Appendix F SRS (site-wide) Regression and Cluster Analysis Approach Results

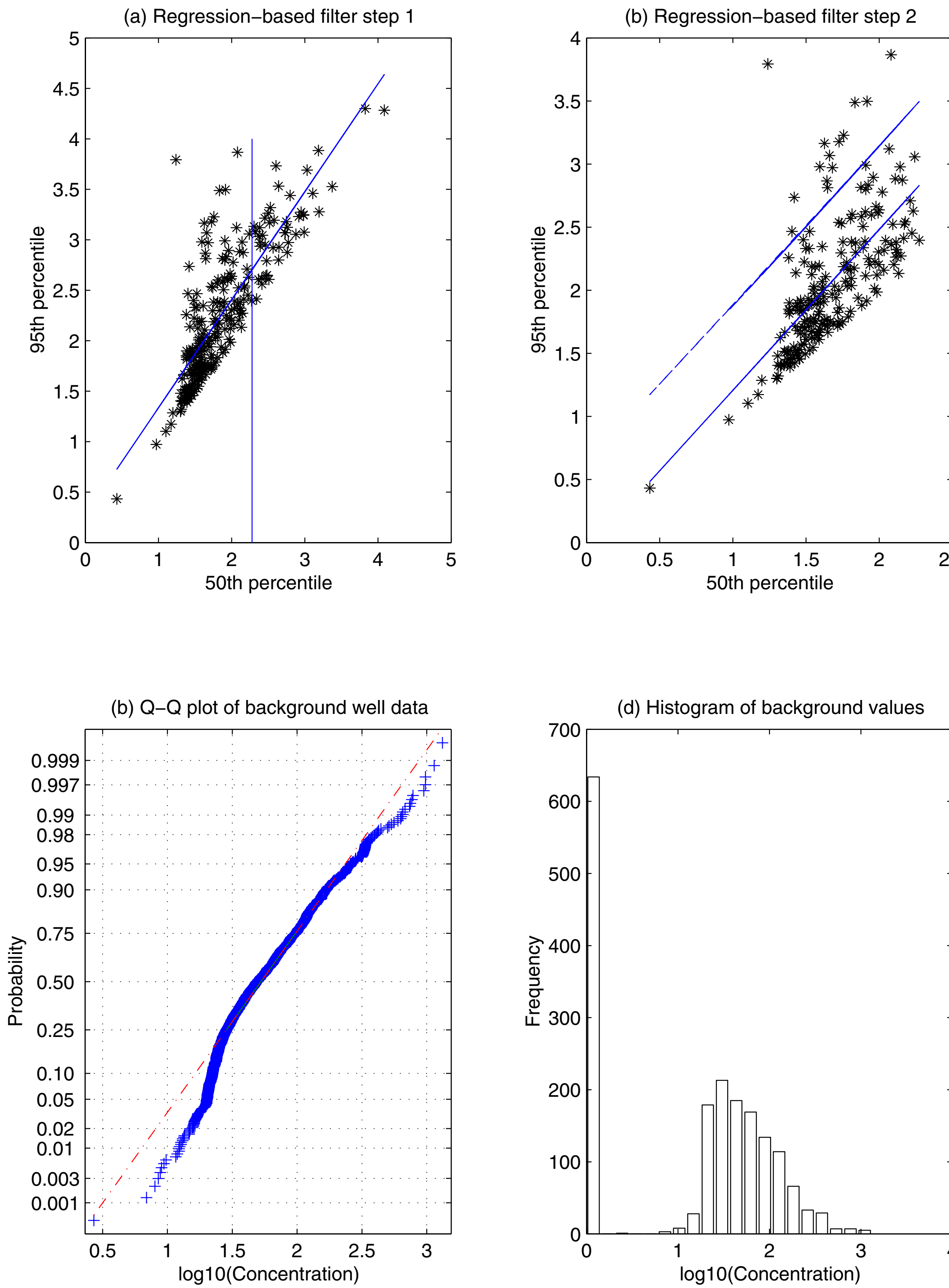

Figure F.1: Aluminum regression approach results for SRS, in $(log_{10}(ug/L))$

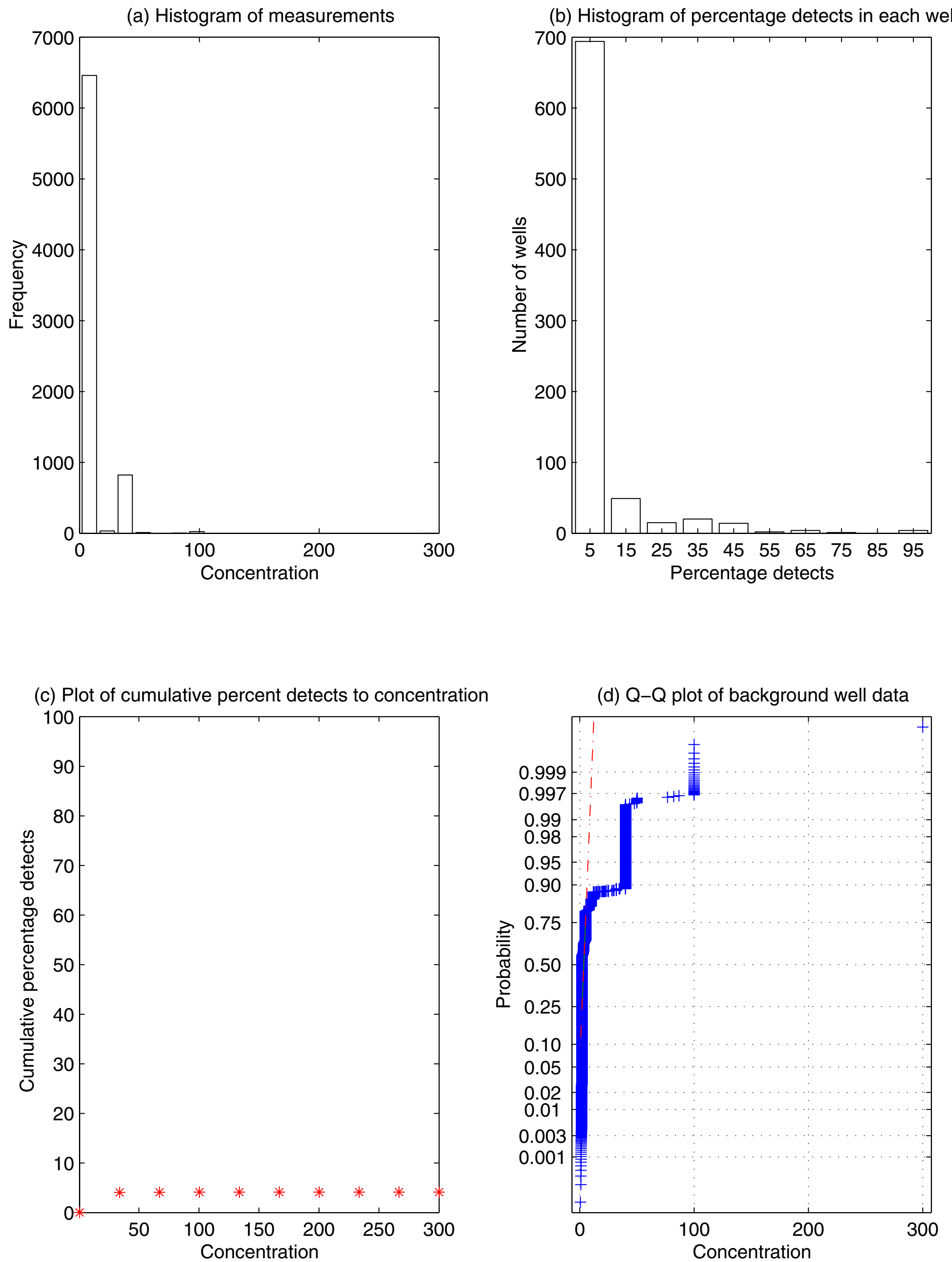

Figure F.2: Arsenic background results for SRS, $((ug/L))$

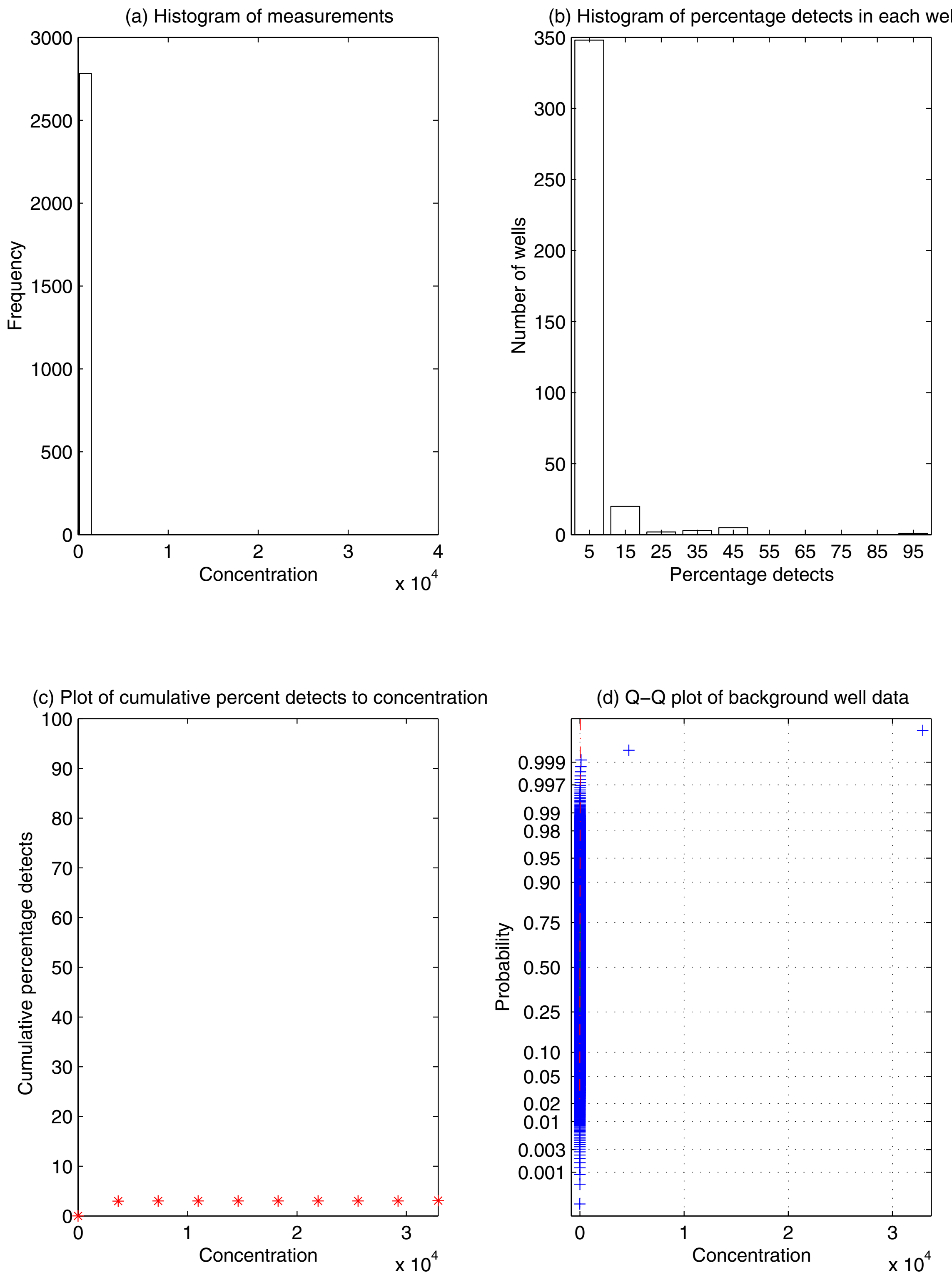

Figure F.3: Cesium-137 background results for SRS, ((pCi/L))

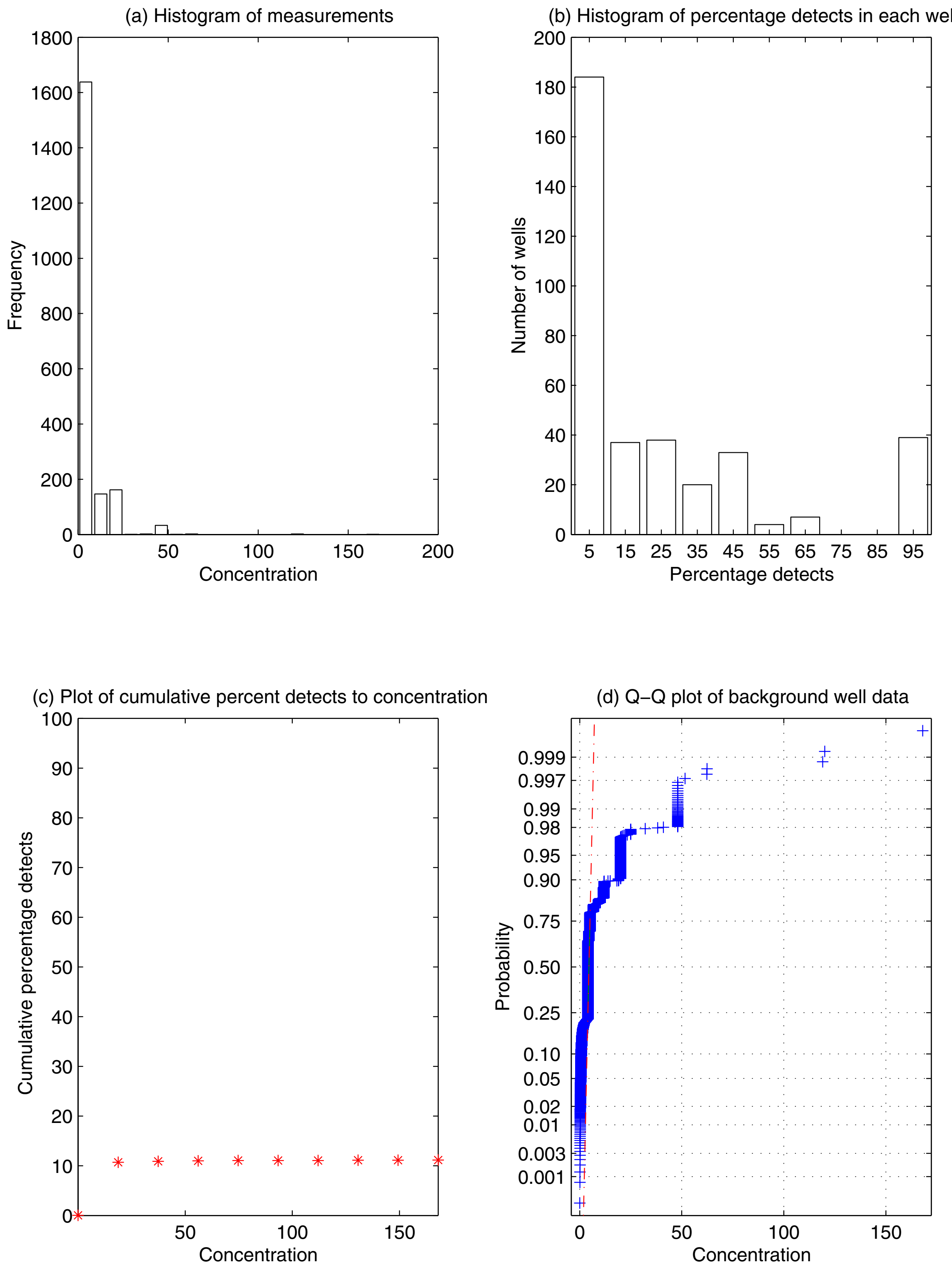

Figure F.4: Cobalt background results for SRS, $((ug/L))$

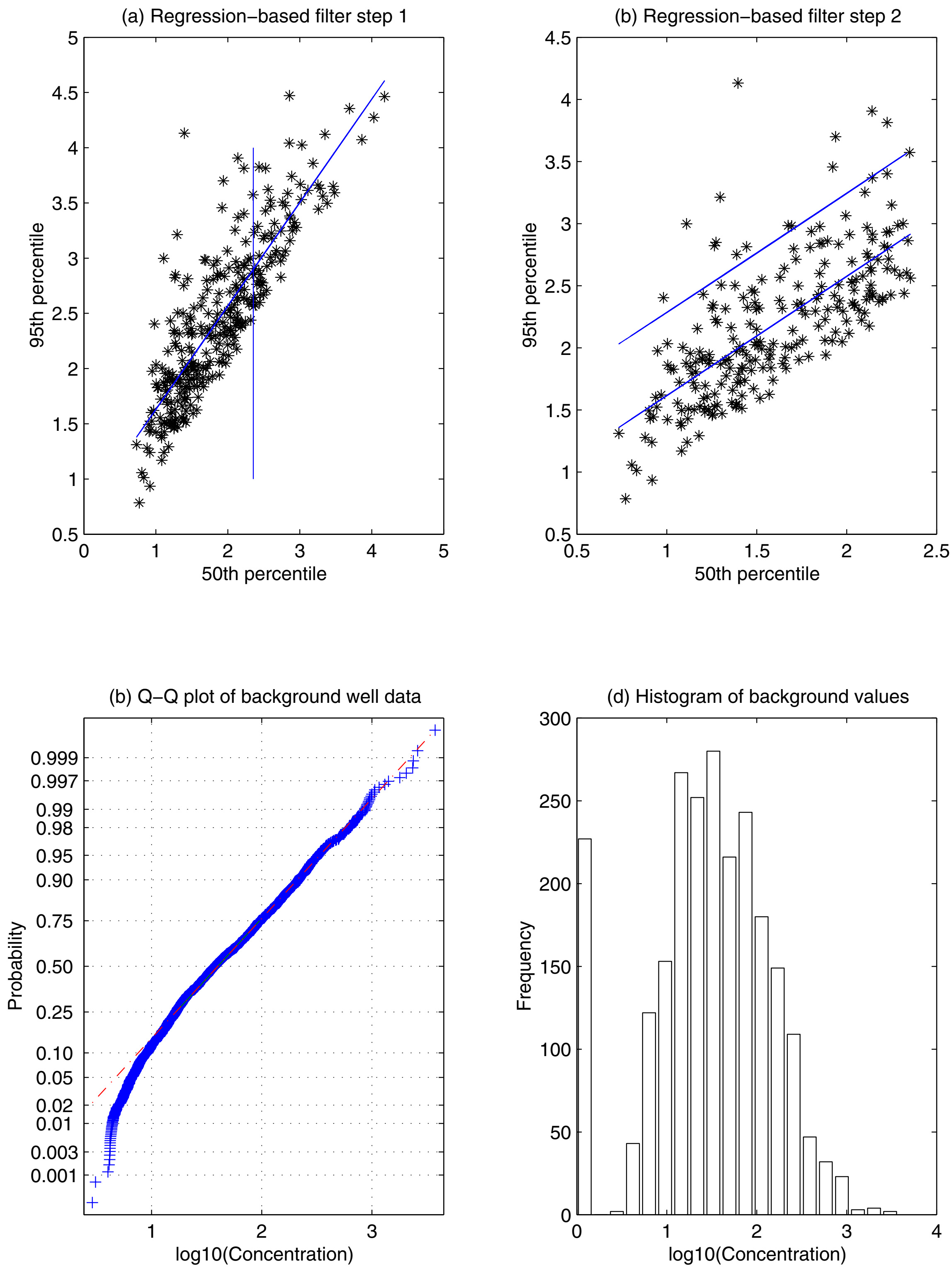

Figure F.5: Iron regression approach results for SRS, in ($log_{10}(ug/L)$)

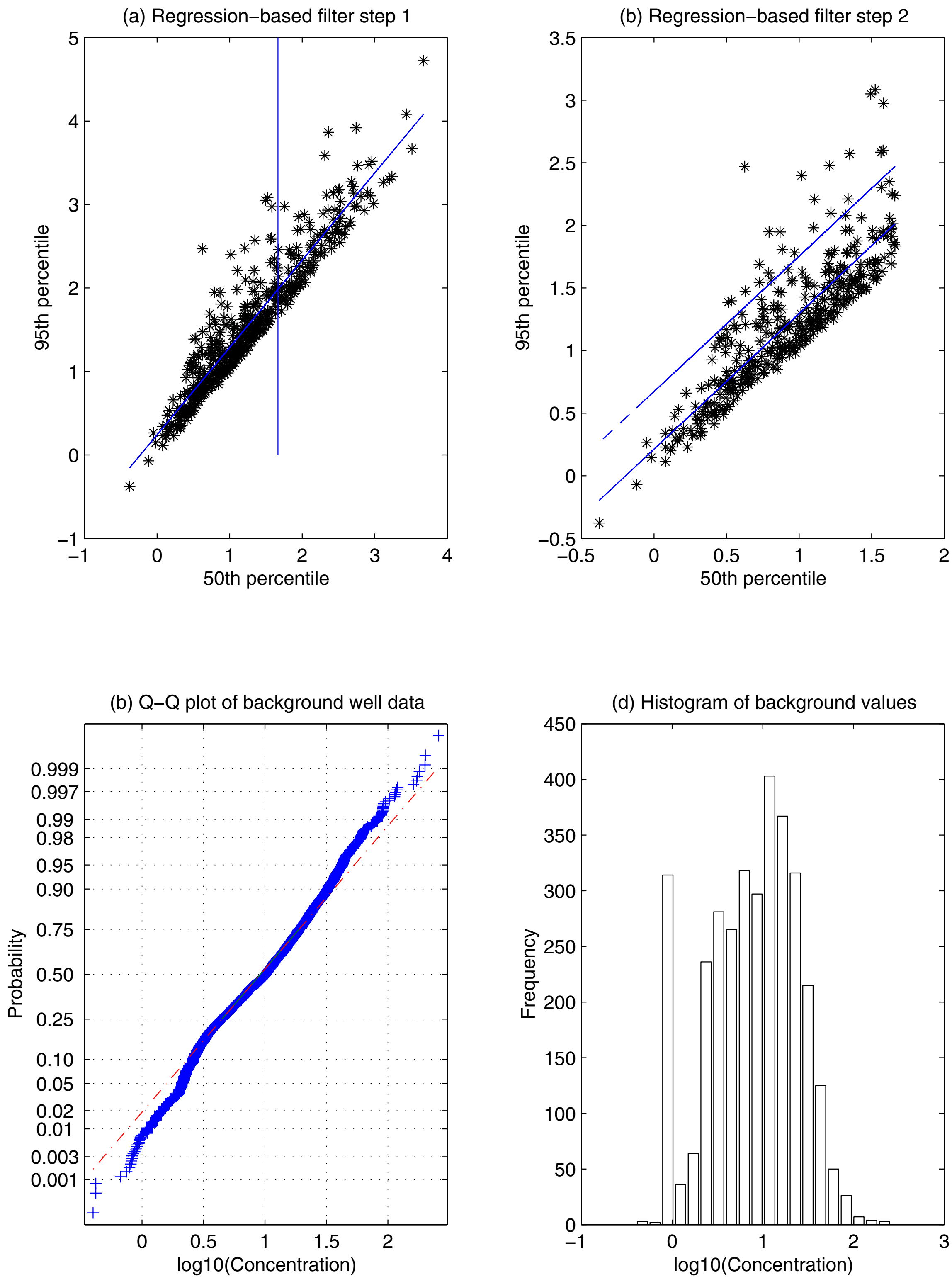

Figure F.6: Manganese regression approach results for SRS, in $(log_{10}(ug/L))$

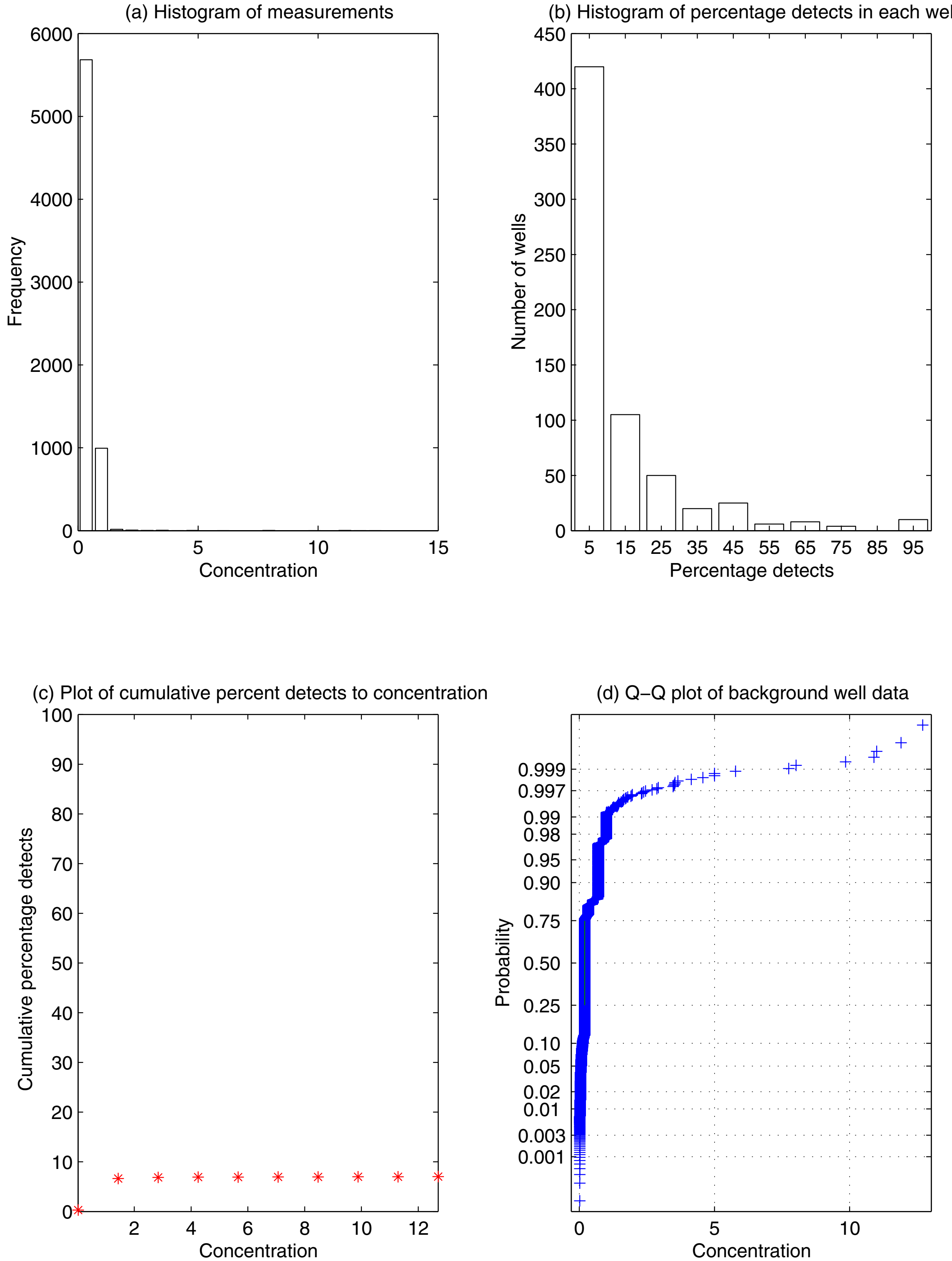

Figure F.7: Mercury background results for SRS, $((ug/L))$

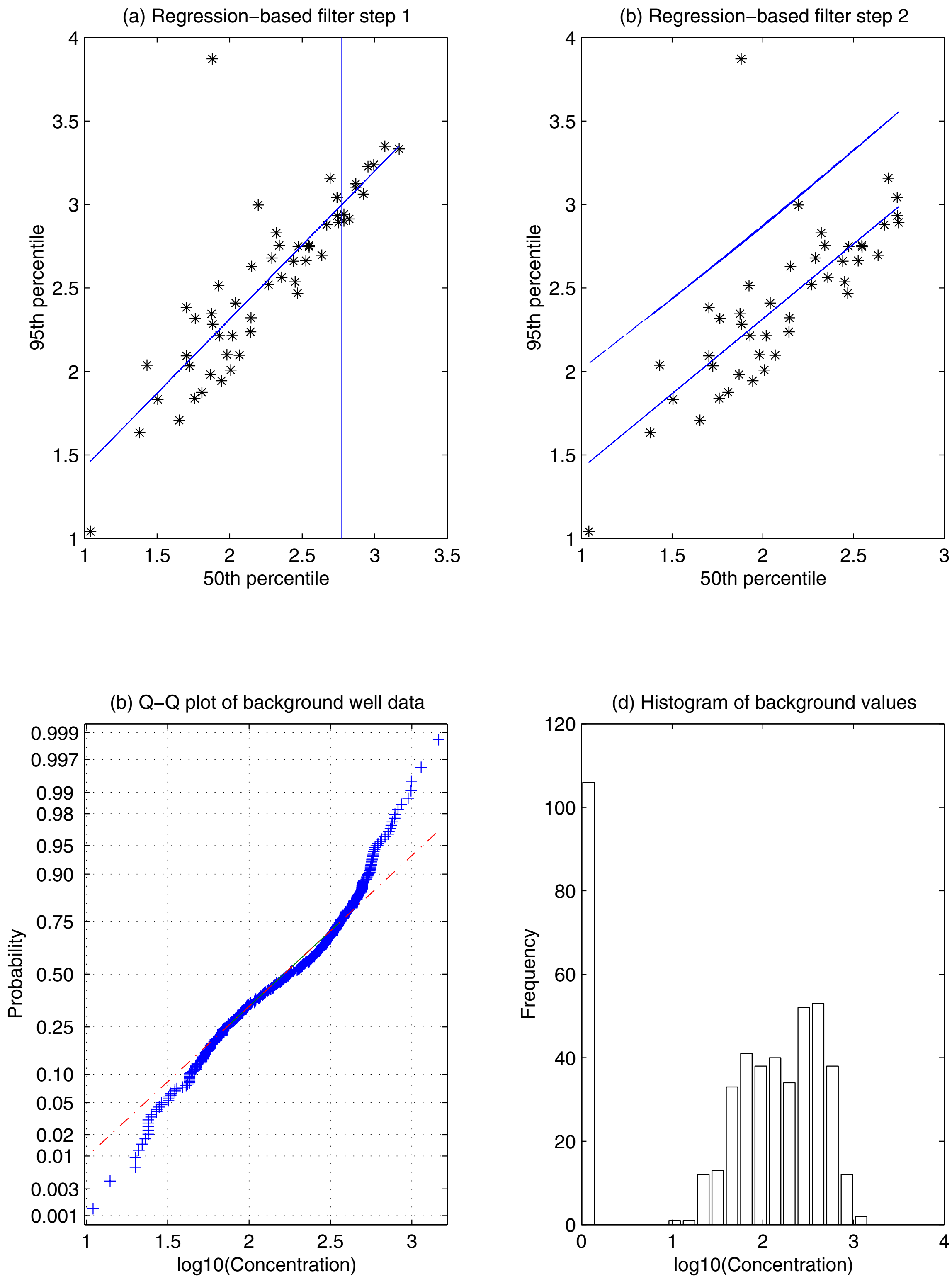

Figure F.8: Nitrate as nitrogen regression approach results for SRS, in $(log_{10}(ug/L))$

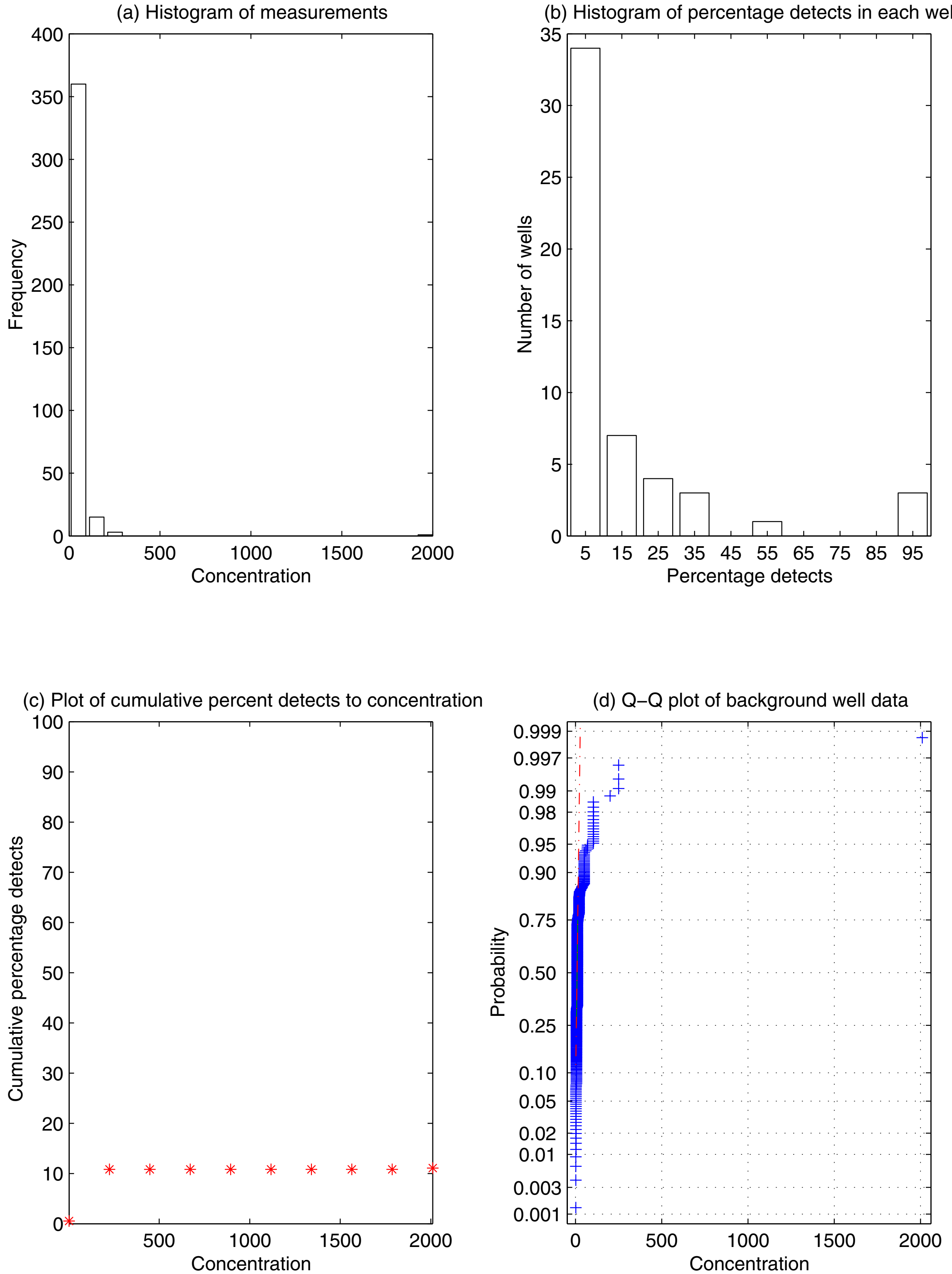

Figure F.9: Nitrite as nitrogen background results for SRS, $((ug/L))$

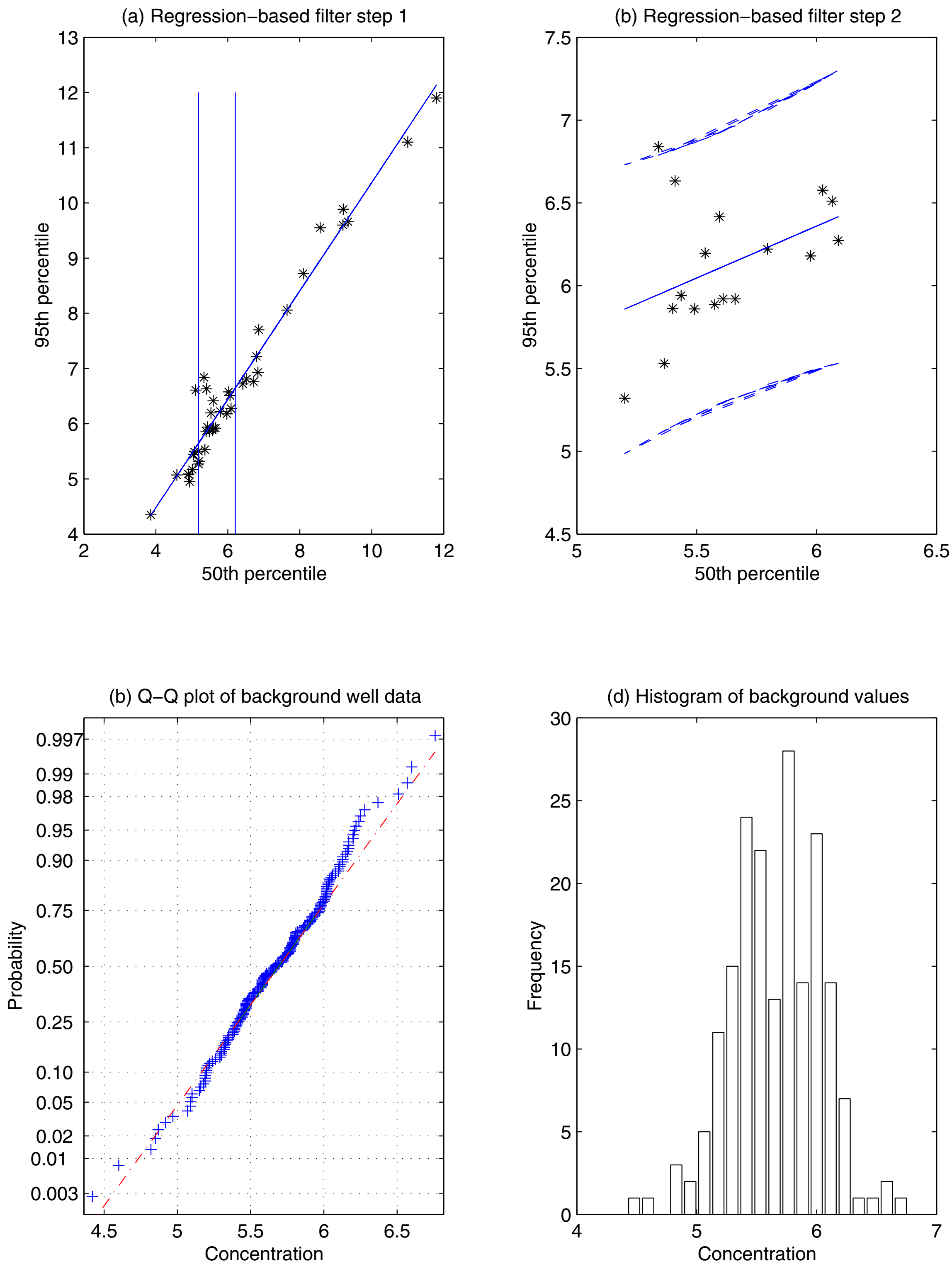

Figure F.10: pH regression approach results for SRS, in normal units

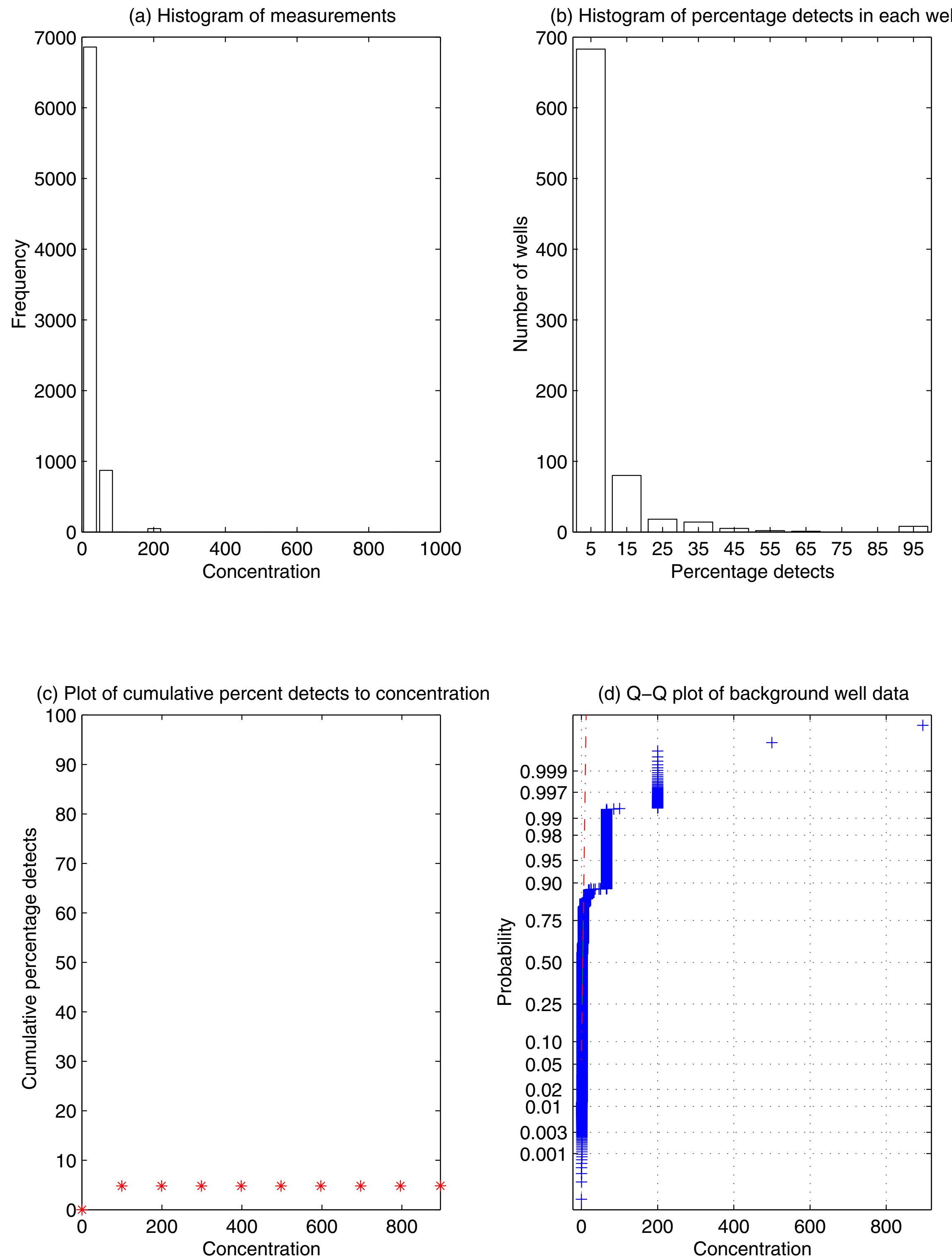

Figure F.11: Selenium background results for SRS, $((ug/L))$

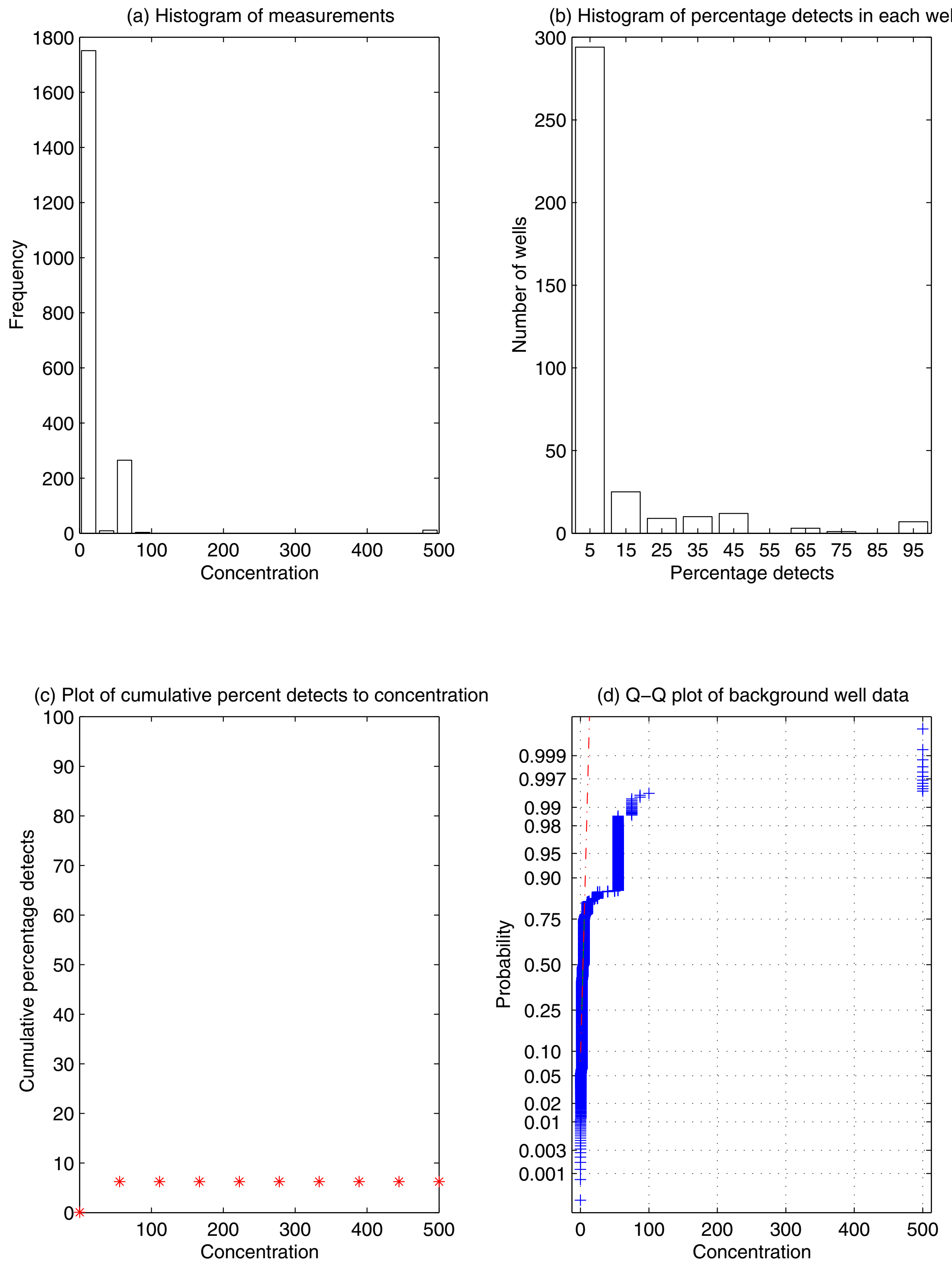

Figure F.12: Thallium background results for SRS, $((ug/L))$

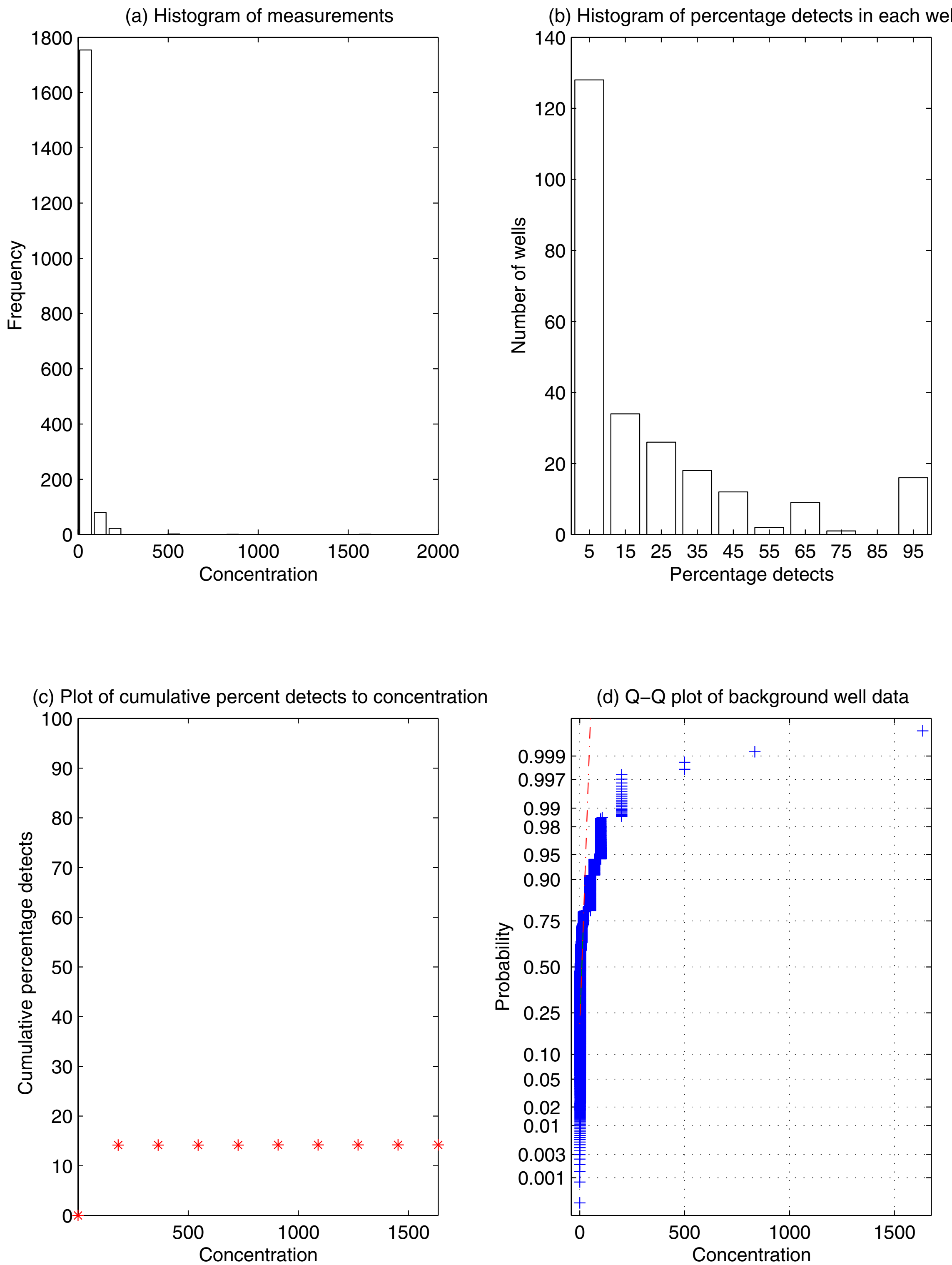

Figure F.13: Tin background results for SRS, $((ug/L))$

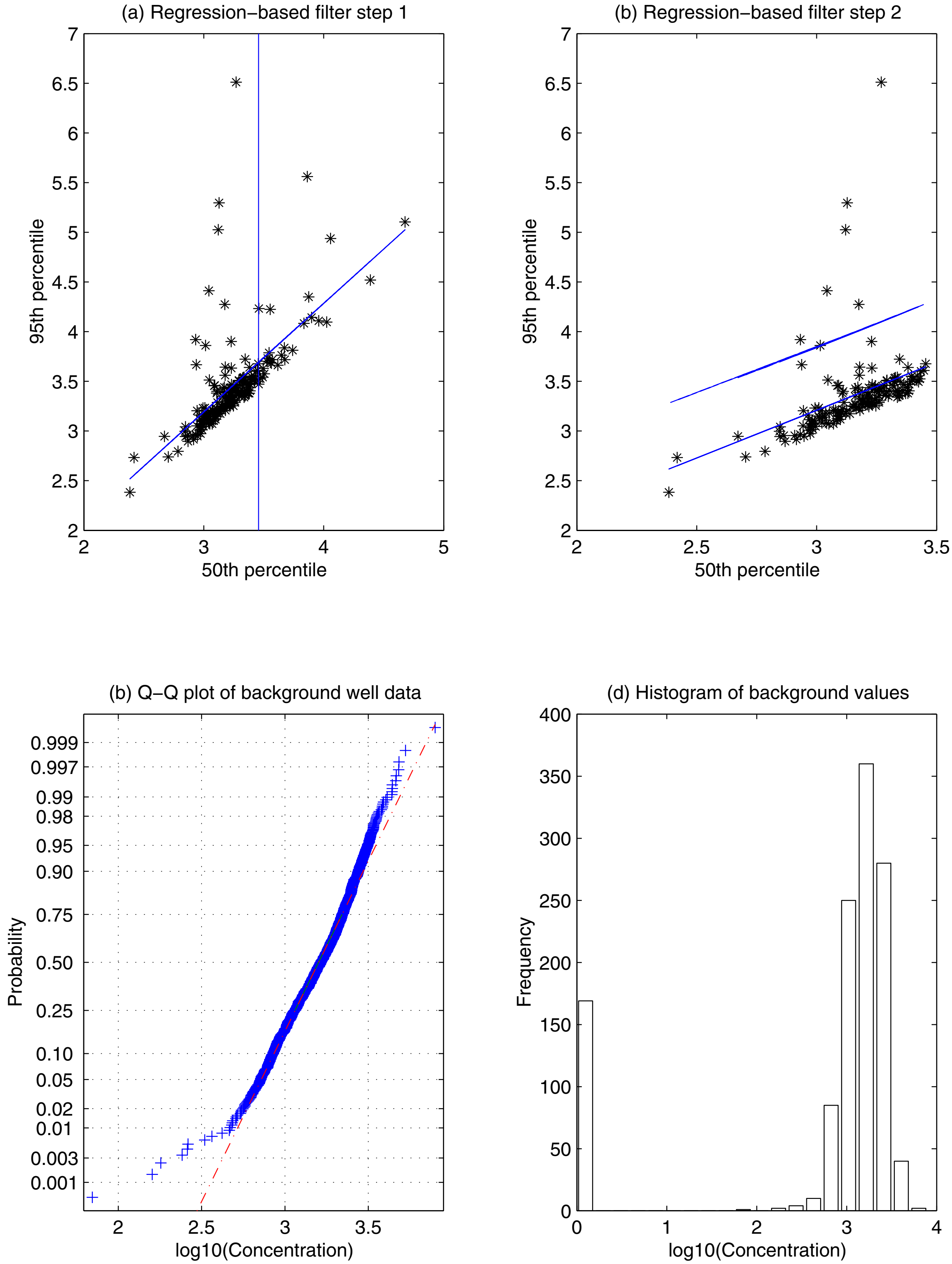

Figure F.14: Tritium regression approach results for SRS, in $(log_{10}(pCi/L))$

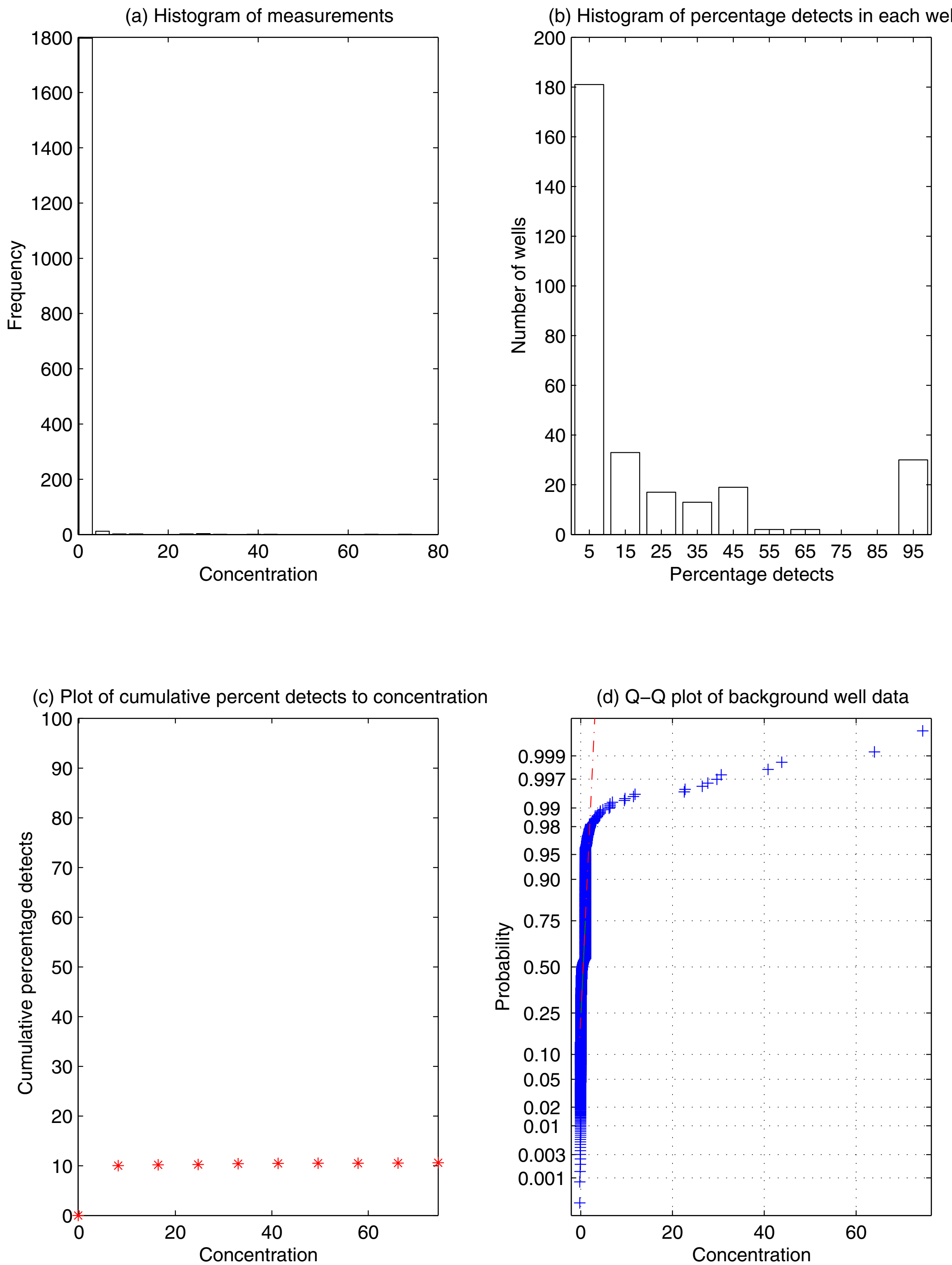

Figure F.15: Uranium-238 background results for SRS, $((pCi/L))$

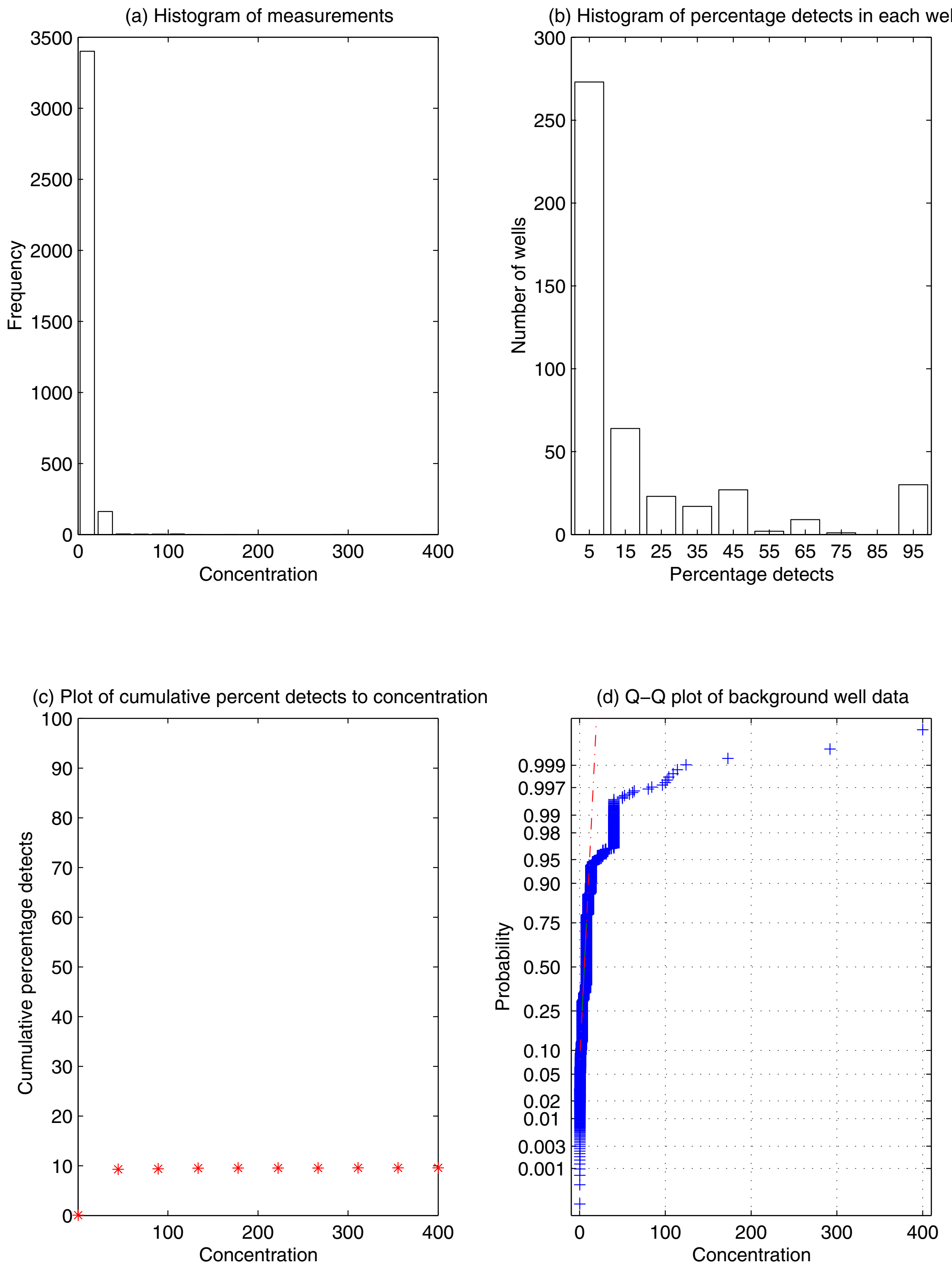

Figure F.16: Vanadium background results for SRS, $((ug/L))$

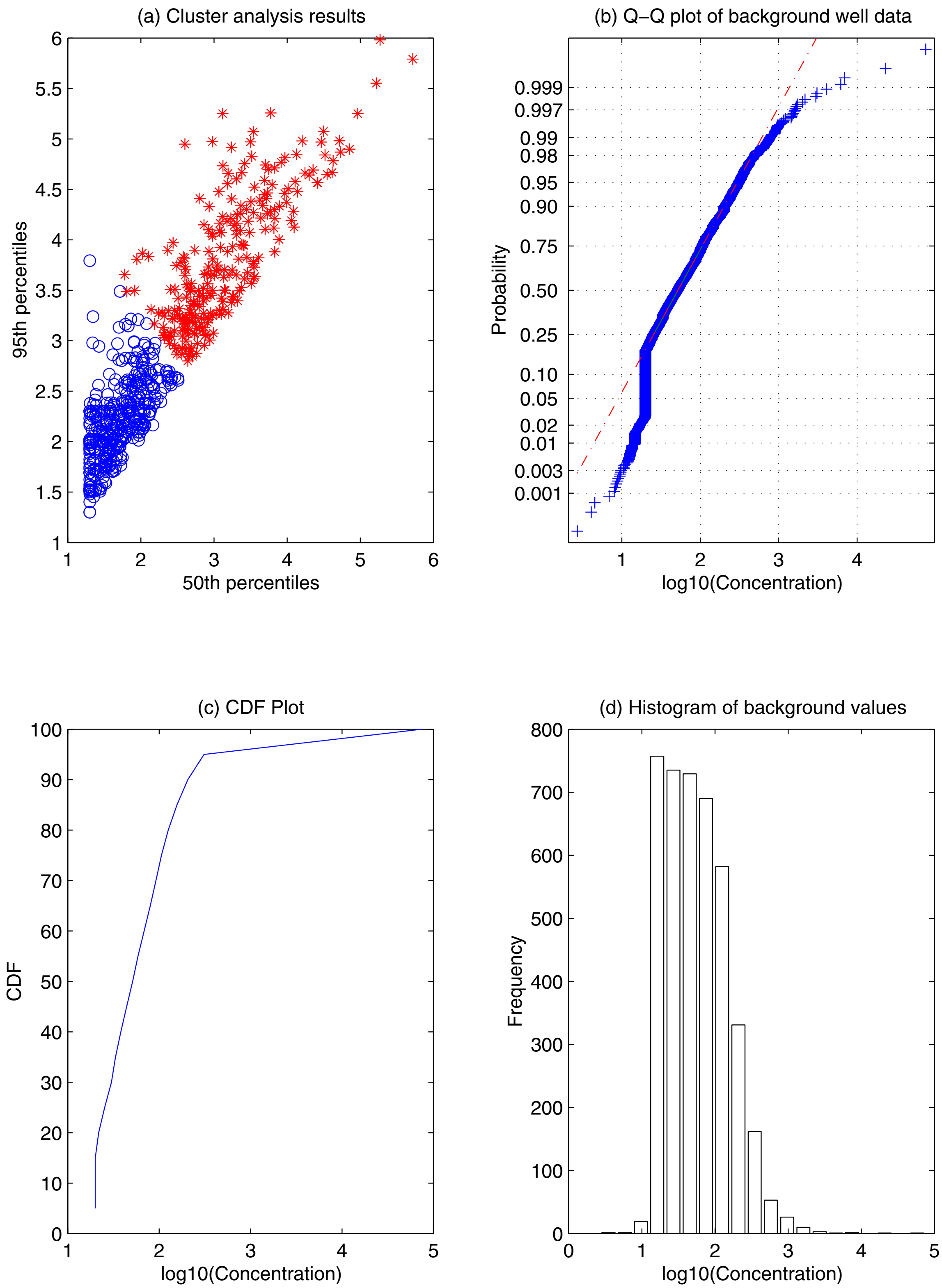

Figure F.17: Aluminum cluster anlaysis approach results for SRS, in $(log_{10}(ug/L))$

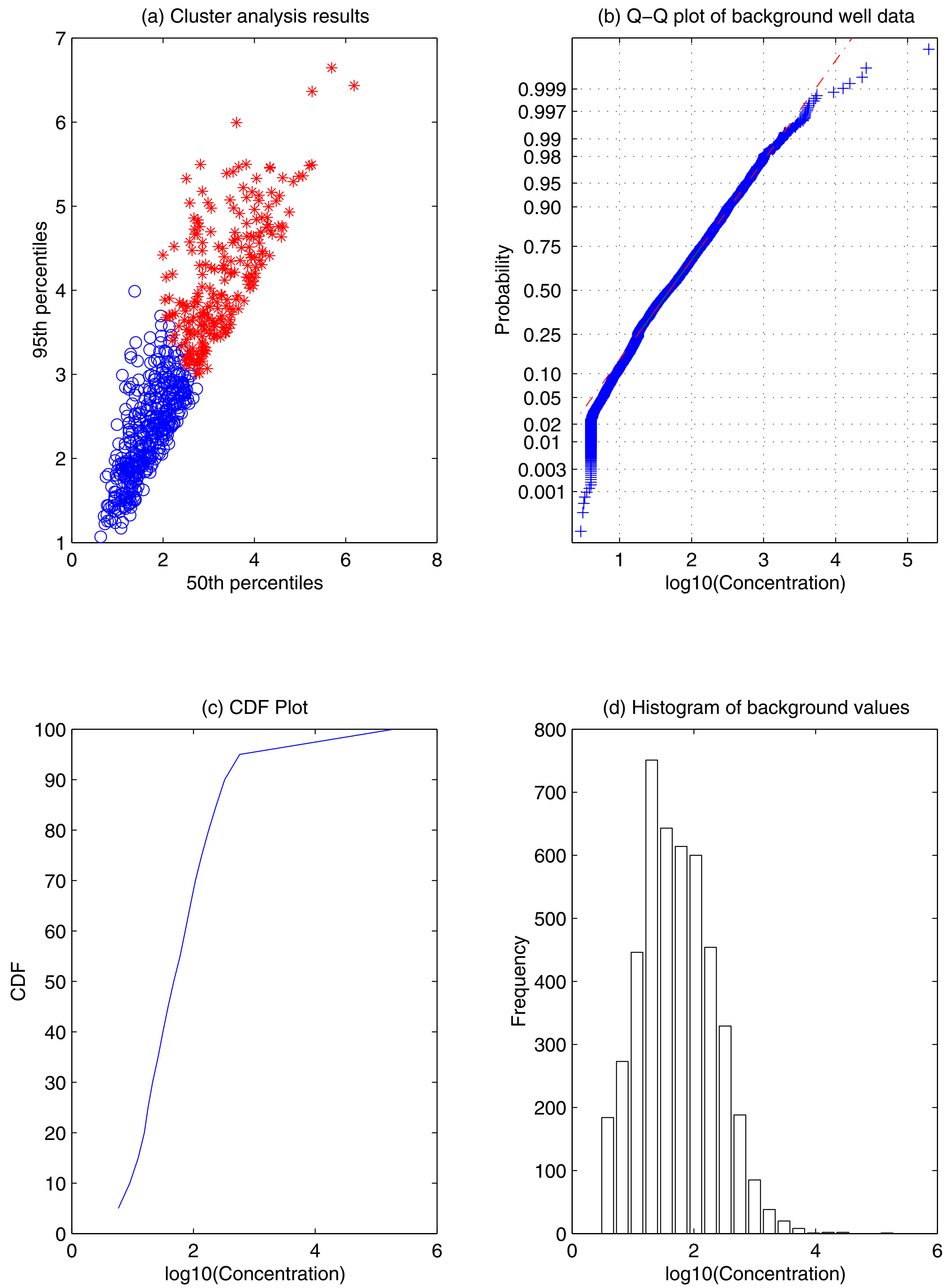

Figure F.18: Iron cluster analysis approach results for SRS, in $(log_{10}(ug/L))$

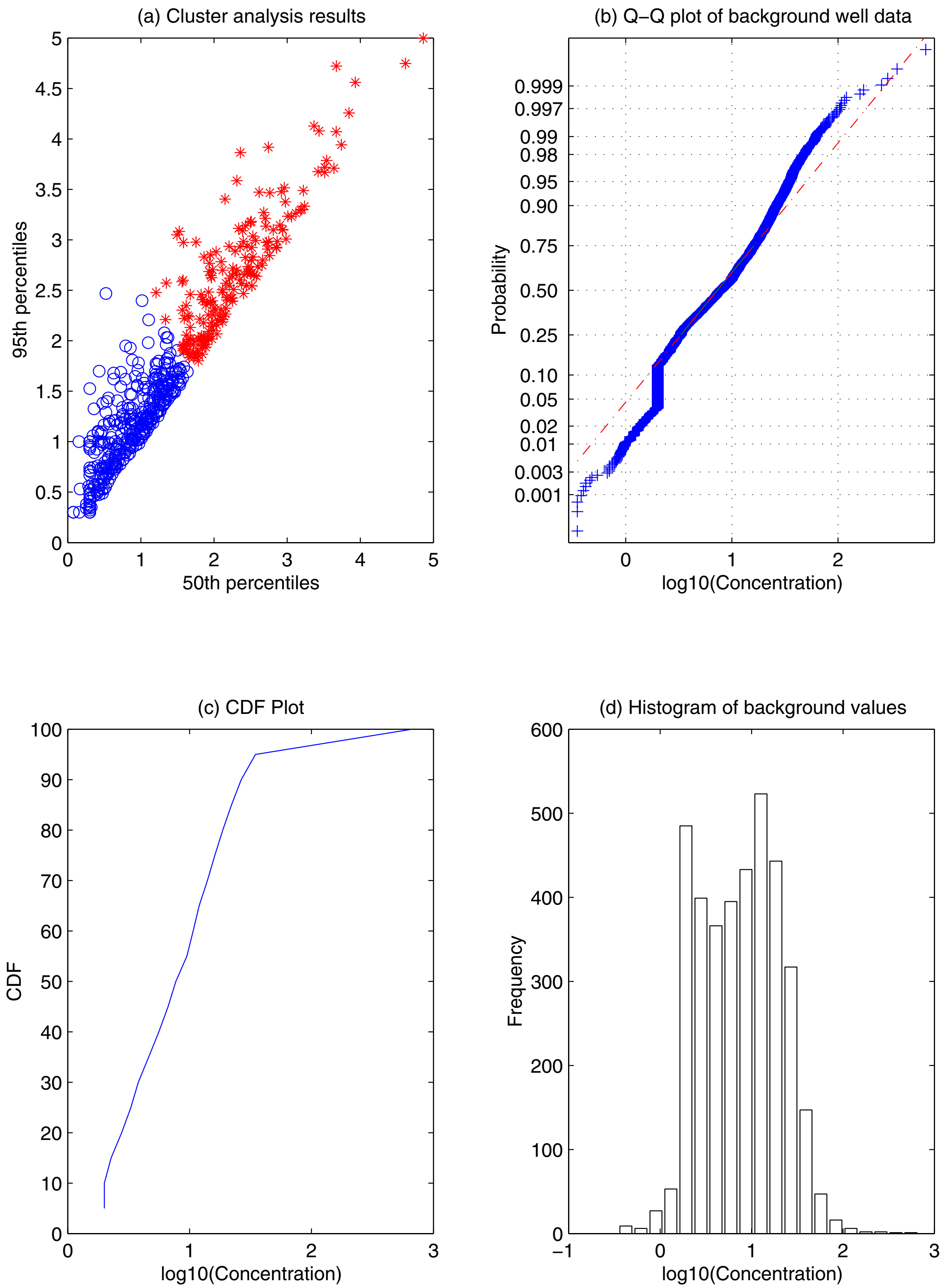

Figure F.19: Manganese cluster analysis approach results for SRS, in $(log_{10}(ug/L))$

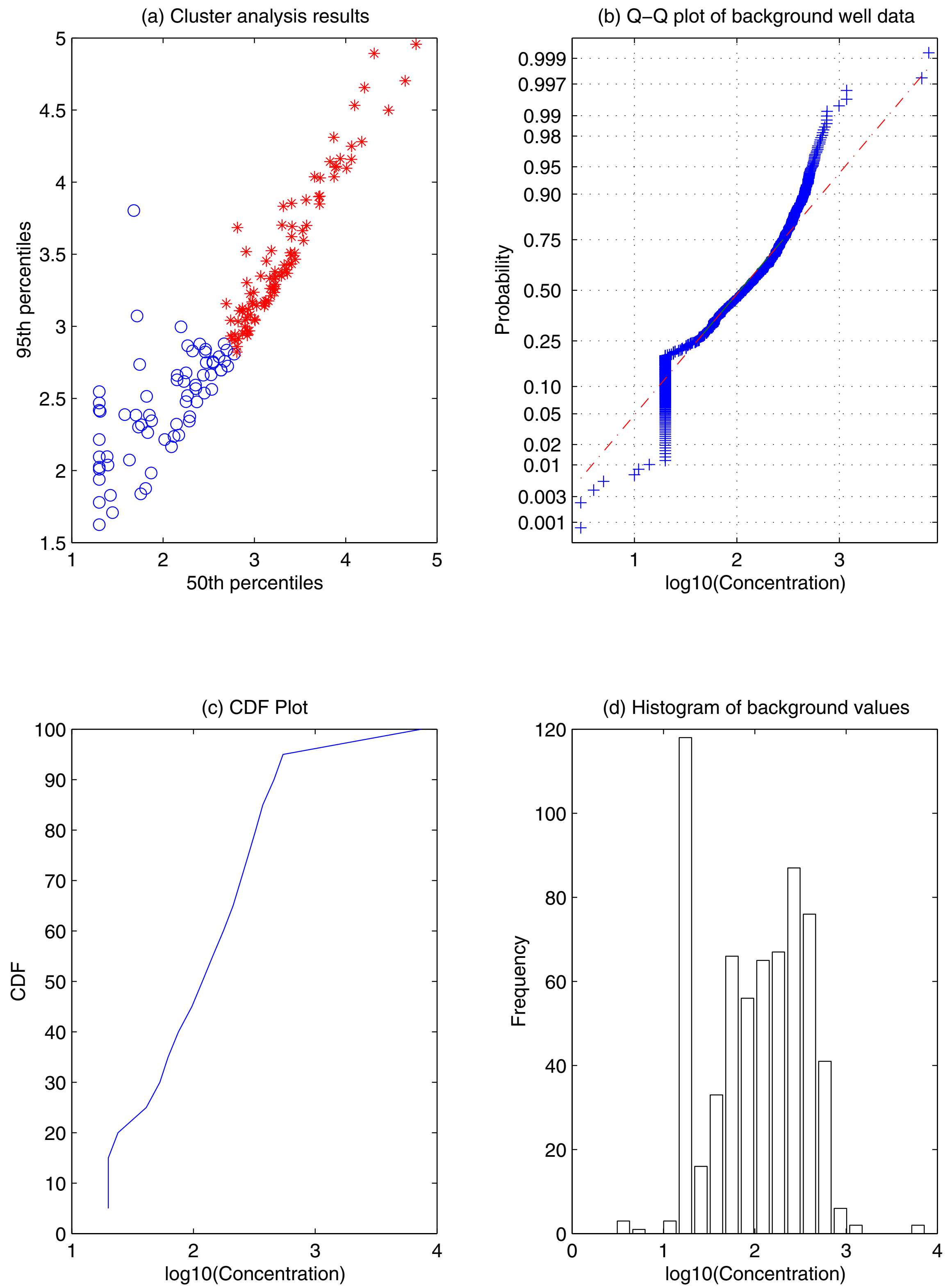

Figure F.20: Nitrate cluster analysis approach results for SRS, in $(log_{10}(ug/L))$

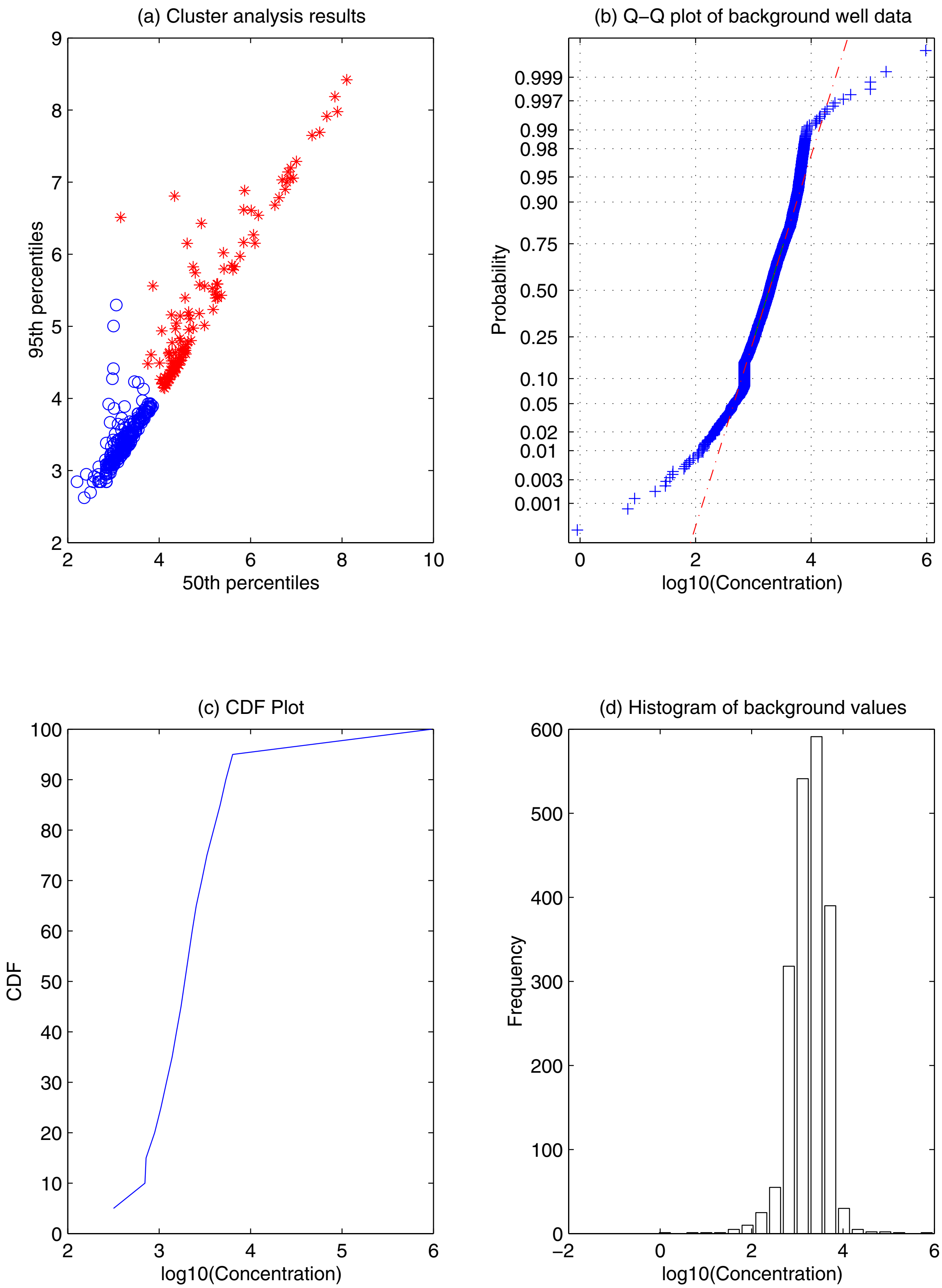

Figure F.21: Tritium cluster analysis approach results for SRS, in $(log_{10}(pCi/L))$

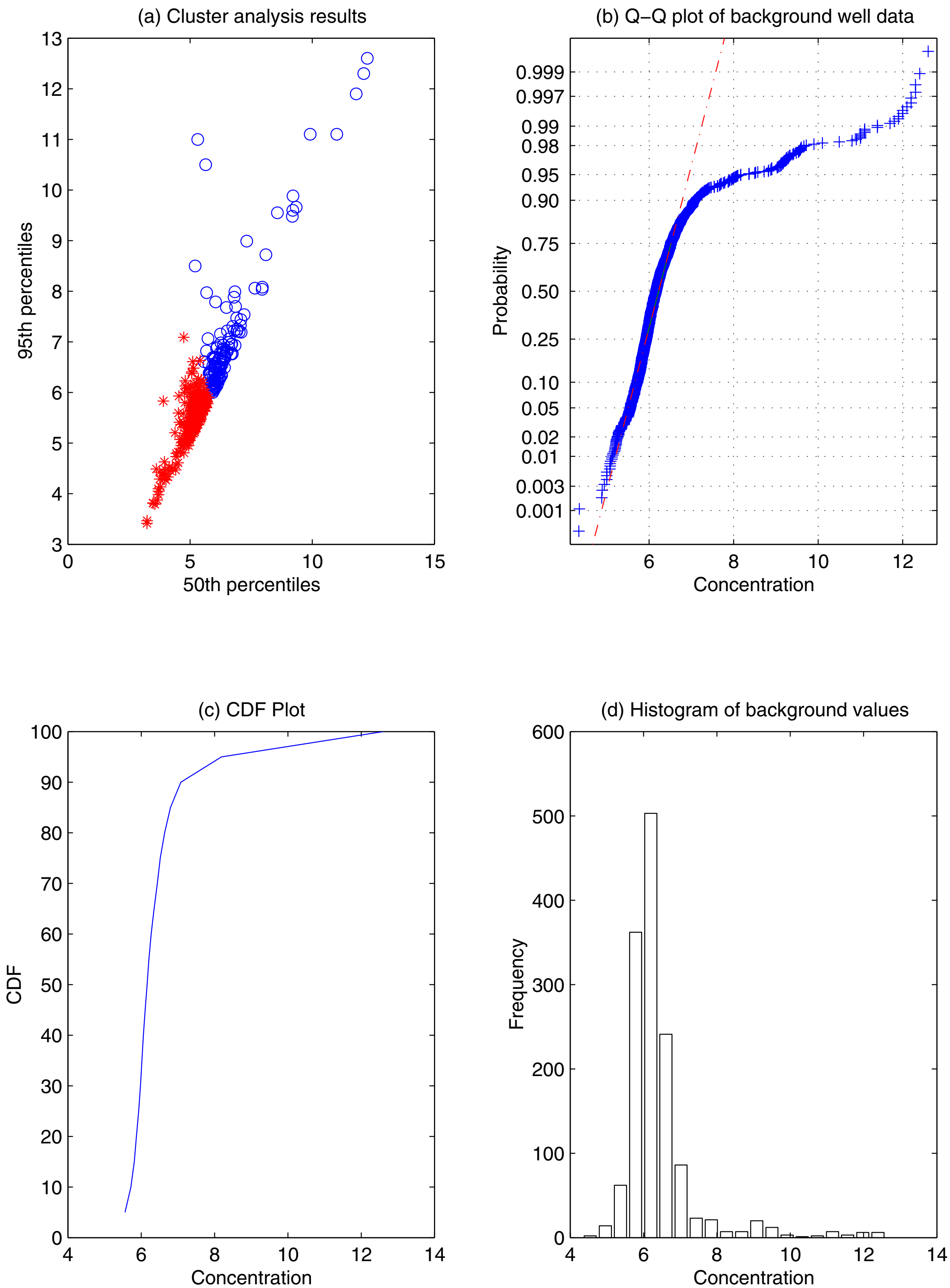

Figure F.22: pH cluster anlysis approach results for SRS, in normal units

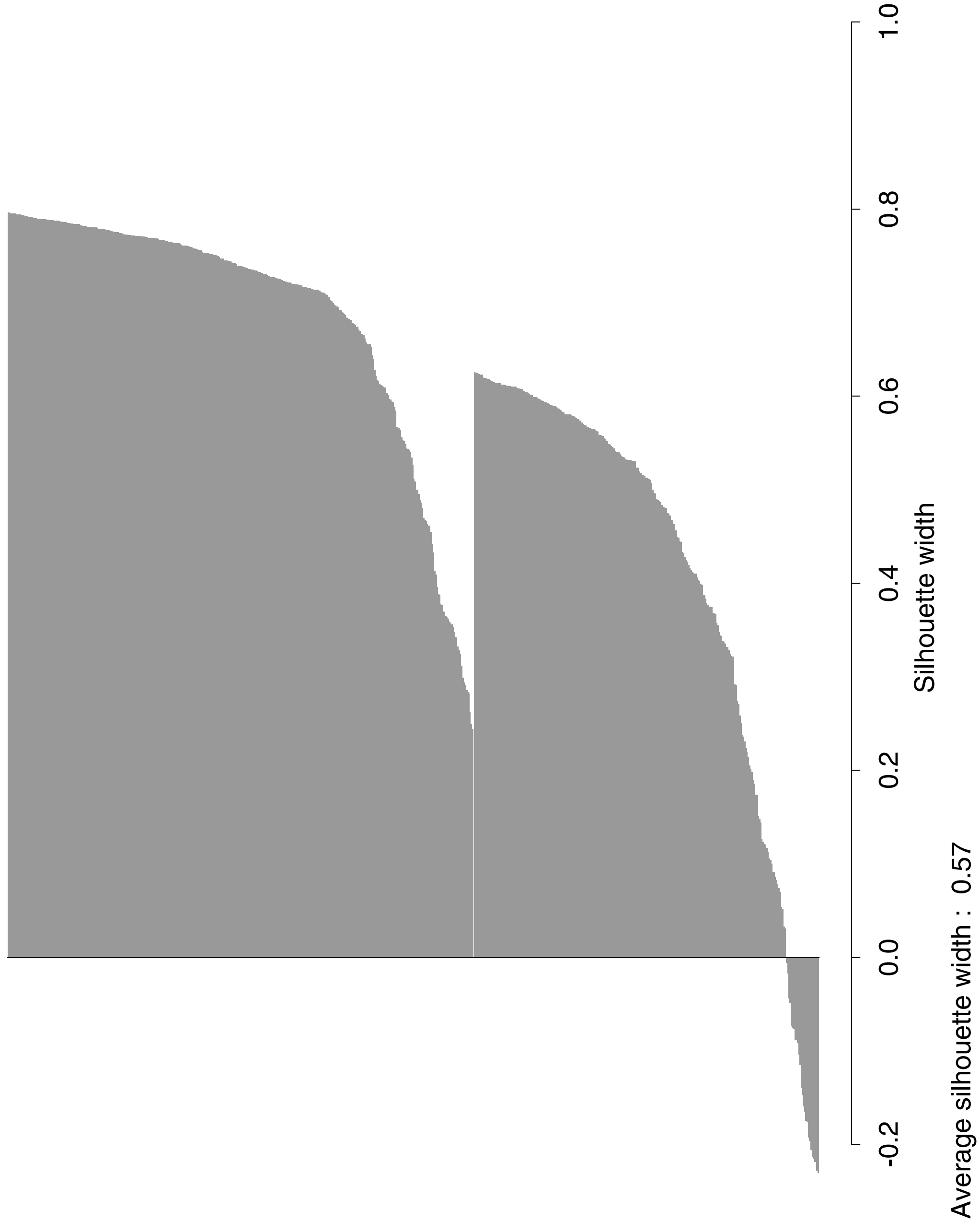

Figure F.23: Aluminum silhouette plot

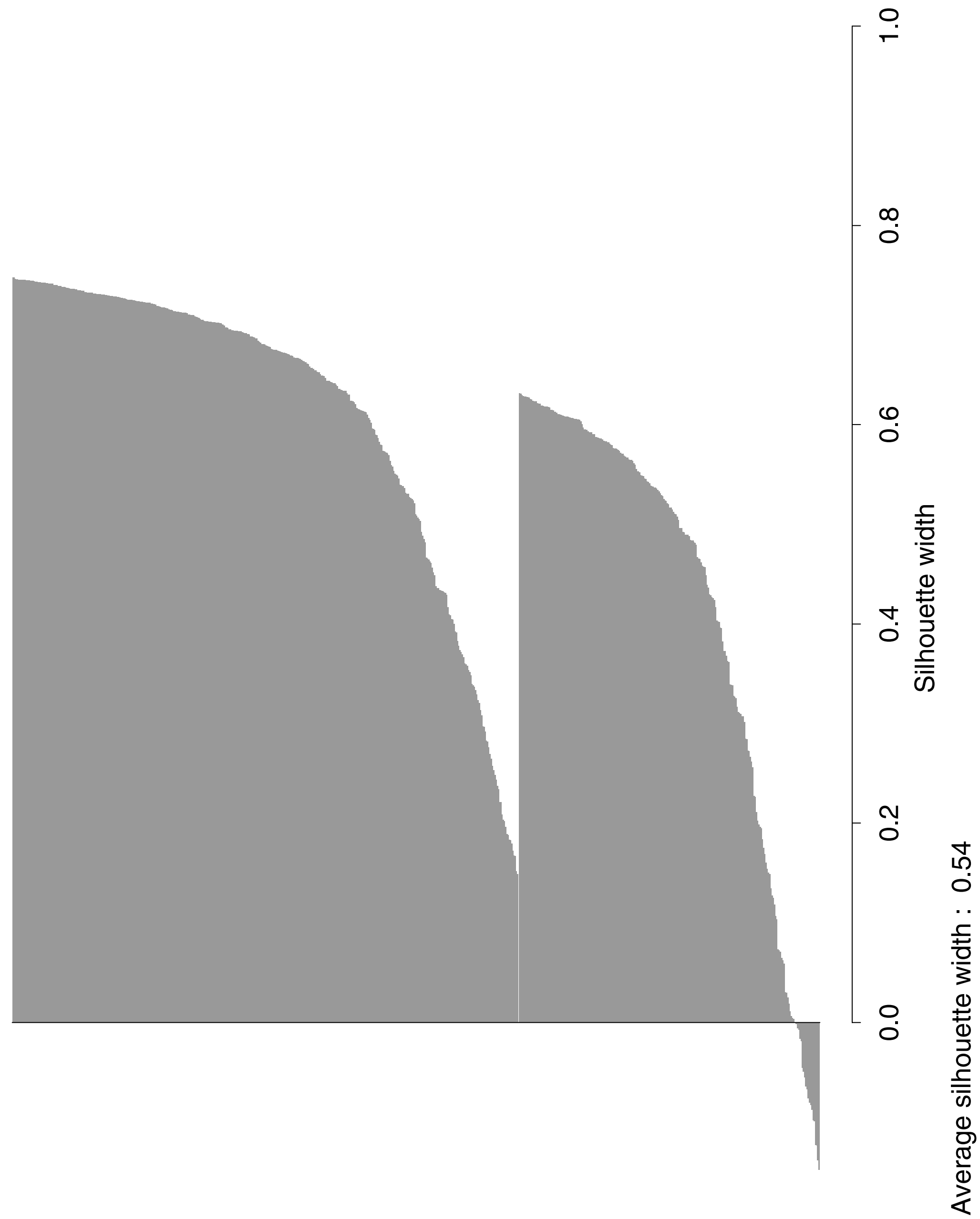

Figure F.24: Iron silhouette plot

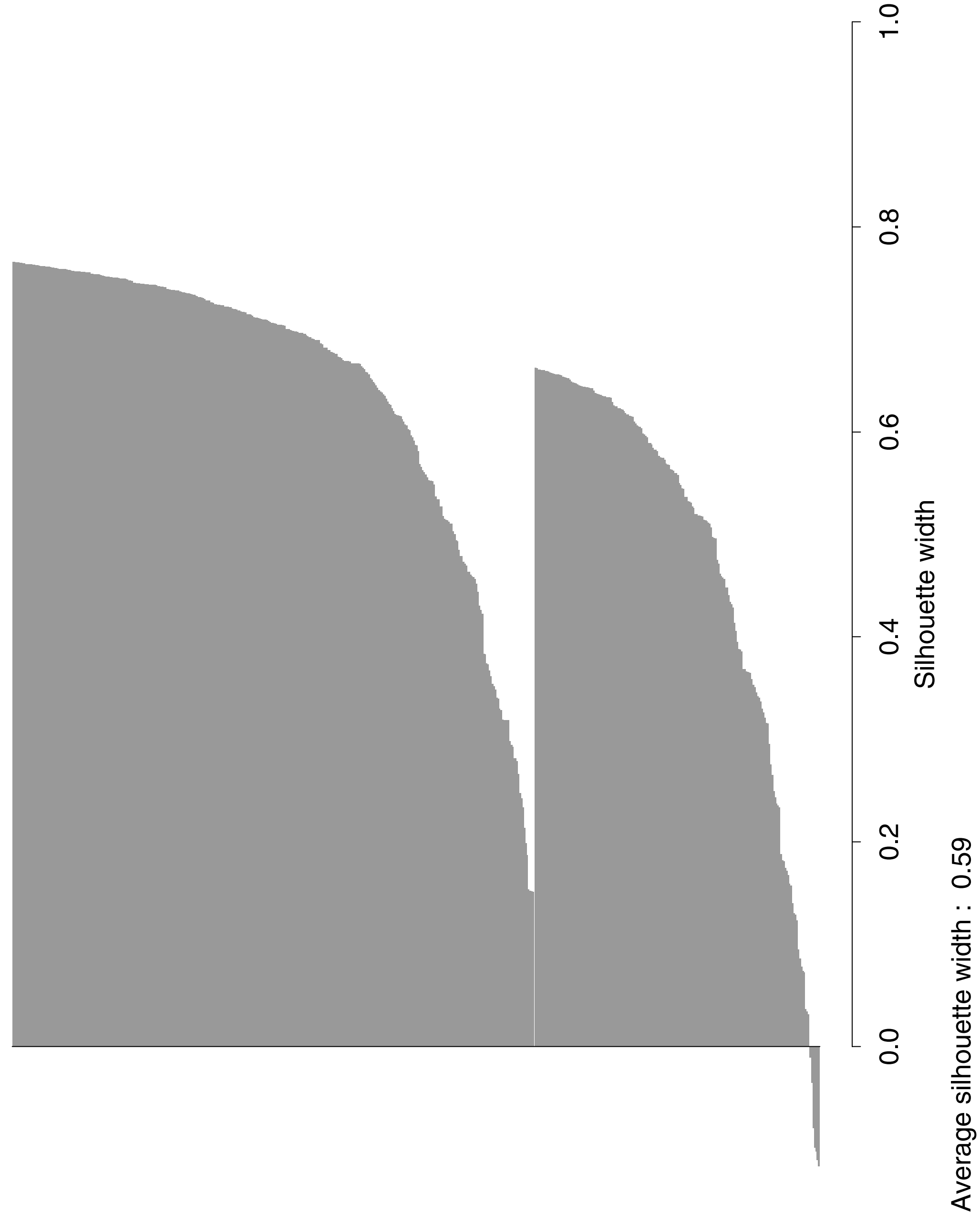

Figure F.25: Manganese silhouette plot

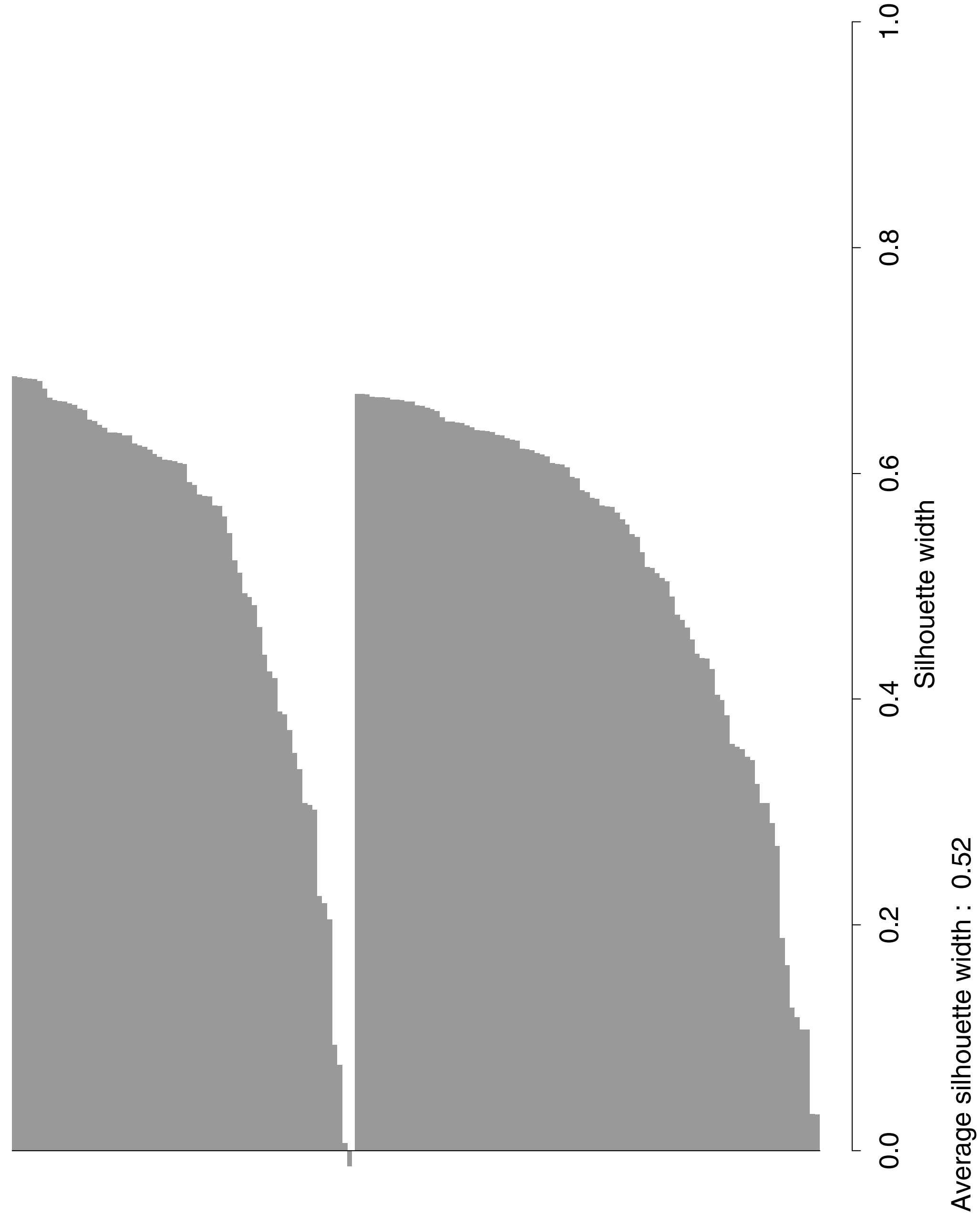

Figure F.26: Nitrate silhouette plot

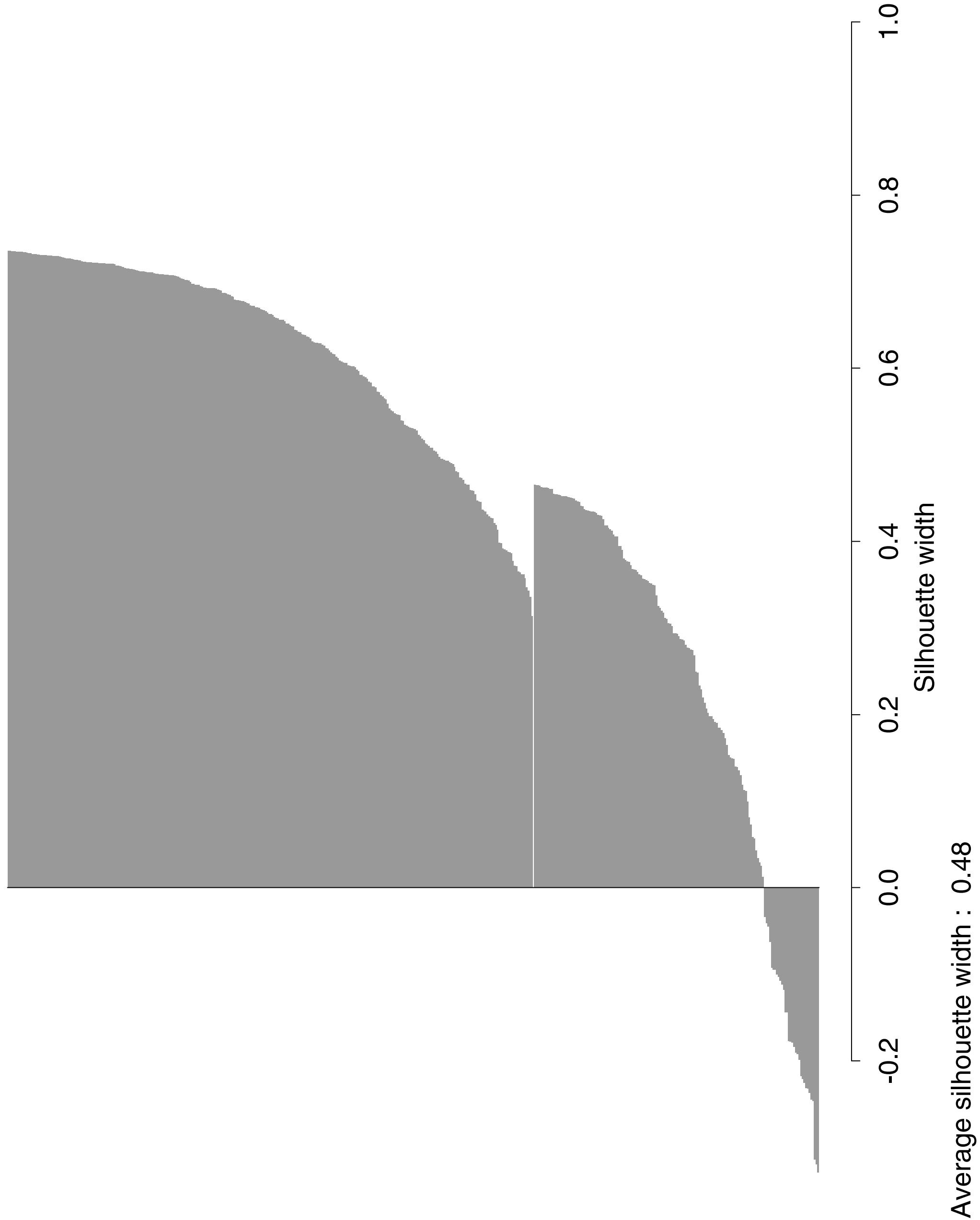

Figure F.27: pH silhouette plot

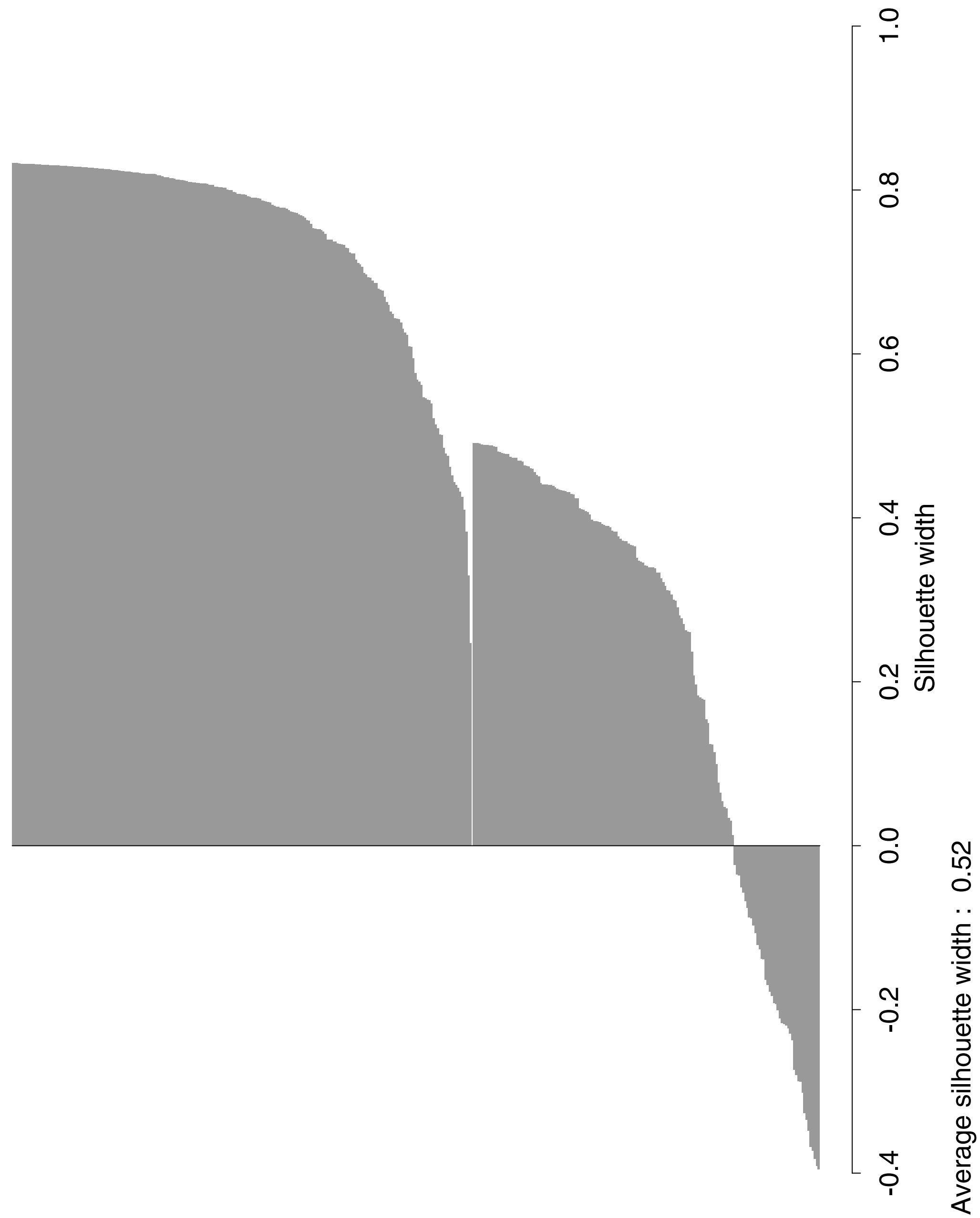

Figure F.28: Tritium silhouette plot

APPENDIX G. GSA - BACKGROUND WELLS THROUGH REGRESSION APPROACH

Arsenic

BG52
BG54
BG55
BG59
BG60
BG61
BG67
BG91
BG92
BG93
BG96
BG101
BG103
BG104
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BG109
BG110
BG122
BGO1D
BGO2D
BGO3D
BGO4D
BGO5D
BGO6D
BGO7D
BGO8D
BGO9D
BGO10DR
BGO11D
BGO12D
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BGO20D
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BGO23D
BGO24D
BGO26D
BGO27D
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FAC8
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BGX7D
BGO44D
YSC2D
FCA9DR
BGO17DR
BGX8DR
BGX11D
FSB121DR
BGO22DR
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BRR8DR
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BGO52D
FST1D
BGO12DR
BGO11DR
BGO3DR

Cesium-137

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FSB0PD
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HSL5D

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FBP13D
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BRR7D
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HAA4D
HAA6D
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BGO12DR
BGO3DR

Mercury

BG54
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HSL7D
FSL7D
FSL2D
FSL3D
FSL4D
FBP5D
FBP6D
FBP9D
FBP10D
FBP13D
BRR6D
BRR7D
HIW2D
FAB2
FAB3
FAB4
HAA1D
HAA2D
HAA4D
HAA6D
BRR8DR
BGO51D
BGO52D
FST1D
BGO12DR
BGO11DR
BGO3DR

Nitrite as nitrogen

FSS1D
FSS2D
FSS3D
FSS4D
HCA4
HR812
HSB83D
HSS3D
HTF17
ZBG1
ZBG1A
ZBG2
HSL3D
HSL2D
HSL4D
HSL8D
HSL7D
HSL6D
FAB1
FAB2
FAB3
FAB4
HAA1D
HAA2D
HAA3D
HAA4D
HAA6D

pH

BGO20D
FCA16A
FTF22
NBG1
NBG2
NBG3
NBG4
NBG5

Selenium

BG52
BG54
BG55
BG59
BG60
BG61
BG67
BG91
BG92
BG93
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HCB4
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HET4D
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SCA4A
SCA5
SCA6
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BGX7D
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BGO17DR
BGX8DR
BGX11D
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BGO22DR
FSB0PD
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FSL4D
FSL5D
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FBP9D
FBP10D
FBP13D
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BRR7D
FNB5
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FAB4
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HAA2D
HAA3D
HAA4D
HAA6D
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BGO3DR

Uranium-238

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BGO40D
BGO45D
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FNB4
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FSB114D
FSB118D
FSB123D
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FSS3D
FSS4D
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HCA1
HCA2
HCA3
HCA4
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HCB3
HCB4
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HET3D
HET4D
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SBG3
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ZDT2
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ZW10
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BGO17DR
BGO22DR
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FSL9D
FSL7D
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FSL5D
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FBP6D
FBP9D
FBP13D
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HAA2D
HAA3D
HAA4D
HAA6D
BGO51D
BGO12DR
BGO3DR

Aluminum

BG91
BG92
BG96
BG101
BG103
BG122
BGO9D
BGO10DR
BGO11D
BGO12D
BGX4D
HMD3D
HMD4D
SBG2
SCA2
SCA3A
SCA4A
BGX7D
BGO12DR
BGO11DR

Cobalt

BGO5D
BGO7D
BGO8D
BGO16D
BGO18D
BGO20D
BGO23D
BGO36D
BGO39D
BGX9D
BRR2D
FAC4
FNB4
FSB76
FSB87D

FSB99D
FSB106D
FSB108D
FSB109D
FSB111D
FSB113D
FSB115D
FSB116D
FSB120D
FSB123D
HAC2
HAC4
HAP1
HCA1
HCA2
HCA3
HCA4
HCB2
HCB3
HCB4
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HET3D
HET4D
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HSB100D
HSB101D
HSB110D
HSB111E
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HTF27
HTF28
HTF29
HTF32
HTF34
NBG1
SBG2
SBG3
ZBG1
ZDT1
ZDT2
ZW9
ZW10
BGO14DR
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FSL8D
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HSL2D
HSL4D
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HSL7D
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FSL3D
FSL4D
FSL5D
HIW2D
HAA1D
HAA2D
HAA3D
HAA4D
BRR8DR
BGO12DR
BGO3DR

<u>Iron</u>

BG92
BG93
BG96
BG103
BG110
BG122
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BGO6D
BGO7D
BGO8D
BGO9D
BGX3D
BGX4D
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FSB78
FSB91D
FSB92D
FSB93D
FSB95DR
FSB99D
FSB107D
FSB109D
FSB113D
FSB117D
FSB118D
FSB120D
FSB122D
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HMD3D
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HSB149D
SCA4A
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ZBG2
BGX6D
BGX7D
FSB0PD
BGO3DR

<u>Manganese</u>

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BGO30D
BGO34D
BGO35D
BGO36D
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BGX4D
BGX12D
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BRR3D
BRR4D
BRR5D
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FAL1
FCA16A
FCA16D
FCA19D
FCB3
FCB4
FCB5
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FET2D
FET4D
FNB1
FNB4
FSB76
FSB109D
FSB122D
FSS2D
FTF18
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HAC3
HAP1
HCA1
HCA4
HET2D
HET3D
HET4D
HMD1D
HSB66
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HSB71
HSB83D
HSB84D
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HSB101D
HSB111E
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HSB142D
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HSB152D
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NBG2
NBG3

NBG4
NBG5
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SCA4
SCA5
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ZBG2
ZW3
ZW5
ZW6
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BGO44D
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HIW2D
FAB2
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FAB4
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HAA4D
BRR8DR
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BGO12DR
BGO11DR
BGO3DR

Tin

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HCB4
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BGX7D
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BGX8DR
BGX11D
BGO22DR
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FSL4D
FSL5D
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BGO12DR
BGO11DR
BGO3DR

Thallium

BGO5D
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FSB0PD
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FSL4D
FSL5D
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BRR7D
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HAA3D
HAA4D
HAA6D
BRR8DR
BGO12DR
BGO3DR

Vanadium

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SBG2
SBG3
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ZDT2
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ZW10
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BGO49D
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BGX6D
BGX7D
BGO44D
BGO17DR
BGX8DR
BGX11D
FSB121DR
FSB0PD
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HSL3D
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HSL4D
HSL8D
HSL5D
FSL9D
FSL4D
FSL5D
FNB5
HAA1D
HAA2D
HAA4D
HAA6D
BRR8DR
BGO51D
BGO52D
BGO12DR
BGO11DR
BGO3DR

APPENDIX H. GSA - BACKGROUND WELLS THROUGH CLUSTERING APPROACH

Nitrate as nitrogen

BGX3D
FAC3
FAC6
FAC8
FSS1D
FSS3D
HAC2
HMD2D
HMD3D
HSB71
HSB131D
HSB140D
HSB141D
ZBG2
FBP5D
FBP9D
FBP13D
FAB2
FAB3
HAA1D
HAA2D
HAA6D

pH

BGO12D
BGO16D
BGO23D
BGO24D
BGO28D
BGO34D
BGO37D
BGX4D
BGX10D
BRR3D
BRR4D
FAC3
FAC6
FAL2
FCA9D
FCA10D
FCA16A
FCA16D
FCA19D
FCB3
FSB106D
FSB109D
FSS1D
FSS2D
FTF9
FTF12
FTF13
FTF21
FTF24A
FTF25A
FTF26
FTF27
HAP1
HCA2
HCA3
HCA4
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HMD4D
HSB138D
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HTF13
HTF14
HTF22
HTF23
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ZDT1
BGO50D
BGX1D
BGX6D
BGX7D
BGX8DR
FSL2D
FBP9D
FAB1
FAB2
FAB3
FAB4
HAA3D

Tritium

BG52
BG54
BG61
BG92
BG103
BG104
BG108
BG109
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BG122
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HMD4D
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HSB150D
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FBP9D
FBP13D
BRR7D
HIW2D
FAB3
HAA1D
HAA4D
BGO51D
BGO52D
FST1D

Aluminum

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BGO45D
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BGX12D
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BRR5D
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FET3D
FET4D
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BGO11DR
BGO3DR

Iron

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BGO45D
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BGX5D
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BGX12D
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FET3D
FET4D
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ZDT1
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FSL5D
FNB5
HIW2D
HAA1D
HAA2D
HAA4D
BRR8DR
BGO51D
BGO52D
BGO12DR
BGO11DR
BGO3DR

Manganese

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BGX4D
BGX12D
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BRR3D
BRR4D
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ZDT1
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BGO44D
YSC2D
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BGX11D
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HSL5D
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FAB4
HAA1D
HAA2D
HAA3D
HAA4D
BRR8DR
BGO52D
BGO12DR
BGO11DR
BGO3DR

APPENDIX I. SRS (SITEWIDE) BACKGROUND WELLS THROUGH REGRESSION APPROACH

Arsenic

ABP3
ABP8D
AC2B
AC3B
ACB1A
ACB2A
ACB3A
ACB4A
AMB5
AMB6
AMB7
AMB8D
AMB9D
AMB10D
AMB10DD
AMB11D
AMB12D
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AOB3
ARP1A
ARP2
ARP3
ARP4
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ASB2A
ASB3A
ASB4
ASB5A
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ASB7
ASB9
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CRP4
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CSB4A
CSB5A
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CSR4
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CRP9D
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ABP10D
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RBW2D
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BGO3DR
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CSF2D
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LFW41R
MSB78DR
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TRW3
TRW4
KRP7

Cesium-137

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DCB16
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HCB4
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HET4D
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PSB7A
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KRB18D
KRB19D
KRB16D
CSB2A
FCA9DR

BGO17DR
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FSB0PD
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FSL3D
FSL4D
FSL5D
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ASB3AR
ASB5AR
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FBP6D
FBP9D
FBP13D
BRR6D
BRR7D
FNB5
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LAC6DU
LAC7DU
LAC8DU
LCO8DU
HAA1D
HAA2D
HAA3D
HAA4D
HAA6D
BRR8DR
CMP10D
CMP14D
CMP30D
CMP31C
CMP32C
DCB17A
DCB18A
DCB19A
DCB20A
DCB21A
DCB22A
DCB23A
DCB24A
CRP5D
CRP7D
CRP8D
CRP9D
MCB11D
RSP1D
RBW1D
RBW2D
BGO12DR
BGO3DR
KRP6
KRP7
RSP7D

Mercury

ABP3
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AC2B
AC3B
ACB1A
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ACB3A
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AMB7
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AMB12D
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ARP4
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CBR3D
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CMP15C
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CRP4
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CSB4A
CSB5A
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CSD9D
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CSD11D
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CSD13D
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CSR4
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DBP4
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DCB2A
DCB3A
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DCB15
DCB16
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DOB4
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FCB6
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FET2D
FET3D
FET4D
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FNB4
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FSB108D
FSB109D
FSB113D
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FSB115D
FSB116D
FSB120D
FSB122D
FSB123D
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FSS3D
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FTF3
FTF6
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HCA3
HCB2
HCB3
HCB4
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HMD4D
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HSB69

HSB70
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HSB112E
HSB115D
HSB116D
HSB117D
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HSB132D
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HSB142D
HSB143D
HSB146D
HSB147D
HSB148D
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HSB151D
HSB152D
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IDP8
IDP9
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IDQ5
IDQ6
IDQ7
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IDQ10
IDQ12
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KAC7
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KDB3
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KSS3D
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LRP2
LRP3
LSB1
LSB2
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LSB4
MCB2
MCB4
MCB6
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MGC36
MGE30
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MGG36
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MSB2D
MSB3D
MSB5A
MSB6A
MSB7A
MSB8A
MSB9C
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MSB14C
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MSB16C
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MSB18C
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MSB27
MSB28
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MSB46C
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MSB82D
MSB83D
MSB85D
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NPM4DD
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PCB1A
PCB3A
PCB4A
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PRP2
PSB1A
PSB2A
PSB3A
PSB4A
PSB5A
PSB6A
PSB7A
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RAC2
RAC3
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RDB2D
RDB3D
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RSA8
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RSD5
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RSD8
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RSE1C
RSE3A
RSE19
SBG2
SBG3
SCA2
SCA3
SCA3A
SCA4
SCA4A
SCA5
SCA6
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SRW6
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SRW10
SRW11
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SRW13C
SRW14C
SRW15C
SRW16C
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TNX8D
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TNX10D
TNX11D
TNX12D
YSB1A
YSB3A
YSB4A
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ZBG1A
ZBG2
ZDT1
ZDT2
BGO50D
BGO29D
BGO14DR
BGO49D
BGX1D
BGX6D
BGX7D
AMB4D
K301P
KRB17D
KRB18D
KRB19D
KRB16D
CSB2A
KSM1D
NPM19A
BGO44D
NPM34A
YSC2D
BGO17DR
BGX8DR
BGX11D
FSB121DR
BGO22DR
HSL3D
HSL2D
FSL1D
HSL7D
FSL7D
FSL2D
FSL3D
DBP5
FSL4D
ASB2AR
ASB3AR
ASB5AR
FBP5D
FBP6D
FBP9D
FBP10D
FBP13D
MSB87C
MSB88D
BRR6D
BRR7D
LAC5DU
LAC6DU
LAC7DU
LAC8DU
LCO8DU
LFW66D
LFW69D
LFW70D
LFW71D
LFW72D
HIW2D
FAB2
FAB3
FAB4
HAA1D
HAA2D
HAA4D
HAA6D
CBR4D
BRR8DR
BGO51D
KCB7
LFW74D
LFW75D
AMB14D
AMB15D
AMB16D
CMP10D
CMP11D
CMP14D
CMP30D
CMP31C
CMP32C
CMP32D
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KDB5
LDB3
LDB4
PDB4
PDB5
DOB7
DOB8
DOB9
DOB10
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DCB18A
DCB19A
DCB20A
DCB21A
DCB22A
DCB23A
DCB24A
TNX13D
TNX14D
TNX15D
TNX16D
TNX17D
TNX18D
TNX19D
TNX20D
TNX21D
TNX22D
DOB14
FST1D
CRP3D
CRP5D
CRP7D
CRP8D
CRP9D
MCB11D
ABP9D
ABP10D
RSP1D
RBW1D
RBW2D
TNX23D
TNX24D
TNX26D
BGO12DR
BGO11DR
BGO3DR
KSB5D
KRP6
CSF1D
CSF2D
LFW6R
LFW8R
LFW41R
MSB78DR
TRW3
TRW4
KRP7

Nitrate as nitrogen

ASB9
KAC2
KAC6
KSS2D
KSS3D
LFW8
LFW10A
LFW16
LFW17
LFW18
LFW21
LFW22
LFW25
LFW31
LFW32
LFW36
LFW37
LFW38
LFW39
LFW40
LFW41
LFW42
LFW44D
LFW46D
LFW47D
LFW48D
LFW57D
LFW58D
LFW59D
LFW60D
LFW61D
LFW62D
PAC2
PAC5
PAC6
PSS3D
LFW63D
LFW66D
LFW67D
LFW68D
LFW69D
LFW70D
LFW71D
LFW72D

Nitrite as nitrogen

CSA1
CSA2
CSA3
CSA4
CSD1D
CSD2D
CSD4D
CSD8D
CSD9D
CSD10D
CSD11D
CSD12D
CSD13D
DCB6
DCB7
FSS1D
FSS2D
FSS3D
FSS4D
HCA4
HR812
HSB83D
HSS3D
HTF17
KSS1D
KSS2D
KSS3D
PSS1D
PSS2D
PSS3D
TNX1D
TNX9D
ZBG1
ZBG1A
ZBG2
HSL3D
HSL2D
HSL4D
HSL8D
HSL7D
HSL6D
FAB1
FAB2
FAB3
FAB4
HAA1D
HAA2D
HAA3D
HAA4D
HAA6D
TNX15D
TNX16D

pH

BGO20D
FCA16A
FTF22
KSS2D
KSS3D
MSB1D
MSB26
MSB53D
MSB60D
MSB61D
NBG1
NBG2
NBG3
NBG4
NBG5
PSS3D

Selenium

ABP3
ABP8D
AC2B

AC3B
ACB1A
ACB2A
ACB3A
AMB5
AMB6
AMB7
AMB8D
AMB9D
AMB10D
AMB10DD
AMB11D
AMB12D
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AOB3
ARP1A
ARP2
ARP3
ARP4
ASB1A
ASB2A
ASB3A
ASB5A
ASB6A
ASB7
ASB9
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BG54
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BG60
BG61
BG67
BG91
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BG93
BG96
BG101
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BG104
BG108
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BG110
BG122
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BGO3D
BGO4D
BGO5D
BGO6D
BGO7D
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BGO9D
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BRD3
BRD5D
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BRR2D
BRR3D
BRR4D
BRR5D
CBR1D
CBR2D
CBR3D
CCB1
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CCB3
CCB4
CDB1
CDB2
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CMP12
CMP13
CMP14C
CMP15C
CRP1
CRP4
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CSA2
CSA3
CSA4
CSB1A
CSB3A
CSB4A
CSB5A
CSB6A
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CSD2D
CSD4D
CSD8D
CSD9D
CSD10D
CSD11D
CSD12D
CSD13D
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CSR1
CSR2
CSR3
CSR4
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DBP4
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DCB12
DCB16
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DOB3
DOB4
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FET3D
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FSB91D
FSB92D
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FSB106D
FSB107D
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FSB113D
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FSB123D
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FSS3D
FSS4D
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HAC4
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HCA4
HCB2
HCB3
HCB4
HET2D
HET3D
HET4D
HMD1D
HMD2D
HMD3D
HMD4D
HR812
HSB65
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HSB67
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HSB69
HSB70
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HSB86D
HSB100D
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HSB102D
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HSB104D
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HSB106D
HSB107D
HSB108D
HSB109D
HSB110D

HSB111E	IDQ6	LFW43D	MSB48D
HSB112E	IDQ7	LFW44D	MSB49D
HSB113D	IDQ8	LFW45D	MSB50D
HSB114D	IDQ9	LFW46D	MSB51D
HSB115D	IDQ10	LFW47D	MSB52D
HSB116D	IDQ12	LFW56D	MSB53D
HSB117D	KAB1	LFW57D	MSB54D
HSB125D	KAB2	LFW58D	MSB55D
HSB126D	KAB3	LFW59D	MSB56D
HSB127D	KAB4	LFW60D	MSB57D
HSB129D	KAC1	LFW61D	MSB58D
HSB130D	KAC3	LFW62D	MSB59D
HSB131D	KAC5	LRP1	MSB60D
HSB132D	KAC6	LRP2	MSB61D
HSB134D	KAC7	LRP3	MSB62D
HSB135D	KCB1	LSB1	MSB63D
HSB136D	KCB2	LSB2	MSB64D
HSB137D	KDB1	LSB3	MSB65D
HSB138D	KDB2	LSB4	MSB67D
HSB139D	KDB3	MCB2	MSB68D
HSB140D	KDT1D	MCB4	MSB69D
HSB141D	KRP1	MCB5	MSB70D
HSB142D	KRP2	MCB6	MSB74D
HSB143D	KRP3	MGC9	MSB77D
HSB146D	KRP4	MGC19	MSB82D
HSB147D	KSB1	MGC32	MSB83D
HSB148D	KSB2	MGC36	MSB85D
HSB149D	KSB3	MGE9	NBG1
HSB150D	KSB4A	MGE21	NBG2
HSB151D	KSS1D	MGG15	NBG3
HSB152D	KSS2D	MGG19	NBG4
HSS3D	KSS3D	MGG23	NBG5
HTF5	LAC1	MGG36	NPM2
HTF6	LAC2	MSB1D	NPM3
HTF7	LAC4	MSB2D	NPM4
HTF8	LCO1	MSB3D	NPM4DD
HTF13	LCO2	MSB4D	PAC1
HTF14	LCO3	MSB5A	PAC2
HTF15	LDB1	MSB6A	PAC3
HTF16	LDB2	MSB7A	PAC4
HTF17	LFW6	MSB8A	PAC5
HTF18	LFW7	MSB9C	PAC6
HTF19	LFW8	MSB11F	PCB1A
HTF20	LFW10A	MSB13D	PCB3A
HTF22	LFW16	MSB14C	PCB4A
HTF23	LFW17	MSB15C	PRP1A
HTF24	LFW18	MSB15D	PRP2
HTF25	LFW19	MSB16C	PRP3
HTF26	LFW20	MSB17D	PRP4
HTF27	LFW21	MSB18C	PSB1A
HTF28	LFW22	MSB20C	PSB2A
HTF29	LFW24	MSB21C	PSB3A
HTF32	LFW25	MSB24	PSB4A
HTF34	LFW26	MSB26	PSB5A
HWS1A	LFW27	MSB27	PSB6A
HWS2	LFW28	MSB28	PSB7A
HXB4D	LFW29	MSB30C	RAC1
HXB5D	LFW30	MSB31C	RAC2
IDB4	LFW31	MSB33	RAC3
IDB5	LFW32	MSB34C	RAC4
IDB6	LFW33	MSB36D	RCP1D
IDB7	LFW34	MSB37D	RDB1D
IDB8	LFW35	MSB38D	RDB2D
IDP4	LFW36	MSB39D	RDB3D
IDP6	LFW37	MSB40D	RRP1
IDP7	LFW38	MSB41D	RRP2
IDP8	LFW39	MSB42D	RRP3
IDP9	LFW40	MSB44C	RRP4
IDQ4	LFW41	MSB46C	RSA7
IDQ5	LFW42	MSB47D	RSA8

RSA9
RSA10
RSB7
RSB8
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RSC3
RSC4
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RSC9
RSC10
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RSE1C
RSE3A
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RSE19
SBG2
SBG3
SCA2
SCA3
SCA3A
SCA4
SCA4A
SCA5
SCA6
SLP1
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SRW12C
SRW13C
SRW14C
SRW15C
SRW16C
TBG1
TBG3
TBG4
TBG5
TBG6
TBG7
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XSB2D
XSB3A
XSB4D
YSB1A
YSB2A
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ZBG1A
ZBG2
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ZW10
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BGO14DR
BGO49D
BGX1D
BGX6D
BGX7D
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KRB18D
KRB19D
KRB16D
CSB2A
KSM1D
NPM19A
BGO44D
NPM34A
YSC2D
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BGO17DR
BGX8DR
BGX11D
FSB121DR
BGO22DR
FSB0PD
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HSL3D
HSL2D
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FSL1D
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HSL7D
HSL6D
HSL5D
FSL9D
FSL7D
FSL2D
FSL3D
DBP5
FSL4D
FSL5D
ASB2AR
ASB5AR
FBP5D
FBP6D
FBP9D
FBP10D
FBP13D
MSB87C
MSB88D
BRR6D
BRR7D
FNB5
LAC5DU
LAC6DU
LAC7DU
LAC8DU
LCO8DU
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LFW66D
LFW67D
LFW68D
LFW69D
LFW70D
LFW71D
LFW72D
HIW2D
FAB3
FAB4
HAA1D
HAA2D
HAA3D
HAA4D
HAA6D
CBR4D
BRR8DR
BGO51D
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KCB7
LFW74D
LFW75D
AMB14D
AMB15D
AMB16D
CMP10D
CMP11D
CMP14D
CMP30D
CMP31C
CMP32D
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KDB5
LDB3
LDB4
PDB4
DOB7
DOB8
DOB9
DOB10
BGO52D
DCB17A
DCB18A
DCB19A
DCB20A
DCB21A
DCB22A
DCB23A
DCB24A
TRW1
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TNX14D
TNX15D
TNX16D
TNX17D
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FST1D
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CRP7D
CRP8D
CRP9D
MCB11D
MCB13D
ABP9D
ABP10D
RSP1D
RBW1D
RBW2D
TNX23D
TNX24D
TNX26D
BGO12DR
BGO11DR
BGO3DR
KSB5D
KRP6
CSF1D
CSF2D
LFW6R
LFW8R
LFW36R
LFW41R
MSB78DR
TRW2
TRW3
TRW4
KRP7
RSP4D
RSP5D
RSP6D
RSP7D

Tritium

ABP3
ACB2A
AOB1
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ARP1A
ARP2
ARP3
ARP4
ASB1A
ASB4
ASB6A
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DBP1
DBP2
DBP3
DBP4
DCB1A
DCB3A
DCB5A
DCB7
DCB13
DOB1
DOB2
KAC5
KAC6

KSS2D
LFW6
LFW20
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LFW27
LFW29
LFW35
LFW41
LFW43D
LFW44D
LFW46D
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MSB53D
MSB70D
MSB74D
MSB77D
MSB82D
MSB85D
RAC1
RAC3
RAC4
RCP1D
RDB1D
RDB2D
RDB3D
RRP1
RRP2
RRP3
RSA7
RSA8
RSA10
RSB7
RSB8
RSC2
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RSE3A
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SRW2
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SRW7
SRW10
SRW11
SRW14C
SRW15C
SRW16C
TBG1
TBG4
TNX1D
TNX2D
TNX3D
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YSB3A
YSB4A
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LFW72D
LFW74D
LFW75D
AMB16D
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CMP32C
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TNX21D
TNX22D
FST1D
MCB11D
MCB13D
ABP9D
ABP10D
TNX23D
TNX24D
LFW6R
TRW4

Uranium-238

ABP3
ABP8D
ARP2
ARP4
ASB1A
ASB2A
ASB3A
ASB5A
ASB6A
ASB7
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BG104
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BG122
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BGO45D
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CRP4
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CSB5A
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DCB16
FNB1
FNB4
FSB76
FSB108D
FSB111D
FSB114D
FSB118D
FSB123D
FSS1D
FSS2D
FSS3D
FSS4D
HAC2
HAC4
HAP1
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HCA4
HCB2
HCB3
HCB4
HET2D
HET3D
HET4D
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HSB103D
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HSB150D
HSB151D
HSB152D
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HTF13
HTF14
HTF15
HTF16
HTF18
HTF19
HTF20
HTF22
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HTF24
HTF25
HTF26
HTF27
HTF28

HTF29
HTF32
HTF34
HXB4D
HXB5D
IDB4
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IDB6
IDB7
IDB8
KRP1
KRP2
KRP3
KRP4
LAC1
LAC2
LAC3
LAC4
LCO1
LCO2
LCO3
LCO4
MCB2
MCB4
MCB5
MCB6
MSB5A
MSB7A
MSB8A
MSB14C
MSB15C
MSB21C
MSB31C
MSB36D
MSB39D
PSB1A
PSB2A
PSB3A
PSB4A
PSB5A
PSB6A
PSB7A
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RSE10
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TNX12D
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XSB3A
XSB4D
ZDT1
ZDT2
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ZW10
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BGO29D
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CSB2A
BGO44D
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BGO17DR
BGO22DR
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FSL7D
FSL2D
FSL3D
FSL4D
FSL5D
ASB2AR
ASB3AR
ASB5AR
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FBP9D
FBP13D
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LAC6DU
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LAC8DU
LCO8DU
HAA1D
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HAA3D
HAA4D
HAA6D
BGO51D
DCB17A
DCB19A
DCB20A
DCB21A
DCB22A
DCB23A
DCB24A
CRP3D
CRP5D
CRP7D
CRP8D
CRP9D
MCB11D
MCB13D
ABP9D
ABP10D
RSP1D
RBW1D
RBW2D
BGO12DR
BGO3DR
KRP6
KRP7
RSP7D

Aluminum

AC2B
AC3B

AMB7
AMB8D
AMB10D
AMB11D
AMB12D
AOB1
AOB2
ARP1A
ARP2
ARP4
ASB1A
ASB4
ASB6A
ASB9
BG92
BG96
BG101
BG103
BG122
BGO9D
BGO10DR
BGO11D
BGO12D
BGX4D
BRD1
BRD2
BRD5D
CCB1
CCB2
CCB3
CCB4
CSA1
CSA3
CSA4
CSB6A
CSD2D
CSD4D
CSD8D
CSD9D
CSD10D
CSD11D
CSD12D
CSD13D
CSR1
CSR2
CSR3
CSR4
DOB1
DOB2
DOB4
GBW1
HMD3D
HWS1A
HWS2
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IDB7
IDB8
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IDP7
IDQ7
IDQ8
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KAB3
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KAC5
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KRP2
KRP3

LFW10A
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LFW57D
LFW58D
LFW59D
LFW61D
LRP1
LRP2
LRP3
MSB1D
MSB5A
MSB7A
MSB13D
MSB15D
MSB17D
MSB18C
MSB21C
MSB24
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MSB27
MSB28
MSB30C
MSB34C
MSB36D
MSB38D
MSB39D
MSB41D
MSB49D
MSB54D
MSB55D
MSB57D
MSB58D
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MSB65D
MSB67D
MSB68D
MSB69D
MSB70D
MSB74D
MSB82D
MSB83D
MSB85D

PSS2D
SBG2
SBG3
SCA2
SCA3A
SRW1
SRW2
SRW4
SRW5
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SRW7
SRW8
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SRW16C
TBG7
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TNX7D
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TNX12D
BGX7D
AMB4D
ASB2AR
ASB3AR
MSB88D
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LFW69D
LFW70D
LFW71D
LFW72D
LFW74D
LFW75D
DOB7
DOB9
TRW1
TNX17D
BGO12DR
BGO11DR
LFW6R
LFW8R
LFW36R
LFW41R
TRW3
TRW4

Cobalt

ABP3
ABP8D
AC2B
AC3B
ACB1A
ACB2A
ACB3A
ACB4A
AMB5
AMB6
AMB7
AMB8D
AMB9D
AMB10D
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AMB11D
AMB12D
AOB1
AOB2
AOB3
ARP1A
ARP2
ARP4
ASB1A
ASB4
ASB6A
ASB9
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BGO7D
BGO8D
BGO16D
BGO18D
BGO20D
BGO23D
BGO36D
BGO39D
BGX9D
BRR2D
CBR1D
CCB1
CCB2
CCB3
CCB4
CMP8
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CMP15C
CRP1
CSA1
CSA2
CSA3
CSA4
CSB1A
CSB3A
CSB4A
CSB5A
CSR1
CSR3
CSR4
DBP1
DBP3
DBP4
DOB2
DOB3
DOB4
FAC4
FNB4
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FSB111D
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FSB116D
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FSB123D
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HAC4
HAP1
HCA1
HCA2
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HCA4
HCB2
HCB3
HCB4
HET2D
HET3D
HET4D
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HSB70
HSB71
HSB83D
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KRP4
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LCO4
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LFW32
LFW34
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LRP2
LSB1
LSB2
LSB3
LSB4
MCB2
MCB4
MCB6
MSB1D
MSB2D
MSB3D
MSB4D
MSB5A
MSB6A
MSB7A
MSB8A
MSB9C
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MSB15D
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MSB49D
MSB50D
MSB51D
MSB52D
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MSB54D
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MSB56D
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MSB59D

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MSB77D
MSB82D
MSB83D
MSB85D
NBG1
PRP2
PSB1A
PSB2A
PSB3A
PSB4A
PSB5A
PSB6A
PSB7A
RAC1
RAC2
RAC3
RAC4
RSE10
SBG2
SBG3
SRW1
SRW2
SRW4
SRW5
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SRW12C
SRW13C
SRW14C
SRW15C
SRW16C
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TBG4
TBG5
TBG6
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TNX4D
TNX7D
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TNX9D
TNX10D
TNX11D
TNX12D
XSB1D
XSB2D
XSB3A
XSB4D
YSB1A
ZBG1
ZDT1
ZDT2
ZW9
ZW10
BGO14DR
AMB4D
CSB2A
FSL6D
FSL8D
HSL1D
HSL3D
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HSL4D
HSL8D
HSL7D
HSL5D
FSL7D
FSL3D
FSL4D
FSL5D
ASB2AR
ASB3AR
ASB5AR
MSB87C
MSB88D
LAC5DU
LAC6DU
LAC7DU
LAC8DU
LCO8DU
LFW71D
HIW2D
HAA1D
HAA2D
HAA3D
HAA4D
BRR8DR
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KCB7
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LFW75D
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AMB15D
AMB16D
CMP10D
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CMP14D
CMP30D
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CMP32D
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DOB10
DOB14
CRP7D
CRP8D
CRP9D
MCB11D
MCB13D
ABP9D
ABP10D
RSP1D
RBW1D
RBW2D
BGO12DR
BGO3DR
KRP6
MSB78DR
KRP7

Iron

ACB2A
ACB3A
ACB4A
AMB7
AMB9D
AMB10D
AMB11D
AMB12D
AOB2
AOB3
ARP1A
ASB1A
ASB6A
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BG96
BG103
BG110
BG122
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BGO6D
BGO7D
BGO8D
BGO9D
BGX3D
BGX4D
BRD2
BRD5D
CCB1
CCB4
CMP14C
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CSA3
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CSD12D
CSD13D
DOB4
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FSB78
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FSB92D
FSB93D
FSB95DR
FSB99D
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FSB109D
FSB113D
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FSB122D
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HSB137D
HSB138D
HSB146D
HSB149D
HWS1A
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IDB6
IDB7
IDB8
IDP4
IDP5
IDP6
IDP7
IDP8
IDQ6
IDQ7
IDQ9
IDQ10
IDQ12
KAC1
KAC3
KAC5
KRP2
KRP4
KSS3D
LAC1
LAC2
LAC3
LCO1
LCO3
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LFW26
LFW27
LFW29
LFW30
LFW31
LFW33
LFW42
LFW43D
LFW56D
LSB1
MSB1D
MSB4D
MSB5A
MSB8A
MSB9C
MSB11F
MSB13D
MSB17D
MSB21C
MSB24
MSB26

MSB27
MSB28
MSB31C
MSB34C
MSB38D
MSB47D
MSB49D
MSB50D
MSB52D
MSB54D
MSB55D
MSB56D
MSB57D
MSB58D
MSB59D
MSB60D
MSB61D
MSB62D
MSB63D
MSB64D
MSB65D
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MSB82D
MSB83D
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PSS2D
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SCA4A
SRW2
SRW4
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SRW6
SRW8
SRW9
SRW10
SRW11
SRW12C
SRW13C
SRW14C
SRW15C
SRW16C
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TBG3
TBG4
TBG6
TBG7
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TNX12D
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XSB2D
XSB3A
XSB4D
YSB2A
ZBG1
ZBG2
BGX1D
BGX6D
BGX7D
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ASB3AR
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LCO8DU
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DOB9
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TNX16D
BGO3DR
TRW2
TRW3
TRW4

Manganese

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AOB2
ARP2
ARP3
ARP4
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BG101
BG103
BG104
BG108
BG109
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BGO3D
BGO6D
BGO8D
BGO12D
BGO16D
BGO21D
BGO23D
BGO24D
BGO26D
BGO34D
BGO35D
BGO36D
BGO39D
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BGX4D
BGX12D
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BRD2
BRD3
BRD5D
BRR2D
BRR3D
BRR4D
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CBR2D
CCB1
CCB2
CCB3
CCB4
CDB1
CDB2
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CMP10
CMP11
CMP13
CMP14C
CMP15C
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CSA3
CSB1A
CSB4A
CSB6A
CSD1D
CSD2D
CSD8D
CSD9D
CSO1
CSR1
CSR3
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DCB3A
DOB3
DOB4
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FAL1
FCA16A
FCA19D
FCB3
FCB4
FCB5
FET1D
FET2D
FET4D
FNB1
FNB4
FSB76
FSB109D
FSB122D
GBW1
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HCA1
HCA4
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HET3D
HET4D
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HSB117D
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HSB152D
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KSS3D
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LSB4
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MSB7A

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PSB6A
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PSS3D
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SRW12C
SRW14C
SRW15C
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TNX7D
TNX8D
TNX9D
TNX11D
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XSB4D
YSB2A
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ZBG2
BGO49D
AMB4D
K301P
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KRB18D
KRB16D
NPM19A
BGO44D
YSC2D
BGX8DR
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HSL8D
HSL5D
ASB3AR
MSB88D
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LAC7DU
LAC8DU
LCO8DU
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FAB3
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HAA4D
CBR4D
BRR8DR
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LFW75D
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CMP14D
CMP32C
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LDB4
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PDB5
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TNX19D
TNX20D
TNX22D
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CRP8D
CRP9D
MCB11D
BGO12DR
BGO11DR
BGO3DR
KSB5D
LFW41R
TRW4

Tin

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AMB7
AMB8D
AMB9D
AMB10D
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AOB2
AOB3
ARP1A
ARP2
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BGO24D
BGO26D
BGO27D
BGO30D
BGO31D
BGO32D
BGO34D
BGO35D
BGO36D
BGO37D
BGO38D
BGO39D
BGO45D
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DOB4
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FSB95DR
FSB97D
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FSS2D
FSS3D
FSS4D
HAC2
HAC4
HAP1
HCA1
HCA2
HCA3
HCA4
HCB2
HCB3
HCB4
HET2D
HET3D
HET4D
HMD2D
HMD4D
HR812
HSB65
HSB66
HSB67
HSB68
HSB69
HSB71
HSB83D
HSB84D
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HSB100D
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HSB103D
HSB104D
HSB105D
HSB106D
HSB107D
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HSB109D
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HSB111E
HSB112E
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HSB115D
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HSB150D
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HSB152D
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HTF7
HTF8
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HTF18
HTF19
HTF20
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HTF23
HTF24
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KRP2
LFW32
LFW34
LFW43D
MSB1D
MSB2D
MSB3D
MSB4D
MSB5A
MSB6A
MSB7A
MSB8A
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MSB58D
MSB59D
MSB60D
MSB62D
MSB63D
MSB64D
SBG2
SBG3
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SRW16C
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TNX11D
TNX12D
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XSB2D
XSB3A
XSB4D
ZDT1
ZDT2
ZW9
ZW10
BGO50D
BGO14DR
BGO49D
BGX1D
BGX6D
BGX7D
AMB4D
BGO44D
BGO17DR
BGX8DR
BGX11D
BGO22DR
FSL6D
FSL8D
HSL1D
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HSL2D
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HSL8D
HSL7D
FSL9D
FSL7D
FSL2D
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FSL4D
FSL5D
ASB3AR
BGO51D
LFW74D
LFW75D
AMB16D
BGO52D
BGO12DR
BGO11DR
BGO3DR

<u>Thallium</u>

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ABP8D
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AMB6
AMB7
AMB8D
AMB9D
AMB10D
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AOB2
AOB3
ARP1A
ARP2
ARP3
ARP4
ASB1A
ASB4
ASB6A
ASB9
BGO5D
BGO7D
BGO8D
BGO16D
BGO18D
BGO20D
BGO23D
BGO36D
BGO39D
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BRR2D
BRR3D
BRR4D
BRR5D
CBR1D
CBR2D
CBR3D
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CCB2
CCB3
CCB4
CMP8
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CMP13
CMP15C
CRP1
CRP4
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CSA2
CSA3
CSA4
CSB1A
CSB3A
CSB4A
CSB5A
CSB6A
CSO1
CSR1
CSR3
CSR4
DBP1
DBP2
DBP3
DBP4
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DCB3A
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DCB10
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DCB13
DCB15
DCB16
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DOB3
DOB4
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FSB108D
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FSB111D
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HSB150D
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KRP4
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MCB6
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MSB63D
MSB64D
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PSB2A
PSB3A
PSB4A
PSB5A
PSB6A
PSB7A
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RAC4
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SBG3
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SRW2
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SRW14C
SRW15C
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TNX9D
TNX10D
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TNX12D
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XSB2D
XSB3A
XSB4D
YSB1A
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AMB4D
CSB2A
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FSB0PD
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HSL3D
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FSL9D
FSL7D
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FSL3D
FSL4D
FSL5D
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CMP31C
CMP32C
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DOB10
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DCB20A
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DCB23A
DCB24A
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DOB14
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CRP5D
CRP7D
CRP8D
CRP9D
MCB11D
MCB13D
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ABP10D
RSP1D
RBW1D
RBW2D
BGO12DR
BGO3DR
KRP6
KRP7

Vanadium

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AMB9D
AMB10D
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AOB3
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ARP2
ARP3
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BGO4D
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BGO6D
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BGO24D
BGO26D
BGO27D
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BGO31D
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CBR3D
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CCB3
CCB4
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CMP13
CMP15C
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CRP4
CSA1
CSA2
CSA3
CSA4
CSB1A
CSB3A

CSB4A
CSB5A
CSO1
CSR1
CSR3
CSR4
DBP1
DBP2
DBP3
DBP4
DCB1A
DCB2A
DCB3A
DCB4A
DCB5A
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DCB7
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HCB4
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HMD3D
HMD4D
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HSB152D
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HTF19
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MCB6
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MSB2D
MSB3D
MSB4D
MSB5A
MSB6A
MSB7A
MSB8A
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MSB58D
MSB59D
MSB60D
MSB63D
MSB64D
NBG1
PRP2
PSB1A
PSB2A
PSB3A
PSB4A
PSB5A
PSB6A
PSB7A
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RAC2
RAC3
RAC4
RSE10
SBG2
SBG3
SRW1
SRW2
SRW4
SRW5
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SRW14C
SRW15C
SRW16C
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TNX9D
TNX10D
TNX11D
TNX12D
XSB1D
XSB2D
XSB3A
XSB4D
YSB1A

ZBG1
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ZW9
ZW10
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BGO29D
BGO14DR
BGO49D
BGX1D
BGX6D
BGX7D
AMB4D
CSB2A
BGO44D
BGO17DR
BGX8DR
BGX11D
FSB121DR
FSB0PD
FSL8D
HSL1D
HSL3D
HSL2D
HSL4D
HSL8D
HSL5D
FSL9D
FSL4D
FSL5D
ASB2AR
ASB3AR
ASB5AR
FNB5
LAC5DU
LAC6DU
LAC7DU
LAC8DU
LCO8DU
LFW63D
LFW66D
LFW67D
LFW68D
LFW69D
LFW70D
LFW71D
LFW72D
HAA1D
HAA2D
HAA4D
HAA6D
BRR8DR
BGO51D
KCB6
KCB7
LFW74D
LFW75D
AMB16D
CMP10D
CMP11D
CMP14D
CMP30D
CMP31C
CMP32C
CMP32D
DOB9
BGO52D
DCB17A
DCB18A
DCB19A
DCB20A
DCB21A
DCB22A
DCB23A
DCB24A
DOB14
CRP7D
CRP8D
CRP9D
MCB11D
MCB13D
ABP9D
ABP10D
RSP1D
RBW1D
RBW2D
BGO12DR
BGO11DR
BGO3DR
KRP6
KRP7

APPENDIX J. SRS (SITEWIDE) BACKGROUND WELLS THROUGH CLUSTERING APPROACH

Nitrate as nitrogen

ASB9
DBP4
DOB3
FAC3
FAC6
FAC8
FSS1D
HAC2
HMD2D
HMD3D
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HSB131D
HSB140D
HSB141D
KAC2
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KSS3D
LAC4
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LFW8
LFW10A
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LFW36
LFW37
LFW38
LFW39
LFW40
LFW41
LFW42
LFW46D
LFW47D
LFW48D
LFW57D
LFW58D
LFW59D
LFW60D
LFW61D
PAC2
PAC5
PAC6
PSS3D
TNX12D
FBP5D
FBP9D
FBP13D
LAC8DU
LFW63D
LFW66D
LFW67D
LFW68D
LFW69D
LFW70D
LFW71D
LFW72D
FAB2
FAB3
HAA1D
HAA2D
DOB7
DOB8
TNX23D

pH

AC3B
ACB1A
AMB7
AMB10DD
AMB11D
AMB12D
BGO12D
BGO16D
BGO23D
BGO24D
BGO28D
BGO34D
BGO37D
BGX4D
BGX10D
BRR3D
BRR4D
CMP13
CMP14C
CMP15C
DOB1
FAC3
FAC6
FAL2
FCA9D
FCA10D
FCA16A
FCA16D
FCA19D
FCB3
FSB106D
FSB109D
FSS1D
FSS2D
FTF9
FTF12
FTF13
FTF21
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FTF25A
FTF26
FTF27
HAP1
HCA2
HCA3
HCA4
HMD2D
HMD4D
HSB138D
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HTF23
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HXB5D
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KAC3
KSS3D
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LCO4
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MSB20C
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MSB46C
MSB48D
MSB49D
MSB50D
MSB52D
MSB62D
MSB64D
MSB67D
NBG3
PAC2
PAC3
PAC5
PAC6
RDB2D
RDB3D
RSC5
RSC9
RSC10
TBG7
TNX1D
TNX12D
YSB1A
YSB3A
ZDT1
BGO50D
BGX1D
BGX6D
BGX7D
BGX8DR
FSL2D
ASB2AR
ASB3AR
FBP9D
MSB87C
LAC5DU
LAC6DU
LAC7DU
FAB1
FAB2
FAB3
FAB4
HAA3D
CMP10D
CMP14D
CMP30D
CMP32C
KDB4
KDB5
LDB3
TNX17D
CRP3D
CRP9D

Tritium

ABP3
ACB2A
AOB1
AOB2
ARP1A
ARP2
ARP3
ARP4
ASB1A
ASB4
ASB6A
BGO26D
BRD1
BRD2
BRD5D
CBR1D
CCB2
CCB4
CMP12
CMP13
CMP15C
CSA3
CSA4
CSD9D
DBP1
DBP2
DBP3
DBP4
DCB1A
DCB2A
DCB3A
DCB5A
DCB6
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DCB13
DCB15
DOB1
DOB2
DOB4
FAC3
FAC4
FAC6
FAC7
FAL1
FAL2
FCA9D
FCA10A
FCA16A

FCA19D
FCB4
FET2D
FNB4
FSS4D
FTF3
FTF4
FTF9
FTF17
FTF20
HWS2
KAC5
KAC6
KRP3
KSS2D
LAC1
LAC4
LCO3
LDB2
LFW6
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LFW19
LFW20
LFW22
LFW23
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LFW27
LFW29
LFW33
LFW35
LFW41
LFW43D
LFW44D
LFW46D
LRP1
LRP2
LRP3
MCB5
MCB6
MSB5A
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MSB33
MSB34C
MSB38D
MSB41D
MSB42D
MSB50D
MSB53D
MSB67D
MSB70D
MSB74D
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MSB85D
PAC2
PAC3
PAC5
PAC6
PCB1A
PCB2A
RAC1
RAC3
RAC4
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RDB1D
RDB2D
RDB3D
RRP1
RRP2
RRP3
RSA7
RSA8
RSA9
RSA10
RSB7
RSB8
RSC2
RSC3
RSC4
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SRW15C
SRW16C
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TBG4
TNX1D
TNX2D
TNX3D
TNX4D
TNX6D
TNX7D
TNX8D
TNX9D
TNX11D
TNX12D
XSB2D
XSB4D
YSB2A
YSB3A
YSB4A
ZW3
ZW6
DBP5
ASB2AR
ASB3AR
ASB5AR
FBP6D
FBP9D
FBP13D
MSB87C
MSB88D
LAC5DU
LAC6DU
LAC8DU
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LFW70D
LFW72D
FAB3
KCB5
KCB6
LFW74D
LFW75D
AMB15D
AMB16D
CMP14D
CMP30D
CMP31C
CMP32C
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TNX14D
TNX15D
TNX16D
TNX17D
TNX18D
TNX19D
TNX21D
TNX22D
FST1D
CRP8D
MCB11D
MCB13D
ABP9D
ABP10D
TNX23D
TNX24D
TNX26D
LFW6R
LFW36R
TRW4

Aluminum

ABP3
AC2B
AC3B
ACB1A
ACB2A
ACB3A
AMB7
AMB8D
AMB9D
AMB10D
AMB10DD
AMB11D
AMB12D
AOB1
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ARP1A
ARP2
ARP4
ASB1A
ASB6A
ASB9
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BG96
BG101
BG103
BG108
BG109
BG122
BGO2D
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BGO7D
BGO8D
BGO9D
BGO10DR
BGO11D
BGO12D
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BGO20D
BGO21D
BGO26D
BGO31D
BGO37D
BGO45D
BGX4D
BGX12D
BRD1
BRD2
BRD5D
BRR1D
BRR2D
BRR4D
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CBR3D
CCB1
CCB2
CCB3
CCB4
CDB2
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CMP10
CMP11
CMP14C
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CRP4
CSA1
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CSA4
CSB4A
CSB6A
CSD2D
CSD4D
CSD8D
CSD9D
CSD10D
CSD11D
CSD12D
CSD13D
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CSR2
CSR3
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DCB16
DOB1
DOB2
DOB4
FAC4
FAL1
FCA16A
FCB2
FCB4
FCB5
FCB6
FET2D
FET3D
FET4D

FSB99D
FSB106D
FSB109D
FSB111D
FSB113D
FSB114D
FSB118D
FSB120D
FSB122D
FSB123D
GBW1
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HAC2
HAC3
HAC4
HAP1
HCA2
HCA3
HET3D
HMD3D
HR812
HSB65
HSB70
HSB71
HSB83D
HSB100D
HSB107D
HSB110D
HSB117D
HSB125D
HSB130D
HSB131D
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HSB137D
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HSB143D
HSB149D
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LFW41
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LFW43D
LFW44D
LFW45D
LFW46D
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LFW61D
LRP1
LRP2
LRP3
LSB1
LSB3
LSB4
MCB4
MCB6
MSB1D
MSB2D
MSB5A
MSB7A
MSB8A
MSB13D
MSB15D
MSB17D
MSB18C
MSB21C
MSB24
MSB26
MSB27
MSB28
MSB30C
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NBG5
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PAC3
PAC4
PRP4
PSB1A
PSB2A
PSB3A
PSB4A
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PSB6A
PSB7A
PSS2D
RAC2
RAC3
SBG2
SBG3
SCA2
SCA3A
SCA4
SCA4A
SRW1
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SRW4
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SRW8
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SRW10
SRW11
SRW12C
SRW13C
SRW14C
SRW15C
SRW16C
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TBG7
TNX2D
TNX5D
TNX6D
TNX7D
TNX8D
TNX9D
TNX11D
TNX12D
XSB3A
XSB4D
YSB1A
ZDT2
ZW2
ZW7
ZW9
BGO50D
BGO14DR
BGO49D
BGX1D
BGX6D
BGX7D
AMB4D
KRB17D
KRB19D
KRB16D
NPM34A
BGO17DR
FSL8D
HSL3D
HSL2D
HSL8D
ASB2AR
ASB3AR
MSB88D
BRR6D
LAC6DU
LAC8DU
LCO8DU
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LFW68D
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LFW71D
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HIW2D
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BGO51D
LFW74D
LFW75D
CMP31C
PDB4
DOB7
DOB9
DOB10
BGO52D
TRW1
TNX17D
TNX19D
TNX20D
DOB12
CRP5D
CRP8D
CRP9D
TNX24D
BGO12DR
BGO11DR
BGO3DR
LFW6R
LFW8R
LFW36R
LFW41R
TRW2
TRW3
TRW4

Iron

ABP3
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ACB3A
ACB4A
AMB5
AMB7
AMB9D
AMB10D
AMB11D
AMB12D
AOB2
AOB3
ARP1A
ARP2
ARP4
ASB1A
ASB4
ASB6A
ASB9
BG61
BG92
BG93
BG96
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BG104
BG109
BG110
BG122
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BGO3D
BGO4D
BGO5D
BGO6D
BGO7D
BGO8D
BGO9D
BGO10DR
BGO11D
BGO12D
BGO15D
BGO16D
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BGO21D
BGO24D
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BGO37D
BGO39D
BGO40D
BGO45D
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BGX4D
BGX5D
BGX9D
BGX12D
BRD1
BRD2
BRD5D
BRR4D
CBR1D
CBR2D
CBR3D
CCB1
CCB4
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CMP11
CMP14C
CMP15C
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CRP4
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CSB5A
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CSD4D
CSD8D
CSD9D
CSD10D
CSD11D
CSD12D
CSD13D
CSO1
CSR3
CSR4
DBP1
DCB3A
DCB4A
DOB4
FAC4
FAL1
FCA2D
FCA10D
FCA16A
FCA16D
FCB5
FCB6
FET1D
FET2D
FET3D
FET4D
FNB1
FNB2
FNB4
FSB76
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FSB79
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FSB91D
FSB92D
FSB93D
FSB95DR
FSB99D
FSB107D
FSB108D
FSB109D
FSB111D
FSB113D
FSB114D
FSB117D
FSB118D
FSB120D
FSB122D
FSB123D
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HCA2
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HET2D
HET3D
HMD2D
HMD3D
HMD4D
HSB65
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HSB71
HSB83D
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HSB86D
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HSB104D
HSB105D
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HSB107D
HSB108D
HSB109D
HSB110D
HSB111E
HSB112E
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HSB132D
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HSB137D
HSB138D
HSB143D
HSB146D
HSB147D
HSB149D
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HXB5D
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KSB2
KSB3
KSS3D
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LAC3
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LFW45D
LFW46D
LFW47D
LFW56D
LFW59D
LFW60D
LRP1
LRP2
LRP3
LSB1
LSB3
MCB4
MCB5
MCB6
MSB1D
MSB2D
MSB4D
MSB5A
MSB8A
MSB9C
MSB11F
MSB13D
MSB17D
MSB18C
MSB21C
MSB24
MSB26
MSB27
MSB28
MSB31C
MSB33
MSB34C
MSB38D
MSB47D
MSB49D
MSB50D
MSB51D
MSB52D
MSB54D
MSB55D
MSB57D

MSB59D
MSB60D
MSB61D
MSB62D
MSB63D
MSB64D
MSB65D
MSB67D
MSB69D
MSB70D
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MSB77D
MSB82D
MSB83D
NBG1
NBG4
NBG5
NPM2
NPM3
PAC1
PCB2A
PCB4A
PRP1A
PSB1A
PSB2A
PSB7A
PSS2D
RAC2
RAC3
RRP1
RRP2
RRP4
RSA8
SCA2
SCA4A
SRW1
SRW2
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SRW11
SRW12C
SRW13C
SRW14C
SRW15C
SRW16C
TBG1
TBG3
TBG4
TBG6
TBG7
TNX1D
TNX2D
TNX7D
TNX12D
XSB1D
XSB2D
XSB3A
XSB4D
YSB2A
ZBG1
ZBG2
ZDT1
BGO14DR
BGO49D
BGX1D
BGX6D
BGX7D
AMB4D
KRB18D
KRB19D
KRB16D
KSM1D
NPM19A
BGO17DR
FSB121DR
FSB0PD
FSL6D
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HSL1D
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FSL2D
DBP5
FSL4D
FSL5D
ASB2AR
ASB3AR
MSB88D
FNB5
LAC6DU
LAC8DU
LCO8DU
LFW63D
LFW66D
LFW67D
LFW68D
LFW70D
LFW72D
HIW2D
HAA1D
HAA2D
HAA4D
BRR8DR
BGO51D
CMP31C
CMP32C
PDB4
DOB7
DOB9
DOB10
BGO52D
TRW1
TNX13D
TNX14D
TNX15D
TNX16D
TNX18D
TNX20D
TNX22D
DOB12
CRP5D
CRP8D
CRP9D
TNX24D
BGO12DR
BGO11DR
BGO3DR
LFW6R
LFW41R
TRW2
TRW3
TRW4

Manganese

ABP3
ABP8D
ACB1A
AMB5
AMB7
AMB9D
AMB12D
AOB1
AOB2
ARP2
ARP3
ARP4
ASB1A
ASB4
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BG108
BG109
BGO2D
BGO3D
BGO6D
BGO8D
BGO12D
BGO16D
BGO21D
BGO23D
BGO24D
BGO26D
BGO32D
BGO34D
BGO35D
BGO36D
BGO39D
BGX3D
BGX4D
BGX12D
BRD1
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CBR1D
CBR2D
CCB1
CCB2
CCB3
CCB4
CDB1
CDB2
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CMP11
CMP12
CMP13
CMP14C
CMP15C
CRP1
CSA1
CSA3
CSB1A
CSB4A
CSB6A
CSD1D
CSD2D
CSD8D
CSD9D
CSO1
CSR1
CSR3
DBP1
DCB2A
DCB3A
DCB8
DOB3
DOB4
FAC6
FAL1
FCA10D
FCA16A
FCA19D
FCB3
FCB4
FCB5
FET1D
FET2D
FET4D
FNB1
FNB4
FSB76
FSB109D
FSB113D
FSB115D
FSB120D
FSB122D
FTF21
HAC2
HCA1
HCA4
HET2D
HET3D
HET4D
HSB65
HSB66
HSB70
HSB71
HSB84D
HSB100D
HSB101D
HSB111E
HSB117D
HSB126D
HSB130D
HSB131D
HSB135D
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HSB147D
HSB149D
HSB151D
HSB152D
HSS3D
HTF8
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HTF24
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HTF26
HTF28
HTF32
HWS2

IDB4
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LFW56D
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LFW60D
LRP2
LRP3
LSB2
LSB4
MCB2
MCB4
MCB5
MCB6
MGA36
MGC36
MSB1D
MSB6A
MSB7A
MSB11F
MSB13D
MSB14C
MSB15C
MSB15D
MSB16C
MSB17D
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MSB26
MSB31C
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MSB64D
MSB65D
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MSB74D
MSB77D
MSB82D
MSB83D
MSB85D
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NBG5
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PAC1
PAC4
PRP1A
PRP2
PSB3A
PSB4A
PSB5A
PSB6A
PSS2D
PSS3D
RAC1
RAC3
RAC4
RSA7
RSA8
RSA9
RSA10
RSB7
RSD3
RSE1B
SCA2
SCA4
SCA5
SRW1
SRW2
SRW4
SRW5
SRW6
SRW7
SRW8
SRW9
SRW10
SRW11
SRW12C
SRW14C
SRW15C
TBG5
TNX4D
TNX5D
TNX6D
TNX7D
TNX8D
TNX9D
TNX11D
XSB1D
XSB4D
YSB2A
YSB3A
ZBG1
ZBG2
ZDT1
BGO49D
AMB4D
K301P
KRB17D
KRB18D
KRB16D
NPM19A
BGO44D
BGX8DR
BGX11D
HSL4D
HSL8D
HSL5D
FSL3D
ASB3AR
MSB88D
LAC5DU
LAC6DU
LAC7DU
LAC8DU
LCO8DU
LFW63D
LFW67D
LFW68D
LFW70D
LFW71D
LFW72D
HIW2D
FAB3
HAA1D
HAA2D
HAA3D
HAA4D
BRR8DR
LFW74D
LFW75D
AMB14D
AMB16D
CMP11D
CMP32C
KDB4
LDB4
PDB4
PDB5
DOB9
DOB10
BGO52D
TNX13D
TNX14D
TNX18D
TNX19D
TNX20D
CRP5D
CRP8D
CRP9D
BGO12DR
BGO11DR
BGO3DR
KSB5D
LFW41R
TRW4

APPENDIX K. RESPONSE TO COMMENTS FROM REVIEWS OF THE DRAFT REPORT

K.1. Comments from the CRESP Internal Review Committee

Comments are italicized and indented, and responses appear in normal text.

> *The authors apply a wide variety of statistical techniques to the data set, but there may be a critical flaw in the analysis , which revolves around a basic assumption of the modeling effort: the methods used assume that some relatively large number of wells in the data set are likely to be uncontaminated, and that the job of the analysis is to weed out the contaminated ones from the uncontaminated set; however, it may be argued that the study should be required to prove that a well belongs in the uncontaminated group, not that it does not belong in this group. In this way, the distribution of concentrations in uncontaminated wells is likely have a central tendency that is lower, thereby lowering the threshold for a finding that a particular well is uncontaminated, or that a well's water quality has been successfully reduced to the baseline level. Such a perspective would be far more protective of public health than the point of view assumed by the authors of this study.*

Based on the methodology used by this study, there is no *a priori* reason to assume that the central tendency of concentrations in uncontaminated wells would be lower if the analysis were to include a well in the uncontaminated group, rather than excluding it from the contaminated group. The regression-based approach has an explicit step that checks for the central tendency of uncontaminated wells (wells whose median value of concentrations is higher than the group median value of concentrations are excluded). The clustering approach divides the wells into two groups, so the issue of including or excluding a well from a group does not arise at all.

> *The inclusion of lists of Tables and Figures would be helpful.*

Lists of tables and figures have been included in the revised manuscript.

> *"US EPA Region IV", "SCDHEC", and "USGS" should be defined.*

Full forms of USEPA, SCDHEC and USGS have been included.

> *Page iii, 1st paragraph, lines 4-6: the statement that "The site is relatively flat and slopes southeastward…." May cause problems with interpretation, in that the western part of the site drains largely to the southwest, its surface waters feeding tributaries of the Savannah River, which forms its southwestern boundary.*

The phrase “and slopes southwestwards” was deleted to prevent problems of interpretation.

> *Page iii, 2nd paragraph: the text refers to “seventeen COPCs in groundwater” but only 15 are identified. Later in the report, nitrate, nitrite, and vanadium are included as COPCs, but strontium-90 appears to be dropped in many tabulations, making it difficult to interpret the statements about the data.*
> *Page 1, 1st paragraph, lines 3-5: this sentence is the same as that appearing on page iii, 1st paragraph (see above comment).*
> *Page 1, 4th paragraph, lines 3-5: the text refers to “sixteen” constituents, but only 15 are identified.*

16 COPCs are identified, and a reason is given for exclusion of strontium-90 from further analysis.

> *Page iii, 2nd paragraph, line 7; “was” should be changed to “were”.*
> *Page iii, 3rd paragraph, line 8: the first “were” should be changed to “was”.*
> *Page 2, 1st paragraph, line 3: the last “reports” should be deleted.*

Typographical errors were corrected.

> *Page 1, 1st paragraph: Although the surface topography is cited, no information on the volume or directional flow of the groundwater is given, yet a paper focused on groundwater quality might be expected to include information on the sub-surface geology and hydrology.*

A more detailed explanation of the sub-surface hydrogeology is included in the revised report.

> *Page 2, 3rd paragraph: it would be helpful to include a map, referenced here, showing the boundaries of the SRS and the General Separations Area (GSA), since their boundaries are not clear in the maps of Appendix C.*

A revised map is included as Figure 10.

> *Page 2, 3rd paragraph: “low-level” and “high-level” should be hyphenated consistently here and elsewhere.*

Suggested modifications were made.

> *Page 2, last paragraph: why is no reference made to historical data on the sampling of groundwater in the region during the time before development of the SRS plant; or the data reported, for example by Looney et al in the March 1987 publication entitled “Selection of Chemical Constituents and Estimation of Inventories for Environmental Analysis of Savannah River Waste Sites”, which contains on-site well sampling data from the mid-1980s?*

Based on discussions with SRS personnel responsible for maintaining GIMS, including Mr. Looney, a decision was made that the most reliable and consistent measurements were those from 1991 onwards. Data from preceding periods were examined and discarded due to quality control problems arising from inconsistencies in sampling, analysis and reporting of data.

> *Also, although Figures 3 and 4 show domestic wells in Georgia that are used for monitoring tritium, no explanation is given as to why these same wells were not used in COPC analyses to provide a view of the larger off-site area.*

Domestic wells in Georgia were used as "control" wells to evaluate the background level estimates for the SRS. They could not be included in the analysis due to this reason.

> *Page 2, last paragraph, last line: "P" wells are said to be "distributed evenly within SRS", but Figure 1 shows this not to be the case; i.e., 4 are shown in the northern third, 4 in the southern third, and 10 in the middle third of the site.*

The statement was rephrased as "distributed throughout the SRS area" to reflect the spatial distribution of wells more precisely.

> *Page 2, 4th paragraph, line 4: "this" should be changed to "these".*
> *Page 2, 4th paragraph, line 5: "strontium" should be changed to "strontium-90".*

Suggested modifications were made.

> *Page 3: the map in Figure 1 has no legend to identify the features shown, and the maps in Appendix E are not clear in many respects.*

As indicated in the caption accompanying the figure, the figure is originally from Strom and Kabeck (1992). No additional details are available in the original figure. The maps in Appendix E are included as color maps in the final report. The color maps are much more informative than the black and white figures included in the draft report.

> *Pages 4 and 5: the symbol for liter is "L" and should be used consistently.*

Suggested modifications were made.

> *Page 4, Tale 1, title: why is the antiquated unit "Tritium Units" used here?*

"Tritium Units" were converted to *p*Ci/L.

> *Page 4, Table 2 : is the "strontium" stable strontium or strontium-90, and what are the units for this entry? Also, this is the first mention of "vanadium".*

"Strontium" refers to dissolved strontium in ug/L. "Strontium" was changed to "Strontium (dissolved)". Vanadium now appears in the list of 16 COPCs.

> *Page 8, Figure 5: what are the units for the tritium levels?*

*p*Ci/L. Units were added to figure caption.

> *Page 12, 1st paragraph, line 5: "detects" should be changed to "that of non-detects".*

Typographical errors were corrected.

> *Page 12, 1st paragraph, last line: A basic criterion of the multistage methodological approach outlined in Figure 9 is the proportion of non-detects for the COPCs. Although this criterion seems reasonable, the considerable uncertainty involved in the characterization of the non-detects (in situ measurements below MDL, etc.), make this an uncertain criterion, as well. Also, it is puzzling that the methodological framework (presented in Figure 9) is based on the decomposition of a spatio/temporal phenomenon into a purely spatial component (modeled in terms of geostatistical variables) and a purely temporal component (represented by time series). It is not clear that this decomposition is a necessary one. It is usually more meaningful physically to view space and time as an integrated process, and statistical predictions are usually improved thereby. Is there a valid reason for using such a decomposition at this stage of the analysis (e.g., inadequate data sets for an accurate experimental calculation of spatiotemporal variograms, space/time support effects, numerical problems in the solution of large space/time systems of equations, the intention to include a composite space/time analysis at a later stage in the investigation, etc.)?*

This issue is addressed in the report. This study is interested in all contamination, past or present. It is immaterial whether a plume passed through a well, is approaching a well, or is currently captured by a well. In that sense, the temporal dimension is required just for the identification of trends. Beyond that, temporal and spatial trends can be treated separately, which is why spatial kriging was used instead of spatiotemporal kriging. The two methods are insensitive to the use of proportion of non-detects as a criterion because the proportions are so widely and clearly separated.

> *Also, although Figure 9 is very useful, it does not include the step of removing all wells from the <20% detect group which have three detects in a row.*

The omission was rectified.

> *Page 12, 2nd paragraph, line 4: "was" should be inserted after "wells".*
> *Page 12, 3rd paragraph, line 2: the second "were" should be changed to "was".*

Typographical errors were corrected.

> *Page 13, Figure 10: since the location of the observation points needs to be visualized clearly if kriging is to be performed, this figure is important and should be more legible.*

Figure 10 has been revised and enlarged.

> *Furthermore, even a cursory look at the map in this figure indicates that the wells are rather clustered in space, so that the observations from these wells are likely to be autocorrelated over space. One would, therefore, expect spatial dependency in the data. In technical terms this spatial dependency appears as a non-diagonal variance-covariance matrix. Hence, before attempting any kriging or other geostatistical technique, it would have been advisable to examine the spatial dependency in the data thoroughly, since the results obtained from any one of the available kriging methods will depend heavily on the variance-covariance matrix, as evident from examination of the estimators for any kriging weights.. An examination of spatial dependency requires the development of a semi-variogram. Although spatial dependency can also be examined with a covariogram, a semi-variogram is preferred because of its robustness to outliers. The development of such a semi-variogram includes an analysis of spatial dependency in various directions over space (testing for anisotropy). Before examining the second-order effects (spatial dependency), as described above, efforts should be made to visualize the presence of first-order effects, otherwise known as a global trend over space. The presence of such a trend should point in the direction of using universal, as opposed to ordinary, kriging.. These methods are now available within the Spatial Statoistics module of S-Plus, a package apparently familiar to the authors of the report. Also, in reporting kriging results, it is important to produce a surface of standard errors. Typically, such errors are high over areas with few observations, providing an idea of the confidence of kriging estimates.*

This study does not have a primary goal of analyzing or mapping the spatiotemporal distribution of concentrations of COPCs, nor does it aim to predict future concentrations. Spatial mapping of concentrations is but one component of one approach (out of two) used to identify unimpacted wells. The simple application of the mapping method should be viewed in this context. Since kriging is only one filtering stage in the methodology, the use of a simple spatial mapping method is considered adequate for excluding wells in obviously contaminated areas. Spatial trends would certainly have an influence on the kriging results, so the analysis now uses a kriging algorithm based on the theory of Spatial Random Fields under the intrinsic hypothesis, instead of Ordinary Kriging. Intrinsic Kriging can be used when spatial trends may or may not be present. The algorithm computes a polynomial spatial covariance for a local neighborhood around the point of spatial estimation, so it accounts for any regional variance in the spatial structure represented by the measurements. A cross-validation algorithm incorporated into the kriging computer code computes optimum orders of spatial intrinsity, and the parameters for the local generalized spatial covariance are estimated on the basis of the spatial pattern of data within the local neighborhood. Details of the intrinsic kriging method are included in the revised report.

> *Page 14 et seq: In the identification of measurements that fell below detection limits of the analytical techniques (non-detects), the detection process itself is considerably uncertain (lab variabilities, measurement errors, different techniques, etc.). Hence the use of a model that would provide a systematic quantification of the uncertainty in the detection process might conceivably aid the background analysis. The statistical characteristics of such models are well-characterized, and the models seem to work well in many practical situations. A stochastic measurement model with additive white noise might be a useful option.*

Formulation of a stochastic model requires that repeated measurements are available at the same instant in time and the same location in space. No such data are available for the SRS area. In any case, analysis of measurement certainty; and prediction or modeling of data; are beyond the scope of this study.

> *Page 14, 2nd paragraph: The description of what measurements are included in the analysis is confusing, in that the combined measurements of blank, U, V, and J qualifiers number far more than the "90,000 measurements" that are said to have been considered for analysis.*

The histogram in Figure 11 may have been confusing because it included data from 1986 onwards, while only data from 1992 onwards was used in the study. A revised histogram was included, which has the distribution of qualifiers from 1992 onwards.

> *Page 14, 2nd paragraph, line 5: the second "is" should be changed to "are".*
> *Page 14, 2nd paragraph, line 13: "were" should be changed to "was".*
> *Page 15, 1st paragraph, line 8: "effects" should be changed to "affects".*

Typographical errors were corrected.

> *Page 15, Table 4: "J" is defined as an "estimated quantity" in the table, but the last paragraph on page 15 states that "all J values except estimated values are rejected…".*

This part has been rephrased to make it clearer.

> *Page 15, 1st paragraph, last line: the captions at the bottom of each page in Appendix B do not seem to make sense.*

The captions have been changed.

Page 16, Table 5: what are the units for "strontium", and should the entry be labeled "strontium-90"?
Page 17, Table 6: why is there no entry for strontium in this table?

Strontium-90 was excluded from all analyses because of insufficient data. Table captions have been changed to reflect the exclusion.

Page 17, 1st paragraph: more details about the computation of the 75th percentile should be added, since no time series includes 100 observations; i.e., does the percentile selected correspond to the observation closest to the 75th rank (e.g., in the case of 10 observations, is the 7th closest to the 75th rank selected?) or is it the result of some kind of interpolation between observations?

The selected percentile corresponds to the observation closest to the 25th rank from the highest to the lowest values (i.e. 75th percentile is 3rd highest in case of 10 observations). This clarification has been added to the discussion.

Page 17, 2nd paragraph et seq: The spatial mapping stage of the analysis (preliminary identification of uncontaminated wells) has important consequences for the subsequent stages, and the use of kriging is a well established geostatistical technique for the purpose. Given the spatial non-homogeneity characteristics of the COPC distributions at certain regions of the SRS, however, it is possible that intrinsic kriging, rather than ordinary kriging might have been preferable for use in these regions

Intrinsic kriging is used in the revised study. Please refer to the revised report for details.

The application of kriging is puzzling in other respects, as well:
1) The same covariance model seems to have been used for all constituents, thereby eliminating the main advantage of kriging, which is to account for the pattern of variability of the attribute under study. No information is provided on how the variogram model was chosen, why the range was 2.1 km, or whether any nugget effect is included in the model. The statement (on page 18, lines 4-6) that "an exponential covariance model with a spatial correlation length of approximately 2.1 kilometers was determined to give the best estimates" implies that a cross validation was performed, but the constituents for which the estimates were the "best" and the criterion according to which the judgement was made are not clear.
2) The reason for having used only a single model, rather than several covariance models (different shapes, anisotropic characteristics, generalized functions, etc.) to capture local variations, is not apparent. Might it have been more realistic to have used a set of covariance models with varying correlation ranges in different neighborhoods for each CPOC? It seems surprising that all COPC's would exhibit the same covariance behavior, particularly if there is localized contamination emanating from different

sources for the different COPC's. More information should be provided about how
the variogram was developed, as this is key to the kriging analysis. Also, the maps in Appendix D are unclear, particularly the difference between wells labeled as "baseline" and those labeled as monitoring wells. Were all wells shown used in the kriging analysis?

These comments are addressed by the use of local neighborhoods in the intrinsic kriging algorithm. Please refer to the revised report for details.

3) Having used the same covariance model for all constituents, a log transform of the data to prevent numerical artifacts in kriging was not justified. The kriging matrices depend only on the data configuration and covariance model, not on the observations themselves.

Log-transform of data is more useful for other filtering steps such as regression and detection of trends. Log transformed data were used for kriging just to maintain consistency with other steps. Since kriging estimates depend on the spatial pattern of measurements rather than the magnitude of measurements, data transformations do not impact kriging results. The distance units were rescaled from meters to kilometers to prevent numerical artifacts due to badly conditioned kriging matrices. The relevant paragraph in the report has been rephrased for greater clarity.

4) The separation of areas on the basis of kriged estimates is likely to be sensitive to the definition of the estimation grid. If the grid is very fine, grid nodes will coincide with well locations and the kriged estimates will correspond to the 75th percentile data. Since the mean of the kriged estimates is generally close to the sample mean, this criterion may simply amount to classifying as potentially uncontaminated the 50% of wells with the smallest 75th percentile data.

This comment assumes that the "mixed" probability distribution from the impacted as well as the unimpacted wells will be close to normal or lognormal. This study shows that the wells come from two separate populations, and the initial mixed distribution is close to, but not clearly, bimodal. Consequently, using the upper-half criterion does not amount to a straightforward rejection of half of the wells. The results in Table 9 and Table 13 indicate unambiguously that this is not the case. For example, Table 13 shows that out of the 843 wells measuring aluminum, 512 were excluded based on the kriging step.

5) A comparative analysis of numerical indicators of the kriging could have been helpful in optimal sampling design for the SRS region.

Optimal sampling design is beyond the scope of this study. The study uses available measurements, but is not intended to analyze the sampling strategy employed for monitoring groundwater quality.

6) Also, in the kriging analysis, all wells in the bottom half of the 75th percentile mapping were considered potentially uncontaminated; however, there is no reason to think that one-half of the wells should be uncontaminated and one half contaminated. Why not a 25/75% split, for example? There is an arbitrariness about this assignment that is troubling. Furthermore, once the wells have been split into the two groups, a well that fell into the potentially uncontaminated group could only be eliminated from further consideration as an uncontaminated site if it failed a subsequent hypothesis test. Of course, a failure in a hypothesis test is difficult to obtain; when the test is done at the alpha=0.05 level, for example, the data must be within approximately 2 standard deviations from the expected value

This comment, like comment 4 above, assumes incorrectly that the initial "mixed" distribution is close to normal or lognormal. Observational evidence in the form of summary statistics (percentiles and histograms indicates otherwise. Since the distribution is not normal or lognormal, having a 50-50 split does not amount to filtering out half of the wells, and confidence tests at the alpha=0.05 level do not apply. Results in Table 9 and Table 13 indicate very clearly that far more than half the wells are filtered out by this step. The mixed population of wells made the application of conventional statistical methods impossible, and this study represents an adaptation that accounts for the unique characteristics of the problem of defining background levels when there is no *a priori* information on a "clean" population.

So, a test must have a lot of power in order to allow a rejection, and for those wells which have a small number of time values for the wells (which is certainly the case for some wells based on the graphs presented), the trend tests probably had little power to detect a trend. Similarly, the null hypothesis of the outlier tests are that the points are not outliers; it would take a lot of evidence to deduce that a point was an outlier. Also, if the bulk of the wells still did not belong in "baseline", this test would be unable to detect that – it would only detect those with values far outside of the mean of the set of potentially uncontaminated wells.

The results indicate that several wells were indeed rejected due to the trend tests. Furthermore, if any well had insufficient data, it was not considered for these tests.

Page 18, 3rd paragraph, line2: the text states that the maps in Appendix C refer to SRS, whereas their captions state that they refer to GSA.
Page 18, 4th paragraph, line 7: "were" should be changed to "was".

Typographical errors were corrected.

Page 18, 4th paragraph et seq: the use of the three types of histograms to identify background wells is not adequately explained.
Page 19, 1st paragraph, last line: "Appendix E" should be changed to

"Appendices D and F". Also, it is not clear how the third type of histogram in these appendices ("cumulative percent detects to concentration") is computed nor what its significance is. Obviously, some subjective judgements were made from these histograms, but no explanation is offered. There should be a discussion, COPC by COPC, of how wells were eliminated from the "baseline" pool
based on these histograms. Again, the emphasis should be on putting wells into the baseline pool, not removing contaminated wells from the pool.

These histograms were included for providing additional information. They were not used in any subsequent analysis. The text has been rewritten to reflect this.

In addition, there is an implicit assumption in this methodology that values over the detection limit indicate contamination – the detection limit is essentially the cutoff point for distinguishing contaminated from uncontaminated wells. This is presumably because the authors believe that virtually none of these compounds are naturally occurring, so that any detection of them, excluding the effects of natural variability, indicates contamination. This is an acceptable assumption to make, but it should be justified by science, not by the fact these compounds fell into the largely undetected category.

This assumption derives logically from the preponderant *observed* presence of non-detects; therefore, it does not require mechanistic arguments to support it. In any case, scientific arguments are supposed to explain observed reality. This study does attribute observed reality (a series of consecutive detects in a dataset that is predominantly composed of non-detects) to the presence of contamination, and in that sense, it constitutes science.

Page 19, 3rd paragraph et seq: this section of the report seems to have a better theoretical background that the other sections, in that the determination of background levels is based in this section on the results of statistical tests, instead of on arbitrary decisions regarding the number of consecutive detects or the threshold value for kriged estimates. The use of control charts is more restricting, but the assumption of independence is reasonable if all wells displaying trends have been removed. The assumption of normality cannot be tested for the small number of observations considered in the study. Furthermore, it should be noted that a normal-score transform, as implemented in Gslib, is usually a better alternative than a log-normal transform since it ensures the normality of the final histogram, regardless of the shape of the original histogram.

The log transform was used when the observations span several orders of magnitude. The use of control charts is supported by the heteroscedasticity of the data because any observation that does not fit into the initial probability distribution would be declared "out of control" and rejected.

Also, it would be of practical interest to derive the multi-point distributions of each COPC -- i.e., to obtain the N-variate (N>1) probability distribution that relates the COPC values at N spatial points simultaneously -- rather than a set of N separate univariate distributions each one of which represents the value at a single point.

A multivariate distribution of concentrations for each COPC would be of interest if the data were to be modeled stochastically (for example, by stochastic simulation methods). Such an exercise is beyond the scope of this work.

Although not essential for the report, a brief introductory discussion of the groundwater regime within which the evaluated wells were located would be helpful. Since all of the wells appear to have been in the vadose zone, one wonders whether any of the observed temporal changes in tritium concentrations, as indicated in Figure 12, might have been related to groundwater flow from one contaminated well to another, as opposed to the contamination of each well independently by surface run-off.

A brief discussion of the hydrogeological regime has been included in the revised report. All the wells were located in the water table aquifer. The basic hypothesis is that wells were contaminated by a subsurface plume. Wastes were never injected into the subsurface from wells, so the question of flow from one contaminated well to another does not arise.

Page 19, Figure 12: this figure is illegible.

The revised figure is more legible.

Page 20: The space/time distributions of certain COPCs may be interrelated (cross-effects, etc.), and if this is the case, the statistical analysis could be improved by considering a multivariable (vectorial) framework. In other words, it may be useful to compare the results of the scalar kriging analysis with vector (or co-kriging) analysis simultaneously involving more than one COPC, etc.

This study does not seek to address issues of co-occurrence of different COPCs. Kriging is used as a simple filter, and co-kriging represents an inappropriate level of complexity for the intended objectives of the filtering step.

Page 20, 2nd paragraph, line 13: "were" should be changed to "was".

Typographical error was corrected.

Page 21, 2nd paragraph et seq: The regression analysis suffers from some of the same problems as the kriging analysis. The regression analysis is essentially *two analyses: the first analysis is really independent of the regression and simply says that all remaining wells whose 50th percentile is greater than the 75th percentile for all the measurements are not baseline. That's another judgement – it moves the breakpoint between contaminated and uncontaminated wells further down the set of wells, but really is not supported by any science or even statistical test. Now, since this analysis has excluded a set of points, and is not dependent on the regression, it should have been before the regression line was fit, since the regression will identify wells that are governed by a process different from that for the other wells.*

The approach used in this study is not conventional regression, and should not be confused as such. Conventional regression would assume that the measurements are from one population (ie, the sample is homoscedastic), whereas a basic assumption behind this study is that the data are heteroscedastic. This method is an adaptation of regression analysis, and should be viewed accordingly.

The regression-based filter is now divided into two separate and consecutive steps: in the first step, the wells are filtered by their central tendency, and in the second one, they are filtered by their dispersion characteristics. Section 3.6 describes the revised regression-based method.

In any case, once that regression is performed, the only way a point can be removed is, once again, to fail the 95% test (based on the 95% confidence interval). (Actually, the picture for this regression was surprising, because one would expect the confidence interval line to diverge away from the mean values, but it seems to remain parallel to the fitted line. Perhaps the divergence in this case was too small to see on the scale of the graph). If the well fails this test, then the interpretation can be made that it is unlikely that the 95th percentile has the same relationship to the 50th percentile as the other wells in the data set.

The dashed line is not the 95th percentile confidence interval. It is the line where the 95th percentile of each individual well should lie, if there is a perfect regression fit. This is a vital difference. It also explains why the dashed line does not diverge away from the mean values.

If the assumption is that contaminated wells tend to have more "pulsing" of concentration than background wells, then this is a reasonable separation criterion. However, there is no science presented to explain why this should be so, and one may question it as a characteristic of long-term contaminated wells. (As an aside, using the procedure shown on page 12, figure 13 implies that 30 tritium wells should be excluded based on the regression analysis, but Table 8 says 8 were excluded. Also, one might suppose that the last 5 columns of Table 8 should add up the "total number of wells"
column, but for some COPC's, they do not.)

The "pulsing" phenomenon referred to in this comment is an observed physical fact, so additional scientific explanations are superfluous. This is not an implied characteristic of long-term or short-term contamination. The pulsing occurs because the 95^{th} percentile of concentrations in a well is higher than its expected value. Contamination drives the 95^{th} percentile higher; hence this is a logically sound and physically intuitive separation criterion. The reason why the total number of wells does not add up is explained in the table footnotes.

Page 21, 2nd paragraph, 3rd bullet: "percentiles" should be changed to "percentile".

Typographical error was corrected.

Page 22, 3rd paragraph: as noted in the text, the choice of exclusion parameters is somewhat arbitrary; hence it needs further explanation and justification (see above comments on Section 3.3).

Additional comments have been added in the revised report to reflect the basic assumptions that influenced the choice of this particular approach and the attendant choice of exclusion parameters.

Page22, last paragraph et seq: the technique of using a cluster algorithm to group wells according to the values of several percentiles is appealing, and it would be interesting to know how the percentiles correlate with one another and whether it is necessary to incorporate all the variables in the analysis.

The percentiles appear to be highly correlated with each other (> 0.8). The reviewer is correct in pointing out that the additional information obtained by including several percentiles in the cluster analysis decreases as the correlation between the percentiles increase. However, as long as all pairs of percentiles have correlation coefficients of less than 1, use of all the percentiles will provide more information than if one or more of the percentiles had been left out of the analysis. Perhaps the only definitive answer to the question of how many percentiles are appropriate to include in the cluster analysis is to perform the analysis using an increasing number of percentiles, until the results of the clustering are essentially unchanged.

Because of its simplicity, cluster analysis is used extensively in a variety of applications. In general, the distance between items to be classified is computed on the basis of a set of variables that characterize the items, and then an algorithm is used, which on the basis of of the calculated distance between items will assign them to a number of classes normally defined by the user. Different types of distance measures are available for the purpose (Euclidean, Manhattan, etc.), and the results depend on the combination of distance and algorithm that is chosen. The authors do not explain the why the particular algorithm was used, nor do they discuss the distance that was used. Whether a different combination would have led to different results is open to *question.*

A method that could achieve the same objective cluster analysis but has a more elaborate statistical theory behind it is discriminant analysis. Was this method considered by the authors?

Application of discriminant analysis was considered. However, it could not be applied since an *a priori* classification of "background" and "not background" wells was unavailable.

Also, there are questions that relate to assumptions of the regression model that are obviously violated. The 95th percentile in a distribution represents a value that is always greater than the 50th percentile. This forces all the points in a scatterplot of such a relationship to be in one side of the 45 degree angle line that splits the first quadrant of the XY coordinate system in half.

This comment incorrectly confuses a 1-1 plot with a regression plot. A 1-1 plot would have a 45 degree angle line, but a regression plot is not required to have that slope *per se*. For example, the linear regression given by y = .57x + .5 will have a slope of .57, which corresponds to an angle of 30 degrees to the horizontal.

In most of the scatterplots shown in Appendices D and F, data points occupy almost all their allowable space, indicating the presence of heteroscedasticity. In attempting to correct for this assumption violation, one would resort to the weighted least squares method of estimation, as opposed to ordinary least squares, and it is not clear how such a correction would affect the 95th confidence interval of the regression line and ultimately the obtained classification of wells.

Heteroscedasticity is a basic and implicit assumption in this study, since there are two different populations: one of impacted wells, and one of unimpacted wells. In that sense, this is not a standard application of the regression method. The regression filter employed here rests on principles of linear regression, but it goes beyond the assumption (employed in standard regression plots) of a single, homogeneous population. It should be reiterated that the 95^{th} confidence intervals are not used - the upper dashed line corresponds to "expected" values of 95^{th} percentiles.

A point related to the above is the spatial distribution of the observations. This is known to lead to a non-diagonal variance-covariance matrix, necessitating the use of generalized least squares for the estimation of parameters in regression analysis. Again, the question is whether such a method would affect the results in any substantial way.

The use of intrinsic kriging addresses this issue by using a generalized polynomial covariance. A singular value decomposition solver is used by the algorithm to solve the kriging system of equations.

> *The computation of the discriminatory power of each percentile could improve the understanding of the clustering. Also, the possibility that the results of the cluster analysis could be inserted back into the kriging system to obtain improved maps of the COPC distributions may deserve to be considered.*

As stated previously, this study does not intend to provide maps of spatial distributions of COPCs. Kriging is merely used as one filtering step among many, in one of the two independent approaches (regression-based and clustering). The results from the two approaches are not intermixed because they are intended to provide independent intercomparison.

> *Finally, it should be noted that modern spatiotemporal geostatistics (MSTG) techniques have features that may be serve well at least some of the goals of the SRS study. These features include: 1) rigorously taking into consideration various forms of physical knowledge (hydrogeologic laws, multiple-point statistics, empirical relationships, hard and soft data), thus improving the accuracy and scientific content of space/time mapping; 2) providing the means to avoid the circular problem of empirical geostatistics (i.e., using the data to estimate the covariance models and then using the same data for kriging purposes); 3)MSTG are non-linear estimators, which permit more flexible estimation criteria (e.g., posterior pdf maximization) which are well-defined even for heavy-tailed fields; 4) N-variate (N>1) probability distributions can be calculated.; 5) non-Gaussian laws are automatically incorporated; and 6) by taking into account physical laws, MSTG techniques possess global estimation features.*

The authors are aware of the power of modern spatiotemporal geostatistics, and have employed spatiotemporal random field (STRF) theory for other applications. However, STRF or other MSTG applications were not considered necessary or appropriate for this study for reasons explained previously.

> *Page 24, 1st paragraph et seq: instead of comparing only the 50th and 95th percentiles of the probability distributions yielded by the regression analysis and the cluster analysis, Q-Q plots could be used to compare the whole distribution, over the full range of values, which could be more informative (the plots in Appendix D are not Q-Q plots but are either normal or log-normal probability plots).*

There is no overriding fundamental difference between a Q-Q plot and a probability plot. Q-Q plots typically plot the observed quantiles versus the theoretical quantiles on plain graph paper. This is often referred to as a normal probability plot if the theoretical quantiles are taken from a normal distribution. Sometimes a normal or a log-normal probability plot graphs the observad quantiles versus the corresponding probabilities (1/n, 2/n, 3/n, etc) but on normal or lognormal probability paper. The plots in Appendix D and Appendix F perform the latter and hence the comment by the reviewer. The plots serve essentially the same purpose.

Each point (star) on the Q-Q plots represents the percentiles for an individual well. The purpose for these plots is to identify how closely each well conforms to the overall grouped probability distribution, hence the choice of these particular percentiles.

> *It is not clear why the authors placed more trust in the results provided by the regression approach, on grounds that it allows for the input of expert judgement. Expert judgement is also used to determine the variables included in the cluster analysis.*

The discussions in the revised report have been rephrased to reflect more clearly that results from both methods are given equal importance.

> *Furthermore, the approach adopted in this study was based on a Boolean, or crisp, classification of wells into contaminated and uncontaminated sets. A "fuzzy" classification would have been a more flexible alternative, which would have allowed a probability of contamination to be assigned to each well. The resulting probabilities could then have been used to compute a weighted average of the probability distribution for each well and, in turn, the probability distribution of background concentrations.*

This study is driven by regulatory motivations, where a binary (yes or no) answer is needed for the contamination status of a well. In that sense, a boolean classification of wells is more appropriate. This discussion is added to the report.

As the authors point out, the distribution of concentrations in the baseline wells in the GSA tend to have higher concentrations than those in the SRS. If these wells are all supposed to represent naturally occurring conditions, this is a surprising result. Unless the geology and hydrology in these areas is quite different, the two sets of distributions should not be very different. The likely explanation is that some of the baseline wells of the GSA wells are contaminated with respect to the background wells of the SRS. Using the spirit of the methodology presented here, one might be tempted to conclude that all of the SRS wells are contaminated and all of the GSA wells are uncontaminated.

This comment seems contradictory because it first asserts: "*The likely explanation is that some of the baseline wells of the GSA wells are contaminated with respect to the background wells of the SRS*"; and then goes on to say "*Using the spirit of the methodology presented here, one might be tempted to conclude that all of the SRS wells are contaminated and all of the GSA wells are uncontaminated*".

The study draws from records of operations at the SRS as well as unambiguous observational evidence that the GSA is far more contaminated than the SRS as a whole. The basic distinction between background and baseline wells was made to reflect the presence of elevated and diffuse contamination in the GSA, and the elevated final distribution of concentrations in the baseline wells in GSA is a consequence of the diffuse contamination of the area as a whole. The baseline wells do not in any way represent different natural conditions in the GSA.

> *Page 25, Table 7: the footnotes should be arranged in logical order.*
> *Page 28, Table 9: "cesium"and "strontium"are called for in the title but are missing from the table.*
> *Page 28, Table 10: this table shares the same number with another "Table 10" which appears on page 30. As a result, all the remaining tables in the report are misnumbered, and the references to "Table 10" in the text on pages 28-33 are ambiguous.*

Typographical errors were corrected.

> *Page 29, Figure 16: In comparing the results of the regression and cluster analysis (discussion around Figure 16 and in the Conclusions), it is stated that the results are very similar or consistent. This is a subjective statement, however, and it is not clear how close the two sets have to be to be called "consistent".*

This discussion has been rewritten.

> *Page 30, Table 10: this table should be renumbered as "Table 11", and its footnotes should be arranged in logical order.*
> *Page 31, Table 11: this table should be renumbered as "Table 12".*
> *Page 32, Table 12: this table should be renumbered as "Table 13", and although "cesium" and "strontium" are called for in the title, they are missing from the table.*
> *Page 45, Figure B.3.: are the units for "cesium-137" correct? Should they be in pCi/L?*
> *Page 66, Figure D.3.: are the units for "cesium-137" correct? Should they be in pCi/L?*
> *Page 108, Figure F.3.: are the units for "cesium-137" correct? Should they be in pCi/L?*
> *Appendix K, pages 176-179: in each figure, the proper units for the respective analyte should be used in the figure legend, not "pCi/l or ?g/l", neither of which is appropriate for use in the legend of the figure for pH (on page 177).*

Typographical errors have been corrected.

K.2. Comments from EPA Region 4.

The background groundwater report should provide a discussion concerning the nature of data used. As the study focused on the water table aquifer, a total of 869 wells were used, and overall, about 90,000 measurements were considered for further statistical analysis to determine the background or baseline values of 15 analytes (aluminum, arsenic, cobalt, iron, manganese, mercury, nitrate, selenium, thallium, tin, cesium-137, strontium-90, tritium, uranium-238, and pH). The report utilized groundwater data from separate studies or investigations, including SRS groundwater monitoring data collected from October 1992 to September 1998, the data from USGS investigations (Clarke et al., 1994 and 1996; Leeth et al., 1996), and probably data from Marine (1976). The report needs to present a clear source-list of data used.

The actual analysis used only data collected from SRS groundwater monitoring wells, from October 1992 to September 1998. The rest of the data were used to evaluate the estimated background and baseline probability distributions obtained from the regression-based and cluster analysis approaches.

Statistical analysis of the data was based on large amounts of data. The use of various "system operations" associated with the statistical analysis for each study may be different and therefore is a concern.

The system operations were specific to this study, and are likely to change for a different setting. However, the study identifies and addresses some fundamental problems encountered in addressing the issue of identifying background levels of COPCs. The approach of this study was to have built-in redundancy to ensure that the issue is addressed comprehensively. The multiple steps; as well as two independent approaches outlined in this study; constitute a sufficiently flexible methodology that would be a sound starting point for other studies that seek to identify background levels in different settings.

As a result of the different sources of data obtained to evaluate background conditions in groundwater, the report should address the nature of data used for the statistical analysis, including comparability of the measurements from period to period, and the variables designed in the system operations. Individual investigations typically have specific goals and variables designed in the system. Therefore, large databases may have data collected for different purposes under different investigations (systems) which could result in difficulties in building the statistical model. The model may then be ill suited for: detecting trends over time; for testing any hypothesis about system behavior because the record is not consistent and comparable from period to period; variables that affect the system have not been observed; or, the range of variable has been restricted by the system's operation. Considering the objective of the report is to formulate statistical approaches for defining background or baseline levels of chemicals in *groundwater at SRS by evaluating the existing groundwater monitoring data, a detailed description concerning the nature of data should be included in the report.*

The study initially considered a far longer time period for examining background levels – from 1986 onwards instead of 1992 onwards. However, examination of data revealed inconsistencies in sampling, analysis, and reporting. Consequently, a shorter period from 1992 to 1996 was chosen for the actual analysis, in order to avoid the data inconsistencies that this comment very correctly alludes to. The preprocessing and selection of data used in the study involved extensive preliminary analyses and informal discussions that could not be included in the report because of their exploratory and tentative nature. Some of the histograms that were prepared for the preliminary analysis of COPCs with a high proportion of non-detects are presented as supplemental data in Appendix B, Appendix D, and Appendix F. The data that were selected for the final study were carefully screened for consistency over the entire time period under consideration, to ensure that they were suitable for the filters such as trend detection.

In general, in the background groundwater report's use of the non-detect (ND) values were handled appropriately. The NDs were classified into three categories (≥ 80%, between 50% and 80%, and ≤ 50%). For the proportion of NDs greater than 50%, statistical analysis relied on histograms and Quantile-Quantile plots. For NDs lower than 50%, two statistical approaches, regression and cluster analysis, were used. The cluster analysis was used as an independent means of confirming the results of the regression analysis. However, the use of zero to replace ND values below the limit of detection can result in biased low mean values, particularly for the following five chemicals; aluminum, iron, manganese, nitrate, and tritium, which have greater than 93% of detects (the censored data is less than 7%). For these five chemical, statistical methods, like the trimmed mean and the Winsorized mean, can be used to estimate the mean values. Hill and Dixon (1982) found that a 15% trimmed mean was a "safe" estimator for asymmetric distribution. If more than 15% of the measurements in the sample have been censored, the 15% trimmed mean cannot be computed. In this way, unbiased mean values for the five chemicals could be obtained. Using zero as replacement value for NDs is not the best way to "treat NDs consistently." Chemicals with a high proportion of NDs should not be treated as same as the chemicals with a low proportion of NDs.

The three categories for non-detects broadly follow the guidance provided in EPA (1989), with the exception that the cutoff for the category with a low proportion of non-detects is at 20% instead of the recommended 15%. According to EPA (1989), an acceptable substitution for non-detects is (Method Detection Limit)/2 when the proportion of non-detects is less than 15%. For the six COPCs in this category, all except aluminum had a fraction of non-detects less than 15%, and for aluminum the fraction was only slightly higher at 19% (sitewide). This one exception was considered acceptable for another major reason: percentiles were used in all filtering steps as well as for reporting summary statistics. Percentiles are robust to non-detects since the relative rank of a measurement will not be influenced by the presence of non-detects. An added consideration was that due to changing (but not incompatible) laboratory analysis methods, the estimated "J" flagged measurements were often lower than the MDLs for the same COPC. Discussions with DOE and EPA Region IV staff on this subject led to the consensus that "J" values represent valuable information, and that they should be not be substituted. Use of Winsorized or trimmed statistics would be incompatible with the use of estimated values. The use of percentiles helped resolve this conundrum in a defensible manner.

> Executive Summary. *In the second paragraph, the document states that 17 COPCs in groundwater are being considered. However, the list of those COPCs that directly follows this statement lists only 15 COPCs. The text should be corrected.*
>
> Page 1, Introduction. *The fourth paragraph on this page states that 16 COPCs are considered in this study. However, as outlined previously, only 15 are listed. The text should be corrected.*
>
> Page 1, Section 2. *The document describes the extensive source of data available from the "P" wells and "C" wells. However, listing the number of "P" wells (within SRS) and the number of "C" wells (outside SRS) that were removed by the various screening processes is needed so the reader can determine how many of the wells within SRS and outside of SRS were retained. The most appropriate place for this information is in Section 4: Results.*
>
> Page 12, Section 3.0 . *The text should be corrected from " If the proportion of <u>detects</u> is lower than 50%, ..." , to " If the proportion of <u>non-detects</u> is lower than 50%, ..."*

These comments relate to clarifications; corrections of typographical errors; or other changes that have been incorporated in the revised report.

> Page 18, Section 3.4. *The text states that "all wells reporting measurements for a specific COPC were checked for the presence of three or more consecutive detects. If such consecutive detected measures were observed, the well was rejected as being contaminated. The rest of the wells were considered background." There appears to be a problem with the text. If a well is rejected as being contaminated, then it is not clear how the well can be considered for subsequent analyses. The way the text reads, wells rejected as being contaminated by the specified criteria are not considered to represent background conditions (i.e. "the rest of the wells were considered background"). Since the well is rejected as being contaminated, but not considered background, the status of the well is unclear. The text should be revised for clarification. The use of the term rejected appears to be the problem. Rejected as being contaminated may mean that the well is considered to be contaminated if three consecutive detect*

values were observed. However, the meaning of the statement "the well was rejected as being contaminated" is ambiguous and should be re-written.

The phrase "rejected as being contaminated" is changed to "is considered contaminated and removed from the set of potentially unimpacted wells." This should make it unambiguous.

Page 19, Section 3.4. For cobalt, mercury, tin, and uranium-238, more discussion is needed to explain the rationale for rejecting wells from the upper half of the 75th percentile range in the kriging maps as being known contaminant wells. The report should describe how was this accomplished.

Section 3.5. As a general statement, the term "removed for" that is used throughout this section of the document (i.e., "when a trend was detected for a COPC in a specific well, that well was <u>removed for</u> the set of potential background wells for that COPC") should be changed to "removed from" for clarity.

Page 20, Section 3.5.2. The discussion of the data needs for the Seasonal Kendall Test should state the minimum number of "seasons" that are required for the test. Just a brief discussion, such as Gilbert's (1987) "many years" suggestion is appropriate.

Typographical errors were corrected and discussion was expanded to make this section clearer.

Page 21, Section 3.5.3. *The requirement of independence is crucial for correct application of the Shewart Cumulative Sum chart analysis. The document does recognize this requirement, and states that "for this study, the measurements were at widely separated time intervals and therefore were considered to meet the criterion of independence". However, some additional analyses would help strengthen the assumption of data independence. If data are available, application of the Darcy Equation, as seen in USEPA (1992) page 8-11 would validate independence. If data are unavailable for determining a reasonable sampling frequency using the Darcy Equation, then analyses of serial correlation, or some further defense of the assumption of independence is needed.*

The issue of data independence becomes crucial only for analyses where replicates are present, or where very high frequency sampling methods are used. Both of these conditions are absent in the dataset used in this study. Further analyses would only corroborate this reasonable and justifiable assumption, so additional effort justifying this assumption was not considered necessary.

Section 3.5. *It is not clear in the report whether control charts were modified to handle non-detects as recommended in USEPA (1989) or USEPA (1993). If so, these modifications should be briefly discussed. If no modifications for non-*

detections were conducted, the rationale behind the approach should be discussed / defended.

The control charts handle non-detects as recommended in USEPA (1989).

Page 21, Section 3.5.3. *The document states that the Shewart Cumulative Sum control chart approach is "more robust for the normality (or log-normality) criterion, so the data need not have an exact normal or log-normal distribution". While this is generally a valid statement, the EPA reference (USEPA, 1989) does suggest normality testing / verification as a precursor to the Shewart-Cumulative Sum control chart analysis. A more defensible reason for not testing normality should be given, or normality testing should be conducted.*

Q-Q plots (not included) of intermediate steps revealed that at this stage, the grouped data from filtered wells were sufficiently close to lognormal or normal distributions to permit the use of control charts.

Section 3.7. *This report used the Partitioning Around Mediods (pam) clustering method, as implemented in S-Plus. This method computes a dissimilarity matrix for a provided n x p data matrix and then determines k mediods, where k is determined by the user. Silhouette plots were created as a graphical output for these analyses. While the approach used to determine an optimal clustering size is valid, a discussion is needed to describe how clusters were divided into "background" versus "not background" wells. Many of the silhouettes do not have a clear division between groups. For example, how were those wells in the "grey" area between clusters in Figure F.23 divided into either "background" or "not background". In addition, many of the plots have negative silhouette widths, which generally indicates that these objects are probably placed in the wrong cluster. A discussion is needed to explain how these "questionable" objects were classified.*

The wells were divided into "background" and "non-background" wells based only on the assignment of wells to clusters by the PAM algorithm. The "background" cluster was identified by examining the median concentration of the well at the medoid of each cluster generated using PAM. Only wells in the cluster corresponding to the medoid well with the lowest median concentration was classified as "background" wells.

The vast majority of the silhouette widths of the potentially background wells presented in the silhouette plots are positive, indicating that cluster indicated by the silhouette diagnostic is in accordance with that assigned by the PAM algorithm. However, a small number of wells have silhouette widths that are either negative, or only marginally positive, indicative of cluster assignments that are incorrect or marginally correct, as judged by the silhouette diagnostic. In the revised report, the wells with a negative silhouette width were not considered part of the background cluster. This change has been made in the report text as well.

A detailed discussion on this subject is included in Section 3.7.

Appendix A. *An explanation should be provided as to why there are no decimals on the last 20 UTM coordinates on page 41*.
Appendix B. *The title of Figure B.1 seems to be wrong. The title should be "Aluminum Baseline results for GSA (ug/L).*

The list of water table wells was obtained from Hiergesell, 1998; and is reproduced without modifications. The other typographical error was corrected.