and Georgiana Slough at times when the Delta Cross Channel (DCC) is open or closed.

Use of Fractional Changes for Climate Data

Fractional changes in streamflows (simulated future streamflows divided by historical simulated streamflows) were applied to the CalSim-II inflows for larger and smaller watersheds. In addition, projected precipitation, used to calculate forecasts, were projected with fractional changes. Change in temperature, used to calculate Old and Middle River flow requirements, were projected with absolute changes. These are further described in the following subsections.

Streamflows

For smaller and larger watersheds in the system, climate change ratios were used to adjust CalSim-II inflow data obtained from the 2017 SWP Delivery Capability Report (DWR, 2018). Tables 2 and 3 list these small and large watersheds, respectively. The climate change ratios were computed based on VIC Model simulations using historical, detrended climate forcing and climate change projections.

Table 2. River Locations for Upper Watersheds in CalSim-II

River Locations	CalSim Arc	Approach
Trinity River at Trinity Lake	I1	Developed climate change ratio
Sacramento River at Shasta Dam	I4	Developed climate change ratio
Feather River at Oroville	I6	Developed climate change ratio
American River North Fork + Middle Fork	I300	Developed climate change ratio. Partitioned from American River (I300 + I8) based on monthly ratios (I300/(I300+I8)) in CalSim-II inflow[1]
American River South Fork + Local Flow	I8	Developed climate change ratio. Partitioned from American River (I300 + I8) based on monthly ratios (I8/(I300+I8)) in CalSim-II inflow[1]
Cosumnes River at Michigan Bar	I501	Developed climate change ratio
Calaveras River at New Hogan	I92	Developed climate change ratio
Merced River at Lake McClure	I20	Developed climate change ratio
San Joaquin River at Millerton Lake	I18_SJR + I18_FG	Developed climate change ratio
San Joaquin River at Millerton Lake (without Fine Gold Creek)	I18_SJR	Developed climate change ratio. Partitioned from San Joaquin River inflow to Millerton Lake (I18) based on monthly ratios in CalSim-II inflow[1]

Table Notes:

[1]CalSim-II inflow data were obtained from the DWR ITP baseline study.

Table 3. River Locations for Small Watershed Tributaries in CalSim-II

Tributary	CalSim Arc	Approach
Cow Creek	I10801	Developed climate change ratio, and used as reference for other locations
Battle Creek	I10803	Used climate change ratio developed based on Cow Creek
Cottonwood Creek	I10802	Developed climate change ratio
Deer Creek	I11309	Developed climate change ratio, and used as reference for other locations
Paynes Creek	I11001	Used climate change ratio developed based on Deer Creek
Red Bank Creek	I112	Used climate change ratio developed based on Deer Creek
Antelope Creek	I11307	Used climate change ratio developed based on Deer Creek
Mill Creek	I11308	Used climate change ratio developed based on Deer Creek
Thomes Creek	I11304	Developed climate change ratio, and used as reference for other locations
Elder Creek	I11303	Used climate change ratio based on Thomes Creek
Lewiston inflow	I100	Not modified
Whiskeytown inflow	I3	Developed climate change ratio
Bear river inflow	I285	Developed climate change ratio
Butte Creek	I217	Developed climate change ratio, and used as reference for other locations
Big Chico Creek	I11501	Used climate change ratio developed based on Butte Creek
Kelly Ridge	I200	Not modified
Fresno River inflow to Hensley Lake	I52	Developed climate change ratio, and used as reference for other locations
Chowchilla River inflow to Eastman Lake	I53	Used climate change ratio developed based on Fresno River inflow to Hensley Lake
Inflow to Black Butte	I42	Developed climate change ratio, and used as reference for other locations
Stony Creek inflow East Park	I40	Used climate change ratio developed based on inflow to Black Butte
Inflow to Stony Gorge	I41	Used climate change ratio developed based on inflow to Black Butte

Precipitation

CalSim-II requires runoff forecasts for the Shasta, Feather, and American river basins. In practice, statistical forecast functions are developed based on observed precipitation and runoff. To mimic the same procedure for forecasts in future climate conditions, forecast functions were developed using projected precipitation and runoff. This approach is consistent with the WSIP CalSim-II modeling under future conditions.

The following steps were taken:

1. Basin-wide average precipitation was computed for future climate condition.
2. Sensitivity factors for precipitation were calculated in reference to historical data for future climate scenario.
3. Historical precipitation indices were perturbed to obtain estimated precipitation indices under future climate scenario. Sensitivity factors for precipitation indices are calculated as the ratio of climate precipitation to historical precipitation for each basin.
4. Perturbed precipitation index estimates were then used to develop regression equations for forecasted runoff.

Temperature

CalSim-II uses temperature data at Sacramento Executive Airport (SEA) to establish trigger dates for Old and Middle River flow requirement in spring months, per U.S. Fish and Wildlife (USFWS) Biological Opinion Reasonable and Prudent Alternative Action 3. To mimic these modeled trigger dates under future climate, temperature sensitivity factors for each climate scenario were calculated at the VIC Model grid location best representative of SEA. Perturbation was applied to the baseline temperature dataset to establish future climate temperature trigger dates.

Use of Projected Runoff from the VIC Model for Impaired Streamflows

Consistent with the WSIP, impairment observed in CalSim-II was reintroduced into projected VIC Model runoff at select locations (Table 4). As information on specific local project operations (impairment) at these locations was not available, impairment was calculated as the difference between the unimpaired historical flow and the CalSim-II inflow time series. The same difference was then applied to projected unimpaired flow to obtain future conditions impaired flows. This method assumes the local project operations will be the same in future climate conditions and does not account for any adaptation in local project operations.

Table 4. River Locations for Upper Watersheds in CalSim-II

River Locations	CalSim Arc	Basis of Bias Correction
Yuba River at Smartsville	I230	Unimpaired flows for use of re-impairment method (re-impairment method uses historical impairment included in CalSim-II inflows based on output from the YCWA HEC model)
American River at Folsom	I300 + I8	Unimpaired flows for use of re-impairment method (re-impairment method uses historical impairment included in CalSim-II inflows based on DWR American River HEC3 model)
Mokelumne River	I504	Unimpaired flows into Pardee Reservoir (I90, use input from EBMUDSIM) for use of re-impairment method (re-impairment method uses historical impairment included in CalSim-II inflows at I504 based on output from EBMUD SIM; in this case re-impairment includes other smaller inflow between I90 and I504)
Stanislaus River at New Melones Dam	I10	Unimpaired flows for use of re-impairment method (re-impairment method uses historical impairment included in CalSim-II inflows)
Tuolumne River at New Don Pedro	I81	Unimpaired flows for use of re-impairment method (re-impairment method uses historical impairment included in CalSim-II inflows)

Table Notes:
EBMUD SIM = East Bay Municipal Utility District Simulation
YCWA HEC = Yuba County Water Agency Hydrologic Engineering Center

Updating Water Year Types and Indices

Water year types and other hydrologic indices used in CalSim-II operational decisions were regenerated using the projected flows and temperatures based on VIC Model simulations (Table 5).

Table 5a. Water Year Types and Other Hydrologic Indices Used in CalSim-II – Table 5a to Table 5c

Table 5a. Water Year Types and Other Hydrologic Indices Used in CalSim-II – Forecasting

Input	CalSim-II File Name	Specification	Raw Data	Raw Data Source	CDEC Station Location/ Station used in VIC Model for Projected Flows
Folsom Inflow Forecast	American_Runoff_ Forecast.table	Fn (WY precip, known streamflows at the time of forecast)	Unimpaired; Basin Precipitation	CDEC; other DWR	AMF; Folsom Basin Precipitation (Index of Gaged)
Oroville Inflow Forecast	Feather_Runoff_ Forecast.table	Fn (WY precip, known streamflows at the time of forecast)	Unimpaired; Basin Precipitation	CDEC; other DWR	FTO; Feather Basin Precipitation (Index of Gaged)
Shasta Inflow Forecast	Sacramento_Runoff_ Forecast.table	Fn (WY precip, known streamflows at the time of forecast)	Unimpaired; Basin Precipitation	CDEC; other DWR	SIS; Shasta Basin Precipitation (Index of Gaged)

Table 5b. Water Year Types and Other Hydrologic Indices Used in CalSim-II – Indices for broad regulatory criteria (simulated with perfect foresight in CalSim-II)

Input	CalSim-II File Name	Specification	Raw Data	Raw Data Source	CDEC Station Location/ Station used in VIC Model for Projected Flows
8RI	EightRiver.table	Sum of eight stations' monthly flows (SacValleyIndex + SJValleyIndex)	Full Natural Flow	CDEC	AMF, FTO, SBB, YRS, MRC, SJF, SNS, TLG
X2 Days	x2days.table	Based on 8RI PMI	Full Natural Flow; Table of electrical conductivity requirements	CDEC; Table available in spreadsheet	8RI (previous line)
SacValley Index	SacValleyIndex.table	Sum of four stations' monthly flows	Full Natural Flow	CDEC	AMF, FTO, SBB, YRS
Sacramento Index	wytypes.table	Water Quality Control Plan 40-30-30	Full Natural Flow	CDEC	AMF, FTO, SBB, YRS
San Joaquin Index	wytypes.table	Water Quality Control Plan 60-20-20	Full Natural Flow	CDEC	MRC, SJF, SNS, TLG
San Joaquin Index	wytypeSJR.table	Water Quality Control Plan 60-20-20	Full Natural Flow	CDEC	MRC, SJF, SNS, TLG
San Joaquin Index – 5-year average	wytypeSJR5.table	5-year running average of WQCP 60-20-20	Full Natural Flow	CDEC	MRC, SJF, SNS, TLG

Table 5c. Water Year Types and Other Hydrologic Indices Used in CalSim-II – Indices and other inputs for Operations policies (with regulatory significance)

Input	CalSim-II File Name	Specification	Raw Data	Raw Data Source	CDEC Station Location/ Station used in VIC Model for Projected Flows
Trinity Index	wytypes.table	Based on TNL WY Total	Full Natural Flow	CDEC	TNL
Shasta Index	wytypes.table	Based on SIS Apr–Jul and WY Totals	Full Natural Flow	CDEC	SIS
Feather River Index	wytypes.table	Based on FTO Apr–Jul and WY Totals	Full Natural Flow	CDEC	FTO
UIFR	UIFR.table	Based on AMF Mar–Nov Totals	--	--	AMF
AmerD893 Index	wytypes.table	Based on AMF Apr–Sep Totals	Full Natural Flow	CDEC	AMF
Delta Index	Delta_Index.table	Based on Jan–May 8RI	Full Natural Flow	CDEC	AMF, FTO, SBB, YRS, MRC, SJF, SNS, TLG

Table Notes:
AMF = American River at Folsom
Apr-Jul = April through July
Apr-Sep = April through September
BRI = Van Duzen River Near Bridgeville at Grizzly Circle
FTO = Feather River at Oroville
Mar-Nov = March through November
MRC = Merced River Near Merced Falls
SBB = Sacramento River Above Bend Bridge
SIS = Sacramento Inflow-Shasta
SJF = San Joaquin River Below Friant
SNS = Stanislaus River-Goodwin
TLG = Tuolumne River-La Grange Dam
TNL = Trinity River at Lewiston
WY = wet years
YRS = Yuba River Near Smartville
"—" = This cell is blank.

Incorporating Effects of SLR in CalSim-II through ANN

Determination of flow-salinity relationships in the Delta is critical to both water project operations and ecosystem management. Operation of the CVP and SWP facilities and management of Delta flows often depend on Delta flow needs for salinity standards.

Salinity in the Delta cannot be simulated accurately by the simple mass balance routing and coarse time step used in CalSim-II. An ANN has been developed that attempts to mimic the flow-salinity relationships as simulated in Delta Simulation Model II (DSM2) and provides a rapid transformation of this information into a form usable by CalSim-II (Sandhu et al., 1999). The ANN is implemented in CalSim-II to confirm operations of the upstream reservoirs and Delta export pumps satisfy specific salinity requirements in the Delta. A more detailed description of the use of ANNs in the CalSim-II model is provided by Wilbur and Munévar (2001).

The ANN developed by DWR (Sandhu et al., 1999; Seneviratne and Wu, 2007) statistically correlates salinity results from a particular DSM2 model run to the peripheral flows (Delta inflows, exports, and diversions), gate operations, and an indicator of tidal energy. The ANN is trained on DSM2 results that may represent historical or future conditions using a full circle analysis (Seneviratne and Wu, 2007). For example, a future SLR may significantly affect the hydrodynamics of the system. The ANN is able to represent this new condition by being retrained using the results from the DSM2 model representing the conditions with the SLR.

The current ANN predicts salinity at various locations in the Delta using the following parameters as input:

- Northern inflows
- San Joaquin River inflow
- DCC gate position
- Total exports and diversions
- Net Delta consumptive use
- An indicator of the tidal energy
- San Joaquin River at Vernalis salinity

Northern inflows include Sacramento River at Freeport flow; Yolo Bypass flow; and combined flow from the Mokelumne, Cosumnes, and Calaveras rivers (eastside streams) minus North Bay Aqueduct and Vallejo exports. Total exports and diversions include those at the SWP Banks Pumping Plant, the CVP Jones Pumping Plant, and Contra Costa Water District (CCWD) diversions, including diversions to Los Vaqueros Reservoir. A total of 148 days of values of each of these parameters is included in the correlation, representing an estimate of the length of memory of antecedent conditions in the Delta.

The ANN model approximates DSM2 model-generated salinity at the following key locations for modeling Delta water quality standards:

- X2

- Sacramento River at Emmaton
- San Joaquin River at Jersey Point
- Sacramento River at Collinsville
- Old River at Rock Slough

In addition, the ANN is capable of providing salinity estimates for Clifton Court Forebay, CCWD Alternate Intake Project, and Los Vaqueros diversion locations.

The ANN may not fully capture the dynamics of the Delta under conditions other than those for which it was trained. It is possible that the ANN will exhibit errors for flow regimes beyond those for which it was trained. Therefore, a new ANN is needed for any SLR scenario or any new Delta configuration (physical changes in Delta) that may result in changed flow-salinity relationships in the Delta.

Two ANNs, retrained by the DWR Bay-Delta Modeling staff, each representing one of the two SLR scenarios (15 cm and 45 cm) were used with the future conditions CalSim-II models, representing 2035. ANN retraining involved the following steps:

The DSM2 model was corroborated using the UnTRIM model to account for SLR effects, enabling a one-dimensional (1-D) model, DSM2, to approximate changes observed in a three-dimensional (3-D) model, UnTRIM.

A range of example long-term CalSim-II scenarios were developed to providea broad range of boundary conditions for the DSM2 models.

Using the grid configuration and the correlations from the corroboration process, several 16-year (water years 1976-1991) DSM2 planning runs were simulated based on the boundary conditions from the identified CalSim-II scenarios to create a training dataset for each new ANN.

ANNs were trained using the Delta flows and Delta cross-channel operations from CalSim-II, along with the salinity (electrical conductivity [EC]) results from DSM2 and the Martinez tide.

The training dataset was divided into two parts: one was used for training the ANN, and the other for validating.

Once the ANN was ready, a full circle analysis was performed to assess the performance of the ANN and confirm similar results were obtained from CalSim-II and DSM2.

A detailed description of the ANN training procedure and the full circle analysis is provided in DWR's 2007 annual report (Seneviratne and Wu, 2007).

Incorporating Effects of SLR in Sacramento River- Georgiana Slough Flow Split

15 cm or 45 cm SLR would change the flow split between Sacramento River and DCC-Georgiana Slough flow. This requires modification of the linear regression equations used to estimate DCC-Georgiana Slough flow in CalSim-II. Table 6 shows the equations to be used in CalSim-II for each SLR condition. The changes to the regression coefficients are made in the .\common\Delta\Xchannel\xc-gates.wresl file.

Table 6. Regression Results for DSM2 Monthly Averaged Cross-Delta Flow (Y-axis) versus Sacramento River Flow Upstream of Sutter Slough (X-axis).

#	Scenario	DCC Open Slope	DCC Open Intercept	DCC Closed Slope	DCC Closed Intercept
1	Current Conditions DSM2[1]	0.3217	1,050.7	0.1321	1,086.6
2	15 or 45 cm SLR DSM2[2]	0.3187	1,094.6	0.1316	1,102.0

Table Notes:
BDCP = Bay Delta Conservation Plan
cm = centimeter
DSM2 = Delta Simulation Model II
SLR = sea level rise

[1] Regression coefficients from 2009 DSM2 recalibration model.

[2] Regression coefficients from 2009 DSM2 recalibration model under 15- and 45-cm SLR using Bay Delta Conservation Plan 040110 No Action CalSim-II results.

The equations to be used with current sea level are:

*Cross-Delta flow (i.e., DCC flow plus Georg. Sl. Flow) = (slope * Sac Flow) + intercept*

Where:

slope = 0.3217, intercept = 1051 cubic feet per second (cfs) when DCC is open slope = 0.1321, intercept = 1087 cfs when DCC is closed.

Assuming the Georgianna Slough flow portion would remain the same whether DCC is open or closed, the split between Georgianna Slough and DCC is calculated as:

*Georgianna Sl. Flow = 0.1321*Qsac + 1087 (whether DCC is open or closed)*

and

*DCC Flow = 0.1896*Qsac - 36 when DCC is open DCC Flow = 0.0 when DCC is closed*

The equation to be used with SLR of 15 or 45 cm are:

*Cross-Delta flow (i.e. DCC flow plus Georg. Sl. Flow) = (slope * Sac Flow) + intercept*

Where

slope = 0.3187, intercept = 1095 cfs when DCC is open slope = 0.1316, intercept = 1102 cfs when DCC is closed

Assuming the Georgianna Slough flow portion would remain the same whether DCC is open or closed, the split between Georgianna Slough and DCC is calculated as:

*Georgianna Sl. Flow = 0.1316*Qsac + 1102 (whether DCC is open or closed)*

and

*DCC Flow = 0.1871*Qsac - 7 when DCC is open DCC Flow = 0.0 when DCC is closed*

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