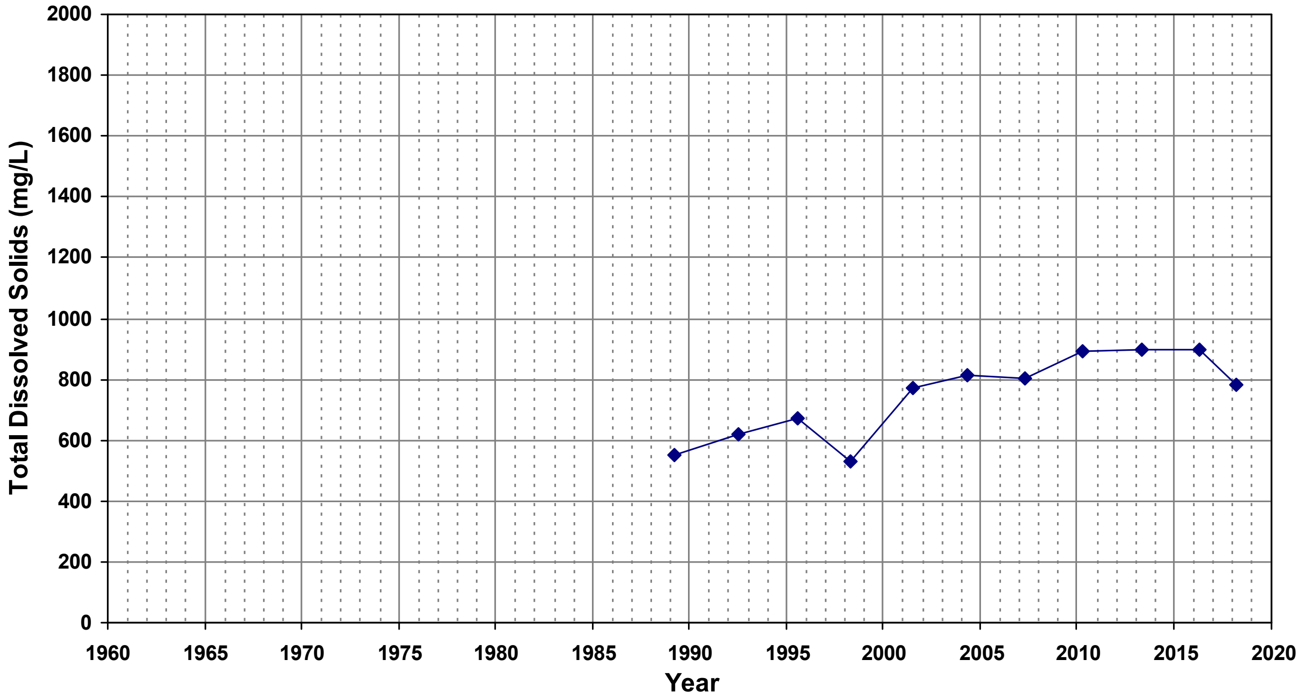
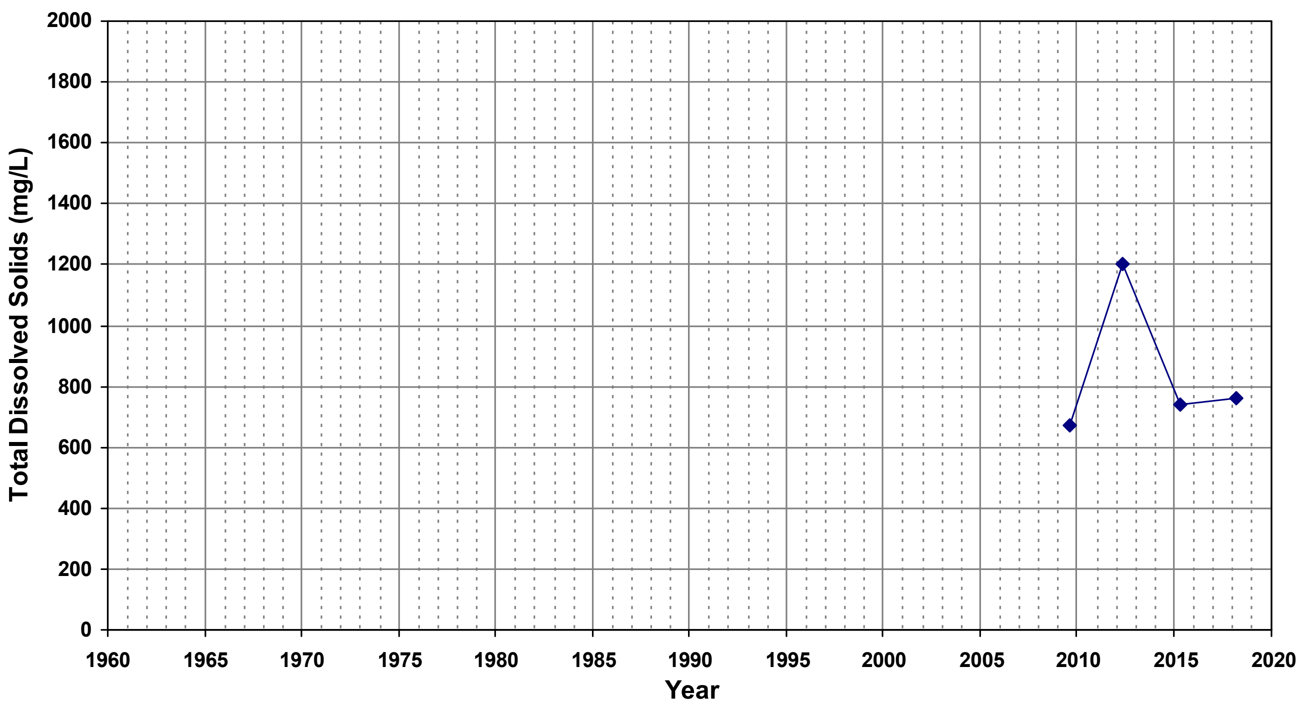
SCWD-Sand Canyon

Well Area: Mint Canyon | RPE (ft msl): 1525
Well Depth (ft): 250 | Screen Elevation (ft msl): 1465 - 1385



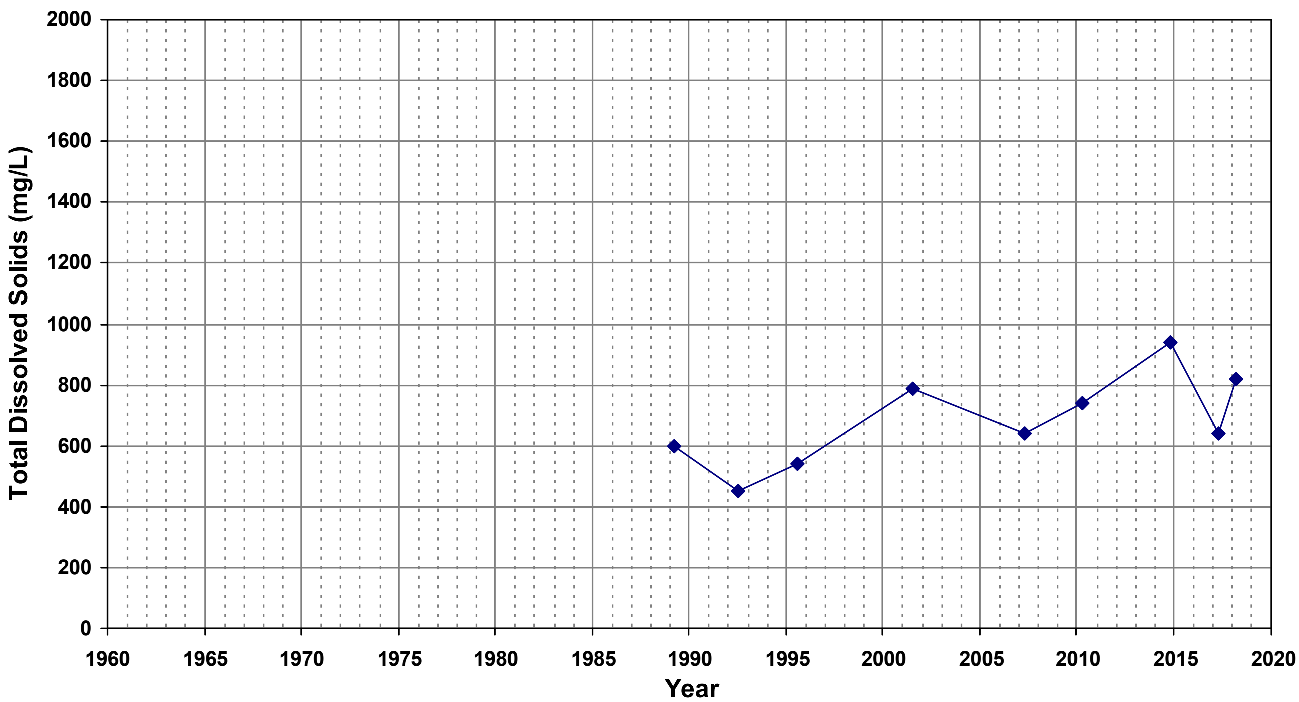
SCWD-SantaClara

Well Area: Above Saugus WRP | RPE (ft msl): 1289
Well Depth (ft): 160 | Screen Elevation (ft msl): 1199 - 1154



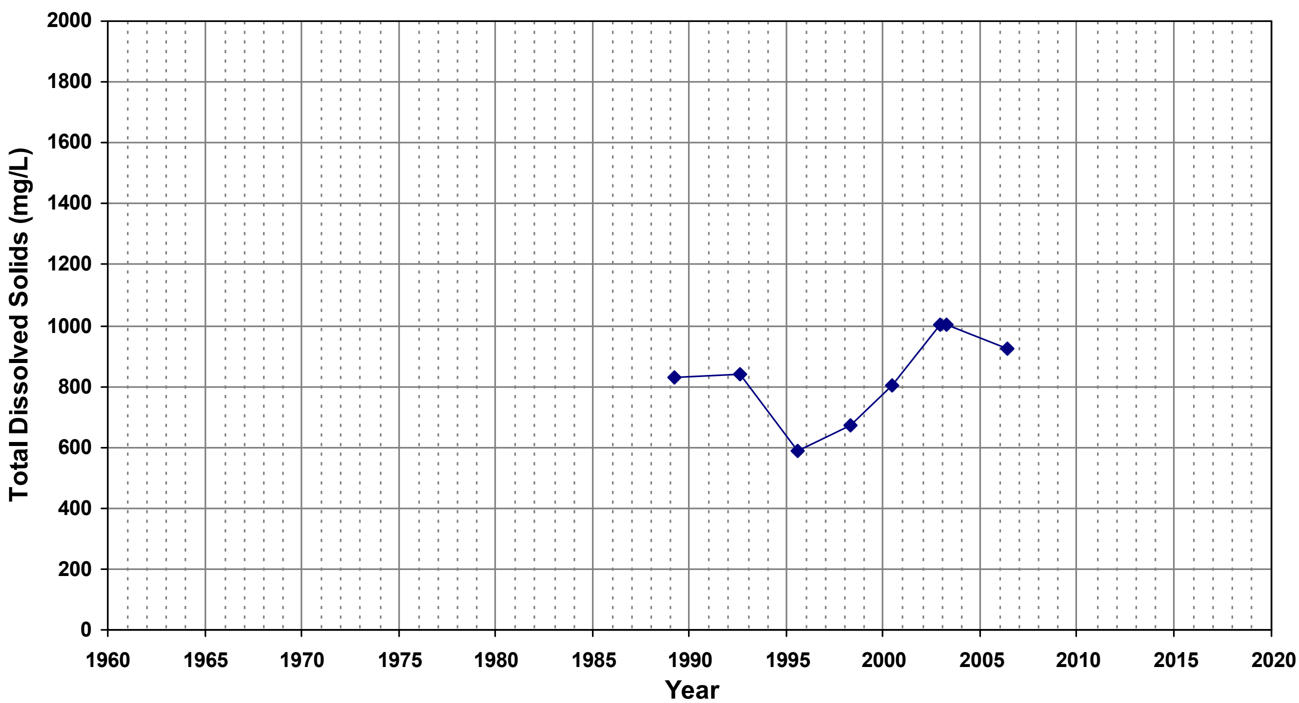
SCWD-Sierra

Well Area: Mint Canyon
Well Depth (ft): 175
RPE (ft msl): 1417
Screen Elevation (ft msl): 1357 - 1242



SCWD-Stadium

Well Area: Above Saugus WRP
Well Depth (ft): 130
RPE (ft msl): 1198
Screen Elevation (ft msl): 1165 - 1068



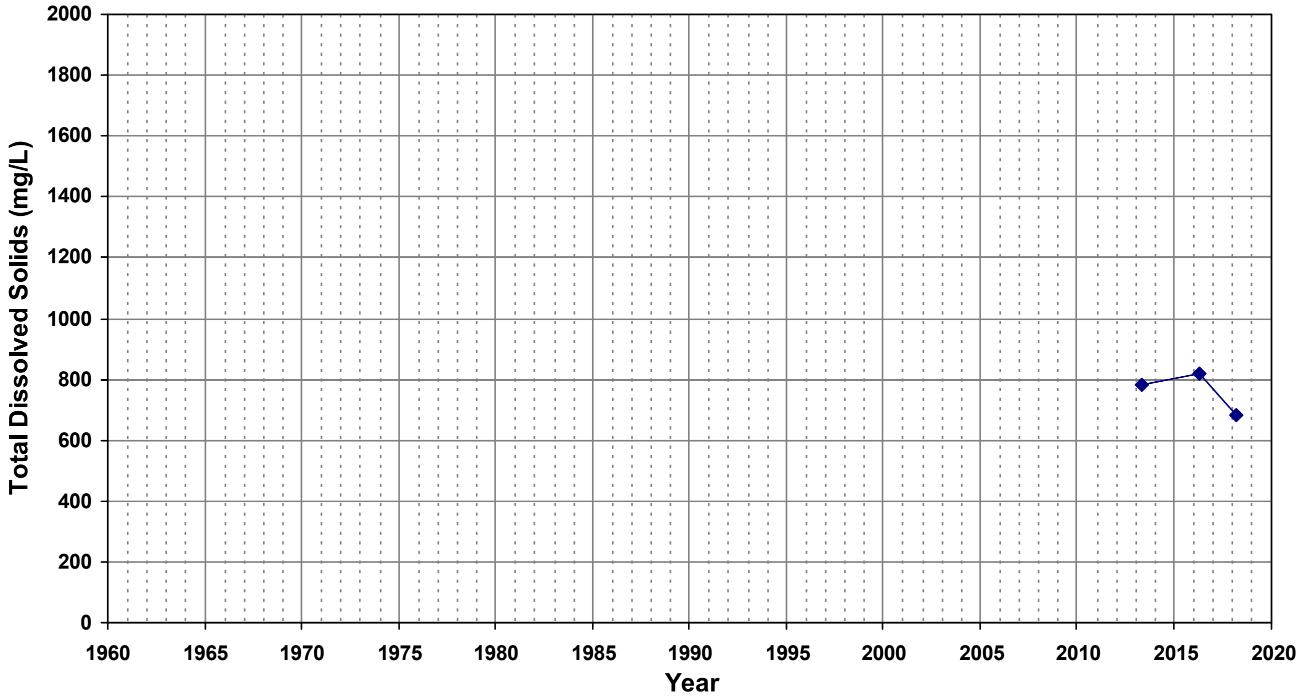
SCWD-Valley Center

Well Area: Above Saugus WRP

Well Depth (ft): 133

RPE (ft msl): 1256

Screen Elevation (ft msl): 1166 - 1131



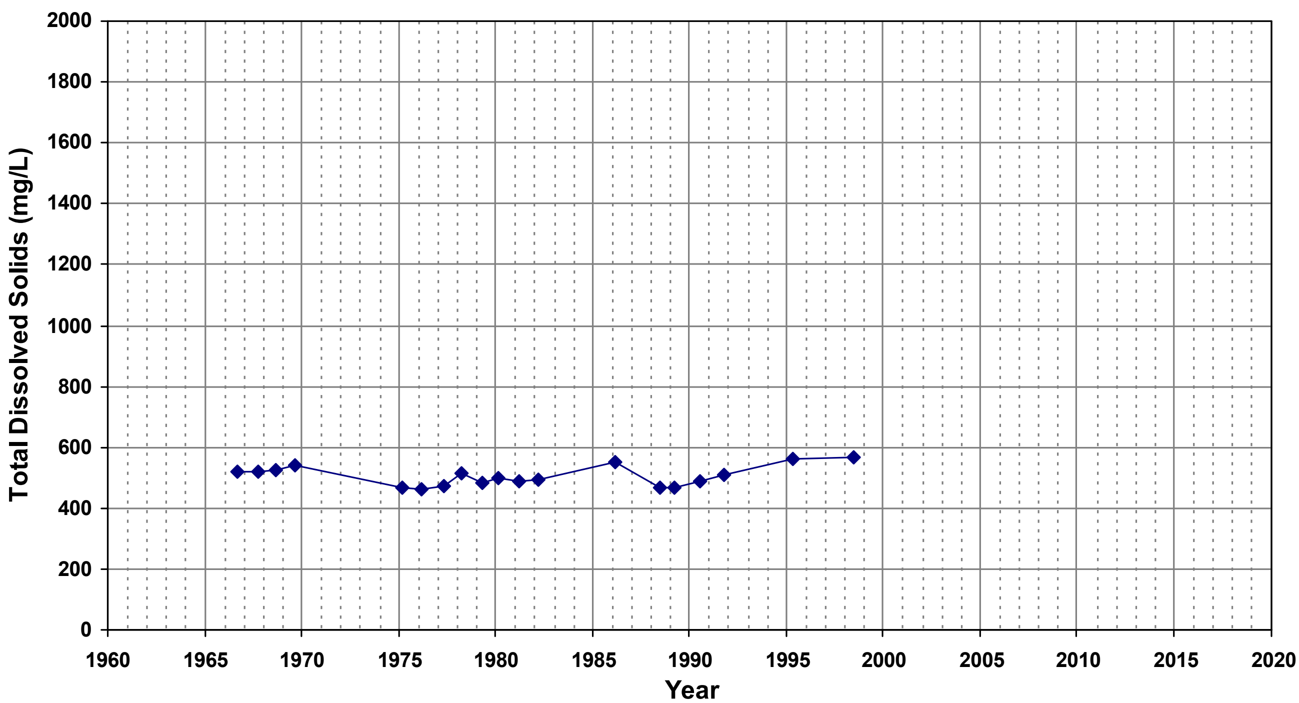
VWD-157

Well Area: Southern Saugus

Well Depth (ft): 2008

RPE (ft msl): 1148

Screen Elevation (ft msl): 562 - -860



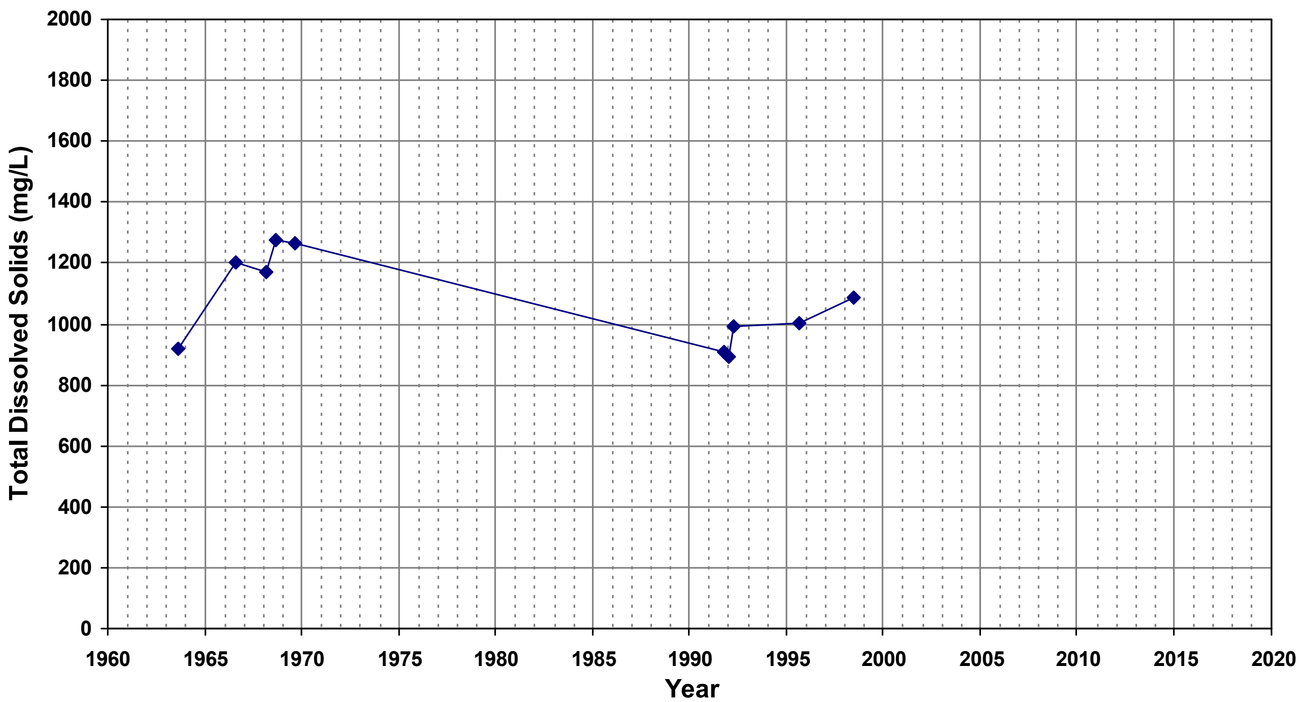
VWD-159

Well Area: Southern Saugus

Well Depth (ft): 1950

RPE (ft msl): 1291.195

Screen Elevation (ft msl): 629 - -609



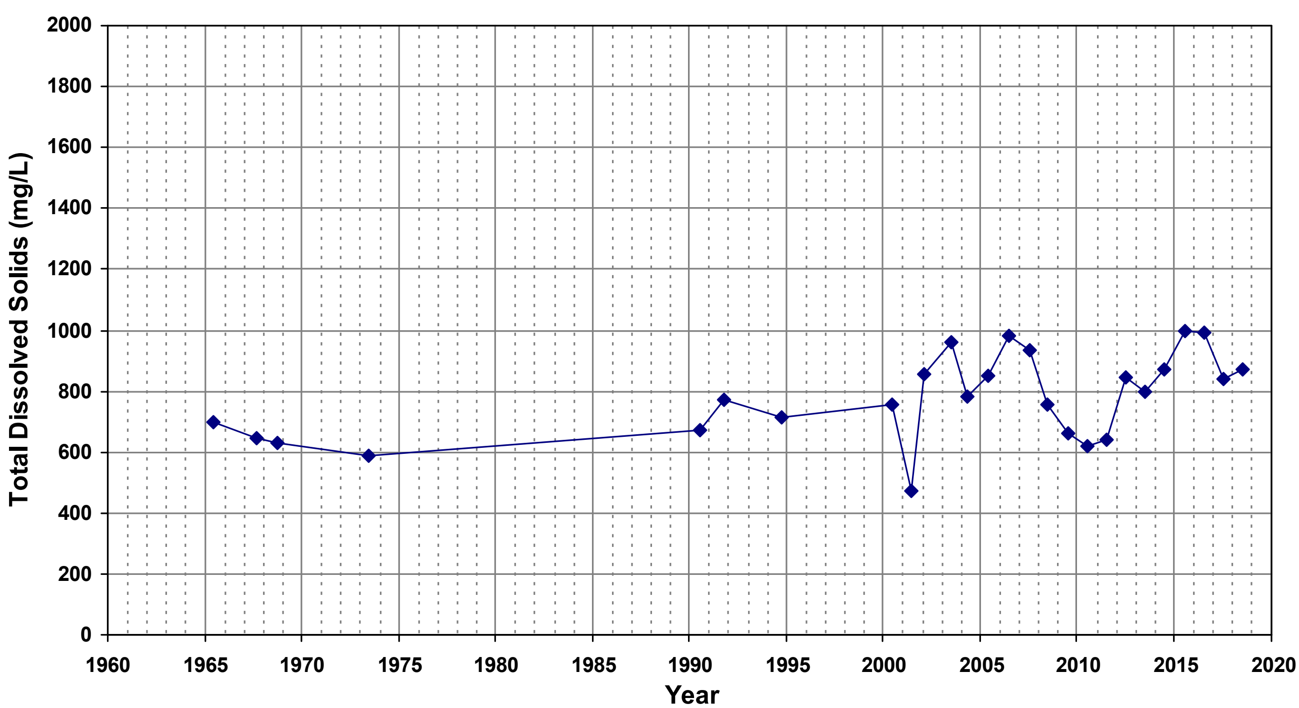
VWD-160

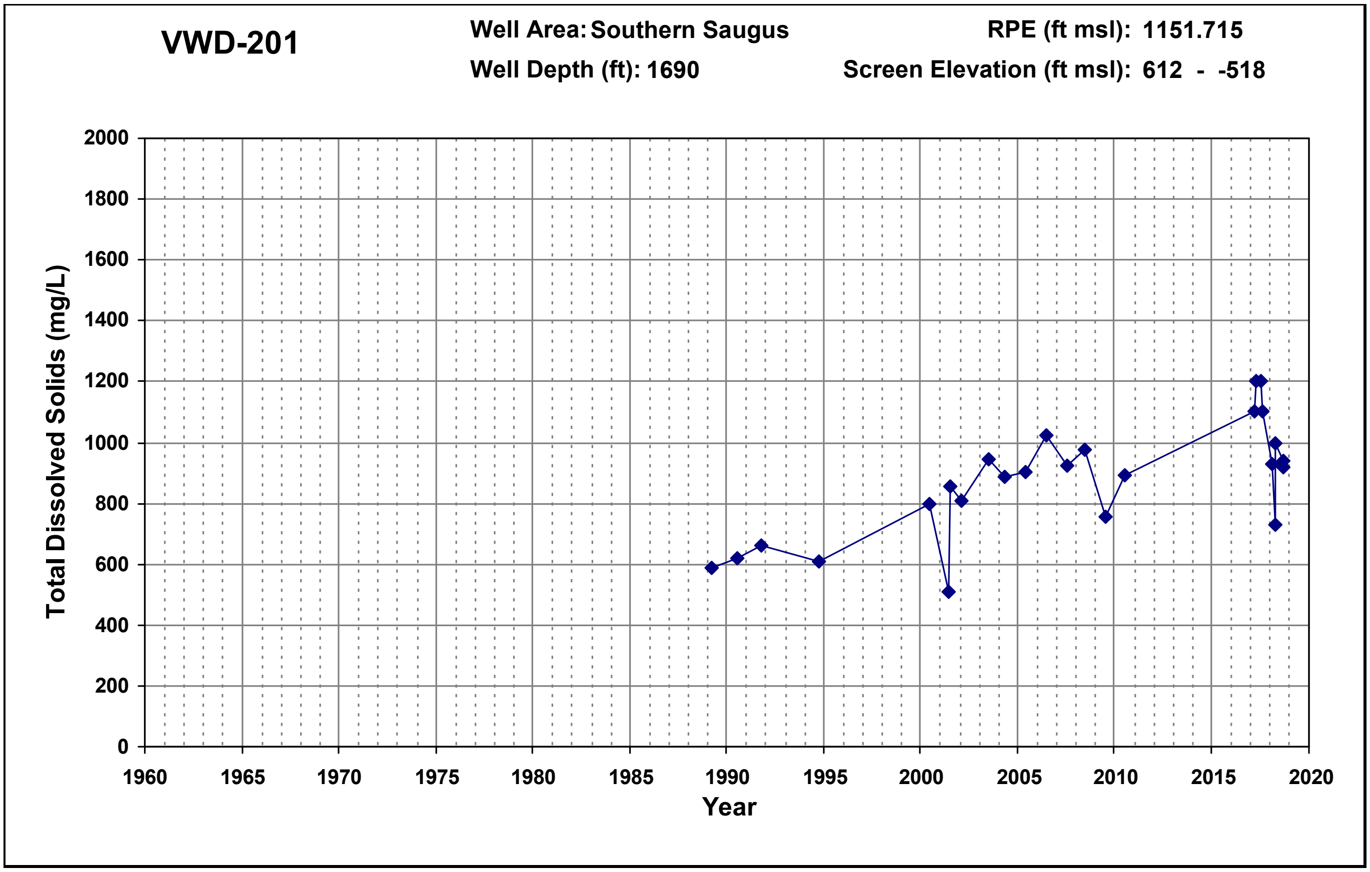
Well Area: Southern Saugus

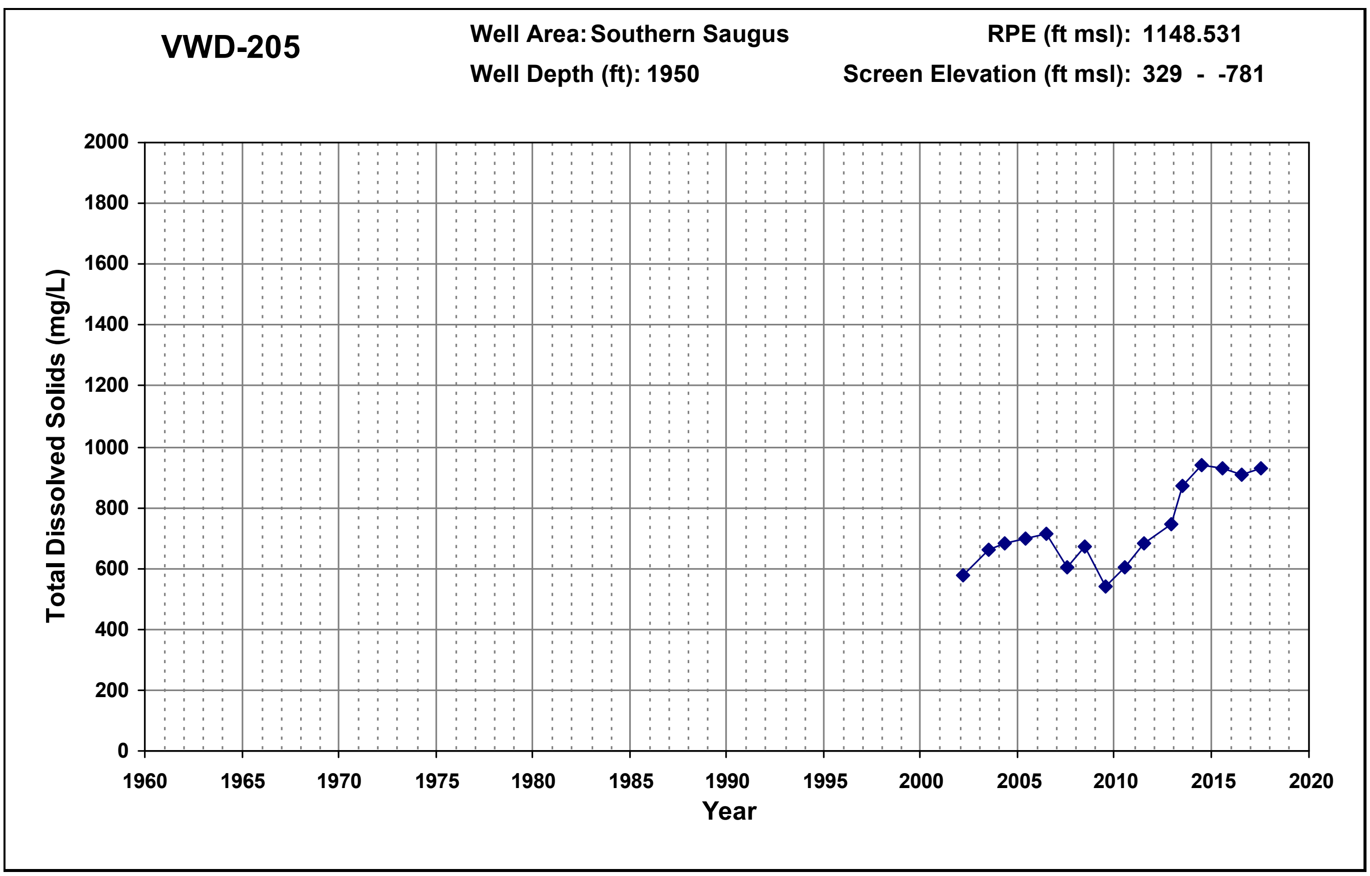
Well Depth (ft): 2000

RPE (ft msl): 1102.083

Screen Elevation (ft msl): 152 - -898




VWD-201
Well Area: Southern Saugus
Well Depth (ft): 1690
RPE (ft msl): 1151.715
Screen Elevation (ft msl): 612 - -518
Total Dissolved Solids (mg/L)
Year
0
200
400
600
800
1000
1200
1400
1600
1800
2000
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020


VWD-205
Well Area: Southern Saugus
Well Depth (ft): 1950
RPE (ft msl): 1148.531
Screen Elevation (ft msl): 329 - -781
Total Dissolved Solids (mg/L)
Year
0
200
400
600
800
1000
1200
1400
1600
1800
2000
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

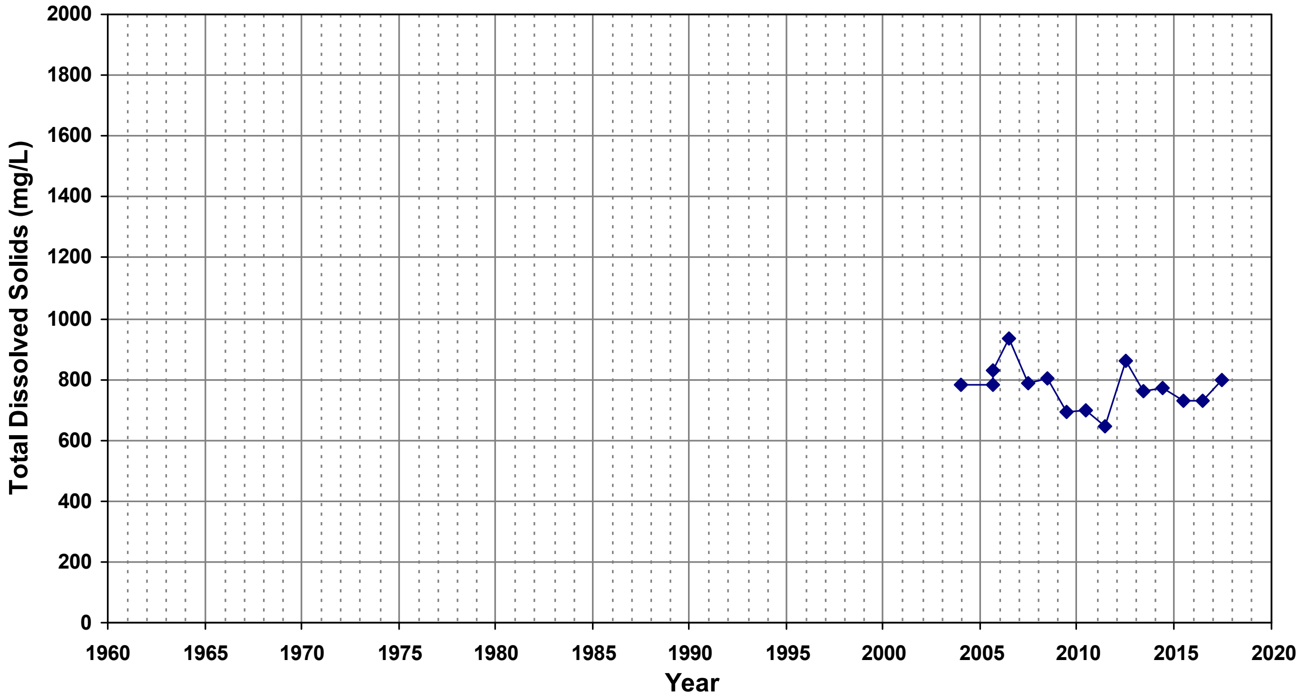
VWD-206

Well Area: Southern Saugus

Well Depth (ft): 2060

RPE (ft msl): 1058.587

Screen Elevation (ft msl): 569 - -981



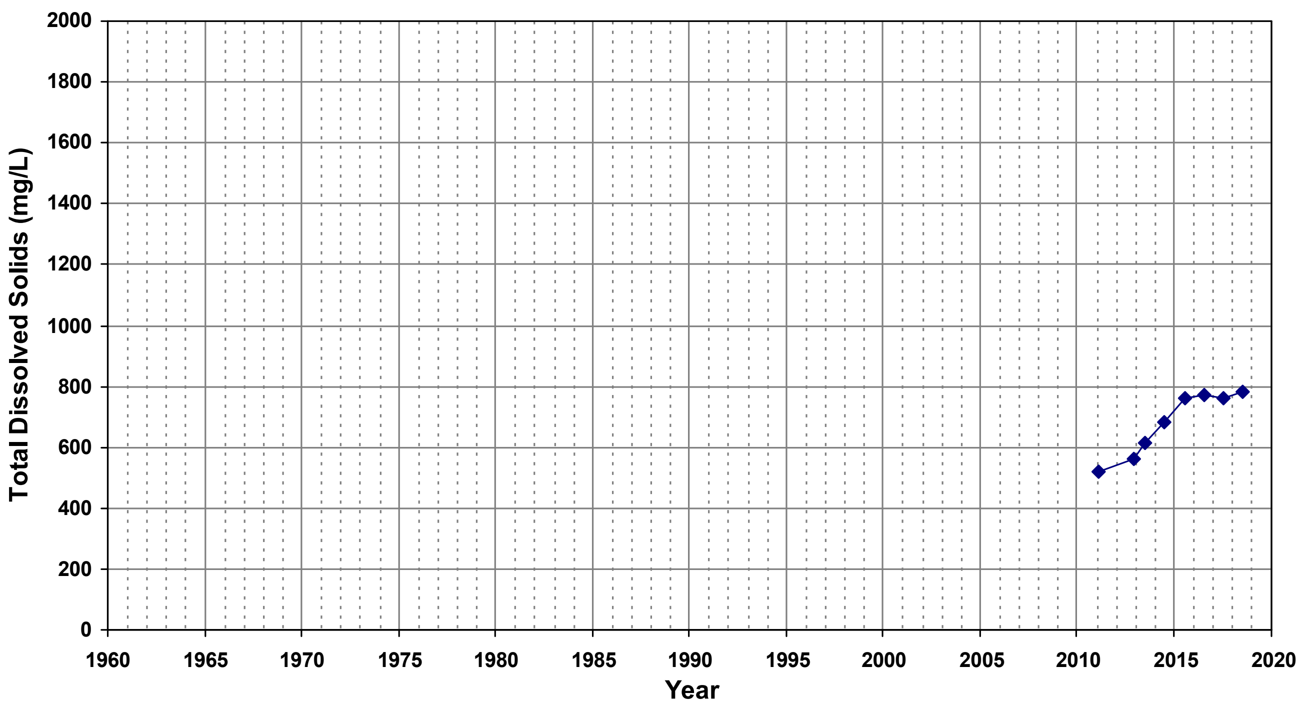
VWD-207

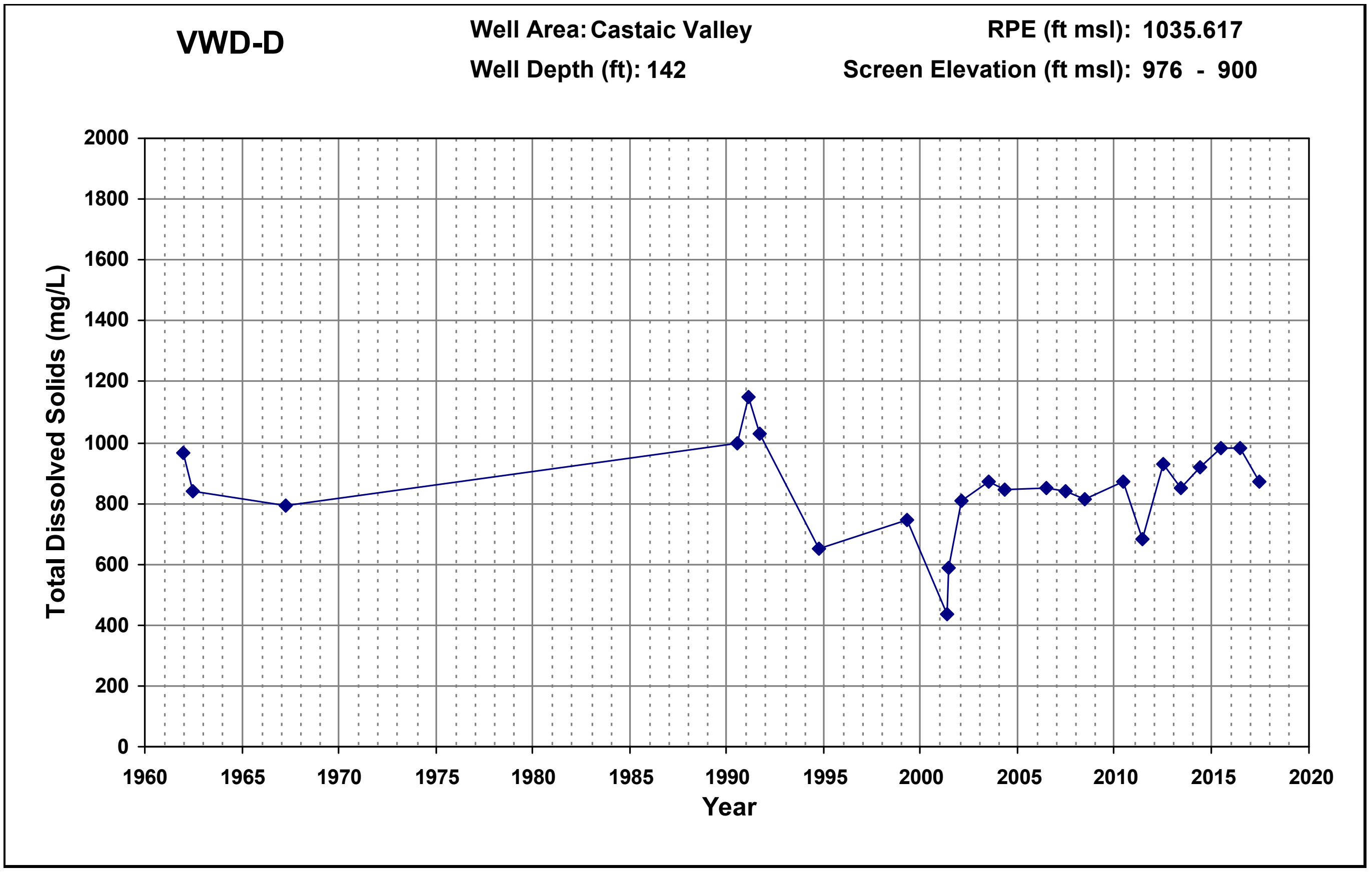
Well Area: Southern Saugus

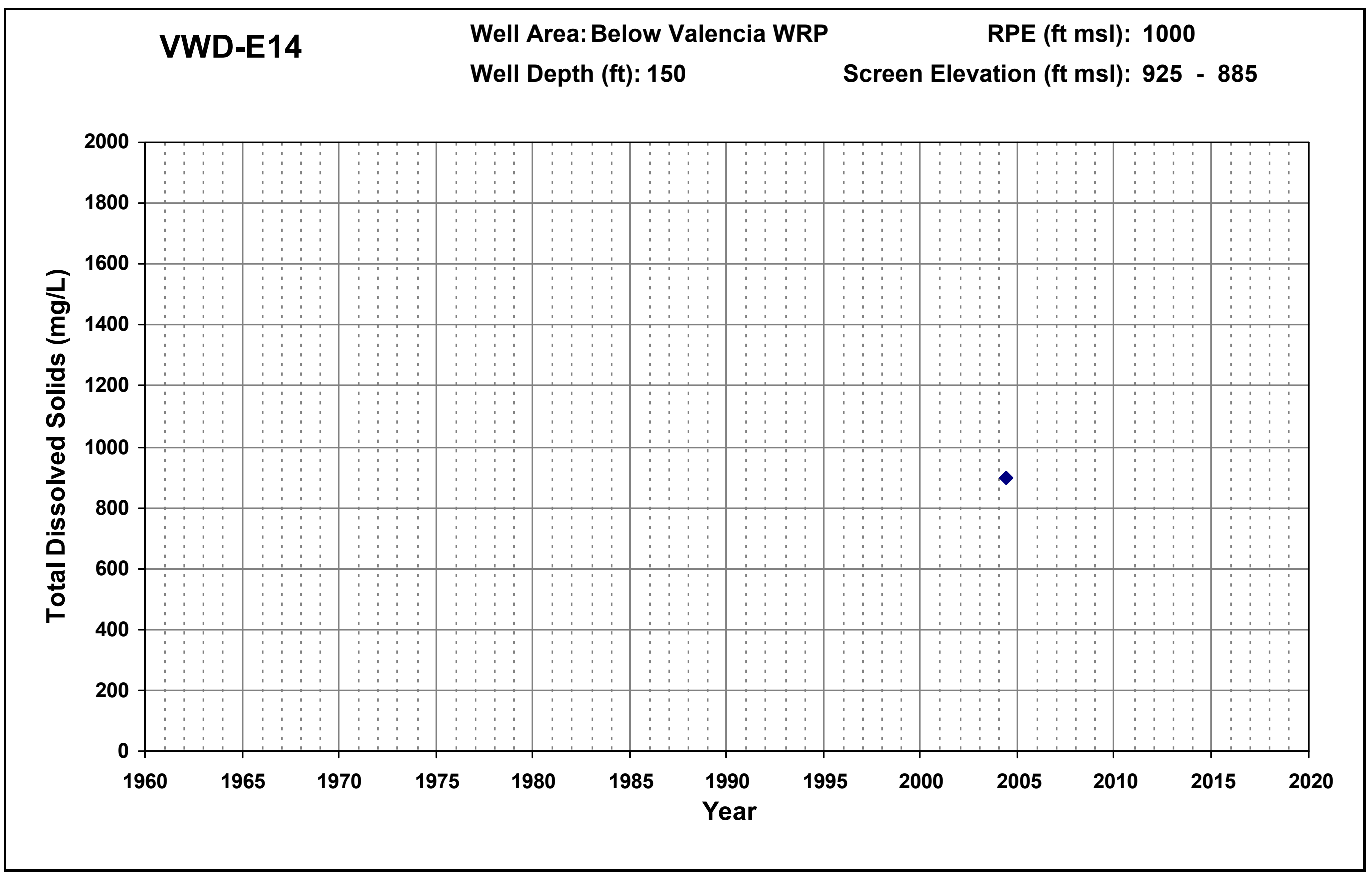
Well Depth (ft): 1220

RPE (ft msl): 1035.74

Screen Elevation (ft msl): 529 - -163




VWD-D
Well Area: Castaic Valley
Well Depth (ft): 142
RPE (ft msl): 1035.617
Screen Elevation (ft msl): 976 - 900
Total Dissolved Solids (mg/L)
2000
1800
1600
1400
1200
1000
800
600
400
200
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year


VWD-E14
Well Area: Below Valencia WRP
Well Depth (ft): 150
RPE (ft msl): 1000
Screen Elevation (ft msl): 925 - 885
Total Dissolved Solids (mg/L)
2000
1800
1600
1400
1200
1000
800
600
400
200
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

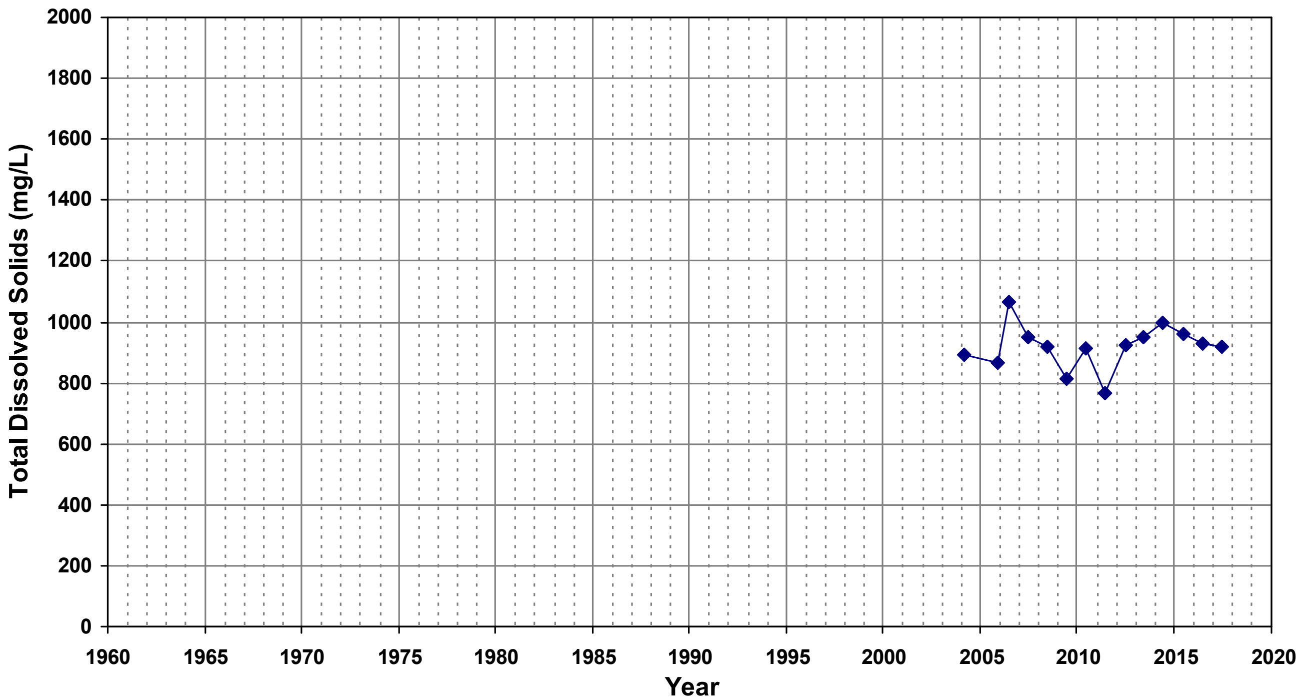
VWD-E15

Well Area: Below Valencia WRP

RPE (ft msl): 1022.957

Well Depth (ft): 160

Screen Elevation (ft msl): 933 - 888



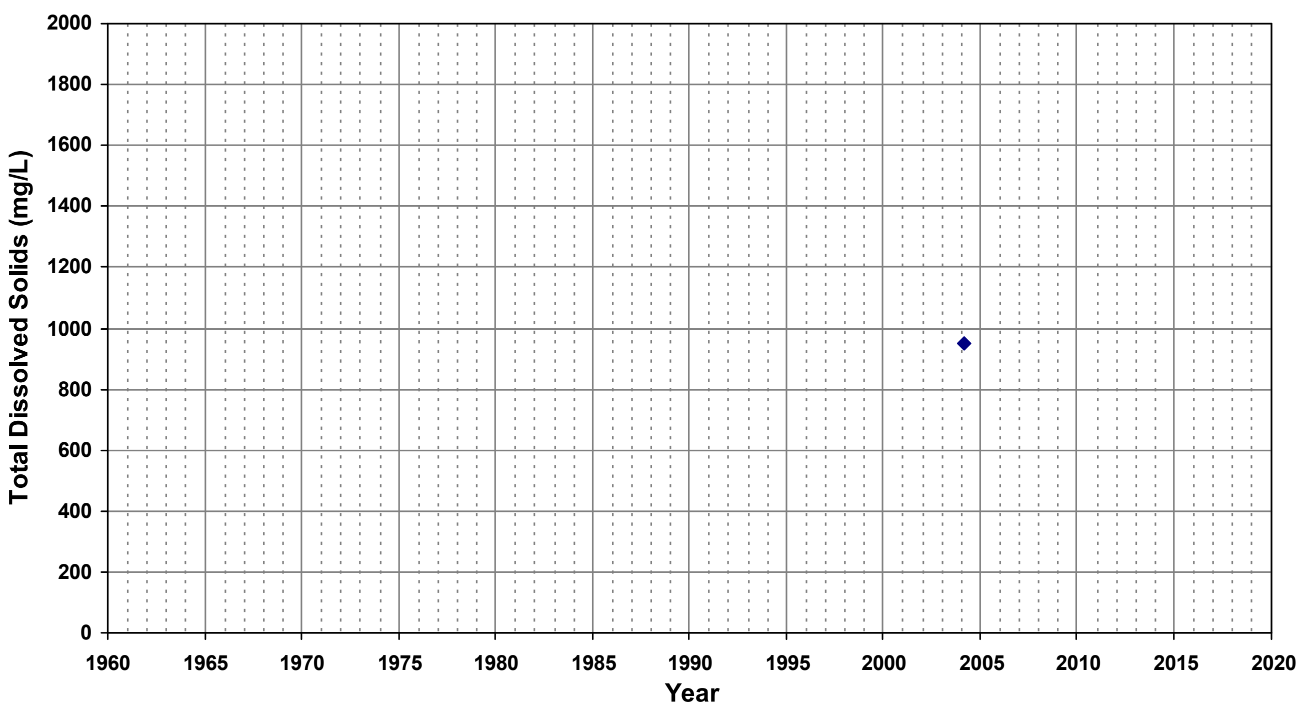
VWD-E16

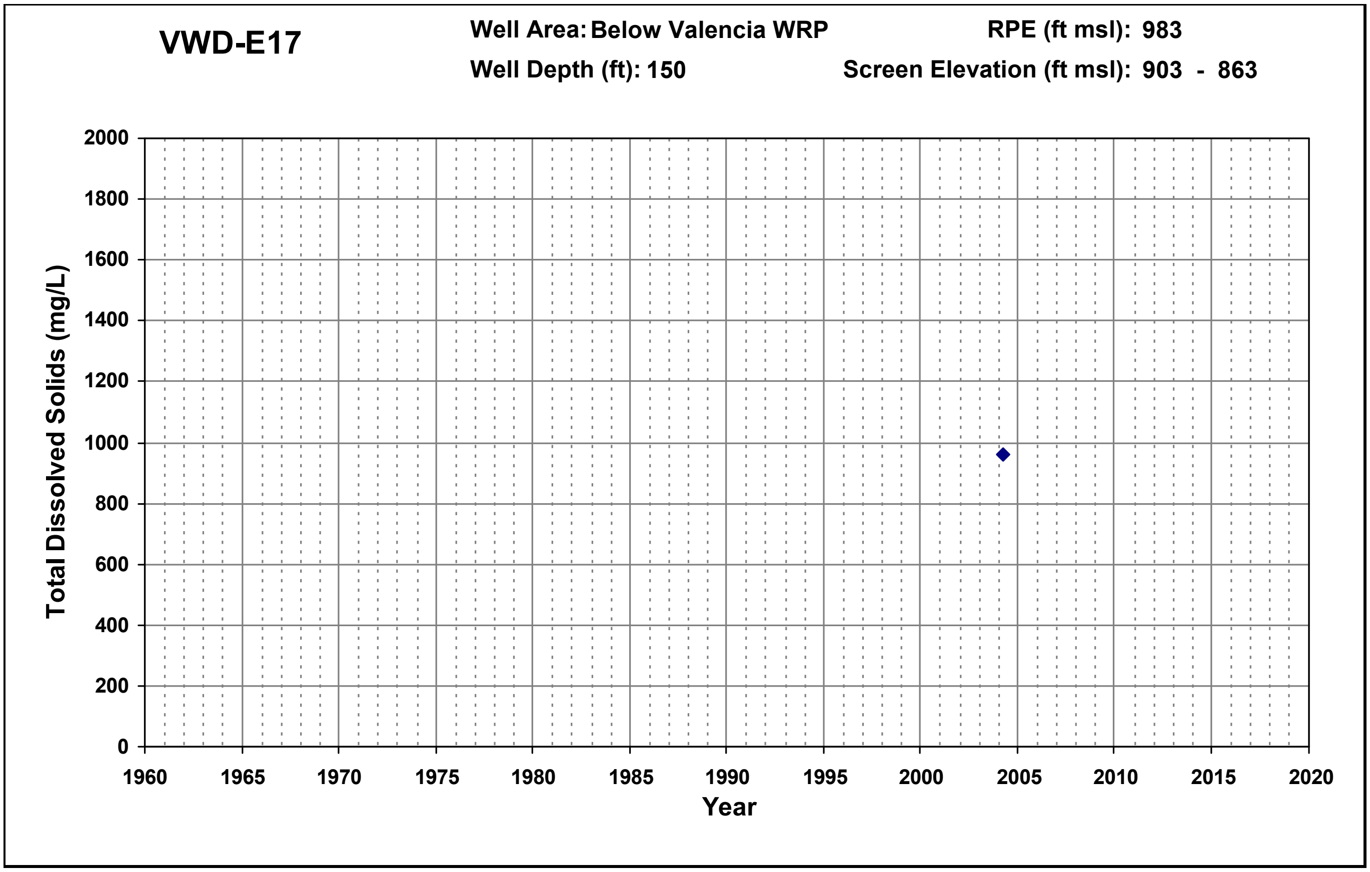
Well Area: Below Valencia WRP

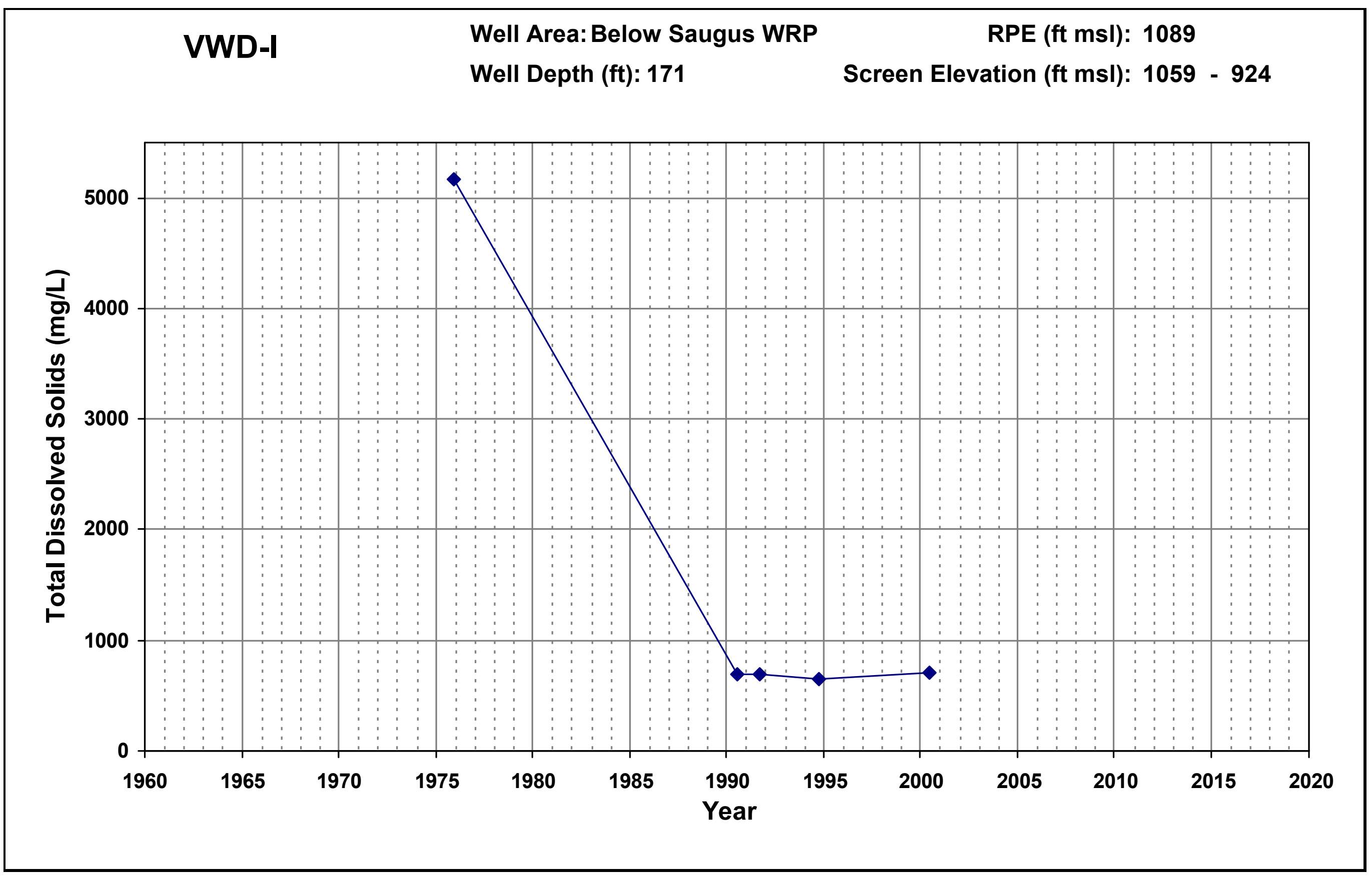
RPE (ft msl): 996

Well Depth (ft): 170

Screen Elevation (ft msl): 916 - 851



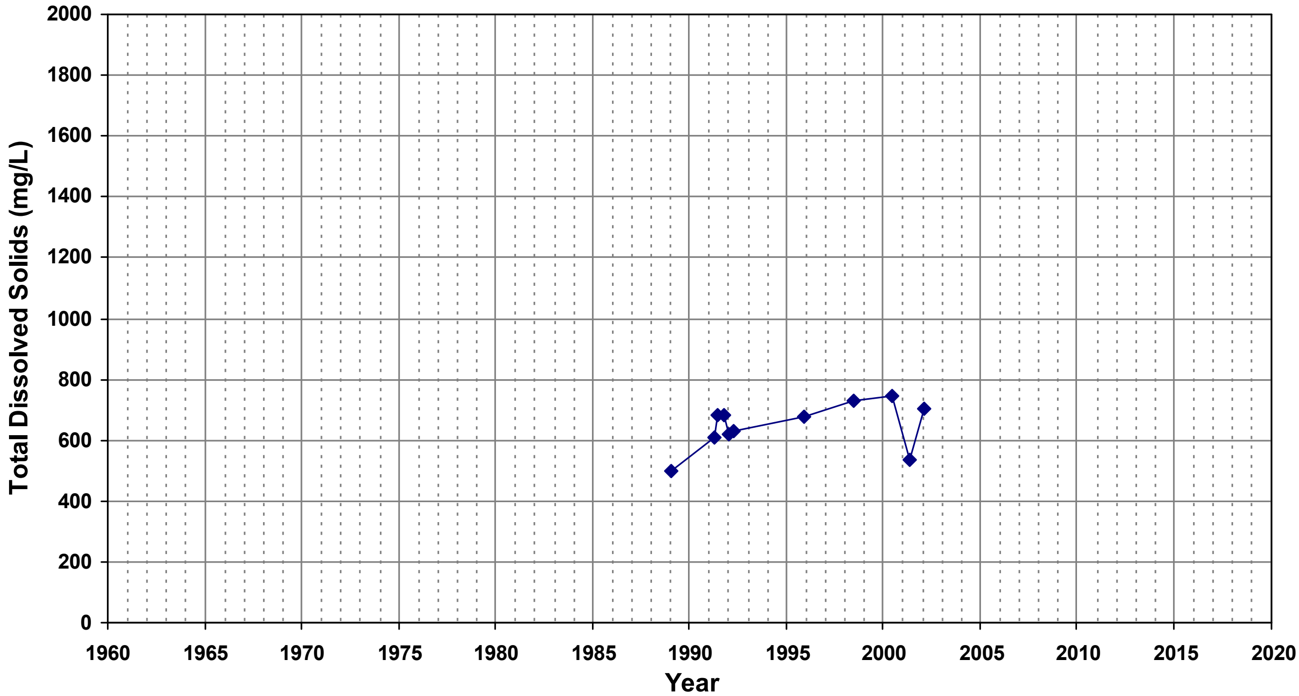

VWD-E17
Well Area: Below Valencia WRP
RPE (ft msl): 983
Well Depth (ft): 150
Screen Elevation (ft msl): 903 - 863
Total Dissolved Solids (mg/L)
2000
1800
1600
1400
1200
1000
800
600
400
200
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year


VWD-I
Well Area: Below Saugus WRP
RPE (ft msl): 1089
Well Depth (ft): 171
Screen Elevation (ft msl): 1059 - 924
Total Dissolved Solids (mg/L)
5000
4000
3000
2000
1000
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

VWD-K2

Well Area: Below Saugus WRP | RPE (ft msl): 1129

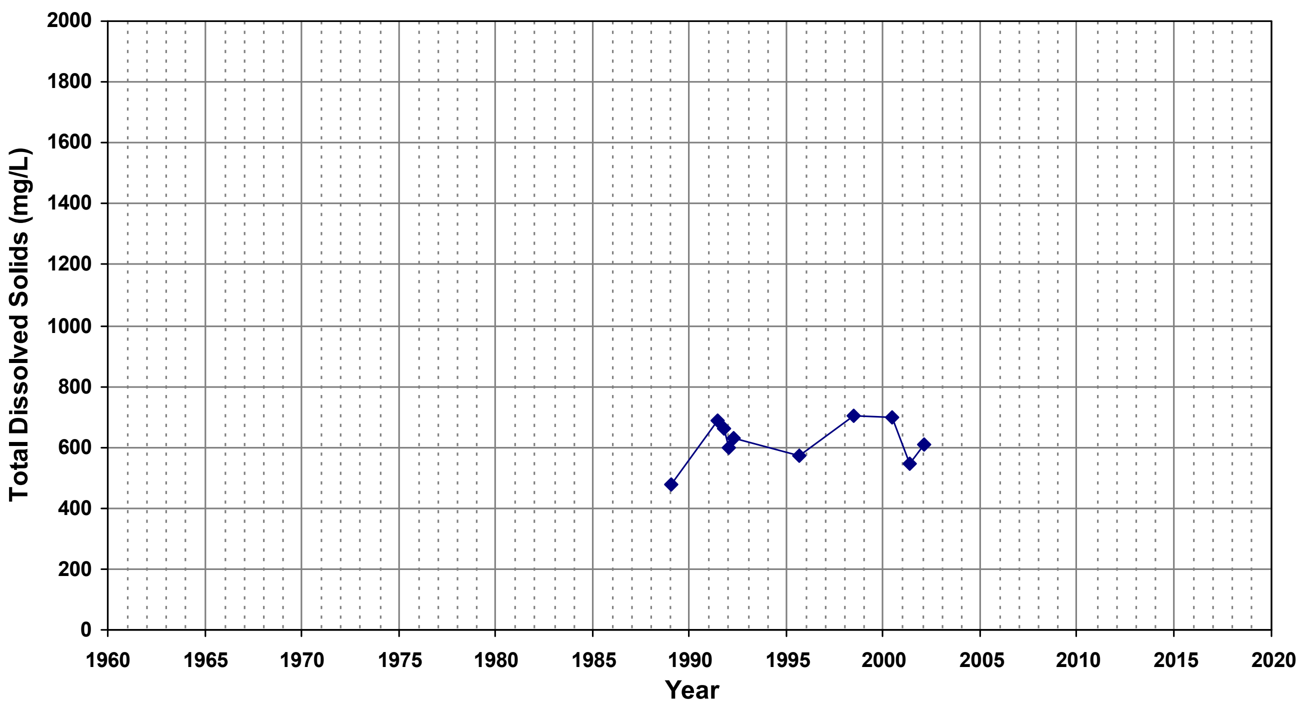
Well Depth (ft): 242 | Screen Elevation (ft msl): 1067 - 899



VWD-L2

Well Area: Below Saugus WRP | RPE (ft msl): 1135

Well Depth (ft): 182 | Screen Elevation (ft msl): 1075 - 955



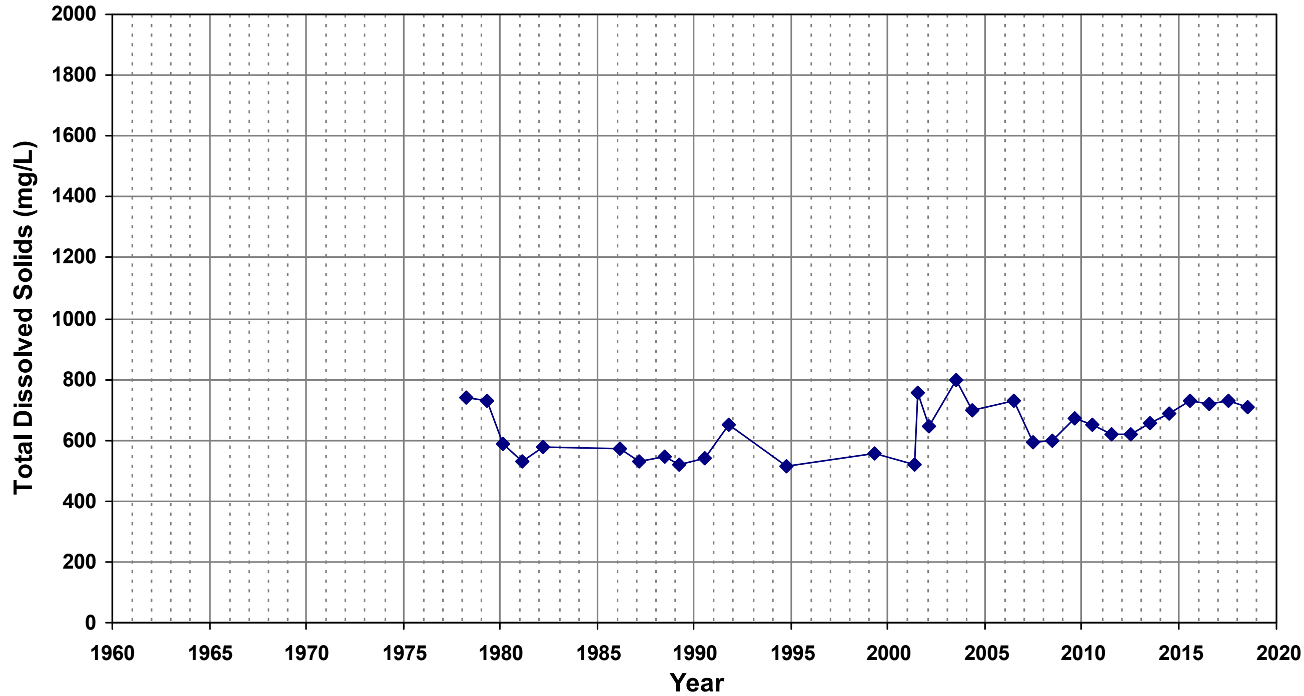
VWD-N

Well Area: Below Saugus WRP

RPE (ft msl): 1131.558

Well Depth (ft): 280

Screen Elevation (ft msl): 1056 - 895



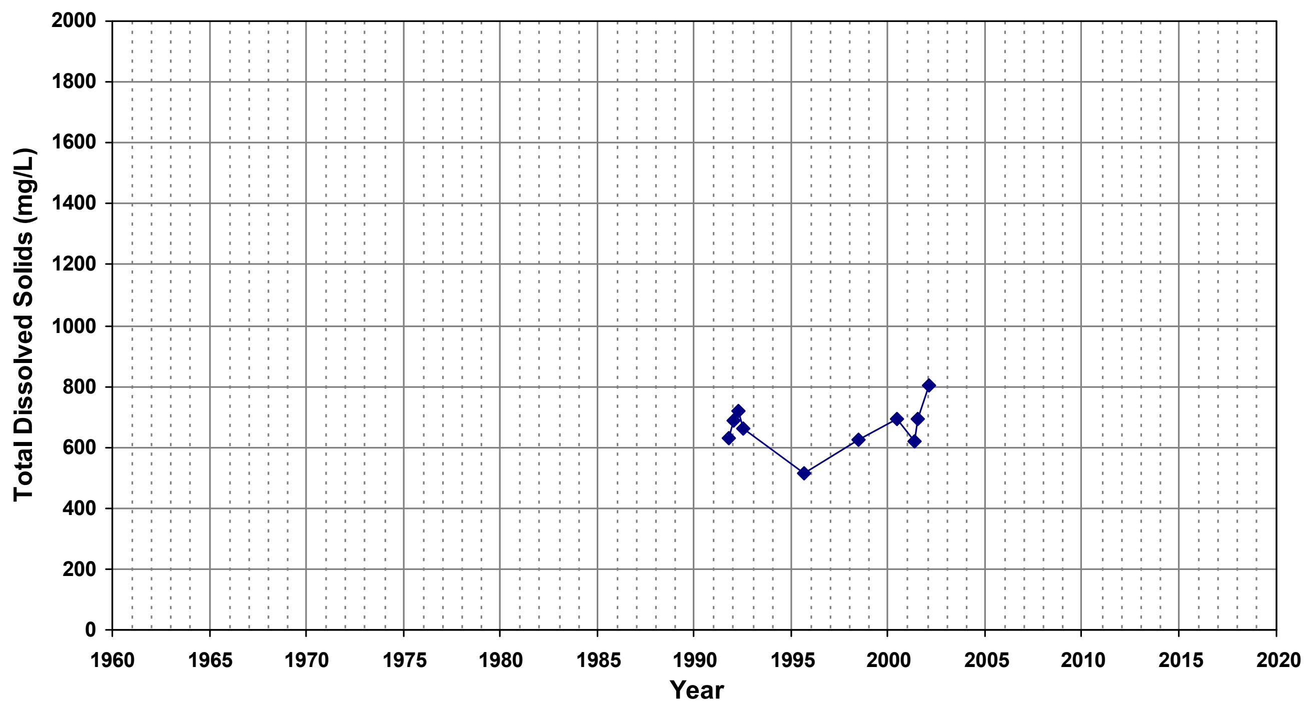
VWD-N3

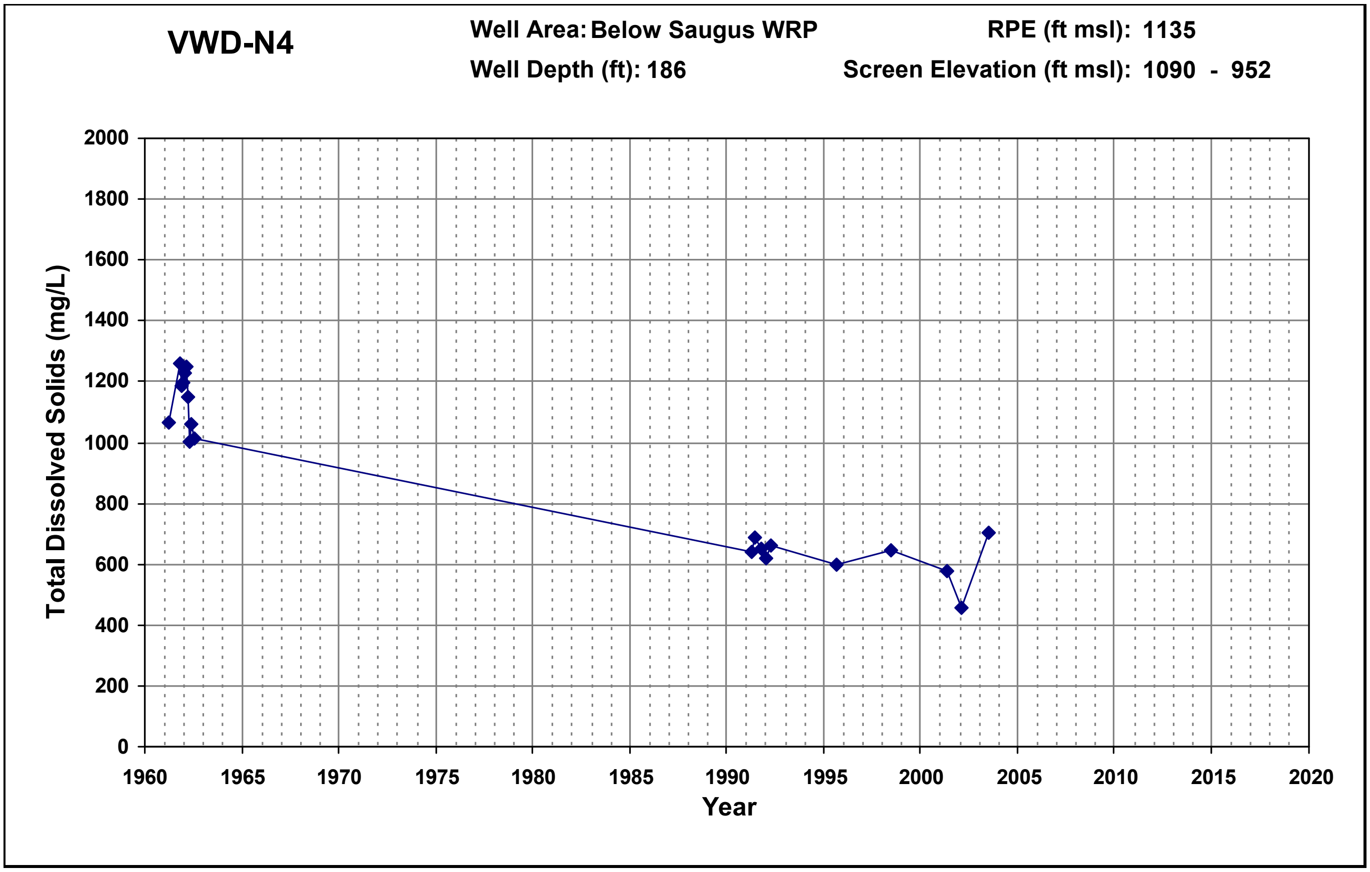
Well Area: Below Saugus WRP

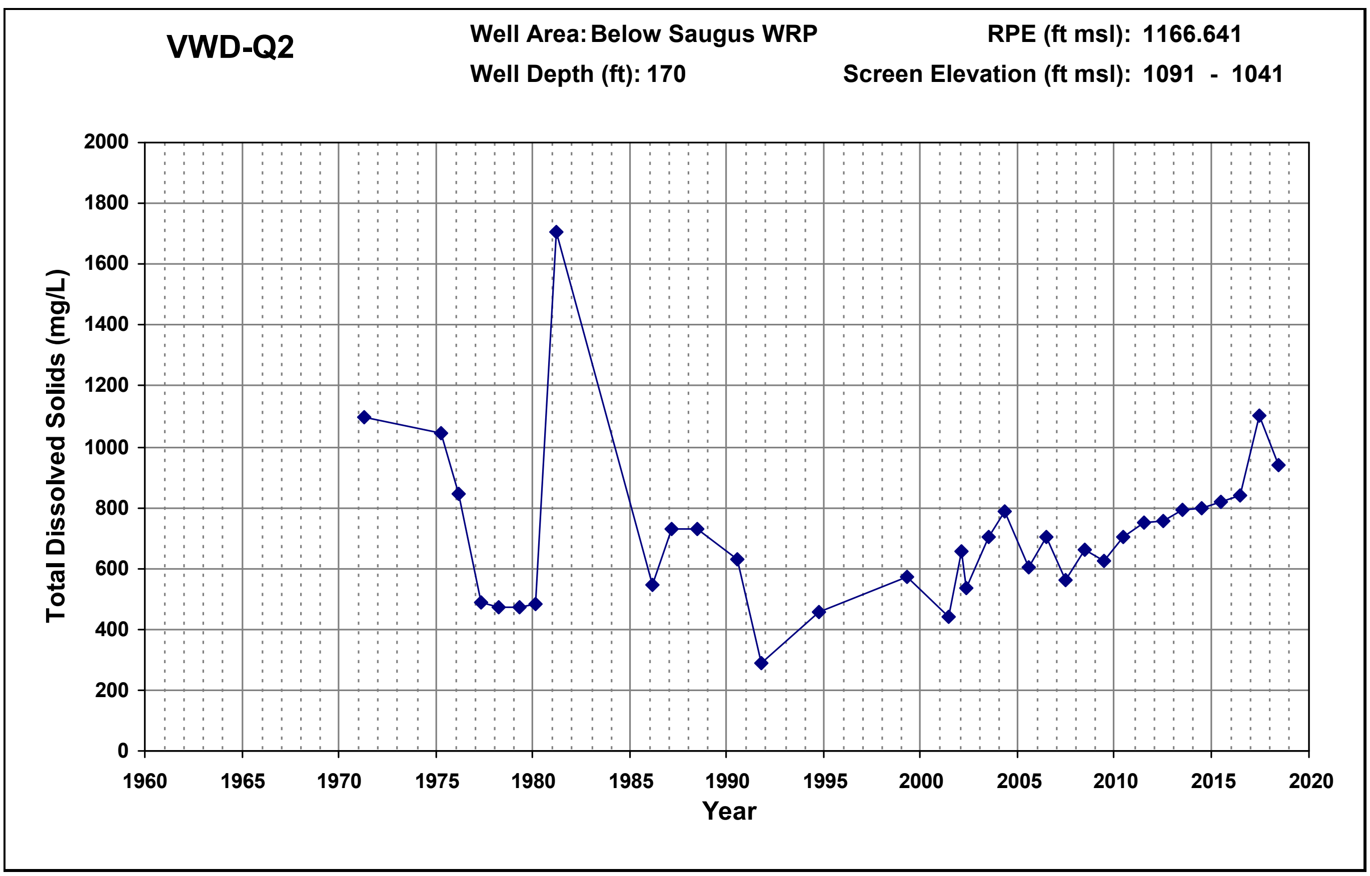
RPE (ft msl): 1132

Well Depth (ft): 173

Screen Elevation (ft msl): 1072 - 962




VWD-N4
Well Area: Below Saugus WRP
RPE (ft msl): 1135
Well Depth (ft): 186
Screen Elevation (ft msl): 1090 - 952
Total Dissolved Solids (mg/L)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year


VWD-Q2
Well Area: Below Saugus WRP
RPE (ft msl): 1166.641
Well Depth (ft): 170
Screen Elevation (ft msl): 1091 - 1041
Total Dissolved Solids (mg/L)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

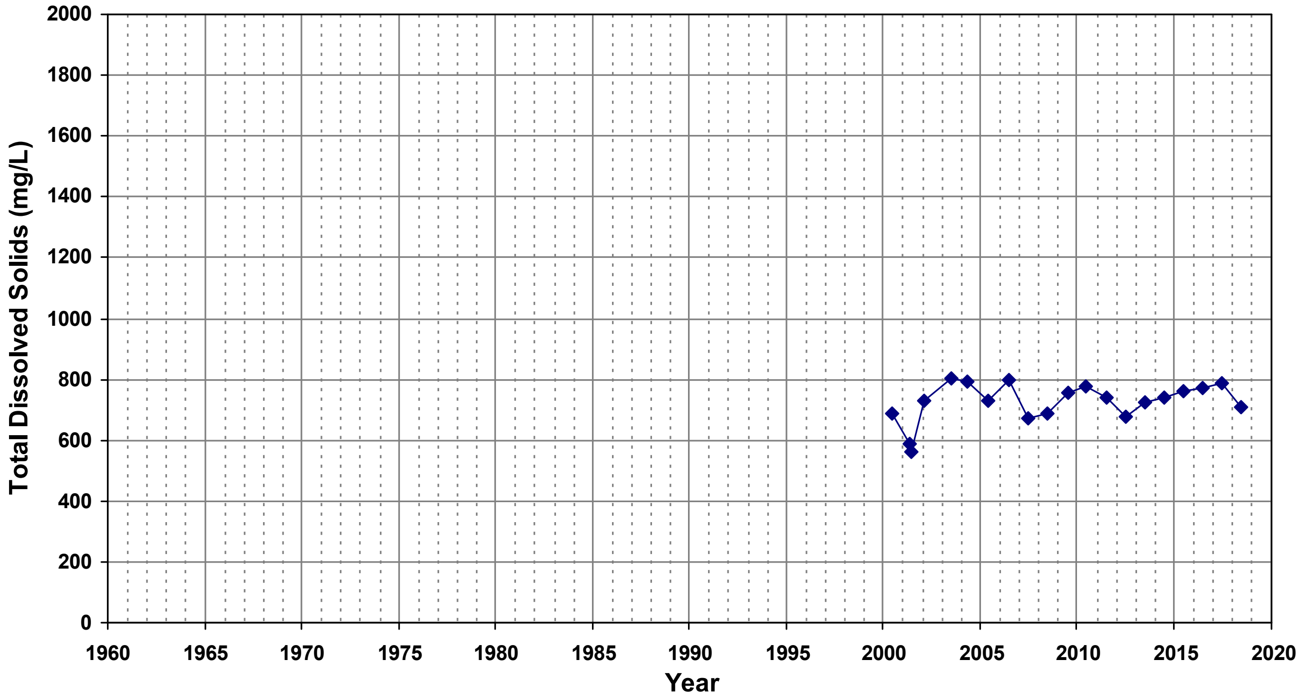
VWD-S6

Well Area: Below Saugus WRP

RPE (ft msl): 1127.164

Well Depth (ft): 220

Screen Elevation (ft msl): 997 - 932



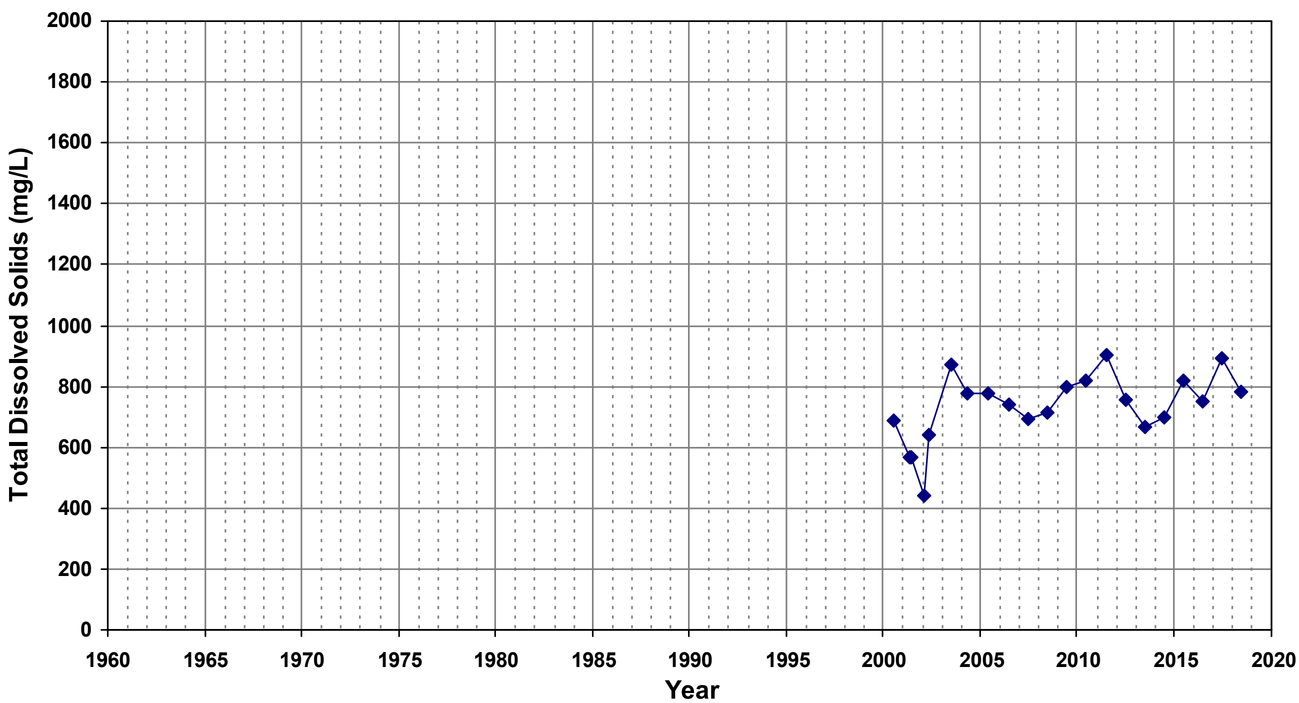
VWD-S7

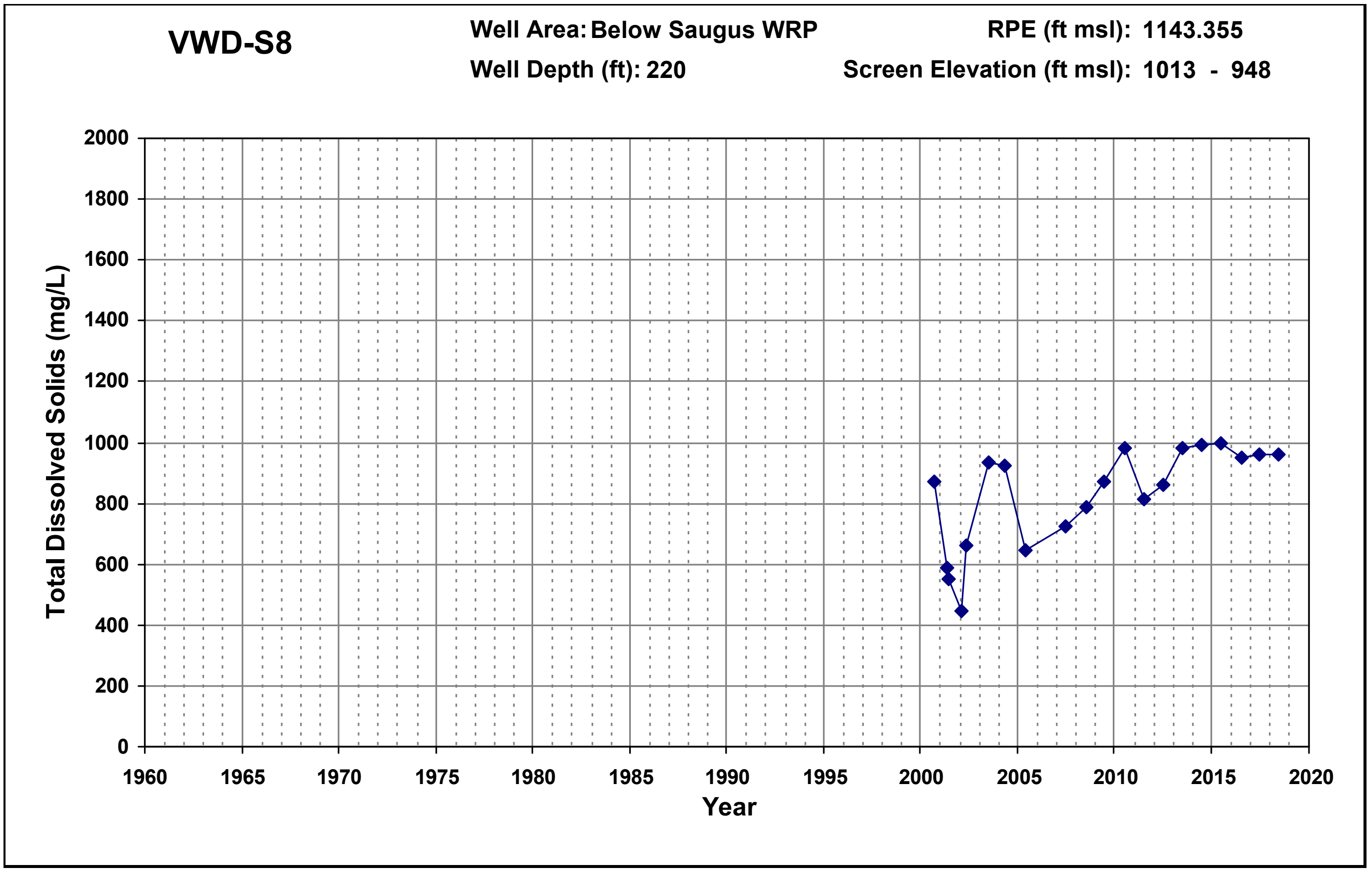
Well Area: Below Saugus WRP

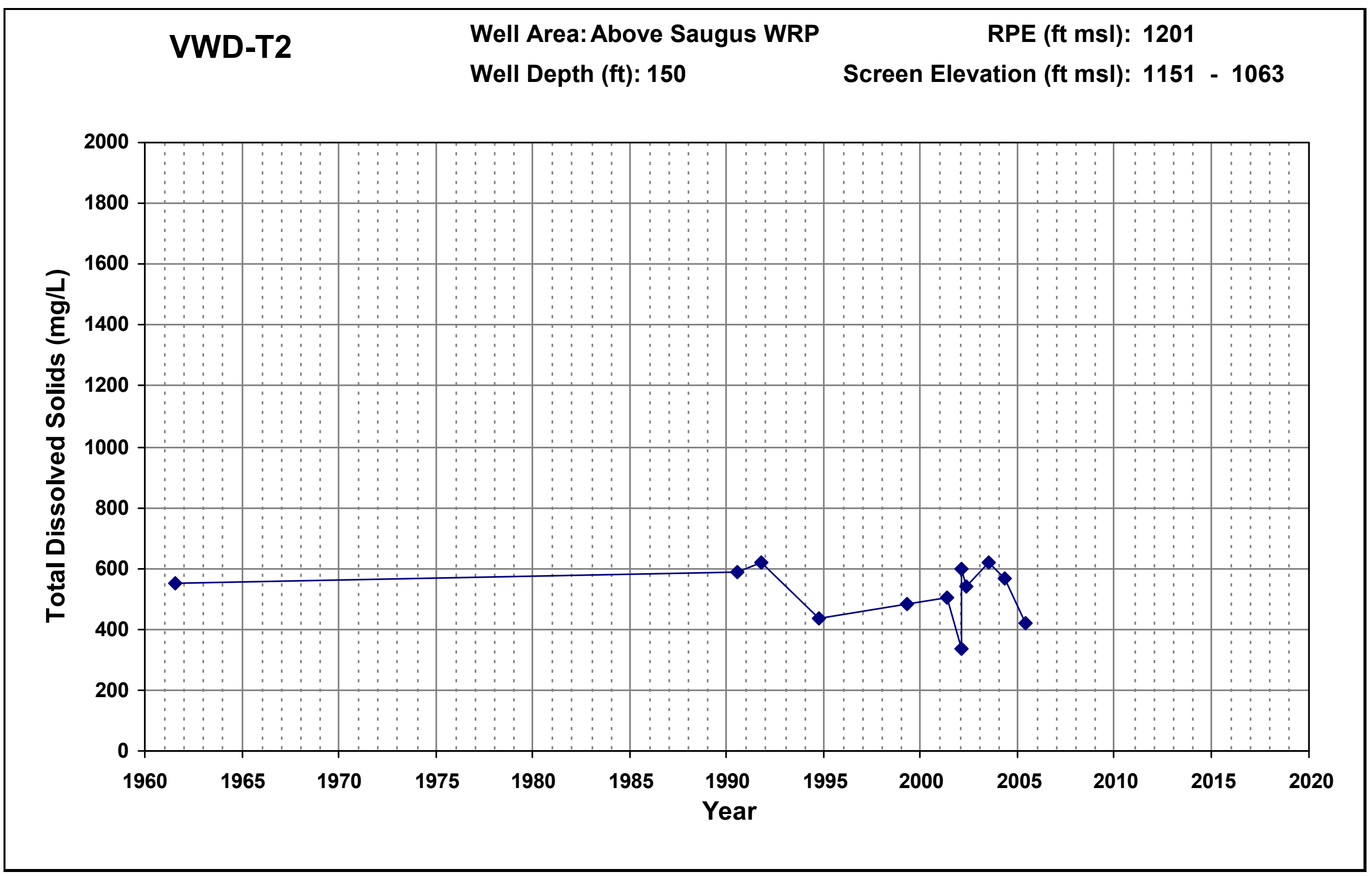
RPE (ft msl): 1128.645

Well Depth (ft): 210

Screen Elevation (ft msl): 999 - 939




VWD-S8
Well Area: Below Saugus WRP
RPE (ft msl): 1143.355
Well Depth (ft): 220
Screen Elevation (ft msl): 1013 - 948
Total Dissolved Solids (mg/L)
Year


VWD-T2
Well Area: Above Saugus WRP
RPE (ft msl): 1201
Well Depth (ft): 150
Screen Elevation (ft msl): 1151 - 1063
Total Dissolved Solids (mg/L)
Year

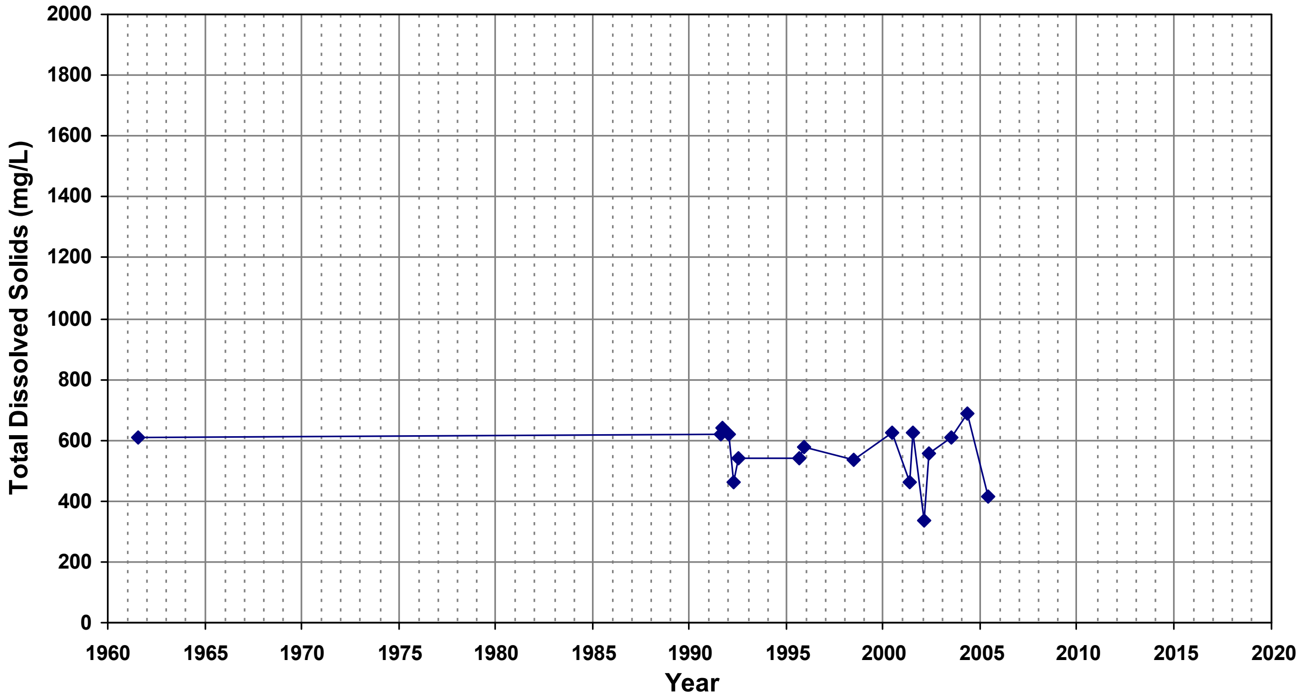
VWD-T4

Well Area: Above Saugus WRP

RPE (ft msl): 1194

Well Depth (ft): 150

Screen Elevation (ft msl): 1144 - 1059



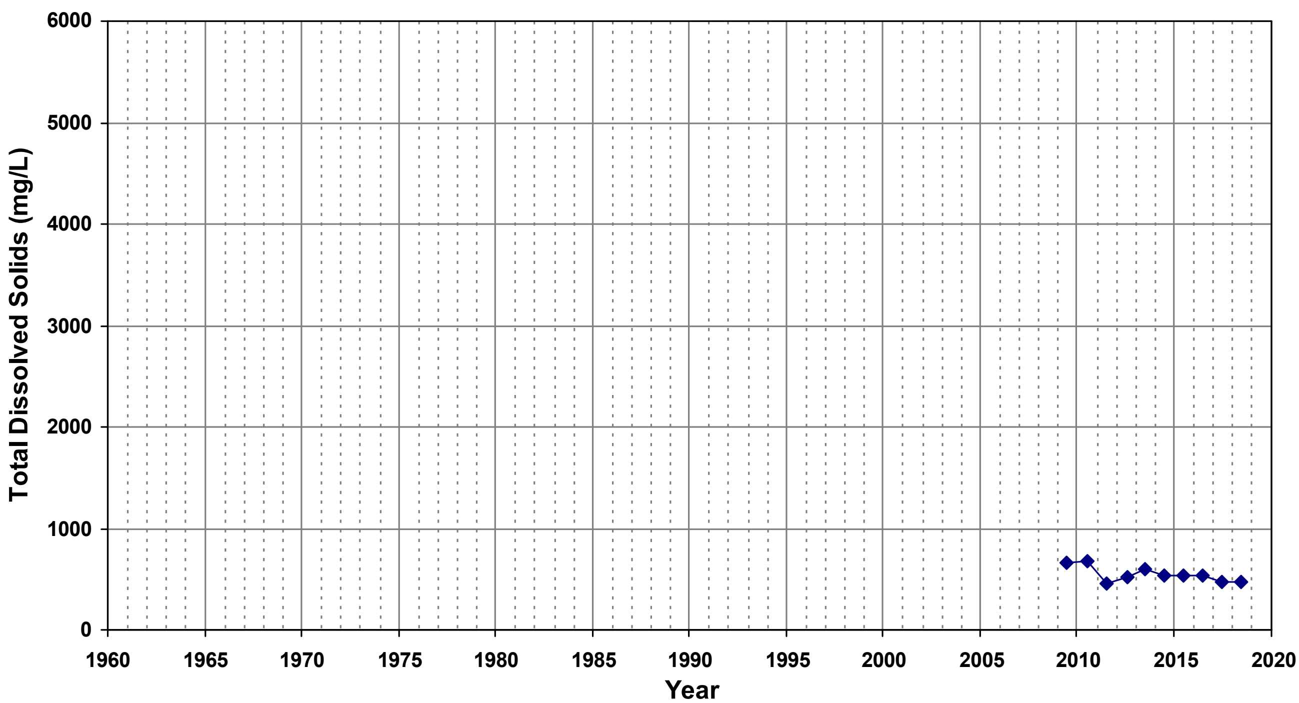
VWD-T7

Well Area: Above Saugus WRP

RPE (ft msl): 1211.08

Well Depth (ft):

Screen Elevation (ft msl): 1131 - 1096



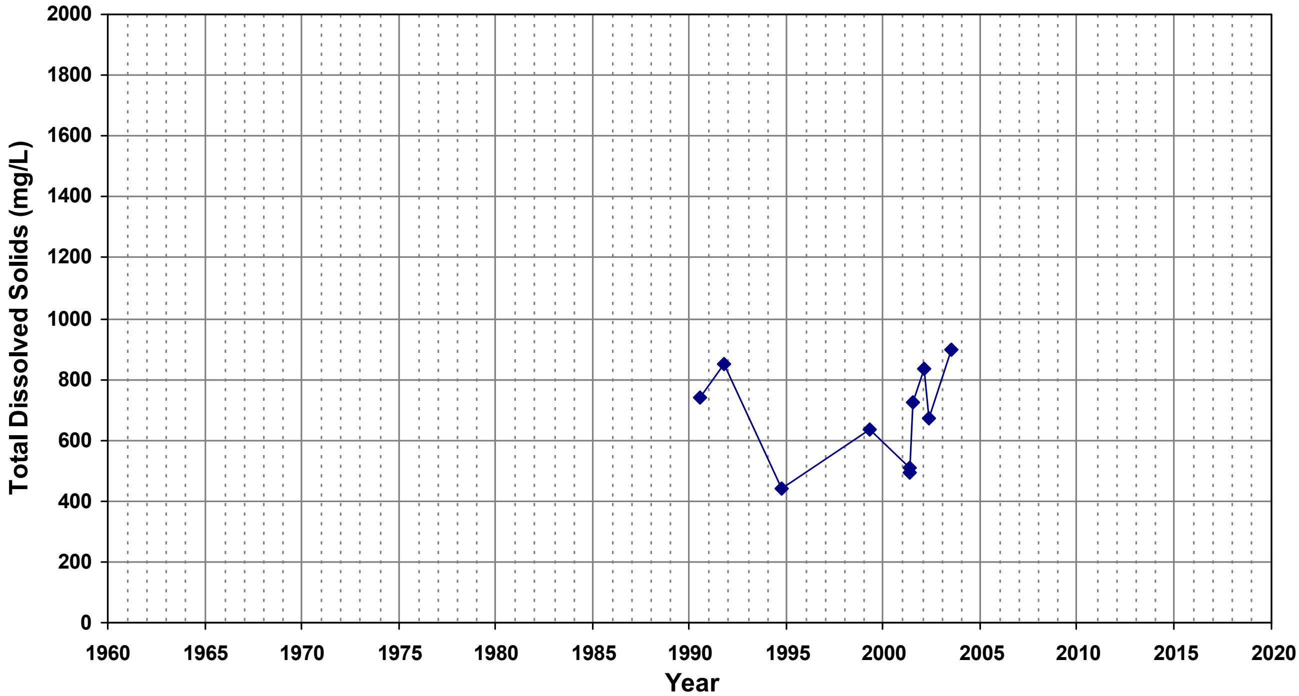
VWD-U3

Well Area: Above Saugus WRP

RPE (ft msl): 1263

Well Depth (ft): 142

Screen Elevation (ft msl): 1217 - 1123



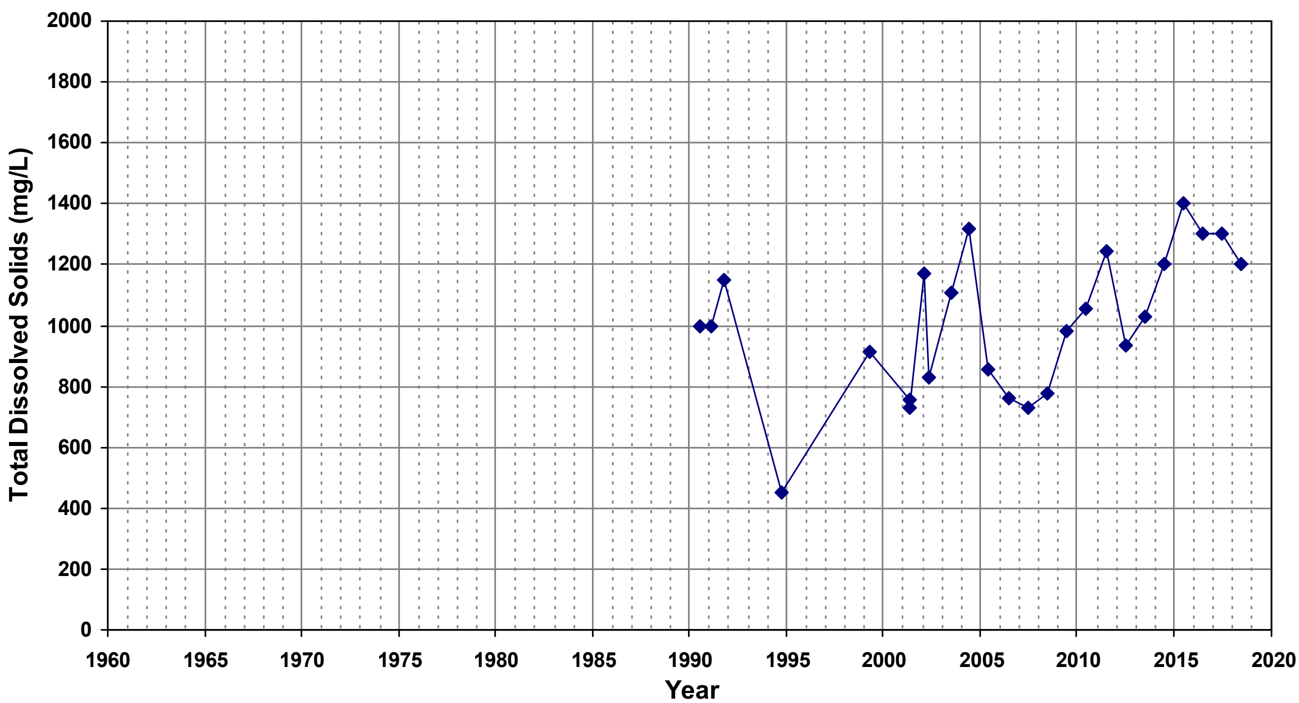
VWD-U4

Well Area: Above Saugus WRP

RPE (ft msl): 1242.795

Well Depth (ft): 135

Screen Elevation (ft msl): 1183 - 1113



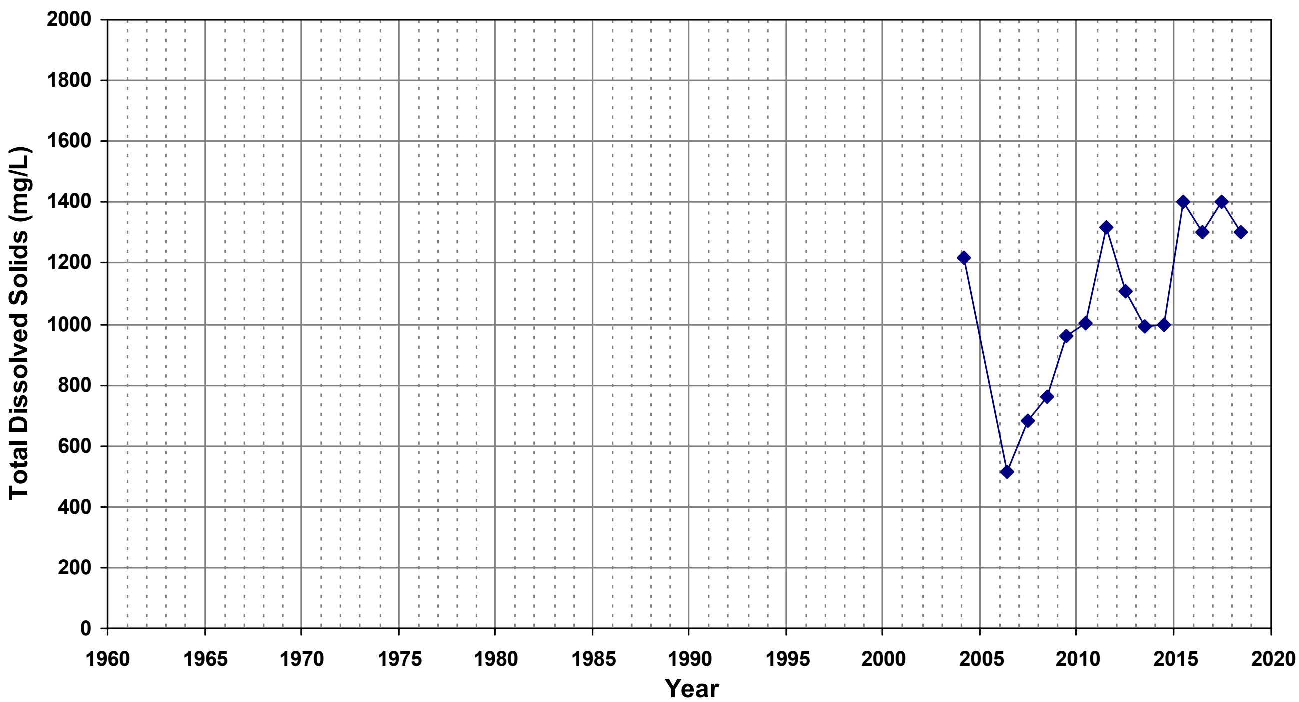
VWD-U6

Well Area: Above Saugus WRP

RPE (ft msl): 1230.6

Well Depth (ft): 175

Screen Elevation (ft msl): 1131 - 1086



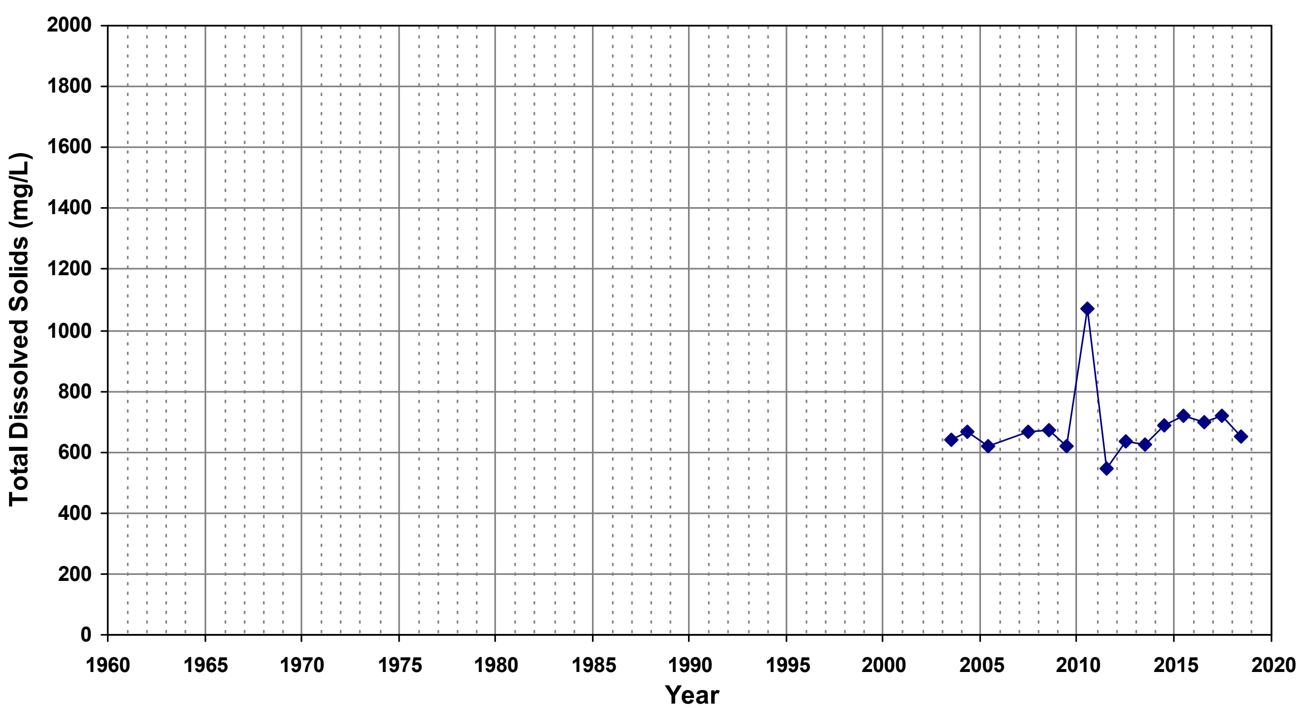
VWD-W10

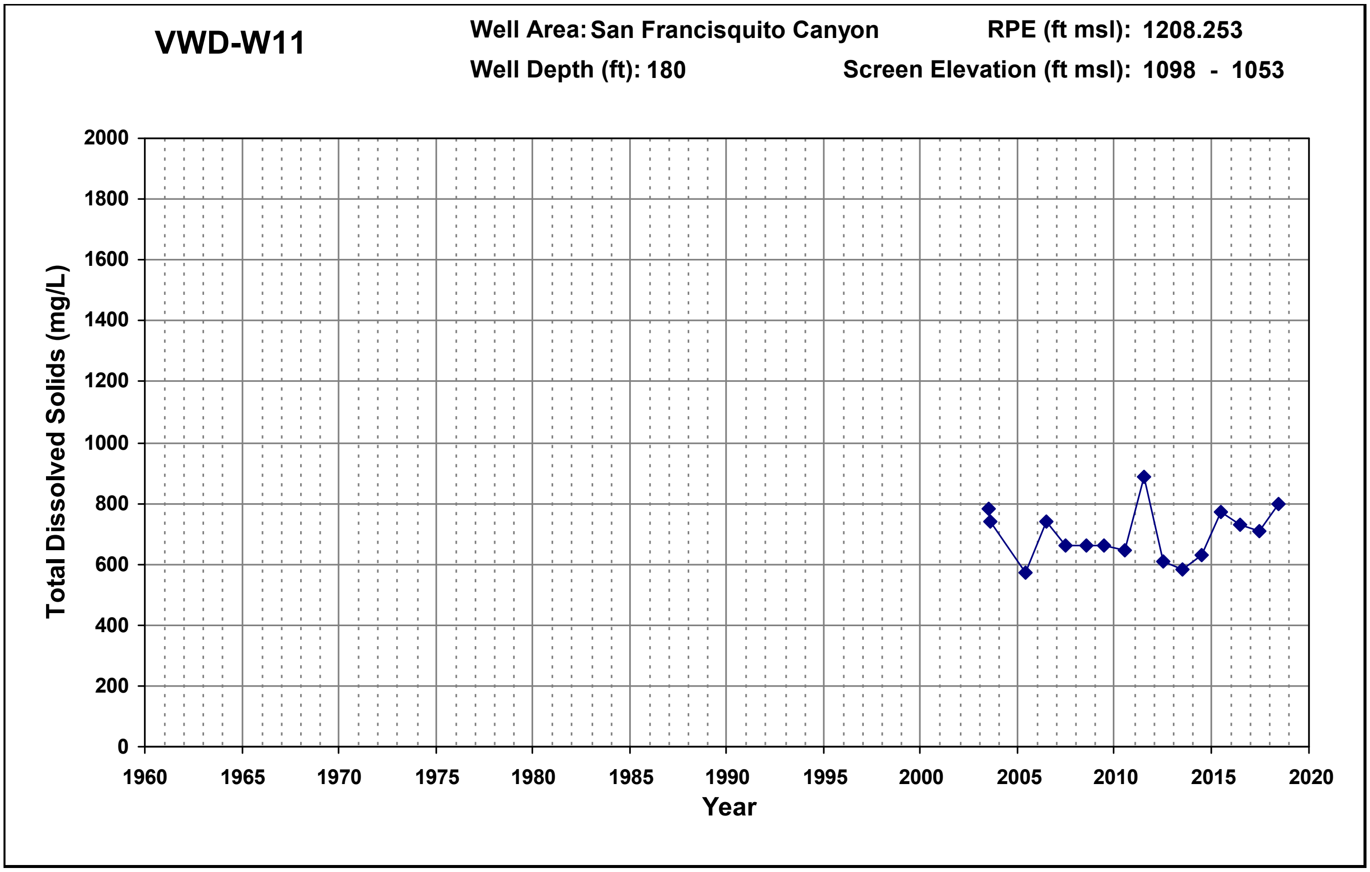
Well Area: San Francisquito Canyon

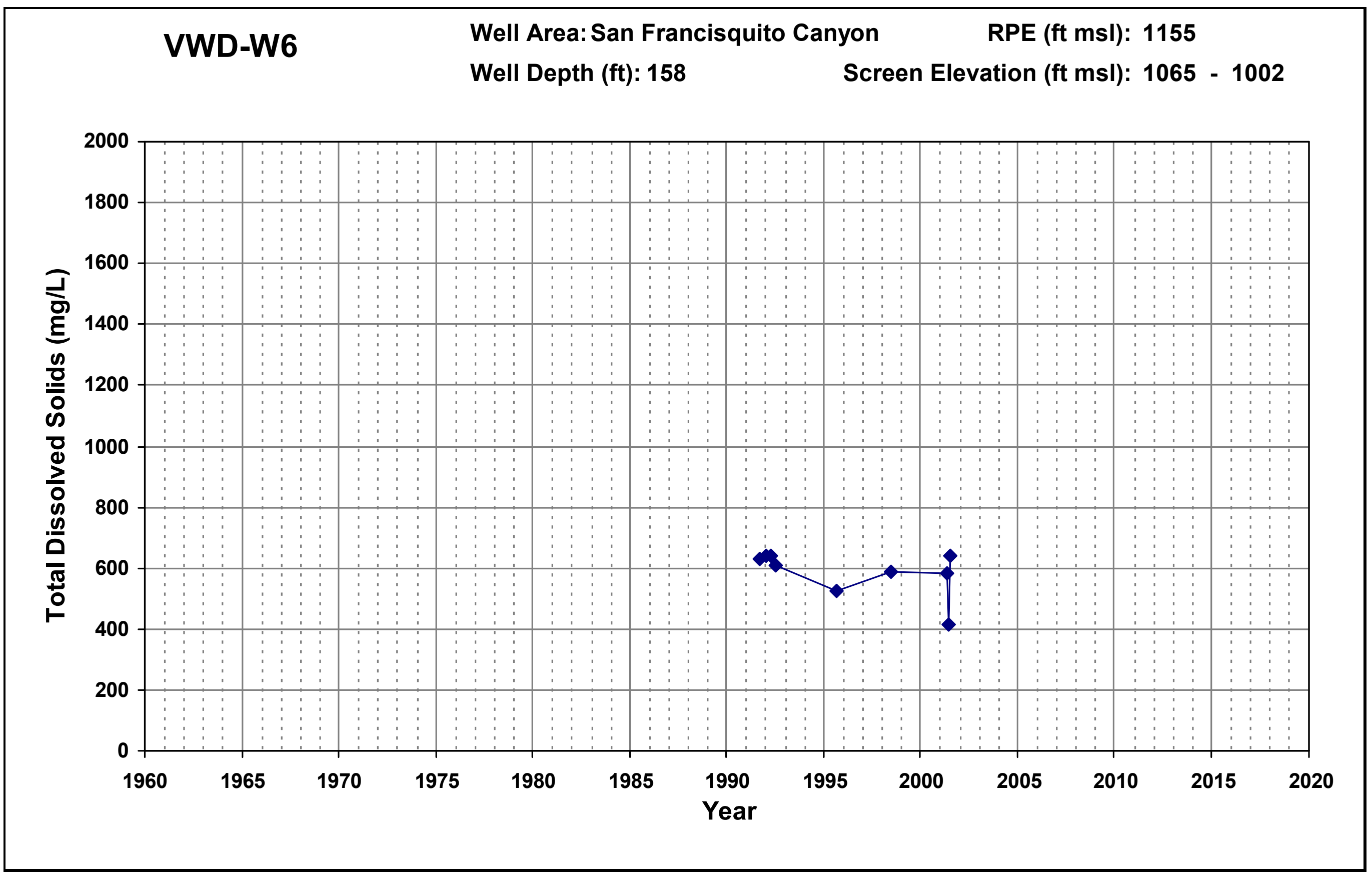
RPE (ft msl): 1130.285

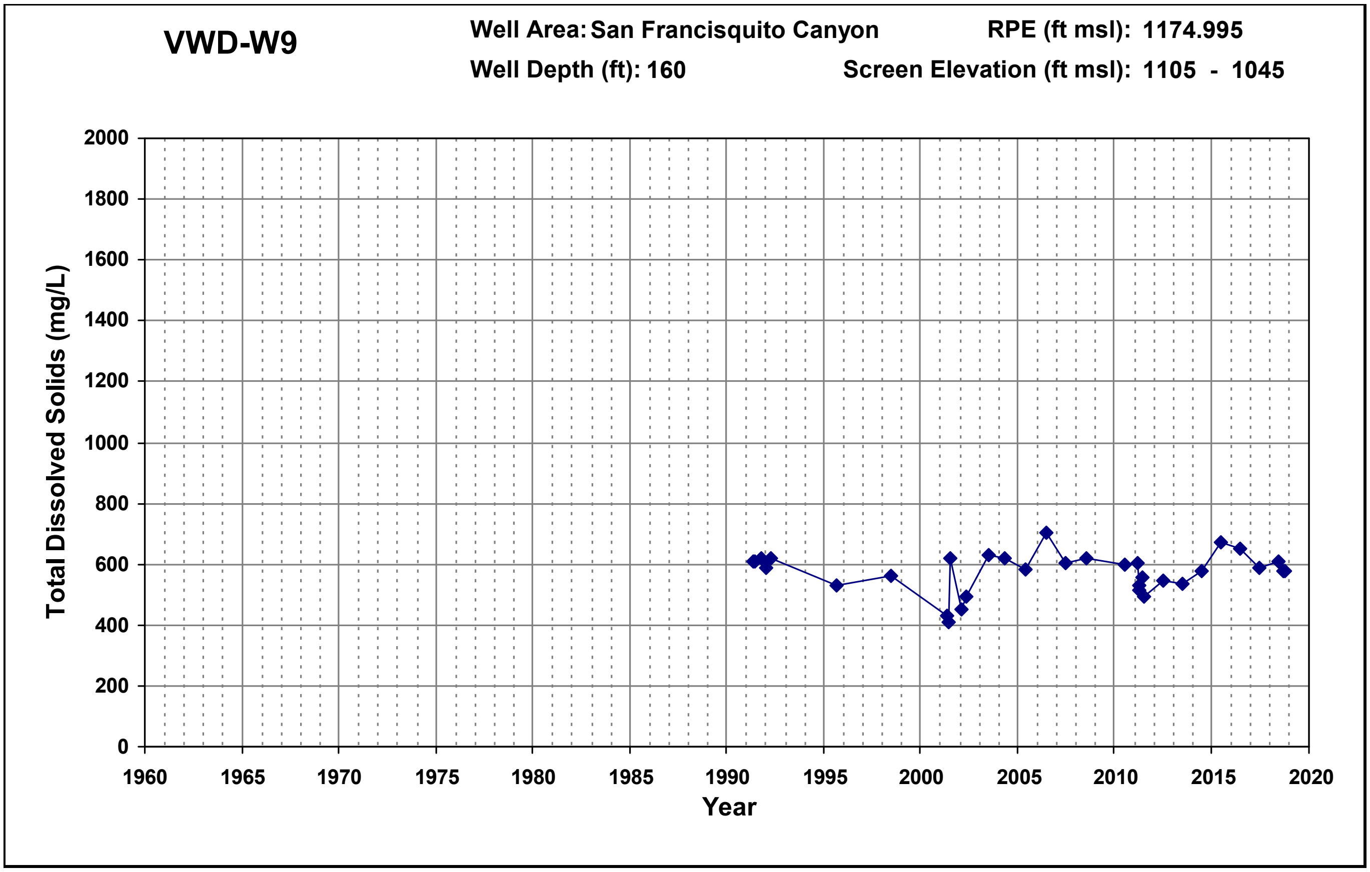
Well Depth (ft): 190

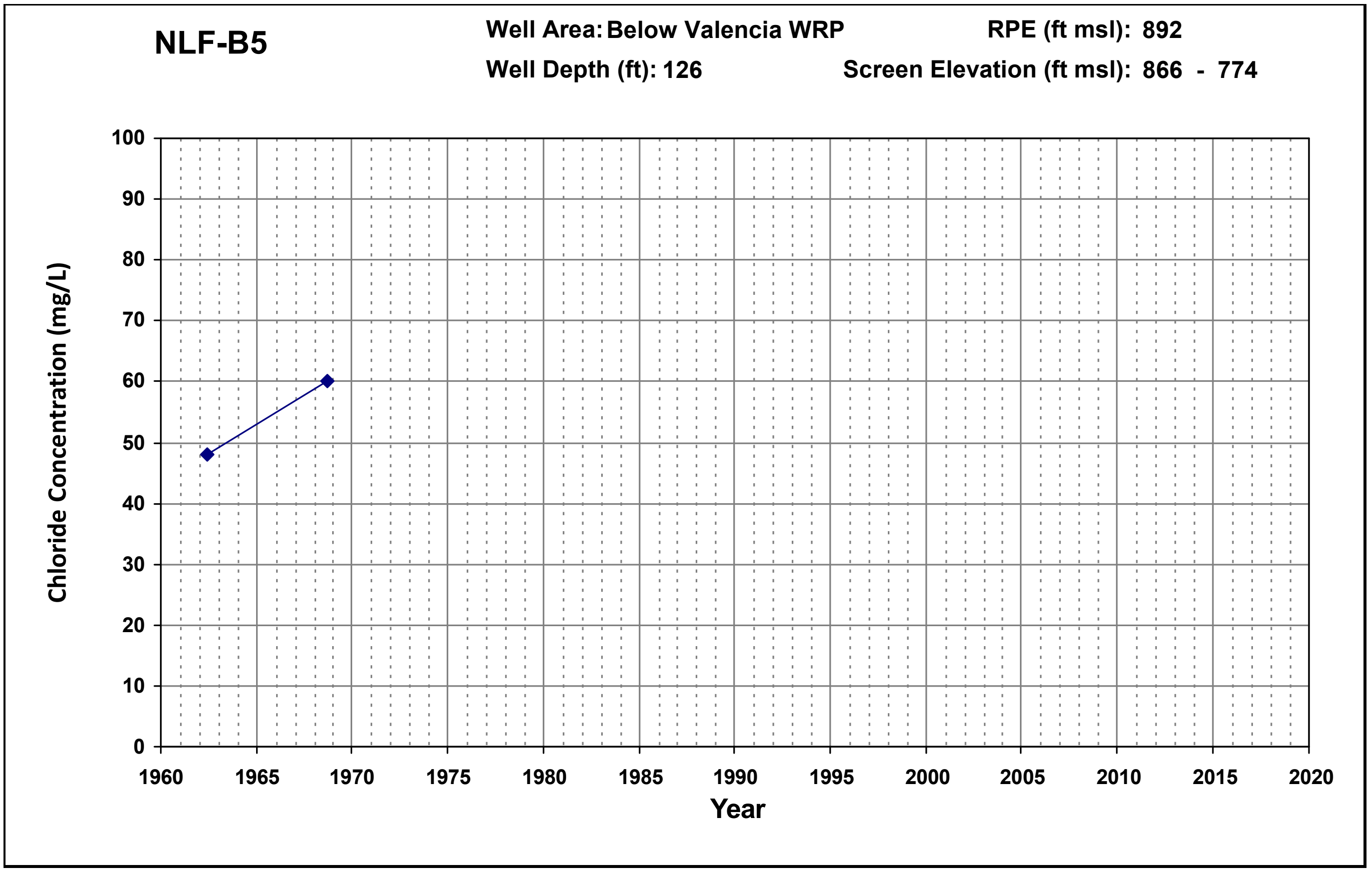
Screen Elevation (ft msl): 1010 - 970

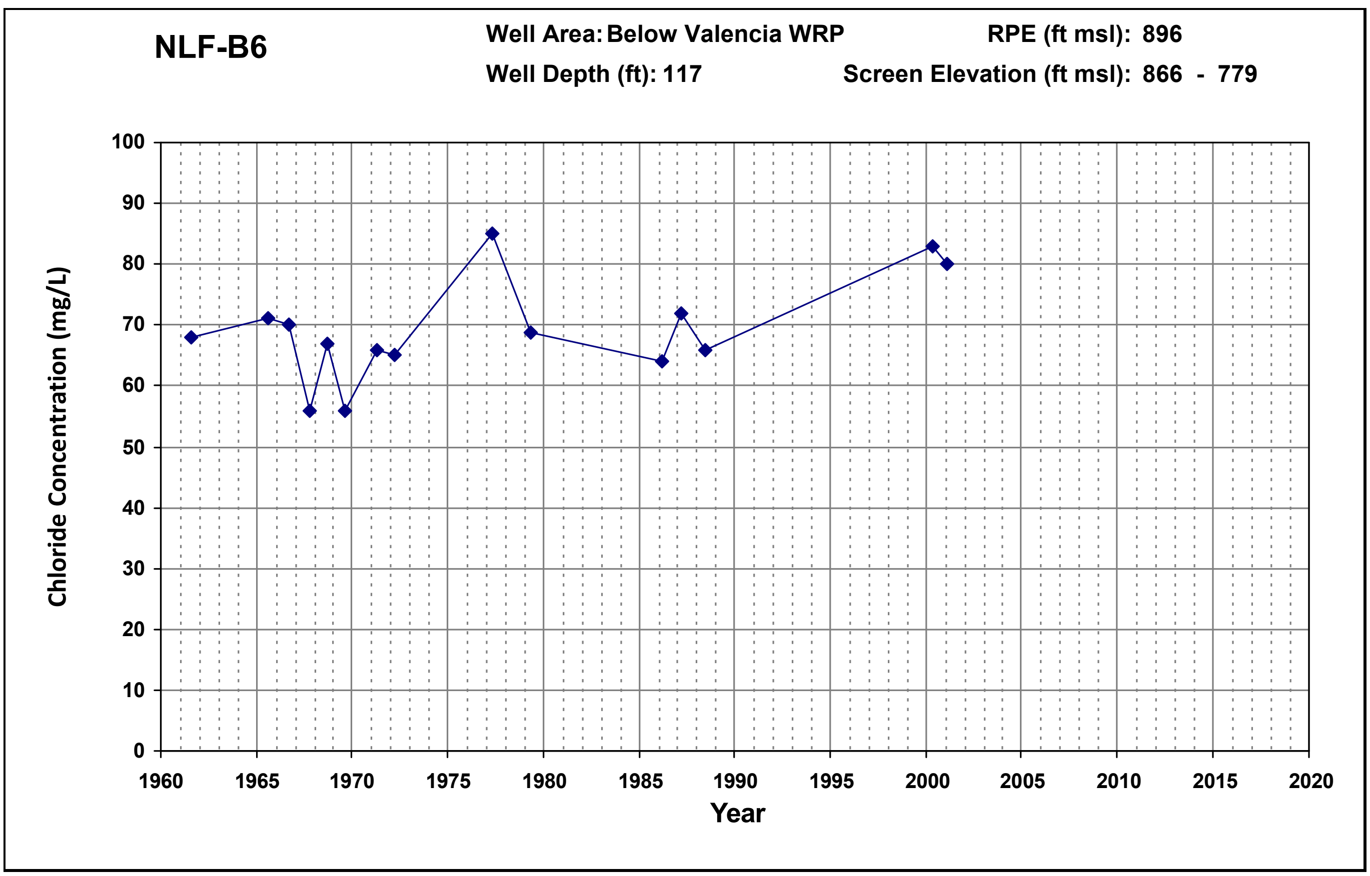


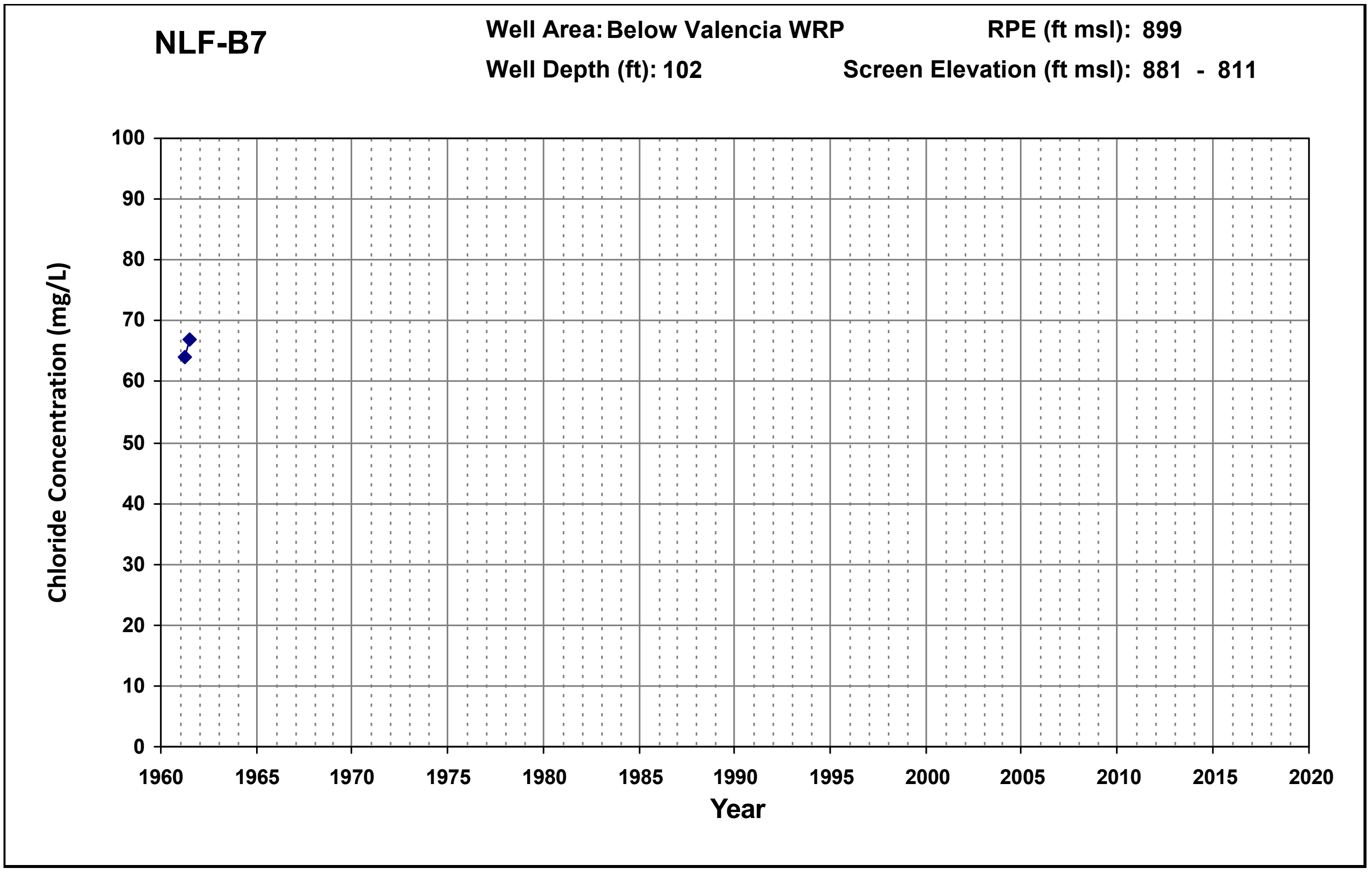

VWD-W11
Well Area: San Francisquito Canyon
RPE (ft msl): 1208.253
Well Depth (ft): 180
Screen Elevation (ft msl): 1098 - 1053
Total Dissolved Solids (mg/L)
Year

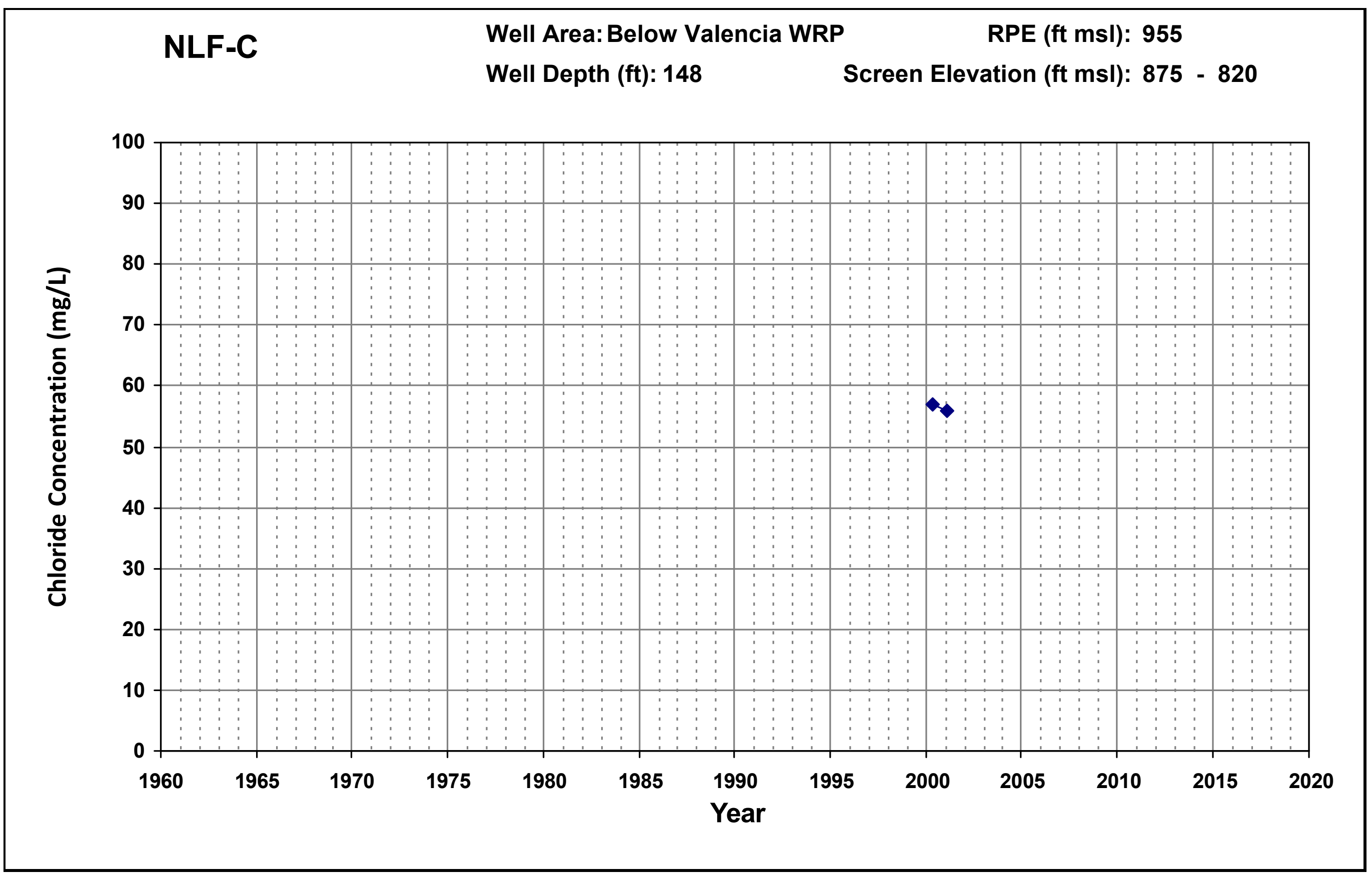

VWD-W6
Well Area: San Francisquito Canyon
RPE (ft msl): 1155
Well Depth (ft): 158
Screen Elevation (ft msl): 1065 - 1002
Total Dissolved Solids (mg/L)
Year


VWD-W9
Well Area: San Francisquito Canyon
RPE (ft msl): 1174.995
Well Depth (ft): 160
Screen Elevation (ft msl): 1105 - 1045
Total Dissolved Solids (mg/L)
2000
1800
1600
1400
1200
1000
800
600
400
200
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year


NLF-B5
Well Area: Below Valencia WRP
RPE (ft msl): 892
Well Depth (ft): 126
Screen Elevation (ft msl): 866 - 774
Chloride Concentration (mg/L)
Year
0
10
20
30
40
50
60
70
80
90
100
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

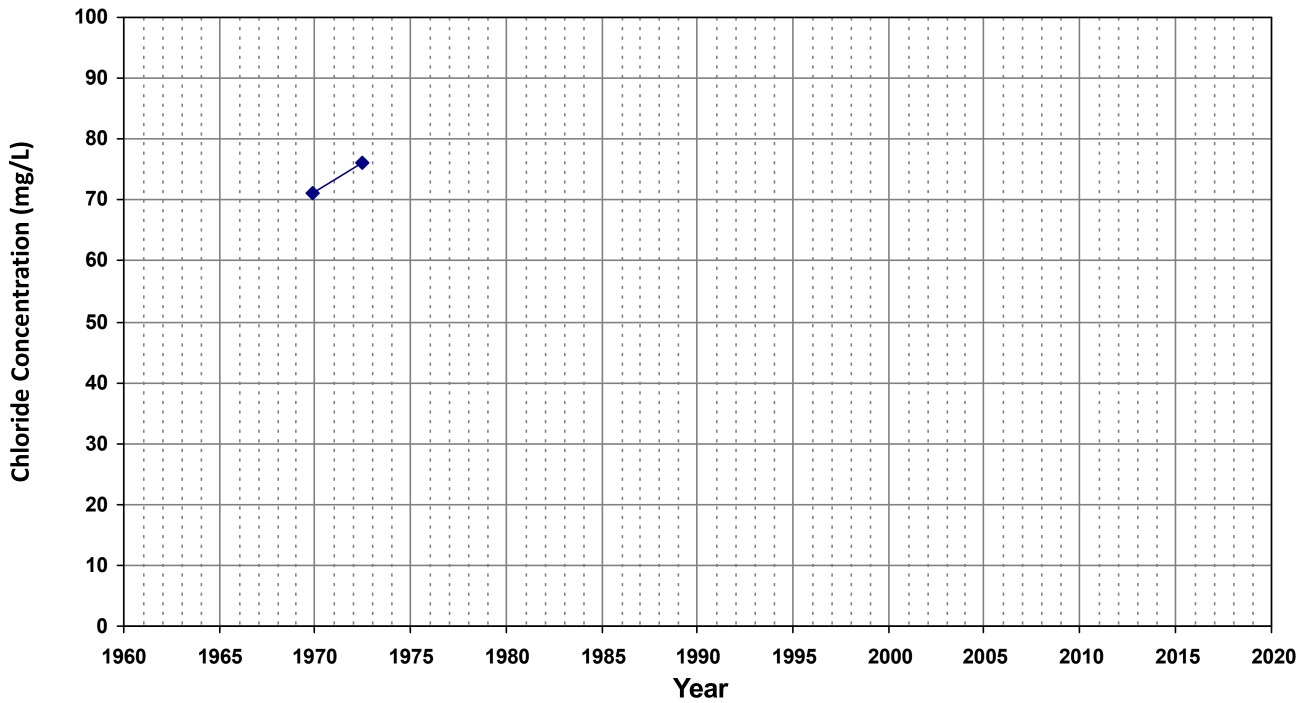

NLF-B6
Well Area: Below Valencia WRP
RPE (ft msl): 896
Well Depth (ft): 117
Screen Elevation (ft msl): 866 - 779
Chloride Concentration (mg/L)
Year
0
10
20
30
40
50
60
70
80
90
100
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020


NLF-B7
Well Area: Below Valencia WRP
RPE (ft msl): 899
Well Depth (ft): 102
Screen Elevation (ft msl): 881 - 811
Chloride Concentration (mg/L)
Year


NLF-C
Well Area: Below Valencia WRP
RPE (ft msl): 955
Well Depth (ft): 148
Screen Elevation (ft msl): 875 - 820
Chloride Concentration (mg/L)
Year

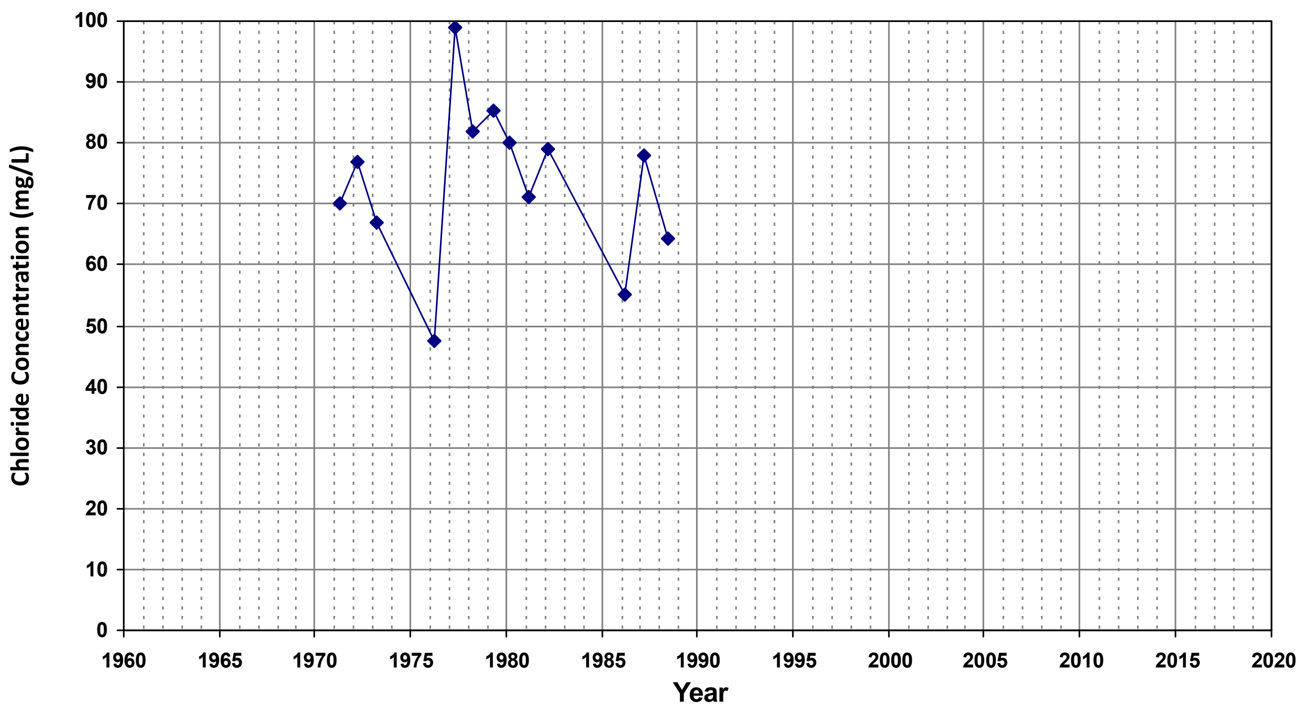
NLF-C5

Well Area: Below Valencia WRP
RPE (ft msl): 955
Well Depth (ft): 139
Screen Elevation (ft msl): 924 - 822



NLF-C6

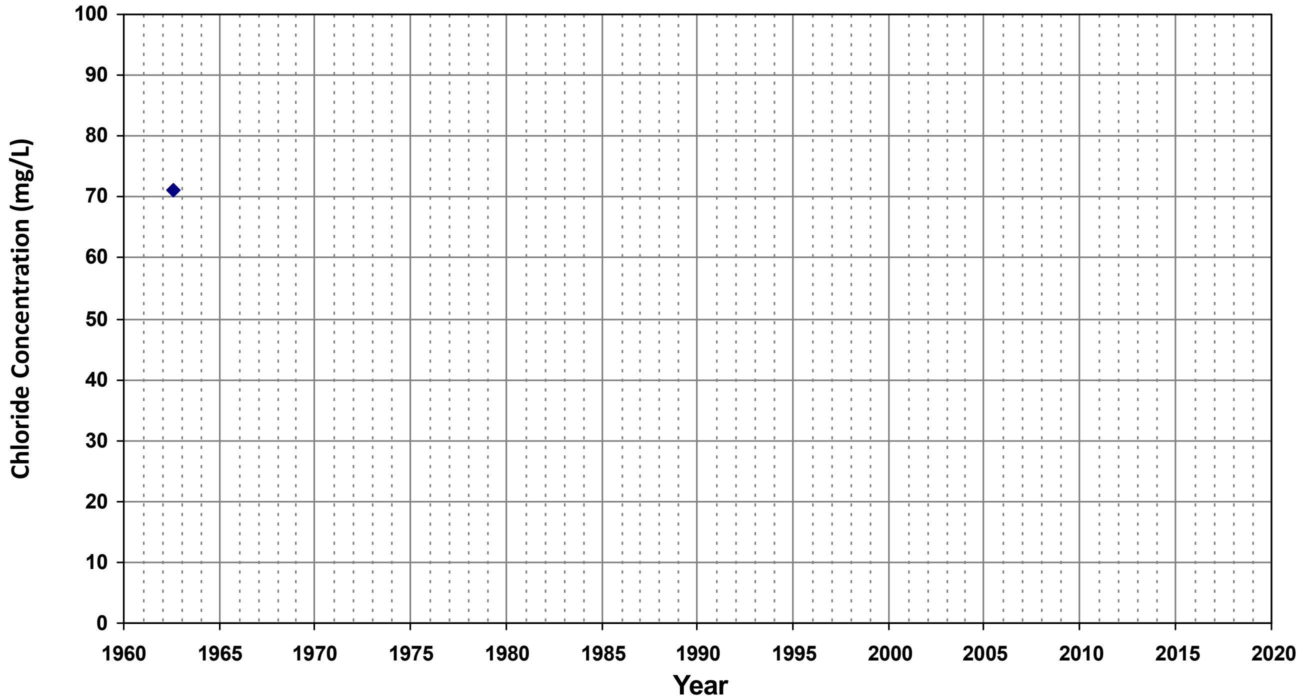
Well Area: Below Valencia WRP
RPE (ft msl): 961
Well Depth (ft): 103
Screen Elevation (ft msl): 935 - 868



NLF-C7

Well Area: Below Valencia WRP **RPE (ft msl): 958**

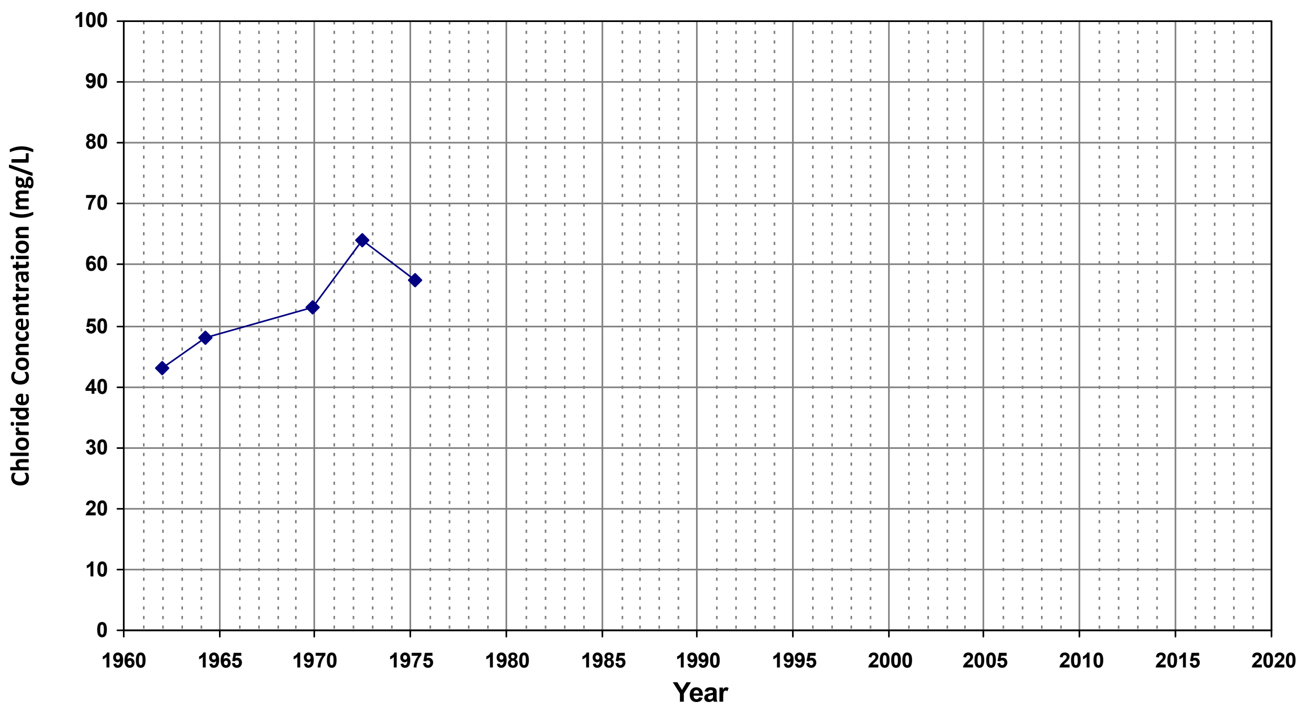
Well Depth (ft): 132 **Screen Elevation (ft msl): 918 - 838**



NLF-C8

Well Area: Below Valencia WRP **RPE (ft msl): 951**

Well Depth (ft): 280 **Screen Elevation (ft msl): 921 - 821**



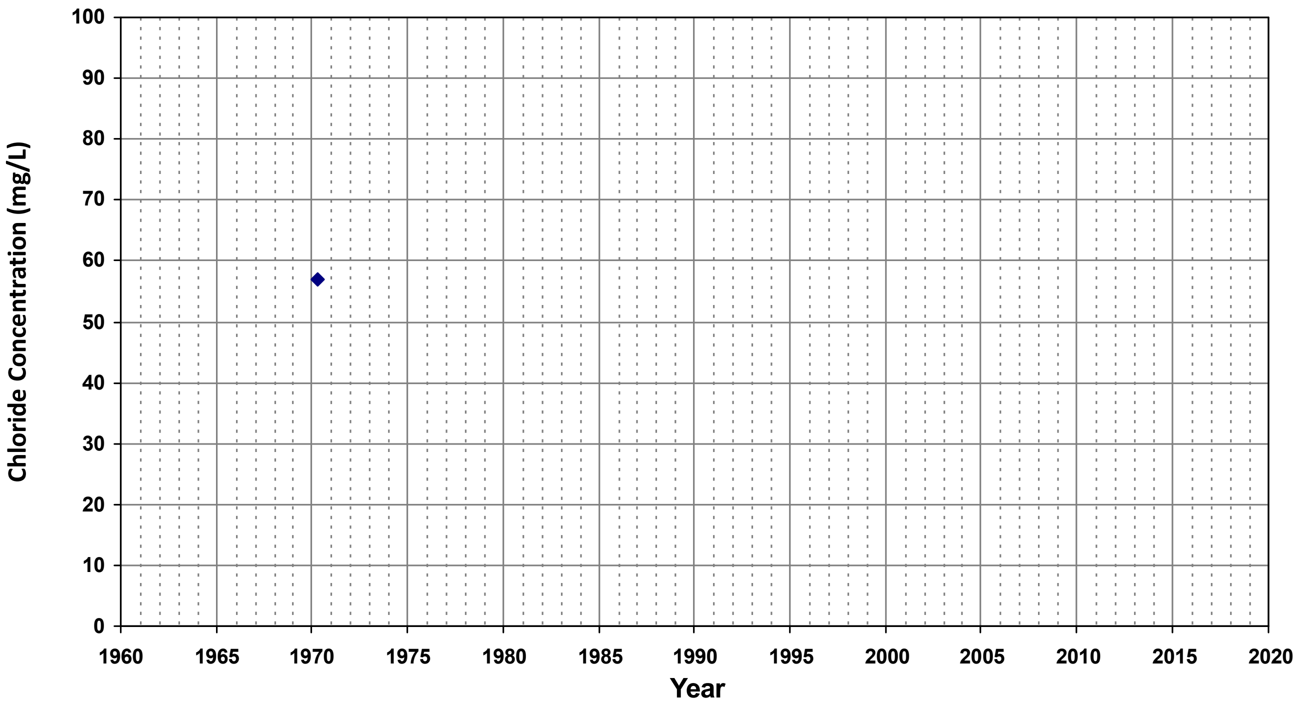
NLF-E3

Well Area: Below Valencia WRP

RPE (ft msl): 991

Well Depth (ft): 255

Screen Elevation (ft msl): 944 - 757



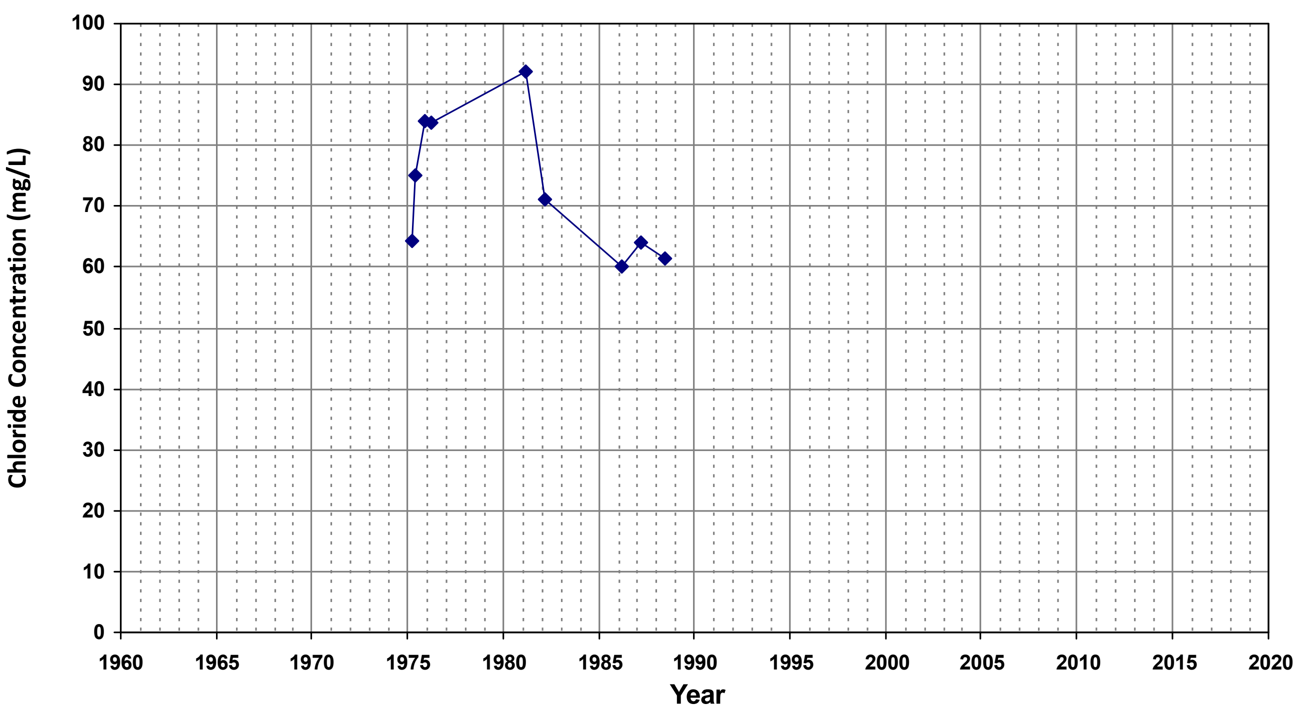
NLF-E4

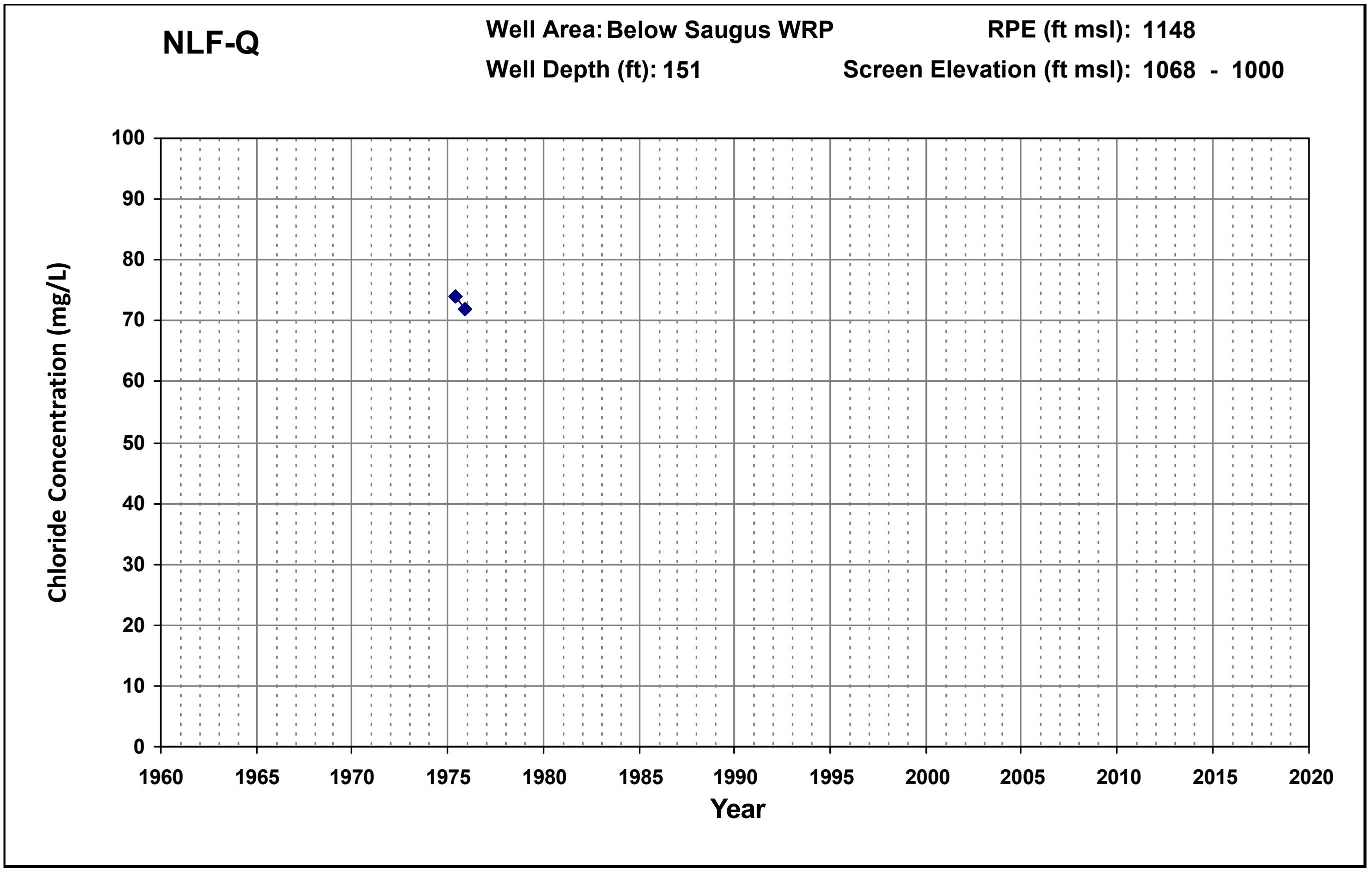
Well Area: Below Valencia WRP

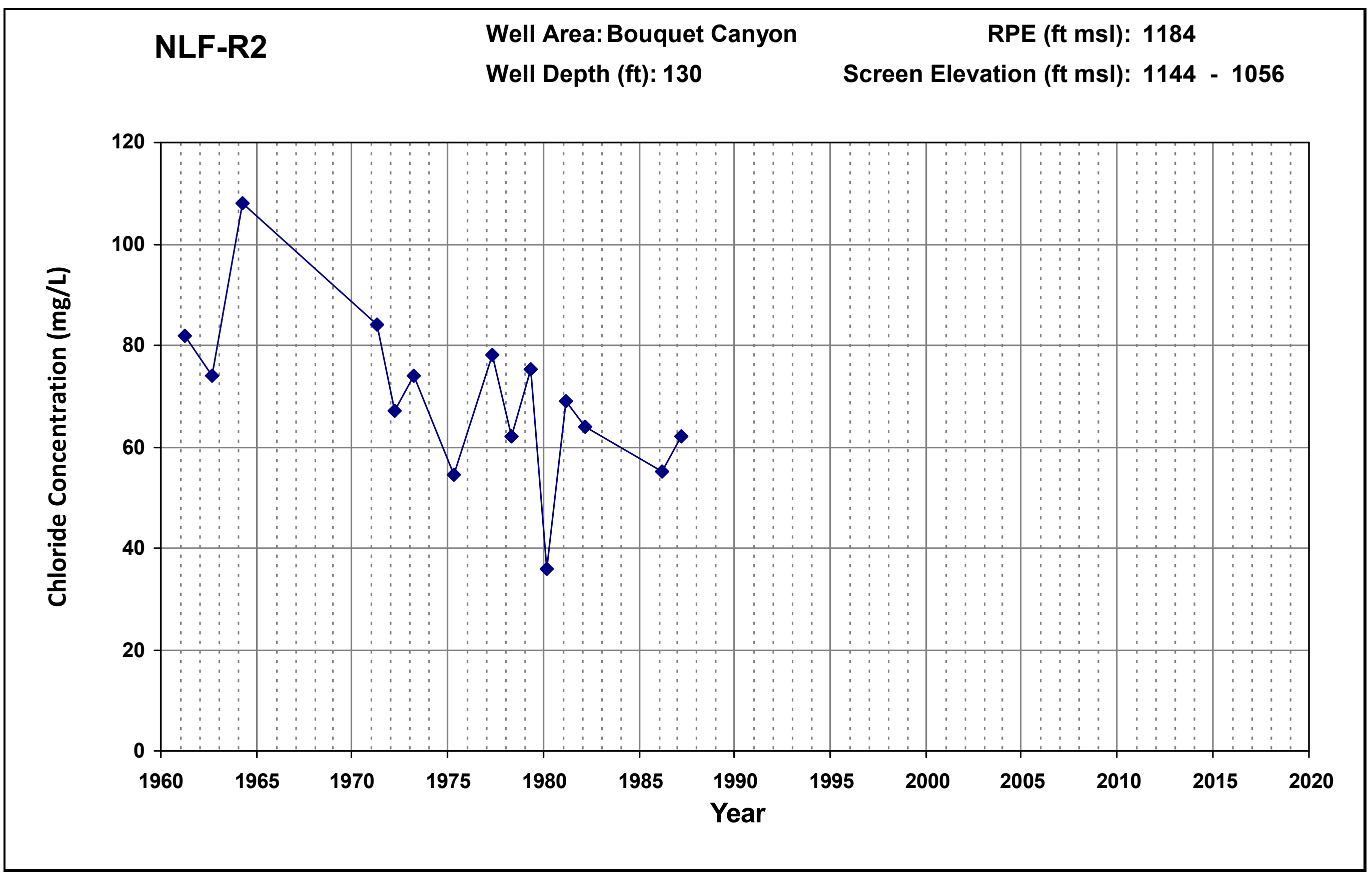
RPE (ft msl): 991

Well Depth (ft): 142

Screen Elevation (ft msl): 941 - 855

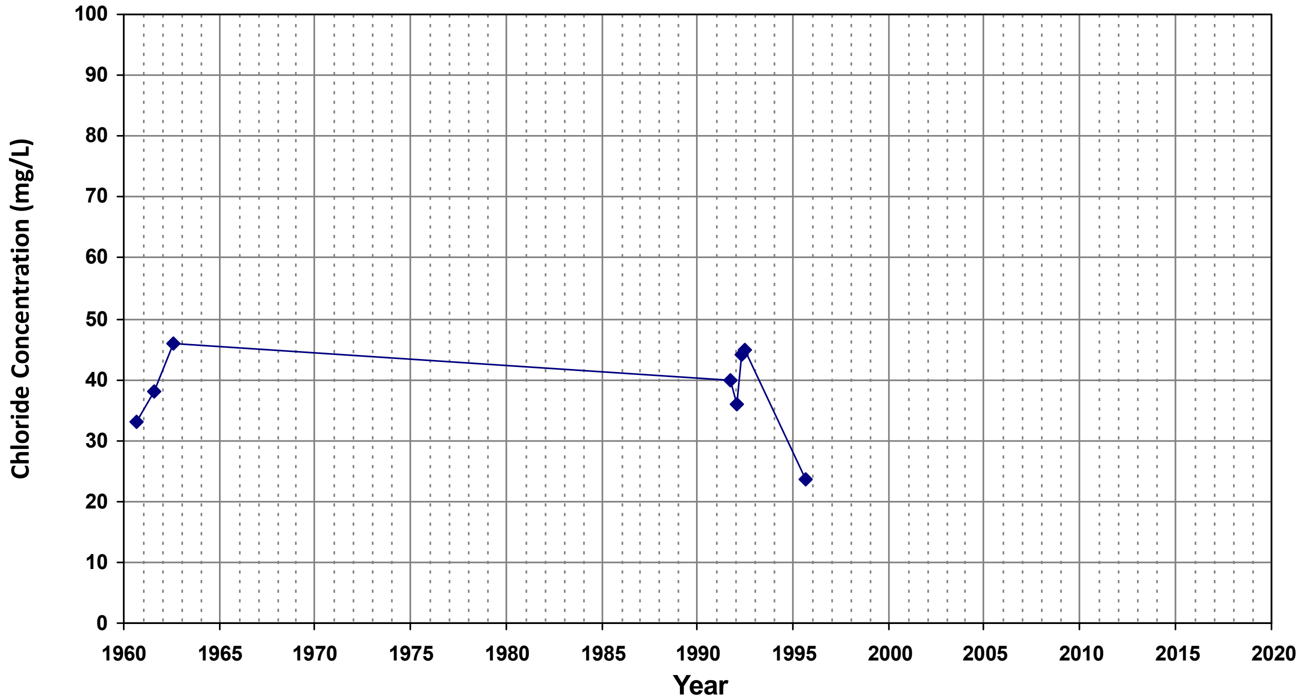



NLF-Q
Well Area: Below Saugus WRP
RPE (ft msl): 1148
Well Depth (ft): 151
Screen Elevation (ft msl): 1068 - 1000
Chloride Concentration (mg/L)
0
10
20
30
40
50
60
70
80
90
100
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year


NLF-R2
Well Area: Bouquet Canyon
RPE (ft msl): 1184
Well Depth (ft): 130
Screen Elevation (ft msl): 1144 - 1056
Chloride Concentration (mg/L)
0
20
40
60
80
100
120
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

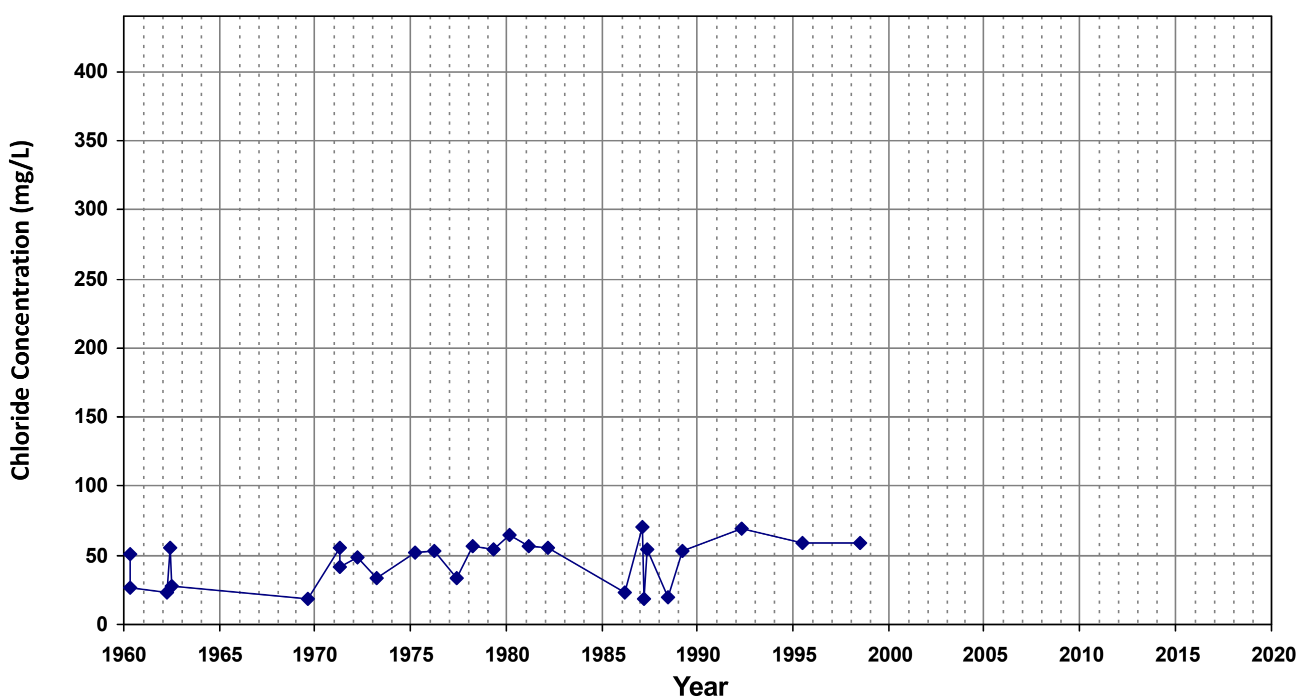
NLF-W4

Well Area: San Francisquito Canyon | RPE (ft msl): 1201
Well Depth (ft): 140 | Screen Elevation (ft msl): 1171 - 1066



NWD-07

Well Area: Southern Saugus | RPE (ft msl): 1250
Well Depth (ft): 994 | Screen Elevation (ft msl): 730 - 276



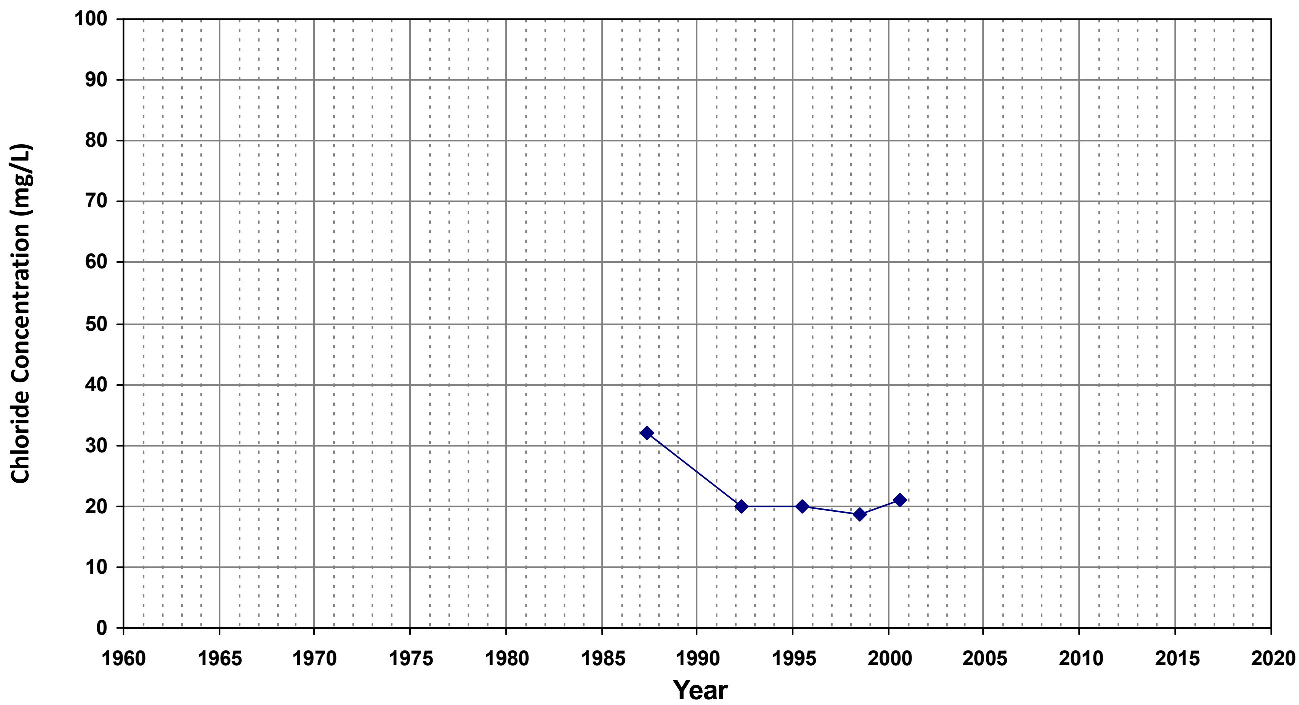
NWD-09

Well Area: Southern Saugus

Well Depth (ft): 675

RPE (ft msl): 1358

Screen Elevation (ft msl): 1047 - 684



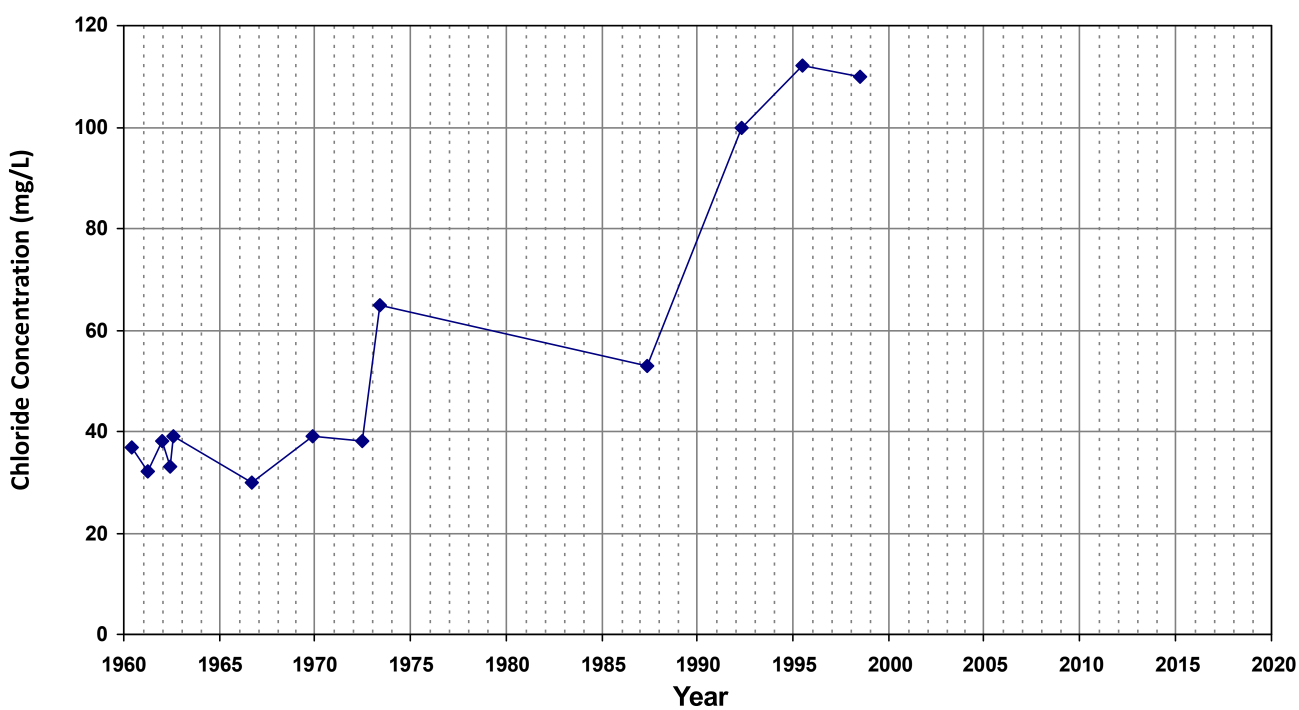
NWD-10

Well Area: Southern Saugus

Well Depth (ft): 1555

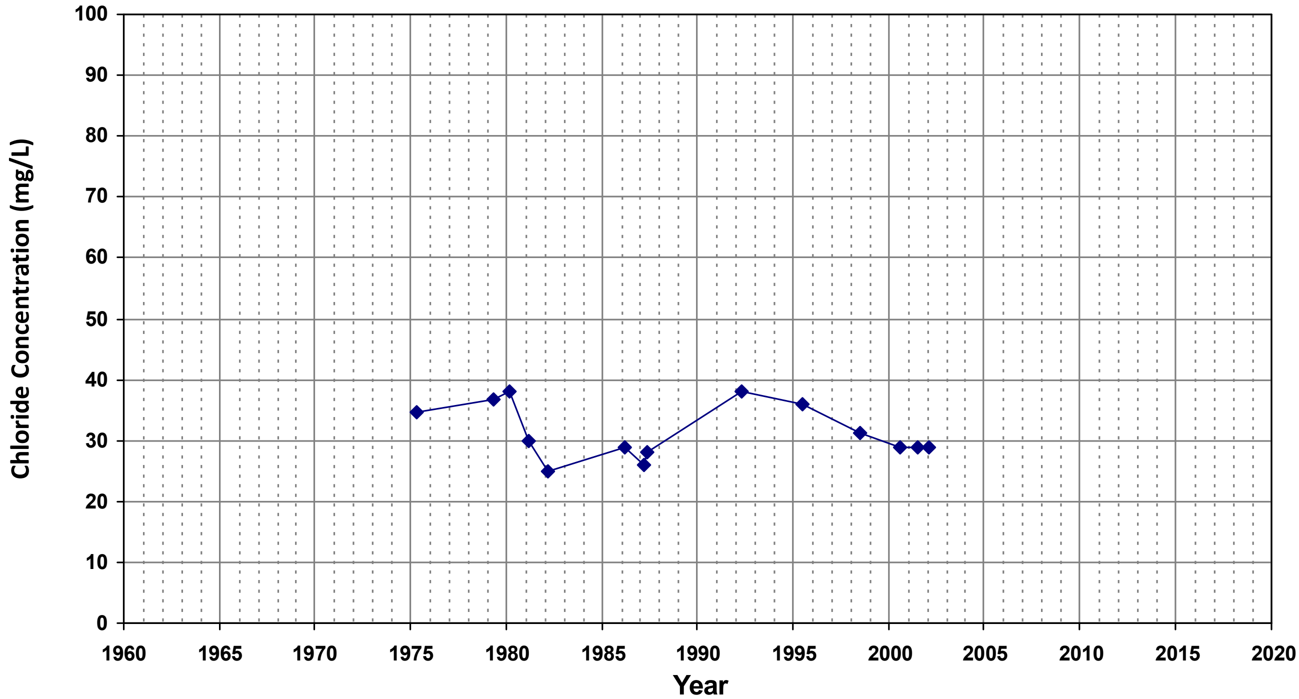
RPE (ft msl): 1204

Screen Elevation (ft msl): 424 - -340



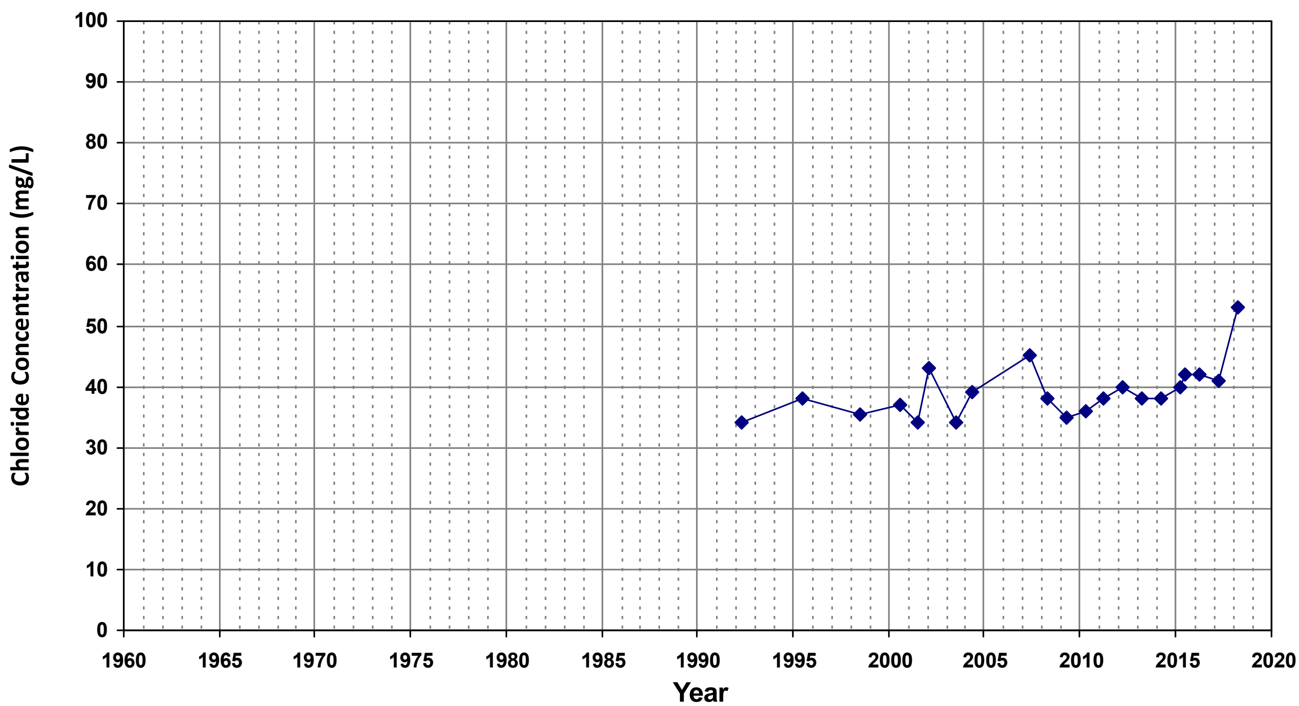
NWD-11

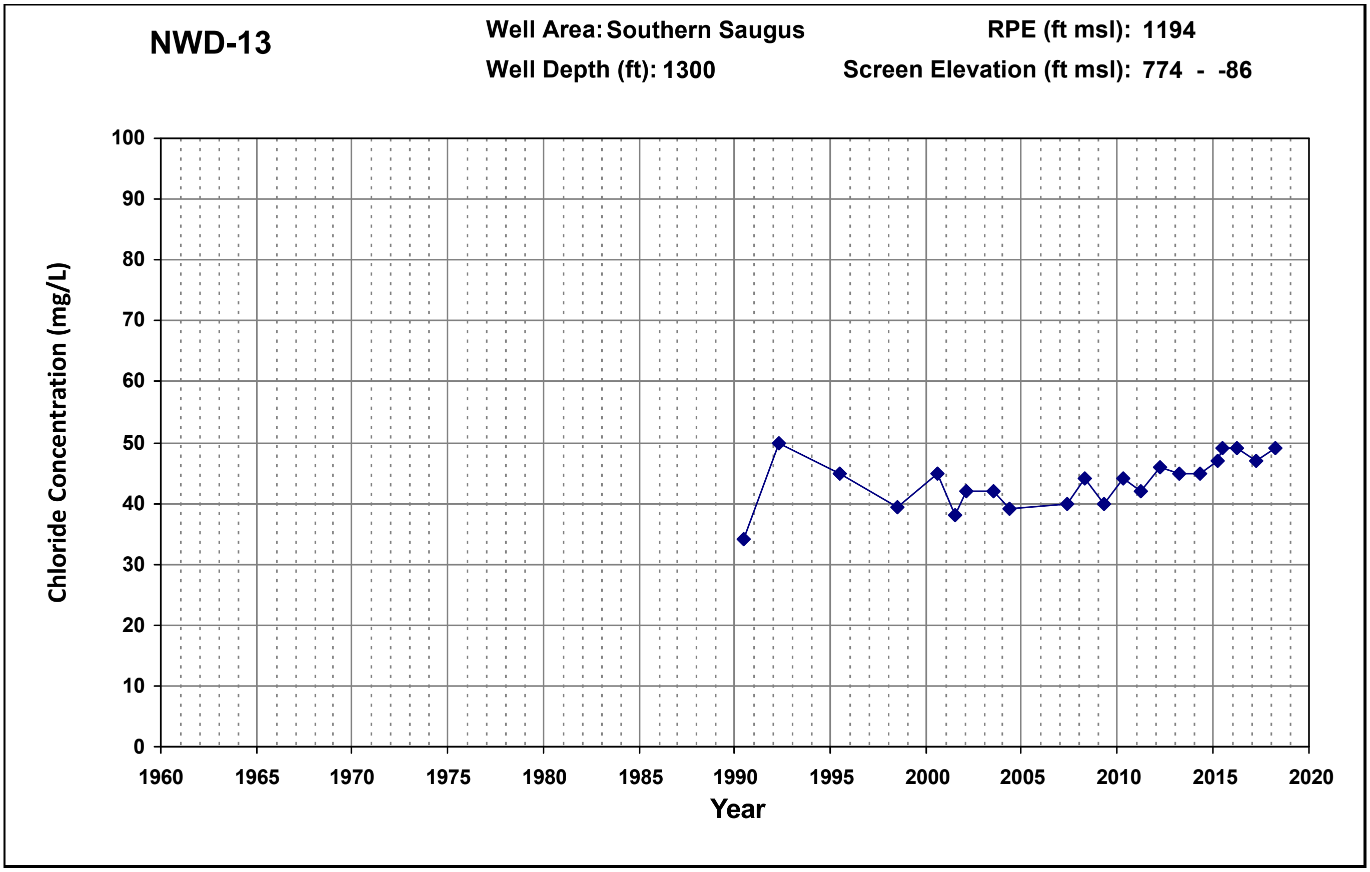
Well Area: Southern Saugus | RPE (ft msl): 1188
Well Depth (ft): 1136 | Screen Elevation (ft msl): 988 - 113

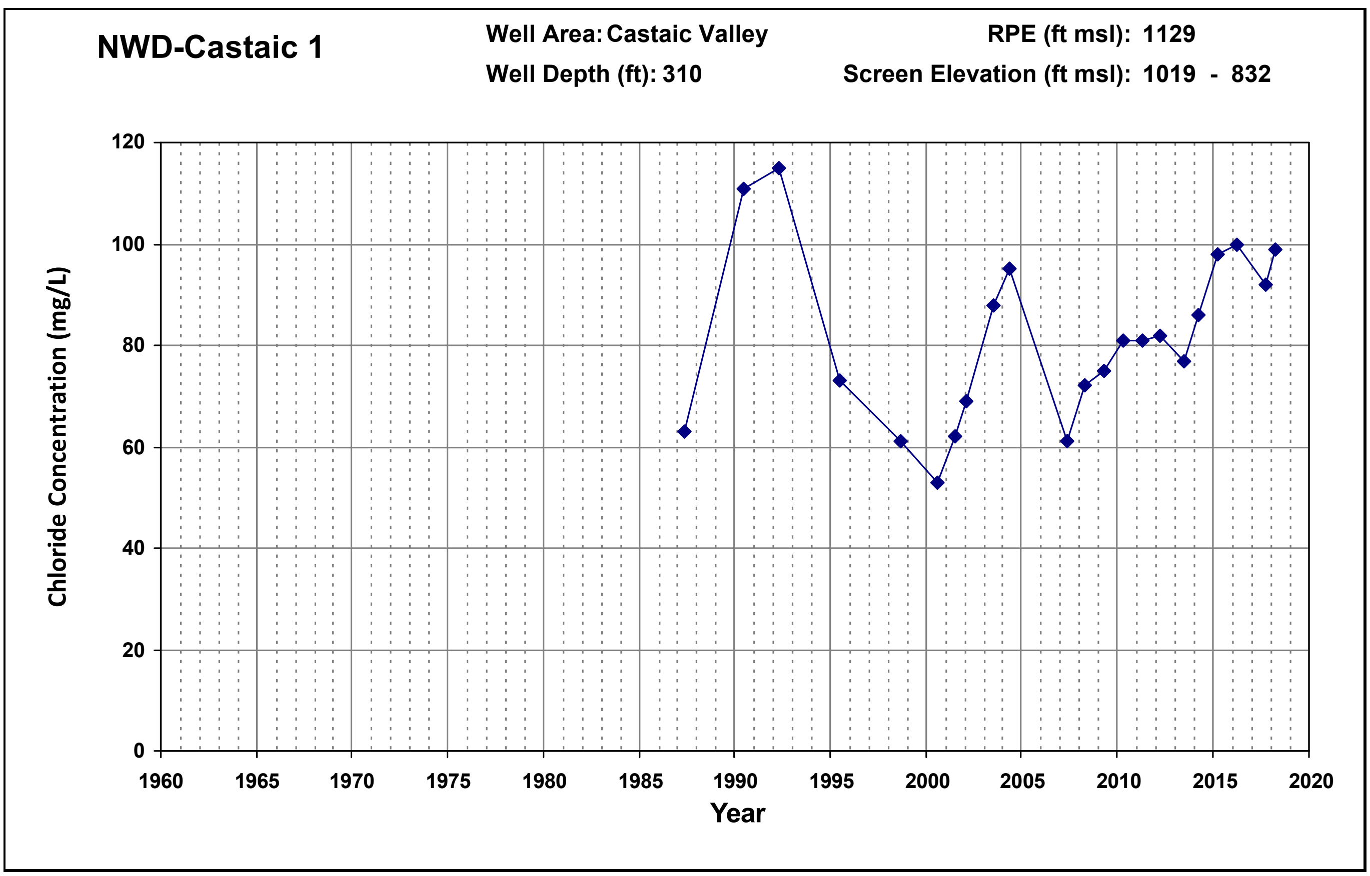


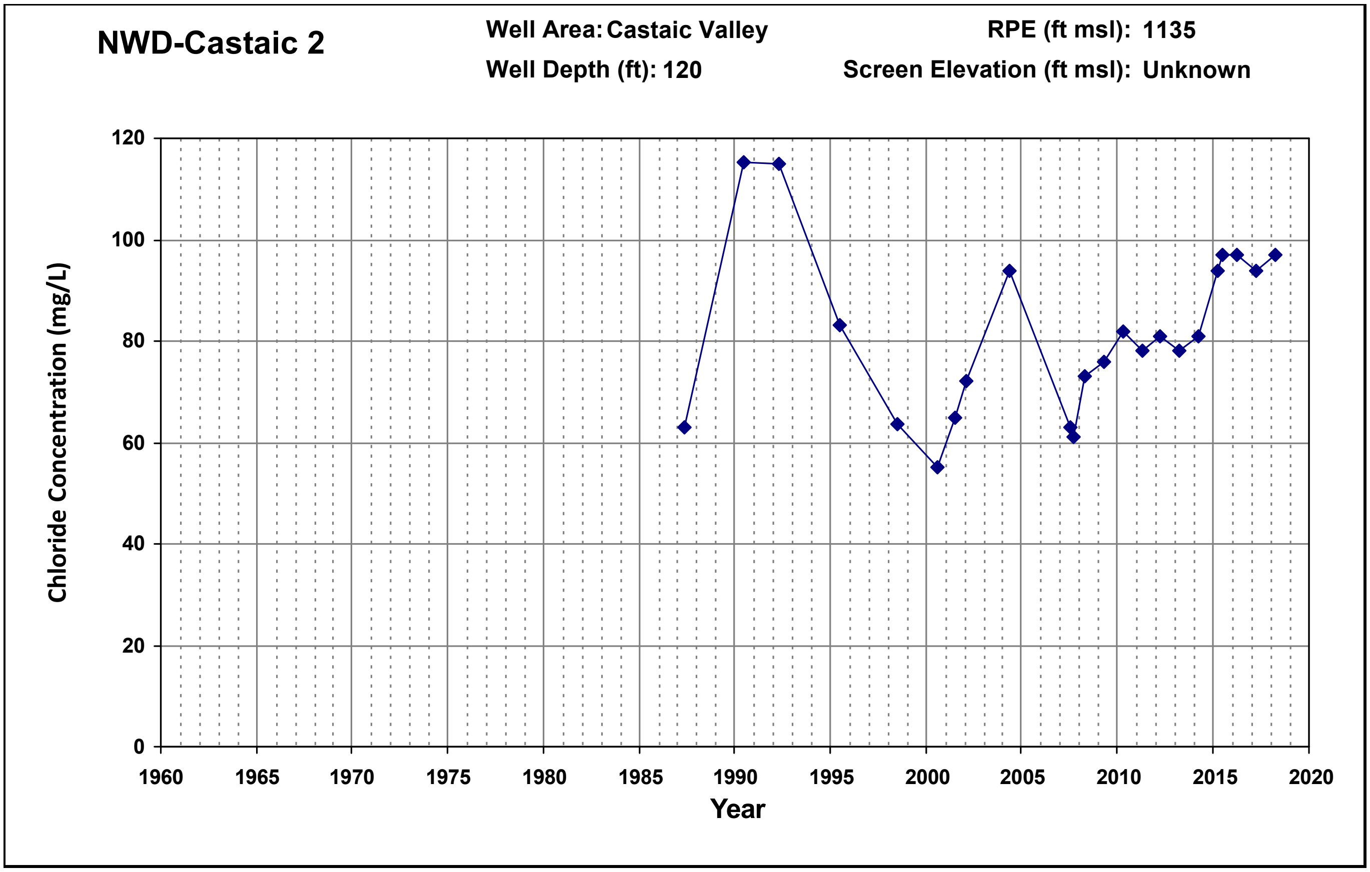
NWD-12

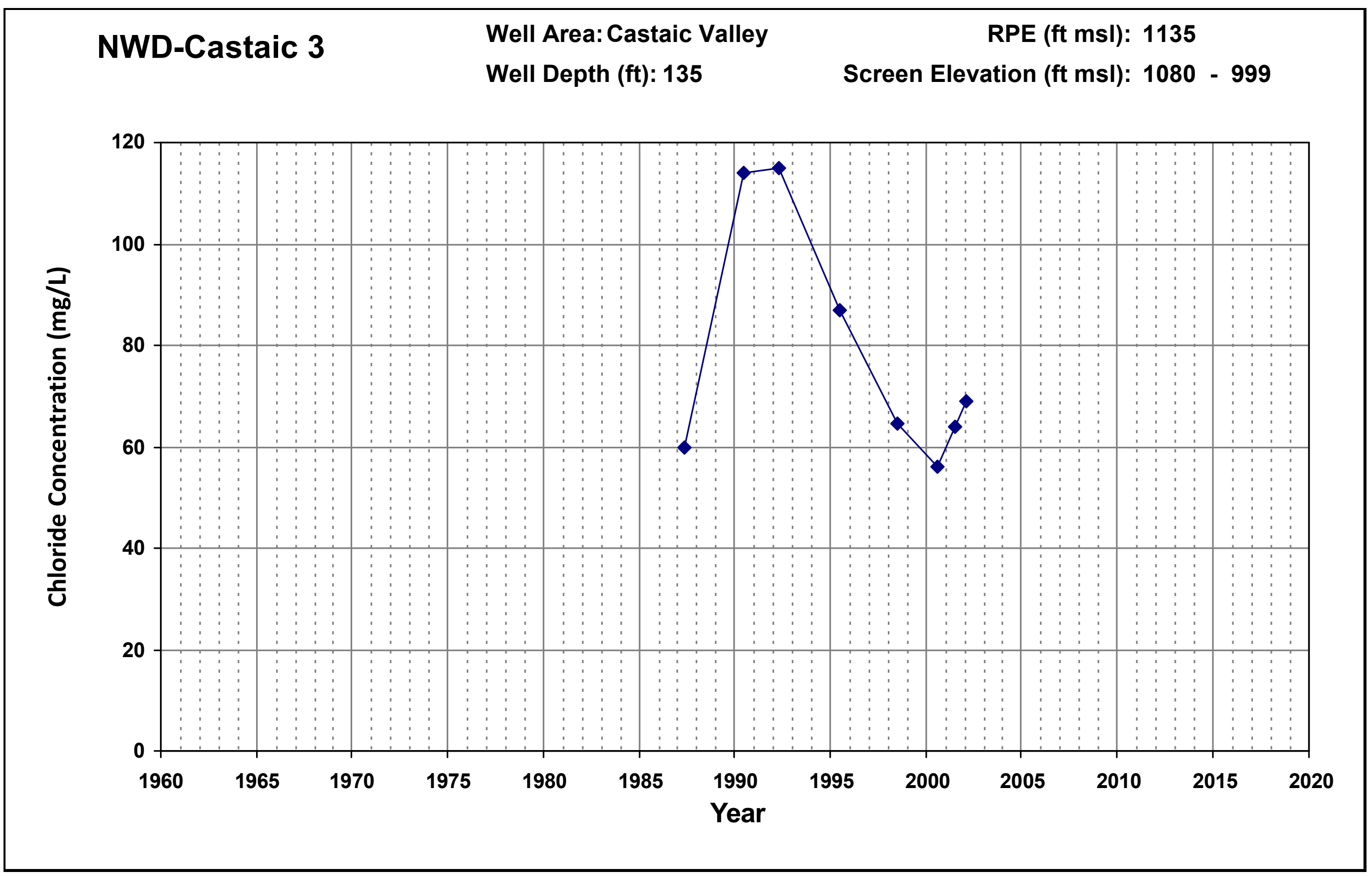
Well Area: Southern Saugus | RPE (ft msl): 1204
Well Depth (ft): 1340 | Screen Elevation (ft msl): 719 - -76

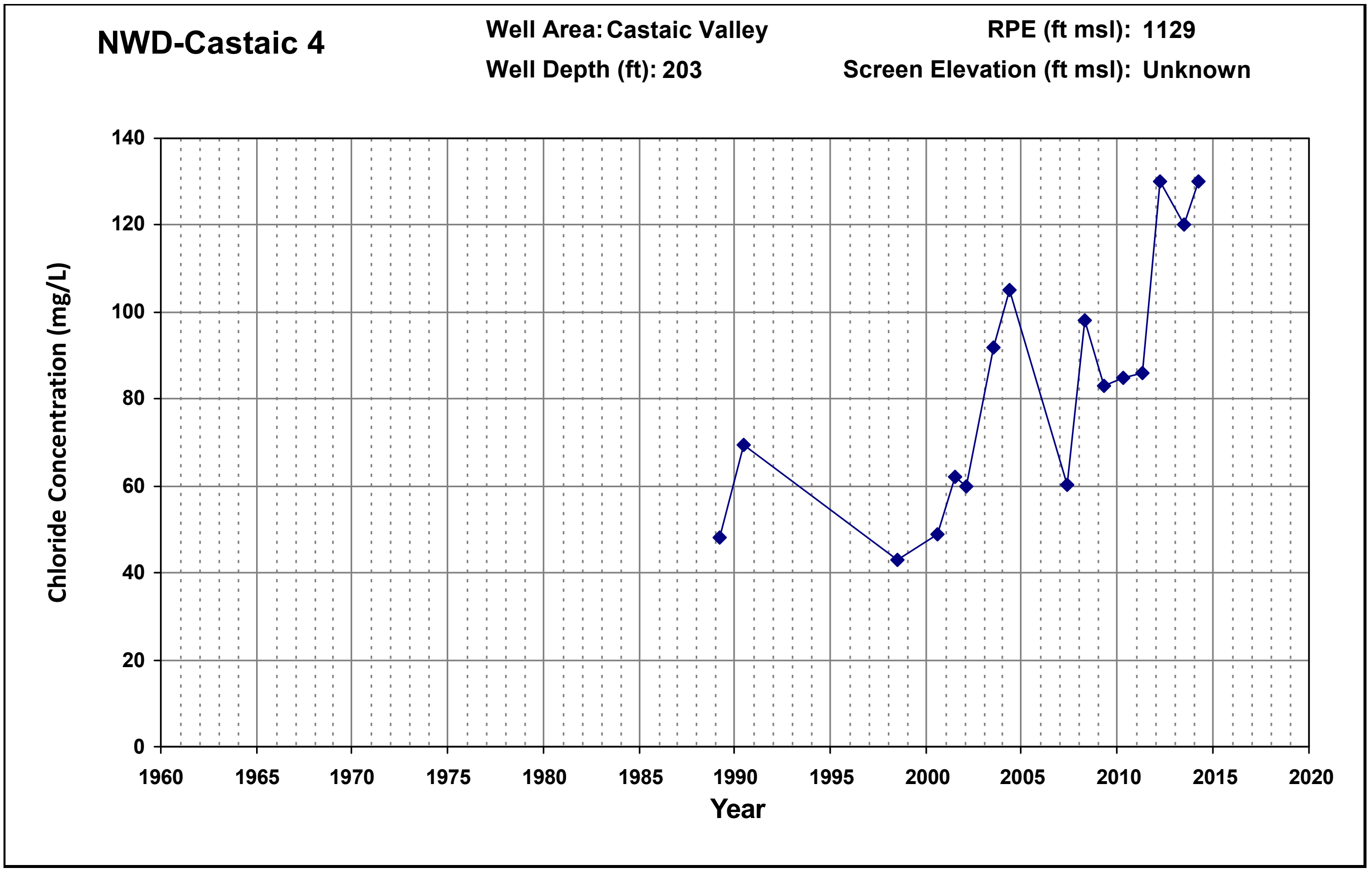


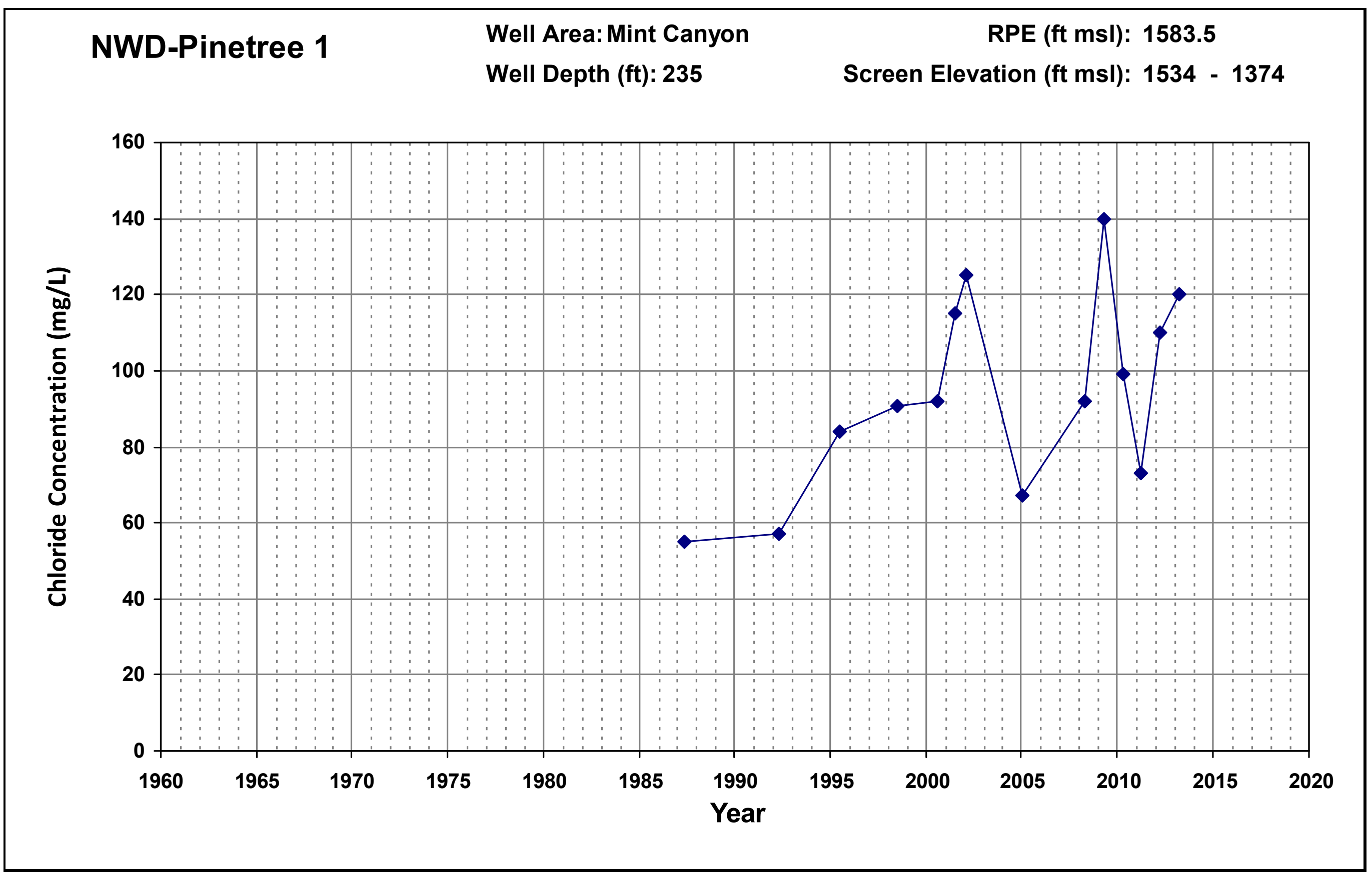

NWD-13
Well Area: Southern Saugus
RPE (ft msl): 1194
Well Depth (ft): 1300
Screen Elevation (ft msl): 774 - -86
Chloride Concentration (mg/L)
100
90
80
70
60
50
40
30
20
10
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

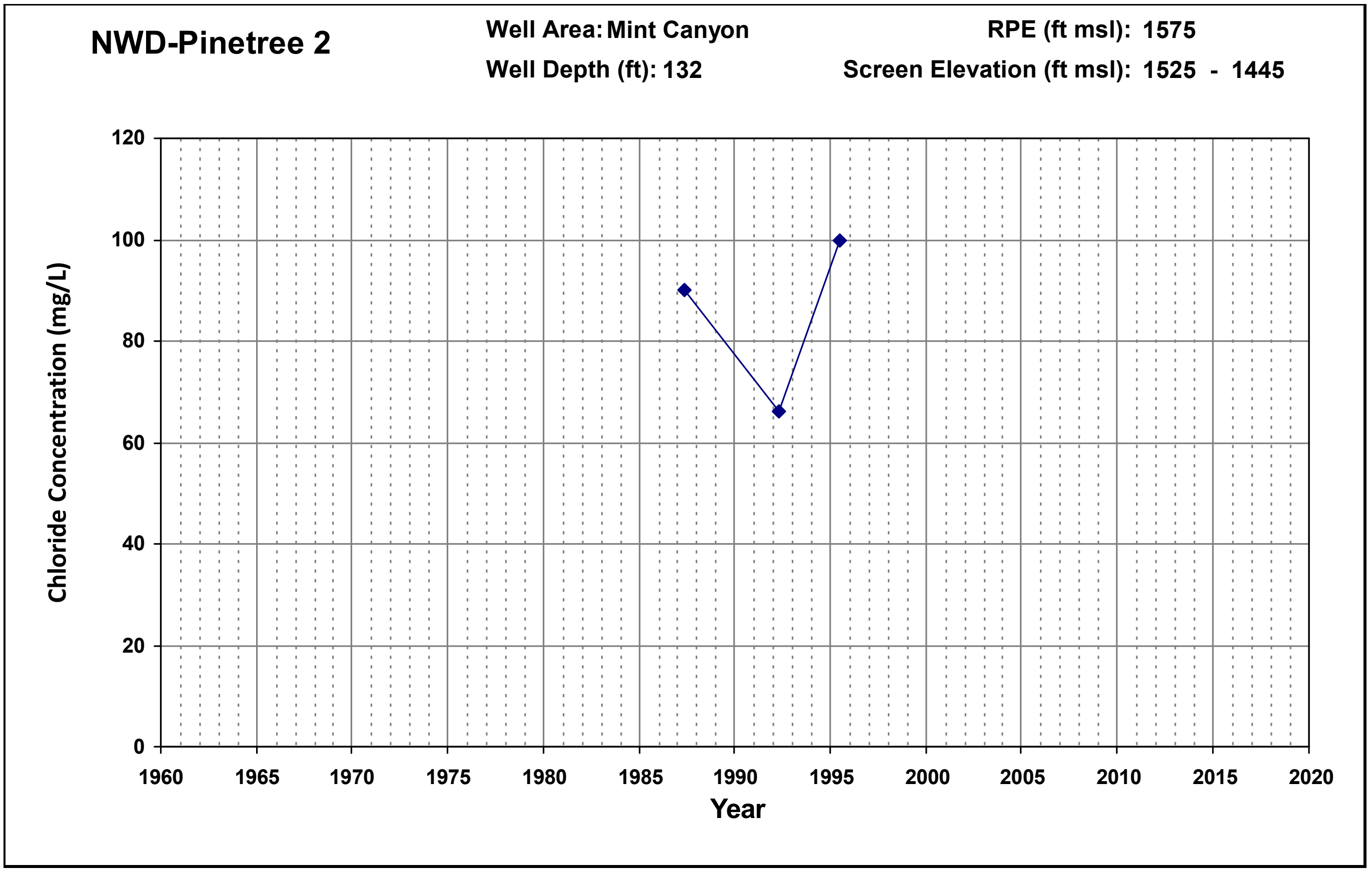

NWD-Castaic 1
Well Area: Castaic Valley
RPE (ft msl): 1129
Well Depth (ft): 310
Screen Elevation (ft msl): 1019 - 832
Chloride Concentration (mg/L)
120
100
80
60
40
20
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

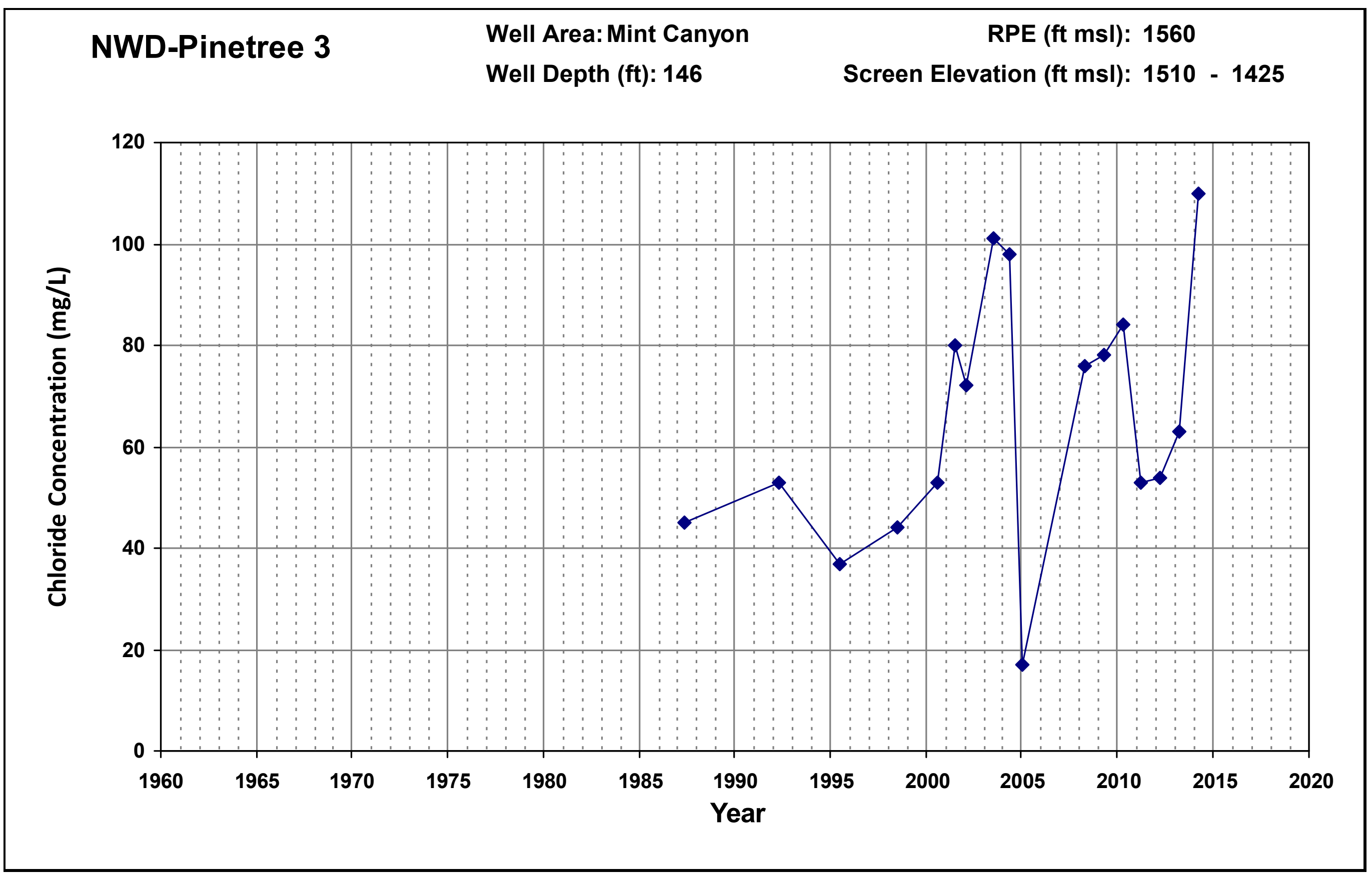

NWD-Castaic 2
Well Area: Castaic Valley
Well Depth (ft): 120
RPE (ft msl): 1135
Screen Elevation (ft msl): Unknown
Chloride Concentration (mg/L)
0
20
40
60
80
100
120
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

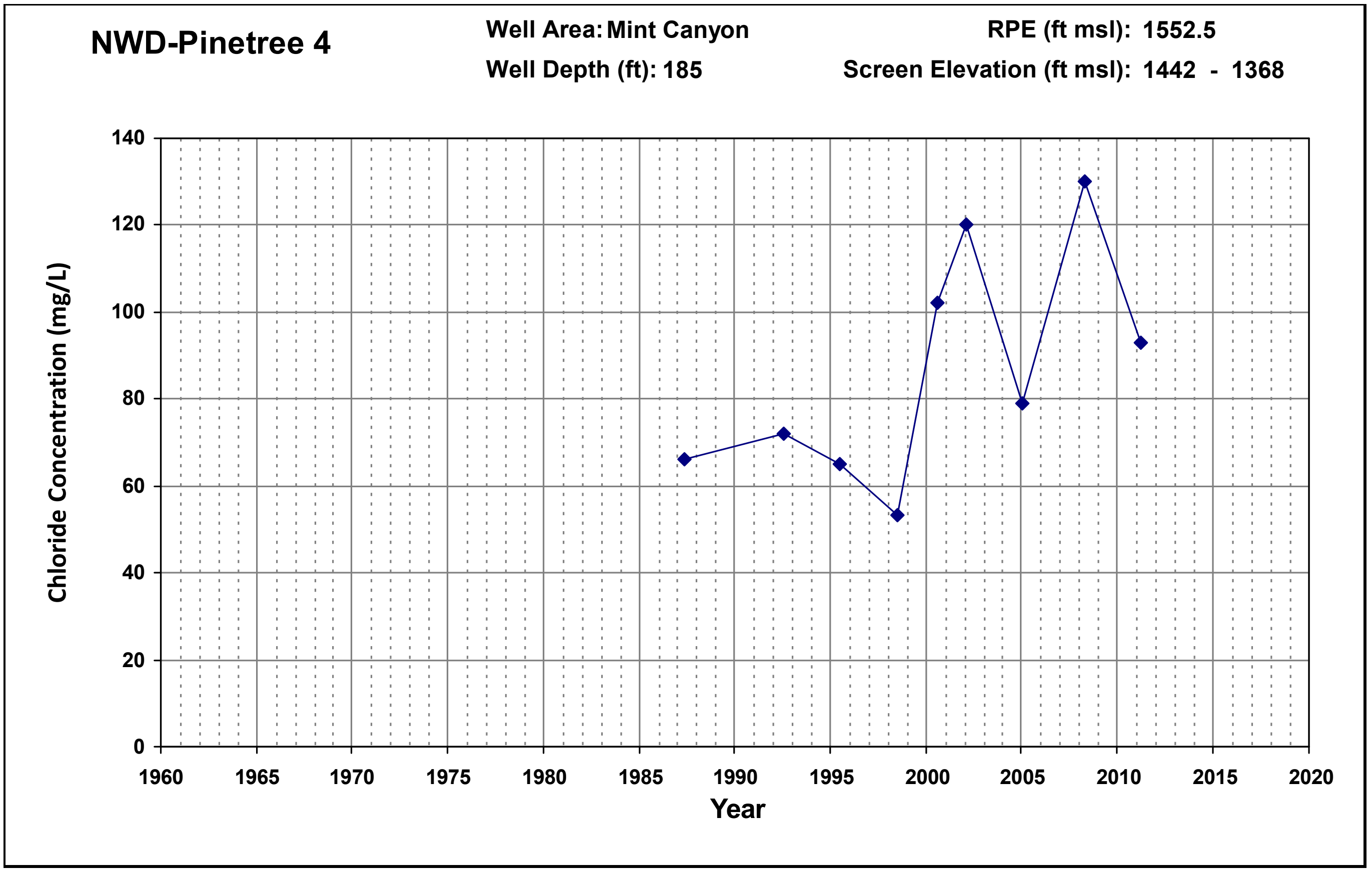

NWD-Castaic 3
Well Area: Castaic Valley
Well Depth (ft): 135
RPE (ft msl): 1135
Screen Elevation (ft msl): 1080 - 999
Chloride Concentration (mg/L)
0
20
40
60
80
100
120
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

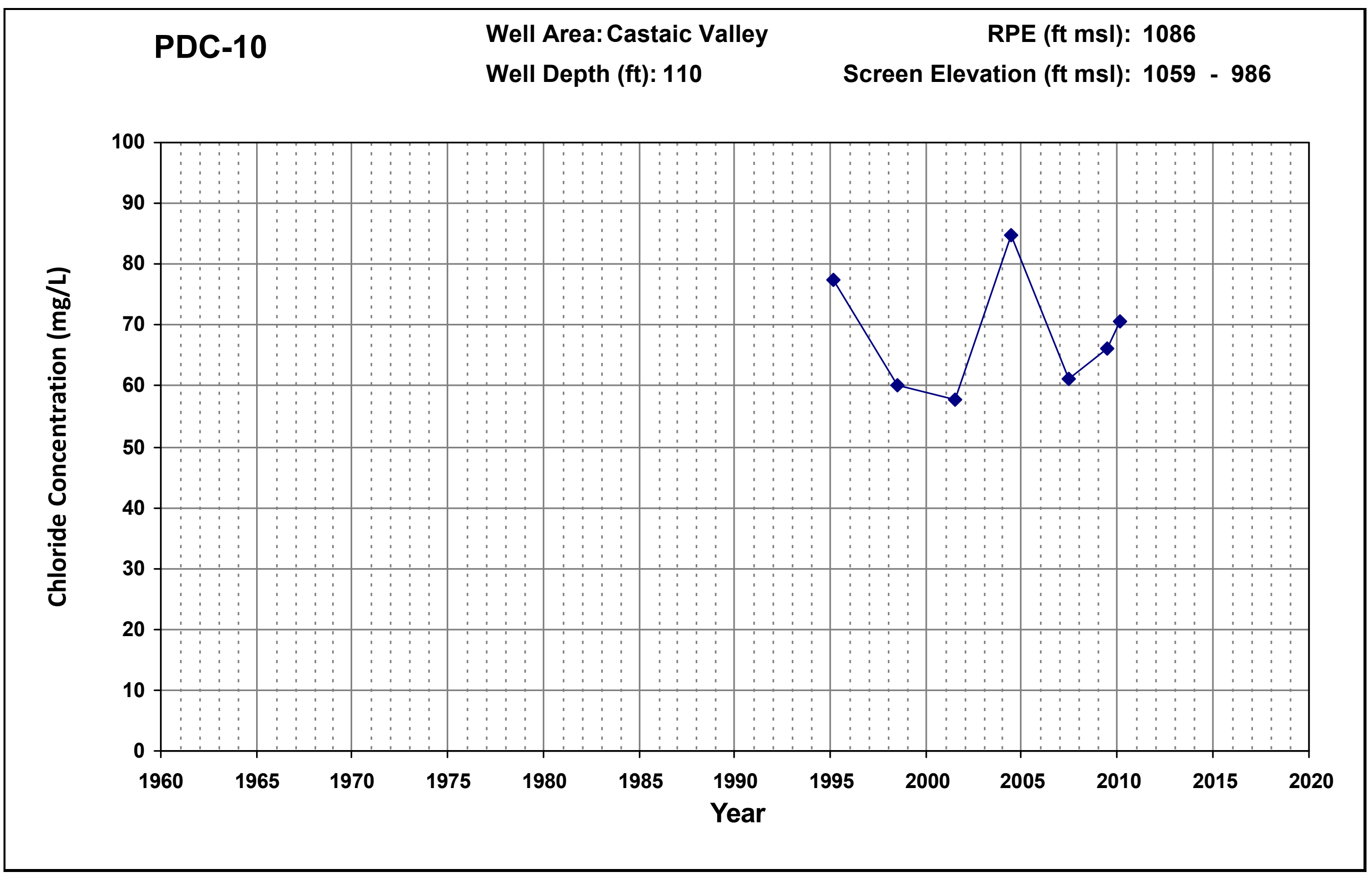

NWD-Castaic 4
Well Area: Castaic Valley
Well Depth (ft): 203
RPE (ft msl): 1129
Screen Elevation (ft msl): Unknown
Chloride Concentration (mg/L)
Year
0
20
40
60
80
100
120
140
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

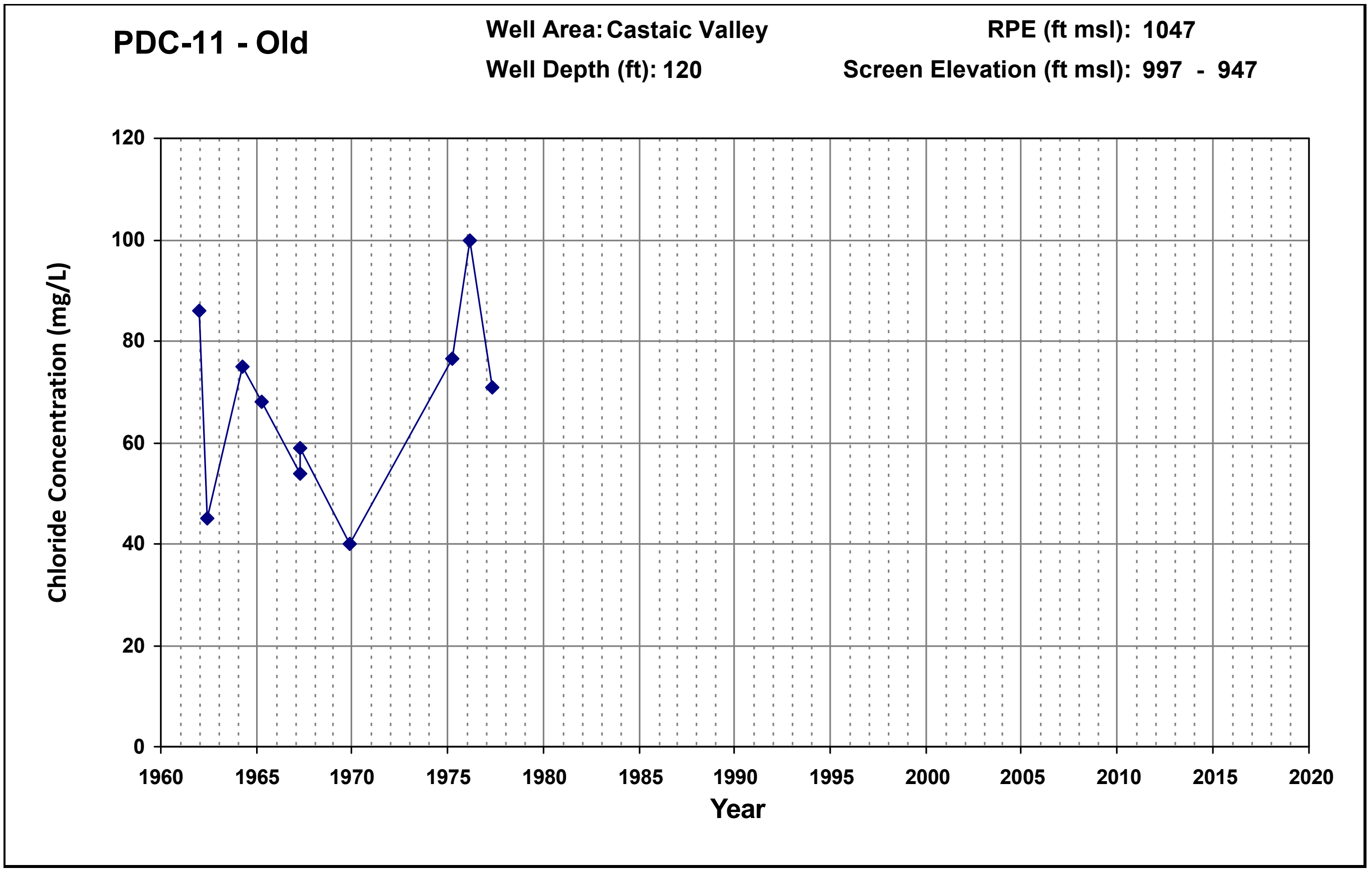

NWD-Pinetree 1
Well Area: Mint Canyon
Well Depth (ft): 235
RPE (ft msl): 1583.5
Screen Elevation (ft msl): 1534 - 1374
Chloride Concentration (mg/L)
Year
0
20
40
60
80
100
120
140
160
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020


NWD-Pinetree 2
Well Area: Mint Canyon
Well Depth (ft): 132
RPE (ft msl): 1575
Screen Elevation (ft msl): 1525 - 1445
Chloride Concentration (mg/L)
120
100
80
60
40
20
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

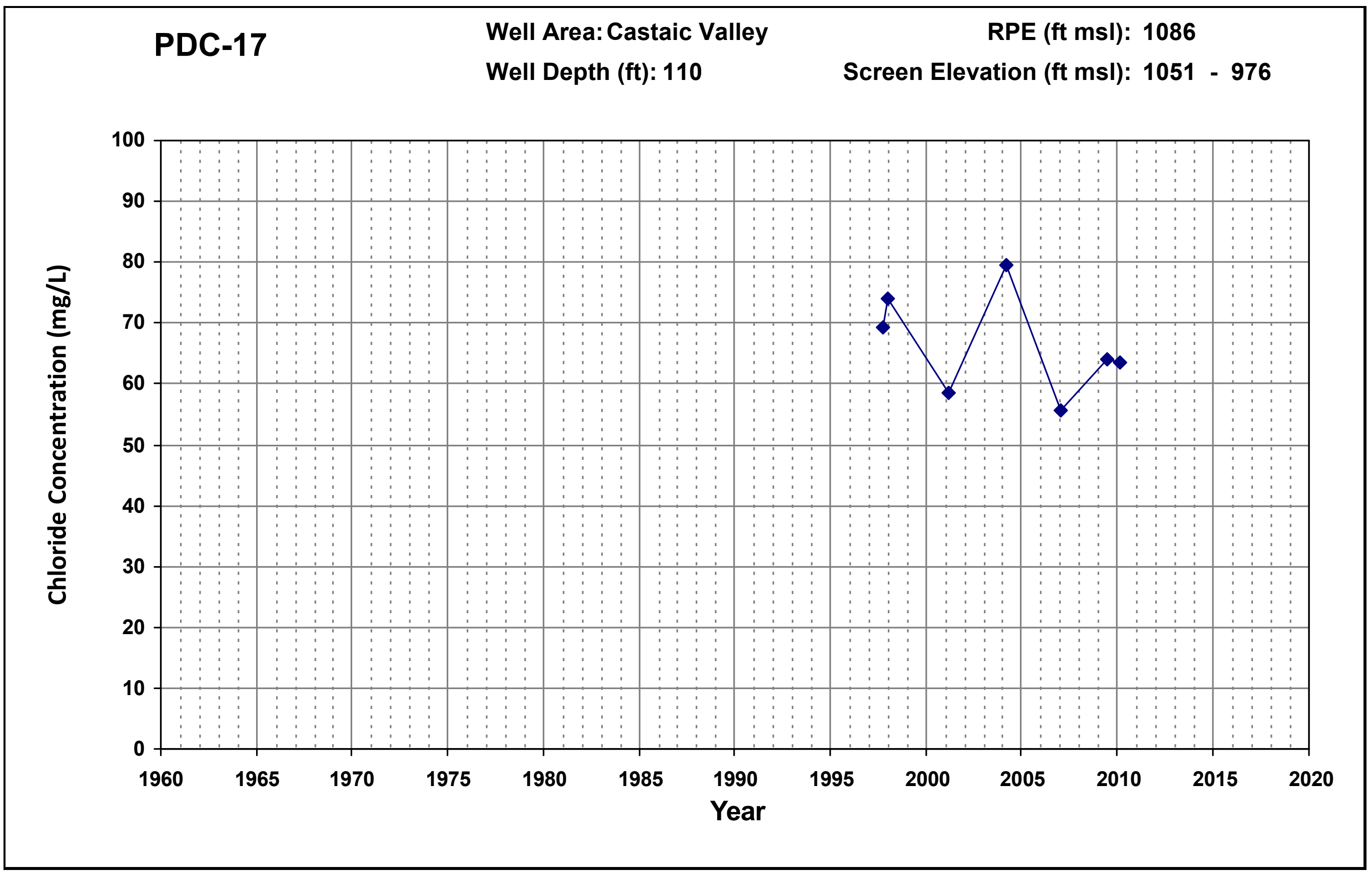

NWD-Pinetree 3
Well Area: Mint Canyon
Well Depth (ft): 146
RPE (ft msl): 1560
Screen Elevation (ft msl): 1510 - 1425
Chloride Concentration (mg/L)
120
100
80
60
40
20
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year


NWD-Pinetree 4
Well Area: Mint Canyon
Well Depth (ft): 185
RPE (ft msl): 1552.5
Screen Elevation (ft msl): 1442 - 1368
Chloride Concentration (mg/L)
0
20
40
60
80
100
120
140
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

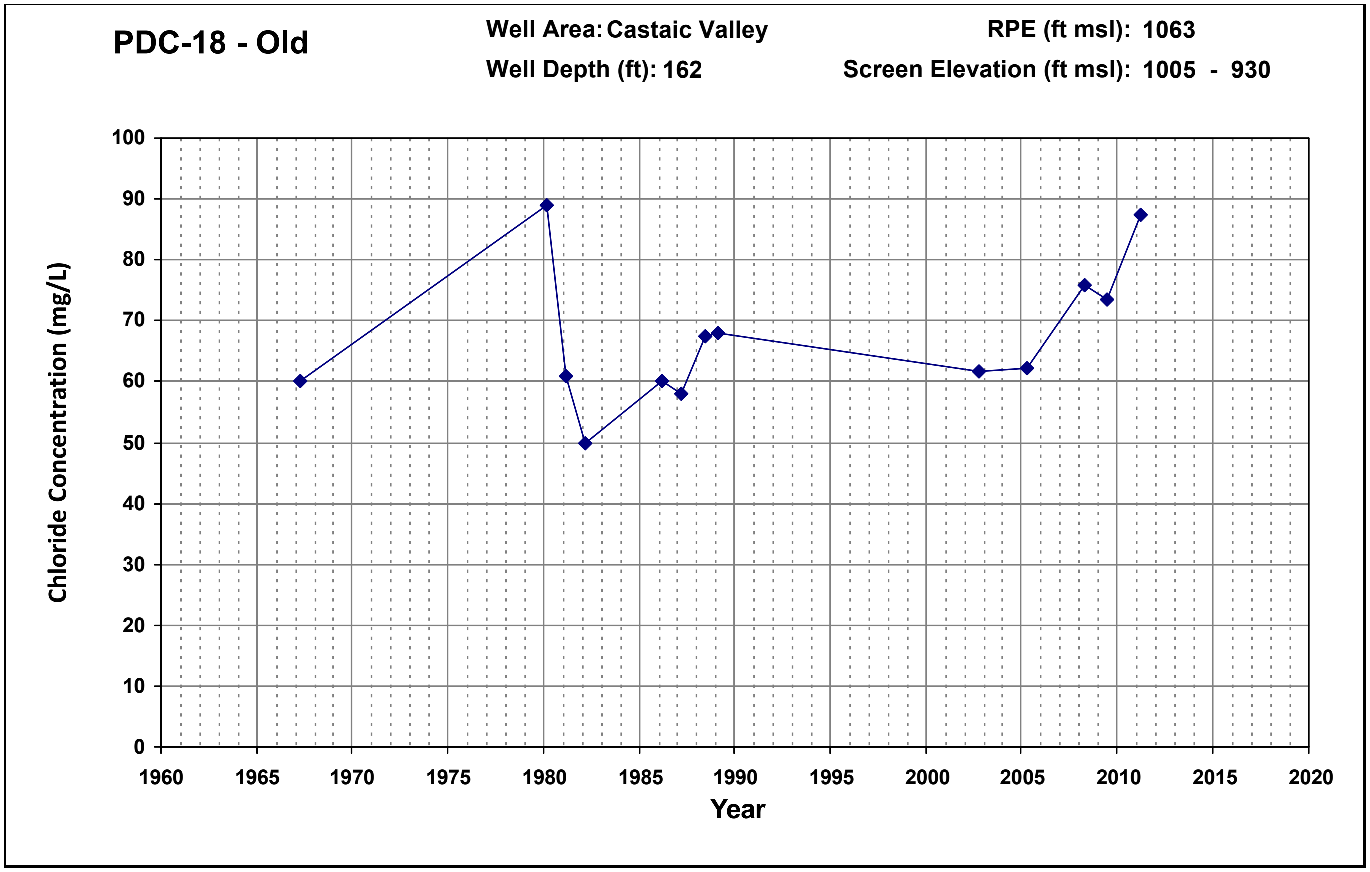

PDC-10
Well Area: Castaic Valley
Well Depth (ft): 110
RPE (ft msl): 1086
Screen Elevation (ft msl): 1059 - 986
Chloride Concentration (mg/L)
0
10
20
30
40
50
60
70
80
90
100
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

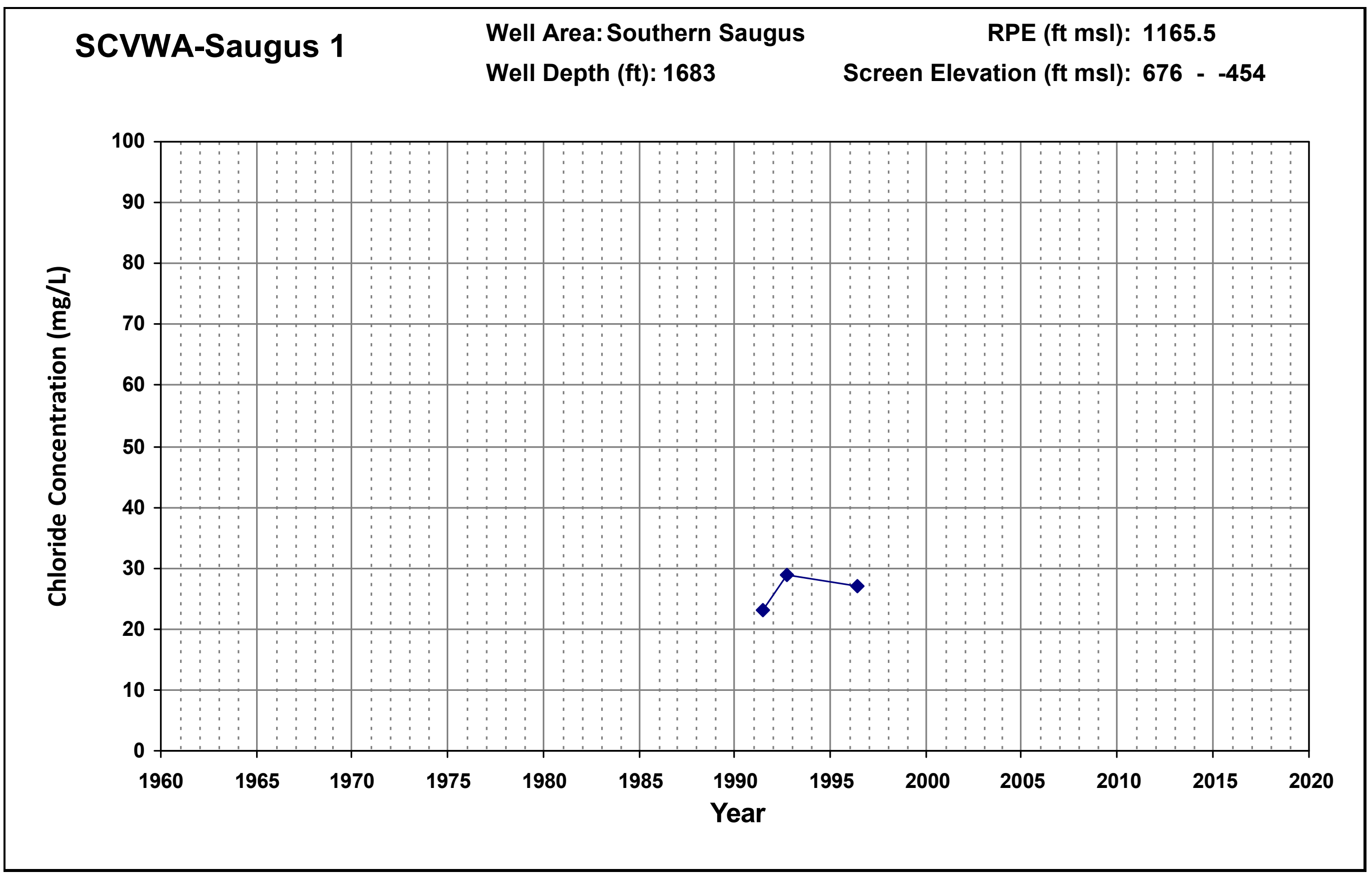


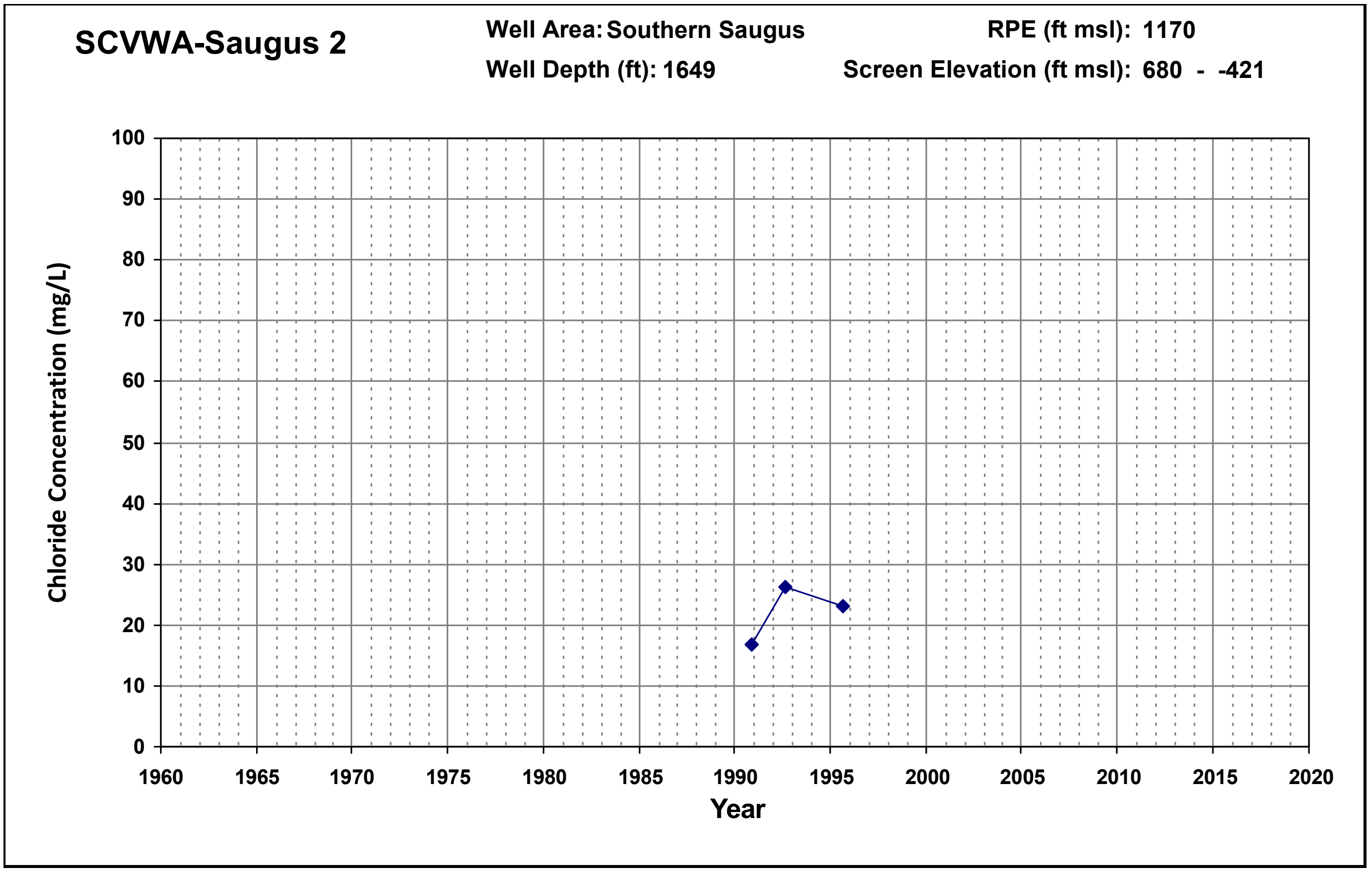
PDC-11 - Old
Well Area: Castaic Valley
Well Depth (ft): 120
RPE (ft msl): 1047
Screen Elevation (ft msl): 997 - 947
Chloride Concentration (mg/L)
Year

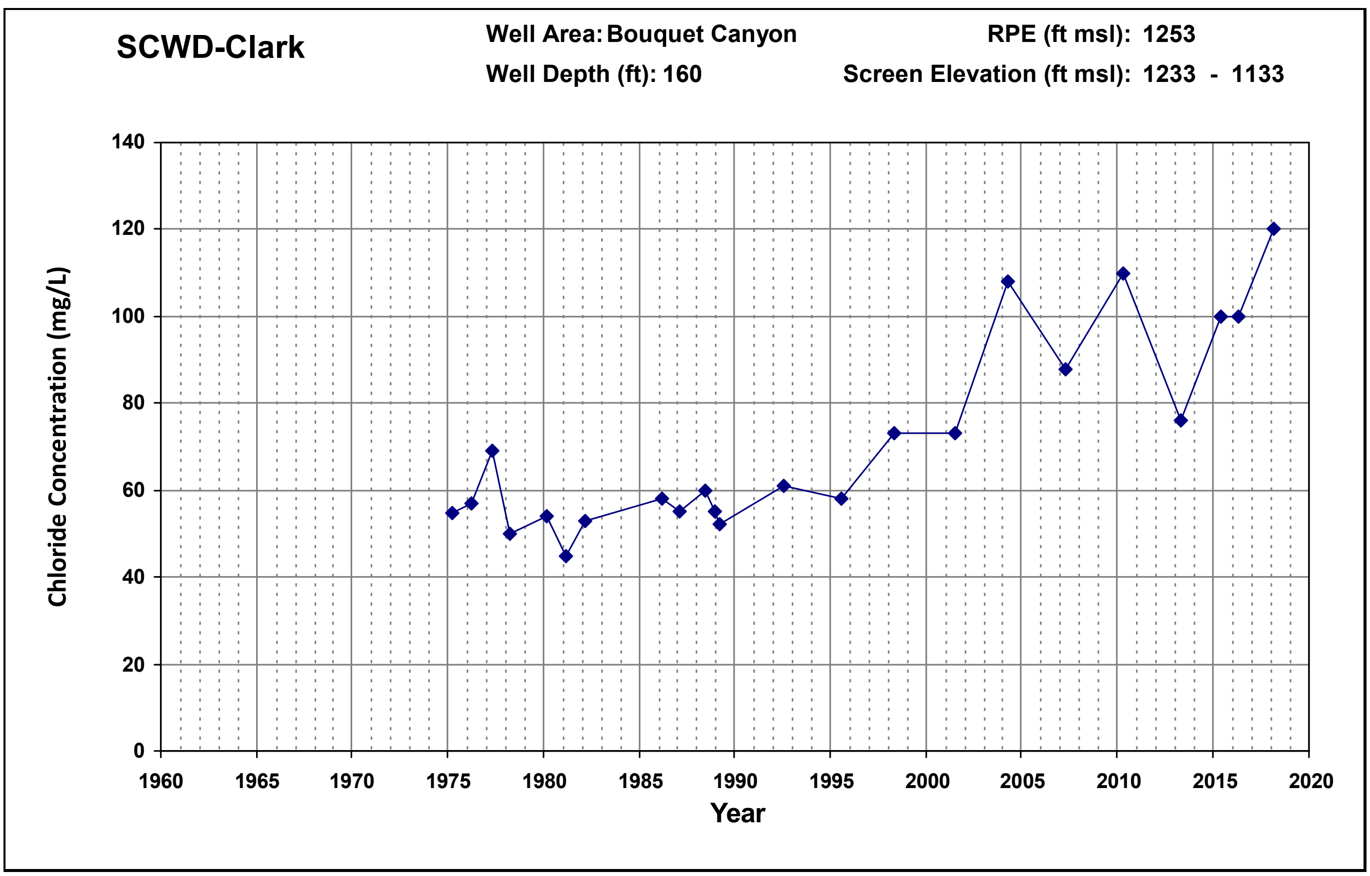


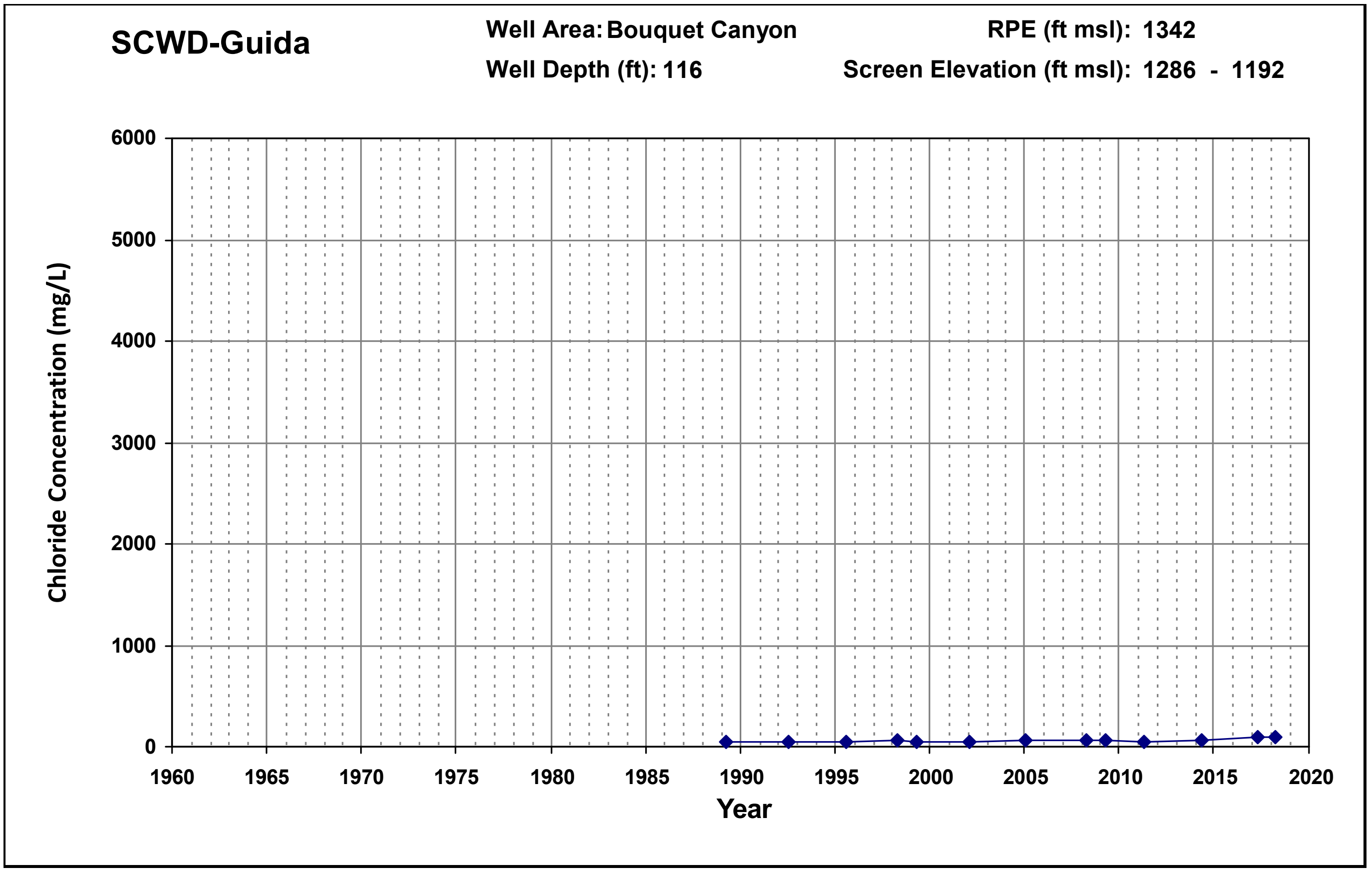
PDC-17
Well Area: Castaic Valley
Well Depth (ft): 110
RPE (ft msl): 1086
Screen Elevation (ft msl): 1051 - 976
Chloride Concentration (mg/L)
Year

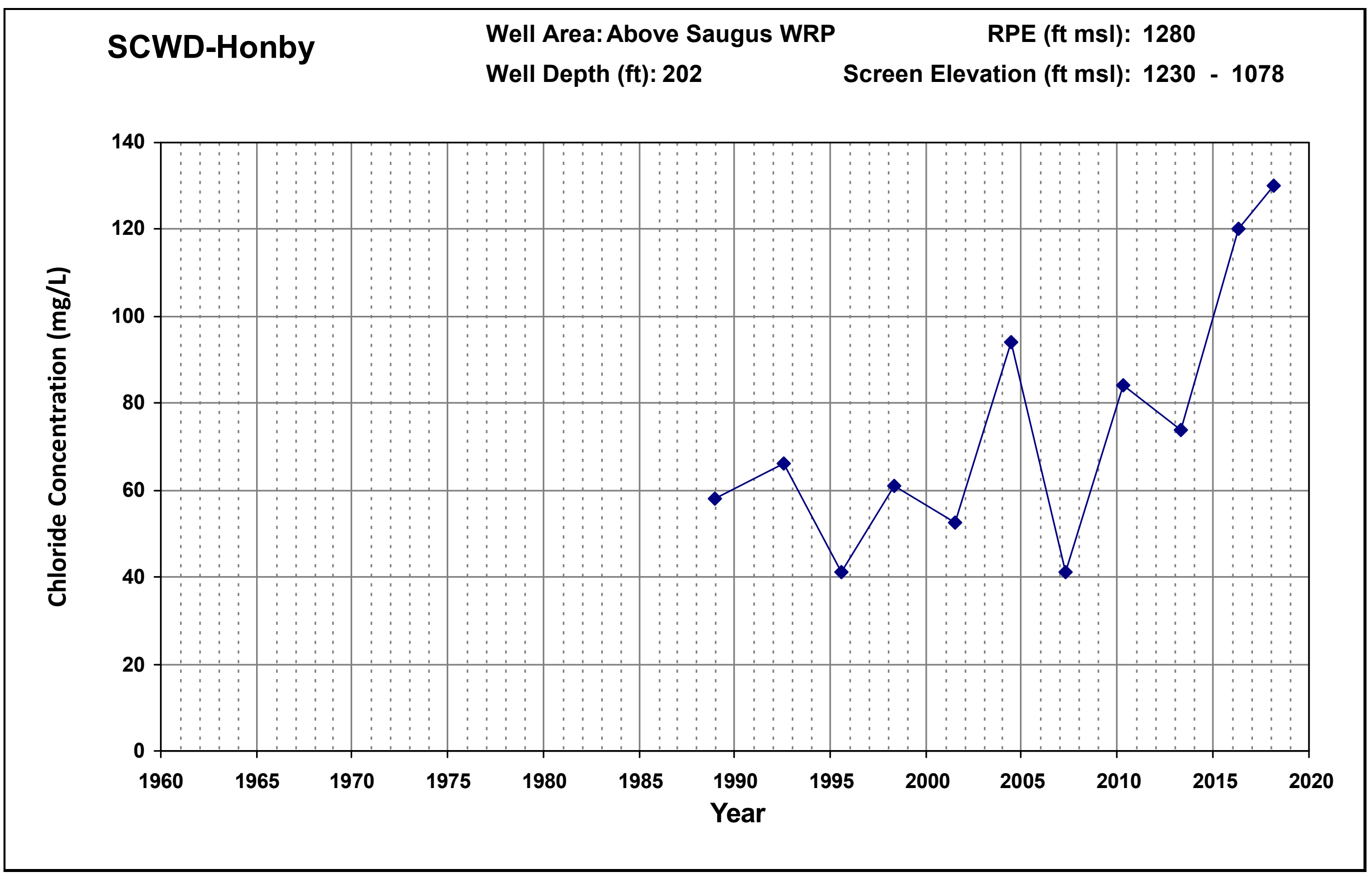

PDC-18 - Old
Well Area: Castaic Valley
RPE (ft msl): 1063
Well Depth (ft): 162
Screen Elevation (ft msl): 1005 - 930
Chloride Concentration (mg/L)
Year

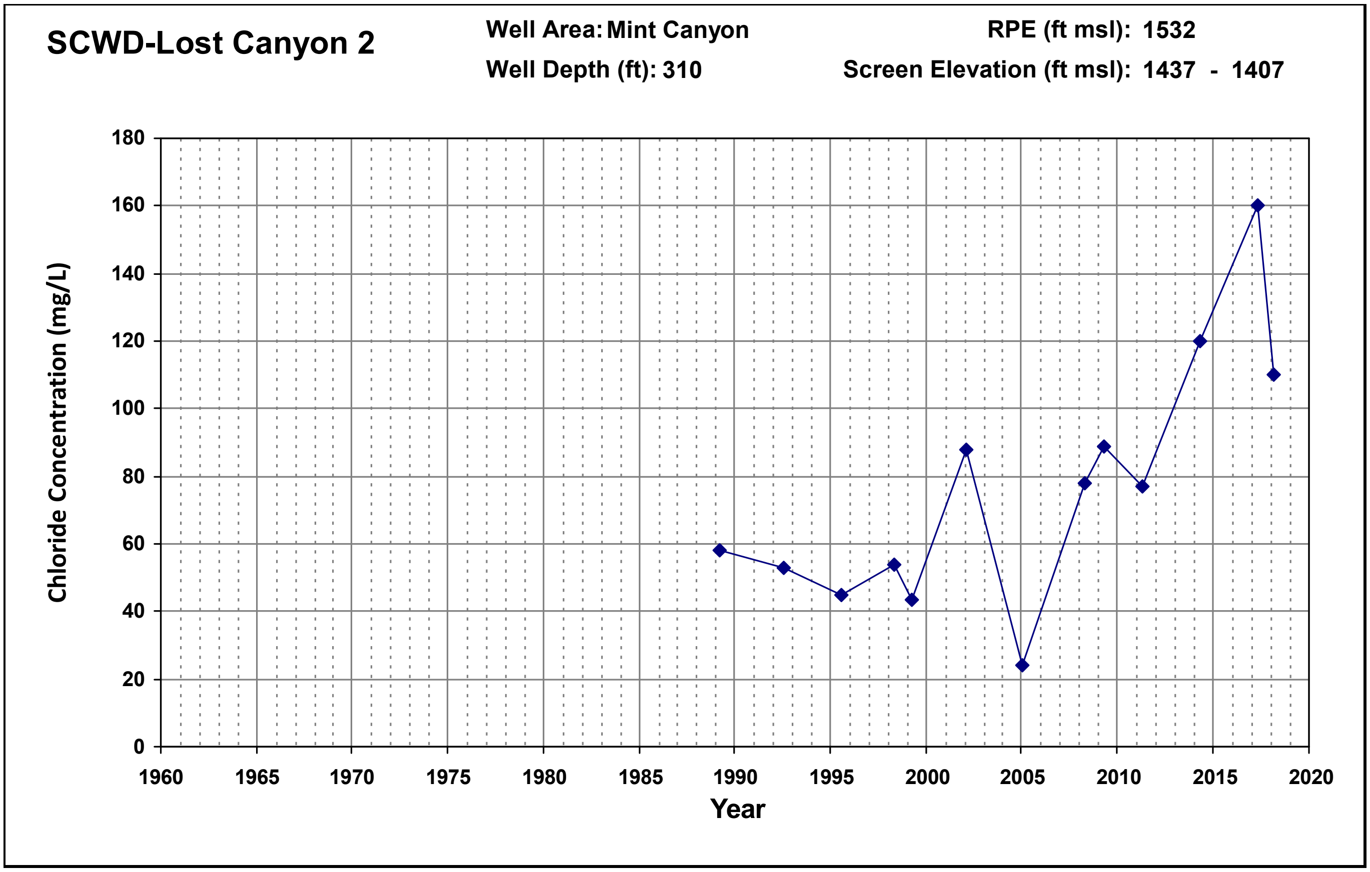

SCVWA-Saugus 1
Well Area: Southern Saugus
RPE (ft msl): 1165.5
Well Depth (ft): 1683
Screen Elevation (ft msl): 676 - -454
Chloride Concentration (mg/L)
Year

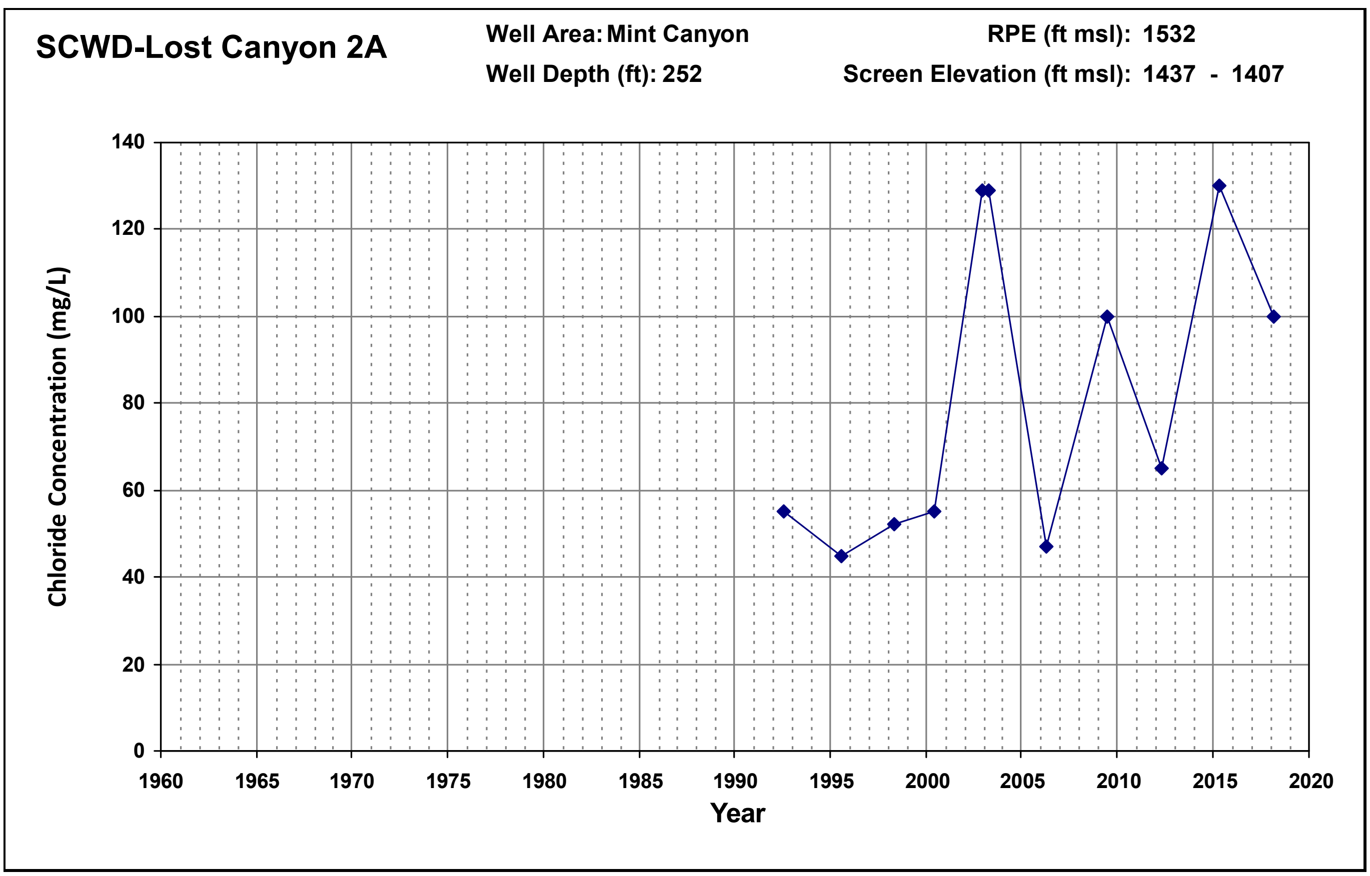

SCVWA-Saugus 2
Well Area: Southern Saugus
RPE (ft msl): 1170
Well Depth (ft): 1649
Screen Elevation (ft msl): 680 - -421
Chloride Concentration (mg/L)
Year
0
10
20
30
40
50
60
70
80
90
100
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

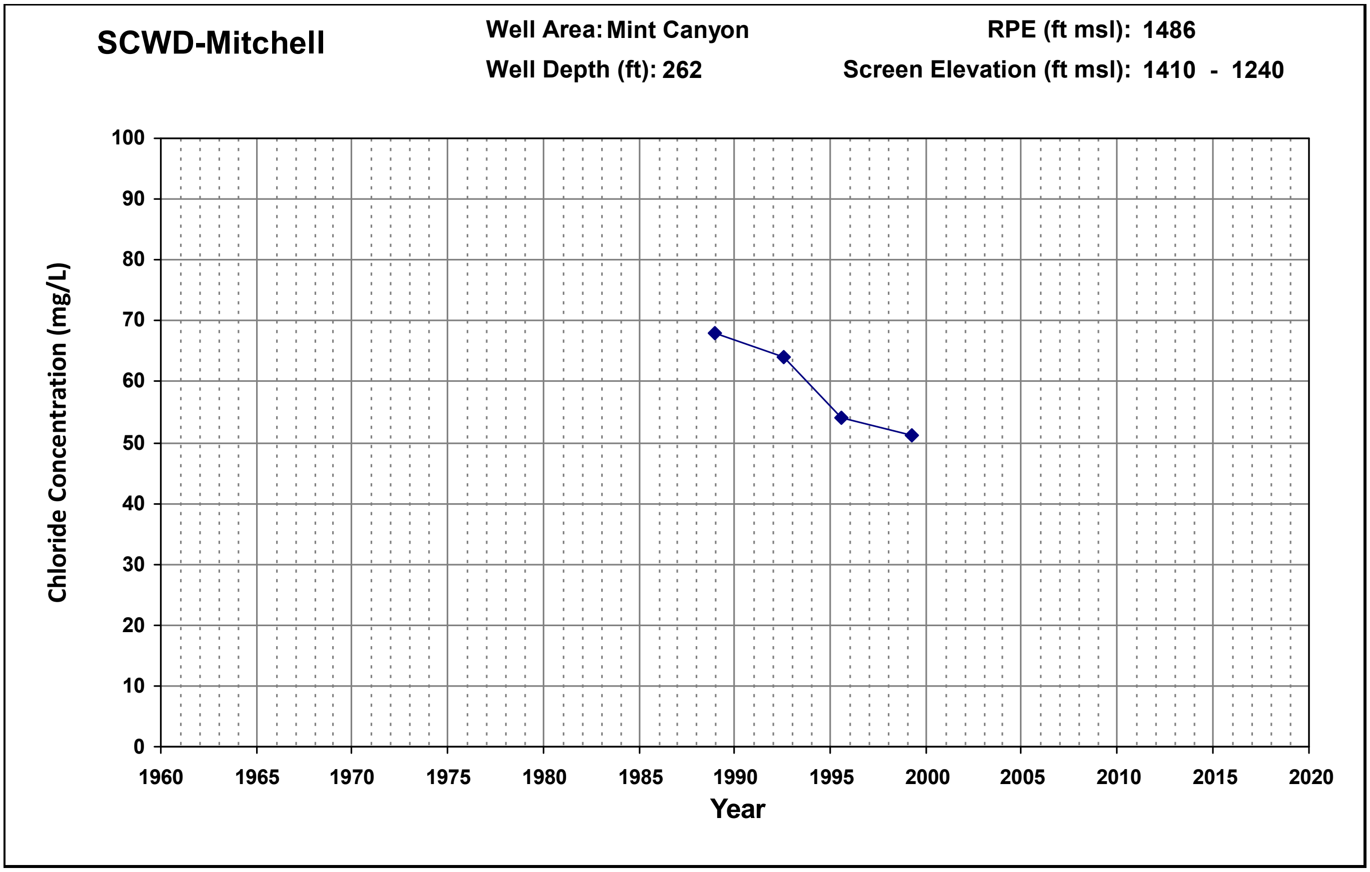

SCWD-Clark
Well Area: Bouquet Canyon
RPE (ft msl): 1253
Well Depth (ft): 160
Screen Elevation (ft msl): 1233 - 1133
Chloride Concentration (mg/L)
Year
0
20
40
60
80
100
120
140
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

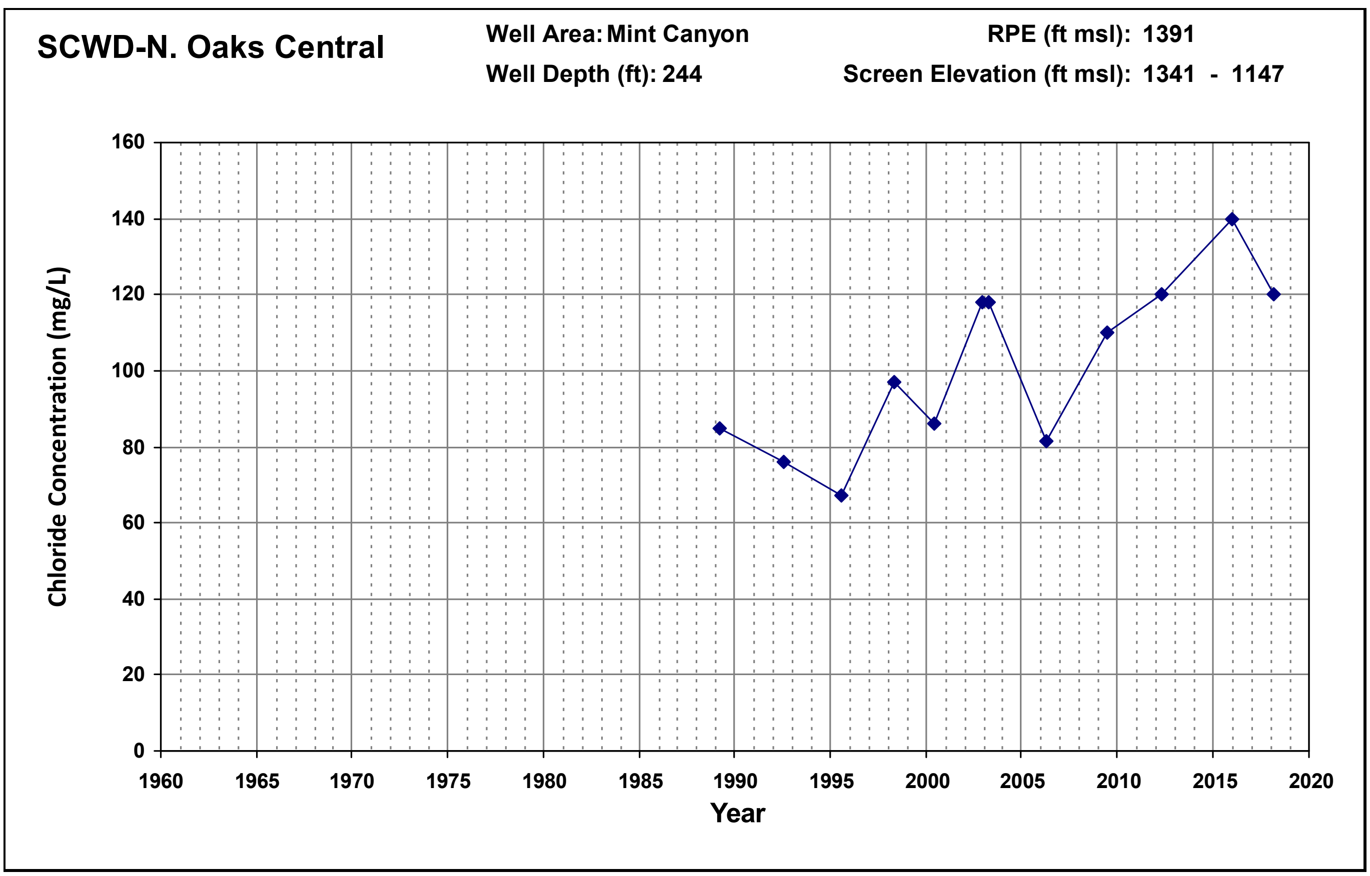

SCWD-Guida
Well Area: Bouquet Canyon
RPE (ft msl): 1342
Well Depth (ft): 116
Screen Elevation (ft msl): 1286 - 1192
Chloride Concentration (mg/L)
6000
5000
4000
3000
2000
1000
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year


SCWD-Honby
Well Area: Above Saugus WRP
RPE (ft msl): 1280
Well Depth (ft): 202
Screen Elevation (ft msl): 1230 - 1078
Chloride Concentration (mg/L)
140
120
100
80
60
40
20
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year


SCWD-Lost Canyon 2
Well Area: Mint Canyon
Well Depth (ft): 310
RPE (ft msl): 1532
Screen Elevation (ft msl): 1437 - 1407
Chloride Concentration (mg/L)
0
20
40
60
80
100
120
140
160
180
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year


SCWD-Lost Canyon 2A
Well Area: Mint Canyon
Well Depth (ft): 252
RPE (ft msl): 1532
Screen Elevation (ft msl): 1437 - 1407
Chloride Concentration (mg/L)
0
20
40
60
80
100
120
140
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year


SCWD-Mitchell
Well Area: Mint Canyon
Well Depth (ft): 262
RPE (ft msl): 1486
Screen Elevation (ft msl): 1410 - 1240
Chloride Concentration (mg/L)
Year
0
10
20
30
40
50
60
70
80
90
100
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020


SCWD-N. Oaks Central
Well Area: Mint Canyon
Well Depth (ft): 244
RPE (ft msl): 1391
Screen Elevation (ft msl): 1341 - 1147
Chloride Concentration (mg/L)
Year
0
20
40
60
80
100
120
140
160
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

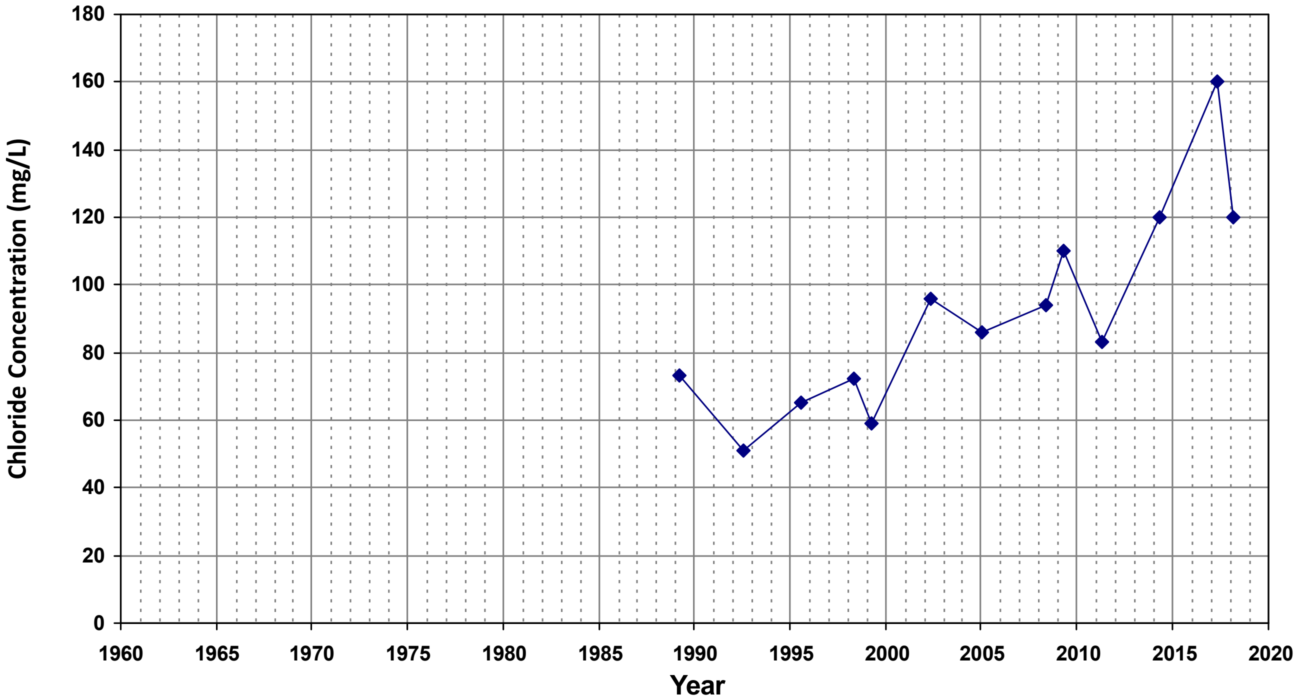
SCWD-N. Oaks East

Well Area: Mint Canyon

Well Depth (ft): 150

RPE (ft msl): 1391

Screen Elevation (ft msl): 1310 - 1241



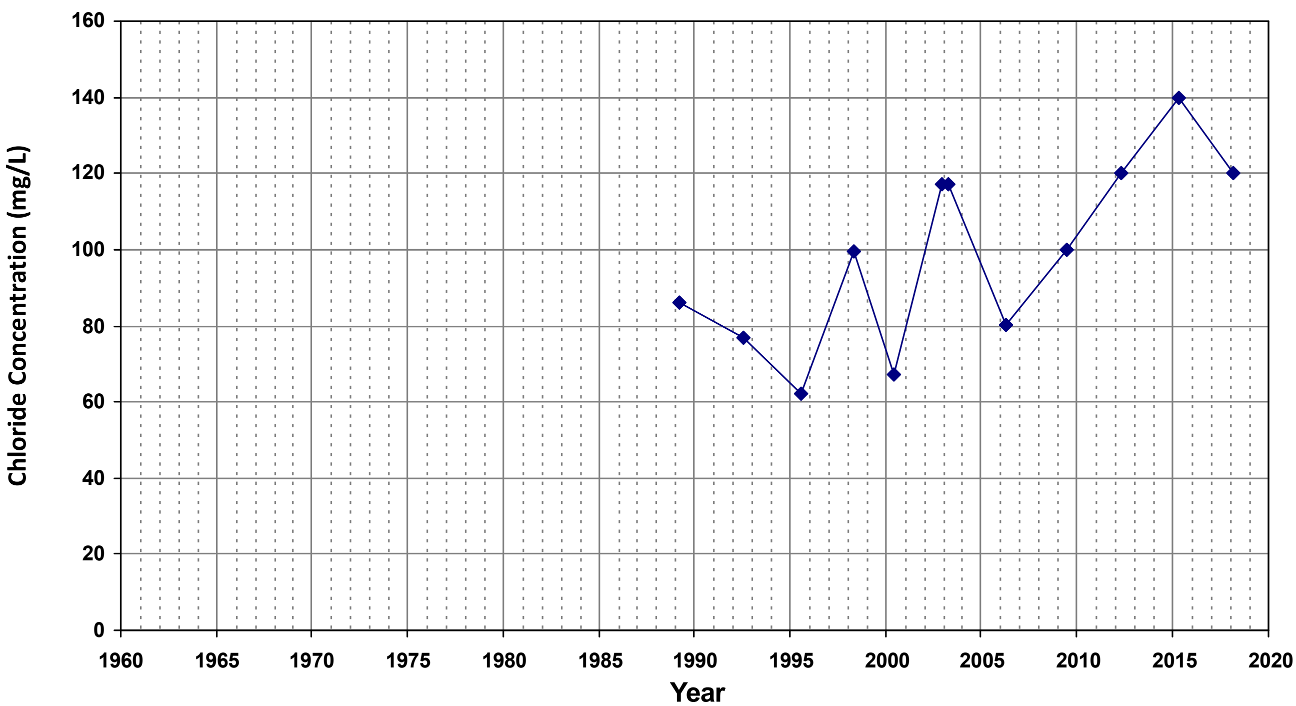
SCWD-N. Oaks West

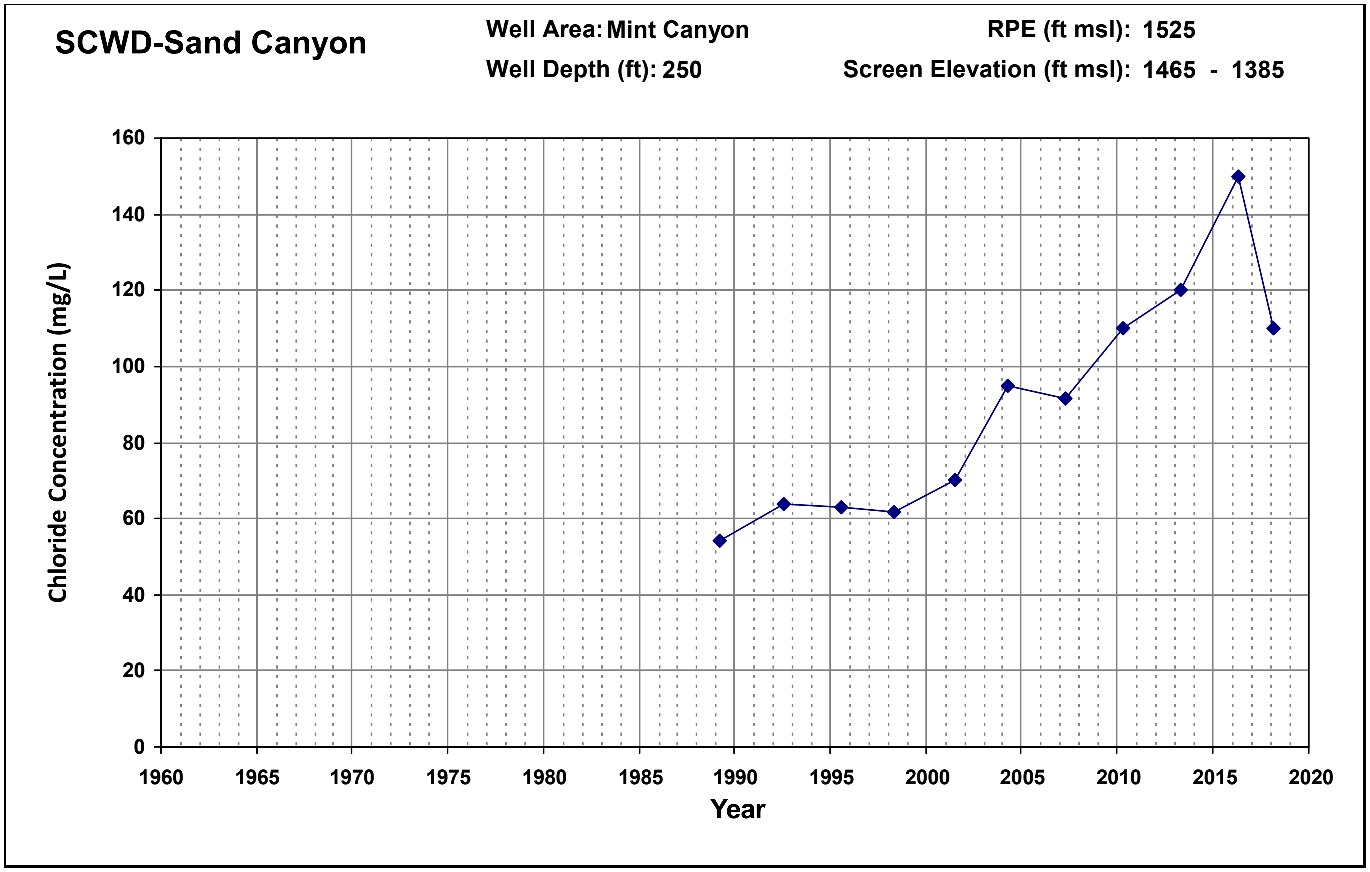
Well Area: Mint Canyon

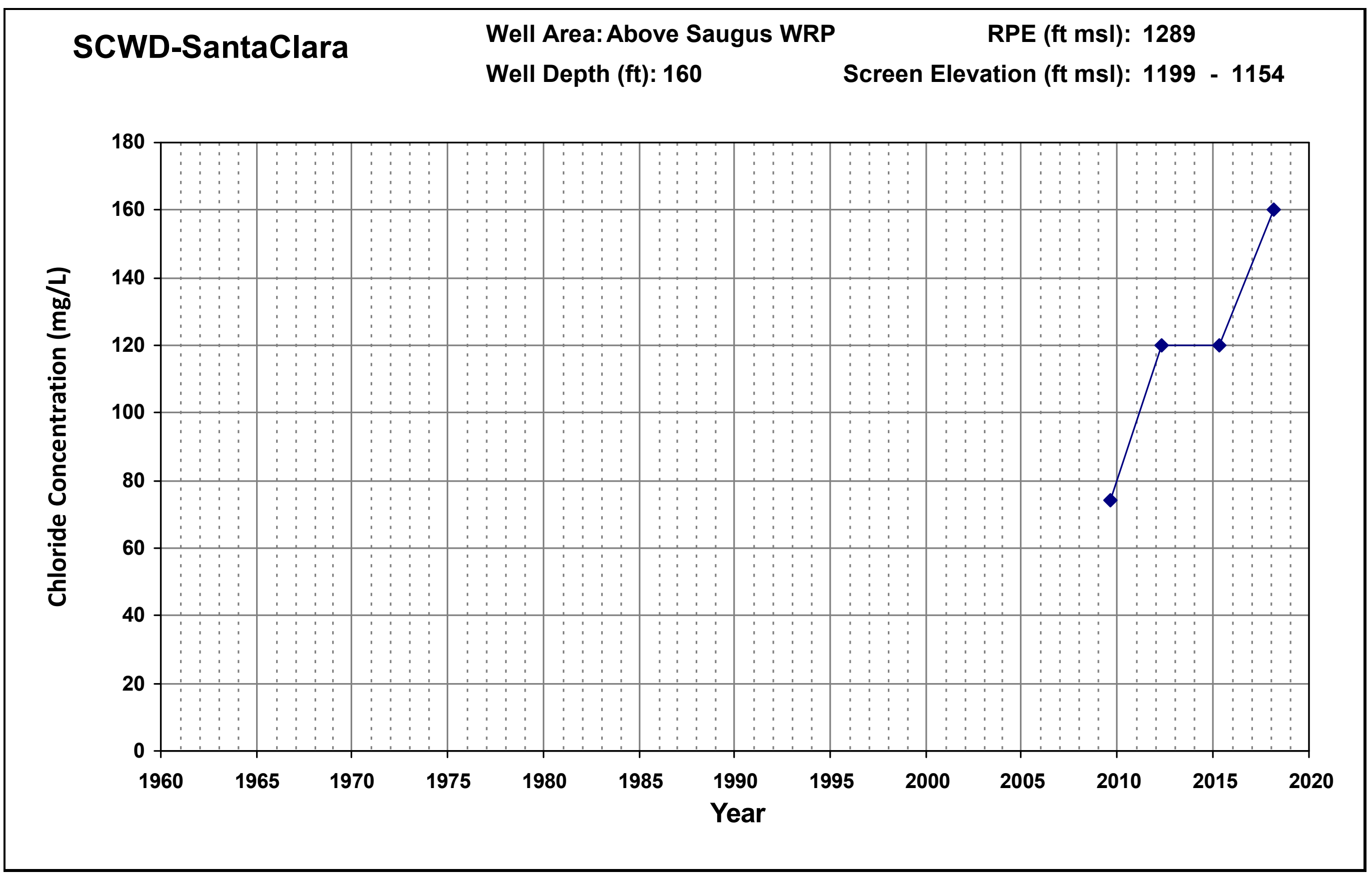
Well Depth (ft): 136

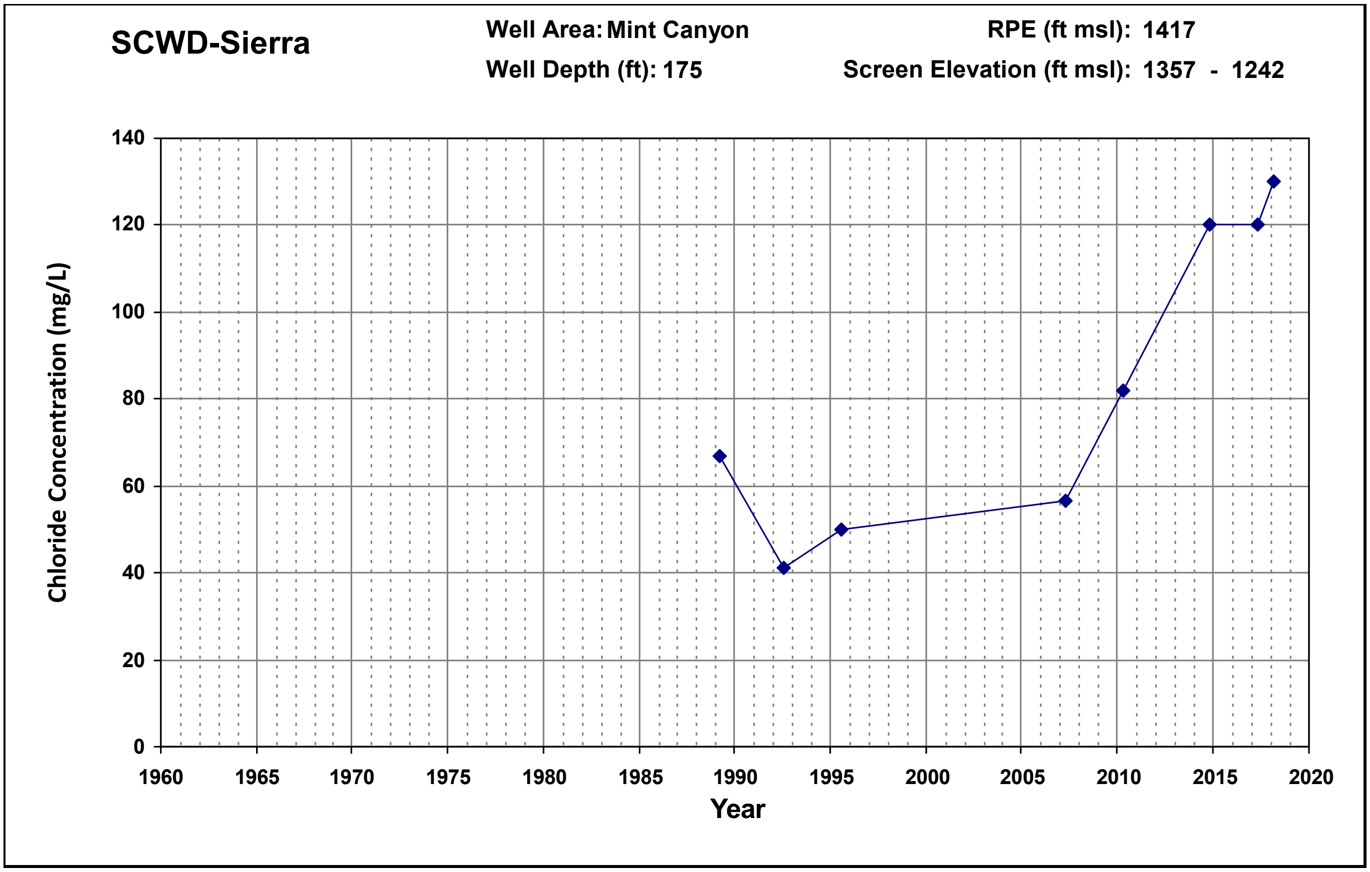
RPE (ft msl): 1387

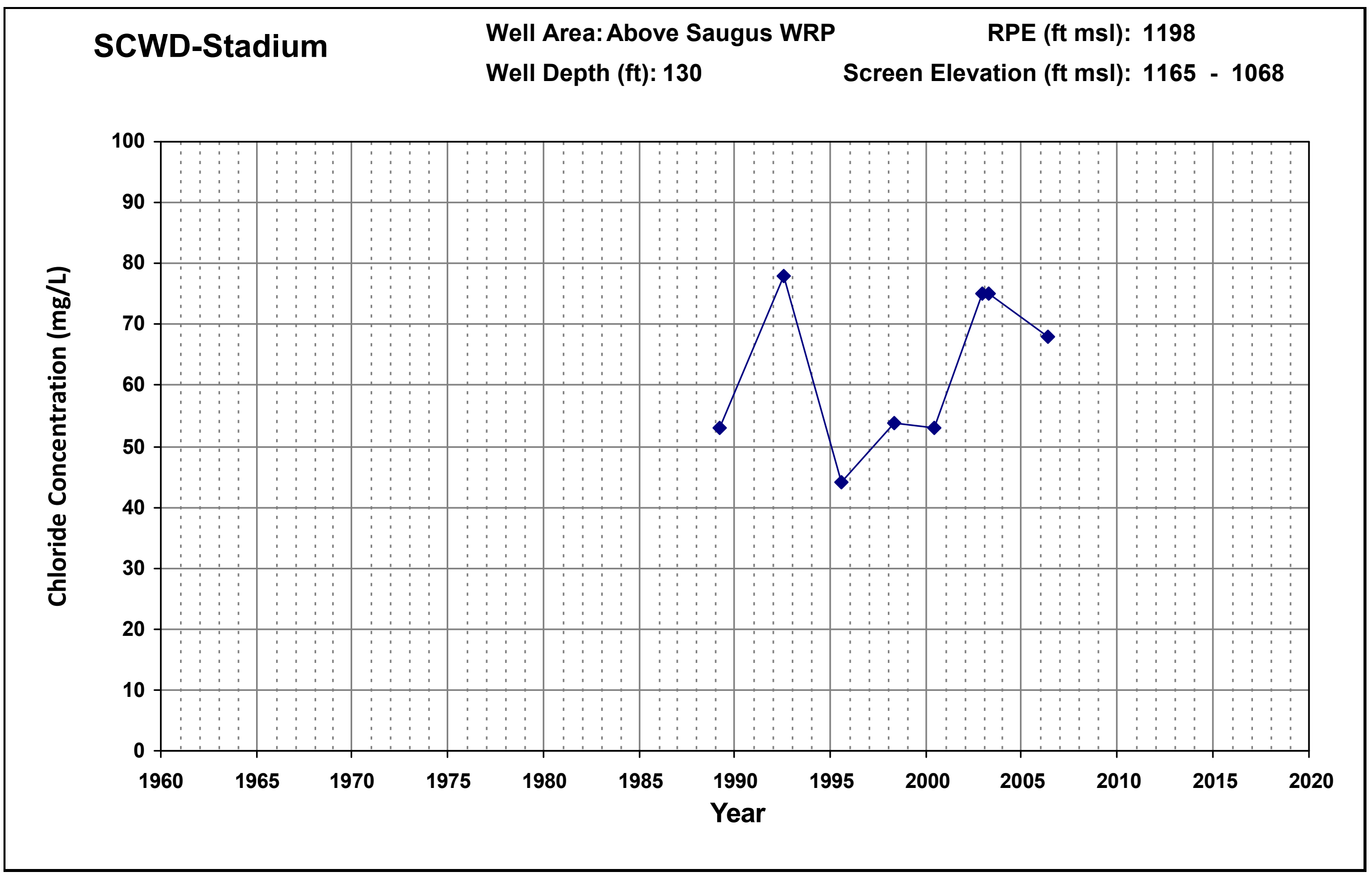
Screen Elevation (ft msl): 1307 - 1269

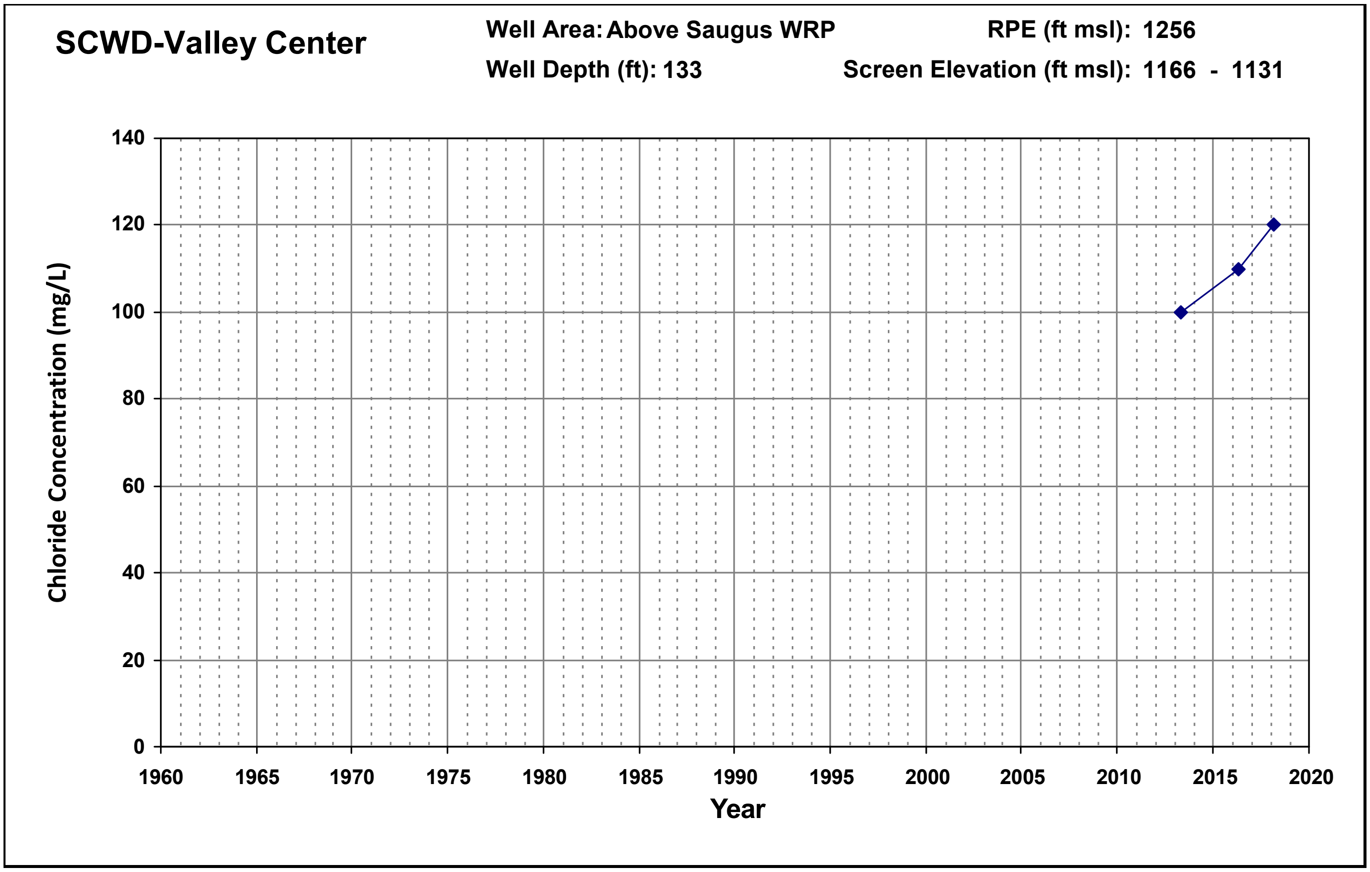



SCWD-Sand Canyon
Well Area: Mint Canyon
Well Depth (ft): 250
RPE (ft msl): 1525
Screen Elevation (ft msl): 1465 - 1385
Chloride Concentration (mg/L)
0
20
40
60
80
100
120
140
160
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

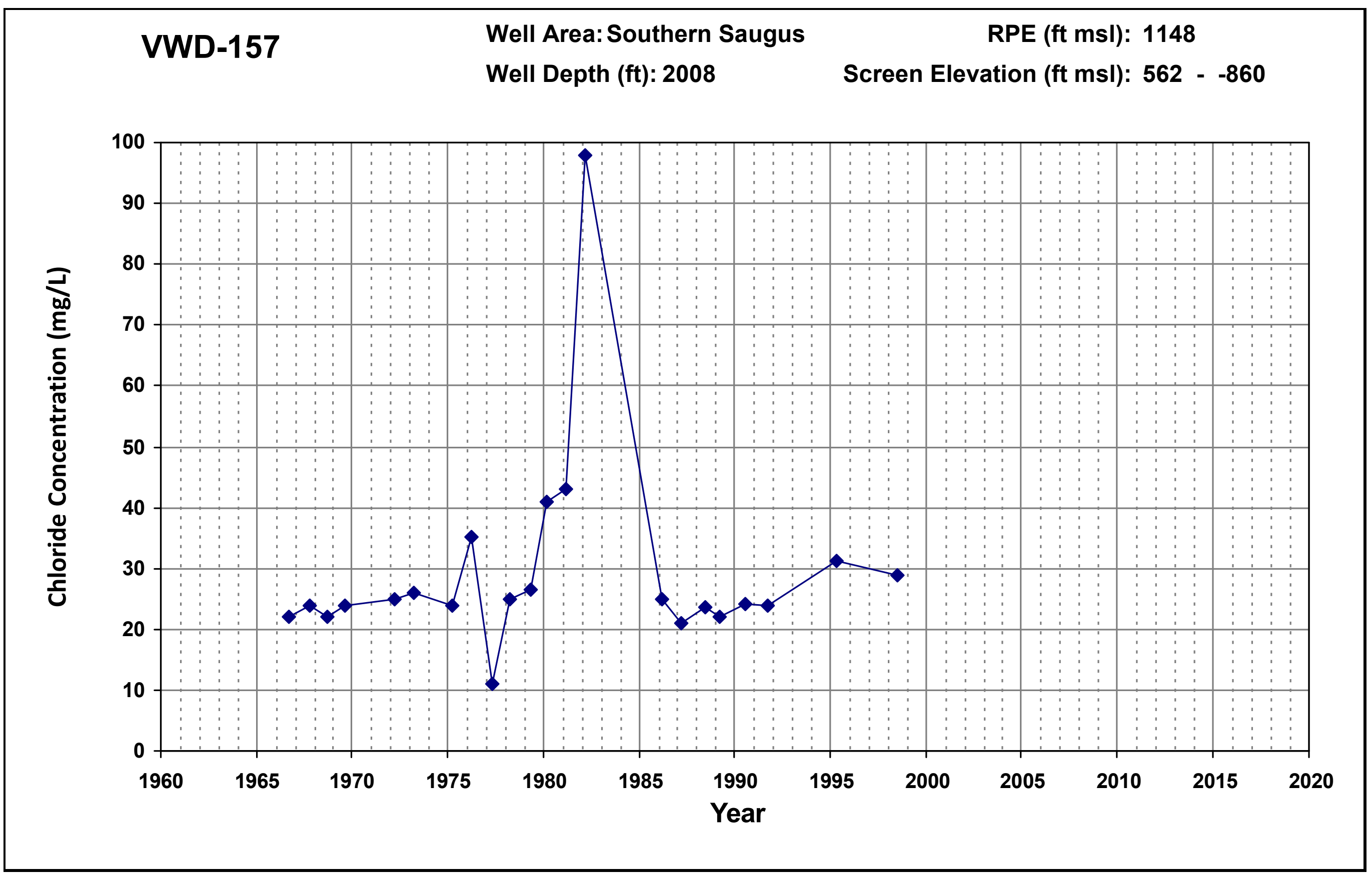

SCWD-SantaClara
Well Area: Above Saugus WRP
Well Depth (ft): 160
RPE (ft msl): 1289
Screen Elevation (ft msl): 1199 - 1154
Chloride Concentration (mg/L)
0
20
40
60
80
100
120
140
160
180
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year


SCWD-Sierra
Well Area: Mint Canyon
Well Depth (ft): 175
RPE (ft msl): 1417
Screen Elevation (ft msl): 1357 - 1242
Chloride Concentration (mg/L)
0
20
40
60
80
100
120
140
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year


SCWD-Stadium
Well Area: Above Saugus WRP
Well Depth (ft): 130
RPE (ft msl): 1198
Screen Elevation (ft msl): 1165 - 1068
Chloride Concentration (mg/L)
0
10
20
30
40
50
60
70
80
90
100
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year



SCWD-Valley Center
Well Area: Above Saugus WRP
Well Depth (ft): 133
RPE (ft msl): 1256
Screen Elevation (ft msl): 1166 - 1131
Chloride Concentration (mg/L)
140
120
100
80
60
40
20
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

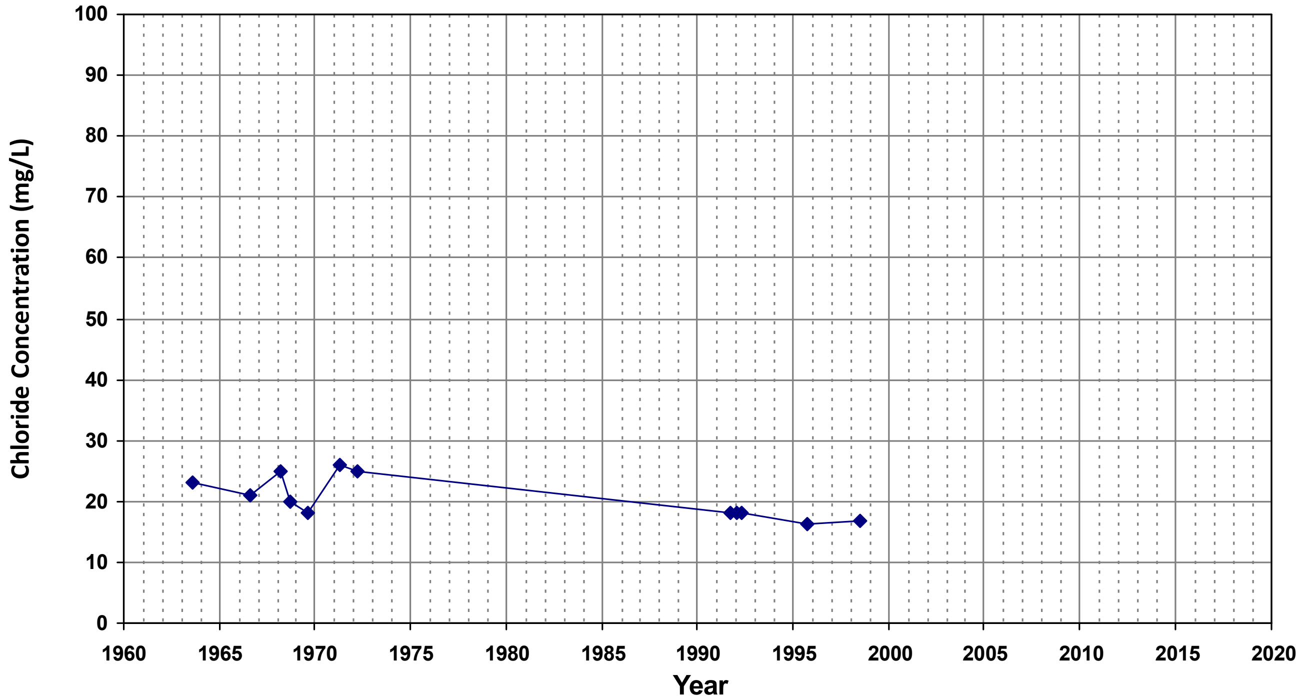


VWD-157
Well Area: Southern Saugus
Well Depth (ft): 2008
RPE (ft msl): 1148
Screen Elevation (ft msl): 562 - -860
Chloride Concentration (mg/L)
100
90
80
70
60
50
40
30
20
10
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

VWD-159

Well Area: Southern Saugus **RPE (ft msl):** 1291.195

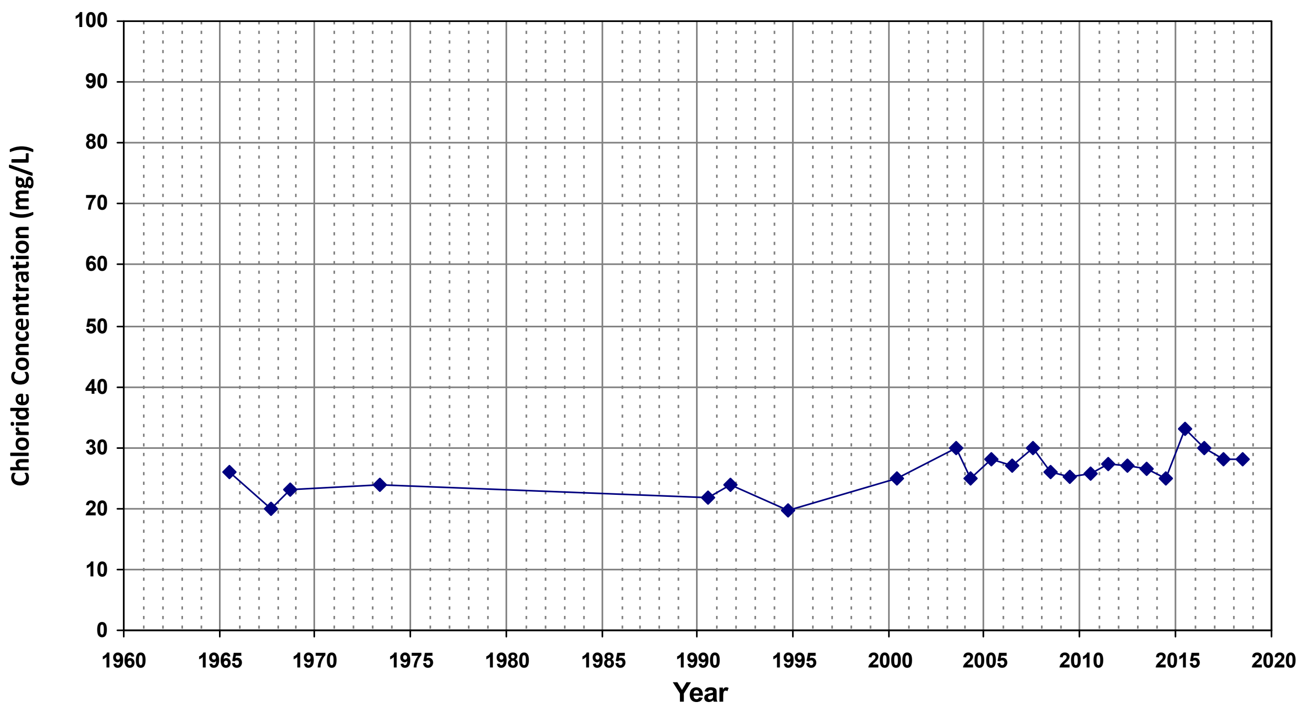
Well Depth (ft): 1950 **Screen Elevation (ft msl):** 629 - -609

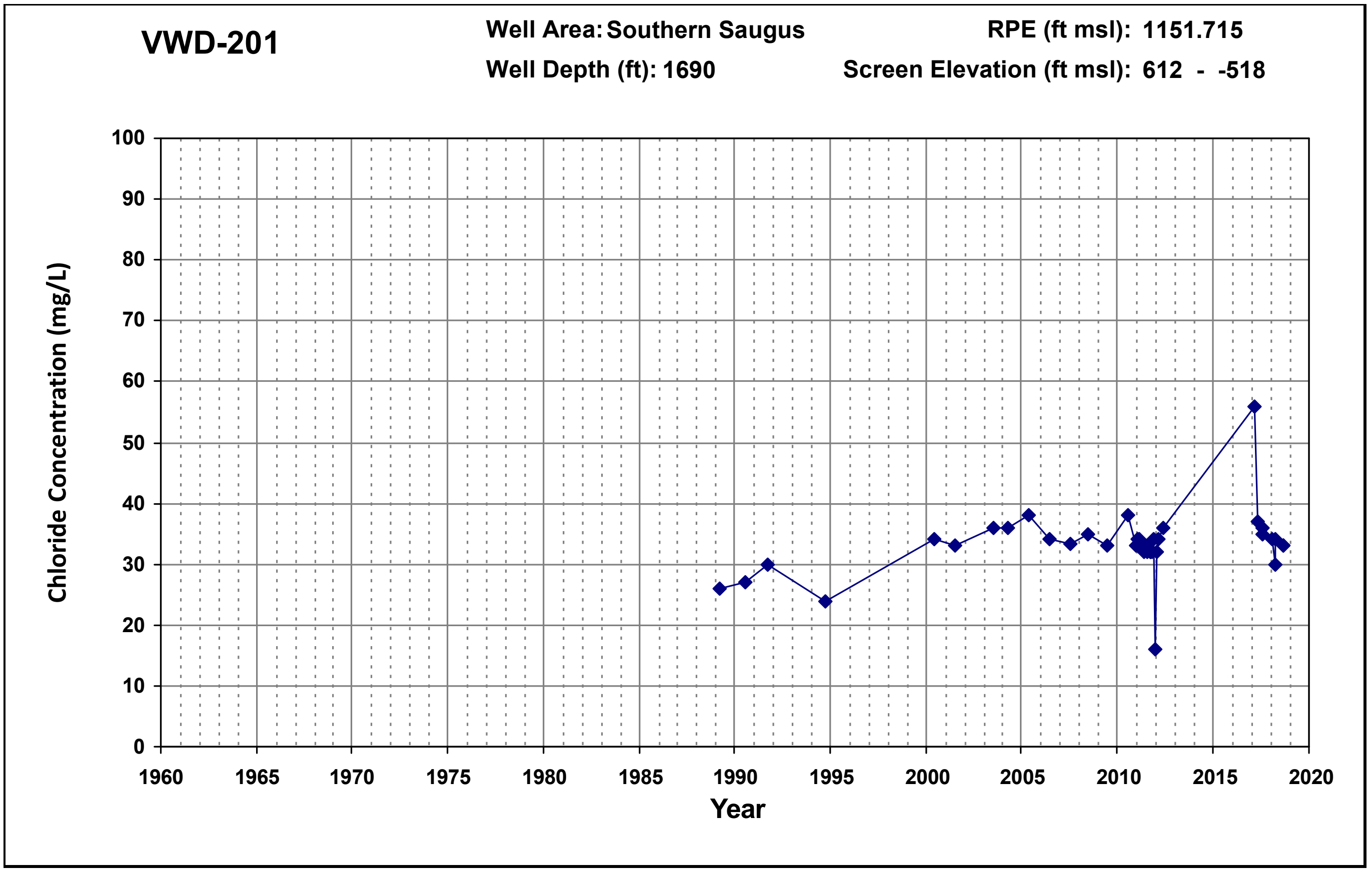


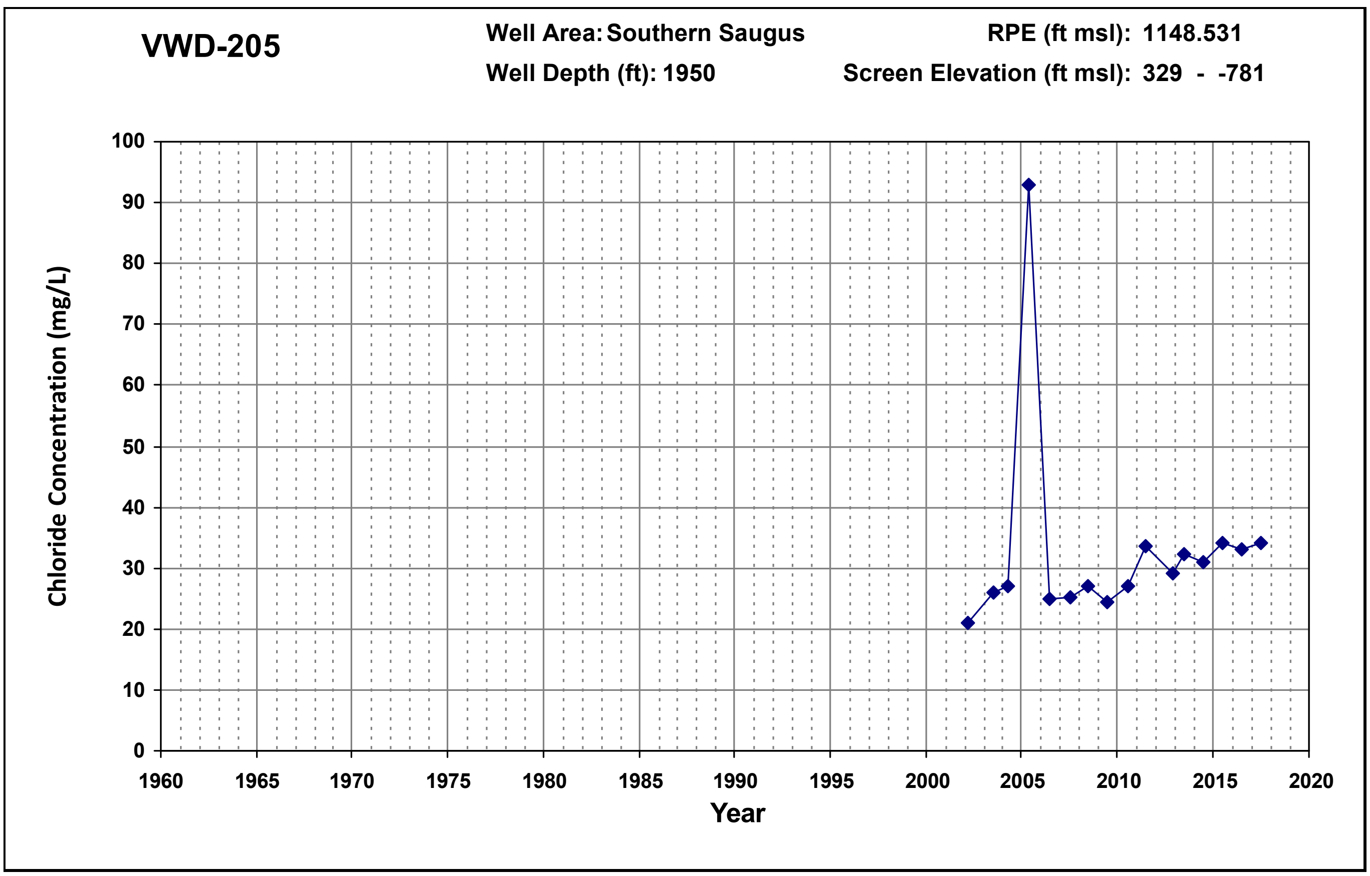
VWD-160

Well Area: Southern Saugus **RPE (ft msl):** 1102.083

Well Depth (ft): 2000 **Screen Elevation (ft msl):** 152 - -898

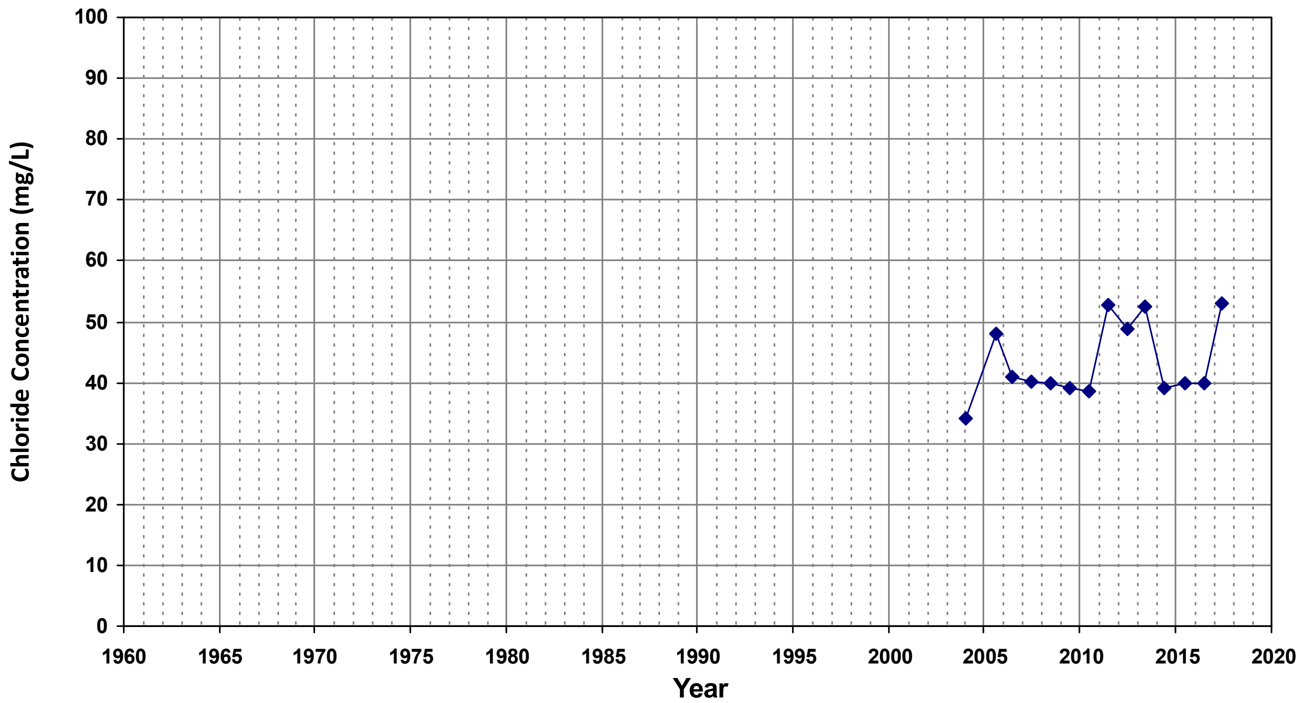



VWD-201
Well Area: Southern Saugus
RPE (ft msl): 1151.715
Well Depth (ft): 1690
Screen Elevation (ft msl): 612 - -518
Chloride Concentration (mg/L)
0
10
20
30
40
50
60
70
80
90
100
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year


VWD-205
Well Area: Southern Saugus
RPE (ft msl): 1148.531
Well Depth (ft): 1950
Screen Elevation (ft msl): 329 - -781
Chloride Concentration (mg/L)
0
10
20
30
40
50
60
70
80
90
100
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

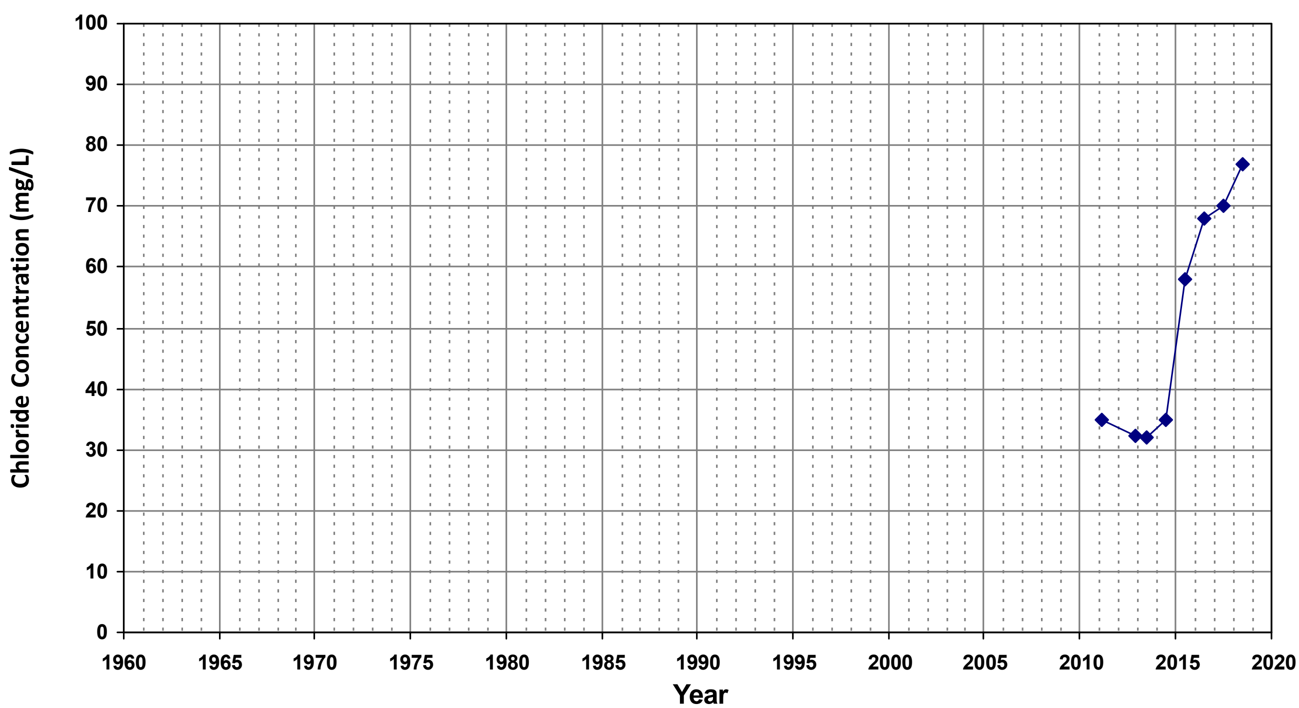
VWD-206

Well Area: Southern Saugus
RPE (ft msl): 1058.587
Well Depth (ft): 2060
Screen Elevation (ft msl): 569 - -981



VWD-207

Well Area: Southern Saugus
RPE (ft msl): 1035.74
Well Depth (ft): 1220
Screen Elevation (ft msl): 529 - -163



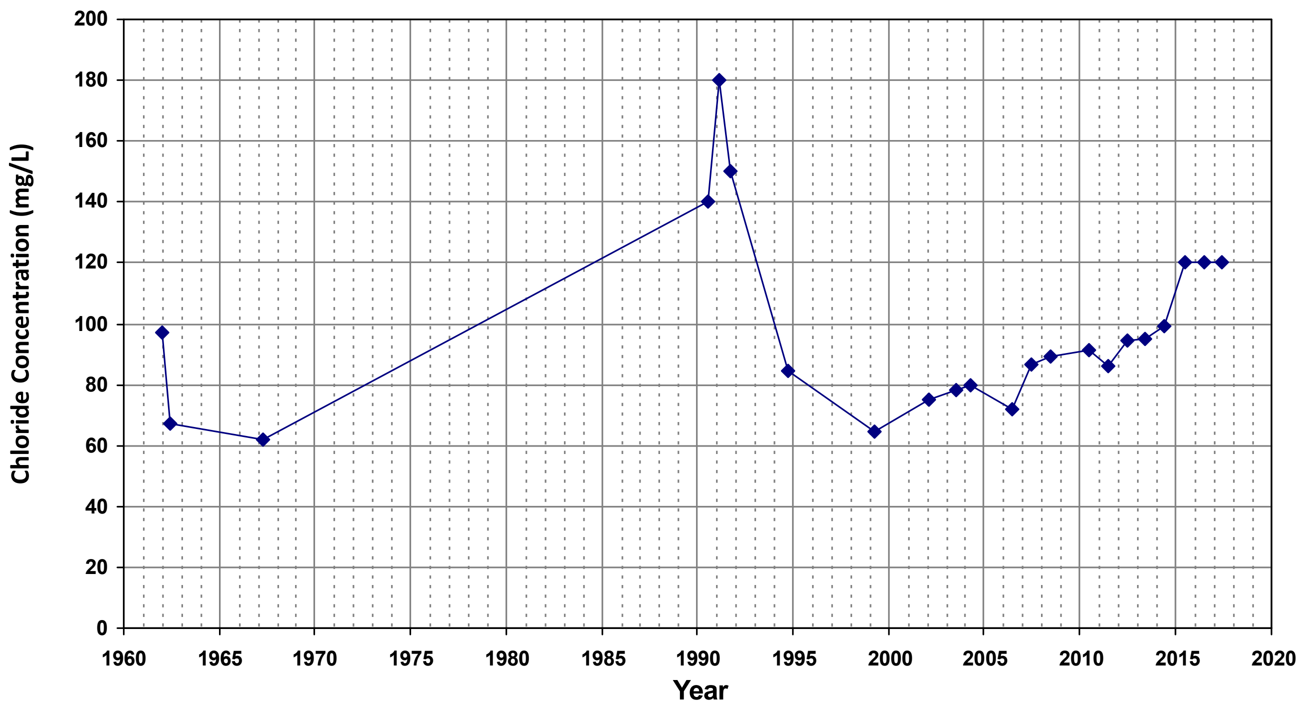
VWD-D

Well Area: Castaic Valley

RPE (ft msl): 1035.617

Well Depth (ft): 142

Screen Elevation (ft msl): 976 - 900



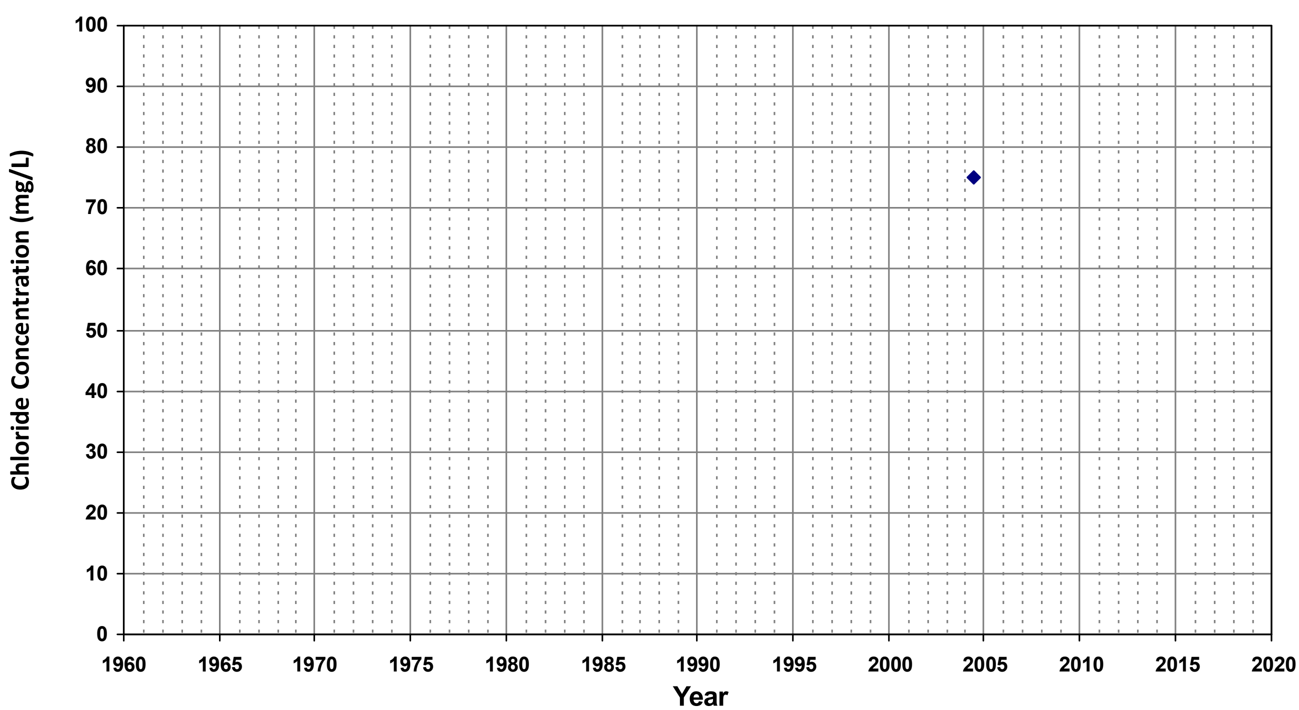
VWD-E14

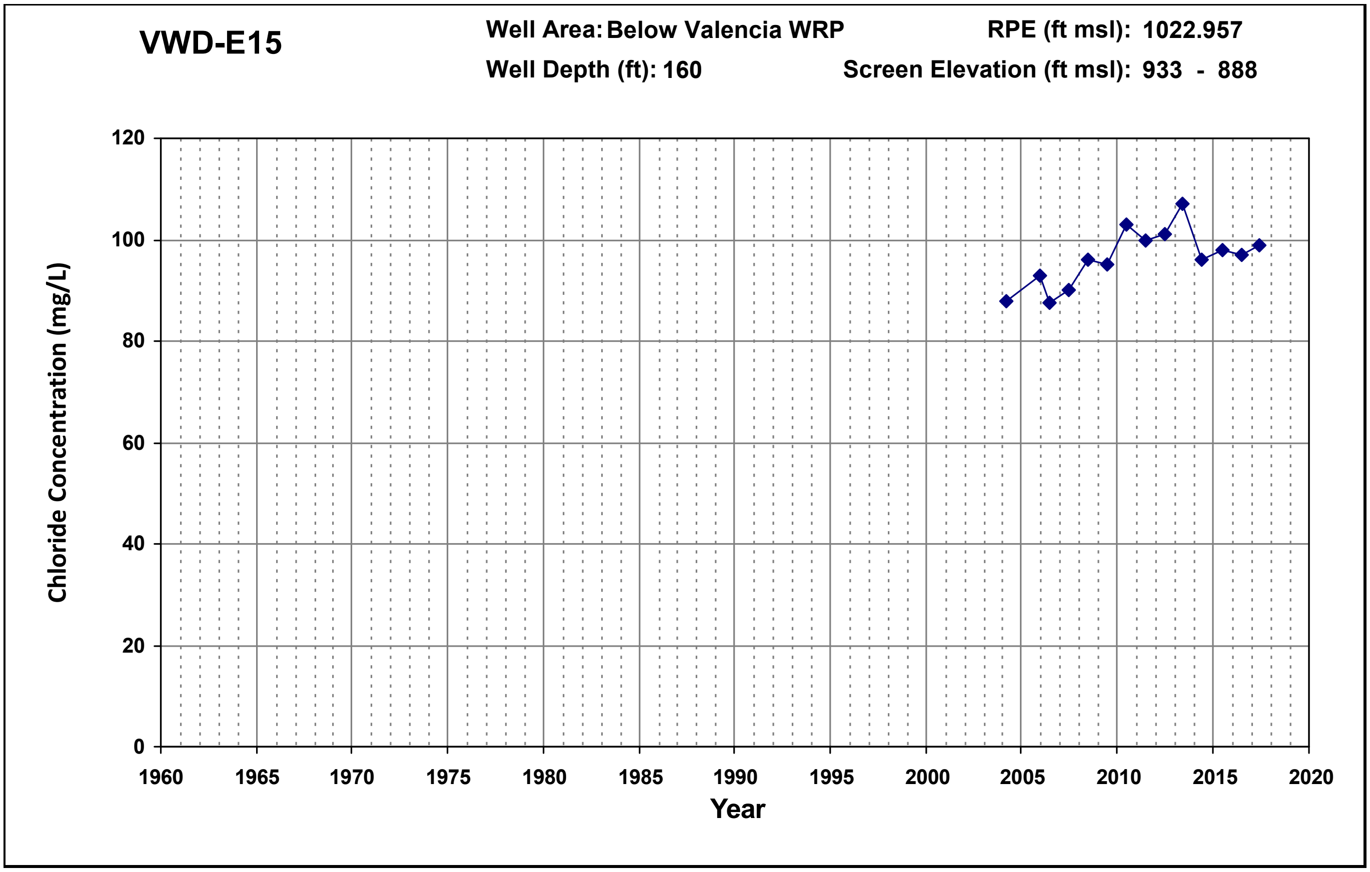
Well Area: Below Valencia WRP

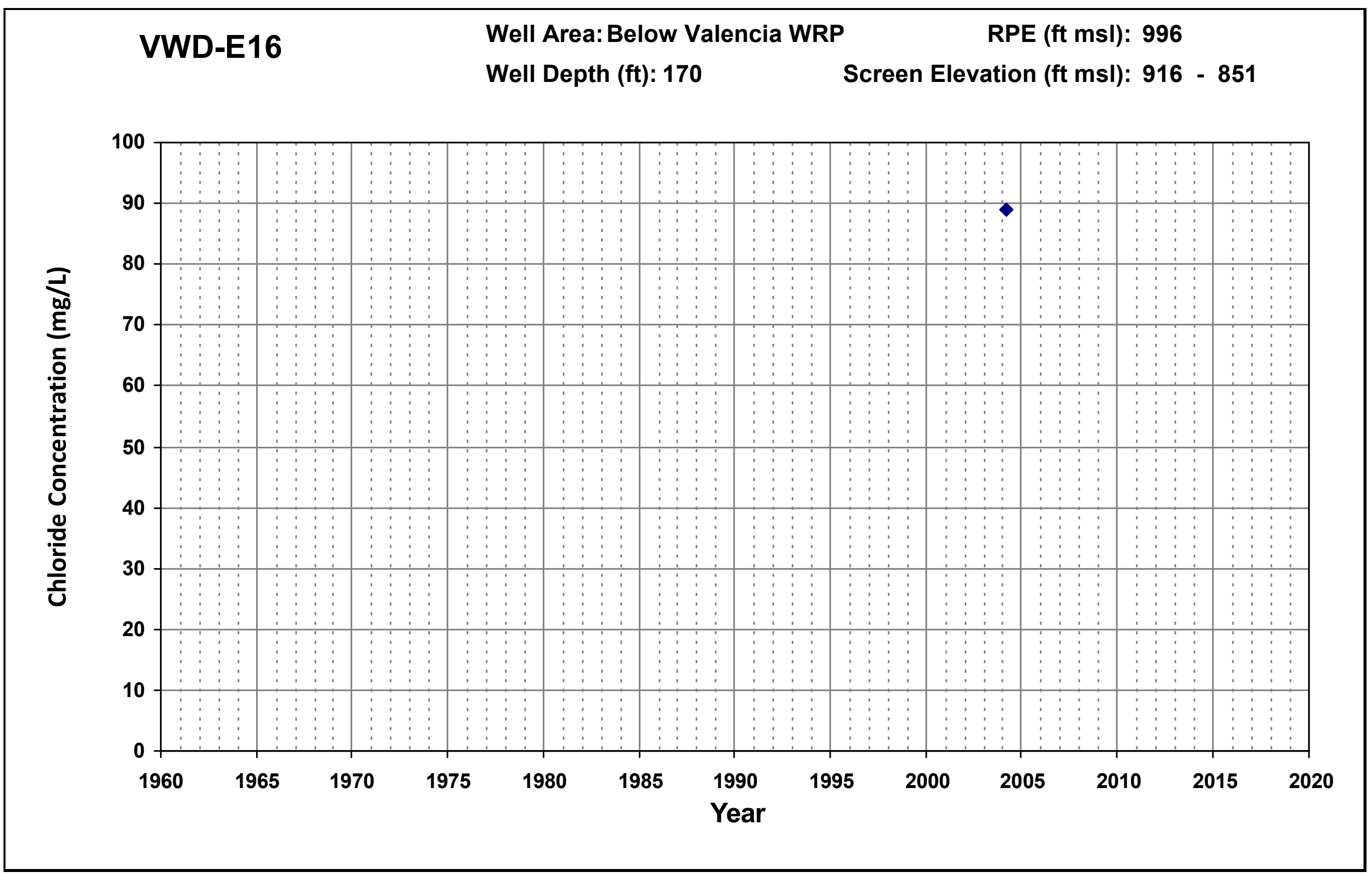
RPE (ft msl): 1000

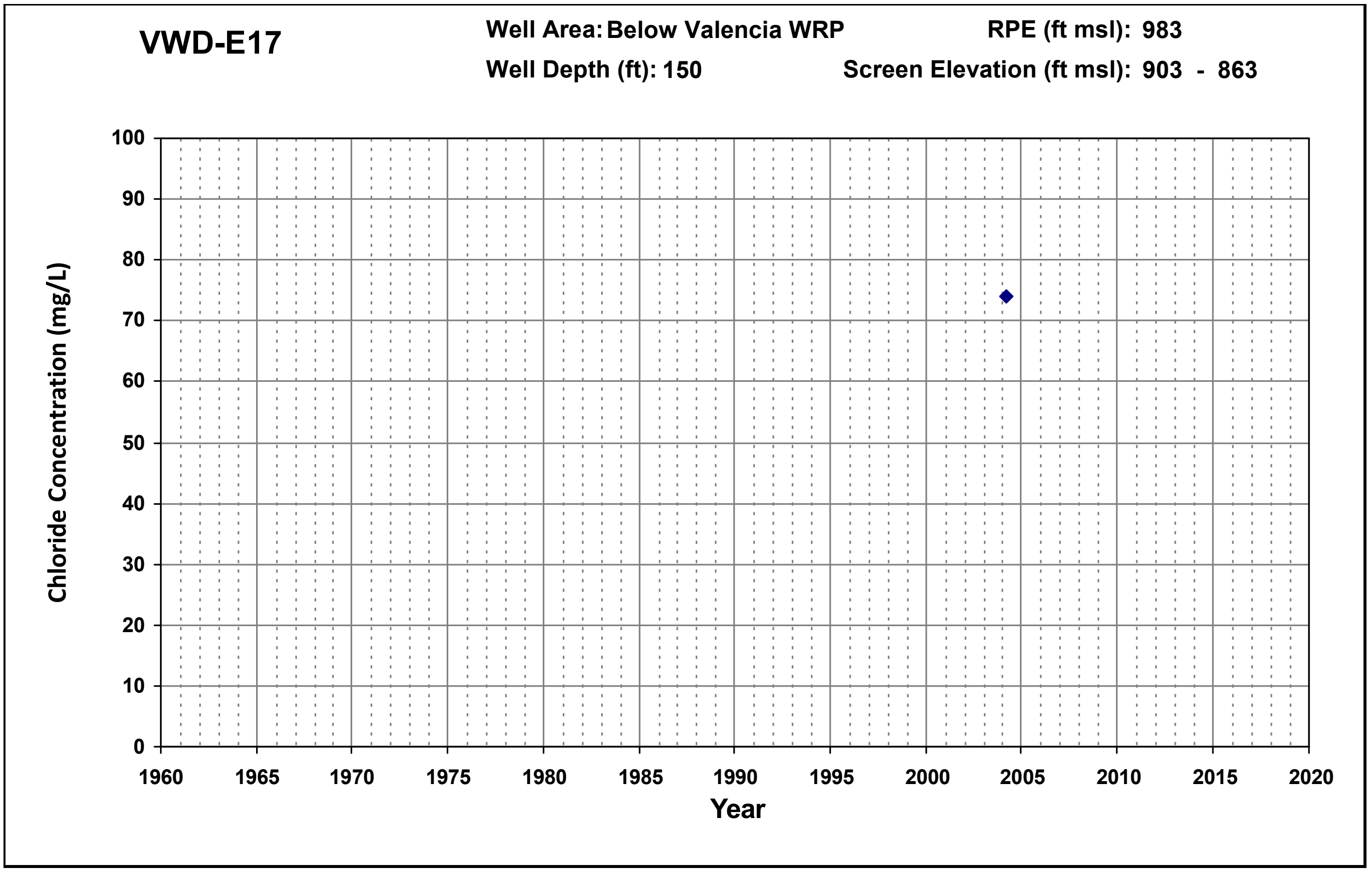
Well Depth (ft): 150

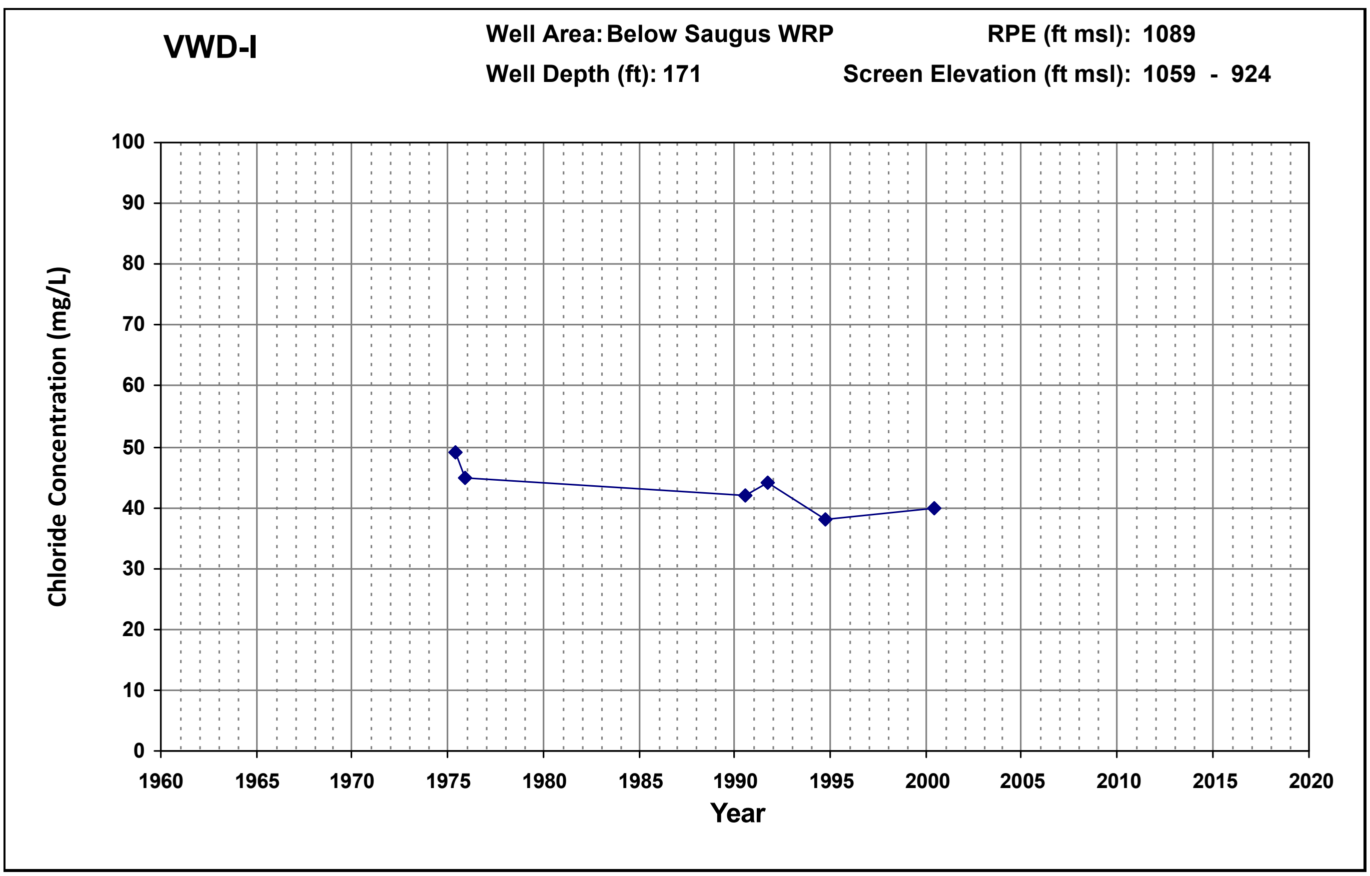
Screen Elevation (ft msl): 925 - 885

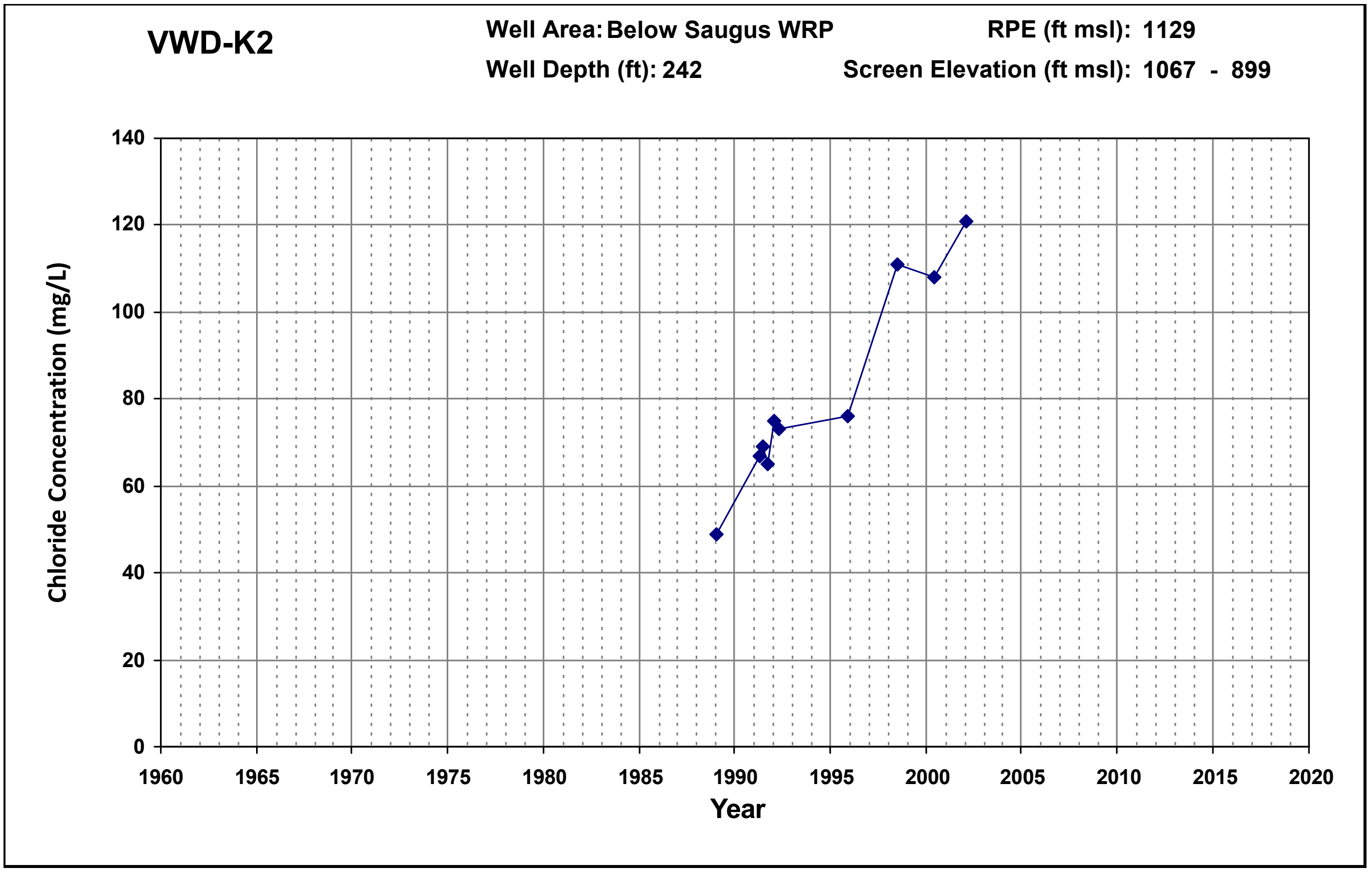


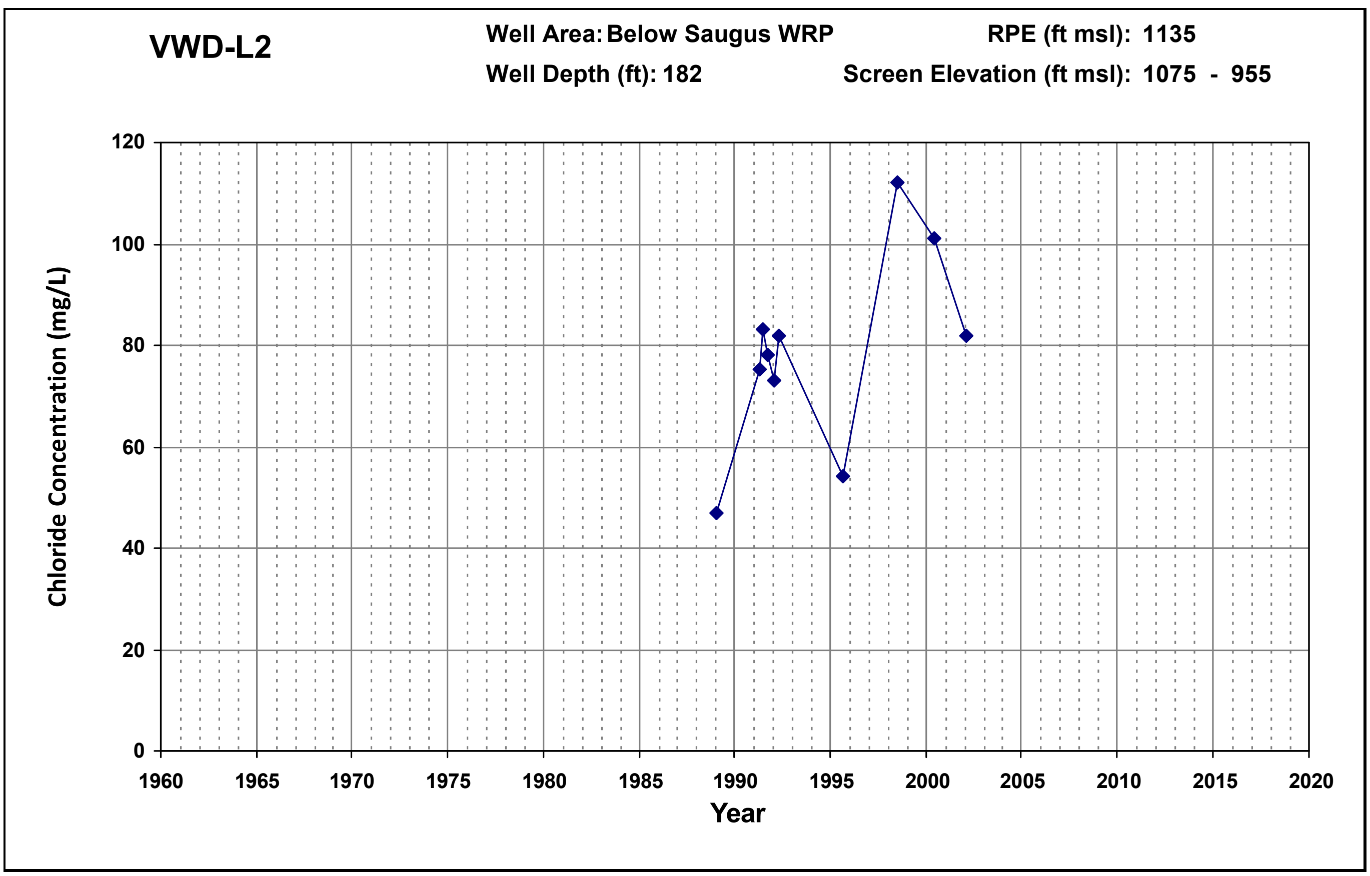

VWD-E15
Well Area: Below Valencia WRP
RPE (ft msl): 1022.957
Well Depth (ft): 160
Screen Elevation (ft msl): 933 - 888
Chloride Concentration (mg/L)
0
20
40
60
80
100
120
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

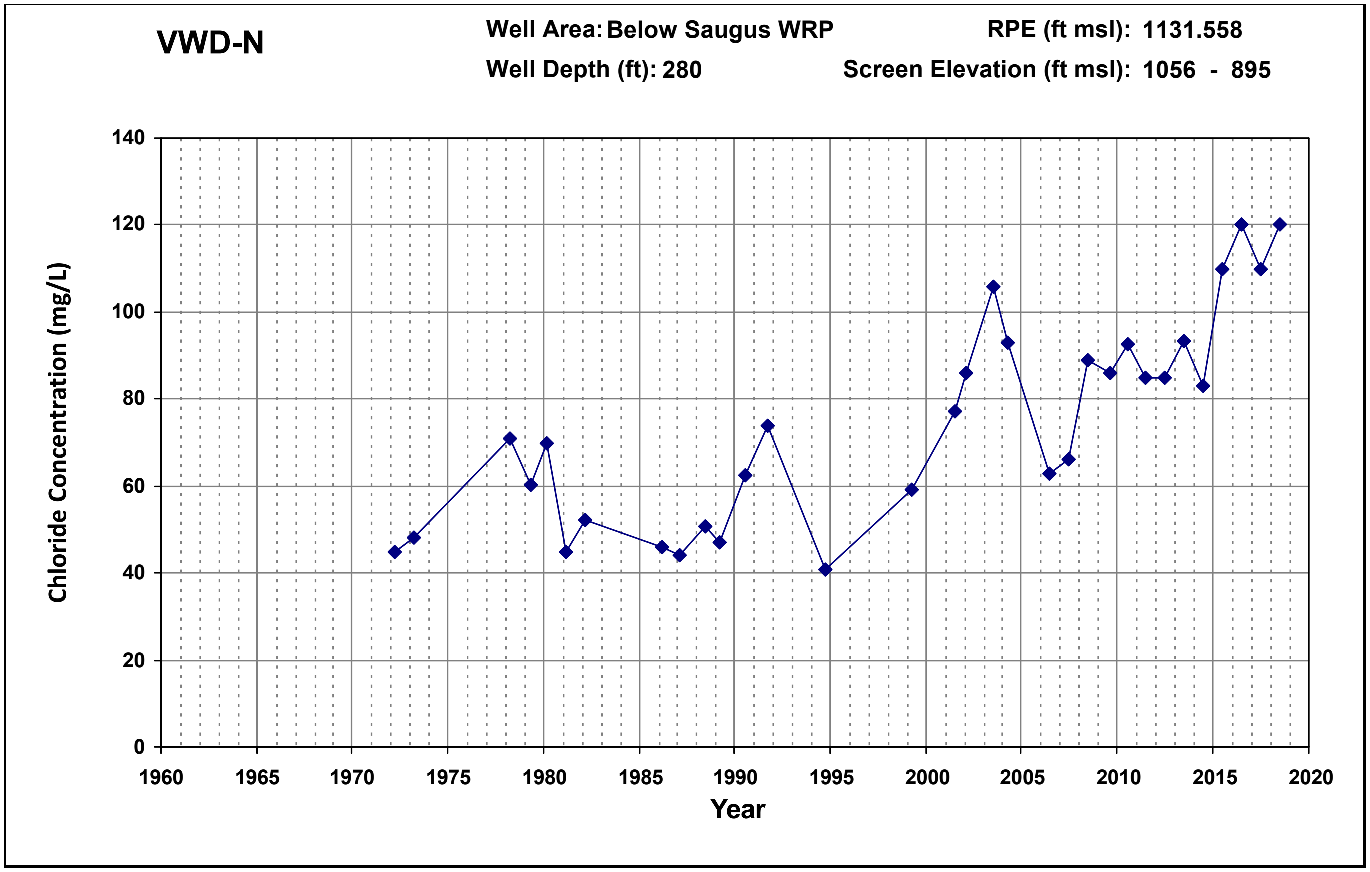

VWD-E16
Well Area: Below Valencia WRP
RPE (ft msl): 996
Well Depth (ft): 170
Screen Elevation (ft msl): 916 - 851
Chloride Concentration (mg/L)
0
10
20
30
40
50
60
70
80
90
100
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

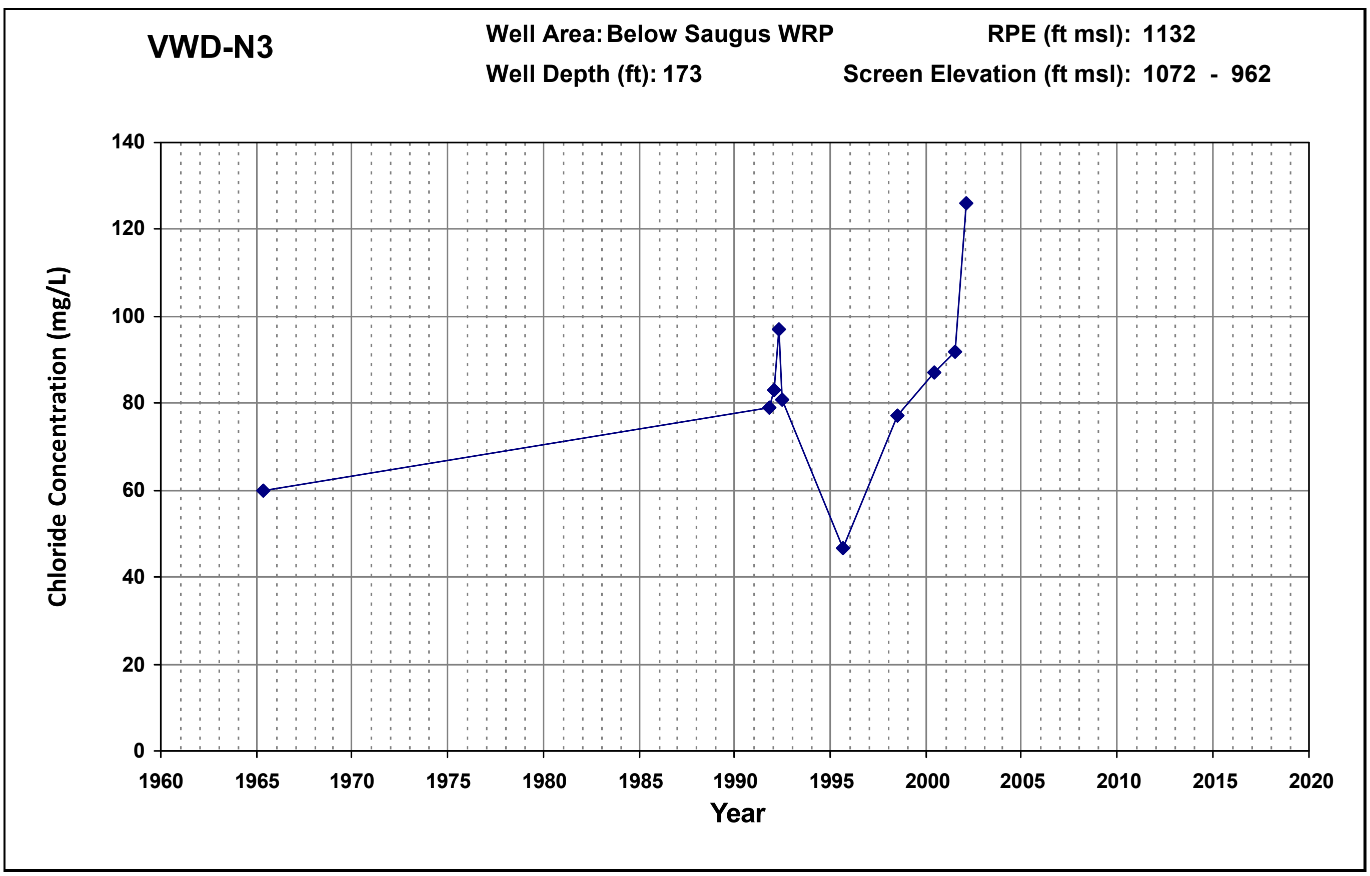

VWD-E17
Well Area: Below Valencia WRP
RPE (ft msl): 983
Well Depth (ft): 150
Screen Elevation (ft msl): 903 - 863
Chloride Concentration (mg/L)
100
90
80
70
60
50
40
30
20
10
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

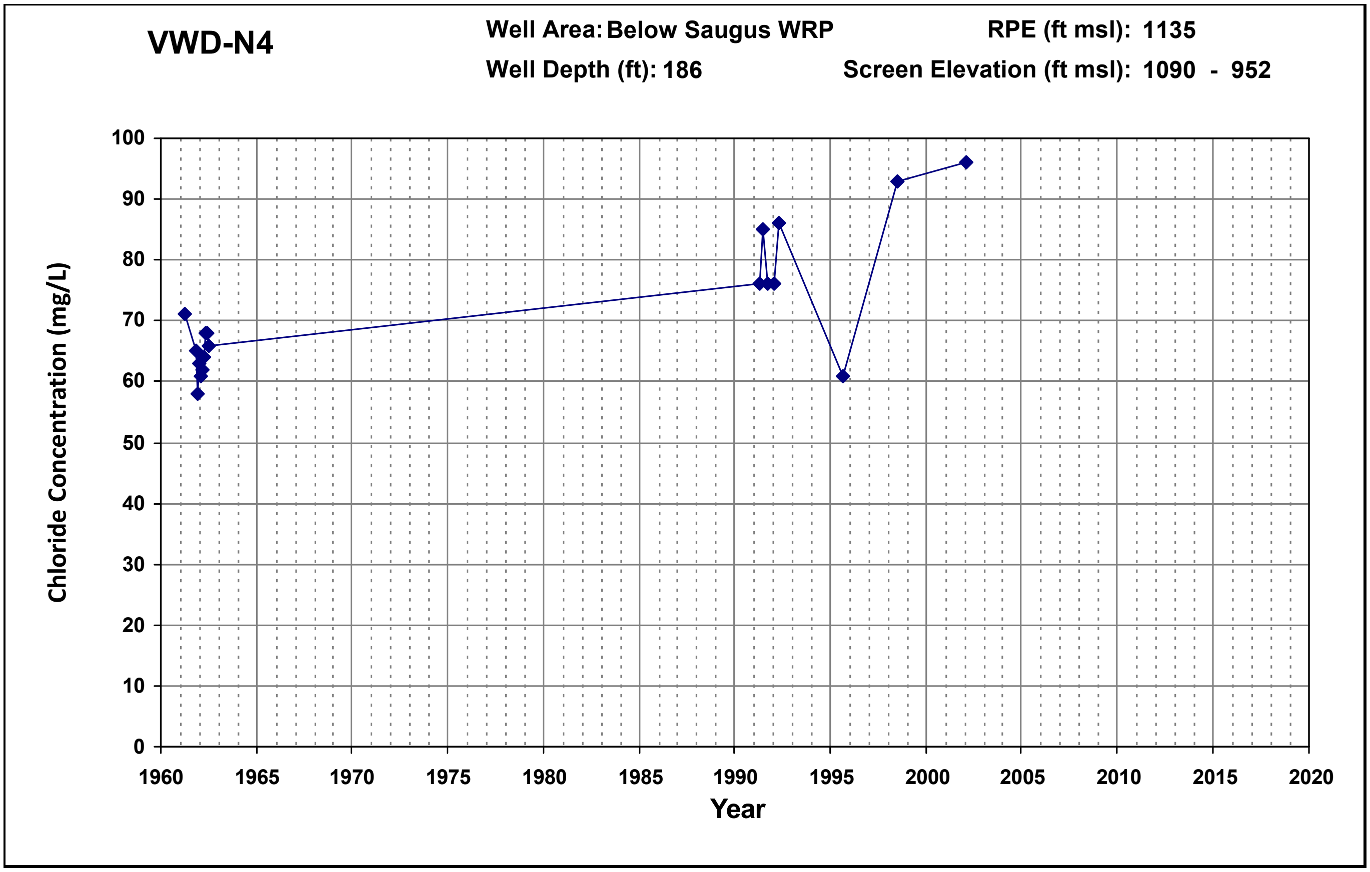

VWD-I
Well Area: Below Saugus WRP
RPE (ft msl): 1089
Well Depth (ft): 171
Screen Elevation (ft msl): 1059 - 924
Chloride Concentration (mg/L)
100
90
80
70
60
50
40
30
20
10
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

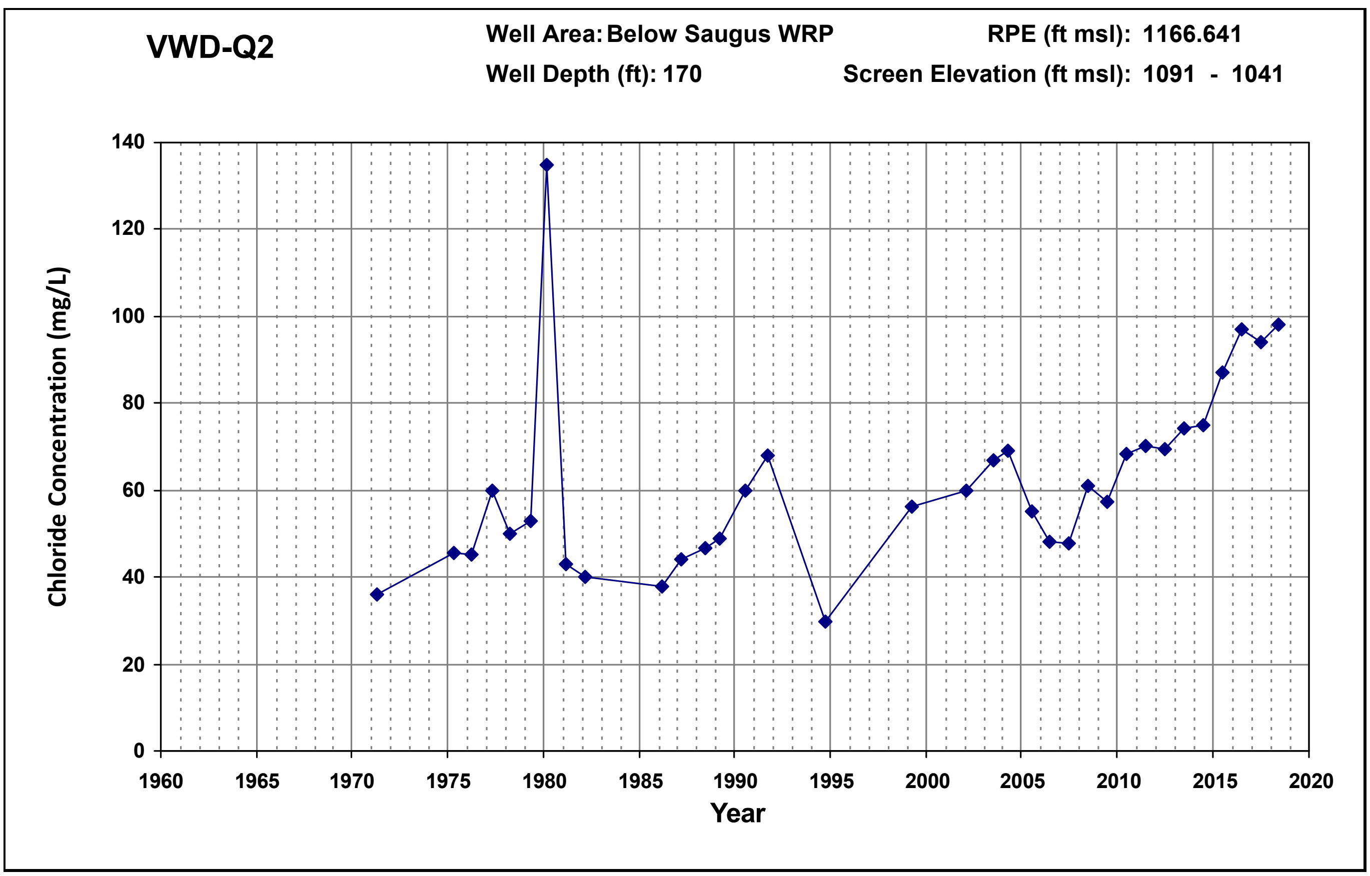

VWD-K2
Well Area: Below Saugus WRP
RPE (ft msl): 1129
Well Depth (ft): 242
Screen Elevation (ft msl): 1067 - 899
Chloride Concentration (mg/L)
0
20
40
60
80
100
120
140
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

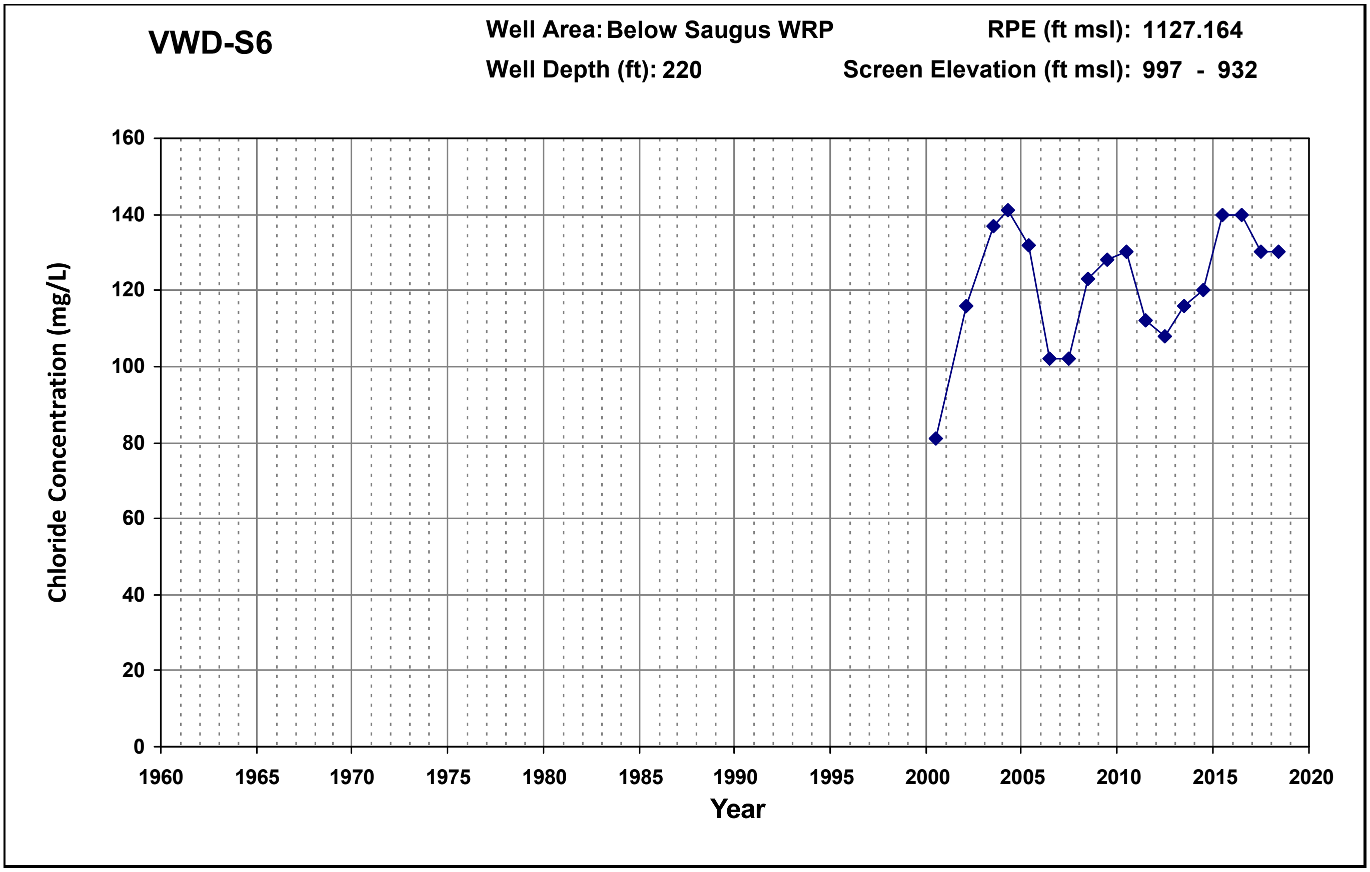

VWD-L2
Well Area: Below Saugus WRP
RPE (ft msl): 1135
Well Depth (ft): 182
Screen Elevation (ft msl): 1075 - 955
Chloride Concentration (mg/L)
0
20
40
60
80
100
120
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year


VWD-N
Well Area: Below Saugus WRP
RPE (ft msl): 1131.558
Well Depth (ft): 280
Screen Elevation (ft msl): 1056 - 895
Chloride Concentration (mg/L)
Year
0
20
40
60
80
100
120
140
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

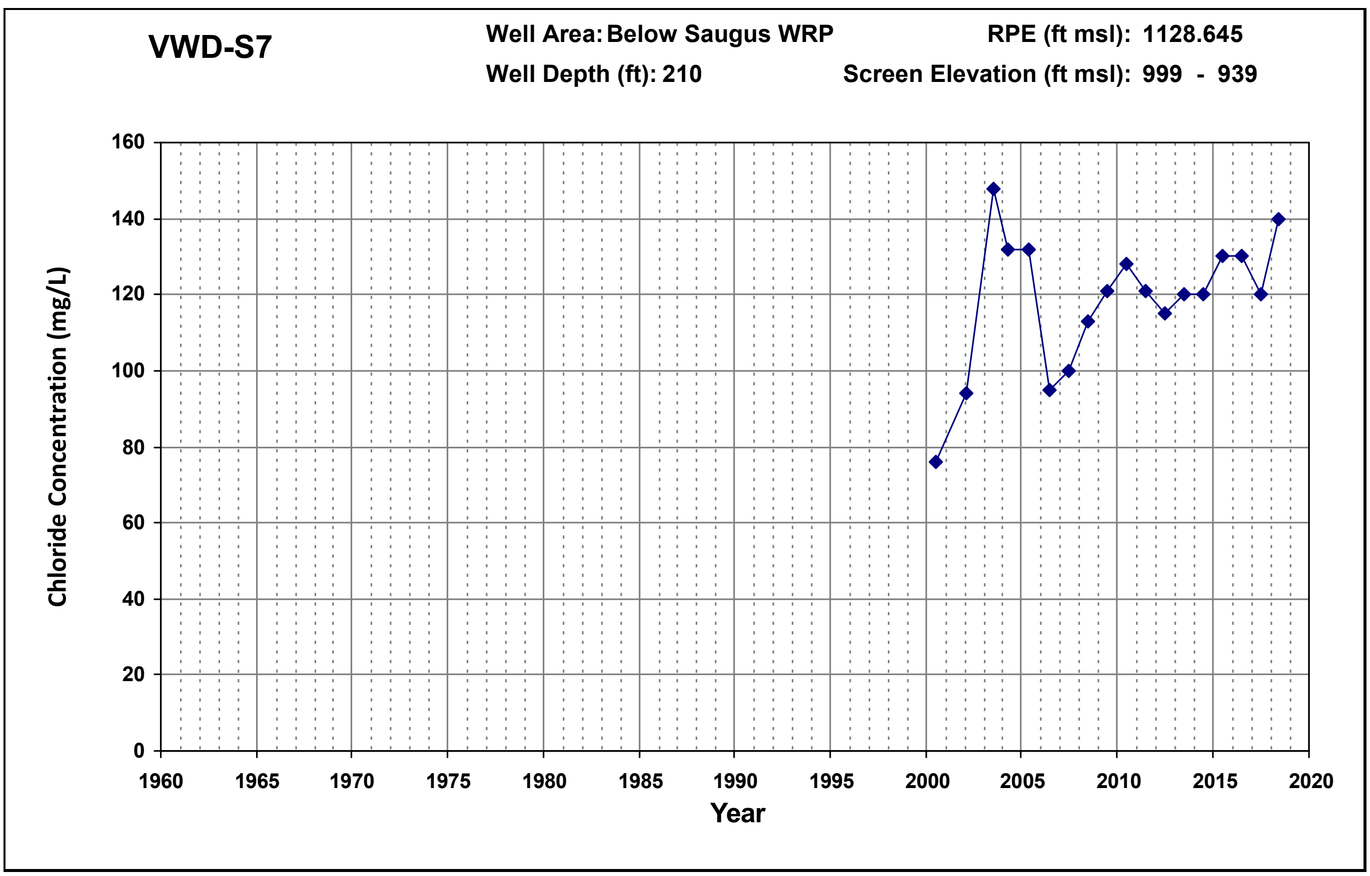

VWD-N3
Well Area: Below Saugus WRP
RPE (ft msl): 1132
Well Depth (ft): 173
Screen Elevation (ft msl): 1072 - 962
Chloride Concentration (mg/L)
Year
0
20
40
60
80
100
120
140
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020


VWD-N4
Well Area: Below Saugus WRP
RPE (ft msl): 1135
Well Depth (ft): 186
Screen Elevation (ft msl): 1090 - 952
Chloride Concentration (mg/L)
0
10
20
30
40
50
60
70
80
90
100
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

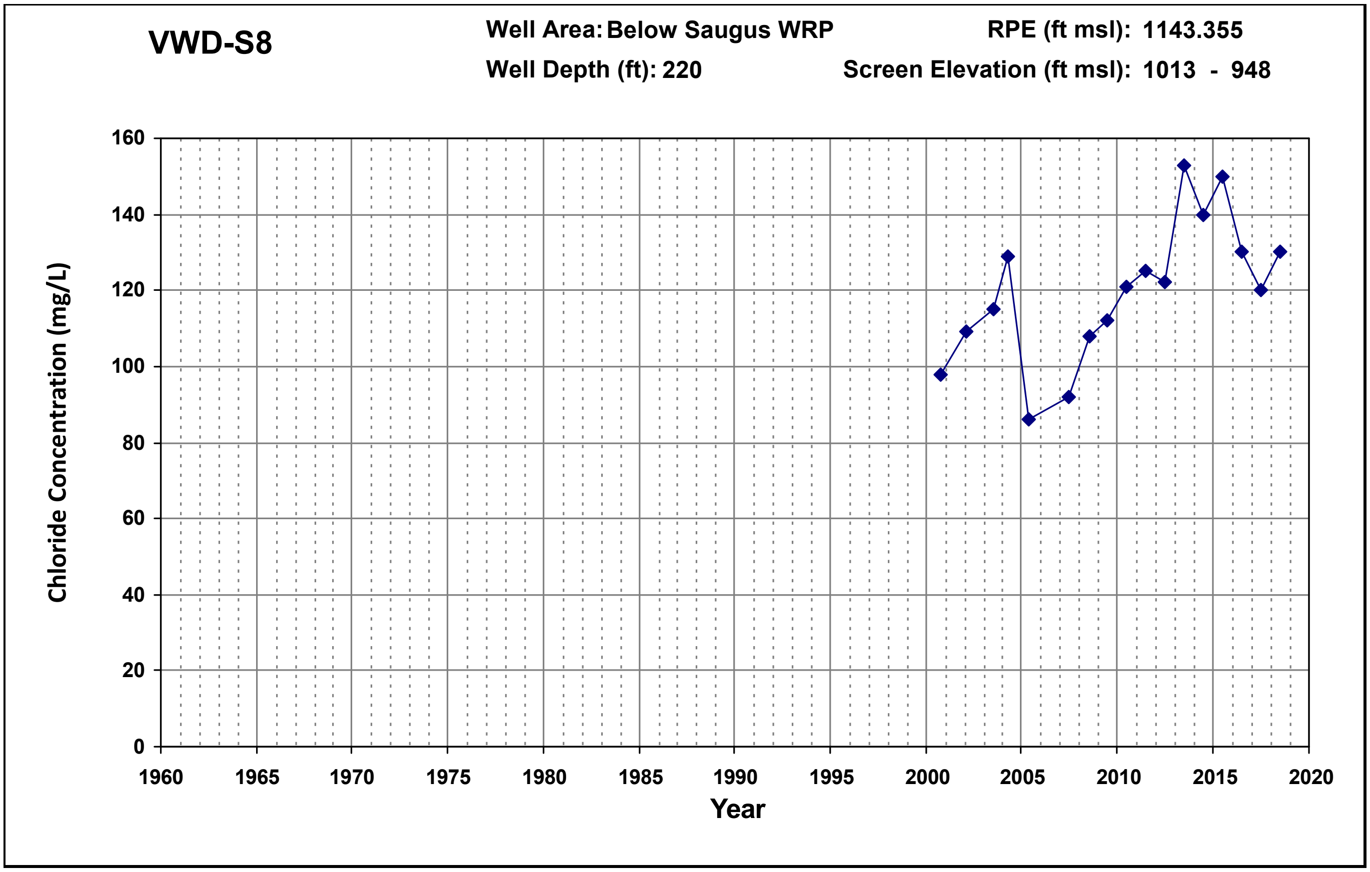

VWD-Q2
Well Area: Below Saugus WRP
RPE (ft msl): 1166.641
Well Depth (ft): 170
Screen Elevation (ft msl): 1091 - 1041
Chloride Concentration (mg/L)
0
20
40
60
80
100
120
140
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

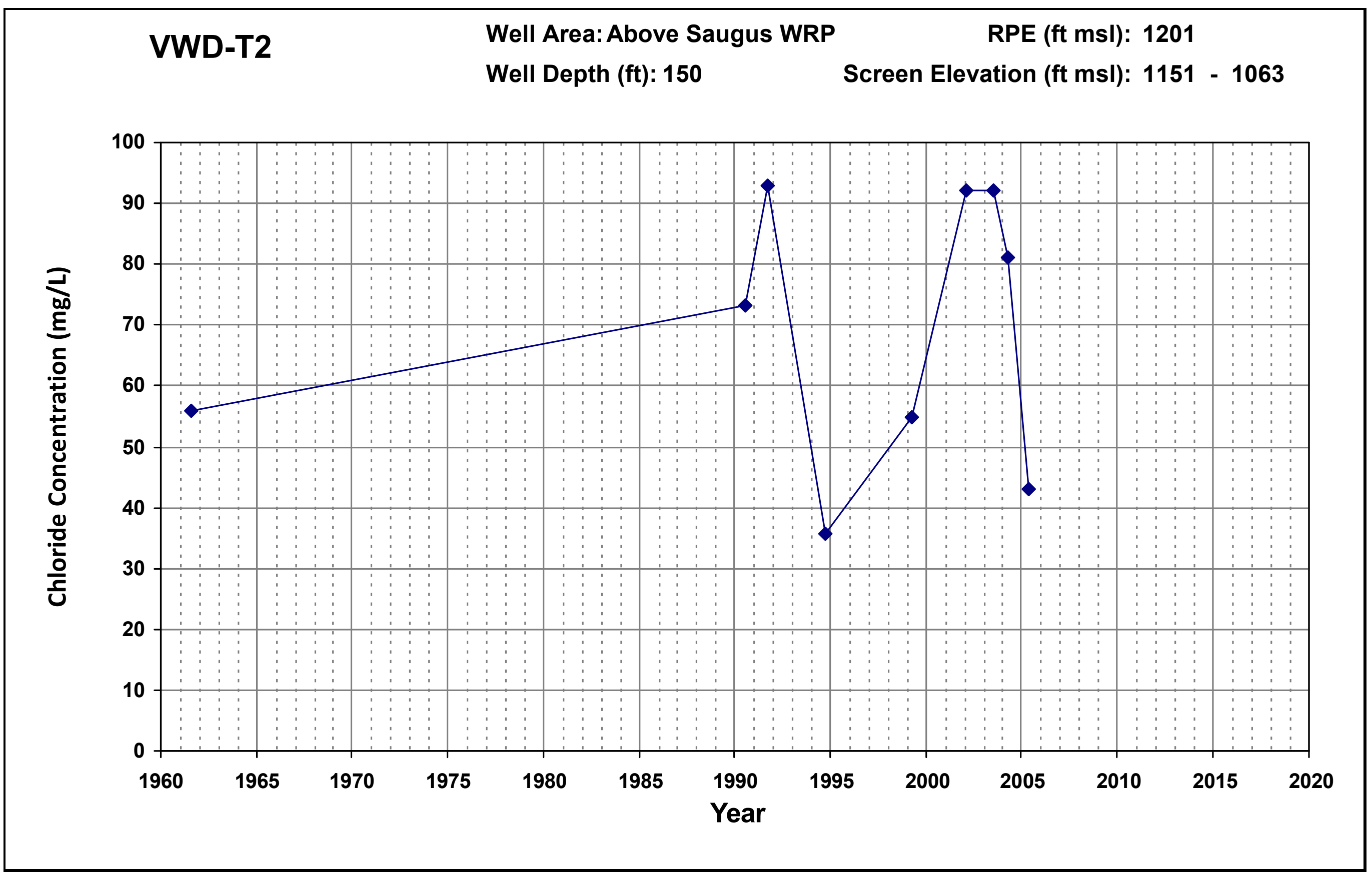


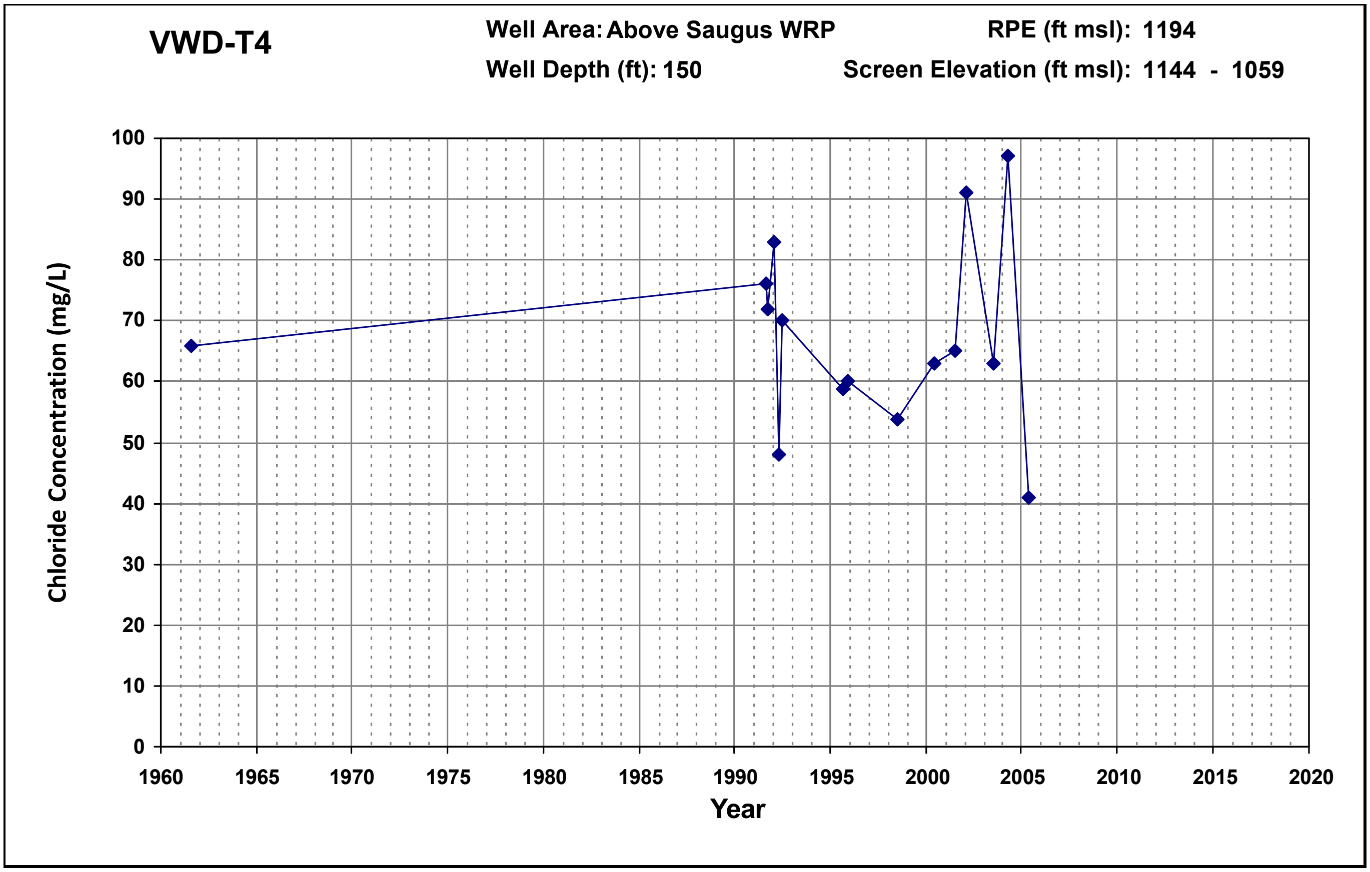
VWD-S6
Well Area: Below Saugus WRP
RPE (ft msl): 1127.164
Well Depth (ft): 220
Screen Elevation (ft msl): 997 - 932
Chloride Concentration (mg/L)
0
20
40
60
80
100
120
140
160
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

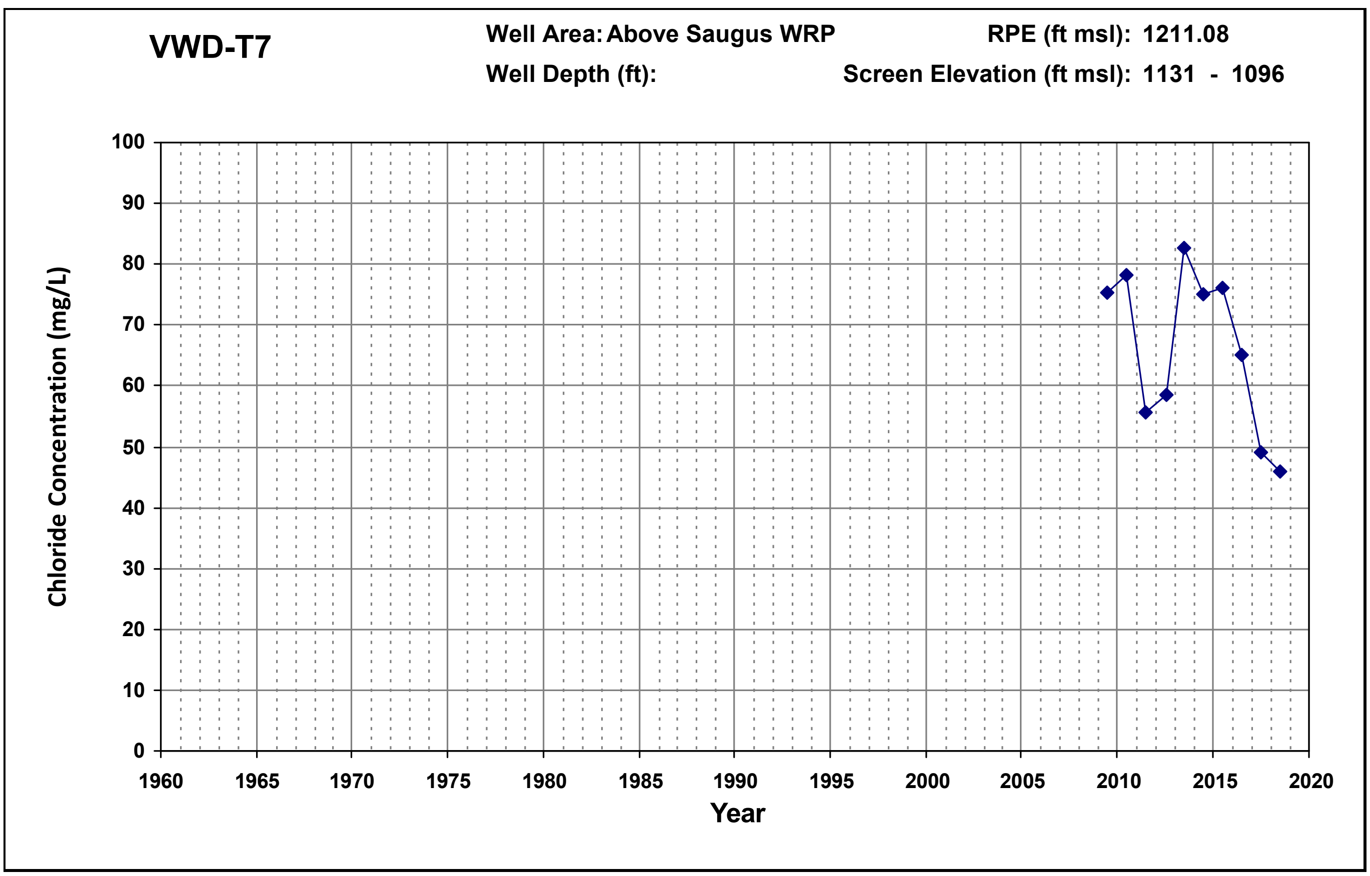


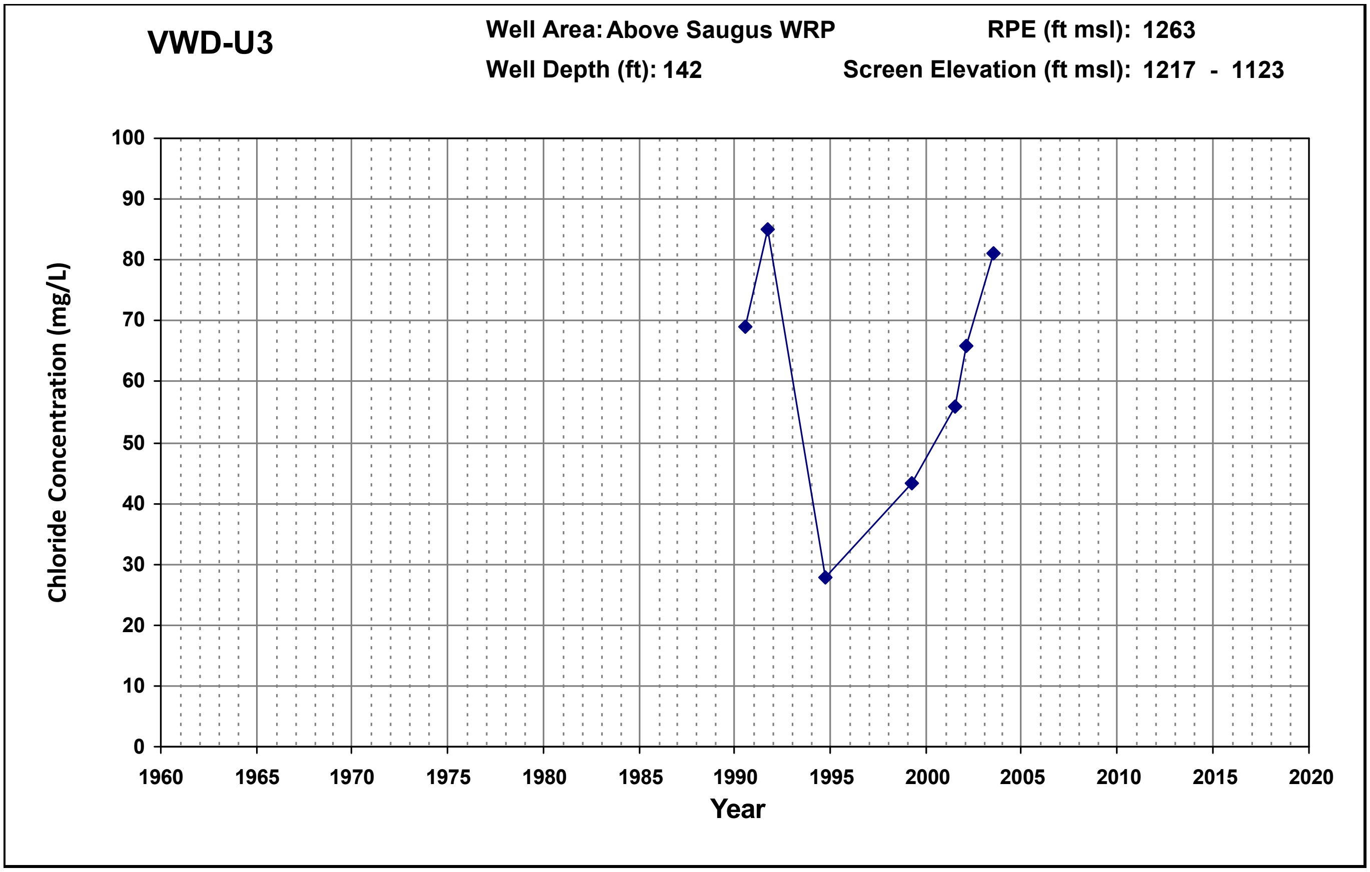
VWD-S7
Well Area: Below Saugus WRP
RPE (ft msl): 1128.645
Well Depth (ft): 210
Screen Elevation (ft msl): 999 - 939
Chloride Concentration (mg/L)
0
20
40
60
80
100
120
140
160
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

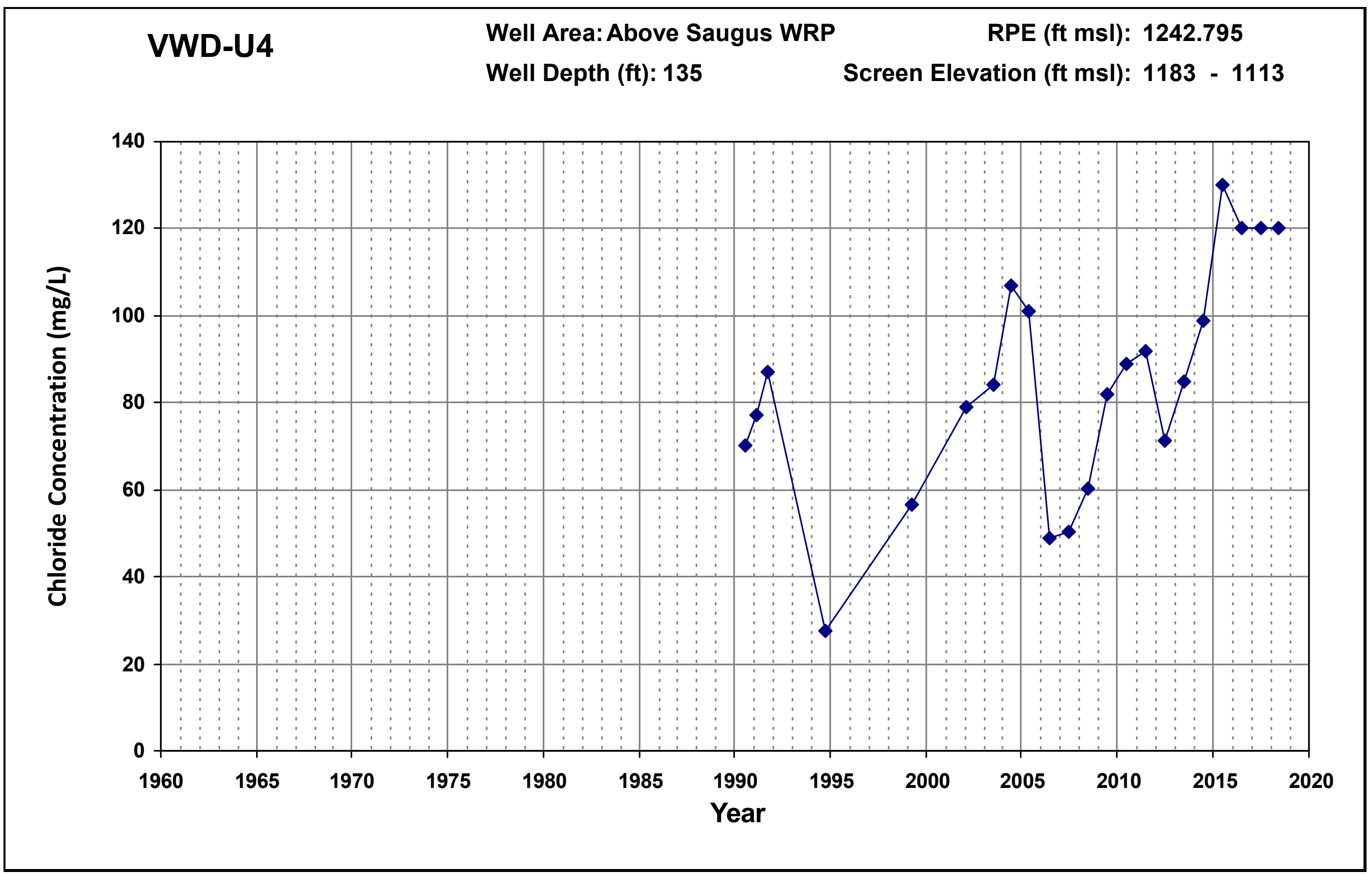

VWD-S8
Well Area: Below Saugus WRP
RPE (ft msl): 1143.355
Well Depth (ft): 220
Screen Elevation (ft msl): 1013 - 948
Chloride Concentration (mg/L)
0
20
40
60
80
100
120
140
160
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year


VWD-T2
Well Area: Above Saugus WRP
RPE (ft msl): 1201
Well Depth (ft): 150
Screen Elevation (ft msl): 1151 - 1063
Chloride Concentration (mg/L)
0
10
20
30
40
50
60
70
80
90
100
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year


VWD-T4
Well Area: Above Saugus WRP
RPE (ft msl): 1194
Well Depth (ft): 150
Screen Elevation (ft msl): 1144 - 1059
Chloride Concentration (mg/L)
0
10
20
30
40
50
60
70
80
90
100
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

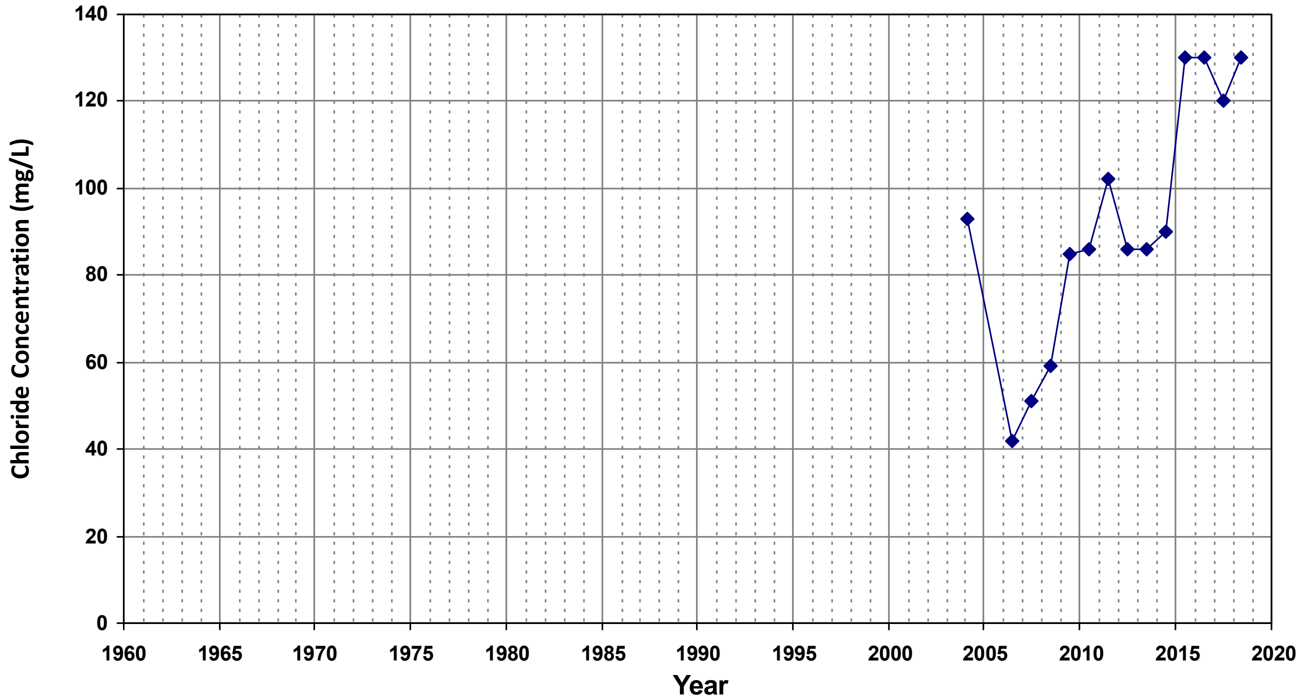

VWD-T7
Well Area: Above Saugus WRP
RPE (ft msl): 1211.08
Well Depth (ft):
Screen Elevation (ft msl): 1131 - 1096
Chloride Concentration (mg/L)
0
10
20
30
40
50
60
70
80
90
100
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year


VWD-U3
Well Area: Above Saugus WRP
RPE (ft msl): 1263
Well Depth (ft): 142
Screen Elevation (ft msl): 1217 - 1123
Chloride Concentration (mg/L)
0
10
20
30
40
50
60
70
80
90
100
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year


VWD-U4
Well Area: Above Saugus WRP
RPE (ft msl): 1242.795
Well Depth (ft): 135
Screen Elevation (ft msl): 1183 - 1113
Chloride Concentration (mg/L)
0
20
40
60
80
100
120
140
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

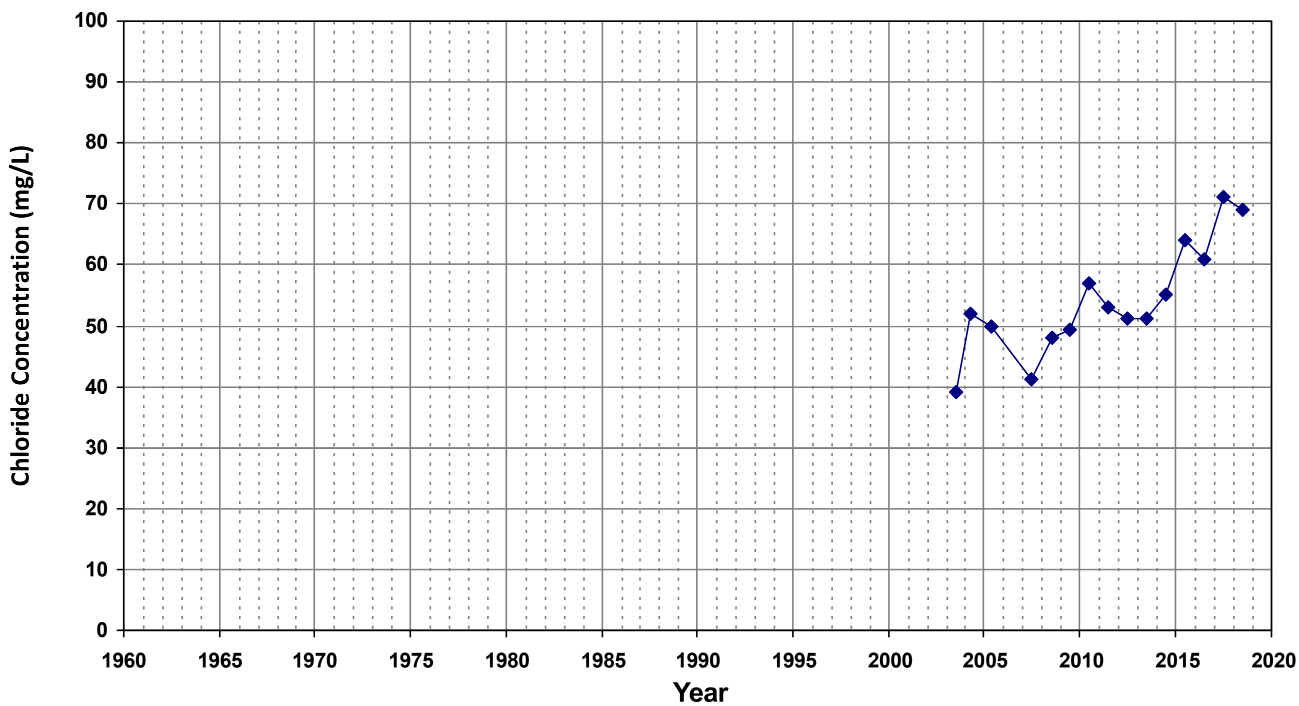
VWD-U6

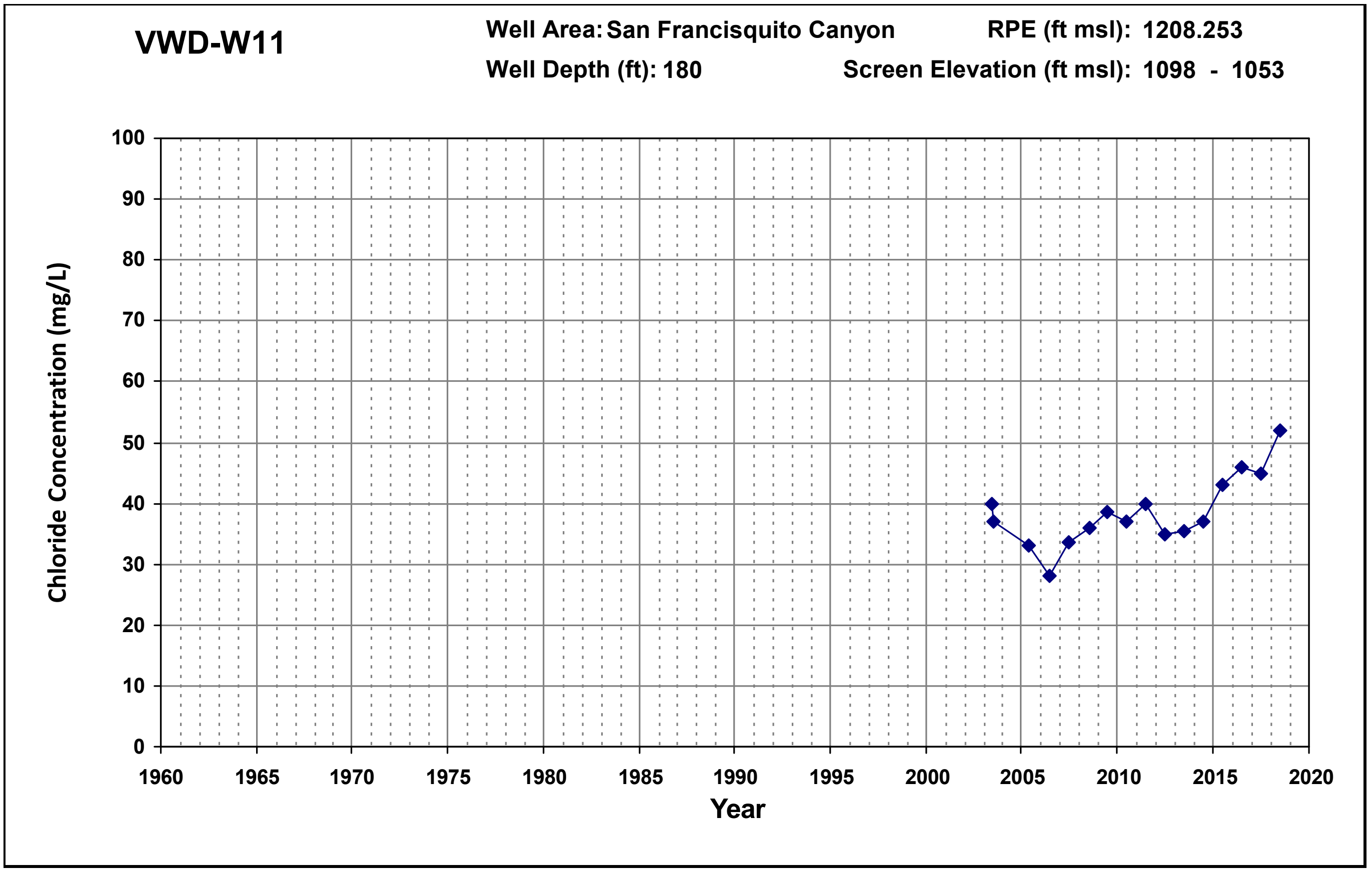
Well Area: Above Saugus WRP **RPE (ft msl):** 1230.6
Well Depth (ft): 175 **Screen Elevation (ft msl):** 1131 - 1086

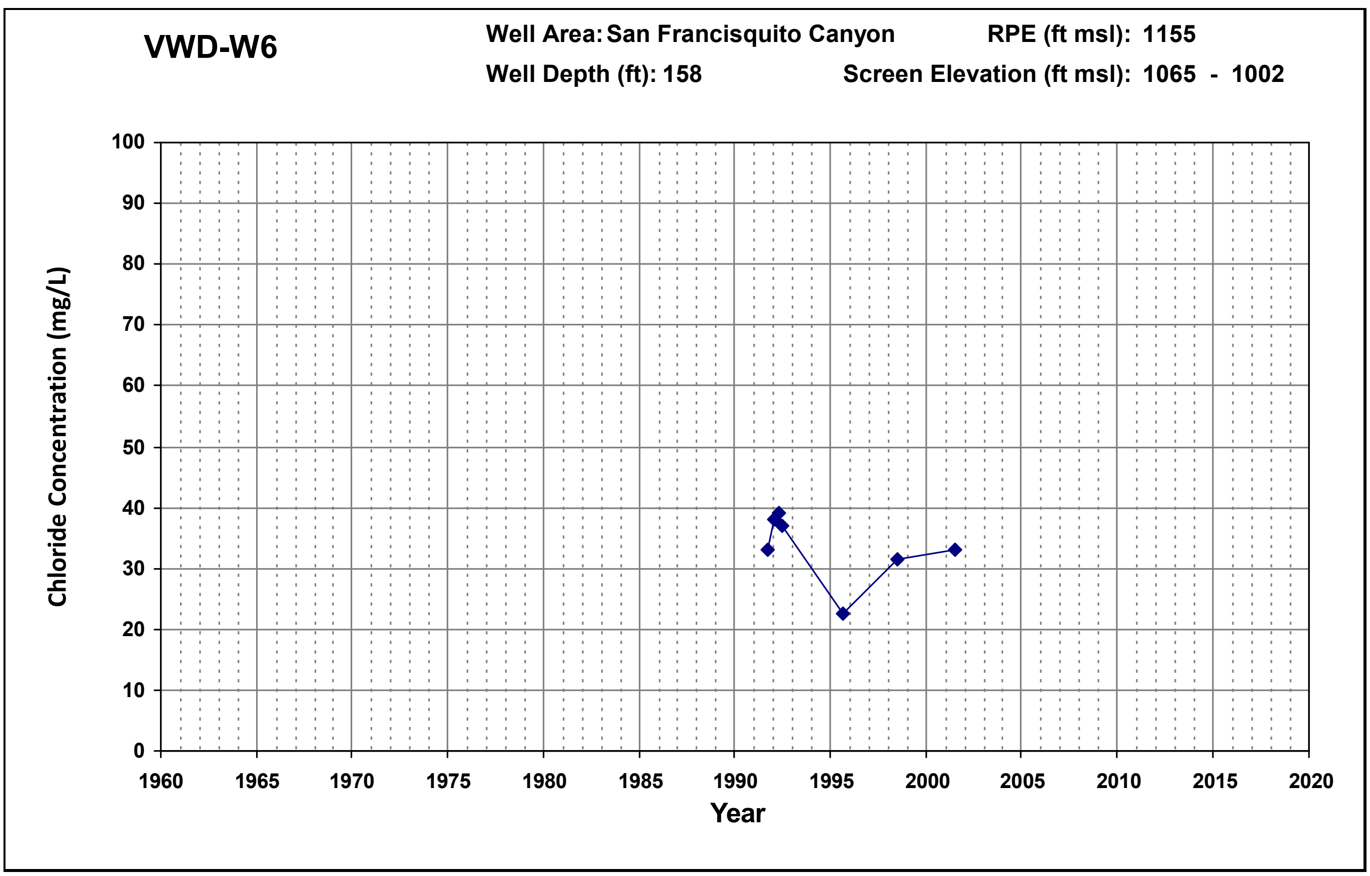


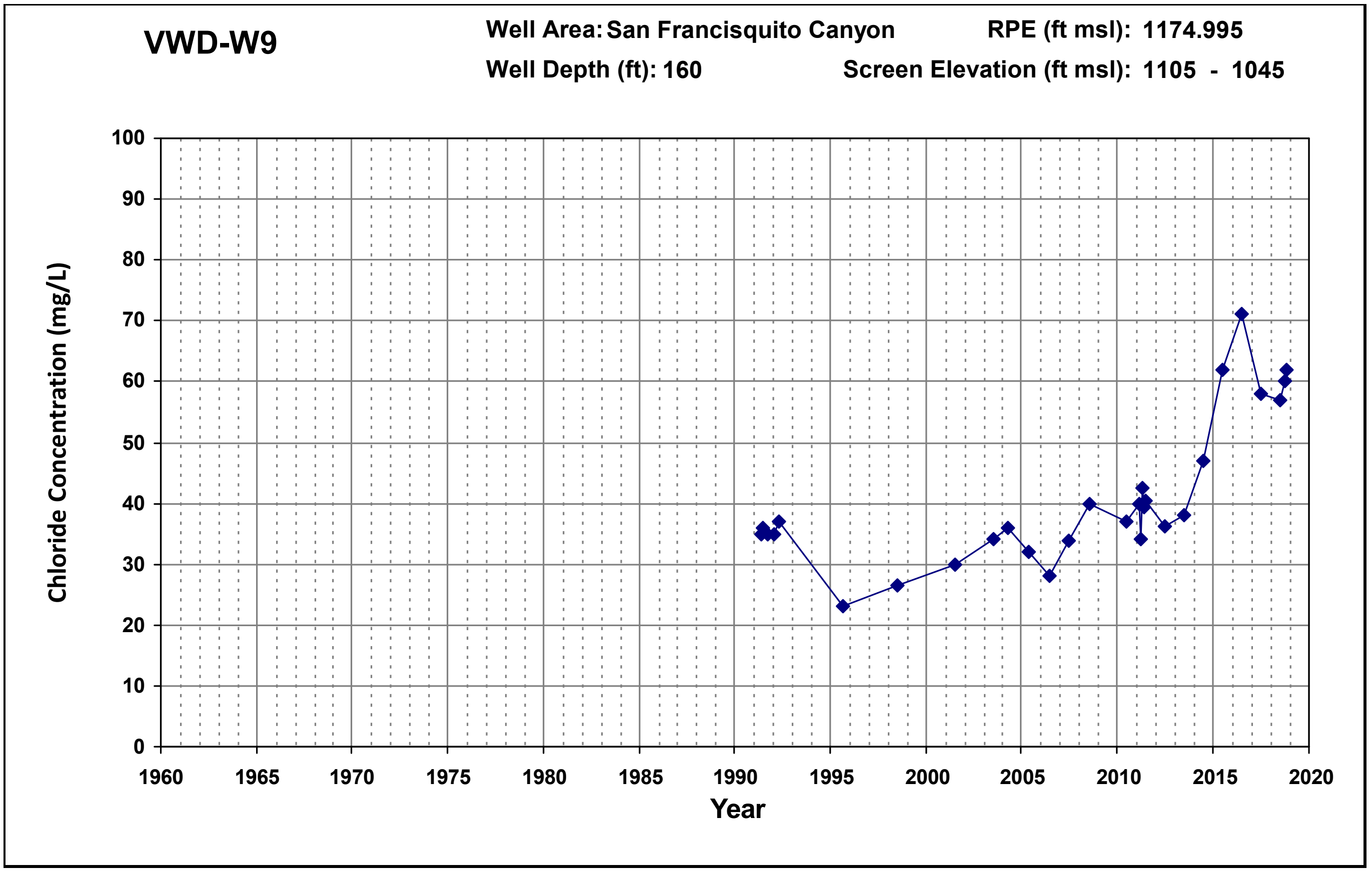
VWD-W10

Well Area: San Francisquito Canyon **RPE (ft msl):** 1130.285
Well Depth (ft): 190 **Screen Elevation (ft msl):** 1010 - 970

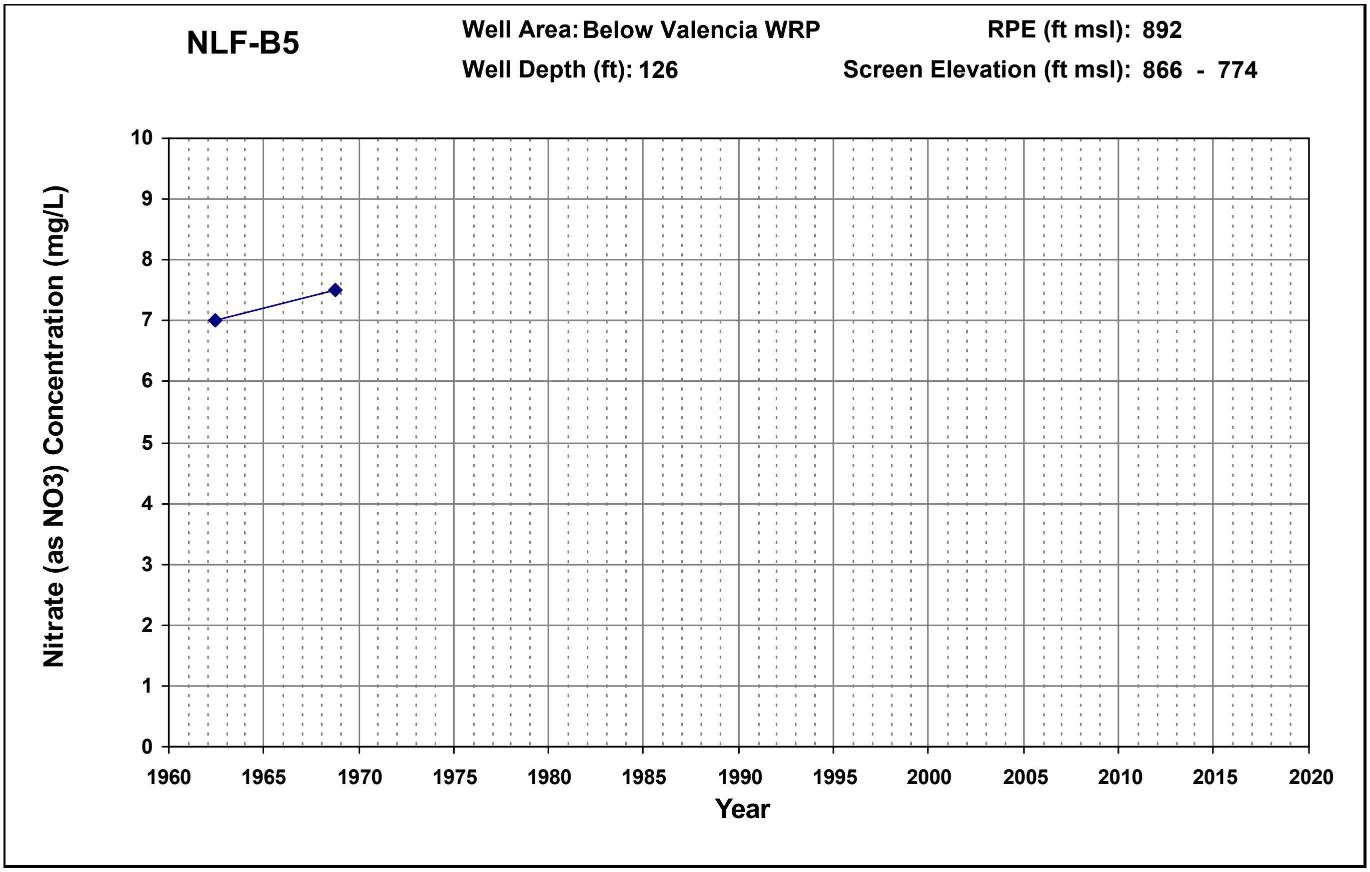


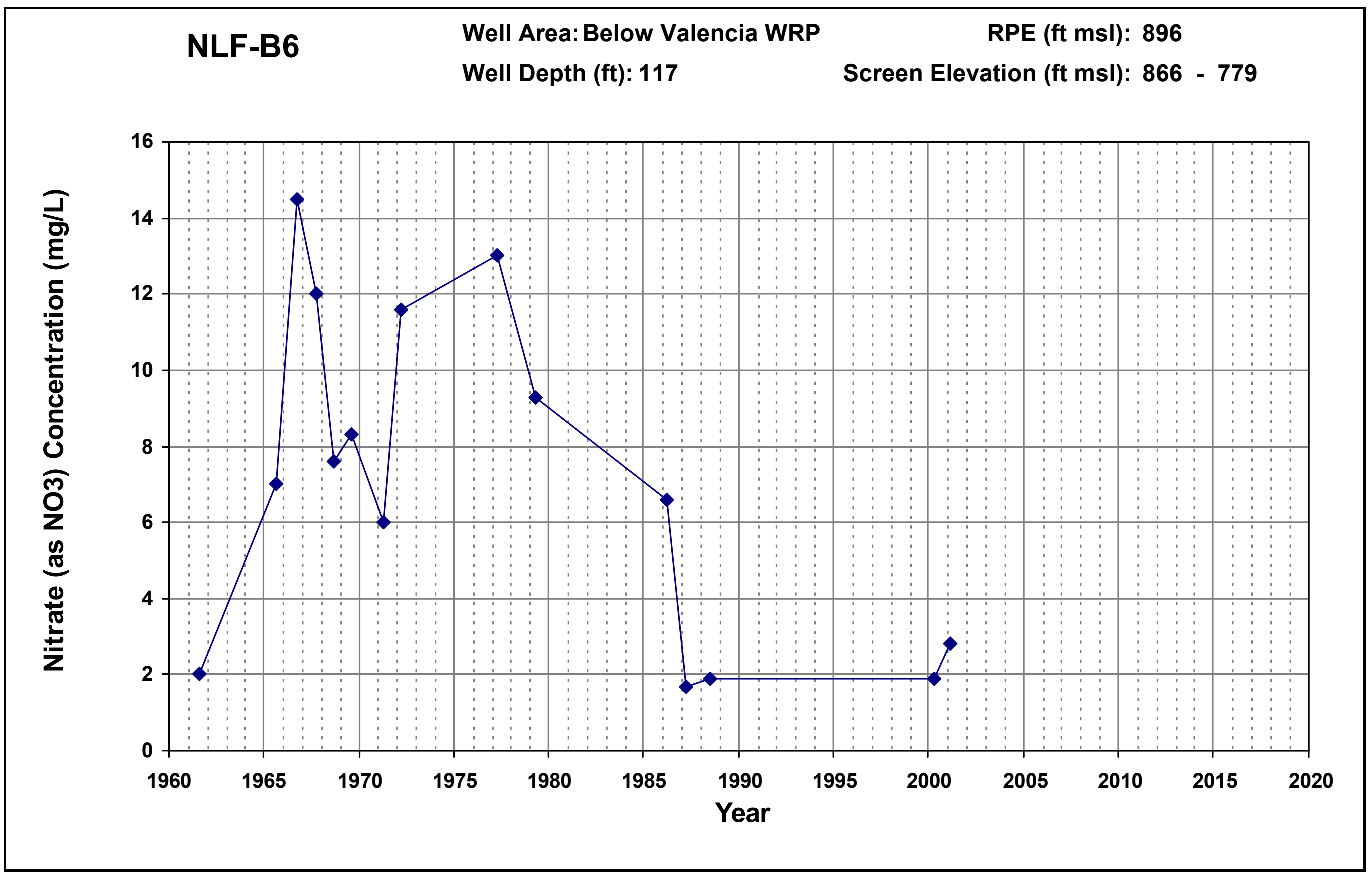

VWD-W11
Well Area: San Francisquito Canyon
RPE (ft msl): 1208.253
Well Depth (ft): 180
Screen Elevation (ft msl): 1098 - 1053
Chloride Concentration (mg/L)
0
10
20
30
40
50
60
70
80
90
100
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year


VWD-W6
Well Area: San Francisquito Canyon
RPE (ft msl): 1155
Well Depth (ft): 158
Screen Elevation (ft msl): 1065 - 1002
Chloride Concentration (mg/L)
0
10
20
30
40
50
60
70
80
90
100
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year



VWD-W9
Well Area: San Francisquito Canyon
RPE (ft msl): 1174.995
Well Depth (ft): 160
Screen Elevation (ft msl): 1105 - 1045
Chloride Concentration (mg/L)
0
10
20
30
40
50
60
70
80
90
100
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year


NLF-B5
Well Area: Below Valencia WRP
RPE (ft msl): 892
Well Depth (ft): 126
Screen Elevation (ft msl): 866 - 774
Nitrate (as NO3) Concentration (mg/L)
10
9
8
7
6
5
4
3
2
1
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year


NLF-B6
Well Area: Below Valencia WRP
RPE (ft msl): 896
Well Depth (ft): 117
Screen Elevation (ft msl): 866 - 779
Nitrate (as NO3) Concentration (mg/L)
16
14
12
10
8
6
4
2
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

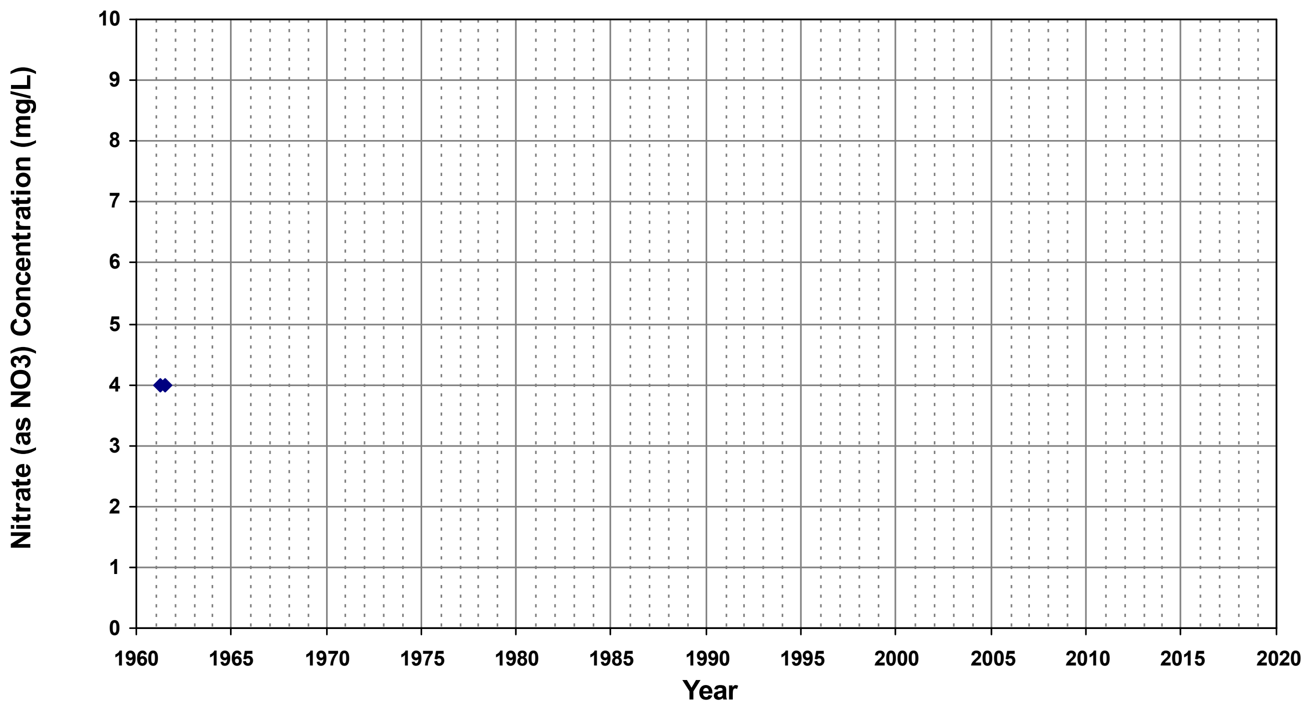
NLF-B7

Well Area: Below Valencia WRP

RPE (ft msl): 899

Well Depth (ft): 102

Screen Elevation (ft msl): 881 - 811



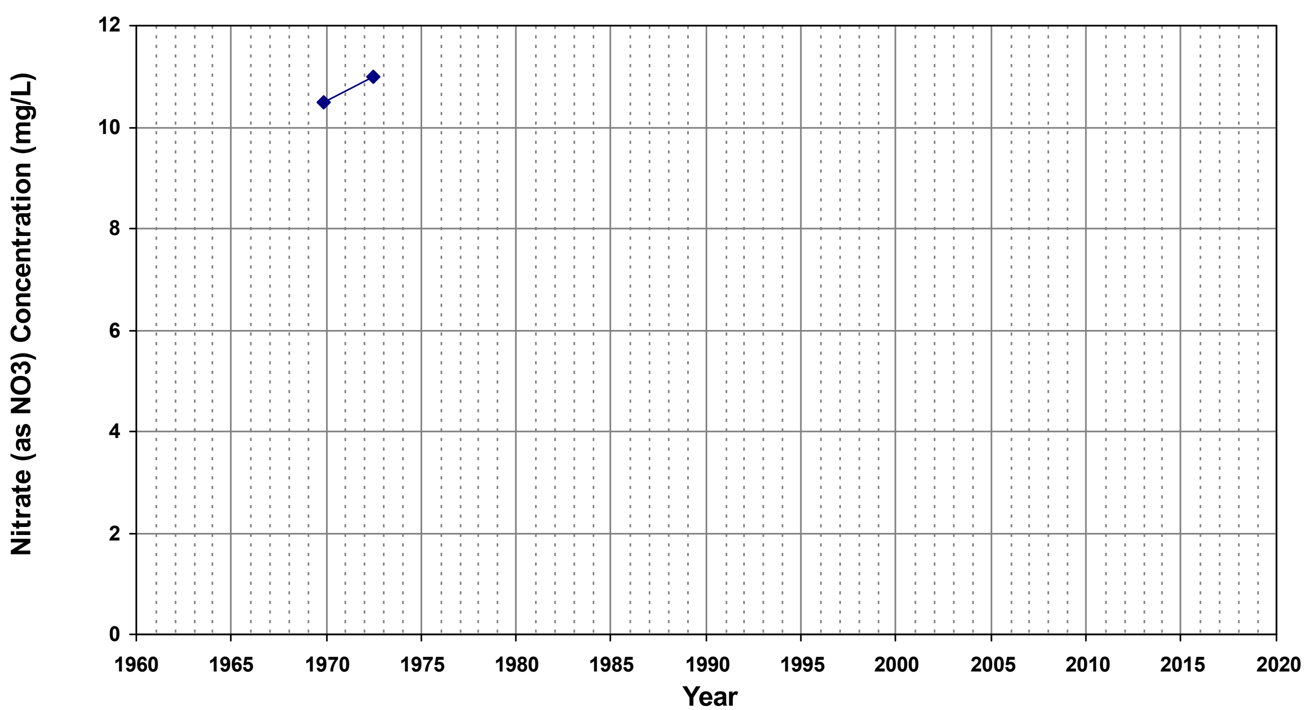
NLF-C5

Well Area: Below Valencia WRP

RPE (ft msl): 955

Well Depth (ft): 139

Screen Elevation (ft msl): 924 - 822



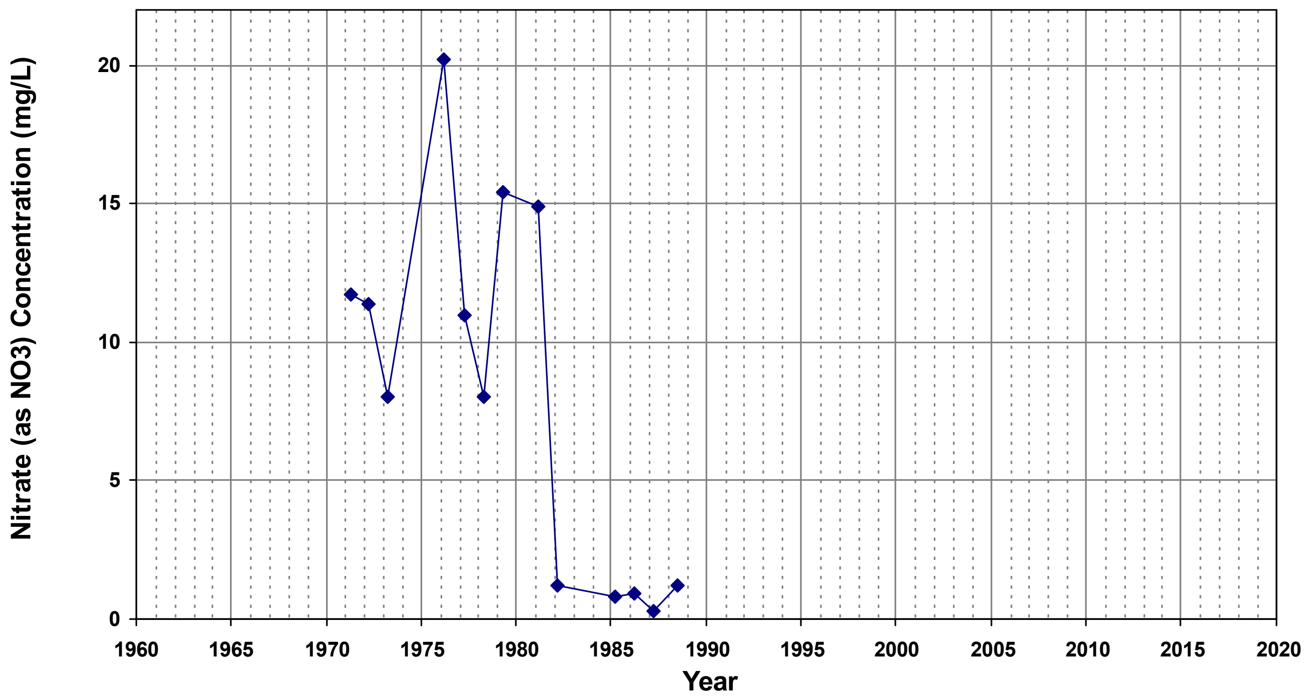
NLF-C6

Well Area: Below Valencia WRP

RPE (ft msl): 961

Well Depth (ft): 103

Screen Elevation (ft msl): 935 - 868



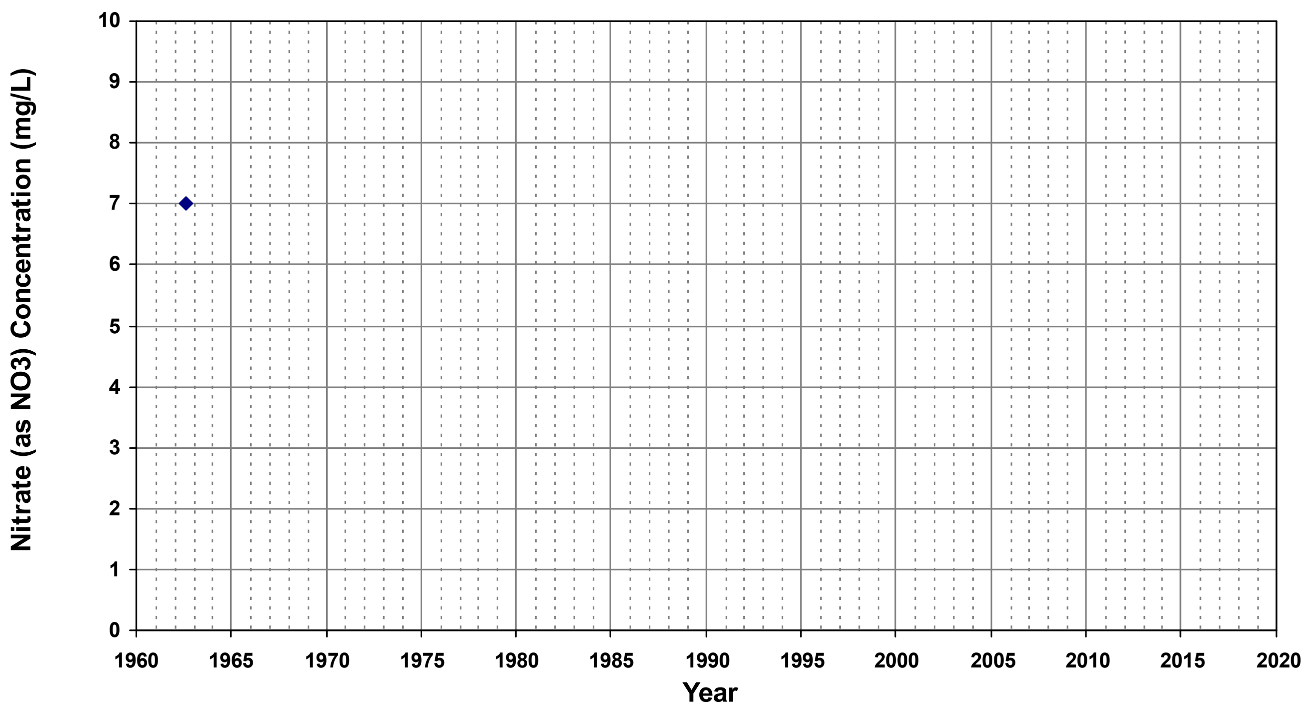
NLF-C7

Well Area: Below Valencia WRP

RPE (ft msl): 958

Well Depth (ft): 132

Screen Elevation (ft msl): 918 - 838



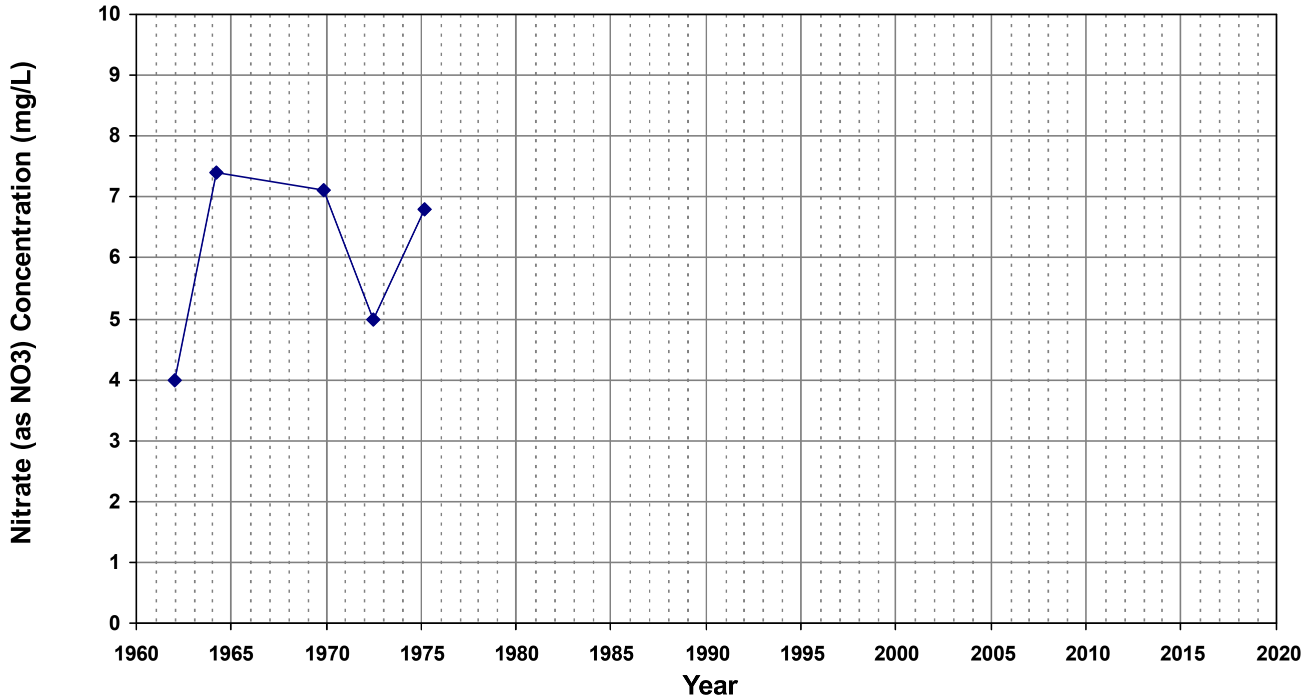
NLF-C8

Well Area: Below Valencia WRP

RPE (ft msl): 951

Well Depth (ft): 280

Screen Elevation (ft msl): 921 - 821



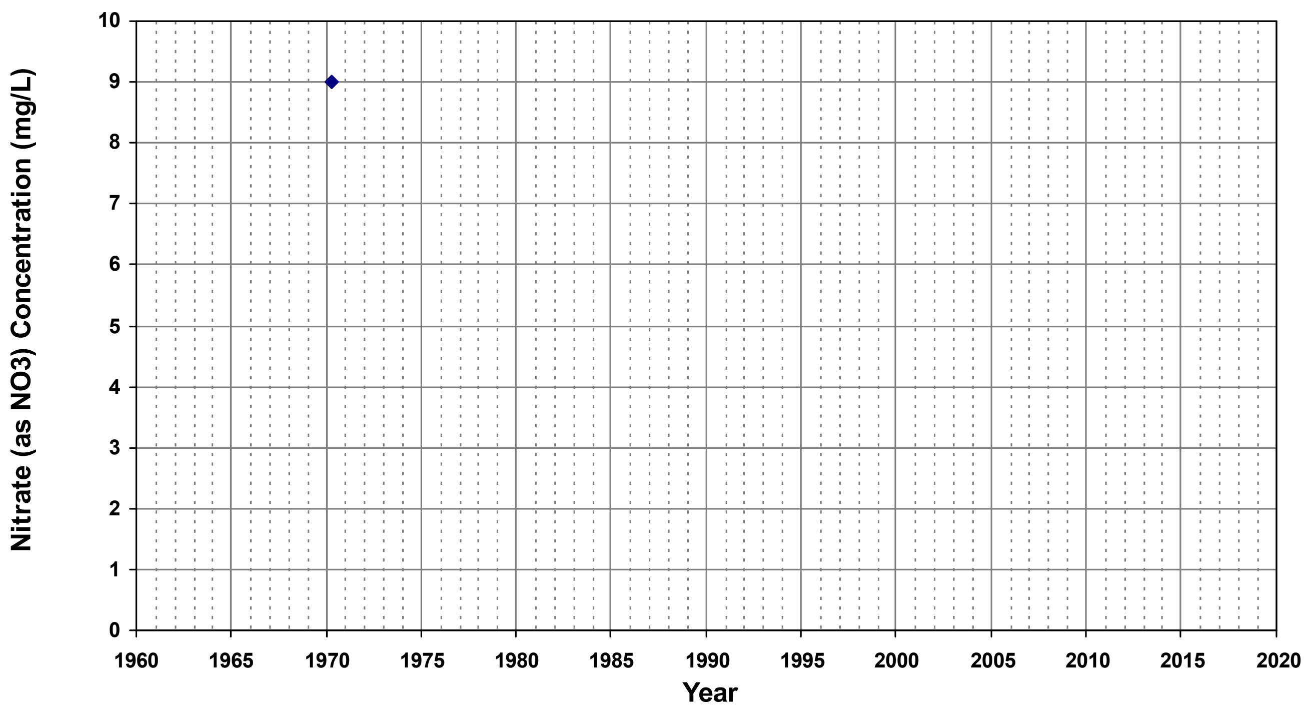
NLF-E3

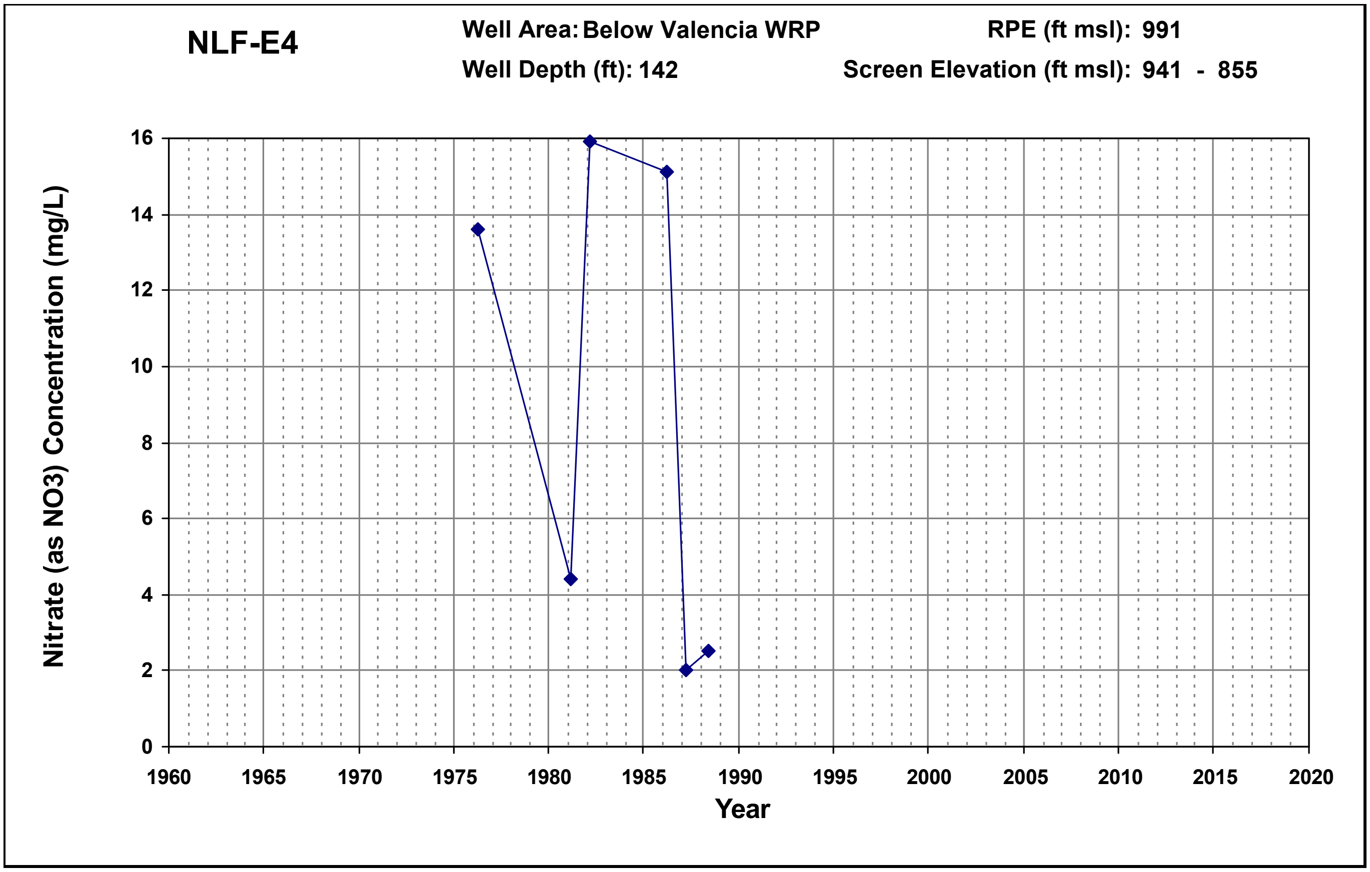
Well Area: Below Valencia WRP

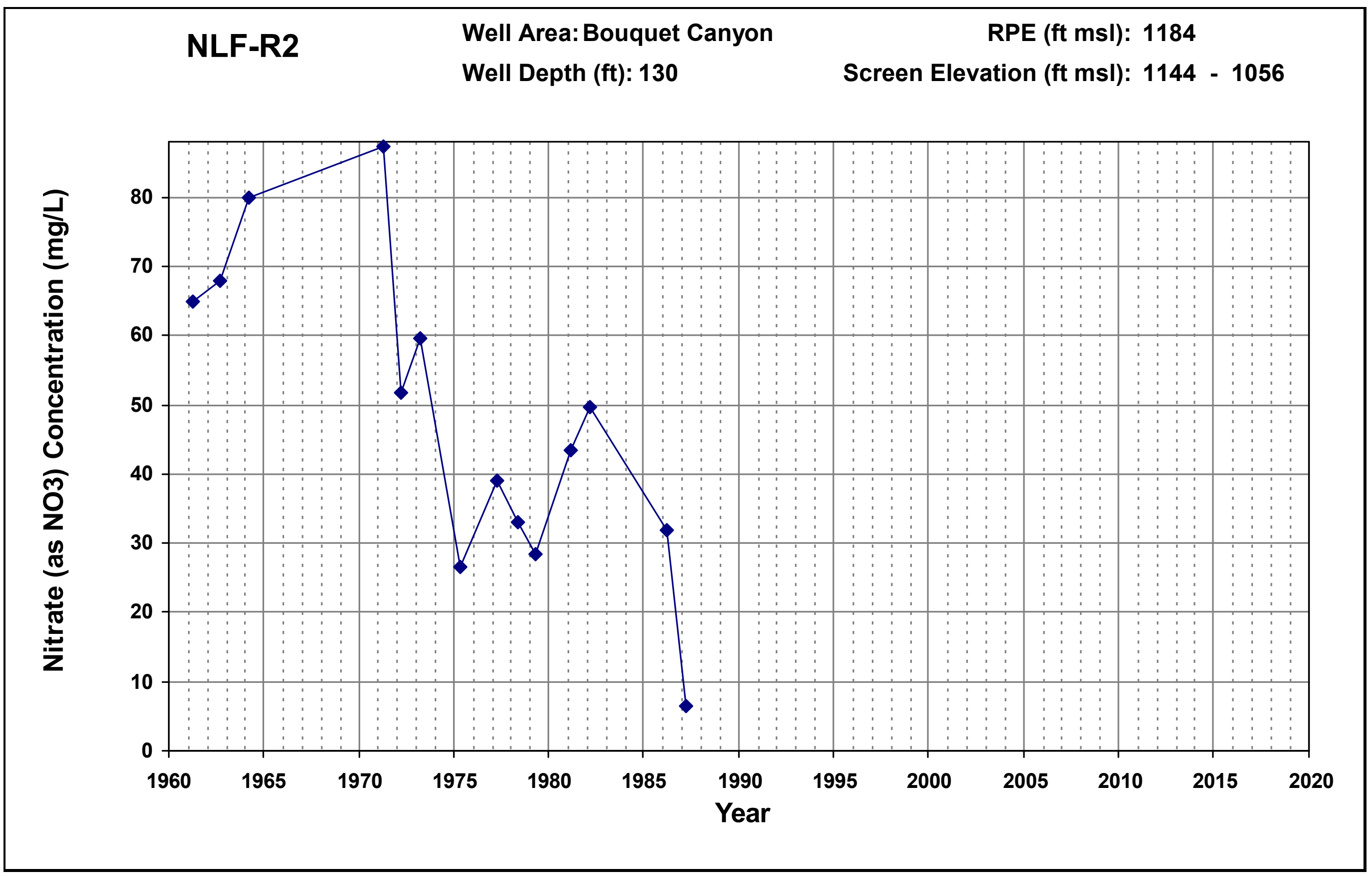
RPE (ft msl): 991

Well Depth (ft): 255

Screen Elevation (ft msl): 944 - 757

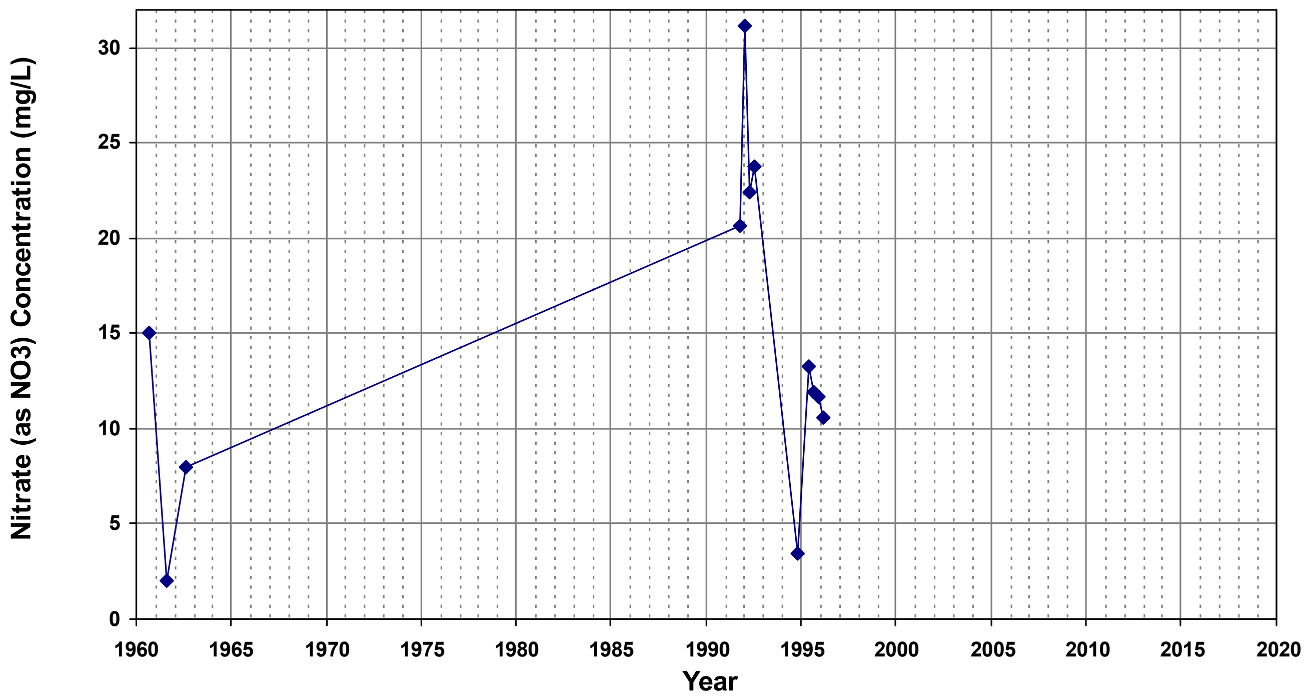



NLF-E4
Well Area: Below Valencia WRP
RPE (ft msl): 991
Well Depth (ft): 142
Screen Elevation (ft msl): 941 - 855
Nitrate (as NO3) Concentration (mg/L)
0
2
4
6
8
10
12
14
16
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year


NLF-R2
Well Area: Bouquet Canyon
RPE (ft msl): 1184
Well Depth (ft): 130
Screen Elevation (ft msl): 1144 - 1056
Nitrate (as NO3) Concentration (mg/L)
0
10
20
30
40
50
60
70
80
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

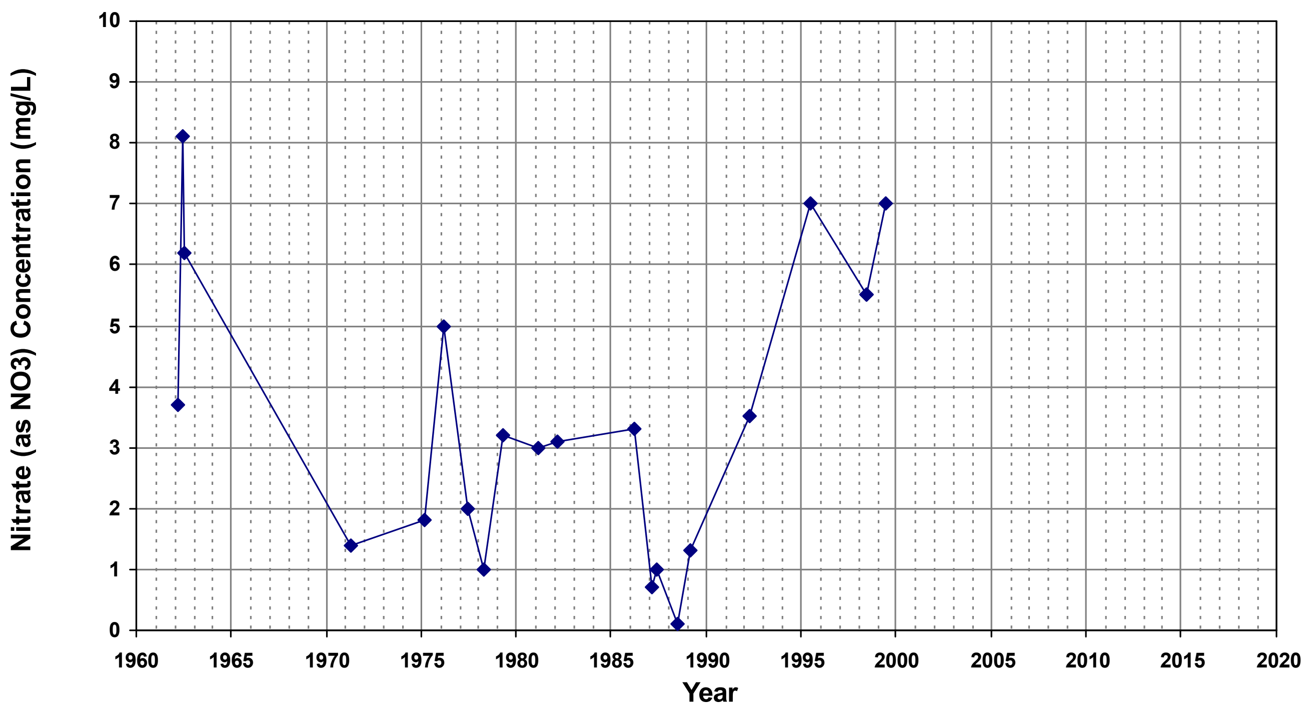
NLF-W4

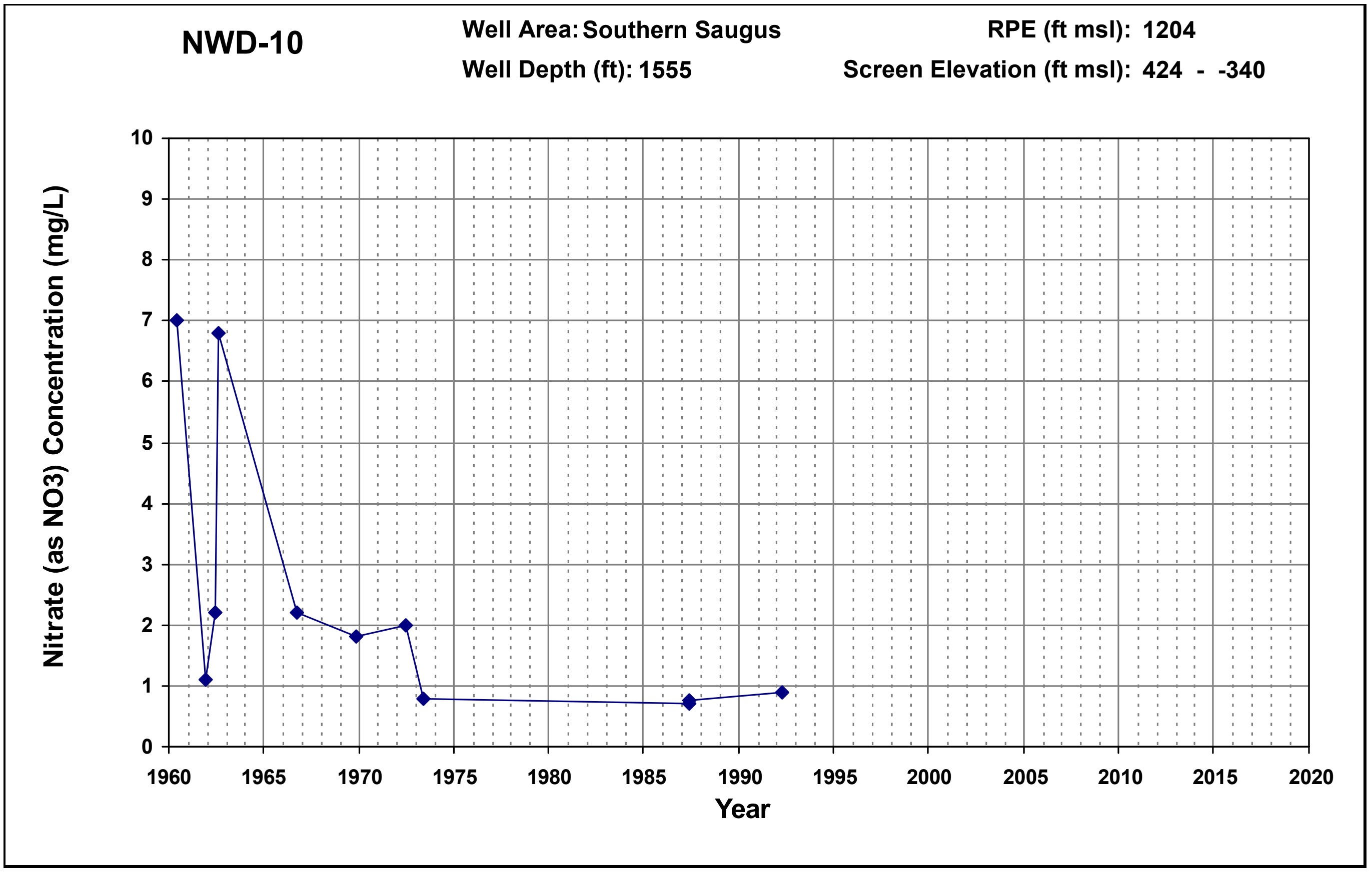
Well Area: San Francisquito Canyon
RPE (ft msl): 1201
Well Depth (ft): 140
Screen Elevation (ft msl): 1171 - 1066

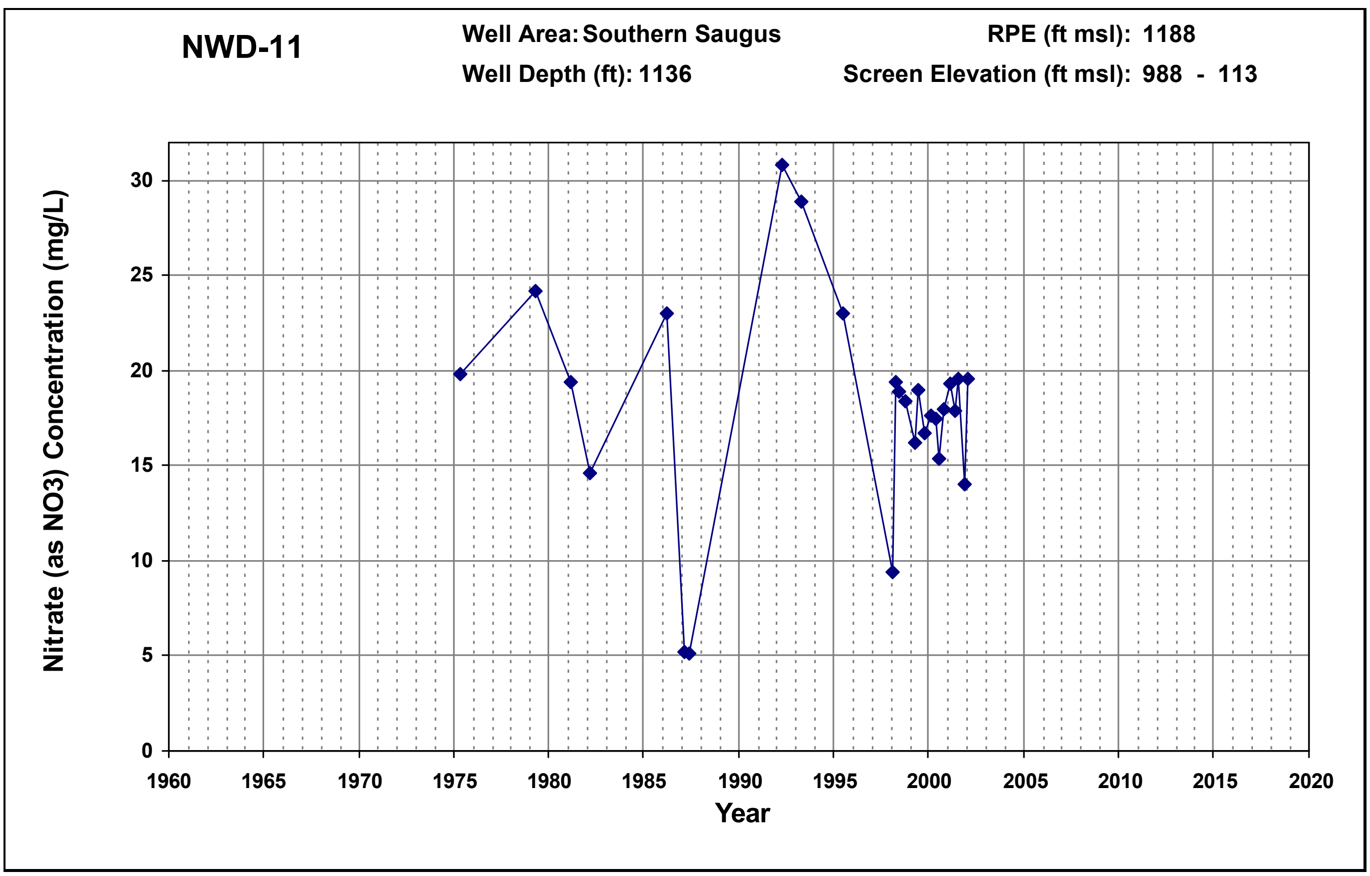


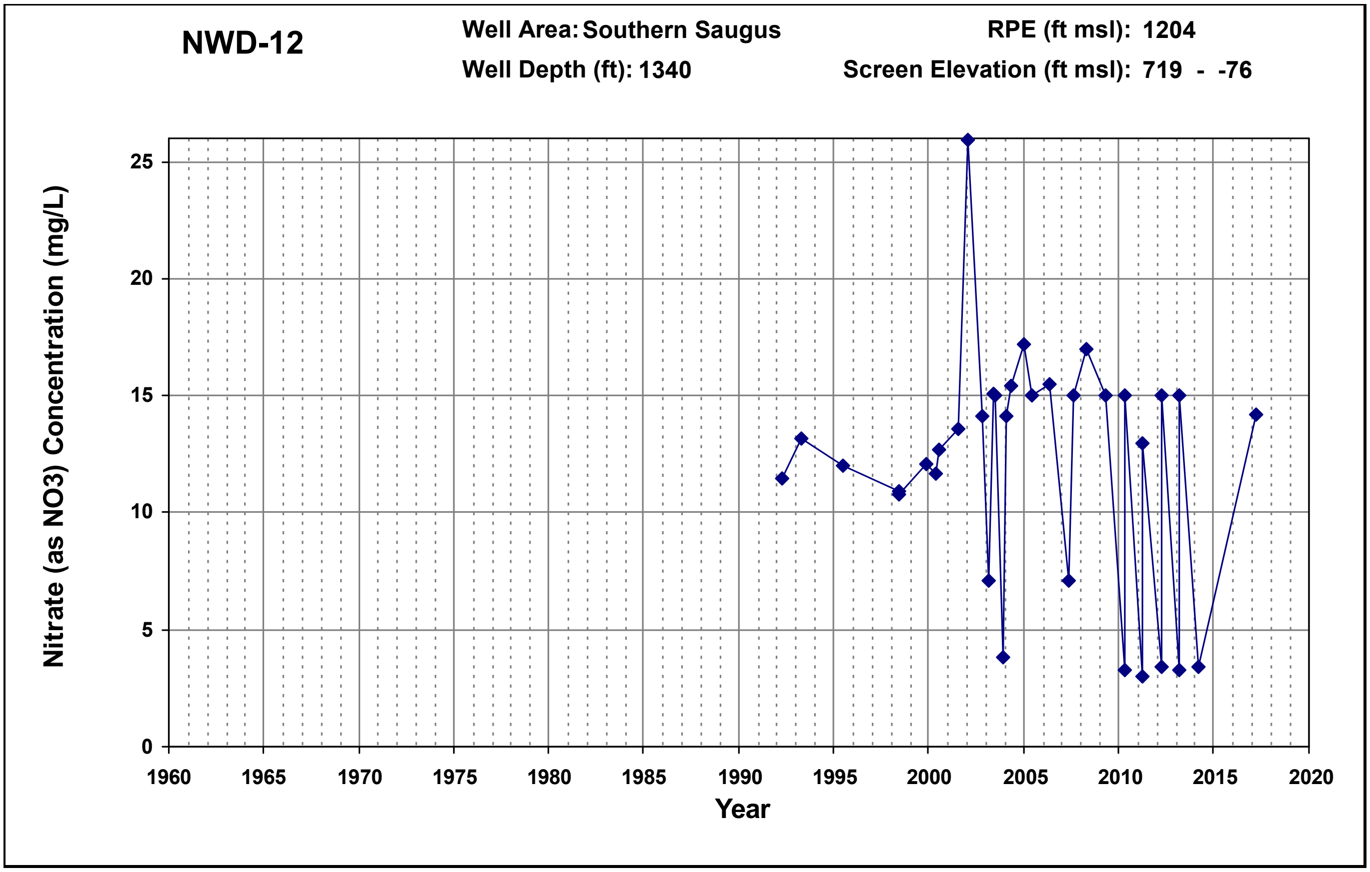
NWD-07

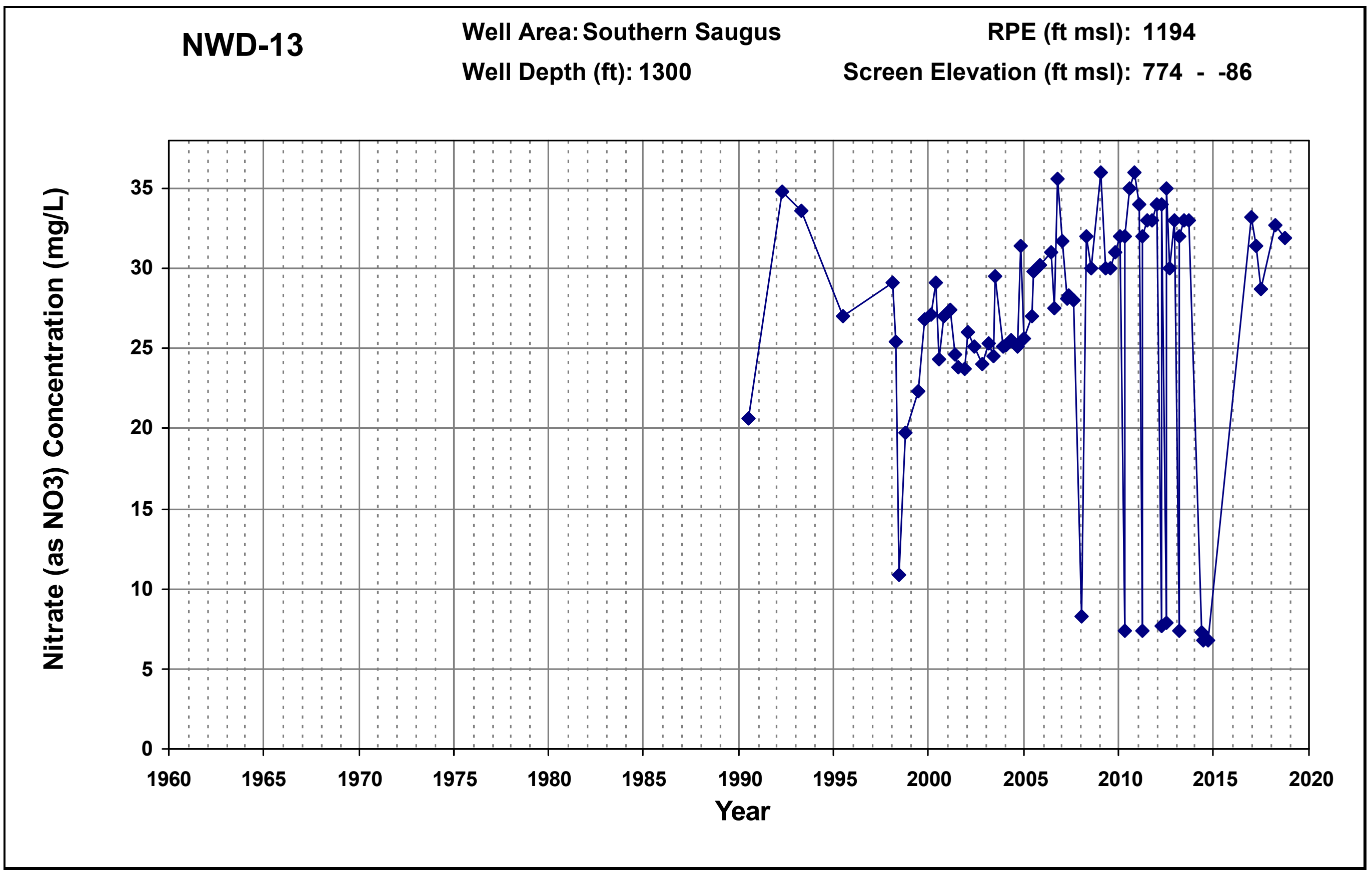
Well Area: Southern Saugus
RPE (ft msl): 1250
Well Depth (ft): 994
Screen Elevation (ft msl): 730 - 276

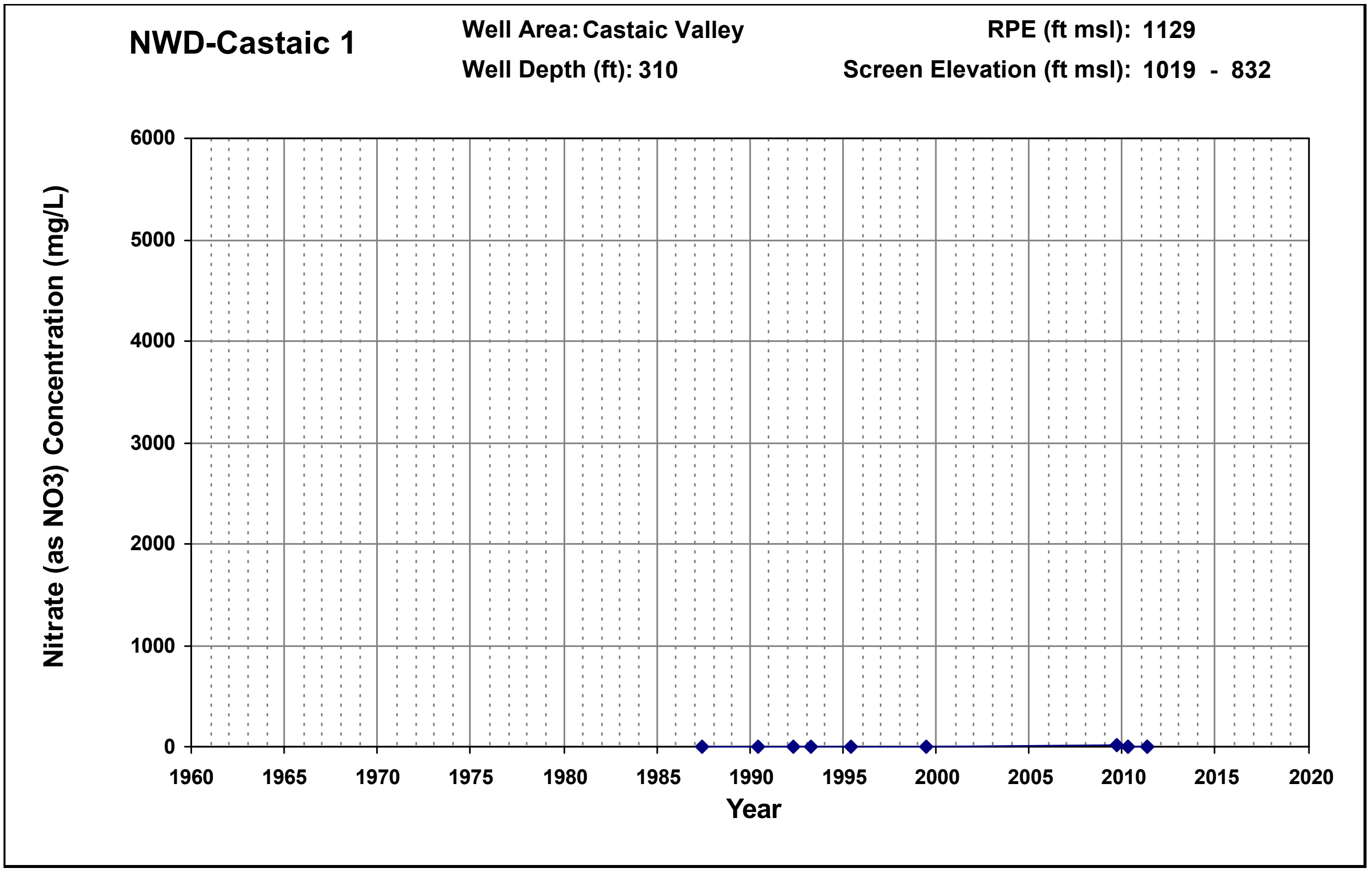


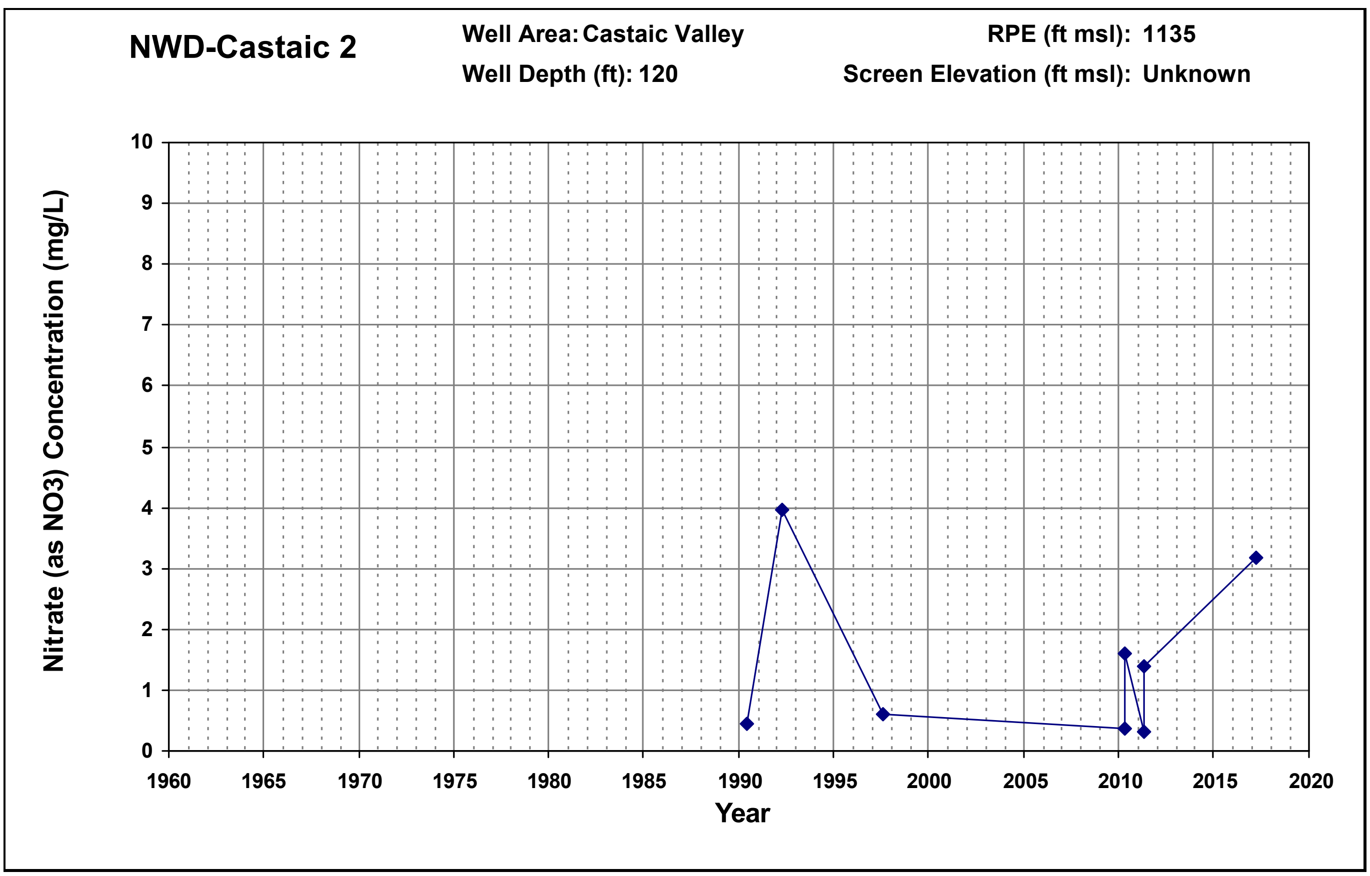

NWD-10
Well Area: Southern Saugus
Well Depth (ft): 1555
RPE (ft msl): 1204
Screen Elevation (ft msl): 424 - -340
Nitrate (as NO3) Concentration (mg/L)
Year
0
1
2
3
4
5
6
7
8
9
10
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

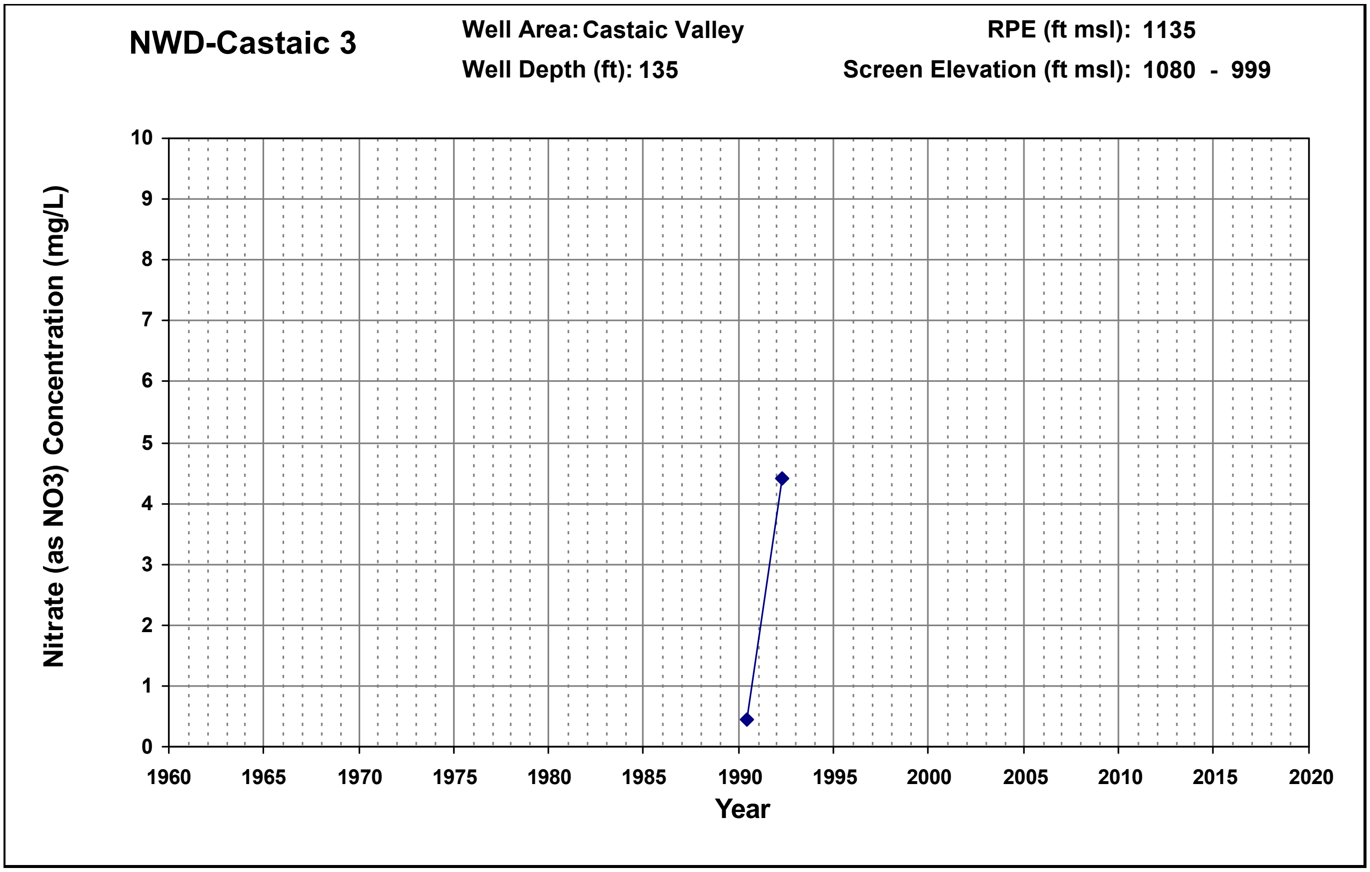

NWD-11
Well Area: Southern Saugus
Well Depth (ft): 1136
RPE (ft msl): 1188
Screen Elevation (ft msl): 988 - 113
Nitrate (as NO3) Concentration (mg/L)
Year
0
5
10
15
20
25
30
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

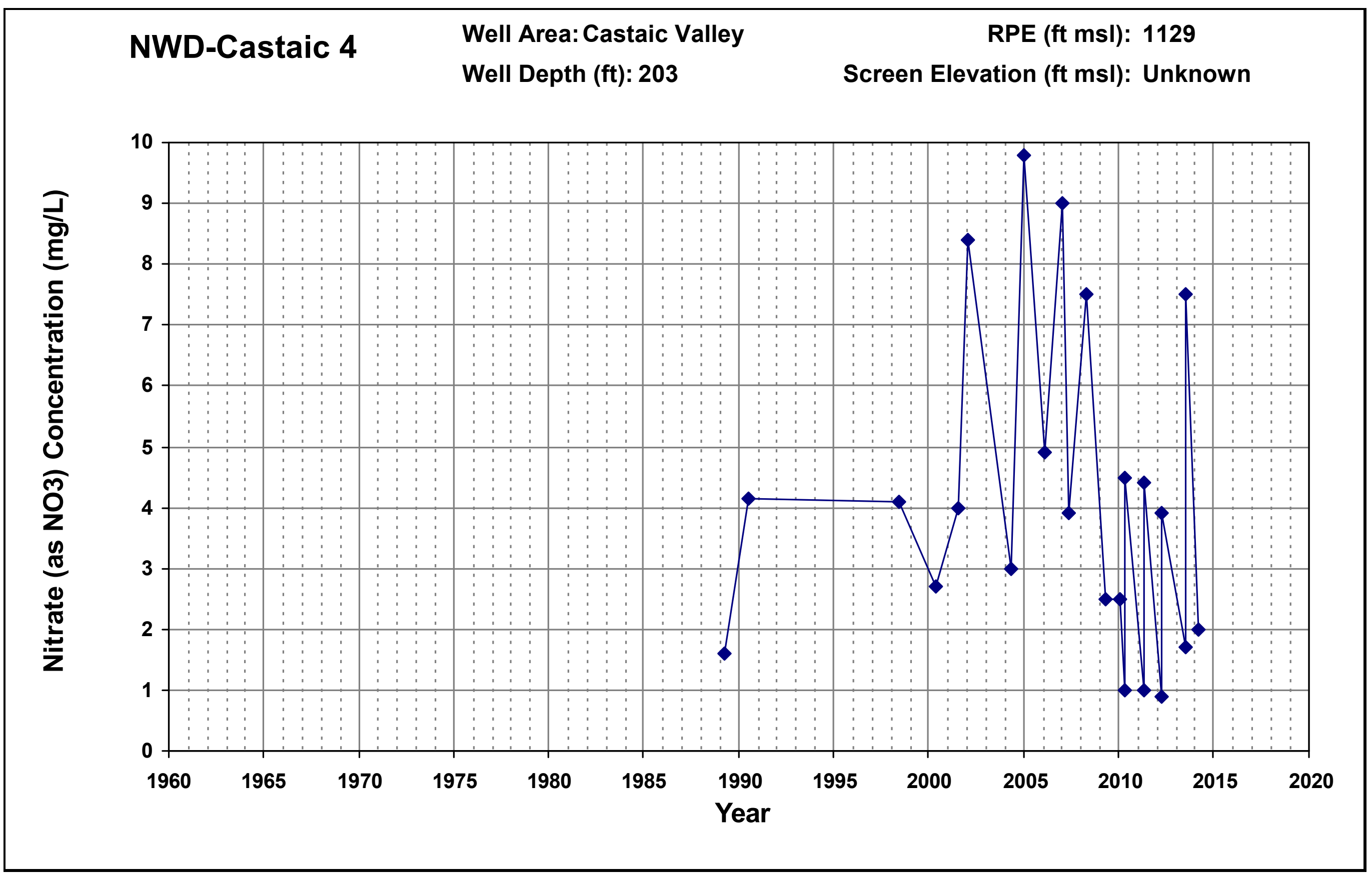

NWD-12
Well Area: Southern Saugus
RPE (ft msl): 1204
Well Depth (ft): 1340
Screen Elevation (ft msl): 719 - -76
Nitrate (as NO3) Concentration (mg/L)
Year

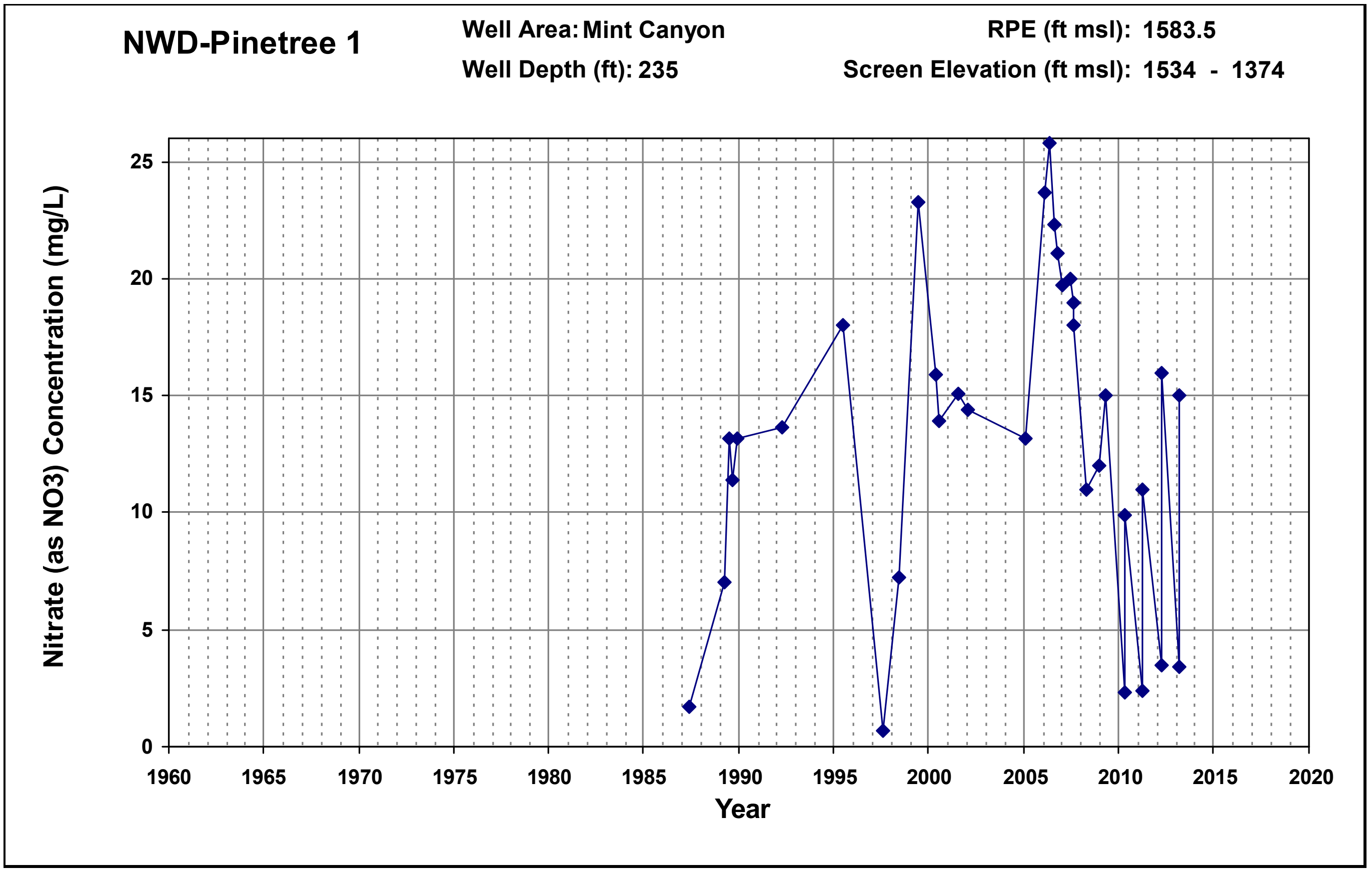

NWD-13
Well Area: Southern Saugus
RPE (ft msl): 1194
Well Depth (ft): 1300
Screen Elevation (ft msl): 774 - -86
Nitrate (as NO3) Concentration (mg/L)
Year

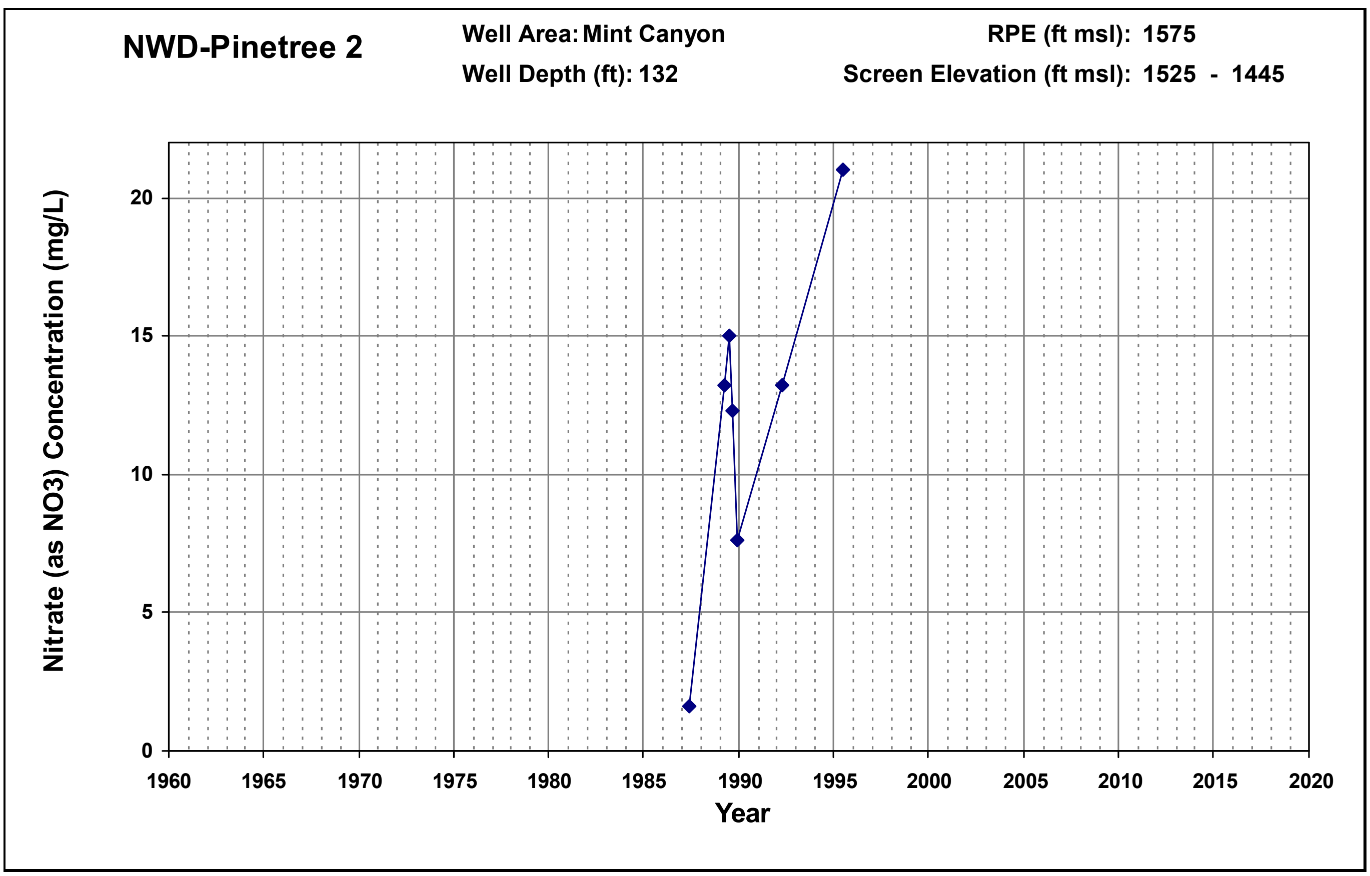

NWD-Castaic 1
Well Area: Castaic Valley
Well Depth (ft): 310
RPE (ft msl): 1129
Screen Elevation (ft msl): 1019 - 832
Nitrate (as NO3) Concentration (mg/L)
6000
5000
4000
3000
2000
1000
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

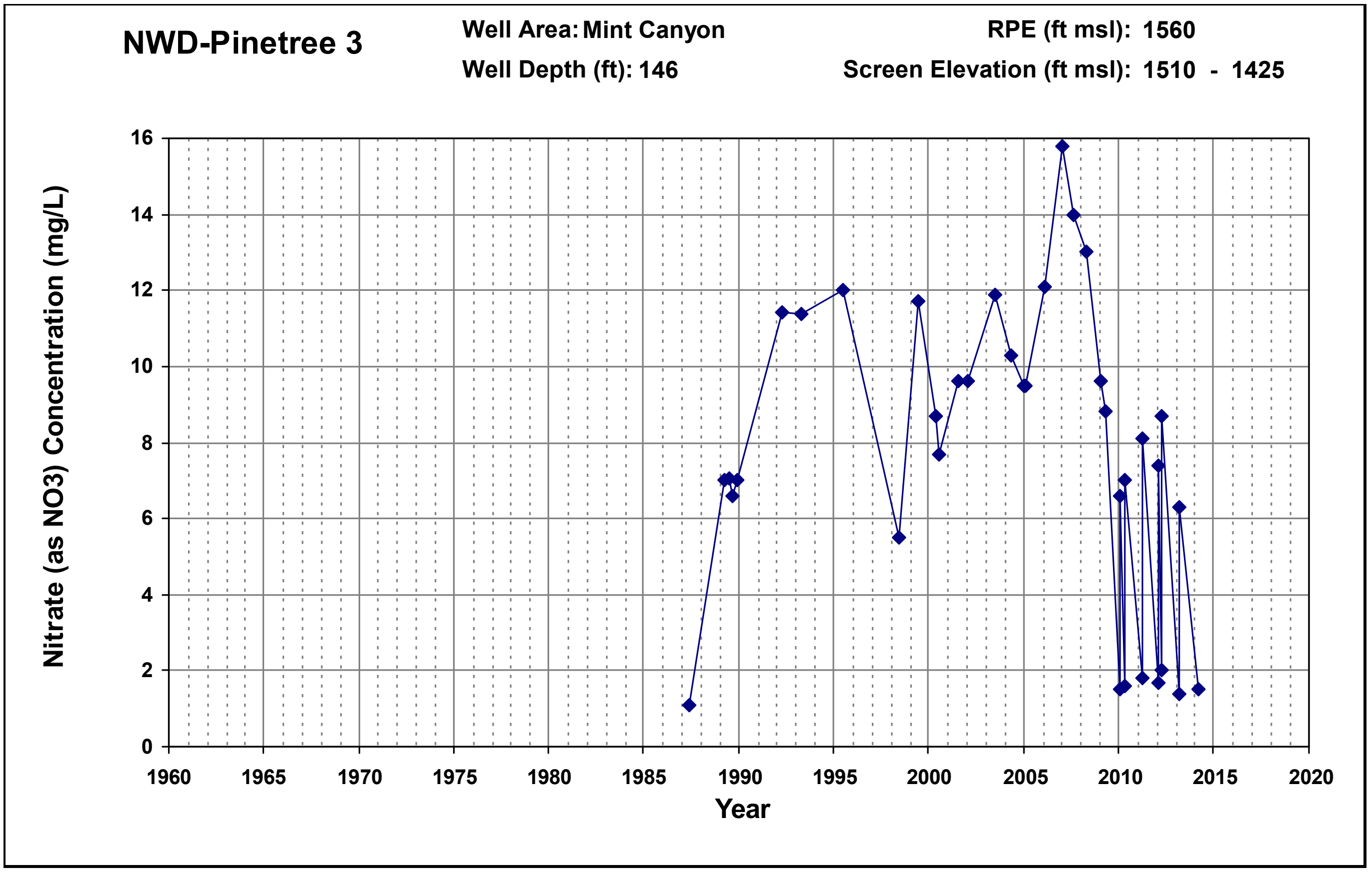

NWD-Castaic 2
Well Area: Castaic Valley
Well Depth (ft): 120
RPE (ft msl): 1135
Screen Elevation (ft msl): Unknown
Nitrate (as NO3) Concentration (mg/L)
10
9
8
7
6
5
4
3
2
1
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year


NWD-Castaic 3
Well Area: Castaic Valley
Well Depth (ft): 135
RPE (ft msl): 1135
Screen Elevation (ft msl): 1080 - 999
Nitrate (as NO3) Concentration (mg/L)
0
1
2
3
4
5
6
7
8
9
10
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

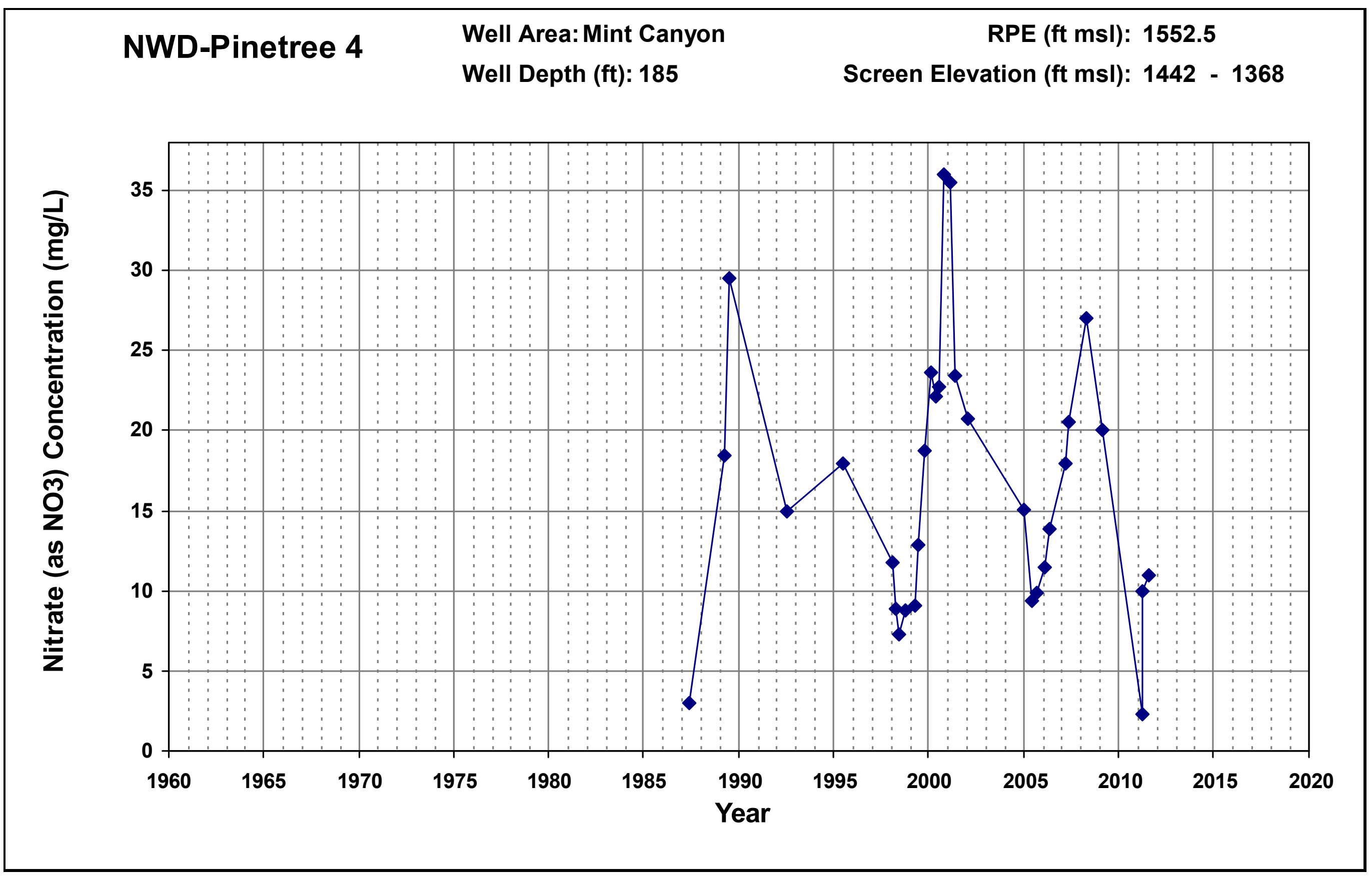

NWD-Castaic 4
Well Area: Castaic Valley
Well Depth (ft): 203
RPE (ft msl): 1129
Screen Elevation (ft msl): Unknown
Nitrate (as NO3) Concentration (mg/L)
0
1
2
3
4
5
6
7
8
9
10
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year


NWD-Pinetree 1
Well Area: Mint Canyon
Well Depth (ft): 235
RPE (ft msl): 1583.5
Screen Elevation (ft msl): 1534 - 1374
Nitrate (as NO3) Concentration (mg/L)
Year
0
5
10
15
20
25
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

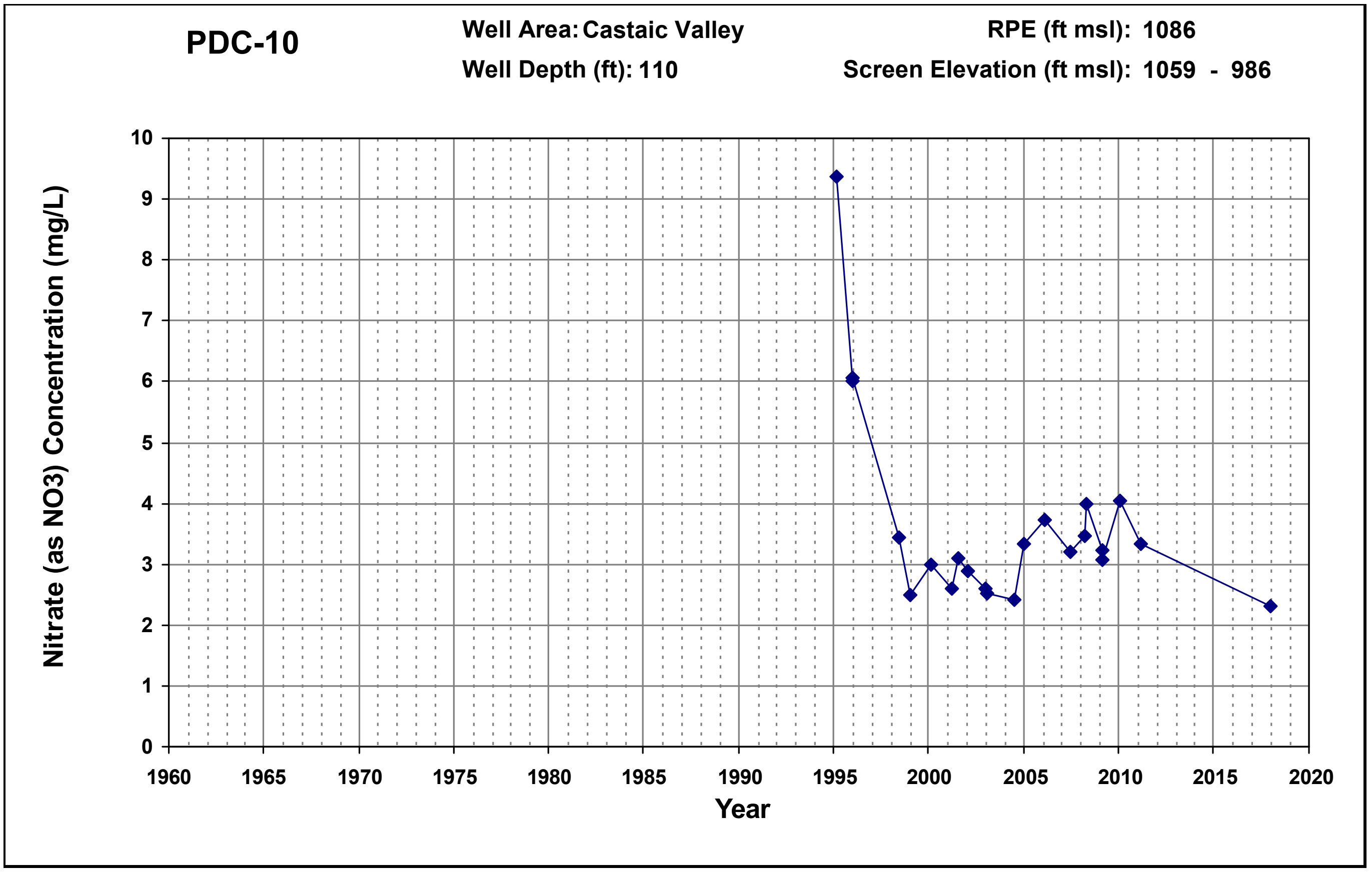

NWD-Pinetree 2
Well Area: Mint Canyon
Well Depth (ft): 132
RPE (ft msl): 1575
Screen Elevation (ft msl): 1525 - 1445
Nitrate (as NO3) Concentration (mg/L)
Year
0
5
10
15
20
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

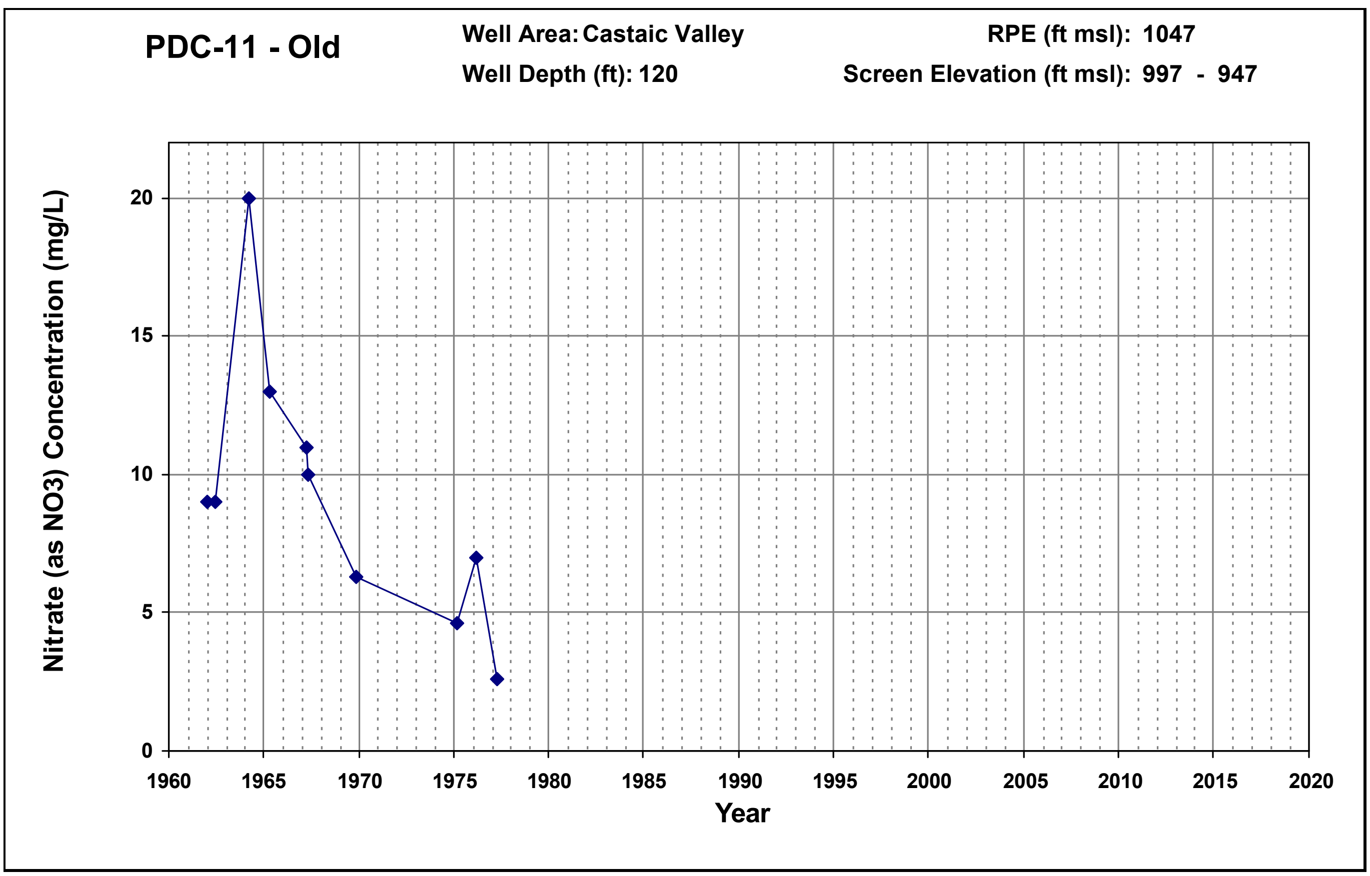


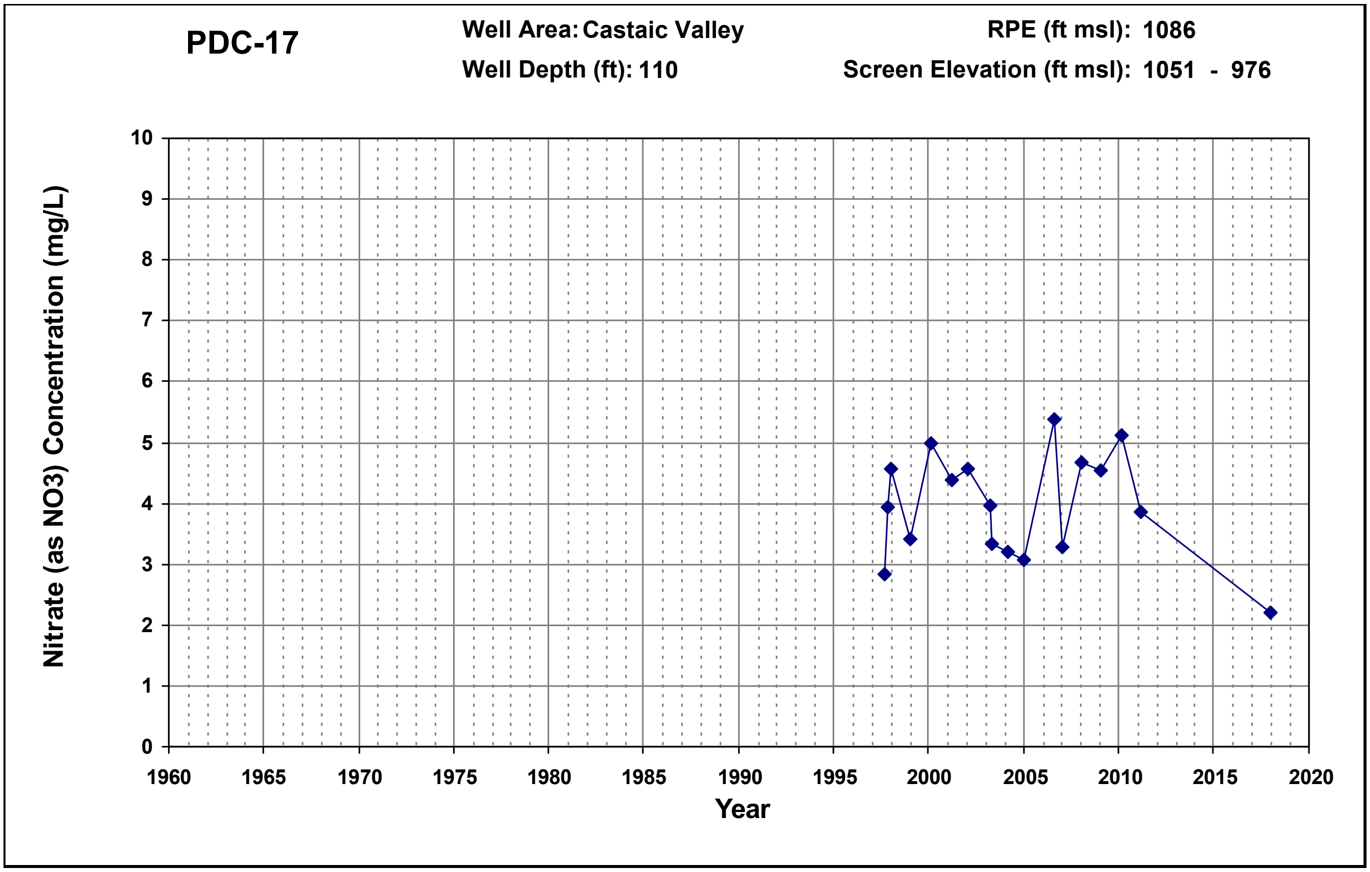
NWD-Pinetree 3
Well Area: Mint Canyon
Well Depth (ft): 146
RPE (ft msl): 1560
Screen Elevation (ft msl): 1510 - 1425
Nitrate (as NO3) Concentration (mg/L)
0
2
4
6
8
10
12
14
16
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

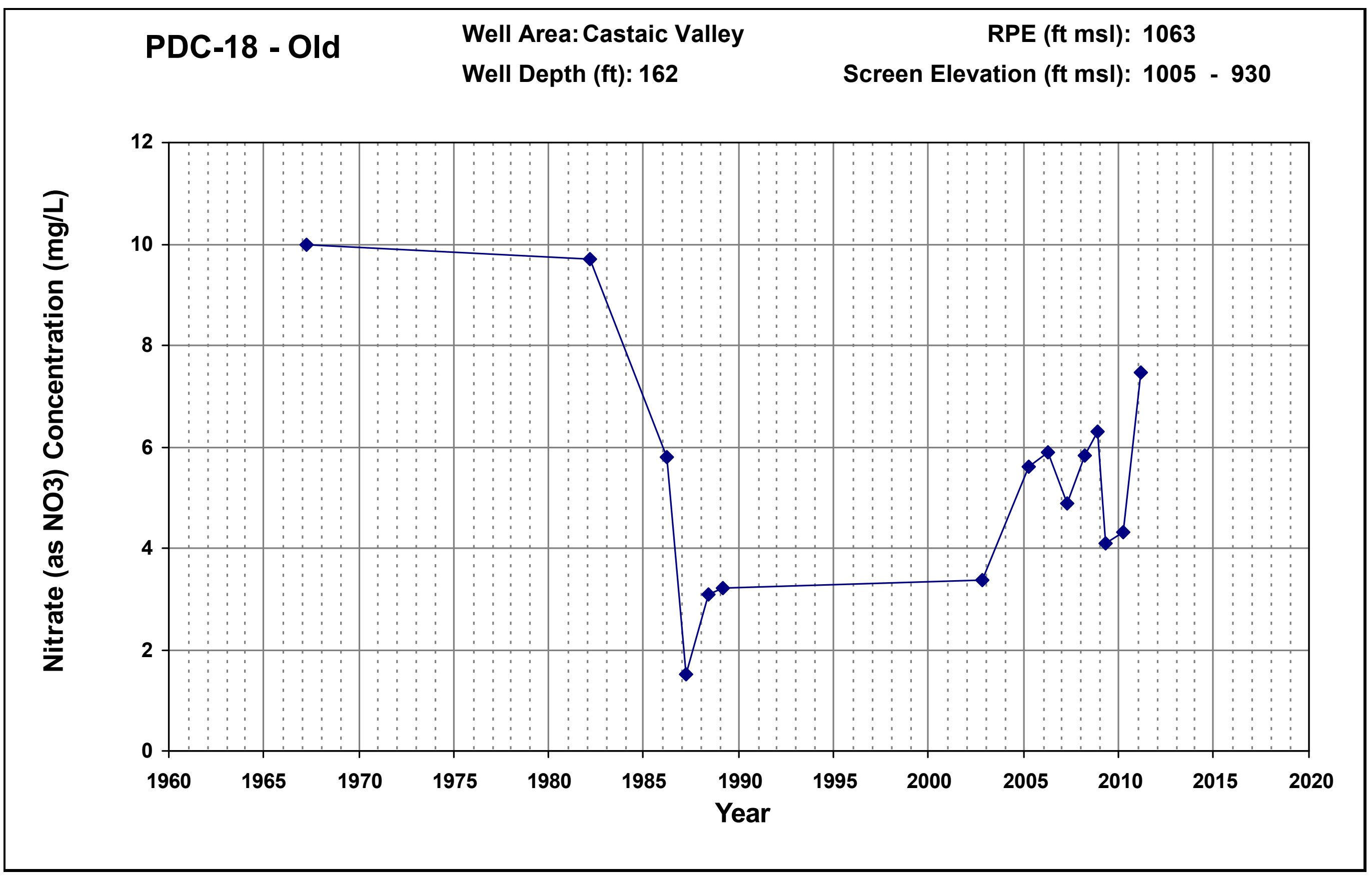


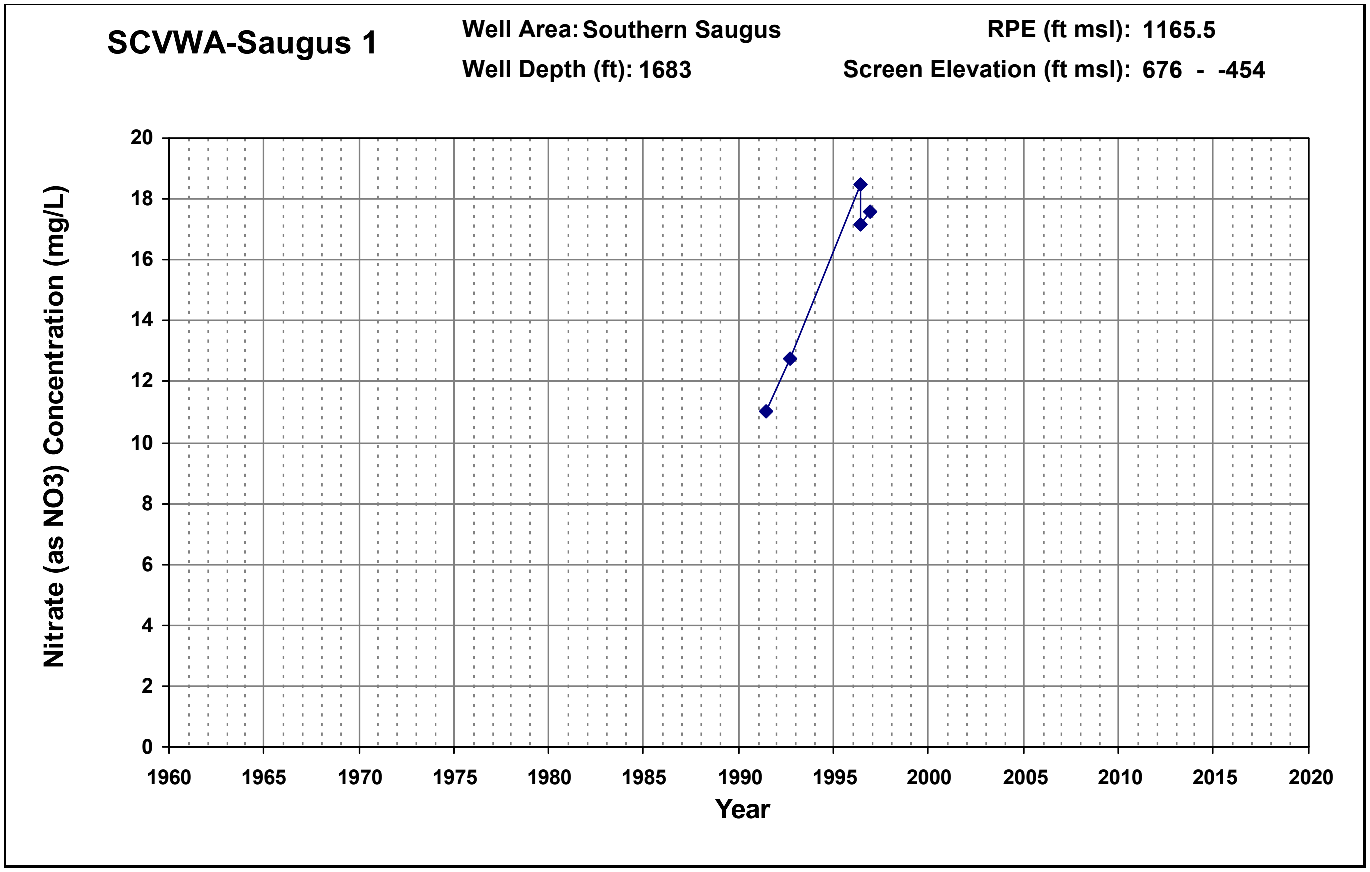
NWD-Pinetree 4
Well Area: Mint Canyon
Well Depth (ft): 185
RPE (ft msl): 1552.5
Screen Elevation (ft msl): 1442 - 1368
Nitrate (as NO3) Concentration (mg/L)
0
5
10
15
20
25
30
35
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

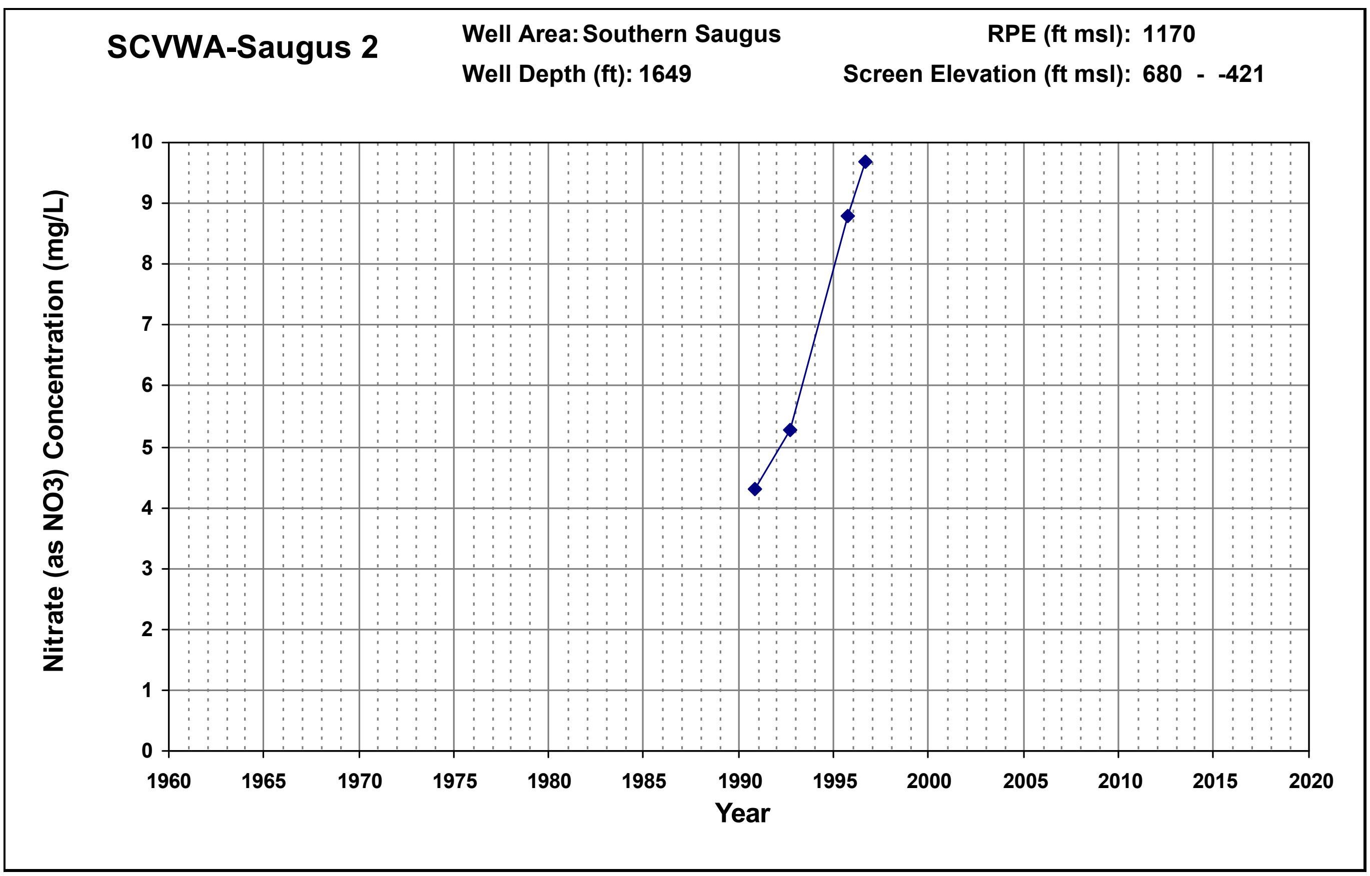

PDC-10
Well Area: Castaic Valley
Well Depth (ft): 110
RPE (ft msl): 1086
Screen Elevation (ft msl): 1059 - 986
Nitrate (as NO3) Concentration (mg/L)
Year
0
1
2
3
4
5
6
7
8
9
10
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

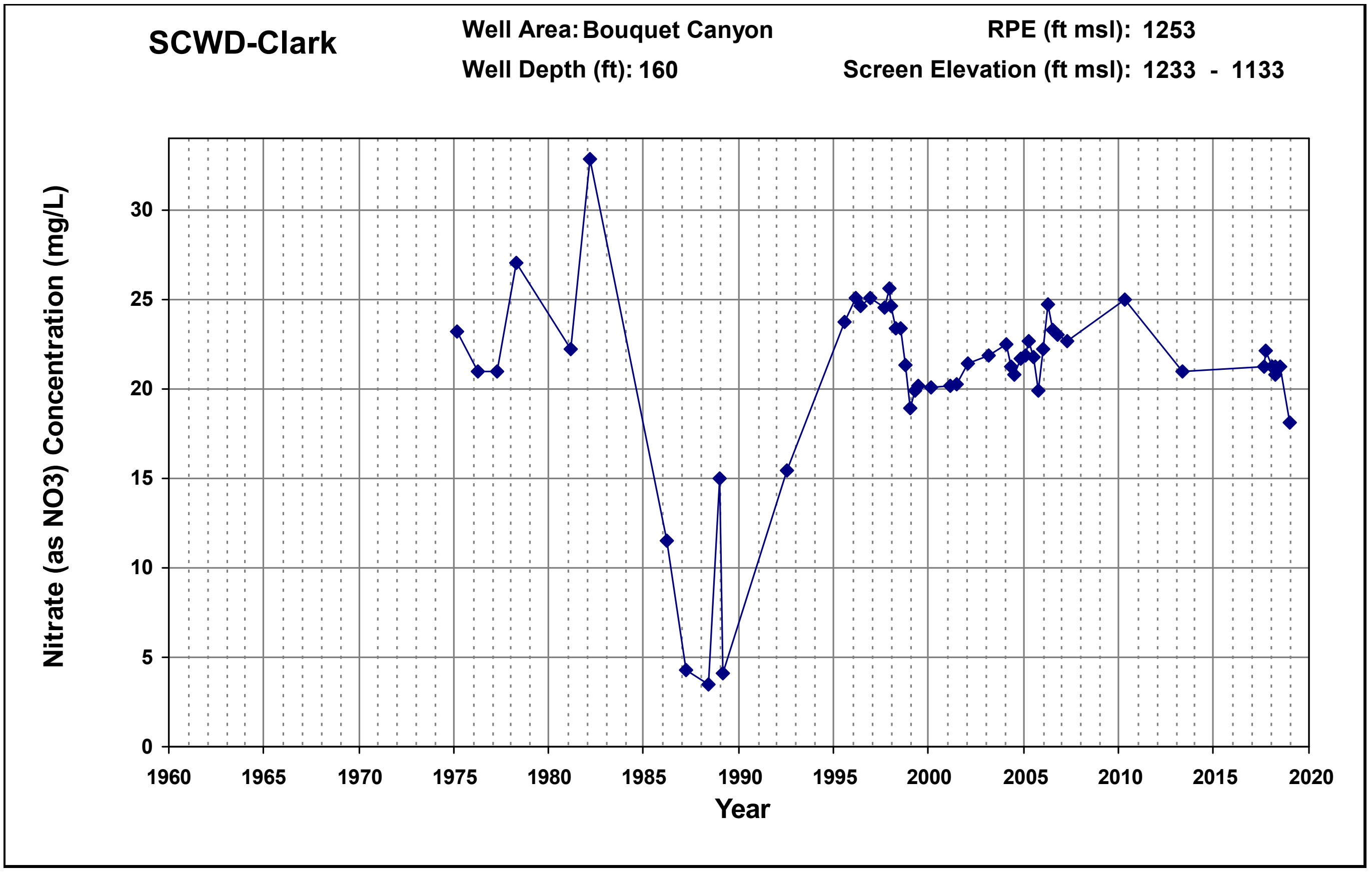

PDC-11 - Old
Well Area: Castaic Valley
Well Depth (ft): 120
RPE (ft msl): 1047
Screen Elevation (ft msl): 997 - 947
Nitrate (as NO3) Concentration (mg/L)
Year
0
5
10
15
20
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020


PDC-17
Well Area: Castaic Valley
Well Depth (ft): 110
RPE (ft msl): 1086
Screen Elevation (ft msl): 1051 - 976
Nitrate (as NO3) Concentration (mg/L)
Year
0
1
2
3
4
5
6
7
8
9
10
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

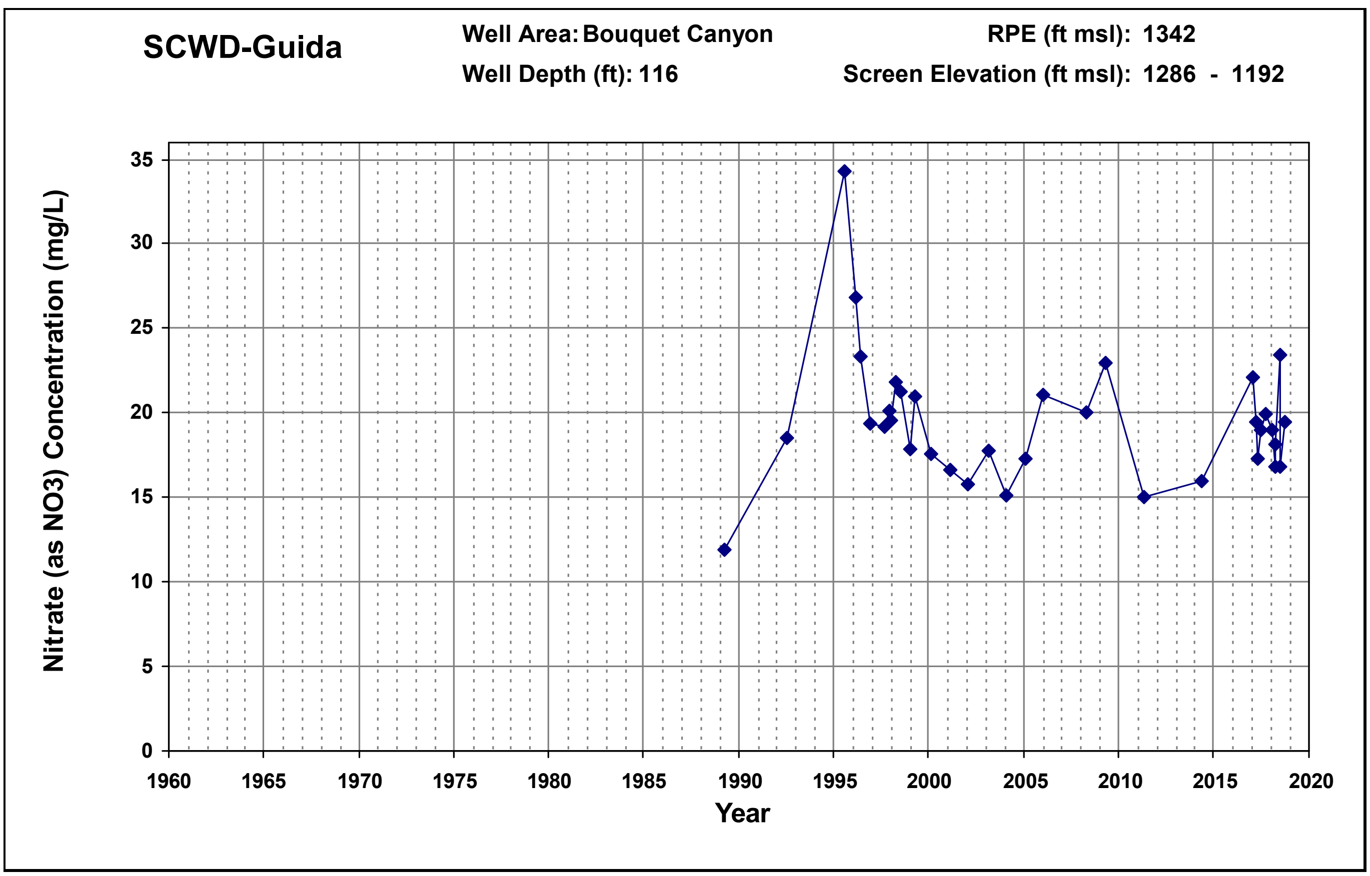

PDC-18 - Old
Well Area: Castaic Valley
Well Depth (ft): 162
RPE (ft msl): 1063
Screen Elevation (ft msl): 1005 - 930
Nitrate (as NO3) Concentration (mg/L)
Year
0
2
4
6
8
10
12
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020


SCVWA-Saugus 1
Well Area: Southern Saugus
Well Depth (ft): 1683
RPE (ft msl): 1165.5
Screen Elevation (ft msl): 676 - -454
Nitrate (as NO3) Concentration (mg/L)
Year
0
2
4
6
8
10
12
14
16
18
20
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020


SCVWA-Saugus 2
Well Area: Southern Saugus
Well Depth (ft): 1649
RPE (ft msl): 1170
Screen Elevation (ft msl): 680 - -421
Nitrate (as NO3) Concentration (mg/L)
Year
0
1
2
3
4
5
6
7
8
9
10
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020



SCWD-Clark
Well Area: Bouquet Canyon
Well Depth (ft): 160
RPE (ft msl): 1253
Screen Elevation (ft msl): 1233 - 1133
Nitrate (as NO3) Concentration (mg/L)
0
5
10
15
20
25
30
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year



SCWD-Guida
Well Area: Bouquet Canyon
Well Depth (ft): 116
RPE (ft msl): 1342
Screen Elevation (ft msl): 1286 - 1192
Nitrate (as NO3) Concentration (mg/L)
0
5
10
15
20
25
30
35
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

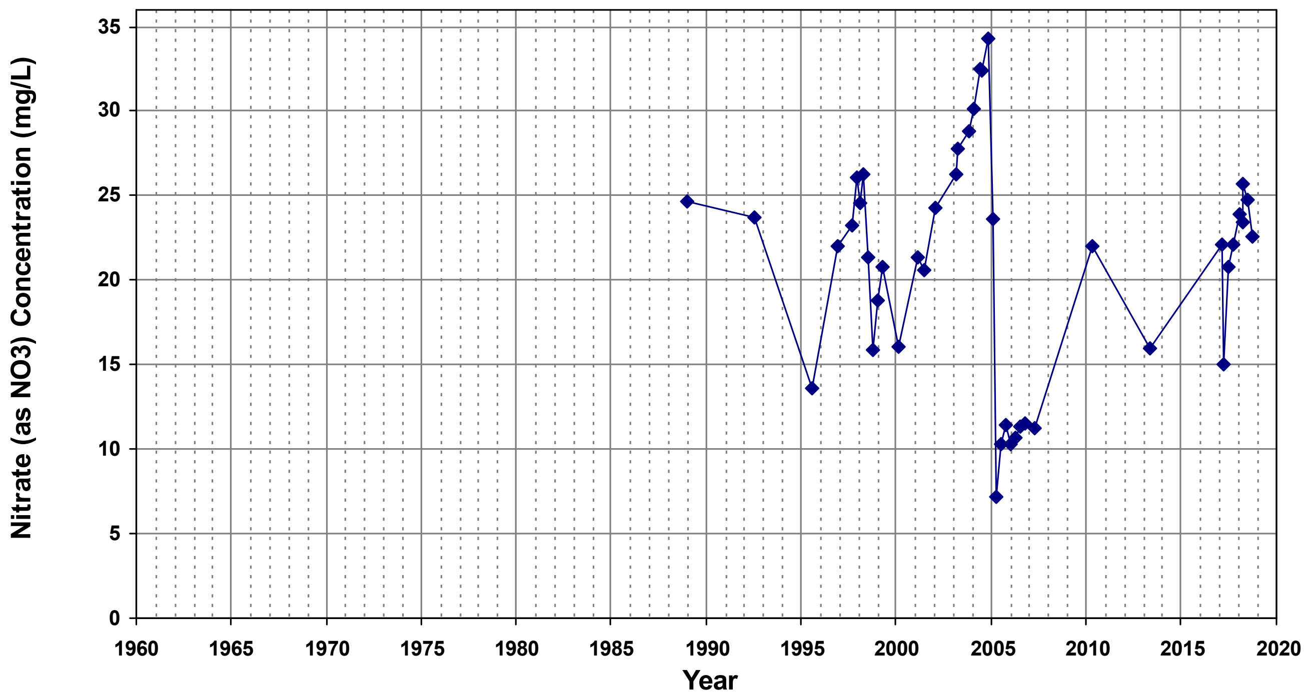
SCWD-Honby

Well Area: Above Saugus WRP

RPE (ft msl): 1280

Well Depth (ft): 202

Screen Elevation (ft msl): 1230 - 1078



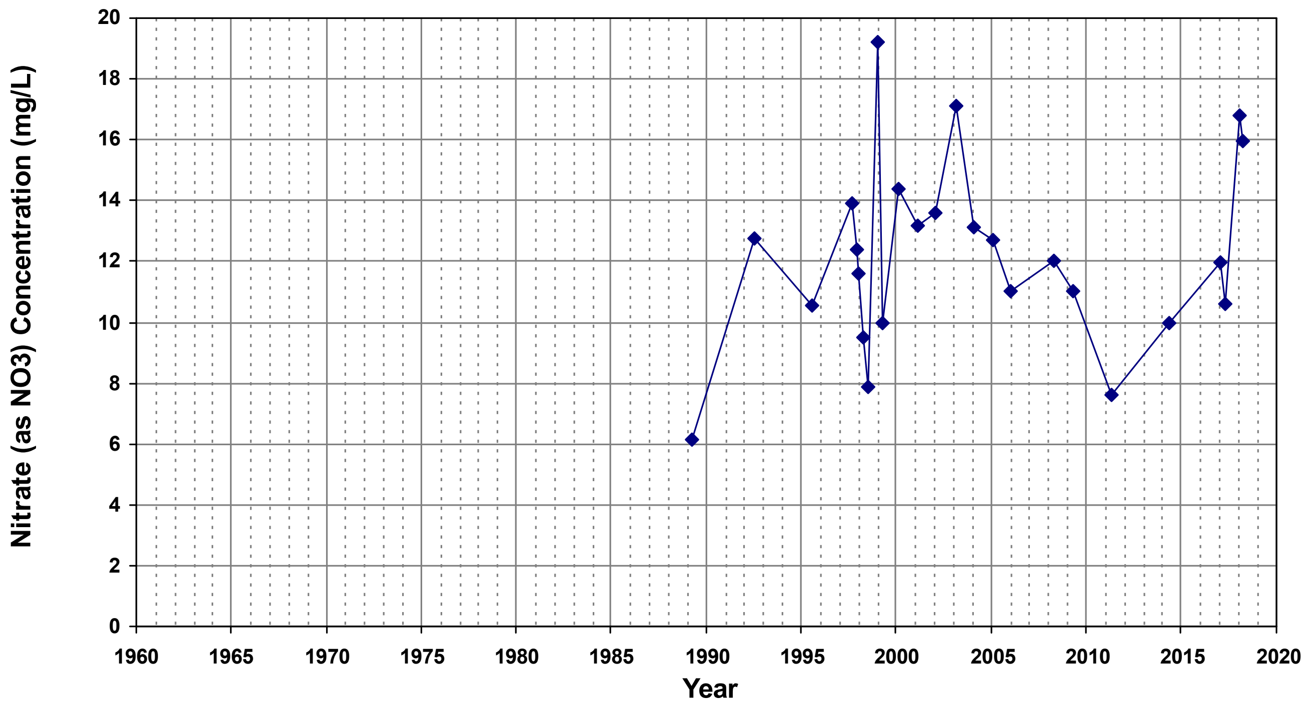
SCWD-Lost Canyon 2

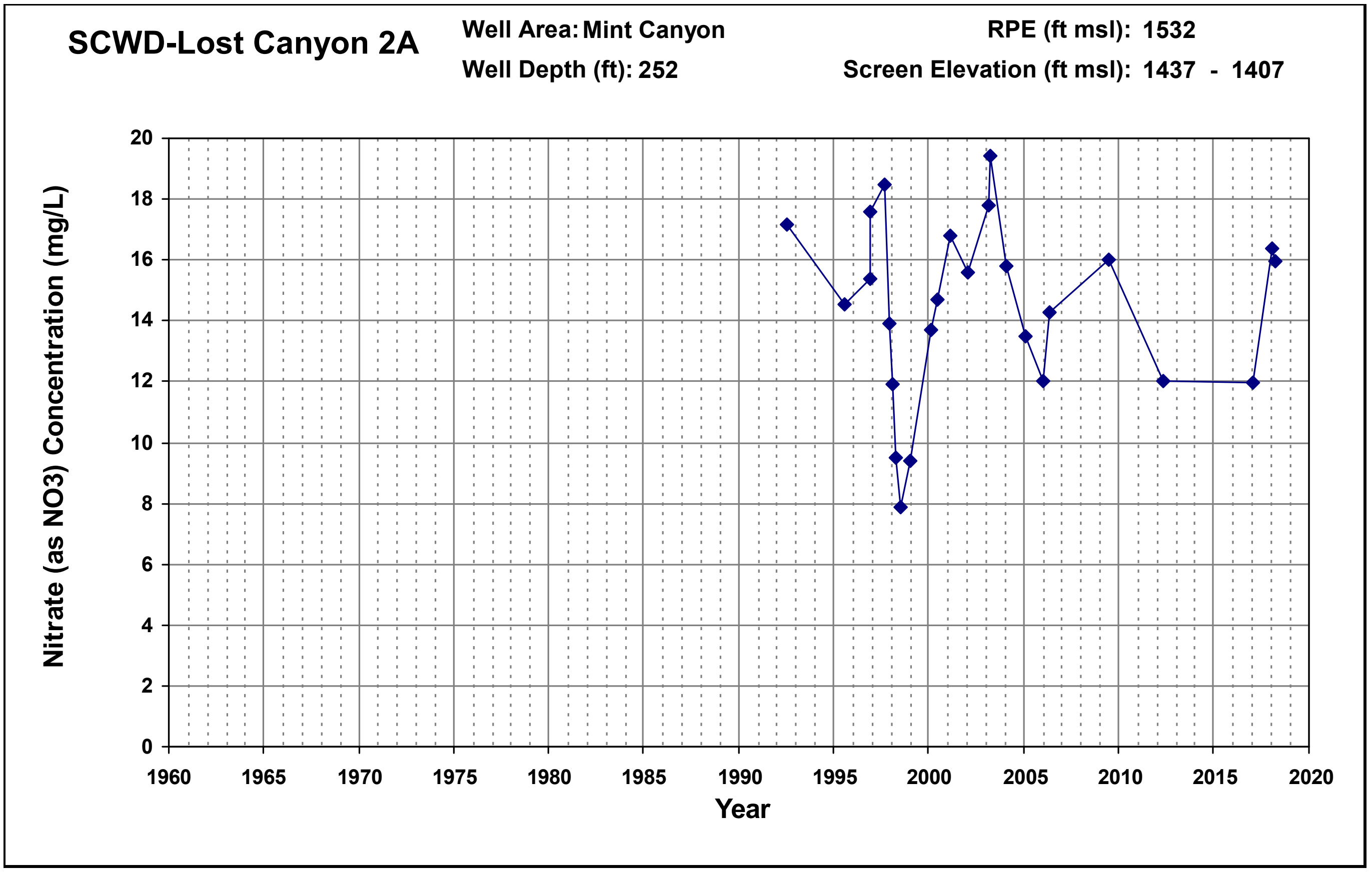
Well Area: Mint Canyon

RPE (ft msl): 1532

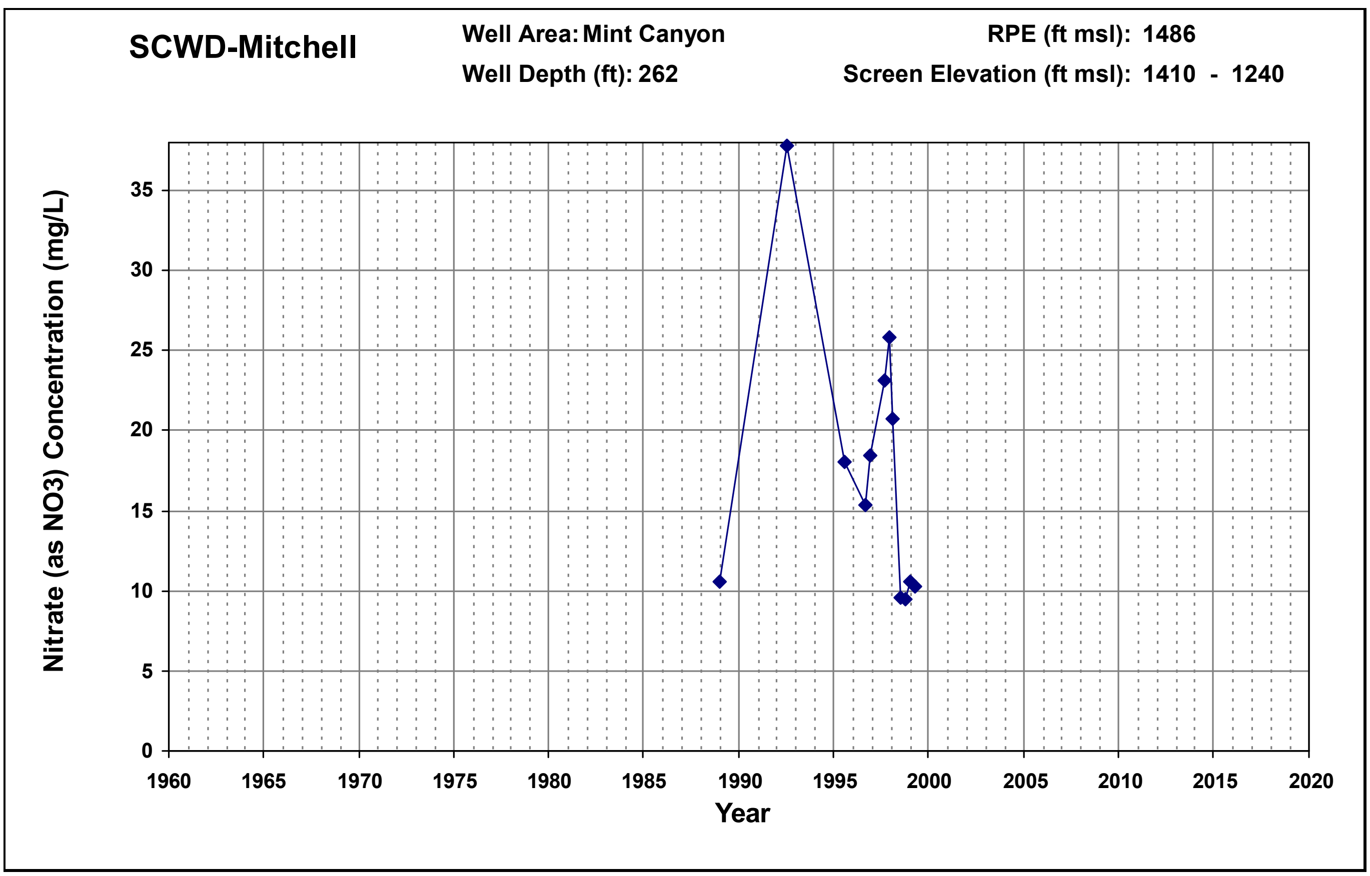
Well Depth (ft): 310

Screen Elevation (ft msl): 1437 - 1407

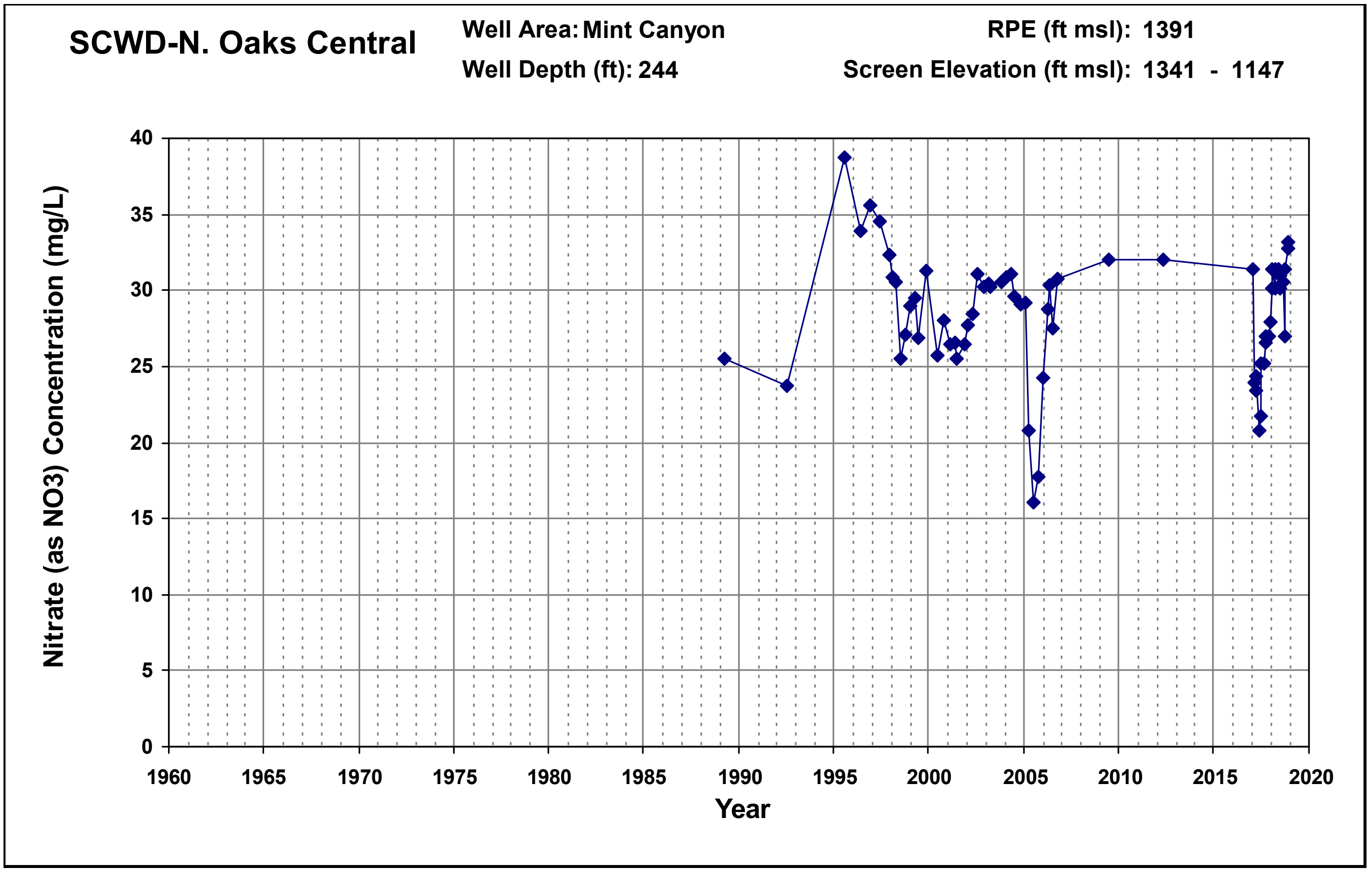


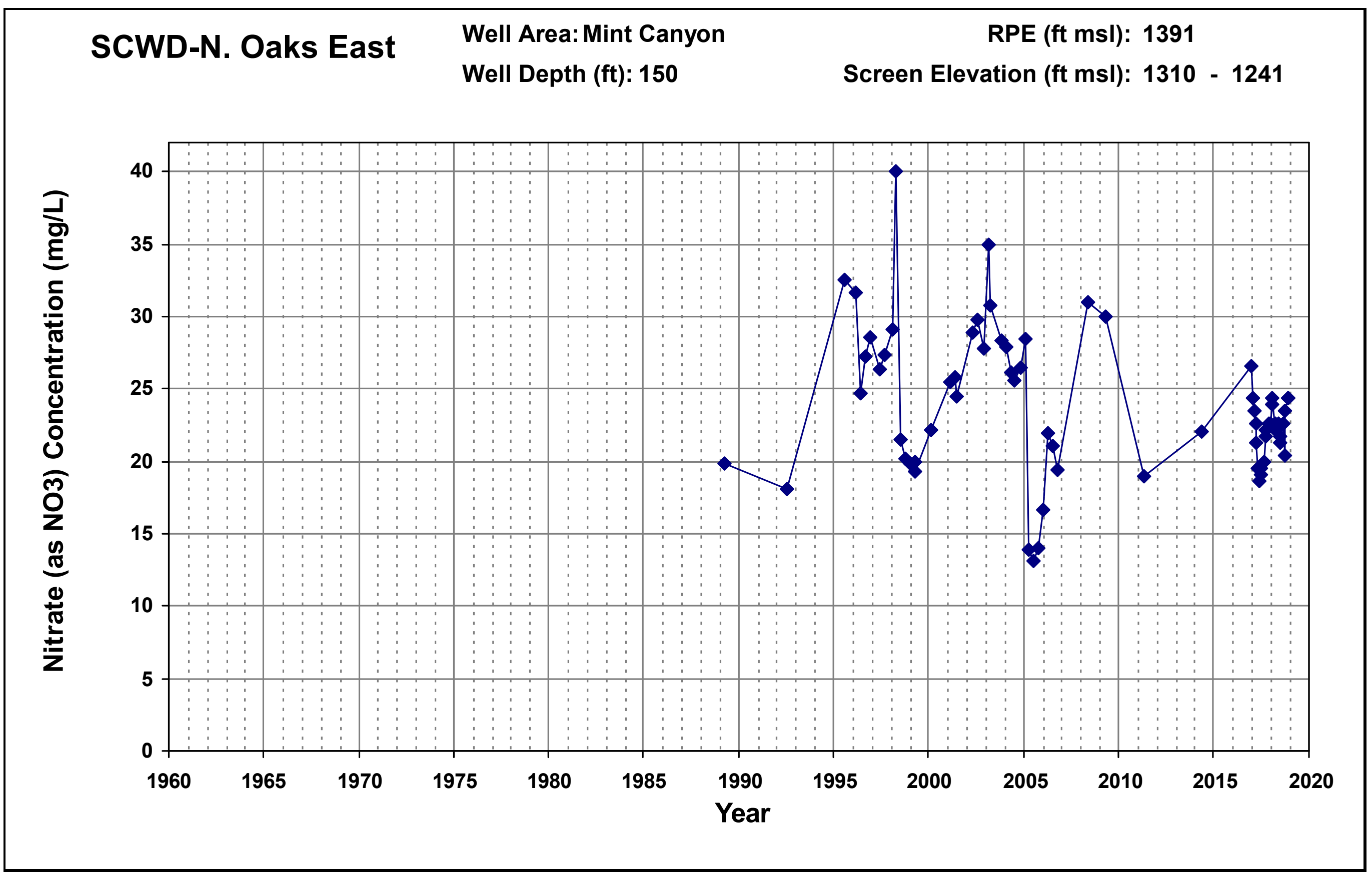


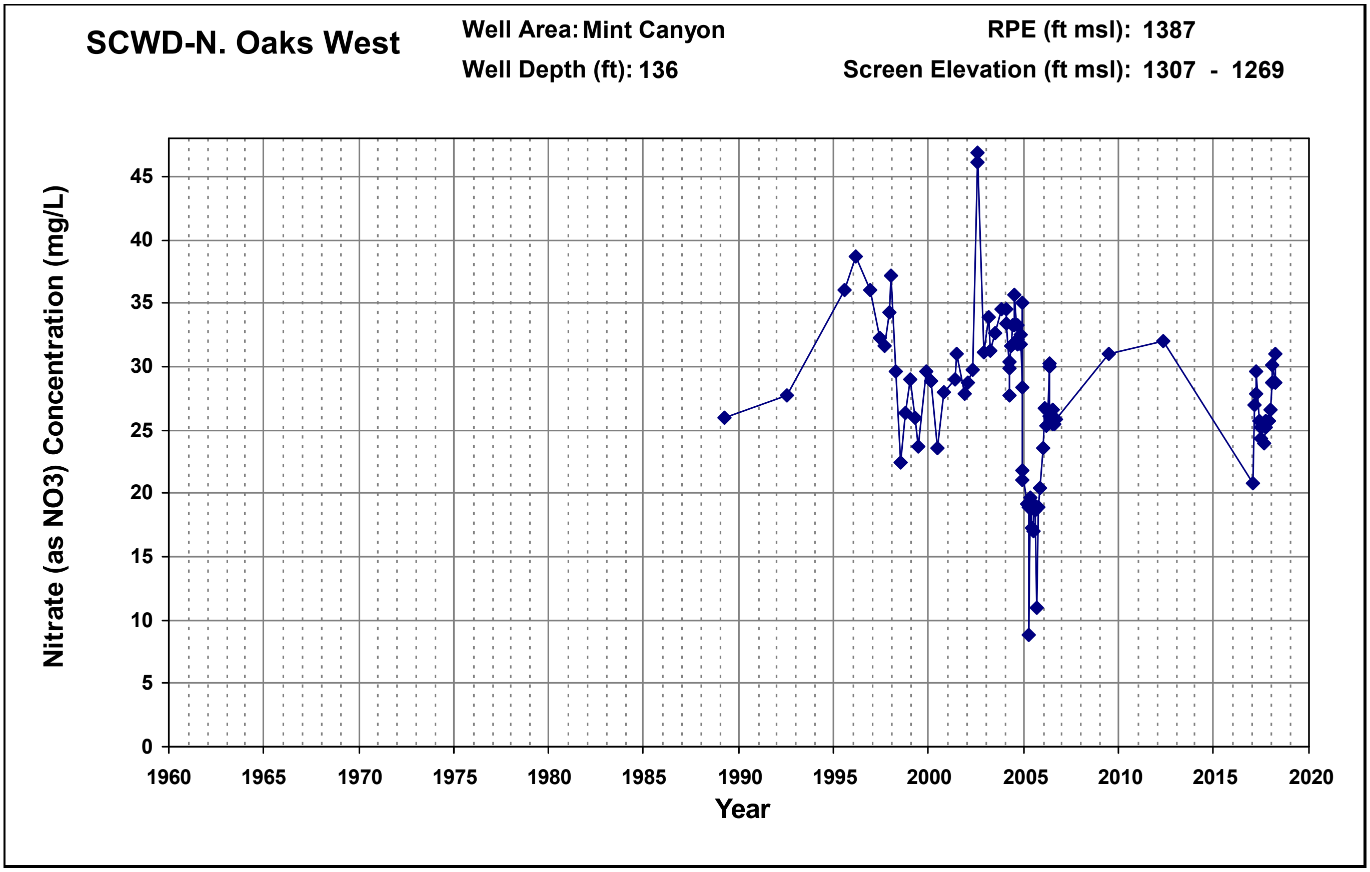
SCWD-Lost Canyon 2A
Well Area: Mint Canyon
Well Depth (ft): 252
RPE (ft msl): 1532
Screen Elevation (ft msl): 1437 - 1407
Nitrate (as NO3) Concentration (mg/L)
0
2
4
6
8
10
12
14
16
18
20
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

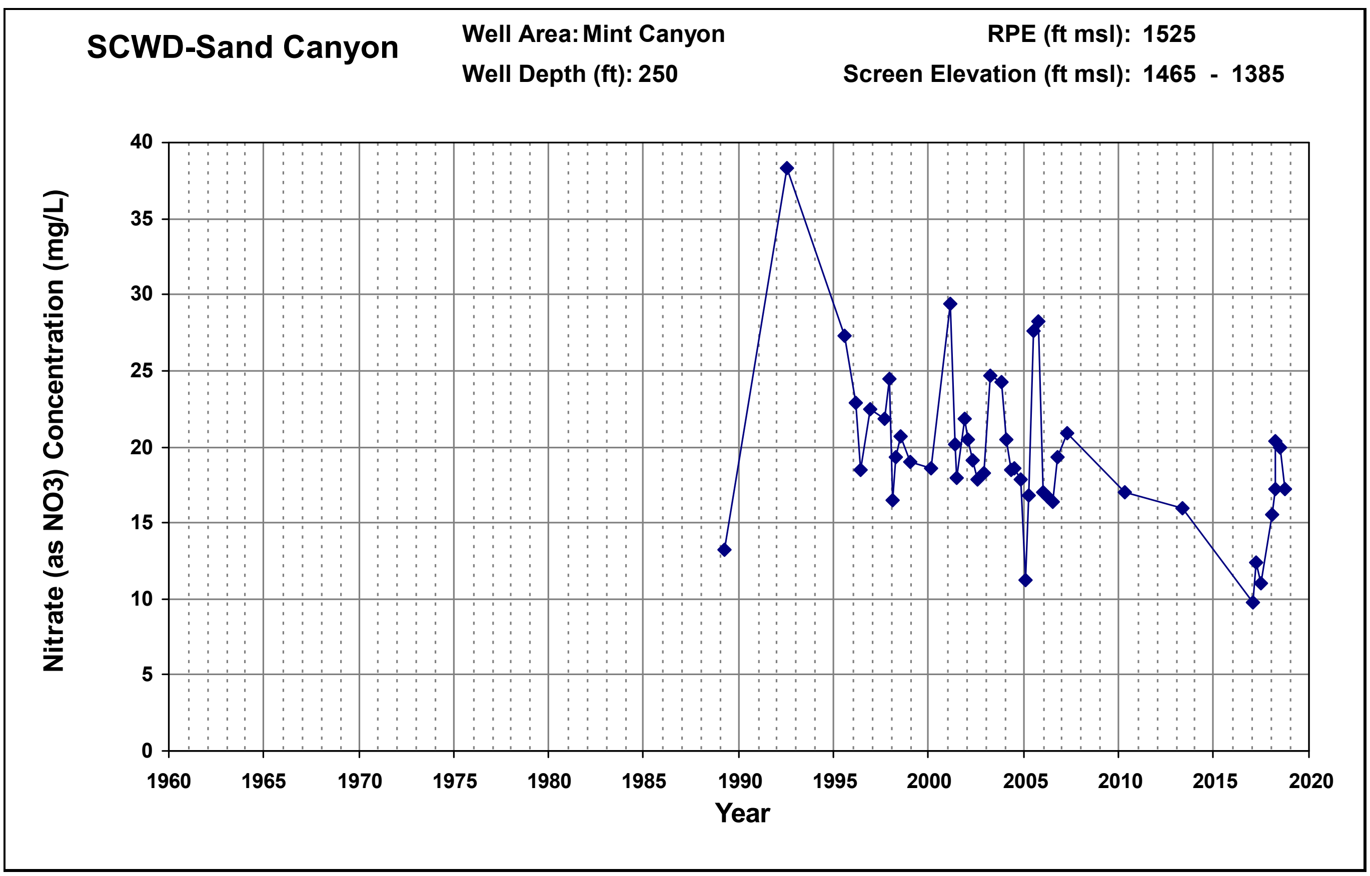


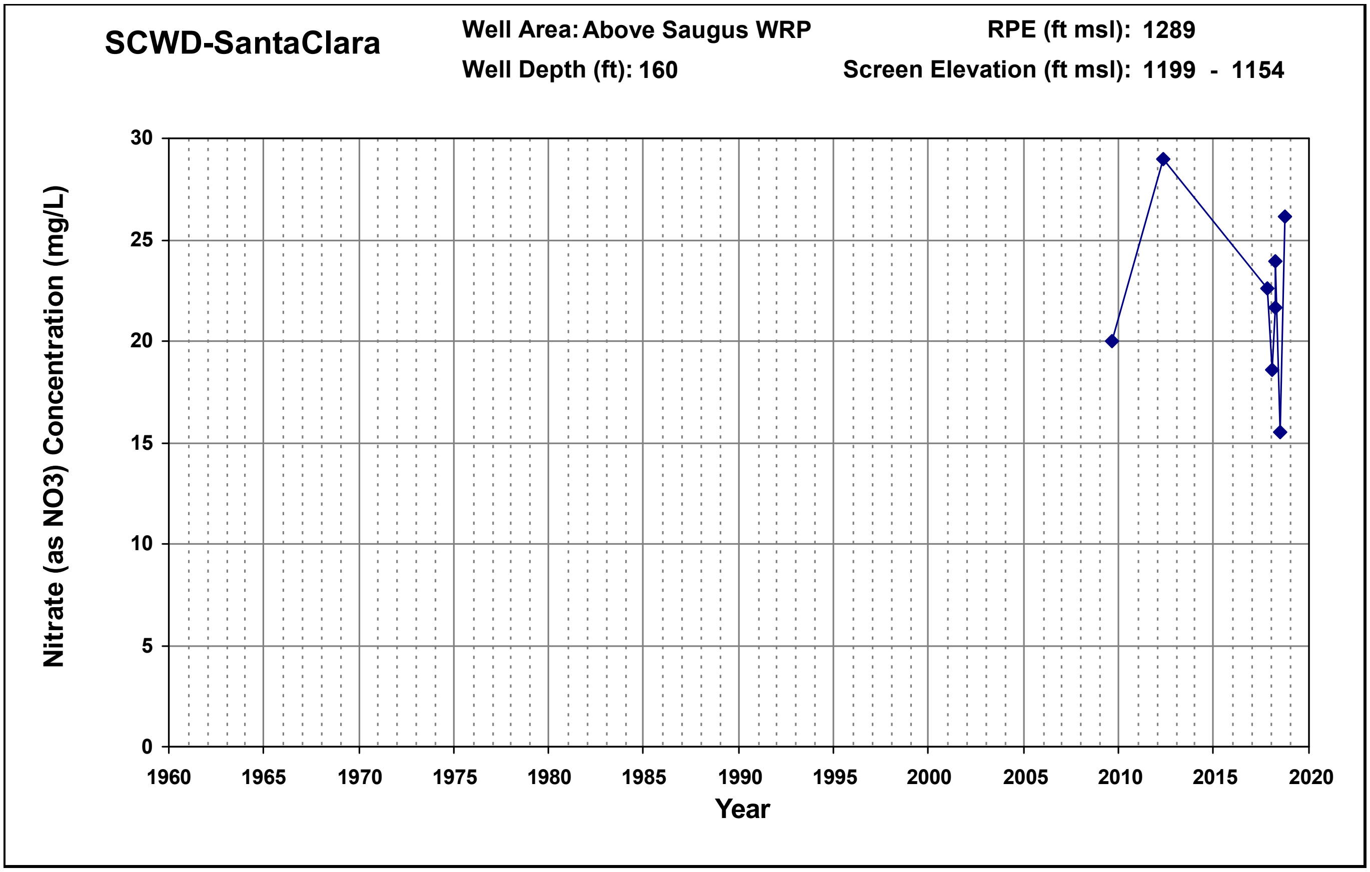
SCWD-Mitchell
Well Area: Mint Canyon
Well Depth (ft): 262
RPE (ft msl): 1486
Screen Elevation (ft msl): 1410 - 1240
Nitrate (as NO3) Concentration (mg/L)
0
5
10
15
20
25
30
35
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

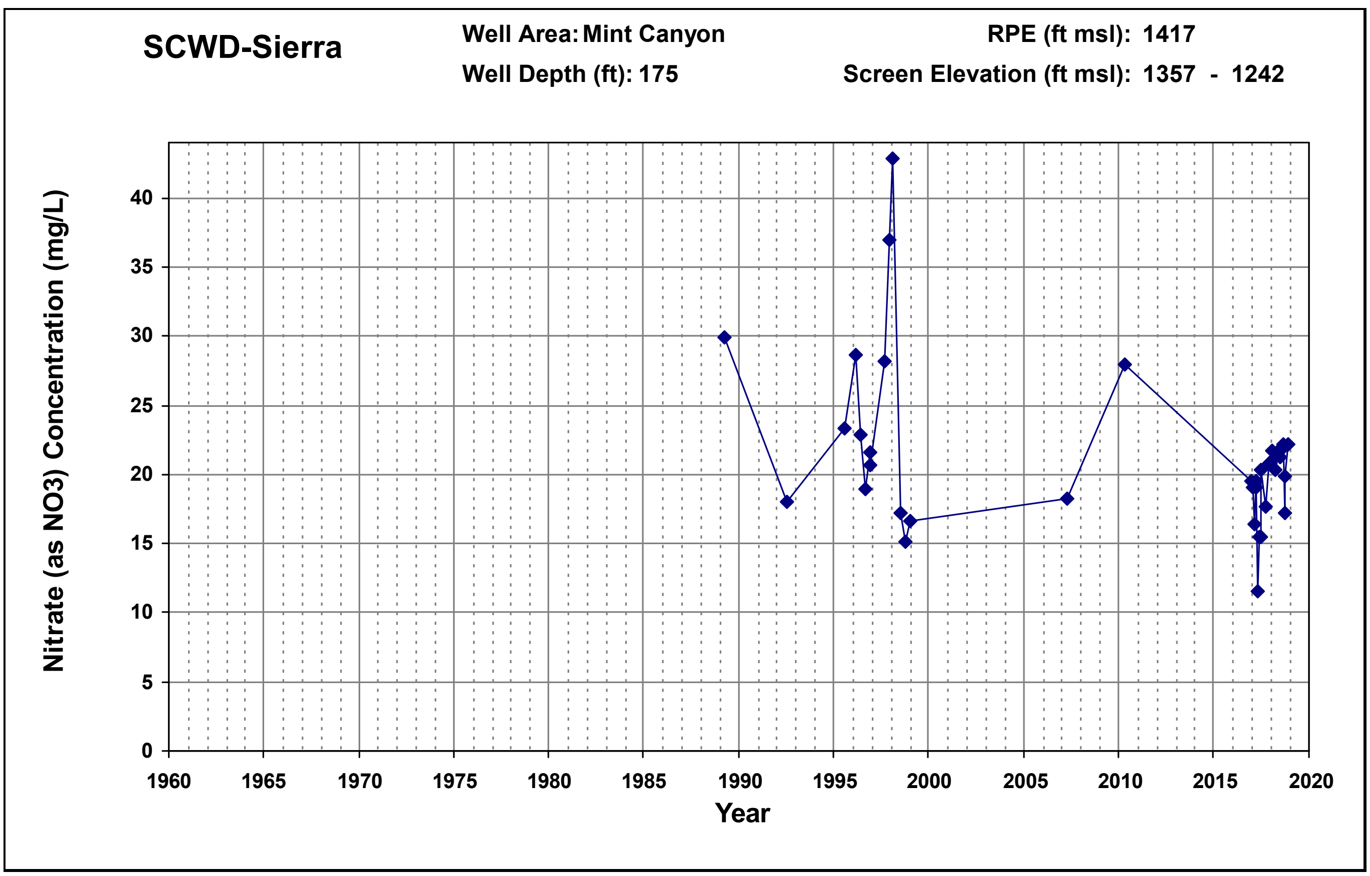

SCWD-N. Oaks Central
Well Area: Mint Canyon
Well Depth (ft): 244
RPE (ft msl): 1391
Screen Elevation (ft msl): 1341 - 1147
Nitrate (as NO3) Concentration (mg/L)
0
5
10
15
20
25
30
35
40
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

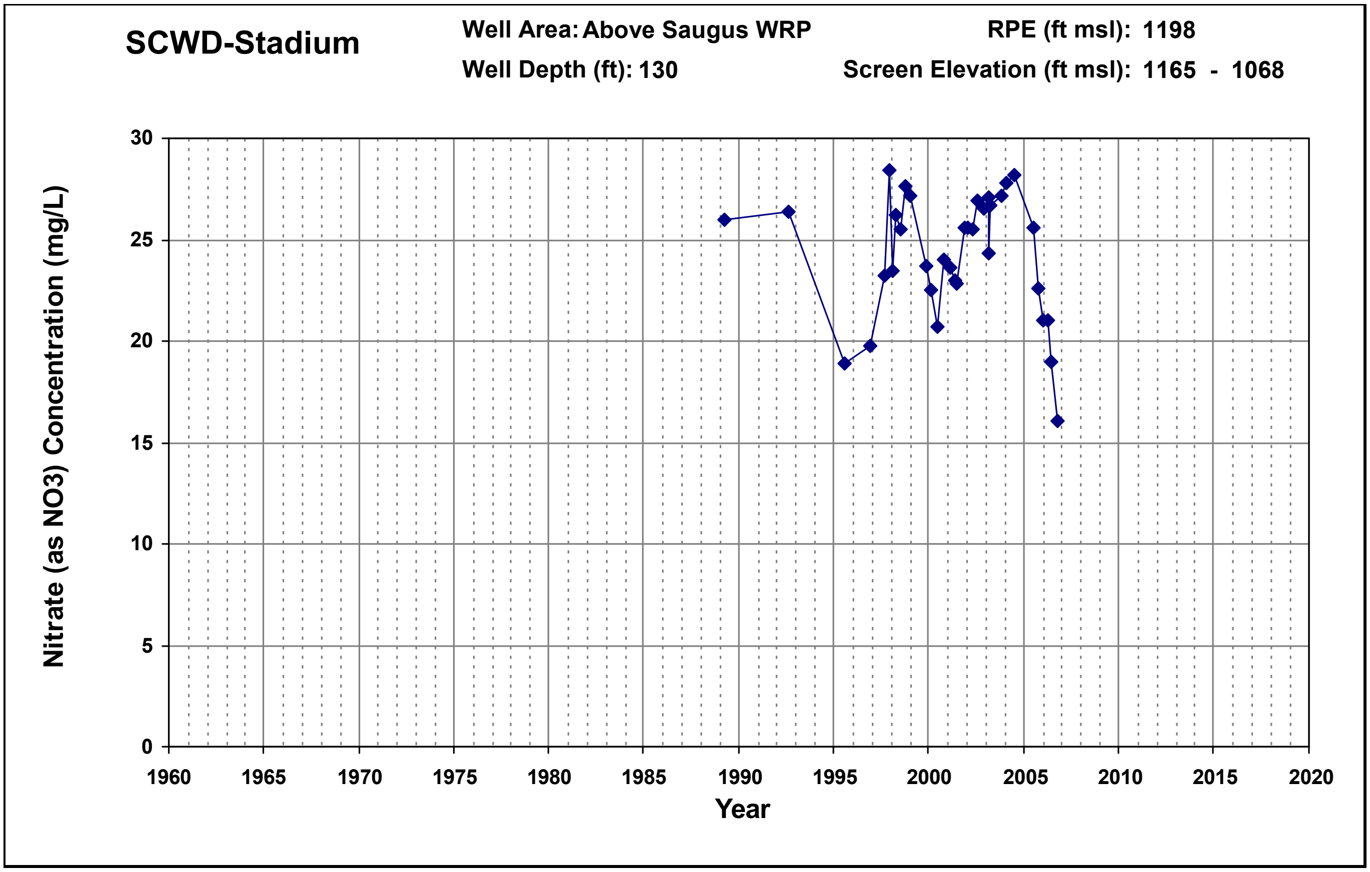

SCWD-N. Oaks East
Well Area: Mint Canyon
Well Depth (ft): 150
RPE (ft msl): 1391
Screen Elevation (ft msl): 1310 - 1241
Nitrate (as NO3) Concentration (mg/L)
0
5
10
15
20
25
30
35
40
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

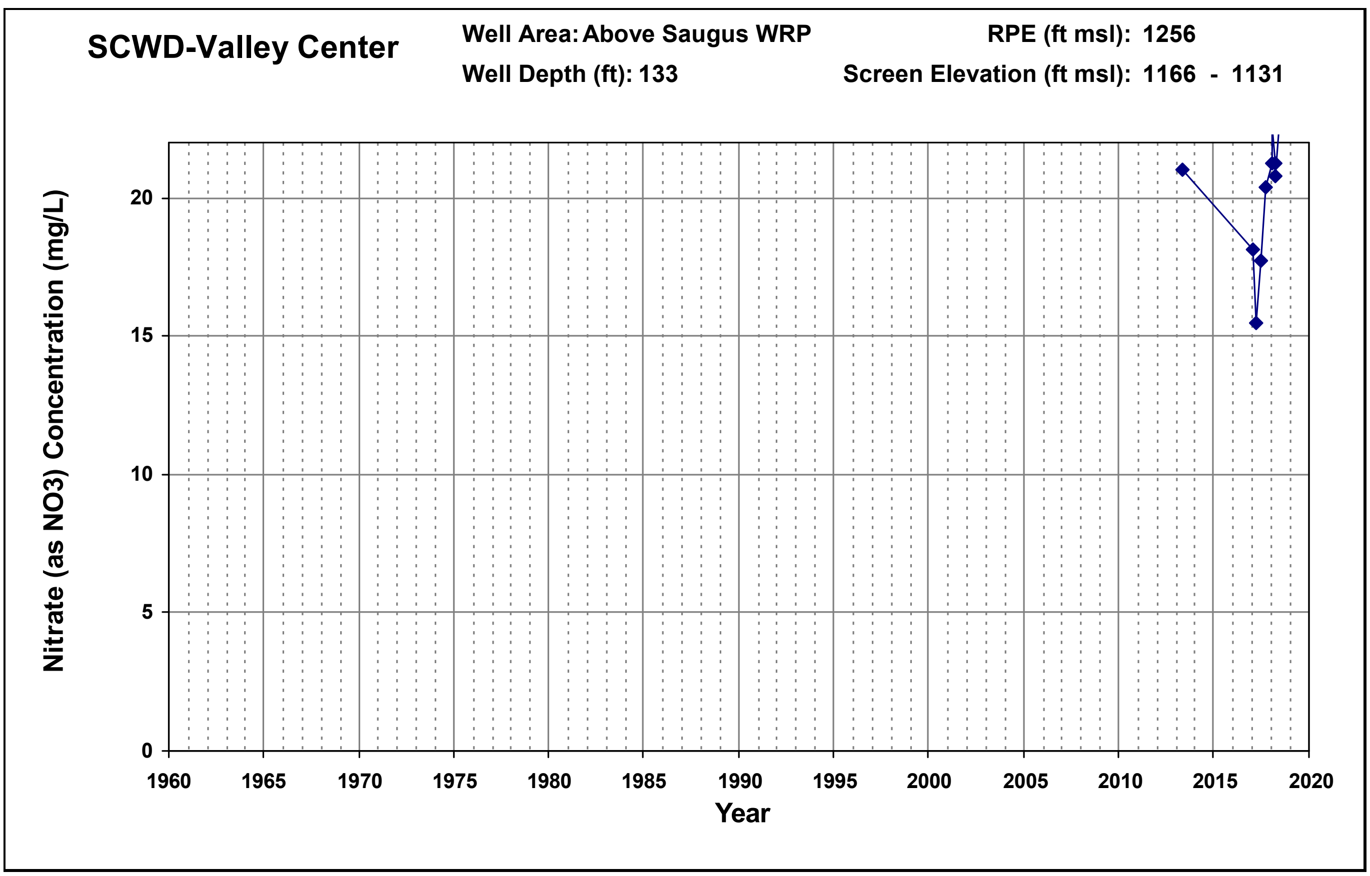

SCWD-N. Oaks West
Well Area: Mint Canyon
Well Depth (ft): 136
RPE (ft msl): 1387
Screen Elevation (ft msl): 1307 - 1269
Nitrate (as NO3) Concentration (mg/L)
0
5
10
15
20
25
30
35
40
45
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

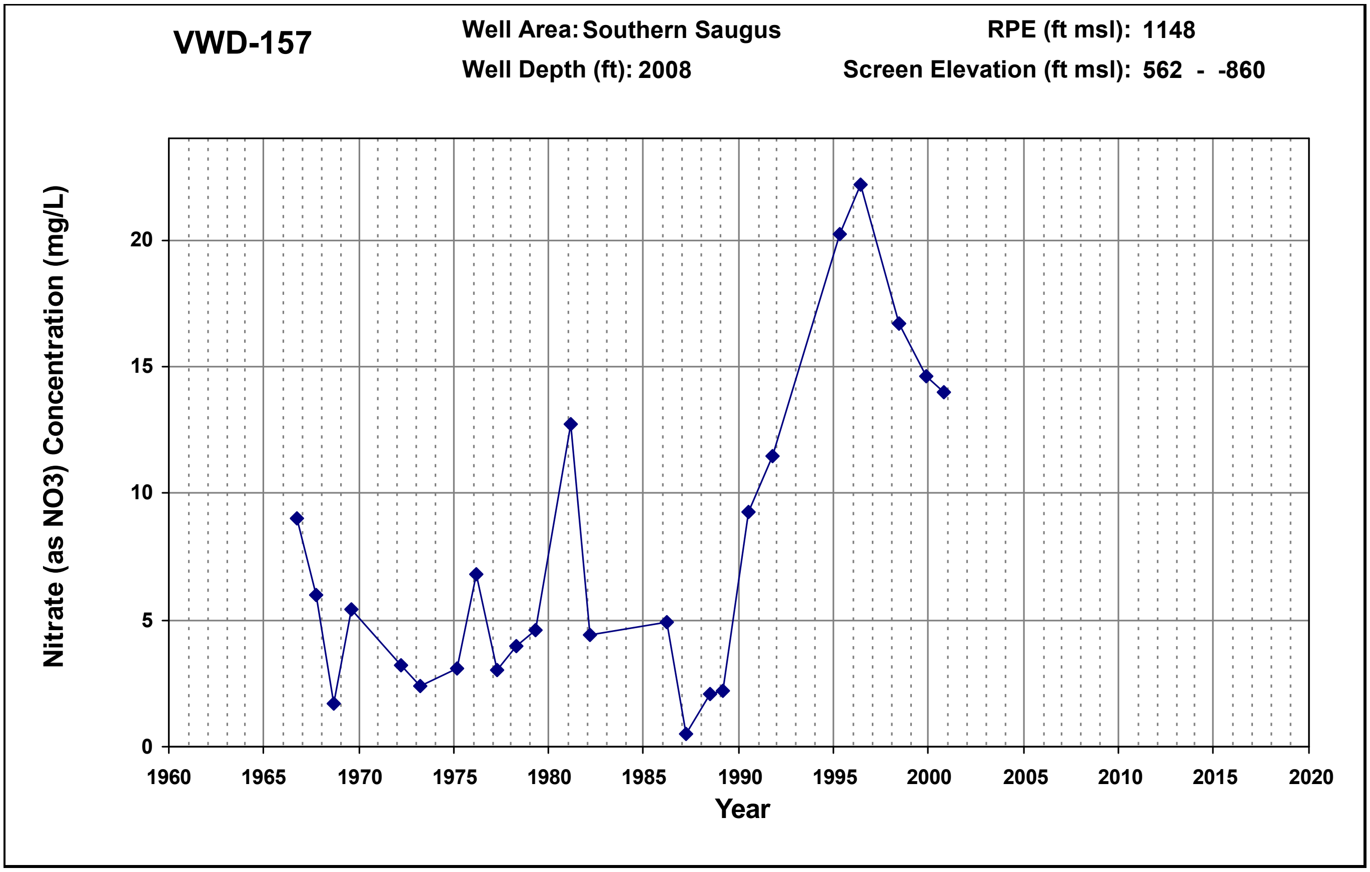

SCWD-Sand Canyon
Well Area: Mint Canyon
Well Depth (ft): 250
RPE (ft msl): 1525
Screen Elevation (ft msl): 1465 - 1385
Nitrate (as NO3) Concentration (mg/L)
0
5
10
15
20
25
30
35
40
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year


SCWD-SantaClara
Well Area: Above Saugus WRP
RPE (ft msl): 1289
Well Depth (ft): 160
Screen Elevation (ft msl): 1199 - 1154
Nitrate (as NO3) Concentration (mg/L)
30
25
20
15
10
5
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

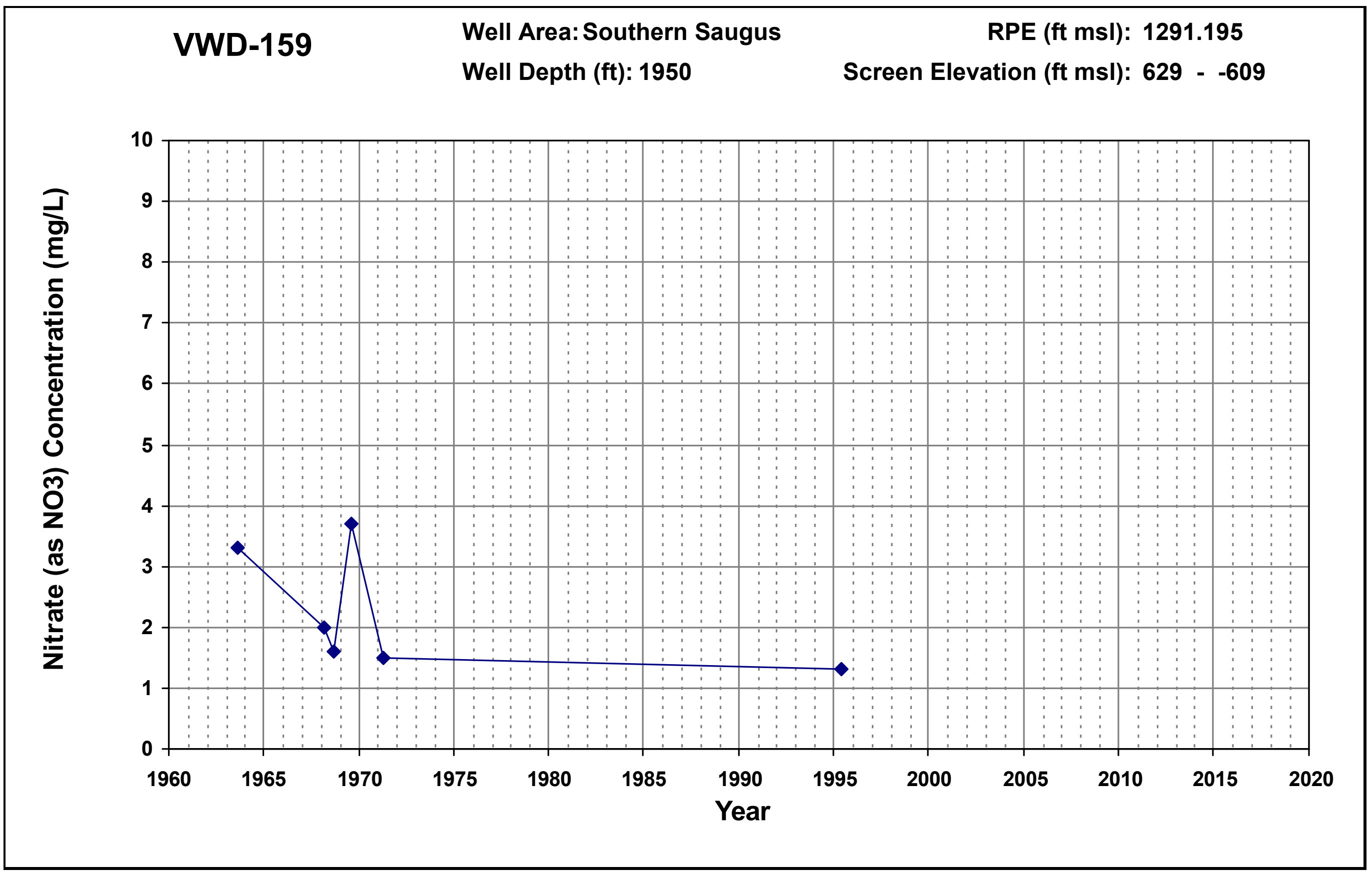

SCWD-Sierra
Well Area: Mint Canyon
RPE (ft msl): 1417
Well Depth (ft): 175
Screen Elevation (ft msl): 1357 - 1242
Nitrate (as NO3) Concentration (mg/L)
40
35
30
25
20
15
10
5
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year


SCWD-Stadium
Well Area: Above Saugus WRP
RPE (ft msl): 1198
Well Depth (ft): 130
Screen Elevation (ft msl): 1165 - 1068
Nitrate (as NO3) Concentration (mg/L)
0
5
10
15
20
25
30
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

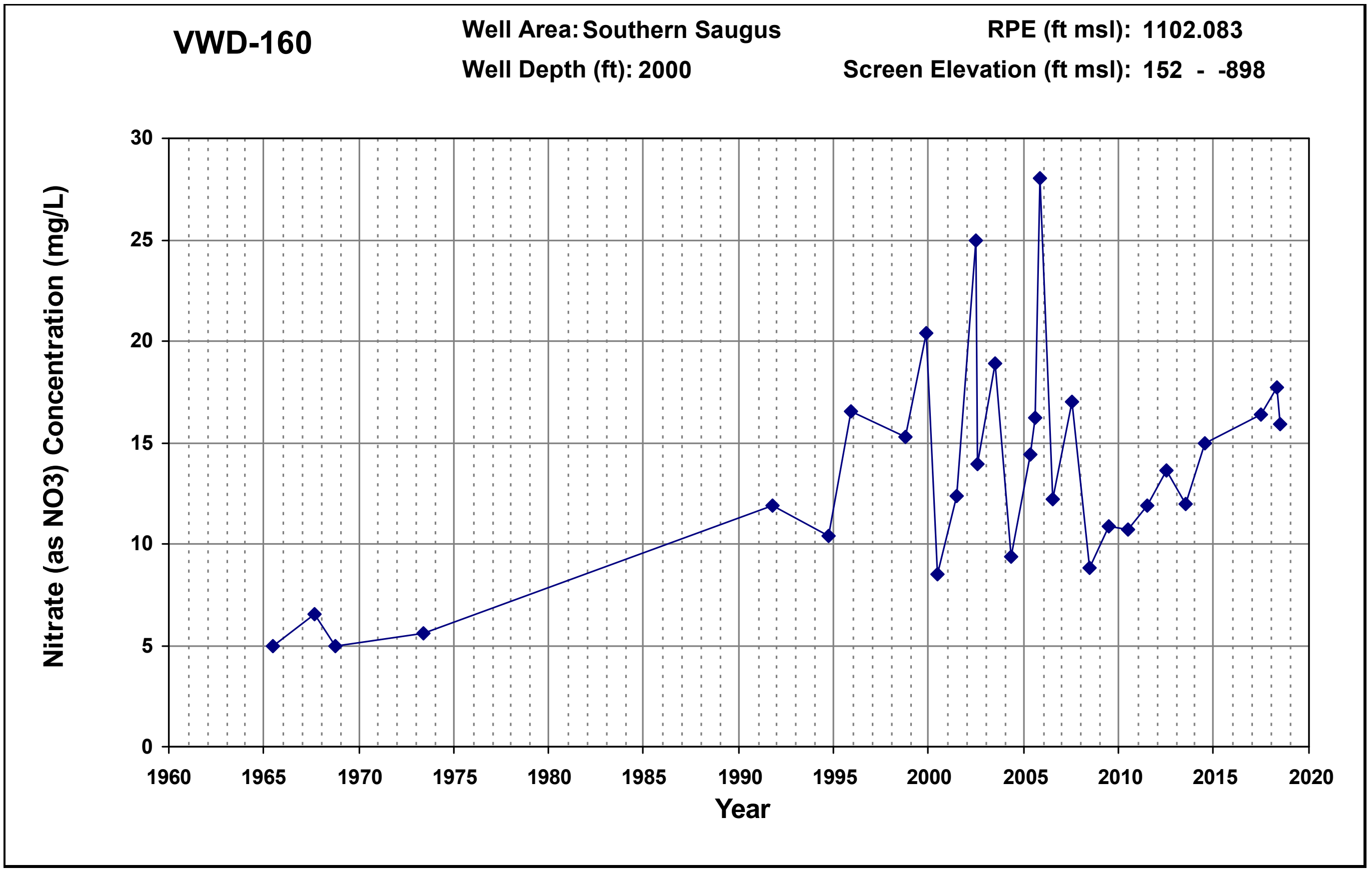

SCWD-Valley Center
Well Area: Above Saugus WRP
RPE (ft msl): 1256
Well Depth (ft): 133
Screen Elevation (ft msl): 1166 - 1131
Nitrate (as NO3) Concentration (mg/L)
0
5
10
15
20
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

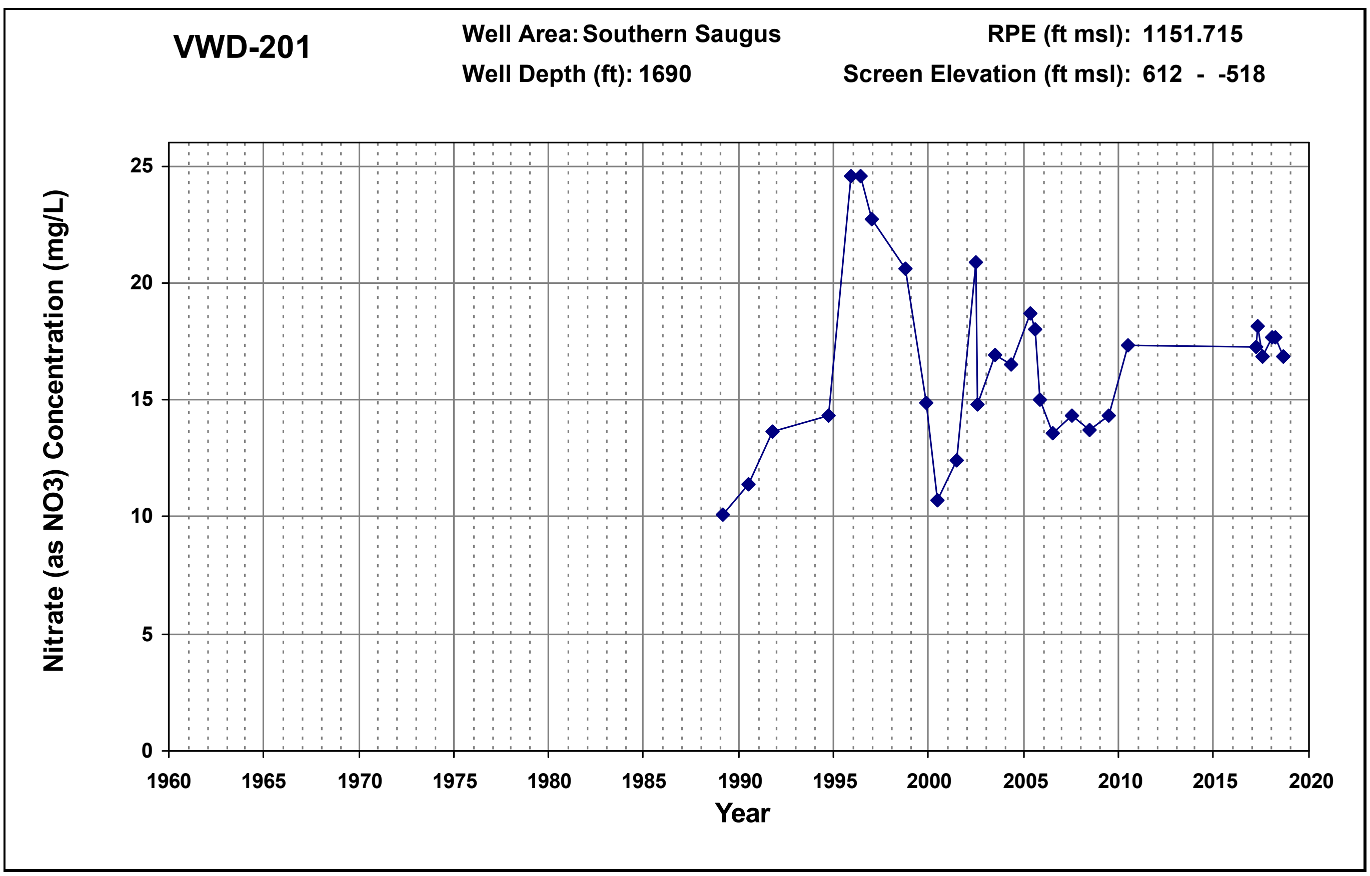


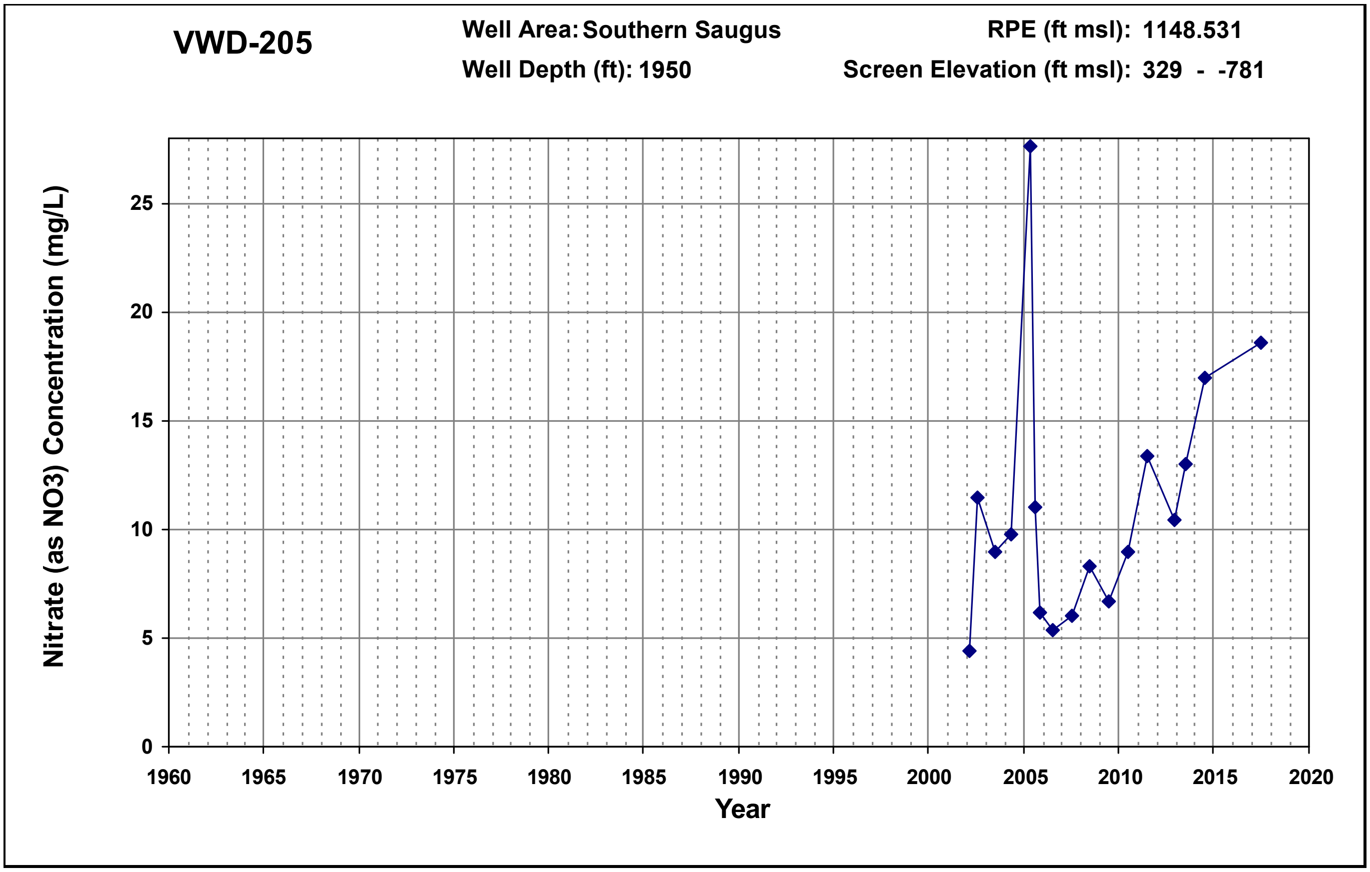
VWD-157
Well Area: Southern Saugus
Well Depth (ft): 2008
RPE (ft msl): 1148
Screen Elevation (ft msl): 562 - -860
Nitrate (as NO3) Concentration (mg/L)
0
5
10
15
20
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

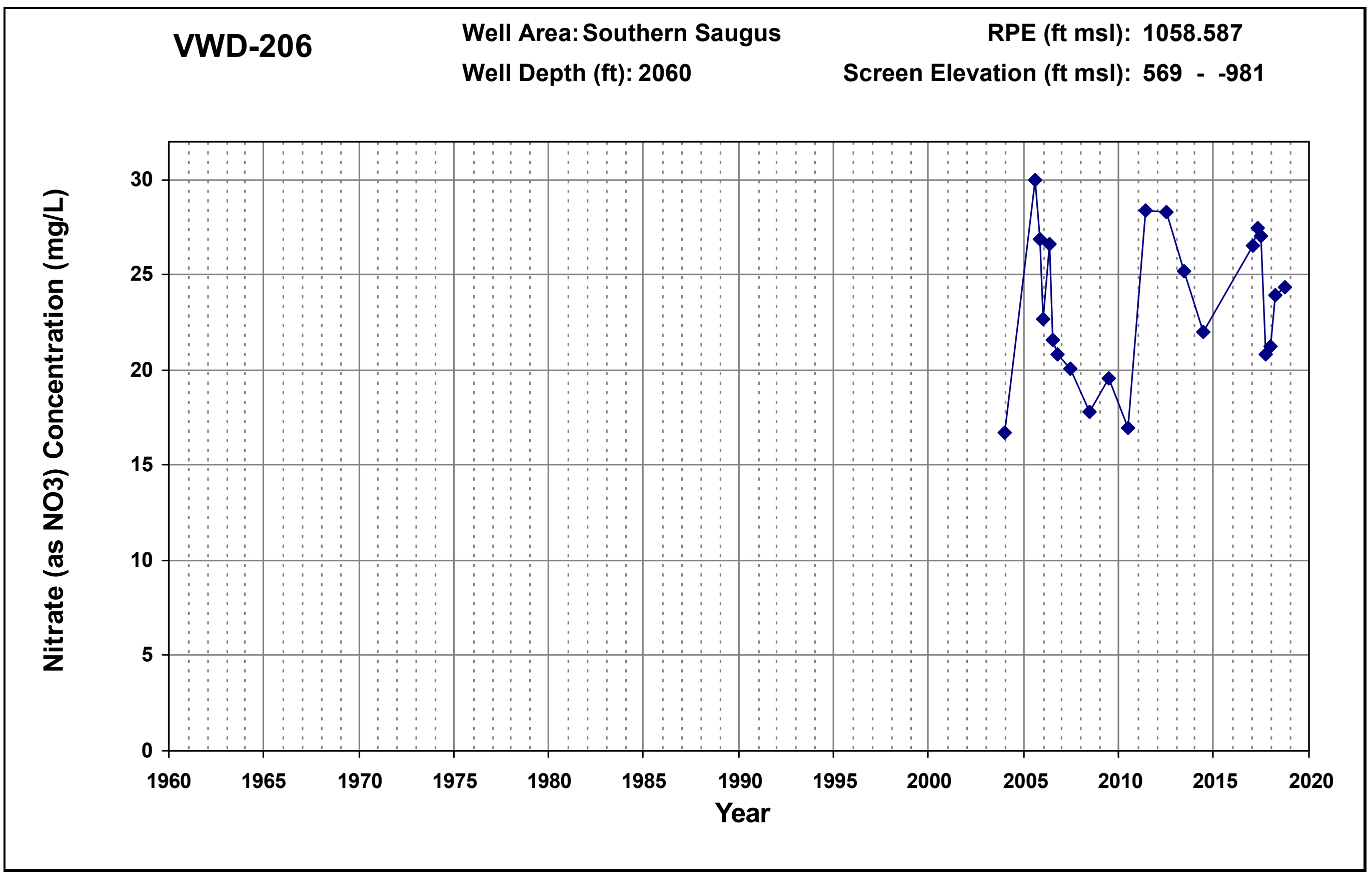


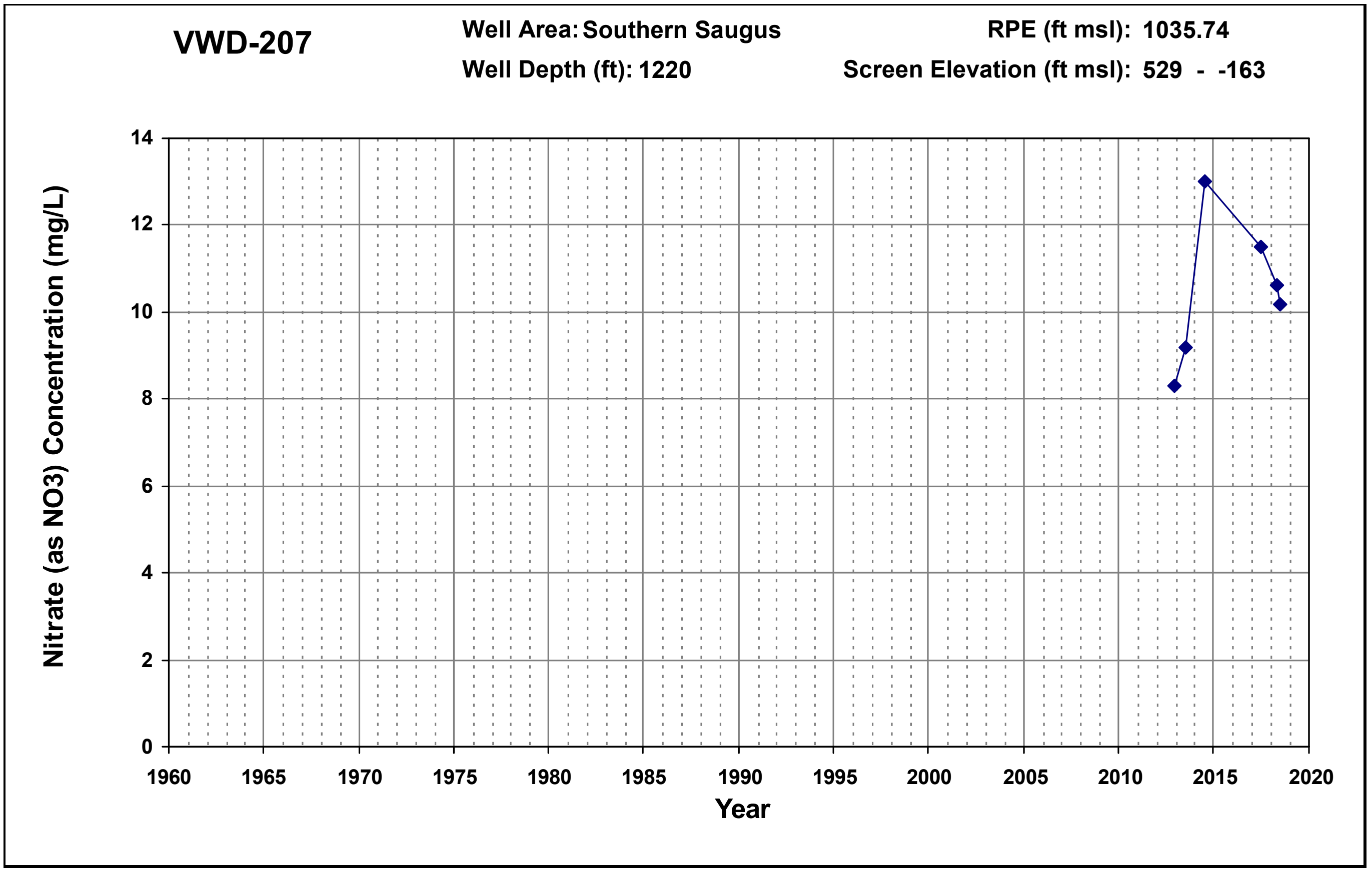
VWD-159
Well Area: Southern Saugus
Well Depth (ft): 1950
RPE (ft msl): 1291.195
Screen Elevation (ft msl): 629 - -609
Nitrate (as NO3) Concentration (mg/L)
0
1
2
3
4
5
6
7
8
9
10
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

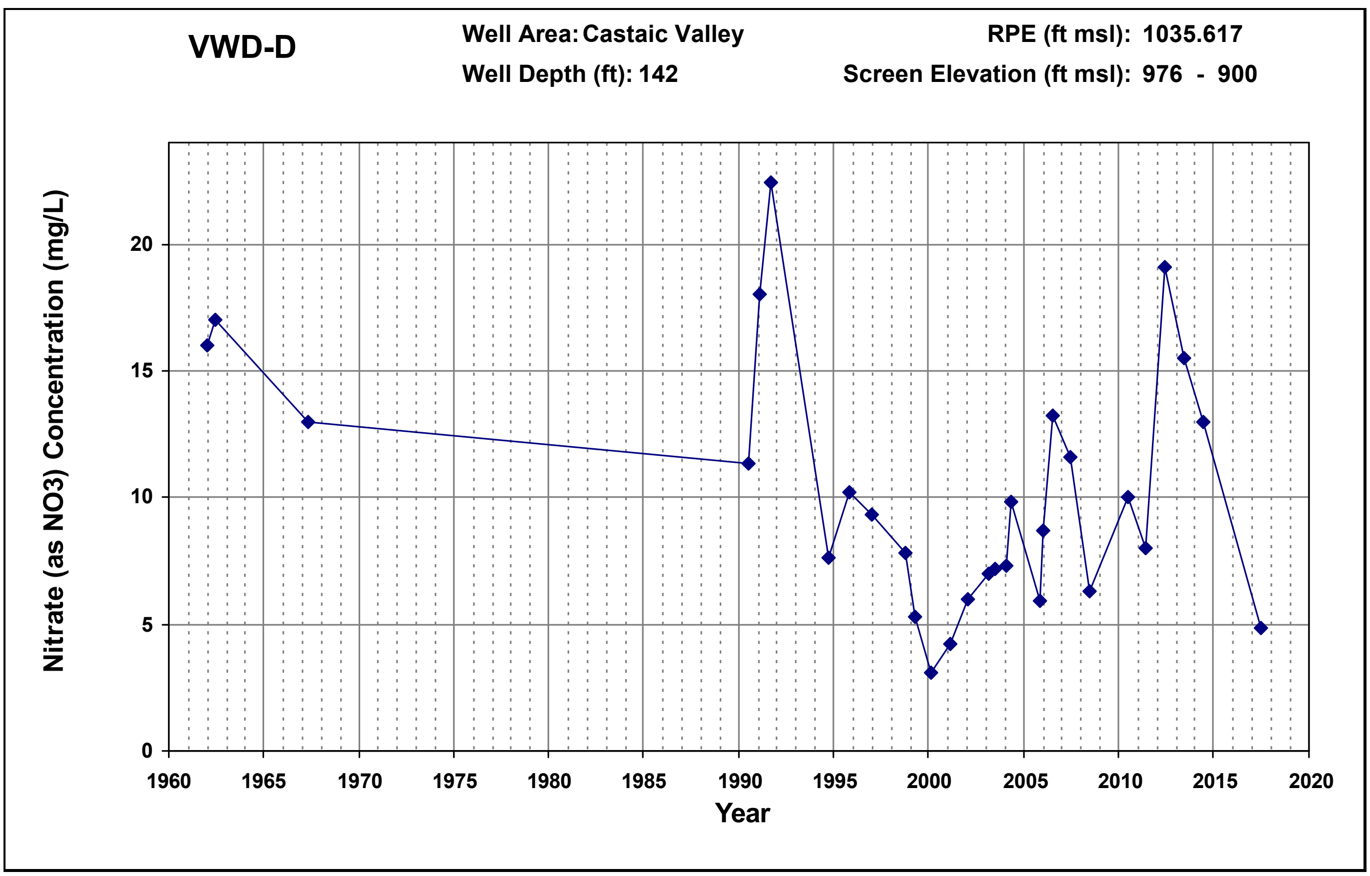

VWD-160
Well Area: Southern Saugus
RPE (ft msl): 1102.083
Well Depth (ft): 2000
Screen Elevation (ft msl): 152 - -898
Nitrate (as NO3) Concentration (mg/L)
0
5
10
15
20
25
30
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year


VWD-201
Well Area: Southern Saugus
RPE (ft msl): 1151.715
Well Depth (ft): 1690
Screen Elevation (ft msl): 612 - -518
Nitrate (as NO3) Concentration (mg/L)
0
5
10
15
20
25
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year


VWD-205
Well Area: Southern Saugus
Well Depth (ft): 1950
RPE (ft msl): 1148.531
Screen Elevation (ft msl): 329 - -781
Nitrate (as NO3) Concentration (mg/L)
Year
0
5
10
15
20
25
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020


VWD-206
Well Area: Southern Saugus
Well Depth (ft): 2060
RPE (ft msl): 1058.587
Screen Elevation (ft msl): 569 - -981
Nitrate (as NO3) Concentration (mg/L)
Year
0
5
10
15
20
25
30
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020


VWD-207
Well Area: Southern Saugus
Well Depth (ft): 1220
RPE (ft msl): 1035.74
Screen Elevation (ft msl): 529 - -163
Nitrate (as NO3) Concentration (mg/L)
Year


VWD-D
Well Area: Castaic Valley
Well Depth (ft): 142
RPE (ft msl): 1035.617
Screen Elevation (ft msl): 976 - 900
Nitrate (as NO3) Concentration (mg/L)
Year

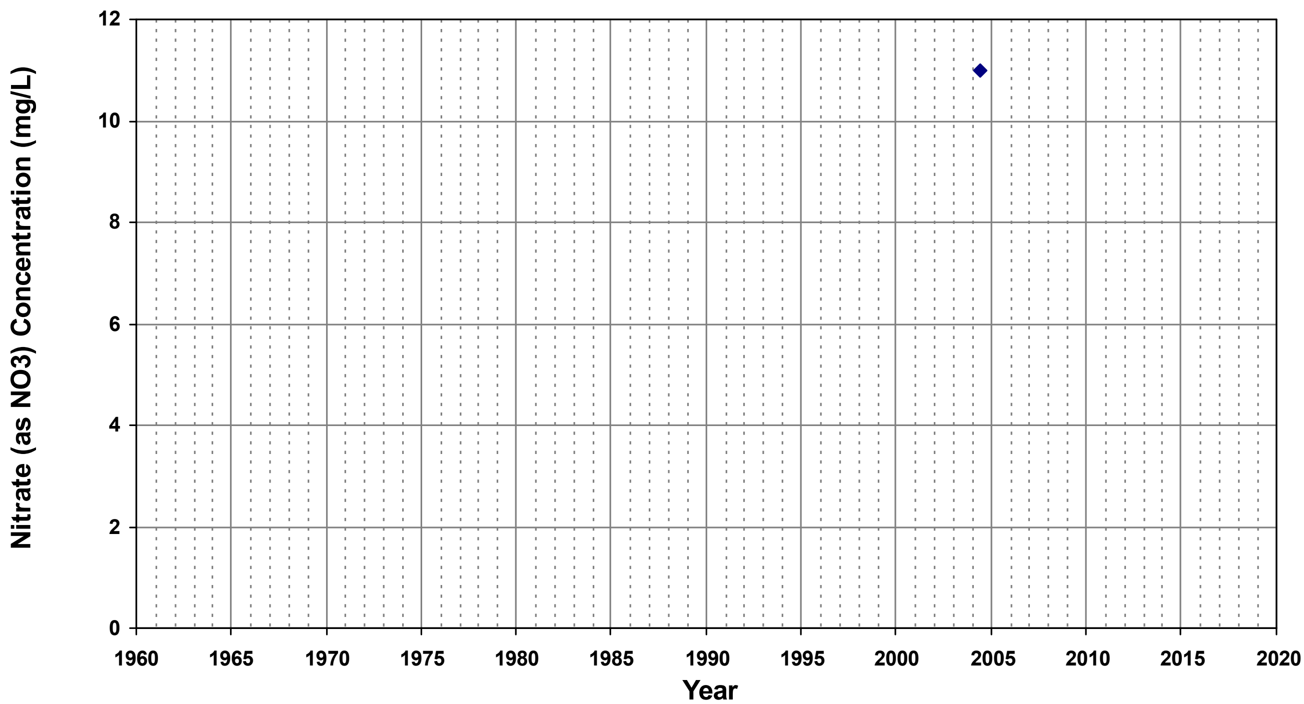
VWD-E14

Well Area: Below Valencia WRP

RPE (ft msl): 1000

Well Depth (ft): 150

Screen Elevation (ft msl): 925 - 885



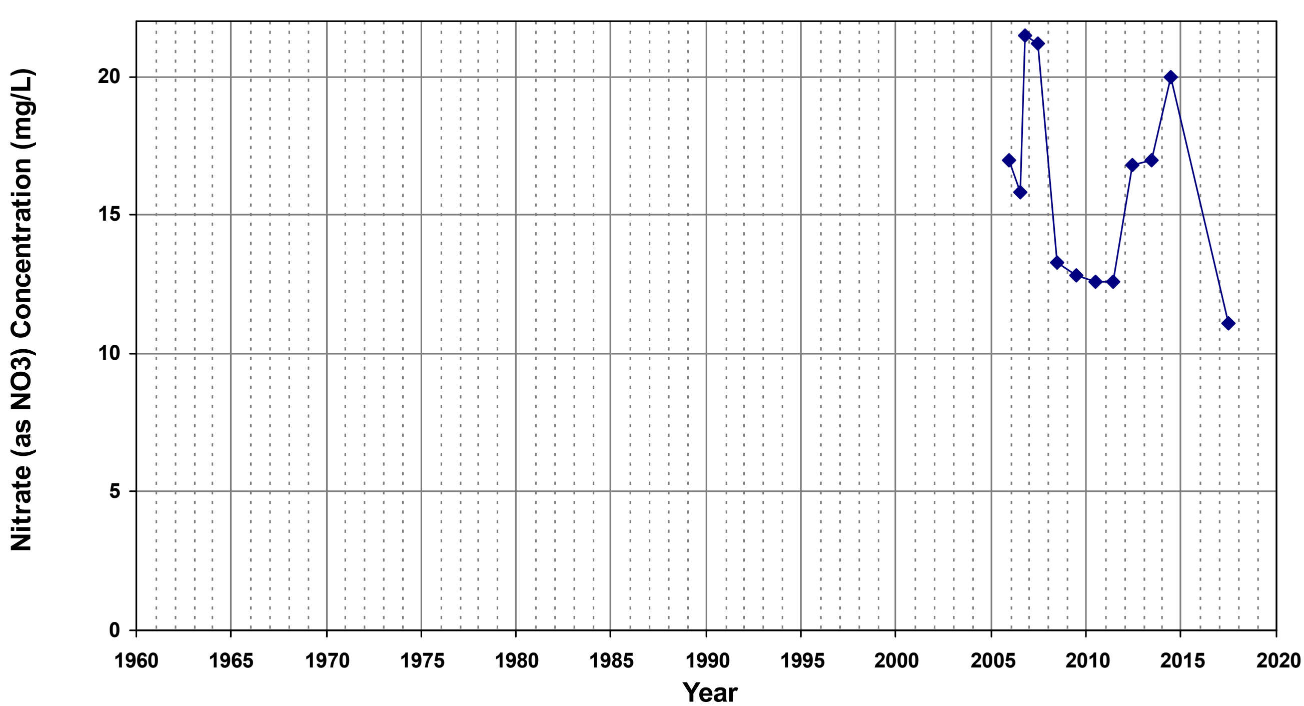
VWD-E15

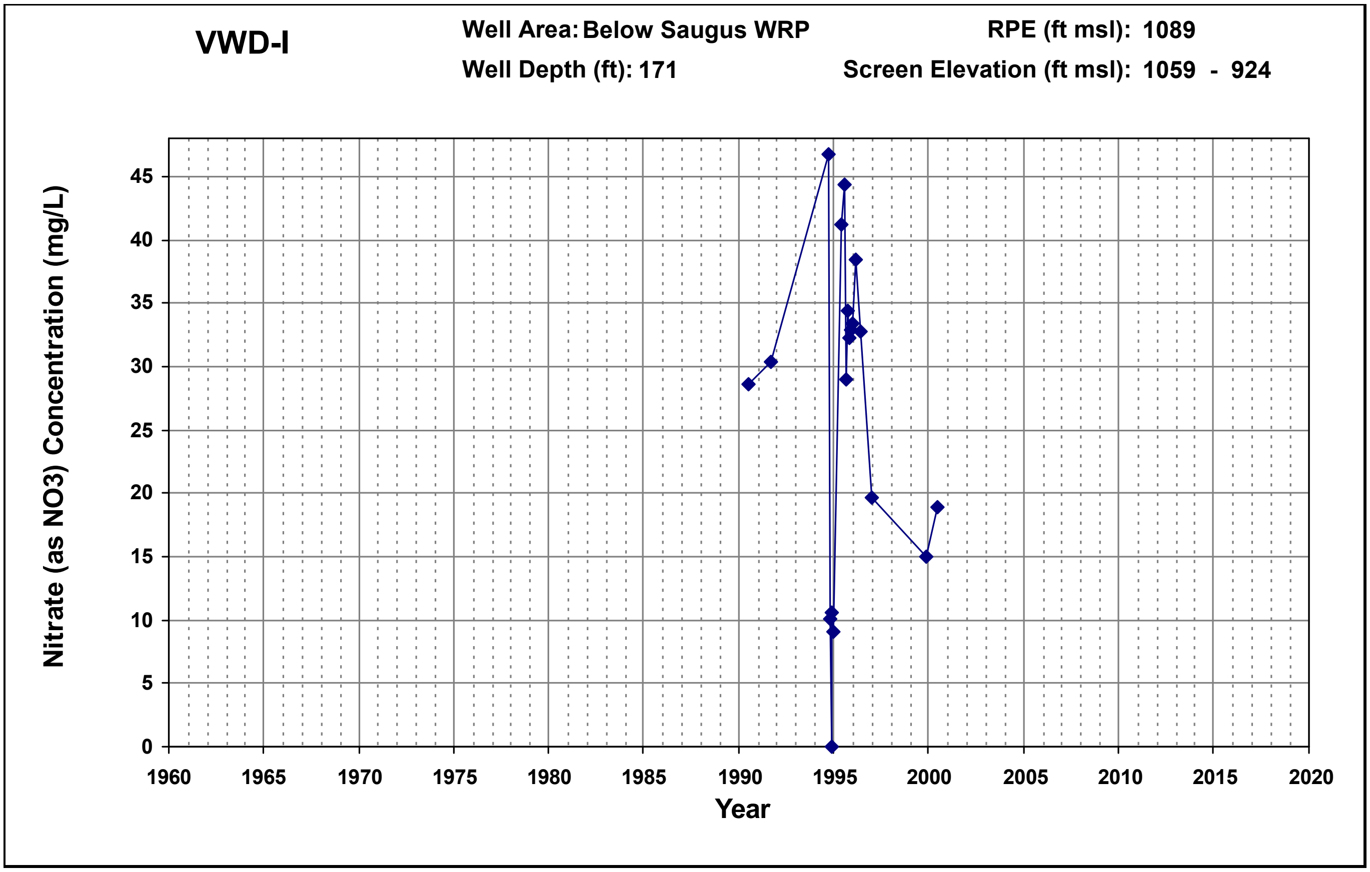
Well Area: Below Valencia WRP

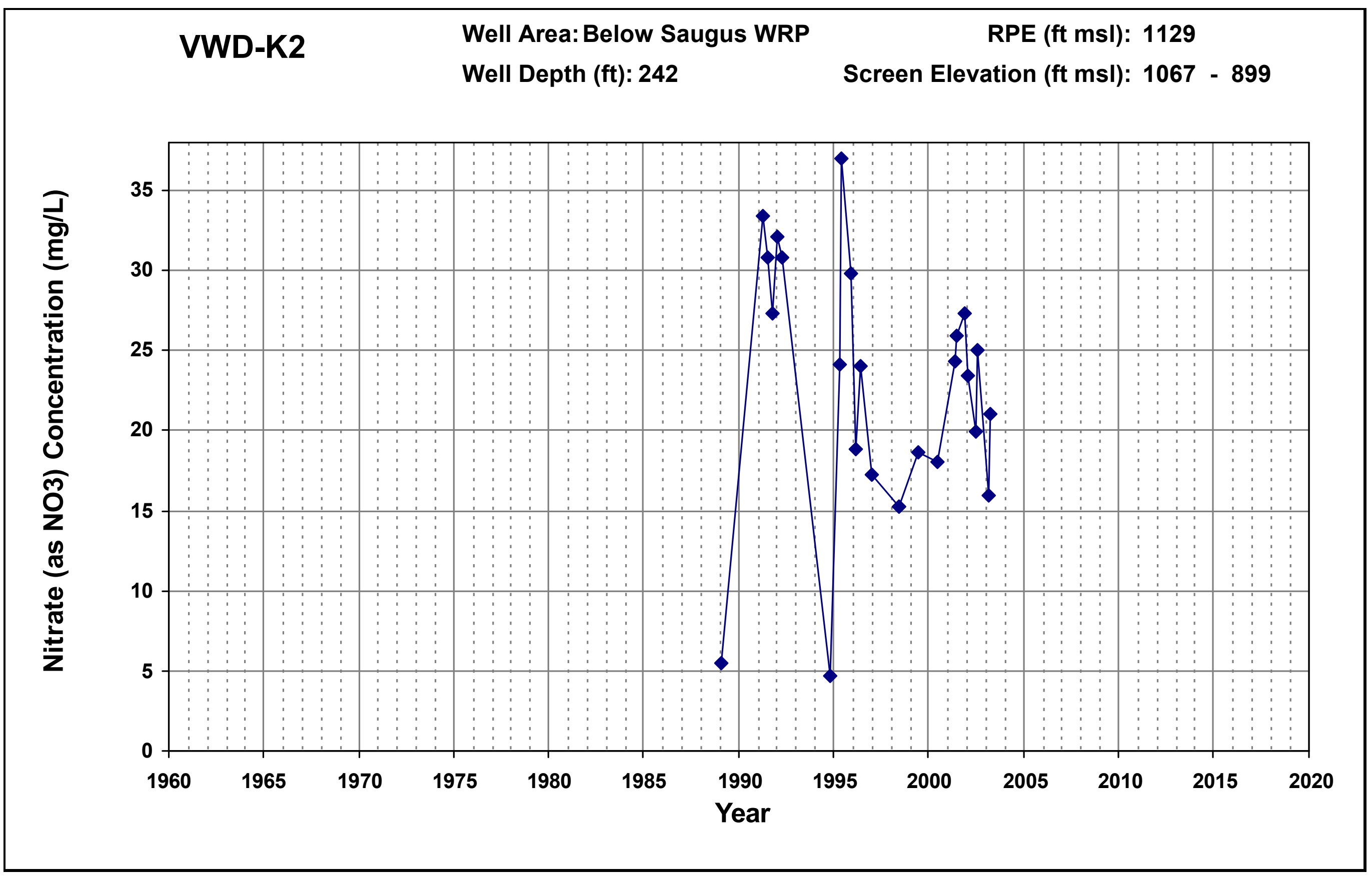
RPE (ft msl): 1022.957

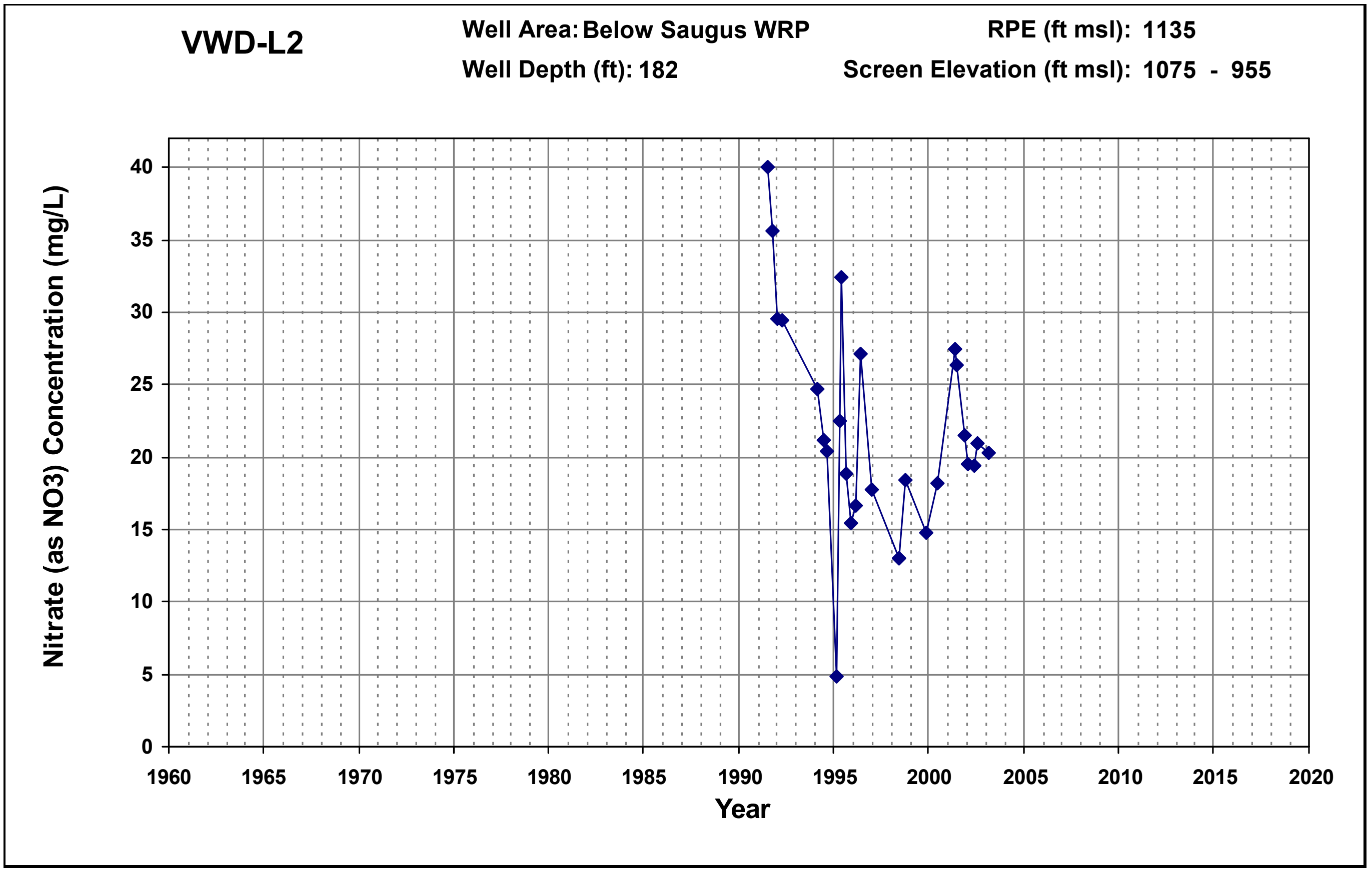
Well Depth (ft): 160

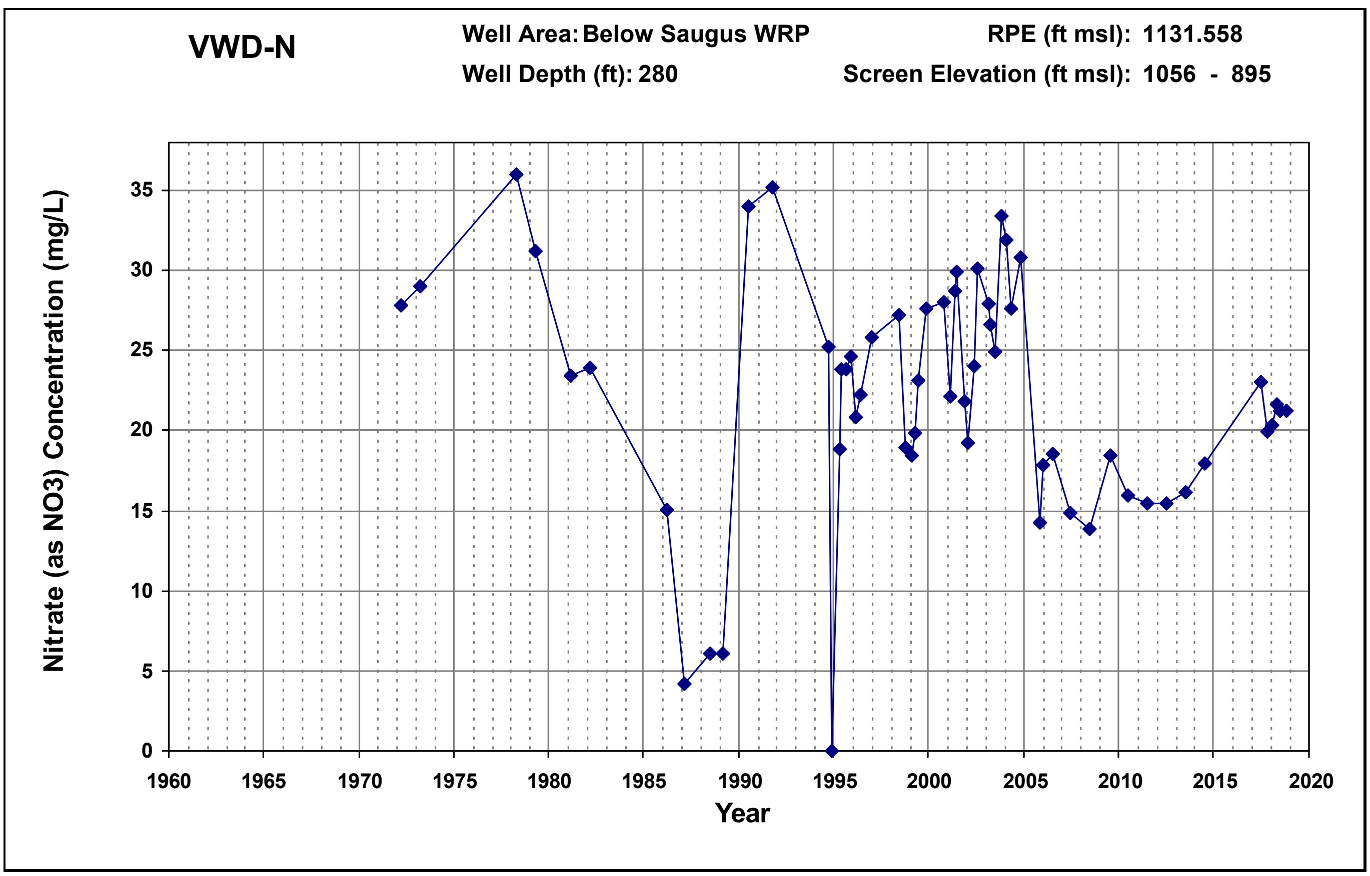
Screen Elevation (ft msl): 933 - 888

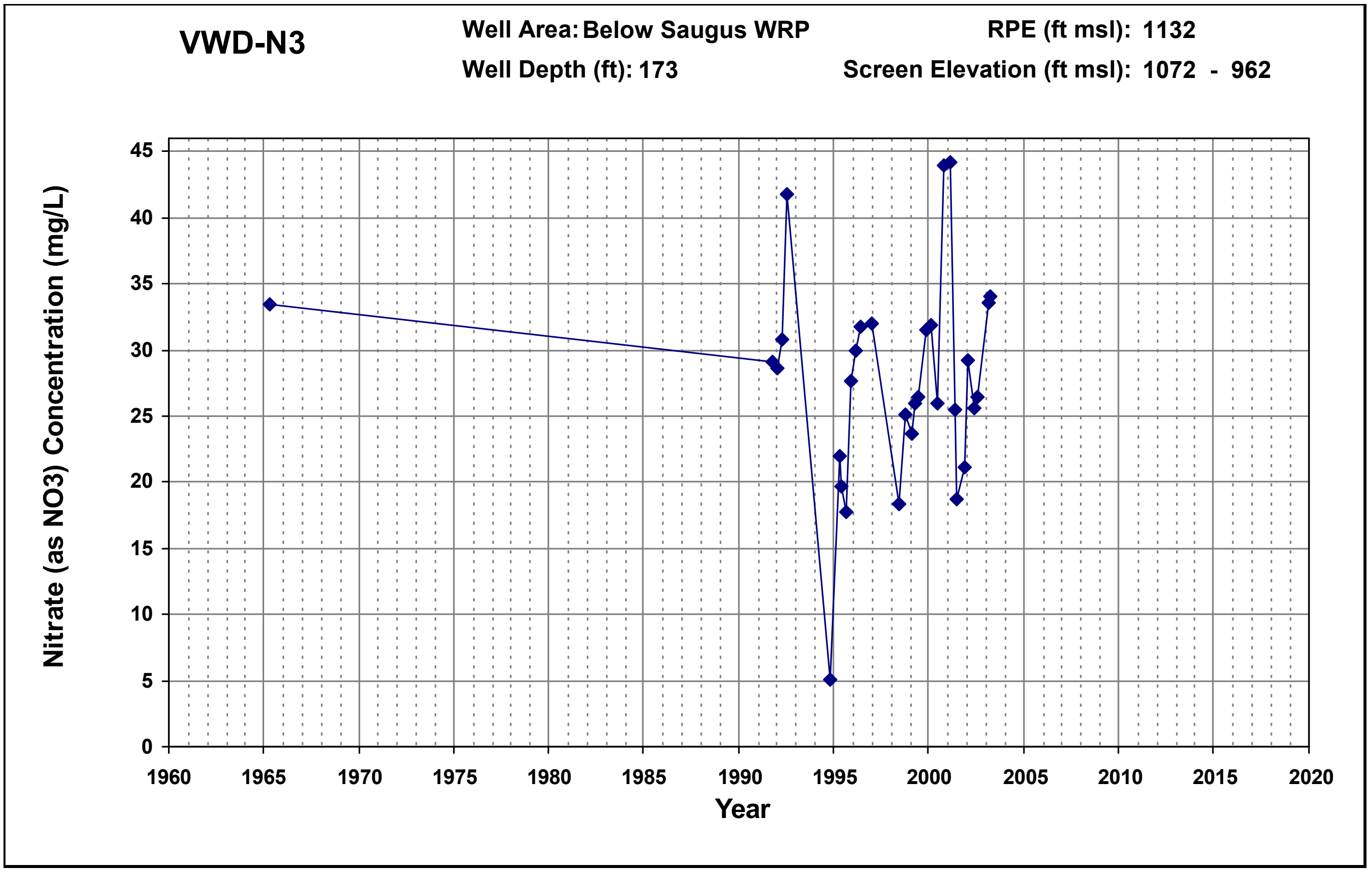


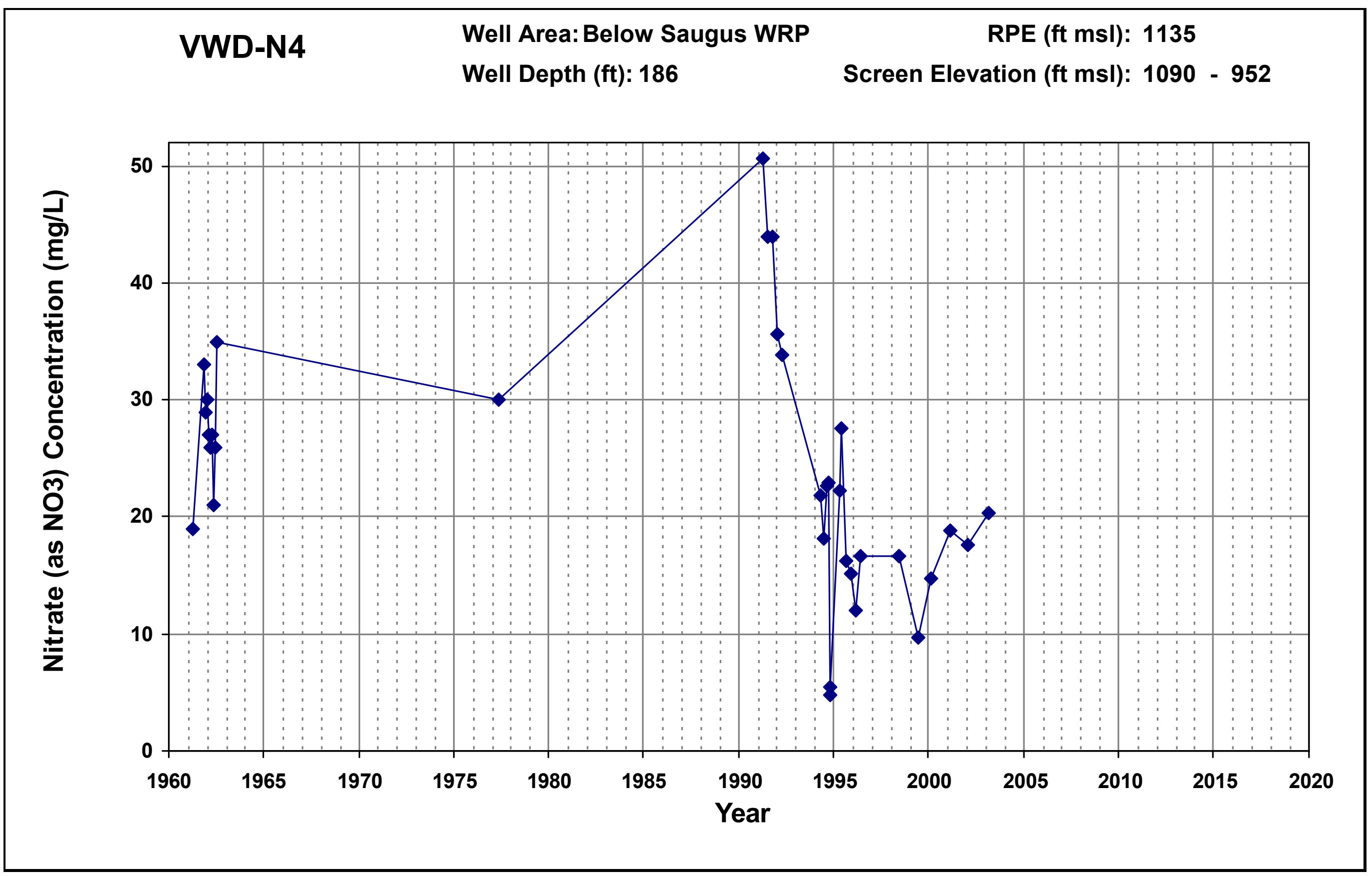

VWD-I
Well Area: Below Saugus WRP
RPE (ft msl): 1089
Well Depth (ft): 171
Screen Elevation (ft msl): 1059 - 924
Nitrate (as NO3) Concentration (mg/L)
0
5
10
15
20
25
30
35
40
45
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

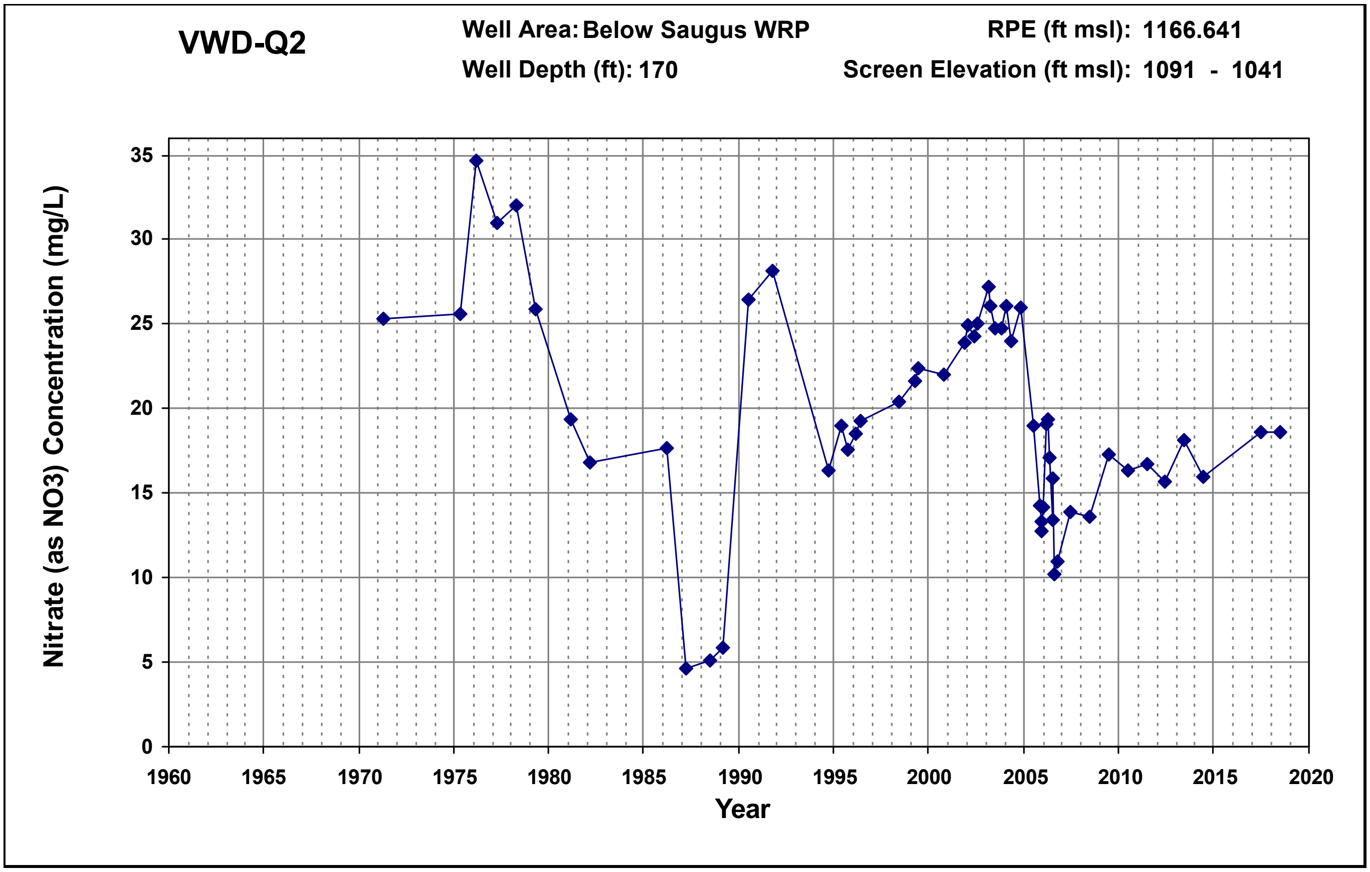

VWD-K2
Well Area: Below Saugus WRP
RPE (ft msl): 1129
Well Depth (ft): 242
Screen Elevation (ft msl): 1067 - 899
Nitrate (as NO3) Concentration (mg/L)
0
5
10
15
20
25
30
35
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

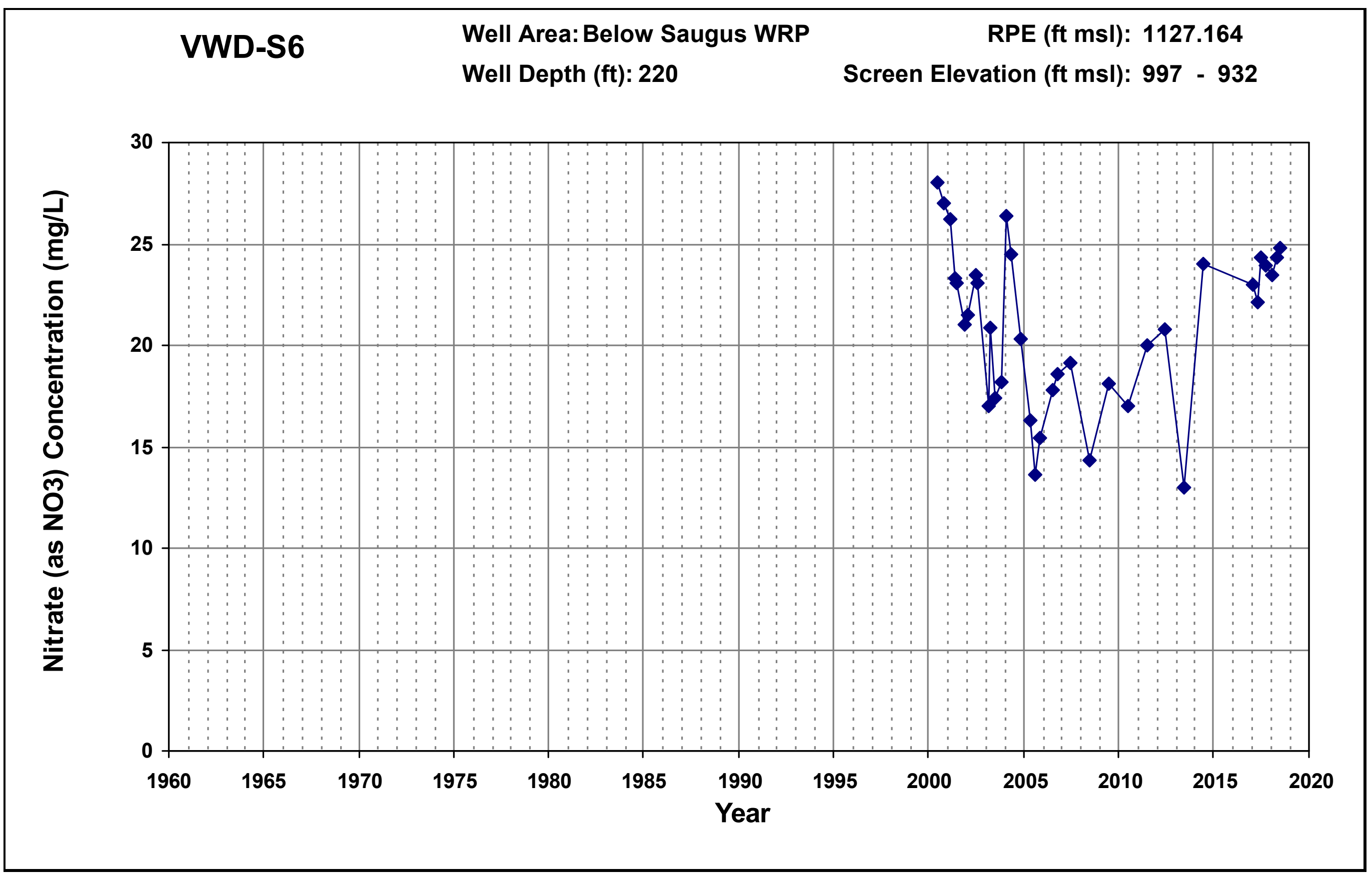

VWD-L2
Well Area: Below Saugus WRP
RPE (ft msl): 1135
Well Depth (ft): 182
Screen Elevation (ft msl): 1075 - 955
Nitrate (as NO3) Concentration (mg/L)
0
5
10
15
20
25
30
35
40
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

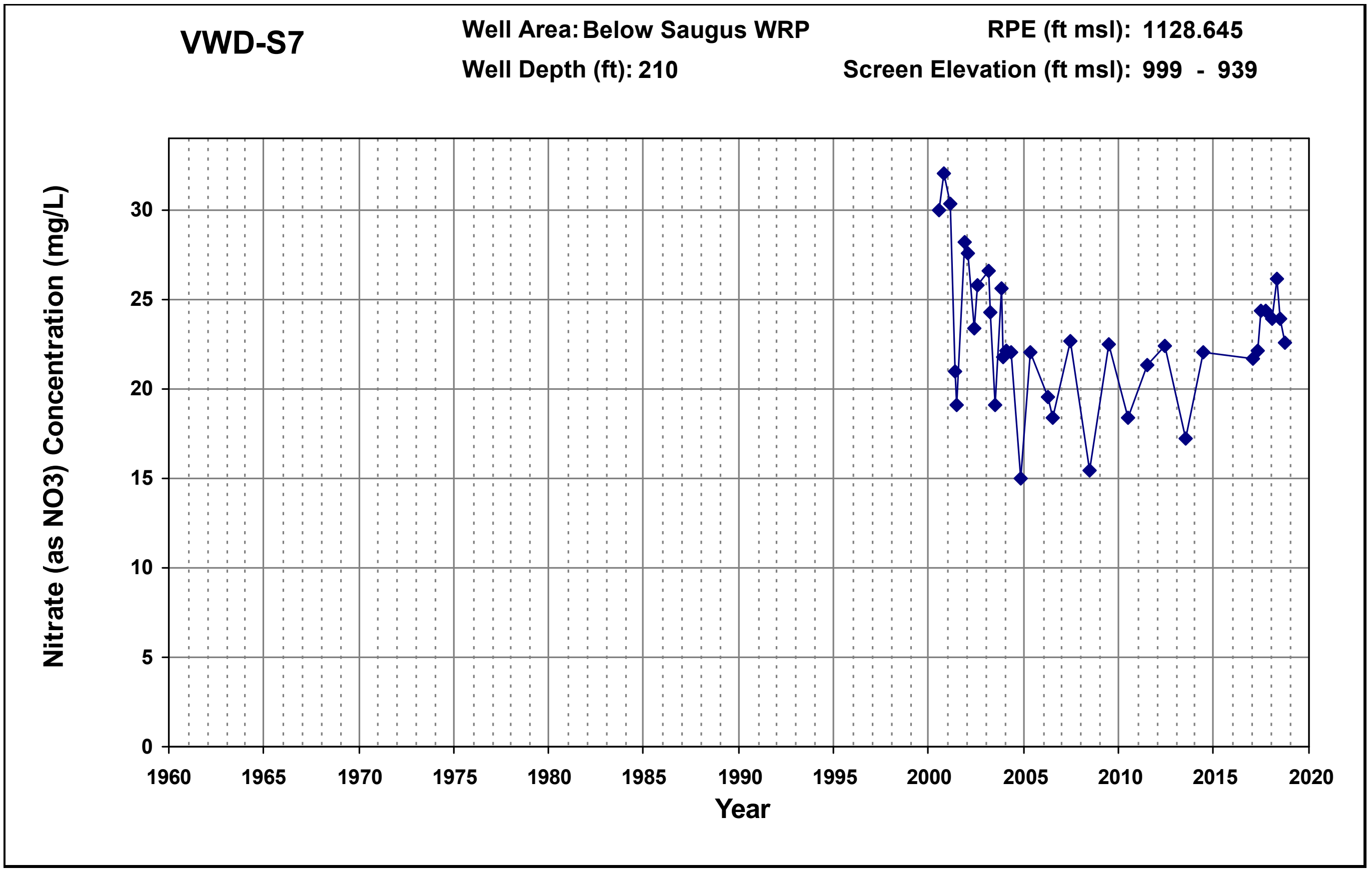

VWD-N
Well Area: Below Saugus WRP
RPE (ft msl): 1131.558
Well Depth (ft): 280
Screen Elevation (ft msl): 1056 - 895
Nitrate (as NO3) Concentration (mg/L)
0
5
10
15
20
25
30
35
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

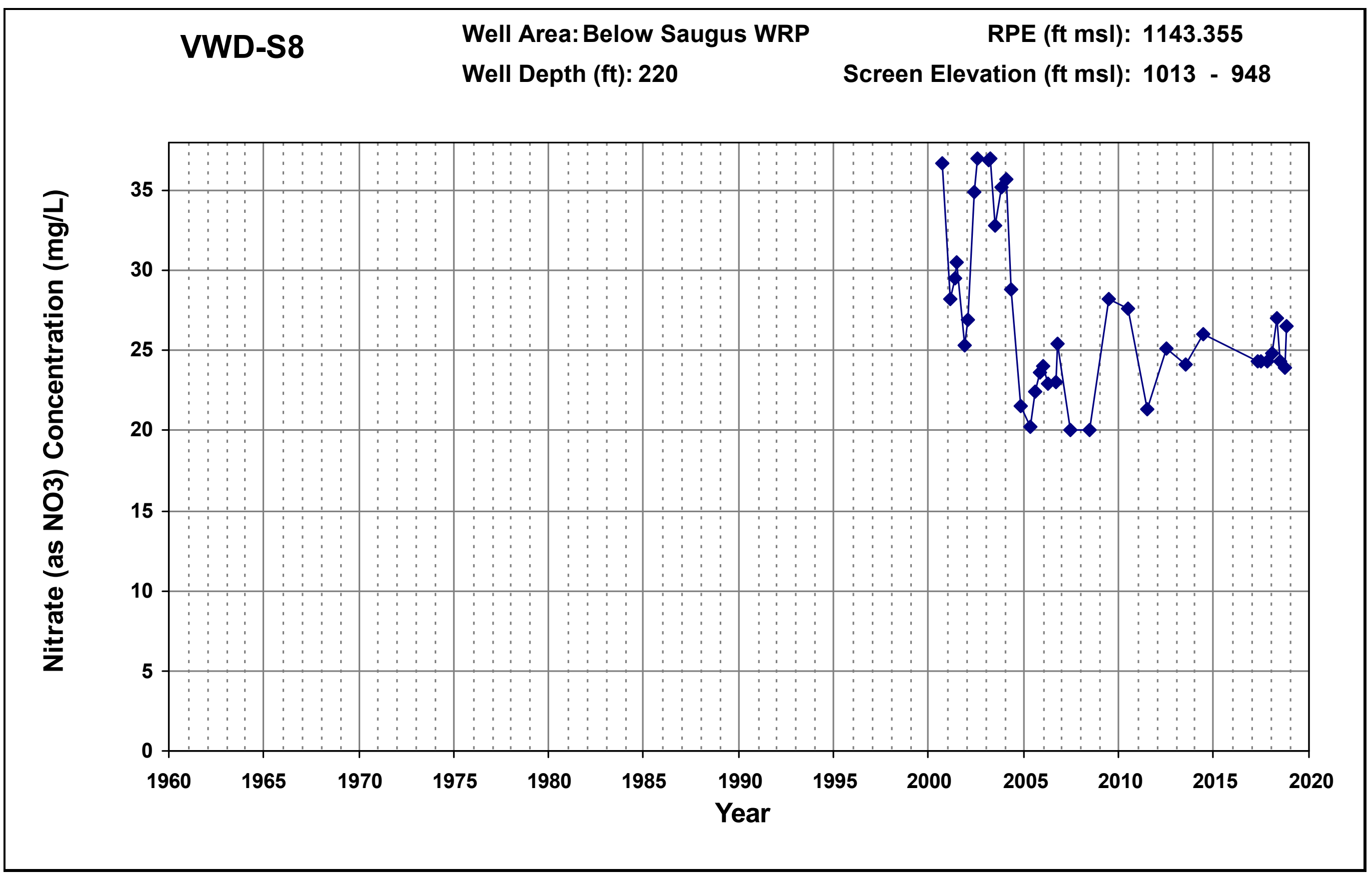

VWD-N3
Well Area: Below Saugus WRP
RPE (ft msl): 1132
Well Depth (ft): 173
Screen Elevation (ft msl): 1072 - 962
Nitrate (as NO3) Concentration (mg/L)
Year
0
5
10
15
20
25
30
35
40
45
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

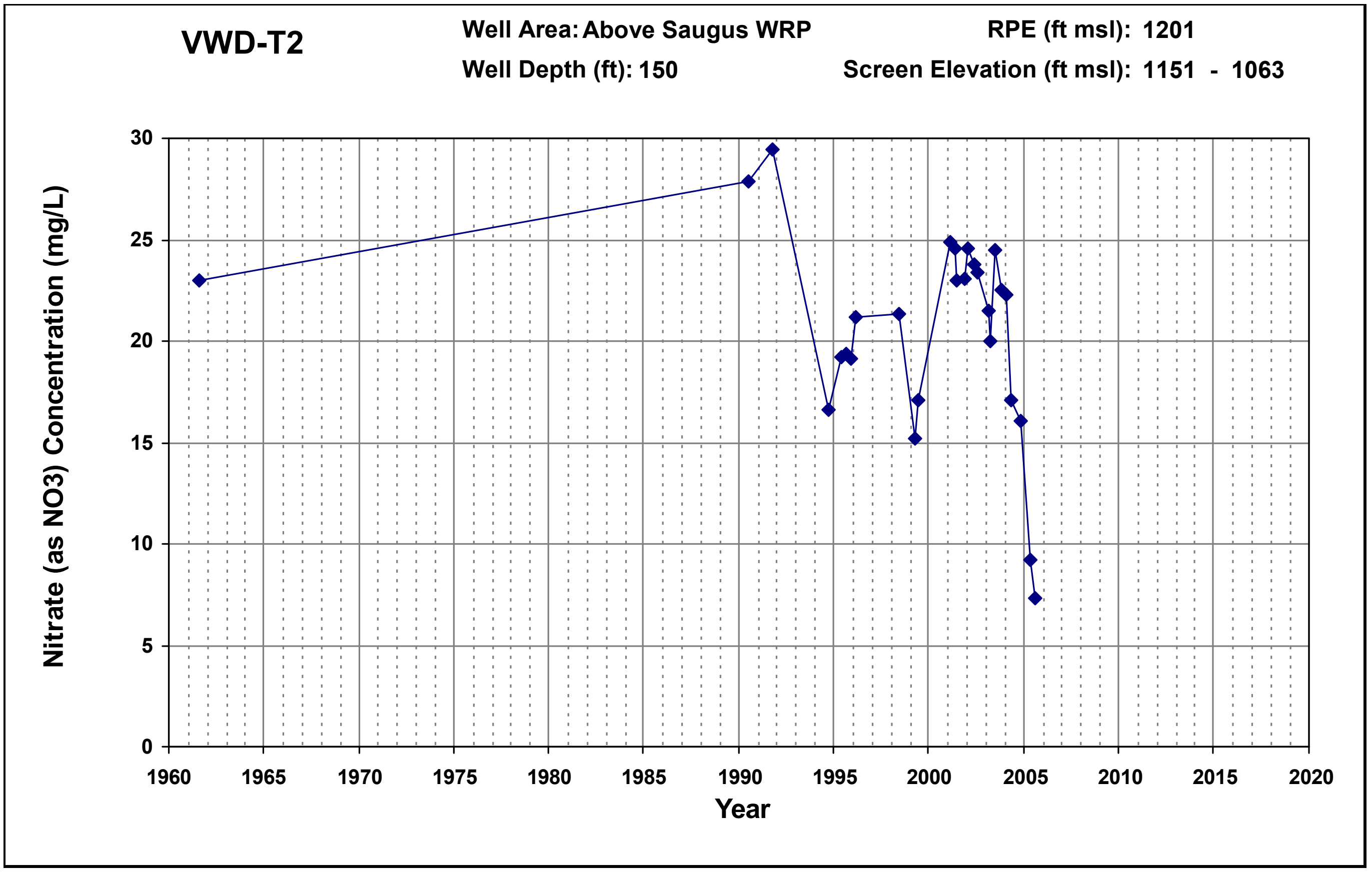

VWD-N4
Well Area: Below Saugus WRP
RPE (ft msl): 1135
Well Depth (ft): 186
Screen Elevation (ft msl): 1090 - 952
Nitrate (as NO3) Concentration (mg/L)
Year
0
10
20
30
40
50
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

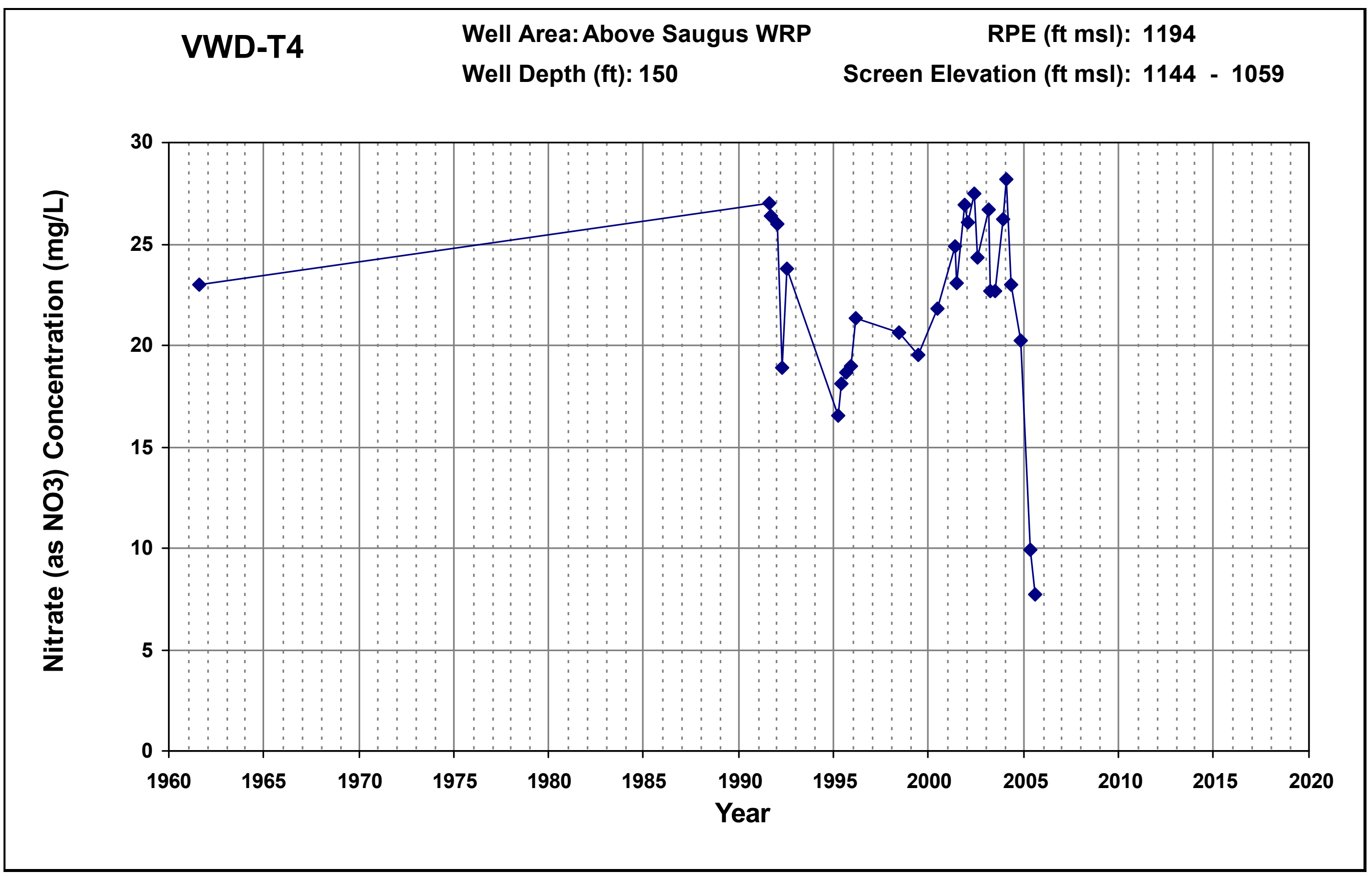

VWD-Q2
Well Area: Below Saugus WRP
Well Depth (ft): 170
RPE (ft msl): 1166.641
Screen Elevation (ft msl): 1091 - 1041
Nitrate (as NO3) Concentration (mg/L)
35
30
25
20
15
10
5
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

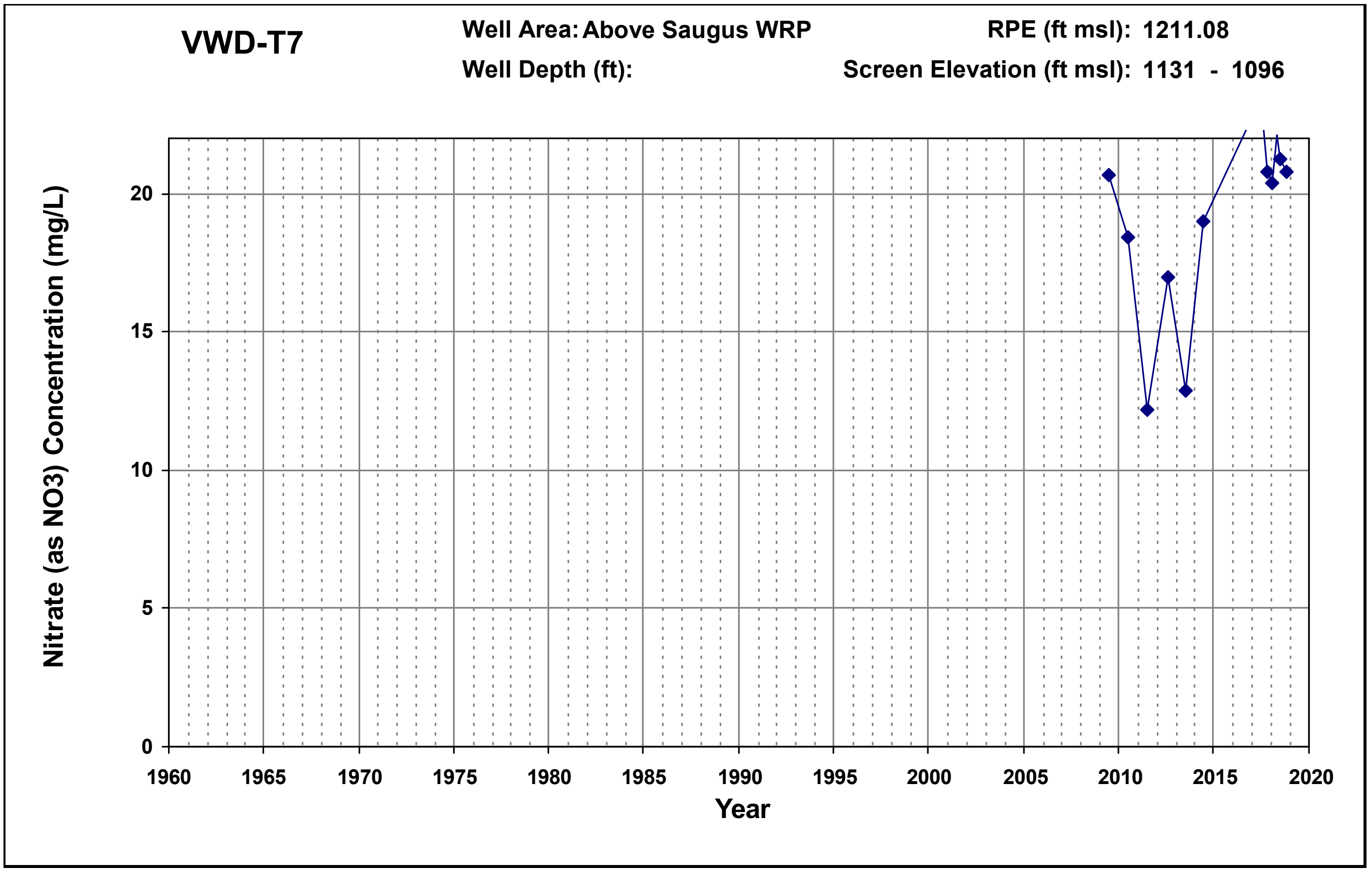

VWD-S6
Well Area: Below Saugus WRP
Well Depth (ft): 220
RPE (ft msl): 1127.164
Screen Elevation (ft msl): 997 - 932
Nitrate (as NO3) Concentration (mg/L)
30
25
20
15
10
5
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year


VWD-S7
Well Area: Below Saugus WRP
Well Depth (ft): 210
RPE (ft msl): 1128.645
Screen Elevation (ft msl): 999 - 939
Nitrate (as NO3) Concentration (mg/L)
0
5
10
15
20
25
30
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

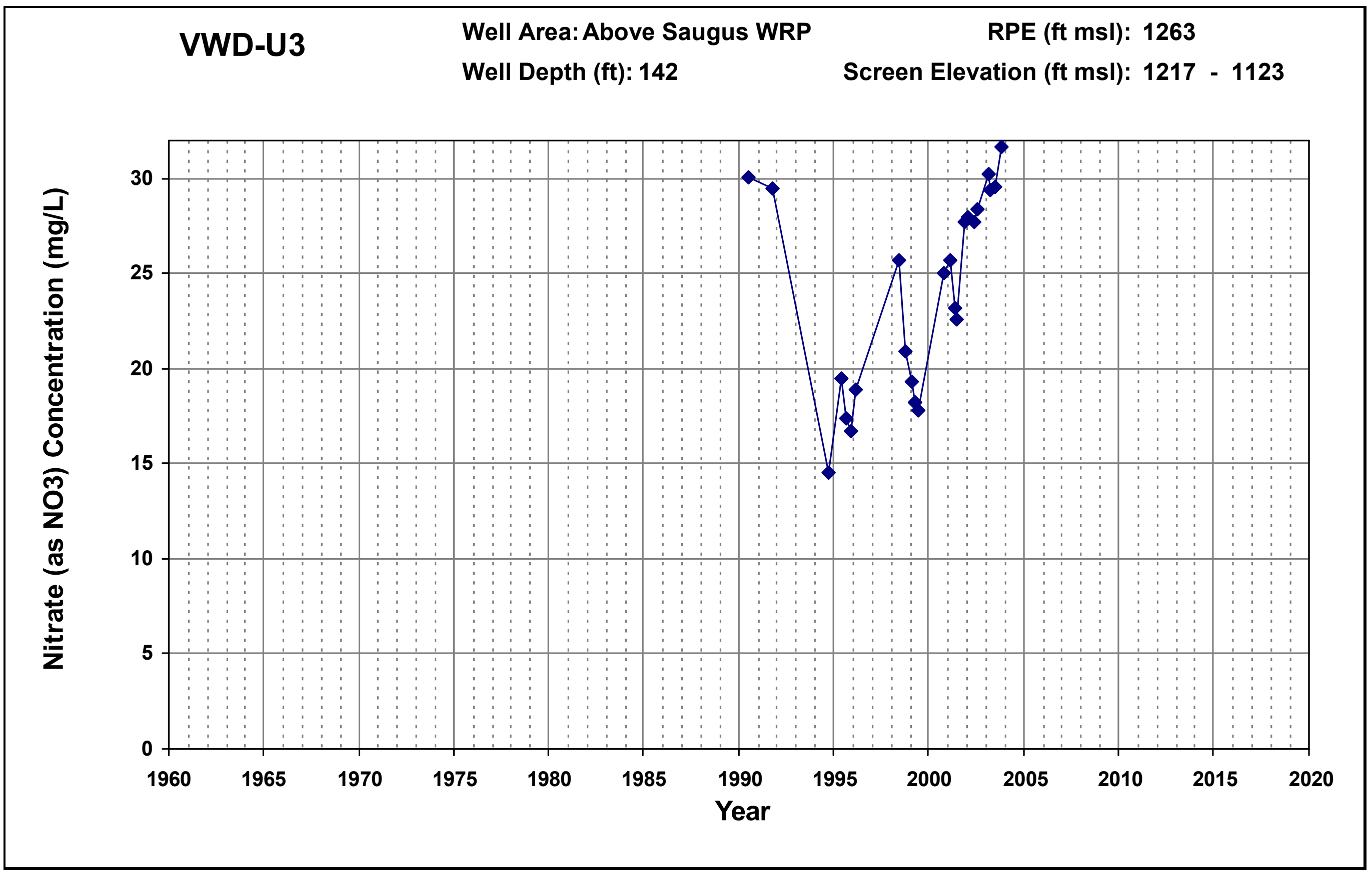

VWD-S8
Well Area: Below Saugus WRP
Well Depth (ft): 220
RPE (ft msl): 1143.355
Screen Elevation (ft msl): 1013 - 948
Nitrate (as NO3) Concentration (mg/L)
0
5
10
15
20
25
30
35
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year


VWD-T2
Well Area: Above Saugus WRP
RPE (ft msl): 1201
Well Depth (ft): 150
Screen Elevation (ft msl): 1151 - 1063
Nitrate (as NO3) Concentration (mg/L)
0
5
10
15
20
25
30
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year


VWD-T4
Well Area: Above Saugus WRP
RPE (ft msl): 1194
Well Depth (ft): 150
Screen Elevation (ft msl): 1144 - 1059
Nitrate (as NO3) Concentration (mg/L)
0
5
10
15
20
25
30
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year



VWD-T7
Well Area: Above Saugus WRP
RPE (ft msl): 1211.08
Well Depth (ft):
Screen Elevation (ft msl): 1131 - 1096
Nitrate (as NO3) Concentration (mg/L)
0
5
10
15
20
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year



VWD-U3
Well Area: Above Saugus WRP
RPE (ft msl): 1263
Well Depth (ft): 142
Screen Elevation (ft msl): 1217 - 1123
Nitrate (as NO3) Concentration (mg/L)
0
5
10
15
20
25
30
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

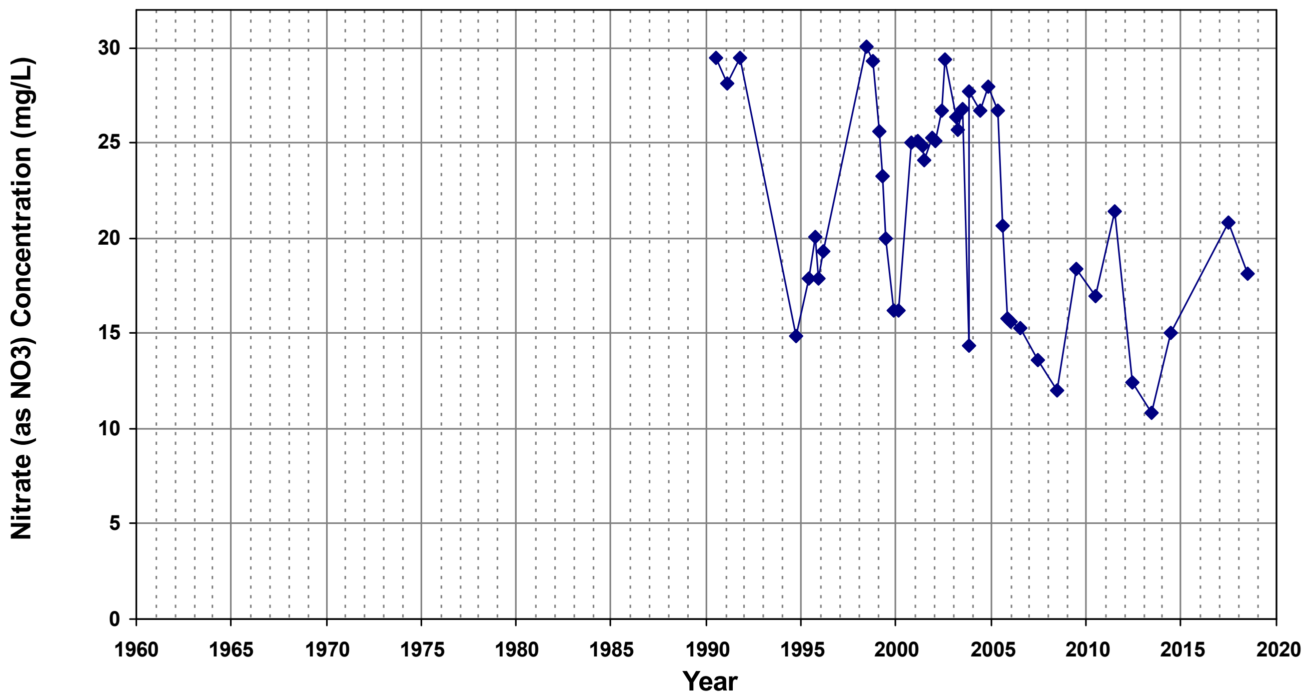
VWD-U4

Well Area: Above Saugus WRP

Well Depth (ft): 135

RPE (ft msl): 1242.795

Screen Elevation (ft msl): 1183 - 1113



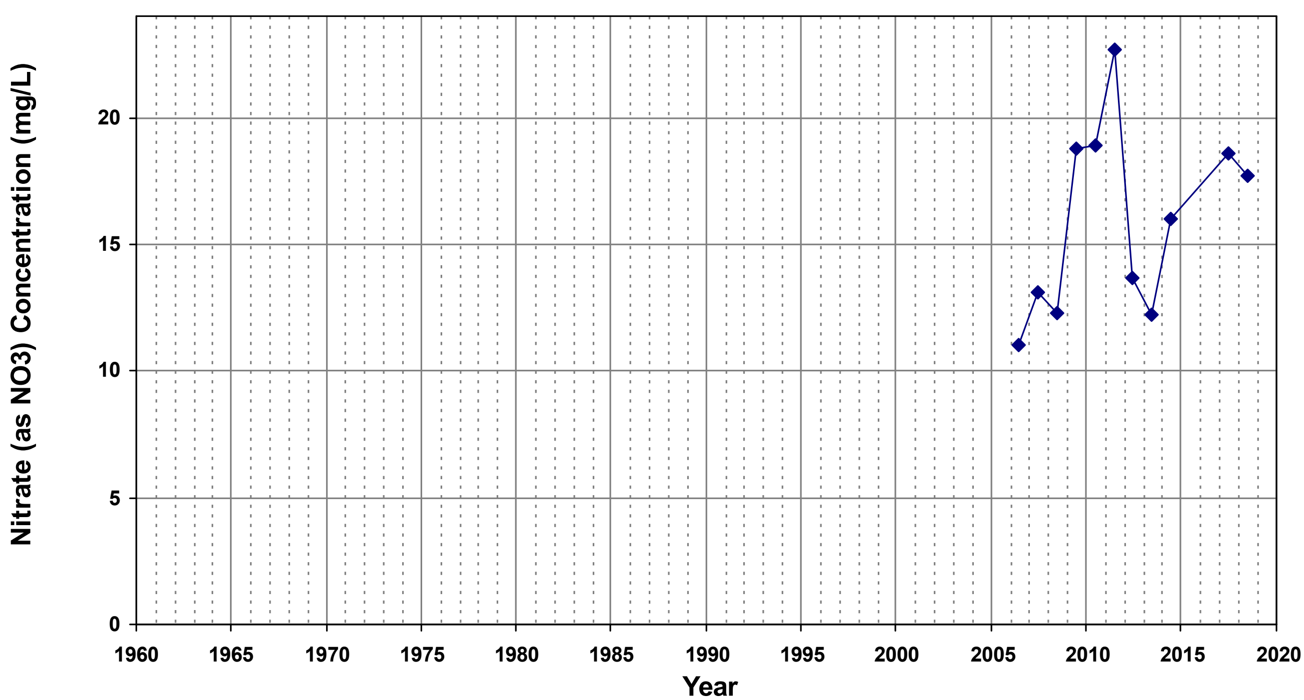
VWD-U6

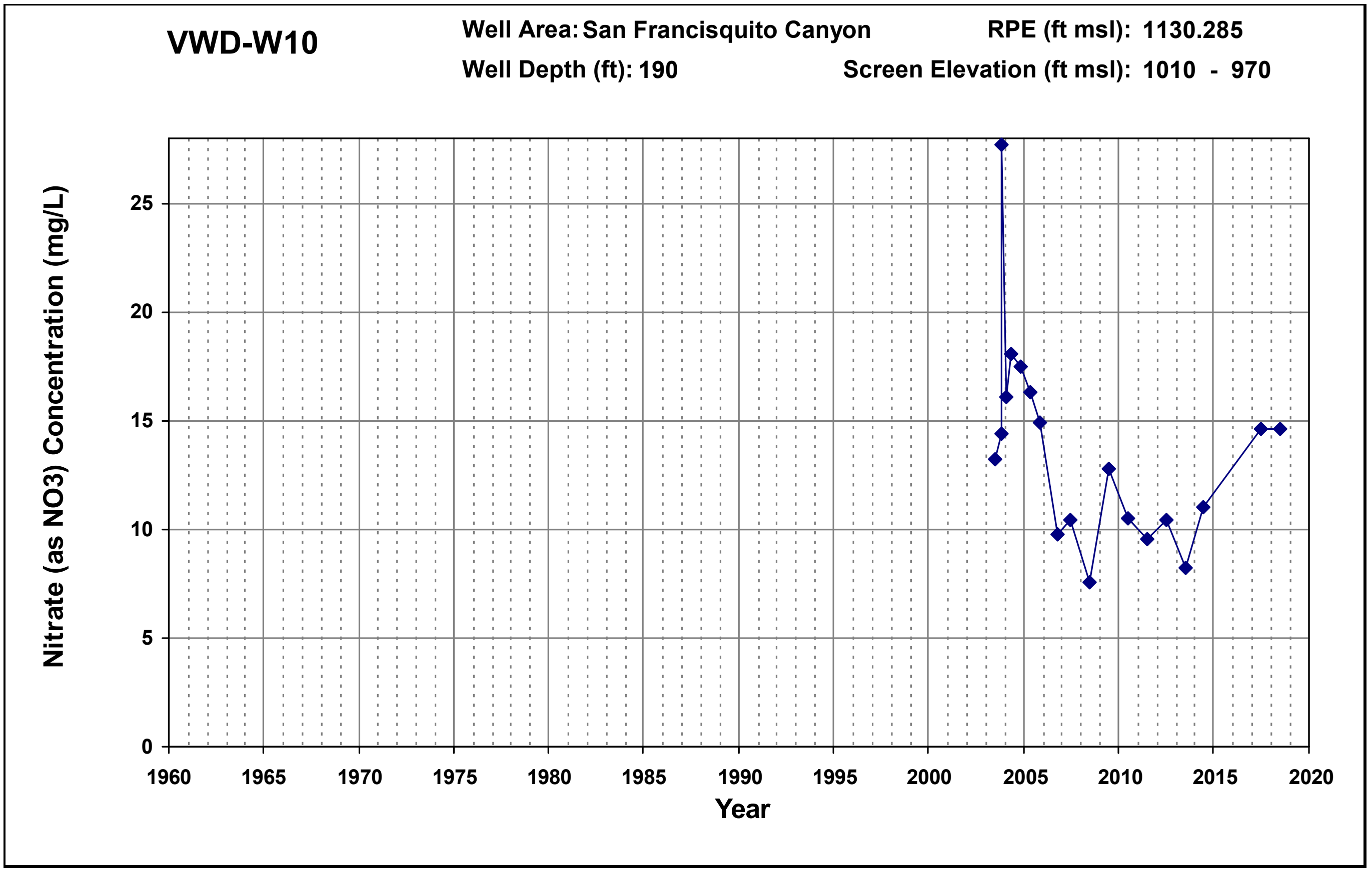
Well Area: Above Saugus WRP

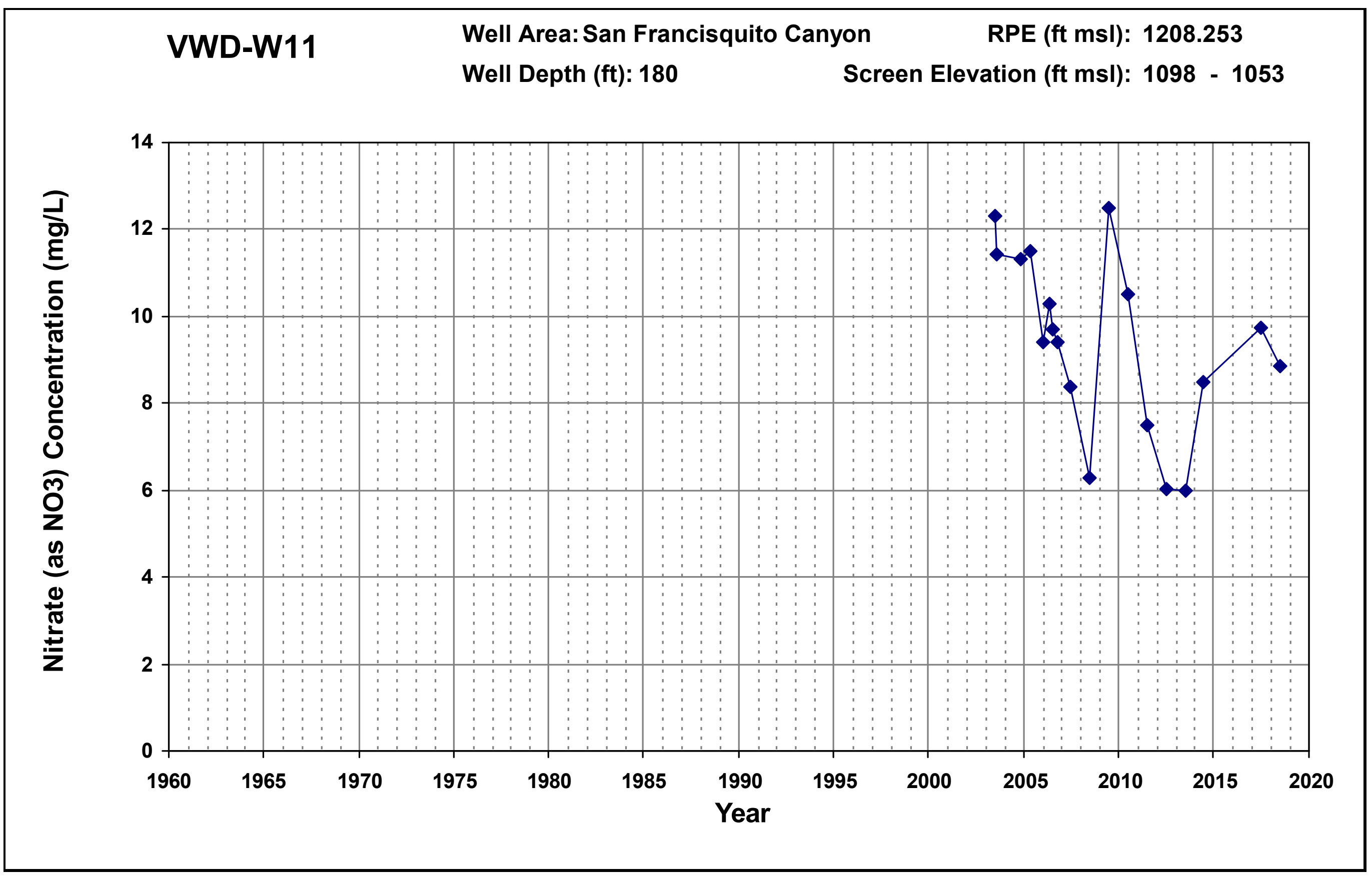
Well Depth (ft): 175

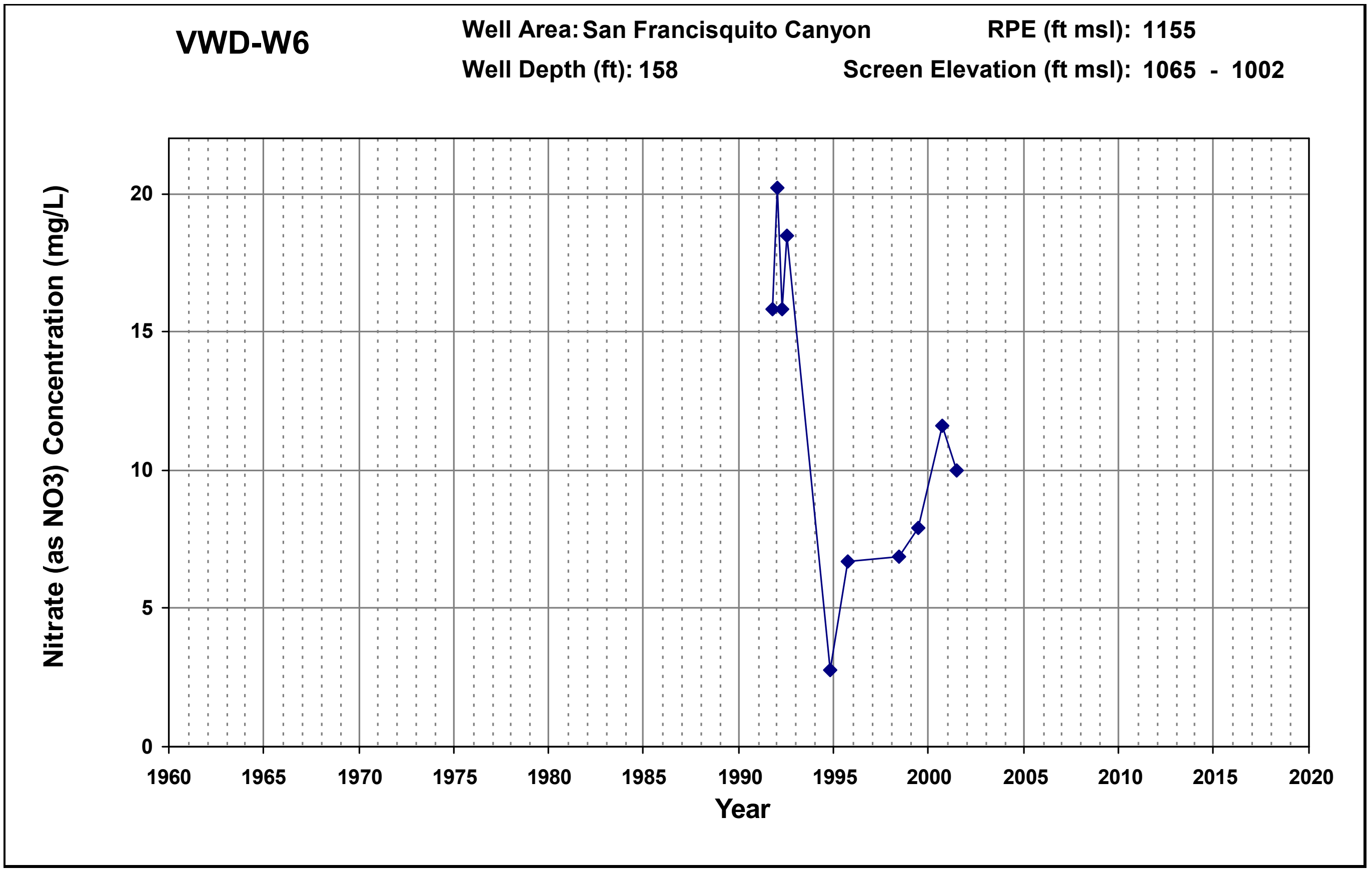
RPE (ft msl): 1230.6

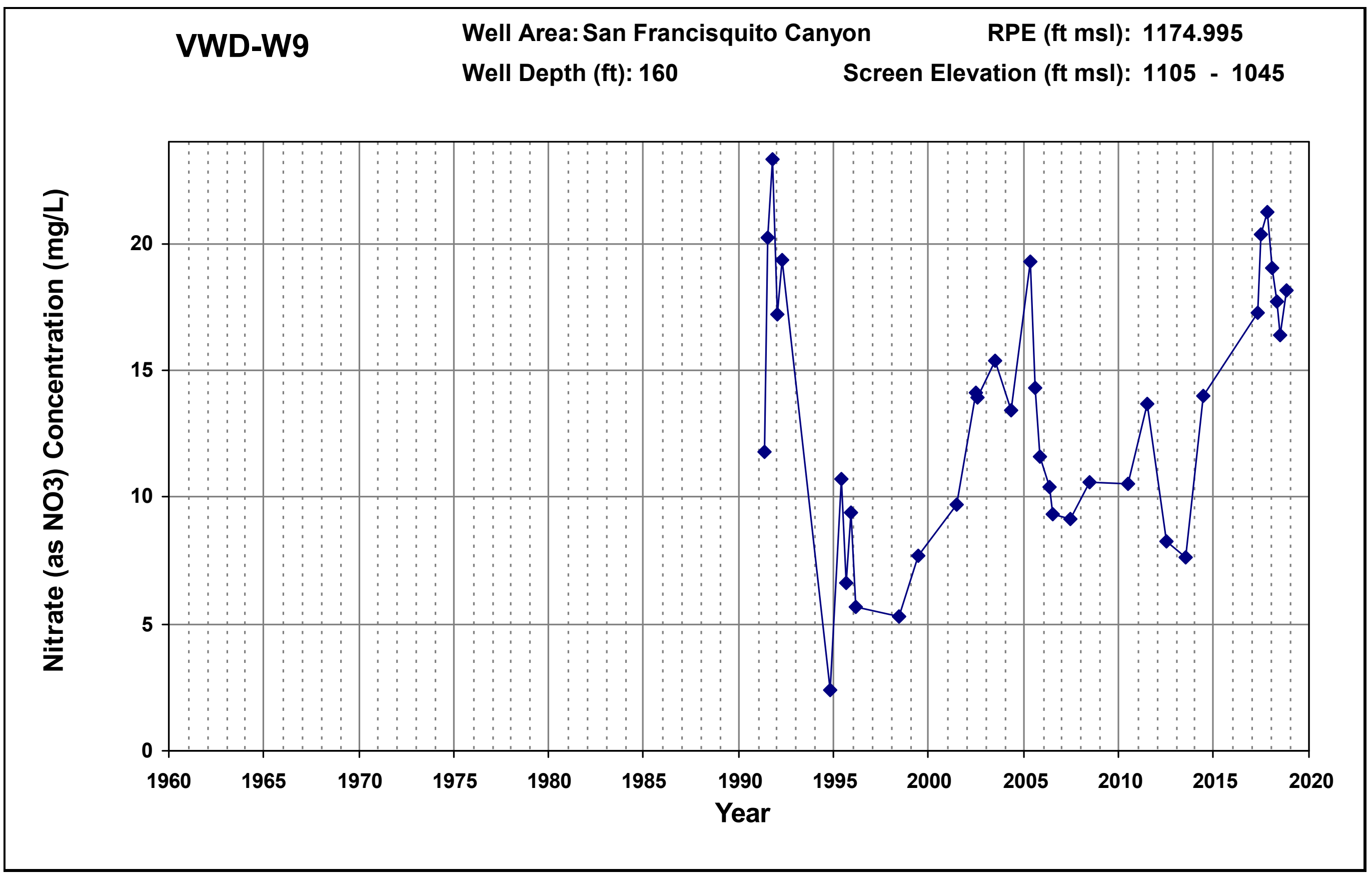
Screen Elevation (ft msl): 1131 - 1086

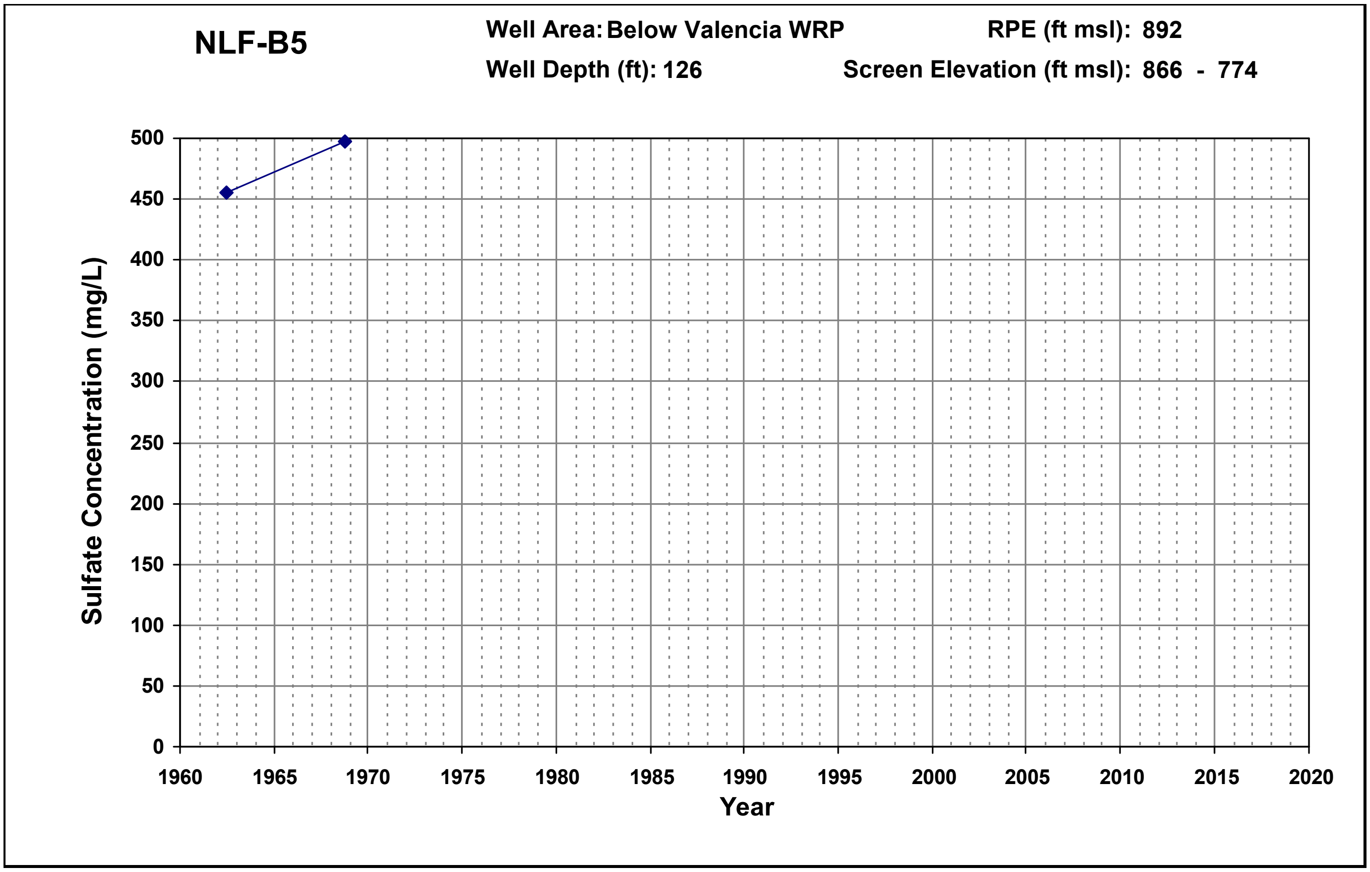


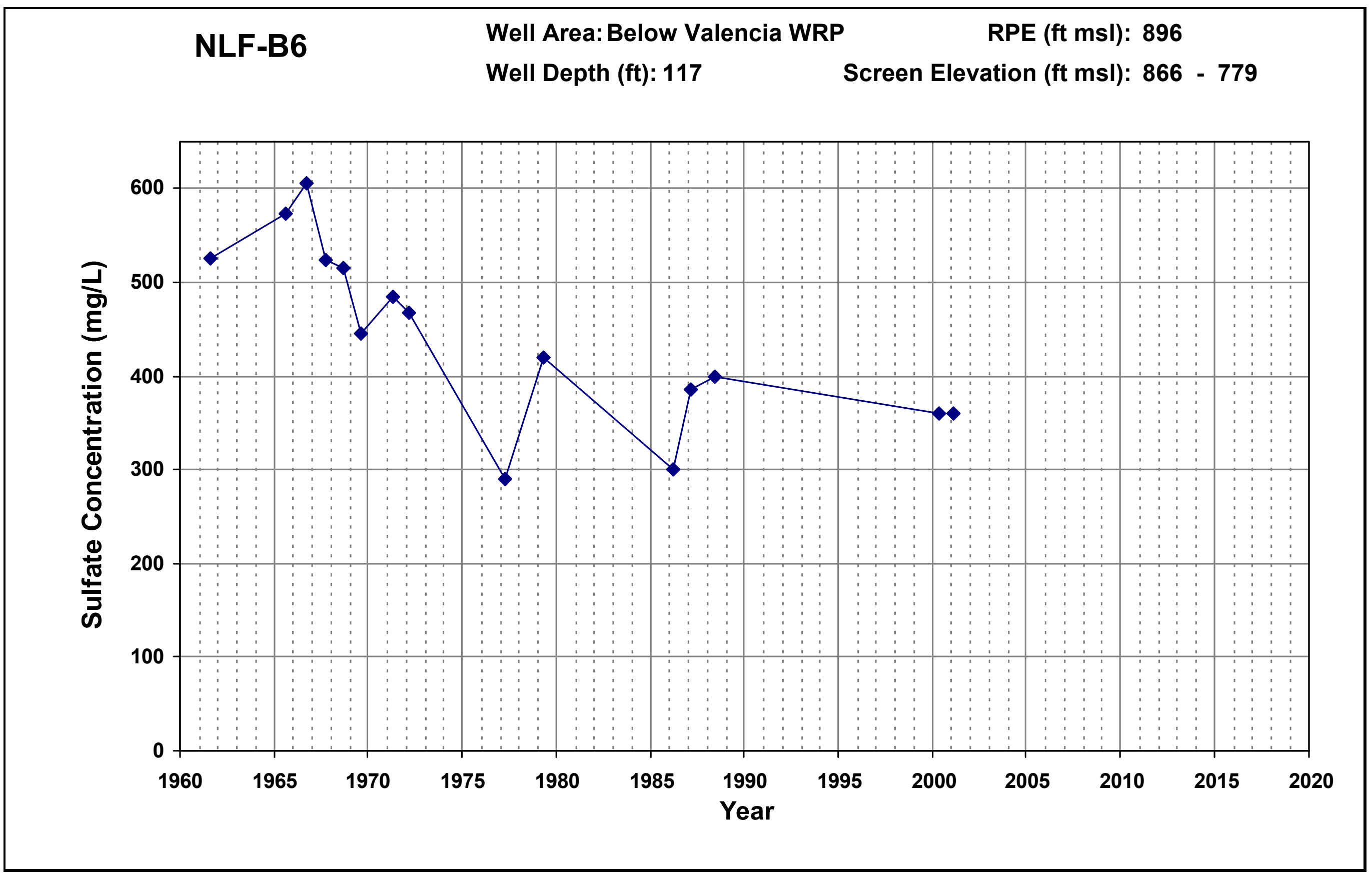

VWD-W10
Well Area: San Francisquito Canyon
RPE (ft msl): 1130.285
Well Depth (ft): 190
Screen Elevation (ft msl): 1010 - 970
Nitrate (as NO3) Concentration (mg/L)
0
5
10
15
20
25
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

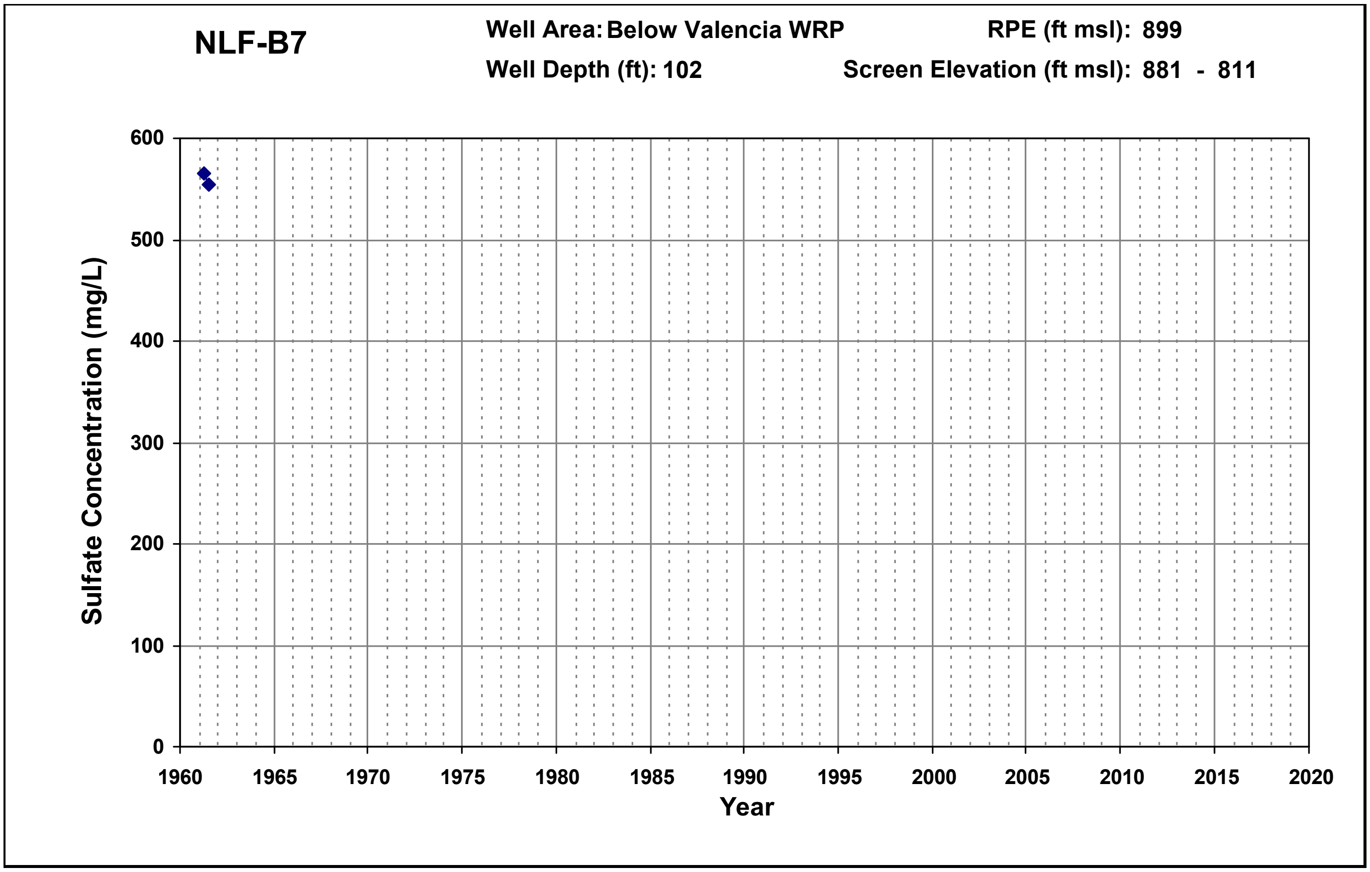

VWD-W11
Well Area: San Francisquito Canyon
RPE (ft msl): 1208.253
Well Depth (ft): 180
Screen Elevation (ft msl): 1098 - 1053
Nitrate (as NO3) Concentration (mg/L)
0
2
4
6
8
10
12
14
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

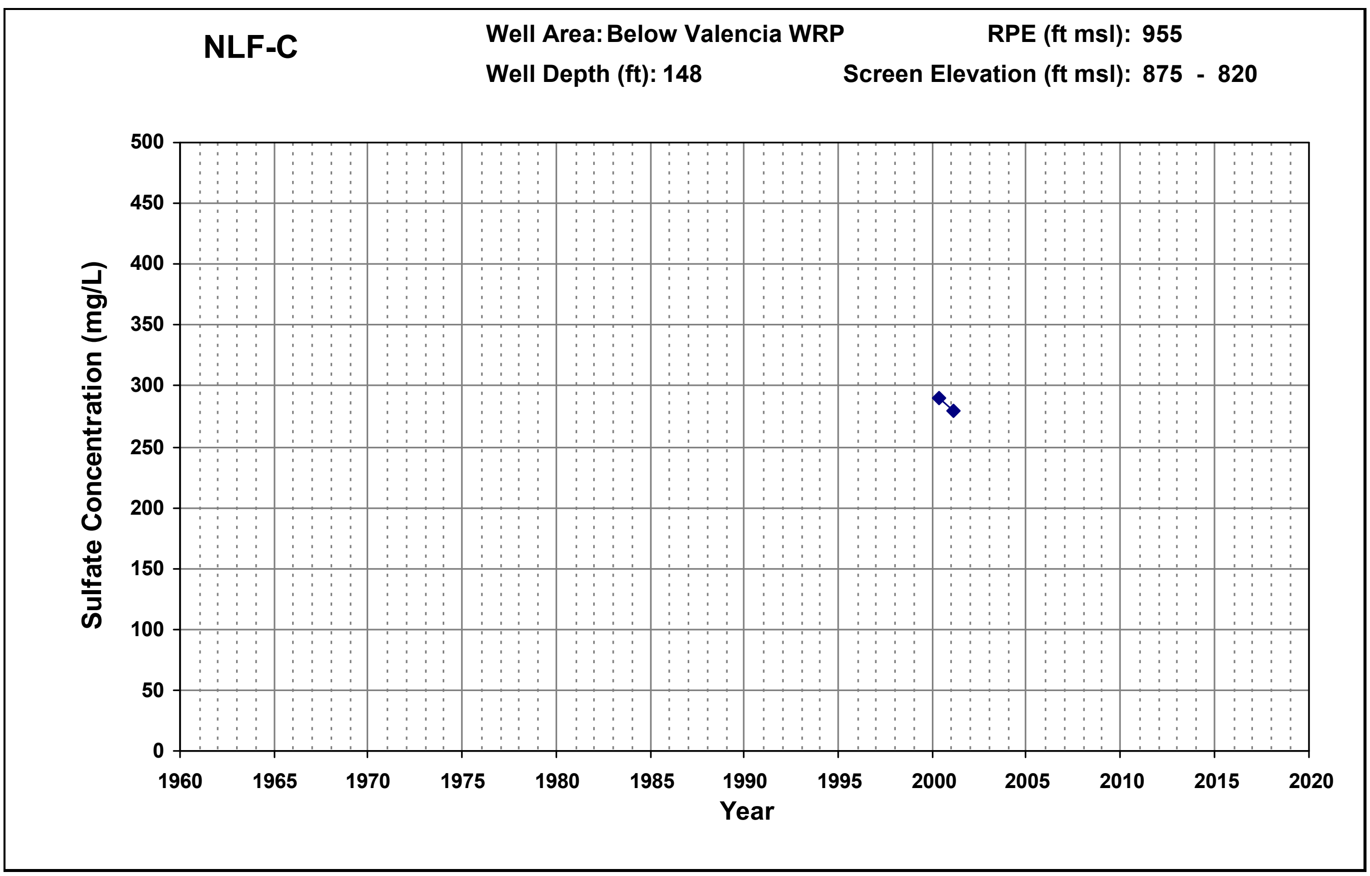

VWD-W6
Well Area: San Francisquito Canyon
RPE (ft msl): 1155
Well Depth (ft): 158
Screen Elevation (ft msl): 1065 - 1002
Nitrate (as NO3) Concentration (mg/L)
0
5
10
15
20
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

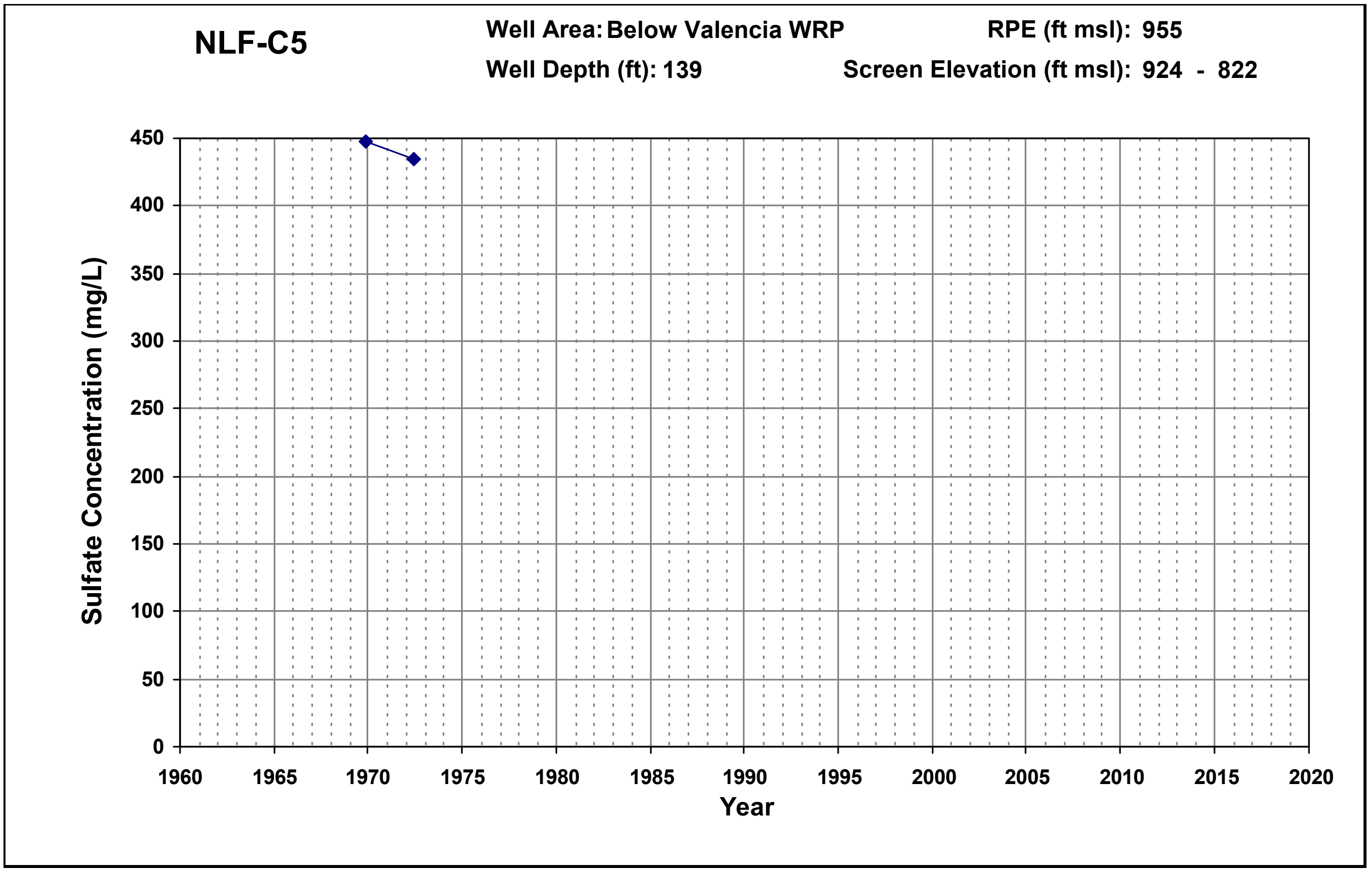

VWD-W9
Well Area: San Francisquito Canyon
RPE (ft msl): 1174.995
Well Depth (ft): 160
Screen Elevation (ft msl): 1105 - 1045
Nitrate (as NO3) Concentration (mg/L)
0
5
10
15
20
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

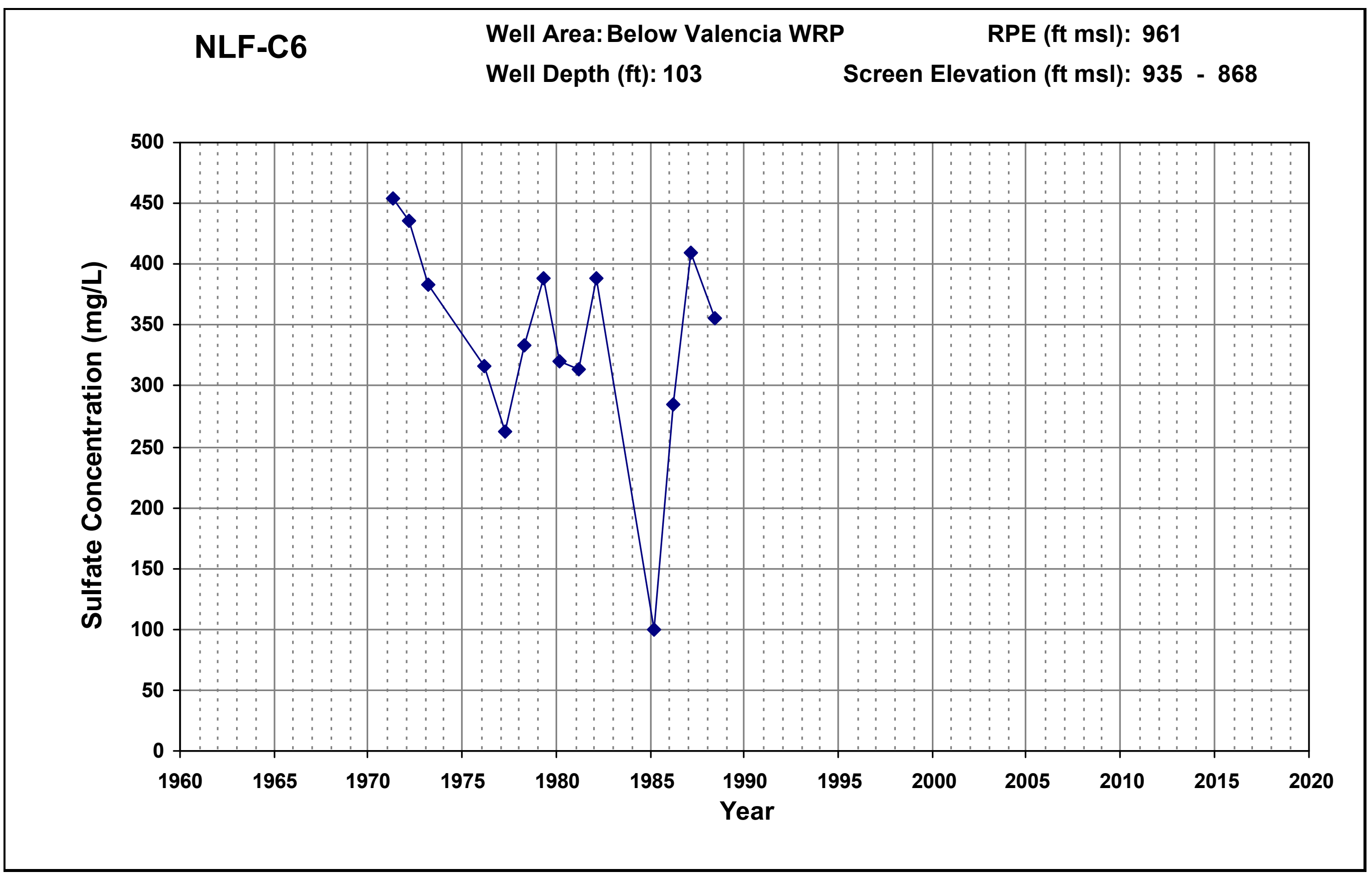

NLF-B5
Well Area: Below Valencia WRP
RPE (ft msl): 892
Well Depth (ft): 126
Screen Elevation (ft msl): 866 - 774
Sulfate Concentration (mg/L)
0
50
100
150
200
250
300
350
400
450
500
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

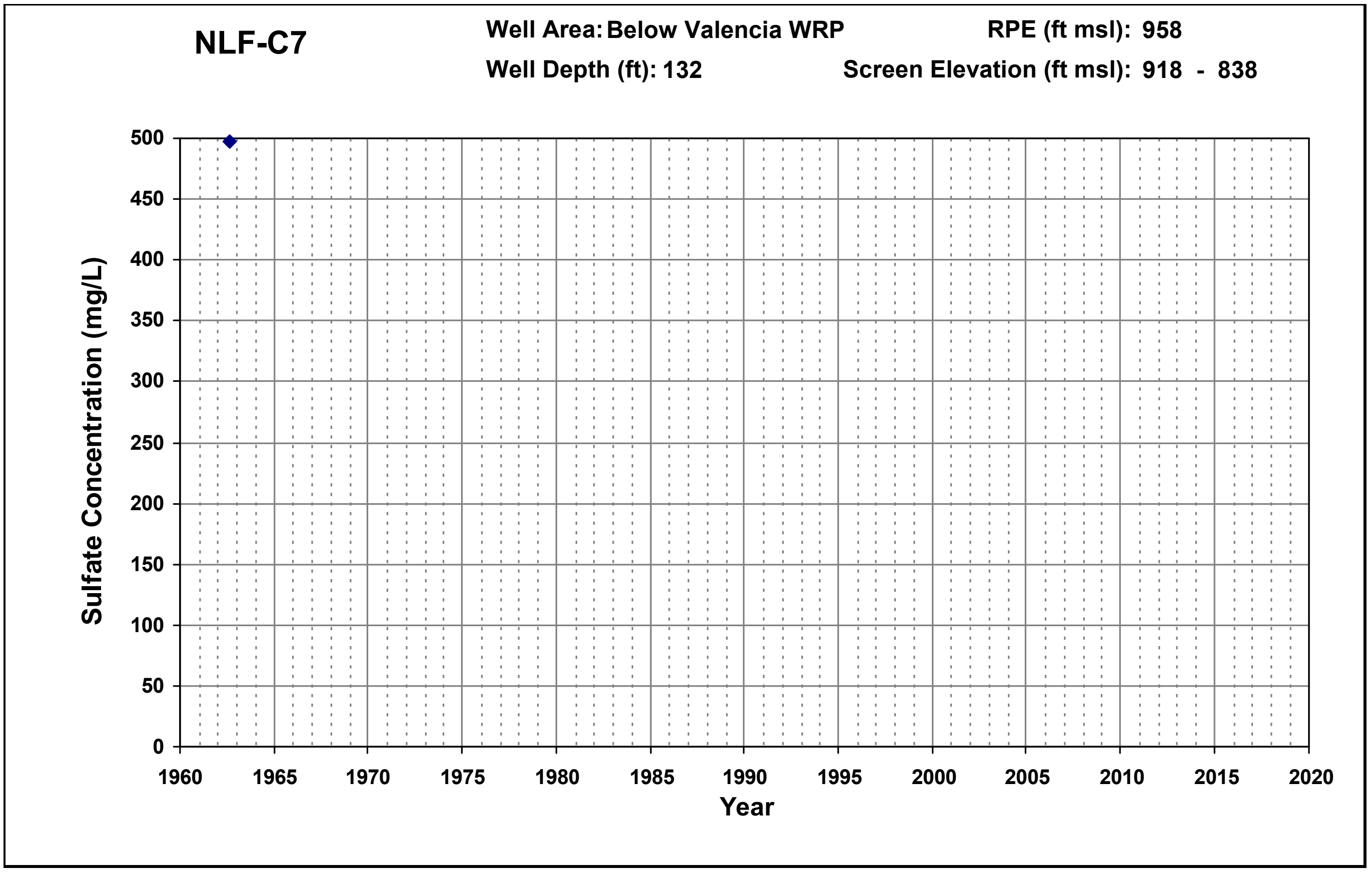

NLF-B6
Well Area: Below Valencia WRP
RPE (ft msl): 896
Well Depth (ft): 117
Screen Elevation (ft msl): 866 - 779
Sulfate Concentration (mg/L)
0
100
200
300
400
500
600
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

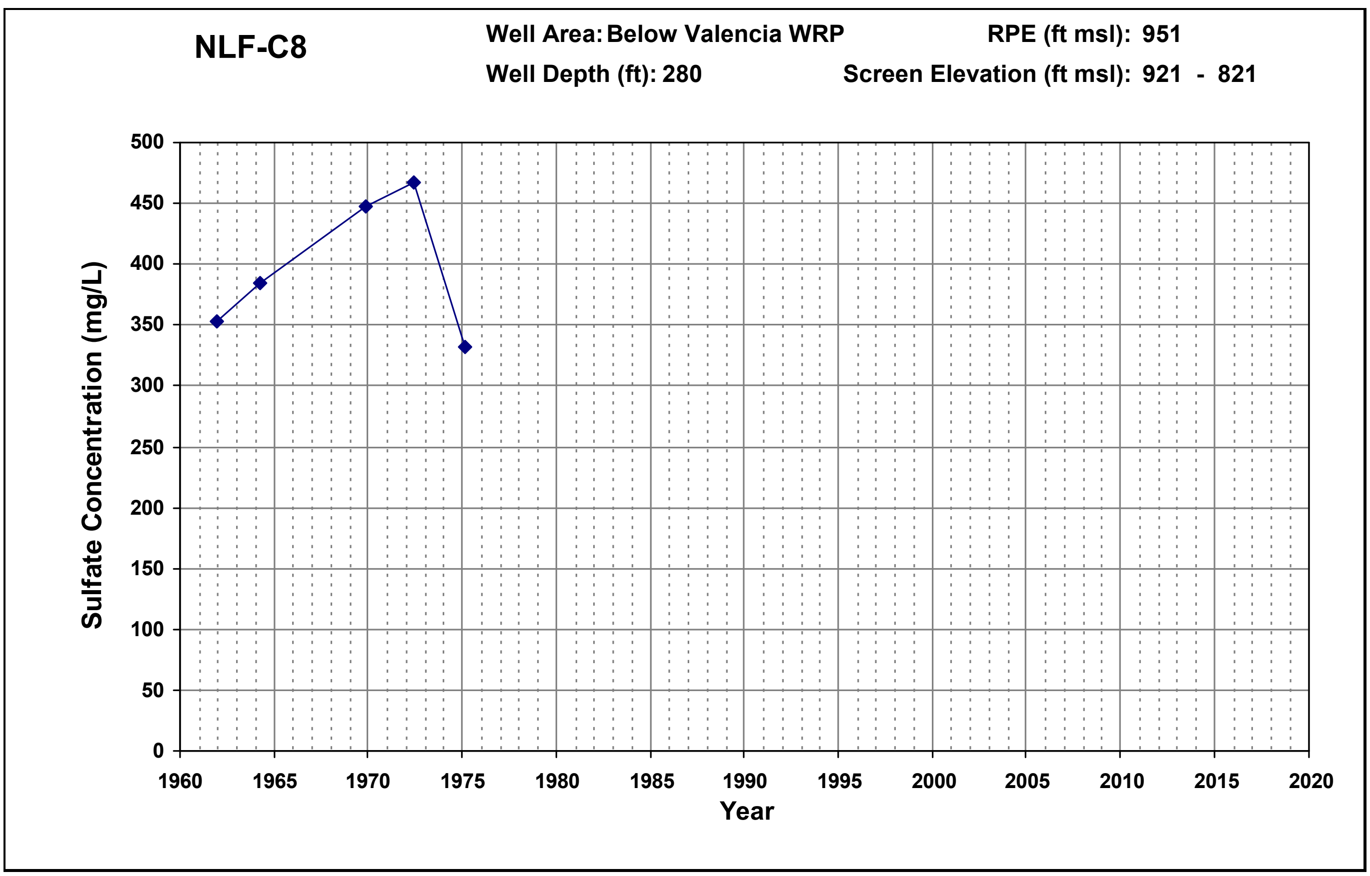

NLF-B7
Well Area: Below Valencia WRP
RPE (ft msl): 899
Well Depth (ft): 102
Screen Elevation (ft msl): 881 - 811
Sulfate Concentration (mg/L)
0
100
200
300
400
500
600
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year


NLF-C
Well Area: Below Valencia WRP
RPE (ft msl): 955
Well Depth (ft): 148
Screen Elevation (ft msl): 875 - 820
Sulfate Concentration (mg/L)
0
50
100
150
200
250
300
350
400
450
500
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year


NLF-C5
Well Area: Below Valencia WRP
RPE (ft msl): 955
Well Depth (ft): 139
Screen Elevation (ft msl): 924 - 822
Sulfate Concentration (mg/L)
0
50
100
150
200
250
300
350
400
450
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year


NLF-C6
Well Area: Below Valencia WRP
RPE (ft msl): 961
Well Depth (ft): 103
Screen Elevation (ft msl): 935 - 868
Sulfate Concentration (mg/L)
0
50
100
150
200
250
300
350
400
450
500
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year


NLF-C7
Well Area: Below Valencia WRP
RPE (ft msl): 958
Well Depth (ft): 132
Screen Elevation (ft msl): 918 - 838
Sulfate Concentration (mg/L)
500
450
400
350
300
250
200
150
100
50
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year


NLF-C8
Well Area: Below Valencia WRP
RPE (ft msl): 951
Well Depth (ft): 280
Screen Elevation (ft msl): 921 - 821
Sulfate Concentration (mg/L)
500
450
400
350
300
250
200
150
100
50
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

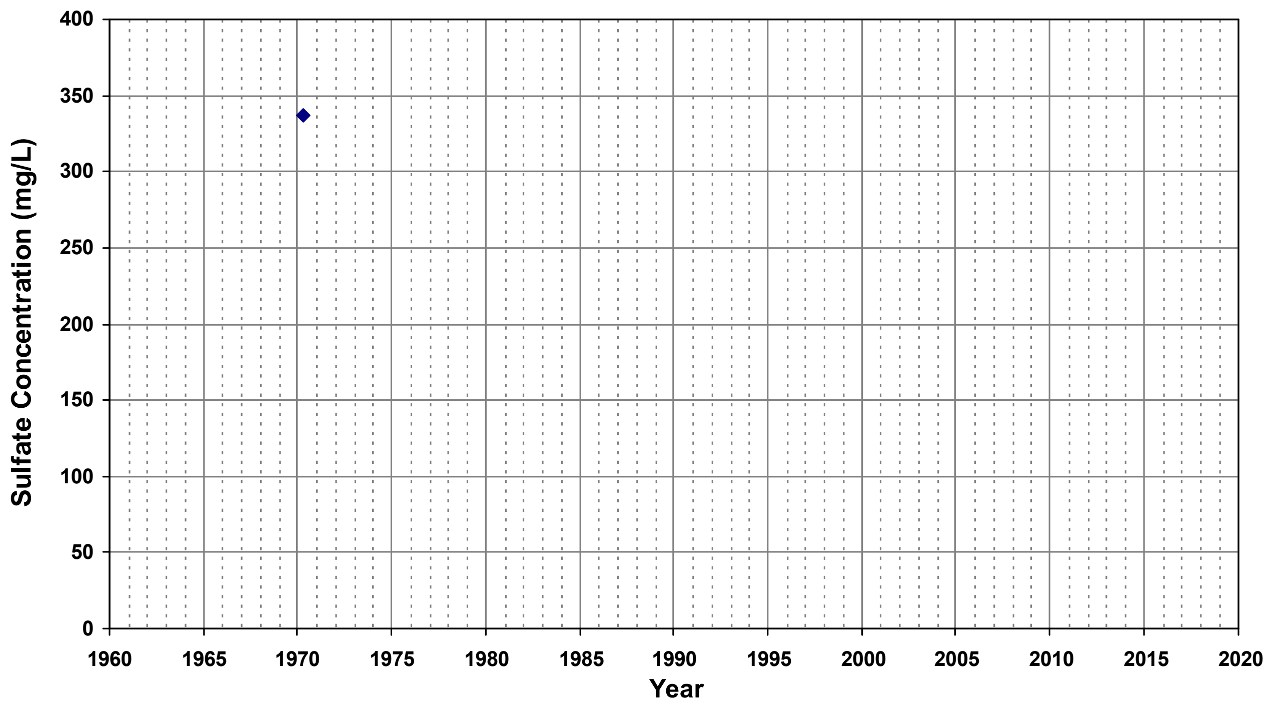
NLF-E3

Well Area: Below Valencia WRP

RPE (ft msl): 991

Well Depth (ft): 255

Screen Elevation (ft msl): 944 - 757



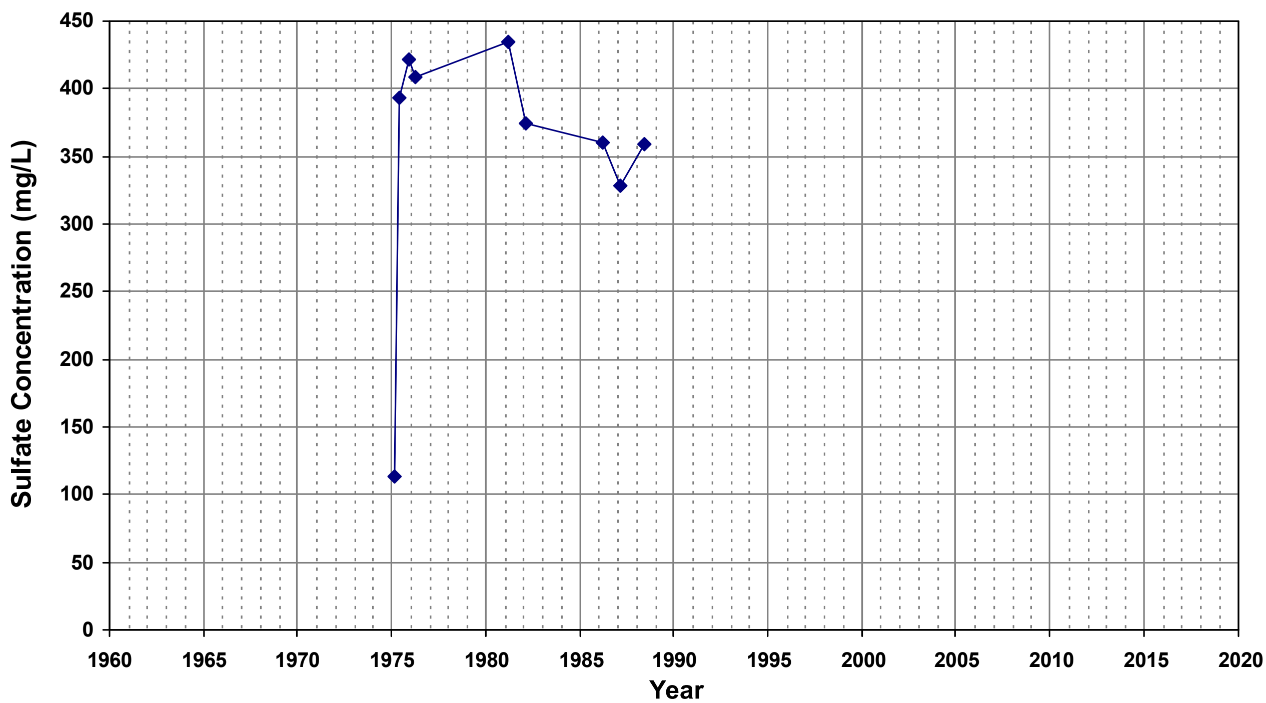
NLF-E4

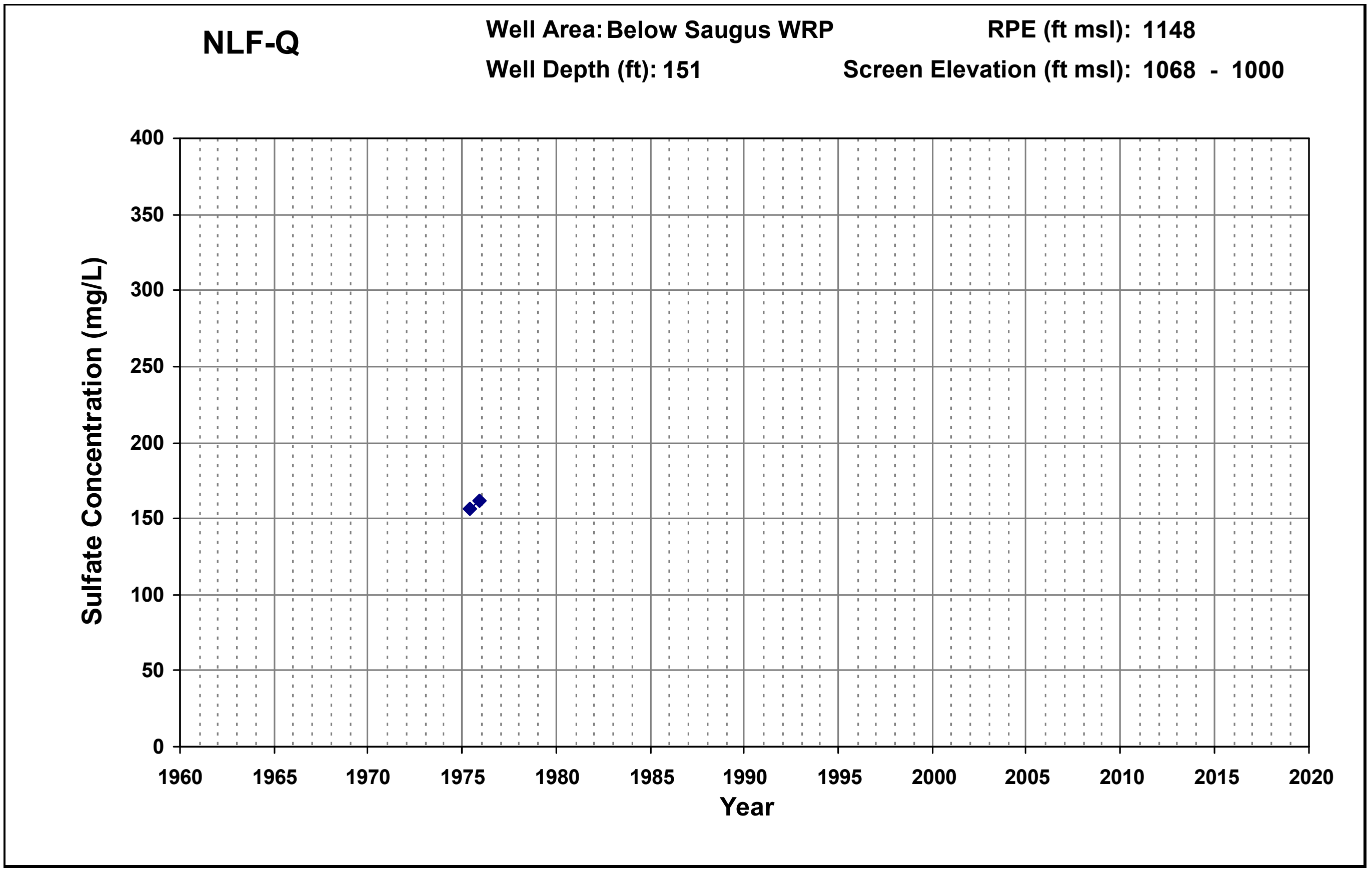
Well Area: Below Valencia WRP

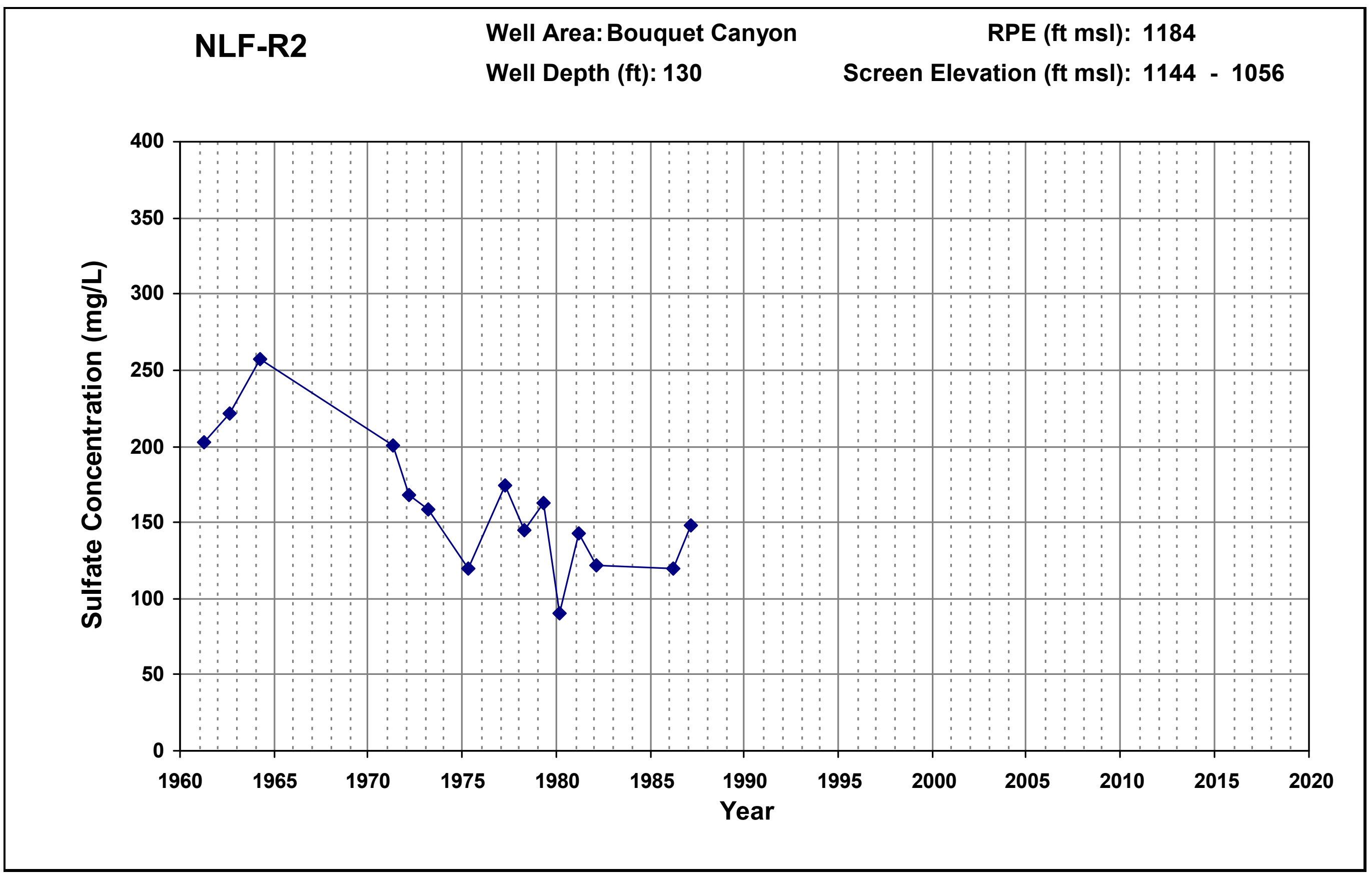
RPE (ft msl): 991

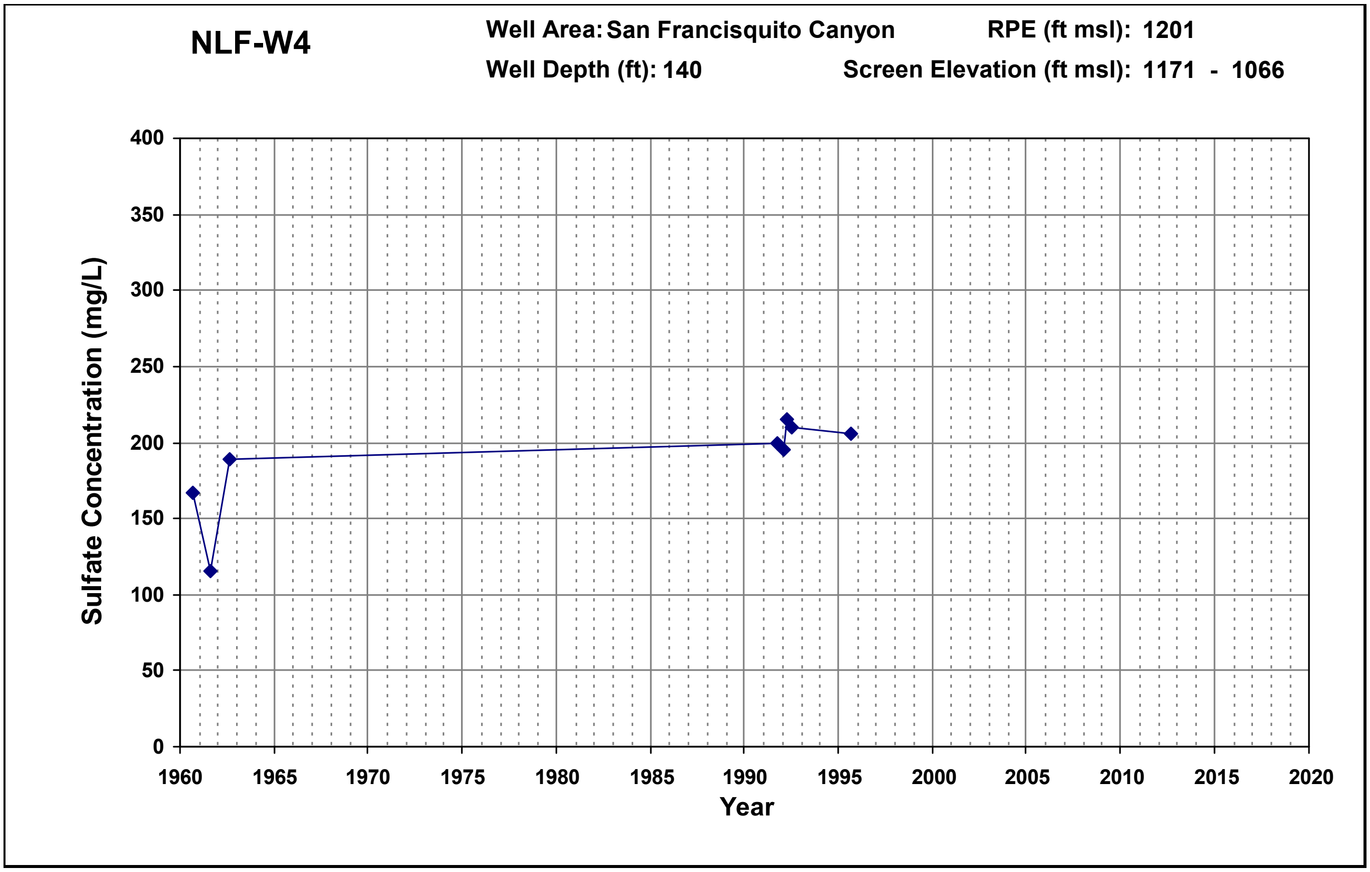
Well Depth (ft): 142

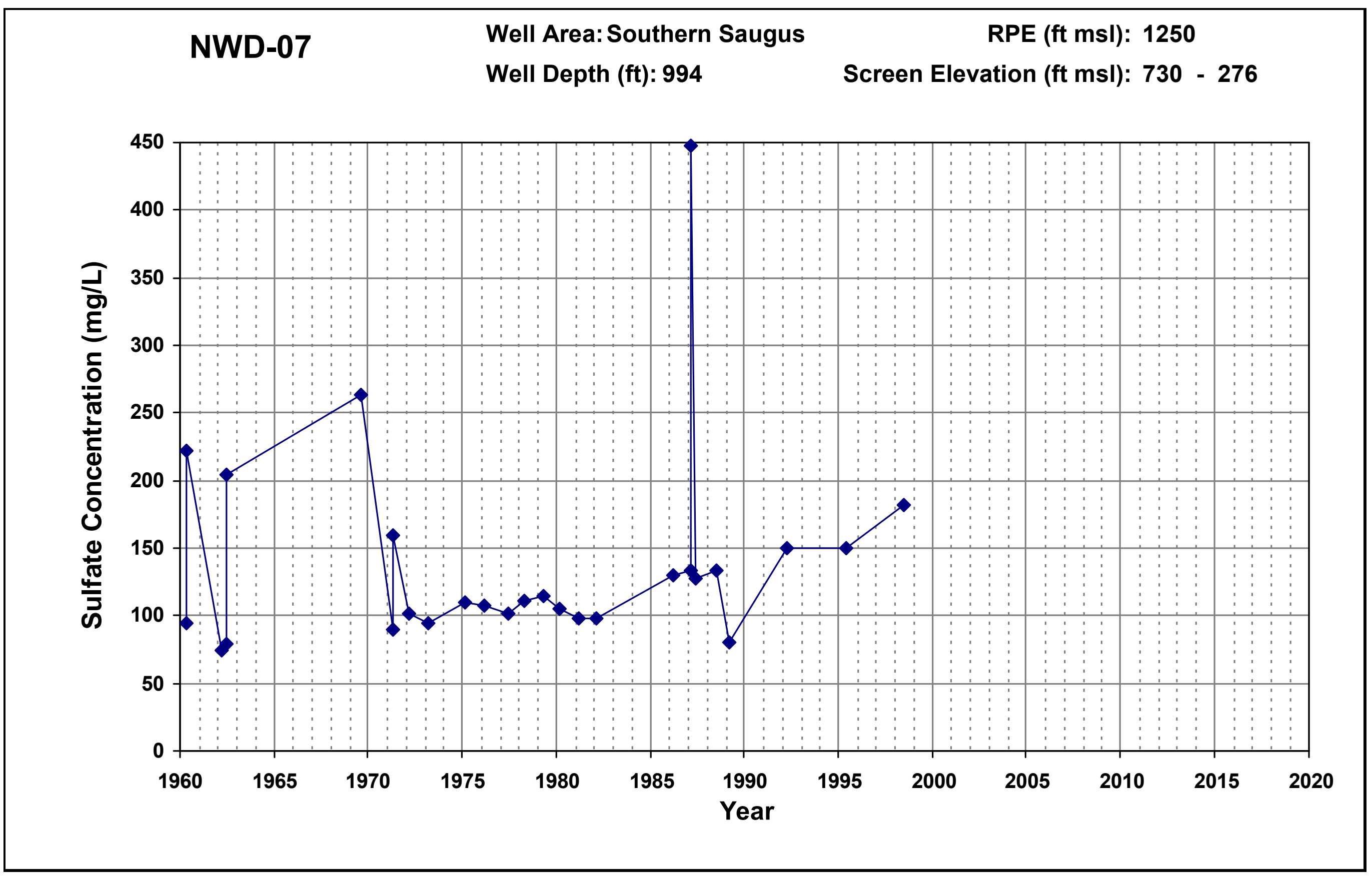
Screen Elevation (ft msl): 941 - 855




NLF-Q
Well Area: Below Saugus WRP
RPE (ft msl): 1148
Well Depth (ft): 151
Screen Elevation (ft msl): 1068 - 1000
Sulfate Concentration (mg/L)
0
50
100
150
200
250
300
350
400
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year


NLF-R2
Well Area: Bouquet Canyon
RPE (ft msl): 1184
Well Depth (ft): 130
Screen Elevation (ft msl): 1144 - 1056
Sulfate Concentration (mg/L)
0
50
100
150
200
250
300
350
400
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year


NLF-W4
Well Area: San Francisquito Canyon
RPE (ft msl): 1201
Well Depth (ft): 140
Screen Elevation (ft msl): 1171 - 1066
Sulfate Concentration (mg/L)
400
350
300
250
200
150
100
50
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year


NWD-07
Well Area: Southern Saugus
RPE (ft msl): 1250
Well Depth (ft): 994
Screen Elevation (ft msl): 730 - 276
Sulfate Concentration (mg/L)
450
400
350
300
250
200
150
100
50
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

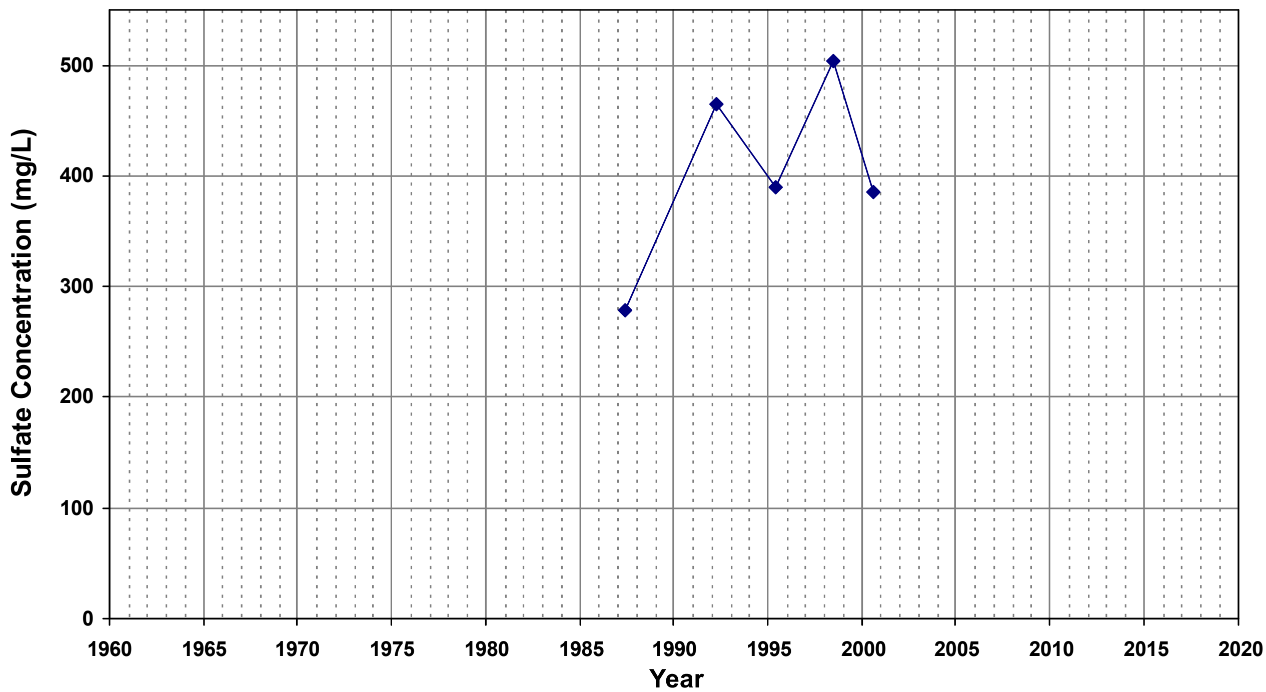
NWD-09

Well Area: Southern Saugus

RPE (ft msl): 1358

Well Depth (ft): 675

Screen Elevation (ft msl): 1047 - 684



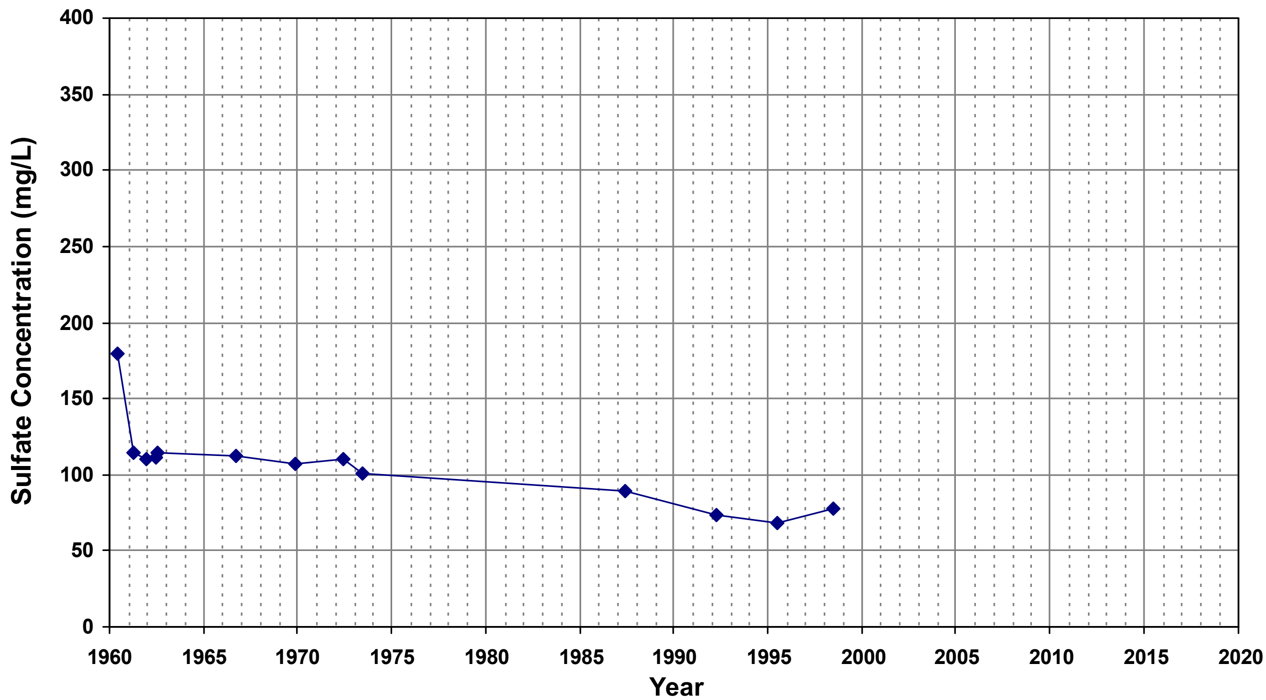
NWD-10

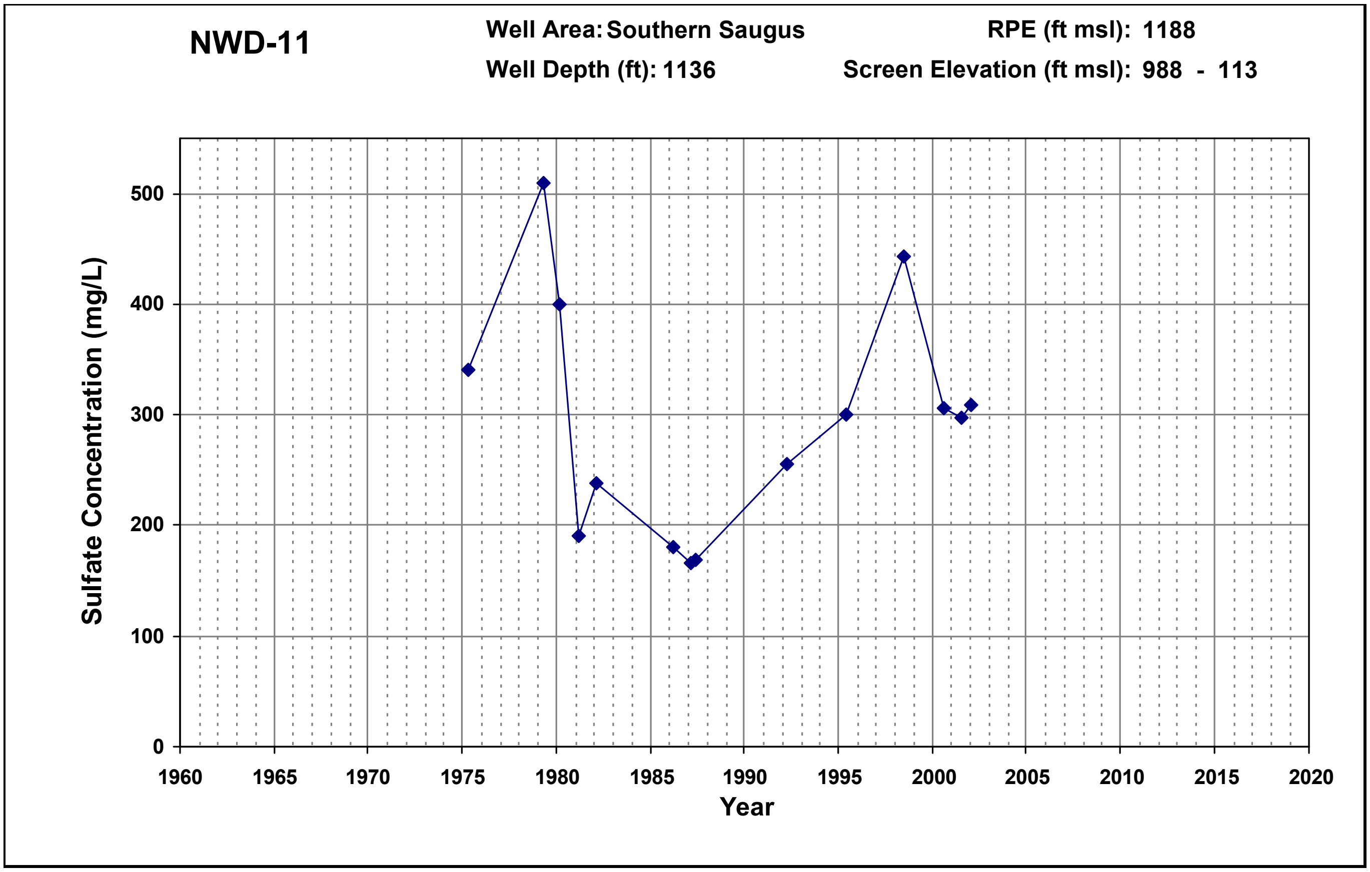
Well Area: Southern Saugus

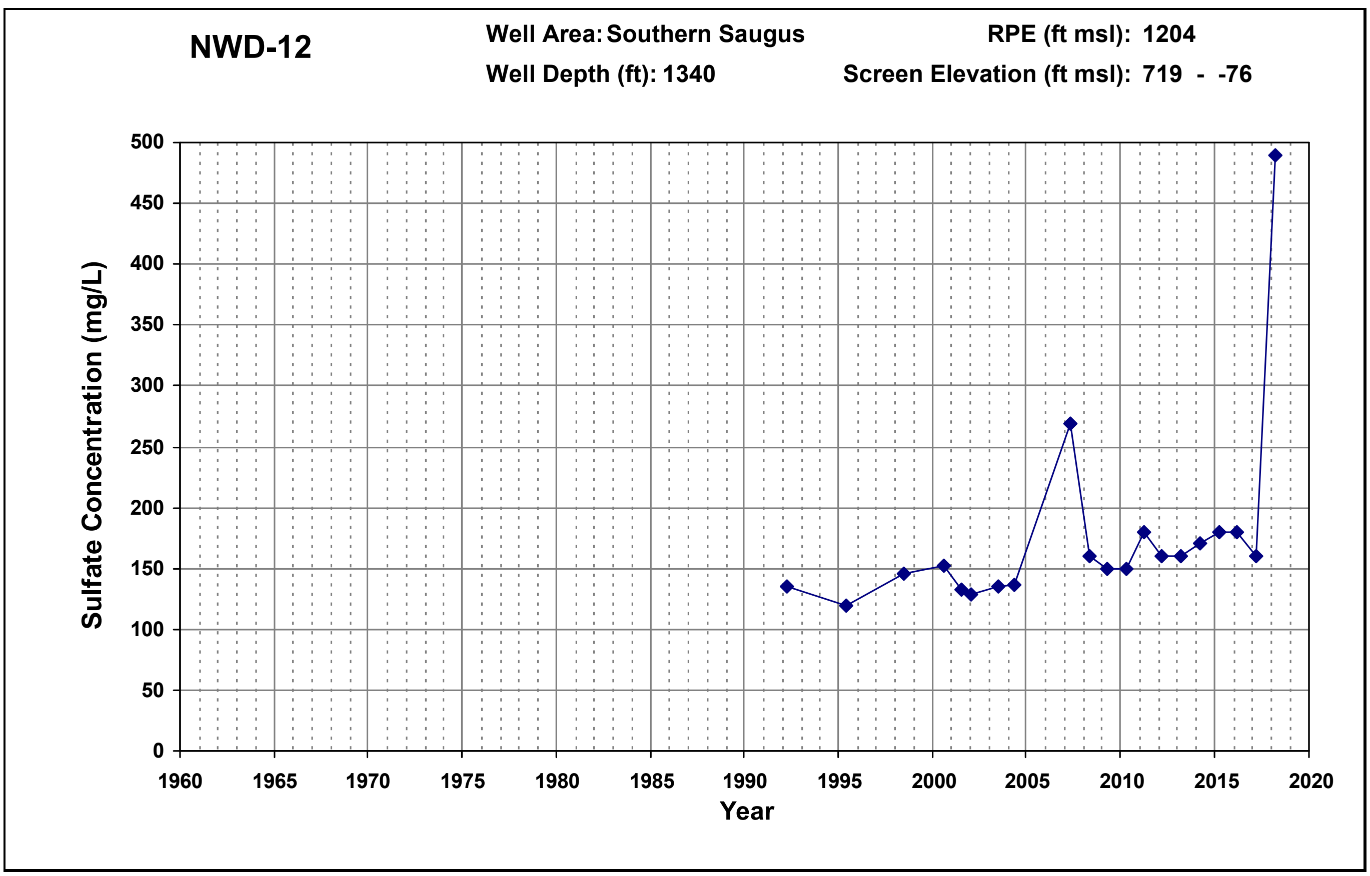
RPE (ft msl): 1204

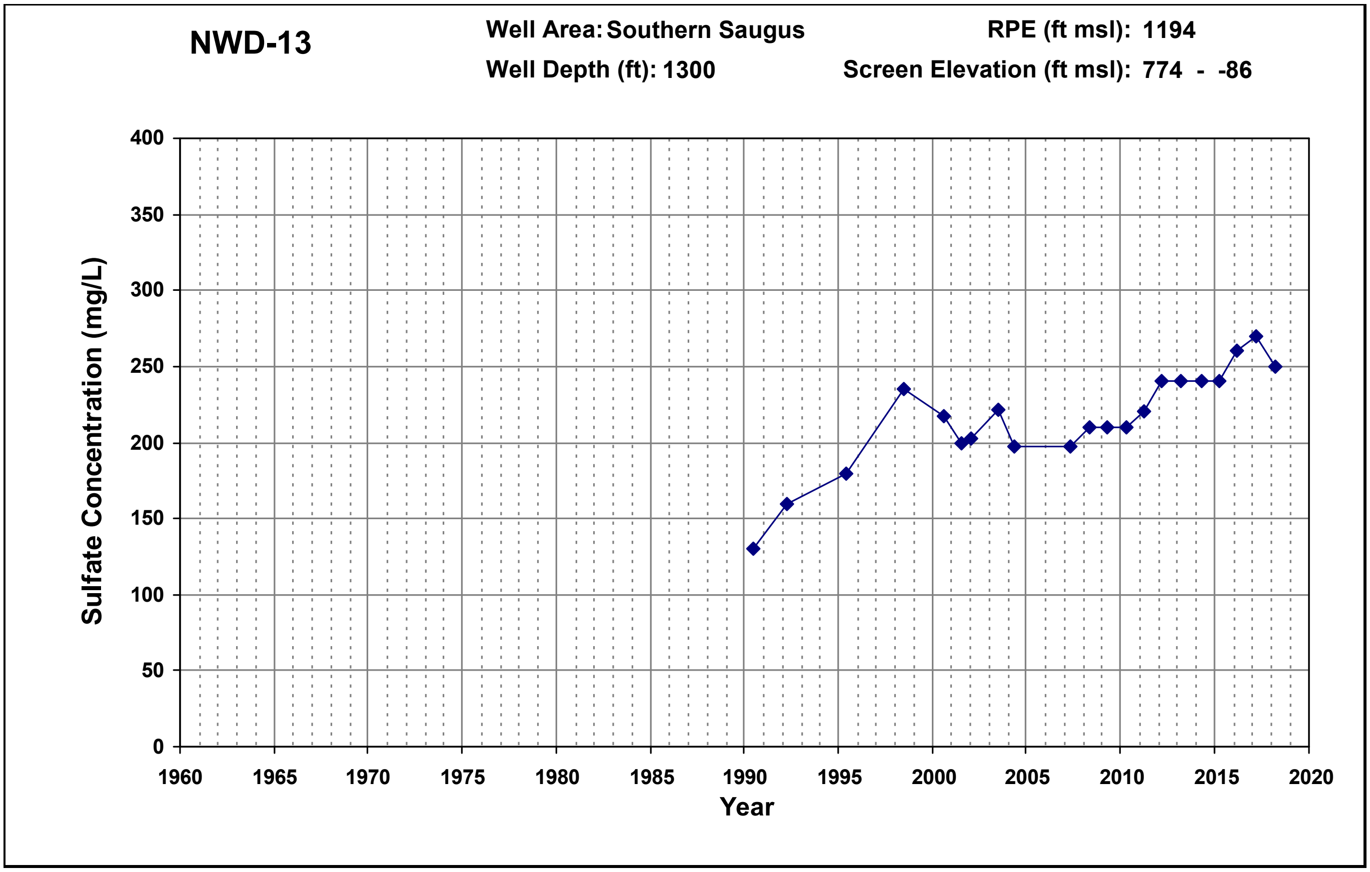
Well Depth (ft): 1555

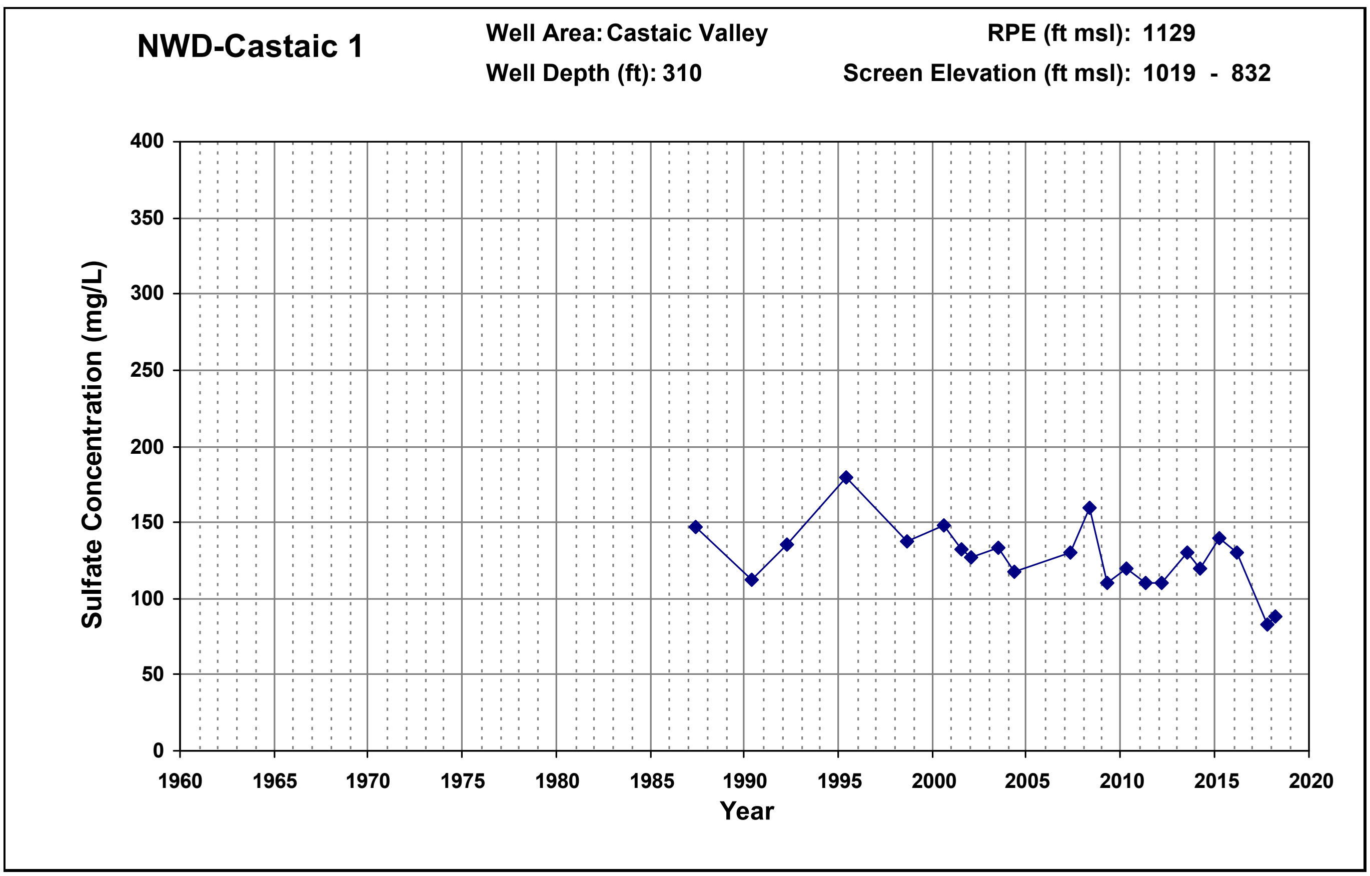
Screen Elevation (ft msl): 424 - -340




NWD-11
Well Area: Southern Saugus
RPE (ft msl): 1188
Well Depth (ft): 1136
Screen Elevation (ft msl): 988 - 113
Sulfate Concentration (mg/L)
0
100
200
300
400
500
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year


NWD-12
Well Area: Southern Saugus
RPE (ft msl): 1204
Well Depth (ft): 1340
Screen Elevation (ft msl): 719 - -76
Sulfate Concentration (mg/L)
0
50
100
150
200
250
300
350
400
450
500
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year


NWD-13
Well Area: Southern Saugus
RPE (ft msl): 1194
Well Depth (ft): 1300
Screen Elevation (ft msl): 774 - -86
Sulfate Concentration (mg/L)
0
50
100
150
200
250
300
350
400
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year


NWD-Castaic 1
Well Area: Castaic Valley
RPE (ft msl): 1129
Well Depth (ft): 310
Screen Elevation (ft msl): 1019 - 832
Sulfate Concentration (mg/L)
0
50
100
150
200
250
300
350
400
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

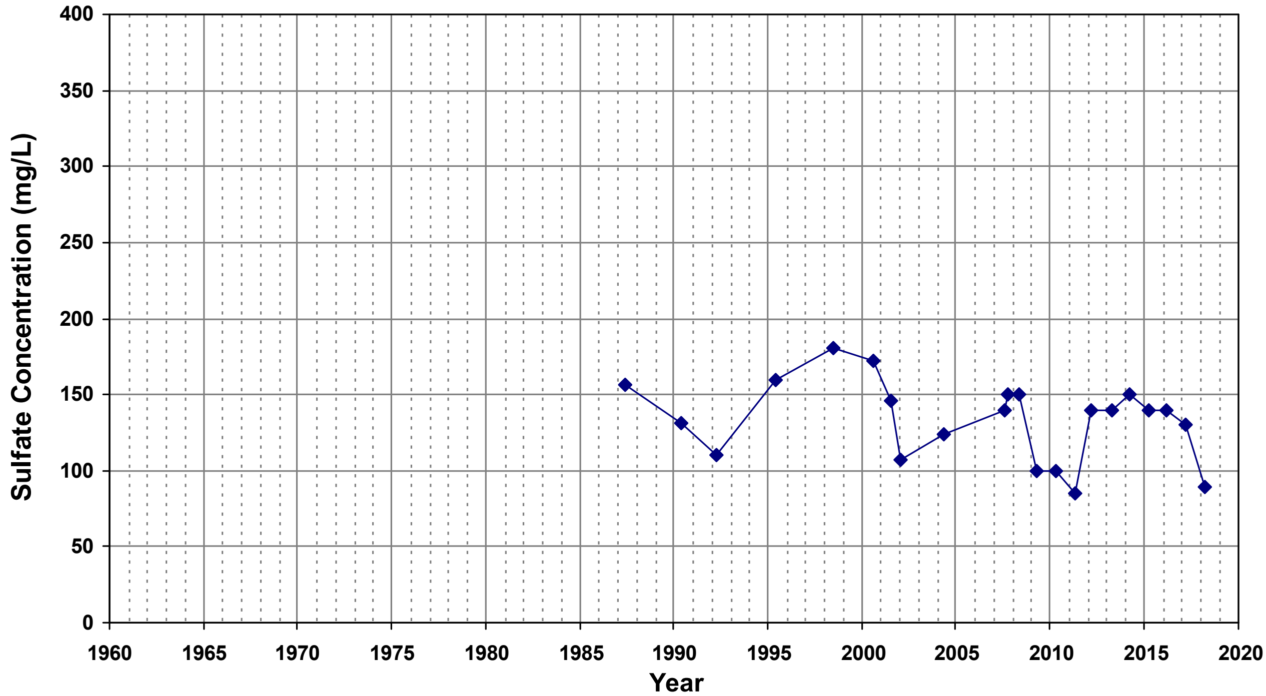
NWD-Castaic 2

Well Area: Castaic Valley

Well Depth (ft): 120

RPE (ft msl): 1135

Screen Elevation (ft msl): Unknown



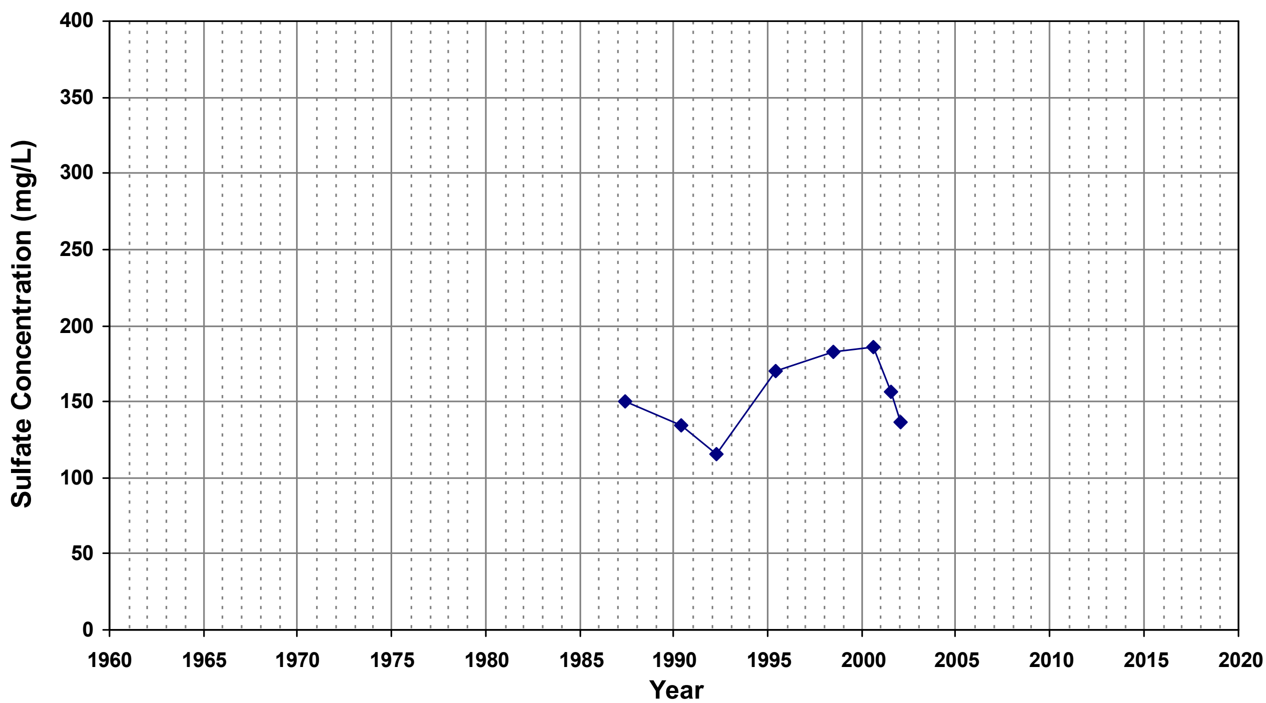
NWD-Castaic 3

Well Area: Castaic Valley

Well Depth (ft): 135

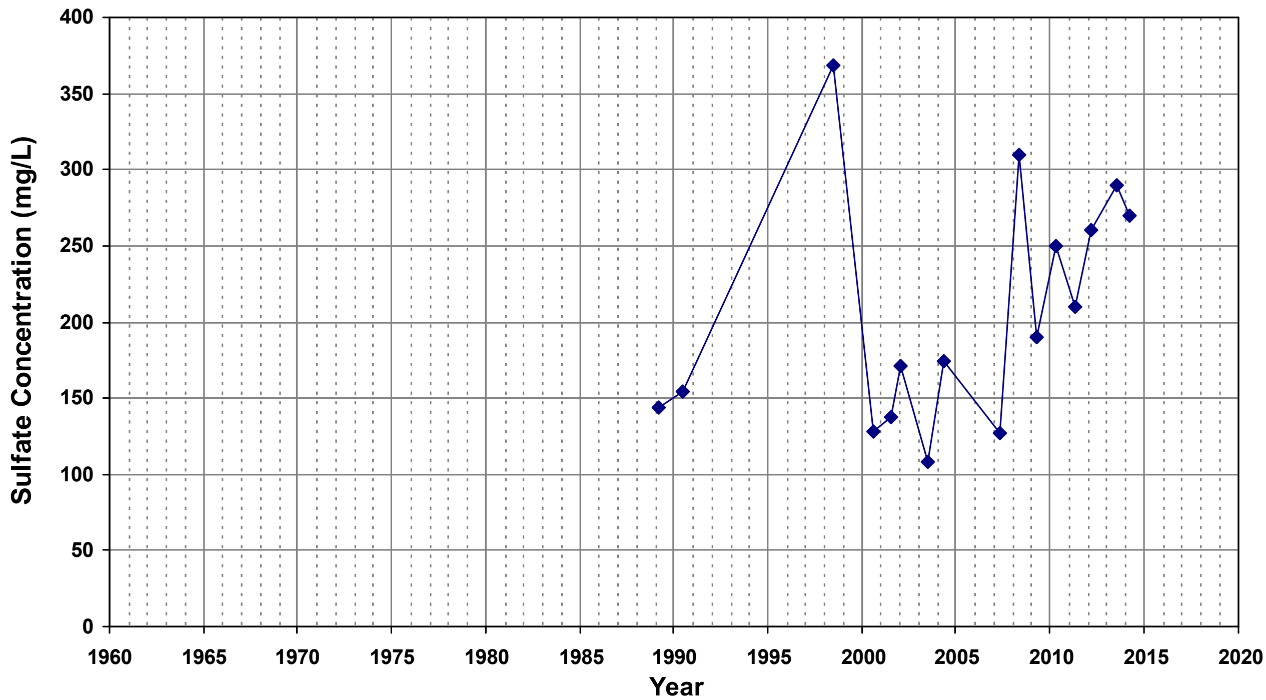
RPE (ft msl): 1135

Screen Elevation (ft msl): 1080 - 999



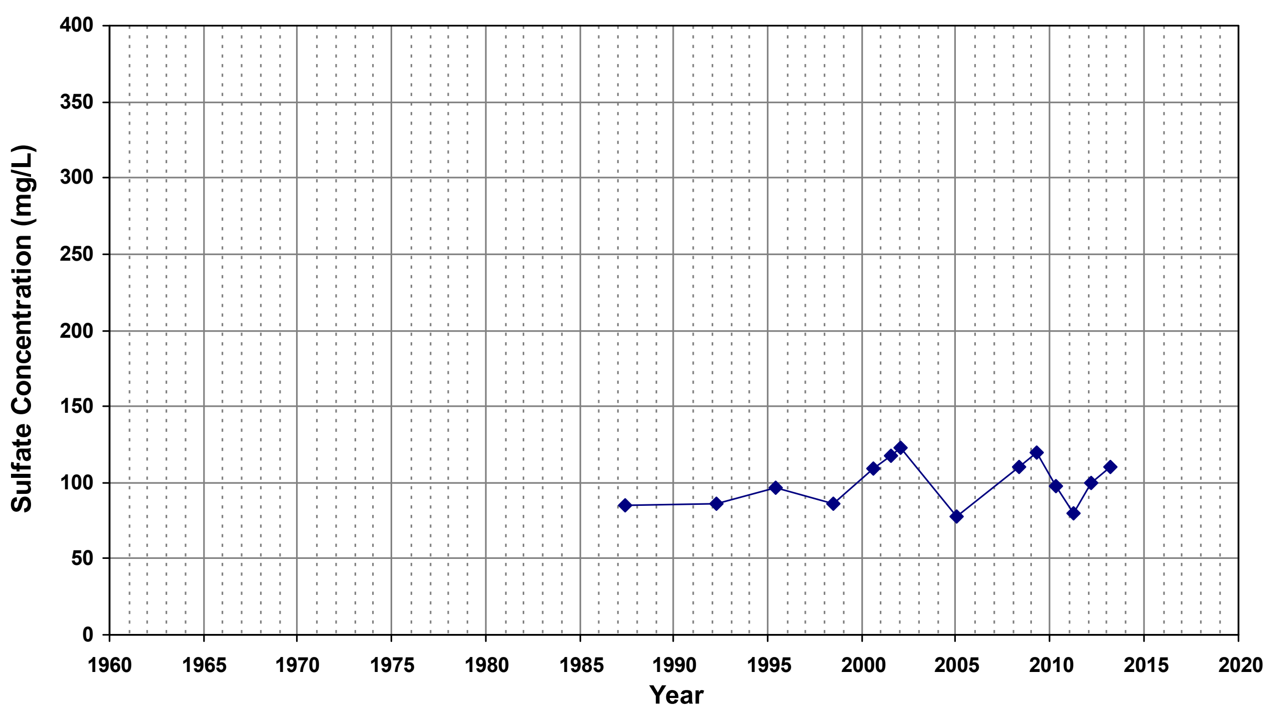
NWD-Castaic 4

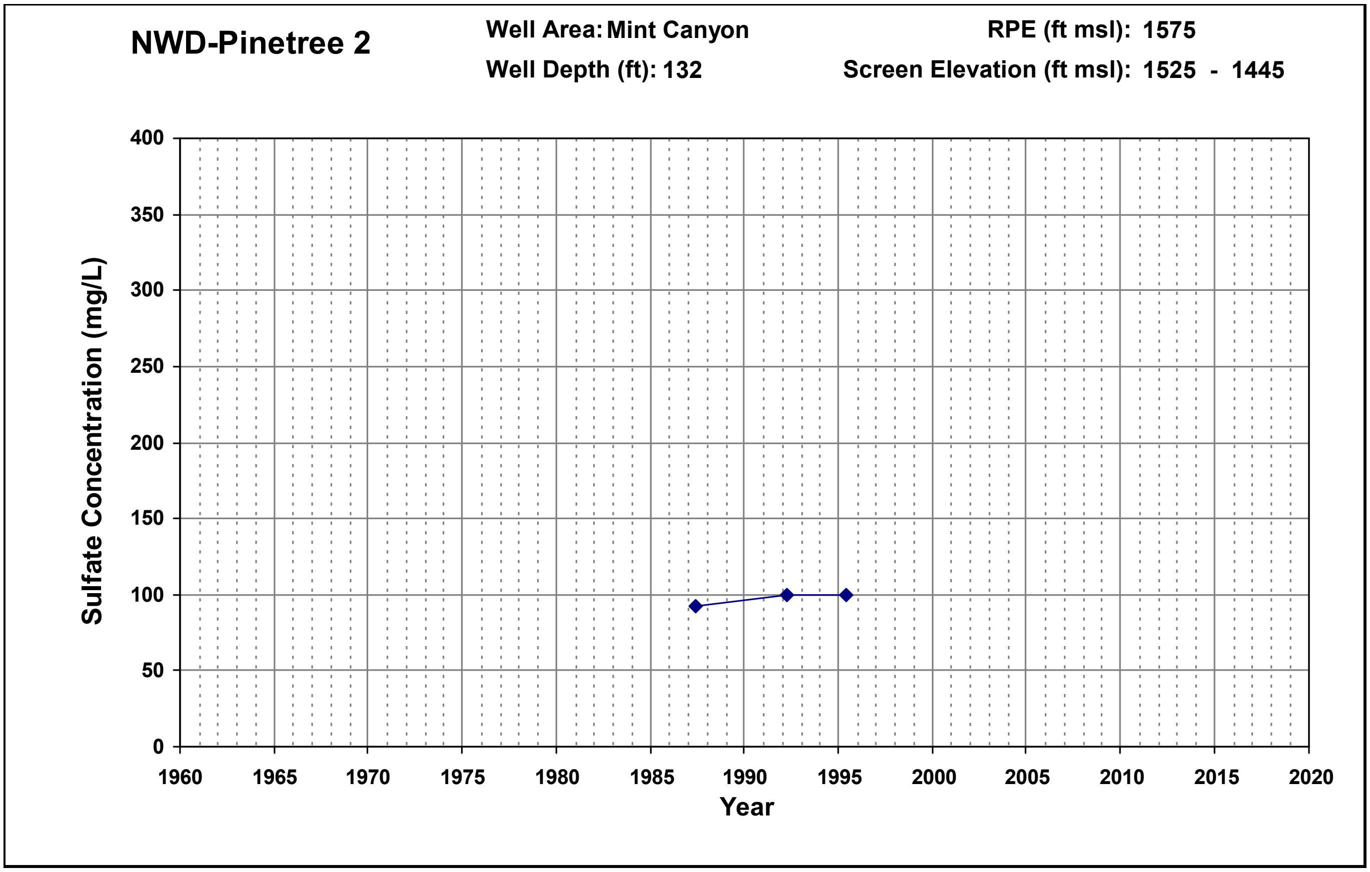
Well Area: Castaic Valley
Well Depth (ft): 203
RPE (ft msl): 1129
Screen Elevation (ft msl): Unknown



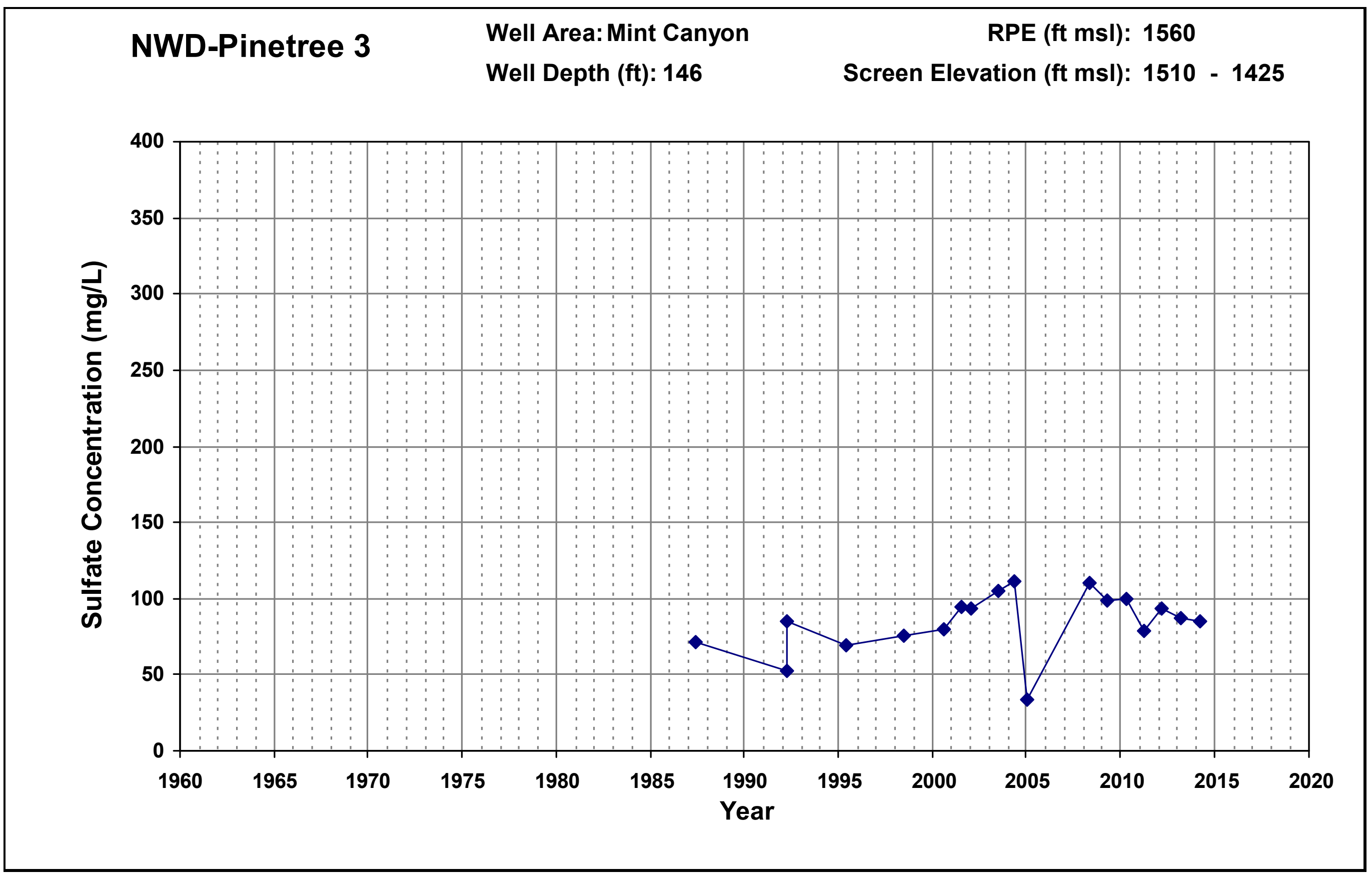
NWD-Pinetree 1

Well Area: Mint Canyon
Well Depth (ft): 235
RPE (ft msl): 1583.5
Screen Elevation (ft msl): 1534 - 1374





NWD-Pinetree 2
Well Area: Mint Canyon
Well Depth (ft): 132
RPE (ft msl): 1575
Screen Elevation (ft msl): 1525 - 1445
Sulfate Concentration (mg/L)
400
350
300
250
200
150
100
50
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year



NWD-Pinetree 3
Well Area: Mint Canyon
Well Depth (ft): 146
RPE (ft msl): 1560
Screen Elevation (ft msl): 1510 - 1425
Sulfate Concentration (mg/L)
400
350
300
250
200
150
100
50
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

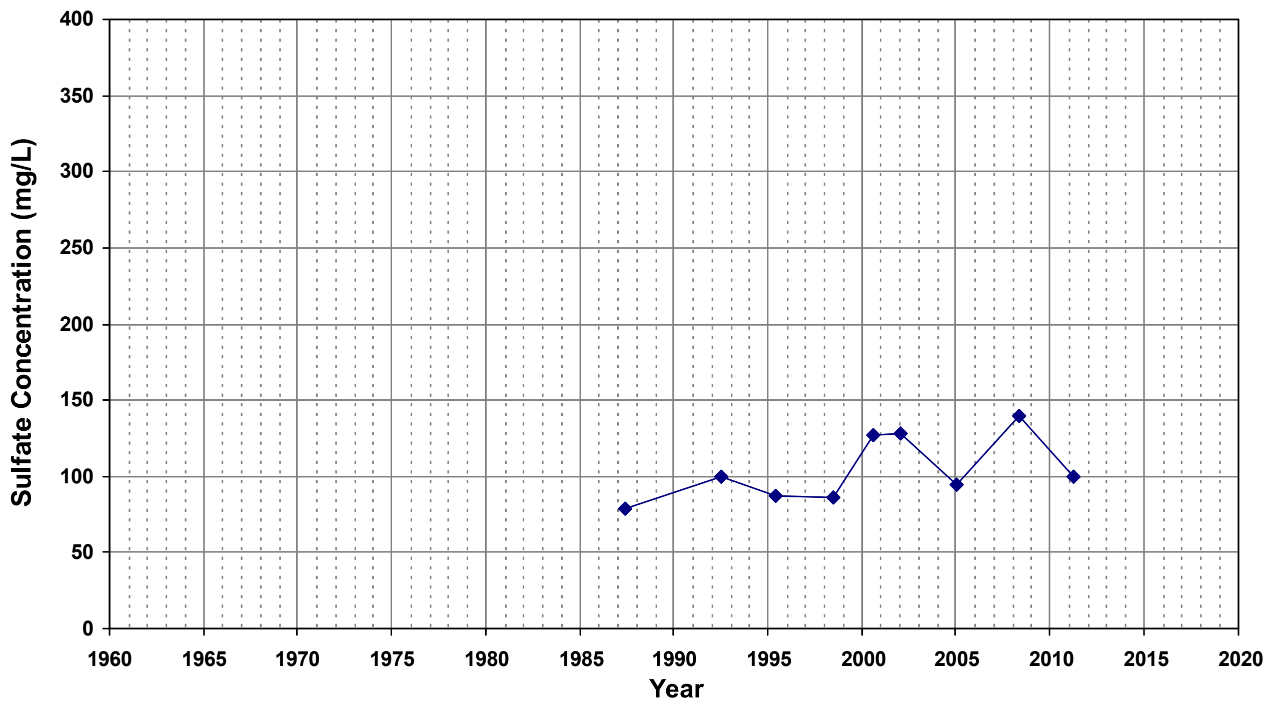
NWD-Pinetree 4

Well Area: Mint Canyon

Well Depth (ft): 185

RPE (ft msl): 1552.5

Screen Elevation (ft msl): 1442 - 1368



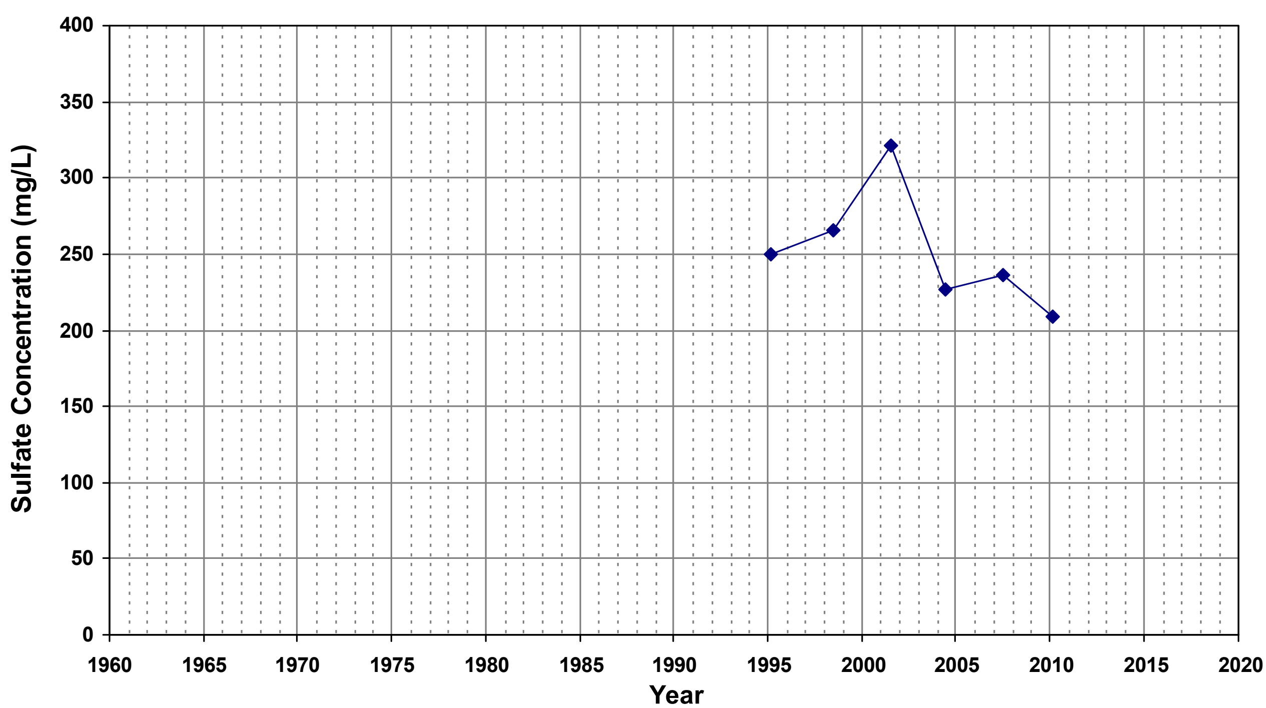
PDC-10

Well Area: Castaic Valley

Well Depth (ft): 110

RPE (ft msl): 1086

Screen Elevation (ft msl): 1059 - 986



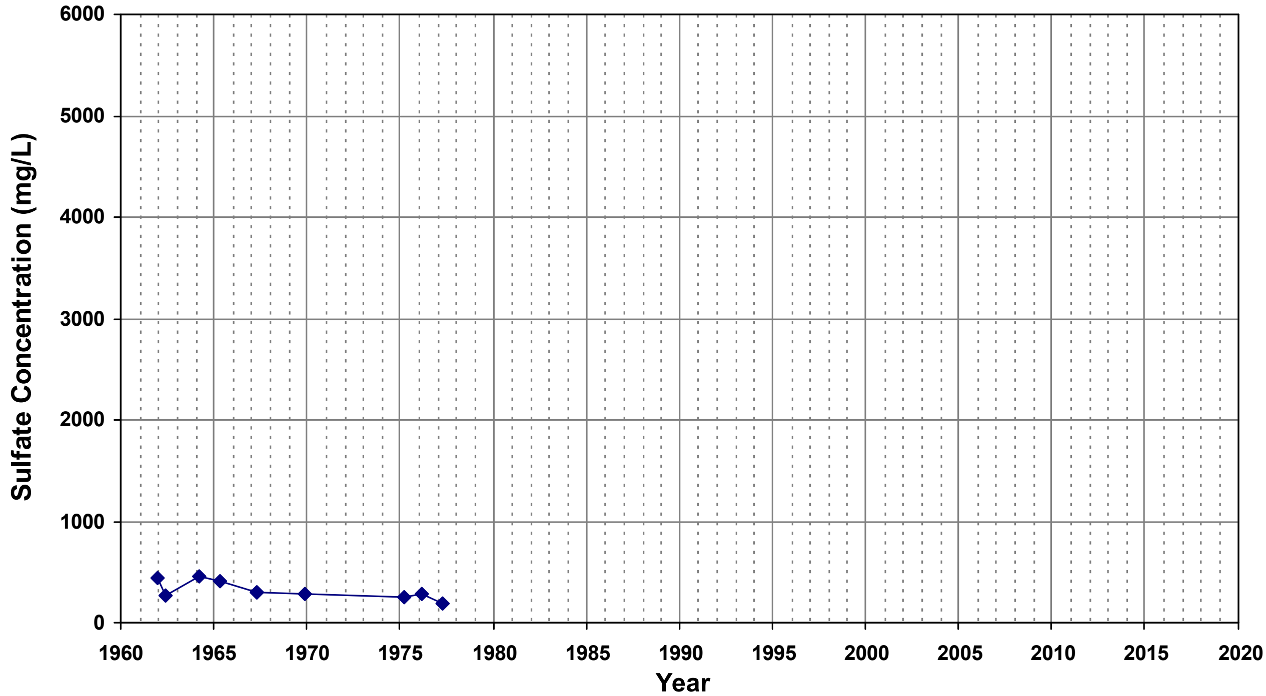
PDC-11 - Old

Well Area: Castaic Valley

Well Depth (ft): 120

RPE (ft msl): 1047

Screen Elevation (ft msl): 997 - 947



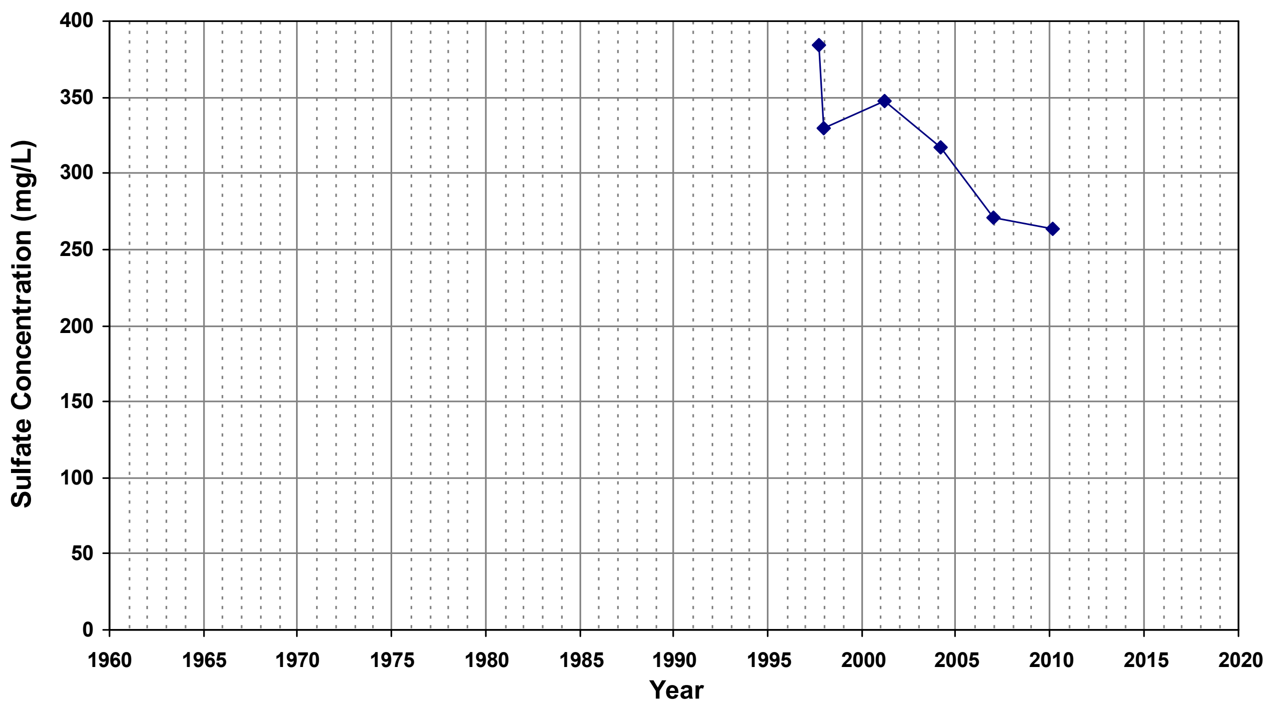
PDC-17

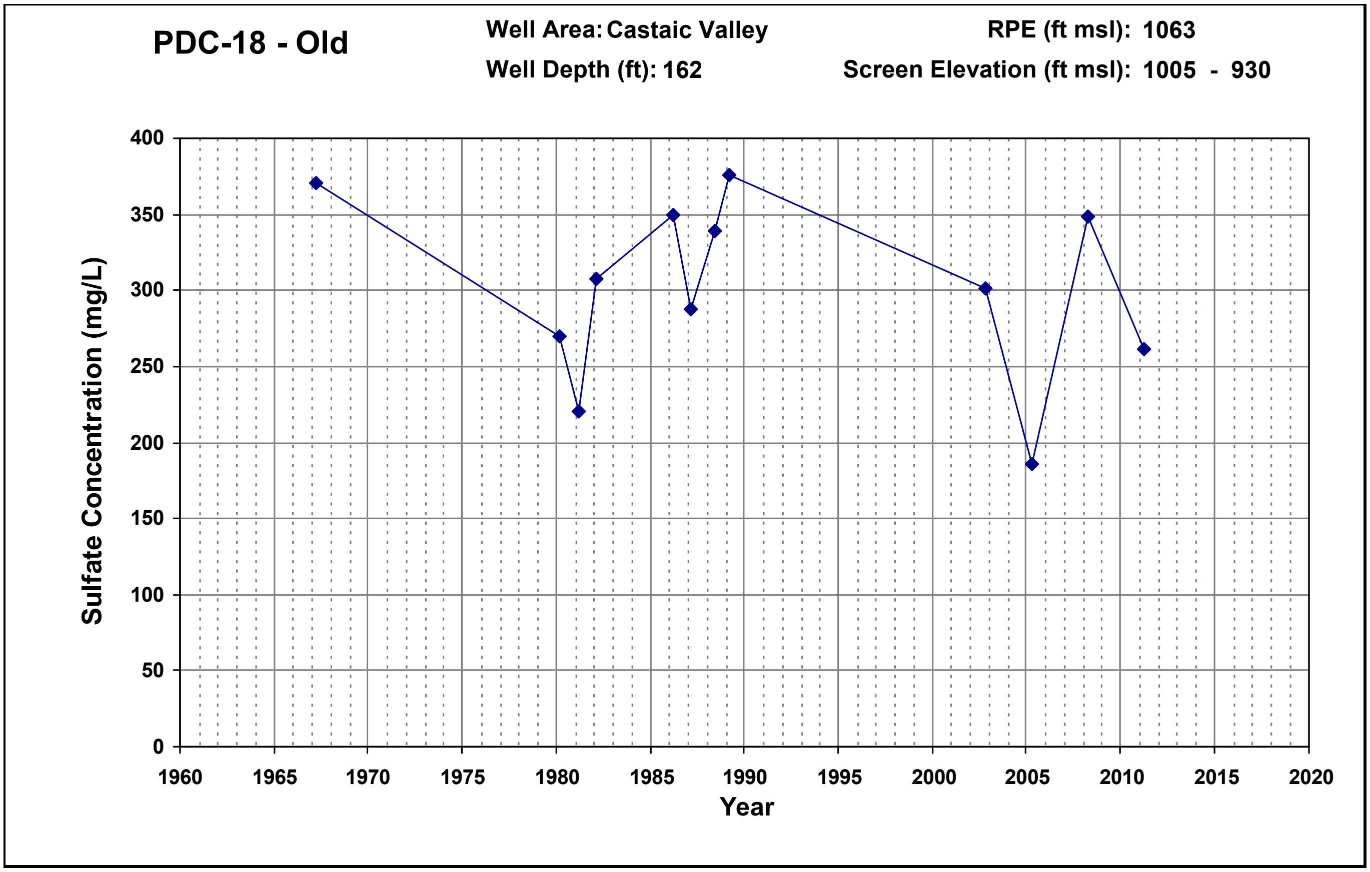
Well Area: Castaic Valley

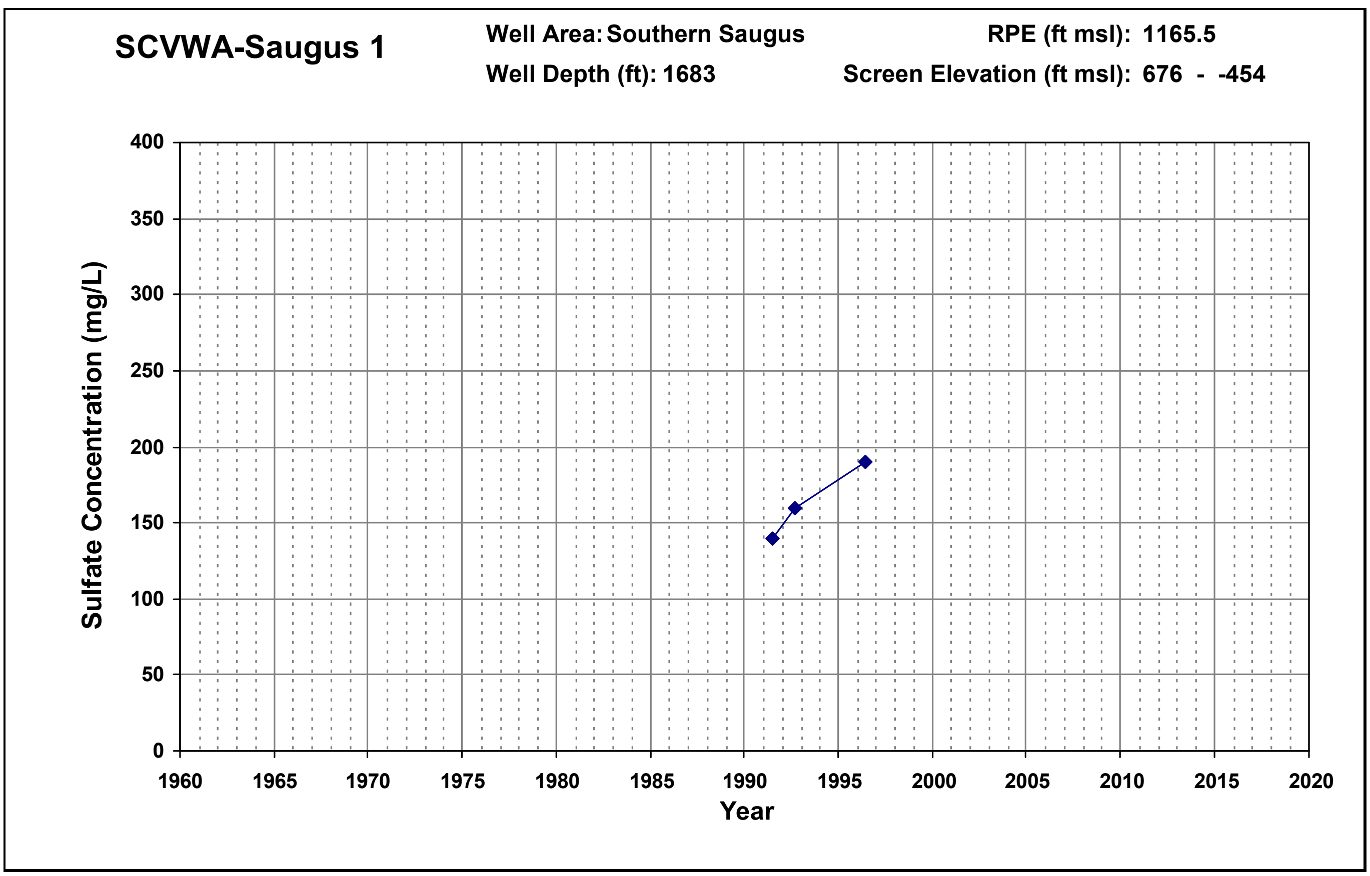
Well Depth (ft): 110

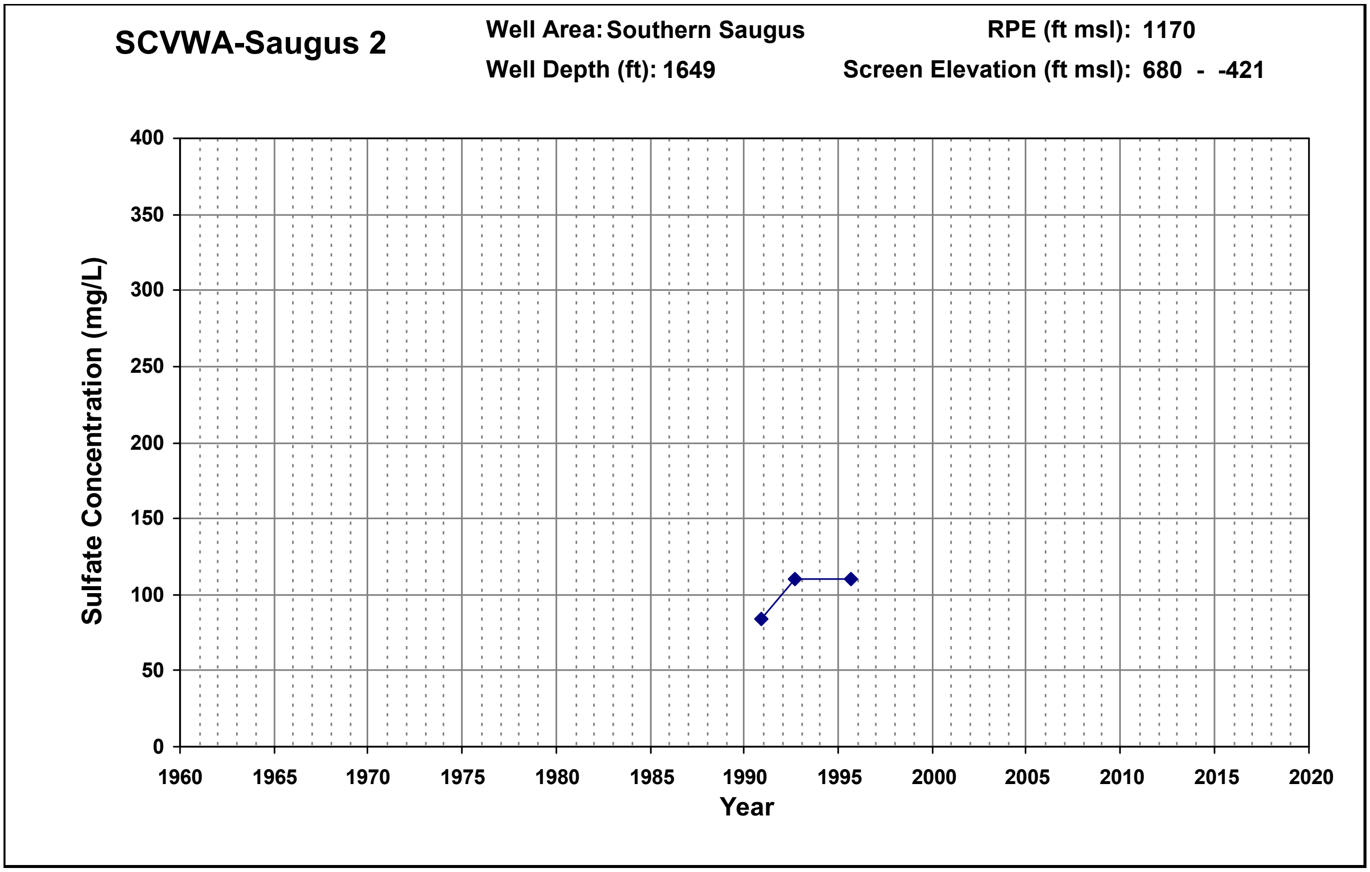
RPE (ft msl): 1086

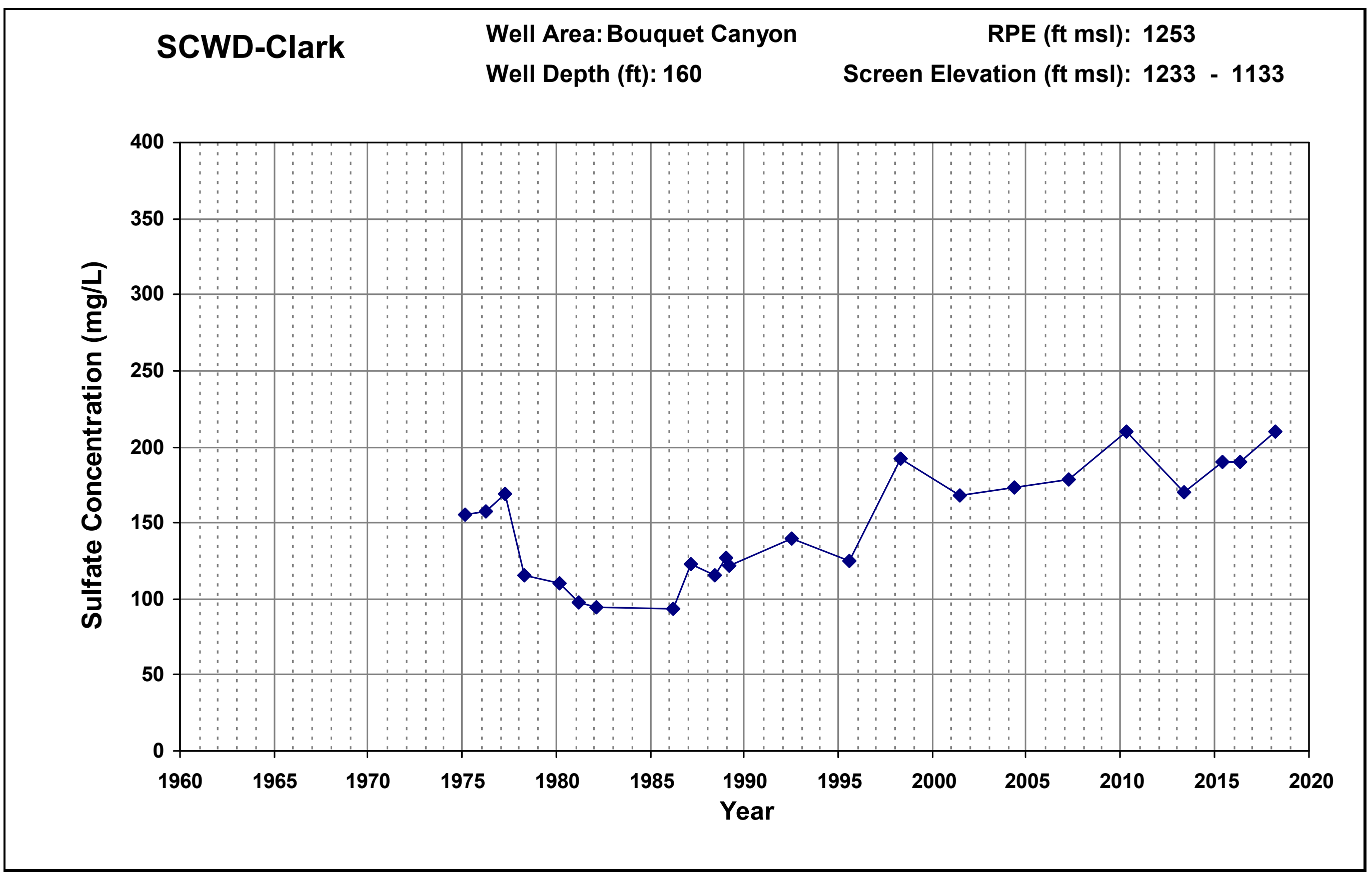
Screen Elevation (ft msl): 1051 - 976

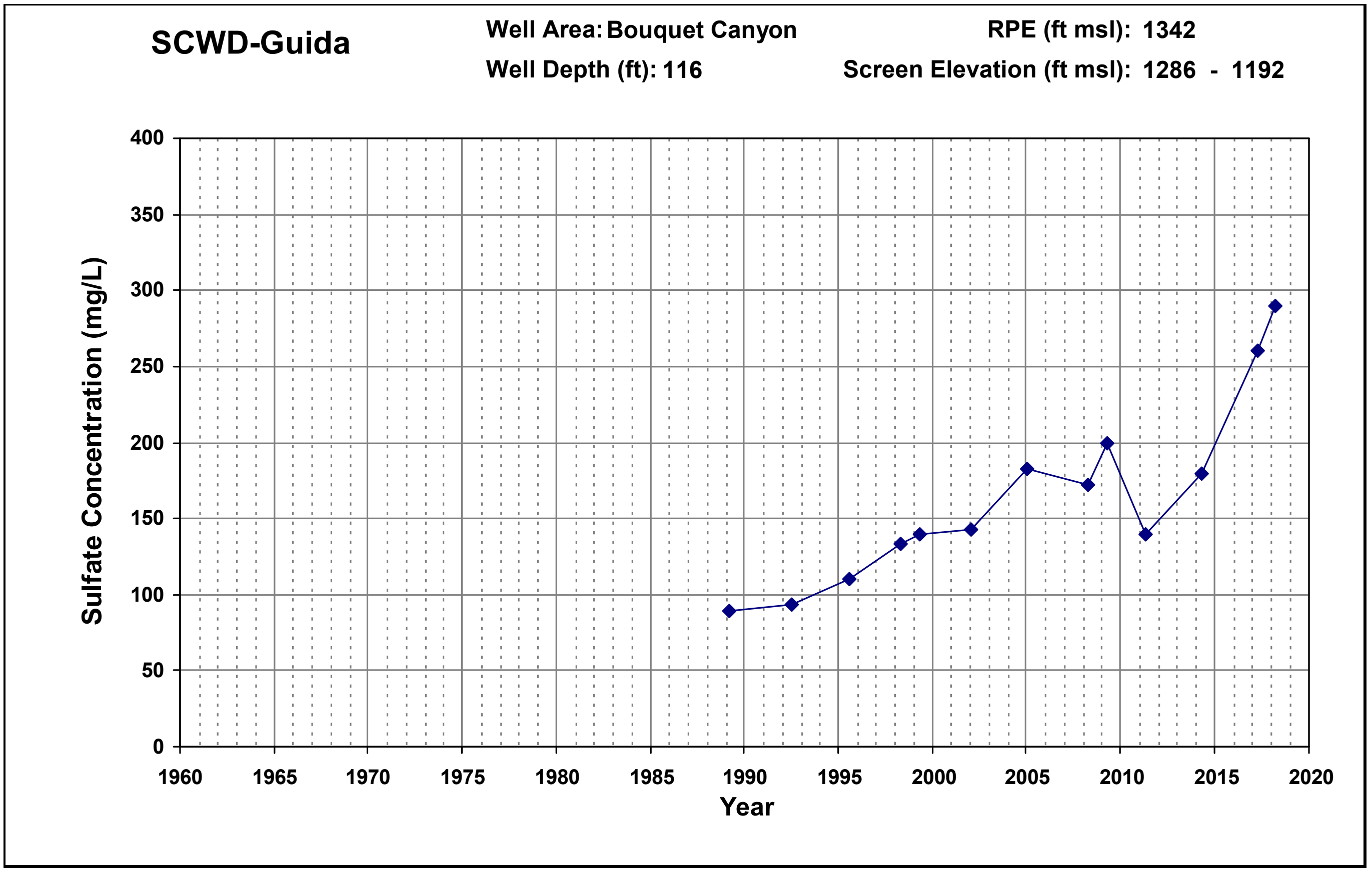


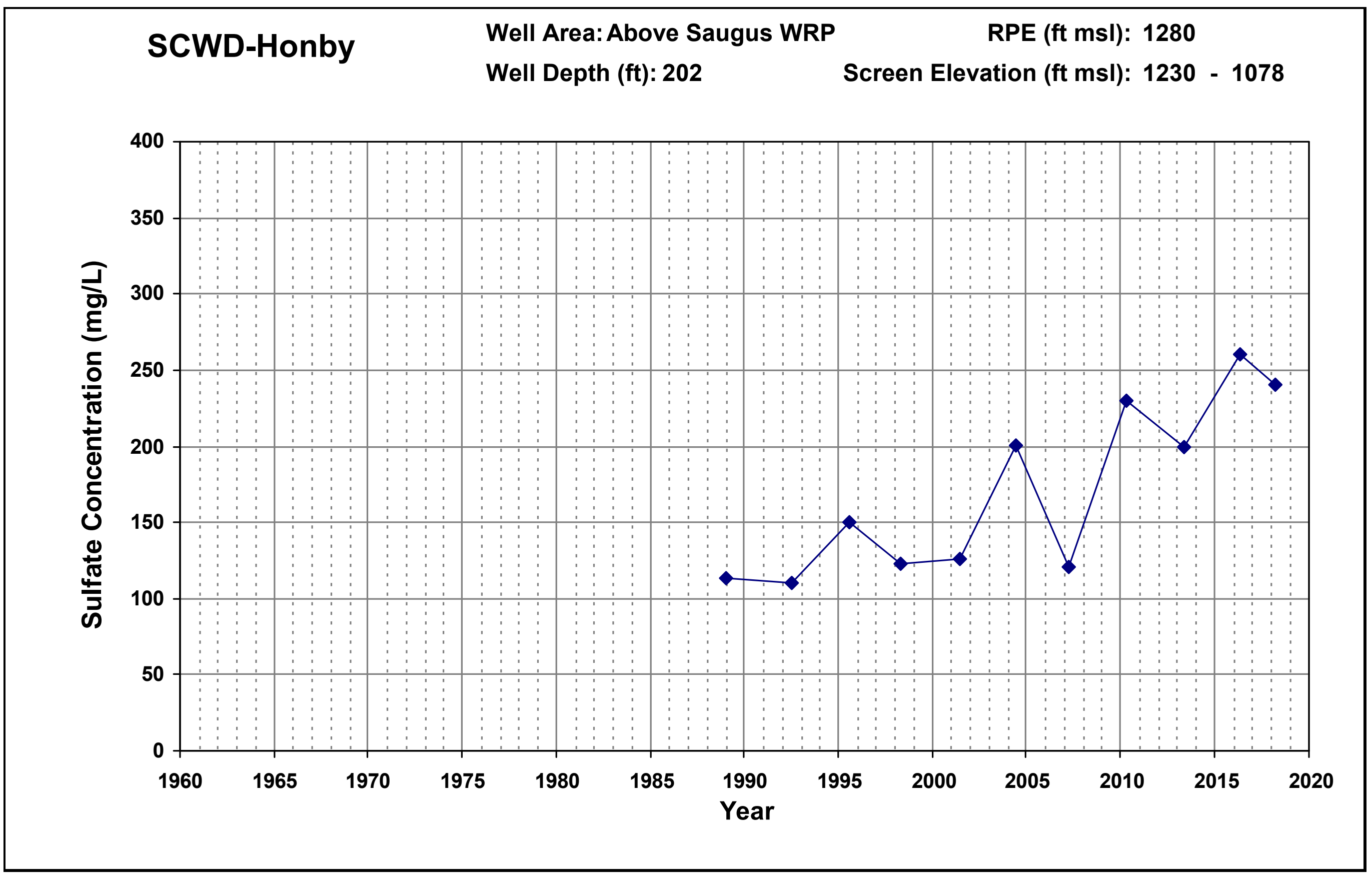

PDC-18 - Old
Well Area: Castaic Valley
Well Depth (ft): 162
RPE (ft msl): 1063
Screen Elevation (ft msl): 1005 - 930
Sulfate Concentration (mg/L)
0
50
100
150
200
250
300
350
400
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

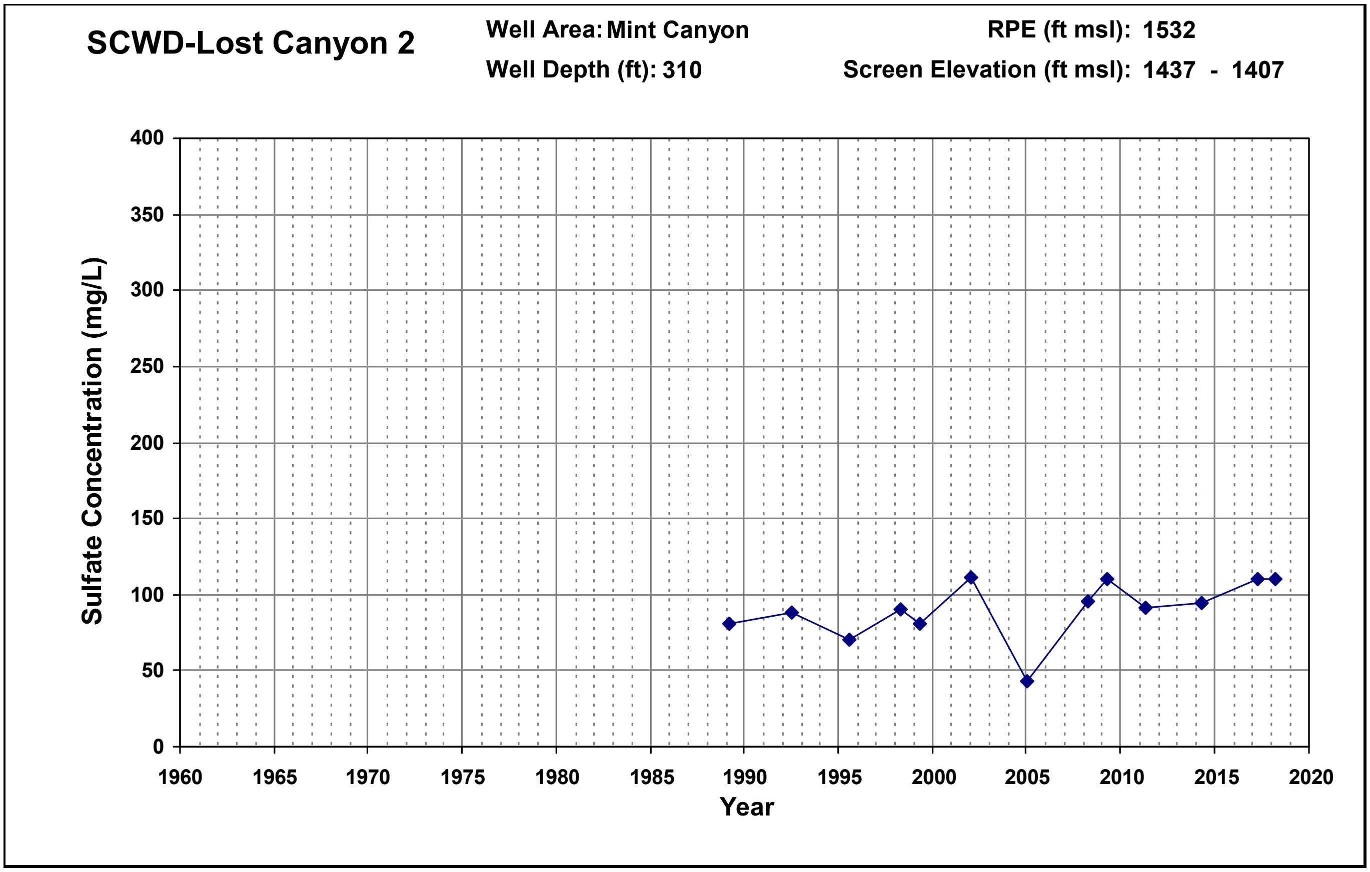

SCVWA-Saugus 1
Well Area: Southern Saugus
Well Depth (ft): 1683
RPE (ft msl): 1165.5
Screen Elevation (ft msl): 676 - -454
Sulfate Concentration (mg/L)
0
50
100
150
200
250
300
350
400
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

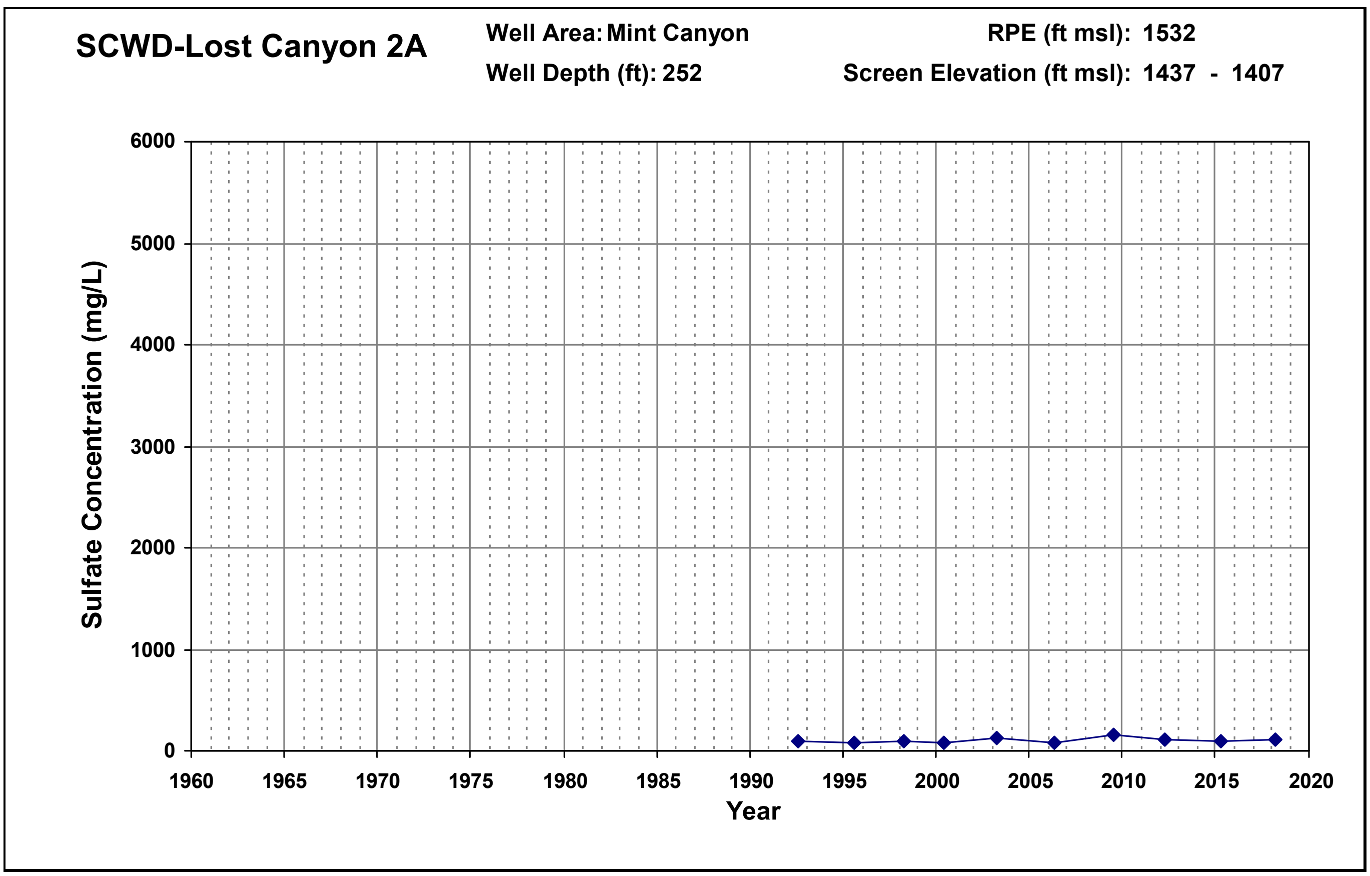

SCVWA-Saugus 2
Well Area: Southern Saugus
RPE (ft msl): 1170
Well Depth (ft): 1649
Screen Elevation (ft msl): 680 - -421
Sulfate Concentration (mg/L)
Year
0
50
100
150
200
250
300
350
400
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

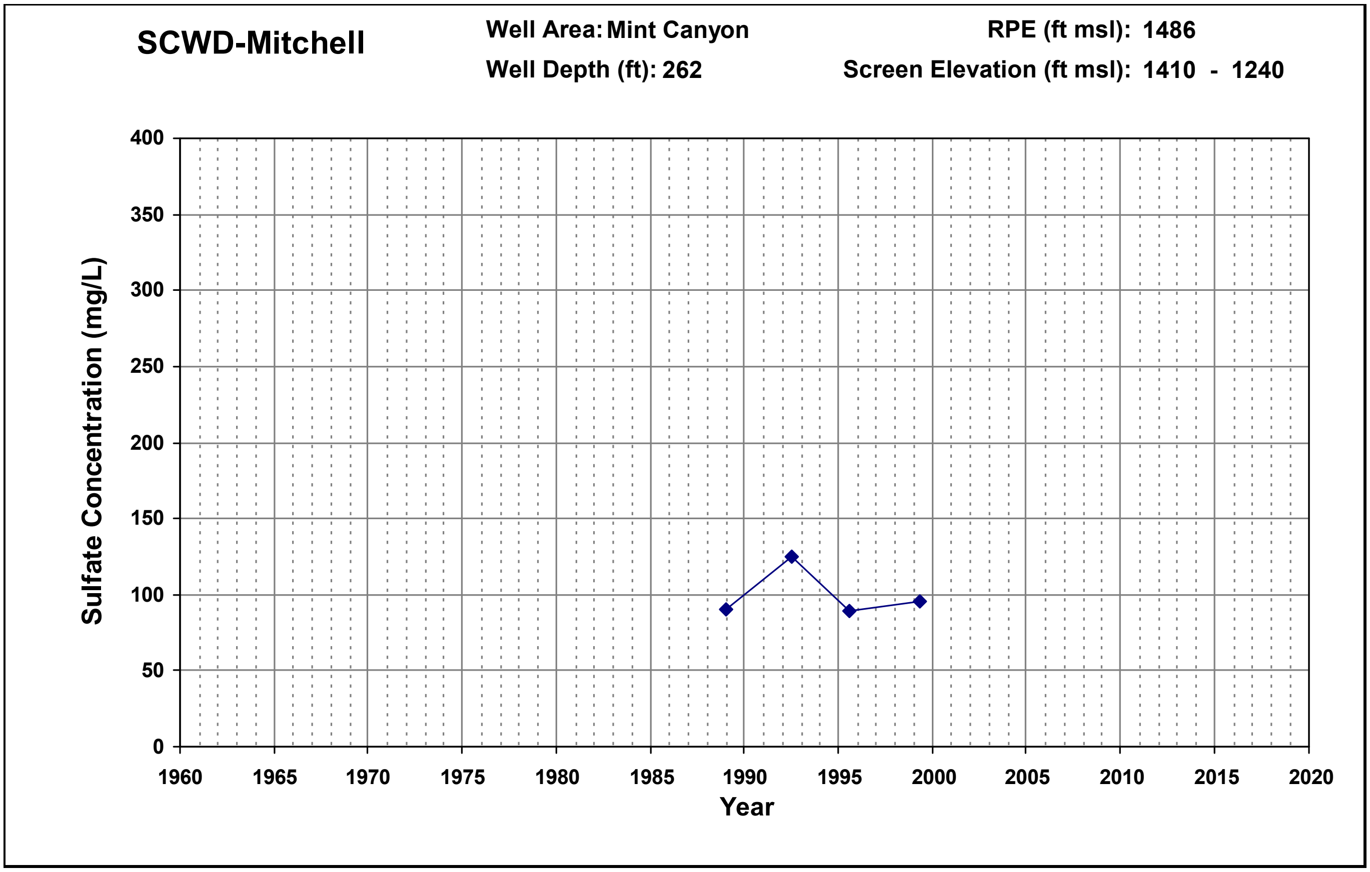

SCWD-Clark
Well Area: Bouquet Canyon
RPE (ft msl): 1253
Well Depth (ft): 160
Screen Elevation (ft msl): 1233 - 1133
Sulfate Concentration (mg/L)
Year
0
50
100
150
200
250
300
350
400
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020


SCWD-Guida
Well Area: Bouquet Canyon
RPE (ft msl): 1342
Well Depth (ft): 116
Screen Elevation (ft msl): 1286 - 1192
Sulfate Concentration (mg/L)
0
50
100
150
200
250
300
350
400
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

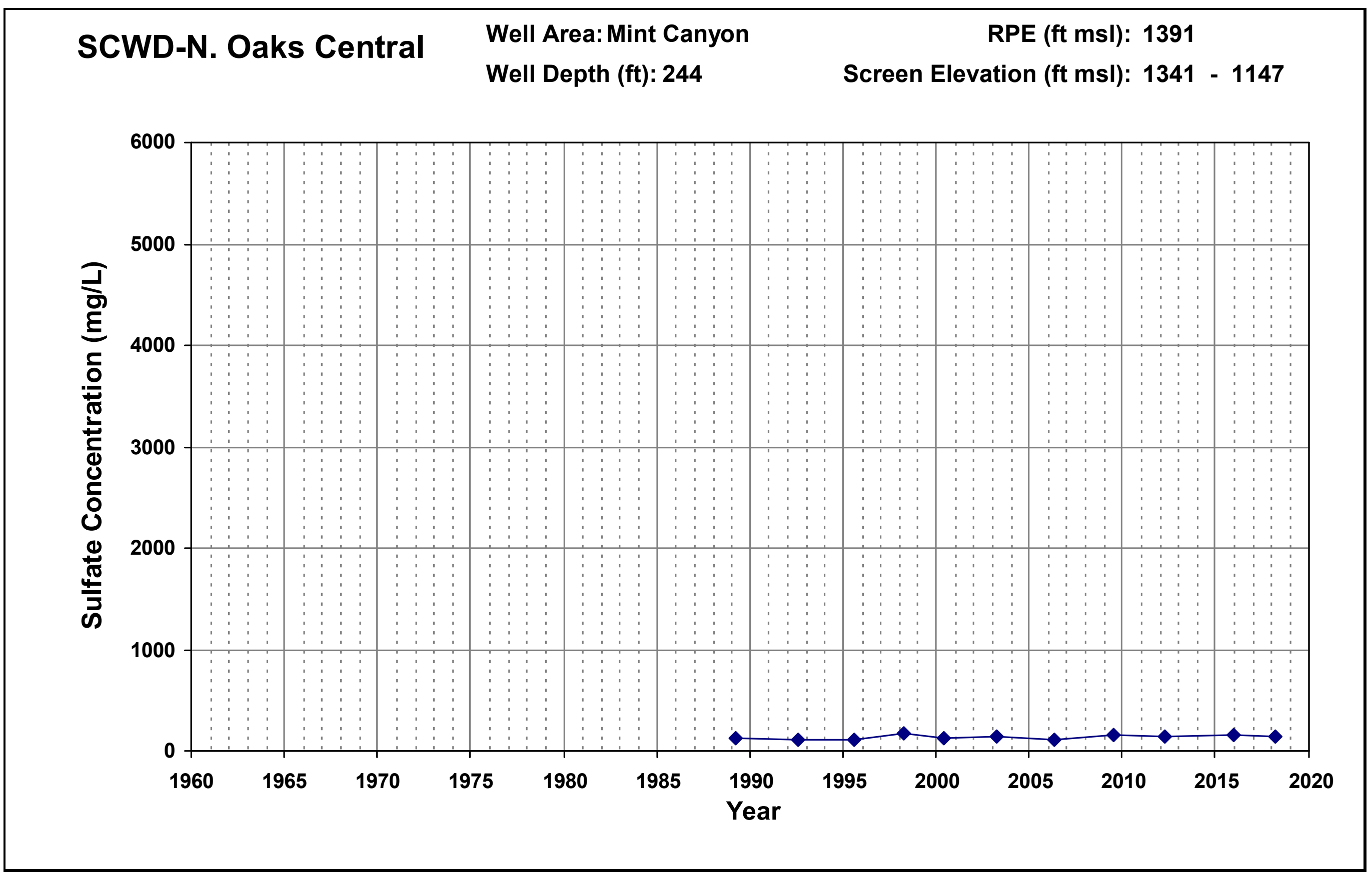

SCWD-Honby
Well Area: Above Saugus WRP
RPE (ft msl): 1280
Well Depth (ft): 202
Screen Elevation (ft msl): 1230 - 1078
Sulfate Concentration (mg/L)
0
50
100
150
200
250
300
350
400
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year


SCWD-Lost Canyon 2
Well Area: Mint Canyon
Well Depth (ft): 310
RPE (ft msl): 1532
Screen Elevation (ft msl): 1437 - 1407
Sulfate Concentration (mg/L)
0
50
100
150
200
250
300
350
400
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

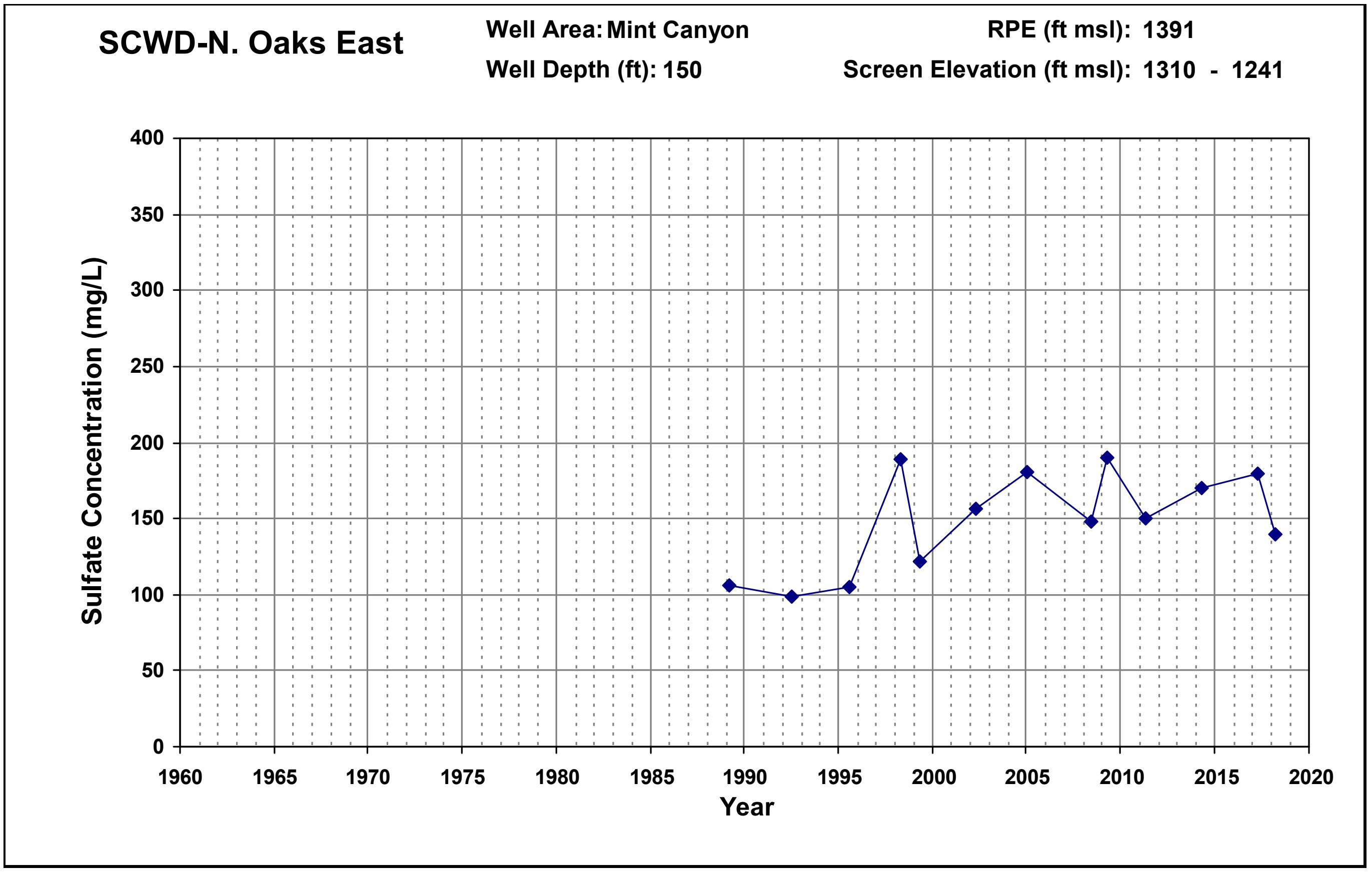

SCWD-Lost Canyon 2A
Well Area: Mint Canyon
Well Depth (ft): 252
RPE (ft msl): 1532
Screen Elevation (ft msl): 1437 - 1407
Sulfate Concentration (mg/L)
0
1000
2000
3000
4000
5000
6000
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

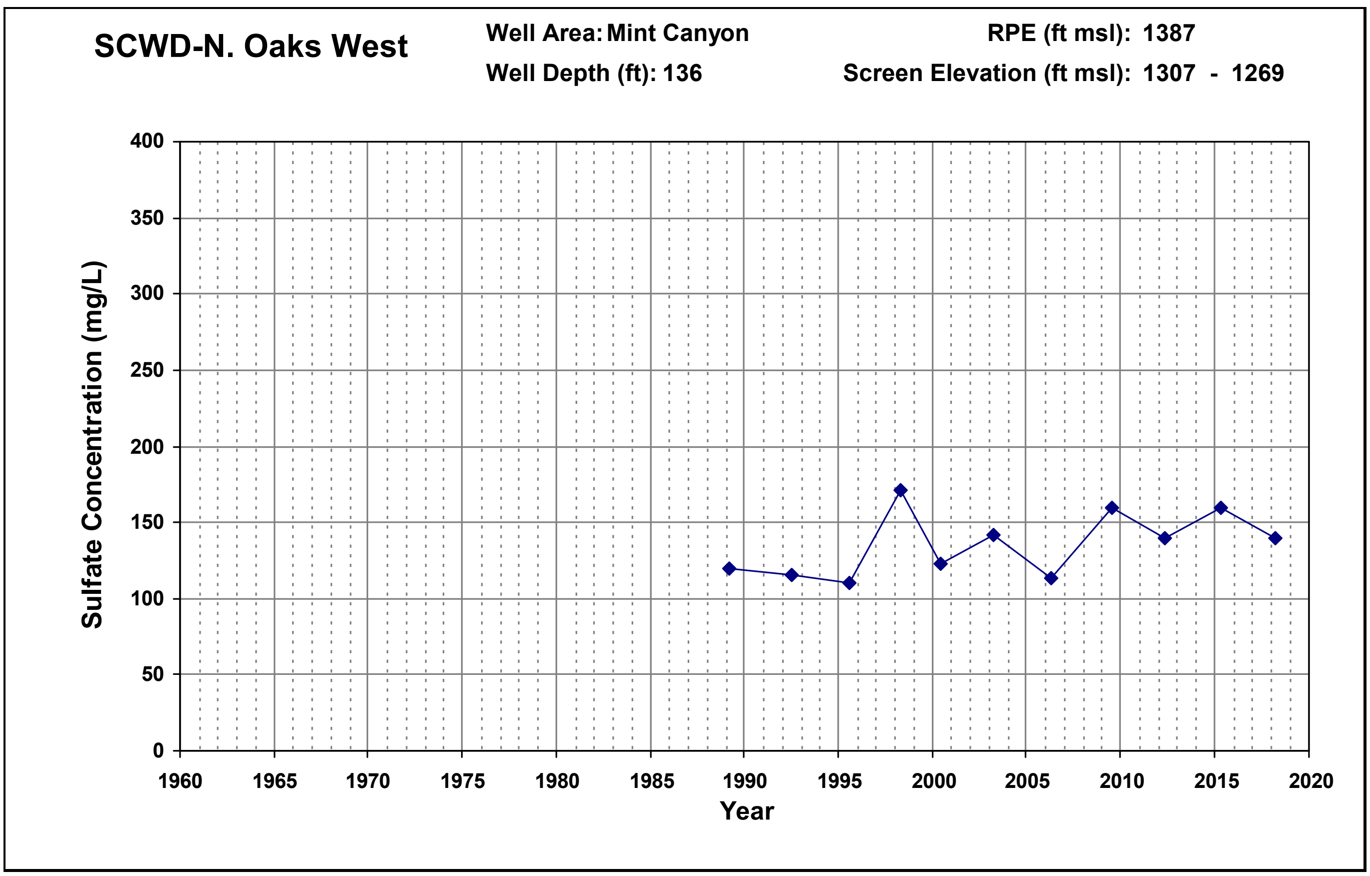


SCWD-Mitchell
Well Area: Mint Canyon
Well Depth (ft): 262
RPE (ft msl): 1486
Screen Elevation (ft msl): 1410 - 1240
Sulfate Concentration (mg/L)
0
50
100
150
200
250
300
350
400
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year



SCWD-N. Oaks Central
Well Area: Mint Canyon
Well Depth (ft): 244
RPE (ft msl): 1391
Screen Elevation (ft msl): 1341 - 1147
Sulfate Concentration (mg/L)
0
1000
2000
3000
4000
5000
6000
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year


SCWD-N. Oaks East
Well Area: Mint Canyon
Well Depth (ft): 150
RPE (ft msl): 1391
Screen Elevation (ft msl): 1310 - 1241
Sulfate Concentration (mg/L)
0
50
100
150
200
250
300
350
400
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year


SCWD-N. Oaks West
Well Area: Mint Canyon
Well Depth (ft): 136
RPE (ft msl): 1387
Screen Elevation (ft msl): 1307 - 1269
Sulfate Concentration (mg/L)
0
50
100
150
200
250
300
350
400
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

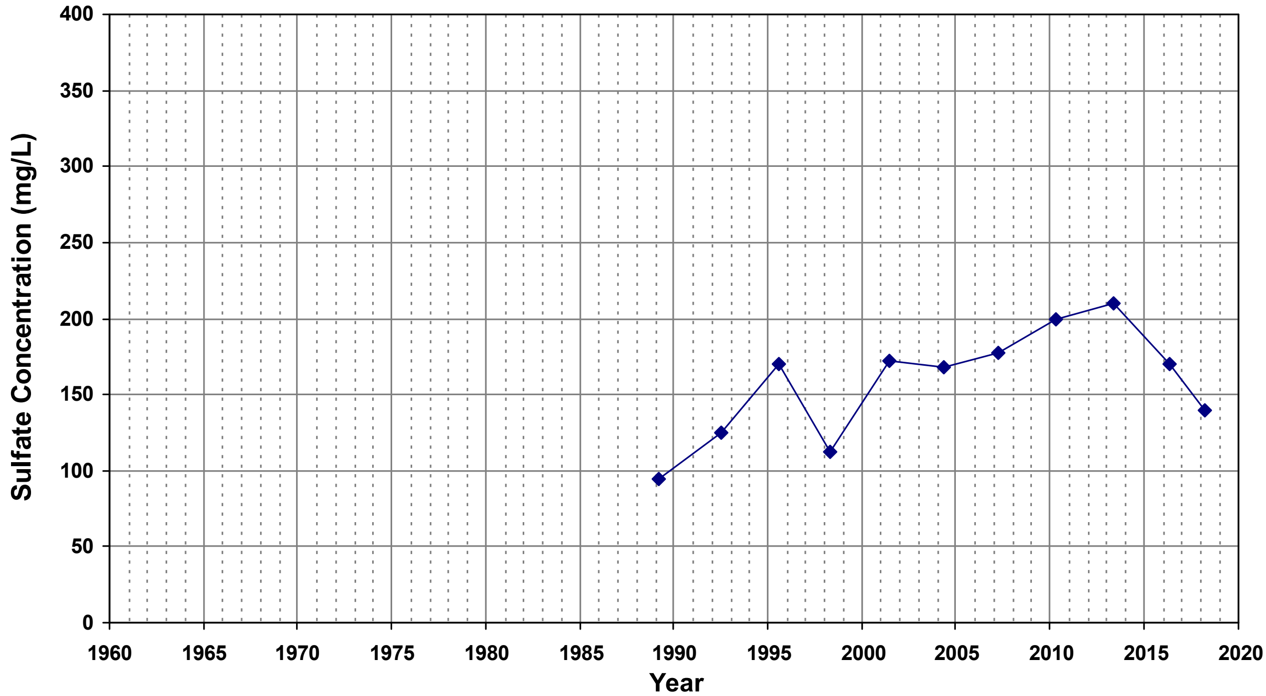
SCWD-Sand Canyon

Well Area: Mint Canyon

Well Depth (ft): 250

RPE (ft msl): 1525

Screen Elevation (ft msl): 1465 - 1385



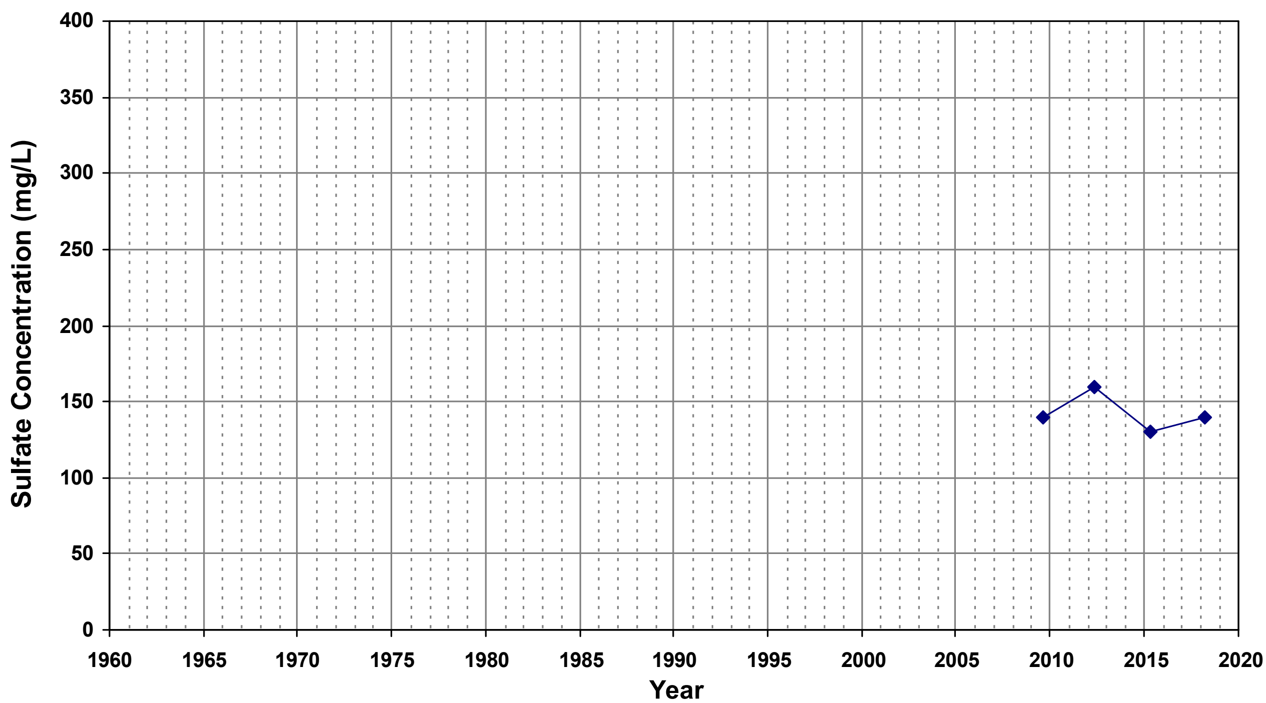
SCWD-SantaClara

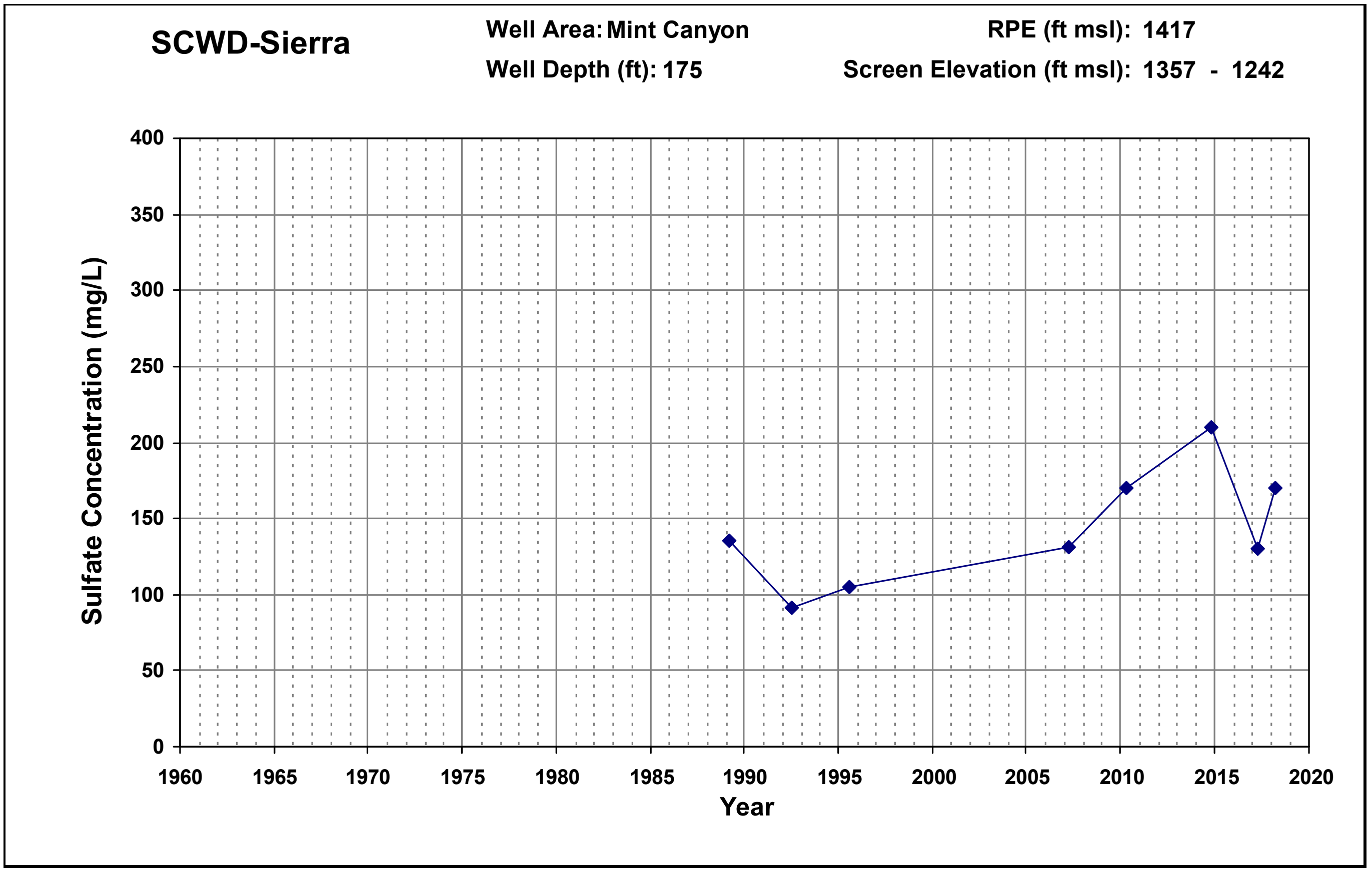
Well Area: Above Saugus WRP

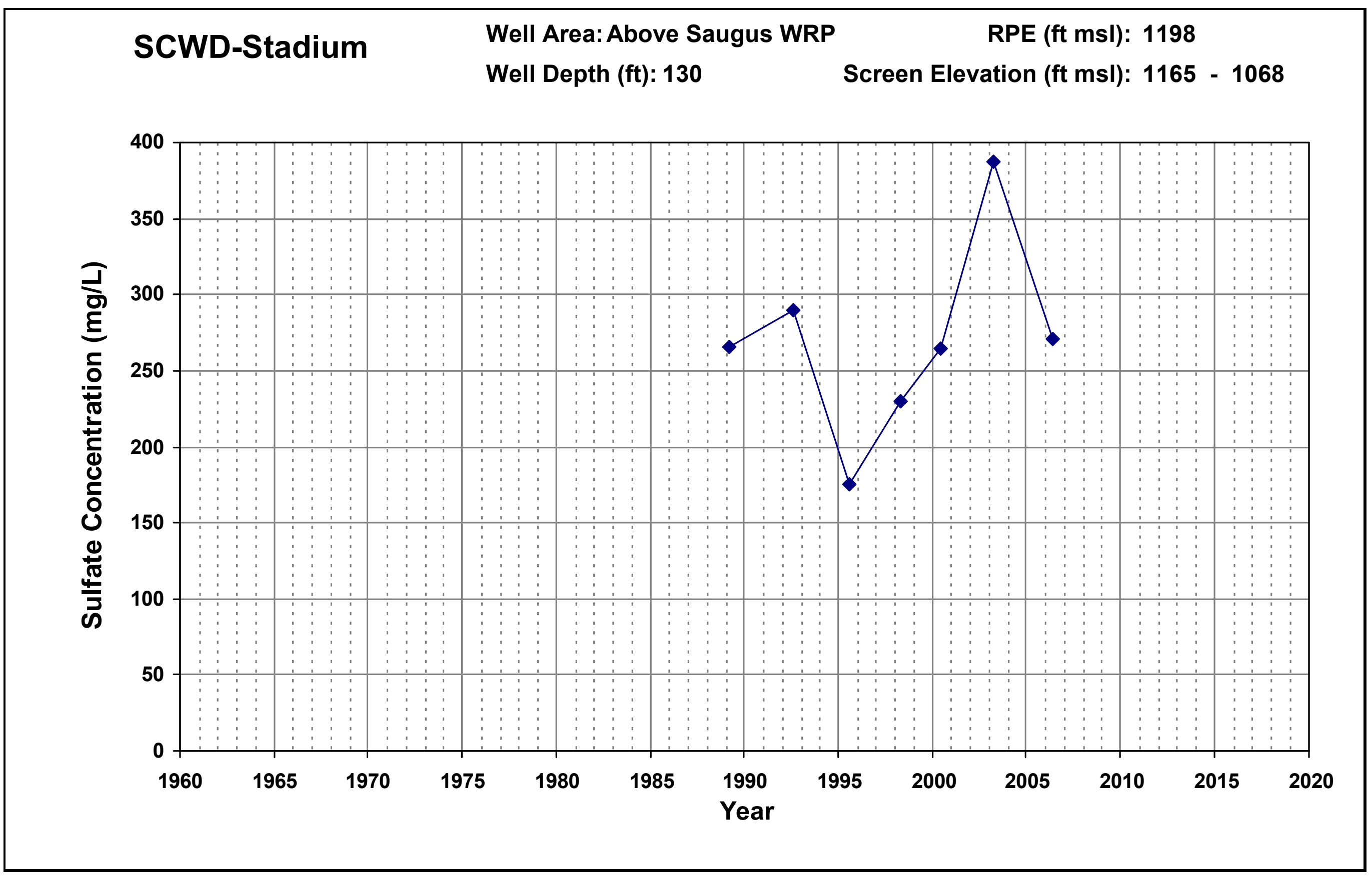
Well Depth (ft): 160

RPE (ft msl): 1289

Screen Elevation (ft msl): 1199 - 1154




SCWD-Sierra
Well Area: Mint Canyon
Well Depth (ft): 175
RPE (ft msl): 1417
Screen Elevation (ft msl): 1357 - 1242
Sulfate Concentration (mg/L)
Year
0
50
100
150
200
250
300
350
400
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020


SCWD-Stadium
Well Area: Above Saugus WRP
Well Depth (ft): 130
RPE (ft msl): 1198
Screen Elevation (ft msl): 1165 - 1068
Sulfate Concentration (mg/L)
Year
0
50
100
150
200
250
300
350
400
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

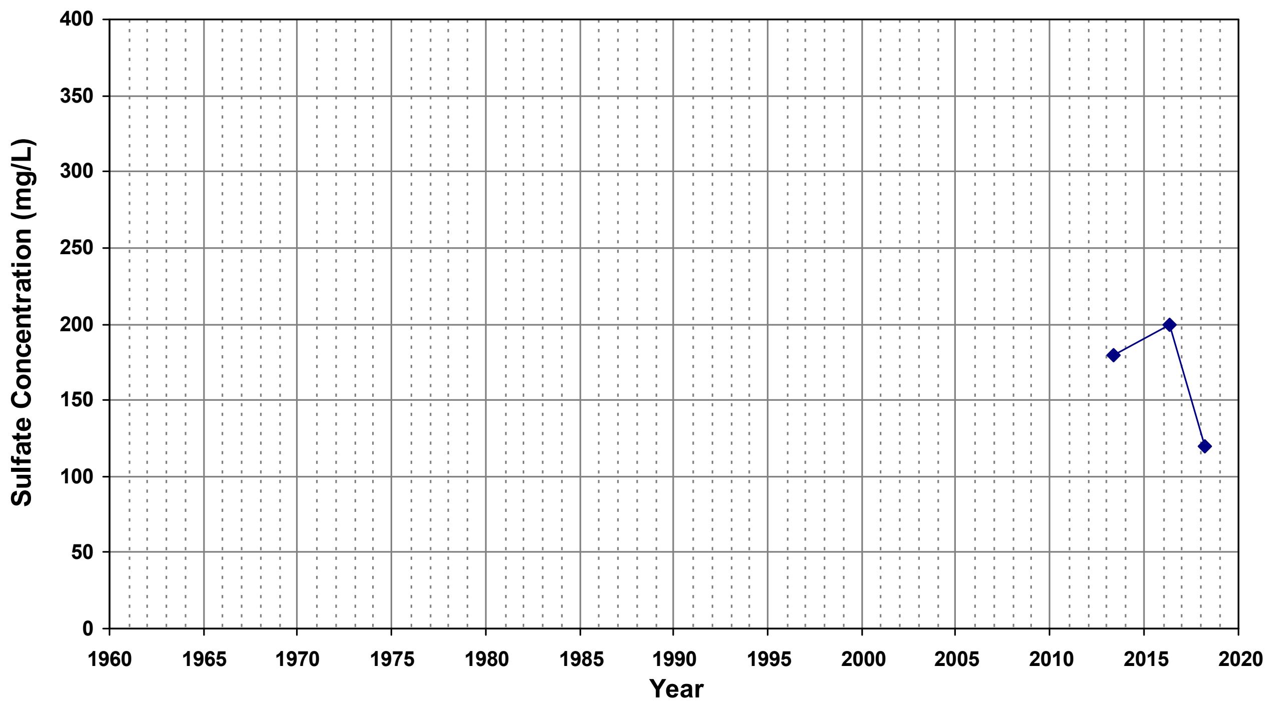
SCWD-Valley Center

Well Area: Above Saugus WRP

RPE (ft msl): 1256

Well Depth (ft): 133

Screen Elevation (ft msl): 1166 - 1131



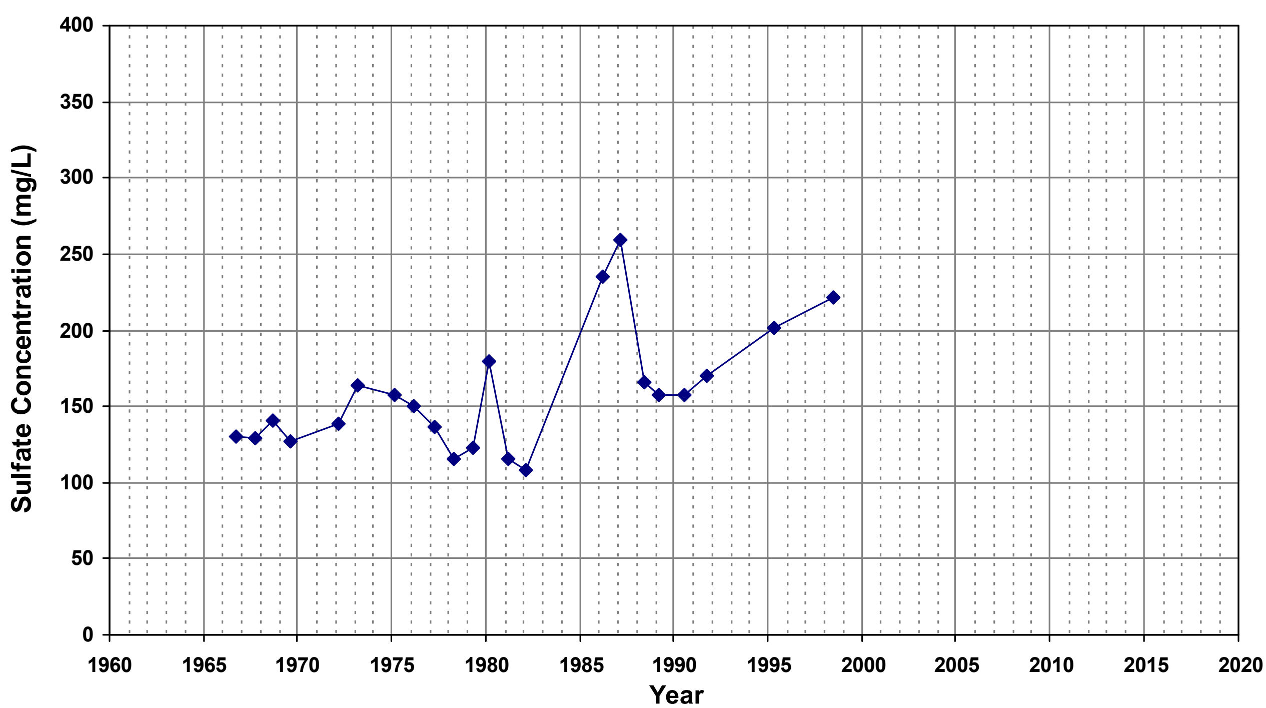
VWD-157

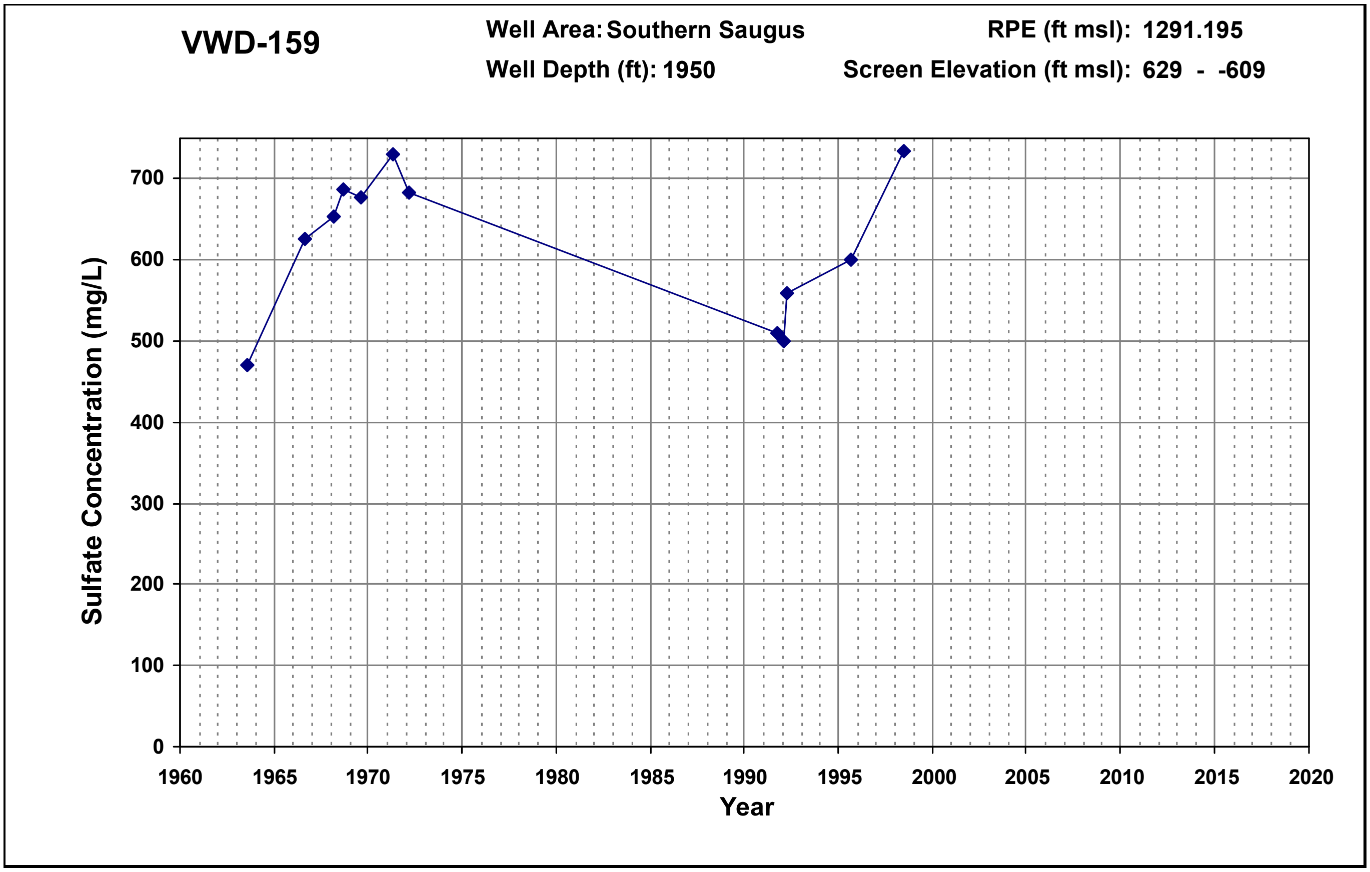
Well Area: Southern Saugus

RPE (ft msl): 1148

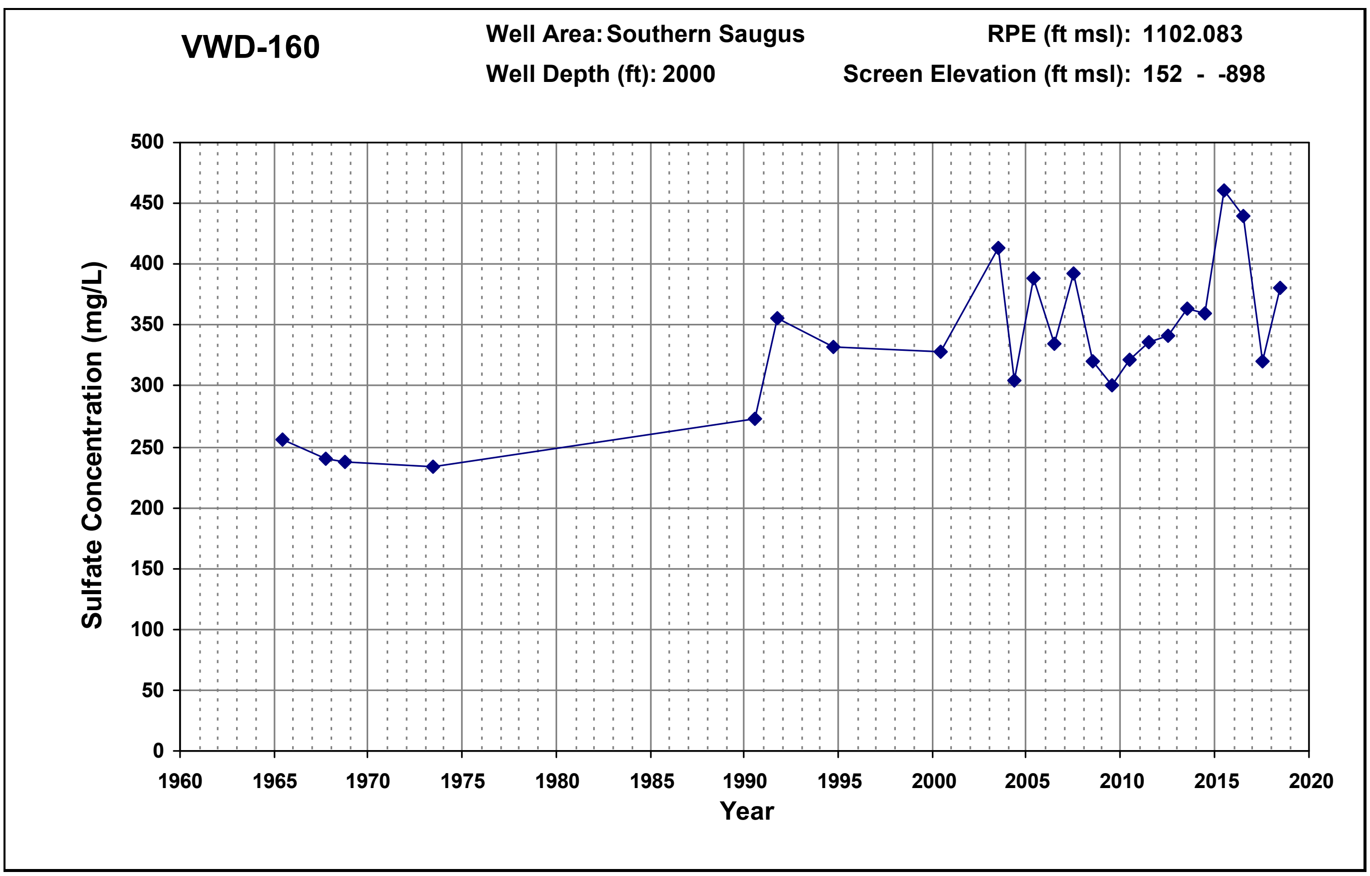
Well Depth (ft): 2008

Screen Elevation (ft msl): 562 - -860





VWD-159
Well Area: Southern Saugus
Well Depth (ft): 1950
RPE (ft msl): 1291.195
Screen Elevation (ft msl): 629 - -609
Sulfate Concentration (mg/L)
0
100
200
300
400
500
600
700
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year



VWD-160
Well Area: Southern Saugus
Well Depth (ft): 2000
RPE (ft msl): 1102.083
Screen Elevation (ft msl): 152 - -898
Sulfate Concentration (mg/L)
0
50
100
150
200
250
300
350
400
450
500
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

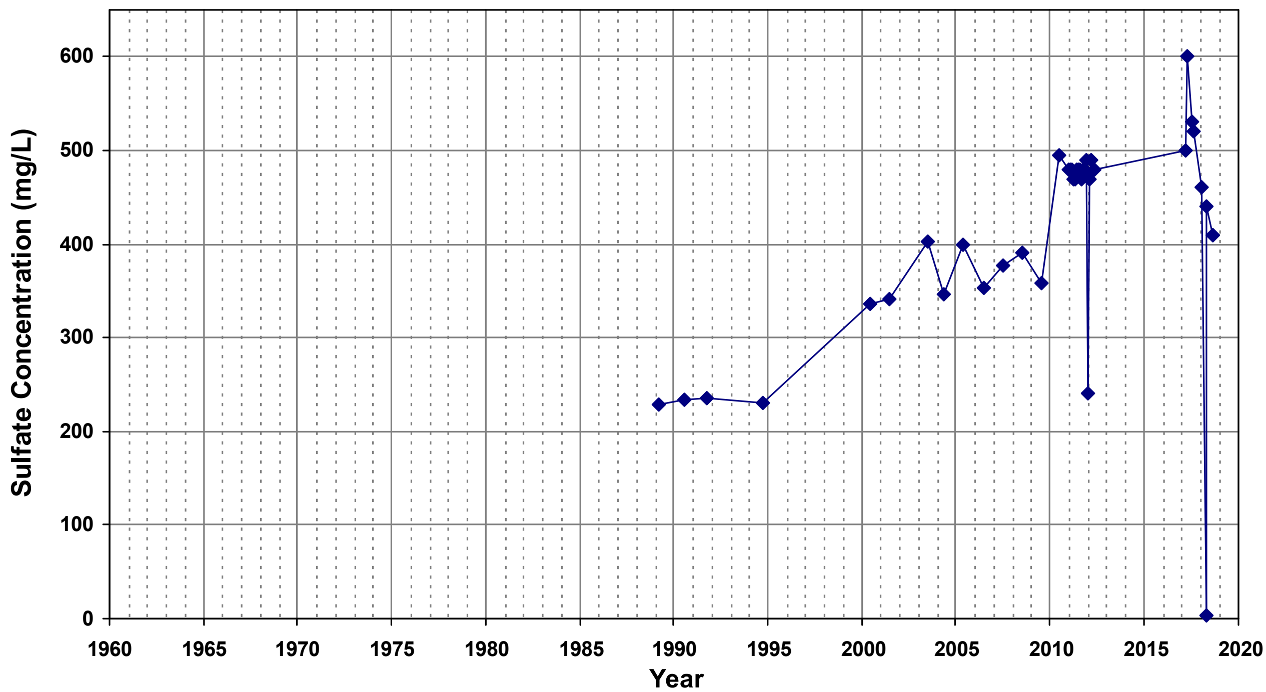
VWD-201

Well Area: Southern Saugus

RPE (ft msl): 1151.715

Well Depth (ft): 1690

Screen Elevation (ft msl): 612 - -518



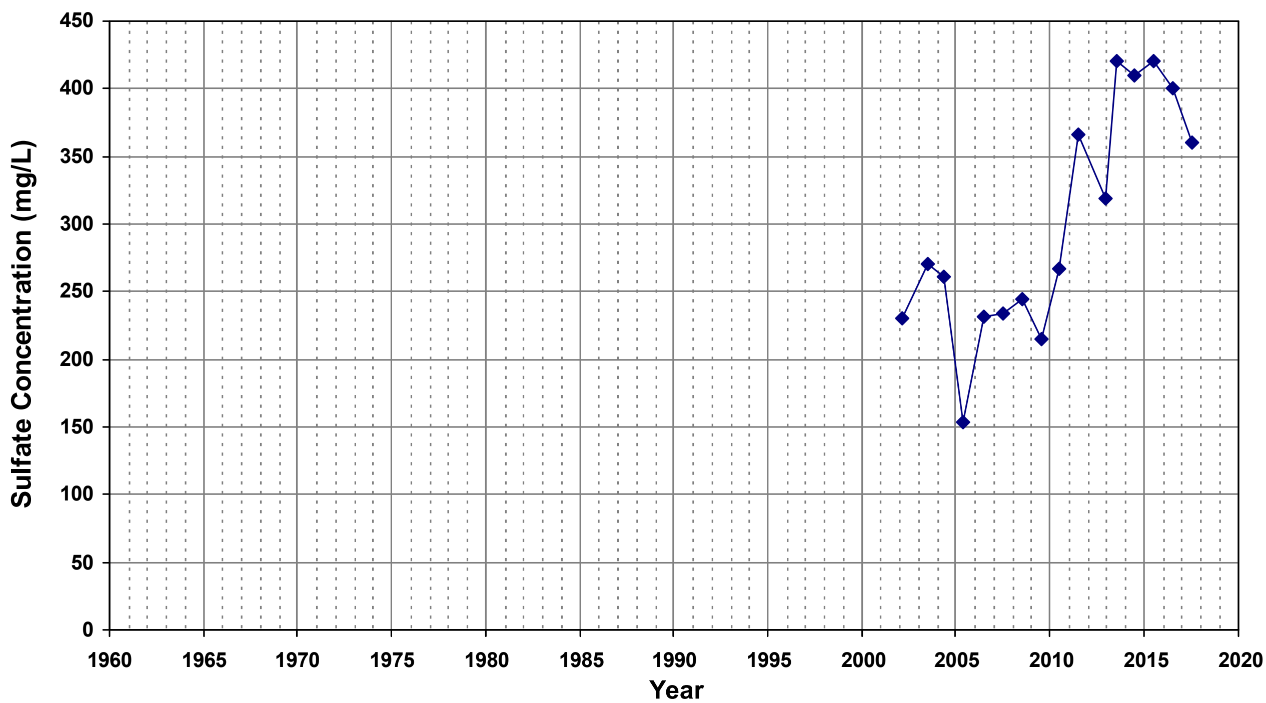
VWD-205

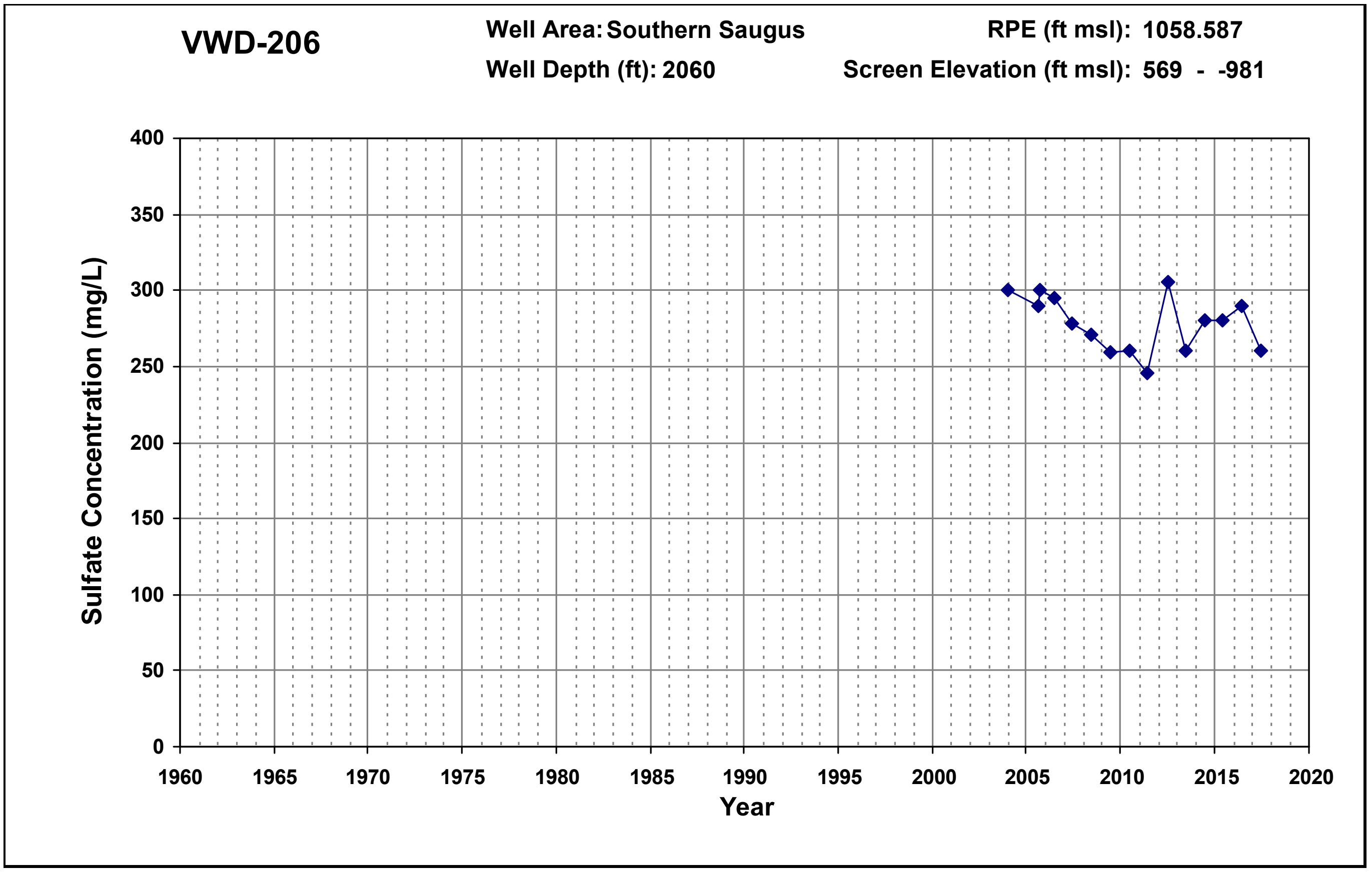
Well Area: Southern Saugus

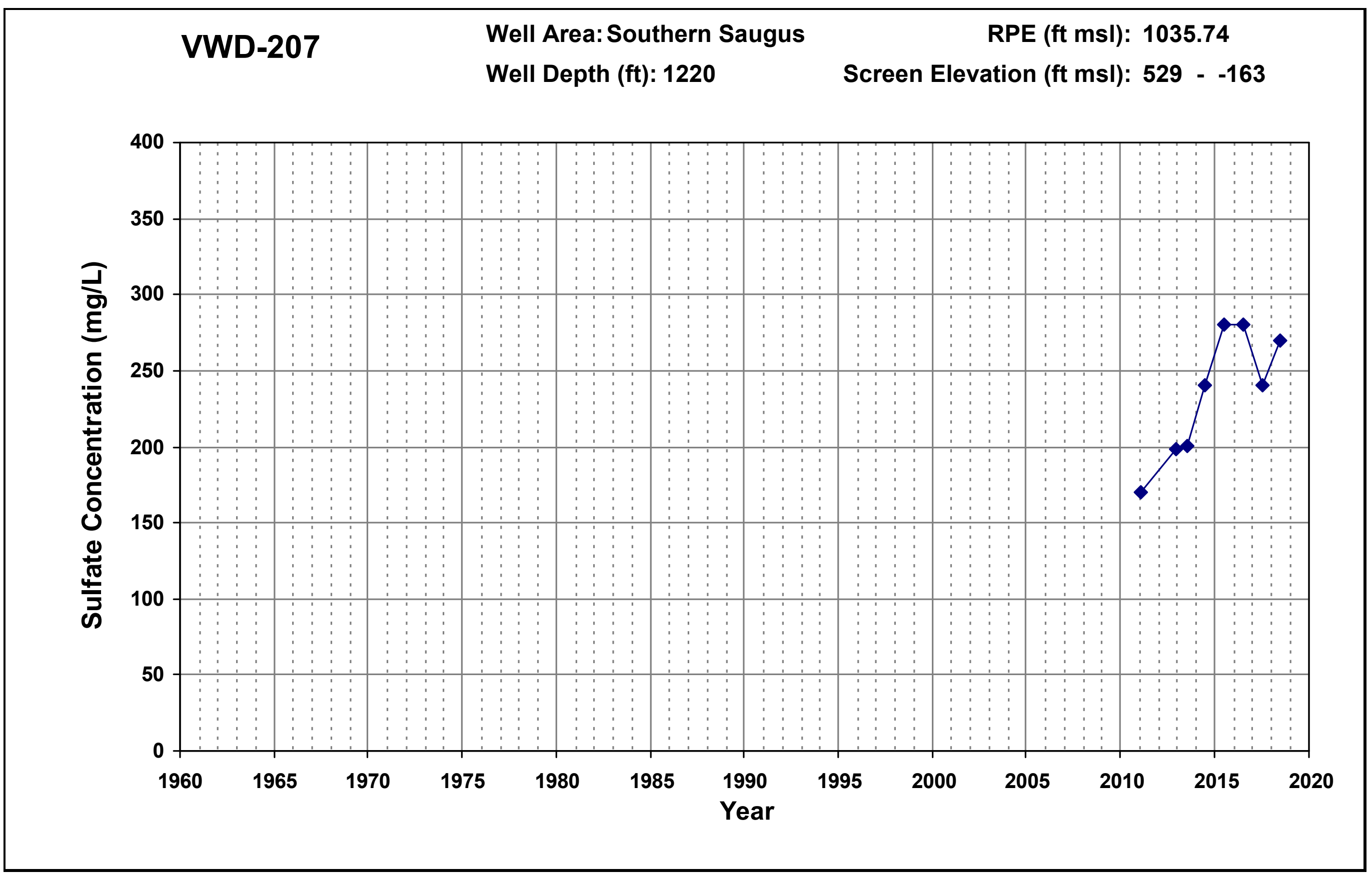
RPE (ft msl): 1148.531

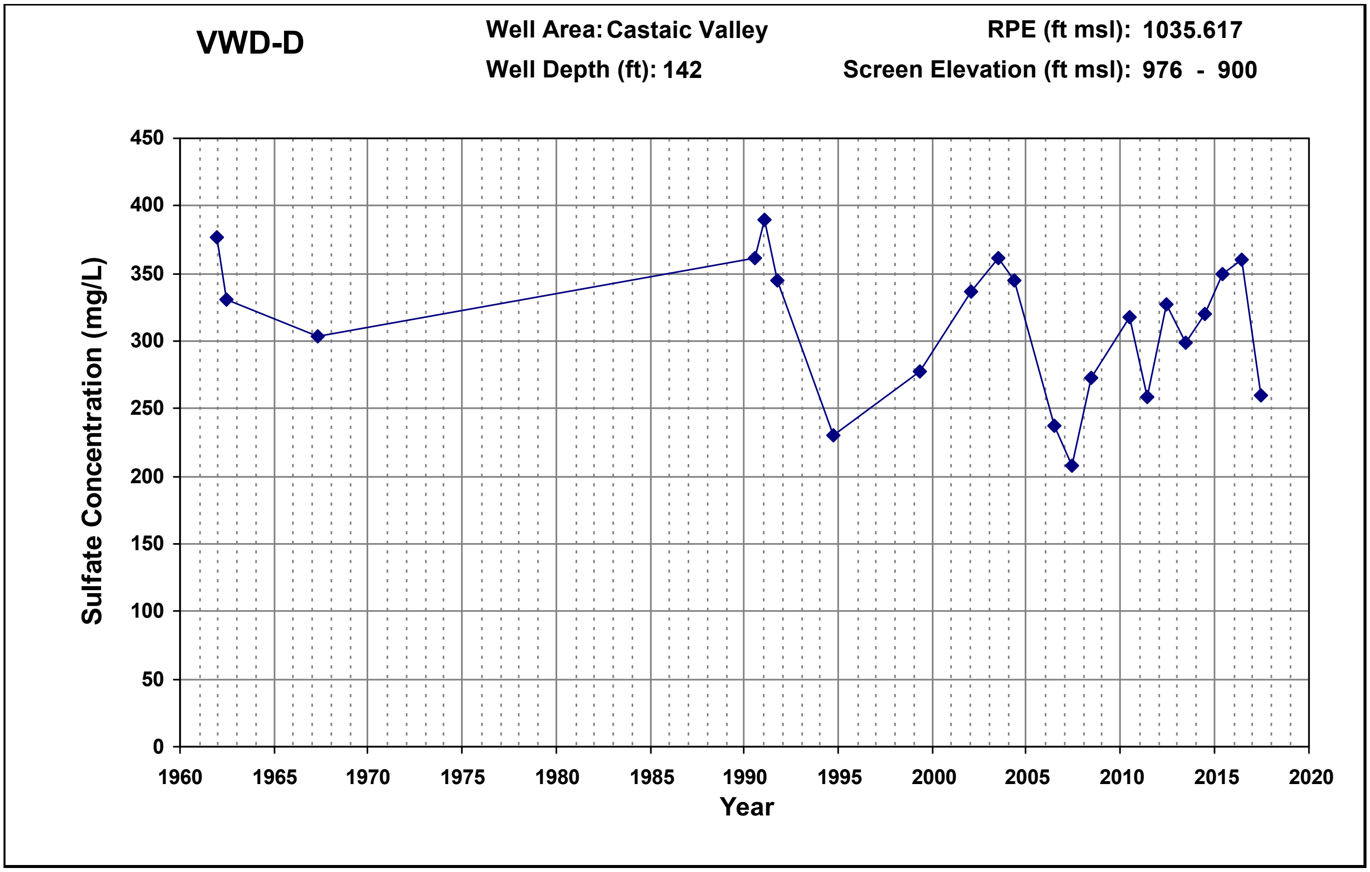
Well Depth (ft): 1950

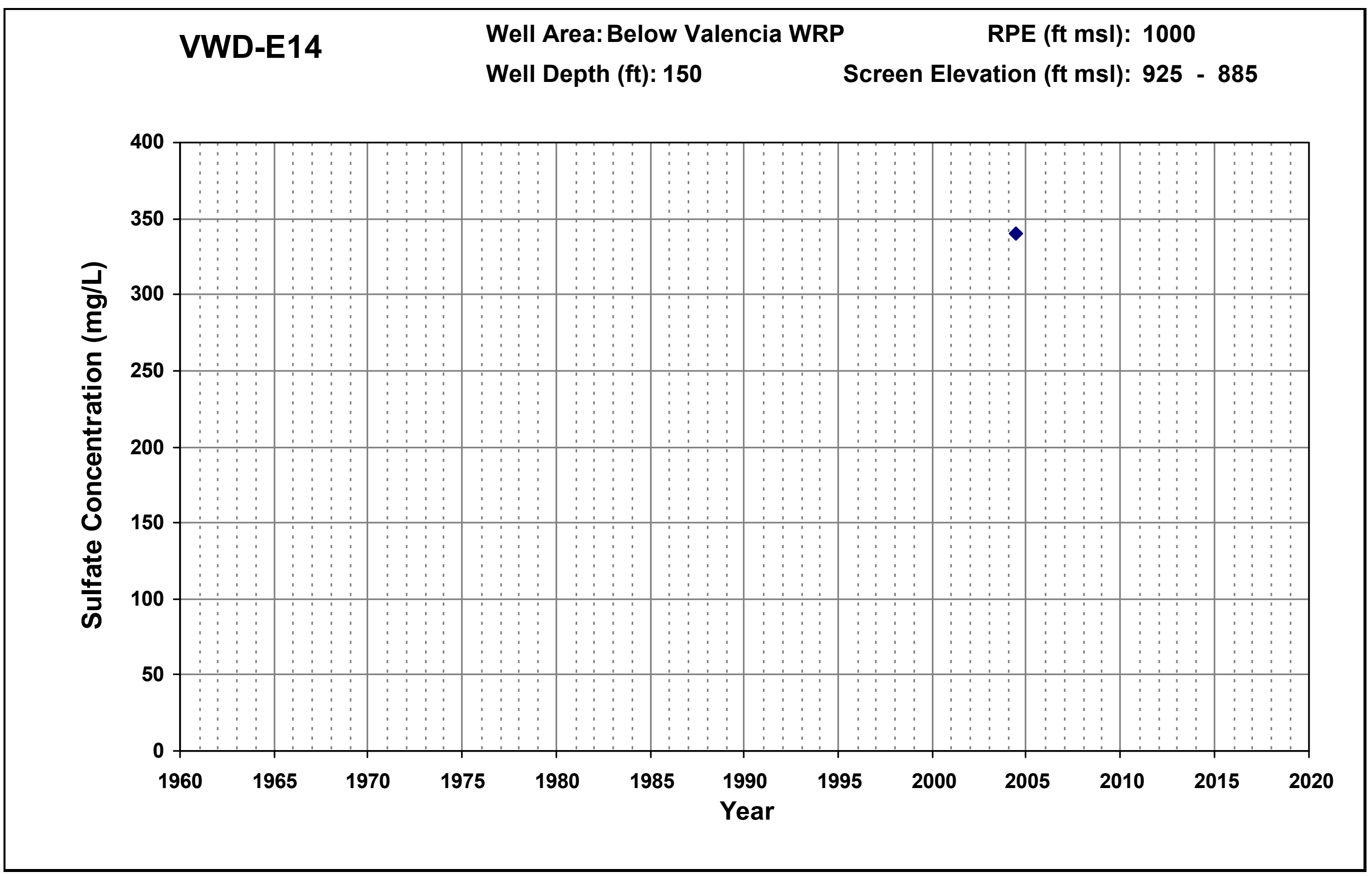
Screen Elevation (ft msl): 329 - -781

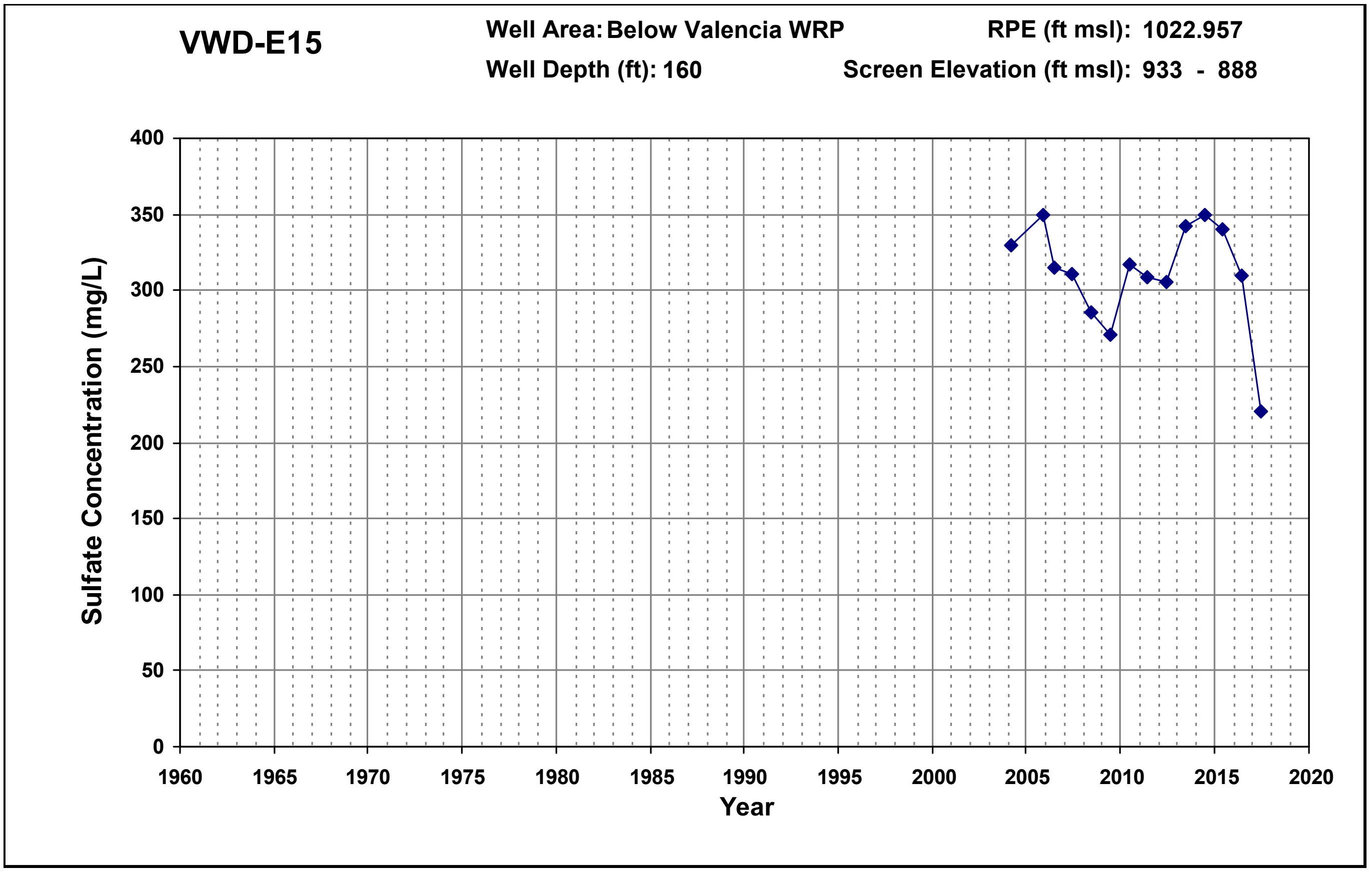


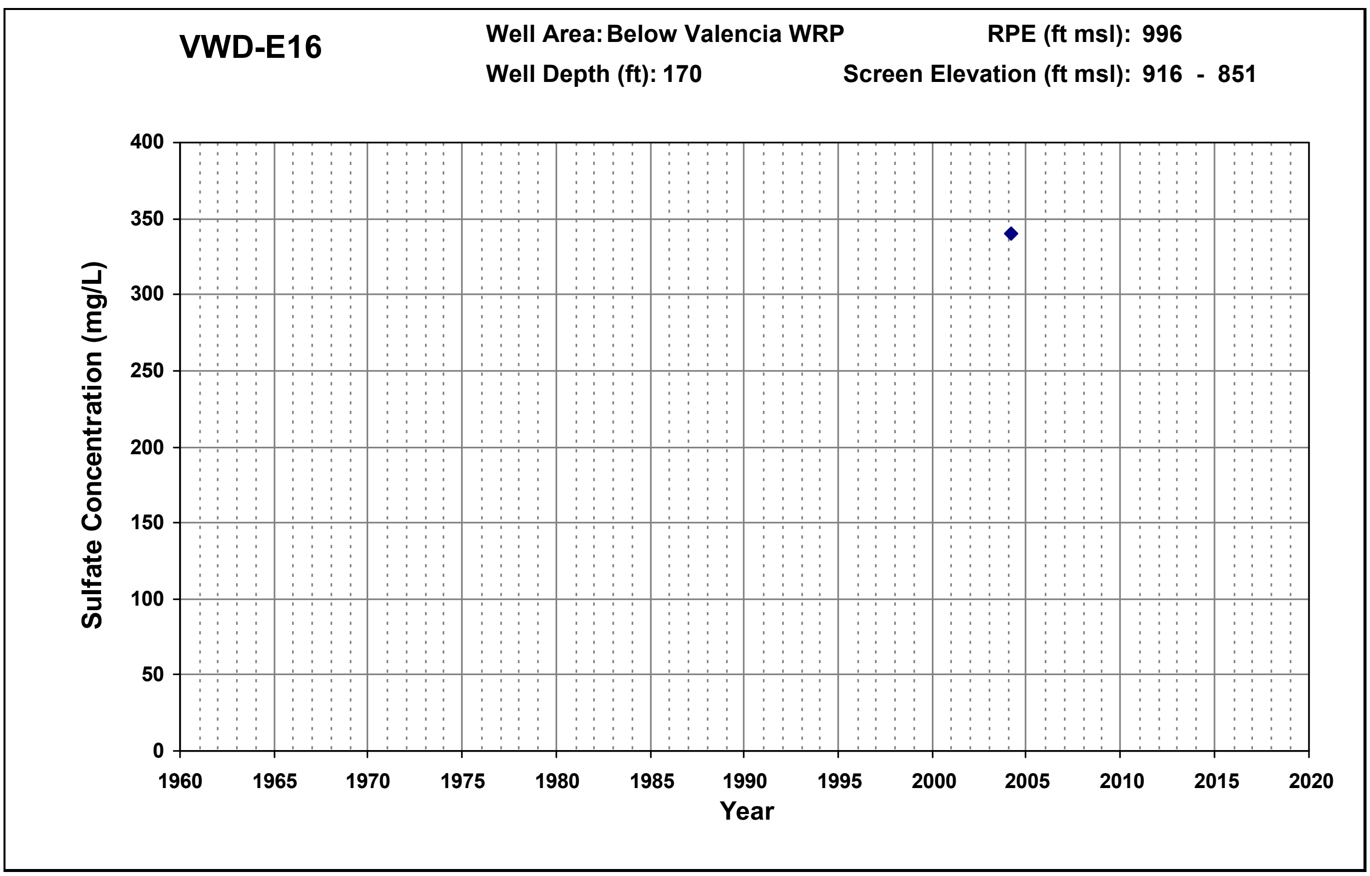

VWD-206
Well Area: Southern Saugus
Well Depth (ft): 2060
RPE (ft msl): 1058.587
Screen Elevation (ft msl): 569 - -981
Sulfate Concentration (mg/L)
400
350
300
250
200
150
100
50
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

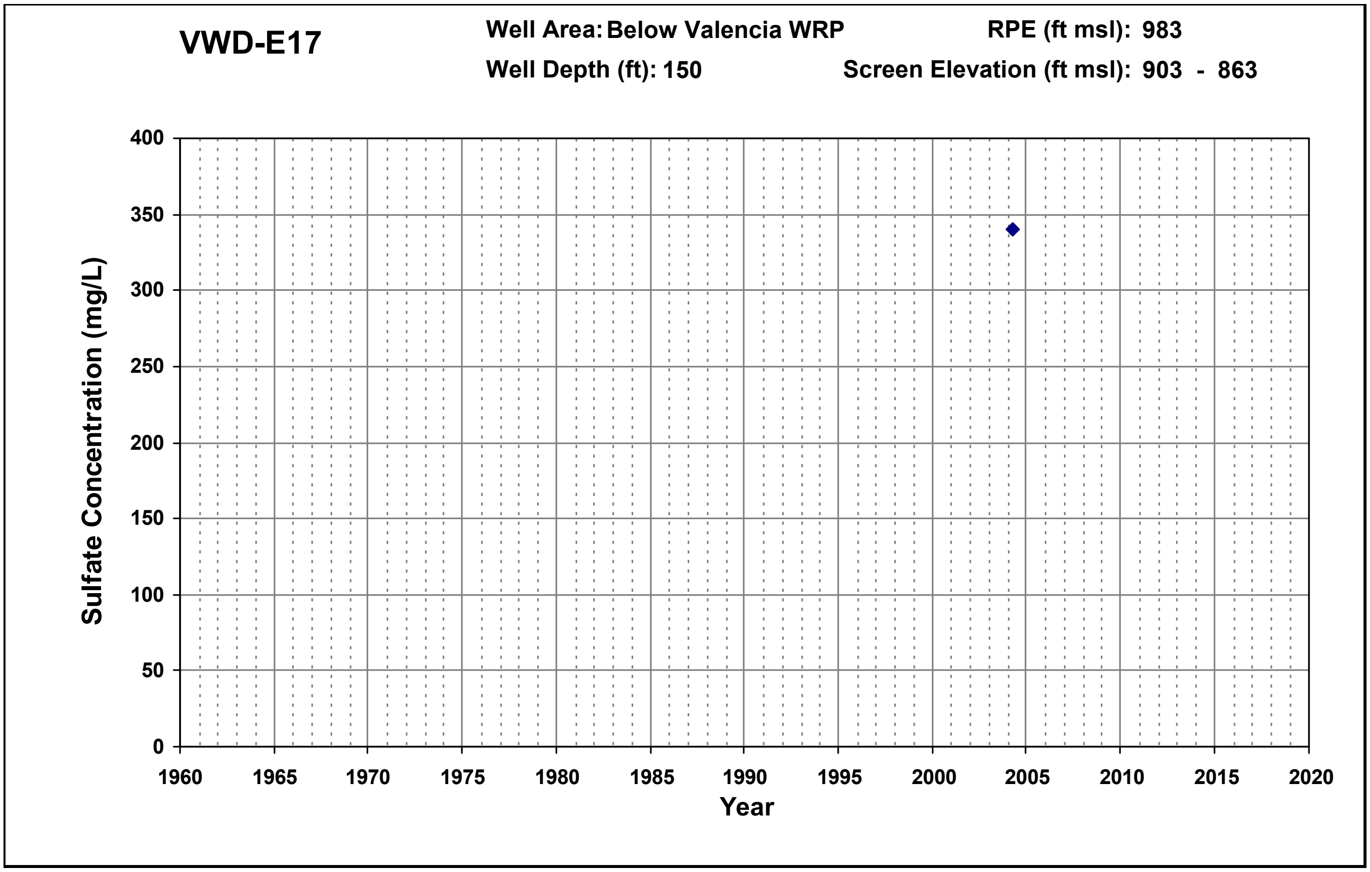

VWD-207
Well Area: Southern Saugus
Well Depth (ft): 1220
RPE (ft msl): 1035.74
Screen Elevation (ft msl): 529 - -163
Sulfate Concentration (mg/L)
400
350
300
250
200
150
100
50
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

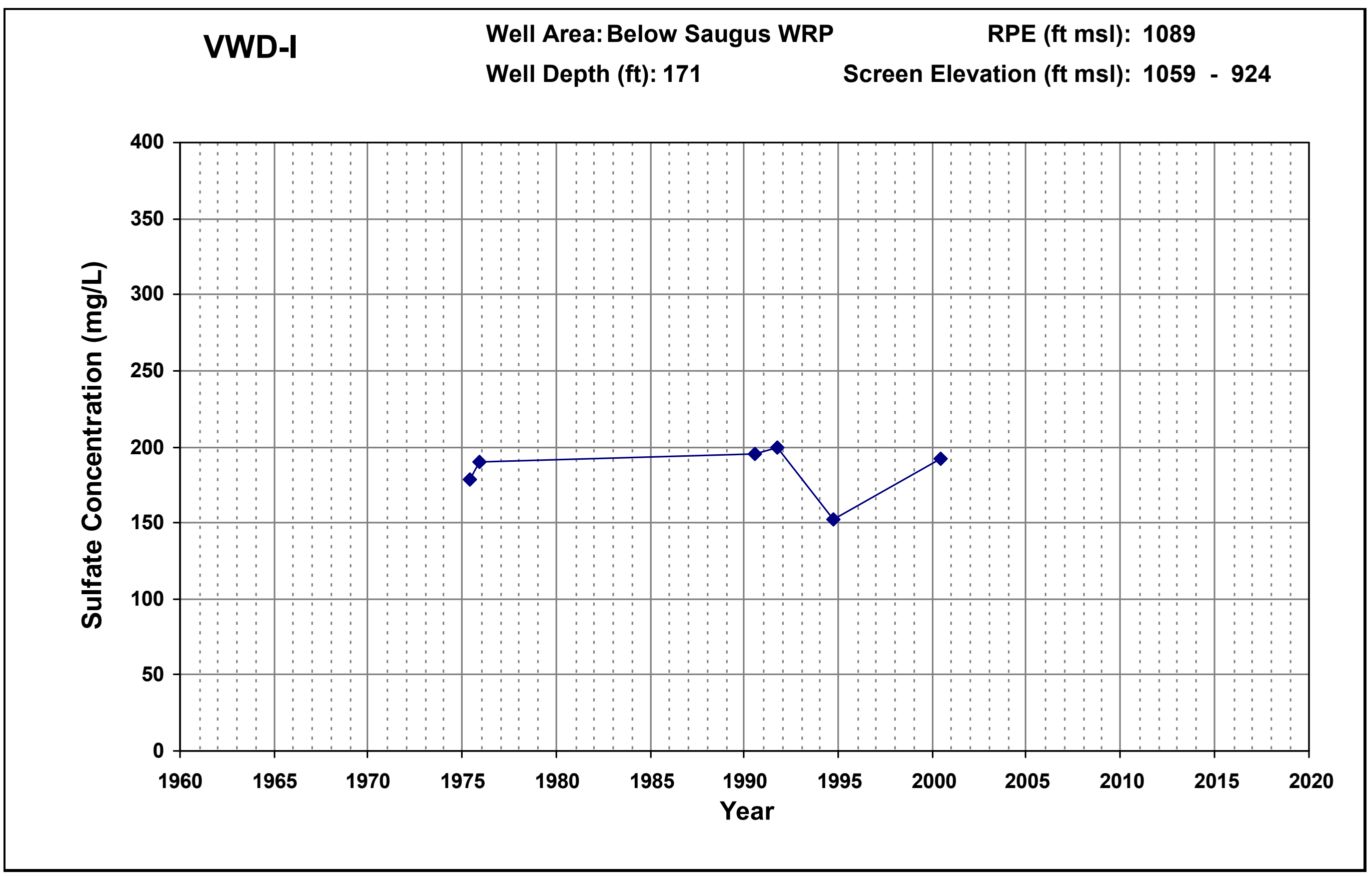

VWD-D
Well Area: Castaic Valley
Well Depth (ft): 142
RPE (ft msl): 1035.617
Screen Elevation (ft msl): 976 - 900
Sulfate Concentration (mg/L)
0
50
100
150
200
250
300
350
400
450
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

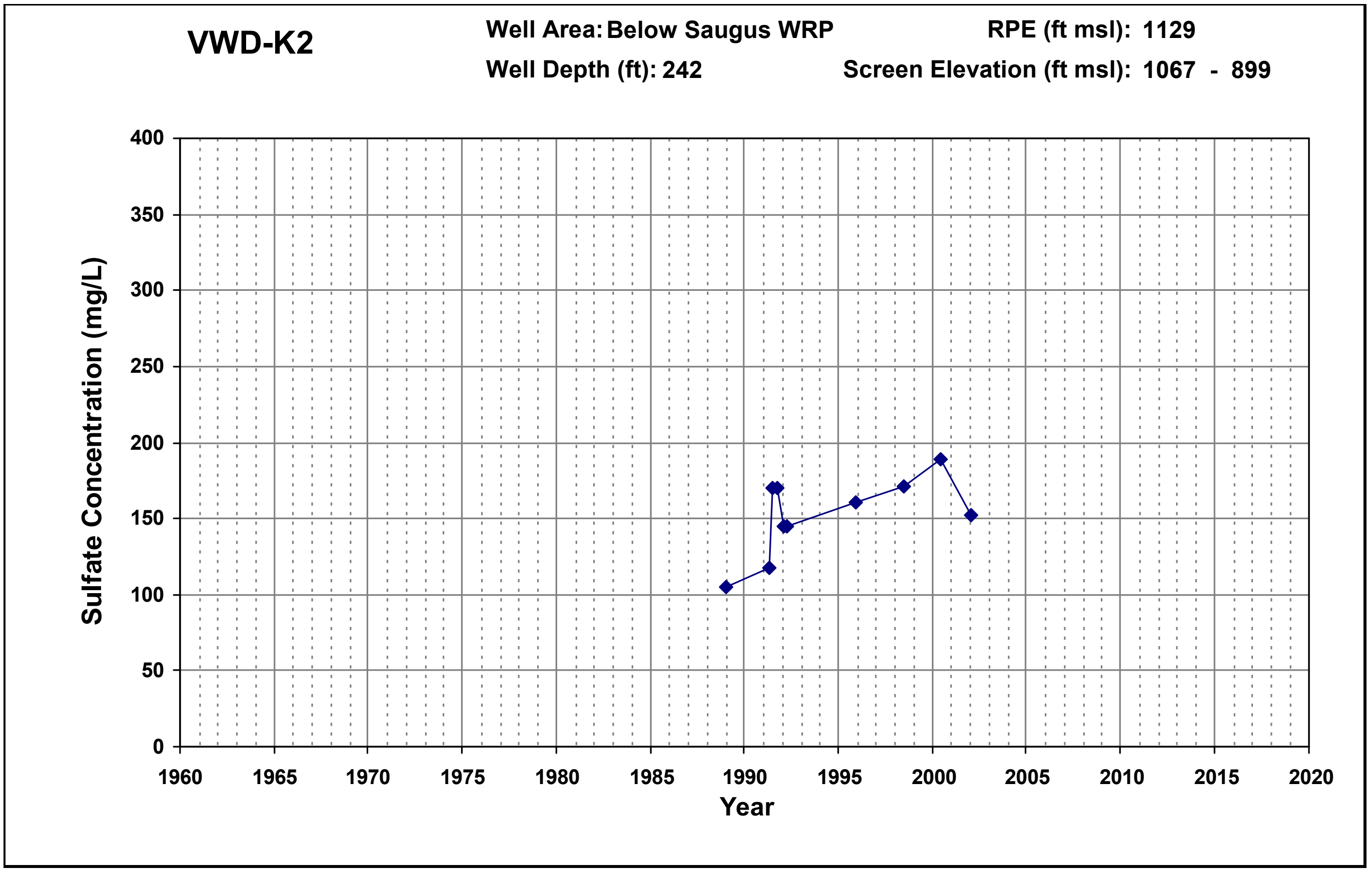

VWD-E14
Well Area: Below Valencia WRP
Well Depth (ft): 150
RPE (ft msl): 1000
Screen Elevation (ft msl): 925 - 885
Sulfate Concentration (mg/L)
0
50
100
150
200
250
300
350
400
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

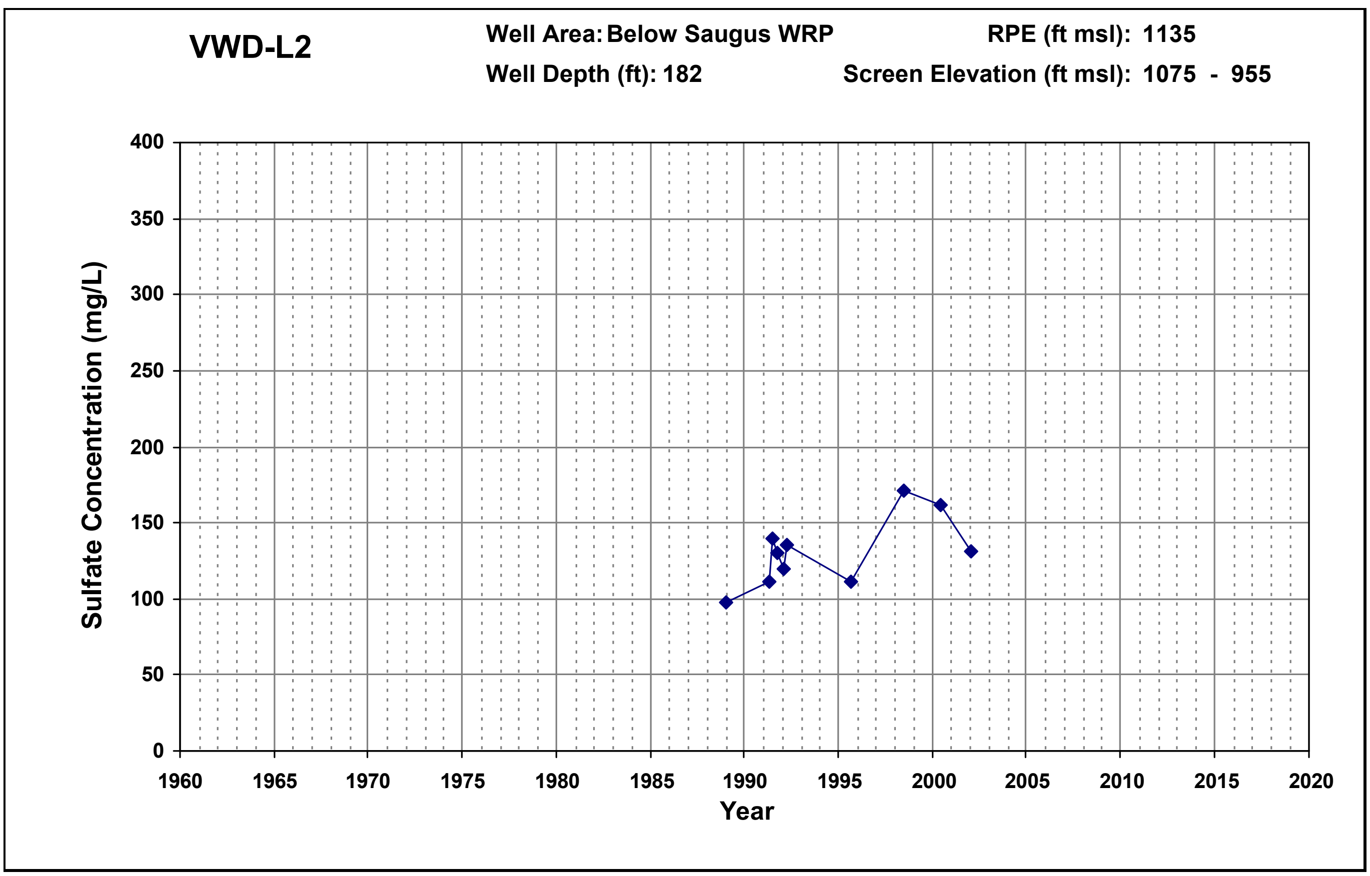

VWD-E15
Well Area: Below Valencia WRP
RPE (ft msl): 1022.957
Well Depth (ft): 160
Screen Elevation (ft msl): 933 - 888
Sulfate Concentration (mg/L)
0
50
100
150
200
250
300
350
400
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

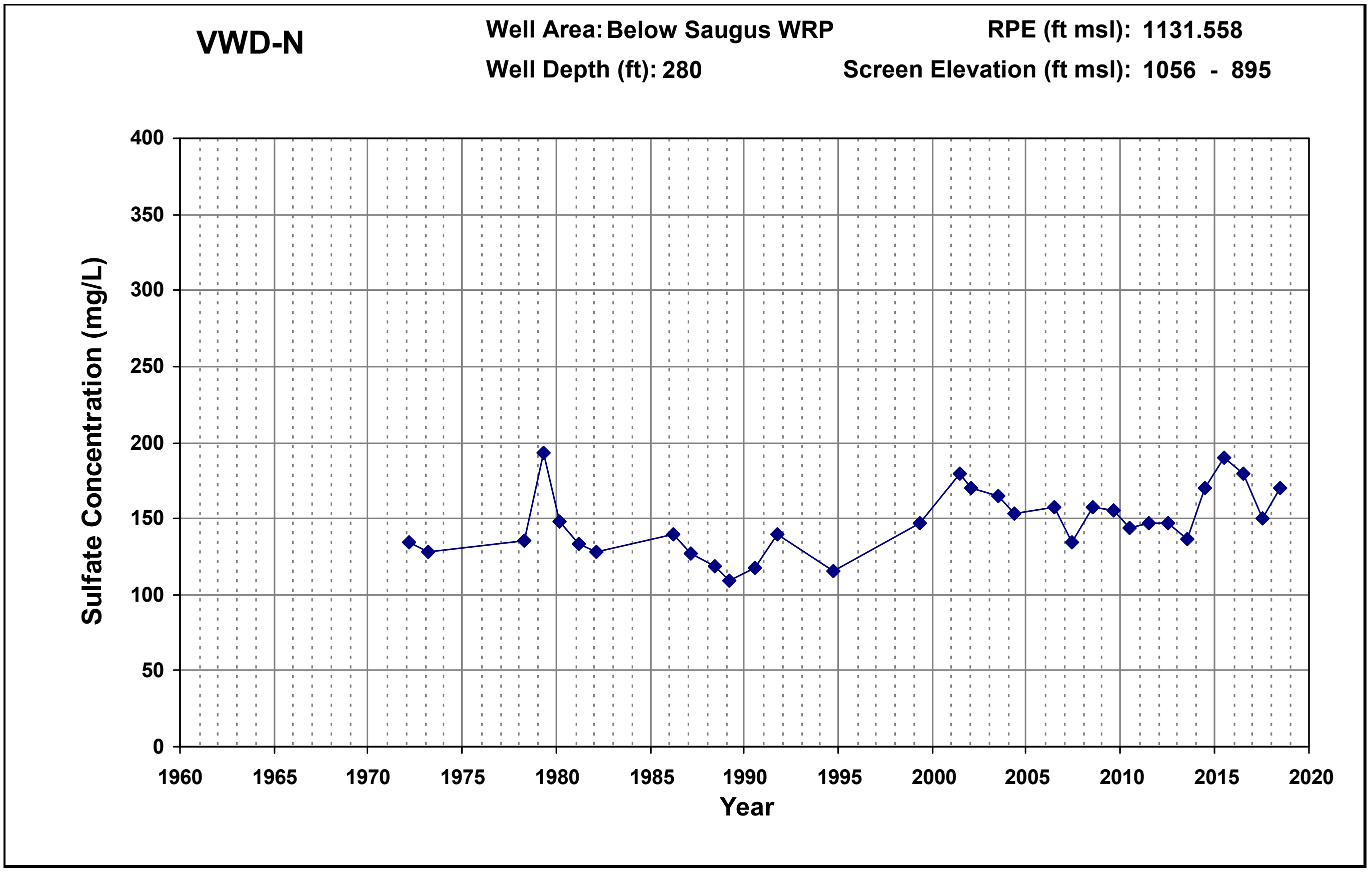

VWD-E16
Well Area: Below Valencia WRP
RPE (ft msl): 996
Well Depth (ft): 170
Screen Elevation (ft msl): 916 - 851
Sulfate Concentration (mg/L)
0
50
100
150
200
250
300
350
400
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

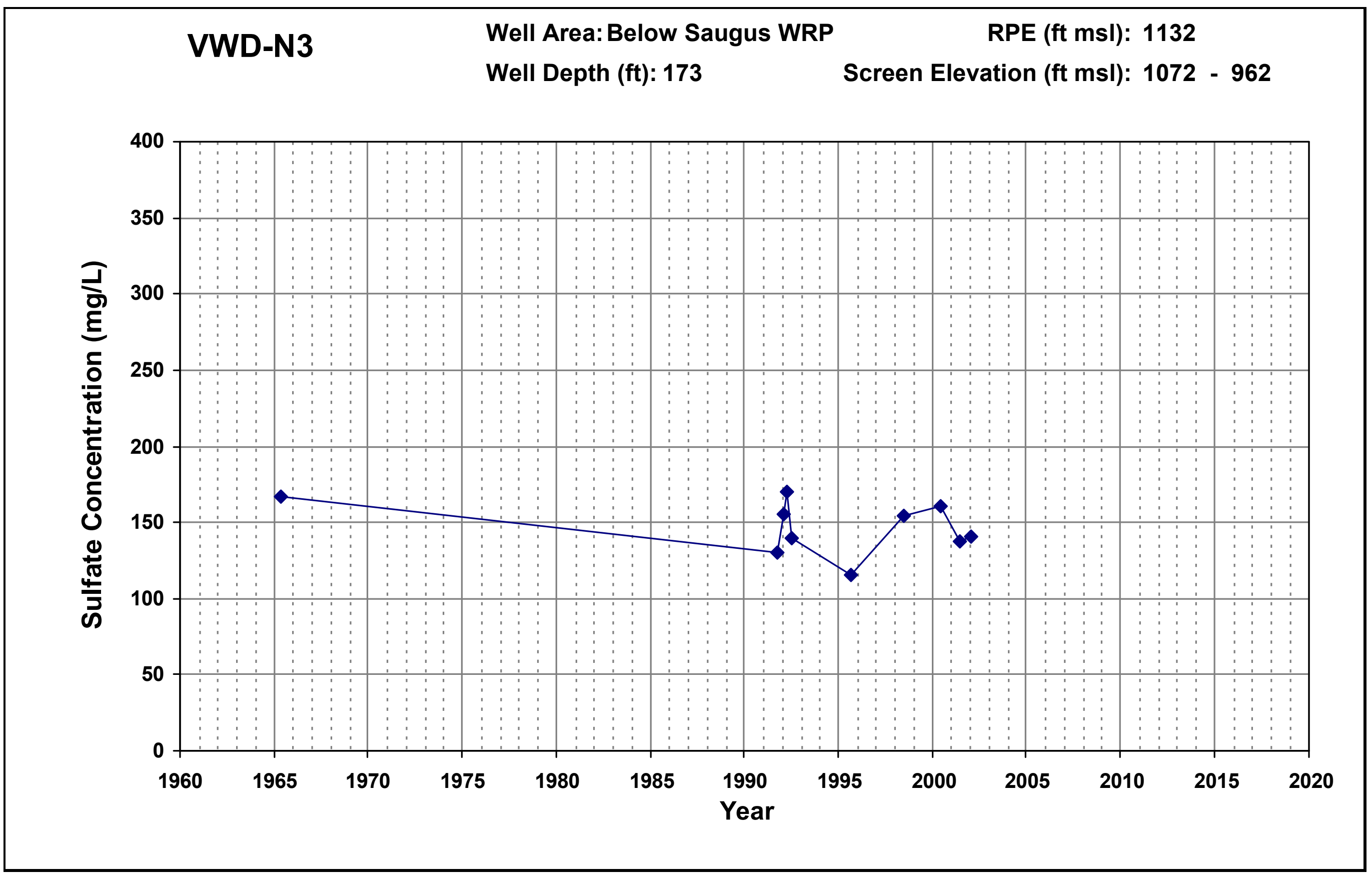

VWD-E17
Well Area: Below Valencia WRP
RPE (ft msl): 983
Well Depth (ft): 150
Screen Elevation (ft msl): 903 - 863
Sulfate Concentration (mg/L)
400
350
300
250
200
150
100
50
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year


VWD-I
Well Area: Below Saugus WRP
RPE (ft msl): 1089
Well Depth (ft): 171
Screen Elevation (ft msl): 1059 - 924
Sulfate Concentration (mg/L)
400
350
300
250
200
150
100
50
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year


VWD-K2
Well Area: Below Saugus WRP
RPE (ft msl): 1129
Well Depth (ft): 242
Screen Elevation (ft msl): 1067 - 899
Sulfate Concentration (mg/L)
400
350
300
250
200
150
100
50
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year


VWD-L2
Well Area: Below Saugus WRP
RPE (ft msl): 1135
Well Depth (ft): 182
Screen Elevation (ft msl): 1075 - 955
Sulfate Concentration (mg/L)
400
350
300
250
200
150
100
50
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year


VWD-N
Well Area: Below Saugus WRP
RPE (ft msl): 1131.558
Well Depth (ft): 280
Screen Elevation (ft msl): 1056 - 895
Sulfate Concentration (mg/L)
400
350
300
250
200
150
100
50
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year


VWD-N3
Well Area: Below Saugus WRP
RPE (ft msl): 1132
Well Depth (ft): 173
Screen Elevation (ft msl): 1072 - 962
Sulfate Concentration (mg/L)
400
350
300
250
200
150
100
50
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

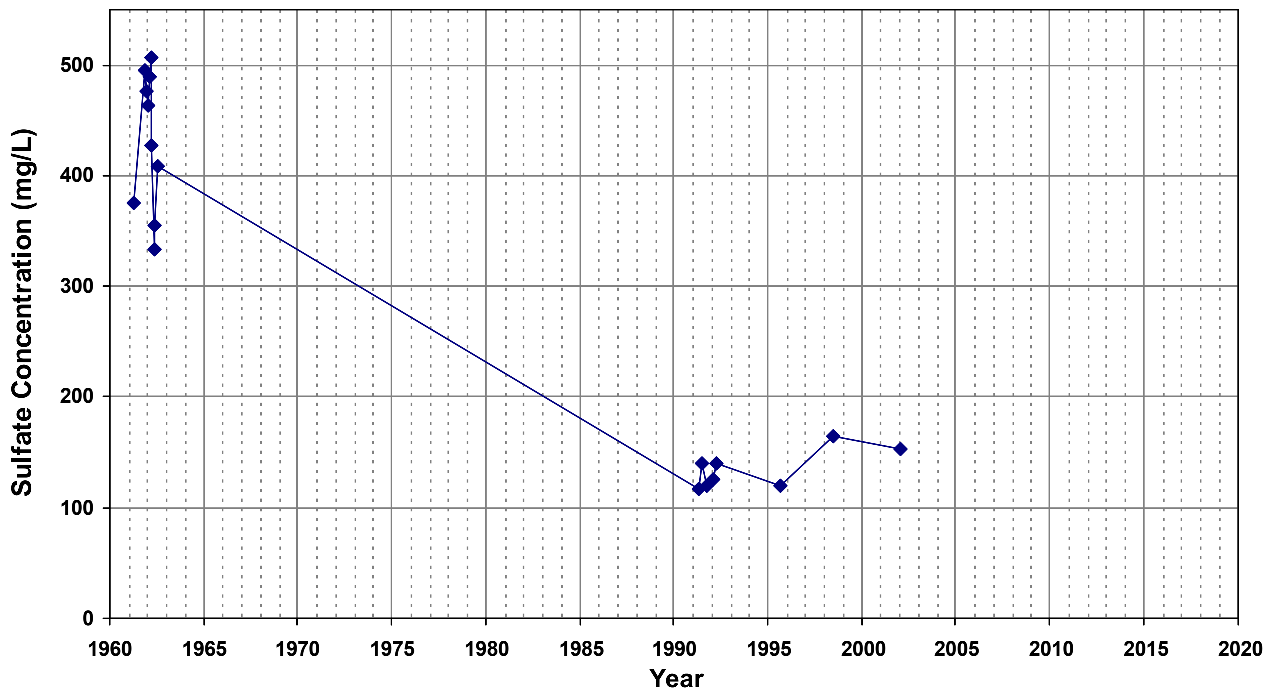
VWD-N4

Well Area: Below Saugus WRP

RPE (ft msl): 1135

Well Depth (ft): 186

Screen Elevation (ft msl): 1090 - 952



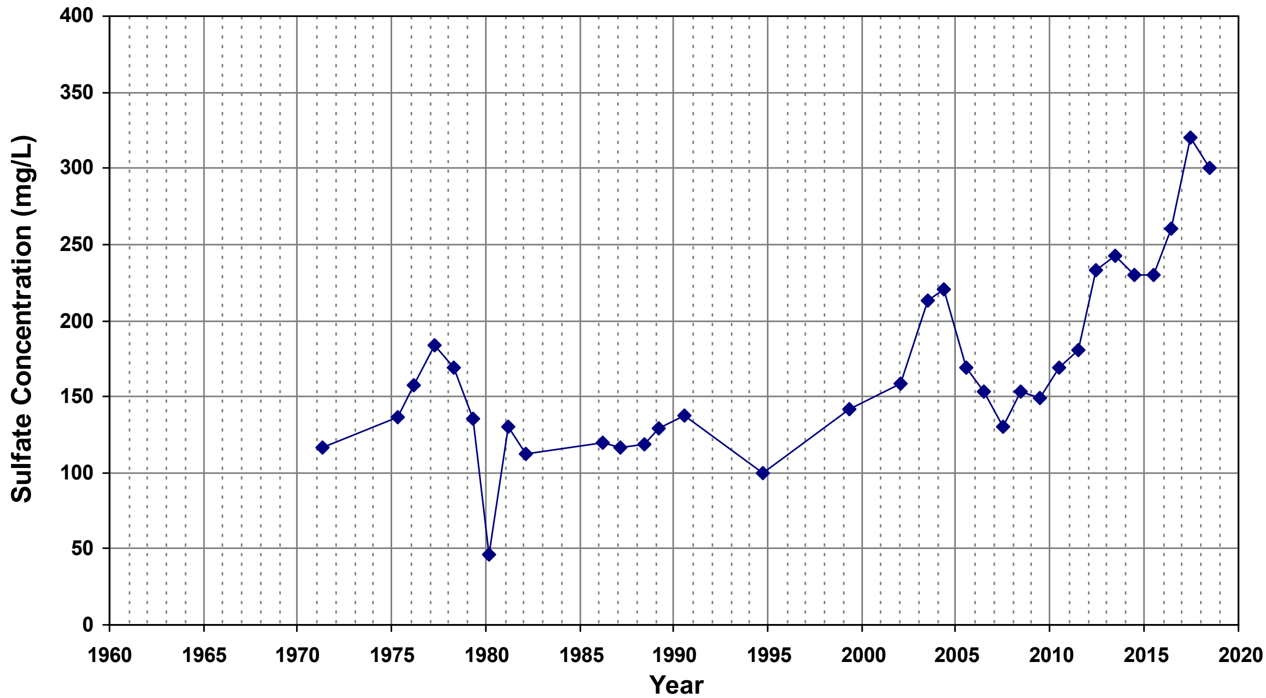
VWD-Q2

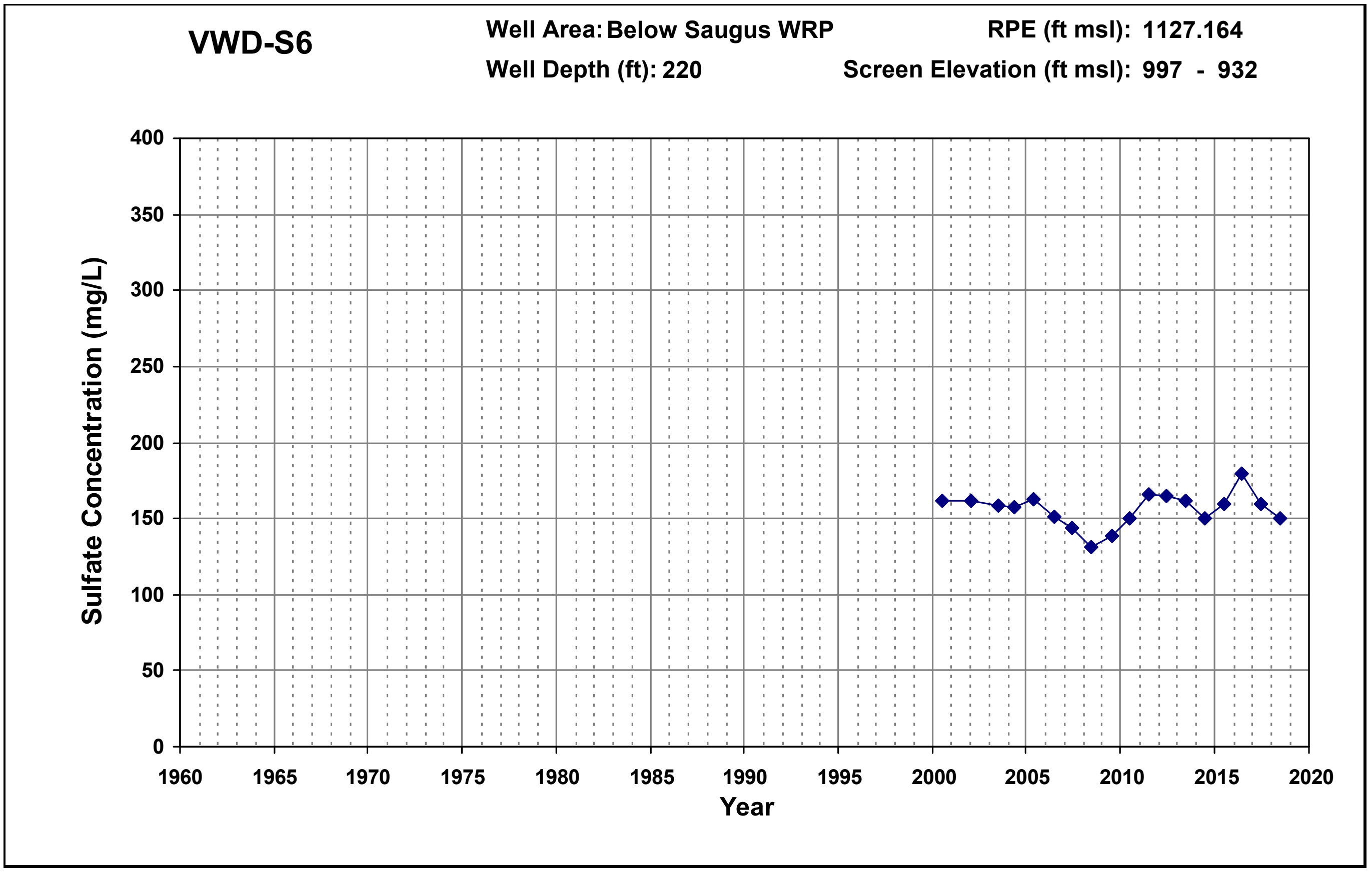
Well Area: Below Saugus WRP

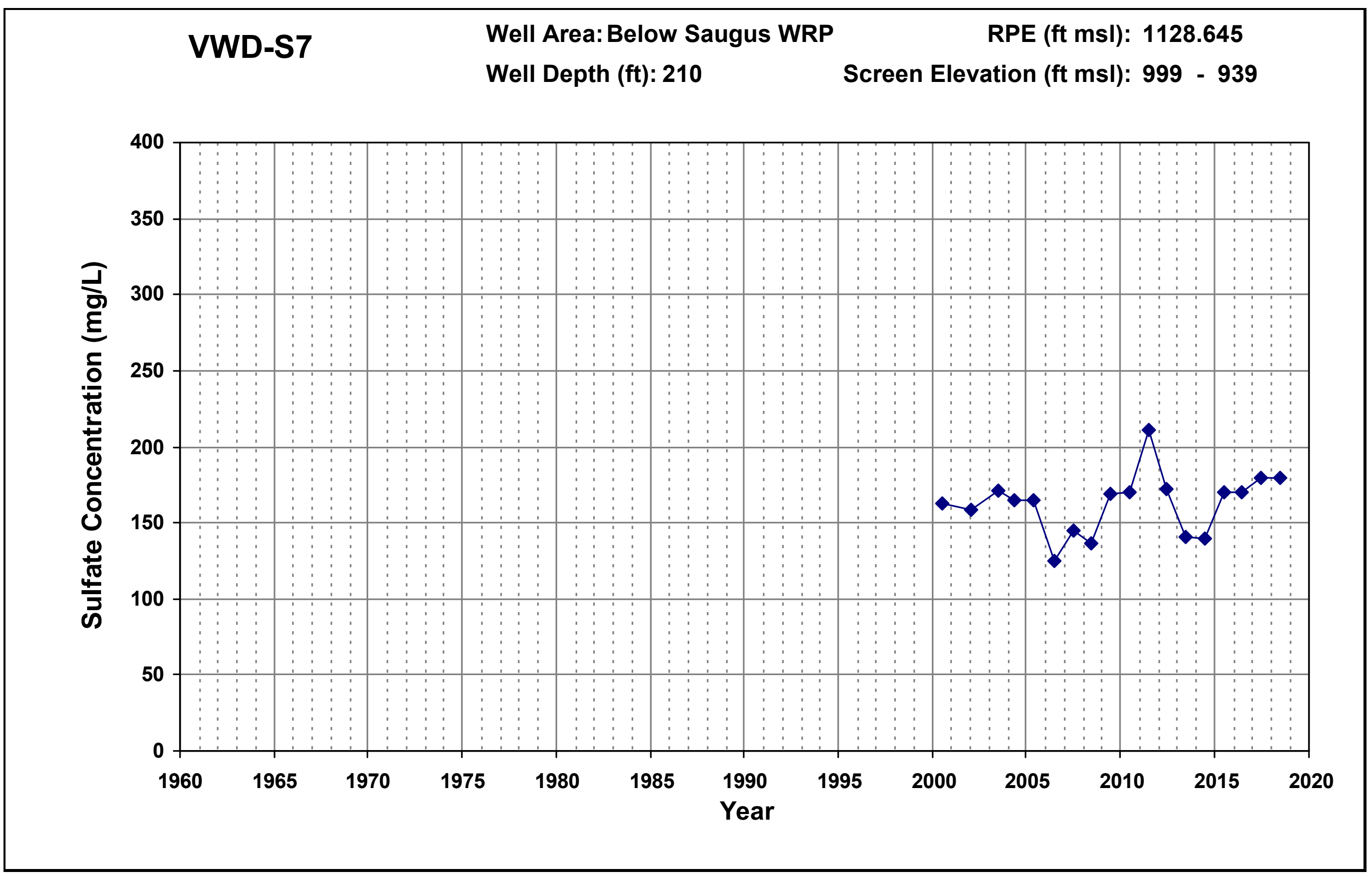
RPE (ft msl): 1166.641

Well Depth (ft): 170

Screen Elevation (ft msl): 1091 - 1041




VWD-S6
Well Area: Below Saugus WRP
Well Depth (ft): 220
RPE (ft msl): 1127.164
Screen Elevation (ft msl): 997 - 932
Sulfate Concentration (mg/L)
400
350
300
250
200
150
100
50
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year


VWD-S7
Well Area: Below Saugus WRP
Well Depth (ft): 210
RPE (ft msl): 1128.645
Screen Elevation (ft msl): 999 - 939
Sulfate Concentration (mg/L)
400
350
300
250
200
150
100
50
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

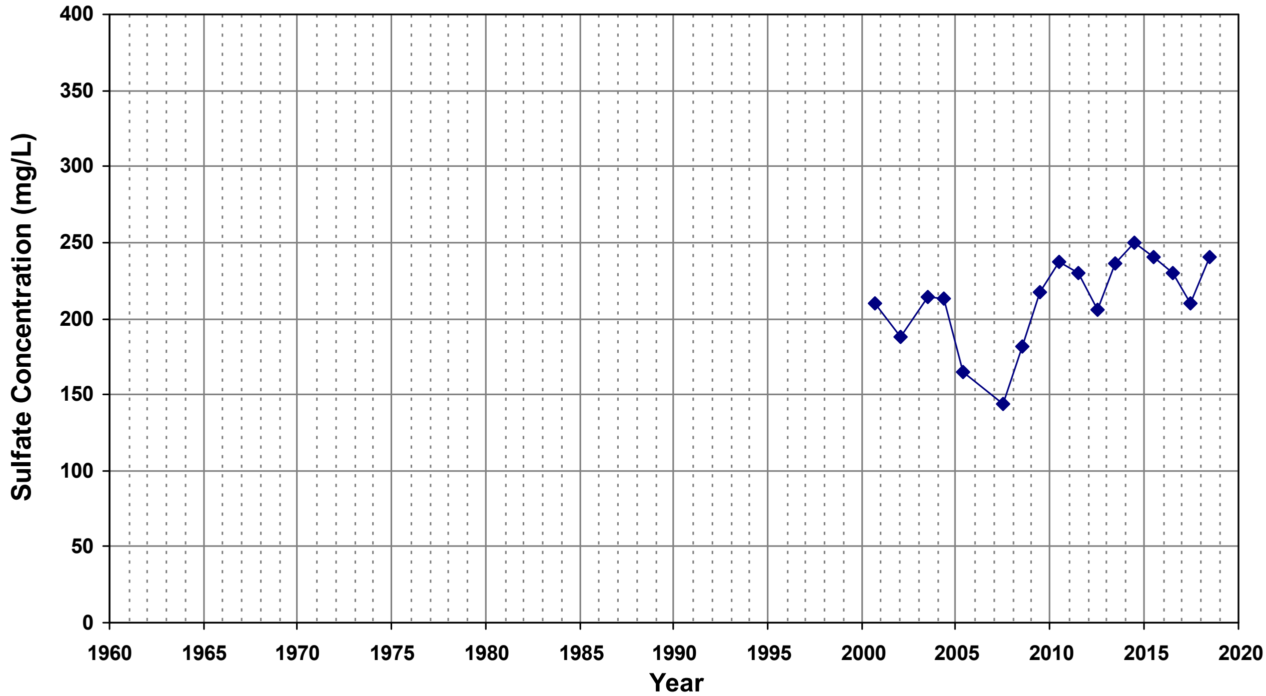
VWD-S8

Well Area: Below Saugus WRP

RPE (ft msl): 1143.355

Well Depth (ft): 220

Screen Elevation (ft msl): 1013 - 948



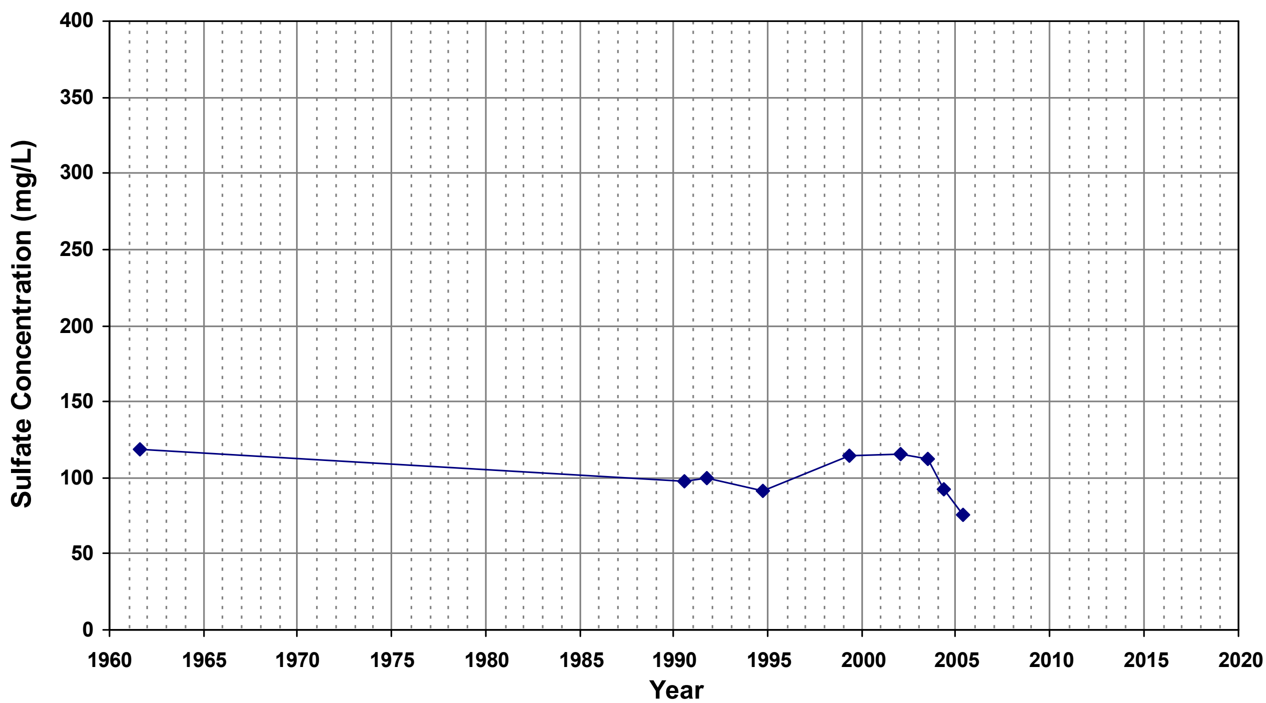
VWD-T2

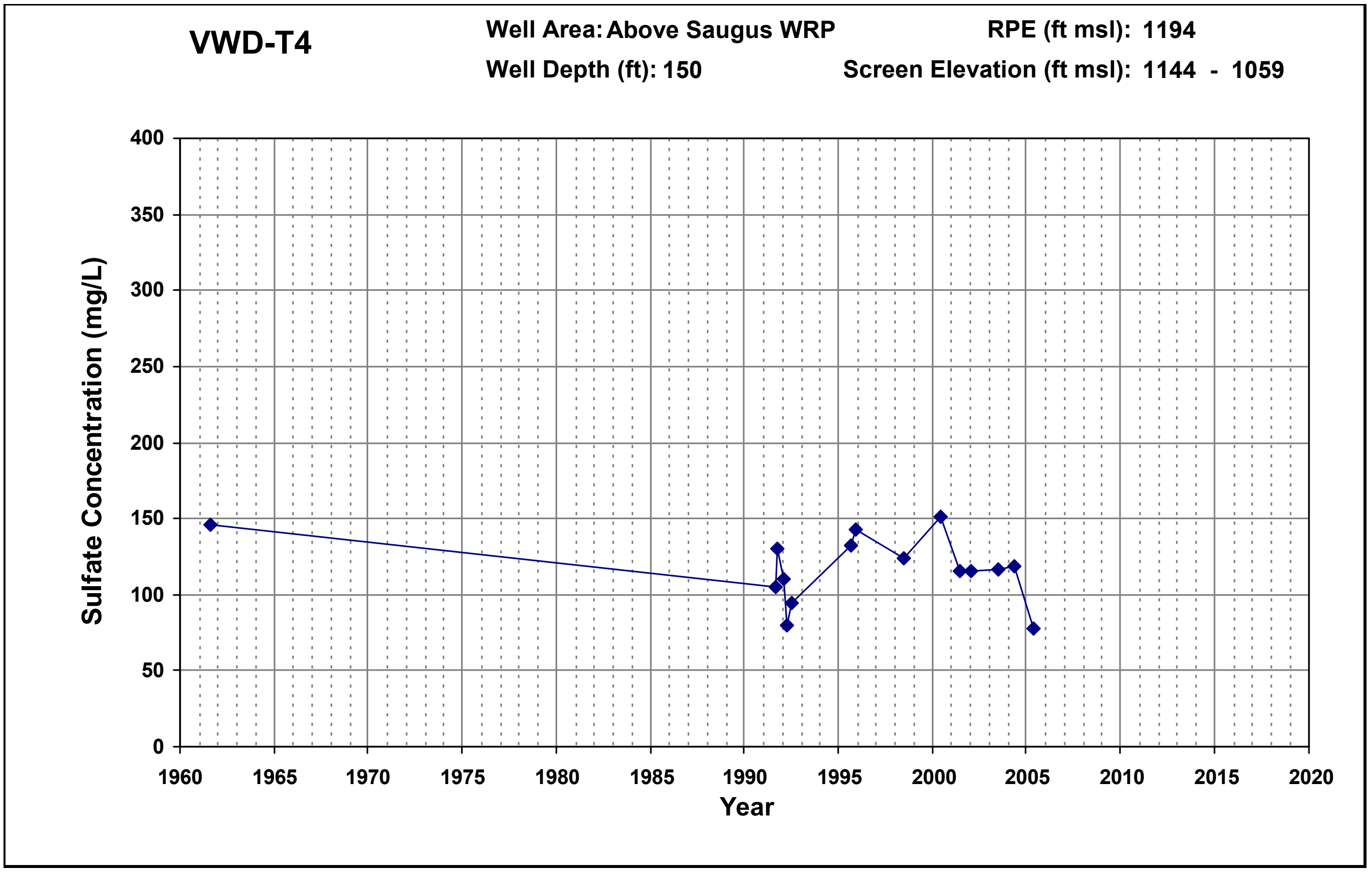
Well Area: Above Saugus WRP

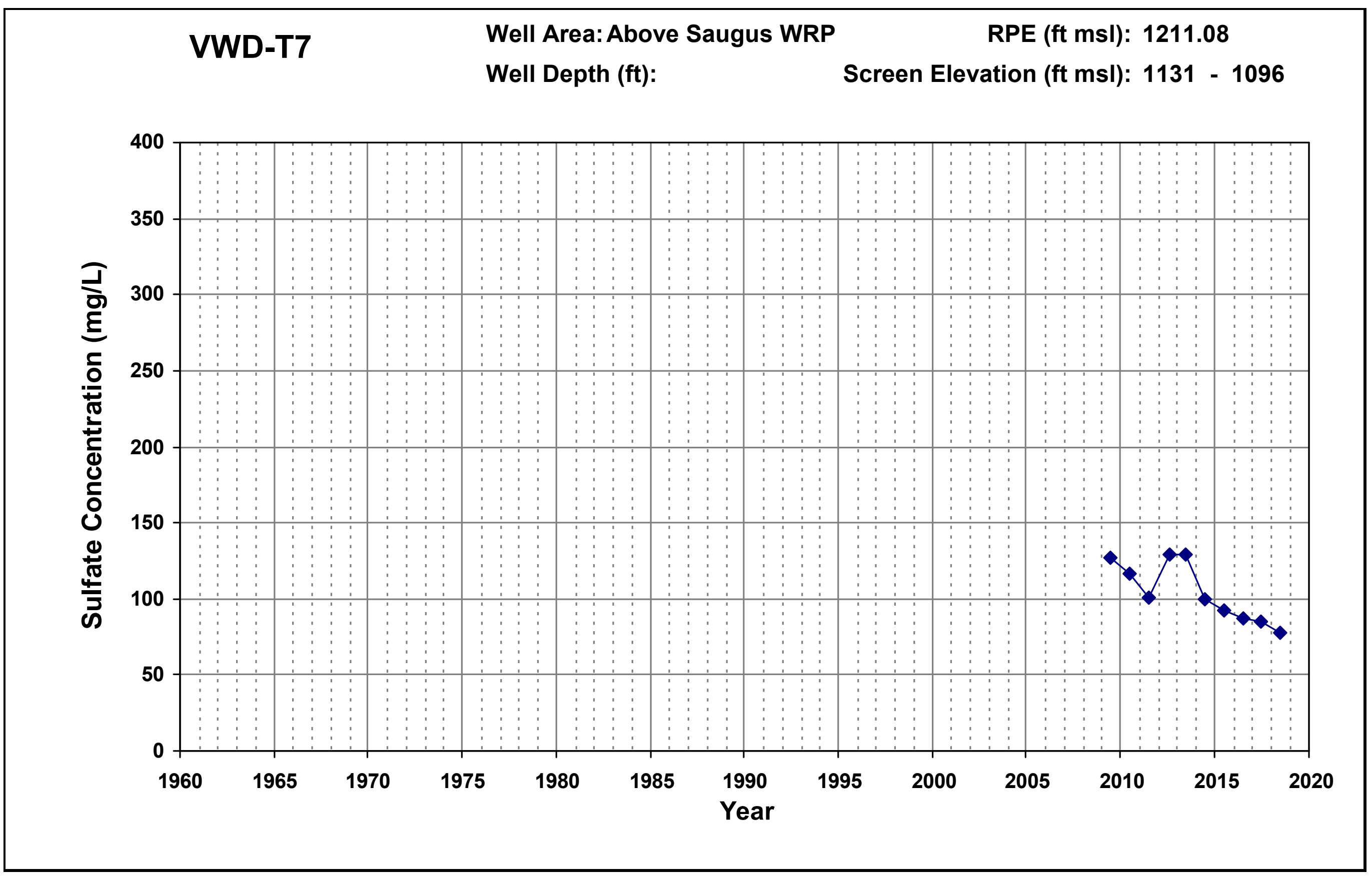
RPE (ft msl): 1201

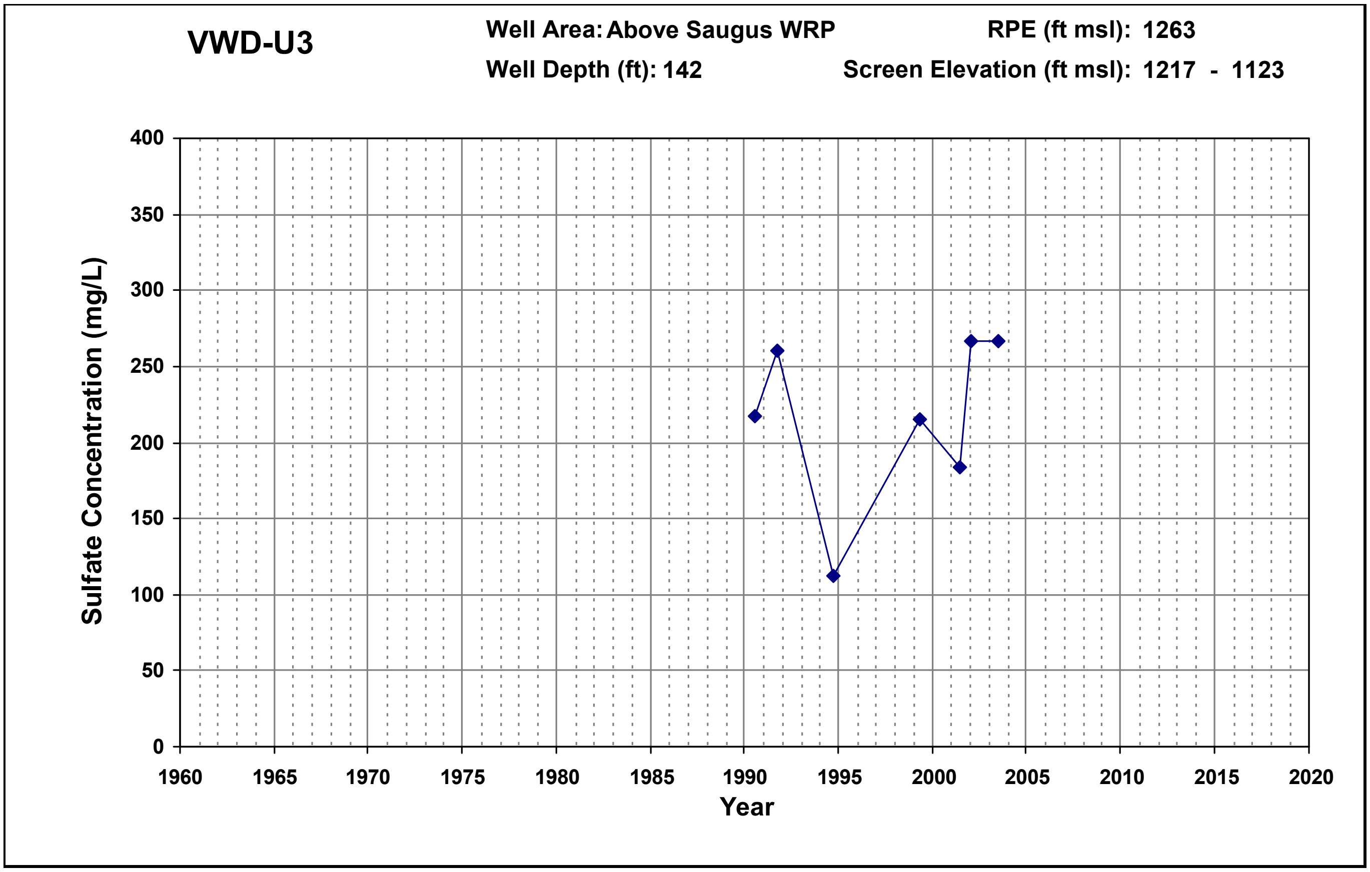
Well Depth (ft): 150

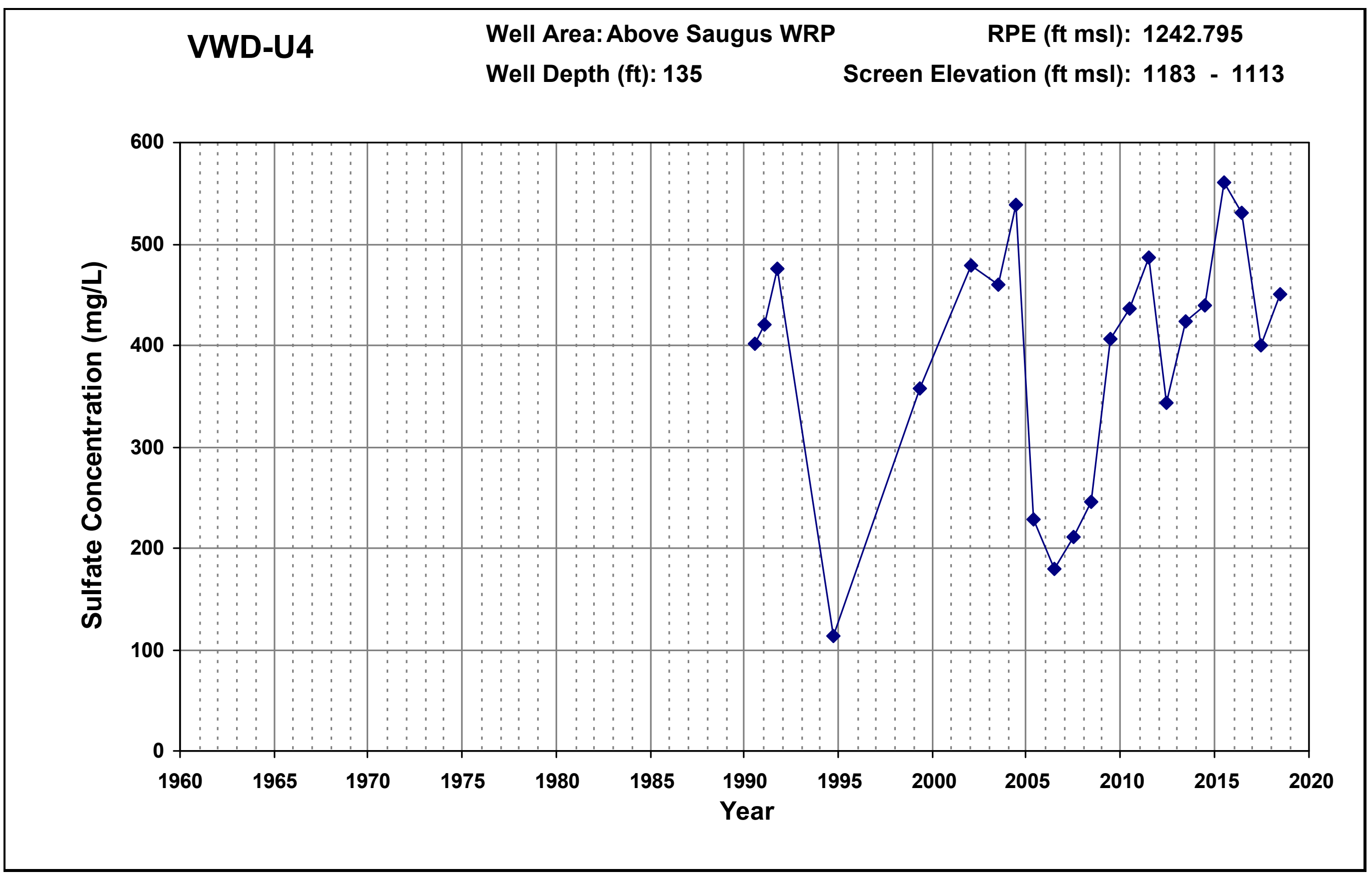
Screen Elevation (ft msl): 1151 - 1063

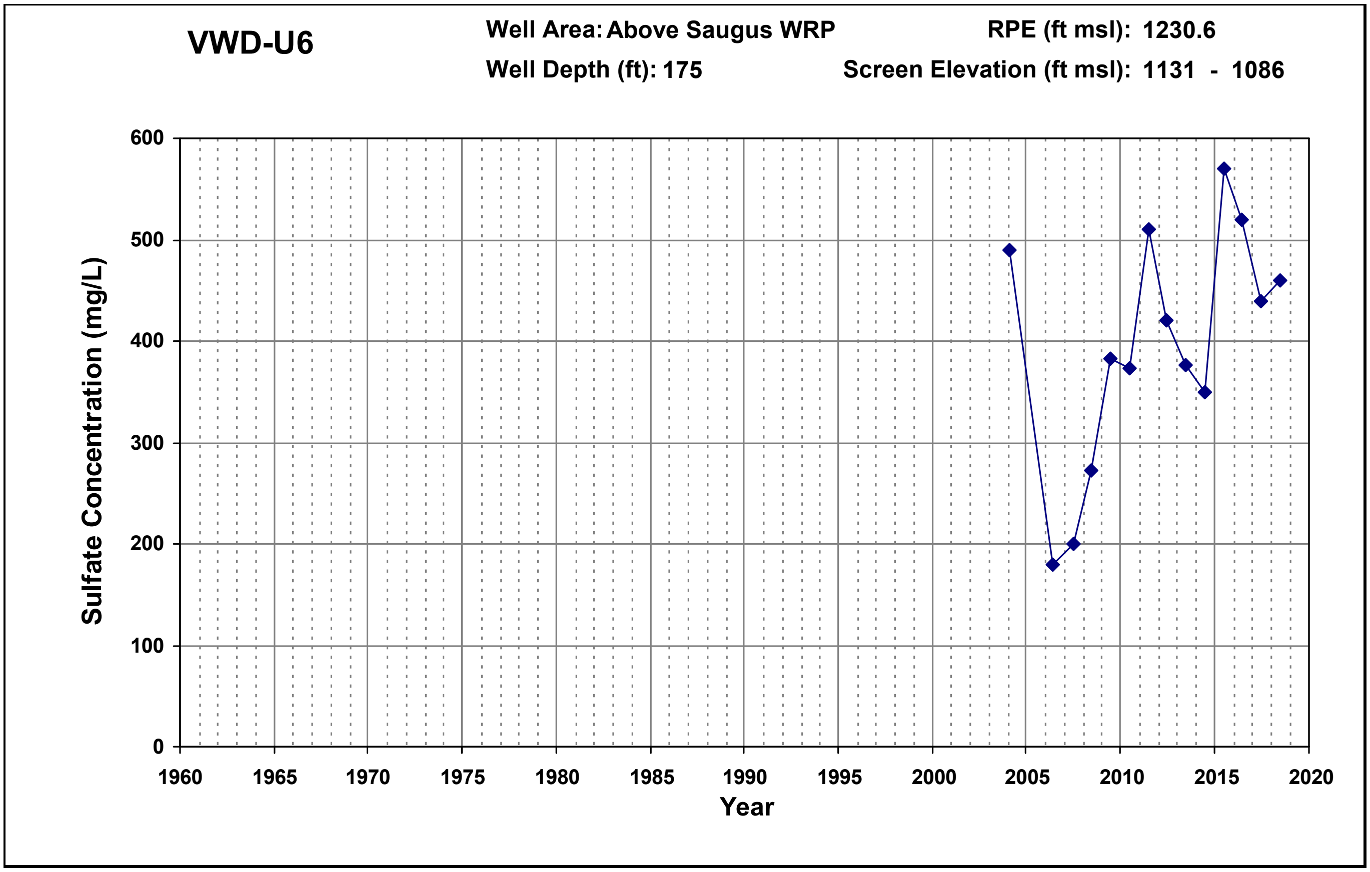


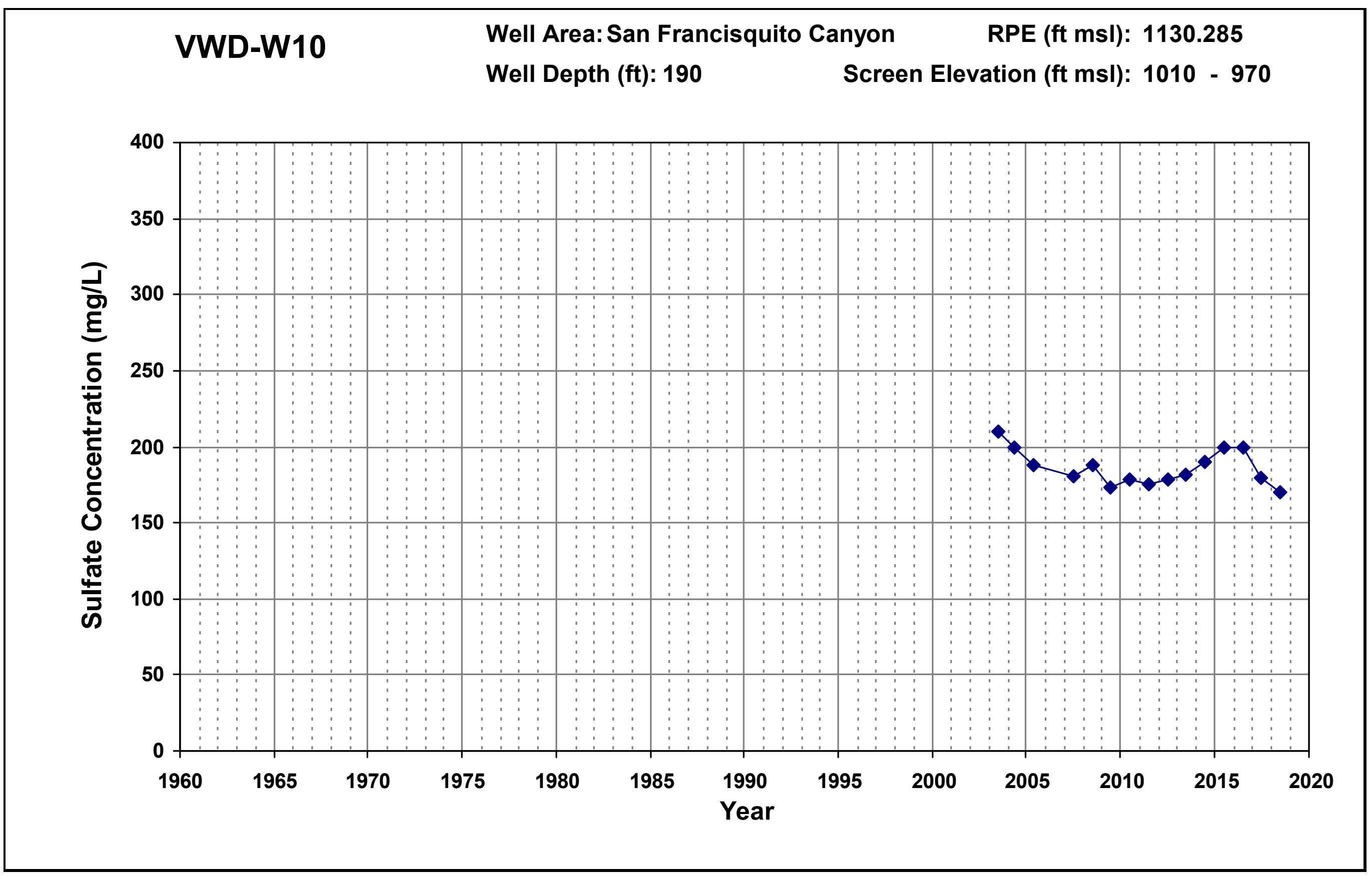

VWD-T4
Well Area: Above Saugus WRP
RPE (ft msl): 1194
Well Depth (ft): 150
Screen Elevation (ft msl): 1144 - 1059
Sulfate Concentration (mg/L)
0
50
100
150
200
250
300
350
400
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year


VWD-T7
Well Area: Above Saugus WRP
RPE (ft msl): 1211.08
Well Depth (ft):
Screen Elevation (ft msl): 1131 - 1096
Sulfate Concentration (mg/L)
0
50
100
150
200
250
300
350
400
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year


VWD-U3
Well Area: Above Saugus WRP
RPE (ft msl): 1263
Well Depth (ft): 142
Screen Elevation (ft msl): 1217 - 1123
Sulfate Concentration (mg/L)
Year
0
50
100
150
200
250
300
350
400
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020


VWD-U4
Well Area: Above Saugus WRP
RPE (ft msl): 1242.795
Well Depth (ft): 135
Screen Elevation (ft msl): 1183 - 1113
Sulfate Concentration (mg/L)
Year
0
100
200
300
400
500
600
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020


VWD-U6
Well Area: Above Saugus WRP
RPE (ft msl): 1230.6
Well Depth (ft): 175
Screen Elevation (ft msl): 1131 - 1086
Sulfate Concentration (mg/L)
0
100
200
300
400
500
600
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year


VWD-W10
Well Area: San Francisquito Canyon
RPE (ft msl): 1130.285
Well Depth (ft): 190
Screen Elevation (ft msl): 1010 - 970
Sulfate Concentration (mg/L)
0
50
100
150
200
250
300
350
400
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

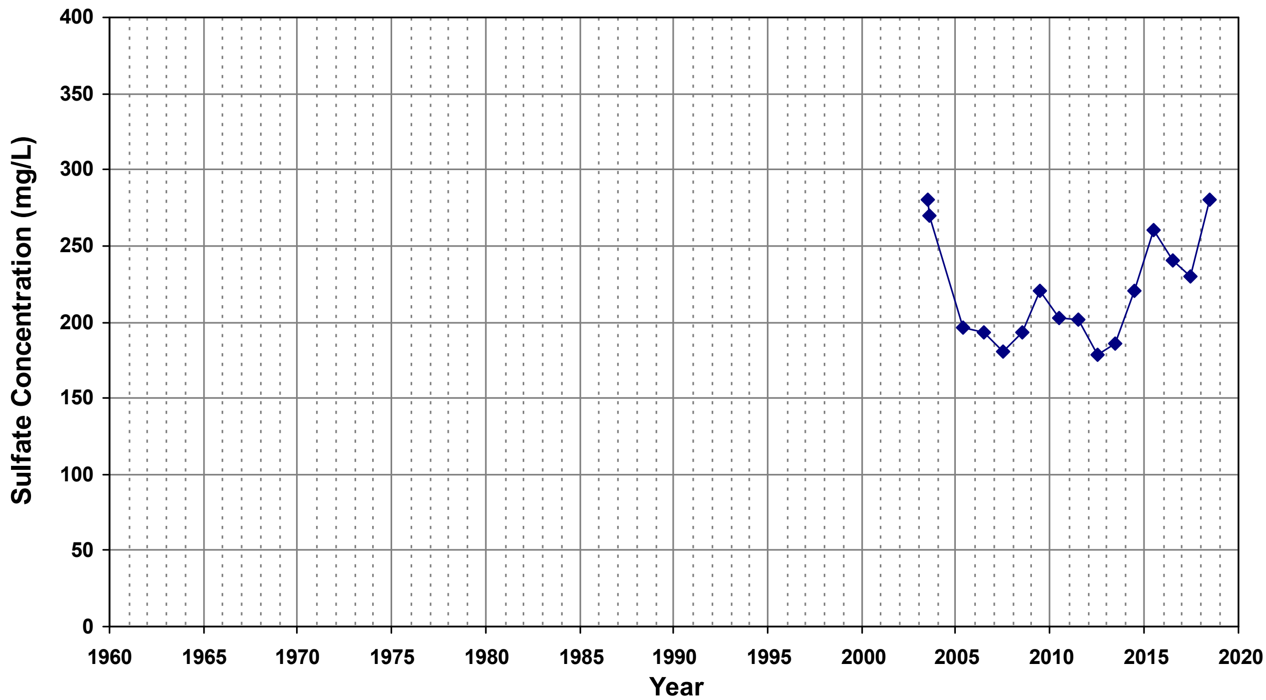
VWD-W11

Well Area: San Francisquito Canyon

Well Depth (ft): 180

RPE (ft msl): 1208.253

Screen Elevation (ft msl): 1098 - 1053



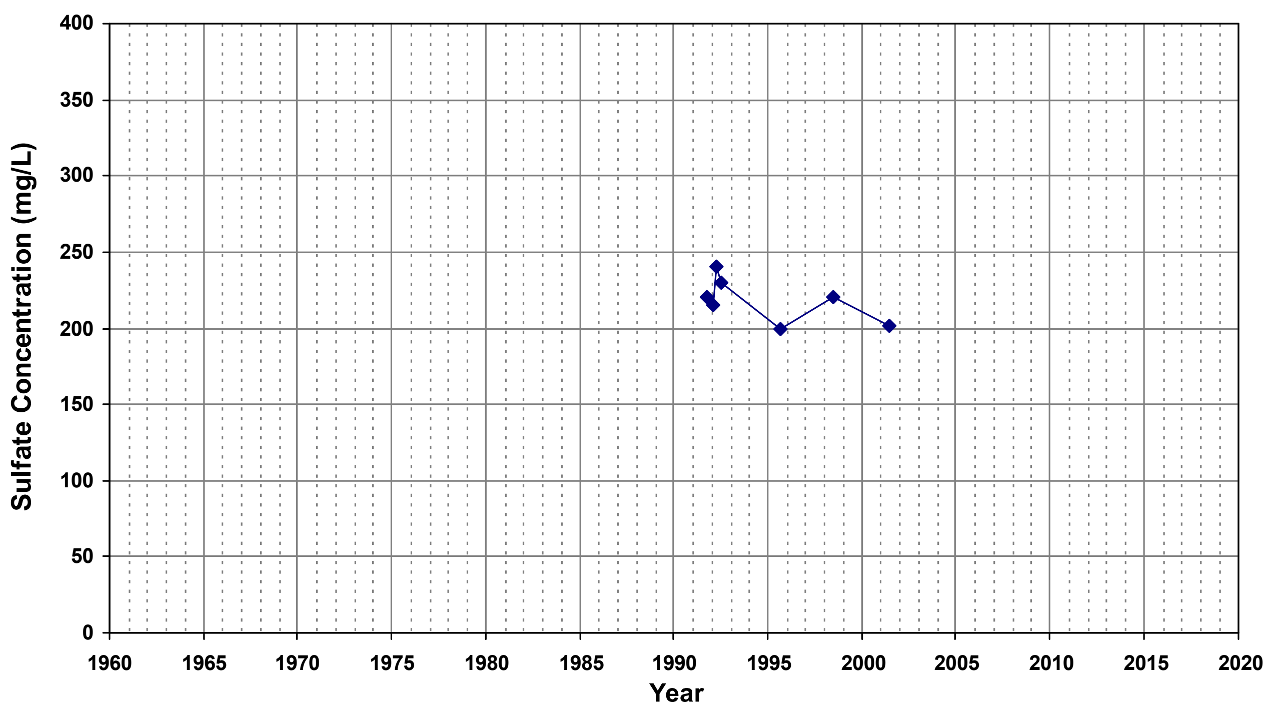
VWD-W6

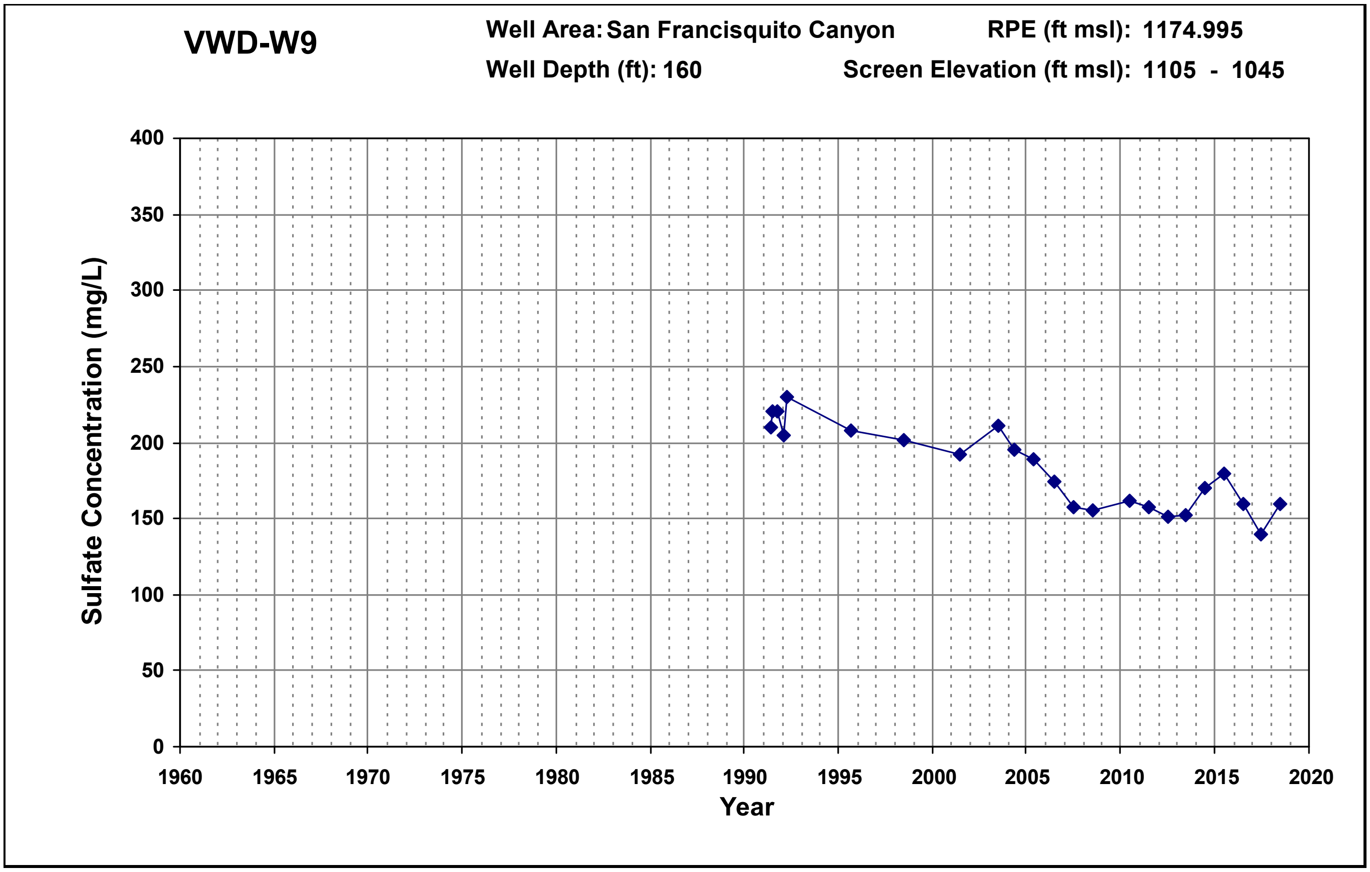
Well Area: San Francisquito Canyon

Well Depth (ft): 158

RPE (ft msl): 1155

Screen Elevation (ft msl): 1065 - 1002





VWD-W9
Well Area: San Francisquito Canyon
RPE (ft msl): 1174.995
Well Depth (ft): 160
Screen Elevation (ft msl): 1105 - 1045
Sulfate Concentration (mg/L)
0
50
100
150
200
250
300
350
400
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

Luhdorff & Scalmanini
Consulting Engineers

Appendix C

TECHNICAL MEMORANDUM

DATE: December 15, 2021 Project No.: 18-1-132

TO: Jeff Barry, GSI Water Solutions, Inc.

FROM: William L. Halligan, PG

SUBJECT: **Revised Subsidence Vulnerability, Santa Clarita Valley Water Agency, Santa Clara River Valley Basin, East Subbasin**

INTRODUCTION

According to the U.S. Geological Survey (USGS), land subsidence is a phenomenon found across the United States, affecting the land surface of over 17,000 square miles in 45 states (Galloway et al., 1999). Land subsidence in California is commonly a result of fluid withdrawal (oil or groundwater). The principal causes of land subsidence are compaction of fine-grained subsurface materials (caused by reduction in hydraulic head affecting the physical structure and orientation of clay minerals and drainage of organic soils. Subsidence can occur in two forms, elastic (temporary) and inelastic (permanent). Impacts from subsidence are primarily related to infrastructure, such as roadways, pipelines, railroad tracks, etc.

GEOLOGIC AND GROUNDWATER CONDITIONS

When discussing the potential for land subsidence, it is important to consider the type of geologic materials that exist and if they may be susceptible to subsidence, along with factors that can create the conditions for subsidence such as groundwater extraction or oil extraction.

Out of the two primary water production aquifers in the Santa Clara River Valley Basin, East Subbasin (Subbasin), the Saugus Formation contains some silt and clay beds occurring predominantly in the central portion of the Subbasin in the vicinity of the Whittaker-Bermite site. The lateral extent of these clay beds has not been fully documented, however, review of available well logs, geophysical logs and other information indicates these beds may be confined to the Whittaker-Bermite site area and west of the site in the vicinity of Saugus Formation wells Saugus 1 and 2, V201, V205, V206, and V207. A schematic depiction of these units is illustrated in **Figure 1**.

The hydrostratigraphic units in the central portion of the Subbasin in the Saugus Formation correspond to alternating coarse and fine-grained beds with the coarse-grained units being relatively thick compared to the fine-grained units and identified as the SI, SIII, SV, SVII, and SVIII units while the fine-grained beds are relatively thin in comparison and designated as the SII, SIV, and SVI units. The coarse-grained units are generally about 200 to 600 feet thick and are generally not susceptible to compaction. This is because the structure of the coarse-grained materials (sand and gravel) do not compact with declines in groundwater elevations like silts and clays.

The silt and clay beds are not laterally continuous throughout the Saugus Formation. In the western portion of the Subbasin in the vicinity of wells V206 and V207, analysis of lithology indicates that clay beds are minimal at the V206 site. Identification of clay beds at depths greater than 1,200 feet exist at the V207 site, however, that well is not constructed at those depths and projections of groundwater levels in the V206 and V207 area are expected to be similar to historical levels during normal years, however, will decline up to a maximum of approximately 150 feet below historical levels during short term droughts of one to five years (**Appendix A**). There are plans to construct and operate four new wells in the vicinity of V206 and V207 in the future. The simulated future low water levels described above include pumping from these not-yet constructed wells. The geology at the locations of these future wells are not known and will be evaluated once those wells are constructed to assess the potential for subsidence near the future wells.

As discussed further below, periods of historical low groundwater elevations were followed by periods of groundwater elevation recovery. Further, some evidence of subsidence exists, but the cause or causes are not clear. Also, impacts to infrastructure from subsidence have not been observed. Through the last nineteen years of reviewing and reporting on the geology and water resources in the Basin (Luhdorff and Scalmanini, 2019), there has not been evidence of chronic groundwater level declines that would contribute to subsidence (Luhdorff and Scalmanini, 2019).

Logs of production and monitoring wells were evaluated to identify areas where the Saugus Formation contains clay beds that could potentially undergo compaction should a pronounced and extended decline in groundwater elevations occur. Analysis of historical geologic cross sections was also conducted (CH2M HILL, 2004) that resulted in the identification of an area of the Subbasin where the Saugus Formation was subdivided into distinct hydrostratigraphic units, separated by three primary fine-grained confining units (CH2M Hill, 2004). As discussed above, this geographic location is in the central portion of the Basin where the Whittaker-Bermite site and production wells Saugus 1, Saugus 2, V201, and V205 are located. The three confining units, SII, SIV, and SVI (CH2M Hill, 2004; Luhdorff and Scalmanini, 2013) are each approximately 50 to 100 feet thick and composed of silts and clays with some coarse-grained materials as estimated from a review of geologic cross sections, well completion reports, and geophysical logs.

Should groundwater levels in the confined Saugus Formation substantially decline over an extended period where compressible layers are present along with decreases in the potentiometric head and associated decrease in pore pressure, some degree of compaction of these clay materials could occur resulting in subsidence. However, these three fine-grained units are at depths that are several hundreds of feet below the potentiometric head in the Saugus Formation when observing both historical Saugus Formation groundwater levels and projected elevations based on model simulations (**Appendix A)**. These clay units are not as extensive in the western portion of the Saugus Formation in the vicinity of V206 and V207 and pinch out (become very thin) toward the South Fork area of the Subbasin where wells NC12 and NC13 are present. As mentioned, data on the occurrence of clay beds in the vicinity of the four new Saugus Formation wells near the Magic Mountain area is not known as the exact location of these wells has not been finalized nor the borings drilled.

Land Surface and Groundwater Elevation Monitoring Data

Land surface elevation monitoring data is available from three separate sources. UNAVCO operates a network of continuous global positioning system (CGPS) sites throughout California and has two sites in the Subbasin outside the margin of the Alluvial valley floor. The second source of data is from the European Space Agency in the form of INSAR data that is available through DWR. The third source of data is from Los Angeles County Department of Public Works (LACDPW) through its network of survey benchmarks throughout the Subbasin. There is also groundwater elevation monitoring conducted by SCV Water from selected wells in the Subbasin including Wells V201, V205, V205M, Saugus 1, and Saugus 2. The locations of these wells are depicted in **Figure 2**.

UNAVCO CGPS

As of February 2020, land surface elevation is being monitored at two continuous global positioning system (CGPS) sites in the Basin as reported by UNAVCO (http://www.unavco.org/data/data.html). Data collection has been ongoing since the early 2000's with daily measurements.

The locations of the UNAVCO CGPS sites along with historic vertical displacement data are presented in **Figure 3**. The relatively stable trend of these plots indicate that long-term subsidence is not occurring. Since the beginning of data collection in the early 2000's at both UNAVCO locations, the net vertical displacement is positive (0.05 ft) at the CTDM site and zero at the SKYB site. This means that the land surface has risen (positive displacement) or stayed the same. In any given year, the vertical displacement is generally less than 0.05 feet, with the exception of 2006 to 2007 at the SKYB site. Within the context of complex southern California geology, the elevation change (less than 0.2 feet vertical change over the last 20 years) seen at the two UNAVCO stations is likely due to tectonic activity since these stations are located north of the San Gabriel fault in locations where minimal groundwater extraction occurs.

DWR ESA INSAR

Land surface elevation data was also obtained from the Department of Water Resources SGMA Data viewer. The TRE Altamira InSAR Dataset contains vertical displacement data from June 2015 through September 2019. These data were collected by the European Space Agency Sentinel-1A satellite and processed by TRE Altamira. The dataset covers more than 200 groundwater basins across the state at a resolution of approximately 100 square meters (almost 1,100 square feet). Vertical displacement for the winter-to-winter period from 2015/2016 through 2018/2019 period over the entire Subbasin from the TRE Altamira InSAR dataset is presented in **Figure 4**. Vertical displacement values in the Subbasin ranged between -0.25 and +0.25 feet. In the central area of the Subbasin in the vicinity of wells V201, V205, Saugus 1, and Saugus 2 the range of displacement was smaller (0.025 to 0.032 feet). To avoid accounting for elastic (temporary) compaction without recognizing corresponding elastic rebound, it is best to evaluate subsidence from a comparison of data collected in the winter or early spring to avoid incorporating elastic or temporary subsidence that can vary season to season and from year to year. Because the satellite data was developed from a summer to early fall time frame, it likely is not a reliable starting and ending date to evaluate inelastic or permanent subsidence. In addition, the resolution of satellite data for subsidence monitoring is not as accurate as ground-based data collection. GPS benchmark monitoring locations such as those maintained by UNAVCO generally have an accuracy of approximately 0.05 feet, while satellite data from the DWR website via the European Space Agency has an error that is approximately 0.02 feet greater than global positioning system measurements.

Los Angeles County Department of Public Works Benchmark Surveys

The Los Angeles County Department of Public Works (LACDPW) has a network of over one hundred benchmarks in the Subbasin as part of a larger survey network in Los Angeles County (http://dpw.lacounty.gov/sur/BenchMark/). LACDPW reportedly surveys these benchmarks approximately every six years. The surveys began in 1978 and the most recent survey in the Subbasin was conducted in 2018. These benchmarks are located in the "Newhall Quad." The Index of benchmarks contained in this quad are depicted in **Figure 5** and the specific benchmarks in the vicinity of existing Saugus Formation wells are presented in **Table 1**.

Ideally land surface data from 1978 to the present could be precisely compared to each successive survey event, but this is not practical because vertical datums changed between 1993 and 1995. Land surface elevation data from 1995, 2009, and 2018 for these benchmarks were evaluated to determine the magnitude of subsidence that occurred over this time period because the elevations were measured using the same NAVD88 vertical datum required by DWR. The benchmark surveys measured prior to 1995 in 1978, 1983, and 1993 were measured using the older and different NGVD29 vertical datum.

Benchmark measurements are recorded to the nearest thousandths of a foot reflect a basic accuracy of ± 0.017 feet per mile (LADPW, 2018). Between 1995 and 2018, benchmarks located near the Saugus Formation production wells in the western and central area of the Subbasin had recorded changes in land surface elevations that ranged from -0.179 to +0.011 feet over the 23-year period between 1995 and 2018 (**Table 1**).

Groundwater elevations in the Saugus Formation historically were most depressed in the early 1990s during the highest amount of pumping from the Saugus Formation. The 1995 dataset was collected by LADPW about one or two years after the peak decline in Saugus Formation groundwater levels. The 1993 benchmark survey was collected using a different vertical datum than the 1995 making it difficult to compare the 1993 to 1995 surveys in order to see if the peak Saugus pumping could be correlated with land surface elevation changes. Generally, the examination of LADPW benchmark data indicates that many factors are contributing to the very small amount of land elevation shifts that have occurred over time. These factors include tectonic influences from this seismically active area of California, the time of year each benchmark survey was collected (meaning it is difficult to determine if land surface changes are elastic or inelastic), and groundwater pumping. LADPW data was also reviewed outside of the areas where these Saugus Wells are located. Positive and negative ground surface elevation changes can be seen in areas away from Saugus Wells, including north of the San Gabriel Fault. In the future, with the implementation of a basin-wide subsidence monitoring program, correlations of groundwater pumping to changes in land surface elevations will be better understood. The yearly rate of subsidence that occurred between 1995 and 2018 was 0.008 feet per year given the maximum subsidence of -0.179 feet noted above. That annual average rate is less than the accuracy of the benchmark surveying equipment and is negligible.

Summary of Land Surface Elevation Data Sets

The data that has been available for review has provided the following understanding of the occurrence of changes in land surface elevations over time as summarized in **Table 2**. From the period spanning 1995 to 2018, LADPW benchmark survey data in the vicinity of the Saugus Formation wells show changes in land surface elevations that have ranged from -0.179 to +0.011 feet over 23 years from 1995 to 2018 with an average annual rate of -0.008 feet per year to less than 0.001 feet per year. The InSAR ground surface elevation data for the three-year period from 2015/16 to 2018/19 in the central portion of the Subbasin where clay beds are most prevalent, the magnitude of subsidence was 0.025 to 0.032 feet or approximately 0.008 to 0.010 feet per year over that very short time frame. The UNAVCO benchmark data showed either no change in land surface elevation over the past 20 years or a rise of 0.05 feet, equating to an annual rise of 0.002 feet per year. The locations of the UNAVCO stations are north of the San Gabriel fault where no large-scale municipal pumping occurs from the Saugus Formation, thereby the changes in land surface elevations are likely the result of the regions seismic activity.

Table 2: Subsidence Datasets

Dataset	Time Period	Range of Elevation Change (ft)	Annual Rate of Elevation Change (ft/yr)
UNAVCO CGPS	**CTDM: 2001-Present**	**+0.05**	**+0.003**
	SKYB: 2006-Present	**+0.00**	**+0.00**
DWR ESA INSAR	**2015-2020**	**-0.025 to +0.028**	**-0.0017 to +0.0056**
LA County DPW Benchmark Surveys	**1995-2018**	**-0.179 to +0.011**	**-0.0078 to +0.00048**

Historical Saugus Formation Groundwater Elevations

Evaluation of groundwater elevation data from the area of the Subbasin where projected groundwater levels during normal years are expected to have the greatest declines as compared to historical elevations (Appendix A) were evaluated. This area is located in the central area of the Subbasin in the vicinity of five wells (Saugus 1, Saugus 2, V201, V205, and V205M). This also corresponds to the area that has the most pronounced evidence of fine-grained clay beds (see discussion of geology above).

Analysis of historical groundwater level data indicated that data was collected beginning in the early 1990s and into 2020, however, only one of the five wells (V201) had a complete dataset for this period while the other four wells had partial datasets (**Appendix A**). Data from Saugus 1 and Saugus 2 are not available after 2011 due to the well repair that impacted the sounding tubes. However, the data from these two wells is valuable because the data (coupled with data from well V201) capture the period (1993) when groundwater levels in the Saugus Formation declined to historic lows. The historic low was brief and was not maintained.

Projected Saugus Formation Pumping

The hydrographs in Appendix A were prepared using results from the Subbasin numerical model and show historical groundwater level data along with projected (future) groundwater elevations. The comparison of the projected and historical data at each well allows one to see simulated future groundwater levels, including during normal periods and drought periods. The future water levels are representative of "full build-out land use conditions" that include the sustained operation of wells V201 and V205 (in part for perchlorate removal), along with additional source capacity for extraction of groundwater from the Saugus Formation in the V206 and V207 area of the Subbasin that would allow SCV Water to extract approximately 35,000 acre feet per year during multiple dry years.

Central Area

Projections of Saugus Formation groundwater pumping volumes in the central area (Saugus 1 and 2, V201, V205) are expected to be higher than historical amounts during normal *and* dry years. Groundwater model simulations of future normal year conditions (Saugus 1 and 2, V201) indicate groundwater levels will be maintained approximately 100 to 150 feet lower in normal years than in the past, with some shorter-term decreases in water level beyond these during drought.

Western Area

Projections of Saugus Formation groundwater pumping in the western area (V206, V207 and four to-be-constructed Saugus wells) are expected to be higher than historical amounts during dry years. Groundwater model simulations of future conditions (V 206 and 207) indicate groundwater levels will be similar to historical normal year levels, but in drought years are projected to be approximately 100 to 150 feet lower than in the past.

Conclusions

The potential for subsidence to occur is driven by many factors as described above, however, the presence of significant clay beds coupled with a significant length of time (years) of sustained groundwater elevations at or below historic lows is one component necessary for inelastic land subsidence (permanent land subsidence) to occur.

Evidence of Past Land Subsidence Caused by Groundwater Extraction

A review of past groundwater elevations show that chronic decline in water levels has not taken place. A review of three different land surface elevation data sets provide good information about elevations over time, but do not suggest clear evidence of groundwater pumping caused subsidence. Land surface elevations have varied across the Subbasin, resulting in some areas showing increases in land surface elevations and other areas exhibiting decreases, dependent on the time frame and location that the datasets cover. The data indicates that many factors appear to contribute to changes in land surface elevations. These factors include:

- The Subbasin being located in a tectonically active area,
- Time of year data is collected and whether it includes the effects of elastic subsidence on the land surface elevation data,
- Frequency of data collection, and;
- Analysis and characterization of the occurrence of significant clay beds and potential for compaction.

Potential Future Land Subsidence

The potential for subsidence in the various areas of the Subbasin to occur in the future is difficult to predict or quantify based on the datasets evaluated and documented above. Groundwater elevations in the future, in particular at full build out, will be lower than in the past. In some areas, groundwater elevations will be lower than past drought water elevations (western area), and in other cases groundwater elevations will be lower both in normal and drought conditions (central area). The central area appears to contain more compressible fine grained layers than the west and because of these factors, there may be a potential for future subsidence, but it is difficult to predict, and should be monitored.

Further, these fine-grained materials are at depths that are several hundreds of feet below the potentiometric head in the Saugus Formation when observing both historical Saugus Formation groundwater levels and projected elevations based on model simulations (**Appendix A)**. This fine-grained unit placement is considered a more favorable condition than physically dewatering clays as the groundwater potentiometric surface becomes lower. These clay units are not as extensive in the western portion of the Saugus Formation in the vicinity of V206 and V207 and pinch out (become very thin) toward the South Fork area of the Subbasin where wells NC12 and NC13 are present. As mentioned above, data on the occurrence of clay beds in the vicinity of the four new Saugus Formation wells near the Magic Mountain area is not known as the exact location of these wells has not been finalized nor the borings drilled.

Approach to Establish a Preliminary Subsidence Minimum Threshold

In order to develop the minimum threshold for subsidence in the GSP, a methodology was developed to approximately estimate the magnitude of subsidence that may occur in the planning and implementation period of the GSP. There was a short period of time between the winter of 2015/2016 to winter 2018/2019 where a comparison of observed land surface elevation from DWR's InSAR dataset could be compared to groundwater level declines in the area of the Basin where clay beds exist in the Saugus Formation and where the potential for future subsidence is the most probable as a result of increased pumping. As described above, the central portion of the Basin in the vicinity of well V-201 is where groundwater levels are predicted by the groundwater model to be lowest in future. In this area, a groundwater level decline of 15 feet was measured between winter of 2015/2016 and winter of 2018/2019. The inSAR data showed a corresponding reduction in ground surface elevation of approximately 0.032 feet. If the change in ground surface elevation shown in the inSAR data is actually related to groundwater extraction, this equates to approximately 0.01 feet of subsidence per 5 feet of groundwater elevation decline. As stated previously, it is not known if the observed reduction in ground surface elevation is related to pumping or to tectonics.

It is anticipated that groundwater elevations could be lower in the future as the Basin Operating Plan is implemented at full build out of the Basin to meet future demands during extended drought periods. The groundwater flow model was used to estimate future groundwater levels in the Basin. The approximate difference between long term average historic groundwater levels observed in well V-201 and future projected groundwater levels is estimated to be on the order of 150 feet. When considering historical low groundwater levels (e.g., 1993) measured at well V-201, the difference between measured groundwater levels and the predicted lowest dry year/drought groundwater levels in the future is approximately 70 feet. Depending on which of the two water level differences that are used, the approximate amount of subsidence that could occur in the future ranges between 0.3 feet of subsidence for the 150 feet of groundwater level decline to approximately 0.14 feet for the 70 feet of decline. This estimate assumes that the inSAR measured reduction in land surface elevation used in the calculations is a direct result of groundwater extraction, which may not be the case. It is also not known over what timeframe this estimated subsidence might occur since it is understood that subsidence effects can be delayed and because the rate of subsidence can be affected by the duration that groundwater levels are below the historical low.

Based on this evaluation, the minimum threshold for subsidence has been preliminarily set at a rate of 0.1 feet in any single year with a maximum subsidence of 0.5 feet over any 5-year period. Due to the considerable uncertainty associated with estimating subsidence rates in the Basin and the lack of a complete data set from which to estimate subsidence, the GSA plans to conduct robust subsidence monitoring and consider adjusting thresholds should monitoring data indicate that this is advisable and warranted.

Data Gaps and Next Steps

Some areas in California that have a history of subsidence (California's Central Valley) and impacts on infrastructure have existing subsidence monitoring networks that can be used to correlate subsidence to groundwater pumping and changes in groundwater elevations.

The East Subbasin has not had a history of impacts on infrastructure related to subsidence in general, regardless of the cause, and therefore, an organized subsidence monitoring program has not been developed. This lack of sufficient historical subsidence data collection has resulted in a large degree of uncertainty in identifying past causes of land surface elevation changes.

With the current uncertainty about the potential for future groundwater extraction to cause land subsidence, a robust monitoring program has been developed and described in the GSP to monitor land surface elevations utilizing the existing subsidence monitoring programs above, but with additional data collection by the SCV GSA. These data will allow for the GSA to determine if land surface elevation changes can be correlated with groundwater extraction and if the changes are elastic or inelastic. Data will be evaluated to help manage groundwater pumping in the Saugus Formation to minimize the impacts of subsidence should it occur.

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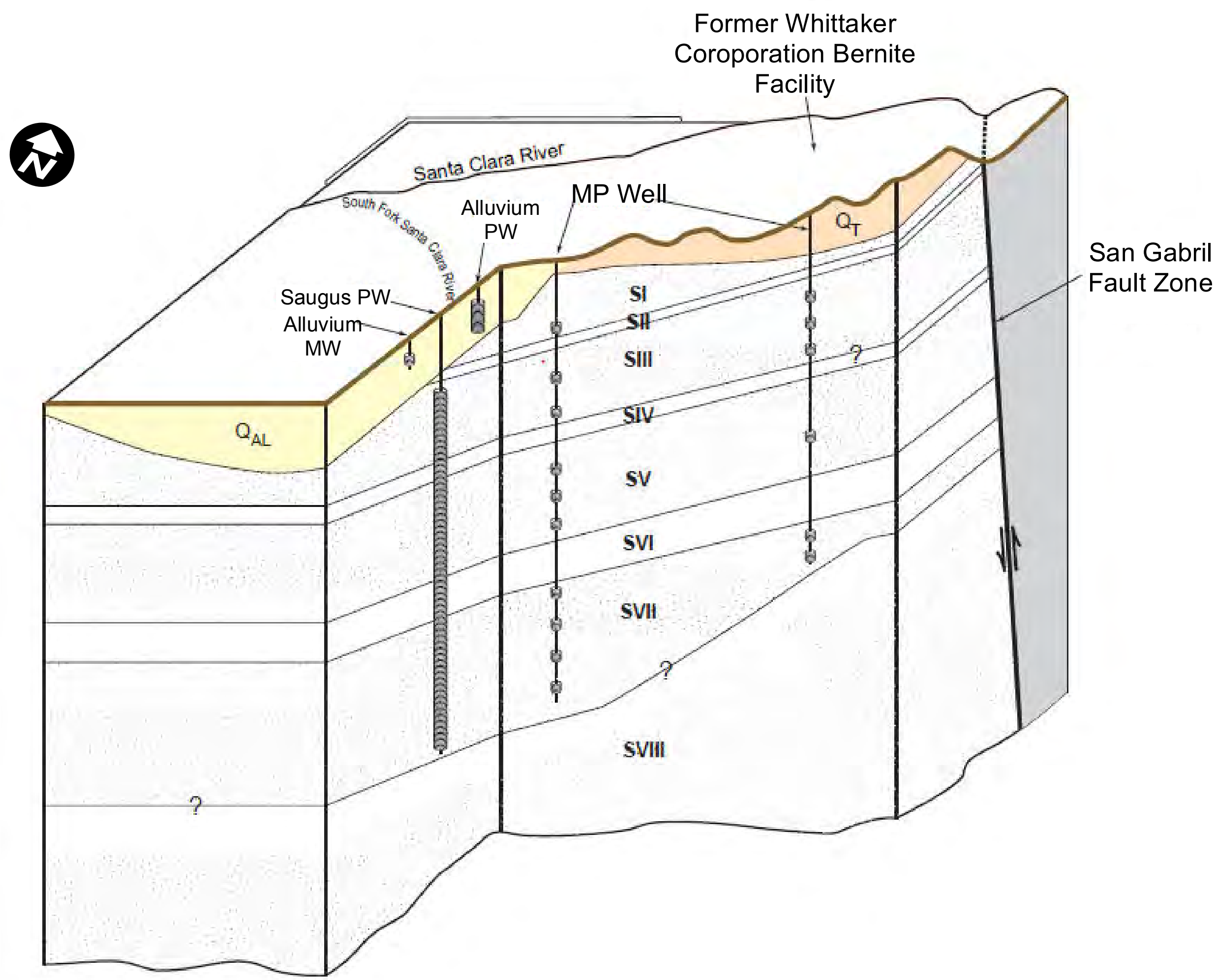
Figures



From CH2MHILL, 2004

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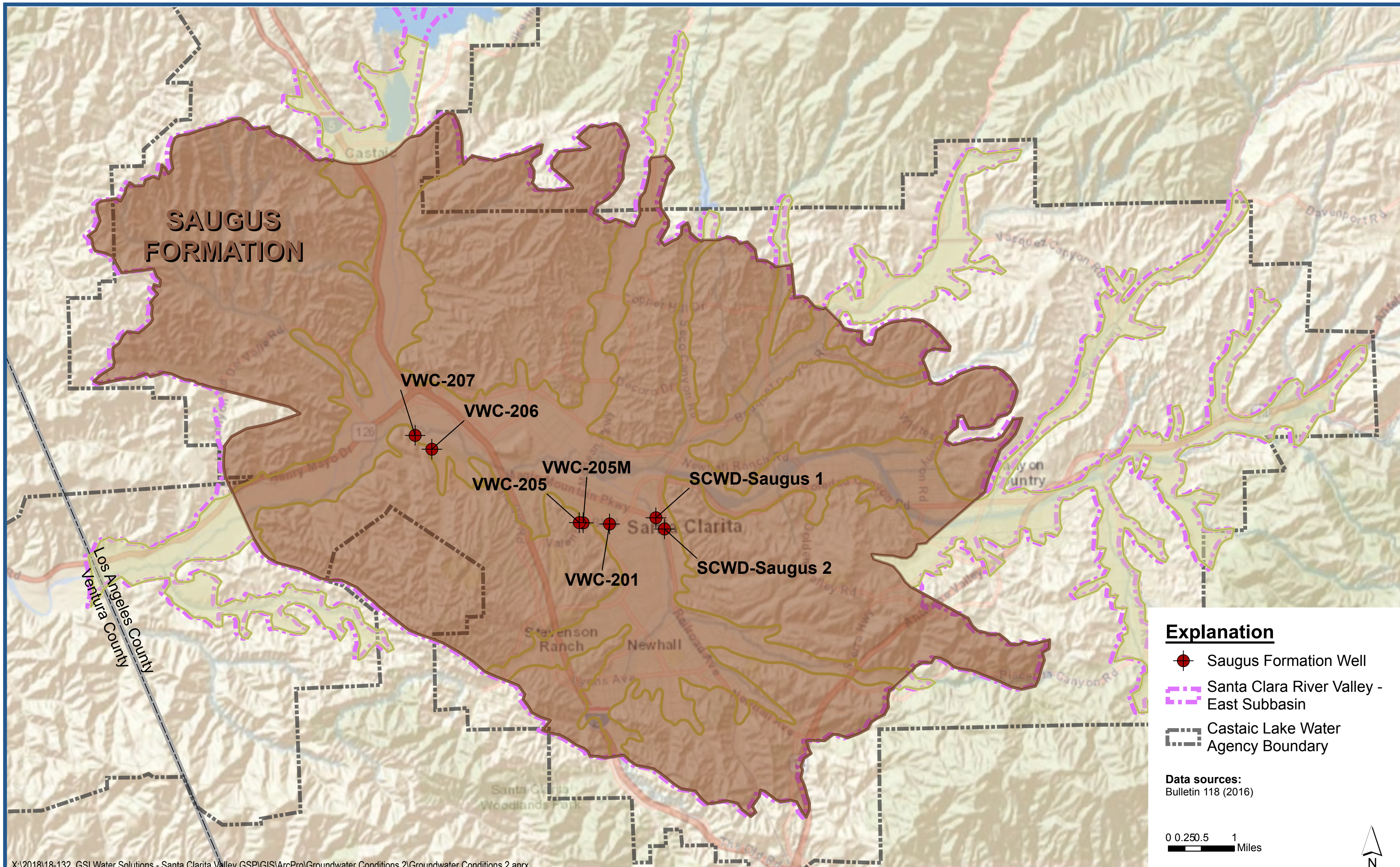
Saugus Hydrostratigraphic Units Schematic

Santa Clara River Valley
East Groundwater Subbasin

Figure 1



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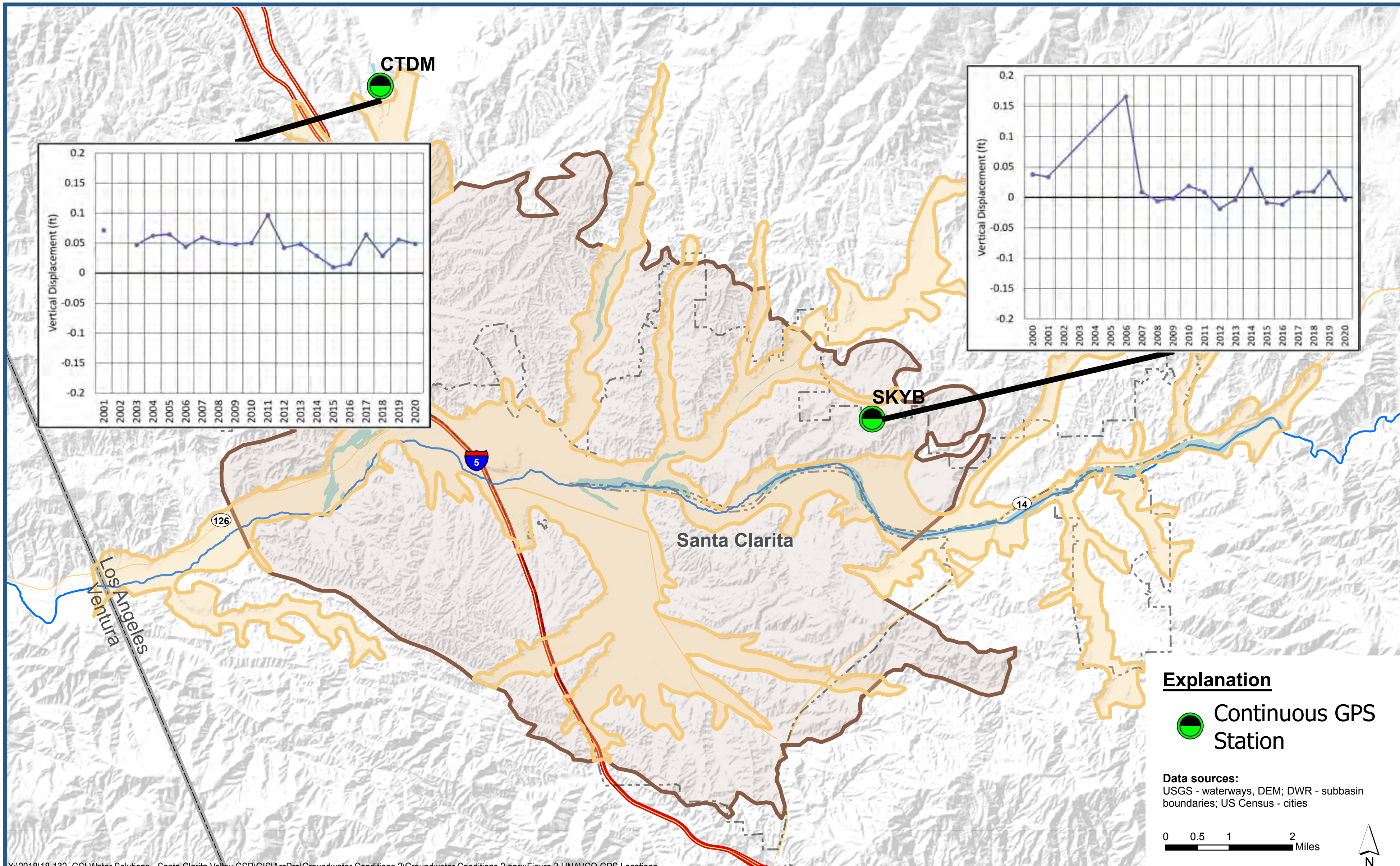
Saugus Formation Well Locations

Santa Clara River Valley East Subbasin
Groundwater Sustainability Plan

Figure 2



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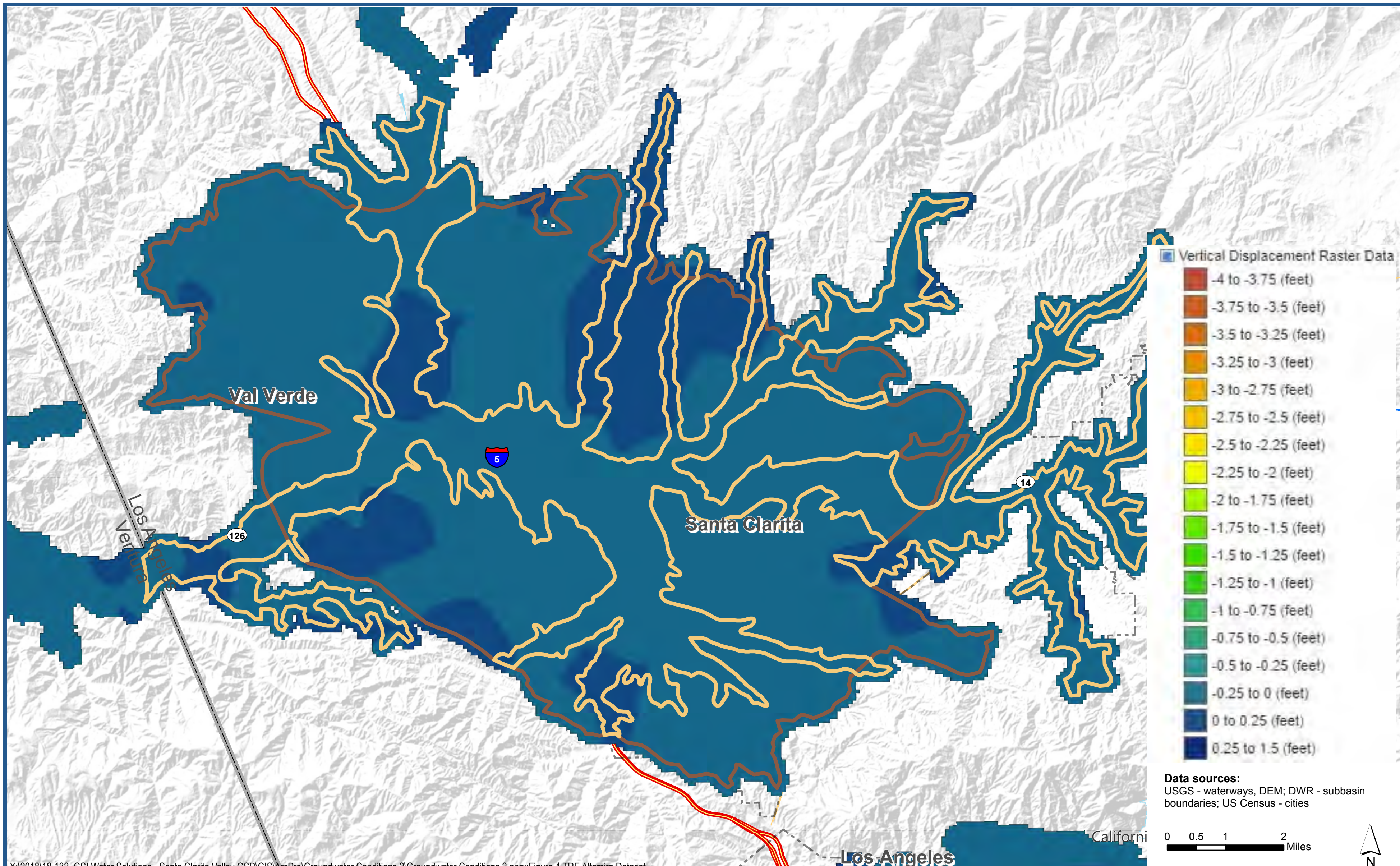
UNAVCO Continuous GPS Station Locations

Santa Clara River Valley East Subbasin
Groundwater Sustainability Plan

Figure 3



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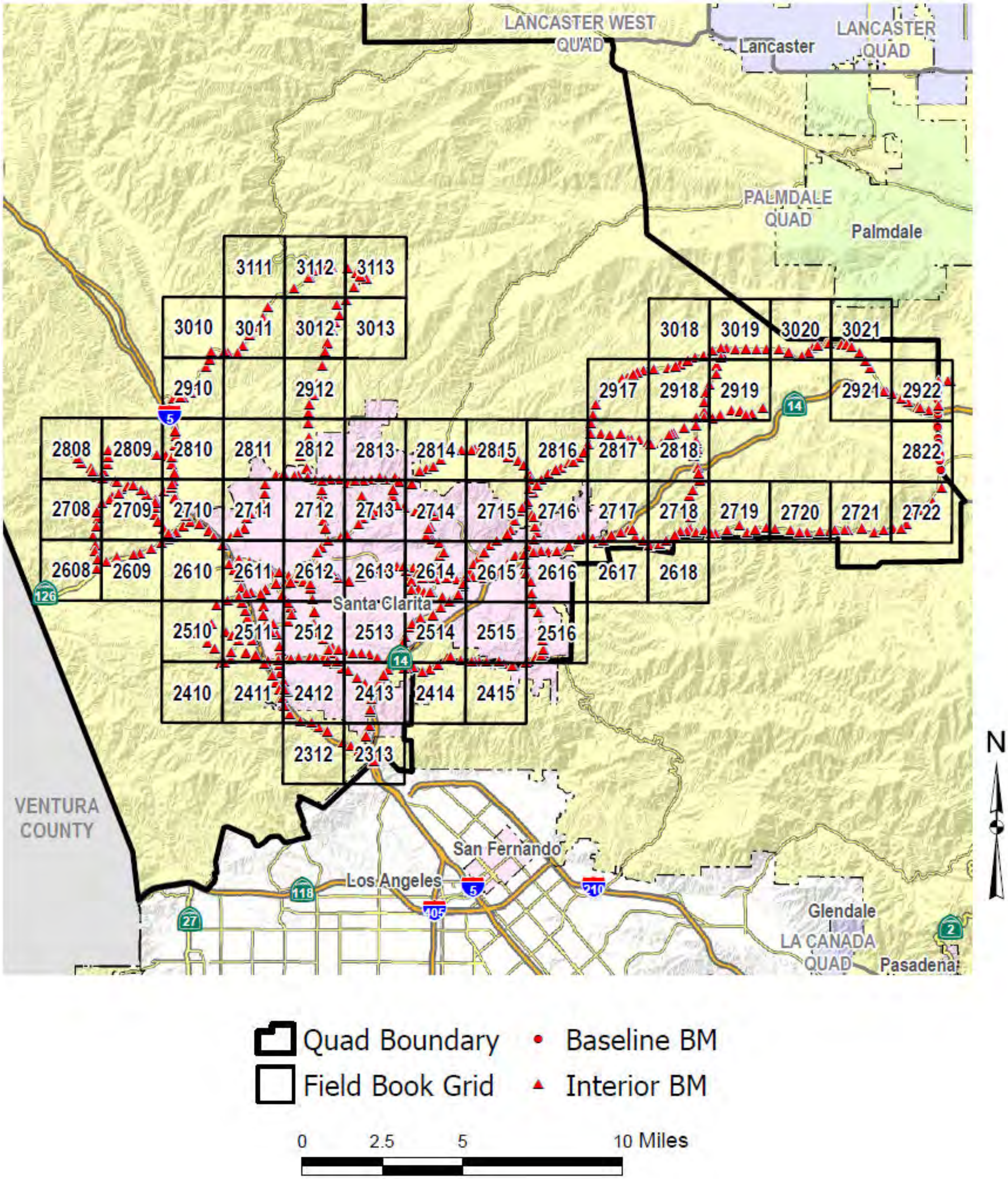
TRE Alatamira InSAR Dataset
(June 2015 - March 2019)

Santa Clara River Valley East Subbasin
Groundwater Sustainability Plan

Figure 4



Data sources:
LA County Department of Public Works

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Newhall Quad Benchmark Index

Santa Clarita Valley Water Report
Santa Clarita Valley, Los Angeles County, California

Figure 5

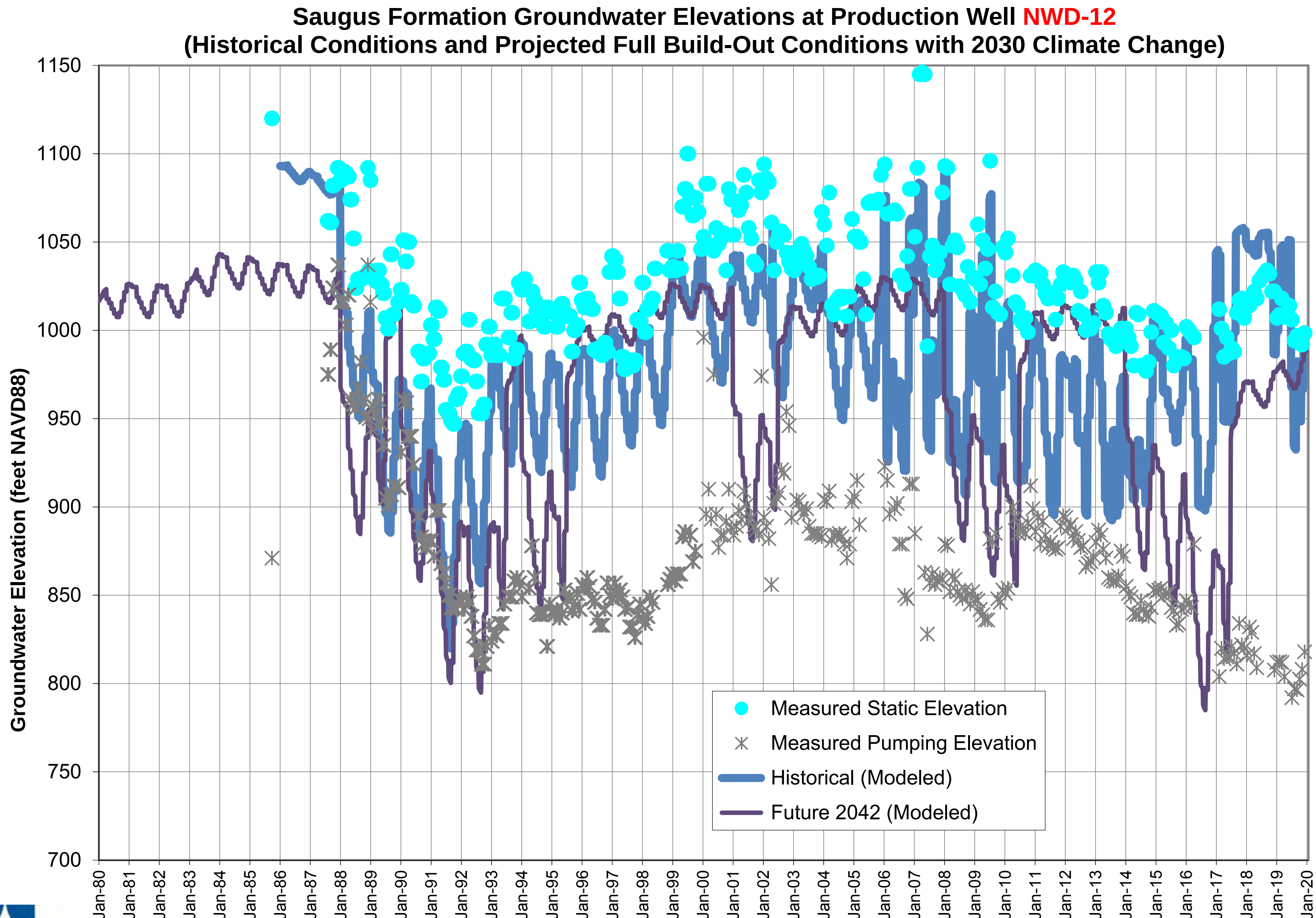
Basin Area	Nearby Well	Benchmark	Year	Elevation (ft, NAVD88)	Total Elevation Change 1995-2018 (ft)
Southern Saugus	VWD-206	1947	1995	1,059.463	-0.082
			2009	1,059.359	
			2018	1,059.381	
		1948	1995	1,034.371	-0.092
			2009	1,034.287	
			2018	1,034.279	
		5210	1995	1,061.530	-0.097
			2009	1,061.448	
			2018	1,061.433	
		5402	1995	1,031.950	-0.126
			2009	1,031.831	
			2018	1,031.824	
		7104	1995	No Data	No Data
			2009	1,047.77	
			2018	1,047.76	
		7106	1995	No Data	No Data
			2009	1,043.68	
			2018	1,043.67	
		7103	1995	No Data	No Data
			2009	1,023.59	
			2018	1,023.58	
	VWD-207	4511	1995	1,012.295	-0.149
			2009	1,012.182	
			2018	1,012.146	
		7204	1995	No Data	No Data
			2009	1,018.51	
			2018	1,018.51	
		6082	1995	No Data	No Data
			2009	1,019.99	
			2018	1,019.97	
	VWD-201	6077	1995	No Data	No Data
			2009	1,146.896	
			2018	1,146.766	
	VWD-205/205M	6078	1995	No Data	No Data
			2009	1,182.083	
			2018	1,182.019	
		5267	1995	1,151.717	-0.099
			2009	1,151.683	
			2018	1,151.618	
		6076	1995	No Data	No Data
			2009	1,151.860	
			2018	1,151.785	

Basin Area	Nearby Well	Benchmark	Year	Elevation (ft, NAVD88)	Total Elevation Change 1995-2018 (ft)
Southern Saugus	Saugus-1	611	1995	1,157.803	-0.068
			2009	1,157.800	
			2018	1,157.735	
		6068	1995	No Data	No Data
			2009	1,166.50	
			2018	1,166.43	
		5311	1995	1,159.535	0.011
			2009	1,159.575	
			2018	1,159.546	
	Saugus-2	5260	1995	1,170.900	-0.056
			2009	1,170.923	
			2018	1,170.844	
		5312	1995	1,168.039	-0.041
			2009	1,168.086	
			2018	1,167.998	
		5259	1995	1,177.996	-0.089
			2009	1,178.015	
			2018	1,177.907	
	VWD-159	5375	1995	1,276.700	-0.042
			2009	1,276.714	
			2018	1,276.658	
		7054	1995	N/A	No data
			2009	1,329.124	
			2018	1,329.073	
		7055	1995	N/A	No Data
			2009	1,348.352	
			2018	1,348.324	
		5085	1995	1,317.921	0.005
			2009	1,317.966	
			2018	1,317.926	
	NWD-12	5256	1995	1,217.960	-0.074
			2009	1,217.936	
			2018	1,217.886	
		6066	1995	No Data	No Data
			2009	1,201.063	
			2018	1,201.025	
	NWD-13	5337	1995	1,192.215	-0.059
			2009	1,192.211	
			2018	1,192.156	
		6067	1995	No Data	No Data
			2009	1,193.131	
			2018	1,193.054	

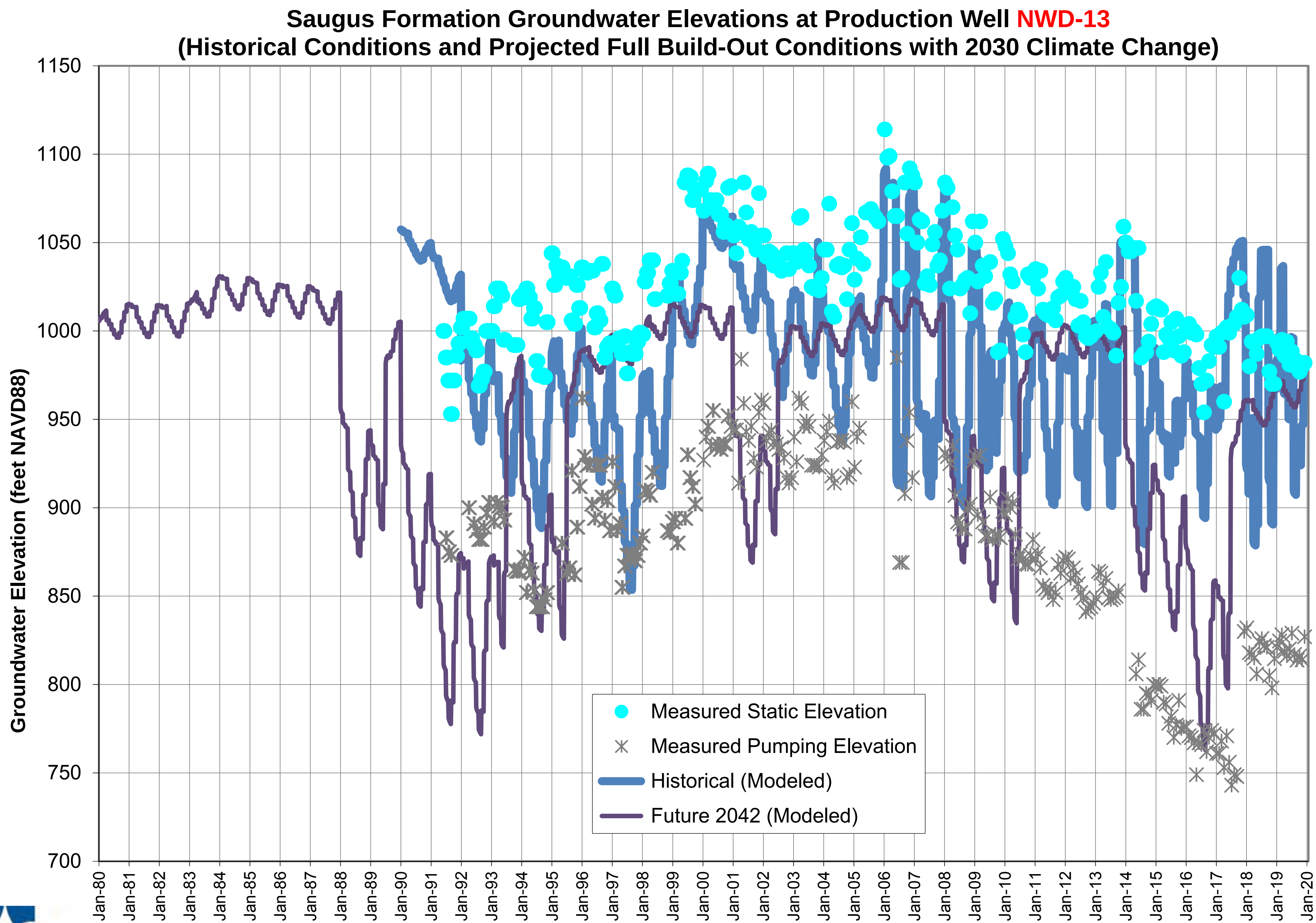
APPENDIX A

Groundwater Elevation Hydrographs, Historical and Projected GSI Water Solutions

LSCE



GSI Water Solutions, Inc.



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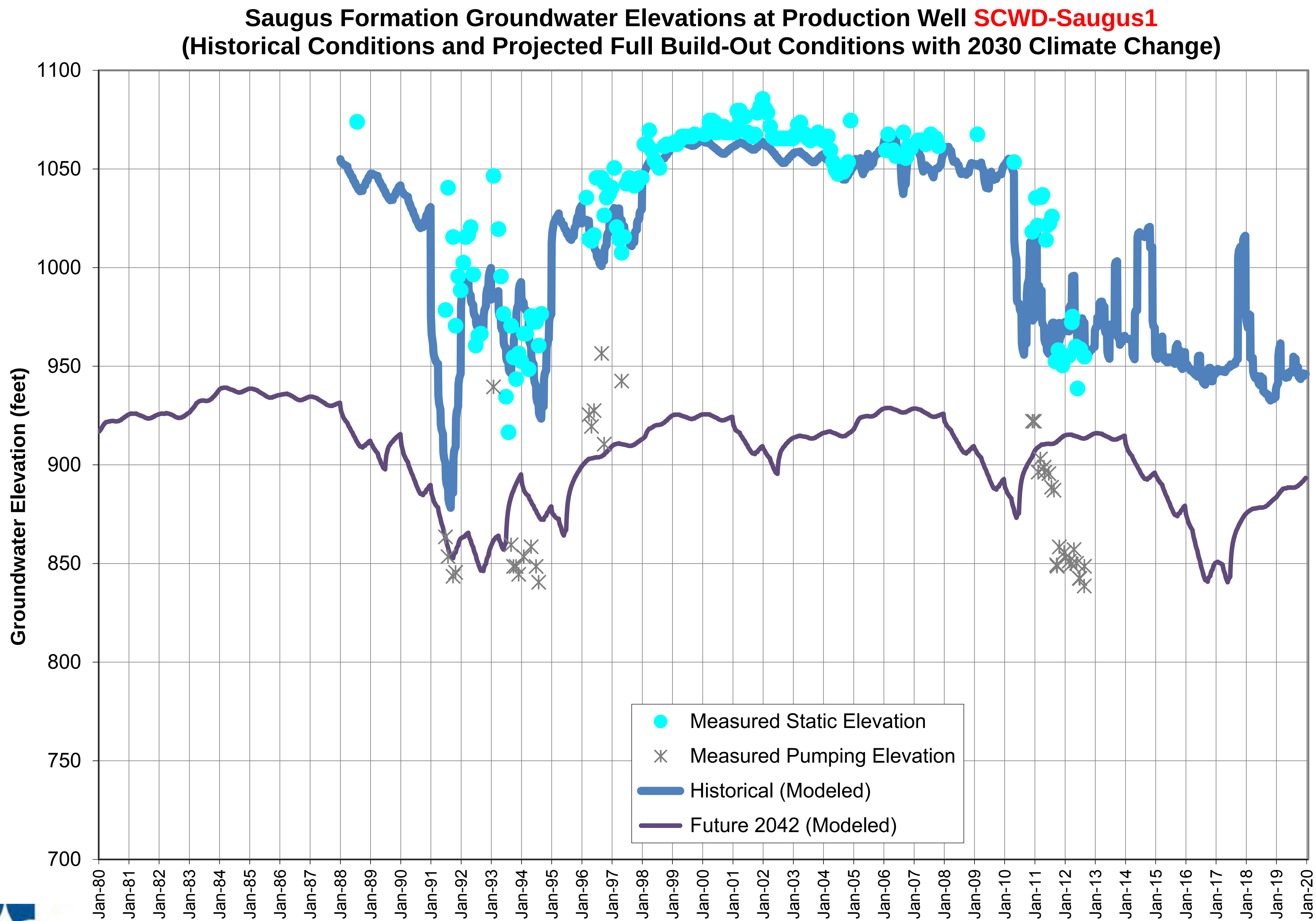

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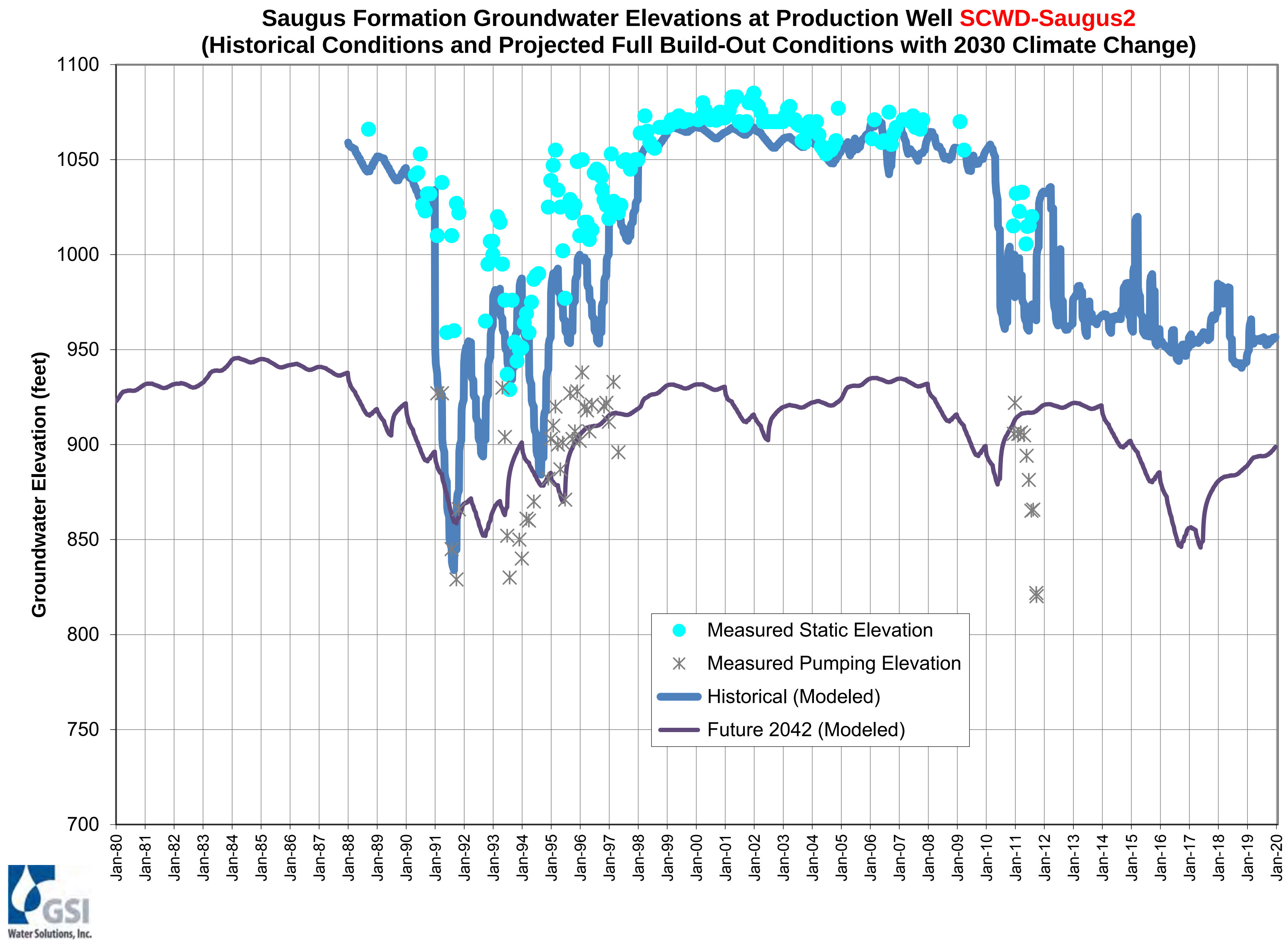

Saugus Formation Groundwater Elevations at Production Well SCWD-Saugus2
(Historical Conditions and Projected Full Build-Out Conditions with 2030 Climate Change)
Groundwater Elevation (feet)
1100
1050
1000
950
900
850
800
750
700
Jan-80
Jan-81
Jan-82
Jan-83
Jan-84
Jan-85
Jan-86
Jan-87
Jan-88
Jan-89
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
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Jan-14
Jan-15
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Jan-17
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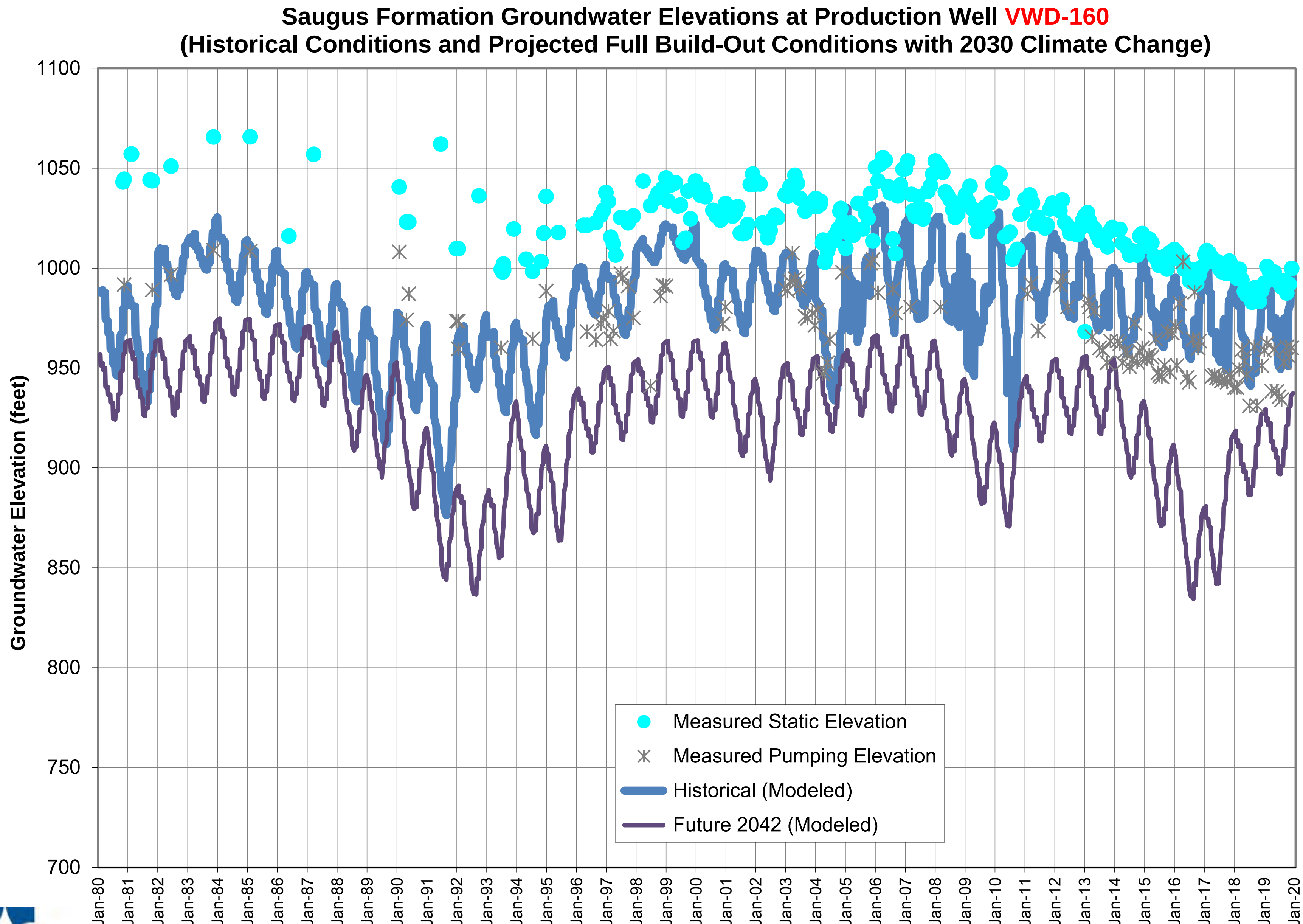
Jan-20
Measured Static Elevation
Measured Pumping Elevation
Historical (Modeled)
Future 2042 (Modeled)
GSI
Water Solutions, Inc.



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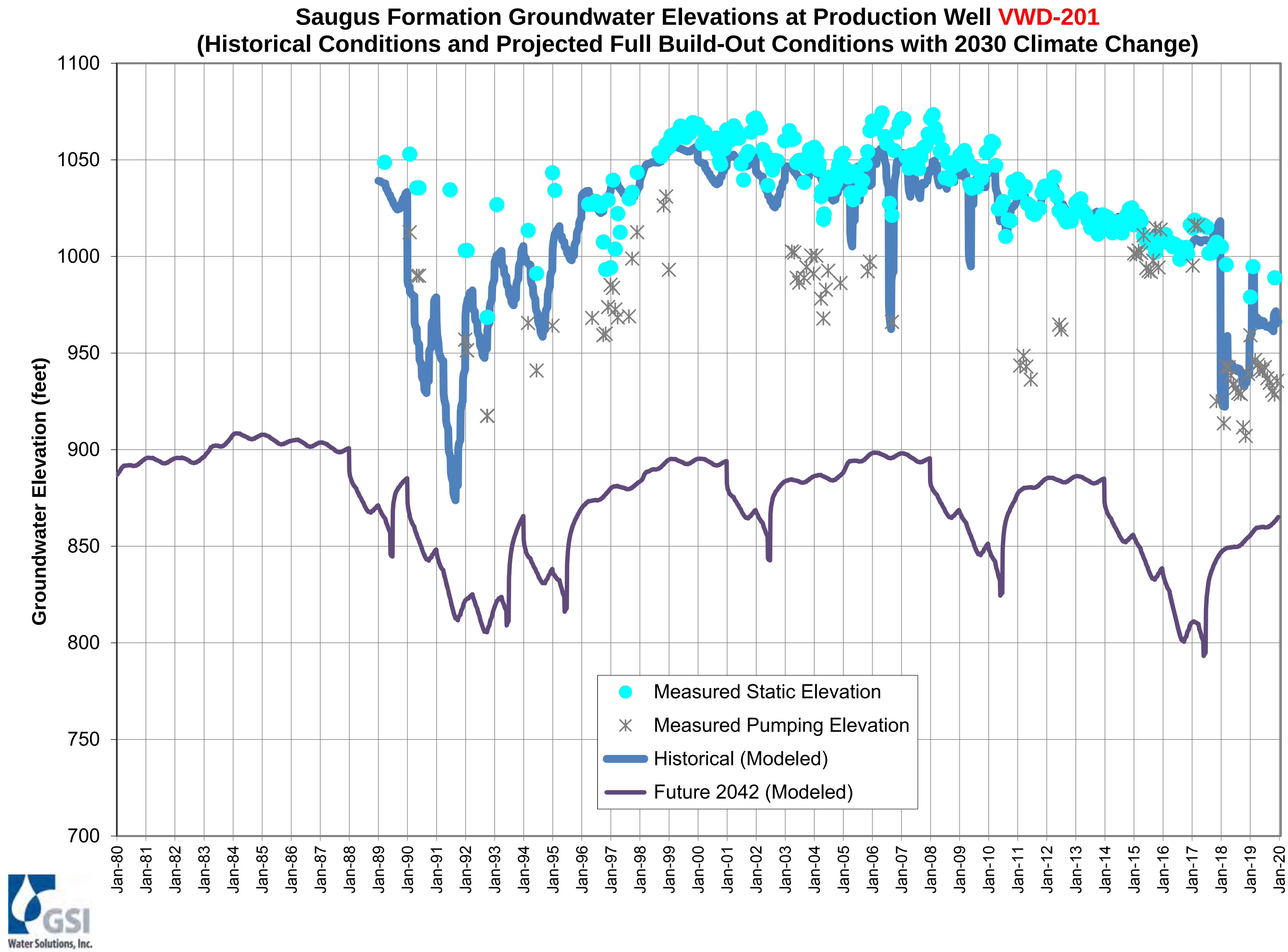

Saugus Formation Groundwater Elevations at Production Well VWD-201
(Historical Conditions and Projected Full Build-Out Conditions with 2030 Climate Change)
Groundwater Elevation (feet)
1100
1050
1000
950
900
850
800
750
700
Jan-80
Jan-81
Jan-82
Jan-83
Jan-84
Jan-85
Jan-86
Jan-87
Jan-88
Jan-89
Jan-90
Jan-91
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Jan-97
Jan-98
Jan-99
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Jan-02
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Jan-07
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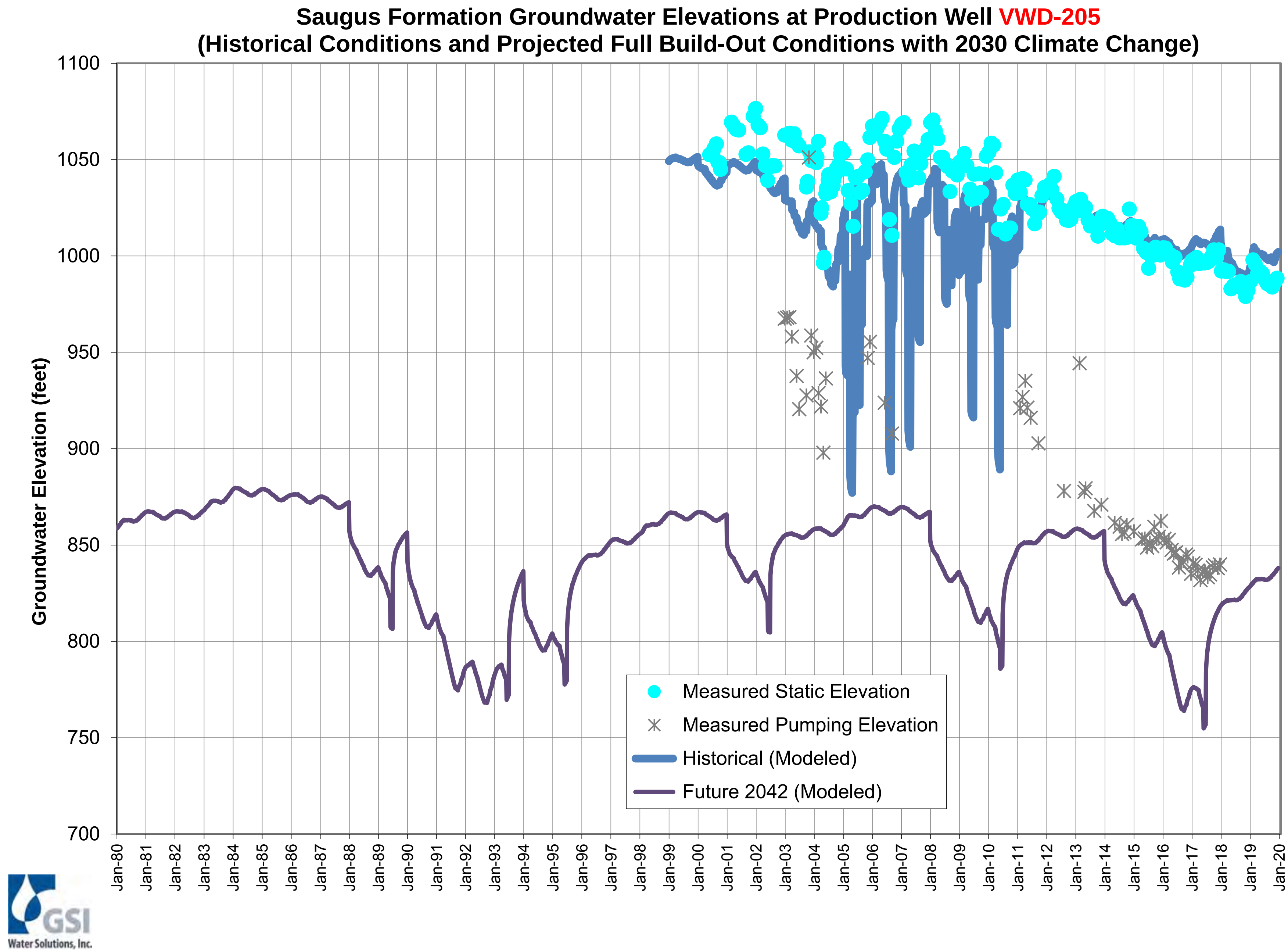
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Measured Static Elevation
Measured Pumping Elevation
Historical (Modeled)
Future 2042 (Modeled)
GSI
Water Solutions, Inc.


Saugus Formation Groundwater Elevations at Production Well VWD-205
(Historical Conditions and Projected Full Build-Out Conditions with 2030 Climate Change)
Groundwater Elevation (feet)
1100
1050
1000
950
900
850
800
750
700
Jan-80
Jan-81
Jan-82
Jan-83
Jan-84
Jan-85
Jan-86
Jan-87
Jan-88
Jan-89
Jan-90
Jan-91
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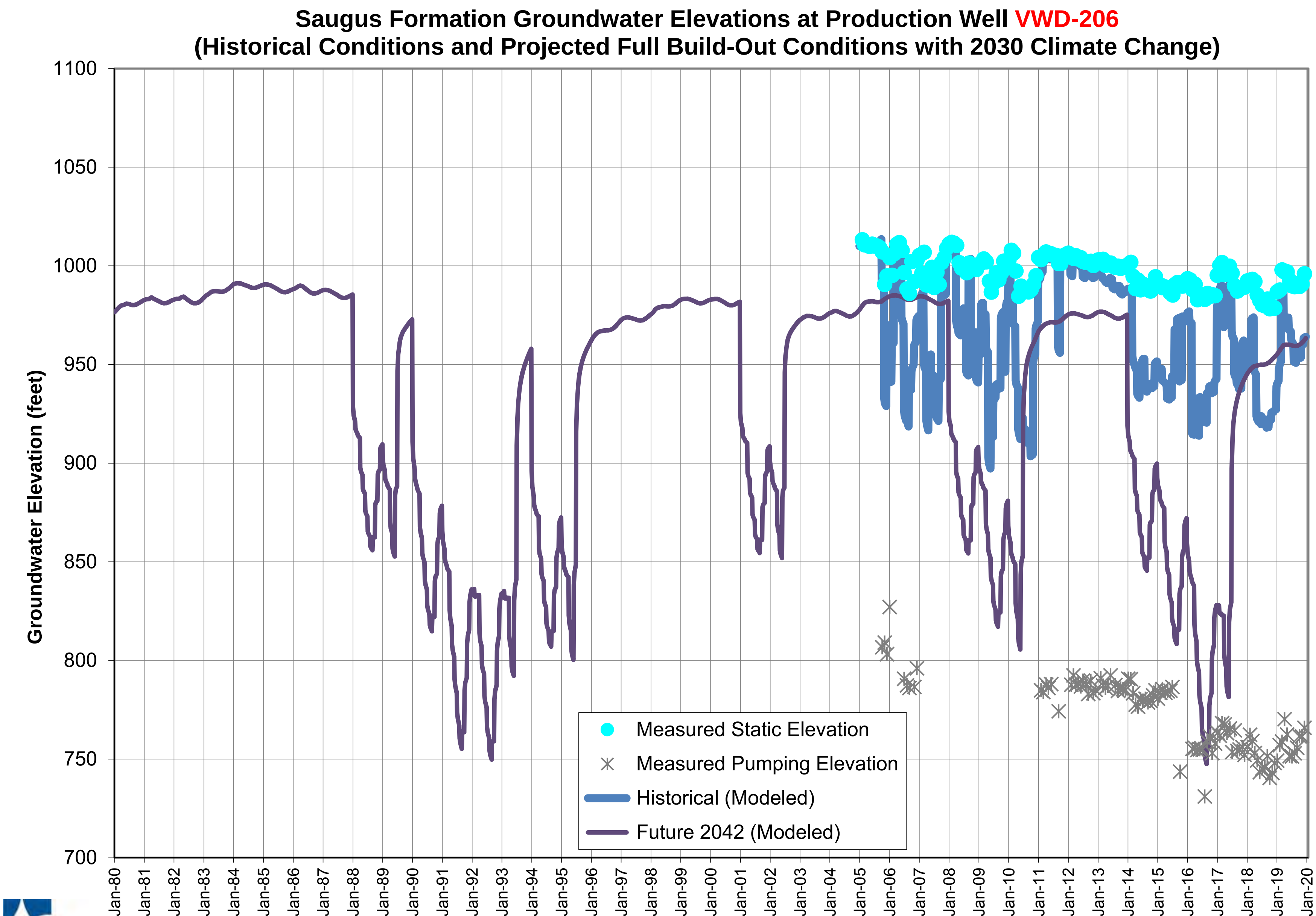
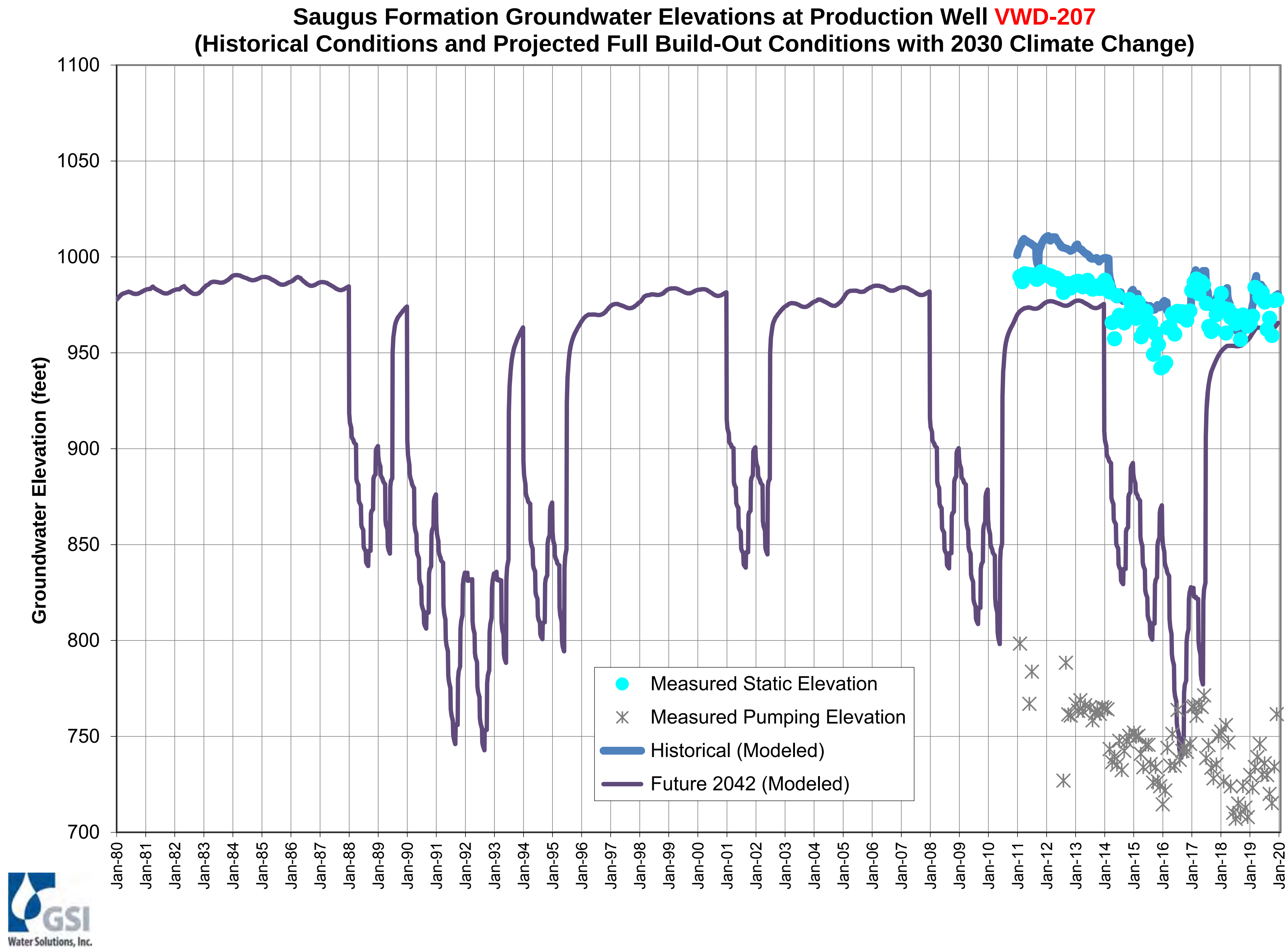
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Measured Static Elevation
Measured Pumping Elevation
Historical (Modeled)
Future 2042 (Modeled)
GSI
Water Solutions, Inc.



GSI Water Solutions, Inc.



Saugus Formation Groundwater Elevations at Production Well VWD-207
(Historical Conditions and Projected Full Build-Out Conditions with 2030 Climate Change)
Groundwater Elevation (feet)
1100
1050
1000
950
900
850
800
750
700
Jan-80
Jan-81
Jan-82
Jan-83
Jan-84
Jan-85
Jan-86
Jan-87
Jan-88
Jan-89
Jan-90
Jan-91
Jan-92
Jan-93
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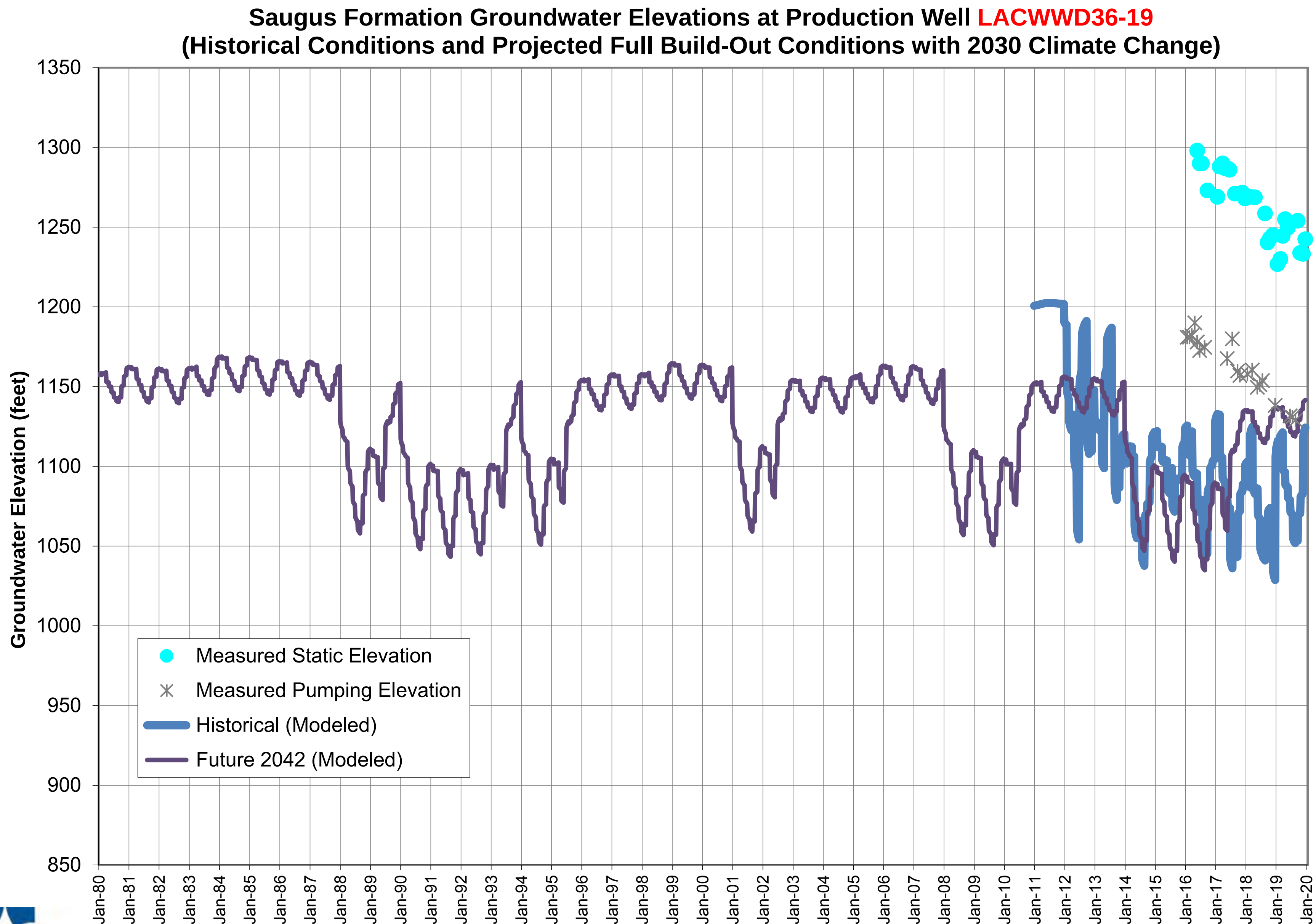
Measured Static Elevation
Measured Pumping Elevation
Historical (Modeled)
Future 2042 (Modeled)
GSI
Water Solutions, Inc.



GSI Water Solutions, Inc.

APPENDIX D

Mapping of Potential Groundwater Dependent Ecosystems within the Santa Clara River Valley East Groundwater Subbasin, Prepared by Environmental Science Associates (ESA)

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MAPPING OF POTENTIAL GROUNDWATER DEPENDENT ECOSYSTEMS WITHIN THE SANTA CLARA RIVER VALLEY EAST GROUNDWATER SUBBASIN

Prepared for
GSI Water Solutions, Inc. and Santa Clarita Valley Water Agency

May 2020

ESA

MAPPING OF POTENTIAL GROUNDWATER DEPENDENT ECOSYSTEMS WITHIN THE SANTA CLARA RIVER VALLEY EAST GROUNDWATER SUBBASIN

Prepared for
GSI Water Solutions, Inc. and Santa Clarita Valley Water Agency

May 2020

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POTENTIAL GROUNDWATER DEPENDENT ECOSYSTEMS WITHIN THE SANTA CLARA RIVER VALLEY EAST GROUNDWATER SUBBASIN

1.0 Introduction

The Sustainable Groundwater Management Act (SGMA) of 2014 established a state policy in the California Water Code for the advancement of sustainable local groundwater management. It requires the establishment of groundwater sustainability agencies (GSAs) to manage groundwater resources for multiple objectives including social, economic, and environmental benefits. SGMA requires GSAs in high and medium priority basins to develop and implement groundwater sustainability plans (GSPs) for the purpose of halting overdraft and bringing groundwater basins into balanced levels of pumping and recharge.

As a part of the process, SGMA requires GSAs to identify and consider groundwater dependent ecosystems (GDEs) within their GSPs. GDEs are defined under SGMA as "ecological communities of species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface" (23 CCR § 351(m)). GDE types include seeps and springs; wetlands and lakes; terrestrial vegetation connected to shallow groundwater; and rivers, streams and estuaries.

To assist in the identification of GDEs, the Nature Conservancy (TNC) has developed a methodology and guidance document to assist in a structured and uniform process for defining and identifying GDEs that may be applied throughout the State. Section 3.0 of this report describes the full TNC methodology. This report accomplishes a portion of the TNC methodology to identify and map potential GDEs within the Santa Clara River Valley East Groundwater Subbasin for consideration in the Santa Clara River Valley East Groundwater Subbasin GSP under preparation by the Santa Clara Valley Groundwater Agency (SCVGSA).

Although the TNC guidance recommends using depth to groundwater as a means of identifying GDEs, the analysis in this report identifies potential GDEs, recognizing future work is needed to evaluate depth to groundwater in conjunction with GDEs. Groundwater depths vary substantially seasonally and year-over-year in this watershed. This report identifies and maps habitats within the natural watershed that require intermittent or perennial water, and characterizes these areas as "potential GDEs." This provides for a conservative accounting of all areas that may or may not be groundwater dependent. Subsequent analysis using depth to groundwater data as an indicator is planned, and would be anticipated to eliminate some areas identified in this report as potential GDEs.

2.0 Environmental Setting

The California Department of Water Resources (DWR) maintains and updates Bulletin 118 that identifies the occurrence and nature of groundwater within the state (DWR 2016), including the establishment and naming of groundwater basin boundaries, the status of pumping and overdraft for each basin, and the identification of priority basins experiencing critical overdraft.

California's 515 groundwater basins are classified into one of four categories: high, medium, low, or very low priority based on components identified in the California Water Code Section 10933(b). Basin priority determines which provisions of California Statewide Groundwater Elevation Monitoring (CASGEM) Program and the SGMA apply in a basin. DWR prioritized groundwater basins through the CASGEM Program in 2014. In 2015, SGMA went into effect and required DWR to prioritize basins. Consequently, DWR used the 2014 CASGEM Basin Prioritization as the initial SGMA basin prioritization, which identified the Santa Clara River Valley East Groundwater Subbasin as a high priority basin (DWR 2019a).

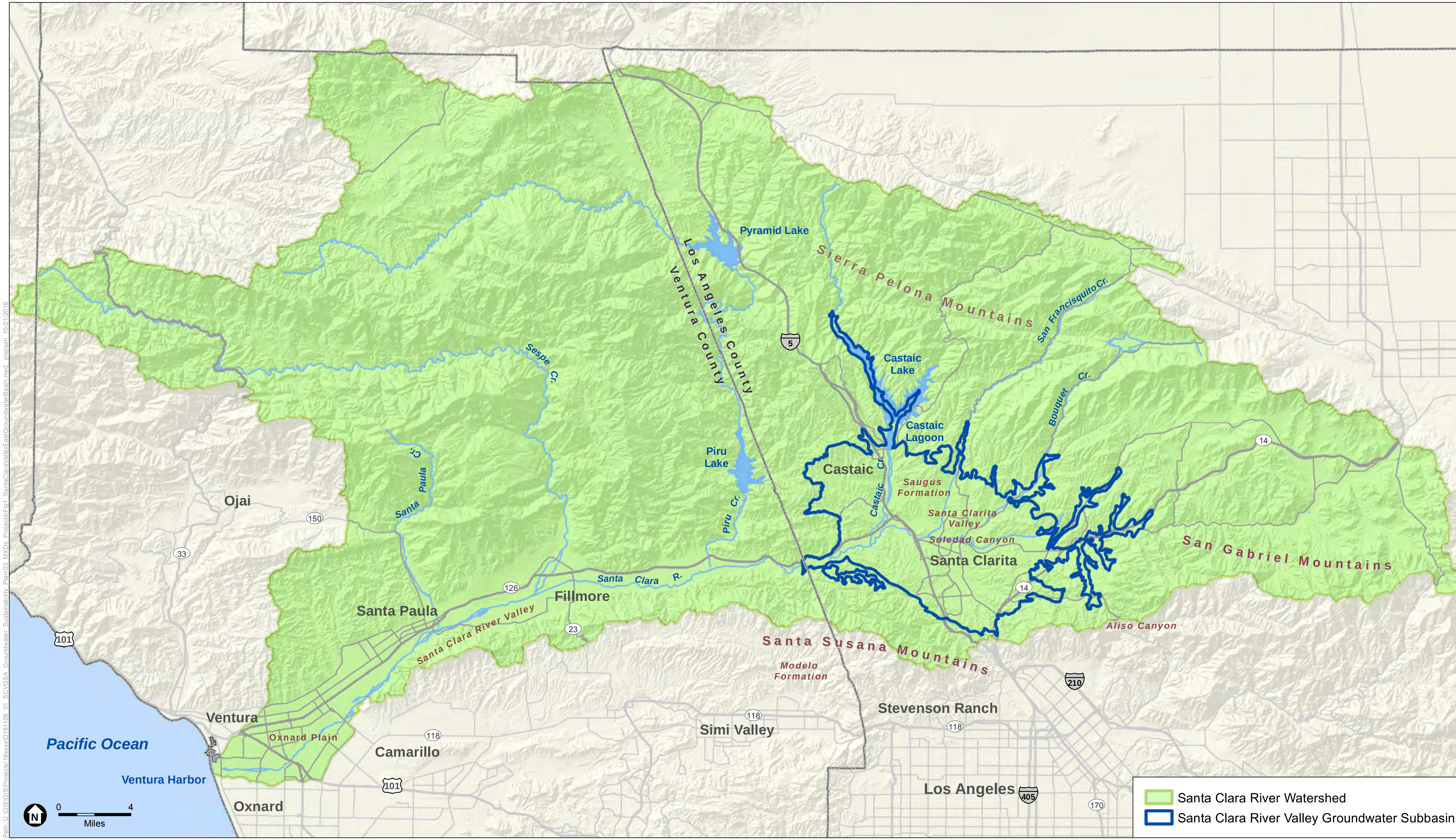
2.1 Santa Clara River Watershed

The Santa Clara River is the largest river system in Southern California remaining in a relatively natural state. The Santa Clara River originates in the northern slope of the San Gabriel Mountains in Los Angeles County, and flows in a westerly direction for approximately 84 miles through Tie Canyon, Aliso Canyon, Soledad Canyon, the Santa Clarita Valley, the Santa Clara River Valley, and the Oxnard Plain before discharging to the Pacific Ocean near the Ventura Harbor (**Figure 1**).

The Santa Clara River and tributary system covers about 1,634 square miles. Major tributaries include Castaic Creek, Bouquet Canyon Creek, and San Francisquito Creek in Los Angeles County, and the Sespe, Piru, and Santa Paula Creeks in Ventura County. Approximately 40 percent of the watershed is located in Los Angeles County and 60 percent is in Ventura County (Watersheds Coalition of Ventura County 2017). Land use within the watershed is predominately open space, with primarily residential, agriculture, and some industrial uses along the mainstem of the river. High quality riparian patches occur along the river and its tributaries (Water Boards 2019).

2.2 Santa Clara River Valley East Groundwater Subbasin

The Santa Clara River Valley East Groundwater Subbasin (Basin) is located in the central-western portion of Los Angeles County. The Basin is bound on the north by the Sierra Pelona Mountains, on the east and southeast by the San Gabriel Mountains, and on the south by the Santa Susana Mountains (**Figure 1**). It is bound on the west by the Modelo Formation, the Saugus Formation, and a thinning of the alluvium near the Piru Subbasin (DWR 2018). This includes nearly the entirety of the City of Santa Clarita as well as unincorporated Los Angeles County communities and census-designated areas such as Castaic and Stevenson Ranch.



SOURCE: ESRI, 2019; ESA, 2019.

Figure 1
Santa Clara Valley East Groundwater Subbasin and Santa Clara River Watershed

ESA

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As discussed in Section 2.1, the area overlaying the Basin is drained by the Santa Clara River and its tributaries. A number of manmade structures or impoundments, such as Castaic Lake, exist throughout the Basin. Some stretches of riparian habitat are present along the length of the river and its tributaries. The habitats support a variety of flora and fauna in the watershed including common species and special status species. The federally endangered and state endangered and fully protected fish, the unarmored threespine stickleback (*Gasterosteus aculeatus williamsoni*, [UTS]), is resident in the Basin within segments of the Santa Clara River and one location in the upper segment of Bouquet Canyon Creek (Howard 2019). Other federal and state listed species that may be present within aquatic and riparian habitats in the watershed include Santa Ana sucker (*Catostomas santaanae*), arroyo toad (*Anaxyrus californicus*), least Bell's vireo (*Vireo bellii pusillus*), southwestern willow flycatcher (*Empidonax trailii extimus*), and the slender-horned spineflower (*Dodecahema leptoceras*).

3.0 TNC Guidance for Identifying GDEs

3.1 The Nature Conservancy Guidance for Preparing Groundwater Sustainability Plans

The Nature Conservancy (TNC) developed a guidance document based on best available science to assist agencies, consultants, and stakeholders to efficiently incorporate GDEs into GSPs. In the guidance, five steps were outlined to inform the GSP process (TNC 2018a):

1. Step 1 – Identify GDEs;
    a. Step 1.1 - Map GDEs
    b. Step 1.2 - Characterize GDE Condition
2. Step 2 – Determine Potential Effects of Groundwater Management on GDEs;
3. Step 3 – Consider GDEs when Establishing Sustainable Management Criteria
4. Step 4 – Incorporate GDEs into the Monitoring Network; and
5. Step 5 – Identify Projects and Management Actions to Maintain or Improve GDEs.

There are two objectives within Step 1 which are to map (Step 1.1) and characterize (Step 1.2) GDEs in the Basin. Step 1.1 is the focus of this report.

3.1.1 Step 1.1 Map GDEs

The mapping process in Step 1.1 begins with the publicly available statewide GDE indicators (iGDE) database that was developed by the TNC in partnership with the California Department of Fish and Wildlife (CDFW) and the DWR using the best available statewide data on vegetation, springs and seeps, wetlands, and riparian mapping. This statewide database identifies polygons where GDEs may be present. These polygons may be refined further using local information and site specific data to ensure the map accurately reflects local conditions.

Aerial photos and local knowledge may be used to refine the data specific to local regions, resulting in addition, removal, and modifications to polygons. To confirm whether the GDE polygons are connected to groundwater, local hydrologic information may be used to confirm a groundwater connection to the potential GDE. For hydrologic data that is missing or insufficient, TNC guidance provides a list of questions to assess whether iGDE polygons are connected to groundwater. These questions include the following from Worksheet 1 of the guidance:

1. Is the iGDE underlain by a shallow unconfined or perched aquifer that has been delineated as being part of a Bulletin 118 principal aquifer in the basin?
2. Is the depth to groundwater under the iGDE less than 30 feet?
3. Is the iGDE located in an area known to discharge groundwater (e.g., springs/seeps)?

If the answer is yes to any of these three questions, per TNC guidance, it is likely a GDE.

Once a hydrologic connection between each iGDE polygon and groundwater is confirmed, the polygons can be designated as actual GDEs (TNC 2018a). As a part of the process, some GDE polygons are removed and other GDE polygons added, where appropriate. TNC recommends that iGDEs with insufficient hydrologic data also be considered GDEs but should be flagged for further investigation.

TNC further recommends grouping and consolidating GDE polygons based on their proximity to each other, GDE type (seeps and springs; wetlands and lakes; terrestrial vegetation; and rivers, streams and estuaries), and association to the same aquifer. Based on DWR's Bulletin 118 and local geologic information, it is recommended to group proximate GDE polygons in the Basin by aquifer.

3.1.2 Step 1.2 Characterize GDE Condition

Once GDEs are mapped, they are then characterized in Step 1.2 by their hydrologic and ecological conditions. Although mapping of potential GDEs is the focus of this report, additional characterization of potential GDEs is an anticipated next step (see discussion in Section 6.0).

To assess the ecological condition of each GDE, the TNC guidance recommends that datasets be reviewed including the iGDE database, USFWS's Environmental Conservation Online System (ECOS), CDFW's California Natural Diversity Database (CNDDB), California Protected Areas Data Portal (CPAD), Areas of Conservation Emphasis (ACE), Regional Water Quality Control Board's (RWQCB's) beneficial use designations, and local plans or studies such as habitat conservation plans and natural resource management plans.

The TNC guidance recommends that the condition of each GDE unit be inventoried and documented by describing the species composition, habitat condition, and other relevant information reflected in Worksheet 2 of the guidance (TNC 2018a). Then the ecological condition of the GDE unit should be characterized as having a high, moderate, or low ecological value based on criteria provided in the TNC guidance.

This step has not been conducted for all the potential GDEs, although field data sheets have been prepared for a representative sampling of the GDE polygons. The identification of riparian habitat in this watershed is considered to represent high ecological values that could potentially support sensitive species. Any further refinement of habitat condition could result in a reduction of assessed ecological values associated with specific GDE polygons (see discussion in Section 6).

4.0 Methods Used to Identify Potential GDEs in the Santa Clara River Valley East Groundwater Subbasin

4.1 Data Compilation and Aerial Imagery Analysis Methods

Both vegetation and wetland layers of the Natural Communities Commonly Associated with Groundwater (NCCAG) dataset (DWR 2019a) were used as the baseline mapping for the locations of potential GDEs. The NCCAG dataset is the same dataset as the statewide GDE indicators (iGDE) database referred to in the TNC guidance (TNC 2018a). The publicly available data compiled into the iGDE database includes several large-scale vegetation and wetland mapping efforts that conform to established State or federal mapping standards. The NCCAG (i.e., iGDE) can be accessed using the NC Dataset Viewer which is a web-based mapping program that allows for the viewing and download of vegetation and wetland layers contained in the NCCAG dataset (DWR 2019b). As further detailed in **Appendix A**, the data sources used to compile the iGDE database include the following:

1. VEGCAMP – The Vegetation Classification and Mapping Program, CDFW
2. CALVEG – Classification and Assessment with Landsat of Visible Ecological Groupings, USDA Forest Service
3. NWI V 2.0. – National Wetlands Inventory (Version 2.0.), United States Fish and Wildlife Service
4. FVEG – California Department of Forestry and Fire Protection, Fire and Resources Assessment Program (CALFIRE FRAP).
5. United States Geologic Survey (USGS) National Hydrography Dataset (NHD)
6. Mojave Desert Springs and Waterholes (Mojave Desert Spring Survey)

Although the iGDE database lists the National Wetland Inventory (NWI) as one of its data sources, it was noted that the entirety of the NWI data was not accurately depicted. Therefore, NWI data were taken from its original U.S. Fish and Wildlife (USFWS) source to identify areas not included in the iGDE database but which contained riverine channels, riparian, or wetland vegetation. Spatial data were assembled in Keyhole Markup Language (KML) files, that were zipped (i.e., saved as KMZs). The KMZs were prepared using the most current aerial imagery available. The original iGDE database was used to create KMZ 1 (Original iGDE Database).

The Basin boundary defined in Bulletin 118, as viewed on the NC Dataset Viewer (DWR 2019b), was used as the area within which potential GDEs are to be identified (DWR 2016).

Using aerial imagery (Google Earth Pro 2019), the next step was to keep, add, or remove potential GDE polygons in accordance with Step 1.1 of the TNC guidance based on an assessment and interpretation of vegetative cover and/or land use. Added polygons included vegetation communities that were already mapped as potential GDE polygons in the original iGDE database, but needed to be revised or added based on the vegetative cover shown on the aerial imagery (i.e., unmapped sections of river channels). These added polygons were assigned one of the vegetation or wetland classifications of an adjacent polygon or an existing classification as used in the iGDE dataset, for consistency (KMZ 2). The added potential GDE polygons were included with the original iGDE database to create a working iGDE database [(KMZ 2 (iGDE Database + Added GDEs)]. Areas that were difficult to assess using aerial imagery were noted as needing a field assessment to confirm the vegetation present, as discussed below.

The methodology described in this report did not implement the TNC methodology considering depth to groundwater as a primary factor for determining GDE. Additional refinement is needed in future steps, and is described in Section 6.0.

4.2 Field Assessment Methods

In order to verify polygons of the working iGDE database reflected in KMZ 2, and to gather species and habitat information, representative potential GDE polygons were selected for a field assessment. These areas included the following:

1. At least one of each habitat type reflected in the original iGDE database
2. Areas where vegetation type or hydrology was unclear based on the aerial imagery analysis (i.e., isolated tree clusters with no obvious connection to a water source)

Prior to the field assessment, a field data sheet was developed that incorporated species and habitat information, and environmental beneficial uses established by the Los Angeles RWQCB (LARWQCB 2016), consistent with TNC guidance for determining the ecological condition of a potential GDE. Additional information on the field data sheet included, but was not limited to, dominant plant species observed within the tree, shrub, and herbaceous layers; wildlife species observed; hydrology information such as the presence of surface flows or ponded water and the source of water; and soil type. The data sheet was completed for each of the potential GDE polygons selected for a field assessment that were accessible.

The field assessment was conducted by ESA biologists on September 5 and 6, 2019. The survey was conducted on foot within accessible portions of the representative potential GDE polygons, which comprised 335 acres. Aerial photography and tablets using ArcGIS Collector were used to accurately locate each polygon. Vegetation communities were characterized and mapped in the field in accordance with the vegetation classifications from the original iGDE database. In areas that were not accessible at the time of the survey, visual observations were made from the nearest accessible locations. Inaccessible locations typically occurred on private or gated property, and trespassing was avoided. Areas where the polygon could not be visually assessed from a distance or with binoculars were not analyzed, and were noted as being inaccessible. Inaccessible polygons accounted for a total of 12 distinct polygons totaling 30 acres (or an estimated 8% of the total survey area). Inaccessible polygons were kept as potential GDE polygons with the original vegetation classification. Datasheets prepared during the field assessment are included in **Appendix B**.

4.3 Refinement of GDE Mapping

4.3.1 Removal of Potential GDE Polygons

After the field assessment, it became evident that some habitat types do not meet the definition of GDEs as defined under SGMA. These areas include the following:

1. Upland habitats that were planted or landscaped, and/or are currently supported by irrigation;
2. Human-made features[1] maintained by management of surface flows (i.e., intakes/outlets) such as golf course ponds, detention basins, concrete-lined channels, open water reservoir/lakes and associated riparian/wetland vegetation (i.e., Castaic Lake);
3. Barren[2] segments of river channels; and
4. Riversidean scrub habitats. Vegetation classified within the original iGDE database as Riversidean Alluvial Scrub, Riverwash Scrub, or Scalebroom were removed from the potential GDEs since these habitats are established in river floodplains where they are dependent on (limited) flood events (Beller et al 2011), and are generally not known to be groundwater dependent.

The remaining potential GDE polygons were compiled into KMZ 3 (iGDE Database + Added GDEs - Removed GDEs).

4.3.2 Remapping and Reclassification of Potential GDE Polygons

A review of all confirmations or modifications of the field-assessed potential GDEs made during the field assessment was conducted in coordination with ESA's Geospatial Services (GIS) staff. Based on the field assessment, a handful of polygons originally classified as Coast Live Oak, Riparian Mixed Hardwood, Riversidean Alluvial Scrub, Scalebroom or Willow (Shrub) were reclassified and remapped from KMZ 3 as necessary and kept as potential GDEs.

The vegetation communities of the potential GDEs from KMZ 3 were then reclassified according to *A Manual of California Vegetation*, *Second Edition* (Sawyer et al 2009) based on the dominant plant species observed during the field assessment. In addition, in accordance with TNC guidance, the potential GDE polygons were also grouped by potential GDE type (seeps and springs; wetlands and lakes; terrestrial vegetation; and rivers, streams and estuaries). The potential GDE polygons reflective of this step were compiled into KMZ 4 (Final Potential GDE Mapping).

4.4 Depth to Groundwater Mapping

Step 1.1 of the TNC guidance recommends that groundwater mapping be conducted to determine where depth to groundwater is greater than 30 feet. The guidance suggests that areas with

[1] Human-made features exclude historic drainage features that were later surrounded by development.

[2] Barren habitat is defined by the absence of vegetation. Any habitat with <2% total vegetation cover by herbaceous, desert, or nonwildland species and <10% cover by tree or shrub species is defined this way (CDFG 1988).

groundwater depths greater than 30 feet may be eliminated from the GDE inventory. The GSAs can use the most appropriate depth to groundwater in their basin. However, in the future, application of depth to groundwater data that reflects seasonality and year type will be applied to this inventory. This additional step will likely reduce the total acreage of GDEs in the watershed compared with the “potential GDE” acreage provided in this assessment.

5.0 Results

5.1 Data Compilation and Aerial Imagery Analysis Methods

The iGDE database source data includes an estimated 6,926 acres of potential GDEs (KMZ 1) categorized by the NCCAG as wetlands and vegetation. These two categories are a combination of a number of different vegetation classifications systems. As such, the vegetation types within the NCCAG dataset associated with these two categories included: Baccharis (Riparian), California Sycamore (*Platanus racemosa*), Coast Live Oak (*Quercus agrifolia*), Fremont Cottonwood *(Populus fremontii)*, Arrowweed (*Pluchea sericea)*, Riparian Mixed Hardwood, Riparian Mixed Shrub, Riversidean Alluvial Scrub, Riverwash Scrub, Narrowleaf Willow (*Salix exigua)*, Scalebroom (*Lepidospartum squamatum*), Tule – Cattail (*Schoenoplectus* sp. – *Typha* sp.), Valley Oak (*Quercus lobata*), Wet Meadows, Willow, and Willow (Shrub). NWI data within the Basin contained the following classifications: Freshwater Emergent Wetland, Freshwater Forested/Shrub Wetland, Freshwater Pond, Lake, and Riverine.

After review of aerial imagery, a total of 1,533 acres of potential GDEs were added to the original iGDE database, totaling 8,459 acres of potential GDEs as reflected in KMZ 2. These added potential GDE polygons included the following vegetation communities: Coast Live Oak, Riparian Mixed Hardwood, Riparian Mixed Scrub, and Willow (Shrub). Several of the less common communities that occurred within the NCCAG dataset were consolidated into the surrounding communities if the analysis of aerial imagery was not conclusive to that specific type of community. This included Baccharis, California Sycamore, Riverwash Scrub, Narrowleaf Willow, Tule-Cattail, and Valley oak. One detention basin and four ponds were also noted as potential GDEs based on the data compilation and aerial imagery analysis, as they are features located along natural drainages.

5.2 Field Assessment

During the field assessment, some areas originally mapped in the iGDE database as Riversidean Alluvial Scrub or Willow (Shrub) were confirmed to be riparian woodland communities (Riparian Mixed Hardwood or Coast Live Oak) along the Santa Clara River mainstem, Castaic Creek, and Bouquet Canyon. Several willow species including Goodding’s willow (*Salix gooddingii*), red willow (*Salix laevigata*), arroyo willow (*Salix lasiolepis*) and narrowleaf willow occurred within much of the Riparian Mixed Hardwood community. Upland habitats surveyed in the field that were planted or landscaped, and/or are currently supported by irrigation, included pine and eucalyptus trees.

It should be noted that not all polygons identified as potential GDEs were visited during the field assessment. Several areas identified for field assessment (such as Potrero Canyon, detention basins, and four ponds) were not accessible due to a number of factors including the presence of private property, locked gates, fences or other factors which prevented entry. Inaccessible areas totaled 30 acres, and vegetation communities or land uses within these inaccessible areas were classified solely based on the aerial imagery analysis.

5.3 Refinement of Potential GDE Mapping

Further refinement of the potential GDEs was conducted to remove habitat types identified in aerial imagery and confirmed in the field visit that do not meet the definition of GDEs as defined under SGMA. Riversidean Alluvial Scrub, Riverwash Scrub, and Scalebroom habitats were removed from the potential GDE database. In addition, habitat types associated with man-made features such as wet meadows on the shores of Castaic Lake, planted/irrigated areas, detention basins, golf course ponds, ponds, barren channels and other man-made features were also removed from the potential GDE database. A total of 6,567 acres were removed from the potential GDE database (KMZ 3).

The remaining potential GDEs were then reclassified in accordance with *A Manual of California Vegetation*, *Second Edition* where applicable, based on observations from the field assessment. **Table 1** lists and **Figure 2** displays the potential GDEs reflected in KMZ 4, totaling an estimated 1,890 acres. The primary vegetation types include Fremont cottonwood forest and coast live oak woodland along the Santa Clara River and its tributaries.

TABLE 1
SUMMARY OF POTENTIAL GROUNDWATER DEPENDENT ECOSYSTEMS WITHIN THE SANTA CLARA RIVER VALLEY EAST GROUNDWATER SUBBASIN

Waterway/Tributary	Tributary ID Number	Vegetation Classification Based on Aerial Imagery Analysis[a]	Revised Vegetation Classification[b]	Area (acres)
Santa Clara River	SCR	Riparian mixed hardwood	Fremont cottonwood forest	698.33
Unnamed tributary to Santa Clara River (Fairfield Way)	SCRTRIB3	Riparian mixed hardwood	Fremont cottonwood forest	1.65
Unnamed tributary to Santa Clara River (Turn Leaf Court)	SCRTRIB2b	Riparian mixed hardwood	Fremont cottonwood forest	1.10
Unnamed tributary to Santa Clara River (Golden Valley Road)	SCRTRIB2a	Coast live oak	Coast live oak woodland	2.33
Unnamed tributary to Santa Clara River (Keaton Street)	SCRTRIB1	Riparian mixed hardwood	Fremont cottonwood forest	5.29
Unnamed tributary to Santa Clara River (Sierra Highway, south of Soledad Canyon Road)	SCRTRIB4	Riparian mixed hardwood	Fremont cottonwood forest	1.01

TABLE 1 (CONTINUED)
SUMMARY OF POTENTIAL GROUNDWATER DEPENDENT ECOSYSTEMS WITHIN THE SANTA CLARA RIVER VALLEY EAST GROUNDWATER SUBBASIN

Waterway/Tributary	Tributary ID Number	Vegetation Classification Based on Aerial Imagery Analysis[a]	Revised Vegetation Classification[b]	Area (acres)
Unnamed tributaries to Santa Clara River (Sierra Highway, north of Soledad Canyon Road)	SCRTRIB5	Coast live oak	Coast live oak woodland	2.34
		Riparian mixed hardwood	Fremont cottonwood forest	1.84
		Pond	Open water	0.50
Unnamed tributary to Santa Clara River (Sand Canyon Road)	SCRTRIB6	*Coast live oak	Coast live oak woodland	41.95
		*Pond	Open water	1.12
Unnamed tributary to Santa Clara River (west of I-5, South of Santa Clara River)	SCRTRIB7	Coast live oak	Coast live oak woodland	12.64
Unnamed tributary to Santa Clara River (west of I-5, Borton Street, Val Verde)	SCRTRIB8	*Coast live oak	Coast live oak woodland	7.69
		*Riparian mixed hardwood	Fremont cottonwood forest	1.66
Unnamed tributaries of Santa Clara River (far western GWB, Del Valle)	SCRTRIB9	Riparian mixed hardwood	Fremont cottonwood forest	0.9
		*Riparian mixed scrub	Mulefat thickets	3.57
South Fork Santa Clara River	SCRTRIB10	Riparian mixed hardwood	Fremont cottonwood forest	67.37
		Riparian mixed scrub	Mulefat thickets	2.33
Unnamed tributary to South Fork Santa Clara River (La Salle Canyon Road)	SCRTRIB11	*Coast live oak	Coast live oak woodland	5.19
		Riparian mixed hardwood	Fremont's cottonwood forest	0.65
		*Detention basin	Detention basin	0.59
Unnamed tributary to South Fork Santa Clara River (The Old Road)	SCRTRIB12	Coast live oak	Coast live oak woodland	44.93
Bouquet Creek	SCRTRIB13	Riparian mixed hardwood	Fremont cottonwood forest	13.07
Unnamed tributary to Bouquet Creek (Forest Route 6N18)	SCRTRIB14	Coast live oak	Coast live oak woodland	1.35
		Riparian mixed scrub	Mulefat thickets	1.29
Castaic Creek	SCRTRIB15	Riparian mixed hardwood	Fremont cottonwood forest	201.10

TABLE 1 (CONTINUED)
SUMMARY OF POTENTIAL GROUNDWATER DEPENDENT ECOSYSTEMS WITHIN THE SANTA CLARA RIVER VALLEY EAST GROUNDWATER SUBBASIN

Waterway/Tributary	Tributary ID Number	Vegetation Classification Based on Aerial Imagery Analysis[a]	Revised Vegetation Classification[b]	Area (acres)
Unnamed tributary to Castaic Creek (Tapia Canyon Road)	SCRTRIB16	Coast live oak	Coast live oak woodland	24.09
Unnamed tributaries to tributary of Castaic Creek (Hasley Canyon Road)	SCRTRIB17	Coast live oak	Coast live oak woodland	4.25
		Riparian mixed hardwood	Fremont cottonwood forest	2.77
San Francisquito Creek	SCRTRIB18	Riparian mixed hardwood	Fremont cottonwood forest	91.22
Placerita Creek	SCRTRIB19	Riparian mixed hardwood	Fremont cottonwood forest	17.58
		Coast live oak	Coast live oak woodland	2.77
Unnamed tributary to Placerita Creek (Oro Fino Mountainway)	SCRTRIB20	Coast live oak	Coast live oak woodland	25.74
Newhall Creek	SCRTRIB21	Riparian mixed hardwood	Fremont cottonwood forest	15.47
Unnamed tributary to Newhall Creek (Pine Street)	SCRTRIB22	Coast live oak	Coast live oak woodland	43.75
Potrero Canyon	SCRTRIB23	*Coast live oak	Coast live oak woodland	3.43
		*Riparian mixed hardwood	Fremont cottonwood forest	35.95
Features Associated with Sand Canyon Golf Course	SCRTRIB24	*Pond	Open water	1.13
		*Riparian mixed hardwood	Fremont cottonwood forest	1.14
		*Riparian mixed scrub	Mulefat thickets	0.12
Total				1,889.96

NOTES:

* Inaccessible during the field assessment.

a Based on KMZ 2.

b Vegetation communities classified using A Manual of California Vegetation, Second Edition (Sawyer et al 2009).

6.0 Discussion

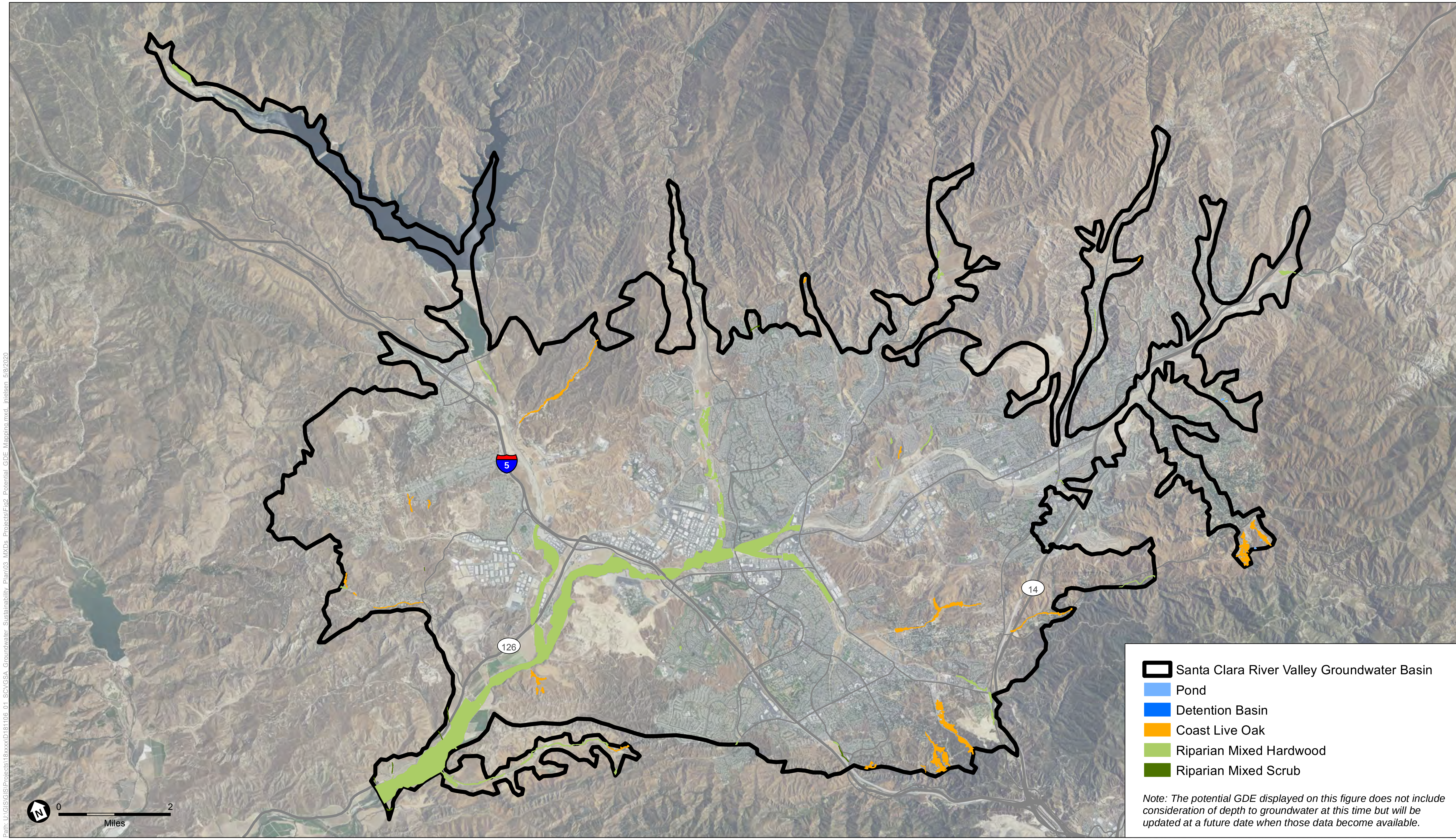
Following the TNC suggested methodology, an estimated 1,890 acres of potential GDE have been documented within the Basin boundaries. The KMZ 4 database provides the geographic location for each distinct potential GDE. The potential GDEs are comprised primarily of riparian corridors. Much of the acreage associated with the potential GDEs occurs in the main stem of the Santa Clara River. However, many smaller potential GDEs are identified within the tributaries reaching into the higher elevations. Some potential GDEs in the higher elevations may be fed from higher elevation seepage disconnected from the shallow groundwater basin.

In accordance with Step 1.1 of the TNC guidance, potential GDEs with a depth to groundwater of greater than 30 feet may indicate that no connection to groundwater is possible to support vegetation. However, the analysis in this report has not applied this 30-foot depth to groundwater refinement in an effort to provide a more conservative approach. Application of depth to groundwater mapping is considered a next step in the refinement of GDEs in the watershed.

However, groundwater levels vary with seasons, hydrologic year types, and alluvial aquifer pumping. This analysis inventories all habitats observed within the semi-arid watershed that require intermittent or perennial access to water, subtracting only the man-made water features and irrigated landscapes (including agricultural land). This approach ensures that all the valued habitat in the local drainages is captured in the potential GDE inventory. This approach allows for future refinement as more data is collected and incorporated on depth to groundwater and other relevant factors.

For example, depth to groundwater within the Santa Clara River channel just above the Valencia Water Reclamation Plant (WRP) discharge may be greater than 30 feet. However, this area supports riparian vegetation and important aquatic habitat. Additional data on the source of water supporting this vegetation is needed to better understand the system. This report recognizes this complexity and captures all the valued habitat in this area to ensure a conservative approach.

Similarly, downstream of the Valencia WRP discharge, the Santa Clara River exhibits surface flows to the western edge of the Basin. Groundwater upwelling is known to occur in this portion of the river (Cox et al 2003), but the location, extent of the connection of the river channel with the underlying alluvial groundwater basin may vary with seasonality and by hydrologic year type, making it difficult to distinguish surface-flow-dependent habitats from GDEs. For purposes of this assessment, the entire 7-mile stretch is considered to be a potential GDE as a conservative assumption. In the future, as additional data on depth to groundwater is refined, it may become apparent that some of this potential GDE acreage is actually disconnected from groundwater and relies solely on surface water flows. Rather than making that conclusion now, this report provides a conservative approach to ensure the existing riparian habitat acreage in the watershed is inventoried.



SOURCE: ESA, 2020; NWI, 2019; NCCAG, 2019.

SCVGSA Groundwater Sustainability Plan

Figure 2
Potential GDE Mapping

ESA

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This report does not complete Step 1.2 of the TNC guidance that recommends characterizing the ecological value of each GDE unit to assist with GDE prioritization. Rather than refine the relative value of each GDE polygon, this report documents the existence of habitat that may be suitable to support sensitive species. Relative quality of the habitat in each stretch of the river may depend on occupation by sensitive species, the season, consistency of water availability, invasive species, nuisance surface flows, urban runoff water quality including trash, and in stream human use including homeless encampments. Additional field verification and/or other study is needed to fully implement Step 1.2 of the TNC guidance for the potential GDE polygons and is a next step in refinement of the GDE inventory. However, in this semi-arid environment, the current existence of riparian, aquatic, and woodland habitats represents important ecological values that have the potential to support sensitive species

In summary, additional refinements to the potential GDEs will be made in the future to more accurately map GDEs. This includes applying depth to groundwater and habitat characterizations consistent with TNC methodology Step 1.2. additional refinement will likely reduce the acreage of actual GDEs in the watershed mapped in this report. This report provides a conservative and inclusive inventory of potential GDEs in the Basin.

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Appendix A

Summary of the “Natural Communities Commonly Associated with Groundwater” Dataset and Online Web Viewer

Summary of the "Natural Communities Commonly Associated with Groundwater" Dataset and Online Web Viewer

California Department of Water Resources
Sustainable Groundwater Management Program

April 2018

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Foreword

April 2018

The objective of this Summary Document is to provide the public with information regarding the "Natural Communities Commonly Associated with Groundwater" dataset (hereafter referred to as the Natural Communities dataset) and online web viewer provided by the California Department of Water Resources (DWR). This Summary document provides information on how Groundwater Sustainability Agencies (GSAs) can potentially use this dataset and apply local knowledge and collaborate with other entities to identify groundwater dependent ecosystems (GDEs) in their respective groundwater basins.

The information provided in this document describes how the Natural Communities dataset is organized, its associated assumptions and limitations, general background information about the development of the dataset, and includes a brief introduction to the online web viewer.

This document is not a substitute for the Regulations for Groundwater Sustainability Plans (GSPs) or other Sustainable Groundwater Management Act (SGMA) requirements. Use of the Natural Communities dataset by a GSA to develop a component of a GSP would not automatically result in DWR approval of a GSP. Use of the Natural Communities dataset is not mandatory; GSAs may use this dataset or other available data and local information to identify GDEs.

The information provided in the Natural Communities dataset or use of this information does not preempt the authority of local land use agencies or alter any water right or the priority of any water right under state or federal law.

Contents

Natural Communities Commonly Associated with Groundwater Dataset and Online Web Viewer

1.1 Natural Communities Dataset Background

The Sustainable Groundwater Management Act (SGMA) and DWR's Groundwater Sustainability Plan (GSP) regulations establish new requirements on the elements that Groundwater Sustainability Agencies (GSAs) are to include in their GSPs. One of those requirements is the identification of groundwater dependent ecosystems (GDEs), and where appropriate, impacts on GDEs. GDEs are defined in the GSP Regulations as 'ecological communities or species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface'. Determination of GDEs within a groundwater basin is the responsibility of the GSAs. DWR created the Natural Communities Commonly Associated with Groundwater dataset (hereafter referred to as the Natural Communities dataset) to assist GSAs in the preparation and implementation of GSPs. Refer to Appendix A for text related to identification of GDEs included in SGMA and the GSP Regulations.

The Natural Communities dataset is a compilation of 48 publicly available State and federal agency datasets that map vegetation, wetlands, springs, and seeps in California. A working group comprised of DWR, the California Department of Fish and Wildlife (CDFW), and The Nature Conservancy (TNC) reviewed the compiled dataset and conducted a screening process to exclude vegetation and wetland types less likely to be associated with groundwater and retain types commonly associated with groundwater, based on criteria described in Klausmeyer et al., 2018. Two habitat classes are included in the Natural Communities dataset: (1) wetland features commonly associated with the surface expression of groundwater under natural, unmodified conditions; and (2) vegetation types commonly associated with the sub-surface presence of groundwater (phreatophytes).

The data included in the Natural Communities dataset do not represent DWRs determination of a GDE. However, the Natural Communities dataset can be used by GSAs as a starting point when approaching the task of identifying GDEs within a groundwater basin.

1.2 Dataset Description

Data Sources

The publicly available data compiled into the Natural Communities dataset include several large-scale vegetation and wetland mapping efforts that conform to established State or federal mapping standards, one large-scale seeps and springs mapping effort that is a component of the National Map, and one mapping effort that updated the locations of Mojave Desert springs. This section describes the data sources used and reasons for inclusion during the development of the Natural Communities dataset.

VEGCAMP – THE VEGETATION CLASSIFICATION AND MAPPING PROGRAM, CDFW

Source link: https://www.wildlife.ca.gov/Data/VegCAMP

The VegCAMP dataset is considered the highest resolution data source of California vegetation mapping available and is used as the basis for the Natural Communities dataset. The purpose of VegCAMP is to maintain maps and classification of all vegetation in the State to support conservation and management decisions at the local, regional, and state levels. Fish and Game Code §1940 directed CDFW to develop and maintain a vegetation dataset for the State of California in compliance with Survey of California Vegetation (SCV) Classification and Mapping Standards (https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=102342&inline).

Based on the SCV standard, vegetation maps consist of geospatially registered polygons which are interpreted through analysis of aerial imagery. The base imagery must meet or exceed the National Agriculture Imagery Program (NAIP) resolution standards (one-meter ground sample distance). The minimum mapping unit is usually 1 or 2 acres, but no more than 10 acres for vegetation. Wetlands are mapped to 0.25 acres. The minimum width of polygons is generally no less than 30 feet (10 meters). Once the polygons are mapped, field reconnaissance surveys are performed to match aerial photograph analysis with the actual vegetation types on the ground.

The Natural Communities dataset includes only 31 of the individual VegCAMP mapping projects and a CDFW-created composite layer of the Central Valley. In areas of overlap between the individual mapping projects, only the dataset that used the most recent aerial imagery was included in the Natural Communities dataset.

CALVEG – CLASSIFICATION AND ASSESSMENT WITH LANDSAT OF VISIBLE ECOLOGICAL GROUPINGS, USDA FOREST SERVICE

Source link:
https://www.fs.usda.gov/detail/r5/landmanagement/resourcemanagement/?cid=stelprdb5347192

The United States Department of Agriculture (USDA) Forest Service Region 5 employs the CALVEG system to classify "existing vegetation". For classification of existing vegetation, a set of U.S. Forest Service standards and procedures has been established at the national and regional levels. The Region 5 CALVEG classification system conforms to the upper levels of the National Vegetation Classification Standard (USNVC) hierarchy as it currently exists (Federal Geographic Data Committee 2008). The USNVC sets guidelines for all federal agencies involved in this work. The CALVEG team's mission was to classify California existing vegetation communities for use in statewide resource planning considerations.

The CALVEG system maps large areas of the State with minimal bias and is supplemented with onsite field visits when appropriate. Map attributes consist of vegetation types using the CALVEG classification system and forest structural characteristics such as tree and shrub canopy cover and tree stem diameters.

The CALVEG dataset includes vegetation maps for almost 75% of California, with data available by ecoregion. The eleven CALVEG datasets were compiled for inclusion in the Natural Communities dataset, but were only used in areas not already mapped by VegCAMP due to its coarser mapping unit.

NWI V 2.0. – NATIONAL WETLANDS INVENTORY (VERSION 2.0.), UNITED STATES FISH AND WILDLIFE SERVICE

Source link: https://www.fws.gov/wetlands/

The purpose of NWI is to provide current, geospatially-referenced information of the status, extent, characteristics, and functions of wetland, riparian, deepwater, and related aquatic habitats in priority areas to promote the understanding and conservation of these resources. These data delineate the areal extent of wetlands and surface waters as defined by the Federal Geographic Data Committee as a National Standard (FGDC-STD-004) in 2013, adapted and modified from Cowardin[1] et al. (1979). As part of the NWI, the USFWS has a program to map riparian vegetation in the arid regions of the United States (USFWS riparian data). The target mapping unit of the dataset is 0.5 acre.

The NWI database was used to map wetlands within the Natural Communities dataset. The NWI database was also used to map springs and seeps, but only in areas not already mapped by the National Hydrography Dataset or the Mojave Desert Springs Survey (described below). Similarly, the USFWS riparian data was only used in portions of Southern California not already mapped by VegCAMP or CALVEG data because the VegCAMP and CALVEG datasets are higher resolution than the USFWS riparian data.

FVEG – CALIFORNIA DEPARTMENT OF FORESTRY AND FIRE PROTECTION, FIRE AND RESOURCES ASSESSMENT PROGRAM (CALFIRE FRAP).

Source link: http://frap.fire.ca.gov/data/frapgisdata-sw-fveg_download

The FVEG dataset was developed in coordination with the CDFW VegCAMP program and the USDA Forest Service Remote Sensing Laboratory to compile a best available land cover dataset. The data cover the entire State of California. The various data sources included in FVEG were standardized by reclassifying the various vegetation types using the California Wildlife Habitat Relationships (CWHR) system classification scheme. FVEG is a gridded dataset with 30-meter cells rather than polygons. The cells were converted to polygons for use in the Natural Communities dataset where applicable.

FVEG was only used in the Natural Communities dataset in areas not already mapped by VegCAMP, CALVEG, or USFWS riparian data.

UNITED STATES GEOLOGIC SURVEY (USGS) NATIONAL HYDROGRAPHY DATASET (NHD)

Source link: https://nhd.usgs.gov/

The National Hydrography Dataset (NHD), a component of The National Map, represents the water drainage network of the United States with features such as rivers, streams, canals, lakes, ponds, coastline, dams, and stream gages. This high-resolution dataset is mapped at a scale of 1:24,000 or better. The NHD contains line features, area features, and point features.

For the Natural Communities dataset, the NHD was used to obtain point locations for springs and seeps. For consistency with the features included in the Natural Communities dataset, spring and seep point locations were buffered with a radius of 50 feet to create a polygon. In areas where NHD seeps and springs data overlapped with NWI wetland data, NHD data was used.

MOJAVE DESERT SPRINGS AND WATERHOLES (MOJAVE DESERT SPRING SURVEY)

Source link: https://www.scienceforconservation.org/products/mojave-desert-spring-survey

The Mojave Desert Spring Survey identified 437 springs within the Inyo, Kern, Los Angeles, and San Bernardino county portions of the Mojave Desert that were previously mapped by other agencies and organizations. In 2015 and 2016, 312 of the springs were field inspected and the geographic coordinates were updated. For the 125 springs not field inspected, coordinates were refined using recent high-resolution imagery and/or reported coordinates used in BLM inspection reports. The refined geographic coordinates for each spring were published in a report of survey results.

For the Natural Communities dataset, the geographic locations included in the report were converted to a shapefile of point locations. For consistency with the features included in the Natural Communities dataset, the point locations were buffered with a radius of 50 feet to create a polygon.

The Mojave Desert Spring Survey dataset is included in the Natural Communities dataset in addition to the NHD and has the same order of preference as the NHD.

Processing & Quality Assurance

After the vegetation, wetland, seeps, and springs data described above were compiled into the Natural Communities dataset, data were screened to exclude vegetation and wetland types less likely to be associated with groundwater and retain types commonly associated with groundwater. The screening, which was conducted by DWR, CDFW, and TNC, was based on the criteria described below and in Klausmeyer et al. 2018.

VEGETATION LAYER

All water features were removed from the source vegetation datasets since water features are mapped in higher detail by NWI. The remaining vegetation alliances (VegCamp), vegetation types (CALVEG), and habitat types (FVEG) were classified by ecoregion and assigned a dominant species, where possible, based on vegetation alliance descriptions, field observations, and/or publications.

Subject matter experts then reviewed the combination of ecoregion location and dominant species names against published lists of phreatophytes to determine (1) if the dominant species was a listed phreatophyte, and if so, (2) was likely to be phreatophytic in that ecoregion or likely to rely on surface water, precipitation, or other non-groundwater sources. If multiple dominant species names were listed for a particular vegetation type, the first phreatophytic species listed was selected to represent the vegetation type. Vegetation alliances, vegetation types, and habitat types determined to be phreatophytic were retained.

For the more general vegetation types that did not have one dominant species, the source metadata and associated reports were reviewed to determine all dominant species associated with that vegetation type. If more than half of the dominant species consisted of phreatophytes, the vegetation type was retained. Broad vegetation categories that lacked supporting descriptions of associated species were not assigned a dominant species and further screened for association with highly disturbed or managed conditions, or likelihood of dependence on non-groundwater sources.

Riparian vegetation is considered to be phreatophytic; all USFWS Riparian Data were therefore retained in areas not already mapped by VegCAMP and CALVEG.

Additional screening was then conducted to retain source features of certain vegetation types located along alluvial floodplains, as well as to remove those located on hillslopes where they are more likely to rely on surface water, rainfall, and fog drip than on groundwater. The hillslope vegetation types include those with the dominant species *Carex barbarae*, *Juglans californica*, *Picea sitchensis*, *Pinus contorta*, *Quercus agrifolia*, or *Sequoia sempervirens*, as well as the “Desert Mixed Wash Shrub” vegetation type. The US Environmental Protection Agency (2013) maps of active river areas were used to clip these vegetation types to remove hillslope areas.

All mapped "Playa" features were also screened using recent high-resolution satellite imagery to remove source features without visible vegetation stands.

WETLANDS LAYER

All wetlands mapped in NWI were first screened based on their wetland classification. Marine and estuarine wetland types were excluded because the ocean is their main source of water. Although some estuarine habitats have documented groundwater inputs, estuarine wetlands were removed due to the level of uncertainty about the amount of groundwater input. All lacustrine wetlands were retained. Palustrine wetlands were also retained, with the exception of vernal pools that are not dependent on groundwater. Vernal pool complexes were screened based on specific wetland codes. Riverine wetlands representing perennial rivers and tidally-influenced freshwater rivers were retained, but intermittent streams were excluded due to uncertainty about which ones receive groundwater input. These retained wetland types were further screened to remove human modified wetlands. Human modified wetlands were identified with modifiers such as 'Farmed', 'Diked/Impounded', and 'Artificially Flooded'.

Additional screening of the retained wetland types was conducted based on their water regime description. The remaining wetlands with water regimes of continuously or seasonally saturated; intermittently exposed; or permanently, semi-permanently, or seasonally flooded were retained. Wetlands with water regimes of intermittently, temporarily, or regularly flooded were excluded.

All seeps and springs, which are a surface expression of groundwater, were retained.

COMPILED NATURAL COMMUNITIES DATASET

Each data source was clipped to the Bulletin 118 Interim Update 2016 Groundwater Basin boundaries (i08_B118_CA_GroundwaterBasins) to remove polygons mapped outside of the groundwater basin boundaries. Any source features underlying agricultural areas identified in the 2014 statewide Crop Mapping data set released in 2017 (i15_Crop_Mapping_2014) were also removed from the Natural Communities dataset. With the exception of narrow riparian corridors, any source features underlying urban areas identified in a compilation of DWR County Land Use Surveys beginning in 2000 through 2014 and the 2014 US Department of Agriculture Cropland Data Layer were removed from Natural Communities dataset. In narrow riparian corridors located in mapped urban areas, source features underlying urban areas within 100 meters of rivers and waterbodies (as mapped in the NHDPlus V2 dataset) were retained.

Additional cursory screening was conducted for 135 individual groundwater basins. The purpose of the additional screening was to visually identify inaccuracies in the datasets. Natural communities that coincide with some of the following areas were removed during this review:

- Irrigated agricultural areas not captured in previous filtering steps
- Engineered water supply canals, aqueducts, ditches, or other conveyance facilities
- Reservoirs, stock ponds, and lakes engineered for water storage
- Heavily disturbed areas, such as quarries, gravel mining operations, and oil fields
- Managed recharge facilities
- Areas no longer in existence due to land use changes
- Areas where depth to groundwater is known to be too great to support phreatophytic vegetation
- Mapping artifacts

Some of the additional processing steps altered the geometry of the vegetation and wetland polygons to make them smaller than the minimum mapping unit for the source data set. All features remaining in the Natural Communities dataset that were smaller than the minimum mapping unit of the respective data source were removed. If no minimum mapping unit was published in the metadata or associated reports for the source data, a minimum mapping unit of 1,000 m^2 (~1/4 acre) was applied. In some cases, the source data included vegetation or wetland features smaller than the published minimum mapping unit. These features were retained in the Natural Communities dataset if they were identical to the polygon in the source dataset (i.e. they had not been modified by the processing steps listed above).

1.3 Natural Communities Online Web Viewer

DWR's NC Dataset Viewer, shown in Figure 1, provides efficient access to the Natural Communities dataset and related source datasets. The NC Dataset Viewer allows users to query the Natural Communities vegetation and wetland datasets as well as the source datasets used in the development of the Natural Communities dataset. The information displayed includes the dominant phreatophytic vegetation type or wetland description, including the primary source dataset for the feature and the year in which the data was developed (see Figure 2). Figure 3 illustrates the information displayed for the VegCAMP vegetation source dataset.

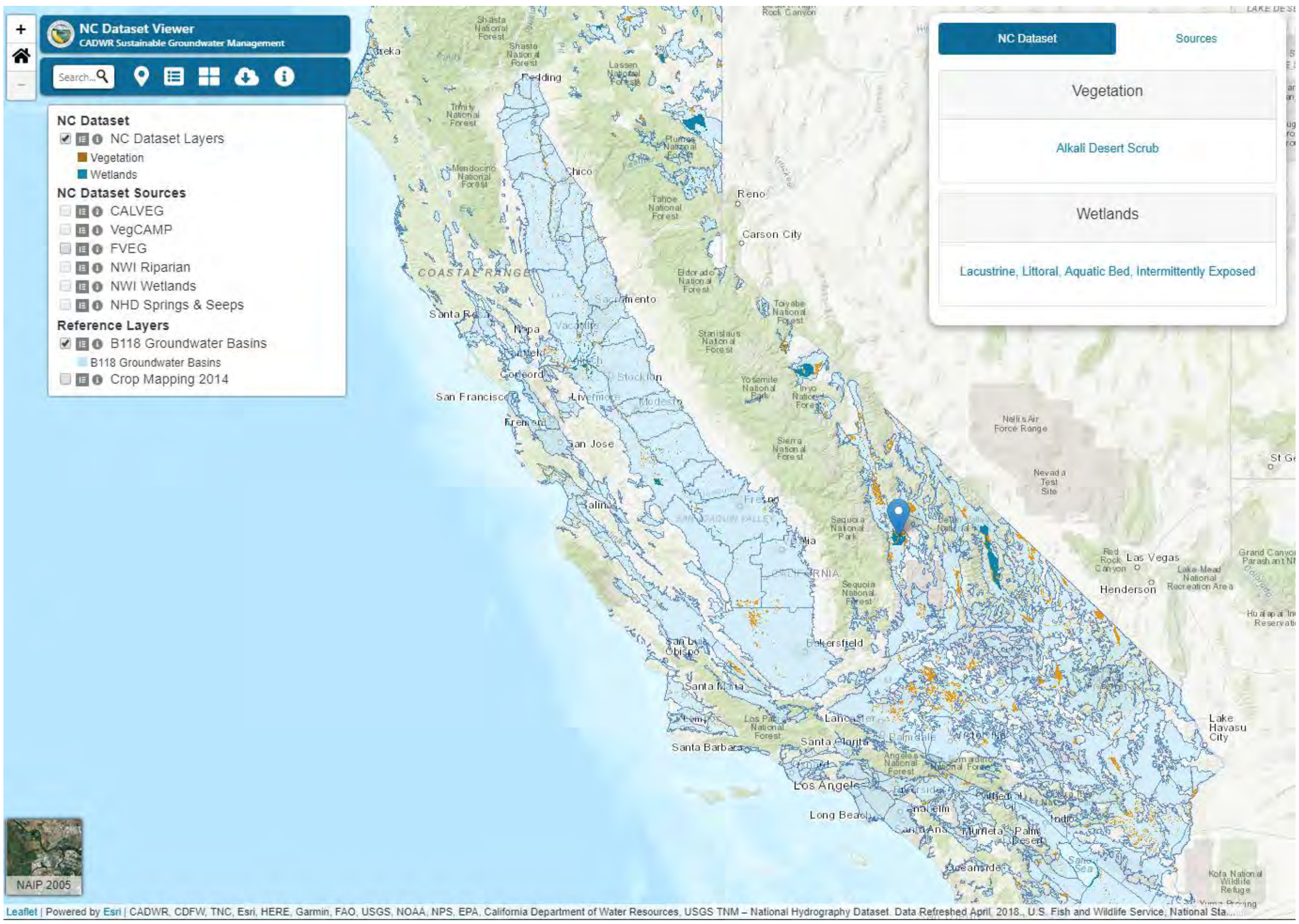

Figure 1. Natural Communities Online Web Viewer Screenshot (https://gis.water.ca.gov/app/NCDatasetViewer)

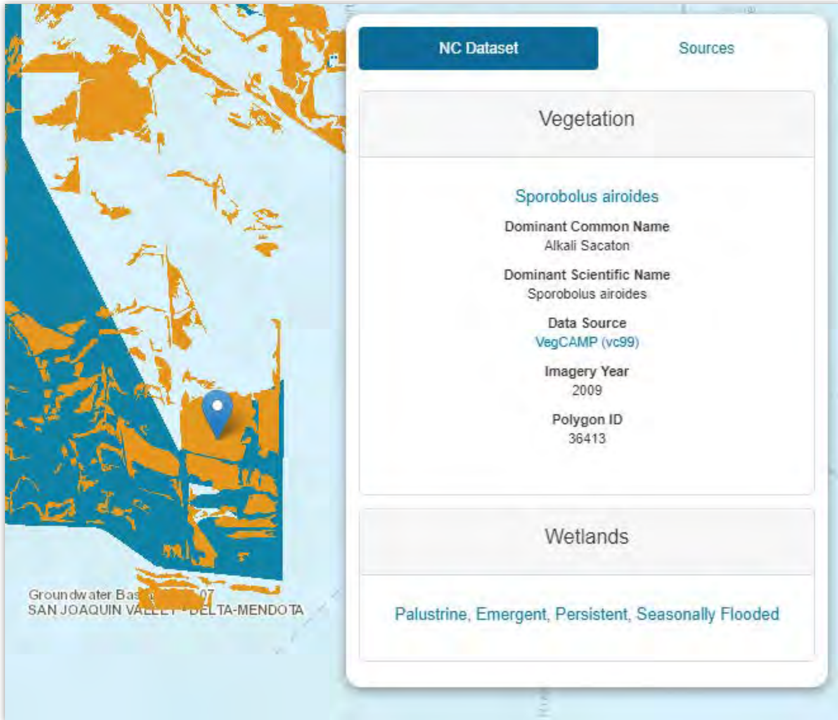

Figure 2 Natural Communities Dataset Query

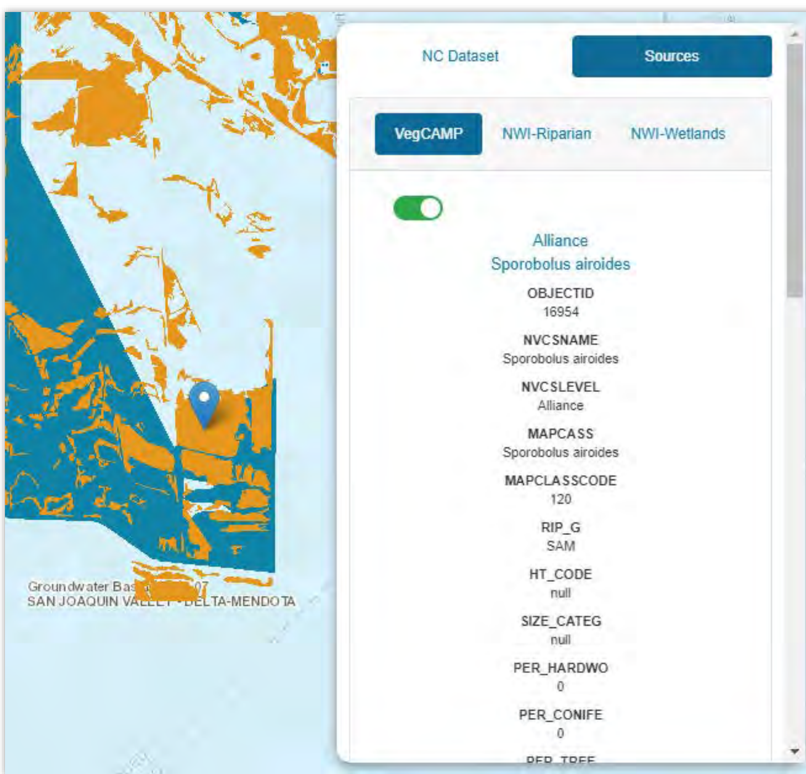

Figure 3 Natural Communities Source Dataset Query

Applicability of the Natural Communities Dataset to GSP Development

The Natural Communities dataset is provided by DWR as a reference dataset and potential starting point for the identification of GDEs in groundwater basins. The Natural Communities dataset and its source data can be reviewed by GSAs, stakeholders, and their consultants using local information and experience related to the validity of mapped features and understanding of local surface water hydrology, groundwater conditions, and geology as illustrated in Figure 4. Appendix A further discusses the requirements of SGMA and the GSP Regulations related to GDEs, environmental users of groundwater, and local habitat.

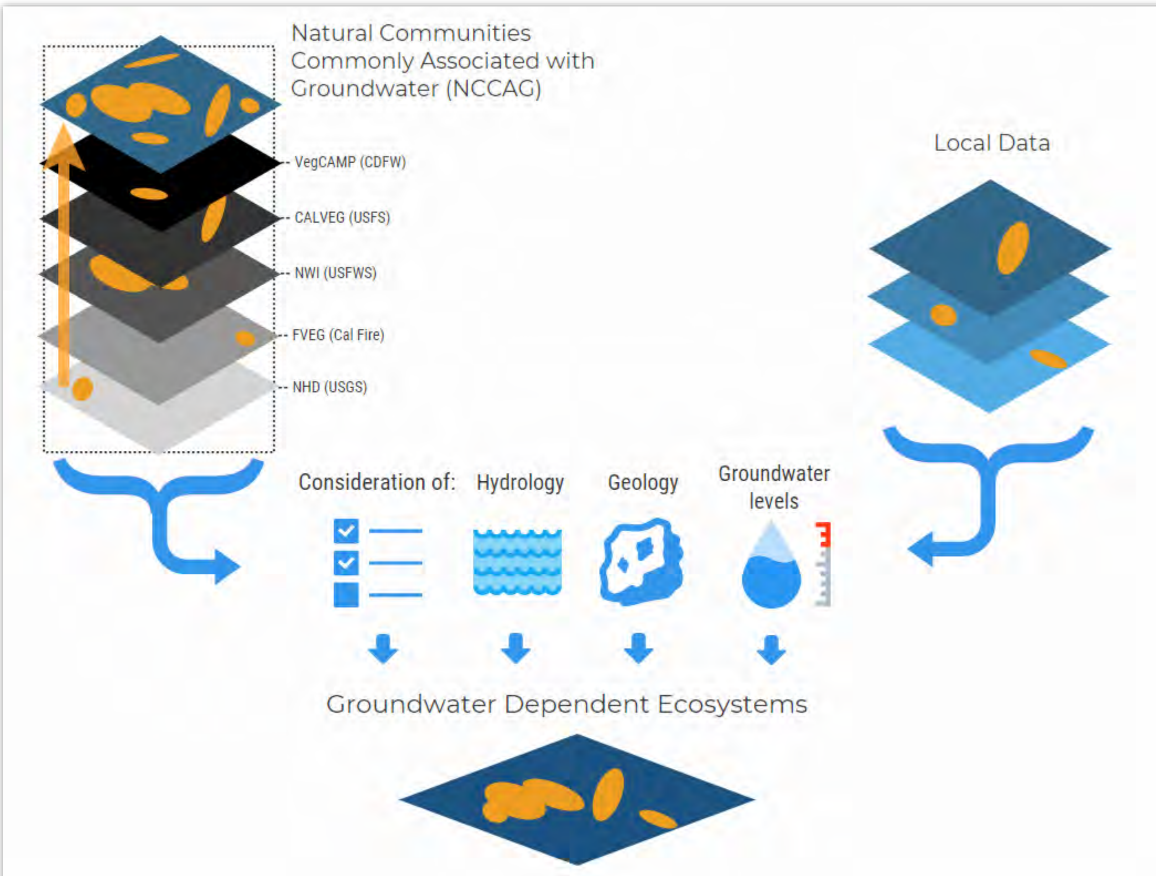

Figure 4. Considerations for the Identification of groundwater dependent ecosystems

The Natural Communities dataset does not prove or make any claim about the nature and/or extent of ecosystem groundwater dependence for any mapped location. Positive identification of a GDE requires understanding of the land use, groundwater levels, hydrology, and geology of an area, which is not within the scope or purpose of the dataset. The Natural Communities dataset and web viewer is not intended to be used for verifying the accuracy of the GSAs' identified GDEs.

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Appendix A

SGMA Requirements Related to GDEs

This section provides references to the requirements for GSAs and DWR related to identification of groundwater dependent ecosystems (GDEs) under SGMA and GSP Regulations.

<u>Sustainable Groundwater Management Act (California Water Code Sections)</u>

§ 10723.2 CONSIDERATION OF ALL INTERESTS OF ALL BENEFICIAL USES AND USERS OF GROUNDWATER

The groundwater sustainability agency shall consider the interests of all beneficial uses and users of groundwater, as well as those responsible for implementing groundwater sustainability plans. These interests include, but are not limited to, all the following:

…

(e) Environmental users of groundwater.

§ 10727.2. A GROUNDWATER SUSTAINABILITY PLAN SHALL INCLUDE ALL OF THE FOLLOWING:

(2) A description of how the plan helps meet each objective and how each objective is intended to achieve the sustainability goal for the basin for long-term beneficial uses of groundwater.

§ 10727.4. ADDITIONAL PLAN ELEMENTS

In addition to the requirements of Section 10727.2, a groundwater sustainability plan shall include, where appropriate and in collaboration with the appropriate local agencies, all of the following:

…

(*l*) Impacts on groundwater dependent ecosystems.

§ 10933. GROUNDWATER ELEVATION MONITORING; PRIORITIZATION OF BASINS BY THE DEPARTMENT

(b) The department shall prioritize groundwater basins and subbasins for the purpose of implementing this section. In prioritizing the basins and subbasins, the department shall, to the extent data are available, consider all of the following:

(8) Any other information determined to be relevant by the department, including adverse impacts on local habitat and local streamflows.

<u>GSP regulations (California Code of Regulations Sections)</u>

§ 351. Definitions

(m) "Groundwater dependent ecosystem" refers to ecological communities or species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface.

§ 353.2. Information Provided by the Department

(b) The Department shall provide information, to the extent available, to assist Agencies in the preparation and implementation of Plans, which shall be posted on the Department's website.

§ 354.14. Hydrogeologic Conceptual Model

(d) Physical characteristics of the basin shall be represented on one or more maps that depict the following:

(4) Delineation of existing recharge areas that substantially contribute to the replenishment of the basin, potential recharge areas, and discharge areas, including significant active springs, seeps, and wetlands within or adjacent to the basin.

§ 354.16. Groundwater Conditions

Each Plan shall provide a description of current and historical groundwater conditions in the basin, including data from January 1, 2015, to current conditions, based on the best available information that includes the following:

(g) Identification of groundwater dependent ecosystems within the basin, utilizing data available from the Department, as specified in Section 353.2, or the best available information.

Appendix B
Potential GDE Field Data Sheets

Potential GDE Field Assessment Datasheet

Date: 9/5/19 **Time:** 7:47
ID#: 01 **Coordinates:** 34.60577162, -118.66730126

Vegetation Community: pine forest

Dominants	Tree	Pine species (likely planted)
	Shrub	CA sagebrush
	Herbaceous	Bromus, avena, festuca
Native vs. non-native %		40/60
Potential Wetland		No
Spring/seep		No

Hydrology:

Present (Flows/Ponded)	No
Depth of surface water	N/A
Source	natural runoff ☒ urban stormwater runoff ☐ treated wastewater effluent ☐ artificial sources ☐
Managed or natural flows	Natural flows

Soils:

Type – clay, silt, sand, gravel, etc.	Silt, loam
Saturation	None

Species Information

Observed	Western scrub jay, CA towhee
Special-status likely to occur	Insects ☐ Click or tap here to enter text. Amphibians ☐ Click or tap here to enter text. Reptiles ☒ coast horned lizard Birds ☐ Click or tap here to enter text. Fish ☐ Click or tap here to enter text. Mammals ☐ Click or tap here to enter text. Plants ☐ Click or tap here to enter text.

Human Alteration:

Beneficial uses (See RWQCB basin plan)	Agricultural Supply (AGR) ☐ Cold Freshwater Habitat (COLD) ☐ Commercial and Sport Fishing (COMM) ☐ Estuarine Habitat (EST) ☐ Freshwater Replenishment (FRSH) ☐ Ground Water Recharge (GWR) ☐ Hydropower Generation (POW) ☐ Industrial Process Supply (PROC) ☐ Industrial Service Supply (IND) ☐ Migration of Aquatic Organisms (MIGR) ☐ Municipal and Domestic Supply (MUN) ☐ Navigation (NAV) ☐ Non-contact Water Recreation (REC-2) ☐ Marine Habitat (MAR) ☐ Preservation of Biological Habitats (BIOL) ☐ Rare, Threatened, or Endangered Species (RARE) ☐ Spawning, Reproduction, and/or Early Development (SPWN) ☐ Warm Freshwater Habitat (WARM) ☐ Water Contact Recreation (REC-1) ☐ Wetland Habitat (WET) ☐ Wildlife Habitat (WILD) ☒

Access: yes, on foot via dirt access road

Potential GDE Field Assessment Datasheet

Photos

Photo 1: Upstream	Northwest 
Photo 2: Downstream	Southeast 

Potential GDE Field Assessment Datasheet

Photo 3: Across	South 

Potential GDE Field Assessment Datasheet

Date: 9/5/19 **Time:** 8:00
ID#: 02 **Coordinates:** 34.60489688, -118.66472959

Vegetation Community:

Dominants	Tree	Pine (likely planted), tree-of-heaven
	Shrub	Felt-leaf yerba santa, CA sagebrush
	Herbaceous	Avena sp.
Native vs. non-native %		50/50
Potential Wetland		No, out of main channel and floodplain, possibly planted
Spring/seep		no

Hydrology:

Present (Flows/Ponded)	No
Depth of surface water	N/A
Source	natural runoff ☒ urban stormwater runoff ☐ treated wastewater effluent ☐ artificial sources ☐
Managed or natural flows	Natural flows

Soils:

Type – clay, silt, sand, gravel, etc.	Loam
Saturation	none

Species Information

Observed	Western scrub jay, mourning dove, wrentit
Special-status likely to occur	Insects ☐ Click or tap here to enter text. Amphibians ☐ Click or tap here to enter text. Reptiles ☒ coast horned lizard Birds ☒ rufous crowned sparrow Fish ☐ Click or tap here to enter text. Mammals ☐ Click or tap here to enter text. Plants ☐ Click or tap here to enter text.

Human Alteration:

Potential GDE Field Assessment Datasheet

Beneficial uses (See RWQCB basin plan)	Agricultural Supply (AGR) ☐ Cold Freshwater Habitat (COLD) ☐ Commercial and Sport Fishing (COMM) ☐ Estuarine Habitat (EST) ☐ Freshwater Replenishment (FRSH) ☐ Ground Water Recharge (GWR) ☐ Hydropower Generation (POW) ☐ Industrial Process Supply (PROC) ☐ Industrial Service Supply (IND) ☐ Migration of Aquatic Organisms (MIGR) ☐ Municipal and Domestic Supply (MUN) ☐ Navigation (NAV) ☐ Non-contact Water Recreation (REC-2) ☐ Marine Habitat (MAR) ☐ Preservation of Biological Habitats (BIOL) ☐ Rare, Threatened, or Endangered Species (RARE) ☐ Spawning, Reproduction, and/or Early Development (SPWN) ☐ Warm Freshwater Habitat (WARM) ☐ Water Contact Recreation (REC-1) ☐ Wetland Habitat (WET) ☐ Wildlife Habitat (WILD) ☒

Access: yes, on foot via dirt access road

Potential GDE Field Assessment Datasheet

Photos

Photo 1: Upstream	North 
Photo 2: Downstream	South 

Potential GDE Field Assessment Datasheet

Photo 3: Across	West 

Potential GDE Field Assessment Datasheet

Date: 9/5/19 **Time:** 8:10
ID#: 03 **Coordinates:** 34.60207775, -118.66661481

Vegetation Community:

Dominants	Tree	Pine (likely planted)
	Shrub	CA sagebrush
	Herbaceous	Avena
Native vs. non-native %		30/70
Potential Wetland		No
Spring/seep		No

Hydrology:

Present (Flows/Ponded)	No
Depth of surface water	N/A
Source	natural runoff ☒ urban stormwater runoff ☐ treated wastewater effluent ☐ artificial sources ☐
Managed or natural flows	Natural flows

Soils:

Type – clay, silt, sand, gravel, etc.	Unknown
Saturation	Unknown, likely no

Species Information

Observed	Western scrub jay, Bewick's wren, house finch, wrentit, rock wren, CA quail, spotted towhee, American crow
Special-status likely to occur	Insects ☐ Click or tap here to enter text. Amphibians ☐ Click or tap here to enter text. Reptiles ☒ coast horned lizard Birds ☐ Click or tap here to enter text. Fish ☐ Click or tap here to enter text. Mammals ☐ Click or tap here to enter text. Plants ☐ Click or tap here to enter text.

Human Alteration:

Potential GDE Field Assessment Datasheet

Beneficial uses (See RWQCB basin plan)	Agricultural Supply (AGR) ☐ Cold Freshwater Habitat (COLD) ☐ Commercial and Sport Fishing (COMM) ☐ Estuarine Habitat (EST) ☐ Freshwater Replenishment (FRSH) ☐ Ground Water Recharge (GWR) ☐ Hydropower Generation (POW) ☐ Industrial Process Supply (PROC) ☐ Industrial Service Supply (IND) ☐ Migration of Aquatic Organisms (MIGR) ☐ Municipal and Domestic Supply (MUN) ☐ Navigation (NAV) ☐ Non-contact Water Recreation (REC-2) ☐ Marine Habitat (MAR) ☐ Preservation of Biological Habitats (BIOL) ☐ Rare, Threatened, or Endangered Species (RARE) ☐ Spawning, Reproduction, and/or Early Development (SPWN) ☐ Warm Freshwater Habitat (WARM) ☐ Water Contact Recreation (REC-1) ☐ Wetland Habitat (WET) ☐ Wildlife Habitat (WILD) ☒

Access: No, fenced off, steep hillside, no trespassing signs.

Potential GDE Field Assessment Datasheet

Photos

Photo 1: Upstream	South 
Photo 2: Downstream	South 

Potential GDE Field Assessment Datasheet

Date: 9/5/19 **Time:** 8:15
ID#: 04 **Coordinates:** 34.60185351, -118.66704698

Vegetation Community: Fremont's cottonwood forest

Dominants	Tree	Cottonwood, willow (unknown)
	Shrub	Mulefat
	Herbaceous	Unknown
Native vs. non-native %		Unknown, 80/20
Potential Wetland		Yes, in main channel
Spring/seep		No

Hydrology:

Present (Flows/Ponded)	No
Depth of surface water	N/A
Source	natural runoff ☒ urban stormwater runoff ☐ treated wastewater effluent ☐ artificial sources ☐
Managed or natural flows	Natural

Soils:

Type – clay, silt, sand, gravel, etc.	Unknown
Saturation	Unknown

Species Information

Observed	none
Special-status likely to occur	Insects ☐ Click or tap here to enter text. Amphibians ☒ arroyo toad Reptiles ☒ coast horned lizard Birds ☒ least Bell's vireo Fish ☐ Click or tap here to enter text. Mammals ☐ Click or tap here to enter text. Plants ☐ Click or tap here to enter text.

Human Alteration:

Beneficial uses (See RWQCB basin plan)	Agricultural Supply (AGR) ☐ Cold Freshwater Habitat (COLD) ☐ Commercial and Sport Fishing (COMM) ☐ Estuarine Habitat (EST) ☐ Freshwater Replenishment (FRSH) ☐ Ground Water Recharge (GWR) ☐ Hydropower Generation (POW) ☐ Industrial Process Supply (PROC) ☐ Industrial Service Supply (IND) ☐ Migration of Aquatic Organisms (MIGR) ☐ Municipal and Domestic Supply (MUN) ☐ Navigation (NAV) ☐ Non-contact Water Recreation (REC-2) ☐ Marine Habitat (MAR) ☐ Preservation of Biological Habitats (BIOL) ☐ Rare, Threatened, or Endangered Species (RARE) ☒ Spawning, Reproduction, and/or Early Development (SPWN) ☐ Warm Freshwater Habitat (WARM) ☐ Water Contact Recreation (REC-1) ☐ Wetland Habitat (WET) ☒ Wildlife Habitat (WILD) ☒

Access: No, fenced and signs.

Potential GDE Field Assessment Datasheet

Photos

Photo 1: Upstream	South 
Photo 2: Downstream	South 

Potential GDE Field Assessment Datasheet

Date: 9/5/19 **Time:** 8:48
ID#: 05 **Coordinates:** 34.49704029, -118.61266316

Vegetation Community: Fremont's cottonwood forest

Dominants	Tree	Fremont's cottonwood, willow (unknown)
	Shrub	Mulefat
	Herbaceous	Unknown
Native vs. non-native %		80/20
Potential Wetland		Yes
Spring/seep		No

Hydrology:

Present (Flows/Ponded)	Yes, flows
Depth of surface water	1-4 inches
Source	natural runoff ☒ urban stormwater runoff ☐ treated wastewater effluent ☐ artificial sources ☐
Managed or natural flows	Managed, overflow from Castaic Lagoon

Soils:

Type – clay, silt, sand, gravel, etc.	Unknown
Saturation	Yes, in upper reaches near Castaic Lagoon. Unknown downstream of that.

Species Information

Observed	none
Special-status likely to occur	Insects ☐ Click or tap here to enter text. Amphibians ☒ arroyo toad Reptiles ☐ Click or tap here to enter text. Birds ☒ least bell's vireo Fish ☐ Click or tap here to enter text. Mammals ☐ Click or tap here to enter text. Plants ☐ Click or tap here to enter text.

Human Alteration:

Potential GDE Field Assessment Datasheet

Beneficial uses (See RWQCB basin plan)	Agricultural Supply (AGR) ☐ Cold Freshwater Habitat (COLD) ☐ Commercial and Sport Fishing (COMM) ☐ Estuarine Habitat (EST) ☐ Freshwater Replenishment (FRSH) ☐ Ground Water Recharge (GWR) ☐ Hydropower Generation (POW) ☐ Industrial Process Supply (PROC) ☐ Industrial Service Supply (IND) ☐ Migration of Aquatic Organisms (MIGR) ☐ Municipal and Domestic Supply (MUN) ☐ Navigation (NAV) ☐ Non-contact Water Recreation (REC-2) ☐ Marine Habitat (MAR) ☐ Preservation of Biological Habitats (BIOL) ☐ Rare, Threatened, or Endangered Species (RARE) ☒ Spawning, Reproduction, and/or Early Development (SPWN) ☐ Warm Freshwater Habitat (WARM) ☐ Water Contact Recreation (REC-1) ☐ Wetland Habitat (WET) ☒ Wildlife Habitat (WILD) ☒

Access: No, fenced and signage.

Potential GDE Field Assessment Datasheet

Photos

Photo 1: Upstream	South 

Potential GDE Field Assessment Datasheet

Date: 9/5/19 **Time:** 9:24
ID#: 06 **Coordinates:** 34.47893088, -118.60244920

Vegetation Community: coast live oak woodland

Dominants	Tree	Coast live oak
	Shrub	CA buckwheat, CA sagebrush
	Herbaceous	Avena, Bromus
Native vs. non-native %		70/30
Potential Wetland		No
Spring/seep		no

Hydrology:

Present (Flows/Ponded)	No
Depth of surface water	N/A
Source	natural runoff ☒ urban stormwater runoff ☐ treated wastewater effluent ☐ artificial sources ☐
Managed or natural flows	Natural flows

Soils:

Type – clay, silt, sand, gravel, etc.	Sand
Saturation	None

Species Information

Observed	Western scrub jay, house finch
Special-status likely to occur	Insects ☐ Click or tap here to enter text. Amphibians ☐ Click or tap here to enter text. Reptiles ☒ coast horned lizard Birds ☐ Click or tap here to enter text. Fish ☐ Click or tap here to enter text. Mammals ☐ Click or tap here to enter text. Plants ☐ Click or tap here to enter text.

Human Alteration:

Potential GDE Field Assessment Datasheet

Beneficial uses (See RWQCB basin plan)	Agricultural Supply (AGR) ☐ Cold Freshwater Habitat (COLD) ☐ Commercial and Sport Fishing (COMM) ☐ Estuarine Habitat (EST) ☐ Freshwater Replenishment (FRSH) ☐ Ground Water Recharge (GWR) ☐ Hydropower Generation (POW) ☐ Industrial Process Supply (PROC) ☐ Industrial Service Supply (IND) ☐ Migration of Aquatic Organisms (MIGR) ☐ Municipal and Domestic Supply (MUN) ☐ Navigation (NAV) ☐ Non-contact Water Recreation (REC-2) ☐ Marine Habitat (MAR) ☐ Preservation of Biological Habitats (BIOL) ☐ Rare, Threatened, or Endangered Species (RARE) ☐ Spawning, Reproduction, and/or Early Development (SPWN) ☐ Warm Freshwater Habitat (WARM) ☐ Water Contact Recreation (REC-1) ☐ Wetland Habitat (WET) ☐ Wildlife Habitat (WILD) ☒

Access: Yes, couldn't gain access to upstream areas, private road and signage

Potential GDE Field Assessment Datasheet

Photos

Photo 1: Upstream	East 
Photo 2: Downstream	West 

Potential GDE Field Assessment Datasheet

Photo 3: Across	South 

Potential GDE Field Assessment Datasheet

Date: 9/5/19 **Time:** 11:01
ID#: 07 **Coordinates:** 34.48136662, -118.67142041

Vegetation Community: Eucalyptus grove

Dominants	Tree	Eucalyptus, silver dollar
	Shrub	Oleander
	Herbaceous	None
Native vs. non-native %		0/100
Potential Wetland		No
Spring/seep		no

Hydrology:

Present (Flows/Ponded)	No
Depth of surface water	N/A
Source	natural runoff ☒ urban stormwater runoff ☐ treated wastewater effluent ☐ artificial sources ☐
Managed or natural flows	Natural flows

Soils:

Type – clay, silt, sand, gravel, etc.	Loam, silt
Saturation	none

Species Information

Observed	American crow, bushtit
Special-status likely to occur: None	Insects ☐ Click or tap here to enter text. Amphibians ☐ Click or tap here to enter text. Reptiles ☐ Click or tap here to enter text. Birds ☐ Click or tap here to enter text. Fish ☐ Click or tap here to enter text. Mammals ☐ Click or tap here to enter text. Plants ☐ Click or tap here to enter text.

Human Alteration:

Potential GDE Field Assessment Datasheet

Beneficial uses (See RWQCB basin plan)	Agricultural Supply (AGR) ☐ Cold Freshwater Habitat (COLD) ☐ Commercial and Sport Fishing (COMM) ☐ Estuarine Habitat (EST) ☐ Freshwater Replenishment (FRSH) ☐ Ground Water Recharge (GWR) ☐ Hydropower Generation (POW) ☐ Industrial Process Supply (PROC) ☐ Industrial Service Supply (IND) ☐ Migration of Aquatic Organisms (MIGR) ☐ Municipal and Domestic Supply (MUN) ☐ Navigation (NAV) ☐ Non-contact Water Recreation (REC-2) ☐ Marine Habitat (MAR) ☐ Preservation of Biological Habitats (BIOL) ☐ Rare, Threatened, or Endangered Species (RARE) ☐ Spawning, Reproduction, and/or Early Development (SPWN) ☐ Warm Freshwater Habitat (WARM) ☐ Water Contact Recreation (REC-1) ☐ Wetland Habitat (WET) ☐ Wildlife Habitat (WILD) ☐

Access: Yes, private driveway

Potential GDE Field Assessment Datasheet

Photos

Photo 1: Upstream	North 
Photo 2: Downstream	South 

Potential GDE Field Assessment Datasheet

Photo 3: Across	East 

Potential GDE Field Assessment Datasheet

Date: 9/5/19 **Time:** 12:19
ID#: 08 **Coordinates:** 34.42664267, -118.58656119

Vegetation Community: Fremont's cottonwood forest

Dominants	Tree	Fremont's cottonwood, red willow
	Shrub	Giant reed, willow (arroyo, red)
	Herbaceous	Festuca sp.
Native vs. non-native %		90/10
Potential Wetland		Yes
Spring/seep		No

Hydrology:

Present (Flows/Ponded)	Yes, flows
Depth of surface water	6-12 inches
Source	natural runoff ☐ urban stormwater runoff ☒ treated wastewater effluent ☐ artificial sources ☒
Managed or natural flows	Managed, originates from upstream culvert from the south side of channel

Soils:

Type – clay, silt, sand, gravel, etc.	Unknown, likely loam, silt
Saturation	yes

Species Information

Observed	none
Special-status likely to occur	Insects ☐ Click or tap here to enter text. Amphibians ☒ arroyo toad Reptiles ☐ Click or tap here to enter text. Birds ☒ least Bell's vireo Fish ☒ UTS Mammals ☐ Click or tap here to enter text. Plants ☐ Click or tap here to enter text.

Human Alteration:

Beneficial uses (See RWQCB basin plan)	Agricultural Supply (AGR) ☐ Cold Freshwater Habitat (COLD) ☐ Commercial and Sport Fishing (COMM) ☐ Estuarine Habitat (EST) ☐ Freshwater Replenishment (FRSH) ☐ Ground Water Recharge (GWR) ☐ Hydropower Generation (POW) ☐ Industrial Process Supply (PROC) ☐ Industrial Service Supply (IND) ☐ Migration of Aquatic Organisms (MIGR) ☐ Municipal and Domestic Supply (MUN) ☐ Navigation (NAV) ☐ Non-contact Water Recreation (REC-2) ☐ Marine Habitat (MAR) ☐ Preservation of Biological Habitats (BIOL) ☐ Rare, Threatened, or Endangered Species (RARE) ☒ Spawning, Reproduction, and/or Early Development (SPWN) ☐ Warm Freshwater Habitat (WARM) ☐ Water Contact Recreation (REC-1) ☐ Wetland Habitat (WET) ☒ Wildlife Habitat (WILD) ☒

Access: yes, from the west side of The Old Road bridge crossing the river.

Potential GDE Field Assessment Datasheet

Photos

Photo 1: Upstream	East 
Photo 2: Downstream	West 

Potential GDE Field Assessment Datasheet

Photo 3: Across	North 

Potential GDE Field Assessment Datasheet

Date: 9/5/19 **Time:** 12:47
ID#: 09 **Coordinates:** 34.42601271, -118.57898257

Vegetation Community: Fremont's cottonwood forest

Dominants	Tree	Fremont's cottonwood, willow (red)
	Shrub	Arundo, sandbar willow
	Herbaceous	White sweetclover
Native vs. non-native %		70/30
Potential Wetland		Yes
Spring/seep		No

Hydrology:

Present (Flows/Ponded)	Yes
Depth of surface water	6 inches
Source	natural runoff ☐ urban stormwater runoff ☐ treated wastewater effluent ☐ artificial sources ☒
Managed or natural flows	Managed flows originating from upstream culvert

Soils:

Type – clay, silt, sand, gravel, etc.	Unknown, sand likely
Saturation	yes

Species Information

Observed	Red-shouldered hawk, red-tailed hawk
Special-status likely to occur	Insects ☐ Click or tap here to enter text. Amphibians ☒ arroyo toad Reptiles ☐ Click or tap here to enter text. Birds ☒ least Bell's vireo Fish ☒ UTS Mammals ☐ Click or tap here to enter text. Plants ☐ Click or tap here to enter text.

Human Alteration:

Potential GDE Field Assessment Datasheet

Beneficial uses (See RWQCB basin plan)	Agricultural Supply (AGR) ☐ Cold Freshwater Habitat (COLD) ☐ Commercial and Sport Fishing (COMM) ☐ Estuarine Habitat (EST) ☐ Freshwater Replenishment (FRSH) ☐ Ground Water Recharge (GWR) ☐ Hydropower Generation (POW) ☐ Industrial Process Supply (PROC) ☐ Industrial Service Supply (IND) ☐ Migration of Aquatic Organisms (MIGR) ☐ Municipal and Domestic Supply (MUN) ☐ Navigation (NAV) ☐ Non-contact Water Recreation (REC-2) ☐ Marine Habitat (MAR) ☐ Preservation of Biological Habitats (BIOL) ☐ Rare, Threatened, or Endangered Species (RARE) ☒ Spawning, Reproduction, and/or Early Development (SPWN) ☐ Warm Freshwater Habitat (WARM) ☐ Water Contact Recreation (REC-1) ☐ Wetland Habitat (WET) ☒ Wildlife Habitat (WILD) ☒

Access: yes, from top of public bridge

Potential GDE Field Assessment Datasheet

Photos

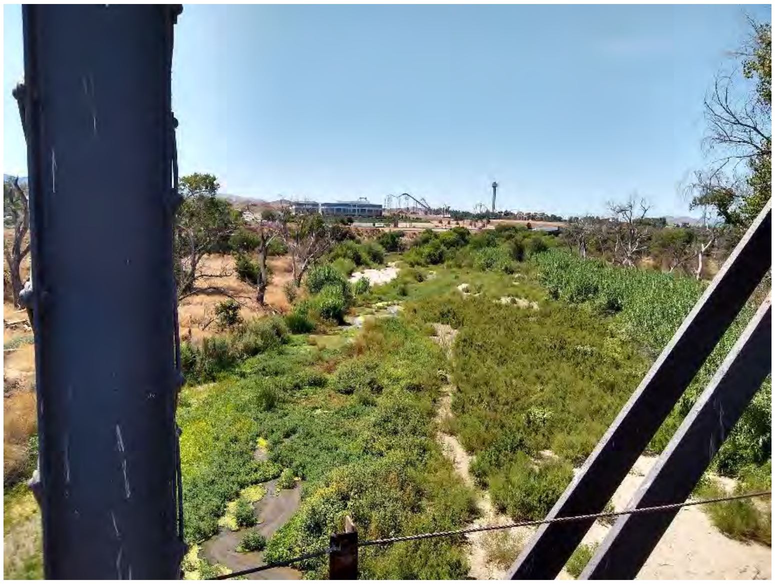
Photo 1: Upstream	East 
Photo 2: Downstream	West 

Photo 3: Across	Southwest 

Potential GDE Field Assessment Datasheet

Date: 9/6/19 **Time:** 7:10
ID#: 10 **Coordinates:** 34.42406756, -118.56550466

Vegetation Community: Fremont's cottonwood forest

Dominants	Tree	Fremont's cottonwood, black willow, arroyo willow
	Shrub	Arundo, mulefat, sandbar willow
	Herbaceous	Shortpod mustard
Native vs. non-native %		80/20
Potential Wetland		Yes
Spring/seep		no

Hydrology:

Present (Flows/Ponded)	Yes, flow
Depth of surface water	1-2 feet
Source	natural runoff ☐ urban stormwater runoff ☐ treated wastewater effluent ☐ artificial sources ☒
Managed or natural flows	Managed sources from upstream culvert

Soils:

Type – clay, silt, sand, gravel, etc.	Sand
Saturation	Yes, in portions of main channel

Species Information

Observed	Western scrub jay, house finch, cottontail
Special-status likely to occur	Insects ☐ Click or tap here to enter text. Amphibians ☒ arroyo toad Reptiles ☒ coast horned lizard Birds ☒ least Bell's vireo Fish ☒ UTS Mammals ☐ Click or tap here to enter text. Plants ☐ Click or tap here to enter text.

Human Alteration:

Beneficial uses (See RWQCB basin plan)	Agricultural Supply (AGR) ☐ Cold Freshwater Habitat (COLD) ☐ Commercial and Sport Fishing (COMM) ☐ Estuarine Habitat (EST) ☐ Freshwater Replenishment (FRSH) ☐ Ground Water Recharge (GWR) ☐ Hydropower Generation (POW) ☐ Industrial Process Supply (PROC) ☐ Industrial Service Supply (IND) ☐ Migration of Aquatic Organisms (MIGR) ☐ Municipal and Domestic Supply (MUN) ☐ Navigation (NAV) ☐ Non-contact Water Recreation (REC-2) ☐ Marine Habitat (MAR) ☐ Preservation of Biological Habitats (BIOL) ☐ Rare, Threatened, or Endangered Species (RARE) ☒ Spawning, Reproduction, and/or Early Development (SPWN) ☐ Warm Freshwater Habitat (WARM) ☐ Water Contact Recreation (REC-1) ☐ Wetland Habitat (WET) ☒ Wildlife Habitat (WILD) ☒

Access: yes, from trail that runs along river and bridge that crossed the river.

Potential GDE Field Assessment Datasheet

Photos

Photo 1: Upstream	East 
Photo 2: Downstream	West 

Potential GDE Field Assessment Datasheet

Photo 3: Across	North 

Potential GDE Field Assessment Datasheet

Date: 9/6/19 **Time:** 7:30
ID#: 11 **Coordinates:** 34.42389194, -118.56138119

Vegetation Community: mulefat thickets

Dominants	Tree	Fremont cottonwood
	Shrub	Mulefat, scalebroom
	Herbaceous	Shortpod mustard
Native vs. non-native %		80/20
Potential Wetland		No
Spring/seep		no

Hydrology:

Present (Flows/Ponded)	No
Depth of surface water	N/A
Source	natural runoff ☒ urban stormwater runoff ☐ treated wastewater effluent ☐ artificial sources ☐
Managed or natural flows	Natural flows

Soils:

Type – clay, silt, sand, gravel, etc.	Sand
Saturation	No

Species Information

Observed	Western scrub jay
Special-status likely to occur	Insects ☐ Click or tap here to enter text. Amphibians ☐ Click or tap here to enter text. Reptiles ☒ coast horned lizard Birds ☐ Click or tap here to enter text. Fish ☐ Click or tap here to enter text. Mammals ☐ Click or tap here to enter text. Plants ☐ Click or tap here to enter text.

Human Alteration:

Potential GDE Field Assessment Datasheet

Beneficial uses (See RWQCB basin plan)	Agricultural Supply (AGR) ☐ Cold Freshwater Habitat (COLD) ☐ Commercial and Sport Fishing (COMM) ☐ Estuarine Habitat (EST) ☐ Freshwater Replenishment (FRSH) ☐ Ground Water Recharge (GWR) ☐ Hydropower Generation (POW) ☐ Industrial Process Supply (PROC) ☐ Industrial Service Supply (IND) ☐ Migration of Aquatic Organisms (MIGR) ☐ Municipal and Domestic Supply (MUN) ☐ Navigation (NAV) ☐ Non-contact Water Recreation (REC-2) ☐ Marine Habitat (MAR) ☐ Preservation of Biological Habitats (BIOL) ☐ Rare, Threatened, or Endangered Species (RARE) ☐ Spawning, Reproduction, and/or Early Development (SPWN) ☐ Warm Freshwater Habitat (WARM) ☐ Water Contact Recreation (REC-1) ☐ Wetland Habitat (WET) ☐ Wildlife Habitat (WILD) ☒

Access: Yes, from trail that runs along the river and bridge that crosses the river.

Potential GDE Field Assessment Datasheet

Photos

Photo 1: Upstream	East 
Photo 2: Downstream	West 

Potential GDE Field Assessment Datasheet

Photo 3: Across	North 

Potential GDE Field Assessment Datasheet

Date: 9/6/19 **Time:** 7:39
ID#: 12 **Coordinates:** 34.42329186, -118.55884619

Vegetation Community: Fremont's cottonwood forest

Dominants	Tree	Fremont's cottonwood
	Shrub	Mulefat, arundo
	Herbaceous	Shortpod mustard
Native vs. non-native %		80/20
Potential Wetland		Yes
Spring/seep		no

Hydrology:

Present (Flows/Ponded)	Yes
Depth of surface water	Less than 6 inches
Source	natural runoff ☒ urban stormwater runoff ☐ treated wastewater effluent ☐ artificial sources ☐
Managed or natural flows	Natural flows,

Soils:

Type – clay, silt, sand, gravel, etc.	Sand
Saturation	Yes, within main channel

Species Information

Observed	American crow, house finch, black phoebe, acorn woodpecker
Special-status likely to occur	Insects ☐ Click or tap here to enter text. Amphibians ☒ arroyo toad Reptiles ☐ Click or tap here to enter text. Birds ☒ least Bell's vireo Fish ☒ UTS Mammals ☐ Click or tap here to enter text. Plants ☐ Click or tap here to enter text.

Human Alteration:

Potential GDE Field Assessment Datasheet

Beneficial uses (See RWQCB basin plan)	Agricultural Supply (AGR) ☐ Cold Freshwater Habitat (COLD) ☐ Commercial and Sport Fishing (COMM) ☐ Estuarine Habitat (EST) ☐ Freshwater Replenishment (FRSH) ☐ Ground Water Recharge (GWR) ☐ Hydropower Generation (POW) ☐ Industrial Process Supply (PROC) ☐ Industrial Service Supply (IND) ☐ Migration of Aquatic Organisms (MIGR) ☐ Municipal and Domestic Supply (MUN) ☐ Navigation (NAV) ☐ Non-contact Water Recreation (REC-2) ☐ Marine Habitat (MAR) ☐ Preservation of Biological Habitats (BIOL) ☐ Rare, Threatened, or Endangered Species (RARE) ☒ Spawning, Reproduction, and/or Early Development (SPWN) ☐ Warm Freshwater Habitat (WARM) ☐ Water Contact Recreation (REC-1) ☐ Wetland Habitat (WET) ☒ Wildlife Habitat (WILD) ☒

Access: yes, from trail that runs along the river

Potential GDE Field Assessment Datasheet

Photos

Photo 1: Upstream	East 
Photo 2: Downstream	West 

Potential GDE Field Assessment Datasheet

Photo 3: Across	North 

Potential GDE Field Assessment Datasheet

Date: 9/6/19 **Time:** 8:15
ID#: 13 **Coordinates:** 34.42000984, -118.55112968

Vegetation Community: Fremont's cottonwood forest

Dominants	Tree	Fremont's cottonwood
	Shrub	Mulefat
	Herbaceous	Shortpod mustard
Native vs. non-native %		60/40
Potential Wetland		No
Spring/seep		No

Hydrology:

Present (Flows/Ponded)	No
Depth of surface water	N/A
Source	natural runoff ☒ urban stormwater runoff ☐ treated wastewater effluent ☐ artificial sources ☐
Managed or natural flows	Natural flows

Soils:

Type – clay, silt, sand, gravel, etc.	Sand
Saturation	No

Species Information

Observed	none
Special-status likely to occur	Insects ☐ Click or tap here to enter text. Amphibians ☐ Click or tap here to enter text. Reptiles ☒ Click or tap here to enter text. Birds ☐ Click or tap here to enter text. Fish ☐ Click or tap here to enter text. Mammals ☐ Click or tap here to enter text. Plants ☐ Click or tap here to enter text.

Human Alteration:

Beneficial uses (See RWQCB basin plan)	Agricultural Supply (AGR) ☐ Cold Freshwater Habitat (COLD) ☐ Commercial and Sport Fishing (COMM) ☐ Estuarine Habitat (EST) ☐ Freshwater Replenishment (FRSH) ☐ Ground Water Recharge (GWR) ☐ Hydropower Generation (POW) ☐ Industrial Process Supply (PROC) ☐ Industrial Service Supply (IND) ☐ Migration of Aquatic Organisms (MIGR) ☐ Municipal and Domestic Supply (MUN) ☐ Navigation (NAV) ☐ Non-contact Water Recreation (REC-2) ☐ Marine Habitat (MAR) ☐ Preservation of Biological Habitats (BIOL) ☐ Rare, Threatened, or Endangered Species (RARE) ☐ Spawning, Reproduction, and/or Early Development (SPWN) ☐ Warm Freshwater Habitat (WARM) ☐ Water Contact Recreation (REC-1) ☐ Wetland Habitat (WET) ☐ Wildlife Habitat (WILD) ☒

Access: Yes, on foot. Accessed via parking lot adjacent to baseball fields.

Potential GDE Field Assessment Datasheet

Photos

Photo 1: Upstream	East 
Photo 2: Downstream	West 

Potential GDE Field Assessment Datasheet

Photo 3: Across	South 

Potential GDE Field Assessment Datasheet

Date: 9/6/19 **Time:** 9:00
ID#: 14 **Coordinates:** 34.47418349, -118.46729076

Vegetation Community: Mulefat thicket - alluvial

Dominants	Tree	Fremont's cottonwood
	Shrub	Mulefat, red willow
	Herbaceous	Shortpod mustard
Native vs. non-native %		60/40
Potential Wetland		No
Spring/seep		No

Hydrology:

Present (Flows/Ponded)	No
Depth of surface water	N/A
Source	natural runoff ☒ urban stormwater runoff ☐ treated wastewater effluent ☐ artificial sources ☐
Managed or natural flows	Natural flows

Soils:

Type – clay, silt, sand, gravel, etc.	Sand
Saturation	No

Species Information

Observed	Mourning dove, black phoebe
Special-status likely to occur	Insects ☐ Click or tap here to enter text. Amphibians ☐ Click or tap here to enter text. Reptiles ☒ coast horned lizard Birds ☐ Click or tap here to enter text. Fish ☒ known UTS habitat Mammals ☐ Click or tap here to enter text. Plants ☐ Click or tap here to enter text.

Human Alteration:

Beneficial uses (See RWQCB basin plan)	Agricultural Supply (AGR) ☐ Cold Freshwater Habitat (COLD) ☐ Commercial and Sport Fishing (COMM) ☐ Estuarine Habitat (EST) ☐ Freshwater Replenishment (FRSH) ☐ Ground Water Recharge (GWR) ☐ Hydropower Generation (POW) ☐ Industrial Process Supply (PROC) ☐ Industrial Service Supply (IND) ☐ Migration of Aquatic Organisms (MIGR) ☐ Municipal and Domestic Supply (MUN) ☐ Navigation (NAV) ☐ Non-contact Water Recreation (REC-2) ☐ Marine Habitat (MAR) ☐ Preservation of Biological Habitats (BIOL) ☐ Rare, Threatened, or Endangered Species (RARE) ☒ Spawning, Reproduction, and/or Early Development (SPWN) ☐ Warm Freshwater Habitat (WARM) ☐ Water Contact Recreation (REC-1) ☐ Wetland Habitat (WET) ☐ Wildlife Habitat (WILD) ☒

Access: yes, on foot via public road

Potential GDE Field Assessment Datasheet

Photos

Photo 1: Upstream	North 
Photo 2: Downstream	South 

Potential GDE Field Assessment Datasheet

Photo 3: Across	East 

Potential GDE Field Assessment Datasheet

Date: 9/6/19 **Time:** 9:14
ID#: 15 **Coordinates:** 34.47386557, -118.46397764

Vegetation Community: Ruderal with some cottonwoods

Dominants	Tree	Fremont's cottonwood, tree-of-heaven
	Shrub	Arundo
	Herbaceous	Bromus, shortpod mustard
Native vs. non-native %		20/80
Potential Wetland		No
Spring/seep		No

Hydrology:

Present (Flows/Ponded)	No
Depth of surface water	N/A
Source	natural runoff ☒ urban stormwater runoff ☐ treated wastewater effluent ☐ artificial sources ☐
Managed or natural flows	Natural flows, floodplain

Soils:

Type – clay, silt, sand, gravel, etc.	Loam
Saturation	No

Species Information

Observed	Northern mockingbird, house finch
Special-status likely to occur	Insects ☐ Click or tap here to enter text. Amphibians ☐ Click or tap here to enter text. Reptiles ☐ Click or tap here to enter text. Birds ☐ Click or tap here to enter text. Fish ☐ Click or tap here to enter text. Mammals ☐ Click or tap here to enter text. Plants ☐ Click or tap here to enter text.

Human Alteration:

Potential GDE Field Assessment Datasheet

Beneficial uses (See RWQCB basin plan)	Agricultural Supply (AGR) ☐ Cold Freshwater Habitat (COLD) ☐ Commercial and Sport Fishing (COMM) ☐ Estuarine Habitat (EST) ☐ Freshwater Replenishment (FRSH) ☐ Ground Water Recharge (GWR) ☐ Hydropower Generation (POW) ☐ Industrial Process Supply (PROC) ☐ Industrial Service Supply (IND) ☐ Migration of Aquatic Organisms (MIGR) ☐ Municipal and Domestic Supply (MUN) ☐ Navigation (NAV) ☐ Non-contact Water Recreation (REC-2) ☐ Marine Habitat (MAR) ☐ Preservation of Biological Habitats (BIOL) ☐ Rare, Threatened, or Endangered Species (RARE) ☐ Spawning, Reproduction, and/or Early Development (SPWN) ☐ Warm Freshwater Habitat (WARM) ☐ Water Contact Recreation (REC-1) ☐ Wetland Habitat (WET) ☐ Wildlife Habitat (WILD) ☒

Access: yes, from public road. No direct access to polygon due to barbed wire fence.

Potential GDE Field Assessment Datasheet

Photos

Photo 1: Upstream	North 
Photo 2: Across	West 

Potential GDE Field Assessment Datasheet

Date: 9/6/19 **Time:** 9:49
ID#: 16 **Coordinates:** 34.47187929, -118.45988401

Vegetation Community: Tamarisk stand (dry pond)

Dominants	Tree	Tamarisk, sandbar willow
	Shrub	Mulefat
	Herbaceous	Grasses, Russian thistle
Native vs. non-native %		50/50
Potential Wetland		Yes
Spring/seep		no

Hydrology:

Present (Flows/Ponded)	No
Depth of surface water	N/A
Source	natural runoff ☒ urban stormwater runoff ☐ treated wastewater effluent ☐ artificial sources ☐
Managed or natural flows	Natural flows

Soils:

Type – clay, silt, sand, gravel, etc.	Loam/silt, cracked soils
Saturation	no

Species Information

Observed	Western scrub jay
Special-status likely to occur	Insects ☐ Click or tap here to enter text. Amphibians ☒ western spadefoot Reptiles ☐ Click or tap here to enter text. Birds ☐ Click or tap here to enter text. Fish ☐ Click or tap here to enter text. Mammals ☐ Click or tap here to enter text. Plants ☐ Click or tap here to enter text.

Human Alteration:

Beneficial uses (See RWQCB basin plan)	Agricultural Supply (AGR) ☐ Cold Freshwater Habitat (COLD) ☐ Commercial and Sport Fishing (COMM) ☐ Estuarine Habitat (EST) ☐ Freshwater Replenishment (FRSH) ☐ Ground Water Recharge (GWR) ☐ Hydropower Generation (POW) ☐ Industrial Process Supply (PROC) ☐ Industrial Service Supply (IND) ☐ Migration of Aquatic Organisms (MIGR) ☐ Municipal and Domestic Supply (MUN) ☐ Navigation (NAV) ☐ Non-contact Water Recreation (REC-2) ☐ Marine Habitat (MAR) ☐ Preservation of Biological Habitats (BIOL) ☐ Rare, Threatened, or Endangered Species (RARE) ☒ Spawning, Reproduction, and/or Early Development (SPWN) ☐ Warm Freshwater Habitat (WARM) ☐ Water Contact Recreation (REC-1) ☐ Wetland Habitat (WET) ☒ Wildlife Habitat (WILD) ☒

Access: yes, on foot, unsure of access

Potential GDE Field Assessment Datasheet

Photos

Photo 1: Upstream	South 
Photo 2: Downstream	North 

Potential GDE Field Assessment Datasheet

Photo 3: Across	West 

Potential GDE Field Assessment Datasheet

Date: 9/6/19 **Time:** 10:36
ID#: 17 **Coordinates:** 34.47048730, -118.46882494

Vegetation Community: Fremont's cottonwood forest

Dominants	Tree	Fremont's cottonwood
	Shrub	CA sagebrush
	Herbaceous	Shortpod mustard, bromus
Native vs. non-native %		80/20
Potential Wetland		No
Spring/seep		no

Hydrology:

Present (Flows/Ponded)	No
Depth of surface water	N/A
Source	natural runoff ☒ urban stormwater runoff ☐ treated wastewater effluent ☐ artificial sources ☐
Managed or natural flows	Natural flows

Soils:

Type – clay, silt, sand, gravel, etc.	Sand, loam
Saturation	no

Species Information

Observed	CA quail
Special-status likely to occur	Insects ☐ Click or tap here to enter text. Amphibians ☐ Click or tap here to enter text. Reptiles ☒ coast horned lizard Birds ☐ Click or tap here to enter text. Fish ☐ Click or tap here to enter text. Mammals ☐ Click or tap here to enter text. Plants ☐ Click or tap here to enter text.

Human Alteration:

Potential GDE Field Assessment Datasheet

Beneficial uses (See RWQCB basin plan)	Agricultural Supply (AGR) ☐ Cold Freshwater Habitat (COLD) ☐ Commercial and Sport Fishing (COMM) ☐ Estuarine Habitat (EST) ☐ Freshwater Replenishment (FRSH) ☐ Ground Water Recharge (GWR) ☐ Hydropower Generation (POW) ☐ Industrial Process Supply (PROC) ☐ Industrial Service Supply (IND) ☐ Migration of Aquatic Organisms (MIGR) ☐ Municipal and Domestic Supply (MUN) ☐ Navigation (NAV) ☐ Non-contact Water Recreation (REC-2) ☐ Marine Habitat (MAR) ☐ Preservation of Biological Habitats (BIOL) ☐ Rare, Threatened, or Endangered Species (RARE) ☐ Spawning, Reproduction, and/or Early Development (SPWN) ☐ Warm Freshwater Habitat (WARM) ☐ Water Contact Recreation (REC-1) ☐ Wetland Habitat (WET) ☐ Wildlife Habitat (WILD) ☒

Access: Yes, from public road.

Potential GDE Field Assessment Datasheet

Photos

Photo 1: Upstream	North 
Photo 2: Downstream	South 

Potential GDE Field Assessment Datasheet

Photo 3: Across	East 

Based on Step 1.2, Characterize GDE Condition, of the GDE Guidance and Worksheet 2

Date: 9/6/19 **Time:** 11:14
ID#: 18 **Coordinates:** 34.43825710, -118.36826252

Vegetation Community: Fremont's cottonwood forest

Dominants	Tree	Fremont's cottonwood
	Shrub	Unknown
	Herbaceous	unknown
Native vs. non-native %		Unknown
Potential Wetland		Yes
Spring/seep		no

Hydrology:

Present (Flows/Ponded)	Yes, flows
Depth of surface water	unknown
Source	natural runoff ☒ urban stormwater runoff ☐ treated wastewater effluent ☐ artificial sources ☐
Managed or natural flows	Natural flows

Soils:

Type – clay, silt, sand, gravel, etc.	unknown
Saturation	Unknown, likely yes in main channel

Species Information

Observed	none
Special-status likely to occur	Insects ☐ Click or tap here to enter text. Amphibians ☒ arroyo toad Reptiles ☐ Click or tap here to enter text. Birds ☒ least Bell's vireo Fish ☒ UTS Mammals ☐ Click or tap here to enter text. Plants ☐ Click or tap here to enter text.

Based on Step 1.2, Characterize GDE Condition, of the GDE Guidance and Worksheet 2

Human Alteration:

Beneficial uses (See RWQCB basin plan)	Agricultural Supply (AGR) ☐ Cold Freshwater Habitat (COLD) ☐ Commercial and Sport Fishing (COMM) ☐ Estuarine Habitat (EST) ☐ Freshwater Replenishment (FRSH) ☐ Ground Water Recharge (GWR) ☐ Hydropower Generation (POW) ☐ Industrial Process Supply (PROC) ☐ Industrial Service Supply (IND) ☐ Migration of Aquatic Organisms (MIGR) ☐ Municipal and Domestic Supply (MUN) ☐ Navigation (NAV) ☐ Non-contact Water Recreation (REC-2) ☐ Marine Habitat (MAR) ☐ Preservation of Biological Habitats (BIOL) ☐ Rare, Threatened, or Endangered Species (RARE) ☒ Spawning, Reproduction, and/or Early Development (SPWN) ☐ Warm Freshwater Habitat (WARM) ☐ Water Contact Recreation (REC-1) ☐ Wetland Habitat (WET) ☒ Wildlife Habitat (WILD) ☒

Access: no, locked gate and signage

Based on Step 1.2, Characterize GDE Condition, of the GDE Guidance and Worksheet 2

Photos

Photo 1: Upstream	South 

Potential GDE Field Assessment Datasheet

Date: 9/6/19 **Time:** 11:17
ID#: 19 **Coordinates:** 34.43843982, -118.37170292

Vegetation Community: Riversidean alluvial scrub

Dominants	Tree	None
	Shrub	CA buckwheat, scalebroom
	Herbaceous	Shortpod mustard, Avena sp.
Native vs. non-native %		70/30
Potential Wetland		No
Spring/seep		no

Hydrology:

Present (Flows/Ponded)	No
Depth of surface water	N/A
Source	natural runoff ☒ urban stormwater runoff ☐ treated wastewater effluent ☐ artificial sources ☐
Managed or natural flows	Natural flows

Soils:

Type – clay, silt, sand, gravel, etc.	Unknown
Saturation	unknown

Species Information

Observed	CA thrasher
Special-status likely to occur	Insects ☐ Click or tap here to enter text. Amphibians ☐ Click or tap here to enter text. Reptiles ☒ coast horned lizard Birds ☐ Click or tap here to enter text. Fish ☐ Click or tap here to enter text. Mammals ☐ Click or tap here to enter text. Plants ☐ Click or tap here to enter text.

Human Alteration:

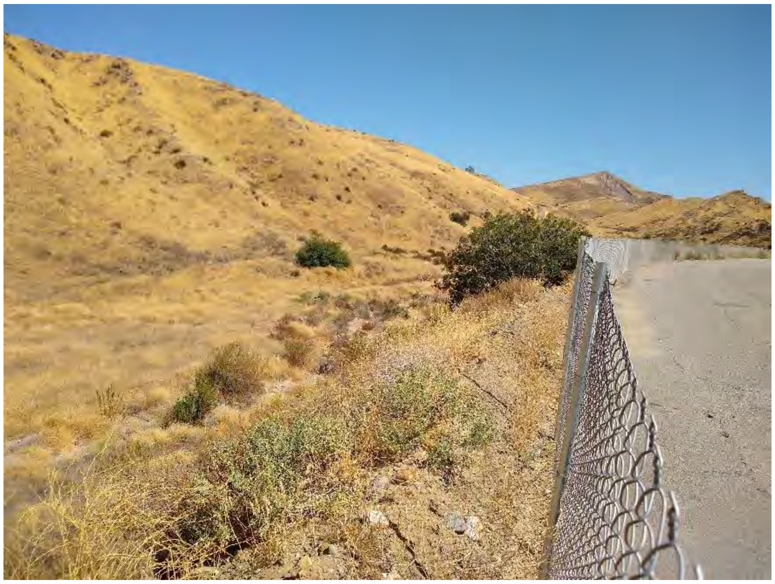
Potential GDE Field Assessment Datasheet

Beneficial uses (See RWQCB basin plan)	Agricultural Supply (AGR) ☐ Cold Freshwater Habitat (COLD) ☐ Commercial and Sport Fishing (COMM) ☐ Estuarine Habitat (EST) ☐ Freshwater Replenishment (FRSH) ☐ Ground Water Recharge (GWR) ☐ Hydropower Generation (POW) ☐ Industrial Process Supply (PROC) ☐ Industrial Service Supply (IND) ☐ Migration of Aquatic Organisms (MIGR) ☐ Municipal and Domestic Supply (MUN) ☐ Navigation (NAV) ☐ Non-contact Water Recreation (REC-2) ☐ Marine Habitat (MAR) ☐ Preservation of Biological Habitats (BIOL) ☐ Rare, Threatened, or Endangered Species (RARE) ☐ Spawning, Reproduction, and/or Early Development (SPWN) ☐ Warm Freshwater Habitat (WARM) ☐ Water Contact Recreation (REC-1) ☐ Wetland Habitat (WET) ☐ Wildlife Habitat (WILD) ☒

Access: no, fenced area, from paved road

Potential GDE Field Assessment Datasheet

Photos

Photo 1: Upstream	North 
Photo 2: Downstream	South 

Potential GDE Field Assessment Datasheet

Photo 3: Across	West 

Potential GDE Field Assessment Datasheet

Date: 9/6/19 **Time:** 11:40
ID#: 20 **Coordinates:** 34.37976687, -118.40929012

Vegetation Community: Riversidean alluvial

Dominants	Tree	None
	Shrub	CA buckwheat, scalebroom
	Herbaceous	Shortpod mustard
Native vs. non-native %		80/20
Potential Wetland		No
Spring/seep		no

Hydrology:

Present (Flows/Ponded)	No
Depth of surface water	N/A
Source	natural runoff ☒ urban stormwater runoff ☐ treated wastewater effluent ☐ artificial sources ☐
Managed or natural flows	Natural flows

Soils:

Type – clay, silt, sand, gravel, etc.	Sand
Saturation	no

Species Information

Observed	CA towhee
Special-status likely to occur	Insects ☐ Click or tap here to enter text. Amphibians ☐ Click or tap here to enter text. Reptiles ☒ coast horned lizard Birds ☐ Click or tap here to enter text. Fish ☐ Click or tap here to enter text. Mammals ☐ Click or tap here to enter text. Plants ☐ Click or tap here to enter text.

Human Alteration:

Beneficial uses (See RWQCB basin plan)	Agricultural Supply (AGR) ☐ Cold Freshwater Habitat (COLD) ☐ Commercial and Sport Fishing (COMM) ☐ Estuarine Habitat (EST) ☐ Freshwater Replenishment (FRSH) ☐ Ground Water Recharge (GWR) ☐ Hydropower Generation (POW) ☐ Industrial Process Supply (PROC) ☐ Industrial Service Supply (IND) ☐ Migration of Aquatic Organisms (MIGR) ☐ Municipal and Domestic Supply (MUN) ☐ Navigation (NAV) ☐ Non-contact Water Recreation (REC-2) ☐ Marine Habitat (MAR) ☐ Preservation of Biological Habitats (BIOL) ☐ Rare, Threatened, or Endangered Species (RARE) ☐ Spawning, Reproduction, and/or Early Development (SPWN) ☐ Warm Freshwater Habitat (WARM) ☐ Water Contact Recreation (REC-1) ☐ Wetland Habitat (WET) ☐ Wildlife Habitat (WILD) ☒

Access: Yes, on foot via public road.

Potential GDE Field Assessment Datasheet

Photos

Photo 1: Upstream	East 
Photo 2: Downstream	West 

Potential GDE Field Assessment Datasheet

Photo 3: Across	South 

Potential GDE Field Assessment Datasheet

Date: 9/6/19 **Time:** 12:15
ID#: 21 **Coordinates:** 34.40907520, -118.45914461

Vegetation Community: Southern willow scrub

Dominants	Tree	Red willow
	Shrub	Mulefat
	Herbaceous	None
Native vs. non-native %		100/0
Potential Wetland		Yes
Spring/seep		no

Hydrology:

Present (Flows/Ponded)	Yes, flows
Depth of surface water	6-12 inches
Source	natural runoff ☒ urban stormwater runoff ☐ treated wastewater effluent ☐ artificial sources ☐
Managed or natural flows	Natural flows

Soils:

Type – clay, silt, sand, gravel, etc.	Sand, cobble
Saturation	yes

Species Information

Observed	Cooper's hawk
Special-status likely to occur	Insects ☐ Click or tap here to enter text. Amphibians ☒ arroyo toad Reptiles ☐ Click or tap here to enter text. Birds ☒ least Bell's vireo Fish ☒ UTS Mammals ☐ Click or tap here to enter text. Plants ☐ Click or tap here to enter text.

Human Alteration:

Potential GDE Field Assessment Datasheet

Beneficial uses (See RWQCB basin plan)	Agricultural Supply (AGR) ☐ Cold Freshwater Habitat (COLD) ☐ Commercial and Sport Fishing (COMM) ☐ Estuarine Habitat (EST) ☐ Freshwater Replenishment (FRSH) ☐ Ground Water Recharge (GWR) ☐ Hydropower Generation (POW) ☐ Industrial Process Supply (PROC) ☐ Industrial Service Supply (IND) ☒ Migration of Aquatic Organisms (MIGR) ☐ Municipal and Domestic Supply (MUN) ☐ Navigation (NAV) ☐ Non-contact Water Recreation (REC-2) ☐ Marine Habitat (MAR) ☐ Preservation of Biological Habitats (BIOL) ☐ Rare, Threatened, or Endangered Species (RARE) ☒ Spawning, Reproduction, and/or Early Development (SPWN) ☐ Warm Freshwater Habitat (WARM) ☐ Water Contact Recreation (REC-1) ☐ Wetland Habitat (WET) ☒ Wildlife Habitat (WILD) ☒

Access: Yes, on foot via dirt access road originating from Canyon Park Boulevard.

Potential GDE Field Assessment Datasheet

Photos

Photo 1: Upstream	South 
Photo 2: Downstream	West 

Photo 3: Across	Southwest 

Potential GDE Field Assessment Datasheet

Date: 9/6/19 **Time:** 12:28
ID#: 22 **Coordinates:** 34.40606270, -118.4583801

Vegetation Community: Eucalyptus grove

Dominants	Tree	Eucalyptus, pepper tree
	Shrub	Wattle
	Herbaceous	None
Native vs. non-native %		0/100
Potential Wetland		No
Spring/seep		no

Hydrology:

Present (Flows/Ponded)	No
Depth of surface water	N/A
Source	natural runoff ☒ urban stormwater runoff ☐ treated wastewater effluent ☐ artificial sources ☐
Managed or natural flows	Natural flows

Soils:

Type – clay, silt, sand, gravel, etc.	Unknown
Saturation	Unknown

Species Information

Observed	None
Special-status likely to occur None	Insects ☐ Click or tap here to enter text. Amphibians ☐ Click or tap here to enter text. Reptiles ☐ Click or tap here to enter text. Birds ☐ Click or tap here to enter text. Fish ☐ Click or tap here to enter text. Mammals ☐ Click or tap here to enter text. Plants ☐ Click or tap here to enter text.

Human Alteration:

Beneficial uses (See RWQCB basin plan)	Agricultural Supply (AGR) ☐ Cold Freshwater Habitat (COLD) ☐ Commercial and Sport Fishing (COMM) ☐ Estuarine Habitat (EST) ☐ Freshwater Replenishment (FRSH) ☐ Ground Water Recharge (GWR) ☐ Hydropower Generation (POW) ☐ Industrial Process Supply (PROC) ☐ Industrial Service Supply (IND) ☐ Migration of Aquatic Organisms (MIGR) ☐ Municipal and Domestic Supply (MUN) ☐ Navigation (NAV) ☐ Non-contact Water Recreation (REC-2) ☐ Marine Habitat (MAR) ☐ Preservation of Biological Habitats (BIOL) ☐ Rare, Threatened, or Endangered Species (RARE) ☐ Spawning, Reproduction, and/or Early Development (SPWN) ☐ Warm Freshwater Habitat (WARM) ☐ Water Contact Recreation (REC-1) ☐ Wetland Habitat (WET) ☐ Wildlife Habitat (WILD) ☐

Access: No direct access, fenced. Access from the apartment complex to the east.

Potential GDE Field Assessment Datasheet

Photos

Photo 1: Downstream	North 
Photo 2: Across	West 

Potential GDE Field Assessment Datasheet

Date: 9/6/19 **Time:** 12:40
ID#: 23 **Coordinates:** 34.37692235, -118.47120834

Vegetation Community: Coast live oak woodland

Dominants	Tree	Coast live oak, CA sycamore
	Shrub	Mulefat
	Herbaceous	Ripgut brome
Native vs. non-native %		70/30
Potential Wetland		No
Spring/seep		No

Hydrology:

Present (Flows/Ponded)	No
Depth of surface water	N/A
Source	natural runoff ☒ urban stormwater runoff ☐ treated wastewater effluent ☐ artificial sources ☐
Managed or natural flows	Natural flows

Soils:

Type – clay, silt, sand, gravel, etc.	Sand, loam
Saturation	No

Species Information

Observed	Acorn woodpecker
Special-status likely to occur	Insects ☐ Click or tap here to enter text. Amphibians ☐ Click or tap here to enter text. Reptiles ☒ coast horned lizard Birds ☐ Click or tap here to enter text. Fish ☐ Click or tap here to enter text. Mammals ☐ Click or tap here to enter text. Plants ☐ Click or tap here to enter text.

Human Alteration:

Beneficial uses (See RWQCB basin plan)	Agricultural Supply (AGR) ☐ Cold Freshwater Habitat (COLD) ☐ Commercial and Sport Fishing (COMM) ☐ Estuarine Habitat (EST) ☐ Freshwater Replenishment (FRSH) ☐ Ground Water Recharge (GWR) ☐ Hydropower Generation (POW) ☐ Industrial Process Supply (PROC) ☐ Industrial Service Supply (IND) ☐ Migration of Aquatic Organisms (MIGR) ☐ Municipal and Domestic Supply (MUN) ☐ Navigation (NAV) ☐ Non-contact Water Recreation (REC-2) ☐ Marine Habitat (MAR) ☐ Preservation of Biological Habitats (BIOL) ☐ Rare, Threatened, or Endangered Species (RARE) ☐ Spawning, Reproduction, and/or Early Development (SPWN) ☐ Warm Freshwater Habitat (WARM) ☐ Water Contact Recreation (REC-1) ☐ Wetland Habitat (WET) ☐ Wildlife Habitat (WILD) ☒

Access: Yes, on foot from Placerita Canyon Road.

Potential GDE Field Assessment Datasheet

Photos

Photo 1: Upstream	East 
Photo 2: Downstream	West 

Potential GDE Field Assessment Datasheet

Photo 3: Across	Southwest 

Potential GDE Field Assessment Datasheet

Date: 9/6/19 **Time:** 1:10

ID#: 24 **Coordinates:** 34.37798037, -118.49246228

Vegetation Community: Coast live oak woodland

Dominants	Tree	Coast live oak, willow (unknown), Fremont's cottonwood
	Shrub	Mulefat
	Herbaceous	Shortpod mustard
Native vs. non-native %		90/10
Potential Wetland		Yes
Spring/seep		No

Hydrology:

Present (Flows/Ponded)	No
Depth of surface water	N/A
Source	natural runoff ☒ urban stormwater runoff ☐ treated wastewater effluent ☐ artificial sources ☐
Managed or natural flows	Natural flows

Soils:

Type – clay, silt, sand, gravel, etc.	Sand, loam
Saturation	No

Species Information

Observed	Mourning dove
Special-status likely to occur	Insects ☐ Click or tap here to enter text. Amphibians ☐ Click or tap here to enter text. Reptiles ☒ coast horned lizard Birds ☐ Click or tap here to enter text. Fish ☐ Click or tap here to enter text. Mammals ☐ Click or tap here to enter text. Plants ☐ Click or tap here to enter text.

Human Alteration:

Beneficial uses (See RWQCB basin plan)	Agricultural Supply (AGR) ☐ Cold Freshwater Habitat (COLD) ☐ Commercial and Sport Fishing (COMM) ☐ Estuarine Habitat (EST) ☐ Freshwater Replenishment (FRSH) ☐ Ground Water Recharge (GWR) ☐ Hydropower Generation (POW) ☐ Industrial Process Supply (PROC) ☐ Industrial Service Supply (IND) ☐ Migration of Aquatic Organisms (MIGR) ☐ Municipal and Domestic Supply (MUN) ☐ Navigation (NAV) ☐ Non-contact Water Recreation (REC-2) ☐ Marine Habitat (MAR) ☐ Preservation of Biological Habitats (BIOL) ☐ Rare, Threatened, or Endangered Species (RARE) ☐ Spawning, Reproduction, and/or Early Development (SPWN) ☐ Warm Freshwater Habitat (WARM) ☐ Water Contact Recreation (REC-1) ☐ Wetland Habitat (WET) ☐ Wildlife Habitat (WILD) ☒

Access: Yes, from top of bank, SR-14 onramp ROW. Fenced off so inaccessible within the polygon.

Potential GDE Field Assessment Datasheet

Photos

Photo 1: Upstream	East 

APPENDIX E

Considerations for Evaluating Effects to Groundwater Dependent Ecosystems in the Upper Santa Clara River Basin,
Prepared by Environmental Science Associates (ESA)

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CONSIDERATIONS FOR EVALUATING EFFECTS TO GROUNDWATER DEPENDENT ECOSYSTEMS IN THE UPPER SANTA CLARA RIVER BASIN

Memorandum

Prepared for
Santa Clarita Valley Groundwater Sustainability Agency

June 2021

ESA

CONSIDERATIONS FOR EVALUATING EFFECTS TO GROUNDWATER DEPENDENT ECOSYSTEMS IN THE UPPER SANTA CLARA RIVER BASIN

Memorandum

Prepared for
Santa Clarita Valley Groundwater Sustainability Agency

June 2021

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Introduction

The Sustainable Groundwater Management Act (SGMA) requires that Groundwater Sustainability Plans (GSPs) identify Groundwater Dependent Ecosystems (GDEs) and consider the effects of groundwater extraction on GDEs when developing and adopting Sustainability Criteria, Measurable Objectives, and Minimum Thresholds.[1] SGMA statute and regulations require specific consideration of both GDEs and interconnected surface waters (ISW) in the development of a GSP. SGMA-governed groundwater plans must:

- Identify GDEs within the basin [23 CCR § 354.16(g)];
- Consider impacts to GDEs [Water Code § 10727.4(l)]; and
- Address six undesirable results, one of which includes depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water. [Water Code § 10721(x)(6).]

Step 1.1 of The Nature Conservancy (TNC) Guidelines provides a methodology to identify GDEs. The GDE Report (ESA, 2020) prepared to support the Upper Santa Clara Basin GSP follows this approach. Step 1.2 of the TNC Guidelines suggests that areas overlying groundwater by more than 30 feet may be removed from the GDE category since the depth is too great to support habitat. The GDE Report prepared by ESA for the basin has mapped the extent of existing vegetation and habitat that could be supported by groundwater but does not include the step of identifying GDEs based on the 30-foot depth to groundwater. The GDE Report will be amended to include the 30-foot depth to groundwater criterion to focus future monitoring on habitat that is reliant on consistent access to groundwater.

SGMA identifies several examples of potential undesirable results for each of the six sustainability indicators that may occur from groundwater extraction. Though SGMA does not specifically identify GDEs as a seventh sustainability indicator, it does require GSAs consider beneficial uses, including GDEs, in the GSP. Figure 10 of the TNC Guidelines provides a flow chart to evaluate if GDEs are being considered alongside the other sustainability indicators. The TNC Guidelines suggest that where there is uncertainty in the way groundwater conditions impact a GDE, it is prudent to undertake additional monitoring, analysis and action and the GSP should include a methodology to determine whether a significant and unreasonable effect to GDEs could occur.

[1] SGMA does not identify an effect to GDEs in and of itself to be a sustainability indicator. As a result, a GSP does not identify minimum thresholds or measurable objectives for effects to GDEs. Rather, SGMA suggests that sustainability indicators should consider how minimum thresholds and measurable objectives may be developed to better understand and minimize significant effects to GDEs.

The California Department of Fish and Wildlife (CDFW) has published guidelines[2] for considering whether effects to GDEs and interconnected surface waters (ISWs) are significant. CDFW's approach suggests answering the following questions in the GSP:

Groundwater Dependent Ecosystems:

1. How will groundwater plans identify GDEs and address GDE protection?
2. How will GSAs determine if GDEs are being adversely impacted by groundwater management?
3. If GDEs are adversely impacted, how will groundwater plans facilitate appropriate and timely monitoring and management response actions?

Interconnected Surface Waters:

1. How will groundwater plans document the timing, quantity, and location of ISW depletions attributable to groundwater extraction and determine whether these depletions will impact fish and wildlife?
2. How will GSAs determine if fish and wildlife are being adversely impacted by groundwater management impacts on ISW?
3. If adverse impacts to ISW-dependent fish and wildlife are observed, how will GSAs facilitate appropriate and timely monitoring and management response actions?

CDFW has outlined specific Management Considerations to be integrated into the GSP:[3]

✓ Data Gaps and Conservative Decision-Making Under Uncertain Conditions

✓ Adaptive Management

✓ Prioritized Resource Allocation

✓ Multi-Benefit Approach

To consider the TNC and CDFW guidance documents, this memo outlines the relationship between groundwater and GDEs documented within the Upper Santa Clara Basin, and identifies a suggested methodology to evaluate whether an effect is significant and unreasonable.

Background

An inventory of potential GDEs has been prepared (ESA, 2020) to accompany the GSP and is referenced in this memo. In addition, the GSP process has included groundwater modeling that has refined the understanding of how the alluvial aquifer interacts with surface water. The modeling results describe a series of groundwater zones cascading into the next as the river flows westward. In each of these zones, the alluvial aquifer thickness varies, resulting in river segments in some areas where groundwater is well below the river channel and does not contribute to surface water flow and segments where groundwater is perennially contributing to surface flow. This complex interaction is described in the GSP.

2 Groundwater Planning Considerations, CDFW, 2019.
3 Groundwater Planning Considerations, CDFW, 2019.

In addition to upwelling groundwater, surface water is discharged to the river by the Santa Clarita Valley Sanitation District, which discharges treated recycled water into the river in two locations. The discharges began in the 1960s at low levels and have increased over time as the Santa Clarita Valley has developed. The Saugus Water Reclamation Plant (WRP) discharges approximately 5 million gallons per day (mgd) and the Valencia WRP discharges approximately 15 mgd (SCVSD, 2013). These surface flows sustain riparian habitat as the water percolates into the alluvial groundwater basin as it flows westward.

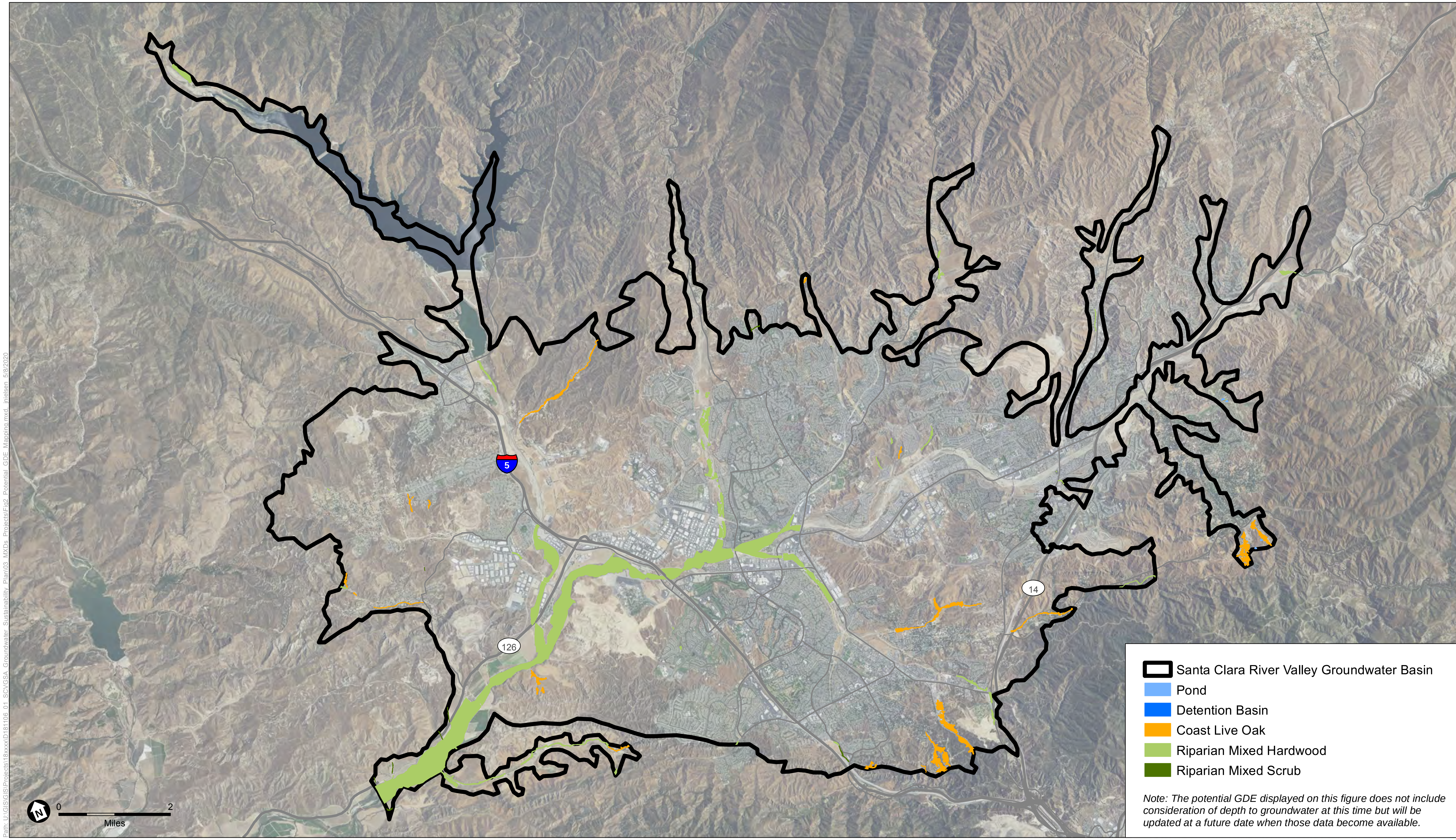
Extent and Types of GDEs

The GDE Report (ESA, 2020) prepared for the GSP follows the TNC Guidelines, identifying potential GDEs in the Upper Santa Clara River Basin. The report describes potential GDEs that occur throughout the basin including in the upper tributaries and in the mainstem of the Santa Clara River (SCR), corresponding to areas where groundwater is consistently available. **Figure 1** identifies these potential GDEs within the entire watershed. The SCR corridor has historically exhibited riparian vegetation in areas where groundwater has been consistently near the surface or has consistently discharged into the streambed creating aquatic habitat. These areas are identified as GDEs. (See GDE Report; ESA, 2020) The GDEs are naturally affected by flood events, drought, varying depth to groundwater, and surface water flows. Access to groundwater fluctuates depending on the season and droughts, resulting in variability from year-to-year and season-to-season.

In the upper reaches of the watershed, GDEs may be dependent on the alluvial aquifer or on downward seepage from surrounding hillsides. Downstream of the confluence with Bouquet Canyon, a riparian corridor within the Santa Clara River channel stretches to the Piru Dry Gap in Ventura County exhibiting both riparian and aquatic habitats that rely on a combination of groundwater upwelling and surface water from multiple sources including WRP discharges, storm water, urban runoff, and other discharges. Much of this area has been designated as “potential GDEs” that may be sustained by groundwater or surface water.

The GDE Report (ESA, 2020) describes habitat types and special status species that may be found within the watershed that rely on aquatic and riparian habitats. The GDE Report assumes that these special status species may be present within the existing habitats in the watershed that have been designated as potential GDEs. In general, riparian habitat in the Upper Santa Clara River Basin support several special status avian species including the least Bell’s vireo and southwestern willow flycatcher. These species are found in the willow and riparian mixed hardwood forests along the length of the river. Aquatic habitat in the Upper Santa Clara River Basin may support several special status species including the arroyo toad, unarmored three-spined stickleback (UTS), and Santa Ana sucker. The UTS have been found in only a few locations within the watershed. Recently, the UTS has not been located below the Valencia WRP discharges, making the short upstream segment at the I-5 bridge a particularly important location.

The TNC Guidelines suggest that when groundwater is consistently greater than 30 feet below ground surface, it can be concluded that the vegetation is not reliant on a groundwater aquifer. **Figure 2** presents a revised map of GDEs within the Upper Santa Clara River Basin considering this 30-foot depth to groundwater criterion. Since groundwater fluctuates over the year and between years, the 30-foot criterion



SOURCE: ESA, 2020; NWI, 2019; NCCAG, 2019.

GDE Considerations Assessment

Figure 1
Potential GDE Mapping

SOURCE: ESA, 2020; NWI, 2019; NCCAG, 2019.

Figure 2
Highest - September, 2011, GDE Mapping

data is taken conservatively from modeled groundwater depths throughout the Basin in the late dry season (September) during a wet year (2011). As illustrated in Figure 2, some of the vegetated areas in the eastern portion of the basin and in the upper canyons have been removed from the GDE category. However, the majority of GDEs identified in the original GDE Report (ESA 2020) are confirmed, particularly the areas within the SCR corridor extending from the confluence with San Francisquito Creek to the western Basin boundary.

Riparian Habitat

Riparian habitat requires a reliable water source. Willow forests occur in areas where groundwater is available year-round. Willow root zones occur most prominently within 1 to 5 feet below the surface, but may reach depths of up to 8 feet (TNC, 2018a). Root depths of mature cottonwood trees may reach over 16 feet (Taylor, 2000). The TNC Guidelines suggest that habitats where underlying groundwater depths are 30 feet or more can be assumed to be disconnected from groundwater (TNC, 2018b). **Table 1** characterizes GDEs in the watershed, focusing on discrete segments of the SCR below Bouquet Canyon. The GDE resources sustained in these reaches rely on a combination of surface flow and groundwater upwelling.

TABLE 1: CHARACTERISTICS OF GDES ALONG SCR CORRIDOR

Segment Description	Dry Year Gaining/Losing	GDE Resource
Upper Reaches and Interim Reaches of SCR	Mostly dry in dry season, Losing	GDEs are present in certain areas of the watershed outside of the SCR mainstem. These areas include oak woodlands that are supported from hillside seepage and riparian habitat where groundwater is shallow or at the surface intermittently.
SCR from Bouquet Canyon to I-5 Bridge	Losing/Gaining	This reach stretches from the confluence of the Bouquet Canyon to the I-5 Bridge. Much of the reach is perennially dry, exhibiting riversidean scrub. The Saugus WRP discharges an average of 5 mgd to the river in this reach that supports a ribbon of riparian vegetation that dissipates as the surface flow infiltrates. Riparian vegetation begins to reemerge below this area that is otherwise a sandy dry wash. Riparian vegetation becomes more established at the confluence of the San Francisquito Creek to the I-5 Bridge. Beginning at the I-5 Bridge for a few 100 feet downstream, perennial surface flows have been recorded resulting from rising groundwater. This perennial flow represents an essential aquatic habitat for sensitive native aquatic species.
SCR from I-5 Bridge to one miles downstream of the VWRP point of discharge	Losing/Gaining	This reach stretches from just below the I-5 bridge to approximately 1 mile below the Valencia WRP discharge. A few 100 feet downstream of the I-5 bridge, the river narrows and becomes a losing reach. However, at this point the Valencia WRP discharges an average of approximately 15 mgd to the river. The river corridor from the I-5 bridge to one mile downstream of the Valencia WRP exhibits a dense cottonwood and willow forest. The river widens in places and vegetation covers the entire flood plain. The dense riparian forest and perennial aquatic habitat exists in this reach supported in part by Valencia WRP surface flow discharges.
SCR from one mile to Castaic Creek	Losing	This reach stretches from approximately 1 mile downstream from the Valencia WRP to just above the confluence with Castaic Creek. This is a losing reach with groundwater levels dropping below 25 feet during the driest months. The riparian forest becomes less dense and wide dry sand bars with scrub habitat are evident. Surface water flows are perennial in this reach supporting a ribbon of riparian habitat on one side of the floodplain.
SCR from Castaic Creek for two miles	Gaining	This reach stretches from just above Castaic Creek for approximately 2 miles downstream. Groundwater upwelling contributes surface flow to this segment even in the driest months of the driest years. The channel begins to narrow and the riparian forest becomes more dense, covering the entire floodplain in many places. Surface water flows are perennial.

Segment Description	Dry Year Gaining/Losing	GDE Resource
SCR from approximately two miles below Castaic Creek to Ventura County border	Losing/Gaining	This reach stretches for another mile to the end of the Upper Santa Clara Basin near the Ventura County border. The channel narrows and the riparian forest is dense in this segment although groundwater levels may drop below 25 feet during the driest months of dry years. Surface water flows are perennial.

Aquatic Habitat

The Valencia WRP discharges of approximately 15 mgd create perennial surface flows. The aquatic habitat also is supported by groundwater upwelling. The cooler groundwater may cool the WRP discharges presenting preferable water quality conditions for extant special status species such as UTS. As a result, groundwater upwelling in areas that historically have been gaining reaches improves aquatic habitat quality.

Historic Groundwater Levels

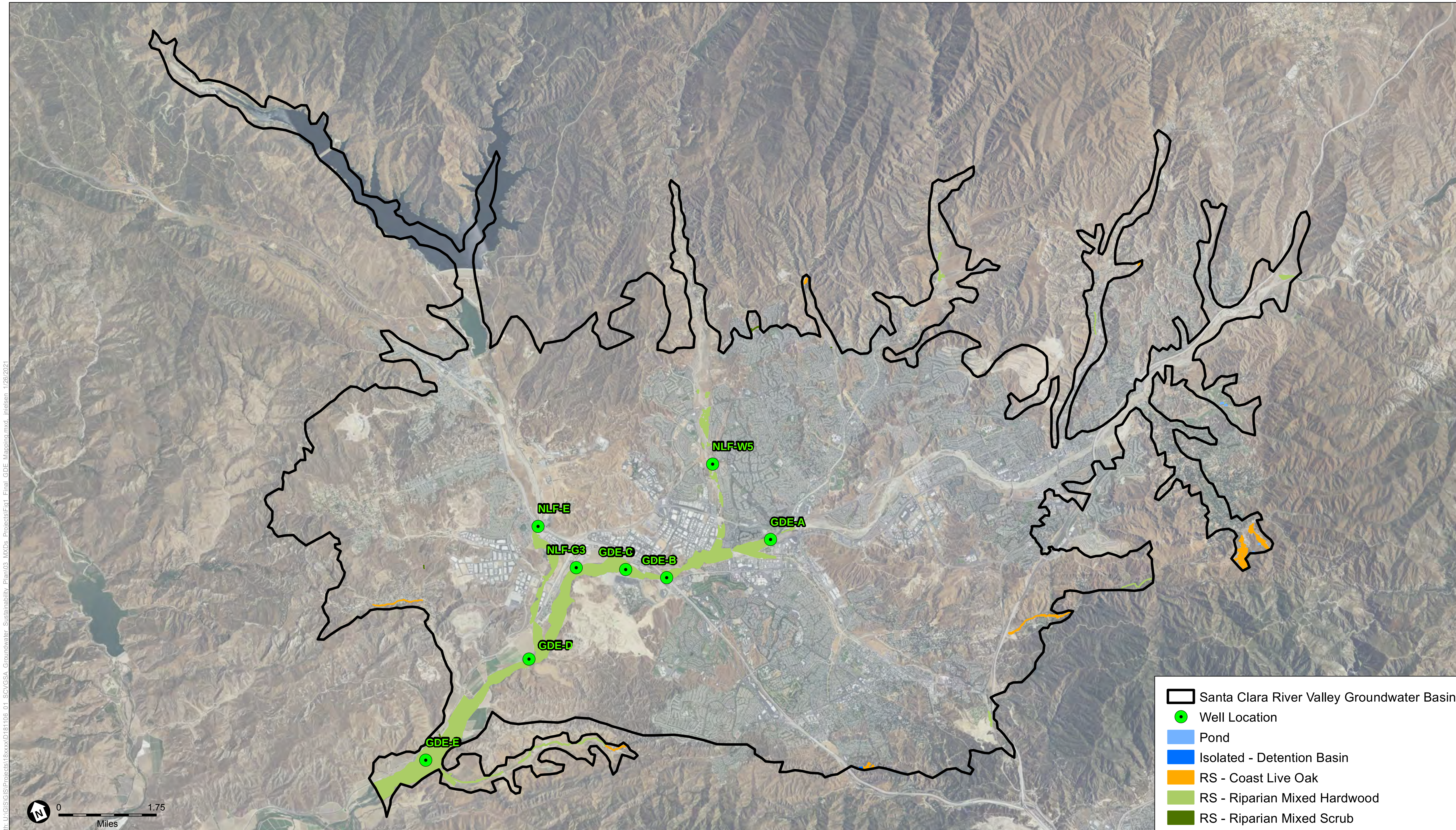
Groundwater levels tend to decline in the late summer and recover in the winter responding to natural recharge and reduced pumping in the winter months, and groundwater levels also reflect multi year drought with progressively lower levels each year, followed by recovery in wetter periods. The existing GDEs have been sustained through a recent drought (2012-2016) that resulted in historically low groundwater levels. **Table 2** summarizes the historic lows recorded in several representative locations along the river corridor. **Figure 3** identifies these locations. When groundwater levels are above these recorded temporary historic lows, it can be inferred that GDEs are not significantly and unreasonably affected. As a result, these existing wells may be used to monitor future groundwater elevations to ensure that GDEs are sufficiently maintained throughout the upper SCR. The locations have been chosen as potential future monitoring locations, but may not all be located within GDE areas.

TABLE 2: GDE MONITORING LOCATIONS AND HISTORICAL LOW GROUNDWATER LEVELS

Location Description	Well Name	Historical Low Depth to Groundwater below River Thalweg (feet bgs)[a]	Historical Low Groundwater Elevation (feet NAVD88)[b]
San Francisquito Canyon	NLF-W5[c]	42	1,108
Santa Clara River Below Mouth of Bouquet Canyon	GDE-A[c]	42	1,089
Santa Clara River at I-5 Bridge	GDE-B	-5	1,062
Santa Clara River Near Valencia WRP	GDE-C	8	1,027
Santa Clara River 1 Mile Downstream of Valencia WRP	NLF-G3	5	975
Santa Clara River Below Mouth of Castaic Creek	GDE-D	3	932
Santa Clara River at Mouth of Potrero Canyon	GDE-E	0	860
Castaic Creek in Lower Castaic Valley	NLF-E[c]	40	981

[a] Subject to change in monitoring plan
[b] Historical groundwater elevations are from simulations conducted using the calibrated groundwater flow model.
[c] Might not be within an actual GDE area.

bgs = below ground surface; GDE = groundwater-dependent ecosystem; NAVD88 = North American Vertical Datum of 1988; WRP = water reclamation plant



SOURCE: ESA, 2020; NWI, 2019; NCCAG, 2019.

GDE Considerations Assessment

Figure 3
Potential Monitoring Locations

ESA

Groundwater levels in the alluvium respond to higher rates of pumping in the summer generally reaching their deepest levels around September (early fall), and recovering entirely in the winter. During prolonged periods of drought, the recovery may not be complete and a lowering of groundwater levels occurs year-over-year until a single or multiple wet seasons completely recover levels, maintaining an historic average baseline level. **Figure 4** depicts this pattern based on a conceptual hydrograph provided in the TNC Guidelines. As shown in the figure, the historic annual cycle has created conditions that support habitat over time.

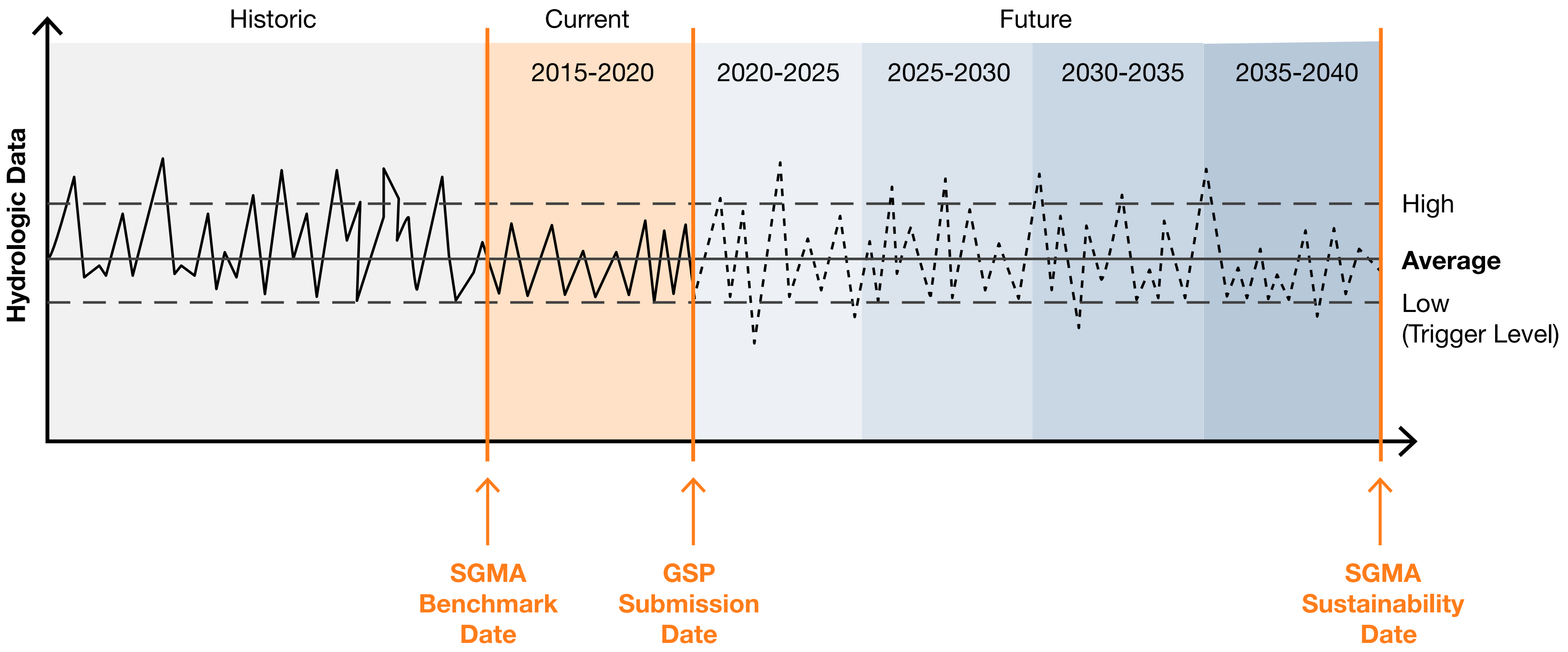
The historic hydrographs of older wells show that groundwater was pumped in large amounts for a short period in the 1950s. Alluvial groundwater levels dropped over 30 feet in some areas for a period of one or two years and then immediately recovered back to previous levels. This sudden major temporary decline has not occurred since the 1950s because urbanization has reduced the amount of agricultural pumping and because importation of state water and discharges of treated wastewater to the river from the WRPs has increased the flow in the river overall. The hydrographs illustrate that alluvial groundwater levels can recover from significant declines in a matter of one or two wet years.

Resilience of Existing Habitat

The existing vegetation within the GDEs has survived a pattern of annually lowering levels with even greater declines in drought years. This pattern affects different parts of the river channel differently. **Figures 5, 6** and **7** schematically depict this seasonal variability within different river segments. The river channel widens and narrows providing varying density of riparian habitat corresponding to river width, proximity to surface water, and groundwater depth.

Discharges from the Valencia WRP provide ~15 mgd of surface water just downstream from the I-5 bridge. This surface water supports riparian habitat. A green ribbon of vegetation can be seen following surface water where shallow groundwater may not be reliably present. In some of these areas, the remaining channel is a dry sand bank. In other areas, riparian vegetation occurs sporadically across the channel, supported either by high soil moisture from lateral movement of perennial surface water or from shallow groundwater. The more sparsely vegetated areas may represent areas where groundwater drops sufficiently often to stress vegetation during normal and dry years.

In these losing reaches and particularly in the eastern portion of the watershed where depth to groundwater is already below the thalweg (bottom of the river channel), groundwater becomes progressively lower as the summer progresses. Vegetation that relies on moisture within the first 1-5 feet exclusively may not survive in areas where groundwater routinely declines by 10 feet. However, some vegetation such as larger trees may develop root systems that can accommodate this variability. In some areas, riparian habitat may experience high degrees of stress during prolonged drought conditions. If the drought lasts long enough, vegetation may not survive. However, when a storm event arrives, these areas may re-establish themselves with emergent riparian vegetation. Furthermore, high flows change the channel morphology periodically, transporting sediment and altering the low flow channel location that may result in vegetation conversions or habitat value fluctuations in these areas.

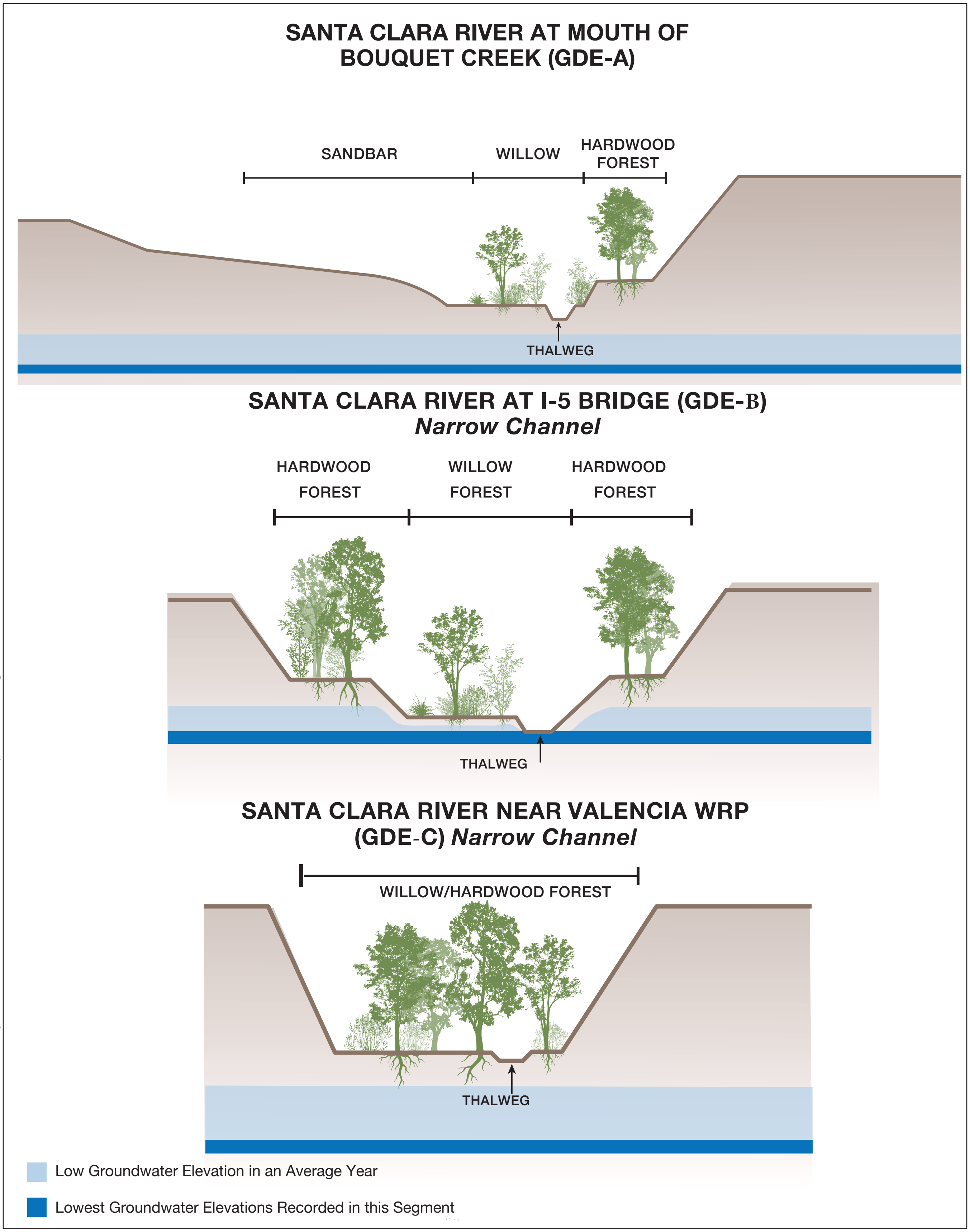


SOURCE: ESA, 2021

GDE Considerations Assessment

Figure 4
Conceptual Groundwater Hydrograph

ESA



SOURCE: ESA, 2020

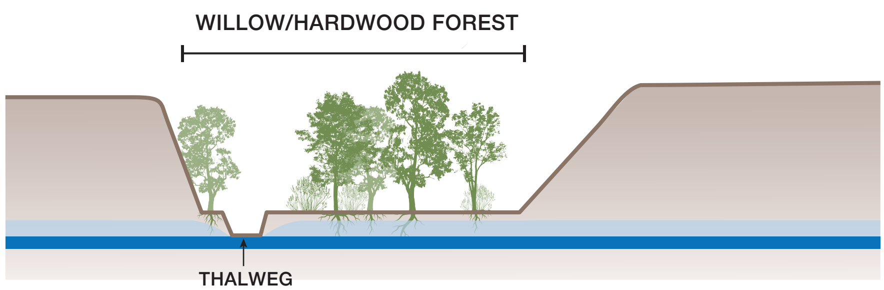
GDE Considerations Assessment

Figure 5
Schematic Cross Sections

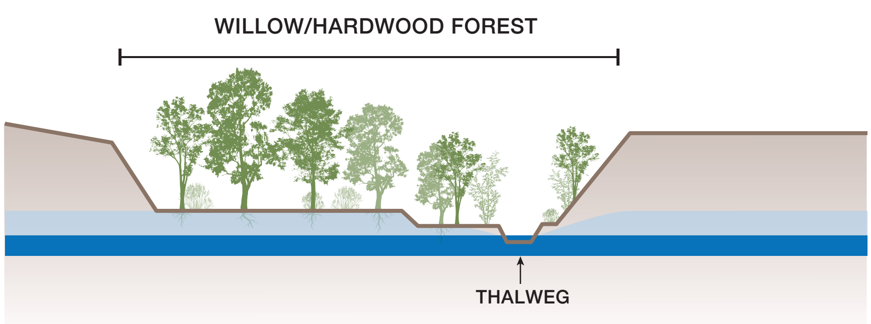
ESA

LAX/19xxx/D201900670.00 - SCVA Future Recycled Water Environmental Considerations Assessment/05 Graphics-GIS-Modeling/Illustrator

SANTA CLARA RIVER BELOW MOUTH OF CASTAIC CREEK (GDE-D)
Narrow Channel



SANTA CLARA RIVER AT MOUTH OF POTRERO CANYON (GDE-E)
Narrow Channel



Low Groundwater Elevation in an Average Year

Lowest Groundwater Elevations Recorded in this Segment

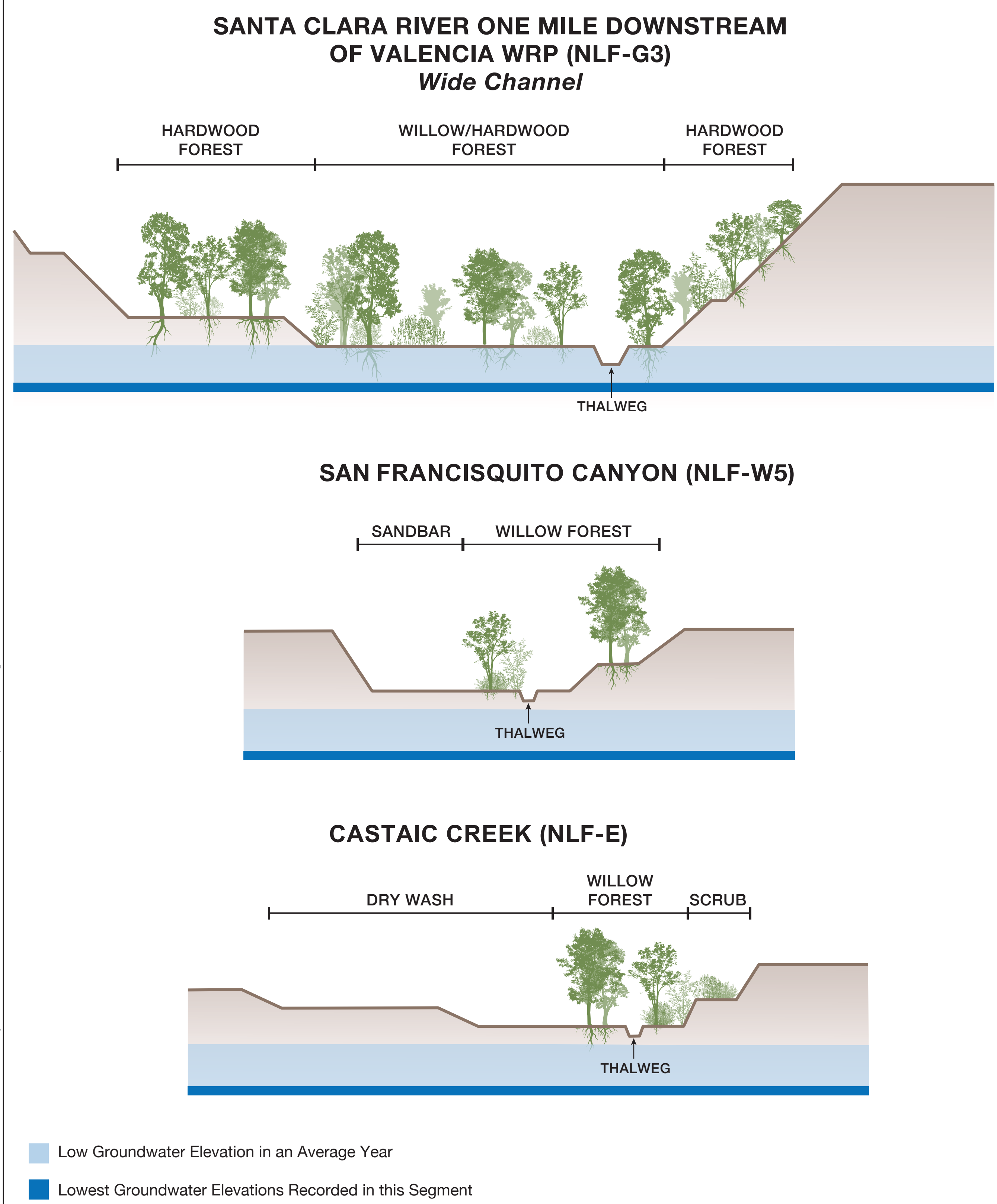
LAX/19xxx/D201900670.00 - SCVA Future Recycled Water Environmental Considerations Assessment/05 Graphics-GIS-Modeling/Illustrator

SOURCE: ESA, 2020

SCVA Future Recycled Water Environmental Considerations Assessment

Figure 6
Schematic Cross Sections

ESA



LAX/19xxx/D201900670.00 - SCVA Future Recycled Water Environmental Considerations Assessment/05 Graphics-GIS-Modeling/Illustrator

SOURCE: ESA, 2020

Figure 7
Schematic Cross Sections

ESA

Figure 8 presents an aerial photograph of the SCR in 1947 showing river segments with thick vegetation and other drier segments corresponding to reliable groundwater availability prior to surface discharges from the WRPs. The historic aerial photograph illustrates that vegetation has persisted in the river channel since the last mid-century similar to the existing condition.

Significant and Unreasonable Effects

The GDE Report has mapped potential GDEs in the watershed that include both aquatic and riparian habitat types. Although these areas have exhibited changing conditions, the existing condition supports significant habitat values. As a result, significant and unreasonable effects to GDEs would include the following:

- Permanent loss or significant degradation of existing riparian or aquatic habitat due to lowered groundwater elevations caused by pumping
- Temporary acute loss of aquatic habitat in specific locations critical to sensitive aquatic species due to lowered groundwater elevations caused by pumping

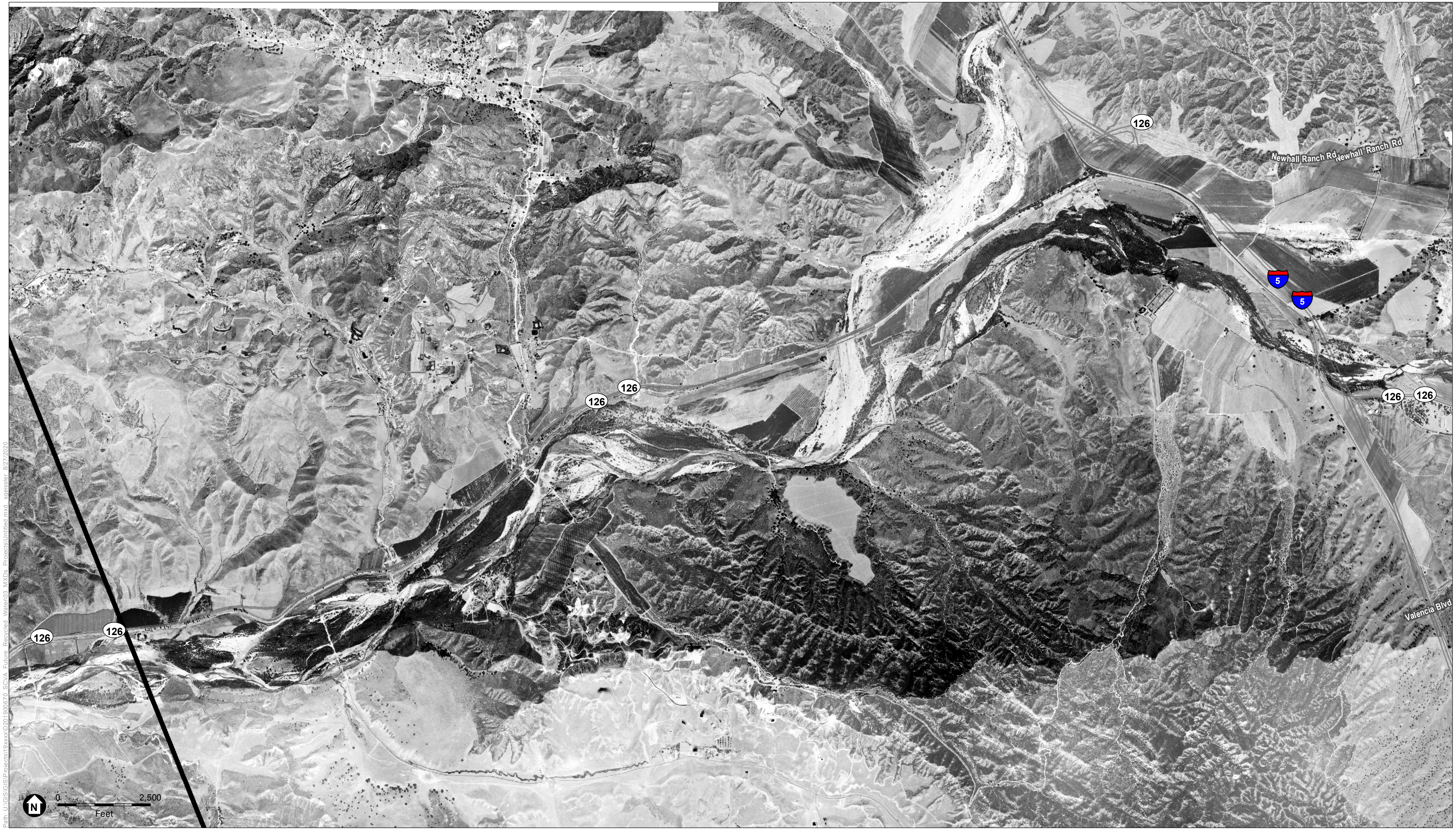
A persistent drop in groundwater levels below root zones caused by groundwater pumping could result in permanent loss of GDEs and as such a monitoring program is needed. A permanent loss of GDEs caused by groundwater pumping would be a significant and unreasonable outcome of groundwater extraction when occurring either acutely or over the long term. Monitoring for groundwater levels in areas where GDEs occur would provide an indication of whether the GDEs are affected.

In areas that currently provide essential habitat to UTS, cessation of surface water in the river channel resulting from groundwater extraction would also be considered a significant and unreasonable effect. Monitoring of groundwater levels as a proxy to surface water in these areas should be conducted to avoid impacts to UTS.

In losing reaches, groundwater levels have historically dropped below the river channel during the dry months and during droughts. In these areas, periodic cessation of surface flow in the river channel may not be a significant and unreasonable effect when compared to baseline conditions.

Management Action Triggers

The river exhibits a diverse and complex interaction between surface water and groundwater. Therefore, distinguishing areas sustained by surface water flows and areas sustained by groundwater is not straightforward. The current GDEs have survived through a recent drought that saw historic low groundwater levels in local wells. When groundwater levels are above the historic lows, it can be inferred that GDEs are not adversely affected. As a result, groundwater wells may be used to monitor groundwater elevations to ensure that GDEs are sufficiently maintained throughout the upper SCR. Management Action Triggers may be established as the historic lows for representative locations along river channel.



SOURCE: HistoricAerials.com (1947-2016).

GDE Considerations Assessment

Figure 8
Historic Aerial
1947

ESA

Trigger levels that require a management action may include:

- Groundwater levels within GDE zones that fall below the lowest historic levels (within previous 40 years).
- Groundwater levels used as a proxy for surface water that fall below the lowest historic levels (within previous 40 years) where UTS may be present (e.g., I-5 Bridge area). In these sensitive habitat areas, an intermediate trigger may be warranted that would provide an early warning of declining groundwater levels. Establishing an intermediate trigger at 2 feet above historic lows (or adjusted depending on characteristic seasonal fluctuations) would ensure that evaluation and management actions are implemented in a timely manner if necessary.

A monitoring plan would be needed that would install monitoring wells located in areas suitable for assessing groundwater levels within a GDE zone. Once groundwater levels reach the Management Action Trigger in any of the river reaches, an evaluation of the cause of the decline should be conducted. Historic low groundwater levels may not indicate a significant or unreasonable effect to GDEs for several reasons. The evaluation should consider the following:

1. Is the affected river segment supported by surface flow from WRP discharges? (Surface water may support habitats during temporary periods of low groundwater.)
2. Is the historic low groundwater level already below the tree/shrub root depths? (If so, further declines in the same year may not effect GDEs.)
3. Will the GDEs survive the temporary loss of access to groundwater? (Depending on the season, groundwater levels may be expected to rise above historic lows within a month or two, avoiding permanent loss of habitat. When groundwater levels are restored sufficiently quickly in the winter months, effects to GDEs may not be significant.)
4. Has the Management Action Trigger been reached often in recent years? Droughts that lower groundwater levels are a natural occurrence, but do not occur every year. To sustain GDEs over the long term, groundwater levels affected by drought conditions must recover sufficiently quickly and remain higher most years in order to support healthy, sustainable habitats over the long term.)
5. Are the declines in groundwater levels resulting from pumping?
6. Has new information been obtained that can be used to refine the trigger level in Table 2 above.

Groundwater levels at representative locations may be established and monitored to ensure GDEs are sustained. If groundwater levels reach the Management Action Trigger level, an evaluation of the cause of the decline should be conducted. If the evaluation concludes that the low groundwater levels resuilt from pumping and may result in significant and unreasonable effects, management actions such as reduced groundwater pumping should quickly be enacted to restore groundwater levels at or above trigger levels.

Management and Monitoring Objectives

Management and monitoring objectives include:

- Avoidance of permanent loss and significant degradation of existing riparian or aquatic habitat due to lowered groundwater elevations caused by pumping
- Avoidance of temporary acute loss of aquatic habitat caused by pumping in specific locations critical to sensitive aquatic species

Implementation Next Steps:

- Development of Trigger-Based Monitoring, Evaluation, and Management Action Plan
- Establishment of a Monitoring Plan that provides data to support better understanding of:
  - Groundwater level fluctuations in distinct zones near GDEs
  - Surface water availability and quality
  - Habitat condition
  - Presence and distribution of special status species

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APPENDIX F

Field Data Collection Work Plan,
SCV GSA Temperature Probe and Piezometer Installation

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GSI Water Solutions, Inc.

TECHNICAL MEMORANDUM

Field Data Collection Work Plan, SCV GSA Temperature Probe and Piezometer Installation

To:	Rick Viergutz, SCV Water
From:	Jeff Barry, GSI Water Solutions, Inc.
Attachments:	Figures
Date:	November 20, 2020

Introduction

This work plan was prepared as a guide to activities associated with the installation of 6 temporary piezometers and up to 40 temperature probes within shallow alluvial deposits of the upper Santa Clara River. The work is being performed for the Santa Clarita Valley Water Groundwater Sustainability Agency (SCV-GSA) as part of the Groundwater Sustainability Plan (GSP) development to improve our understanding of surface water and groundwater interconnection. The piezometers and temperature probes will be used to measure water levels and temperature in the alluvium near the river. Temperature sensors placed within or above the water table will be able to detect the temperature signature of the underlying groundwater; thus temperature will be used as a tracer for surface water influence. Because temperature probes will be installed to a depth of 10 feet below ground surface (bgs), they will be located below the effects of diurnal air temperature fluctuations and so they will reflect groundwater temperatures, even though they may not be submerged below the water table. Temperature will also be measured directly in the river. Temperature monitoring will allow identification of locations and time periods where warmer river water (heated by the sun and discharge from wastewater treatment plants) is recharging shallow groundwater and places where cooler groundwater is discharging to the river. The timing and direction of this exchange (gaining or losing stream) may change depending on the time of year and whether it is a dry versus wet year. Changes in temperature in the river, shallow temperature probes, and shallow groundwater will be correlated with river flow and groundwater levels to assess groundwater and surface water interactions over time. Our goal is to monitor these installations for up 18 months.

Figure 1 shows the tentative locations where the temporary piezometers and temperature probes will be located. Locations for existing alluvial wells that have a history of water level data are also shown. The sites were selected to prevent impacts to vegetation and habitat and to provide data in the areas where we believe exchanges between groundwater and surface water are occurring. We anticipate that some of the locations shown on the map will change depending upon accessibility to the area, habitat considerations, river flow considerations, and property boundaries. The probes and piezos will be located on either Fivepoint property or City of Santa Clarita property. The City of Santa Clarita has given approval and is executing an agreement with SCV Water. Access to Fivepoint property is still pending. Both of these organizations will provide final approval for all locations. A permit will also be obtained from the LA County Flood Control District for work in the floodway. The temporary piezometers and temperature probes will be removed by SCV Water once they are no longer needed for monitoring purposes.

A task by task description of the field work that will be performed is presented in the following sections.

Task 1: Confirm Temperature Probe and Piezometer Locations

Figure 1 shows tentative locations for the piezometers and temperature probes. The locations will be field checked prior to installation of equipment to ensure that they can be accessed and that impacts to the vegetation and river habitat are prevented. As a result of the field check, some of the locations shown on Figure 1 may change due to density of vegetation, accessibility for equipment, proximity to river (20 foot setback is desired), and health and safety considerations. Final siting of the temporary piezometers and temperature probes will be coordinated with landowners and the California Department of Fish and Wildlife (CDFW).

The land area approximately west of the I-5 Bridge is owned by Fivepoint and the land east of the I-5 Bridge is owned by the City of Santa Clarita. Permission to access these locations will be obtained prior to conducting any field work. In addition, these sites are located within the floodway and so a minor modification permit will be obtained from the Los Angeles County Flood Control District (LACFCD).

Task 2: Temporary Piezometer Installation and Monitoring

The temporary piezometers will be drilled and installed to a depth of approximately 25 feet (depending on location) using a truck mounted hollow stem auger under the supervision of GSI Water Solutions (GSI) staff. The piezometers will be located outside of the main river channel as shown in Figure 1. Figure 2 provides a schematic diagram of how the temporary piezometers will be constructed. Permits for the construction of the temporary piezometers will be obtained from the appropriate agencies (e.g., LA County) as required.

The piezometers will be fitted with water level transducers and integrated data loggers to allow collection of groundwater level and temperature data on an hourly basis. The data loggers will consist of TD-Divers manufactured by VanEssen Instruments. The TD-Diver is a stainless steel submersible datalogger that is designed for long-term uninterrupted, water level monitoring using a pressure sensor at a fixed level under the water surface. The pressure sensor measures the equivalent hydrostatic pressure of the water to calculate the total water depth, which is autonomously measured along with pressure and temperature then recorded into internal memory. The transducer will be programmed to measure water levels every hour for a one to two year period. The transducer will measure and record temperature to an accuracy of 0.1 °C and a temperature resolution of 0.01 °C. Water levels will also be manually monitored in piezometers on a periodic basis by GSI staff when data loggers are downloaded. Wellhead elevations will be surveyed by SCV Water surveying staff so that depth to groundwater measurements can be converted to groundwater elevations. Given the minimal disturbance from installing the piezometers, it is anticipated that their installation will qualify for a Class 4 CEQA Exemption.

Task 3: Temporary Temperature Probe Installation and Monitoring

A series of temporary temperature probes will be installed within the alluvium near the active river channel at tentative locations shown on Figure 1. Up to 40 probes will be installed to a depth of up to 10 feet within a two-inch diameter protective PVC pipe using either a truck mounted direct push method or hollow stem augur rig. The direct push method involves use of a steel tube with removable point that is pushed into the ground. This method will be used unless it is found that rocks and boulders prohibit advancement of the probes. The probes will be advanced within 25-100 feet of the presently active river channel.

Temperature probes will also be installed in the hyporheic zone sediments of the river bottom, as access allows at selected locations, to allow monitoring of river temperature. We will consult with CDFW to determine the most appropriate method for placing the temperature probes in the hyporheic zone. We anticipate placing the probes in the river sediments and extending the buried cord to the river bank at a marked location so that it can be accessed. It is understood that these probes will be subject to loss during high flow events.

Each temperature probe will consist of a HOBO TMC temperature probe from Onset Computer Corporation of Bourne, MA, which can be used in air, soil & underwater. The temperature probe will measure temperature to an accuracy of 0.25 °C and a temperature resolution of 0.03 °C.

Figure 3 is a schematic diagram showing how the temperature probe assembly will be constructed. The temperature probe will be placed at the bottom of a PVC pipe if a hollow stem augur is used or they will be placed with the backfill of hole made by the steel pipe associated with the push probe assembly. The temperature cable will be brought to the surface and placed within a water tight case placed within a flush mounted irrigation control box. Data loggers will be installed within each control box to record hourly temperature measurements. Metal objects will be placed inside the box so that it can be found with a metal detector if it is buried for some reason.

These probes will be monitored for up to 12 months by GSI and/or SCV Water staff, who will monitor the probes for a period of 6 months during GSP development and 6 months after GSP submittal to determine if it is possible to differentiate times when cooler groundwater is discharging to the river and other times when warmer river water is recharging the groundwater system. Temperature probes also will be installed upstream and downstream of the Saugus and Valencia water reclamation plant (WRP) discharges to differentiate the effects of warm water discharges from WRPs and cooler groundwater discharges to the river. Temperature data will be correlated with river flow and groundwater levels and temperature.

Given the minimal disturbance from installing the piezometers and temperature probes, it is anticipated that equipment installation will qualify for a Class 4 CEQA Exemption. SCV Water anticipates the piezometers and temperature probes will be needed for a period of 12 to 18 months, but may be retained for a longer duration if they provide useful data. They will be removed by SCV Water once they are no longer needed for monitoring purposes.

Figures

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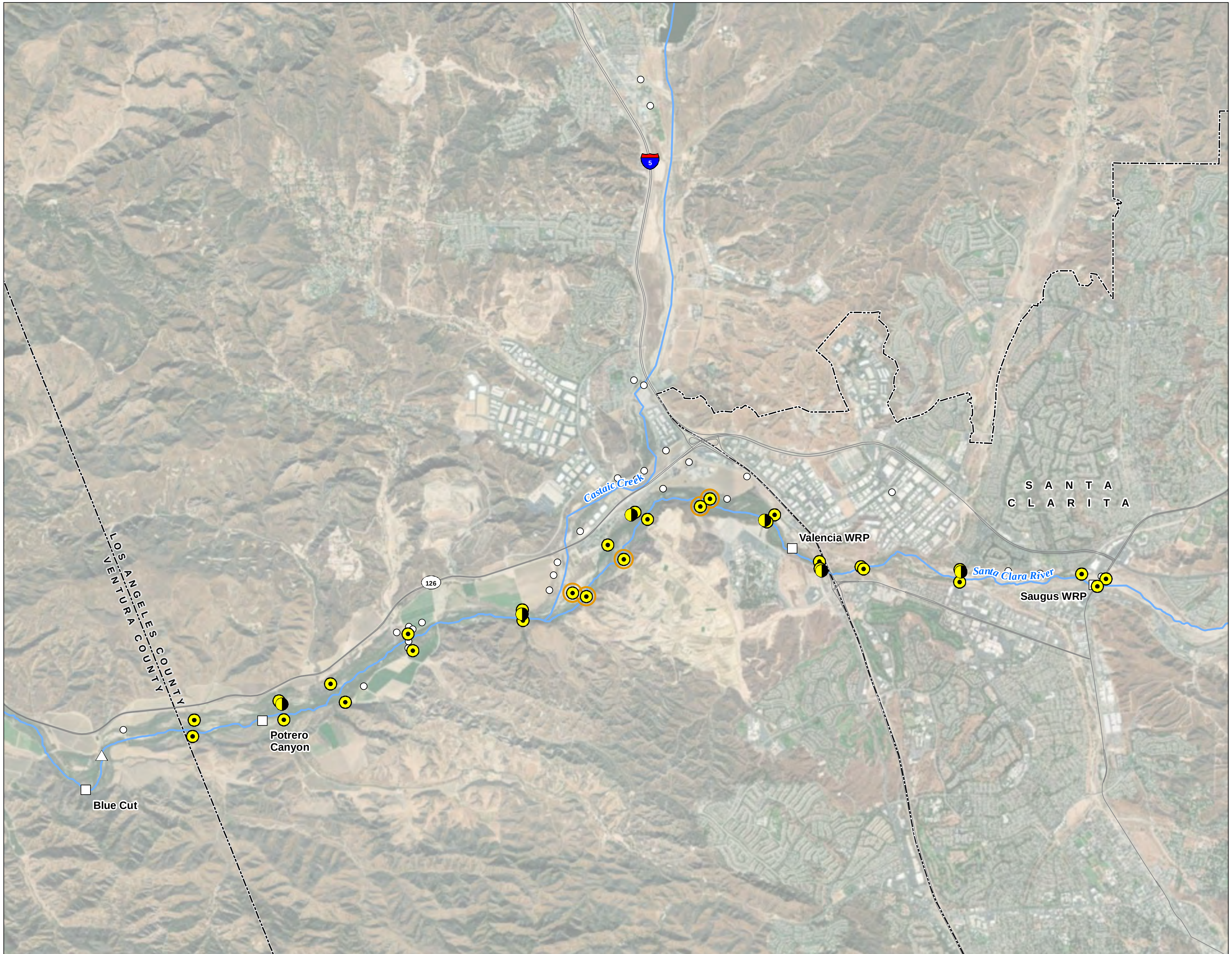

FIGURE 1

Preliminary Piezometer and Temperature Probe Locations

SCV GSA Temperature Probe and Piezometer Installation
Santa Clarita, California

LEGEND

- Potential Temperature Probe Location
- Probe Location to be Discussed, Difficult Access
- Proposed Temporary Piezometer
- Alluvial Well with Water Level Record
- Reach Point
- County Line Gage
- City Boundary
- County Boundary

ALL NEW INSTALLATIONS/IMPROVEMENTS NOT TO BE OWNED OR MAINTAINED BY LACFCD/ LACDPW. TO BE OWNED AND MAINTAINED BY SCV Water.

N

0 2,400 4,800 7,200
Feet

Date: October 23, 2019
Data Sources: USGS, DigitalGlobe 2018

GSI Water Solutions, Inc.

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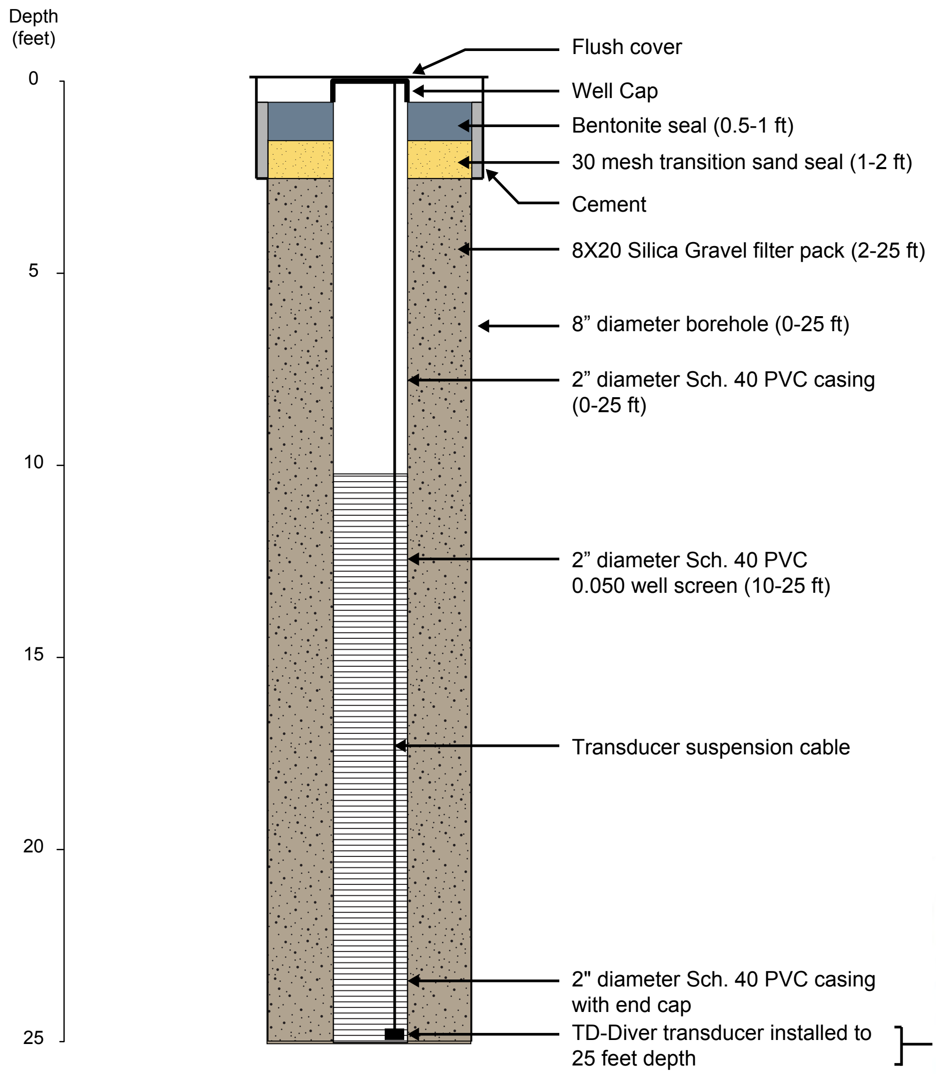

Transducer

NOTE:
Horizontal not to scale

FIGURE 2

Schematic Temporary Piezometer Installation

SCV GSA Temperature Probe and Piezometer Installation
Santa Clarita, California

GSI Water Solutions, Inc.

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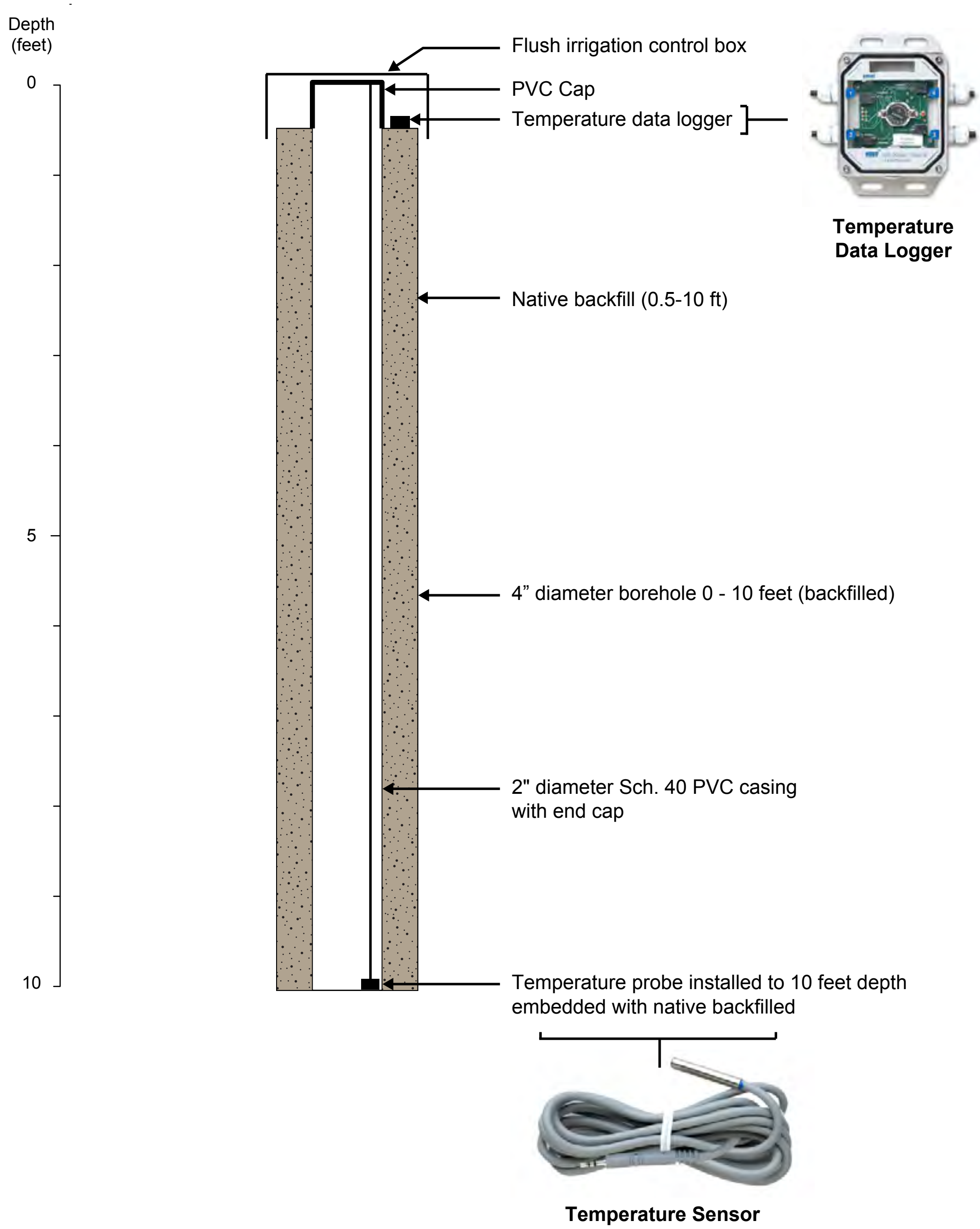

NOTE:
Horizontal not to scale

FIGURE 3

Schematic Temperature Probe Installation

SCV GSA Temperature Probe and Piezometer Installation
Santa Clarita, California

APPENDIX G

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

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Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

December 2021

Prepared for:

Santa Clarita Valley Groundwater Sustainability Agency

SCV GSA

Prepared by:

GSI Water Solutions, Inc.

55 SW Yamhill St., Suite 300, Portland, OR, 97204

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Abbreviations and Acronyms

AFY	acre-feet per year
ASR	aquifer storage and recovery
ASTM	American Society for Testing and Materials
BMPs	Best Management Practices
CGSTAB	Orthomin/stabilized conjugate-gradient package
CHD	time-variant specified head package
CIMIS	California Irrigation Management Information Service
CLN	Connected Linear Network
CLN	Connected Linear Network package
County Line	Los Angeles/Ventura County Line
CVFD	control volume finite difference
DEM	digital elevation model
DWR	California Department of Water Resources
East Subbasin	Santa Clara River Valley East Groundwater Basin
ESA	Environmental Science Associates
ET	evapotranspiration
EVT	Evapotranspiration package
ft/day	foot per day
ft^2/day	square feet per day
GAGE	Gage package
GHB	General Head Boundary package
GIS	geographic information systems
gpd	gallons per day
gpd/ft	gallons per day per foot
GSI	GSI Water Solutions, Inc.
GSP	groundwater sustainability plan
GUI	graphical user interface
GV	Groundwater Vistas
HFB	Horizontal Flow Barrier package
HSPF	Hydrologic Simulation Program – FORTRAN
I-5	Interstate 5
LA	Los Angeles
LACFCD	Los Angeles County Flood Control District
LACWWD36	Los Angeles County Waterworks District 36
LADPW	Los Angeles Department of Public Works
LSCE	Luhdorff and Scalmanini Consulting Engineers
mi^2	square miles
MNW	Multi-Node Well package
NAD83	North American Datum of 1983

NAVD88	North American Vertical Datum of 1988
NED	National Elevation Dataset
NLF	Newhall Land & Farming Company
NWD	Newhall Water Division
RCH	Recharge package
regional model	Santa Clarita Valley Groundwater Flow Model
SCV Water	Santa Clarita Valley Water Agency
SCV-GSA	Santa Clarita Valley Groundwater Sustainability Agency
SCVGWFM	Santa Clarita Valley Groundwater Flow Model
SCWD	Santa Clarita Water Division
SFR	Streamflow-Routing package
SGMA	Sustainable Groundwater Management Act
SMS	Sparse Matrix Solver package
TIB	Transient IBOUND package
TNC	The Nature Conservancy
USGS	U.S. Geological Survey
UWCD	United Water Conservation District
VWD	Valencia Water Division
WELL	Well package
WRP	water reclamation plant

SECTION 1: **Introduction**

1.1 Background

This report describes the development of a three-dimensional numerical groundwater flow model for the groundwater basin located in the Santa Clarita Valley in northwestern Los Angeles County, California. The model simulates conditions in the local groundwater basin, which is defined in California Department of Water Resources (DWR) Bulletin 118 as the Santa Clara River Valley East Subbasin (DWR Basin 4-4.07). As shown in Figure 1-1, the Santa Clara River Valley East Groundwater Basin (East Subbasin) is the eastern-most and furthest upstream subbasin in the group of six subbasins that together comprise the Santa Clara River Valley Groundwater Basin.

The groundwater model simulates the occurrence and movement of groundwater flow in the East Subbasin, which contains two aquifers: a surficial aquifer called the Alluvial Aquifer and an underlying thick aquifer system that is present in a geologic unit called the Saugus Formation. The model simulates groundwater flow processes and groundwater budgets in both aquifers, as well as the connection of the local groundwater resources to the Santa Clara River and its tributaries. The model uses multiple layers to provide a three-dimensional representation of groundwater movement horizontally within individual model layers and vertical movement between layers. This model is called the Santa Clarita Valley Groundwater Flow Model (SCVGWFM or the regional model). This model uses the U.S. Geological Survey (USGS) software MODFLOW-USG (Panday et al., 2013; Panday, 2019) and replaces a model that was first developed in 2004 (CH2M HILL, 2004a) using the European MicroFEM finite-element software (Hemker and de Boer, 2003 and 2017). The model has been developed by GSI Water Solutions, Inc. (GSI), for the Santa Clarita Valley Water Agency (SCV Water) to use as its primary tool for analyzing groundwater management options in the context of future water demand and water supply conditions in the East Subbasin. Figure 1-2 shows the locations of the service areas for SCV Water, its three retail divisions (the Newhall Water Division [NWD], the Santa Clarita Water Division [SCWD], and the Valencia Water Division [VWD]), and a fourth retailer (Los Angeles County Waterworks District 36 [LACWWD36]) that works cooperatively with SCV Water on groundwater basin management and planning activities. Figure 1-3 shows the locations of production wells that were present as of 2019, categorized by whether they are completed in the Alluvial Aquifer or the Saugus Formation.

1.2 Modeling Objectives

In accordance with the requirements of the State of California's Sustainable Groundwater Management Act (SGMA), the Santa Clarita Valley Groundwater Sustainability Agency (SCV-GSA) is developing a groundwater sustainability plan (GSP) for the East Subbasin. As the local wholesaler and supplier of municipal water supply in the Santa Clarita Valley, SCV Water is working cooperatively with the SCV-GSA to develop and implement the GSP. As part of supporting GSP development, and to facilitate future groundwater management activities, SCV Water commissioned the development of a MODFLOW-USG version of the regional model for the purposes of (1) using well known and widely used software that is in the public domain (i.e., MODFLOW-USG) and (2) providing detailed and sophisticated methods of simulating stream/aquifer interactions to support future water budget analyses and subsequent GSP planning and implementation activities. The new regional model was designed and developed to support GSP development and implementation as follows:

1. The regional model will be used to develop historical, present, and future water budgets as required by SGMA and as described by DWR in two documents that provide Best Management Practices (BMPs) for groundwater modeling (DWR, 2016a) and water budget development (DWR, 2016b).

Climate change effects on pumping sustainability will also be assessed using the regional model, as described in DWR's two climate change guidance documents (DWR, 2018a and 2018b).

2. The regional model will be used to help develop minimum thresholds and measurable objectives for sustainability indicators.
3. The regional model will be used to assess the effectiveness and benefits of a range of programs and projects designed to maintain the sustainability of pumping in the basin and avoid undesirable results.
4. The regional model will be used to help evaluate the potential effects of groundwater management activities on surface water resources and groundwater-dependent ecosystems (GDEs), which is one sustainability indicator under SGMA.
5. The alternatives evaluation is anticipated to consider a variety of different strategies for groundwater pumping, banking of imported and/or treated water supplies, and discharges of treated water into the Santa Clara River.
6. The new regional model will be used to guide development of the GSP and support future implementation and monitoring programs, and, given the model's ability to simulate groundwater levels in pumping and non-pumping wells, provide detailed water budgets anywhere desired in the model domain, as well as calculate in-stream flow rates.
7. The regional model's simulation capabilities and its familiarity to the groundwater modeling community will support model review efforts and future refinements when needed—attributes that in turn are expected to support stakeholder communications and engagement.

1.3 Previous Hydrogeological, Water Use, and Modeling Studies

Groundwater level and pumping records in this groundwater basin have been maintained by the purveyors and certain private well owners for many years, in some cases dating back to the 1950s. Additionally, the basin's geology and hydrology have been the subject of several prior studies, and several other studies have used groundwater modeling to support planning efforts related to water supply sustainability and groundwater quality protection. Following is a list of the studies that are most pertinent to the development of the regional model:

- **Basin-Wide Hydrogeologic Characterization Studies (USGS, 1972; RCS, 1986, 1988, 2002).** The USGS (Robson, 1972) conducted the first water resource investigation of the basin. This study examined the hydrogeologic characteristics of both aquifer systems and included the development of an electric analog model to evaluate the feasibility of artificial recharge into the alluvium (using planned imported water supplies). Later, Richard C. Slade & Associates (RCS) conducted more detailed studies to characterize the extent, thickness, and geologic structures in the Saugus Formation (RCS, 1988 and 2002) and the Alluvial Aquifer (RCS, 1986). These reports also summarized the water well construction and testing information and basin-wide groundwater elevation and groundwater quality data that were available at those times. These studies provide the basis for understanding geologic conditions regionally and in local sub-areas.
- **Geophysical and Hydrogeologic Characterization Study at and near the Western Basin Boundary (Geomatrix, 2007).** As part of a study to develop Total Maximum Daily Loads (TMDLs) for the Santa Clara River, Geomatrix conducted a surface geophysics program to evaluate the total thickness and saturated thickness of the Alluvial Aquifer at and near the western boundary of the

East Subbasin, which is near the Los Angeles (LA)/Ventura County Line. The study was conducted to fill a data gap arising from the absence of wells in this area. The field program consisted of first drilling soil borings and conducting geophysical logging in each boring, followed by conducting seismic refraction sounding surveys along four profile lines totaling approximately 9,000 linear feet. Of the four surveyed profile lines, one was conducted along an access road located at the County Line, and a second was conducted approximately 0.8 mile upstream of the County Line along an access road leading to the mouth of Potrero Canyon. These two profiles provided critical data for defining the thickness of the Alluvial Aquifer in the new regional model for the East Subbasin.

- **Development of Prior Conceptual and Numerical Groundwater Models (CH2M HILL, 2004a and 2005; GSI and LSCE, 2013).** These reports document the initial development of—and refinements to—the local water purveyors' prior numerical model, which used the MicroFEM finite-element software (Hemker and de Boer, 2003 and 2017). The original model used seven layers to simulate the variability in aquifer thickness across the East Subbasin. As discussed by GSI and Luhdorff and Scalmanini Consulting Engineers (LSCE 2013), one of the model layers in the Saugus Formation was later subdivided to provide more vertical resolution in the model simulations, which resulted in the model using eight layers to simulate groundwater flow. Through the course of the three work efforts documented by the above-referenced reports, the model was calibrated to a 32-year record of monthly groundwater elevations and estimates of monthly groundwater discharges to the Santa Clara River (derived from streamflow and other records).
- **Annual Reports (such as LSCE, 2020).** These reports provide information annually about the water supply conditions for the Santa Clarita Valley, including the annual volumes of groundwater pumping and other water uses dating back to 1980. Each annual report describes the state of the local groundwater resources, as well as the state of water supply requirements and other sources of water supply to the Santa Clarita Valley. Each report reviews the sufficiency and reliability of water supplies to meet the prior year's demand, and then provides a short-term outlook of water supply and demand for the following year. These reports have been prepared annually since 1998 for the local wholesale and retail water purveyors to use for their internal future reference and for communications with local stakeholders.

The new regional model (using the MODFLOW-USG software) builds upon the capabilities of the original model (using the MicroFEM software). As such, the original model was an important starting point for development of the new regional model. The original model was developed as part of a Memorandum of Understanding (MOU) that was entered into in August 2001 by the local water purveyors and the United Water Conservation District (UWCD), located downstream in Ventura County.[1] The new regional model uses the original model's layering system to represent the two aquifers in the basin, uses similar techniques and tools to define groundwater recharge and discharge processes in the model, and relies on the historical records of groundwater levels and streamflows compiled over the years for prior model calibration purposes (with additional data for the years 2013 through 2019). The original model was used for several past studies, including the following:

- Evaluating the long-term sustainability, or operational yield, of the Alluvial Aquifer and the Saugus Formation for multi-decadal periods of fluctuating local hydrology and imported water availability (CH2M HILL and LSCE, 2005; LSCE and GSI, 2009) which has supported the

[1] Memorandum of Understanding Between the Santa Clara River Valley Upper Basin Water Purveyors and United Water Conservation District. August 2001.

development of the 2015 Urban Water Management Plan (UWMP; KJC et al., 2016) and prior UWMPs since 2005.

- Evaluating offsite pumping strategies to capture, contain, and prevent further spreading of a perchlorate plume that is present in the Saugus Formation near the Whittaker-Bermite property (CH2M HILL, 2004b; GSI and LSCE, 2014).
- Developing time-varying groundwater budgets (GSI, 2014a) to support development of the basin's Salt Nutrient Management Plan.
- Evaluating alternative locations and rates for recharge of the Alluvial Aquifer by infiltrating treated water and/or imported water supplies in spreading basins (Carollo, 2015; KJC, 2016; GSI, 2017a).
- Evaluating aquifer storage and recovery (ASR) of imported water supplies as a method for augmenting pumping capacities from the Saugus Formation during curtailment years for imported water supplies (Carollo, 2015).
- Evaluating the potential rates and locations of temporary groundwater pumping redistribution to respond to short-term water level declines in certain Alluvial production wells at the east end of the basin during the middle of the recent drought that began in the latter half of 2011 (GSI, 2014b).
- Evaluating the potential range of effects of climate change on groundwater recharge rates and timing (from precipitation and streamflows) and on the basin pumping plan (LSCE and GSI, 2009; GSI, 2017b).

1.4 Conceptual Model Overview

A conceptual model of a groundwater basin's hydrogeology and water supply conditions is a descriptive construct that serves as the primary underlying basis for developing a numerical groundwater flow model. A conceptual model typically describes the basin's geographic setting and climate; its geology and the water-bearing potential of its various geologic units; groundwater occurrence and movement, including the connections that exist between multiple aquifers in a basin; the hydraulic properties of its aquifers; recharge and discharge processes for the basin's aquifers; the amounts and local uses of groundwater and other water supplies; and the temporal aspects of water use and the natural hydrologic system.

The East Subbasin lies within the relatively flat-lying Santa Clarita Valley and portions of the surrounding hills and mountains. Developable quantities of groundwater are present in the alluvium and in portions of the Saugus Formation. These units are underlain and laterally bounded by non-water-bearing bedrock units that are Miocene, Oligocene, and pre-Tertiary in geologic age and which do not contain significant quantities of water that can be developed for municipal purposes. Figure 1-4 shows the location of the groundwater basin within the local watershed, along with the locations of stream gages situated within or near the groundwater basin. Figure 1-5 identifies the tributaries and subwatersheds that extend upstream of the groundwater basin boundary and contribute surface flow into the groundwater basin area.

The hydrologic processes that affect groundwater conditions in the Alluvial Aquifer and the Saugus Formation are the following:

- Groundwater recharge processes, which consist of:
  - Deep percolation of precipitation directly over the basin
  - Streambed leakage of storm flows in ephemeral streams (which are the tributaries to the Santa Clara River and the reach of the Santa Clara River extending upstream from the mouth of San Francisquito Canyon)

- Streambed leakage of water that is discharged into the Santa Clara River from two water reclamation plants (WRPs), the Saugus and Valencia WRPs; see Figure 1-2 for their locations
- Streambed leakage of water that is discharged into Castaic Creek from periodic water releases out of Castaic Lagoon
- Streambed leakage of water that is discharged into Bouquet Creek from periodic water releases out of Bouquet Reservoir
- Deep percolation of water that is used for irrigation of certain agricultural lands (including leakage from conveyance systems)
- Deep percolation of water that is used outdoors in urban areas (including leakage from urban water supply conveyance systems)
- Deep percolation from septic systems in certain rural areas where residential developments are served by public water supplies, but not sanitary storm sewers
- Lateral subsurface inflow of groundwater into the Alluvial Aquifer (beneath Castaic Dam and where tributaries enter the groundwater basin)

- Groundwater discharge processes, which consist of:
  - Groundwater extraction (pumping) by agricultural, municipal, and private domestic well owners and for groundwater treatment/remediation systems
  - Evapotranspiration by deep-rooted phreatophytes (withdrawing water from the water table, not just from the unsaturated zone)
  - Groundwater discharge to streams (primarily to portions of the Santa Clara River west of the mouth of Bouquet Canyon)
- Changes in the volume of groundwater in storage

Figure 1-6 shows the areal extent of the Alluvial Aquifer and the Saugus Formation. The Alluvial Aquifer is present in the alluvial valley occupied by the Santa Clara River and also in alluvium that lies in each tributary valley. Development of agricultural and municipal groundwater supplies from this unconfined aquifer has occurred primarily in the alluvial valleys that contain the Santa Clara River and Castaic Creek, and also in the lower reaches of Bouquet Canyon and San Francisquito Canyon. The Saugus Formation contains lenticular and interfingered beds of poorly to well-consolidated sandstone, conglomerate, and siltstone that are at least 7,500 feet thick in the deepest part of the basin. RCS (1988 and 2002) found that the groundwater-yielding capability of the Saugus Formation is likely limited north and east of the San Gabriel Fault compared with areas lying south and west of the fault (where all Saugus groundwater development has occurred to date).

See Appendix A for further discussions of the basin's geographic setting, climate, geology, and groundwater occurrence. Section 3 of this report and a separate report discussing surface water/groundwater interactions (GSI, 2021a) contain more in-depth discussions and quantification of the hydrologic processes that are simulated in the model. Detailed discussions of historical water uses in the East Subbasin are presented in a separate report on the development of water budgets in the East Subbasin (GSI, 2021b).

1.5 Report Organization

The remainder of this report is organized as follows:

- Section 2 discusses the selection of the groundwater flow model software code, then provides a description of the code's design, its input and output files, and other supporting software.
- Section 3 discusses the construction of the numerical model, including the modeling software; the extent of the model domain; the design of the model grid spatially and vertically; the model's boundary conditions and the modeling packages that represent them; the estimation of

groundwater recharge rates to use in the model; the assignment of groundwater pumping rates and their allocation among layers; and initial estimates of the potential ranges in magnitude of aquifer hydraulic properties (transmissivity, horizontal and vertical hydraulic conductivity, storativity, and specific yield).

- Section 4 describes the calibration process for the numerical model; the historical data sets that were used to conduct calibration and their method of simulation in the model; the calibration results; observations of model parameter sensitivity that were made during calibration; and the outcome of the calibration process as it relates to the model's usefulness and limitations.
- Section 5 discusses the applicability of the numerical model for use in managing local groundwater resources, including a summary of certain key attributes that make it useful for these purposes.
- Section 6 is a list of references cited in this report.
- Appendices A through E provide supporting material.
  - Appendix A Summary of Physical Setting and Hydrogeology for the East Subbasin
  - Appendix B SCV Recharge Compiler
  - Appendix C 2007 Geophysical Study Report
  - Appendix D Published Groundwater Elevation Contour Maps for the Year 2000
  - Appendix E Stream Gage Sites near the Western Boundary of the East Subbasin

This report is one of a series of reports for the East Subbasin that present the hydrogeologic conceptual model (RCS, 2021; LSCE, 2021), the understanding of groundwater/surface water interactions (GSI, 2021a), and detailed analyses of historical and projected surface and groundwater budgets (GSI, 2021b). Together, these reports build upon the prior studies described in Section 1.3 and provide the current updated understanding of the geologic, groundwater, surface water, and water use conditions in the East Subbasin.

SECTION 2: **Selection and Description of the Modeling Software**

The GSP regulations state the following regarding the software codes to be used under SGMA for groundwater and surface water models:

> *23 CCR §352.4(f) Groundwater and surface water models used for a Plan shall meet the following standards:*
> *(1) The model shall include publicly available supporting documentation.*
> *(2) The model shall be based on field or laboratory measurements, or equivalent methods that justify the selected values, and calibrated against site-specific field data.*
> *(3) Groundwater and surface water models developed in support of a Plan after the effective date of these regulations shall consist of public domain open-source software.*

As stated by DWR's BMP guidance document for groundwater resources modeling (DWR, 2016a), the public domain and open-source software requirement only applies to model codes that solve the equations for groundwater flow and transport, and does not apply to other supporting tools and software that are used to generate model input files or process model output data. The modeling BMP also discusses that it is highly likely that a groundwater model will be part of an ongoing long-term effort to support and provide for sustainable management of a groundwater basin; accordingly, the model must be able to be adapted to refined hydrogeologic interpretations and to incorporate additional data that are acquired over time from studies and monitoring programs.

In addition to the SGMA requirements for modeling software, SCV Water sought specific capabilities in a new groundwater model, particularly relating to estimating surface water flow rates in streams, interfacing with visualization software, and supporting peer-review and stakeholder engagement processes during GSP development. Accordingly, this section of the report discusses the process for selecting the software tools (Section 2.1), a description of the core groundwater modeling software and its input and output files (Sections 2.2 and 2.3), and a description of two other software tools that support the groundwater modeling software (Section 2.4).

2.1 Software Selection

Prior to development of the new regional model, SCV Water and GSI conducted an evaluation in early 2018 of multiple software codes that provide three-dimensional numerical solution capabilities for groundwater flow, capture-zone, and flowline analyses, and that can support water quality studies in some manner. Codes that were evaluated were the finite-element model MicroFEM; two groundwater flow models developed by the USGS (the structured finite-difference-grid model MODFLOW-NWT [Niswonger et al., 2011] and the unstructured-grid version of MODFLOW named MODFLOW-USG [Panday et al., 2013; Panday, 2019]); and an integrated watershed-groundwater model developed by the USGS (GSFLOW [Markstrom et al., 2008]), which uses an older version of the MODFLOW structured finite-difference-grid software for its groundwater simulations (MODFLOW-2005 [Harbaugh, 2005]). The comparison of these codes was conducted using an evaluation similar to, but more detailed than, that described by DWR in its BMP document for groundwater modeling under SGMA (see Figure 4 in the modeling BMP) (DWR, 2016a). Each model was evaluated using qualitative and quantitative ranking systems that evaluated each software code against 43 different capabilities and characteristics that were grouped into the following five categories:

- Methods for simulating surface water/groundwater exchanges and for simulating hydrologic processes in stream channels
- Methods for simulating surface hydrologic processes outside of stream channels

- Methods for simulating groundwater hydraulics, with particular emphasis on simulating well/aquifer interactions and drawdown in the long-screened production wells in the Saugus Formation (which span multiple model layers)
- Numerical implementation methods, such as flexibility in grid design; simulation of the drying and potential re-wetting of individual model grid cells over time; the types of solver algorithms and the ability to adjust solver parameters to increase run-time efficiency and solution accuracy; and other run-time logistical characteristics (such as memory requirements, file sizes, and file management)
- Other implementation considerations, including the availability of (and support by) commercially or publicly available graphical user interfaces (GUIs); access to technical support and training; linkages to particle-tracking and solute-transport models and calibration software; data exchange with geographic information systems (GIS) and data visualization and animation software tools; and the familiarity of the groundwater modeling community outside of the USGS with each software code

The analysis resulted in MODFLOW-USG and MODFLOW-NWT scoring substantially higher than GSFLOW and MicroFEM because of their particularly robust groundwater simulation capabilities, the availability of well-supported GUIs, their detailed and flexible solvers, their ability to communicate with other software packages, the broad familiarity and support of the groundwater modeling community with the MODFLOW family of software codes and the GUIs that support them, and the subsequent benefits that are expected to accrue to SCV Water during peer reviews of the model and communication with external stakeholders. While the MicroFEM software has also provided robust simulation capabilities to date, the MODFLOW-USG model offers additional benefits as follows:

1. It is part of the MODFLOW family of software tools, which are the most widely known models in the groundwater and hydrologic modeling community. These tools are widely used and are supported by multiple GUIs and visualization programs that facilitate the pre-processing, post-processing, information management, and visualization aspects of groundwater modeling efforts. The USGS provides ongoing support and continued development of the MODFLOW family of modeling codes, and training programs and conferences are widely available through the USGS and other public and private entities.
2. MODFLOW-USG provides a variety of flexible gridding methods and grid types that allow a grid to have high spatial resolution where needed (such as the finite-element method built into MicroFEM), without adding more grid nodes/cells in places where higher resolution is unnecessary. These gridding methods also provide the capability to simulate the thinning and pinching out of model layers/geologic units in a more robust manner than is available with the other software codes that were evaluated.
3. MODFLOW-USG provides more detailed and sophisticated methods of representing stream/aquifer interactions than are available in MicroFEM, including in particular the ability to calculate flow rates and instream channel hydraulics during the groundwater solution process.
4. MODFLOW-USG has a robust Connected Linear Network (CLN) package that greatly facilitates the process of simulating water levels in long-screened production wells, such as those in the Saugus Formation. This package is similar to the Multi-Node Well (MNW2) package (Konikow et al., 2009) that is used for structured grids in MODFLOW-NWT (Niswonger et al., 2011) and MODFLOW-2005 (Harbaugh, 2005). However, the CLN package allows for specification of well efficiency values, whereas MNW2 makes use of empirical well-loss coefficients that are often unmeasured or harder to derive from commonly used aquifer test analysis methods than well efficiency estimates.

5. Packages that are available in the structured version of MODFLOW (MODFLOW-NWT; Niswonger et al., 2011) are also supported by MODFLOW-USG, most importantly including:
    a. The Streamflow-Routing (SFR7) package, which is based on the SFR2 package (Niswonger and Prudic, 2010) for structured grids and is used to simulate both the perennial and ephemeral reaches of the Santa Clara River, as well as each of the ephemeral tributaries to the Santa Clara River;
    b. The Evapotranspiration (EVT) package, which simulates groundwater withdrawal by phreatophytes; and
    c. The Horizontal Flow Barrier (HFB6) package, which is based on the original HFB package of Hsieh and Freckleton (1993) and which simulates the flow-limiting influence of fault zones.
6. MODFLOW-USG provides the capability to simulate the movement and concentration of inorganic (geochemical) constituents and organic chemicals in groundwater, using the Block-Centered Transport process documented by Panday (2019).

Compared with the original model, SCV Water and GSI identified that the basin's groundwater modeling capabilities and local water resources management/planning activities would benefit from MODFLOW-USG having the following attributes and functionality:

- Substantially more sophisticated and direct simulation of the occurrence of dry cells and the time-dependent variability in dry compared with partially or fully saturated conditions in a given model cell
- Substantial gains in the flexibility to adjust solver parameters, which facilitates solution convergence and run-time efficiency (particularly when the model contains dry cells)
- Substantial efficiency gains and decreased time requirements for conducting detailed analyses of groundwater elevations, groundwater budgets, and stream/aquifer interactions
- Increased flexibility to modify the spatial grid, the model's layering, and the various input terms that are needed to represent surface and subsurface hydrologic processes
- Increased efficiencies conducting sensitivity analyses, updating/checking model calibration, choosing efficient solver algorithms, minimizing model run times, streamlining file management, and linking to Cloud computing resources if warranted
- Substantially greater capabilities contained in commercial GUIs, which facilitates (1) visualizing and managing the modeling process real-time; (2) evaluating, displaying, and reporting model output; and (3) importing and exporting geologic and hydrologic data and simulation results with other commercial packages for three-dimensional visualization and animation

2.2 MODFLOW-USG Code Description

As described by Panday et al. (2013), MODFLOW-USG was developed to support a variety of unstructured grid types that can provide a user with the ability to generate spatially irregular types of grids, in marked contrast to the rectangular (structured) grids that are common to finite-difference models such as MODFLOW-NWT and its predecessors. The types of irregular (unstructured) grids supported by MODFLOW-USG include local rectangular grids nested inside a structured regional model grid, and other grid types that do not require the use of a structured parent grid but instead can solely make use of prismatic triangles, rectangles, hexagons, and other cell shapes. The new regional model for the East Subbasin uses Quadtree gridding methods, which consist of high-resolution (small) rectangular cells that can be arranged in an irregular geometry within the lower-resolution (larger cells) parent grid. Rather than representing the three-dimensional groundwater flow equation using the traditional finite-difference formulation inherent to structured grids, MODFLOW-USG uses a control volume finite difference (CVFD) formulation, which allows a given model cell to be connected to an arbitrary number of adjacent cells, thereby providing significant capability to connect areas of low and high spatial resolution and to simulate the thinning and pinching out of individual model layers.

Like its predecessor code MODFLOW-NWT, the MODFLOW-USG code provides robust solution methods for solving the drying and rewetting of individual cells in the model grid. This is achieved using an upstream weighting approach for calculating inter-cell hydraulic conductance terms, and by addressing the nonlinearities of the unconfined groundwater-flow equation that arise during cell drying and rewetting by using a Newton-Raphson formulation for the nonlinear solver. The upstream weighting method treats the nonlinearities of cell drying and rewetting by using a continuous function of groundwater head, rather than discrete methods used in earlier versions of MODFLOW. This formulation creates an asymmetric matrix that must be solved, unlike the standard MODFLOW formulations for structured grids which solve a symmetric matrix. Accordingly, MODFLOW-USG contains a new solver package called the Sparse Matrix Solver (SMS) package, which for the linear solver includes an Orthomin/stabilized conjugate-gradient (CGSTAB) package called χMD (Ibaraki, 2005). As stated in the documentation for MODFLOW-USG, the SMS package provides several methods for resolving nonlinearities and supports multiple symmetric and asymmetric linear solution schemes to solve the matrix arising from the flow equations and the Newton-Raphson formulation, respectively. For the new regional model in the East Subbasin, GSI to date has primarily used the Delta-Bar-Delta/Newton-Raphson nonlinear solution method and the χMD Orthomin/linear solver for most simulations.

2.3 MODFLOW-USG Input and Output Files

The primary input and output files associated with a given MODFLOW-USG simulation of the new regional model for the East Subbasin are provided in Sections 2.3.1 and 2.3.2.

2.3.1 Input Files

Eighteen primary input files are used to construct and run the MODFLOW-USG flow model simulations for the new regional model in the East Subbasin. These are:

- The .NAM file, which lists the names of all input files to be read and all output files to be created (see also the .MFU file created by the GUI which runs the model)
- The .BAS file, which identifies which cells are active versus inactive in each model layer, and also specifies the initial groundwater elevations to use at each active cell in the model
- The .LPF file, which specifies the layer type flag (which is set to a value of 4 for upstream weighting), the method of calculating interblock transmissivity, the values of aquifer properties (horizontal and vertical hydraulic conductivity and anisotropy, specific yield, and specific storage), and the head value to be specified for dry cells
- The .DIS file, which contains grid discretization information, including the number of grid nodes, the horizontal area of each grid cell/node, the number of layers, the top and bottom elevations of each grid cell/node, stress period and time step information, and the measurement units for length and time (see also the files *nodes.csv* and *nodes_xyz.csv* for other related grid information)
- The .SMS file, which contains the specifications for the linear and nonlinear solver routines
- The .OC file, which is the output control file specifying the writing of results to the model run log file (the .LST file) and to the various binary output files containing the model results

- The initial-heads file, which contains starting groundwater elevations for the beginning of the simulation
- Eleven separate files for flow processes:
  - The .RCH file for the RCH package
  - The .EVT package for evapotranspiration (by phreatophytes withdrawing water from the water table)
  - The .CHD file for time-variant specified heads
  - The .HFB file for faults
  - The .SFR file for groundwater/surface water interactions
  - The .GAG file for streamflow calculations
  - The .WEL file for specified subsurface inflows, for Alluvial Aquifer pumping, and for storing pumping rates for Saugus Formation wells (which are simulated using the CLN package)
  - The .GHB file for head-dependent subsurface inflows
  - The .CLN file for connected linear networks (wells spanning multiple model layers)
  - The *well-info.csv* file, which contains basic data for each CLN well
  - The .TIB file for the transient IBOUND array (which specifies the periods that CLN wells are not physically present during a transient simulation, as documented by Panday [2019])

2.3.2 Output Files

Each simulation of the new regional model creates the following seven output files for each period during the simulation:

- The .HDS file, which is a binary file containing the computed heads (groundwater elevations) calculated at each node in the aquifer matrix
- The .CLN.HDS file, which is a binary file containing the computed heads inside each CLN well
- The .DDN file, which is a binary file containing the drawdowns (the changes in water levels since the beginning of the simulation) at each node in the aquifer matrix
- The .CBB file, which is a binary file containing the cell-by-cell flux terms in and out of each cell face in the aquifer matrix
- The .CBCLN file, which is a binary file containing the computed flux terms in and out of each CLN well
- The FLOWREDUTION.DAT file, which is a text file listing any reductions in pumping (due to dewatered cells) that might have occurred at one or more wells at any given period during the simulation
- The GAGE_STR.DAT file, which is a text file providing the streamflow and channel calculations from the SFR7 package for each period during the simulation

2.4 Supporting Software

In addition to using MODFLOW-USG, the new regional model relies on other two key companion codes for its successful operation.

2.4.1 Graphical User Interface

Version 7 of Groundwater Vistas (GV) is the GUI that was used to develop the model and manage the modeling process (ESI, 2017). GV is a popular and widely used program for managing model simulations and has an enhanced level of support for MODFLOW-USG. GV supports the entire family of MODFLOW codes for groundwater flow, particle-tracking, and solute transport. GV also supports certain codes developed by parties other than the USGS, including (1) the mod-PATH3DU particle-tracking code (Muffels et al., 2018) developed specifically for MODFLOW-USG and (2) the PEST suite of utilities for model calibration (Doherty and Hunt, 2010; Doherty et al., 2010a and 2010b). The new regional model was developed primarily using Version 7.24, Build 220 of GV, which was released in May 2020. The simulations developed to date with the new regional model (using GV Version 7) are expected to be readily usable in newer versions of GV, based on its long record of compatibility importing existing models into new updated versions of the GV software.

2.4.2 SCV Recharge Compiler

The SCV Recharge Compiler is a Visual Basic program developed in Microsoft Excel that was written by GSI to translate all recharge terms into the form that is needed by the RCH package for MODFLOW-USG. This tool specifies the total amount of recharge occurring at each grid node in the uppermost model layer, and for each period during a given model simulation. The design of this tool also allows for calibration of various recharge terms, such as the relationship between rainfall and deep percolation outside of streambeds, and the infiltration rates (streambed hydraulic conductivity values) for ephemeral reaches of streams. This tool also estimates the surface flow entering the model in ungaged tributary streams from the upper reaches of their watersheds (i.e., the portion of the watershed upstream of the East Subbasin), and it provides mechanisms for tracking and infiltrating this flow as a given ephemeral stream enters the groundwater basin. (The subsequent return of infiltrated water back into streams from the groundwater system is handled in the SFR7 package, as discussed in Section 3.3.) Figure 2-1 shows the hydrologic processes that are implemented in the SCV Recharge Compiler and shows the process flow chart for use of this tool during a given model simulation. See Appendix B for further details about the construction of this tool and the specification of input values for the various hydrologic processes that it evaluates.

SECTION 3: **Model Construction**

This section discusses the new regional model's grid design (Section 3.1); its layering (Section 3.2); its boundary conditions (Section 3.3); the methods and data used to estimate groundwater recharge rates (Section 3.4); the assignment of historical pumping in the model, from both the Alluvial Aquifer and the Saugus Formation (Section 3.5); and the assignment of aquifer physical properties (Section 3.6).

3.1 Grid Design

The grid uses the California State Plane Zone 5, North American Datum of 1983 (NAD83) horizontal coordinate system. The grid consists of square cells having a 500-foot regular grid spacing regionally (in the parent grid), with a Quadtree grid consisting of square cells 250 feet on a side embedded in the parent grid to represent (1) the Alluvial Aquifer and (2) adjoining areas in the Saugus Formation where production wells and observation wells are present or are anticipated to be present in the future. The 250-foot cell size for the Quadtree grid was chosen to provide greater resolution than the parent grid, while avoiding smaller cell sizes that would have posed problems for simulating flow in the Santa Clara River under conditions other than drought periods or summer-season low-flow conditions.

Figure 3-1 shows the active portion of the grid in the uppermost model layer (Layer 1). The areal extent of this active grid largely conforms with DWR's Bulletin 118 basin boundary but has minor departures arising from (1) geologic mapping from prior local studies (RCS, 1988 and 2002) and (2) excluding the area where Castaic Lake is present (DWR, 2016c). The active portion of the grid contains 33,952 cells in the uppermost model layer, occupying an area of 60,762 acres (95 square miles [mi^2]). The grid includes a large surrounding area that is inactive in the model, including the location of the Piru Subbasin (DWR Basin 4-4.06). In total, the active and inactive portions of the grid contain 74,342 cells occupying an area of 246,550 acres (385 mi^2). The corner of the grid is inactive and is located at easting 6,296,583 feet and northing 1,947,887 feet. The grid is aligned with true north (i.e., is not rotated).

3.2 Layering

The model uses eight layers to represent the two principal aquifers (the Alluvial Aquifer and the Saugus Formation) that are present in the East Subbasin. The uppermost layer (Layer 1) contains the Alluvial Aquifer and (in adjoining areas) the Saugus Formation. Layers 2 through 8 represent just the Saugus Formation. The base of the Saugus Formation represents the bottom of the deepest member (the Sunshine Ranch Member) comprising the Saugus Formation, with its depth/elevation defined from mapping estimates developed by RCS (1988 and 2002). As shown by the grid maps presented in Figures 3-2 through 3-8, the areal extent of the Saugus Formation decreases with depth.

Figures 3-9 through 3-16 show the bottom elevations of each model layer, and Figures 3-17 through Figure 3-24 show the resulting layer thicknesses arising from the bottom elevation contours and the digital elevation model (DEM) that represents the ground surface elevation. The DEM that was used to construct the model's layers was obtained from the 2013 National Elevation Dataset (NED) published by the USGS and titled *USGS NED n35w119 1/3 arc-second 2013 1 x 1 degree ArcGrid*.[2] This DEM uses the North American Vertical Datum of 1988 (NAVD88) as its vertical datum. The use of eight model layers and the definitions of the contact elevations for the top and bottom of each layer in the new regional model conform

[2] USGS online data source. Available at the USGS website https://catalog.data.gov/dataset/usgs-ned-n35w119-1-arc-second-2013-1-x-1-degree-arcgrid86566. (Accessed July 13, 2020.)

to the eight-layer design used in the MicroFEM model, as described by GSI and LSCE (2013). Further details regarding layering design are described below.

3.2.1 Alluvial Aquifer

The shape of the bottom elevation of the Alluvial Aquifer generally mimics the ground surface elevation changes within the alluvial valleys occupied by the river and its tributaries, and also incorporates estimates of alluvium thickness and saturated thickness developed in local geologic studies.

3.2.1.1 Elevation Gradient

Within the East Subbasin, the Santa Clara River occupies a valley that has an elevation change of approximately 1,050 feet over a distance of approximately 21 miles, for an average elevation gradient of approximately 50 feet per mile. However, this gradient changes significantly along the length of the river as follows:

- **Eastern Portion of the East Subbasin.** The riverbed elevation drops 720 feet from where river flows are measured just upstream of the East Subbasin (at the Lang Station/Capra Railroad Crossing stream gage) to the mouth of Bouquet Canyon (a distance of approximately 12.2 miles), for an elevation gradient of nearly 60 feet per mile.
- **Central Portion of the East Subbasin.** From the mouth of Bouquet Canyon to Interstate 5 (I-5) (a distance of approximately 2.5 miles), the elevation drops by approximately 80 feet, for an elevation gradient of 32 feet per mile (which is roughly half as large as the gradient in the reach upstream of Bouquet Canyon).
- **Western Portion of the East Subbasin.** From I-5 to the mouth of Castaic Creek (a distance of approximately 3 miles), the elevation drops by approximately 125 feet, for an elevation gradient of 42 feet per mile, indicating that the river's gradient steepens slightly after passing along the south side of Round Mountain. From the mouth of Castaic Creek to the western boundary of the East Subbasin (a distance of approximately 3.5 miles), the gradient becomes gentler, as reflected by an elevation drop of approximately 110 feet and a resulting elevation gradient of approximately 31 feet per mile.

3.2.1.2 Variations in Saturated Thickness

In 2002, RCS compiled and geographically grouped hydrogeologic data from Alluvial Aquifer wells to estimate the aquifer's base elevation at each location and the range of aquifer saturated thickness values during various historical periods. RCS (2002) then categorized the different geographic areas of the Alluvial Aquifer for the purposes of defining variations in saturated thickness from one area to the next, which was necessary due to the need to extrapolate across areas with low densities of wells. For each of the 27 geographic areas (which were called "alluvial storage units" in the RCS studies), the saturated thickness was defined from the average base elevation of the aquifer and the water level elevations measured during 1945 (at the end of a period of high-rainfall years), 1965 (at the end of a long drought period), the fall of 1985, and the spring of 2000. The spatial distribution of the Alluvial Aquifer's thickness is shown in Figure 3-17 (with the Alluvial Aquifer present in the stippled area shown on the map). In tributaries to the Santa Clara River (which are displayed in Figure 1-5), saturated thicknesses for the Alluvial Aquifer ranged approximately as follows:

- **Sand Canyon:** Between 40 and 50 feet, except for 10 feet or less in 1965 (at the end of a drought) and 105 feet at the lower end of the canyon in 1945 (at the end of a high-rainfall period).

- **Mint Canyon:** Between 45 and 55 feet in the upper canyon and 55 to 75 feet in the lower canyon, but as low as 10 feet throughout the canyon in 1965.
- **Bouquet Canyon:** Between 85 and 95 feet, except for a slightly higher saturated thickness in the lower reaches of the canyon in 1945 (115 feet) and much lower saturated thicknesses throughout the canyon in 1965 (20 to 45 feet).
- **South Fork Santa Clara River:** Between 35 and 50 feet in the upper watershed and between 75 and 160 feet near the mouth of the canyon depending on local hydrologic conditions.
- **San Francisquito Canyon:** Increasing in the down-canyon direction from 40 feet to as much as 130 feet, except in 1965 when the saturated thickness was on the order of 15 feet in the upper reaches of the canyon, 35 feet in the middle reaches of the canyon, and 75 feet in the lower reaches of the canyon.
- **Castaic Valley:** Between 60 and 75 feet in the upper portion of this valley and 80 to 105 feet in the lower portion of this valley, except in 1945 when it was approximately 115 feet in both portions of this valley.

Along the Santa Clara River, RCS (2002) estimated the typical saturated thickness of the Alluvial Aquifer to range as follows:

- **Upstream of Mint Canyon:** Between 80 and 90 feet, but as little as 30 feet in 1965 and as much as 120 feet in 1945.
- **From the Mouth of Mint Canyon to the Mouth of Bouquet Canyon:** Between 105 and 120 feet, but as little as 40 to 55 feet in 1965 and as much as 130 feet in 1945. Geologic mapping and groundwater model calibration efforts also suggest that basement bedrock may underlie the alluvium at depths as shallow as 10 to 30 feet in the bend of the river where production wells are absent (between SCWD's North Oaks wellfield and its Honby and Santa Clara production wells; see Figure 1-3 for the locations of these wells).
- **From the Mouth of Bouquet Canyon to I-5:** On the order of 170 feet, but as little as 110 feet in 1965. Along the south side of Round Mountain, the river is thought to possibly pass over a very thin veneer of alluvium, given the river's thin passageway between the Saugus Formation outcrop comprising Round Mountain on the north side of the river and terrace deposits on the south side of the river.
- **From I-5 to the Mouth of Castaic Creek:** Between 115 to 135 feet, but as little as 100 feet in 1965 in the eastern portion of this area.
- **From the Mouth of Castaic Creek to the Western Basin Boundary:** A geophysical survey conducted in 2007 identified that the alluvium's total thickness at the western end of western boundary of the East Subbasin is as little as 30 feet. See Appendix C for the report that documents this study (Geomatrix, 2007), which is the basis for defining the base elevation of the alluvium in this area in the new regional model. The saturated thickness at and near the western basin boundary ranges from 23 to 28 feet and is fixed through the use of a specified-head boundary condition at this location (see Section 3.3.6 for details).

3.2.2 Saugus Formation

The first (2004) version of the MicroFEM model represented the Saugus Formation using seven layers, with the third through sixth layers being 500 feet thick (representing the Saugus Formation's freshwater-bearing deposits) and the seventh (deepest) layer representing the remaining thickness of the unit (corresponding to the brackish Sunshine Ranch Member, which is not a source of agricultural or municipal supply in the basin). In 2013, the third model layer (from depth 500 feet to depth 1,000 feet) was subdivided into two 250-foot-thick layers to reflect the differences in completion depths of certain production wells in the central portion of the basin. This layering system has been used to develop the new regional model. See Figure 3-25 for a schematic diagram of the model's layering and Table 3-1 for information regarding the relationship between the new model layering system and the open intervals of each production well in the Saugus Formation.

This eight-layer representation of the groundwater basin is also used in the new regional model, and the definitions of layer thickness are the same in the new regional model as were used in the most recent version of the MicroFEM model. As shown in Figures 3-9 through 3-16, the Saugus Formation is present at progressively fewer model grid cells with depth, due to the bowl-shaped structure of this geologic unit and the underlying bedrock units. Figure 3-26 shows cross-sectional views of the model's layering along west-to-east lines passing through the northernmost reach of the river west of I-5 (parent grid row 66) and extending eastward from the western basin boundary (parent grid row 86). Figure 3-27 shows cross-sectional views of the model's layering along south-to-north lines passing through Castaic Valley (parent grid column 162) and the alluvial valley occupied by the South Fork Santa Clara River (parent grid column 205).

3.3 Boundary Conditions

The new regional model uses no-flow boundary conditions to define inactive cells within the model grid. The model also uses the following MODFLOW-USG packages for boundary conditions that relate to specific hydrologic processes. These packages are the following:

- **The Recharge (RCH) package**, which uses specified-flux boundary conditions to represent deep percolation of rainfall, river storm flows, and land-applied water
- **The Connected Linear Network (CLN) package**, which uses head-dependent boundary conditions to simulate flow exchanges between the aquifer matrix and groundwater production wells that span multiple model layers
- **The Well (WELL) package**, which simulates pumping from production wells completed in the Alluvial Aquifer, stores groundwater pumping rate data for Saugus Formation production wells (for use by the CLN package), and is used as a specified-flux boundary condition to specify the rate of subsurface inflow to the Alluvial Aquifer beneath Castaic Dam (at the upper end of Castaic Valley)
- **The Transient IBOUND (TIB) package**, which is unique to MODFLOW-USG and specifies the periods that CLN wells are not physically present during a transient simulation
- **The General-Head Boundary (GHB) package**, which uses head-dependent boundary conditions to compute subsurface inflows in the Alluvial Aquifer beneath each tributary stream where it crosses into the groundwater basin
- **The Evapotranspiration (EVT) package**, which uses head-dependent boundary conditions to represent evapotranspiration from the Alluvial Aquifer by phreatophytes withdrawing water from the water table
- **The time-variant specified head (CHD) package**, which uses specified-head boundary conditions to hold steady the groundwater elevation in the Alluvial Aquifer at the western boundary of the East Subbasin (the downgradient end of the model), which thereby also holds steady the saturated thickness of the Alluvial Aquifer at that location
- **The Horizontal Flow Barrier (HFB) package**, which uses specified-flux boundary conditions to control the rate of groundwater movement across the San Gabriel Fault zone in the Saugus Formation

- **The Streamflow-Routing (SFR7) package**, which uses head-dependent boundary conditions for computing groundwater/surface water exchanges in the Santa Clara River and its tributaries, specifying inflows to the river from the two WRPs and at outfalls for treated groundwater discharges, and routing streamflow from cell-to-cell for water-balance tracking purposes
- **The Gage (GAGE) package** for calculating streamflow rates from SFR7

The RCH package is discussed in Section 3.4. Following are descriptions of how the other boundary condition packages are implemented in the new regional model. See Figure 3-28 for the locations of the WELL inflow, GHB, CHD, HFB, and SFR boundary condition packages in the Alluvial Aquifer; Figure 3-29 for the locations of the EVT boundary condition package for riparian mixed hardwood forests and coast live oak woodlands; Figure 3-30 for the locations and designations of stream segments in the SFR7 package; and Figure 3-31 for the locations of boundary conditions (HFBs and CLN wells) in the Saugus Formation.

3.3.1 CLN Package (Groundwater Pumping from Multi-Layer Wells)

Table 3-3 lists the layer assignments, CLN node numbers, aquifer matrix numbers, and well-loss properties for each of the 18 Saugus Formation wells that have operated at one time or another during the 1980–2019 model calibration period. Each of these wells span multiple layers in the model. During model calibration, each CLN well was initially assumed to have a well efficiency of 70 percent; as calibration progressed, this assumed value was deemed not worth varying because of the potential for changing well efficiencies over time and the limited amount of data on actual historical well efficiencies.

3.3.2 WELL Package (Groundwater Pumping and Subsurface Inflow into the Alluvial Aquifer in Castaic Valley)

The grid contains four model cells across the width of Castaic Valley at the location of Castaic Dam. Subsurface inflow rates are specified and held steady over time throughout the model calibration period. The rate of subsurface inflow to the Alluvial Aquifer at this location was examined during model calibration and was ultimately specified to be 1,675 acre-feet per year (AFY).

3.3.3 TIB Package (Timing of Installing or Abandoning Multi-Layer Wells)

The TIB package in MODFLOW-USG provides the capability of not simulating the exchange of groundwater between the aquifer matrix and a CLN well during those periods when the well is not in the ground. This prevents the well from being simulated as a conduit for flow between model layers during the periods when it is not present. Table 3-3 lists the periods that each Saugus Formation production well is present, compared with absent, in the model. Note that if a well is in the ground but is not pumping, it is treated as being present, which allows water to move between the well and the aquifer matrix and also potentially between model layers within the CLN well itself.

3.3.4 GHB Package (Subsurface Inflows to the Alluvial Aquifer in Tributary Valleys)

Table 3-2 provides information on the setup of GHBs in each tributary valley to the Santa Clara River (other than Castaic Valley). GHBs were used to simulate the subsurface flows of water that likely occur from the thin surficial alluvium just outside the model (groundwater basin) boundary. The GHBs were also used to help guide the model on groundwater elevations in the upper ends of these tributaries and were checked during model construction and calibration to ensure that flow is predominantly (if not exclusively) into the model domain (i.e., inflow to the model) rather than flowing out of (discharge from) the model. As shown in Table 3-2 and Figure 3-28, a total of 149 cells use GHBs in the model. Low values of thickness and hydraulic conductivity were used on the GHBs to limit inflow rates and avoid creating a large source of water, given the conceptual understanding that the alluvium thins considerably along the groundwater basin boundary.

3.3.5 EVT Package (Groundwater Withdrawal by Phreatophytes)

The EVT package was used to specify groundwater withdrawals of shallow groundwater by phreatophytes within riparian corridors along streams, and in upland areas. The locations of two types of communities (riparian mixed hardwood forests and coast live oak woodlands) identified as potential GDEs were developed in a recent mapping study (ESA, 2020). See Figure 3-29 for a map showing the geographic distribution of these two types of potential GDE communities. As shown on the map, the riparian mixed hardwood forests are located the Santa Clara River from Bouquet Canyon downstream to the western basin boundary, in the lower and upper reaches of Castaic Valley, in the central and lower portions of San Francisquito Canyon, and at the downstream end of the South Fork Santa Clara River. Environmental Science Associates (ESA) (2020) indicates that the predominant species that are present in these riparian corridors are Fremont Cottonwood, willow trees and shrubs, and non-native grasses (such as *Arundo donax [Arundo]*).

The EVT package requires the specification of the evapotranspiration (ET) surface, the ET extinction depth, and the potential ET demand. The EVT package sets actual ET withdrawals to be equal to the potential ET demand rate when groundwater is at or above the ET surface. When the water table is below the ET extinction depth, phreatophytes are no longer able to withdraw groundwater. For water table depths between the ET surface and the ET extinction depth, the actual ET withdrawal rate follows a linear function between the maximum rate at the ET surface elevation and no withdrawal at the elevation corresponding to the extinction depth. The selection of these ET parameters was as follows:

- The ET surface was set at a depth of 5 feet below ground surface, on the rationale that *Arundo* (a significant water user) can have root mats as deep as 3 feet below ground surface (Alden et al., 1998; Mackenzie, 2004; California Invasive Plant Council, 2011) and therefore could likely withdraw groundwater from a somewhat greater depth than the depths of the roots. Cottonwoods and willows would be expected to readily withdraw shallow groundwater.
- The ET extinction depth is the water table depth (below the ET surface) at which phreatophytes would no longer be able to withdraw groundwater. The U.S. Forest Service Fire Effects Information System website (https://www.fs.fed.us/database/feis/plants/tree/popfre/all.html) reports that rooting depths in mature stands of Fremont Cottonwood range between 3 and 5 meters (9.8 to 16.4 feet), based on studies by Zimmerman (1969) and Braatne et al. (1996). Given that deep-rooted trees can withdraw groundwater from depths greater than the depths of their root systems, the ET extinction depth was set at 25 feet. For comparison, as part of its preliminary screening and mapping process for GDEs, The Nature Conservancy (TNC) uses a depth of 30 feet as the cutoff depth for distinguishing where GDEs may be present compared with absent (Rohde et al., 2018).
- The ET demand rate was specified as follows:
  - **Riparian Mixed Hardwood Forests.** In support of the model development effort, ESA estimated monthly riparian demands for a mixture of 40 percent Fremont Cottonwood, 30 percent willow, and 30 percent *Arundo*. Average monthly reference ET rates for a well-irrigated grass cover were downloaded from the Santa Clarita California Irrigation Management Information Service (CIMIS) station No. 204 and were multiplied by vegetation coefficients for cottonwoods and willows (published by Howes et al., 2015). For *Arundo*, ESA developed monthly demand curves by adjusting the crop coefficient for large-stand permanent wetlands to make annual ET demands match mean and median results from *Arundo* studies by TNC (2019). Table 3-4 presents the annual and monthly demands for these species, including the reference grass cover and the large-stand permanent wetland, followed by the aggregate demand for the mixture of cottonwood (40 percent), willow (30 percent), and *Arundo* (30 percent) that is representative of current conditions along the Santa Clara River's riparian corridor (ESA, 2020). As shown in Table 3-4 and

Figure 3-32, the annual ET demand is estimated to be nearly 6 feet per year when using TNC's median demand for *Arundo*, with the monthly demand ranging from 0.21 to 0.87 feet per month (64 to 264 millimeters per month). These monthly values were programmed directly into the model and were assumed to be representative of potential ET demands in all years throughout the 1980–2019 calibration period.

- **Coast Live Oak Woodlands.** The ET demand rates for these potential GDEs were set equal to the values for rain-fed oak grassland mix shown in Table 3-4 (as published by Howes et al., 2015).
- **Other Locations.** A low value of 0.0001 feet per day (ft/day) was used in all other areas throughout the model simulation period, to allow for possible ET in other locations where groundwater potentially could be present close to the ground surface during and after high-rainfall years. The use of a low ET rate reflects the absence of GDEs in these locations.

3.3.6 CHD Package (Specified Heads at the Western Basin Boundary)

The CHD package is used to specify the groundwater elevation in the Alluvial Aquifer at the western boundary of the East Subbasin (the downgradient end of the model; see Figure 3-28). The use of a CHD boundary is based on (1) the historically minimal measured fluctuations in groundwater levels at the western end of the basin (compared with the fluctuations seen elsewhere) and (2) the substantially thinner aquifer system in this area (20 to 30 feet at the mouth of Potrero Canyon, and likely less at and immediately west of the western basin boundary) compared with the rest of the basin (hundreds of feet thick where the Saugus Formation is present, and several tens of feet to approximately 100 feet thick elsewhere).

A groundwater elevation value of 823 feet is used in Layer 1 of the model at the 13 grid cells that span the width of the Alluvial Aquifer at the western basin boundary. The elevation of 823 feet is based on a groundwater elevation contour map published by RCS (2002) for spring 2000; see Appendix D, which presents this map (which is Plate 4.3 in the RCS, 2002 report). This groundwater elevation value at the western basin boundary is approximately 18 feet higher than the groundwater level displayed in a geophysical cross section at the western basin boundary (Geomatrix, 2007; see Appendix C). The groundwater elevation contour map was chosen as the source for the modeled groundwater elevation at the western basin boundary because (1) the map shows contours and groundwater elevation measurements at nearby observation wells that were accessible at that time, and (2) the 823-foot groundwater elevation at the western basin boundary produces a horizontal gradient from Potrero Canyon to the western basin boundary that is similar to the hydraulic gradient occurring upgradient of Potrero Canyon. (In contrast, the cross sections displayed in the geophysical study show a much steeper head gradient below versus above Potrero Canyon—a steepening that cannot be correlated with local geologic conditions, which show no reason for such a significant change in gradient to occur in this area).

3.3.7 HFB Package (Flow Across the San Gabriel Fault)

The HFB package was used to limit the groundwater flow rate across the San Gabriel Fault. HFBs were established at 1,606 cells, mostly in Layers 2 through 8, but also in Layer 1 where the Saugus Formation is present at the ground surface (i.e., where the alluvium is absent). The hydraulic conductivity across each HFB was specified as 1×10^{-5} ft/day, with the thickness of each HFB cell set to 100 feet to reflect the understanding that the San Gabriel Fault is described as a series of steeply dipping faults constituting a fault zone rather than a single narrow fault trace (RCS, 1988; CH2M HILL, 2005 and 2015).

3.3.8 SFR7 and GAGE Packages (Santa Clara River and Tributaries)

GSI (2020) presents the conceptual understanding of groundwater/surface water interactions along the central and western portions of the alluvial valley occupied by the Santa Clara River. The SFR7 and GAGE packages are used to simulate these interactions in the model. A total of 139 stream segments containing

2,367 stream reaches were programmed into the SFR7 package to allow for simulation of non-storm (dry-weather) flows in the Santa Clara River and its tributaries. See Table 3-5 for an index of the streams corresponding to each stream segment, and Figure 3-30 for the locations of each stream segment. Storm flows and controlled releases from upstream reservoirs outside the basin boundary were not directly tracked in the SFR7 package, but instead were accounted for in terms of their influence on groundwater recharge by using the SCV Recharge Compiler (see Appendix B for details). This approach of using different tools to simulate the influences of storm flows compared with dry-weather flows allowed the role of the SFR7 package to be focused on simulating the influence of dry-weather flows in the Santa Clara River, which are the flow conditions that influence species and habitat management for conservation efforts in the perennial reach of the river (below the mouth of San Francisquito Canyon). Although the topic of dry-weather flows is of primary interest in the western portion of the basin, the SFR7 package was applied to all model cells containing the Santa Clara River and its tributaries, so that groundwater drainage into these stream systems (under high water tables) could be simulated and tracked from cell-to-cell to account for their contribution to streamflow along each stream system and the potential for reinfiltration within the basin.

Consistent with the approach of using the SFR7 package to evaluate dry-weather flows, the monthly and annual releases of water at the groundwater basin boundary from Castaic Dam/Lagoon (into Castaic Creek) and upstream of the groundwater basin boundary from Bouquet Reservoir (into Bouquet Creek) were handled by the SCV Recharge Compiler, as described in Section 3.4 below. Inflows to the Santa Clara River occurring internally within the groundwater basin boundary (discharges from the Saugus and Valencia WRPs; see Figures 1-2 and 3-30) were programmed into the SFR7 package, because they occur internally (not outside the basin), are not of a storm-flow nature, and have an important influence on dry-weather flows. See Tables 3-6 through 3-8 for the monthly and annual values of these flows since 1980. Additionally, periodic short-duration discharges to the river occur from outfalls conveying treated water from perchlorate-treatment programs at certain wells pumping from the Saugus Formation. These discharges are estimated to be as follows:

- Outfall for wells SCWD-Saugus1 and SCWD-Saugus2, discharging into Segment 41, just upstream of the Saugus WRP: 1,792 acre-feet from May 2010 through January 2011
- Outfall for well VWD-201, discharging into Segment 79, just downstream of the Saugus WRP: Approximately 6,500 AF from January 2018 through December 2019 (and continuing at this time)
- Outfall for onsite extraction wells at the Whittaker-Bermite property, discharging into Segment 40, about 1 mile upstream of the Saugus WRP: Approximately 500 AF from August 2017 through December 2019 (and continuing at this time)

The GAGE package (a companion to the SFR7 package) was used to write out streamflows from the SFR7 computations at each time during the simulation. Streamflow rates were written at the end of each of the 139 reaches and were evaluated during model calibration at specific locations where stream conditions are of interest. A generic cross-sectional profile designed to help simulate dry-weather flow conditions was defined in each stream segment using a low-flow channel 10 feet wide and 3 feet deep for the channel invert, with an adjoining 40-foot-wide area for braided streamflow near the invert. The remainder of the 250-foot-wide model grid cell containing an SFR boundary condition provided further flow capacity, with the top of the streambed being 8 feet above the channel invert at the edges of each SFR grid cell.

Because Light Detection and Ranging (LiDAR) data indicate that the low-flow channel is much narrower than the model grid cells where the SFR boundary condition is being used, the streambed elevations chosen were slightly above the absolute lowest invert elevation, but below the levels of the adjoining flow areas where wide streams or numerous braided channels could be present under flows that exceed the capacity of the low-flow channel. The thickness of the streambed was set at 1 foot, and the hydraulic conductivity of the streambed was varied during model calibration to improve the simulation of (1) observed groundwater levels in wells near the Santa Clara River and (2) measured dry-weather streamflows at the former County Line gage (which was located approximately three-fourths of a mile west of the County Line during water years 1953 through 1996). See Table 3-5 for the streambed hydraulic conductivity values used in the SFR package.

3.4 Estimation of Groundwater Recharge Rates

Groundwater recharge was defined on a month-by-month basis for the full calibration period (January 1980 through December 2019). Groundwater recharge rates were specified at each grid cell using a Visual Basic tool in Microsoft Excel that was developed by GSI to accompany the new regional model. A primary purpose of this tool was to compile the recharge rates from multiple hydrologic processes into the form required by the numerical model; specifically, the model's RCH package (like most groundwater modeling software) requires that a single value for recharge be provided at any given time and location, rather than inputting the recharge rates corresponding to each individual hydrologic process. This tool (named the SCV Recharge Compiler) was therefore used to assemble the multiple recharge processes into the form required for input to the RCH package for MODFLOW-USG.

See Appendix B for a detailed description of the SCV Recharge Compiler. As shown in Figure 2-1, this tool specifies the monthly volumes/rates of groundwater recharge (deep percolation) resulting from the combined influences of the following hydrologic processes:

- Direct precipitation within the model grid area (including infiltration of surface water runoff)
- Seepage from streambeds to the underlying water table (a process that occurs exclusively over the Alluvial Aquifer, along the Santa Clara River and its tributaries); this includes not only stormwater, but controlled releases of water into stream reaches located at or upstream of the groundwater basin boundary (from Castaic Dam into Castaic Creek and from Bouquet Reservoir into Bouquet Creek)
- Irrigation on agricultural lands
- Irrigation in urban areas (residential, commercial, golf courses, parks/recreational areas)
- Septic systems in residential developments that are served by public water supplies, but not sanitary storm sewers

For tributaries of the Santa Clara River, the SCV Recharge Compiler estimates surface water inflows from ungaged upstream contributing watersheds, based on the basin size and regional isohyetal maps of annual precipitation. The SCV Recharge Compiler uses these surface inflow estimates plus the gaged inflows on the Santa Clara River itself (at the Lang Station/Capra Railroad Crossing stream gage) to track the amount of stormwater that is available to infiltrate from one node to the next in the downstream direction on each ephemeral stream reach lying within the groundwater model domain. This process also makes use of streambed conductance values that are specified in the SCV Recharge Compiler in each ephemeral stream to control the rate of groundwater recharge, which allowed these conductance terms to be adjusted during model calibration.

No diversions of water are known to occur from the Santa Clara River or its tributaries within the East Subbasin. Water is discharged into the Santa Clara River within the interior of the basin from two WRPs (as modeled using the SFR7 package) and in two tributaries along or upstream of the basin (Castaic Creek and Bouquet Creek, as modeled using the SCV Recharge Compiler). Table 3-9 lists monthly and annual releases from Castaic Dam/Lagoon into Castaic Creek. Table 3-10 lists monthly and annual releases from Bouquet Reservoir into Bouquet Creek. Releases from Bouquet Reservoir occur well upstream of the groundwater basin boundary, and a portion of these releases is lost to evapotranspiration and to local domestic pumping. Through trial-and-error calibration, 5 percent of the flow released from Bouquet Reservoir was simulated as being present in Bouquet Creek where it enters the groundwater basin, with additional subsurface inflow occurring beneath the creek at the groundwater basin boundary.

The SCV Recharge Compiler also includes the capability to simulate future surface spreading basins, future changes in land use, and climate change factors that have been published by DWR for use during the preparation of GSPs.

3.5 Assignment of Groundwater Pumping Rates and Depths

Pumping rates from agricultural and municipal production wells were assigned in the model at wells that operated at any time during the period from January 1980 through December 2019. The locations of these wells are shown on Figure 3-33. The WELL package is used to store groundwater pumping rate input data in the model for each production well in the basin. Production wells completed in the Alluvial Aquifer are simulated using the WELL package, while the CLN package is used to simulate groundwater flow conditions at and near Saugus Formation production wells, which are completed in multiple model layers. In the Saugus Formation production wells, at each time step in the simulation the model calculates the amount of pumping that is contributed by each of the aquifer layers penetrated by the well.

Pumping rates from groundwater production wells were assigned using the following information:

- Water use records maintained by the local water purveyors. These records were available as annual and monthly volumes of groundwater production from each well. For some wells, only annual data were available for the 1980s and 1990s, and in a few cases extending into the early 2000s.
- Annual water use records for agricultural wells. Monthly records were not available.
- Well construction records, which were needed to determine which model layers each Saugus Formation production well should be assumed to be pumping from.

For the period of 1980 through 2019, Tables 3-11 and 3-12 summarize the annual pumping volumes from each agricultural and municipal well in the Alluvial Aquifer and the Saugus Formation, respectively. Small domestic wells are not inventoried in this basin and hence are represented in the model as pumping centers that are assumed to be scattered across the upper reaches of certain tributary canyons where rural residential land parcels are present.[3] As discussed in prior annual reports for the basin (see LSCE, 2020), small domestic wells are estimated to pump 500 AFY in and near the groundwater basin, with some of this production potentially occurring from older bedrock units underlying and surrounding the Alluvial Aquifer and Saugus Formation. As shown in the last row of Tables 3-11 and 3-12, total pumping since 1980 has ranged between 20,286 and 43,406 AFY from the Alluvial Aquifer and between 3,716 and 14,917 AFY from the Saugus Formation.

Table 3-13 summarizes the monthly distribution of pumping that was applied to production data for wells and periods for which only annual data were available. Separate distributions of monthly demand were used for agricultural compared with municipal wells, given that agricultural wells are used exclusively for outdoor water demands whereas municipal wells are used to meet indoor and outdoor demands. These monthly distributions are the same as those that were developed during construction of the original model (CH2M HILL, 2004a) and were developed at that time from crop consumptive use requirements published by CIMIS.

[3] Domestic pumping centers in the model are located in Castaic Valley, San Francisquito Canyon, Bouquet Canyon, Dry Canyon, and Mint Canyon and are simulated as pumping from the Alluvial Aquifer.

The monthly distribution of urban demand was determined at that time by examining monthly flow records for the two WRP and monthly demand distributions recorded by one of the former retail water providers (Valencia Water Company) over a period of several years.

3.6 Assignment of Aquifer Physical Properties

The hydraulic conductivity distribution used in the model is shown in Figures 3-34 through 3-40 and in Table 3-14. This distribution is based on model calibration results, on data collected from a small number of controlled aquifer tests, and from specific capacity measurements in individual pumping wells across the groundwater basin.

3.6.1 Alluvial Aquifer

Available groundwater elevation data and aquifer test data indicate that the Alluvial Aquifer is unconfined (i.e., is under water table conditions). RCS (1986 and 2002) reported transmissivity values to range between 4,700 square feet per day (ft^2/day), or 35,000 gallons per day (gpd) per foot (gpd/ft) and more than 100,000 ft^2/day, or 750,000 gpd/ft (CH2M HILL, 2004a). The specific yield of the Alluvial Aquifer has been estimated in past studies to range from about 0.09 to 0.16 (RCS, 1986 and 2002; CH2M HILL, 2004a); efforts to calibrate the numerical model to hydrographs throughout the alluvium indicate that the specific yield is on the order of 0.10 in much of the Alluvial Aquifer, with the exception of higher values (on the order of 0.20) in the upper portion of Castaic Valley and the lower portion of Bouquet Canyon (see Figure 3-41).

Based on interpretations of aquifer tests, specific capacity tests, and groundwater model calibration results, the hydraulic conductivity of the Alluvial Aquifer is estimated to range from 250 to 1,500 feet per day (ft/day) in the alluvial valley occupied by the Santa Clara River, and 75 to 700 ft/day in the alluvium that occupies the various tributary valleys. These values are consistent with lithologic descriptions for the Alluvial Aquifer, which describe sandy gravel, gravelly sand, gravel, cobbles, and boulders in the eastern and central portions of the basin and a mixture of sands and gravels in the western portion of the basin.

During the multiple efforts since 2004 to build the original MicroFEM model, update its calibration with new data, build the new regional model, incorporate the geophysical study conducted at the western basin boundary (which changed the understanding of the Alluvial Aquifer's thickness at that location), and calibrate the model to the significant drought that occurred from 2011 through 2016, it has become apparent that a large percentage of the specific capacity data collected in Alluvial Aquifer wells result in underestimation of the hydraulic conductivity of this aquifer. This observation and conclusion became particularly apparent during the effort to calibrate the new regional model to (1) the 1980–1996 record of gaged flows near the County Line (after incorporating the geophysical study results) and (2) the groundwater level responses in the eastern third of the basin to the first-ever year-long (and in several cases multi-year) period of not operating wells at the far east end of the alluvium (during and after the 2011–2016 drought). Repeated testing with the model indicated that calibration quality was markedly improved by relying on the tests that had the highest reported specific capacity values while pumping at rates similar to or higher than most tests. The same tests that were evaluated during construction of the original model (see Appendix B of CH2M HILL, 2004a) were reviewed during construction of the new model to find tests that meet these criteria, and to reevaluate those test results with respect to the water level data that were collected at the time of each test, rather than relying solely on previously published summaries of average saturated thickness values in alluvial subareas (RCS, 1980 and 2002). Table 3-15 shows test results and hydraulic conductivity calculations for 13 wells that were identified as having been pumped at high rates while recording high specific capacity values. Water level data were recorded on or near the day of testing at nine of these wells, while the water levels at four wells had to be estimated from the previously published estimates of saturated thickness. Calculations of transmissivity and hydraulic conductivity were conducted using methods described by Driscoll (1986) for unconfined aquifers and by assuming that well efficiencies range between 60 and 80 percent (to bracket the likely effect of well losses on the drawdown measurements during each field test). As shown in Table 3-15, these calculations indicate that hydraulic conductivity values for the Alluvial Aquifer range from about 700 ft/day to nearly 1,500 ft/day along the Santa Clara River, between 500 and 1,200 ft/day in Bouquet Canyon, and between 550 and 850 ft/day in Castaic Valley. See Figure 3-34 for the locations of the wells from which these hydraulic conductivity estimates are derived (as listed in Table 3-15).

3.6.2 Saugus Formation

Available groundwater elevation data and aquifer test data indicate that the groundwater resources in the Saugus Formation are present under semi-confined to confined conditions (i.e., under pressure rather than being a water table aquifer). In areas where the Saugus crops out at the ground surface, the uppermost saturated zones are partially unconfined because the permeable beds are folded upwards. In the highlands, the Saugus beds are exposed at the ground surface, whereas in the lowlands along the Santa Clara River, the uppermost Saugus beds are in contact with the Alluvial Aquifer.

RCS (1988 and 2002) estimated that transmissivity values in the Saugus Formation range between about 400 and 25,000 ft^2/day (3,000 to 180,000 gpd/ft), but with a more typical range of between 5,500 and 11,000 ft^2/day (40,000 and 80,000 gpd/ft). RCS (1988 and 2002) estimated that storativity values are on the order of 10^{-3} to 10^{-4}. Later, in March 2004, separate 72-hour constant-rate aquifer tests were conducted at production wells VWD-205 and NWD-13, from which the transmissivity of the Saugus Formation at these two locations was estimated to range from approximately 5,700 to 47,500 ft^2/day, corresponding to bulk hydraulic conductivity values estimated to range from 4 to nearly 35 ft/day. (See Table 4-2 and Appendix G.2 in CH2M HILL [2005] for details regarding these tests.)

Figures 3-36 and 3-37 show the locations of wells where testing data are available in the Saugus Formation. The estimates of aquifer parameter values by RCS are based on data from well performance tests (summarized in Table 3-16) and from an ASR pump test and study that was conducted in the Saugus Formation at Well VWD-205 (RCS, 2001 and 2002). The RCS transmissivity values and the length of the open interval of each production well have been used to estimate hydraulic conductivity values from these tests (see Table 3-16). These hydraulic conductivity estimates range between 1.1 and 23.2 feet per day. In prior studies, analyses of the ASR test data and subsequent numerical modeling analyses indicated that the bulk hydraulic conductivity of the Saugus Formation at wells VWD-201 and VWD-205 is approximately 6.5 ft/day (CH2M HILL, 2004a). Specific capacity values at these two wells (10 to 20 gpm/ft) were found to be higher than in NWD’s production wells to the south (2 to 10 gpm/ft) and similar to, if not slightly less than, those observed in other VWD and SCWD Saugus Formation wells to the immediate west and northeast (which reported values between 25 and 50 gpm/ft; see CH2M HILL, 2004a). Based on these data and on model calibration evaluations, the hydraulic conductivity of the Saugus Formation in the primary area that has historically been targeted for groundwater development (the area south of the Holser Fault and extending southward nearly to the mouth of Placerita Canyon [just north of the town center for the Town of Newhall]) is represented in the new regional model as gradually decreasing with depth, from values of 6.5 to 30 ft/day in the upper hydrostratigraphic units to values of 0.1 to 4 ft/day in deeper hydrostratigraphic units.

SECTION 4: **Model Calibration and Parameter Sensitivity**

Before a model is used for predictive purposes, it must be demonstrated that the model provides a reasonable representation of historically observed conditions in the groundwater basin that it represents. This section of the report describes the process and results of calibrating the new regional model for the East Subbasin. Following are discussions of the calibration process (Section 4.1), a summary of the calibration data sets (Section 4.2), calibration results (Section 4.3), parameter sensitivity observations that were made during calibration (Section 4.4), and a summary of the resulting model's simulation capabilities from the standpoint of the calibration effort (Section 4.5).

4.1 Calibration Process

After constructing the model, a calibration process was conducted in which the model's hydrogeologic and streambed parameters were adjusted until the model was able to reasonably replicate two aspects of the historically observed conditions: (1) the general physical characteristics of the system (e.g., groundwater flow directions and locations of gaining compared with losing stream reaches), and (2) the quantifiable aspects of the system (groundwater elevations, the changes in groundwater levels that occur in response to variations in natural system conditions and groundwater pumping, and fluctuations in non-storm streamflows in the Santa Clara River at the western basin boundary). The model's parameters are inputs to the model that consist of values or coefficients describing the spatial distribution of hydrogeologic and streambed properties and the spatial and temporal distribution of model boundary conditions. The calibration process made use of four separate types of data sets: (1) groundwater elevation records in production wells, (2) groundwater elevation records in non-pumping observation wells, (3) the conceptual understanding of the locations of ephemeral and perennial streams, and (4) stream gaging records. The first, second, and fourth data sets are affected by how the aquifer responds to short- and long-term changes in ambient background (natural) hydrology, groundwater pumping, and changing land uses and water uses (including changes in WRP discharges to the Santa Clara River and reservoir releases into two of the river's tributaries).

4.1.1 Time Period

The calibration runs consisted of transient (time-varying) simulations for calendar years 1980 through 2019. The transient simulations varied the hydrologic processes on a monthly basis, and calculations were conducted three times each month (i.e., once every approximately 10 days throughout the 40-year simulation period). The purpose of using transient simulations was to create a model capable of simulating seasonal and long-term variations in groundwater elevations, groundwater recharge, and groundwater discharge for a historical period characterized by variable rainfall and recharge and changing land use and water use patterns. This 40-year period was chosen for the following reasons:

- The volume of data is greater during this period than in years prior to 1980. In particular, SCWD and VWD installed several production wells in the Saugus Formation during this period. Also, regular monitoring of groundwater levels was performed at more wells during this period than before. Stream gaging records are also available near the western basin boundary during the first 17 years of this period (through water year 1996), after which the gage was moved downstream to a location 3.5 miles west of (downstream of) the East Subbasin.
- Annual pumping volumes are well known and well documented during this period but are not as well known in prior years. Hence, it would be more difficult to calibrate a model prior to the 1980s because of the uncertainties in pumping volumes in earlier decades. (Robson [1972] provides brief discussions of the early years of groundwater usage in the basin.)

- Significant urban growth occurred in the Santa Clarita Valley between 1980 and 1999. This growth resulted in changes in land use and increased importation of water beginning in late 1979. Simulation methods for these evolving processes are described in Sections 4.3 through 4.5 of Appendix B.
- The local hydrology varied considerably during this period and included single-year and multi-year droughts (including the significantly below-normal rainfall period that began in late 2011 and lasted through late 2016). The Alluvial Aquifer showed multi-year periods of water level declines followed by multi-year periods of water level recovery. Additionally, water levels in the Saugus Formation fluctuated in response to changing pumping during this period (changes that arose from the installation of new wells plus temporary shut-downs of certain wells in response to groundwater contamination).

4.1.2 Calibration Goals

The success of the model calibration process was defined by its ability to satisfy a set of calibration goals developed from a review of the types and quality of the data sets available in the East Subbasin. As noted by Reilly and Harbaugh (2004) and DWR (2016a), it is important for groundwater modeling investigators to use the calibration process to evaluate the appropriateness of the conceptualization of the groundwater flow system and the model's representation of that system; focusing on quantitative measures of goodness-of-fit between measured and simulated values of groundwater elevations and changes in those elevations is insufficient by itself. Accordingly, a series of qualitative, quantitative, and semi-quantitative calibration goals were developed for evaluating the calibration quality of the regional model, as described below.

4.1.2.1 Qualitative Calibration Goals

Three qualitative goals were identified:

- **Calibration Goal 1.** Simulate the general directions of groundwater flow and groundwater elevations on a long-term basis in both aquifer systems, as arising from natural hydrologic conditions and pumping operations from agricultural and municipal water supply wells. Regional groundwater elevation contour maps prepared by RCS (2002; see Appendix D) for the Alluvial Aquifer in spring 2000 and the Saugus Formation in fall 2000 were used to evaluate calibration quality.
- **Calibration Goal 2.** At nodes where streams are not present, maintain groundwater elevations below ground surface. At stream nodes, groundwater elevations should also be below ground surface in ephemeral reaches at most times, though this will not necessarily be the case during the periodic large rainfall/runoff events that are the largest natural sources of recharge to the aquifer system (particularly the Alluvial Aquifer). In perennial reaches of streams, the groundwater level should be higher than the channel bed elevation.
- **Calibration Goal 3.** Simulate the geographic distribution of stream reaches that are ephemeral (flowing primarily in response to storm events) versus perennial (flowing on a continuous or near-continuous basis). The understanding of the locations of ephemeral and perennial reaches is based on historic visual observations, aerial photography, and stream gaging records on:
  - **The Santa Clara River** at Lang Station/Capra Railroad Crossing (the Los Angeles Department of Public Works [LADPW] gage F93B-R/F93C-R), at Highway 99/Old Road Bridge (LADPW gage F92C-R), at the former County Line gaging station until October 1996 (USGS gage 11108500, named "Santa Clara River at LA/Ventura County Line"), and at the existing Piru gaging station in Ventura County beginning in 1996 (USGS gage 11109000, named "Santa Clara River Near Piru")

- **Bouquet Creek,** in Bouquet Canyon (LADPW gage 377B-R)
- **Mint Creek** in Mint Canyon (LADPW gage F328B-R).

4.1.2.2 Quantitative and Semi-Quantitative Calibration Goals

Two semi-quantitative goals and one quantitative goal were identified:

- **Calibration Goal 4.** Simulate seasonal and year-to-year variability in groundwater levels in production and observation wells, as arising from natural variability in rainfall recharge and stream gains/losses, as well as monthly and annual variations in production from water supply wells. This is a semi-quantitative goal because it is not based on statistical calculations (which are discussed below in Calibration Goal 6).
- **Calibration Goal 5.** Simulate seasonal low flows in the Santa Clara River at the western basin boundary, near the site of the USGS's former County Line gaging station that operated through water year 1996 (USGS gage 11108500). This goal is evaluated for the summer season flows of July through September, which correspond to months of minimal rainfall in the East Subbasin, based on precipitation records at the Newhall-Soledad weather station. This goal is evaluated by reviewing model-estimated streamflows during individual years and as a cumulative sum of annual summer flow volumes during the 40-year calibration period.
- **Calibration Goal 6.** Obtain statistics for groundwater elevation residuals and groundwater elevation change residuals that are within reasonable limits for groundwater model calibration, in keeping with American Society for Testing and Materials (ASTM) guidelines (ASTM, 1996; Spitz and Moreno, 1996). In particular, achieve a relative error (as expressed by the scaled mean residual and the scaled standard deviation) of no greater than 10 percent. (The relative error, or scaled residual, equals the value of the statistic [the mean or standard deviation of all residuals] divided by the range in measured values.) Statistics were not calculated for streamflows for the reasons discussed in Section 4.2.4.

4.1.3 Model Parameters Adjusted during Calibration

The model parameters evaluated and adjusted during calibration of the numerical model were the following:

- Horizontal and vertical hydraulic conductivity
- Storage coefficients (specific storage and specific yield)
- The annual rainfall-runoff-recharge relationship that determines deep percolation of rainfall over the groundwater basin and streamflow coming into the basin from upstream watershed areas
- Streambed conductances

4.1.3.1 Horizontal and Vertical Hydraulic Conductivity

Figures 3-34 through 3-40 show the locations of zones of uniform hydraulic conductivity that were implemented into the new regional model during the course of constructing and calibrating the model. The model uses zones primarily to distinguish model layers and geographic areas on the basis of lithology and differences in groundwater level fluctuations (such as spatial variability in the Alluvial Aquifer's responses to rainfall recharge events). Table 3-14 lists the horizontal and vertical hydraulic conductivity values that are used in the model, based on the results of the calibration process.

4.1.3.2 Storage Coefficients

Specific yield values are assigned to each model layer, including those below Layer 1 to account for the unconfined flow conditions that would exist wherever Layer 1 is simulated as being dry at a given time during the simulation. Specific yield values were allowed to range between 0.01 and 0.30 during model calibration. As discussed in Section 3.6.1 and shown in Figure 3-41, the Alluvial Aquifer is simulated with a value of 0.10 in most locations, except in the upper portion of Castaic Valley and the lower portion of Bouquet Canyon where the specific yield has been set at a value of 0.20 based on model calibration to production well hydrographs in those locations.

For all but the uppermost model layer, the storage coefficient for the Saugus Formation is equal to the product of the layer thickness and the user-specified value of specific storage (which has units of 1/ft, or ft^{-1}, in the regional model). Specific storage was set equal to 10^{-6} ft^{-1} throughout each model layer representing the Saugus Formation.

4.1.3.3 Rainfall-Runoff-Recharge Relationship

The two nonlinear coefficients in the rainfall-runoff-recharge relationship (see Appendix B and Turner, 1986) were varied during various model calibration tests to evaluate the sensitivity of the model's calibration quality to these coefficients. Tests were conducted that evaluated whether to raise or lower the threshold low value of annual rainfall at which deep percolation of rainfall can occur, and whether to allow more or less deep percolation to occur during the periodic "episodic rainfall" years (when rainfall is substantially above historical averages, resulting in recharge events that "refill" the Alluvial Aquifer in the central and eastern portion of the groundwater basin).

4.1.3.4 Bed Permeability in the Santa Clara River and its Tributaries

Streambed permeability terms control the volume of groundwater/surface water exchanges in both ephemeral reaches and perennial reaches of streams. For groundwater recharge processes in ephemeral stream reaches, the streambed permeability and bed conductance terms are controlled in the SCV Recharge Compiler, as described in Appendix B. These terms are specified in the SFR7 package of MODFLOW-USG in perennial reaches, and also in SFR7 stream cells that are present in ephemeral reaches to drain off groundwater when groundwater elevations exceed the streambed elevation.

4.2 Calibration Data Sets

As discussed previously in this section, the calibration process made use of four separate types of data sets: (1) groundwater elevation records in production wells, (2) groundwater elevation records in non-pumping observation wells, (3) the conceptual understanding of the locations of ephemeral versus perennial stream reaches within the East Subbasin, and (4) stream gaging records on the Santa Clara River near the western boundary of the East Subbasin. The locations of calibration data (wells, stream gages, and the definitions of ephemeral and perennial streams) are shown on Figure 4-1 for the Alluvial Aquifer. Figure 4-2 shows the locations of production and observation wells that provided calibration data for the Saugus Formation.

4.2.1 Groundwater Levels in Production Wells

The local water purveyors have collected groundwater levels at their production wells on a generally monthly basis throughout the 40-year historical calibration period, and these data are maintained in a database that is used to generate annual reports on groundwater conditions in the East Subbasin. The model calibration effort evaluated groundwater elevations and fluctuations in 78 production wells which are listed in Table 4-1 and are as follows:

- 16 Saugus Formation production wells, which consist of 15 existing wells plus a former well (Well 157, owned by the former Valencia Water Company [now VWD]) that was taken out of service in 2005 and subsequently destroyed
- 62 production wells in the Alluvial Aquifer, which include 8 production wells that are not operating but are used for regular water level measurements (VWD's E14, E16, E17, and I wells, and Newhall Land & Farming Company's [NLF's] E, G3, X3, and W5 wells)

A report on water use and local groundwater basin conditions has been published annually through a cooperative effort between the local purveyors since the late 1990s. Since that time, greater attention has been given to the methodology for, and timing of, static water level measurements to minimize the influences of groundwater pumping on the well measured. In the Alluvial Aquifer, which is an unconfined aquifer, measurements that are reported to be static during the 1980s and into the 1990s in a few cases are similar to dynamic measurements collected in more recent years at certain wells—primarily in the eastern portion of the basin. In these cases, the model calibration effort focused more on the past 2 to 3 decades of water level data than on earlier years. These types of relationships are much less frequent in Saugus Formation production wells, most likely because the Saugus Formation is a confined aquifer system that has water levels that recover more quickly when a well stops pumping than is the case with wells constructed in the unconfined Alluvial Aquifer.

4.2.2 Groundwater Levels in Observation Wells

The model calibration effort evaluated groundwater elevations and fluctuations in 31 non-pumping observation wells situated at 11 different locations along the Santa Clara River and the South Fork Santa Clara River (see Table 4-2) and are as follows:

- **Saugus Formation.** Seven nested observation wells/well clusters and one single observation well (together comprising a total of 28 observation wells) are used in the calibration process for the Saugus Formation. Three of these observation well groups (wells MP-1, MP-2, and SG-1) lie along the eastern side of the lower reaches of the South Fork Santa Clara River, and the remaining five wells (MP-5, Library, Mall, DW-1, and DW-2) lie to the west and northwest of the South Fork Santa Clara River and south of the Santa Clara River. These wells use short screens to monitor water levels in discrete depth intervals within the Saugus Formation, and therefore in some cases may not measure groundwater elevations/pressures that are representative of the bulk aquifer formation or bulk thickness of a given model layer. Nonetheless, they are helpful for complementing the data sets that are available from production wells.
- **Alluvial Aquifer.** Three observation wells in this aquifer are used in the calibration process. Well AL-12a is located along the lower reaches of the South Fork Watershed.[4] Wells LACFCD-7177B and LACFCD-7179D are located in the eastern end of the Alluvial Aquifer, along the Santa Clara River. While the Los Angeles County Flood Control District (LACFCD) measures water levels in other wells in the Santa Clarita Valley, most of the data from those other wells are unsuitable for calibration because of short durations, intermittent measurements with long data gaps in some cases, unknown/unconfirmed locations, poor estimates of ground surface elevations or reference point elevations (for converting depth measurements to elevations), or the data are known to be for production wells already accounted for in this analysis.

[4] Data are available at Well AL-12a beginning in July 2005 and continuing through May 2013. During the remainder of 2013 and continuing through 2018, this non-pumping observation well was dry due to its shallow depth.

4.2.3 Visual Observations and Stream Gaging for Ephemeral and Perennial Streams

Aerial photographs show that the Santa Clara River transitions from an ephemeral stream to a perennial stream at the mouth of San Francisquito Canyon, with flow occurring in the perennial reach during most times except for extended and/or intense drought periods. Stream gage stations are maintained on the Santa Clara River upstream of the eastern basin boundary at the Lang Station/Capra Railroad Crossing stream gage (LADPW gage F93B-R), at the Old Road Bridge just west of I-5 (LADPW gage F92C-R), and downstream of the western basin boundary (at the County Line gage [USGS gage 11108500] until October 1996 and at the Piru gage [USGS gage 11109000] beginning in October 1996 and continuing to the present).

The tributaries to the Santa Clara River are ephemeral. Most tributaries are ungaged, with stream gages being present on just two of these tributaries: in Mint Canyon (LADPW gage 328B-R) and Bouquet Canyon (LADPW gage 377B-R). Controlled releases of water also occur periodically from the Castaic Dam/Lagoon complex into Castaic Creek; these releases are measured and reported by DWR, but no long-term gaging station exists on Castaic Creek.

See Figure 4-1 for the locations of these stream gages.

4.2.4 Streamflow Measurements in the Santa Clara River

Streamflow monitoring began in October 1952 at the former USGS stream gage Station 11108500, which was named Santa Clara River at LA/Ventura County Line and is locally referred to at times as the "County Line" stream gage. This gage was located 0.75 miles downstream of the County Line where the river turns southward as it enters a horseshoe bend in an area known locally as "Blue Cut." This gage operated continuously through September 1996, but was subject to periods of missing data during and after extreme high flow events. This gage reportedly had notable uncertainty in its readings at times because of maintenance difficulties, the braided nature of the river channel, and the spatial and temporal variability in gaining versus losing conditions of the Santa Clara River over short distances.[5]

In October 1996, the County Line stream gage was decommissioned and a new USGS gage was put into operation at a bridge crossing on NLF's Las Brisas property in Ventura County. This new gage (Station 11109000, Santa Clara River near Piru) is located 2.75 miles downstream of the former gage station and 3.5 miles downstream of the County Line. This new gage is still in operation today and has provided a high-quality continuous record of streamflow since it was installed. However, because of this gage's significant distance from the County Line and the western boundary of the East Subbasin, its data are slightly less reliable for use in model calibration than the earlier data from the County Line gage. Appendix E provides more information on the locations of these two gages.

Streamflow monitoring has occurred since the early 1930s at the Old Road Bridge (LADPW gage F92C-R), though with periodic interruptions in the data set. During the model calibration period (1980-2019), continuous records are available except in the early 1980s, certain months in the 1990s, and water year 2003. This gaging station provides a helpful data set for evaluating model calibration because it is located in

[5] Personal communication, Earl LaPensee/Richard C. Slade Associates, April 23, 2020. See also Section 4.3.2 of Aqua Terra Consultants (2009), who encountered difficulties calibrating an Hydrologic Simulation Program – FORTRAN (HSPF) surface water flow model to stream gage measurements at the Old Road Bridge gaging station and the former County Line gaging station. Aqua Terra Consultants (2009) discusses that streamflow rates are inherently difficult to accurately measure under low-flow conditions at many stream gaging sites because of changing alluvial, sandy beds; multiple meandering channels; dynamic scouring and deposition impacting water levels; and problems related to stream levels below minimum depths for monitoring devices.

the perennial reach of the river but upstream of the Valencia WRP outfall, which is a notable source of water to the river that came online in 1967 and eventually became the largest water treatment facility as urbanization continued in the basin.

4.3 Calibration Results

Simulation results from the final calibrated model are presented in the form of:

- Groundwater elevation contour maps (Figures 4-3 through 4-10)
- Time-series plots containing groundwater elevation hydrographs (Figures 4-11 through 4-14 for the Saugus Formation and Figures 4-15 through 4-25 for the Alluvial Aquifer)
- Time-series plots of simulated compared with measured streamflows in the Santa Clara River and its tributaries (Figures 4-26 through 4-41)
- Calibration statistics presented in Table 4-3 and Figures 4-42 through 4-45
- Maps showing the geographic distribution of model error (residuals maps) presented in Figures 4-46 through 4-49

Following are discussions of calibration quality with respect to historical groundwater conditions in the Saugus Formation (Section 4.3.1) and the Alluvial Aquifer (Section 4.3.2), the model's ability to simulate perennial and ephemeral conditions in the Santa Clara River and its tributaries (Section 4.3.3), historically measured streamflows on the Santa Clara River (Section 4.3.4), and statistical measures of the model's calibration quality (Section 4.3.5).

4.3.1 Saugus Formation

4.3.1.1 Groundwater Elevation Contour Maps

Figures 4-4 through 4-10 show that the model simulates Saugus Formation groundwater as flowing towards the center of the basin (towards the Santa Clara River in the areas west of the San Gabriel Fault), which is consistent with interpretations by RCS (2002; see Appendix D). South of the river, the hydraulic gradients in the upper portion of the Saugus Formation (model Layers 2 through 4) are stronger (i.e., the contours are more closely spaced) than is the case in the deeper portions of the Saugus Formation (model Layers 5 through 8).

Steep horizontal hydraulic gradients are observed in each unit across the San Gabriel Fault, but not across the Holser Fault—a result that is consistent with an aquifer testing study (CH2M HILL, 2005) which concluded that the Holser Fault likely does not act as a restriction or barrier to groundwater movement. Figures 4-4 through 4-10 also show a line of closely spaced contours north of the river, extending between the Holser and San Gabriel Faults; this is simulated to improve calibration to groundwater elevations at the LACWWD36-19 production well, which is the only well north of the Santa Clara River where groundwater levels are routinely measured in the Saugus Formation.

4.3.1.2 Groundwater Elevation Hydrographs

Groundwater elevation hydrographs in the Saugus Formation are generally well matched, except in the southern periphery of the basin and in the northwest portion of the basin where only one well is present. Observations about the measured versus modeled hydrographs at specific wells are as follows:

- Figure 4-11 shows that good calibration quality to groundwater elevations and elevation trends is achieved at NWD's two active production wells (NWD-12 and NWD-13) and at a former well (NWD-11) that is used for water level monitoring.
- Similar results occur further north at SCWD's two production wells and at four VWD production wells (Figure 4-12). The calibration quality is mixed at observation (monitoring) wells that are just east of these production wells (Figure 4-13a). The model appears to generally simulate the trends in groundwater elevations at the observation (monitoring) wells and in some cases the groundwater elevations in certain wells (such as the deepest wells at the SG-1 and MP-1 well clusters). However, the model has difficulty matching absolute groundwater elevations and vertical hydraulic gradients at several of the monitoring wells, possibly because their short screens measure head pressures in thin discrete zones in the aquifer, in contrast to the thick layers that are used in the model and are pumped by long-screened production wells constructed in the Saugus Formation. Although the monitoring wells show some discrepancies in vertical hydraulic gradients, the model's ability to simulate water level fluctuations and trends is the primary calibration aspect of interest at the various depths and locations of these short-screened monitoring wells. Further west, the model provides a reasonably close replication of the trends and groundwater elevations in the monitoring well locations west of the South Fork Santa Clara River (Figure 4-13b).
- In the western portion of the groundwater basin, the model simulates the historical groundwater elevations and trends at VWD's three production wells in this area, as shown in Figure 4-14. In contrast, in the northwest portion of the basin, simulated groundwater elevations at the LACWWD-36 production well are too low compared with both the static and pumping water levels.

4.3.2 Alluvial Aquifer

4.3.2.1 Groundwater Elevation Contour Maps

Figure 4-3 shows that the model simulates Alluvial Aquifer groundwater as flowing parallel with the geographic alignments and vertical gradients of the Santa Clara River and its tributaries, which is consistent with interpretations by RCS (2002; see Appendix D). Inspection of simulated groundwater elevations indicates that groundwater levels can lie above the bed elevation of the Santa Clara River at some locations between the mouth of San Francisquito Canyon and the western basin boundary, which is consistent with the conceptual understanding of the occurrence of overall gaining streamflow conditions in this area, with a mixture of shorter reaches that are gaining and shorter reaches that are losing.

Simulated groundwater elevations at times are slightly above the ground surface beneath streams entering the groundwater basin in some tributary valleys to the Santa Clara River but drop below the streambed further downstream in the upper reaches of these valleys (well before entering the Santa Clara River). This observation indicates that, at the groundwater basin boundary, the alluvium's thickness and/or hydraulic conductivity in some of these tributary valleys may be too small.

4.3.2.2 Groundwater Elevation Hydrographs

Seasonal and year-to-year groundwater elevation fluctuations differ in magnitude across the length of the Alluvial Aquifer adjacent to the Santa Clara River, as well as in the tributary valleys. Previous studies have divided the Alluvial Aquifer into multiple subareas for the purposes of evaluating these differences, and also quantifying differences in groundwater production from various parts of the alluvium. See the annual reports for the basin, such as the 2019 annual report (LSCE, 2020). The alluvial subareas are shown in Figure 4-15 and are used to discuss the model's calibration quality to groundwater elevation hydrographs in the Alluvial Aquifer.

The model generally simulates the historical groundwater elevations and their fluctuations throughout the Alluvial Aquifer. Specific observations about the model's calibration quality in this regard follow, beginning upstream and including tributary valleys where production wells are present:

- **Mint Canyon Subarea.** The high and low groundwater elevations, recorded over the course of many years of variable rainfall, are well matched in the two observation wells (LACFCD-7177B and -7179D) that are present in the eastern portion of the basin (in the Mint Canyon subarea; see Figure 4-16). The fit of the high and low groundwater elevations is also good at NWD's nearby production wells, particularly the Pinetree1 and Pinetree4 wells. However, in many of these wells, the model simulates too rapid of a decline in groundwater levels following major recharge events (i.e., after high groundwater elevations are observed). Also, during droughts, simulated groundwater levels are slightly higher than the levels measured at the two other Pinetree wells and also at two other production wells just to the west (SCWD's Lost Canyon 2 and Lost Canyon 2A wells; see Figure 4-17). The remaining wells in the Mint Canyon area are well matched (see Figures 4-17 and 4-18), except for an upward trend in simulated groundwater levels at several wells during 2016 that appears to precede the observed water level recovery. Several of these wells were shut off or pumped at very low rates/volumes as the drought progressed, causing their observed water levels to stop declining and, in some cases, to rise slightly, but at lower recovery rates than simulated by the model. Repeated testing of antecedent recharge rates and aquifer parameters resulted in a closer fit to measured water levels than the fit achieved in initial simulations during the calibration process; however, repeated testing could not fully replicate the actual timing of water level recovery rates during and after the latter part of the 2011–2016 drought.
- **Above Saugus WRP Subarea.** In this subarea, the high and low groundwater elevations are well-matched, along with general elevation trends. However, as was noted above for the Mint Canyon subarea, water levels at some wells in the Above Saugus WRP subarea decline too rapidly after major recharge events and rise somewhat faster in the model in 2016 and 2017 than was observed in these wells (see Figure 4-19).
- **San Francisquito Canyon and Bouquet Canyon.** In these two northern tributaries to the Santa Clara River, the groundwater elevations and elevation trends are generally well-matched, particularly in San Francisquito Canyon where the trends are well-matched in all four production wells (see Figure 4-20). In Bouquet Canyon, the model tends to slightly or moderately under-predict groundwater elevations at many times, and the simulated trends occasionally are the opposite of those recorded by static water level measurements. Repeated testing in Bouquet Canyon could not resolve these discrepancies.
- **Below Saugus WRP Subarea.** Groundwater elevations and elevation trends are generally well-matched in this subarea, including at observation wells AL-12A and VWD-I, the latter of which is a former production well that has been out of service since late 1991 but has continued to be used for monthly water level measurements since that time (see Figure 4-21). While the drought and post-drought conditions of recent years are well-simulated at VWD-Q2, VWD's wells just to the west (N, N7, and S8) show simulated decreases in water levels during the drought that are less than the observed amounts of the decreases in water levels.
- **Castaic Valley Subarea.** Groundwater elevations and elevation trends are generally well-matched in NWD's Castaic wellfield, in the upper (northern) portion of Castaic Valley (see Figure 4-22). Groundwater elevations in this area during the recent drought are somewhat below the

measured static elevations but well above the measured pumping elevations. In the lower (southern) portion of Castaic Valley, Figure 4-23 shows that groundwater elevations and elevation trends are well-matched, except for a modest over-prediction of groundwater elevations at one of the six wells in this area (NLF-E).

- **Below Valencia WRP Subarea.** The groundwater model readily simulates the small seasonal fluctuations and the near absence of year-to-year changes in groundwater elevations that make this subarea unique compared with the rest of the Alluvial Aquifer (see Figures 4-24 and 4-25). Groundwater elevations are closely matched at some wells (such as NLF-B14) while differences are notable at other nearby wells (such as NLF-B10 and NLF-B16). Lack of survey control, uncertainties about water-level recovery rates prior to measuring static water levels, and a lack of information about nearby pumping creates considerable uncertainty in the interpretation of the water level data from agricultural wells in this subarea. This may explain why the model closely simulates groundwater elevations at some wells (such as NLF-C6) while appearing to notably overestimate groundwater elevations in other nearby wells (such as NLF-C4). Specifically, the model closely simulates the hydrograph for well NLF-C6 (which has not been pumped since 2004 and thereby is providing truly static water level data), whereas simulated water levels are higher than the reportedly "static" water levels at NLF-C4 (which is used each year to meet agricultural water demands and may not be showing water levels that represent static conditions in the well or the aquifer). This data quality issue is further indicated by the data at NLF-C10, which showed a 15- to 20-ft decline in its static water level readings during the first year of monitoring. While these data are uncertain with respect to absolute elevations of the water table, there are consistently small variations in water levels at each well throughout this area despite the increased urbanization and the variable nature of precipitation and streamflows during the 40-year calibration period; this is a strong indication of the importance of groundwater discharges from the Saugus Formation to the Alluvial Aquifer in this area.

While small adjustments to aquifer parameters could potentially improve certain aspects of these calibration hydrographs, the model's good fit to the historical high and low water levels renders the model a useful tool for groundwater management analyses in the Alluvial Aquifer.

4.3.3 Ephemeral versus Perennial Stream Reaches

The model provides a realistic representation of the occurrence of ephemeral versus perennial stream reaches in the basin, as indicated by analyses of model results along the Santa Clara River and in its gaged and ungaged tributaries.

- **Gaged Tributaries.** Figures 4-26 and 4-27 present hydrographs (time-series plots) of measured versus modeled non-storm (dry-weather) streamflows in two ephemeral tributaries to the Santa Clara River (Mint Canyon and Bouquet Canyon). Both hydrographs show that the model simulates minimal to no flow in both streams except during wet years, such as 1983, 1993, 1998, and 2005. In Mint Canyon, Figure 4-26 shows that the model simulates the continuous occurrence of flow upstream of the Mint Canyon stream gage (LADPW station 328B-R), which likely is an over-estimation of flow in the furthest upstream reaches of Mint Canyon. However, non-storm flows at the mouth of Mint Canyon are simulated as zero at most times and are very small at the few times that they are non-zero in value. Similarly, Figure 4-27 shows that the model-simulated flows in Bouquet Creek are non-zero at most times, which is similar to the observations from measured data at LADPW station 377B-R. The near absence of non-storm flows at the mouths of Bouquet Canyon and Mint Canyon is consistent with the understanding that the ephemeral tributary valleys do not contribute flow to the Santa Clara River during non-storm periods.

- **Large Ungaged Tributaries (South Fork and Castaic Creek).** The model simulates non-storm (dry-weather) streamflow in the South Fork Santa Clara River during wet and normal years, with little to no such flow during droughts (see Figure 4-28), which is consistent with the conceptual understanding of this drainage during drought periods but may overestimate flow at other times. Non-storm flows in Castaic Creek are simulated as occurring only near its mouth (see Figure 4-29), with no flow occurring during drought years at this location and in all years just upstream at the mouth of Hasley Canyon (approximately 0.65 miles upstream of Highway 126). These observations are consistent with the understanding that Castaic Creek generally flows only in response to releases of water from the Castaic Dam/Lagoon complex and the largest storm events that occur in the basin.
- **Santa Clara River Upstream of Valencia WRP.** As shown in Figure 4-30, the model simulates the prevailing absence of flow in the Santa Clara River at the mouth of Bouquet Canyon, followed by nearly perennial flow at the mouth of San Francisquito Canyon and continuing further downstream to the I-5 Bridge and the Valencia WRP. These observations are consistent with the conceptual understanding that the perennial reach of the Santa Clara River begins at the mouth of San Francisquito Canyon, where Saugus Formation bedrock is near the ground surface along the southeastern flank of Round Mountain (which is a Saugus Formation outcrop) and continues to the location of the outfall from the Valencia WRP. The model also shows the occurrence of near-zero flow conditions during the summer months of the 2014–2016 drought period, which is consistent with visual observations of zero to near-zero flows in the river during the summer months of those 3 years.
- **Santa Clara River Downstream of Valencia WRP.** As shown in Figure 4-31, the model simulates a reduction in streamflow from the Valencia WRP downstream to Castaic Creek. The simulation of continued perennial flow conditions but a reduction in flow in this portion of the river is consistent with the understanding that groundwater levels likely are below the river in this area. Figure 4-32 shows that the river gains considerable flow from Castaic Creek to the mouth of Potrero Canyon, which is an expected result from the model because this portion of the river occupies the sole area in the East Subbasin where groundwater from the Saugus Formation can naturally discharge into the Alluvial Aquifer, and thereby enhances streamflows in the river. The model simulates a small amount of loss in the Santa Clara River from Potrero Canyon to the western basin boundary, as shown in Figure 4-33, which reflects the fact that this river reach is located downstream of where the Saugus Formation is present and hence loses the upwelling influence occurring further upstream. However, the river remains perennial at the western basin boundary despite the small streamflow losses that occur in this far western end of the groundwater basin.

4.3.4 Modeled vs. Gaged Streamflows in the Santa Clara River

Figure 4-34 compares the gaged streamflows at Old Road Bridge (LADPW gage F92C-R) with simulated streamflows approximately 500 feet upstream of the gage (at I-5) and approximately 2,000 feet downstream of the gage (immediately above the outfall for the Valencia WRP). During the summer low-flow seasons, simulated flows at the I-5 Bridge are generally higher than measured at Old Road Bridge, while the simulated flows above the Valencia WRP outfall are similar to the Old Road Bridge gaged flows during drought years but exceed the Old Road Bridge gaged flows in wet years. Figure 4-35 shows that the modeled flows match well with the sum of the Old Road Bridge gaged flows and discharges into the river from the Valencia WRP outfall. Together, these plots indicate that the model generally simulates the observed perennial low-flow conditions in this portion of the river and the notable increase in flow that occurs at the Valencia WRP.

As shown in Figure 4-36, at the western boundary of the groundwater basin (and the model) simulated flows in the Santa Clara River generally are higher than those recorded at the former County Line gage (located 0.75 miles downstream of the basin boundary) and the existing Piru gage (located 3.5 miles downstream of the basin boundary). As discussed in Section 4.3.3, the river is thought to be losing water between the mouth of Potrero Canyon and the basin boundary, based on groundwater level measurements conducted during a geophysical study (Geomatrix, 2007; see Appendix D) and recent aerial photographs of the streambed in 2006, which were taken when the river channel was free of vegetation that had been removed by high streamflows in early 2005. As shown in Figures 4-37 through 4-39, close inspection of the 2006 channel conditions at and beyond the basin boundary shows braided streamflow occurring in the channel approaching the location of the former gage in Blue Cut (the horseshoe bend in the river), with most of the flow then disappearing into the alluvial fill material immediately south of the former gage and little to no flow being visible in the channel as it enters the southern bend of the horseshoe. This visible loss of flow as the river enters the Blue Cut horseshoe bend is consistent with the understanding that the river is already losing water to the underlying alluvial sediments at and west of the mouth of Potrero Canyon. The aerial photos also show that the portion of the stream channel downstream of the horseshoe bend is initially dry (or nearly so), with a sudden distinct reemergence of flow into a wide and mostly non-braided channel as the river passes out of Blue Cut and flows to the northwest.

Figure 4-40 compares the model-simulated streamflow at the basin boundary with the gaged flows at the former and current gage sites and shows how applying a stream-loss factor to translate the model output to the gage sites can produce a reasonable replication of the measured streamflows during non-storm periods. Specifically, between the western basin boundary and the former gage site, a loss rate that is 2.5 times the loss-rate between Potrero Canyon and the western basin boundary provides a good fit to the measured data prior to October 1996 at the former County Line gage site, particularly when trying to match the lowest flows that occurred during the driest periods (the summers of 1988, 1989, 1991, and 1996) before the former gage was decommissioned. Inspection of the hydrograph shows that after the gage was relocated to the Piru site (3.5 miles downstream of the western basin boundary), the adjusted flows are slightly below the gaged flows during the summer months, which suggests that the river is receiving a small net influx of water between the western basin boundary and the current gage site 3.5 miles further downstream.

Figure 4-41 shows a plot of cumulative summer-season streamflows for the 40-year calibration period (1980 through 2019), as predicted by the model and as estimated from the stream gage measurements at the former and current gaging stations. These cumulative streamflows represent dry-weather streamflow volumes during the months of July through September, added up from one year to the next. The 3-month period of July through September was used as the basis for this analysis because inspection of rainfall and stream gaging records showed that these three months are the months that are least affected by rainfall and stormwater runoff in most years. The plot in Figure 4-41 shows that (1) the cumulative streamflows at the western basin boundary (the western boundary of the model) depart from the measured cumulative flows, and (2) the translation of flows to the downstream gaging stations (which focused on the driest years prior to 1997) provides a reasonable replication of summer-season gaged flows. The small departures from the gaged data that appear in the adjusted simulation results closely follow the occurrence of the highest rainfall/runoff years in the basin (occurring in 1983, 1993, and 2005), which is in contrast to the relatively unchanged slope of the cumulative curve for the gaged summer-season flows. The adjusted curve also shows a gentler slope than the slope of the measured curve beginning in 2007/2008 and continuing through 2019, which suggests that the model may slightly underpredict the amount of dry-season streamflow exiting the basin during periods of prolonged dry conditions or particularly intense droughts.

4.3.5 Statistical Measures

Calibration statistics were calculated for the residuals of groundwater elevations and groundwater elevation changes over time. As defined by ASTM (1996), the residual is equal to the measured value minus the simulated value at any point in time for a given well that is used for model calibration. The calibration statistics were calculated for all times when static water level measurements are available for a given well. For each given well, the groundwater elevation changes over time at the well were calculated as changes since the time of the first field measurement that occurred during the 1980–2019 calibration time period. Static water levels were used because they represent conditions in the aquifer, whereas pumping water levels are influenced by well losses and variability over many years in the condition of both the well and the well's pump.

Statistics were calculated for all residual values during the 40-year simulation period and were calculated for the entire aquifer system (89 target wells, consisting of 78 production wells and 11 observation wells), the Alluvial Aquifer alone (65 target wells, consisting of 62 production wells and 3 observation wells), and the Saugus Formation alone (24 target wells, consisting of 16 production wells and 8 observation wells). The target wells included each production well where a continuous or nearly-continuous water level record is available over multiple years or decades; three Alluvial Aquifer monitoring wells (AL-12A, LACFCD-7177B, and LACFCD-7179D) that could be located and verified as not coinciding with another well already being analyzed and also not being a bedrock well; and eight Saugus Formation observation/monitoring wells (DW-1B, DW-2, Library-A, Mall-A, SG1-HSU3a, SH1-HSU3c, MP1-08, and MP5-03) whose groundwater elevation hydrographs (discussed in Section 4.3.1.2) indicate that the well is monitoring the regional flow system rather than locally discrete water-bearing strata.

Table 4-3 presents summary statistics for groundwater elevations and groundwater elevation changes. Figures 4-42 and 4-43 present scatter diagrams that plot the modeled values (on the vertical axis) against the simulated values on the horizontal axis, and which include three diagonal lines: one showing a perfect fit, and the other two representing one standard deviation of residual values on each side of the perfect-fit line. For groundwater elevations, the table and plots show that the calibration goal of 10 percent or less for scaled statistics is met for the scaled absolute residual mean (ranging from 1.0 percent to 5.7 percent) and is closely met for the scaled standard deviation (ranging from 2.7 percent to 10.5 percent). The scaled statistics for groundwater elevation changes meet the 10 percent goal for the scaled residual mean (ranging from 0.7 percent to 5.2 percent) and is slightly exceeded for two of the three scaled standard deviations (8.5 percent for both aquifers combined, 12.2 percent for the Alluvial Aquifer, and 11.6 percent for the Saugus Formation alone). Inspection of the elevation-change statistics indicate that the residual error for the Alluvial Aquifer is caused by the wells in the eastern portion of the basin (in the Mint Canyon subarea and the Above Saugus WRP subarea) where groundwater levels (1) decline too quickly following high-rainfall/recharge events and, in some cases, (2) recover too quickly during the latter portion of the 2011–2016 drought (as discussed in Section 4.3.2.2).

After reviewing the statistics, the analysis was repeated without five Saugus Formation production wells that are near the perimeter of the model, away from the primary focus area in the central portion of the basin (wells LACWWD36-19, VWD-159, NWD-7, NWD-9, and NWD-10). Even though the calibration statistics in the initial analysis met the calibration goal, this second analysis was of interest to understand (and quantify) the extent to which these five peripheral wells are affecting the statistics and the model's calibration quality, given the difficulties in improving the calibration in these peripheral areas where only limited data are available. Table 4-4 and Figures 4-44 and 4-45 present these statistics and show that the mean, standard deviation, and scaled statistics for the Saugus Formation decreased notably in value in the case of groundwater elevations. For groundwater elevation changes in the Saugus Formation, the absolute value of the mean residual increased slightly (from 22.9 to 27.6 ft), the standard deviation decreased slightly (from

37.8 to 27.3 ft), the scaled absolute mean increased from 0.7 percent to 4.5 percent, and the scaled standard deviation decreased slightly (from 11.6 percent to 9.5 percent). The scaled statistics were all below 10 percent in the analysis that did not include the five perimeter wells.

Maps showing the locations of wells with overall positive residuals versus negative residuals provide a means of evaluating whether there is spatial bias in the calibration—in particular, whether certain geographic areas of the model tend to be dominated by positive or negative residuals (an indicator of spatial bias) versus having a mixture of positive and negative residuals in localized areas (an indication that spatial bias is minimal). For both the Alluvial Aquifer and the Saugus Formation, spatial bias was evaluated using both (1) the mean values of head (groundwater elevation) residuals and (2) the mean values of head-change residuals at each well. For each individual well, the residual mean values are equal to the average over time of all residuals at that well. Figures 4-46 and 4-47 show the geographic distribution of the residual mean values in the Alluvial Aquifer for heads and head changes, respectively. Figures 4-48 and 4-49 show the residual mean values in the Saugus Formation for heads and head changes, respectively. Observations from these maps are as follows:

- **Alluvial Aquifer.** Head residuals tend to cluster (Figure 4-46), particularly (1) in the eastern end of the basin where positive residuals dominate because of the model's tendency to show too rapid a decline in groundwater levels after large rainfall/recharge events, and (2) at the west end of the basin where the model tends to slightly over-predict groundwater elevations. Head-change residuals (Figure 4-47) show a better mixture of positive and negative residuals, though there are more wells with overall negative than positive residuals (indicating a tendency for the model to over-predict the amount of change occurring in groundwater levels over time).
- **Saugus Formation.** Head residuals tend to show a good mixture of positive and negative residuals (Figure 4-48), except the southernmost wells and the northernmost well show large positive residuals which reflect the difficulty that was encountered raising groundwater levels sufficiently high to simulate historically observed groundwater levels at those wells. Head-change residuals (Figure 4-49) show some clustering of positive and negative residuals, indicating a tendency for the model to slightly over-predict the amount of change occurring in groundwater levels at several wells over time.

The streamflow evaluations discussed previously in Section 4.3.4 (and presented in Figures 4-36 through 4-41) evaluate the model against semi-quantitative goals pertaining to streamflow conditions in the Santa Clara River. Statistical calculations were not performed for streamflows because of the uncertainties associated with the current and former stream gages being located downstream of the basin boundary.

4.4 Observations of Parameter Sensitivity during Calibration

Calibration and testing of the new regional model was conducted over an approximately 2-month period, primarily using manual calibration methods because of the model's long run times. During this effort, observations were made about the general influences that adjusting certain model parameters would have on improving or degrading the model's ability to simulate historically measured groundwater elevations and groundwater elevation trends for the Alluvial Aquifer and the Saugus Formation as well as historically measured streamflows at the former County Line stream gage. Following are some of the noteworthy observations from this process.

The following observations about model sensitivity were made regarding upgradient areas of the model:

- Groundwater elevations at the LACWWD36-19 production well were sensitive to the placement or absence of a low-permeability fault zone south of the well and north of the Santa Clara River (see Figures 3-34 through 3-39). Without such a feature, initial calibration simulations produced simulated static groundwater elevations that were more than 300 feet below the measured static elevations. Because no other production wells or observation wells are known to be present in the Saugus Formation in the area situated north of the river and west of the San Gabriel Fault, the nature of the geologic features supporting the high groundwater elevations at this well are unknown. However, the placement of a low-permeability hydraulic conductivity zone was deemed appropriate because of the presence of the high recorded groundwater elevations at this well.

- The selection of hydraulic conductivity values in the southern portion of the Saugus Formation (south of NWD's wells 10 through 13) was instrumental in calibrating groundwater elevations and groundwater elevation trends at NWD's active and inactive production wells. This zone (zone 18; see Figures 3-34 and 3-35) uses a vertical hydraulic conductivity of 1 ft/day, compared with its horizontal hydraulic conductivity of 2 ft/day. The need for a relatively high vertical hydraulic conductivity in this zone is consistent with the understanding that groundwater recharge to the Saugus Formation at the southern edge of the groundwater basin is potentially an important recharge mechanism (in addition to leakage from the Alluvial Aquifer from the Santa Clara River east of I-5).
- In the eastern portion of the Alluvial Aquifer, tests were conducted to seek improvements in the too-early simulated onset of water level recovery towards the end of the 2011–2016 drought period. Because hydraulic conductivity values were already similar to those estimated from the highest specific-capacity wells in this area, further increases in hydraulic conductivity were deemed as unsupported by field data and were not tested as a means of reducing the magnitude and timing of water level recovery. Initial tests that raised the specific yield from 0.10 to 0.20 resulted in overall poor matches to long-term hydrographs in this area. Further tests of lower streambed recharge rates, lower rainfall infiltration rates prior to the drought, and lower hydraulic conductivity values in the Alluvial Aquifer resulted in varying degrees of worsening of the match to observed groundwater elevation trends and, in some cases, observed groundwater elevations.

The following observations about model sensitivity were made in the center of the basin (primarily the downgradient areas that are situated at and west of I-5):

- Streambed conductance has an influential role on simulation quality in the calibration model, including in the perennial reach of the river. Changes as small as a factor of 2 in streambed conductance west of I-5 were found to have a discernible effect on dry-weather flows downstream of the Valencia WRP, with the influence becoming pronounced when dividing or multiplying by a factor of 10. The model's current representation of Santa Clara River flows west of I-5 is based in part on careful adjustment of the conductance terms in Segments 85 through 107 (from the mouth of San Francisquito Canyon to the mouth of Castaic Creek; see Figure 3-30), to reflect field observations of a small amount of net streamflow loss occurring between the outfall from the Valencia WRP and Castaic Creek.[6]
- The ET surface and the ET extinction depth have a noteworthy influence on the annual volume of ET that occurs from uptake of groundwater by deep-rooted vegetation along the riparian corridor of the Santa Clara River. Sensitivity tests indicated that lowering the ET surface to a depth of 5 feet (in contrast to placing it at the ground surface) caused a 23 to 28 percent increase in annual ET, which varied in accordance with year-to-year fluctuations in basin-wide rainfall and rainfall recharge. Lowering the ET extinction depth from 15 feet to 30 feet increased ET withdrawals by an additional 7 to 11 percent. The combined effect of these two model tests was

[6] Personal communication, Andy Collison/ESA to John Porcello/GSI Water Solutions, December 6, 2016.

a 32 to 43 percent increase in ET, depending on background hydrologic conditions. The calibrated model uses an ET surface placed 5 feet below ground surface, and an extinction depth 25 feet below ground surface.

- West of the Valencia WRP, the selection of the deep percolation rate beneath irrigated agricultural lands has little influence on simulated groundwater levels in the Alluvial Aquifer (see Figure A-1 in Appendix A for the locations of agricultural lands). The choice of the horizontal and vertical hydraulic conductivity in the upper layers of the Saugus Formation at and west of the Valencia WRP has a notable effect on groundwater elevations in the southern portion of the Saugus Formation, and also has enough of an effect on Alluvial Aquifer groundwater levels so as to sometimes cause notable effects on the rates at which groundwater discharges from the alluvium into the river west of the Valencia WRP.
- The selection of the hydraulic conductivity values in multiple Alluvial Aquifer zones downstream of the Valencia WRP (see Figure 3-33) was crucial for calibrating the model's simulation of dry-weather flows in the Santa Clara River to measured streamflows, particularly after the thin nature of the alluvium in the vicinity of Potrero Canyon and the western basin boundary was programmed into the model using the results from a 2007 geophysical study. Initially low hydraulic conductivity values (on the order of 100 to 550 ft/day) produced unreasonably high simulated streamflow volumes. Reinspection of specific capacity data in this area revealed that one well (NLF-B5, located in zone 50) has a specific capacity that produces hydraulic conductivity estimates of more than 1,000 ft/day, and potentially as high as 1,500 ft/day. The model calibration process has resulted in the use of hydraulic conductivity values of 1,000 ft/day at the western basin boundary and the mouth of Potrero Canyon, and values as high as 1,400 ft/day extending upstream to and just east of NLF's C wellfield (which is located in zone 49). As discussed in Section 3.1.6, these values are consistent with lithologic descriptions for the Alluvial Aquifer, which describe sandy gravel, gravelly sand, gravel, cobbles, and boulders in the eastern and central portions of the basin and a mixture of sands and gravels in the western portion of the basin.

4.5 Calibration Outcome

DWR's modeling BMP (DWR, 2016a) states the following regarding the decision-making processes involved in assessing whether a model is sufficiently calibrated for its intended uses:

> No model is perfectly calibrated, and establishing desired calibration accuracy a priori is difficult. One criteria that could be considered is whether additional calibration would change a GSA's approach to achieving sustainability. If a more accurate model does not change the decision a GSA would make, then additional calibration is not necessary. [p. 28]

The process of calibrating the new regional model to a 40-year period of groundwater elevation and streamflow data has resulted in a model that is deemed by GSI to be suitable for its intended applications, which include evaluating groundwater sustainability and potential projects that can improve sustainability if needed, evaluating groundwater pumping strategies between and during drought periods, and supporting water quality studies. The primary attributes of the model's calibration that make this tool appropriate for its intended uses are:

- Its ability to simulate groundwater elevations and flow directions, as well as historical trends in groundwater elevations and river flows, during a 4-decade period that reflects (1) multiple cycles of rainfall and streamflows and (2) the effects of increased urbanization on changes in land use and water use, thereby meeting the goals established for the calibration process (calibration goals 1 through 6 as described in Section 4.1.2)

- Its ability to simulate these same characteristics in smaller geographic areas of interest within the East Subbasin (for example, in multiple subareas of the Alluvial Aquifer)
- The use of groundwater elevation and streamflow data to constrain the model's calibration (rather than relying solely on groundwater elevation data)
- The consistency of the calibration results with the conceptual models for the groundwater and river systems, which have been described in numerous prior reports (including RCS, 2002; CH2M HILL, 2004a and 2005; CH2M HILL and HGL, 2006 and 2008; Geomatrix, 2007; and basin annual reports, such as LSCE, 2020)
- The model's use of an integrated model of the watershed (the SCV Recharge Compiler) to define the amount of rainfall and stormwater that is potentially available to recharge the groundwater system
- The incorporation of a streamflow routing capability (using the SFR7 package) that allows streamflows to be directly simulated in the model
- The use of MODFLOW-USG, which allows efficient simulation of local-scale conditions with a high-resolution grid that is efficiently integrated into the parent grid

The calibration process has resulted in a new regional model that reasonably replicates, on a monthly and annual basis, historically observed groundwater elevation fluctuations and the dynamic and spatially variable nature of flows in the Santa Clara River and groundwater/surface water exchanges throughout the East Subbasin—capabilities that are necessary for evaluating and designing groundwater management strategies and monitoring and evaluating their effectiveness. Accordingly, as envisioned by DWR in its modeling BMP document (DWR, 2016a), the model can serve as a valuable tool for comparing the benefits and impacts of various management strategies with respect to one another, which in turn will facilitate an adaptive management approach to continuing the current management program and/or implementing new programs under the GSP.

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SECTION 5: **Model Applicability to Local Water Resource Management**

This section provides a summary of the model's applicability to current and future groundwater management activities (Section 5.1), a summary of the model's limitations (Section 5.2), and recommendations for future maintenance of the model (Section 5.3).

5.1 Model Applicability

The process of constructing and calibrating the SCVGWFM (the new regional groundwater flow model) to a 40-year record of groundwater level and streamflow records has resulted in a model that is well-suited for its intended applications. As discussed in Section 1.2 of this report, the SCVGWFM was built to support GSP development and implementation by virtue of its use of widely known groundwater modeling software that (1) enables the use of unstructured grids, (2) provides rigorous numerical treatment of multi-layer production wells, and (3) allows for calculation of instream flow rates while simulating groundwater/surface water exchanges—a combination of capabilities that does not exist in any other groundwater modeling code. The primary attributes that make the SCVGWFM appropriate for its intended uses are as follows:

- The model's boundaries extend outward to the groundwater basin boundary, thereby avoiding the introduction of artificial boundary influences on simulation results and their interpretations. The full areal extent of the basin's two principal aquifers—the Alluvial Aquifer and the Saugus Formation—lie entirely within the active domain of the model grid.
- The SCVGWFM simulates historical trends in groundwater elevations and streamflows across the basin, particularly in the Alluvial Aquifer where significant differences in these trends occur in different parts of the basin.
- The SCVGWFM has been calibrated to a 40-year period that was characterized by increased urbanization, variations in agricultural water use, increased State Water Project imports (which began in late 1979), associated changes in land use and water use, significant rainfall/recharge events during El Niño years, and periods of prevailing below-normal rainfall conditions (including a deep drought characterized by far-below-normal rainfall from late 2011 through 2016). The model's calibration includes periods of normal, above-normal, and below-normal rainfall years, which makes it useful for examining groundwater resource management topics under a variety of future climatic conditions.
- For the portion of the alluvial valley hosting the perennial reach of the Santa Clara River, the SCVGWFM can simulate the surface and shallow groundwater hydrologic processes that are of interest to the SCV-GSA, SCV Water, and local stakeholders. Specifically, the model simulates the discharge of treated water to the Santa Clara River from the Saugus and Valencia WRPs, the spatial changes in flow in the river arising from streambed seepage to the water table in losing reaches, and groundwater discharge to the river in gaining reaches. The model also simulates the seasonal variations in groundwater uptake by phreatophyte plant communities that are comprised of native species (predominantly Fremont Cottonwood and various species of willow trees and shrubs) and invasive species (predominantly *Arundo*).
- The SCVGWFM includes a companion code developed by GSI—named the SCV Recharge Compiler—that determines the monthly volume of rainfall that is available to streams that are tributaries to the Santa Clara River (from the portions of those tributaries that lie in the contributing watersheds situated upstream of the groundwater basin boundary). The SCV Recharge Compiler also computes how much of this runoff entering the groundwater basin can

recharge the Alluvial Aquifer, and the locations of that recharge. Together, the SCV Recharge Compiler and the SCVGWFM allow for estimation of the time-varying magnitude of storm-driven groundwater recharge and the effects of that recharge on groundwater return flows to the Santa Clara River. In summary, the SCVGWFM is actually a groundwater flow model coupled with an empirical tool that estimates stormwater generation from each watershed lying upstream of, and extending into, the East Subbasin.

5.2 Model Limitations

The SCVGWFM has been created through a detailed process of planning, construction, and calibration. Accordingly, the model is a viable and reliable tool for the SCV-GSA and SCV Water to use for development, implementation, and monitoring of the GSP for the East Subbasin, and for other groundwater resource planning and management programs. Nonetheless, despite its detail and the in-depth nature of the calibration and validation process, the numerical model is a simplification of a complex hydrogeologic system and has been designed with certain built-in assumptions. Like any model, it is not perfect and should be used with care. Predictive simulation results should be examined by qualified and experienced hydrogeologists and water resource managers. Future modeling analyses, interpretations, and conclusions should not be viewed as absolute results and could change as the model is refined in the future as new data become available.

As with any groundwater model, there are data limitations inherent in the use of the model, in particular because of the small number of wells in certain areas. This is particularly the case (1) in the Saugus Formation north of the Holser Fault, where only one deep production well is present (LACWWD36-19) and (2) in the Alluvial Aquifer along several tributaries to the Santa Clara River where few (if any) wells are present. The use of the model in these areas for in-depth predictive analyses would best be preceded by further study and modeling of the local groundwater system (including local calibration refinements wherever new data are sufficient in volume and quality to support such an effort).

5.3 Recommendations for Future Maintenance of the Model

The process of calibrating and validating the SCVGWFM has resulted in a tool that reasonably represents historically observed groundwater elevations, their seasonal and annual fluctuations, historical streamflow data near the western basin boundary, as well as the relative magnitudes of groundwater recharge and discharge mechanisms as understood by local hydrogeologists before the development of the SCVGWFM began. The model's reasonable representation of historical data, and its agreement with the conceptual model, make it a useful and important tool to support water supply planning and groundwater resource management in the East Subbasin.

Continued maintenance of the model is recommended, to ensure that it will continue to be ready for future groundwater resource planning and system evaluation needs. Maintenance activities should be determined by SCV Water based on how it plans to use the model to support long-term programs (water supply planning, groundwater supply augmentation, and groundwater resource protection) and to support near-term decision-making on matters such as wellfield operations, site development impacts on groundwater, or other specific resource management topics. Maintenance activities could include one or more of the following activities, to the extent deemed necessary and appropriate by SCV Water:

- **Extending the calibration period as new data become available.** This can be thought of as a "calibration check" process, for which the objective is to evaluate the model's ability to simulate more recent conditions than those for the pre-2020 period to which the model was calibrated. Events that could warrant an extension of the calibration period include the collection of data at new locations and the occurrence of different groundwater conditions than those experienced in the past (e.g., if the onset of an extended drought were to cause decreased pumping at some wells, the need to increase pumping elsewhere, lower recharge to the aquifer, and accordant changes in observed groundwater levels). Additionally, whenever new production wells are installed, long-term water level monitoring should commence in the well, and controlled pumping tests should be conducted to provide quantitative estimates of aquifer properties—particularly in areas where wells have not been previously constructed.

- **Upgrades to model software.** New versions of the MODFLOW family of software tools periodically become available that add/improve existing MODFLOW packages and/or improve solver capabilities and reduce model run times. These updates can occur every few years. Additionally, updates to the GUI (GV) occur frequently, although major upgrades in its features occur only every few years. Updates to MODFLOW and GV do not need to be conducted on a regular schedule for the model to remain functional and suitable for its intended uses. If SCV Water elects to use the model in an updated version of MODFLOW or under a major update of GV, the model should be run with the new software to confirm that it converges and runs properly, and to check that simulation results are similar to those obtained from the earlier software.
- **Model-sharing and cooperative efforts with local stakeholders and other government agencies.** When a municipality or water provider has developed a detailed numerical groundwater model of a regional aquifer system, it is common to receive requests for the model from local landowners/stakeholders or other government agencies. Keeping the model updated with recent software and a calibration that is not several years old is generally helpful for increasing the confidence of other stakeholders and for providing the model's owner (SCV Water) with opportunities to ensure that the model is being used correctly.

The thoroughness and completeness of much of the available groundwater and surface hydrologic data set has had a long history of greatly facilitating the ability to (1) construct and calibrate the original groundwater flow model and the new regional model described in this report, and (2) check the calibration of the model as new data become available from the monthly monitoring programs that are conducted across the basin. These activities should continue in order to support groundwater model maintenance and SCV Water's other monitoring and resource planning programs. Critical data for SCV Water and its retail water divisions to collect include well-by-well groundwater pumping volumes, routine groundwater level measurements under static and pumping conditions, and rainfall (at the former NWD office). These data—along with other critical hydrologic data (particularly stream gaging data) collected by city, county, state, and federal cooperating agencies—provide valuable information for identifying and understanding the changes that occur in the surface and groundwater systems, including the nature of the exchanges of water between groundwater and local streams.

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SECTION 6: **References**

6.1 References Directly Related to Model Development

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TABLES

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Table 3-1
Allocation of Pumping by Model Layer for Current and Former Production Wells Completed in the Saugus Formation
Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

			Kh	Open Interval (ft)		Ground	Layer	Layer	Depth to	Thickness of	Layer	Thickness of Open Interval In	Transmissivity (ft^2/day) of Open	Approximate Proportion of Pumping From
Well Name	Status As Of 2019	Model Layer	(ft/day)	Depth to Top	Depth to Bottom	Elev. (ft)	Top Elev. (ft)	Bottom Elev. (ft)	Layer Bottom (ft)	Overlying Layers (ft)	Thickness (ft)	This Model Layer (ft)	Interval In This Model Layer	Each Model Layer
NWD-4	Destroyed	2	0.5	134		1386	1318	873	513	68	445	379	190	87.5%
		3	0.5		567		873	623	763	513	250	54	27	12.5%
NWD-7	Inactive	3	0.5	520		1250	1133	719	531	117	414	11	6	4.2%
		4	0.5				719	469	781	531	250	250	125	95.8%
		5			974		469	-281	1531	781	750	193	0	0.0%
NWD-9	Inactive	2	0.5	311		1352	1273	828	524	79	445	213	107	58.7%
		3	0.5		674		828	578	774	524	250	150	75	41.3%
NWD-10	Inactive	4	6.5	780		1207	464	214	993	743	250	213	1,385	73.5%
		5	1		1544		214	-286	1493	993	500	500	500	26.5%
NWD-11	Inactive	2	30	200		1187	1072	692	495	115	380	295	8,850	73.1%
		3	6.5				692	442	745	495	250	250	1,625	13.4%
		4	6.5		1075		442	192	995	745	250	250	1,625	13.4%
NWD-12	Active	3	6.5	485		1203	706	456	747	497	250	250	1,625	46.0%
		4	6.5				456	206	997	747	250	250	1,625	46.0%
		5	1		1280		206	-294	1497	997	500	283	283	8.0%
NWD-13	Active	3	6.5	420		1197	702	452	745	495	250	250	1,625	46.0%
		4	6.5				452	202	995	745	250	250	1,625	46.0%
		5	1		1280		202	-298	1495	995	500	285	285	8.1%
NLF-156	Inactive	2	30	320		1048	854	454	594	194	400	274	8,220	59.2%
		3	6.5				454	204	844	594	250	250	1,625	11.7%
		4	6.5				204	-46	1094	844	250	250	1,625	11.7%
		5	4				-46	-546	1594	1094	500	500	2,000	14.4%
		6	2		1800		-546	-1046	2094	1594	500	206	412	3.0%
SCWD-Saugus1	Active	3	6.5	490		1163	644	394	769	519	250	250	1,625	29.8%
		4	6.5				394	144	1019	769	250	250	1,625	29.8%
		5	4				144	-355	1518	1019	499	499	1,996	36.6%
		6	2		1620		-355	-855	2018	1518	500	102	204	3.7%
SCWD-Saugus2	Active	3	6.5	490		1159	639	389	770	520	250	250	1,625	30.1%
		4	6.5				389	139	1020	770	250	250	1,625	30.1%
		5	4				139	-361	1520	1020	500	500	2,000	37.1%
		6	2		1591		-361	-861	2020	1520	500	71	142	2.6%
VWD-157	Destroyed	3	6.5	586		1152	632	382	770	520	250	184	1,196	20.6%
		4	6.5				382	132	1020	770	250	250	1,625	28.0%
		5	4				132	-368	1520	1020	500	500	2,000	34.5%
		6	2		2008		-368	-868	2020	1520	500	488	976	16.8%
VWD-159	Active	3	0.5	662		1292	749	499	793	543	250	131	66	5.7%
		4	0.5				499	249	1043	793	250	250	125	10.8%
		5	0.5				249	-251	1543	1043	500	500	250	21.7%
		6	2		1900		-251	-751	2043	1543	500	357	714	61.8%
VWD-160	Active	4	6.5	950		1101	300	50	1051	801	250	101	657	18.5%
		5	4				50	-450	1551	1051	500	500	2,000	56.3%
		6	2		2000		-450	-950	2051	1551	500	449	898	25.3%
VWD-201	Active	3	6.5	540		1152	633	383	769	519	250	229	1,489	27.5%
		4	6.5				383	133	1019	769	250	250	1,625	30.0%
		5	4				133	-367	1519	1019	500	500	2,000	36.9%
		6	2		1670		-367	-867	2019	1519	500	151	302	5.6%
VWD-205	Active[1]	4	6.5	820		1147	340	90	1057	807	250	237	1,541	33.9%
		5	4				90	-410	1557	1057	500	500	2,000	44.0%
		6	2		1930		-410	-910	2057	1557	500	500	1,000	22.0%
VWD-206	Active	3	6.5	490		1072	489	239	833	583	250	250	1,625	26.4%
		4	6.5				239	-11	1083	833	250	250	1,625	26.4%
		5	4				-11	-511	1583	1083	500	500	2,000	32.4%
		6	2		2040		-511	-1011	2083	1583	500	457	914	14.8%
VWD-207	Active	3	6.5	507		1122	495	245	877	627	250	250	1,625	45.9%
		4	6.5				245	-5	1127	877	250	250	1,625	45.9%
		5	4		1199		-5	-505	1627	1127	500	72	288	8.1%
LACWWD36-19	Active	2	1	400		1411	1199	749	662	212	450	262	262	18.2%
		3	1				749	499	912	662	250	250	250	17.4%
		4	1				499	249	1162	912	250	250	250	17.4%
		5	1				249	-251	1662	1162	500	500	500	34.8%
		6	0.4		2100		-251	-751	2162	1662	500	438	175	12.2%

Notes

In the model, some wells are constrained to not extend into certain layers if their open intervals would penetrate only a minor percentage of that layer's thickness.

The proportion of pumping from each model layer is an estimate and is provided for general informational purposes; the MODFLOW-USG model calculates the actual proportions for each well at every time step during the model simulation.

[1]The status of well VWD-205 is indicated as Active because it was not in use as of the end of 2019 due to perchlorate presence; treatment options for this well are under evaluation by SCV Water.

Elev. = elevation

ft = feet

ft/day = feet per day

Kh = horizontal hydraulic conductivity, in units of feet per day. Elevations, depths, and thicknesses are in units of feet.

Table 3-2
Specifications for General-Head Boundary Cells
Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

Grid Node Number	Reach Number	Head (ft)	Cell Width (ft)	Saturated Thickness (ft)	GHB Distance (ft)	Hydraulic Conductivity (ft/day)	Description
32521	1	1960	250	25	10	1	Santa Clara River at Lang Gage
32523	1	1960	250	25	10	1	Santa Clara River at Lang Gage
33294	1	1960	250	25	10	1	Santa Clara River at Lang Gage
33296	1	1960	250	25	10	1	Santa Clara River at Lang Gage
36361	2	1905	250	50	10	0.05	Pole Canyon
37132	2	1905	250	50	10	0.05	Pole Canyon
37135	2	1905	250	50	10	0.05	Pole Canyon
26258	3	2050	250	25	10	0.5	Bee Canyon
26894	3	2050	250	25	10	0.5	Bee Canyon
25587	4	1859	250	25	10	0.5	Tick Canyon
25584	4	1859	250	25	10	0.5	Tick Canyon
31099	0	1770	250	25	10	0.5	Unnamed Tributary
33221	0	1780	250	25	10	0.5	Unnamed Tributary
30465	0	1800	250	25	10	0.5	Unnamed Tributary
40351	0	1735	250	25	10	0.5	Unnamed Tributary
41212	0	1735	250	25	10	0.5	Unnamed Tributary
42025	0	1690	250	25	10	0.5	Unnamed Tributary
44756	0	1810	250	25	10	0.5	Unnamed Tributary
54344	0	1990	250	25	10	0.5	Unnamed Tributary
54345	0	1990	250	25	10	0.5	Unnamed Tributary
54348	0	1990	250	25	10	0.5	Unnamed Tributary
49706	5	1980	250	25	10	0.5	Oak Spring Canyon
49708	5	1980	250	25	10	0.5	Oak Spring Canyon
52469	0	1770	250	25	10	0.5	Unnamed Tributary
52470	0	1770	250	25	10	0.5	Unnamed Tributary
56834	0	1890	250	25	10	0.5	Unnamed Tributary
60451	6	2010	250	25	10	0.5	Iron Canyon
64072	0	1955	250	25	10	0.5	Unnamed Tributary
64657	0	1955	250	25	10	0.5	Unnamed Tributary
64660	0	1955	250	25	10	0.5	Unnamed Tributary
64661	0	1955	250	25	10	0.5	Unnamed Tributary
64697	7	2060	250	25	10	0.5	Sand Canyon
64698	7	2060	250	25	10	0.5	Sand Canyon
66978	0	2080	250	25	10	0.5	Unnamed Tributary
67807	0	2105	250	25	10	0.5	Unnamed Tributary
67389	0	2075	250	25	10	0.5	Unnamed Tributary
31072	0	1700	250	25	10	0.5	Unnamed Tributary
31065	0	1695	250	25	10	0.5	Unnamed Tributary
31696	0	1680	250	25	10	0.5	Unnamed Tributary
33918	0	1675	250	25	10	0.5	Unnamed Tributary
32394	0	1680	250	25	10	0.5	Unnamed Tributary
26191	0	1787	250	25	10	0.5	Unnamed Tributary
22614	0	1965	250	25	10	0.5	Unnamed Tributary
16997	0	1943	250	25	10	0.5	Unnamed Tributary
17000	0	1943	250	25	10	0.5	Unnamed Tributary
17519	0	1905	250	25	10	0.5	Unnamed Tributary
17522	0	1905	250	25	10	0.5	Unnamed Tributary
12051	8	2090	250	25	10	0.5	Mint Canyon
12054	8	2090	250	25	10	0.5	Mint Canyon
12057	8	2090	250	25	10	0.5	Mint Canyon
12504	8	2090	250	25	10	0.5	Mint Canyon
12506	8	2090	250	25	10	0.5	Mint Canyon
16907	0	1560	250	25	10	0.5	Unnamed Tributary
16915	0	1585	250	25	10	0.5	Unnamed Tributary
21473	0	1700	250	25	10	0.5	Unnamed Tributary
21476	0	1700	250	25	10	0.5	Unnamed Tributary
17499	0	1735	250	25	10	0.5	Unnamed Tributary
17501	0	1735	250	25	10	0.5	Unnamed Tributary
12006	0	1810	250	25	10	0.5	Unnamed Tributary
12009	0	1810	250	25	10	0.5	Unnamed Tributary
12932	9	1805	250	25	10	0.5	Vasquer Canyon
9094	10	1812	250	25	10	0.5	Texas Canyon
6295	11	1761	250	25	10	0.5	Bouquet Canyon
6298	11	1761	250	25	10	0.5	Bouquet Canyon
10333	12	1646	250	25	10	0.5	Haskell Canyon
10313	0	1645	250	25	10	0.5	Unnamed Tributary
13815	0	1550	250	25	10	0.5	Unnamed Tributary
13821	0	1550	250	25	10	0.5	Unnamed Tributary
12841	13	1540	250	25	10	0.5	Dry Canyon
12842	13	1540	250	25	10	0.5	Dry Canyon

Table 3-2
Specifications for General-Head Boundary Cells
Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

Grid Node Number	Reach Number	Head (ft)	Cell Width (ft)	Saturated Thickness (ft)	GHB Distance (ft)	Hydraulic Conductivity (ft/day)	Description
1860	14	1520	250	25	10	0.5	San Francisquito Canyon
1861	14	1520	250	25	10	0.5	San Francisquito Canyon
2487	0	1280	250	25	10	0.5	Unnamed Tributary
797	15	1400	250	25	10	0.5	Marple Canyon
4648	0	1330	250	25	10	0.5	Unnamed Tributary
48631	0	1599	250	25	10	0.5	Unnamed Tributary
49620	0	1595	250	25	10	0.5	Unnamed Tributary
49623	0	1595	250	25	10	0.5	Unnamed Tributary
50590	0	1595	250	25	10	0.5	Unnamed Tributary
51521	0	1535	250	25	10	0.5	Unnamed Tributary
51522	0	1535	250	25	10	0.5	Unnamed Tributary
51510	0	1525	250	25	10	0.5	Unnamed Tributary
51511	0	1525	250	25	10	0.5	Unnamed Tributary
51512	0	1525	250	25	10	0.5	Unnamed Tributary
54268	0	1525	250	25	10	0.5	Unnamed Tributary
65151	16	1625	250	25	10	0.5	Placerita Creek
65153	16	1625	250	25	10	0.5	Placerita Creek
68568	17	1542	500	25	10	0.5	Whitney Canyon
73267	18	1757	250	25	10	0.5	Newhall Creek
73256	18	1757	250	25	10	0.5	Newhall Creek
72914	18	1757	250	25	10	0.5	Newhall Creek
72912	18	1757	250	25	10	0.5	Newhall Creek
73262	18	1757	250	25	10	0.5	Newhall Creek
73263	18	1757	250	25	10	0.5	Newhall Creek
73266	18	1757	250	25	10	0.5	Newhall Creek
73569	19	1559	250	25	10	0.5	Gavin Canyon
72894	0	1610	250	25	10	0.5	Unnamed Tributary
71468	0	1490	250	25	10	0.5	Unnamed Tributary
71095	20	1535	250	25	10	0.5	Towsley Canyon
68850	21	1465	250	25	10	0.5	South Fork Santa Clara River
63207	22	1640	250	25	10	0.5	Pico Canyon
63807	22	1640	250	25	10	0.5	Pico Canyon
65428	0	1570	250	25	10	0.5	Unnamed Tributary
60802	23	1482	250	25	10	0.5	Potrero Canyon
59447	0	1450	250	25	10	0.5	Unnamed Tributary
60124	0	1430	250	25	10	0.5	Unnamed Tributary
56605	0	1360	250	25	10	0.5	Unnamed Tributary
54929	0	1370	250	25	10	0.5	Unnamed Tributary
54018	0	1330	250	25	10	0.5	Unnamed Tributary
53064	0	1280	250	25	10	0.5	Unnamed Tributary
52104	0	1280	250	25	10	0.5	Unnamed Tributary
60786	0	1360	250	25	10	0.5	Unnamed Tributary
59415	0	1320	250	25	10	0.5	Unnamed Tributary
60096	0	1330	250	25	10	0.5	Unnamed Tributary
58678	0	1260	250	25	10	0.5	Unnamed Tributary
58671	0	1260	250	25	10	0.5	Unnamed Tributary
58667	0	1260	250	25	10	0.5	Unnamed Tributary
51172	0	1260	250	25	10	0.5	Unnamed Tributary
51165	0	1250	250	25	10	0.5	Unnamed Tributary
51164	0	1250	250	25	10	0.5	Unnamed Tributary
51161	0	1250	250	25	10	0.5	Unnamed Tributary
51159	0	1250	250	25	10	0.5	Unnamed Tributary
52074	0	1250	250	25	10	0.5	Unnamed Tributary
53028	0	1200	250	25	10	0.5	Unnamed Tributary
53031	0	1200	250	25	10	0.5	Unnamed Tributary
53032	0	1200	250	25	10	0.5	Unnamed Tributary
59393	0	1220	250	25	10	0.5	Unnamed Tributary
59388	0	1200	250	25	10	0.5	Unnamed Tributary
54861	0	1180	250	25	10	0.5	Unnamed Tributary
54864	0	1180	250	25	10	0.5	Unnamed Tributary
57242	0	1120	250	25	10	0.5	Unnamed Tributary
57243	0	1120	250	25	10	0.5	Unnamed Tributary
53006	0	1045	250	25	10	0.5	Unnamed Tributary
53936	0	1045	250	25	10	0.5	Unnamed Tributary
45119	0	955	250	25	10	0.5	Unnamed Tributary
45115	0	955	250	25	10	0.5	Unnamed Tributary
32638	24	1445	250	25	10	0.5	San Martinez Grande Canyon
33409	24	1445	250	25	10	0.5	San Martinez Grande Canyon
33410	24	1445	250	25	10	0.5	San Martinez Grande Canyon
30637	0	1230	250	25	10	0.5	Unnamed Tributary

Table 3-2

Specifications for General-Head Boundary Cells

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

Grid Node Number	Reach Number	Head (ft)	Cell Width (ft)	Saturated Thickness (ft)	GHB Distance (ft)	Hydraulic Conductivity (ft/day)	Description
30640	0	1230	250	25	10	0.5	Unnamed Tributary
30641	0	1230	250	25	10	0.5	Unnamed Tributary
31959	0	1240	250	25	10	0.5	Unnamed Tributary
31960	0	1240	250	25	10	0.5	Unnamed Tributary
31966	0	1240	250	25	10	0.5	Unnamed Tributary
32704	0	1240	250	25	10	0.5	Unnamed Tributary
68853	21	1465	250	25	10	0.5	South Fork Santa Clara River
66097	0	1925	500	500	10	0.5	Unnamed Tributary
66525	0	1925	500	500	10	0.5	Unnamed Tributary

Notes

ft = feet

ft/day = feet per day

GHB = general-head boundry

Table 3-3

Specifications for Connected Linear Networks (CLNs)

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

Well Name	Easting (ft)	Northing (ft)	Top Layer	Bottom Layer	Number of Layers Penetrated	CLN Node Number					Aquifer Node Number to Which CLN Node is Connected					Years When Well is Present During the Calibration Period (1980–2019)			Well Name
						CLN Node1	CLN Node2	CLN Node3	CLN Node4	CLN Node5	GW Node1	GW Node2	GW Node3	GW Node4	GW Node5				
NLF-156	6377435	1979116	2	6	5	1	1	1	1	1	46230	68599	89624	107774	123225	1980	through	2019	NLF-156
LACWWD36-19	6368049	1992202.38	2	6	5	2	2	2	2	2	37688	61688	82729	102412	118713	2009	through	2019	LACWWD36-19
NWD-4	6401352	1956017	2	3	2	5	5	---	---	---	58382	79589	---	---	---	1980	through	1984	NWD-4
NWD-7	6401264	1962732	3	4	2	6	6	---	---	---	77762	98774	---	---	---	1980	through	2019	NWD-7
NWD-9	6404122	1956997	2	3	2	7	7	---	---	---	58142	79358	---	---	---	1980	through	2019	NWD-9
NWD-10	6399388	1965803	4	6	3	8	8	8	---	---	97686	114714	129705	---	---	1980	through	2019	NWD-10
NWD-11	6399004	1968019	2	4	3	9	9	9	---	---	54327	75865	96881	---	---	1980	through	2019	NWD-11
NWD-12	6399282	1965920	3	5	3	3	3	3	---	---	76517	97532	114574	---	---	1986	through	2019	NWD-12
NWD-13	6399098	1967327	3	5	3	4	4	4	---	---	76198	97214	114290	---	---	1988	through	2019	NWD-13
SCWD-Saugus1	6397847	1973452	3	6	4	10	10	10	10	---	72886	93904	111413	126576	---	1986	through	2019	SCWD-Saugus1
SCWD-Saugus2	6398514	1972540	3	6	4	11	11	11	11	---	73539	94557	112002	127157	---	1986	through	2019	SCWD-Saugus2
VWD-157	6395696	1974099	3	6	4	12	12	12	12	---	72537	93555	111094	126263	---	1980	through	2004	VWD-157
VWD-159	6390972	1962392	3	6	4	13	13	13	13	---	77690	98702	115659	130590	---	1980	through	2019	VWD-159
VWD-160	6388950	1976191	4	6	3	14	14	14	---	---	91996	109704	124992	---	---	1980	through	2019	VWD-160
VWD-201	6394125	1973032	3	6	4	15	15	15	15	---	73185	94203	111679	126838	---	1987	through	2019	VWD-201
VWD-205	6391703	1973191	4	6	3	16	16	16	---	---	94181	111657	126816	---	---	1997	through	2019	VWD-205
VWD-206	6379894.5	1979308.5	3	6	4	17	17	17	17	---	68617	89642	107792	123243	---	2003	through	2019	VWD-206
VWD-207	6379935.5	1978292	3	5	3	18	18	18	---	---	69332	90355	108376	---	---	2009	through	2019	VWD-207

Notes

CLN = Connected Linear Network

ft = feet

Table 3-4
Derivation of Monthly ET Demands for a Representative Vegetation Mixture in Riparian Mixed Hardwood Forests
Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

Vegetation Type	Evapotranspiration Demand													
	Jan (mm)	Feb (mm)	Mar (mm)	Apr (mm)	May (mm)	Jun (mm)	Jul (mm)	Aug (mm)	Sep (mm)	Oct (mm)	Nov (mm)	Dec (mm)	Total (mm)	Total (ft)
Reference surface (grass)[a]	77.5	86.1	129.5	159.6	181.2	204.1	220.0	213.1	163.6	128.0	89.9	67.7	1,720.1	5.6
Large stand permanent wetland[b]	54.2	60.2	103.6	159.6	190.3	244.9	264.0	255.8	171.8	140.7	89.9	50.8	1,785.7	5.9
Estimated *Arundo* (median of TNC values)[c]	77.3	85.8	147.6	227.4	271.2	349.1	376.2	364.5	244.9	200.6	128.1	72.3	2,545.0	8.3
Estimated *Arundo* (mean of TNC values)[c]	113.9	126.5	217.6	335.2	399.7	514.6	554.6	537.3	360.9	295.7	188.9	106.6	3,751.5	12.3
Large stand willow[b]	62.7	57.7	71.2	94.1	134.1	175.5	204.6	202.5	175.1	134.3	77.3	60.2	1,449.4	4.8
Large stand cottonwood[b]	62.7	62.0	79.0	105.3	148.6	191.9	224.4	217.4	175.1	138.2	79.1	60.2	1,543.8	5.1
Rain fed oak-grassland mix[b]	41.8	33.6	63.4	94.1	99.7	61.2	39.6	23.4	11.5	5.1	32.4	71.7	577.6	1.9

Santa Clara River Riparian Corridor	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Total
Mixture of 30% *Arundo*,	mm	67.1	67.8	97.2	138.6	181.0	234.1	264.0	257.0	196.0	155.8	93.3	63.9	1,815.9	6.0
40% cottonwood, and	ft	0.22	0.22	0.32	0.45	0.59	0.77	0.87	0.84	0.64	0.51	0.31	0.21	5.96	
30% willow[d]	ft/day	0.0071	0.0079	0.0103	0.0152	0.0192	0.0256	0.0279	0.0272	0.0214	0.0165	0.0102	0.0068		

Notes

ET = evapotranspiration ft = feet ft/day = feet per day mm = millimeters TNC = The Nature Conservancy

[a] Values are from the Santa Clarita California Irrigation Management Information Service (CIMIS) station No. 204, located at SCV Water's Rio Vista Water Treatment Plant.

[b] Evapotranspiration demands were calculated by Environmental Science Associates, Inc. (ESA) by applying published vegetation coefficients (published by Howes et al., 2015) to the reference ET values for grass cover (from CIMIS station 204).

[c] Evapotranspiration demands were calculated by ESA by adjusting the crop coefficient for large-stand permanent wetlands until annual ET demands match the mean and median values published in Arundo studies by TNC (2019).
(Available at https://groundwaterresourcehub.org/public/uploads/pdfs/TNC_Arundo_ET_Literature_Review_Feb2019.pdf).

[d] The mixture of vegetation types was provided to the groundwater modeling team by ESA based on their report mapping the locations of potential GDEs (ESA, 2020).

Table 3-5

Index of Streams, Stream Segments, and Streambed Permeability Values Used in the SFR7 Package

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

Santa Clara River				Tributaries to the Santa Clara River			
Segment No.	No. of Reaches	Description	Bed K (ft/day)	Segment No.	No. of Reaches	Description	Bed K (ft/day)
1	34	From Lang Station to Bee Canyon	25	2	21	Bee Canyon	25
3	9	From Bee Canyon to Pole Canyon	25	4	11	Pole Canyon	25
5	8	From Pole Canyon to Unnamed Tributary	25	6	3	Unnamed Tributary to Santa Clara River	25
7	5	From Unnamed Tributary to Tapie Canyon	25	8	3	Tapie Canyon	25
9	9	From Tapie Canyon to Tick Canyon	25	10	21	Tick Canyon	25
13	4	From Tick Canyon to Unnamed Tributary	25	11	1	Tributary to Tick Canyon	25
14	26	From Unnamed Tributary to Oak Spring Canyon	25	12	3	Tick Canyon	25
16	10	From Oak Spring Canyon to Sand Canyon	25	15	42	Oak Spring Canyon	25
24	3	From Sand Canyon to Unnamed Tributary	25	17	39	Sand Canyon	25
26	33	From Unnamed Tributary to Mint Canyon	25	18	21	Iron Canyon	25
38	10	From Mint Canyon to Unnamed Tributary	25	19	13	Sand Canyon	25
39	83	From Unnamed Tributary to Outfall for SATP	25	20	15	Unnamed Tributary to Sand Canyon	25
40	20	From SATP Outfall to Former SPTF Outfall	25	21	11	Sand Canyon	25
41	2	From Former SPTF Outfall to Saugus WRP Outfall	25	22	17	Unnamed Tributary to Sand Canyon	25
42	2	From Saugus WRP Outfall to Bouquet Canyon	25	23	14	Sand Canyon	25
60-62	15	From Bouquet Canyon to S. Fork Santa Clara River	25	25	9	Unnamed Tributary to Santa Clara River	25
78-80	15	From S. Fork Santa Clara River to San Francisquito Canyon	25	27	54	Mint Canyon	25
85-93	28	From San Francisquito Canyon to Valencia WRP Outfall	5	28	22	Unnamed Tributary to Mint Canyon	25
94-107	58	From Valencia WRP Outfall to Castaic Creek	5	29	5	Mint Canyon	25
119-130	47	From Castaic Creek to San Martinez Canyon	25	30	27	Unnamed Tributary to Mint Canyon	25
132-133	10	From San Martinez Canyon to Potrero Canyon	25	31	3	Mint Canyon	25
135-139	18	From Potrero Canyon to Western Boundary of East Subbasin	25	32	1	Unnamed Tributary to Mint Canyon	25
				33	1	Mint Canyon	25
				34	1	Unnamed Tributary to Mint Canyon	25
				35	5	Mint Canyon	25
				36	1	Unnamed Tributary to Mint Canyon	25
				37	51	Mint Canyon	25
				43	17	Texas Canyon	0.5
				44	16	Bouquet Canyon	0.5
				45	27	Bouquet Canyon	0.5
				46	31	Vasquer Canyon	0.5
				47	5	Bouquet Canyon	0.5
				48	18	Unnamed Tributary to Bouquet Canyon	0.5
				49	17	Bouquet Canyon	0.5
				50	11	Unnamed Tributary to Bouquet Canyon	0.5
				51	14	Bouquet Canyon	0.5
				52	16	Unnamed Tributary to Bouquet Canyon	0.5
				53	16	Bouquet Canyon	0.5
				54	44	Plum Canyon	0.5
				55	13	Bouquet Canyon	0.5
				56	65	Haskell Canyon	0.5
				57	35	Bouquet Canyon	0.5 to 25
				58	71	Dry Canyon	0.5 to 25
				59	13	Bouquet Canyon	25
				63	25	Newhall Creek	0.5
				64	14	Whitney Canyon	0.5
				65	19	Newhall Creek	0.5
				66	26	Railroad Aqueduct Canyon	0.5
				67	27	Newhall Creek	0.5
				68	84	Placerita Creek	0.5
				69	4	Placerita Creek	0.5
				70	21	Gavin Canyon	0.5
				71	17	Towsley Canyon	0.5
				72	16	Gavin Canyon	0.5
				73	14	S. Fork Santa Clara River	0.5
				74	27	S. Fork Santa Clara River	0.5
				75	70	Pico Canyon	0.5
				76	9	S. Fork Santa Clara River	0.5
				77	49	S. Fork Santa Clara River	0.25
				81-84	138	San Francisquito Canyon	25
				108	38	Castaic Creek	25
				109	55	Marple Canyon	25
				110	12	Castaic Creek	25
				111	32	Charlie Canyon	25
				112	69	Castaic Creek	25
				113	24	Hasley Canyon	25
				114	28	Romera Canyon	25
				115	5	Hasley Canyon	25
				116	23	Sloan Canyon	25
				117	53	Hasley Canyon	25
				118	27	Castaic Creek	25
				131	67	San Martinez Canyon	25
				134	81	Potrero Canyon	25

Notes

ft/day = feet per day

K = streambed permeability

No. = number

S = south

SATP = Saugus Aquifer Treatment Plant (for the groundwater extraction and treatment system on the Whittaker-Bermite property)

SCV Water = Santa Clarita Valley Water Agency

SPTF = Saugus Perchlorate Treatment Facility (for the groundwater extraction and treatment system at SCV Water's Saugus1 and Saugus2 production wells)

WRP = water reclamation plant

GSI Water Solutions, Inc.

Table 3-6

Discharges from the Saugus Water Reclamation Plant (1980-2019)

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

Cal Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1980	361.54	364.92	418.62	414.33	418.62	386.71	361.54	361.54	349.88	361.54	359.08	371.05	**4,529.37**
1981	381.52	336.86	390.08	397.75	444.31	411.57	416.72	429.09	430.90	433.85	412.49	459.54	**4,944.68**
1982	445.26	398.74	455.73	443.79	446.22	433.66	433.85	421.48	415.25	433.85	430.90	437.65	**5,196.38**
1983	459.54	421.08	513.77	541.39	562.29	545.07	520.43	476.66	457.60	481.42	476.94	533.75	**5,989.92**
1984	558.48	504.65	499.50	485.22	475.71	442.87	457.63	455.73	451.16	467.15	474.18	518.52	**5,790.80**
1985	503.30	461.47	505.20	457.60	448.12	443.79	451.92	458.58	452.08	470.00	460.36	497.59	**5,610.03**
1986	497.68	474.94	527.78	500.78	499.12	483.13	481.23	475.28	499.77	510.81	518.24	551.53	**6,020.30**
1987	523.98	474.88	542.14	487.28	425.35	382.51	391.41	402.98	394.66	396.81	411.39	429.95	**5,263.35**
1988	442.75	411.17	438.58	434.37	439.93	430.08	444.84	456.56	434.71	464.38	435.85	460.39	**5,293.61**
1989	461.50	410.31	440.88	449.59	463.86	436.18	475.74	478.72	462.17	471.41	451.40	465.95	**5,467.72**
1990	462.94	403.35	432.29	426.06	483.10	491.60	513.27	503.72	488.90	492.65	507.87	511.58	**5,717.33**
1991	494.80	422.60	479.10	427.47	490.42	516.40	556.64	525.34	486.39	473.59	469.72	492.52	**5,834.99**
1992	487.57	506.58	530.38	472.03	489.28	475.99	492.61	520.49	491.91	498.32	451.59	513.73	**5,930.47**
1993	594.79	534.22	616.19	580.48	615.34	587.29	622.09	603.54	578.36	608.77	566.49	567.01	**7,074.58**
1994	601.16	605.80	694.01	676.60	686.69	643.64	641.59	644.83	619.43	663.38	654.59	684.98	**7,816.70**
1995	657.39	577.44	675.46	704.31	699.25	631.58	641.21	634.55	616.85	612.67	568.05	581.28	**7,600.05**
1996	532.76	503.73	525.15	501.76	516.59	506.37	511.83	524.20	532.15	578.42	557.92	583.18	**6,374.06**
1997	564.15	515.57	514.68	461.25	469.02	417.06	442.38	473.78	474.14	503.27	521.10	552.74	**5,909.15**
1998	528.95	541.35	543.22	510.97	616.48	586.47	426.21	398.62	456.65	501.36	521.10	533.71	**6,165.10**
1999	541.32	484.64	550.84	529.38	543.22	511.89	547.03	531.81	521.10	527.05	487.03	514.68	**6,290.00**
2000	492.80	486.82	501.36	487.95	503.27	466.78	457.60	508.98	584.62	555.59	513.73	595.55	**6,155.06**
2001	591.74	531.04	571.77	510.05	499.46	489.80	485.19	519.44	510.05	527.05	553.32	560.35	**6,349.26**
2002	519.44	458.86	518.49	492.56	490.90	525.70	564.15	550.84	517.42	551.79	556.08	567.01	**6,313.23**
2003	550.84	500.11	528.00	342.49	352.00	331.44	327.27	334.88	324.07	325.36	325.00	352.00	**4,593.46**
2004	359.61	359.55	384.35	371.95	376.74	361.82	377.69	372.93	396.81	405.28	370.11	395.76	**4,532.60**
2005	409.08	359.18	378.64	359.06	387.20	370.11	383.40	409.08	396.81	406.23	394.05	437.62	**4,690.46**
2006	449.99	392.70	433.82	426.27	462.36	451.13	457.60	449.99	449.29	499.46	485.19	482.34	**5,440.13**
2007	471.87	429.64	475.68	453.89	473.78	467.70	474.73	483.29	463.10	433.82	437.32	468.07	**5,532.87**
2008	481.39	447.66	467.12	452.97	467.12	433.63	489.00	490.90	475.06	494.71	491.64	506.12	**5,697.30**
2009	497.56	446.83	499.46	479.67	500.41	490.72	491.85	410.03	370.11	373.88	406.01	469.97	**5,436.51**
2010	508.02	435.66	481.39	461.25	475.68	453.89	468.07	471.87	454.81	469.97	458.49	487.09	**5,626.20**
2011	478.53	435.66	498.51	459.41	475.68	454.81	469.97	465.21	439.16	477.58	459.41	456.65	**5,570.59**
2012	469.02	444.99	477.58	468.62	480.43	467.70	484.24	499.46	475.99	468.07	460.33	476.63	**5,673.06**
2013	483.29	427.07	478.53	468.62	481.39	473.22	496.61	495.66	491.64	493.75	486.11	491.85	**5,767.74**
2014	496.61	449.41	493.75	489.80	535.61	522.02	533.71	528.00	512.81	528.00	499.00	520.39	**6,109.12**
2015	500.41	438.24	498.51	472.30	488.05	468.62	492.80	487.09	468.62	489.95	451.13	461.41	**5,717.13**
2016	484.24	444.99	479.48	459.41	467.12	438.24	478.53	486.14	459.41	486.14	465.86	488.05	**5,637.61**
2017	485.19	446.83	483.29	462.18	473.78	467.70	483.29	485.19	475.99	492.80	475.06	484.24	**5,715.53**
2018	484.24	409.88	475.68	451.13	447.14	436.40	469.97	446.19	412.46	444.28	431.79	410.99	**5,320.14**
2019	405.28	385.82	457.60	447.44	430.96	432.71	453.80	448.09	446.52	451.89	443.76	402.42	**5,206.31**

Notes

All values are in units of acre-feet.

Cal = calendar

Table 3-7

Discharges from the Valencia Water Reclamation Plant (1980-2019)

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

Cal Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1980	266.40	258.11	256.88	239.39	247.37	211.77	218.83	218.83	211.77	228.34	239.39	247.37	**2,844.44**
1981	248.32	219.99	249.27	234.79	243.56	236.63	253.08	254.98	247.68	262.59	284.51	270.20	**3,005.60**
1982	274.96	247.49	284.47	270.69	276.86	268.85	274.96	268.30	254.12	266.40	270.69	283.52	**3,241.33**
1983	286.38	261.24	300.65	288.19	295.89	277.14	287.33	295.89	281.74	286.38	276.22	294.94	**3,431.99**
1984	302.55	281.25	304.45	293.71	320.63	314.89	319.68	316.82	313.97	321.58	314.89	318.73	**3,723.15**
1985	309.21	282.73	315.87	315.81	333.00	330.54	353.93	358.69	348.04	360.59	357.24	340.61	**4,006.24**
1986	350.12	341.16	373.91	359.08	376.76	380.26	414.82	453.83	445.63	439.56	420.77	445.26	**4,801.17**
1987	454.96	415.07	472.39	489.09	549.54	567.06	602.66	594.34	578.45	632.95	600.08	624.42	**6,581.01**
1988	621.53	557.33	588.42	587.29	602.75	536.81	575.04	605.79	586.76	607.88	599.71	601.92	**7,071.23**
1989	621.87	592.50	694.93	665.90	670.81	708.01	714.33	731.15	668.05	677.41	672.78	675.79	**8,093.54**
1990	697.79	644.09	724.64	694.93	666.24	693.09	725.10	713.90	691.77	699.78	657.93	680.11	**8,289.38**
1991	714.47	662.51	702.10	626.97	667.85	645.39	646.92	690.68	708.91	743.01	717.20	747.77	**8,273.79**
1992	776.31	776.95	819.12	812.95	823.87	799.14	852.42	869.54	817.55	827.68	811.11	785.82	**9,772.45**
1993	778.21	732.97	862.88	858.06	868.59	924.35	910.45	845.76	815.71	833.39	818.47	858.12	**10,106.96**
1994	799.14	728.68	808.65	776.12	801.99	760.47	771.55	763.94	739.30	762.99	734.69	759.18	**9,206.70**
1995	889.52	776.80	935.18	886.60	883.81	847.93	853.37	814.36	825.84	833.39	823.08	855.27	**10,225.15**
1996	893.32	838.36	935.18	889.36	901.89	875.55	902.84	891.42	886.60	817.22	809.27	816.26	**10,457.28**
1997	815.31	712.35	866.69	828.60	852.42	879.24	860.03	850.51	824.00	825.78	777.96	775.36	**9,868.23**
1998	777.26	787.11	955.16	954.73	983.70	964.86	1,135.92	1,138.77	1,019.18	993.22	910.54	905.69	**11,526.14**
1999	930.43	867.88	961.82	952.89	984.65	967.62	1,003.68	1,017.95	961.18	1,019.85	1,040.35	986.56	**11,694.87**
2000	1,010.34	956.73	1,026.51	1,012.73	1,066.47	1,072.58	1,147.34	1,146.38	1,006.29	1,078.84	1,031.15	1,010.34	**12,565.70**
2001	963.72	915.14	1,043.64	1,012.73	1,080.74	1,048.64	1,119.75	1,104.52	1,058.77	1,106.43	1,053.24	1,062.66	**12,569.99**
2002	1,106.43	1,001.07	1,118.80	1,100.20	1,185.39	1,163.72	1,210.13	1,245.33	1,212.52	1,199.66	1,140.71	1,153.04	**13,836.99**
2003	1,158.75	1,082.70	1,204.42	1,311.03	1,366.15	1,338.65	1,415.62	1,423.23	1,372.72	1,345.22	1,315.63	1,320.48	**15,654.60**
2004	1,314.77	1,262.88	1,345.22	1,295.38	1,342.36	1,330.36	1,370.90	1,413.72	1,284.33	1,414.67	1,369.95	1,396.59	**16,141.14**
2005	1,518.36	1,467.67	1,597.33	1,532.91	1,628.72	1,541.20	1,577.35	1,586.86	1,505.29	1,599.23	1,521.86	1,476.50	**18,553.29**
2006	1,490.78	1,330.18	1,545.00	1,521.86	1,525.02	1,455.58	1,485.07	1,487.92	1,400.34	1,427.03	1,382.84	1,431.79	**17,483.41**
2007	1,428.94	1,325.02	1,440.35	1,425.19	1,454.62	1,417.83	1,461.28	1,497.43	1,460.18	1,530.73	1,470.31	1,486.02	**17,397.91**
2008	1,527.88	1,382.14	1,469.85	1,412.30	1,477.46	1,462.94	1,485.07	1,487.92	1,440.84	1,440.35	1,409.54	1,438.45	**17,434.74**
2009	1,403.25	1,325.02	1,412.76	1,346.94	1,443.21	1,373.64	1,375.66	1,501.24	1,504.37	1,511.71	1,451.89	1,443.21	**17,092.90**
2010	1,449.87	1,306.98	1,411.81	1,355.22	1,395.64	1,361.67	1,409.91	1,407.06	1,344.17	1,408.96	1,348.78	1,440.35	**16,640.42**
2011	1,378.52	1,239.95	1,423.23	1,309.19	1,368.05	1,316.55	1,381.37	1,419.42	1,366.27	1,358.54	1,339.57	1,367.10	**16,267.76**
2012	1,335.70	1,261.10	1,362.34	1,336.81	1,377.56	1,338.65	1,384.22	1,414.67	1,351.54	1,407.06	1,336.81	1,374.71	**16,281.17**
2013	1,331.90	1,205.58	1,339.51	1,293.54	1,349.97	1,322.08	1,392.79	1,396.59	1,330.36	1,334.75	1,290.78	1,304.31	**15,892.16**
2014	1,272.91	1,174.65	1,323.34	1,239.22	1,268.16	1,236.46	1,277.67	1,280.53	1,229.09	1,213.93	1,201.47	1,269.11	**14,986.53**
2015	1,234.86	1,138.56	1,282.43	1,183.98	1,237.71	1,189.50	1,215.83	1,231.06	1,187.66	1,189.20	1,164.64	1,185.39	**14,440.82**
2016	1,178.73	1,111.58	1,219.64	1,148.07	1,222.49	1,195.95	1,195.85	1,236.76	1,176.61	1,202.51	1,168.33	1,198.71	**14,255.25**
2017	1,267.21	1,137.70	1,202.51	1,155.44	1,219.64	1,250.27	1,269.11	1,298.60	1,194.11	1,198.71	1,182.14	1,192.05	**14,567.47**
2018	1,217.74	1,096.45	1,250.08	1,185.82	1,271.96	1,215.28	1,229.15	1,265.30	1,272.36	1,259.60	1,209.76	1,283.38	**14,756.89**
2019	1,311.92	1,212.46	1,286.23	1,156.36	1,254.84	1,210.68	1,237.71	1,291.94	1,216.20	1,188.24	1,181.22	1,325.24	**14,873.04**

Notes

All values are in units of acre-feet.

Cal = calendar

Table 3-8

Combined Discharges from the Saugus and Valencia Water Reclamation Plants (1980-2019)

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

Cal Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1980	627.94	623.03	675.51	653.72	665.99	598.47	580.37	580.37	561.64	589.88	598.47	618.42	7,373.81
1981	629.84	556.86	639.35	632.54	687.88	648.19	669.80	684.07	678.58	696.44	696.99	729.74	7,950.28
1982	720.22	646.23	740.20	714.49	723.08	702.52	708.81	689.78	669.37	700.25	701.60	721.18	8,437.71
1983	745.91	682.32	814.42	829.58	858.18	822.21	807.76	772.55	739.35	767.80	753.16	828.69	9,421.91
1984	861.03	785.90	803.95	778.94	796.34	757.76	777.31	772.55	765.13	788.73	789.06	837.25	9,513.95
1985	812.51	744.19	821.08	773.41	781.12	774.33	805.85	817.27	800.11	830.59	817.61	838.20	9,616.28
1986	847.80	816.10	901.69	859.86	875.88	863.39	896.05	929.11	945.40	950.37	939.01	996.80	10,821.47
1987	978.94	889.95	1,014.54	976.36	974.89	949.57	994.07	997.32	973.11	1,029.76	1,011.47	1,054.37	11,844.36
1988	1,064.28	968.51	1,027.00	1,021.66	1,042.68	966.88	1,019.88	1,062.35	1,021.47	1,072.26	1,035.56	1,062.32	12,364.84
1989	1,083.37	1,002.82	1,135.81	1,115.50	1,134.68	1,144.19	1,190.07	1,209.86	1,130.23	1,148.82	1,124.18	1,141.74	13,561.26
1990	1,160.73	1,047.43	1,156.93	1,120.99	1,149.35	1,184.70	1,238.37	1,217.62	1,180.68	1,192.43	1,165.79	1,191.69	14,006.71
1991	1,209.27	1,085.11	1,181.20	1,054.44	1,158.28	1,161.79	1,203.56	1,216.02	1,195.30	1,216.59	1,186.92	1,240.28	14,108.78
1992	1,263.88	1,283.53	1,349.50	1,284.98	1,313.16	1,275.12	1,345.03	1,390.03	1,309.47	1,326.00	1,262.70	1,299.55	15,702.93
1993	1,373.00	1,267.19	1,479.07	1,438.54	1,483.93	1,511.64	1,532.54	1,449.30	1,394.07	1,442.16	1,384.96	1,425.13	17,181.54
1994	1,400.30	1,334.48	1,502.67	1,452.72	1,488.68	1,404.11	1,413.14	1,408.77	1,358.72	1,426.37	1,389.29	1,444.16	17,023.41
1995	1,546.91	1,354.24	1,610.65	1,590.91	1,583.06	1,479.51	1,494.58	1,448.92	1,442.69	1,446.06	1,391.13	1,436.55	17,825.19
1996	1,426.08	1,342.09	1,460.33	1,391.13	1,418.47	1,381.92	1,414.67	1,415.62	1,418.75	1,395.64	1,367.19	1,399.45	16,831.33
1997	1,379.47	1,227.92	1,381.37	1,289.86	1,321.43	1,296.30	1,302.41	1,324.29	1,298.14	1,329.04	1,299.06	1,328.09	15,777.38
1998	1,306.21	1,328.46	1,498.39	1,465.70	1,600.18	1,551.32	1,562.13	1,537.39	1,475.83	1,494.58	1,431.64	1,439.40	17,691.24
1999	1,471.75	1,352.52	1,512.66	1,482.27	1,527.88	1,479.51	1,550.71	1,549.76	1,482.27	1,546.91	1,527.39	1,501.24	17,984.87
2000	1,503.14	1,443.55	1,527.88	1,500.69	1,569.74	1,539.36	1,604.94	1,655.36	1,590.91	1,634.43	1,544.88	1,605.89	18,720.76
2001	1,555.47	1,446.18	1,615.40	1,522.78	1,580.20	1,538.44	1,604.94	1,623.97	1,568.82	1,633.48	1,606.56	1,623.01	18,919.25
2002	1,625.87	1,459.93	1,637.28	1,592.75	1,676.29	1,689.42	1,774.28	1,796.16	1,729.93	1,751.45	1,696.79	1,720.05	20,150.22
2003	1,709.59	1,582.81	1,732.42	1,653.52	1,718.15	1,670.09	1,742.88	1,758.11	1,696.79	1,670.58	1,640.63	1,672.48	20,248.05
2004	1,674.39	1,622.43	1,729.57	1,667.33	1,719.10	1,692.19	1,748.59	1,786.65	1,681.14	1,819.94	1,740.06	1,792.36	20,673.74
2005	1,927.45	1,826.85	1,975.97	1,891.97	2,015.92	1,911.31	1,960.75	1,995.95	1,902.10	2,005.46	1,915.91	1,914.13	23,243.75
2006	1,940.77	1,722.88	1,978.82	1,948.13	1,987.38	1,906.70	1,942.67	1,937.91	1,849.62	1,926.50	1,868.03	1,914.13	22,923.54
2007	1,900.81	1,754.67	1,916.03	1,879.08	1,928.40	1,885.53	1,936.01	1,980.72	1,923.27	1,964.55	1,907.62	1,954.09	22,930.79
2008	2,009.26	1,829.80	1,936.96	1,865.27	1,944.57	1,896.57	1,974.06	1,978.82	1,915.91	1,935.06	1,901.18	1,944.57	23,132.04
2009	1,900.81	1,771.86	1,912.23	1,826.60	1,943.62	1,864.35	1,867.51	1,911.27	1,874.48	1,885.59	1,857.91	1,913.18	22,529.41
2010	1,957.89	1,742.64	1,893.20	1,816.48	1,871.32	1,815.56	1,877.98	1,878.93	1,798.98	1,878.93	1,807.27	1,927.45	22,266.62
2011	1,857.05	1,675.61	1,921.74	1,768.60	1,843.73	1,771.36	1,851.34	1,884.64	1,805.43	1,836.12	1,798.98	1,823.75	21,838.35
2012	1,804.72	1,706.09	1,839.92	1,805.43	1,858.00	1,806.35	1,868.46	1,914.13	1,827.52	1,875.12	1,797.14	1,851.34	21,954.23
2013	1,815.19	1,632.65	1,818.04	1,762.16	1,831.36	1,795.30	1,889.39	1,892.25	1,822.00	1,828.51	1,776.89	1,796.16	21,659.90
2014	1,769.52	1,624.06	1,817.09	1,729.01	1,803.77	1,758.47	1,811.38	1,808.53	1,741.90	1,741.93	1,700.47	1,789.50	21,095.65
2015	1,735.27	1,576.80	1,780.94	1,656.28	1,725.76	1,658.12	1,708.64	1,718.15	1,656.28	1,679.14	1,615.77	1,646.80	20,157.95
2016	1,662.97	1,556.57	1,699.12	1,607.49	1,689.61	1,634.18	1,674.39	1,722.91	1,636.03	1,688.66	1,634.18	1,686.75	19,892.86
2017	1,752.40	1,584.53	1,685.80	1,617.61	1,693.41	1,717.97	1,752.40	1,783.79	1,670.09	1,691.51	1,657.20	1,676.29	20,283.01
2018	1,701.98	1,506.33	1,725.76	1,636.95	1,719.10	1,651.68	1,699.12	1,711.49	1,684.82	1,703.88	1,641.55	1,694.37	20,077.02
2019	1,717.20	1,598.28	1,743.84	1,603.80	1,685.80	1,643.39	1,691.51	1,740.03	1,662.73	1,640.14	1,624.98	1,727.66	20,079.36

Notes

All values are in units of acre-feet.

Cal = calendar