

Appendix A3: Time Series Full Scale Column Influent and Effluent Constituent Concentration Breakthrough Plots

This appendix shows sets of line graphs illustrating effluent concentrations as a function of total treated water volume, If the effluent concentrations approach the influent concentrations, then breakthrough is assumed to have occurred. If the effluent concentrations decrease with use, then performance would be improving with “aging” of the filter media.

Figure A3-1. Breakthrough plots for total aluminum.	5
Figure A3-1. Breakthrough plots for total aluminum (cont.).....	6
Figure A3-2. Breakthrough plots for filtered aluminum.....	7
Figure A3-2. Breakthrough plots for filtered aluminum (cont).	8
Figure A3-3. Breakthrough plots for ammonia nitrogen.	9
Figure A3-3. Breakthrough plots for ammonia nitrogen (cont.).....	10
Figure A3-4. Breakthrough plots for total antimony.	11
Figure A3-4. Breakthrough plots for total antimony (cont.).....	12
Figure A3-5. Breakthrough plots for filtered antimony.....	13
Figure A3-5. Breakthrough plots for filtered antimony (cont.).	14
Figure A3-6. Breakthrough plots for total arsenic.	15
Figure A3-6. Breakthrough plots for total arsenic (cont.).	16
Figure A3-7. Breakthrough plots for filtered arsenic.....	17
Figure A3-7. Breakthrough plots for filtered arsenic (cont.).....	18
Figure A3-8. Breakthrough plots for total boron.	19
Figure A3-8. Breakthrough plots for total boron (cont.).	20
Figure A3-9. Breakthrough plots for filtered boron.....	21
Figure A3-9. Breakthrough plots for filtered boron (cont.).....	22
Figure A3-10. Breakthrough plots for total cadmium.	23
Figure A3-10. Breakthrough plots for total cadmium (cont.).....	24
Figure A3-11. Breakthrough plots for filtered cadmium.	25
Figure A3-11. Breakthrough plots for filtered cadmium (cont.).	26
Figure A3-12. Breakthrough plots for total calcium.....	27
Figure A3-12. Breakthrough plots for total calcium (cont.).	28
Figure A3-13. Breakthrough plots for filtered calcium.	29
Figure A3-13. Breakthrough plots for filtered calcium (cont.).....	30

Figure A3-14. Breakthrough plots for chloride.	31
Figure A3-14. Breakthrough plots for chloride (cont.).....	32
Figure A3-15. Breakthrough plots for total chromium.	33
Figure A3-15. Breakthrough plots for total chromium (cont.).	34
Figure A3-16. Breakthrough plots for filtered chromium.	35
Figure A3-16. Breakthrough plots for filtered chromium (cont.).....	36
Figure A3-17. Breakthrough plots for COD.	37
Figure A3-17. Breakthrough plots for COD (cont.).	38
Figure A3-18. Breakthrough plots for color.	39
Figure A3-18. Breakthrough plots for color (cont.).....	40
Figure A3-19. Breakthrough plots for conductivity.	41
Figure A3-19. Breakthrough plots for conductivity (cont.).....	42
Figure A3-20. Breakthrough plots for total copper.	43
Figure A3-20. Breakthrough plots for total copper (cont.).....	44
Figure A3-21. Breakthrough plots for filtered copper.	45
Figure A3-21. Breakthrough plots for filtered copper (cont.).	46
Figure A3-22. Breakthrough plots for fluoride.	47
Figure A3-22. Breakthrough plots for fluoride (cont.).	48
Figure A3-23. Breakthrough plots for total iron.	49
Figure A3-23. Breakthrough plots for total iron (cont.).	50
Figure A3-24. Breakthrough plots for filtered iron.	51
Figure A3-24. Breakthrough plots for filtered iron (cont.).....	52
Figure A3-25. Breakthrough plots for total lead.....	53
Figure A3-25. Breakthrough plots for total lead (cont.).	54
Figure A3-26. Breakthrough plots for filtered lead.	55
Figure A3-26. Breakthrough plots for filtered lead (cont.).....	56
Figure A3-27. Breakthrough plots for total magnesium.	57
Figure A3-27. Breakthrough plots for total magnesium (cont.).	58
Figure A3-28. Breakthrough plots for filtered magnesium.	59
Figure A3-28. Breakthrough plots for filtered magnesium (cont.).....	60
Figure A3-29. Breakthrough plots for total manganese.....	61
Figure A3-29. Breakthrough plots for total manganese (cont.).....	62
Figure A3-30. Breakthrough plots for filtered manganese.	63
Figure A3-30. Breakthrough plots for filtered manganese (cont.).....	64

Figure A3-31. Breakthrough plots for total nickel.....	65
Figure A3-31. Breakthrough plots for total nickel (cont.).....	66
Figure A3-32. Breakthrough plots for filtered nickel.	67
Figure A3-32. Breakthrough plots for filtered nickel (cont.).....	68
Figure A3-33. Breakthrough plots for nitrate nitrogen.....	69
Figure A3-33. Breakthrough plots for nitrate nitrogen (cont.).	70
Figure A3-34. Breakthrough plots for nitrite nitrogen.....	71
Figure A3-34. Breakthrough plots for nitrite nitrogen (cont.).....	72
Figure A3-35. Breakthrough plots for nitrite plus nitrate nitrogen.....	73
Figure A3-35. Breakthrough plots for nitrite plus nitrate nitrogen (cont.).	74
Figure A3-36. Breakthrough plots for oxidation reduction potential (ORP).....	75
Figure A3-36. Breakthrough plots for oxidation reduction potential (ORP) (cont.).	76
Figure A3-37. Breakthrough plots for pH.....	77
Figure A3-37. Breakthrough plots for pH (cont.).....	78
Figure A3-38. Breakthrough plots for phosphate.	79
Figure A3-38. Breakthrough plots for phosphate (cont.).....	80
Figure A3-39. Breakthrough plots for total potassium.	81
Figure A3-39. Breakthrough plots for total potassium (cont.).....	82
Figure A3-40. Breakthrough plots for filtered potassium.....	83
Figure A3-40. Breakthrough plots for filtered potassium (cont.).....	84
Figure A3-41. Breakthrough plots for total sodium.....	85
Figure A3-41. Breakthrough plots for total sodium (cont.).....	86
Figure A3-42. Breakthrough plots for filtered sodium.	87
Figure A3-42. Breakthrough plots for filtered sodium (cont.).....	88
Figure A3-43. Breakthrough plots for sulfate.....	89
Figure A3-43. Breakthrough plots for sulfate (cont.).	90
Figure A3-44. Breakthrough plots for total suspended solids.	91
Figure A3-44. Breakthrough plots for total suspended solids (cont.).....	92
Figure A3-45. Breakthrough plots for total thallium.	93
Figure A3-45. Breakthrough plots for total thallium (cont.).	94
Figure A3-46. Breakthrough plots for filtered thallium.....	95
Figure A3-46. Breakthrough plots for filtered thallium (cont.).....	96
Figure A3-47. Breakthrough plots for total nitrogen.....	97
Figure A3-47. Breakthrough plots for total nitrogen (cont.).	98

Figure A3-48. Breakthrough plots for total phosphorus.....	99
Figure A3-48. Breakthrough plots for total phosphorus (cont.).....	100
Figure A3-49. Breakthrough plots for UV-254.....	101
Figure A3-49. Breakthrough plots for UV-254 (cont.).....	102
Figure A3-50. Breakthrough plots for total zinc.....	103
Figure A3-50. Breakthrough plots for total zinc (cont.).....	104
Figure A3-51. Breakthrough plots filtered total zinc.....	105
Figure A3-51. Breakthrough plots filtered total zinc (cont.).....	106

Aluminum, Total: Column Breakthrough Testing

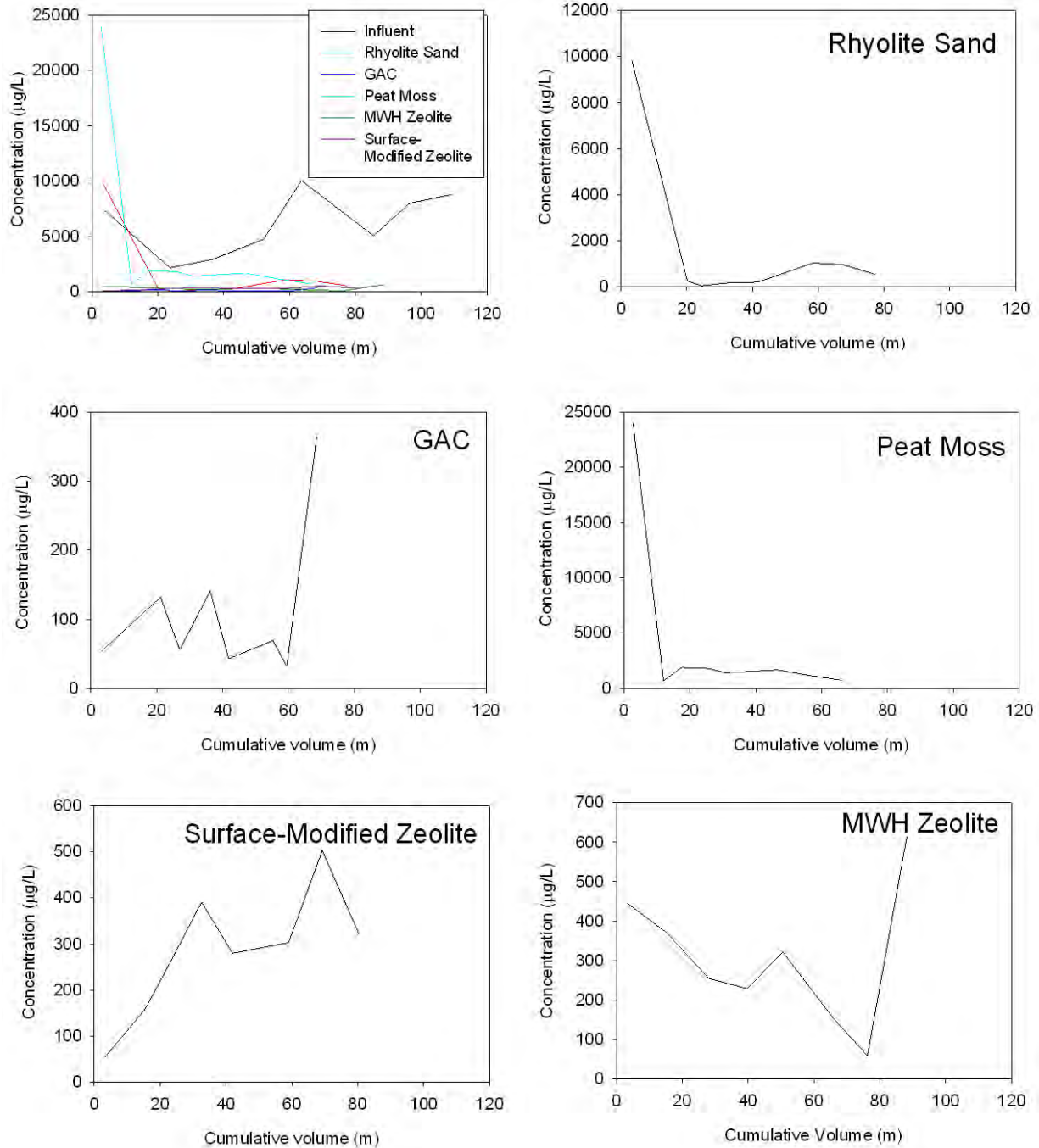


Figure A3-1. Breakthrough plots for total aluminum.

Aluminum, Total: Column Breakthrough Testing

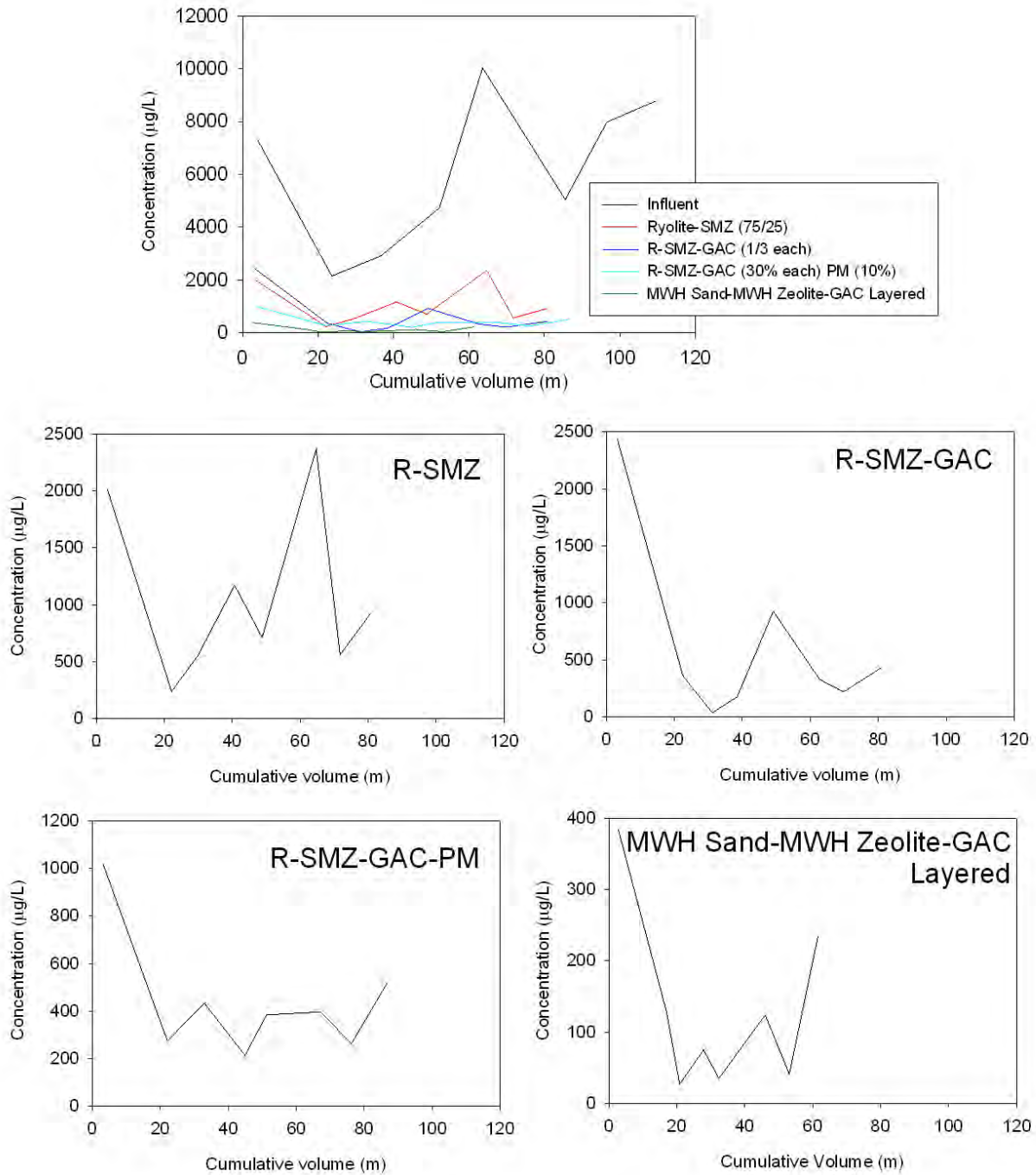


Figure A3-1. Breakthrough plots for total aluminum (cont).

Aluminum, Filtered: Column Breakthrough Testing

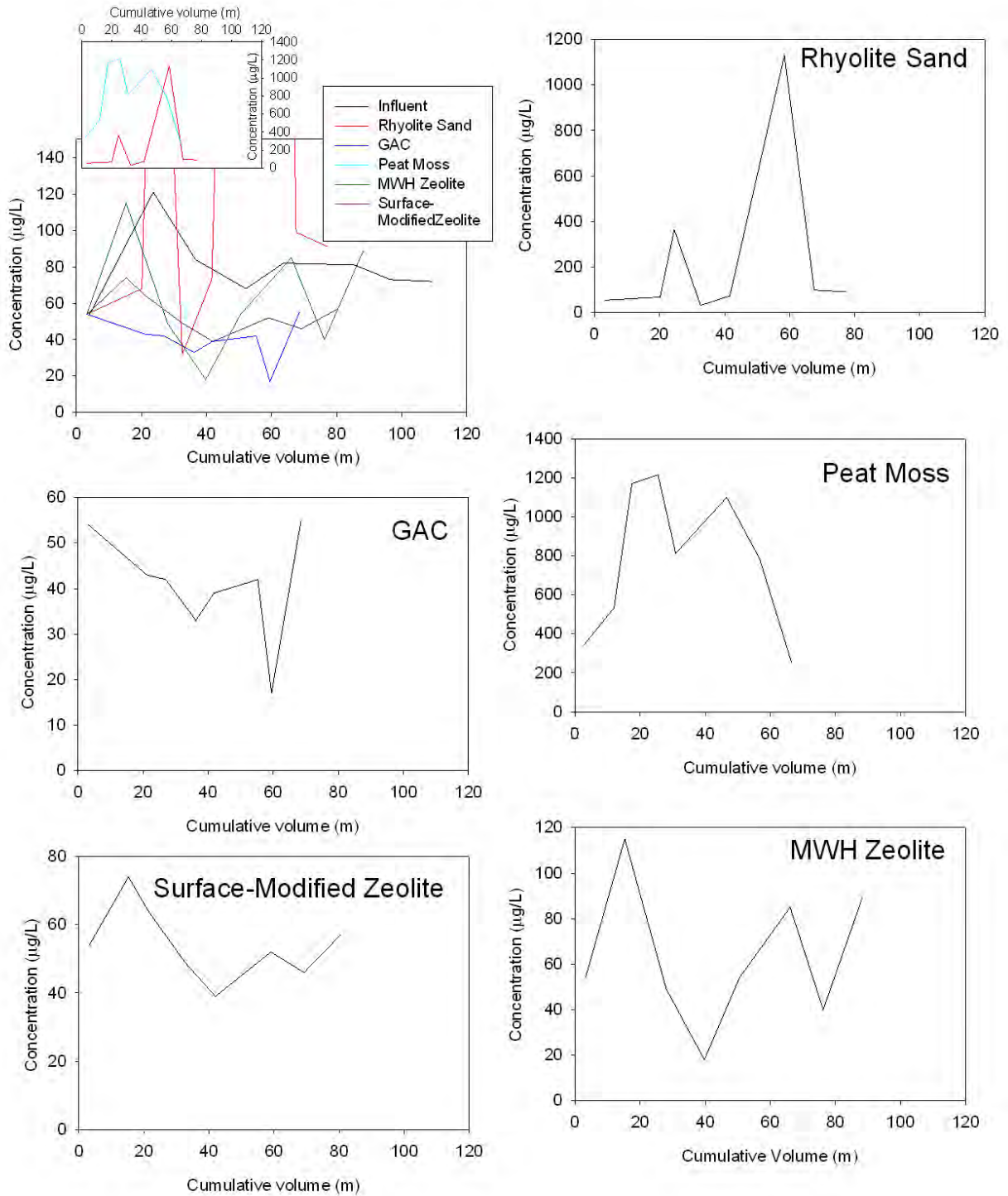


Figure A3-2. Breakthrough plots for filtered aluminum.

Aluminum, Filtered: Column Breakthrough Testing

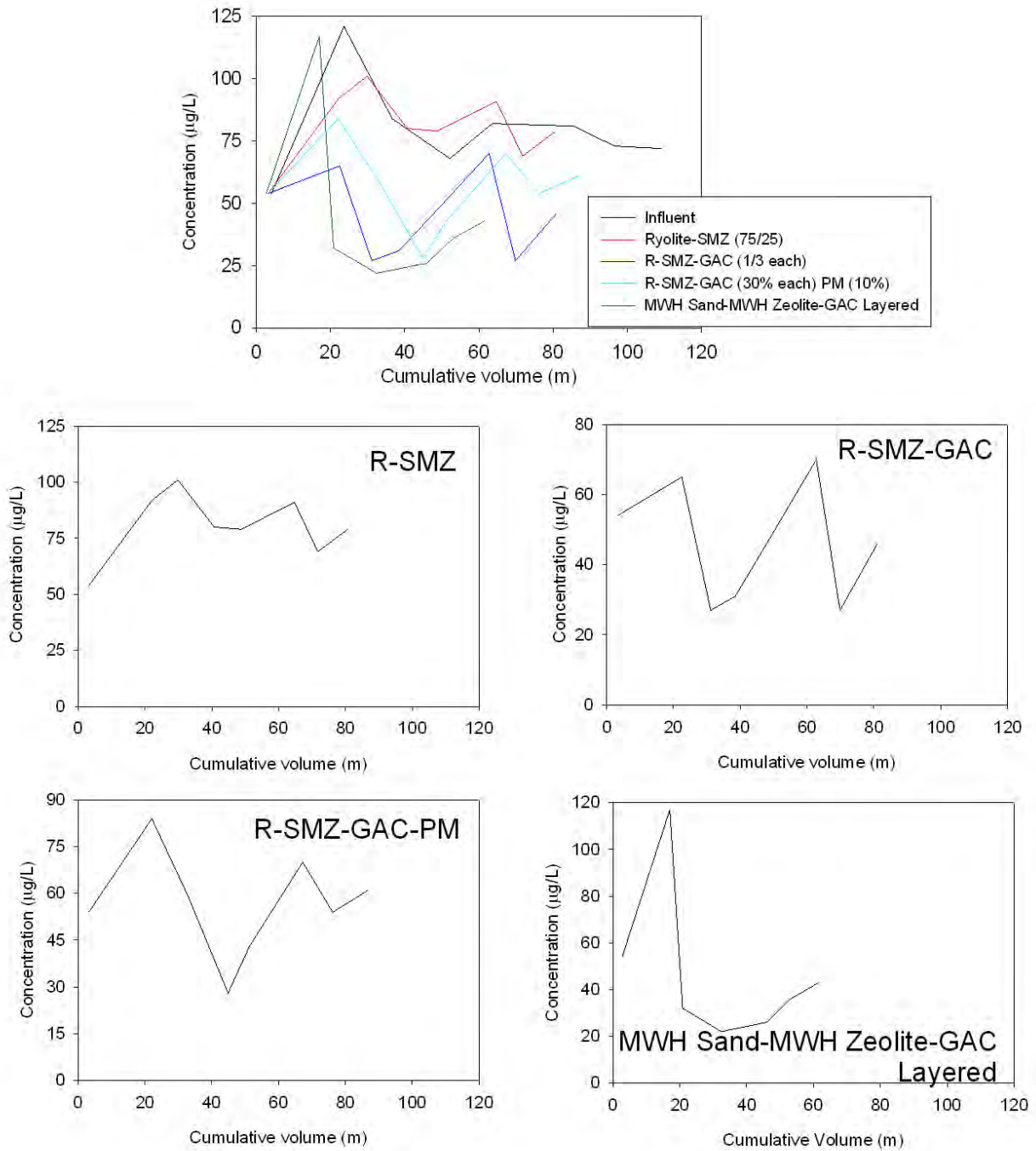


Figure A3-2. Breakthrough plots for filtered aluminum (cont).

Ammonia-N: Column Breakthrough Testing

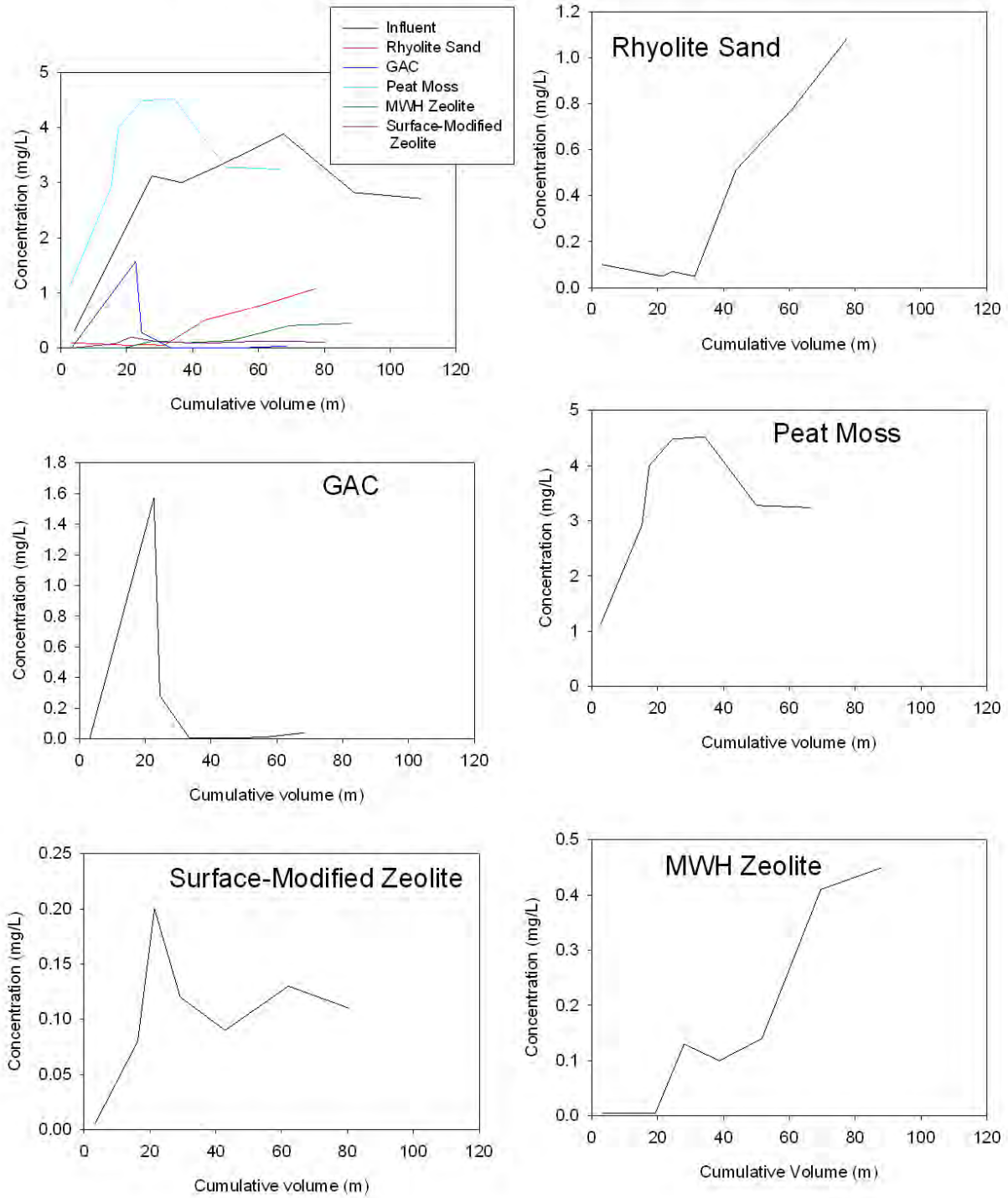


Figure A3-3. Breakthrough plots for ammonia nitrogen.

Ammonia-N: Column Breakthrough Testing

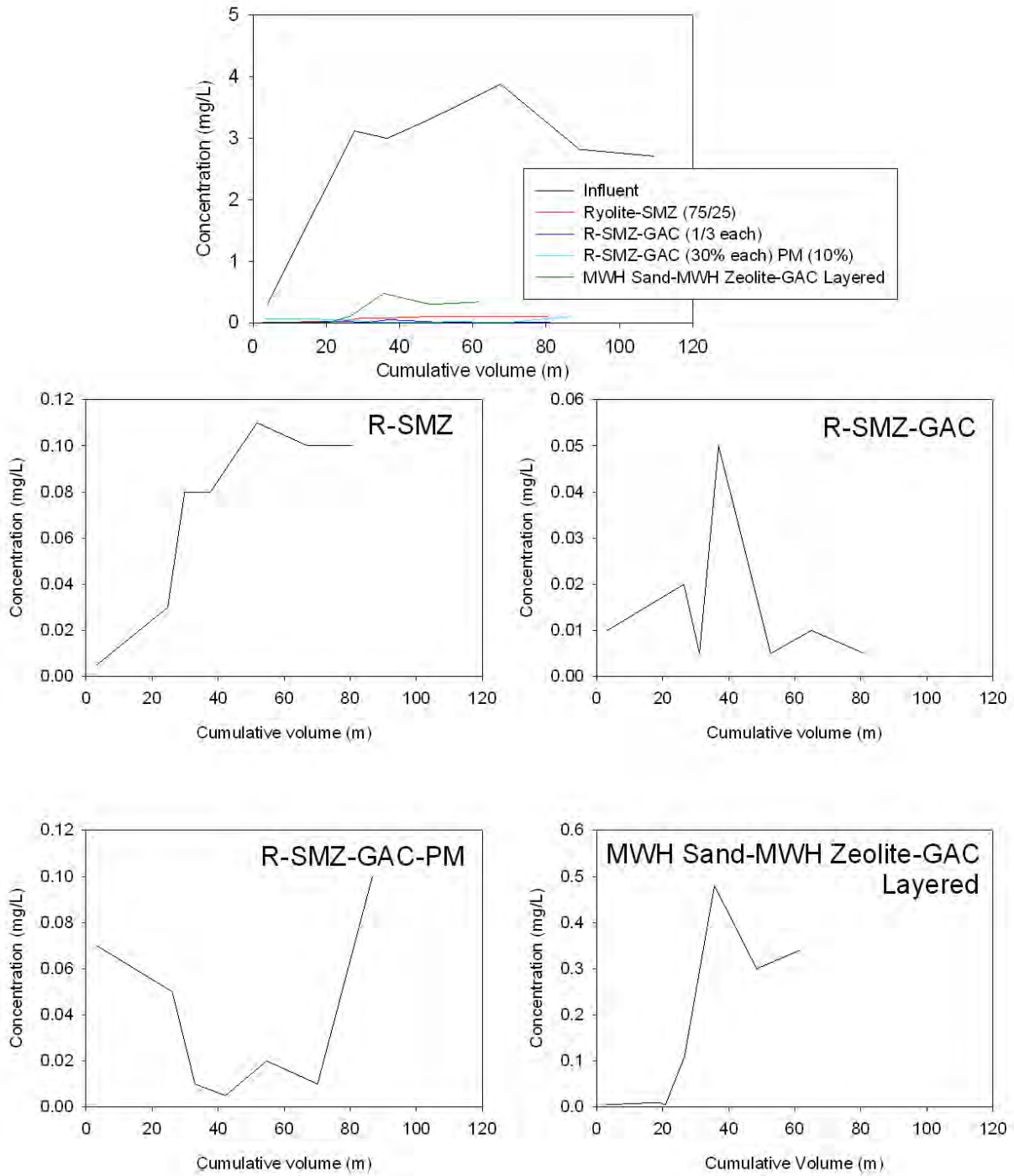


Figure A3-3. Breakthrough plots for ammonia nitrogen (cont.).

Antimony, Total: Column Breakthrough Testing

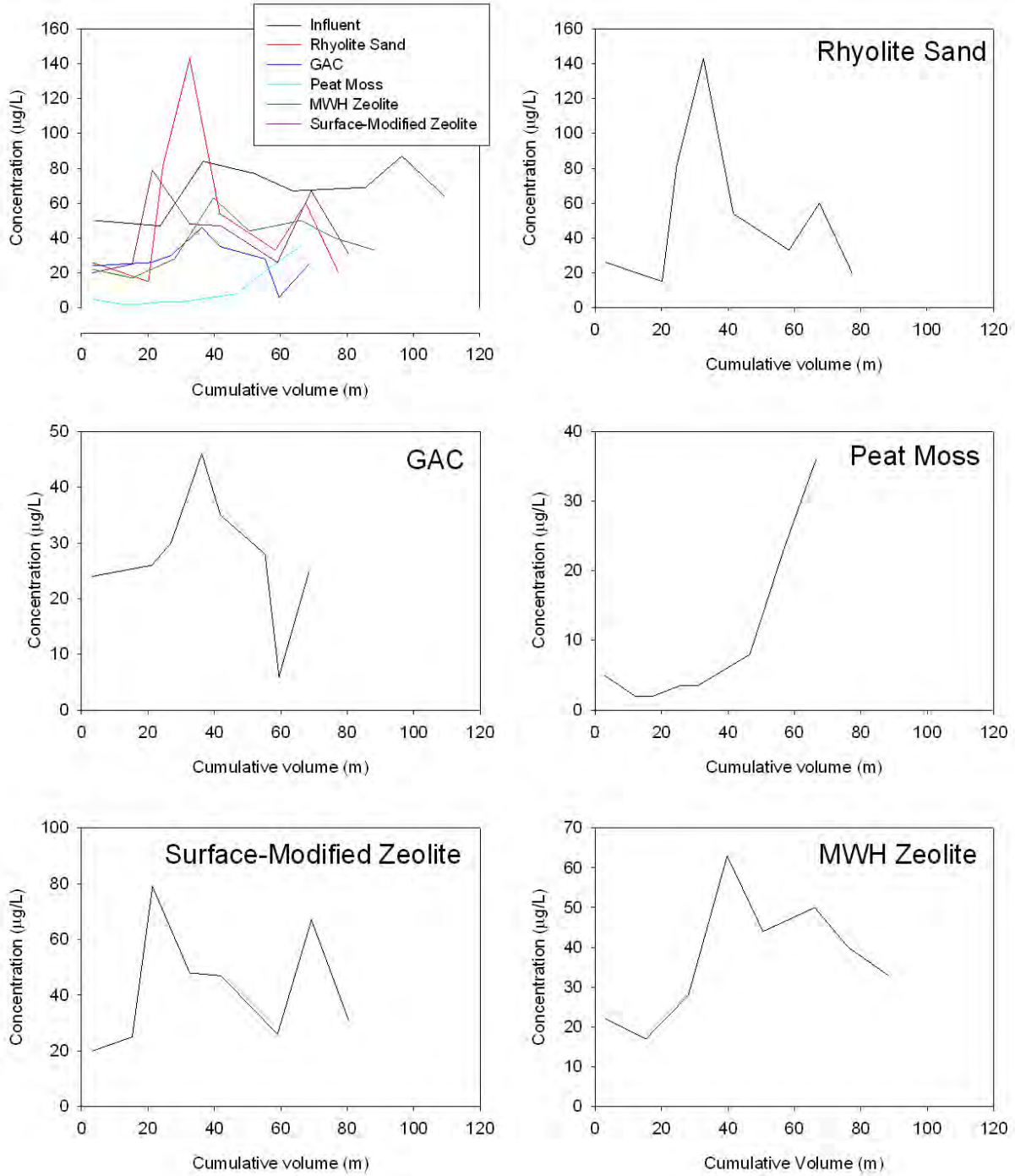


Figure A3-4. Breakthrough plots for total antimony.

Antimony, Total: Column Breakthrough Testing

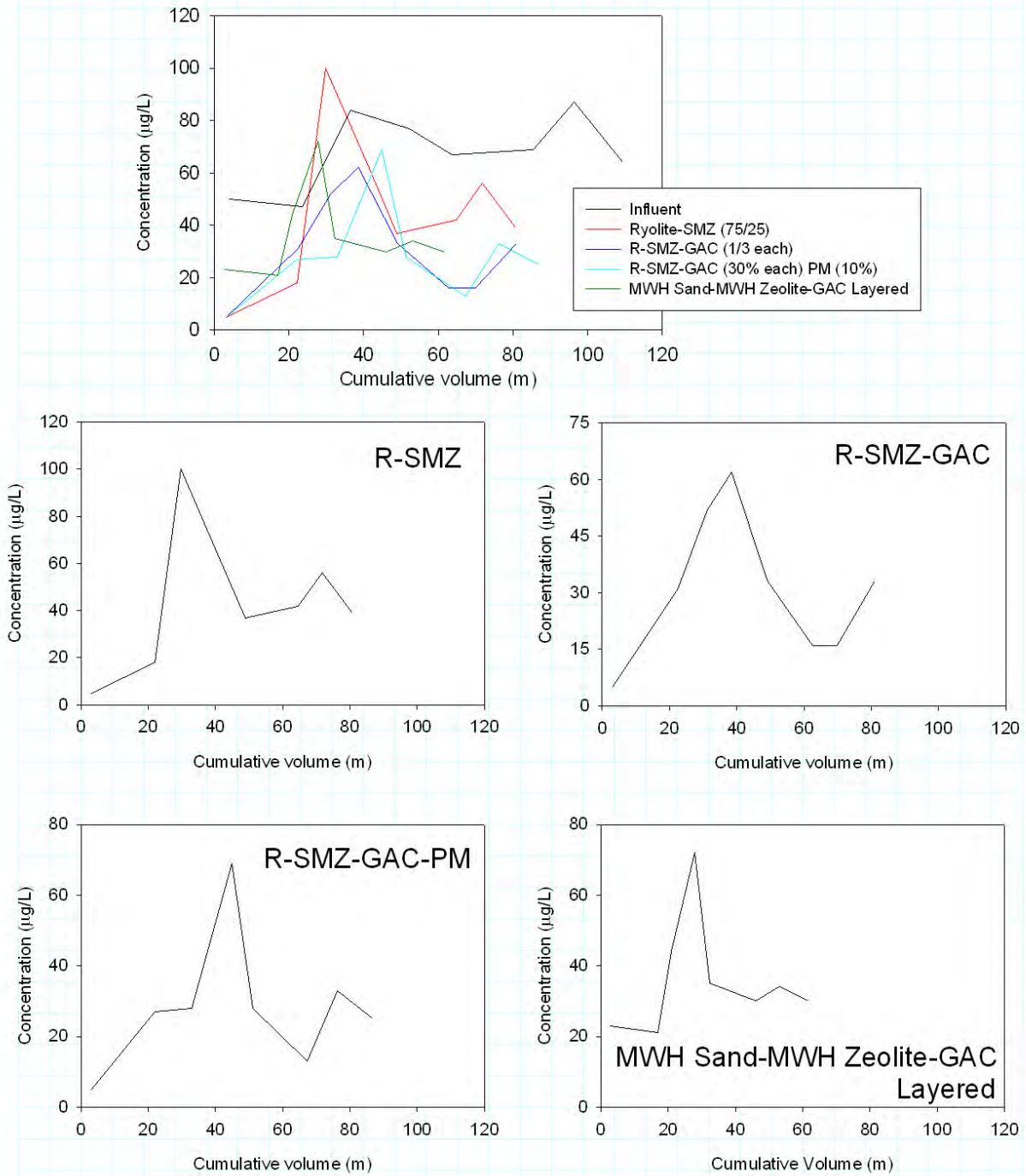


Figure A3-4. Breakthrough plots for total antimony (cont).

Antimony, Filtered: Column Breakthrough Testing

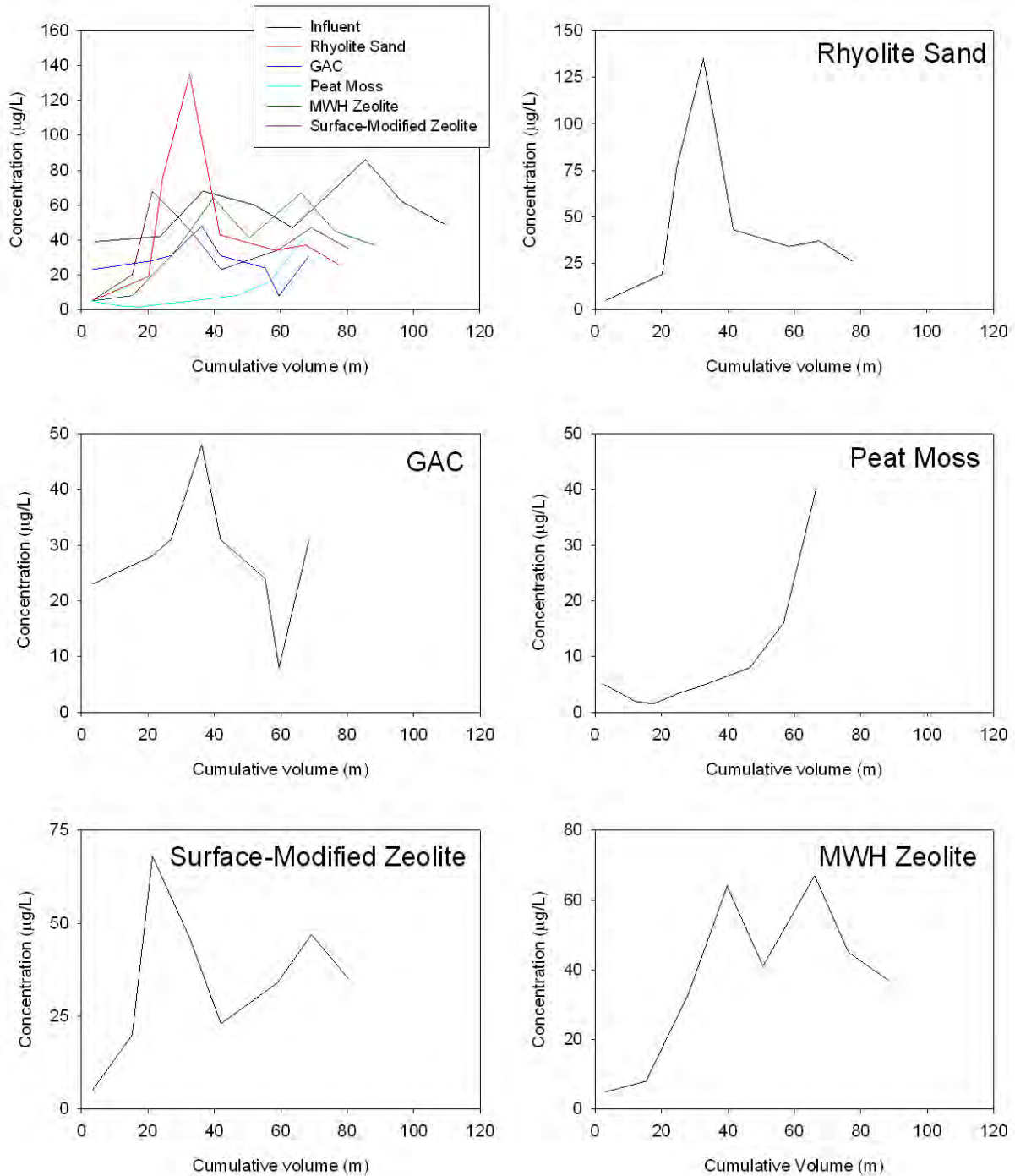


Figure A3-5. Breakthrough plots for filtered antimony.

Antimony, Filtered: Column Breakthrough Testing

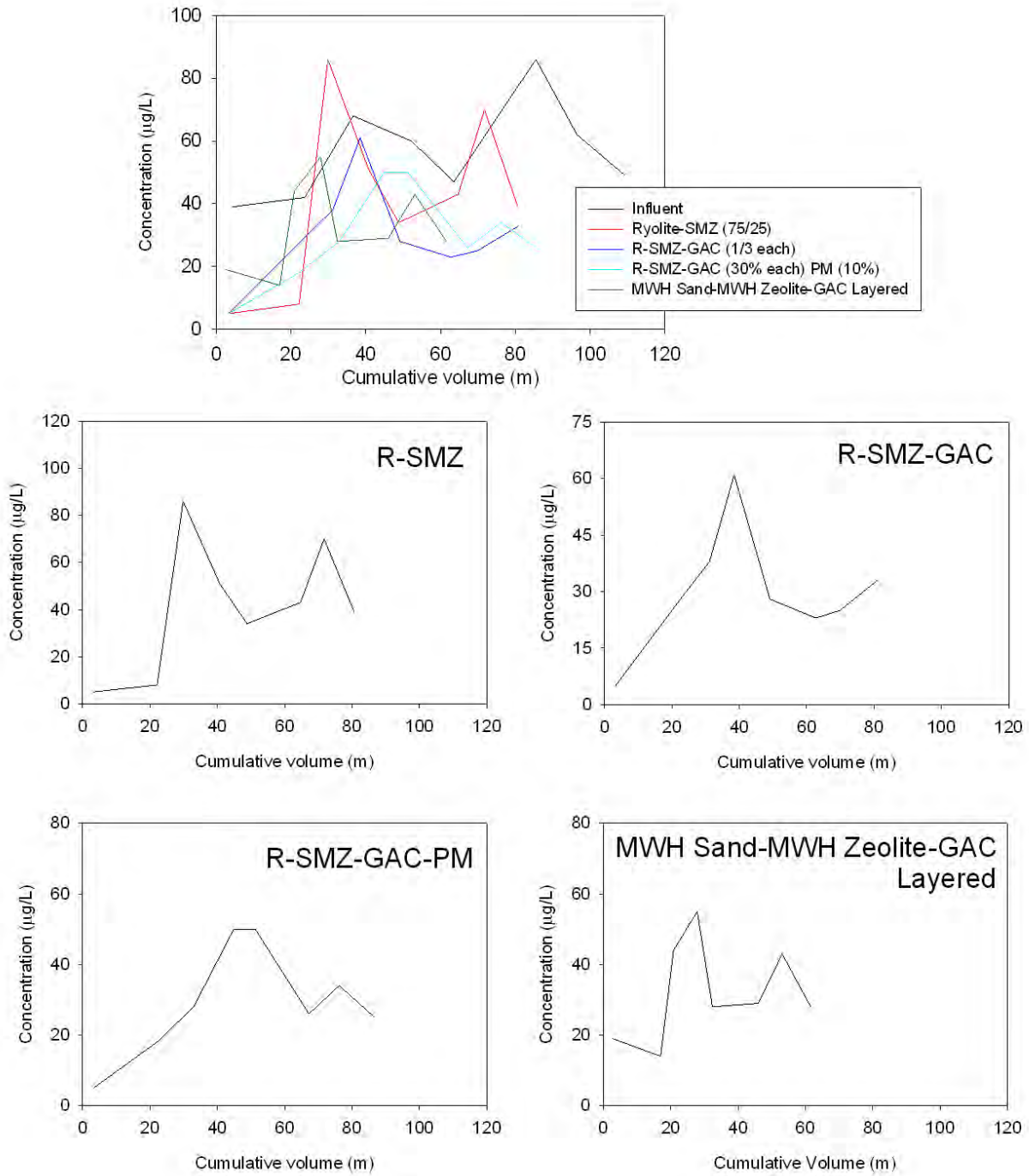


Figure A3-5. Breakthrough plots for filtered antimony (cont.).

Arsenic, Total: Column Breakthrough Testing

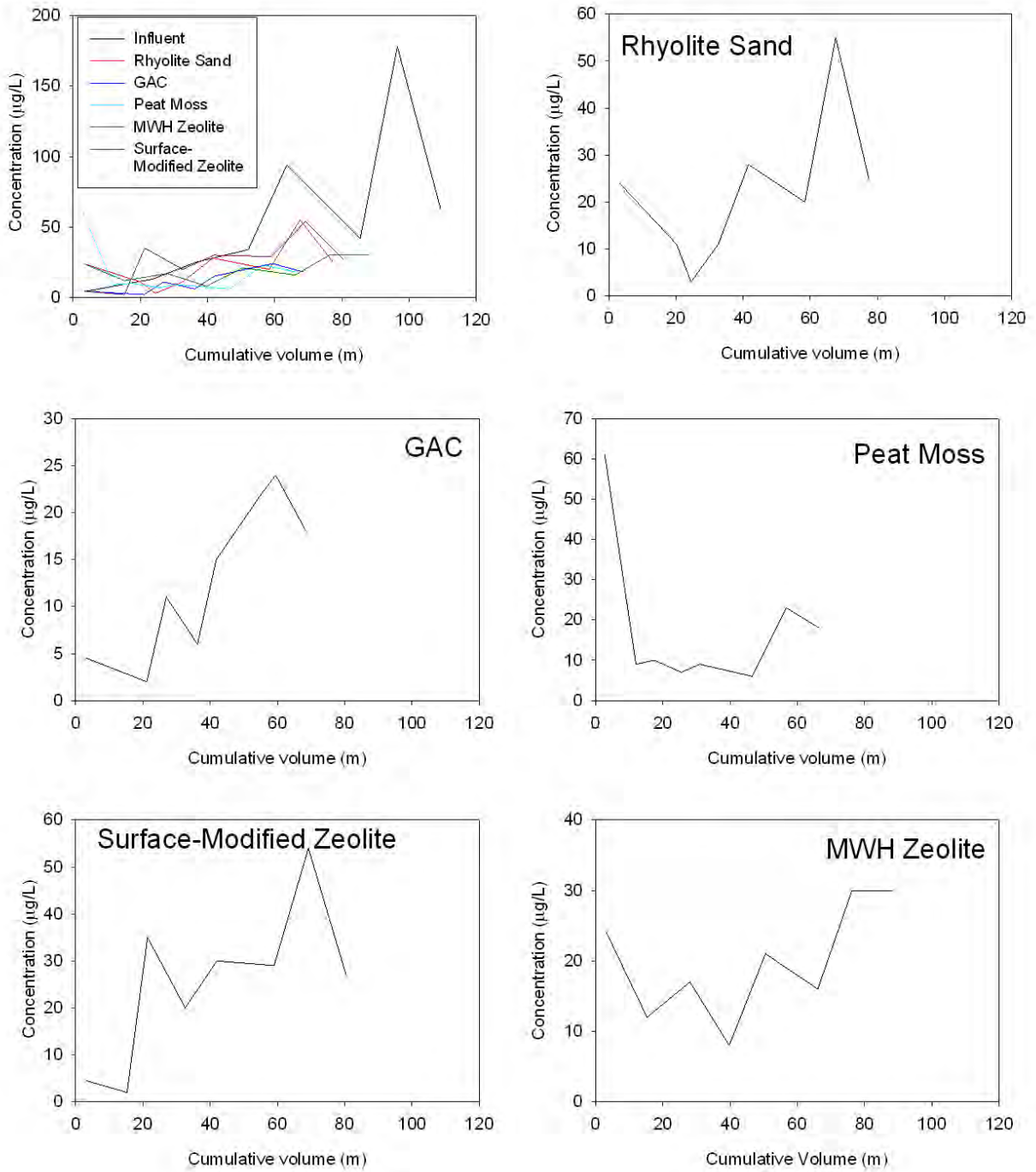


Figure A3-6. Breakthrough plots for total arsenic.

Arsenic, Total: Column Breakthrough Testing

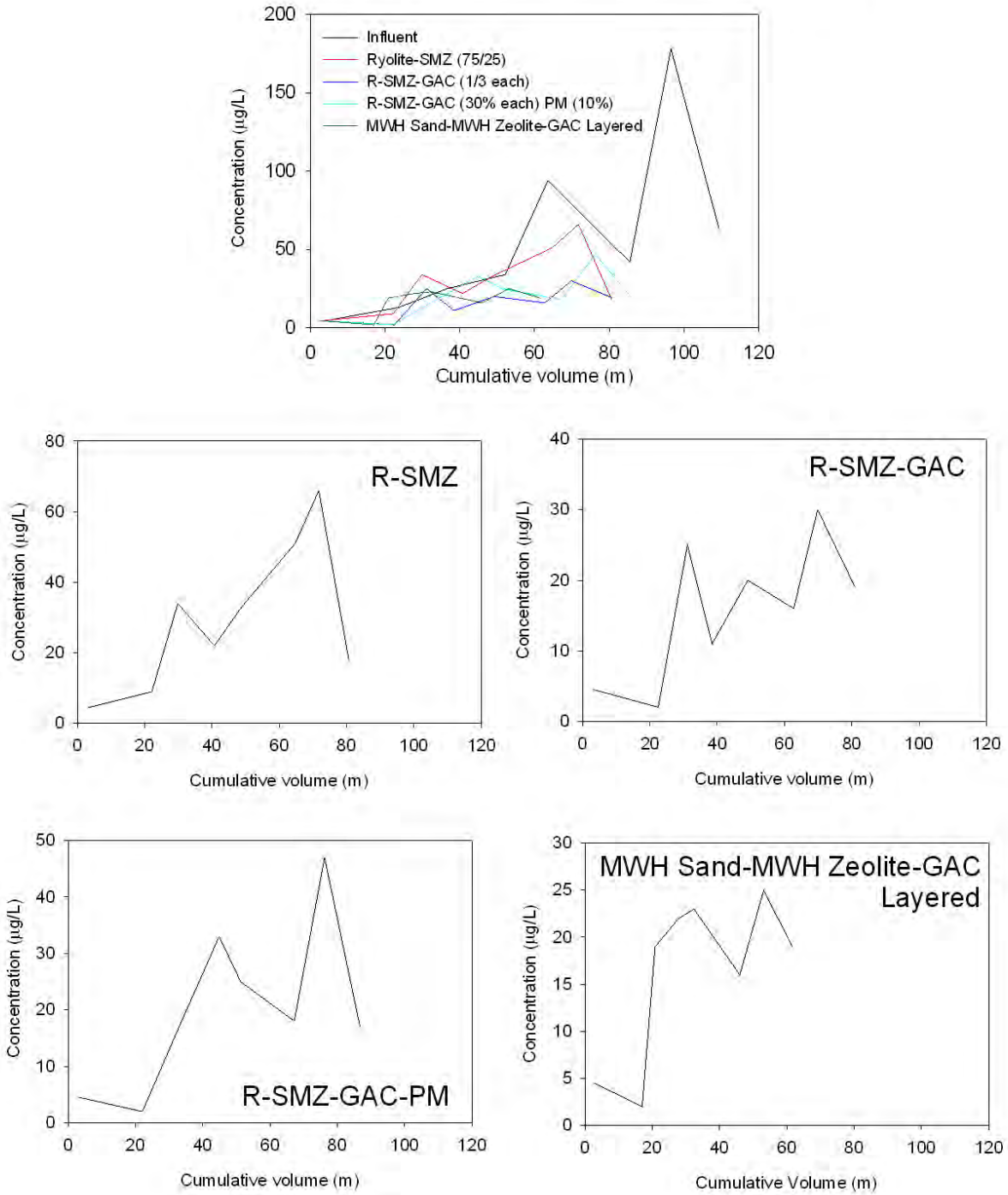


Figure A3-6. Breakthrough plots for total arsenic (cont.).

Arsenic, Filtered: Column Breakthrough Testing

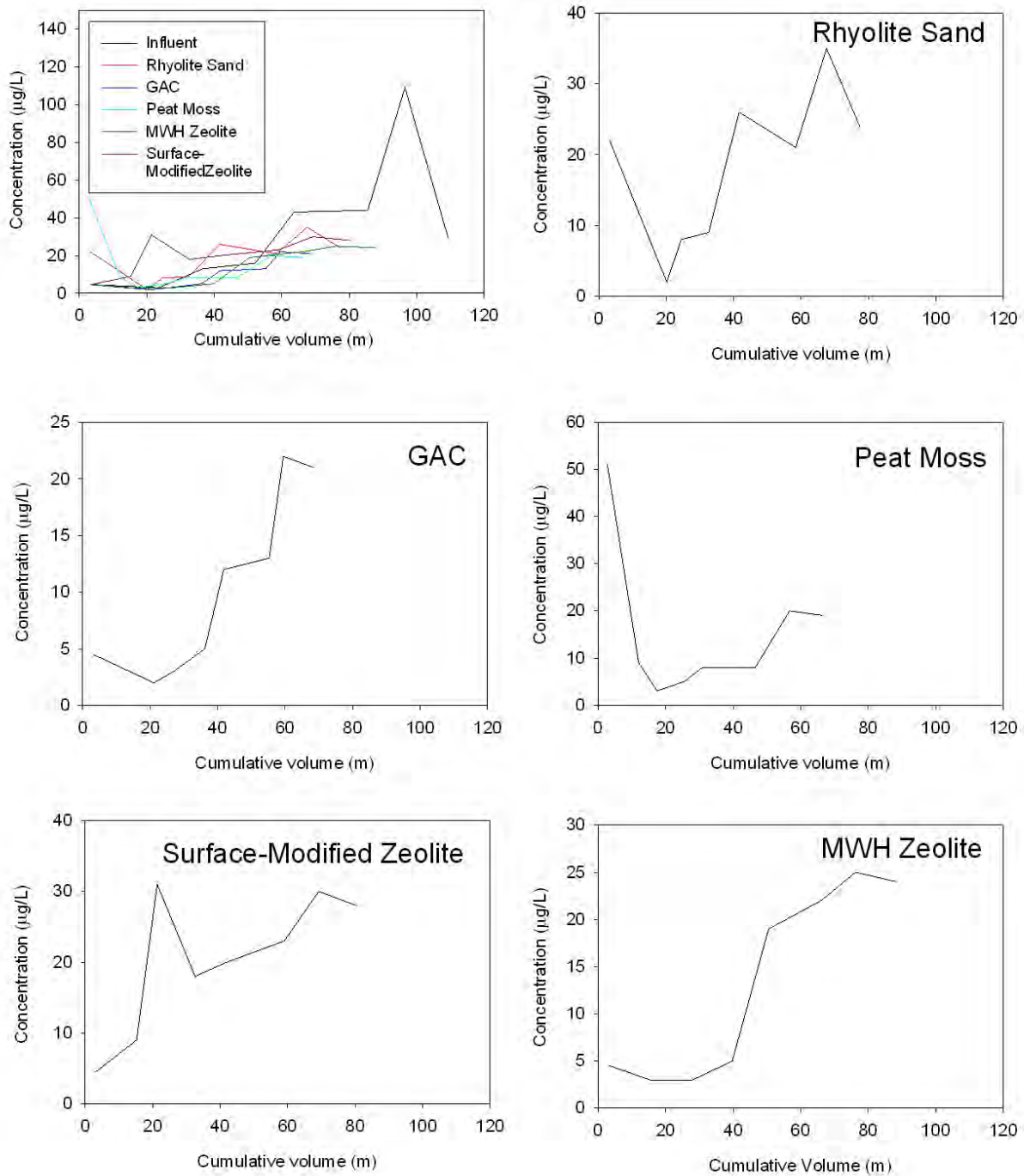


Figure A3-7. Breakthrough plots for filtered arsenic.

Arsenic, Filtered: Column Breakthrough Testing

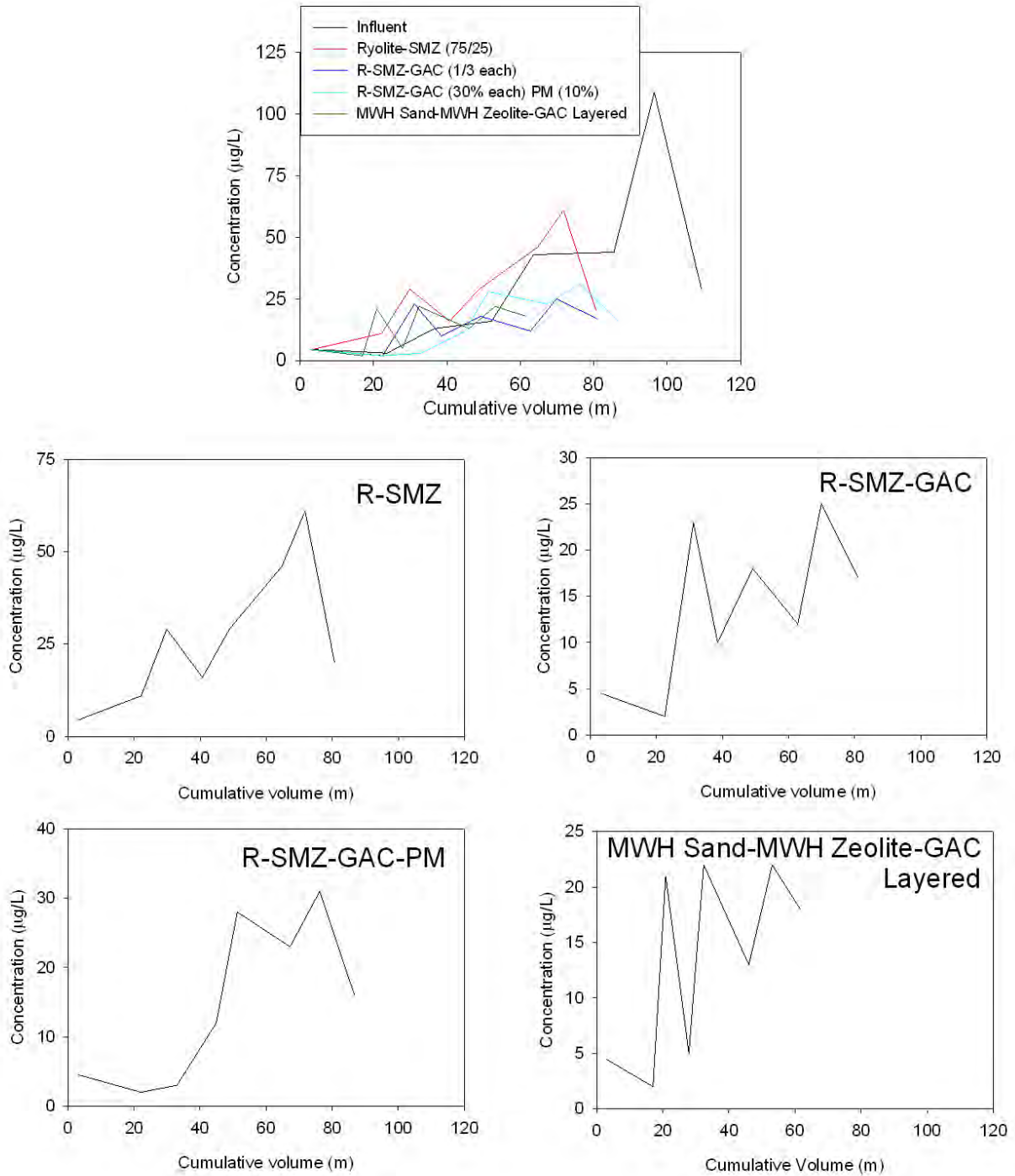


Figure A3-7. Breakthrough plots for filtered arsenic (cont.).

Boron, Total: Column Breakthrough Testing

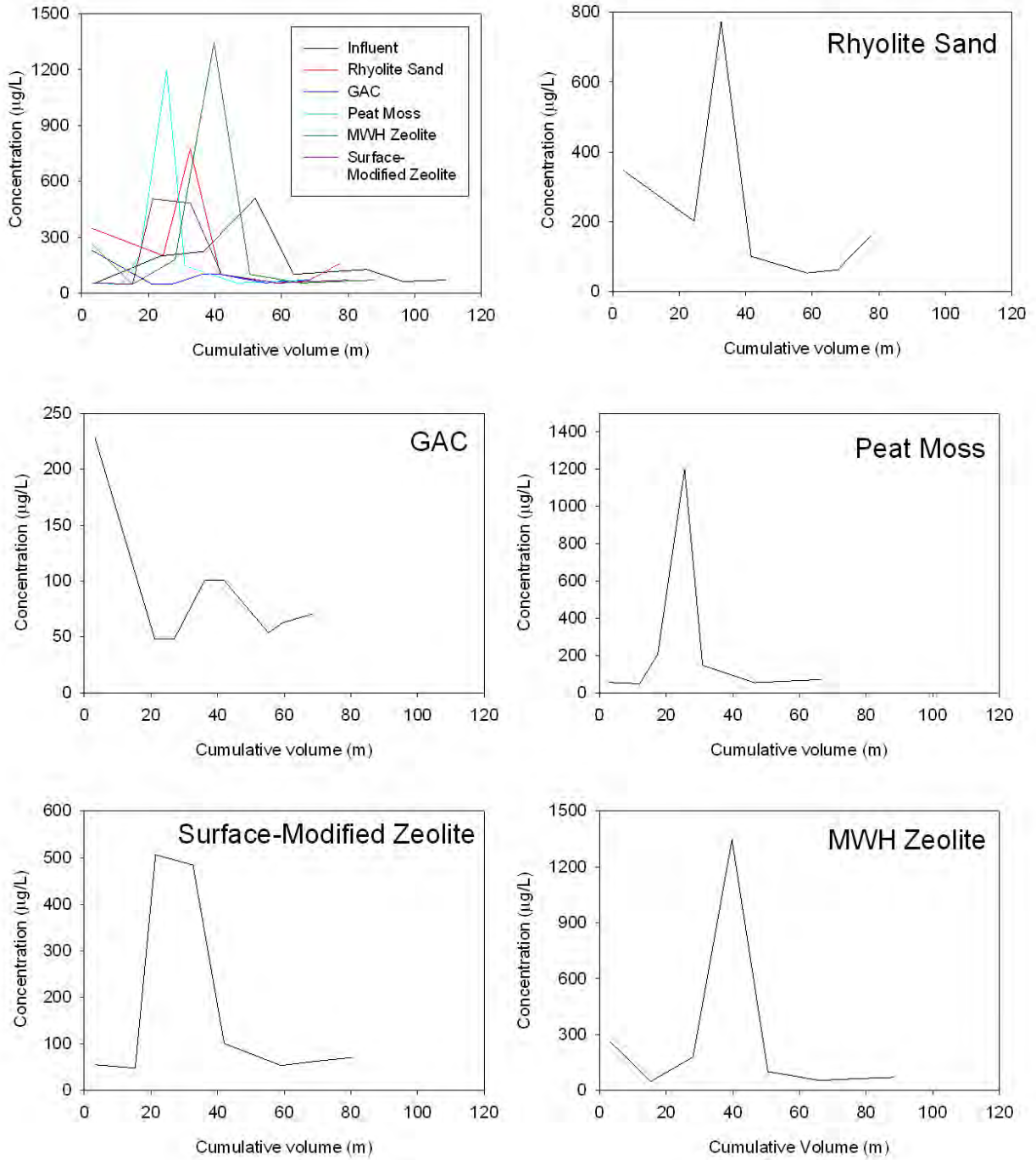


Figure A3-8. Breakthrough plots for total boron.

Boron, Total: Column Breakthrough Testing

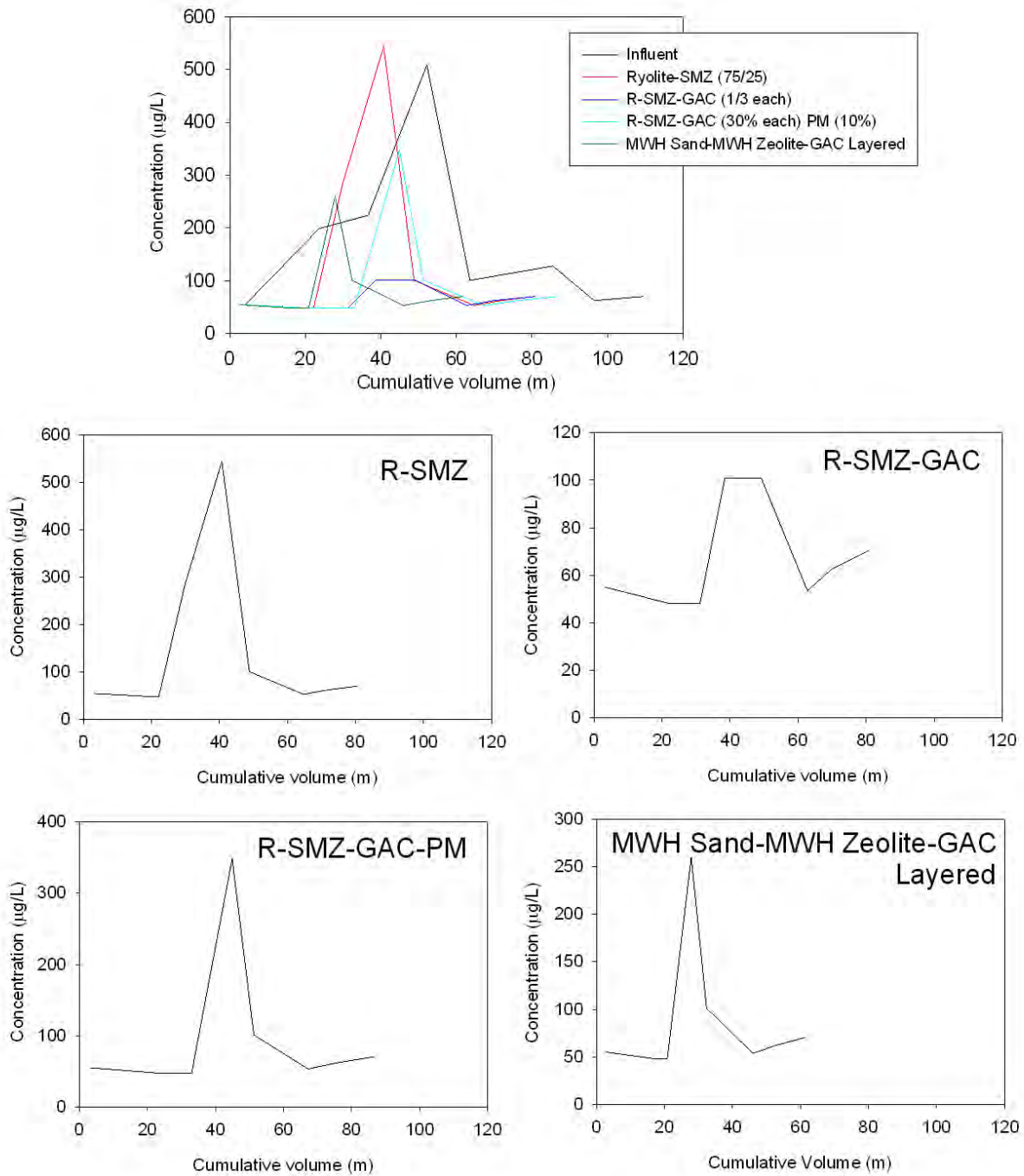


Figure A3-8. Breakthrough plots for total boron (cont.).

Boron, Filtered: Column Breakthrough Testing

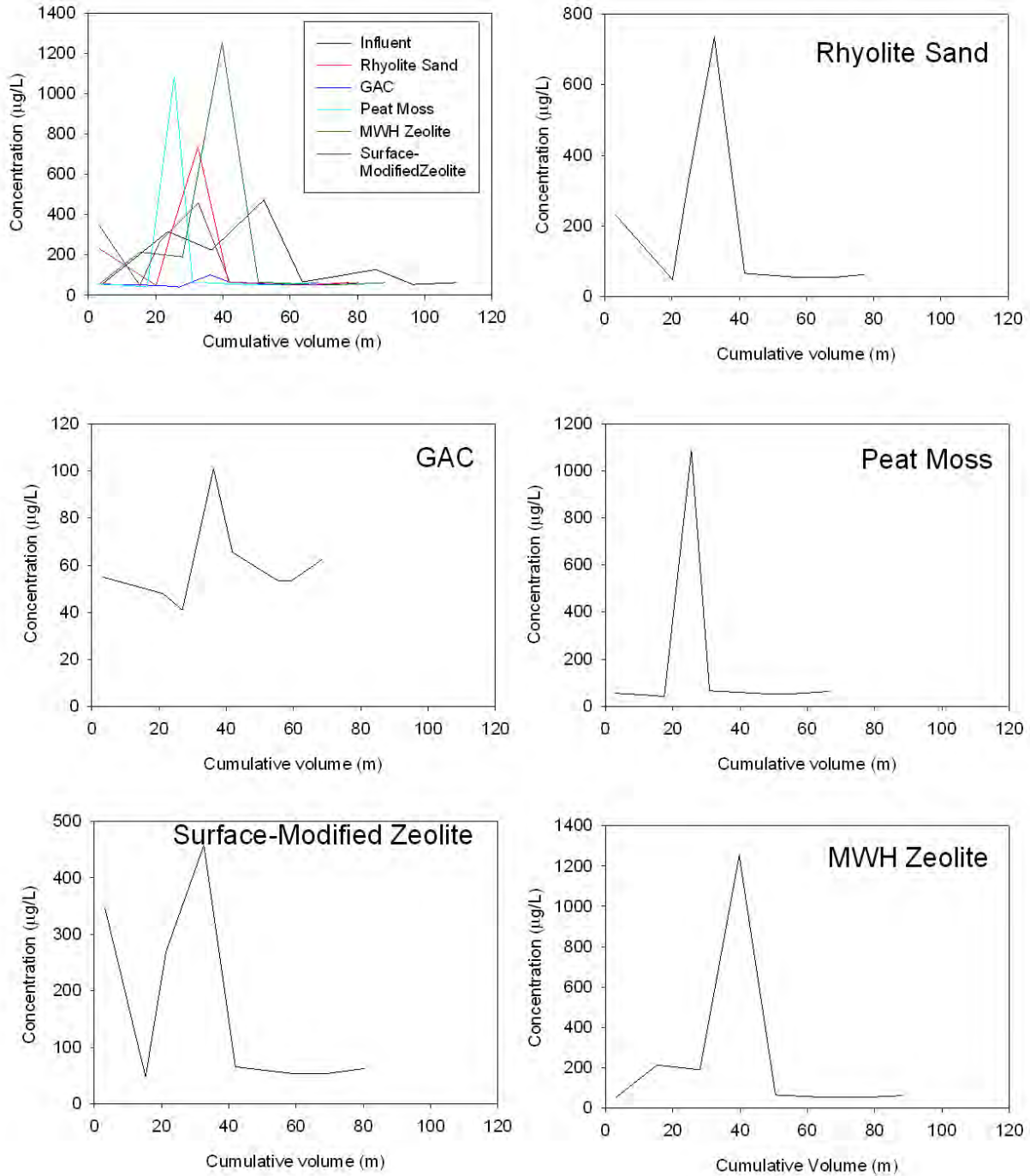


Figure A3-9. Breakthrough plots for filtered boron.

Boron, Filtered: Column Breakthrough Testing

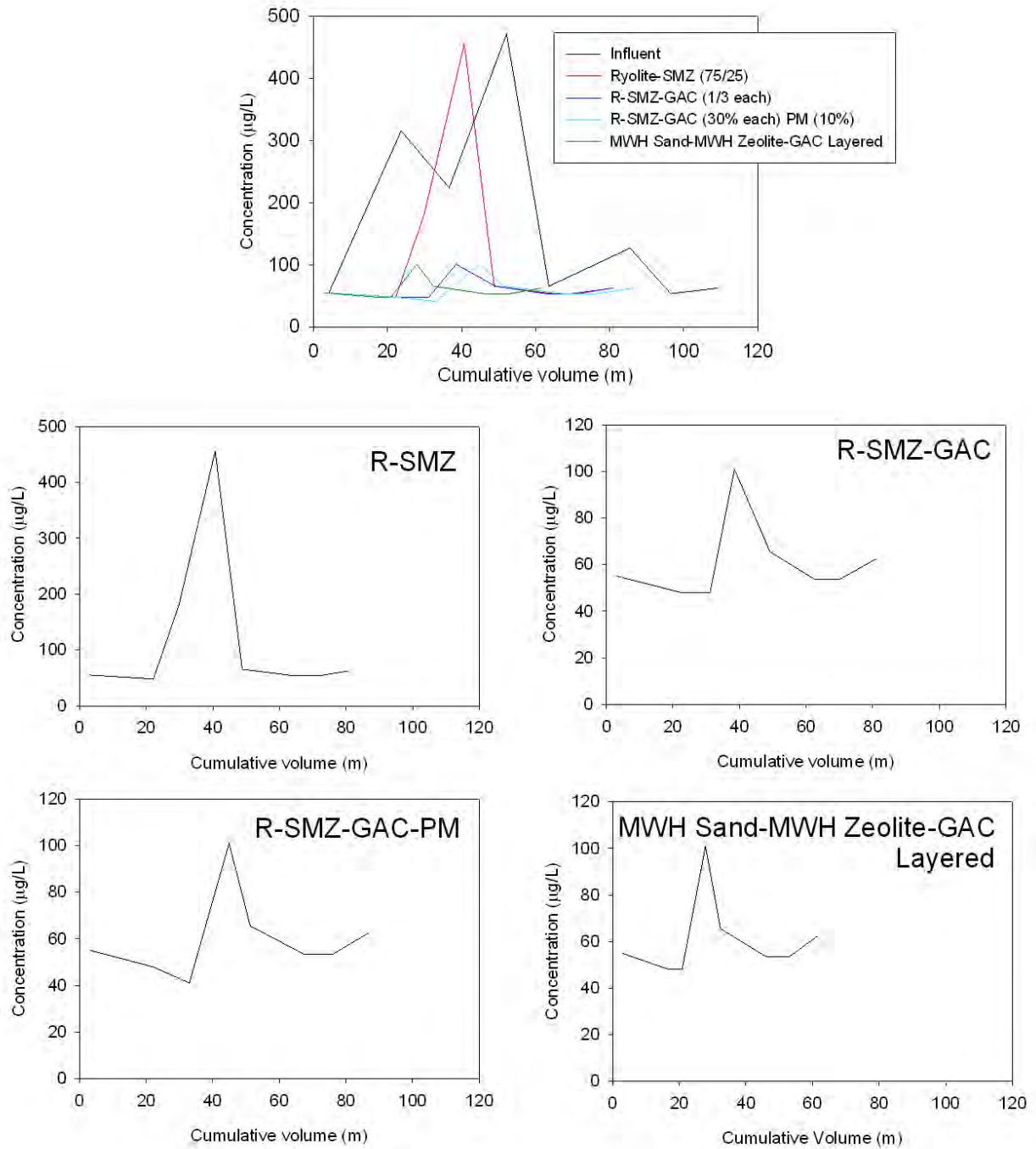


Figure A3-9. Breakthrough plots for filtered boron (cont.).

Cadmium, Total: Column Breakthrough Testing

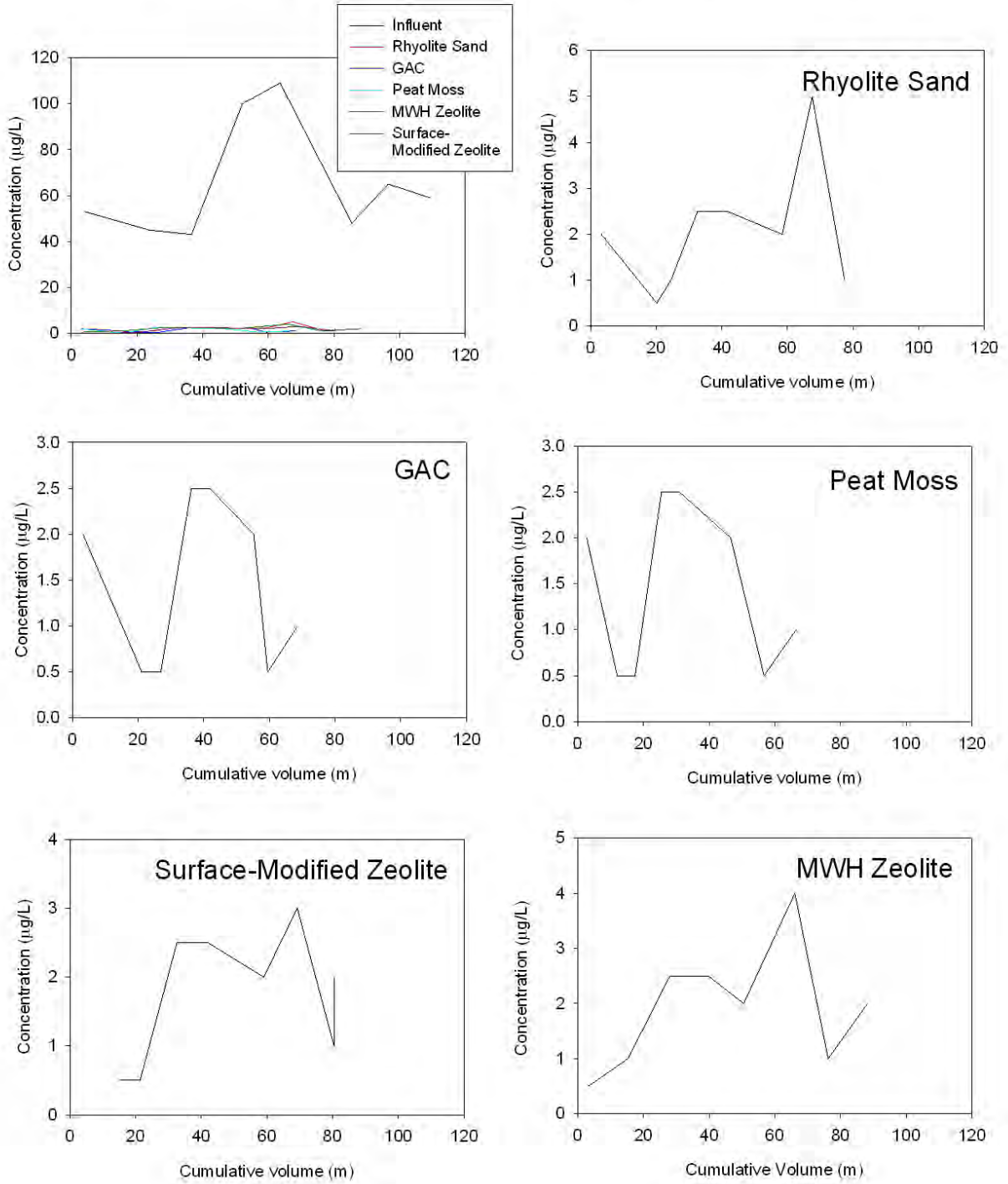


Figure A3-10. Breakthrough plots for total cadmium.

Cadmium, Total: Column Breakthrough Testing

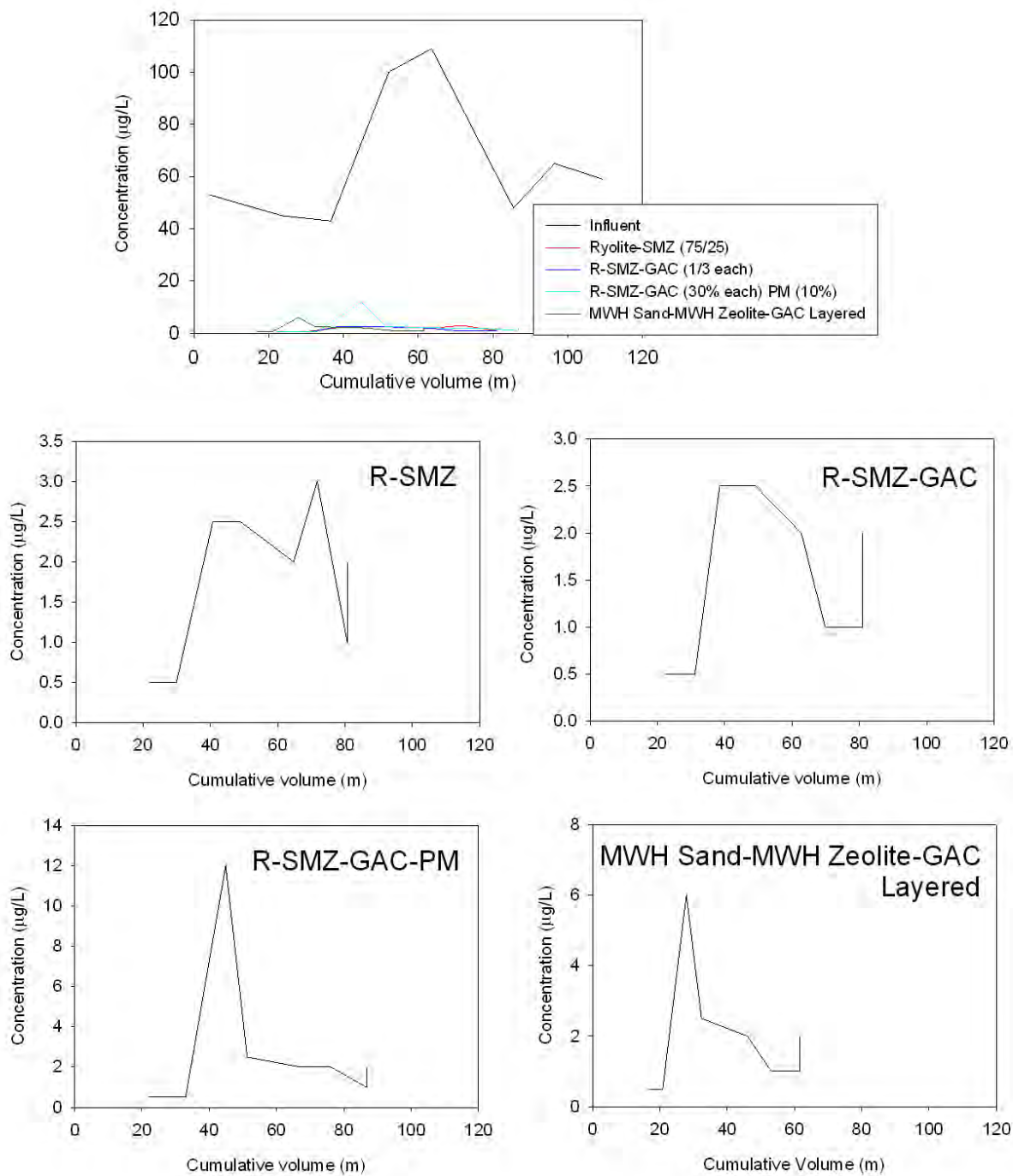


Figure A3-10. Breakthrough plots for total cadmium (cont.).

Cadmium, Filtered: Column Breakthrough Testing

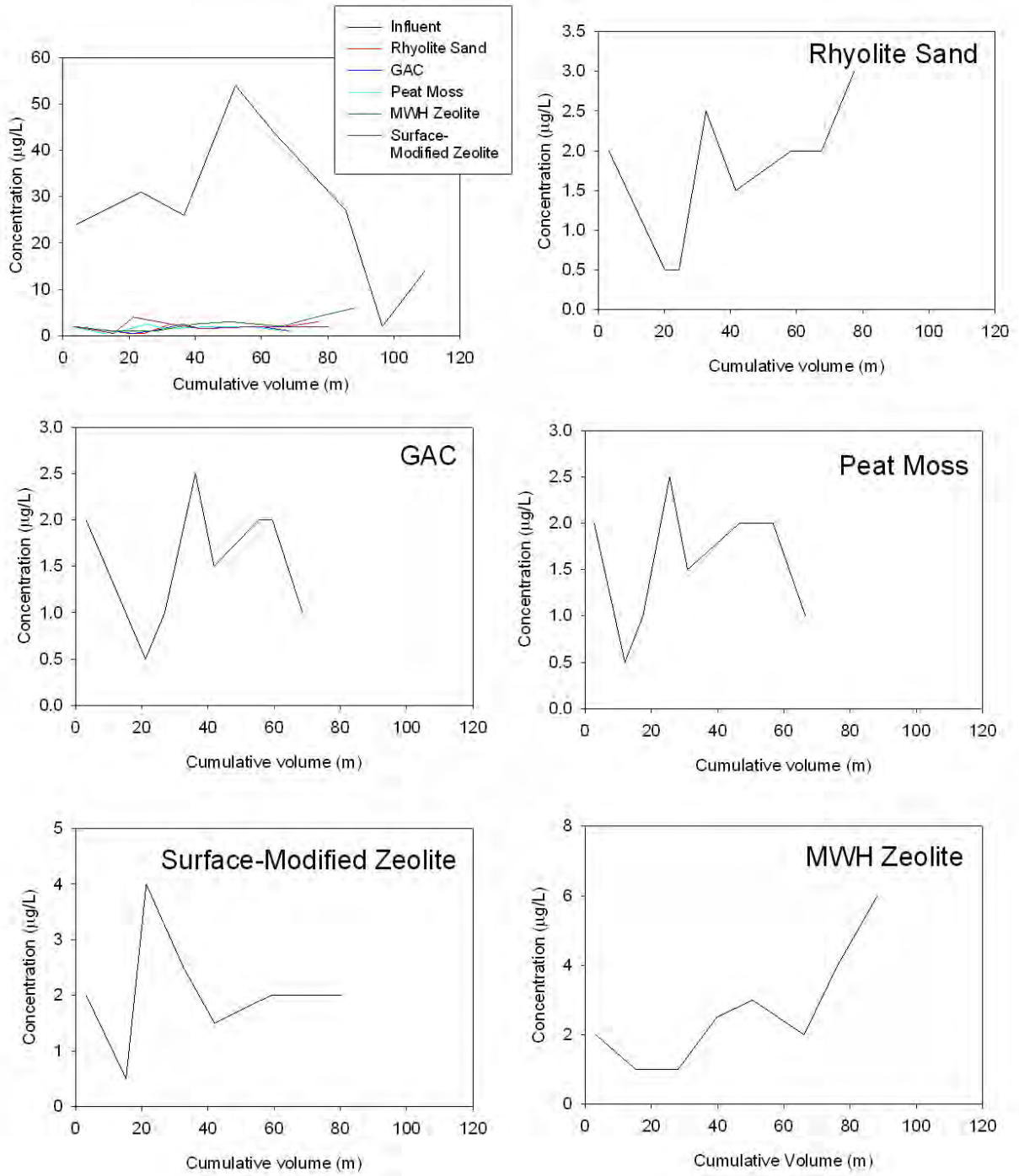


Figure A3-11. Breakthrough plots for filtered cadmium.

Cadmium, Filtered: Column Breakthrough Testing

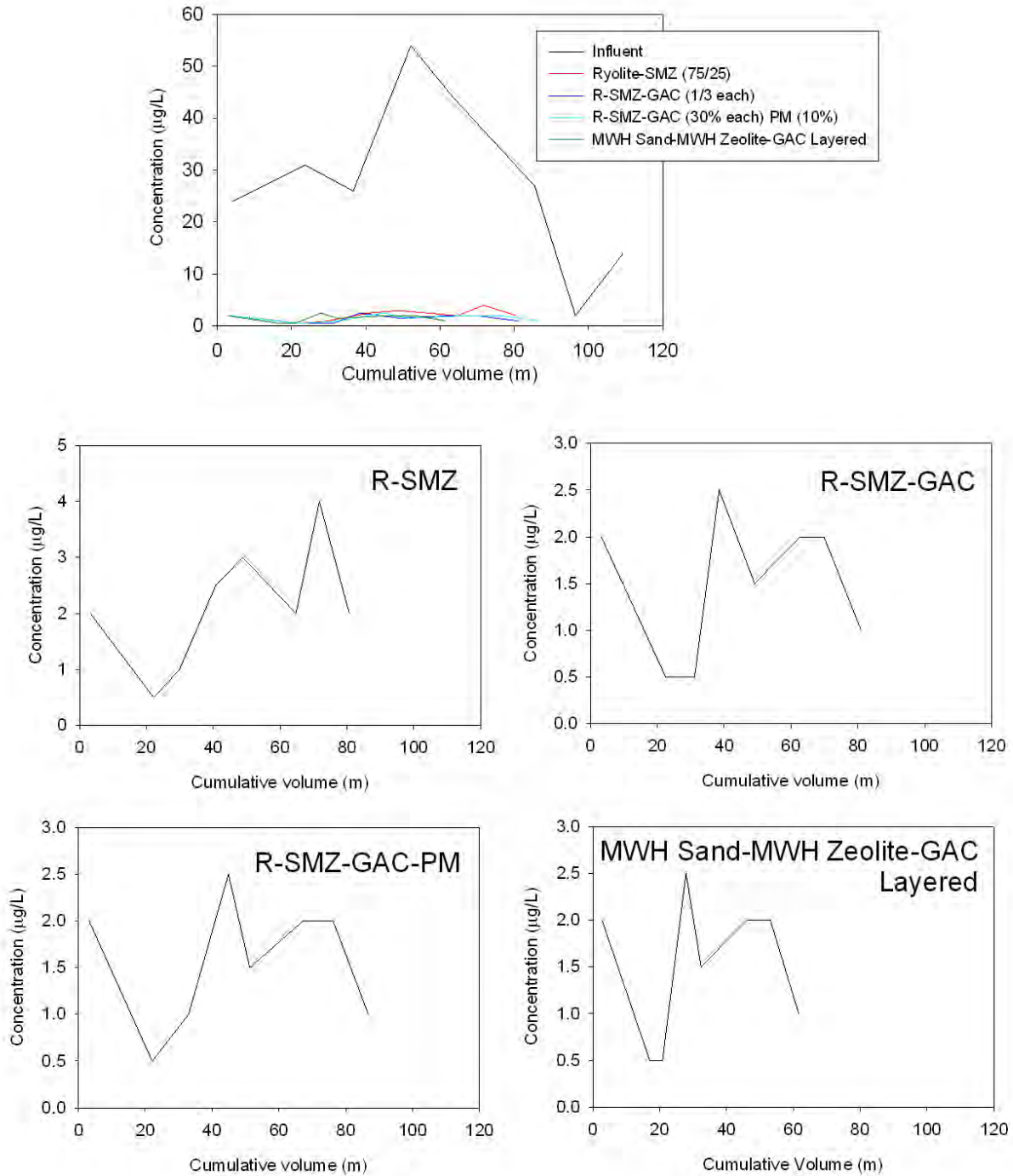


Figure A3-11. Breakthrough plots for filtered cadmium (cont.).

Calcium, Total: Column Breakthrough Testing

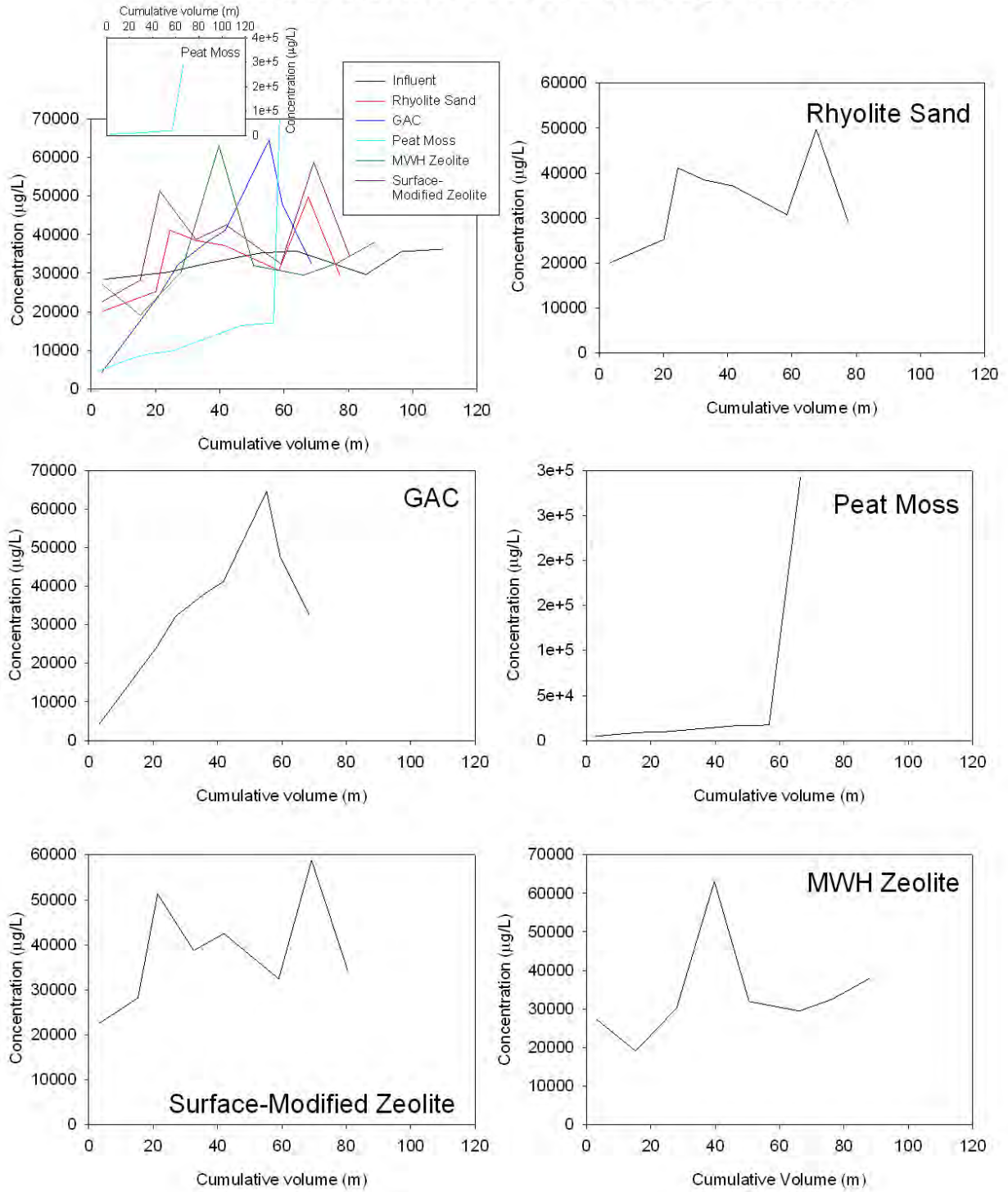


Figure A3-12. Breakthrough plots for total calcium.

Calcium, Total: Column Breakthrough Testing

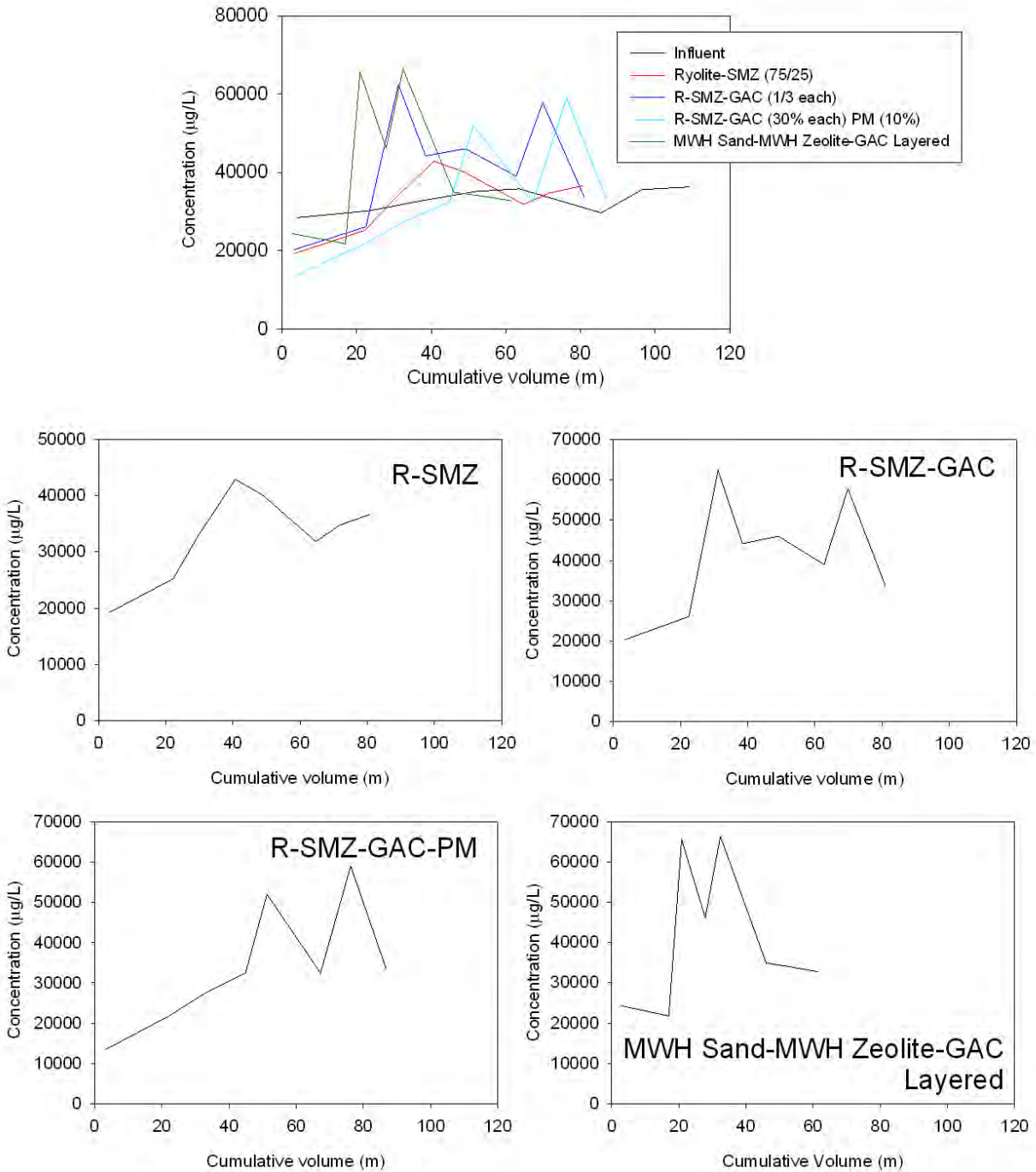


Figure A3-12. Breakthrough plots for total calcium (cont.).

Calcium, Filtered: Column Breakthrough Testing

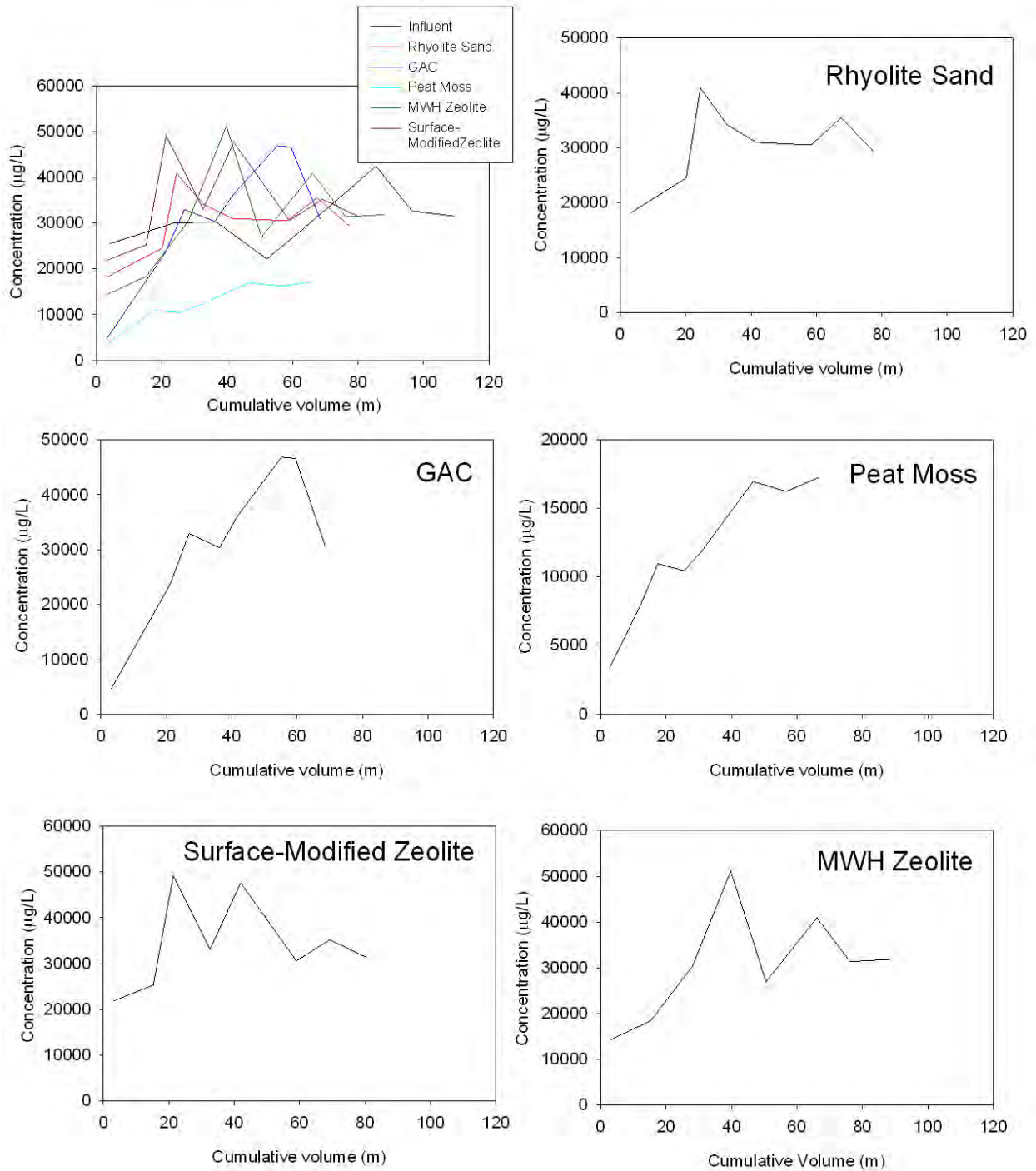


Figure A3-13. Breakthrough plots for filtered calcium.

Calcium, Filtered: Column Breakthrough Testing

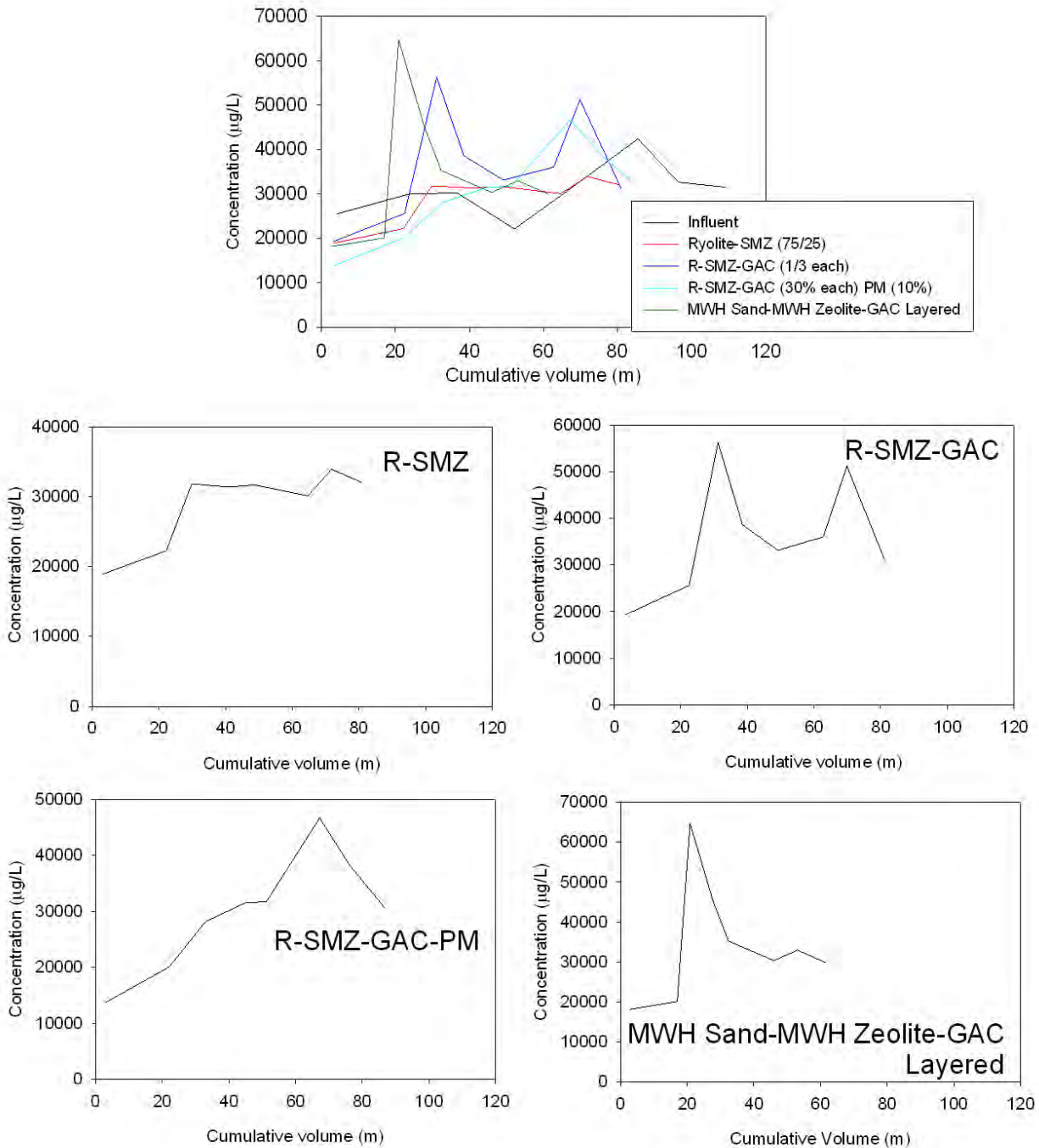


Figure A3-13. Breakthrough plots for filtered calcium (cont.).

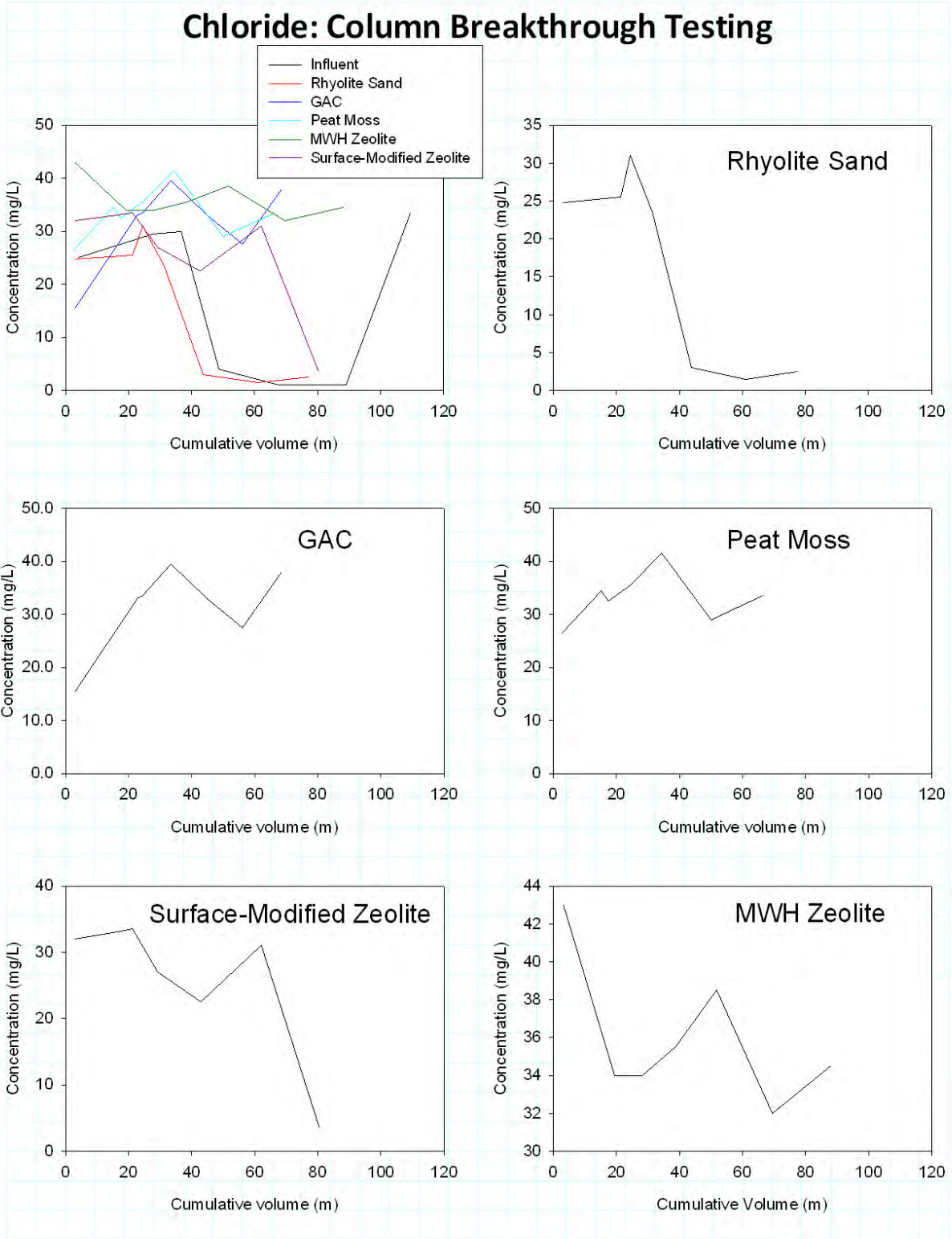


Figure A3-14. Breakthrough plots for chloride.

Chloride: Column Breakthrough Testing

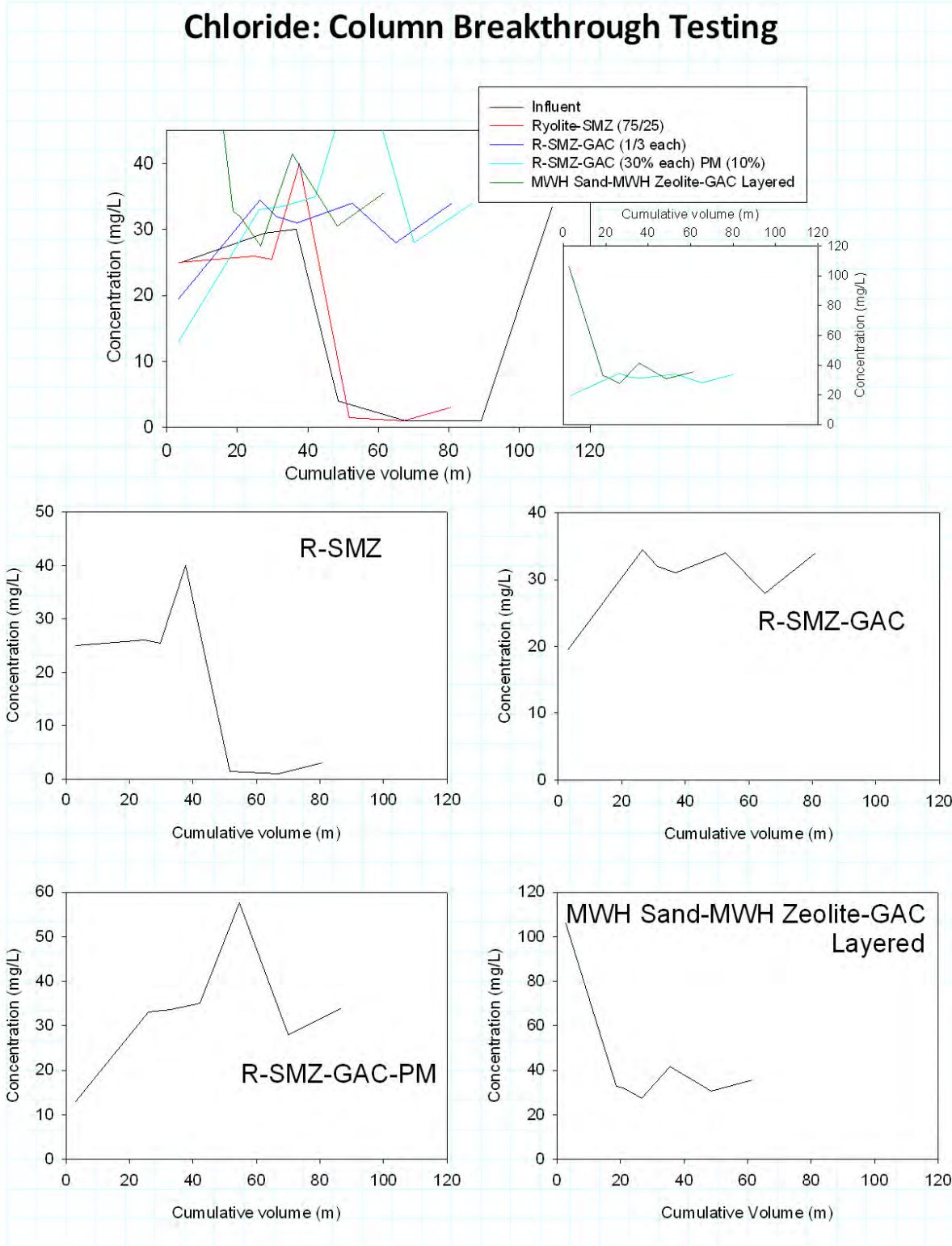


Figure A3-14. Breakthrough plots for chloride (cont.).

Chromium, Total: Column Breakthrough Testing

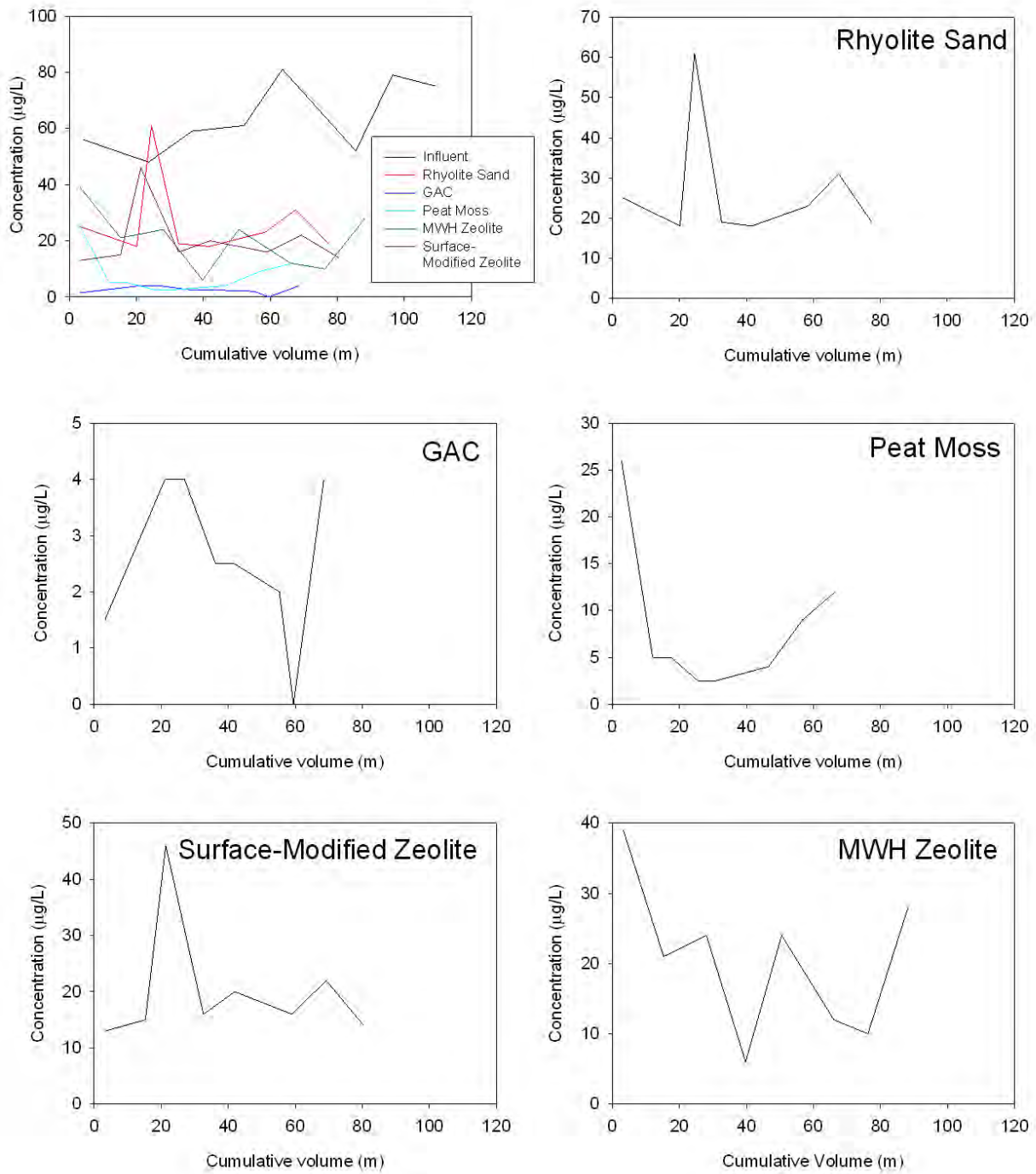


Figure A3-15. Breakthrough plots for total chromium.

Chromium, Total: Column Breakthrough Testing

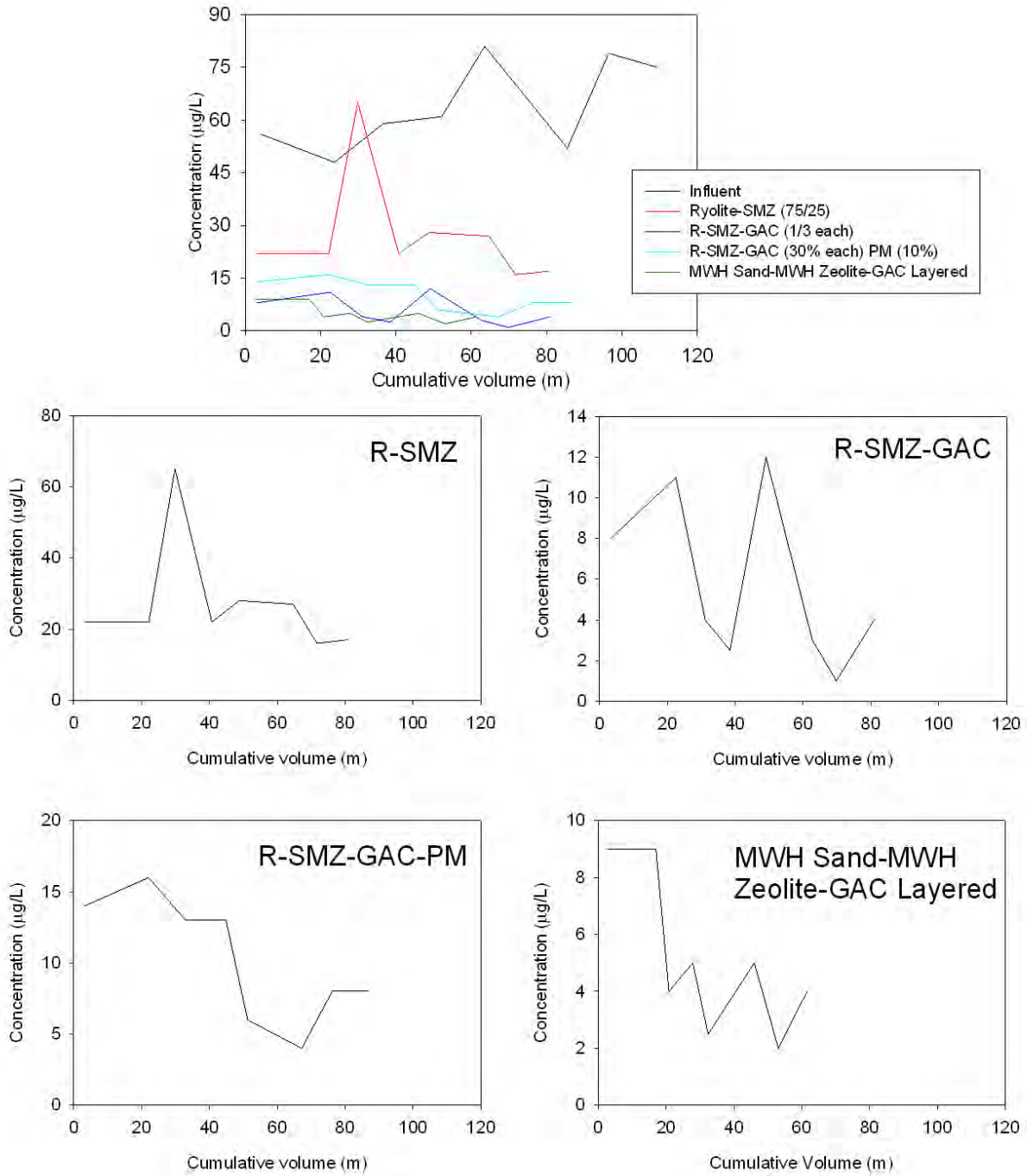


Figure A3-15. Breakthrough plots for total chromium (cont.).

Chromium, Filtered: Column Breakthrough Testing

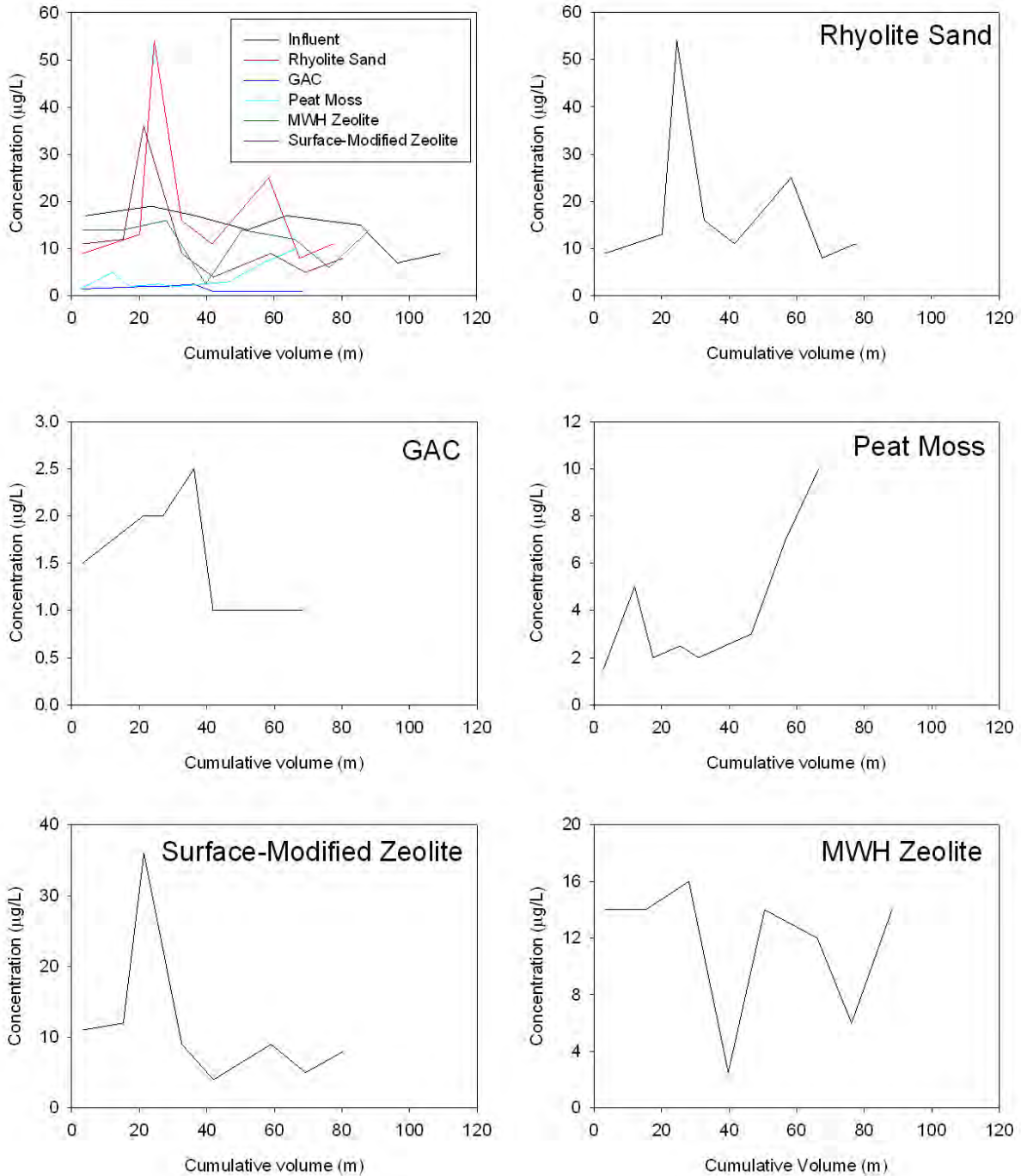


Figure A3-16. Breakthrough plots for filtered chromium.

Chromium, Filtered: Column Breakthrough Testing

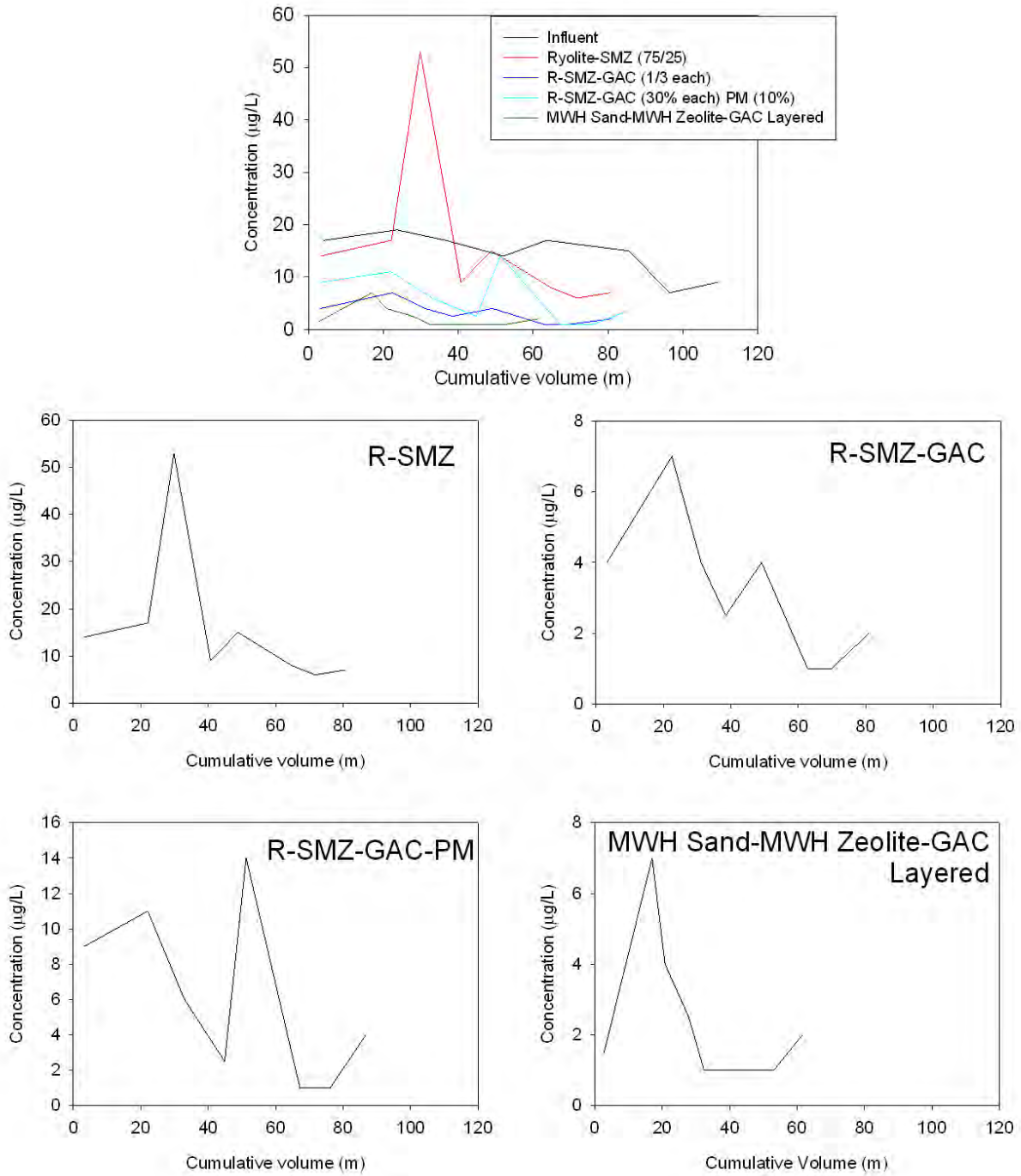


Figure A3-16. Breakthrough plots for filtered chromium (cont.).

Chemical Oxygen Demand: Column Breakthrough Testing

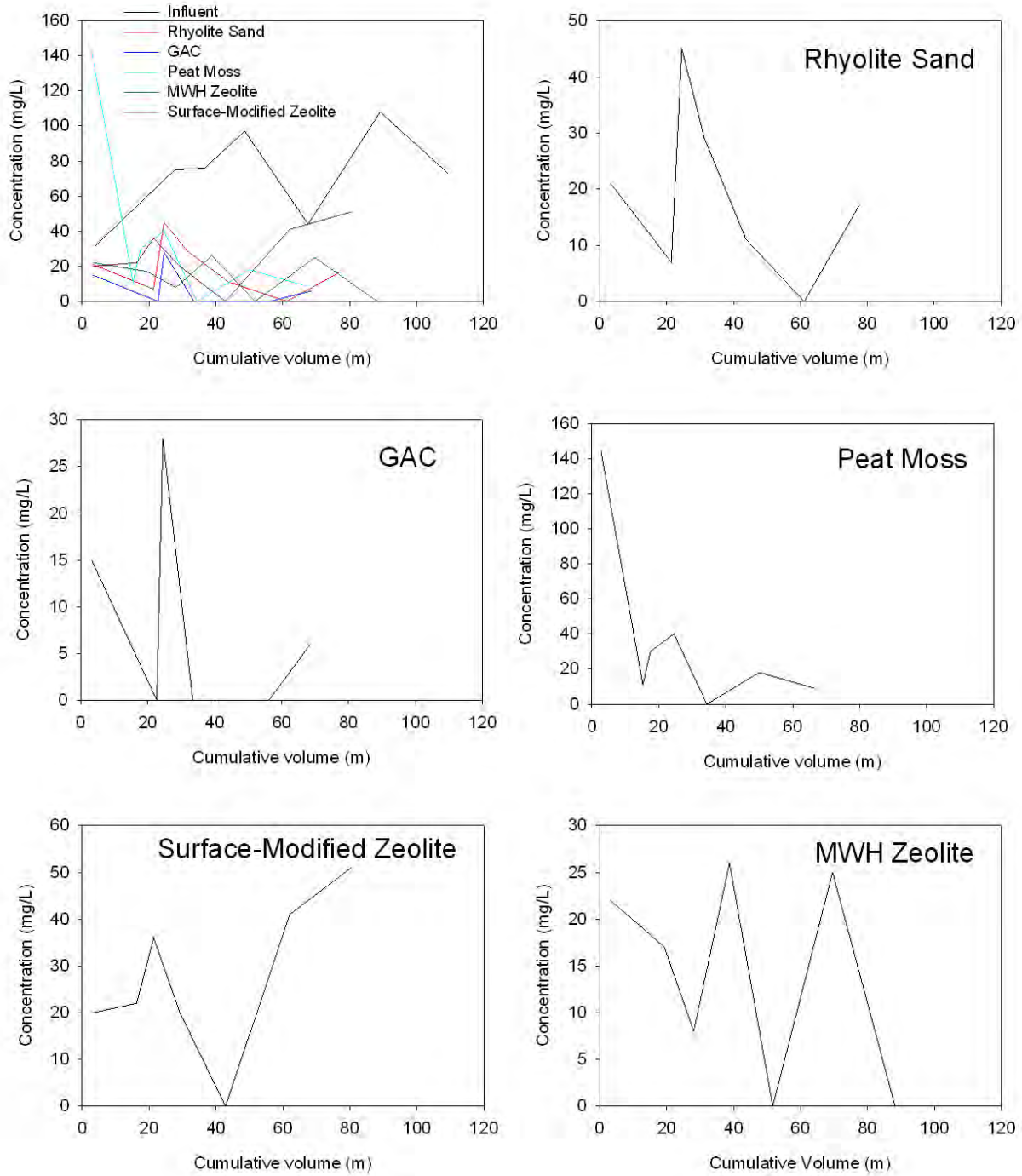


Figure A3-17. Breakthrough plots for COD.

Chemical Oxygen Demand: Column Breakthrough Testing

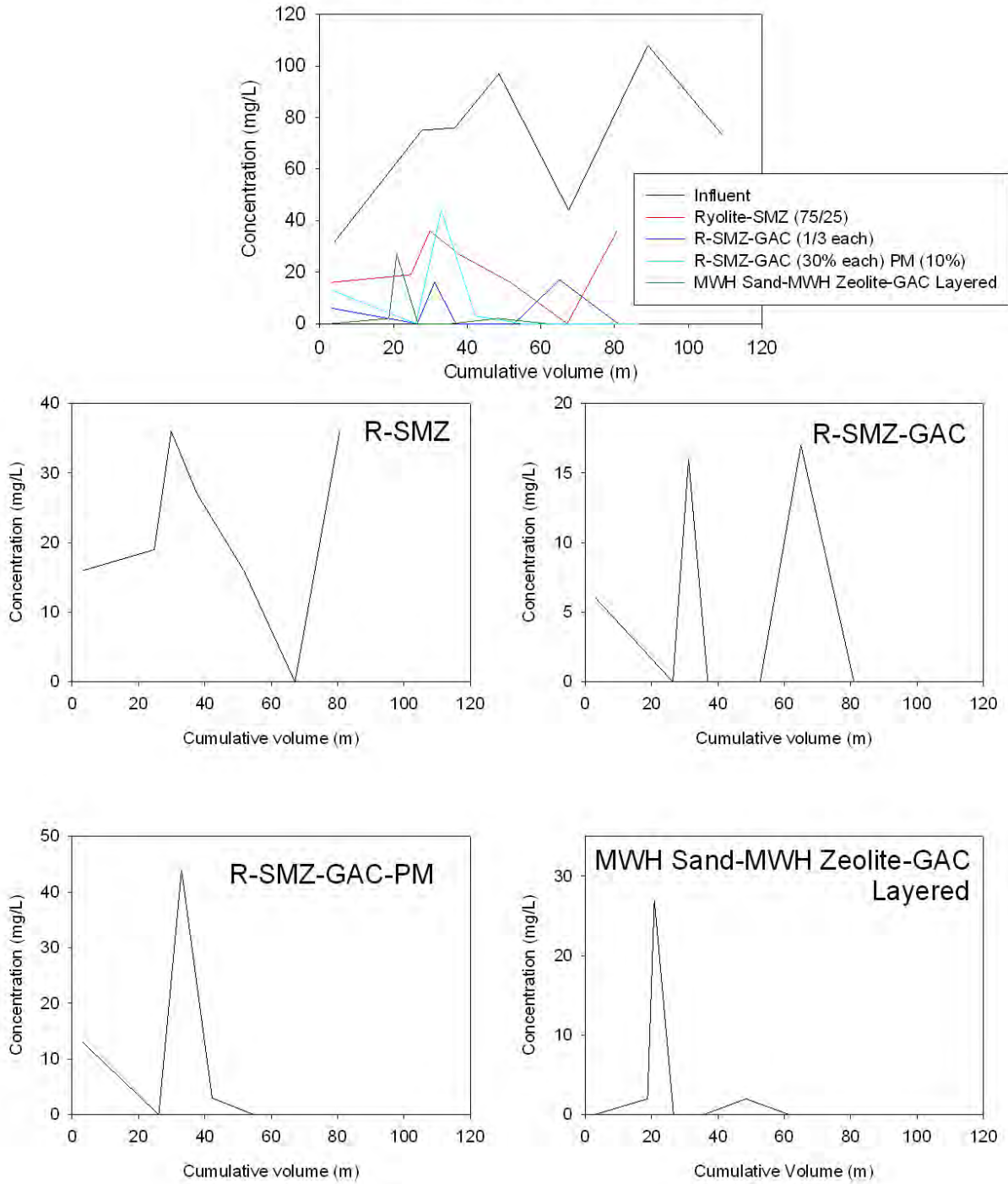


Figure A3-17. Breakthrough plots for COD (cont.).

Color, Apparent: Column Breakthrough Testing

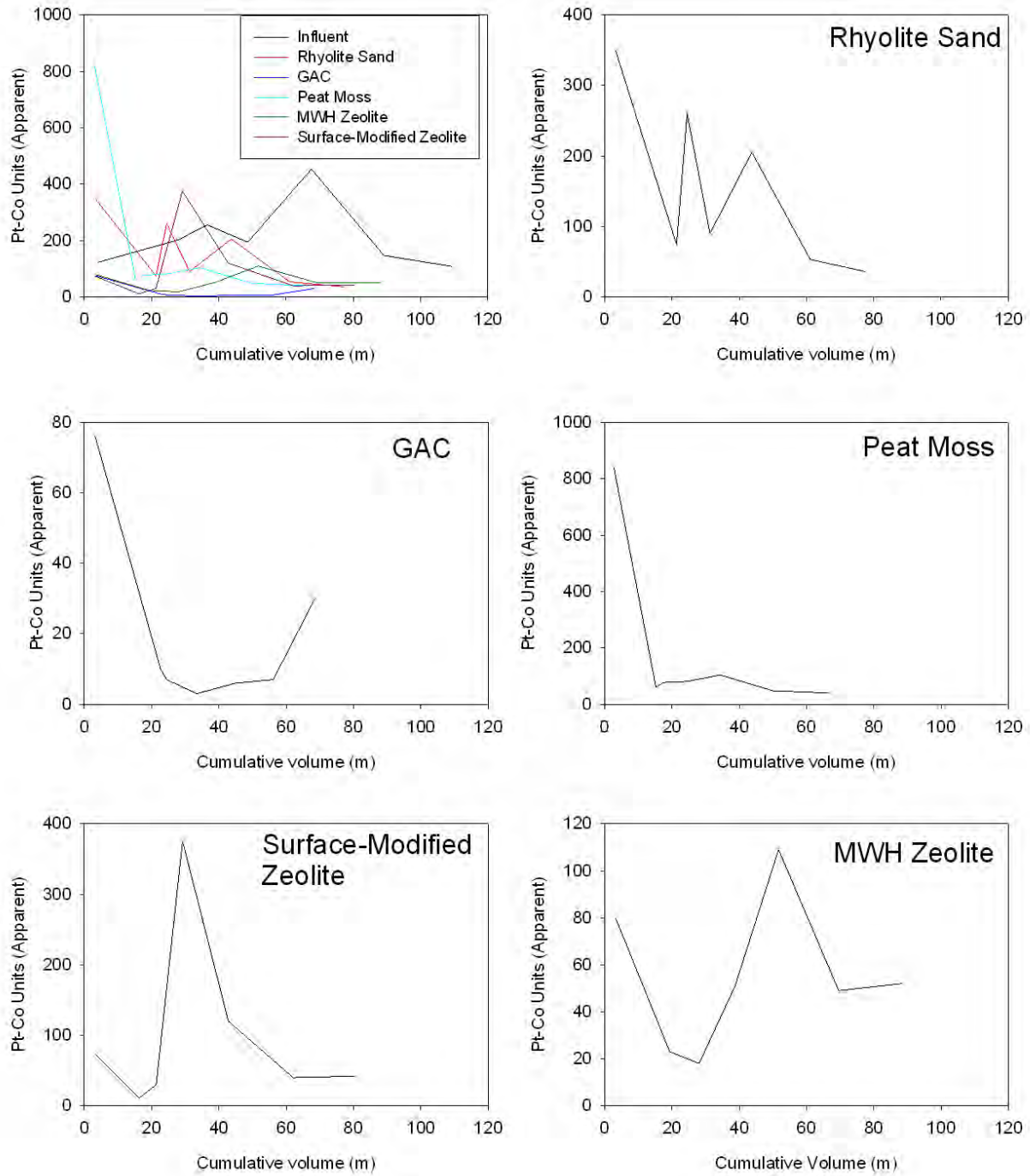


Figure A3-18. Breakthrough plots for color.

Color, Apparent: Column Breakthrough Testing

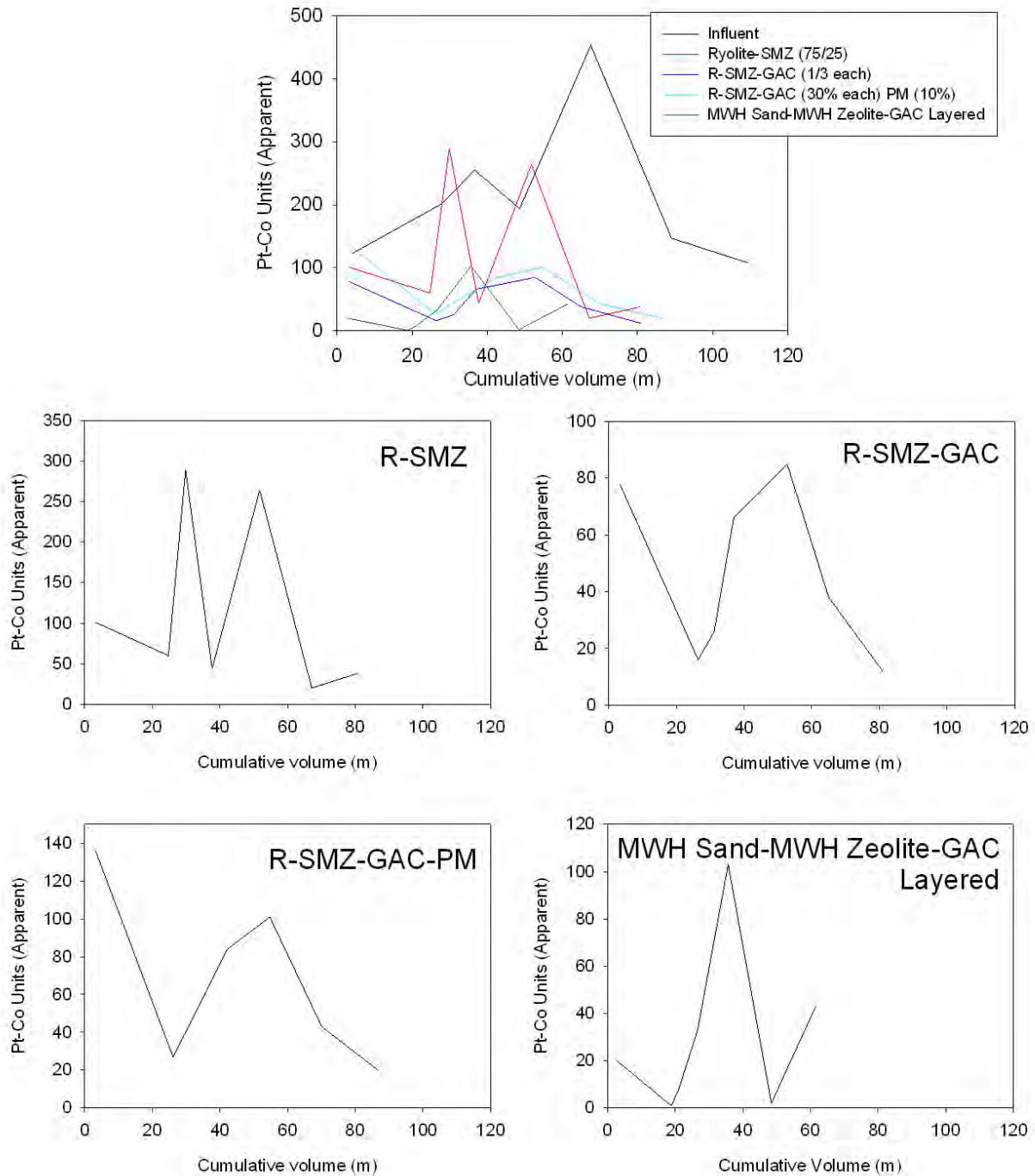


Figure A3-18. Breakthrough plots for color (cont.).

Conductivity: Column Breakthrough Testing

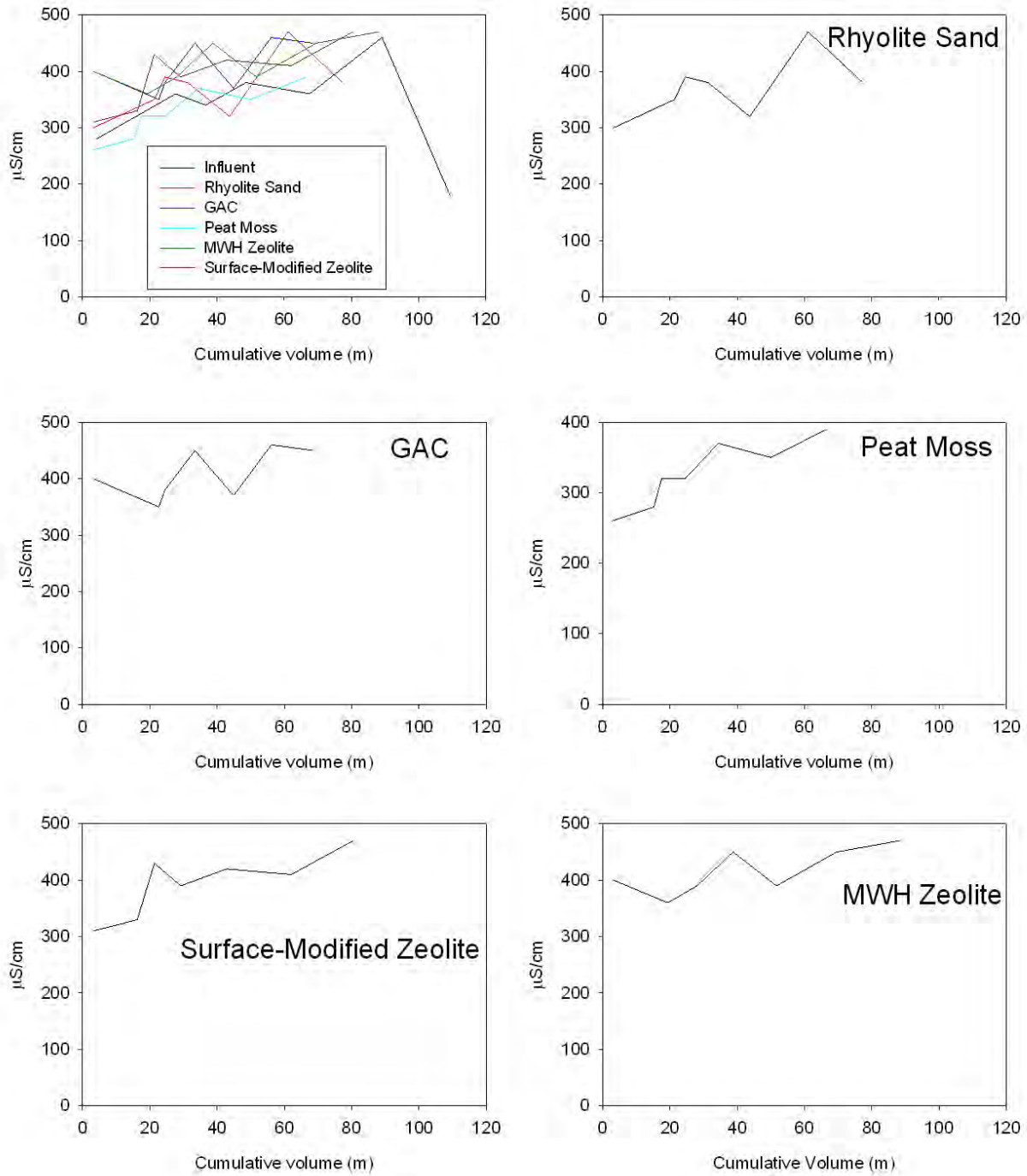


Figure A3-19. Breakthrough plots for conductivity.

Conductivity: Column Breakthrough Testing

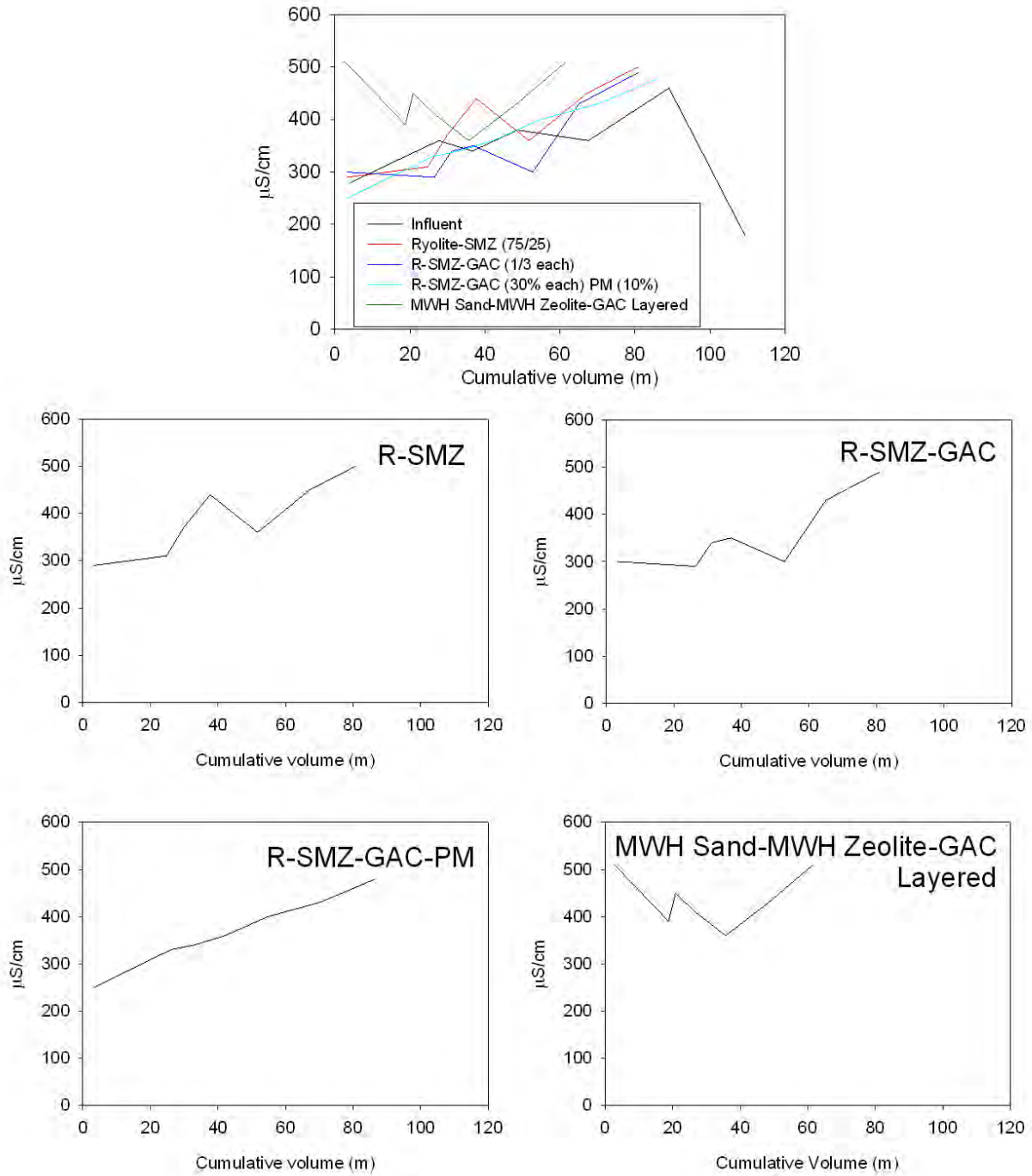


Figure A3-19. Breakthrough plots for conductivity (cont.).

Copper, Total: Column Breakthrough Testing

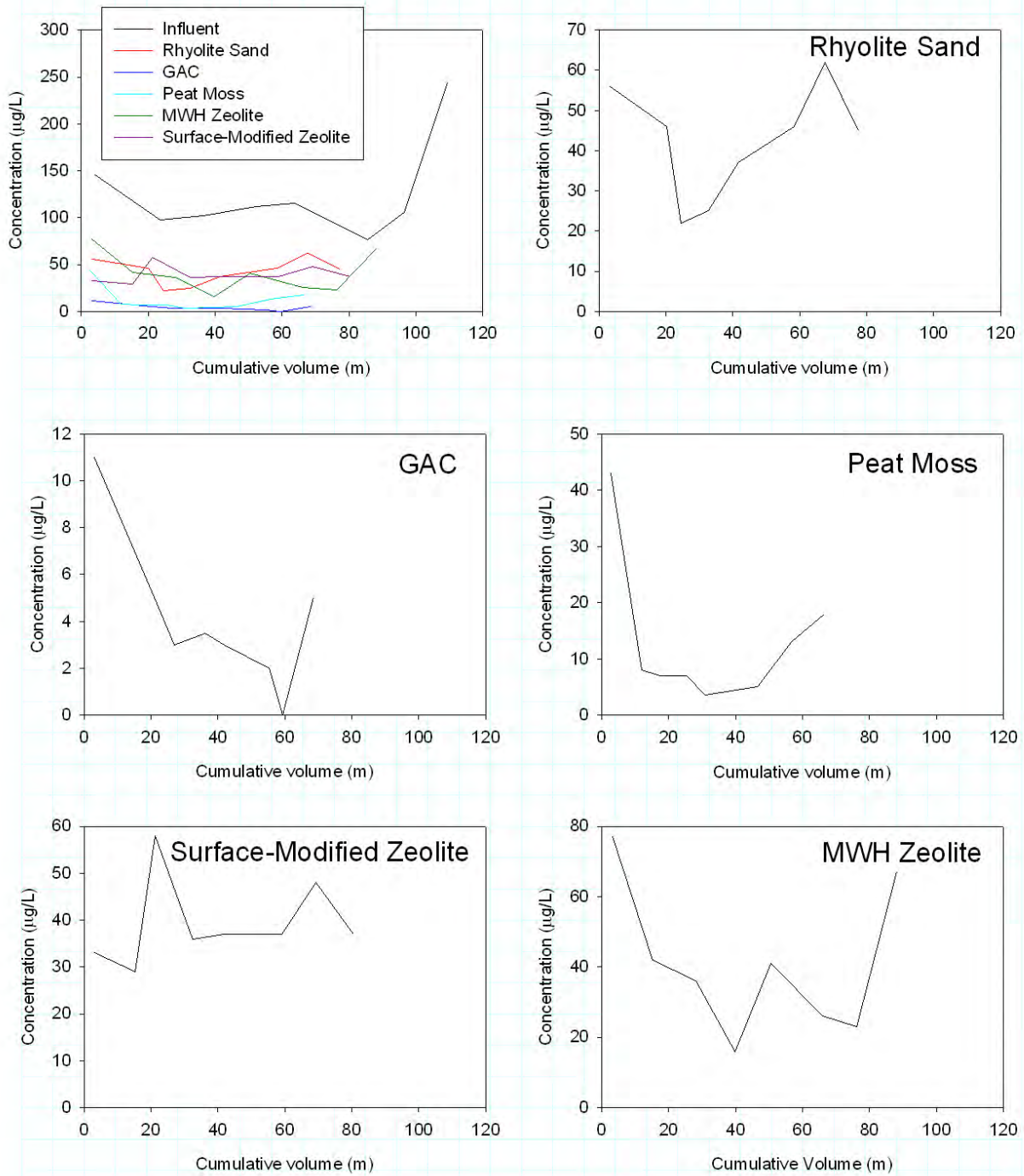


Figure A3-20. Breakthrough plots for total copper.

Copper, Total: Column Breakthrough Testing

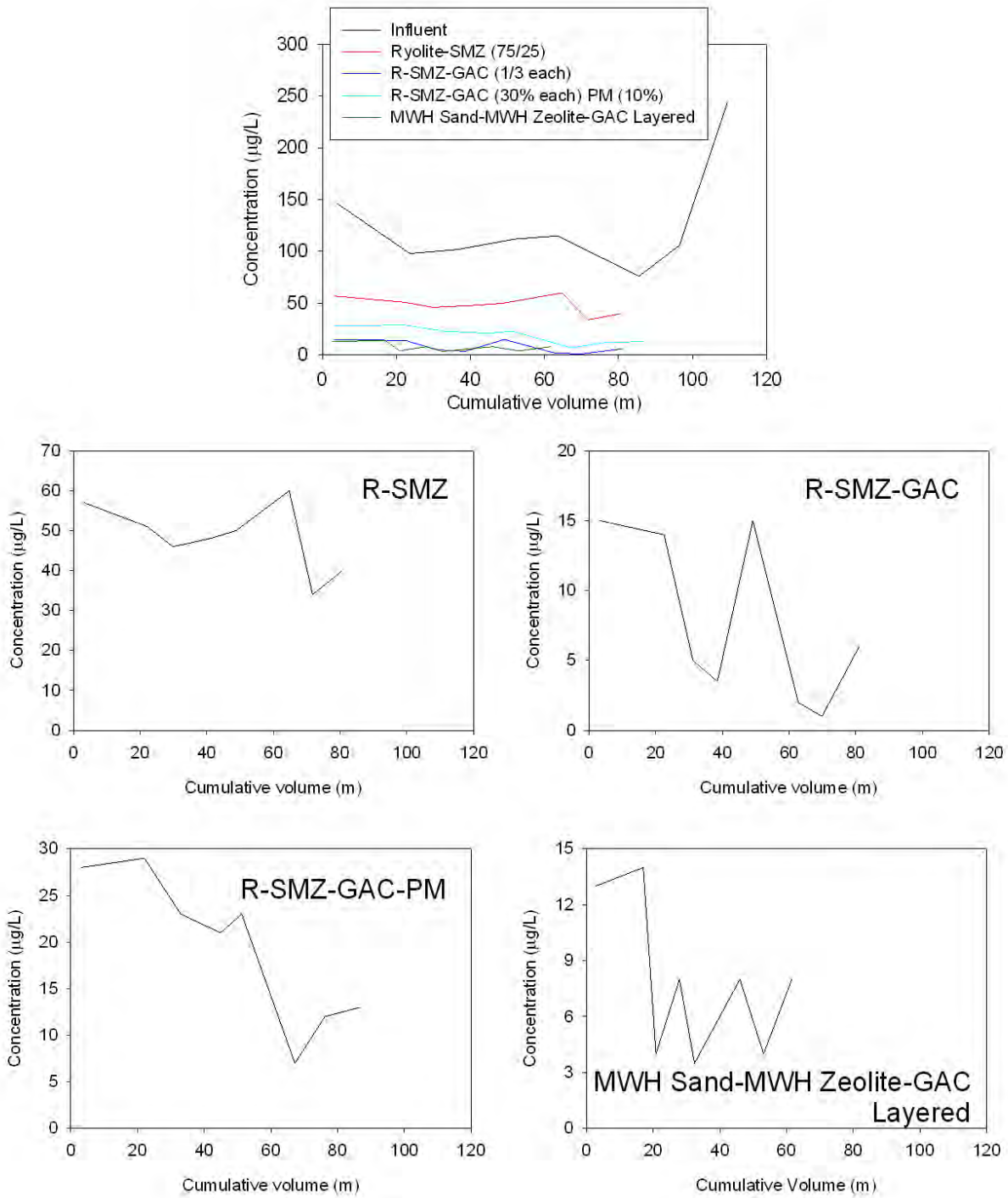


Figure A3-20. Breakthrough plots for total copper (cont.).

Copper, Filtered: Column Breakthrough Testing

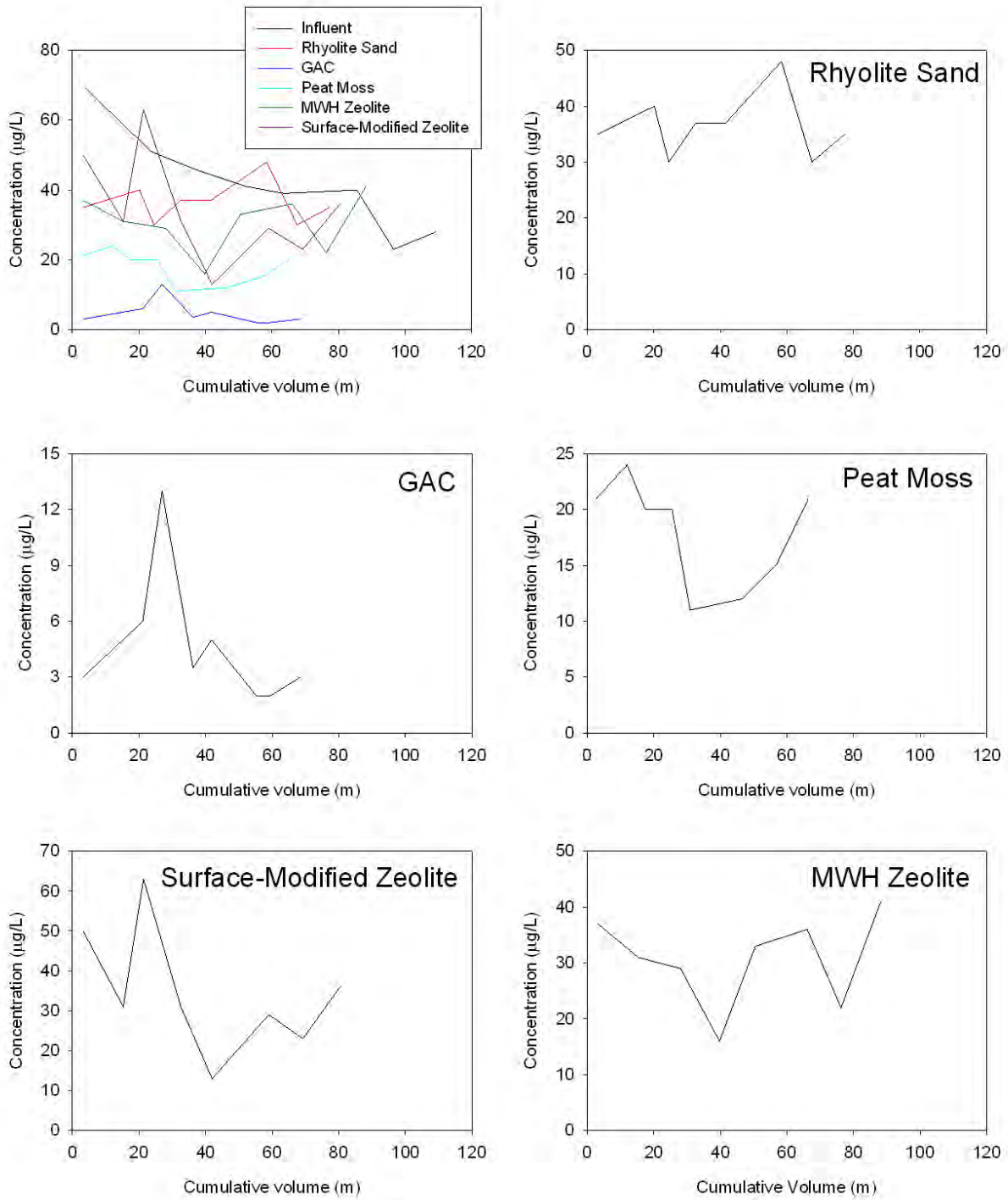


Figure A3-21. Breakthrough plots for filtered copper.

Copper, Filtered: Column Breakthrough Testing

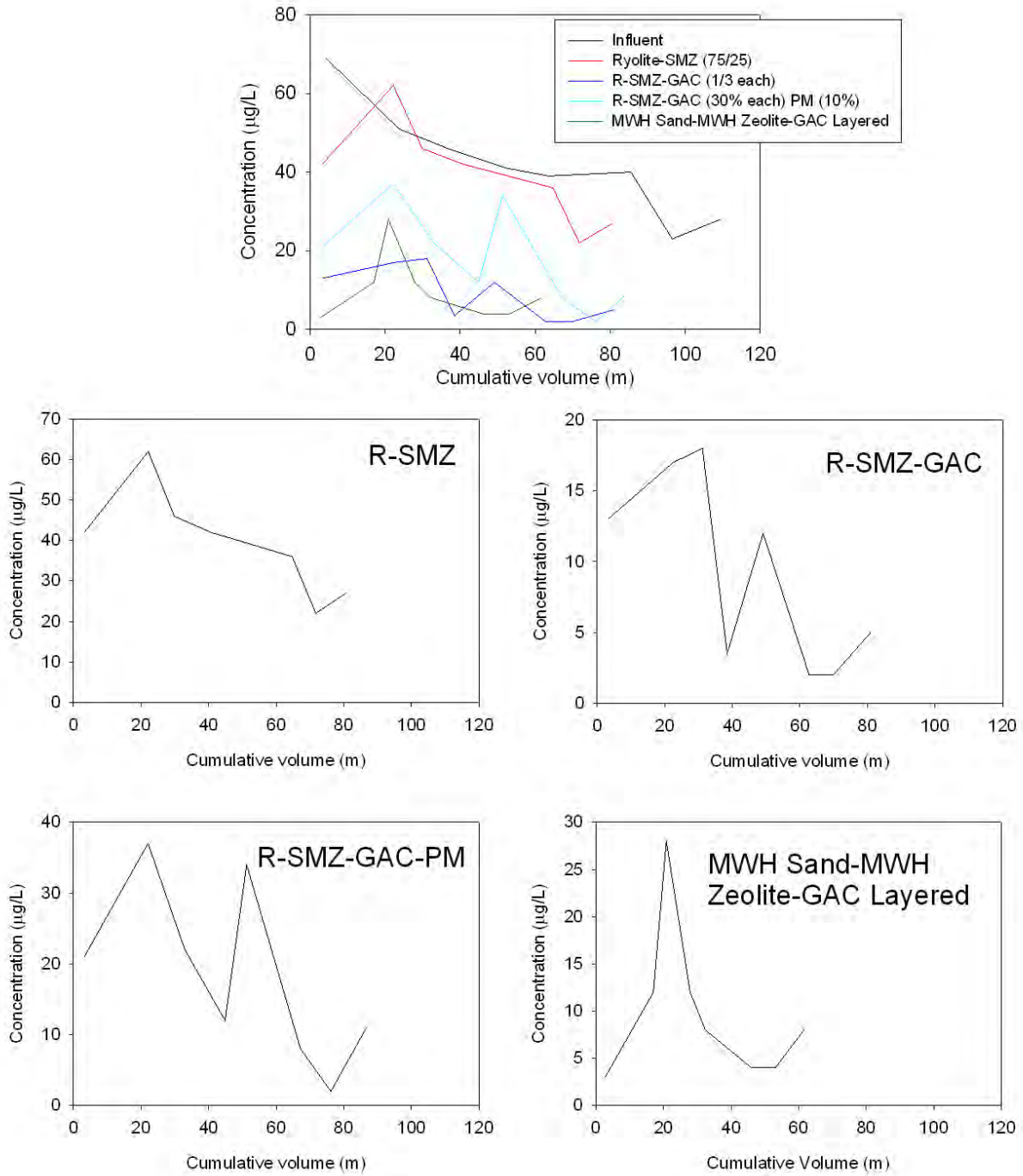


Figure A3-21. Breakthrough plots for filtered copper (cont.).

Fluoride: Column Breakthrough Testing

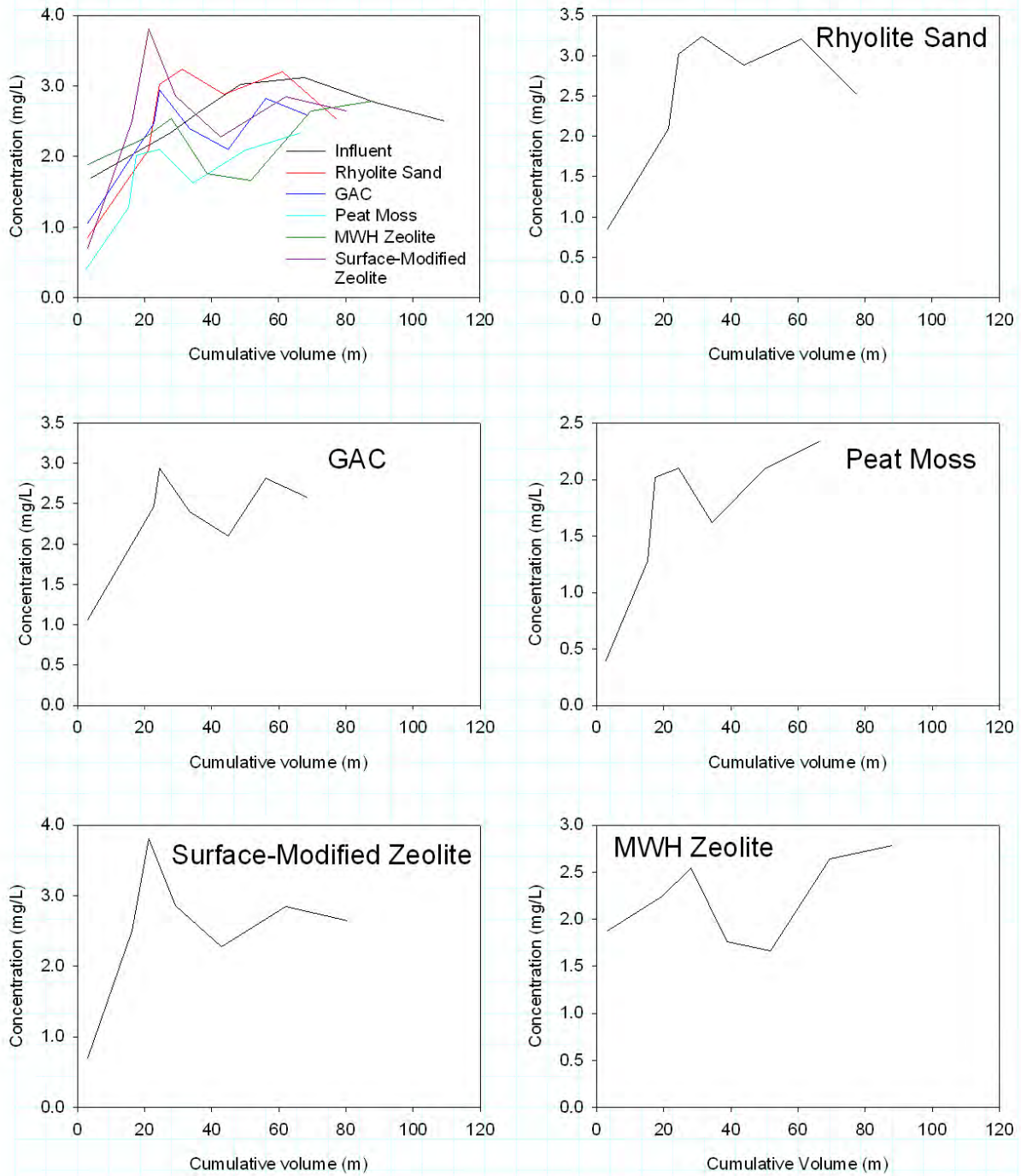


Figure A3-22. Breakthrough plots for fluoride.

Fluoride: Column Breakthrough Testing

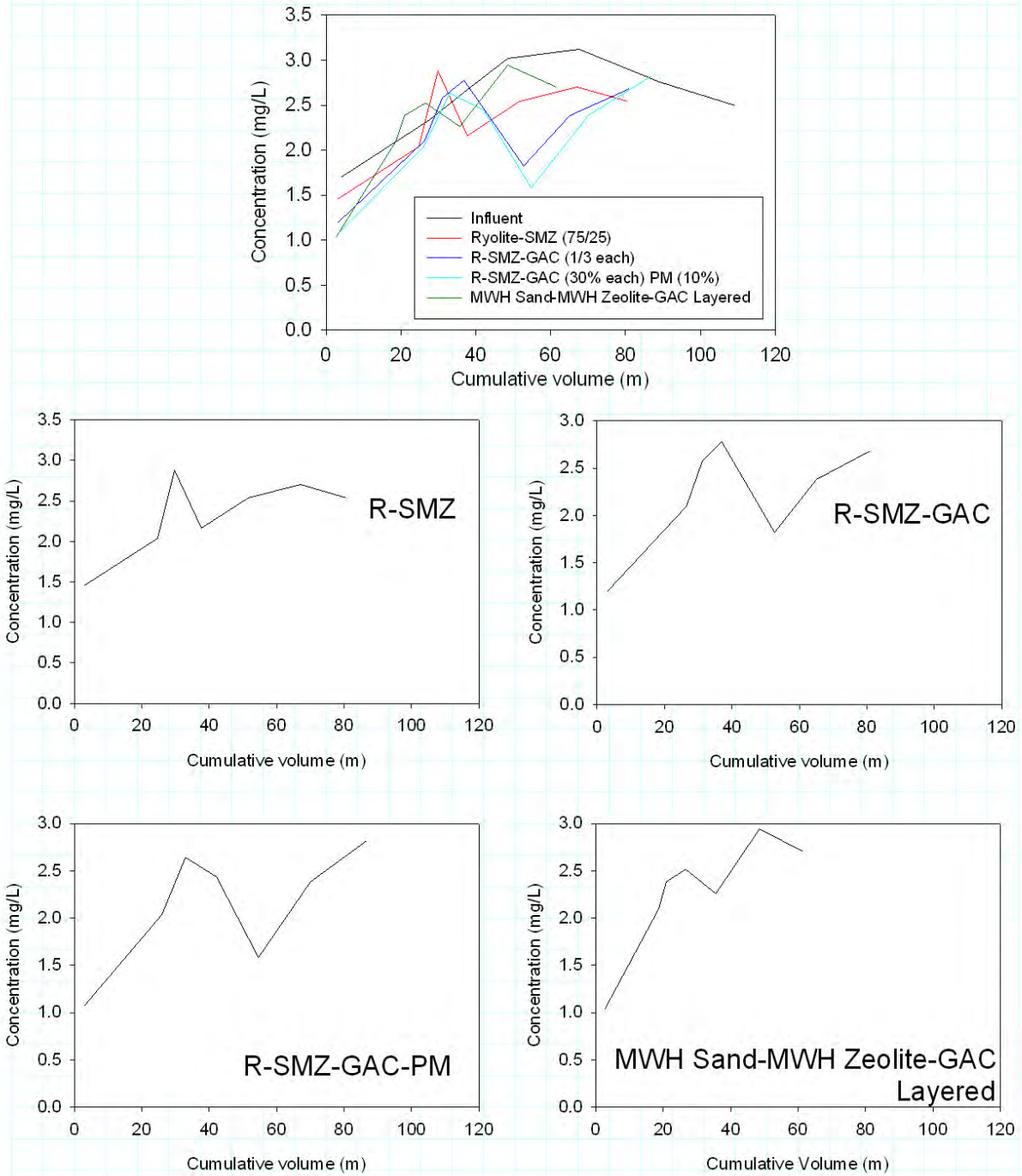


Figure A3-22. Breakthrough plots for fluoride (cont.).

Iron, Total: Column Breakthrough Testing

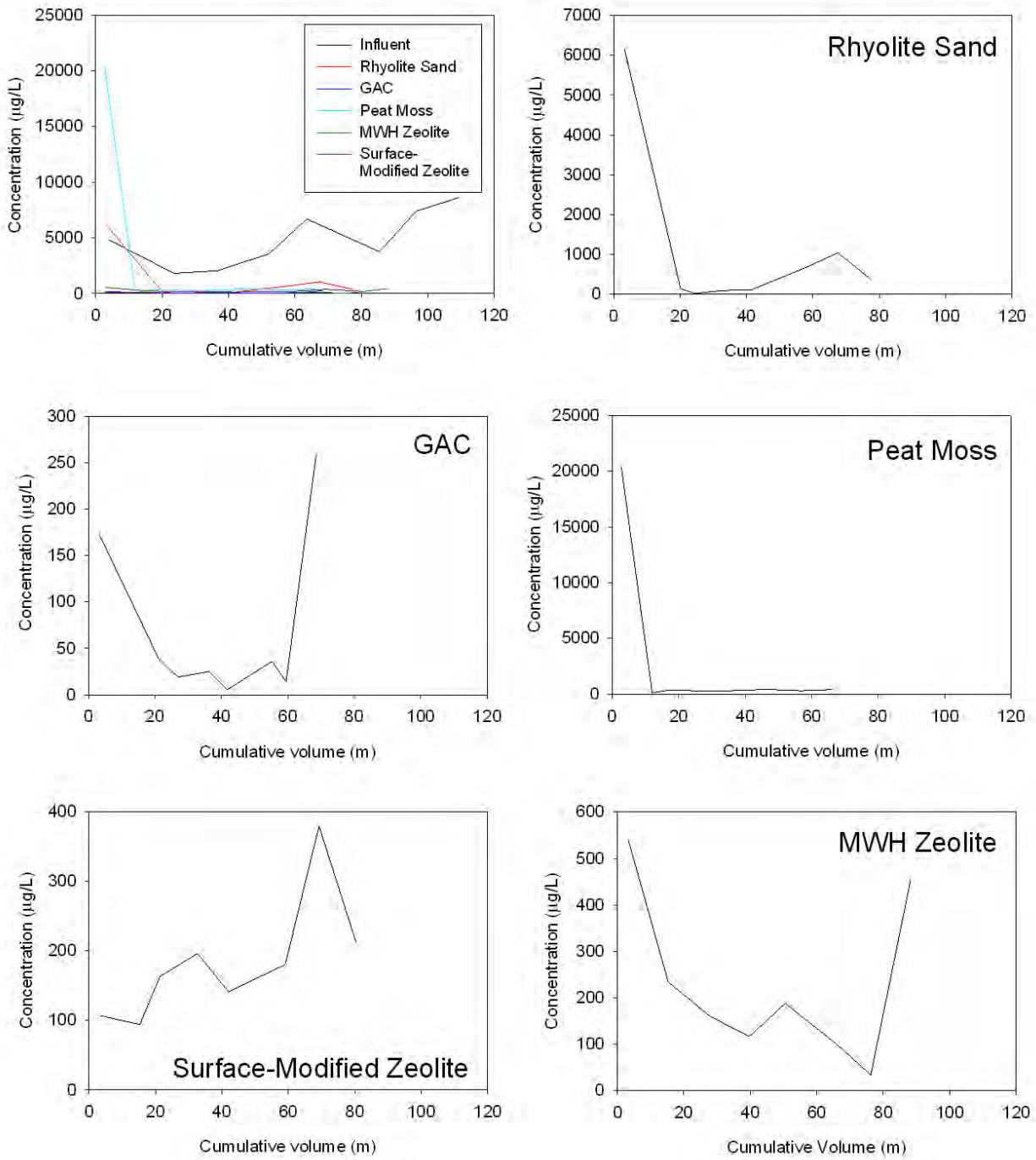


Figure A3-23. Breakthrough plots for total iron.

Iron, Total: Column Breakthrough Testing

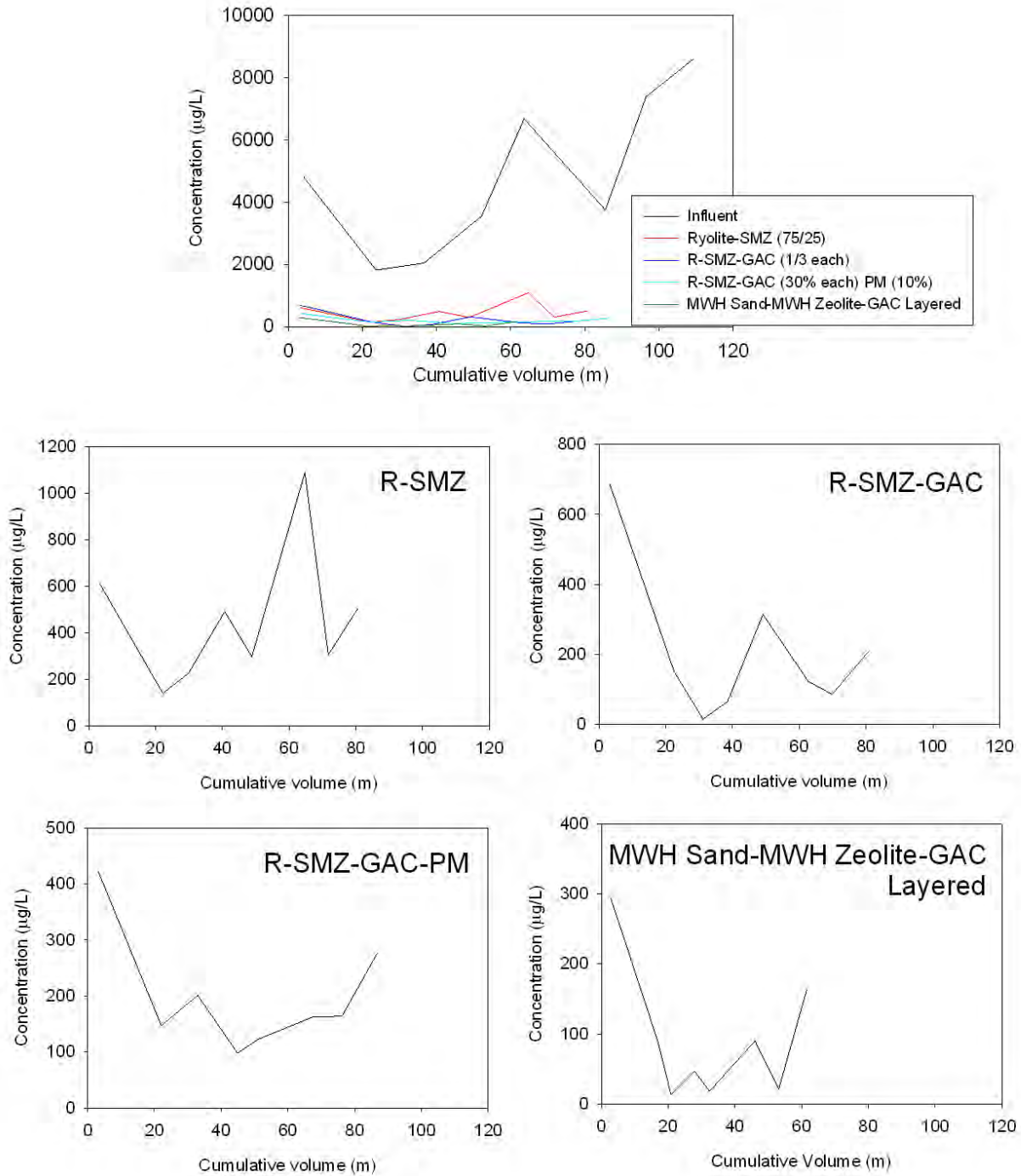


Figure A3-23. Breakthrough plots for total iron (cont.).

Iron, Filtered: Column Breakthrough Testing

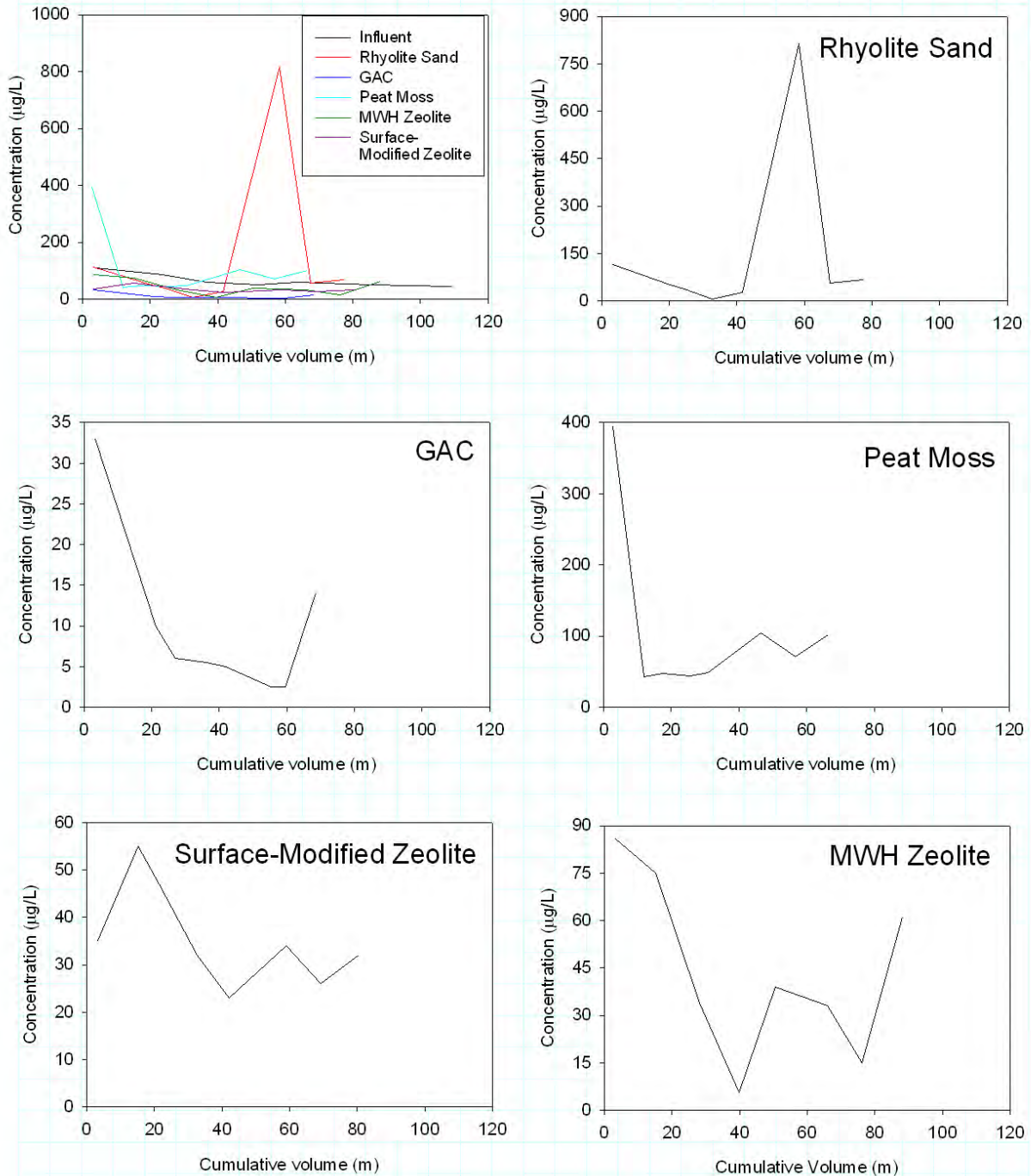


Figure A3-24. Breakthrough plots for filtered iron.

Iron, Filtered: Column Breakthrough Testing

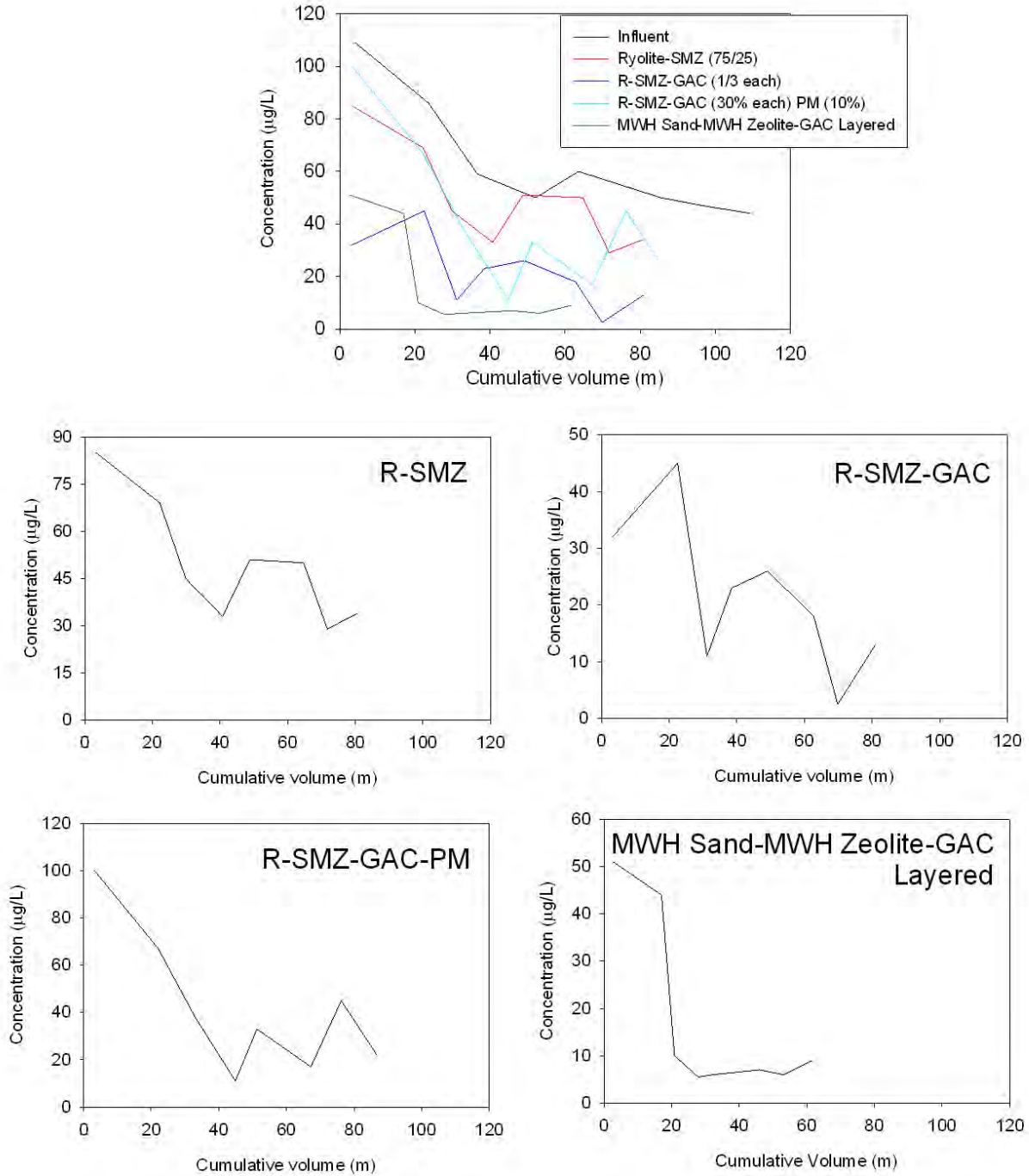


Figure A3-24. Breakthrough plots for filtered iron (cont.).

Lead, Total: Column Breakthrough Testing

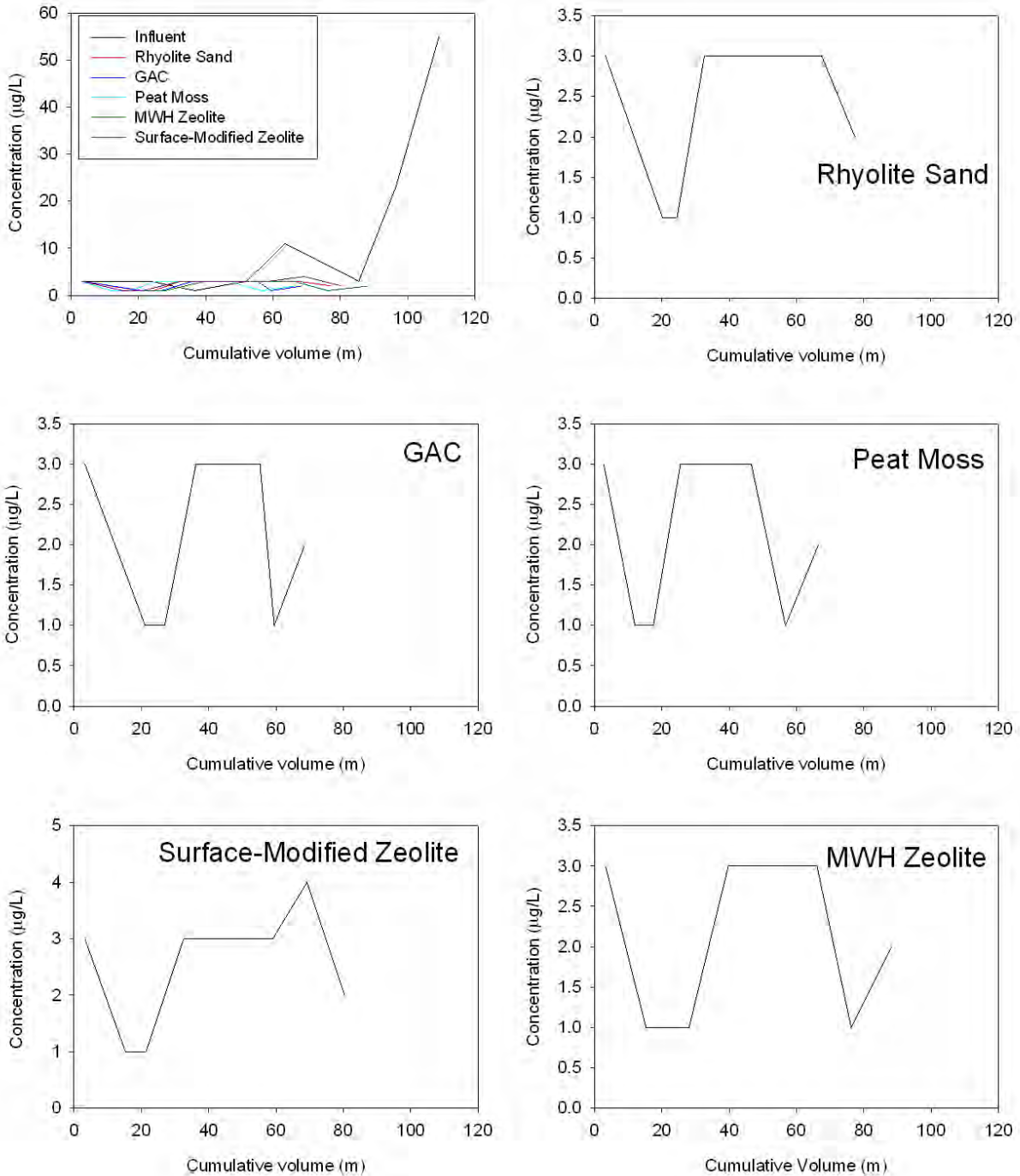


Figure A3-25. Breakthrough plots for total lead.

Lead, Total: Column Breakthrough Testing

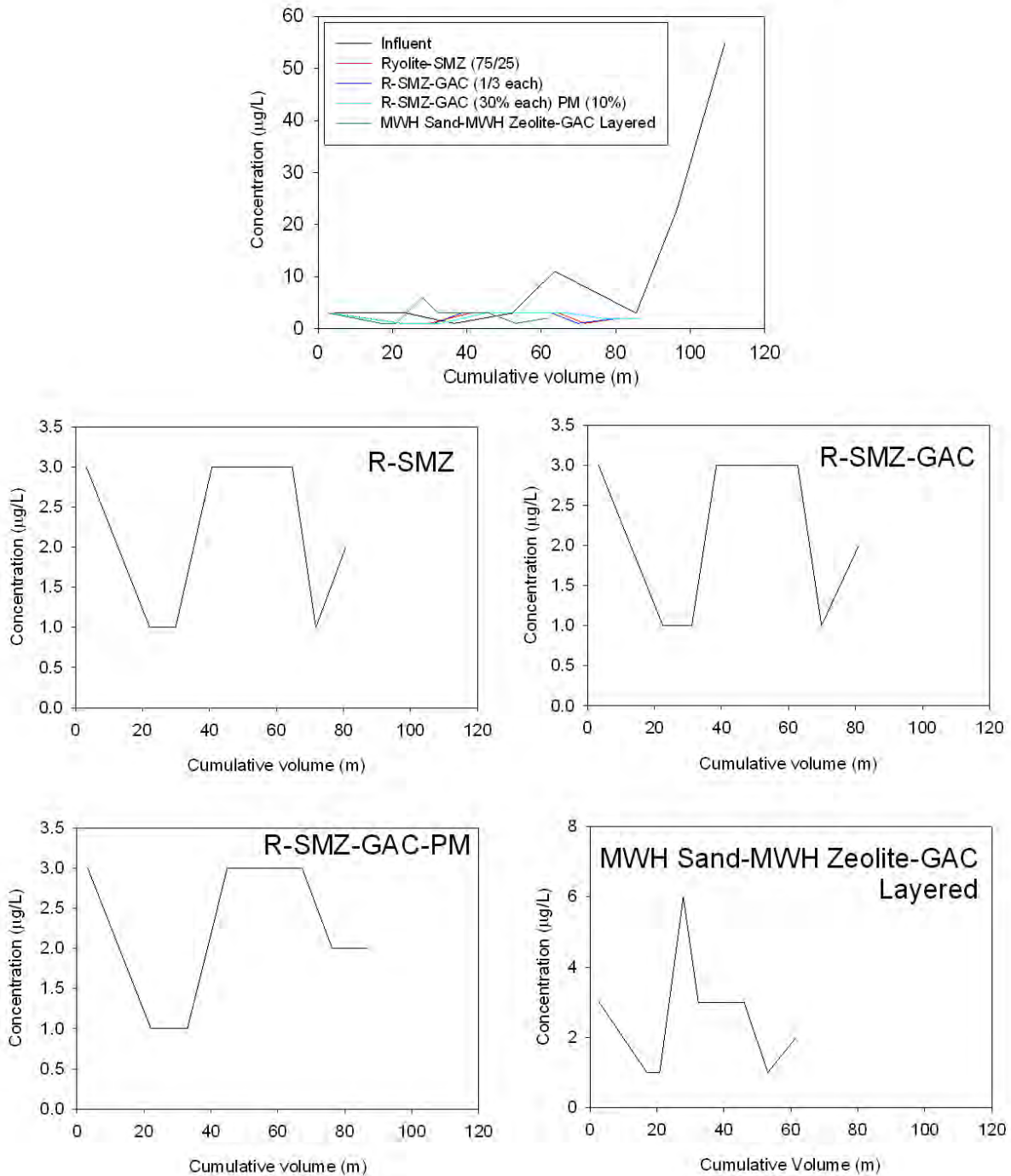


Figure A3-25. Breakthrough plots for total lead (cont.).

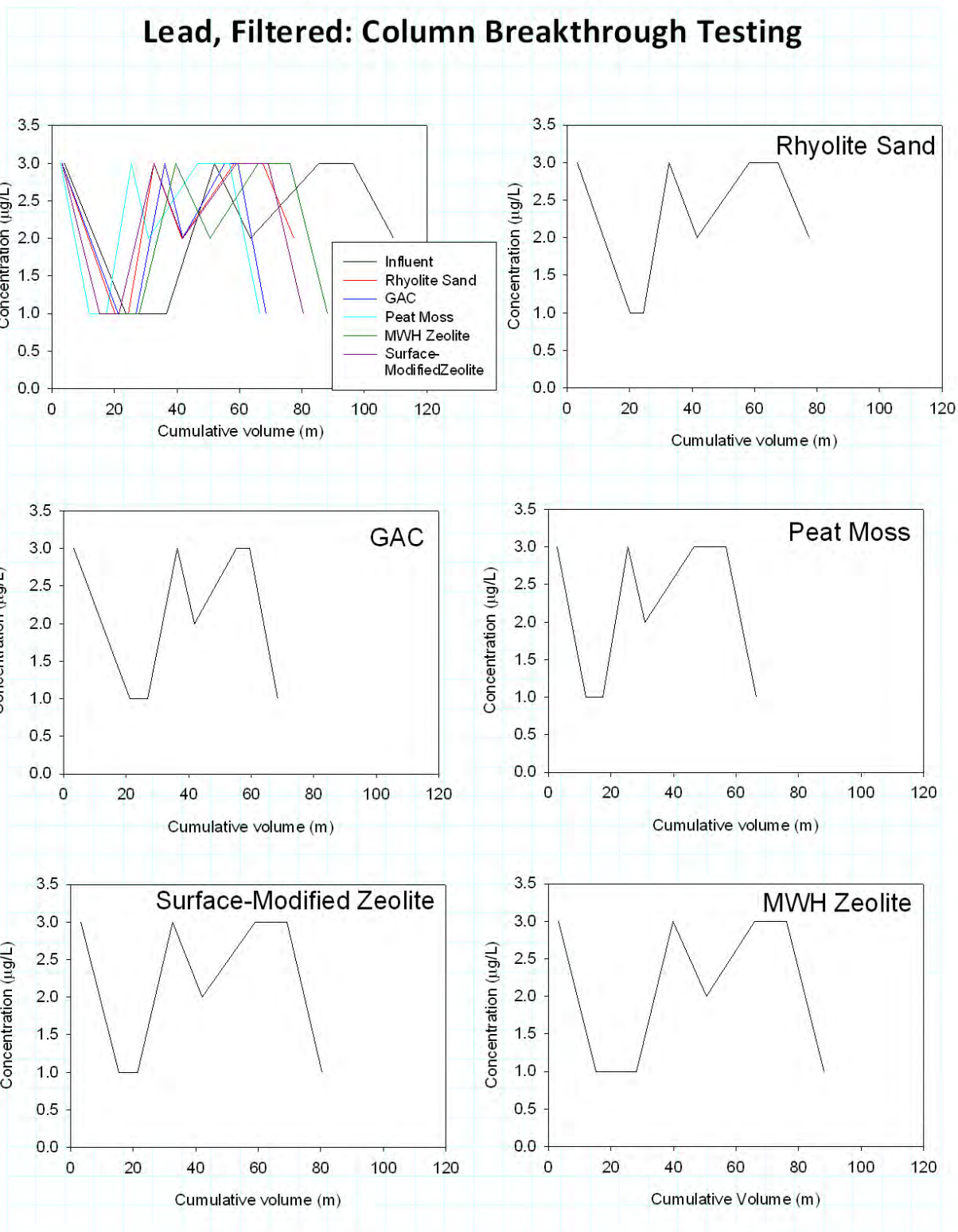


Figure A3-26. Breakthrough plots for filtered lead.

Lead, Filtered: Column Breakthrough Testing

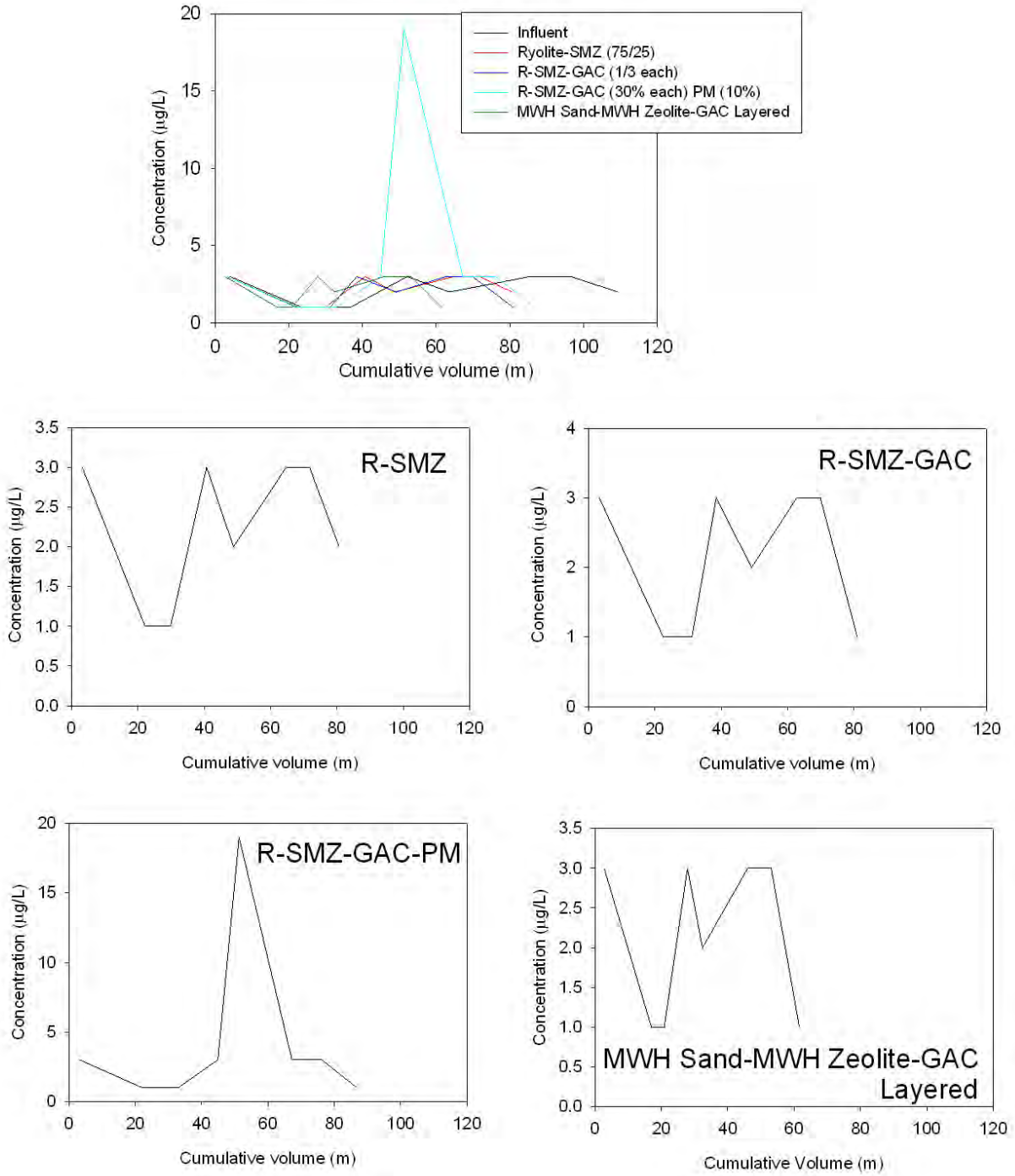


Figure A3-26. Breakthrough plots for filtered lead (cont.).

Magnesium, Total: Column Breakthrough Testing

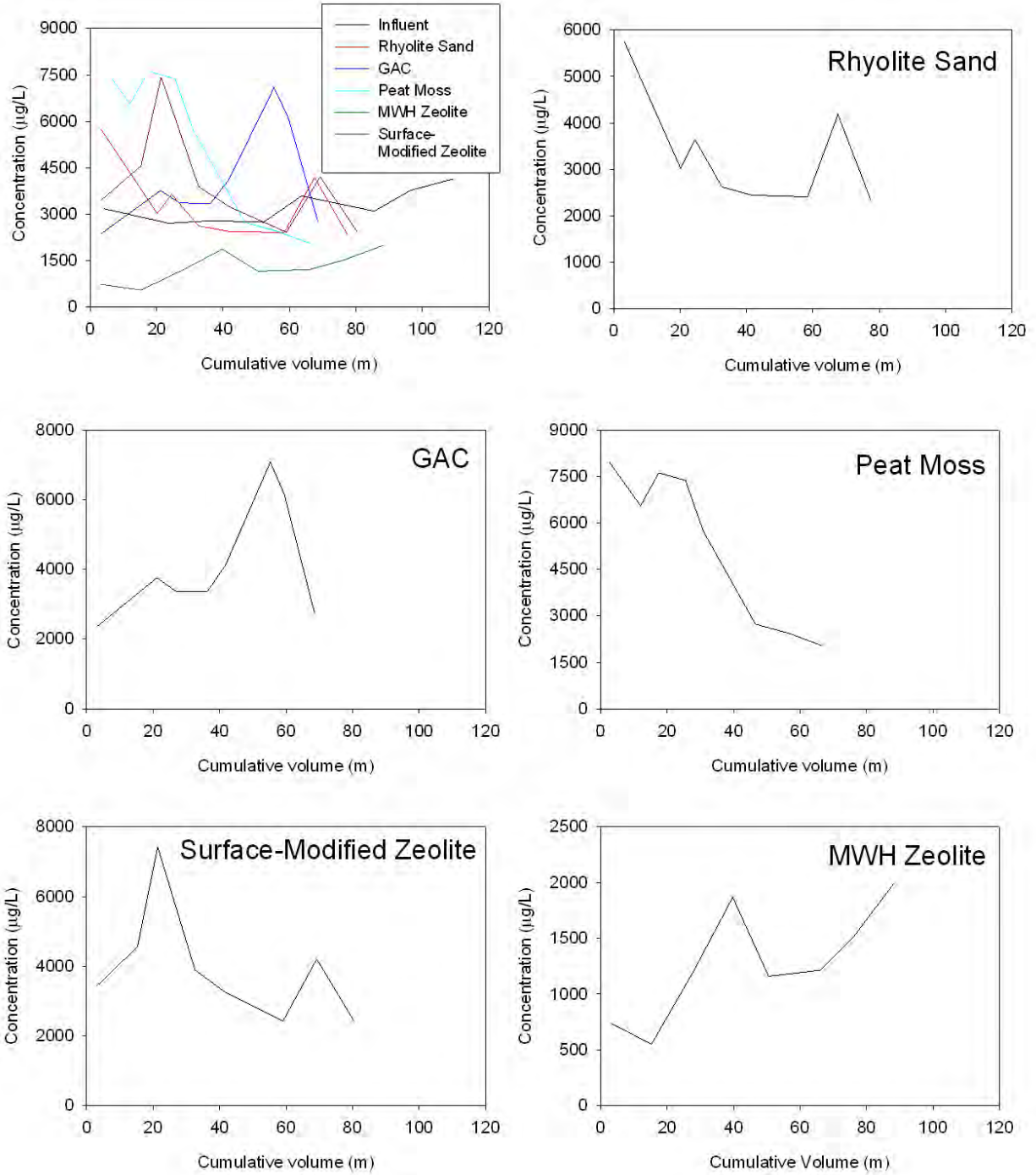


Figure A3-27. Breakthrough plots for total magnesium.

Magnesium, Total: Column Breakthrough Testing

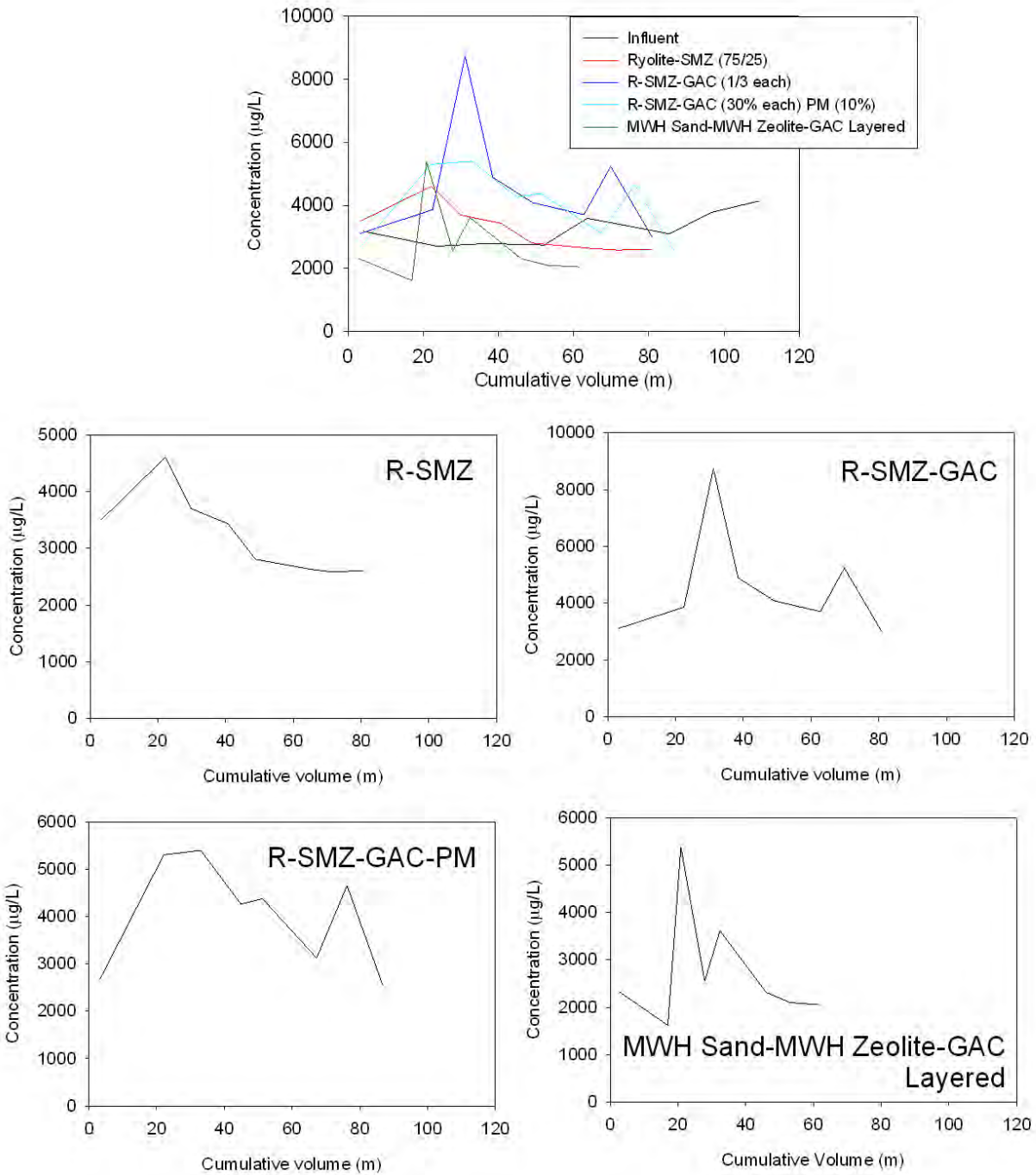


Figure A3-27. Breakthrough plots for total magnesium (cont.).

Magnesium, Filtered: Column Breakthrough Testing

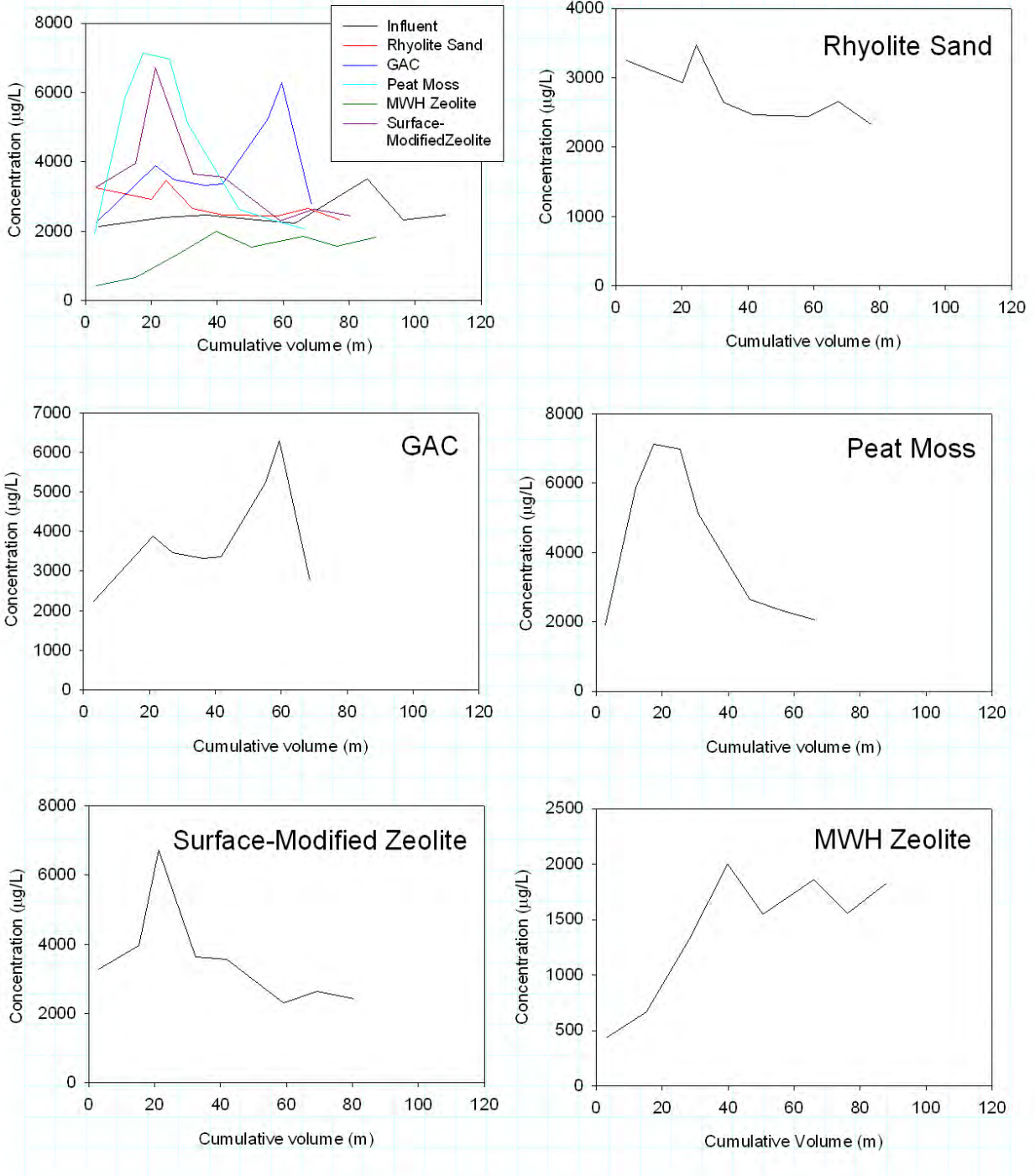


Figure A3-28. Breakthrough plots for filtered magnesium.

Magnesium, Filtered: Column Breakthrough Testing

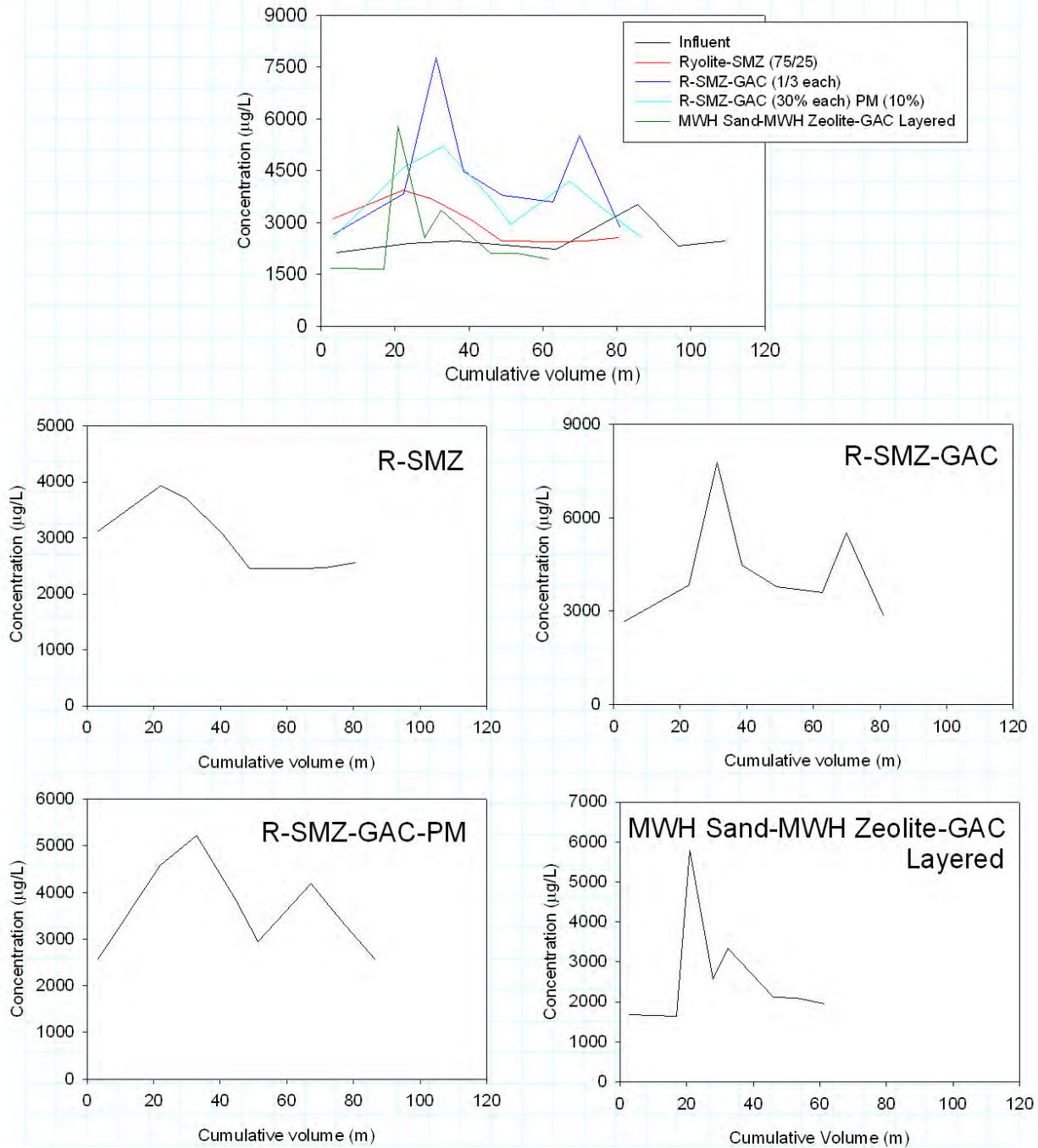


Figure A3-28. Breakthrough plots for filtered magnesium (cont.).

Manganese, Total: Column Breakthrough Testing

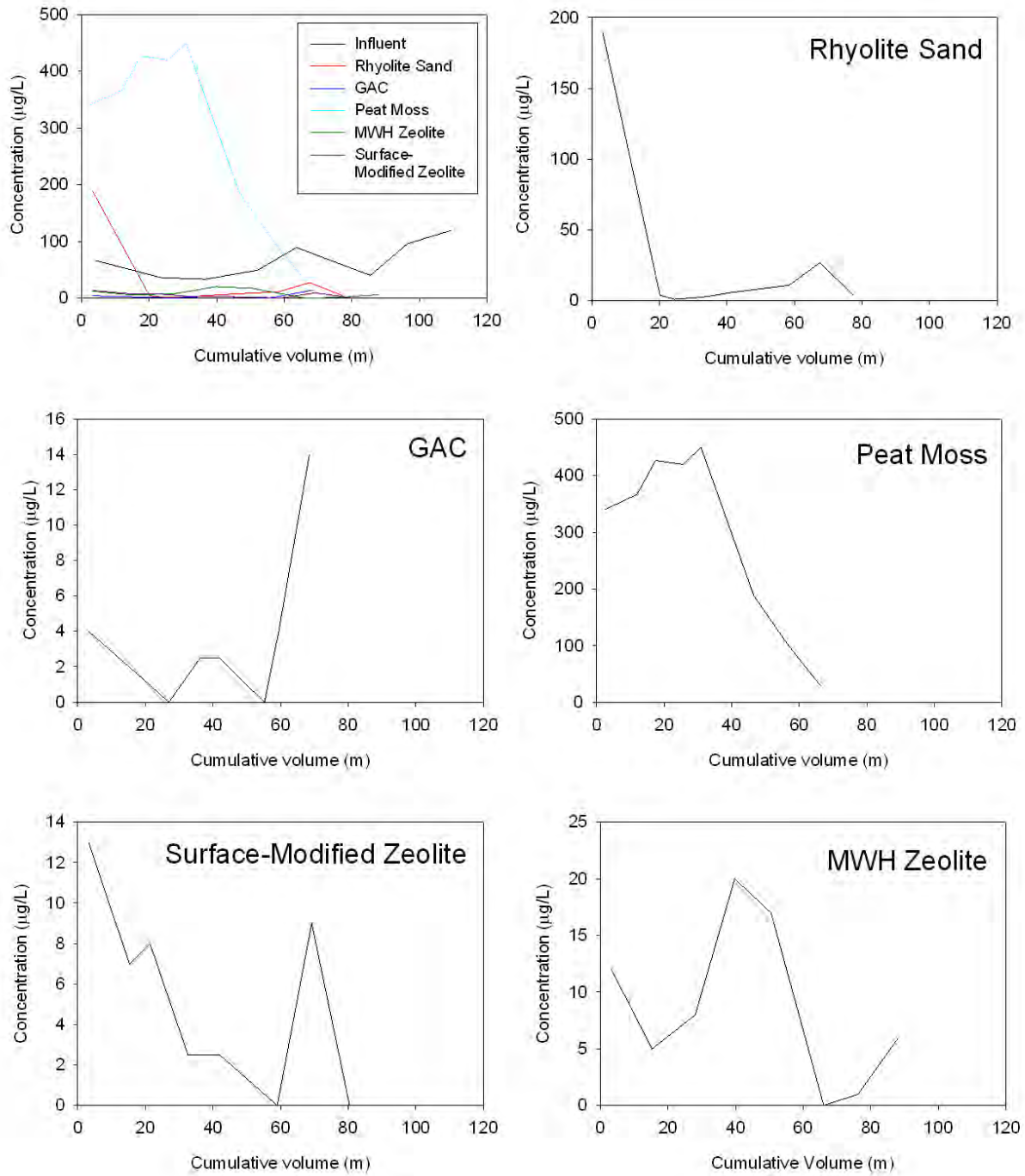


Figure A3-29. Breakthrough plots for total manganese.

Manganese, Total: Column Breakthrough Testing

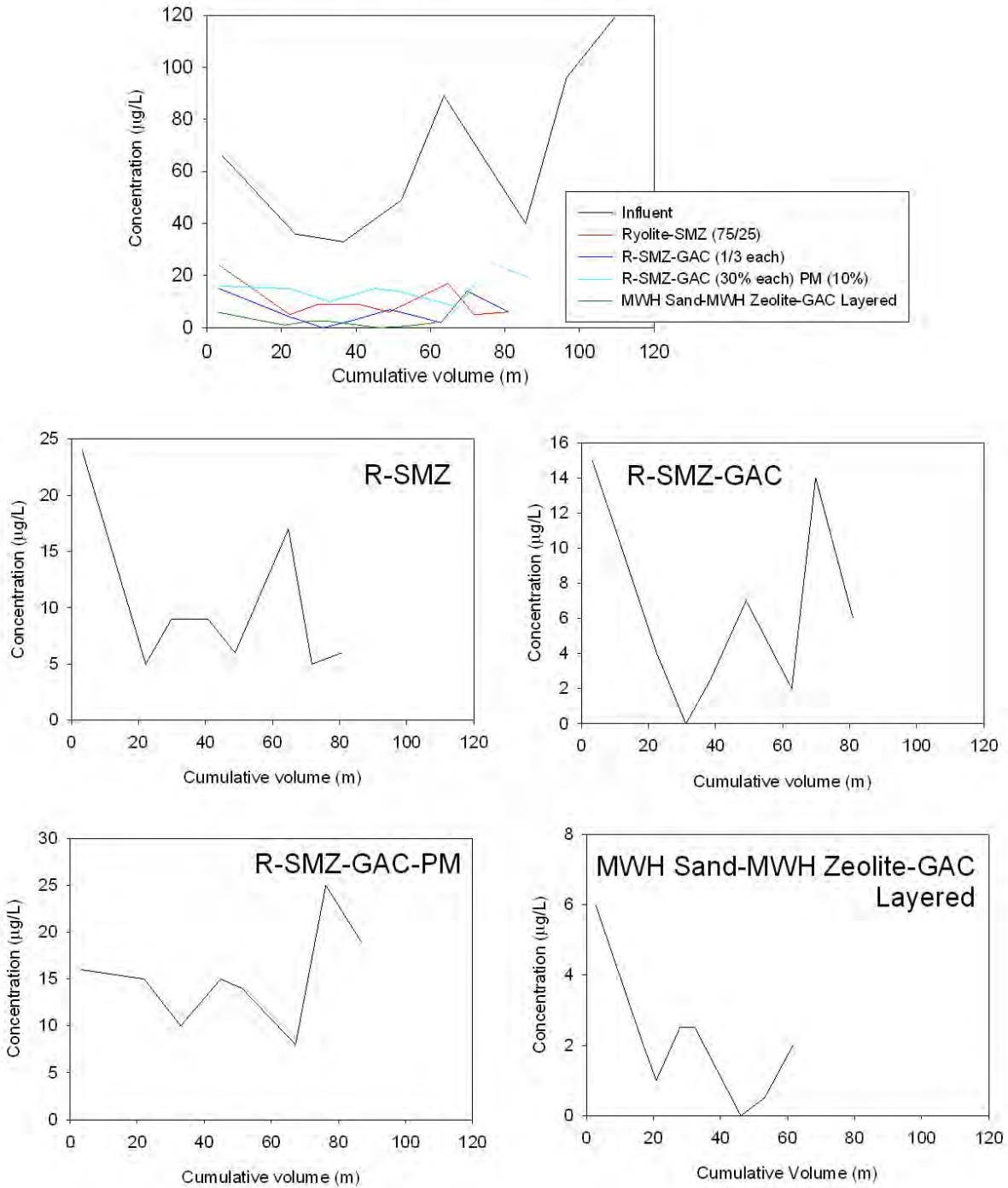


Figure A3-29. Breakthrough plots for total manganese (cont.).

Manganese, Filtered: Column Breakthrough Testing

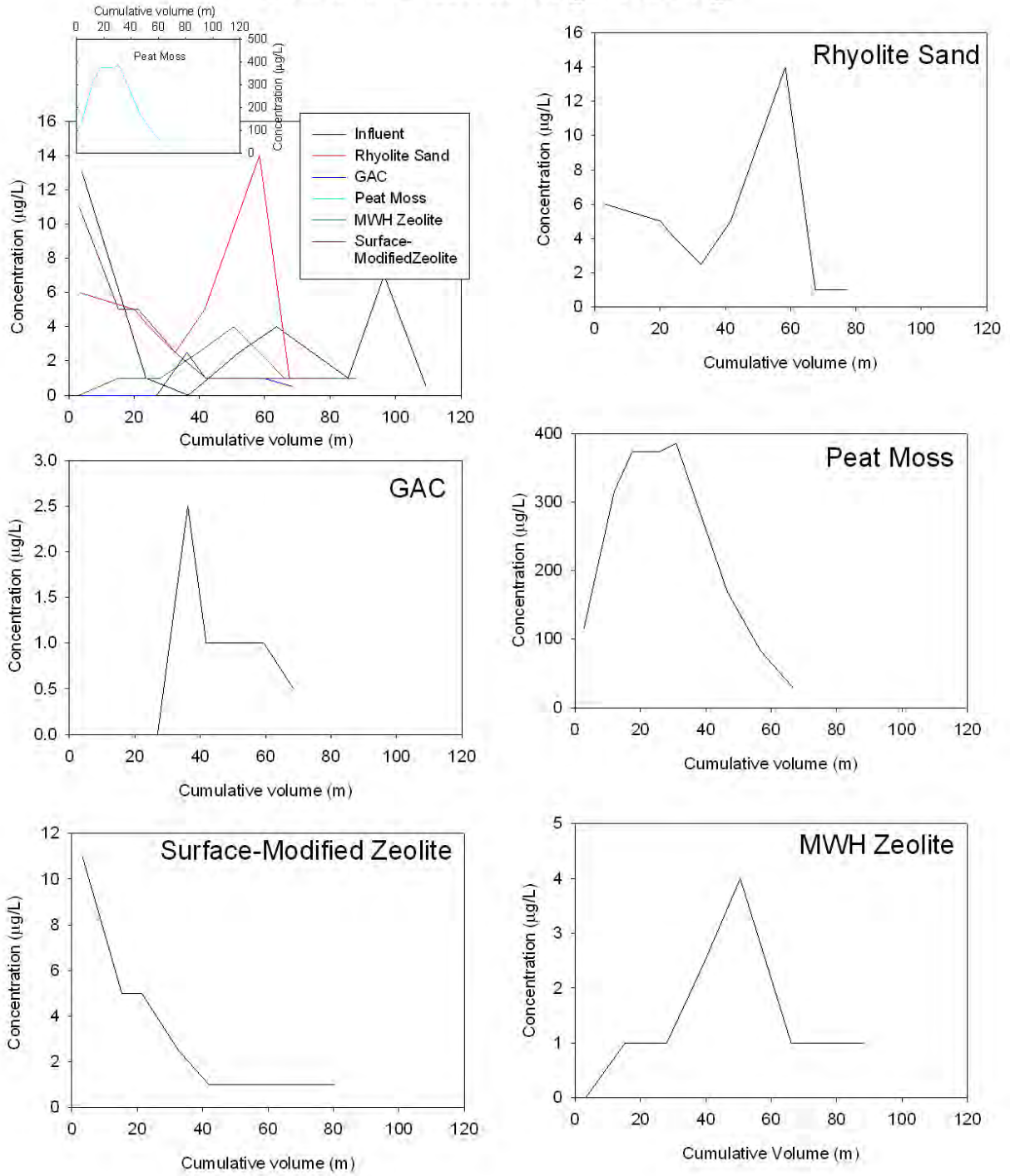


Figure A3-30. Breakthrough plots for filtered manganese.

Manganese, Filtered: Column Breakthrough Testing

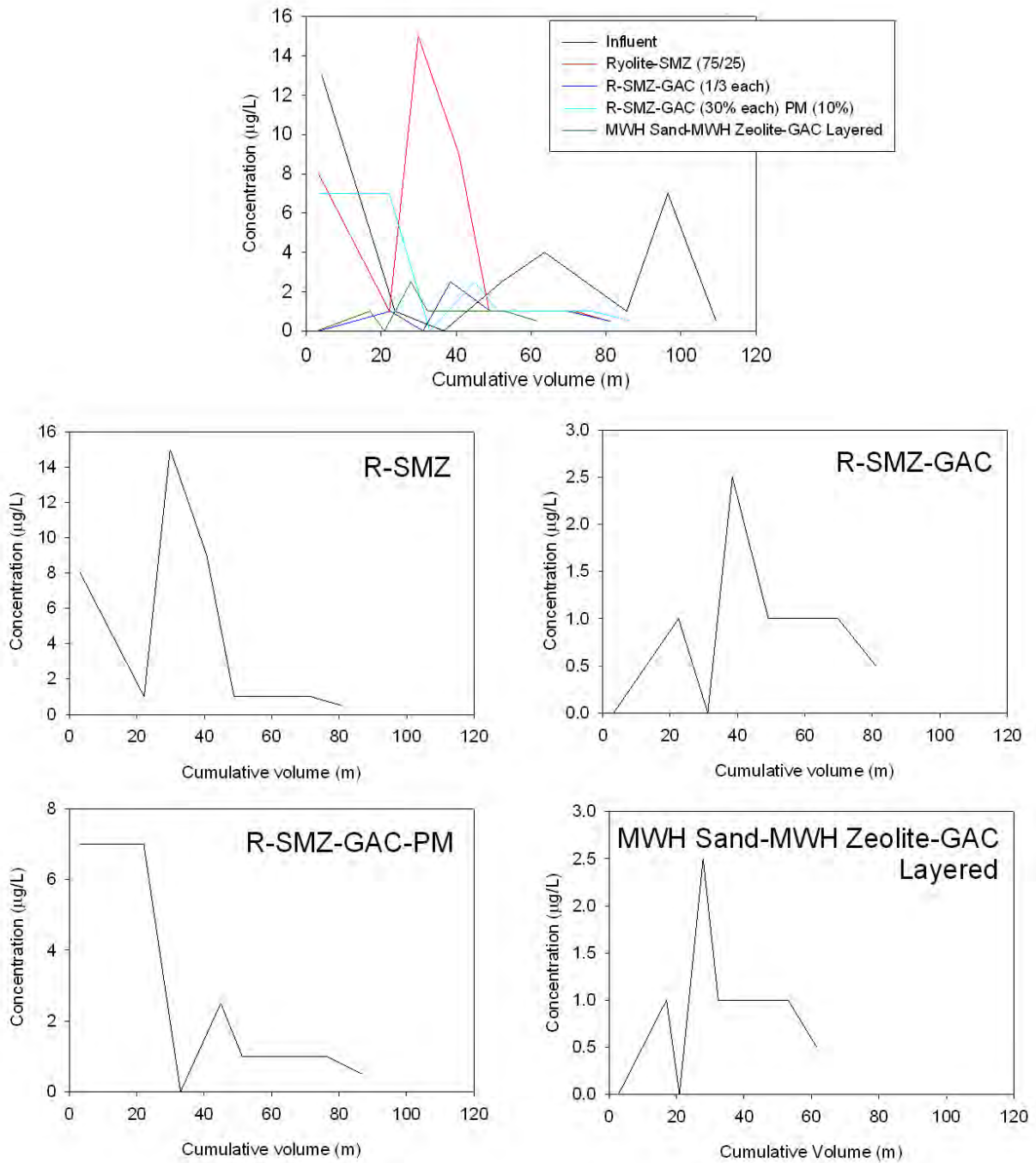


Figure A3-30. Breakthrough plots for filtered manganese (cont.).

Nickel, Total: Column Breakthrough Testing

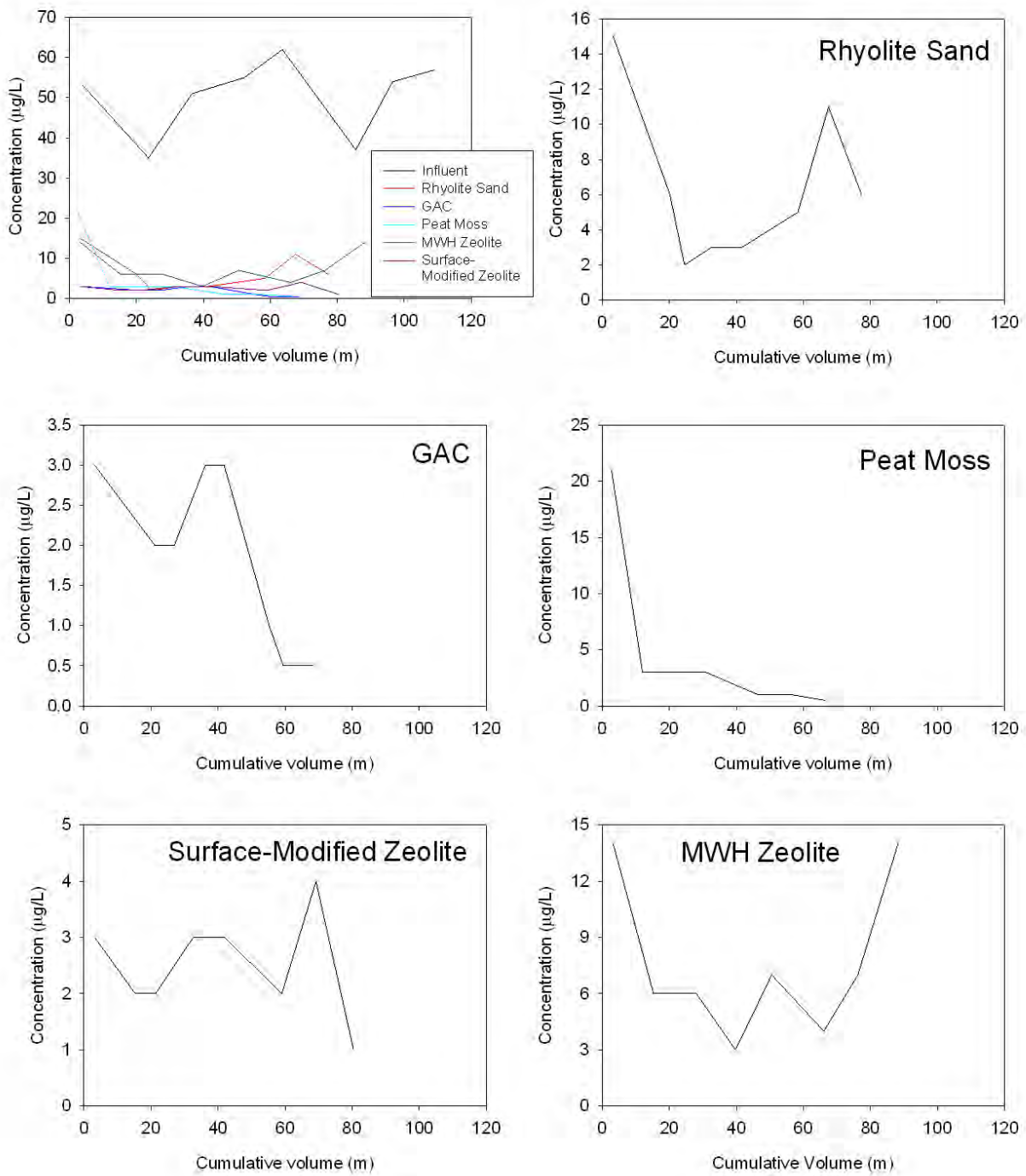


Figure A3-31. Breakthrough plots for total nickel.

Nickel, Total: Column Breakthrough Testing

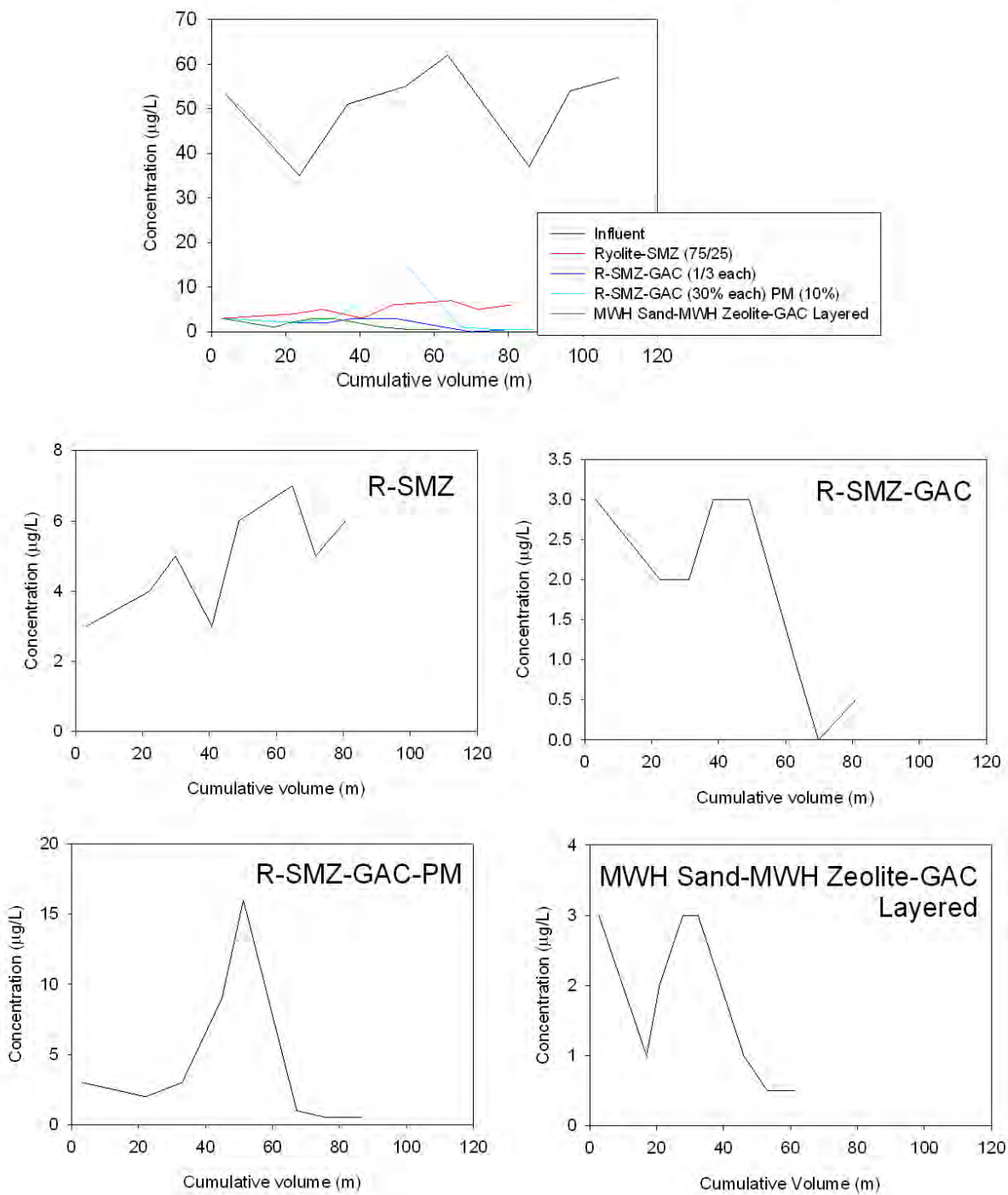


Figure A3-31. Breakthrough plots for total nickel (cont.).

Nickel, Filtered: Column Breakthrough Testing

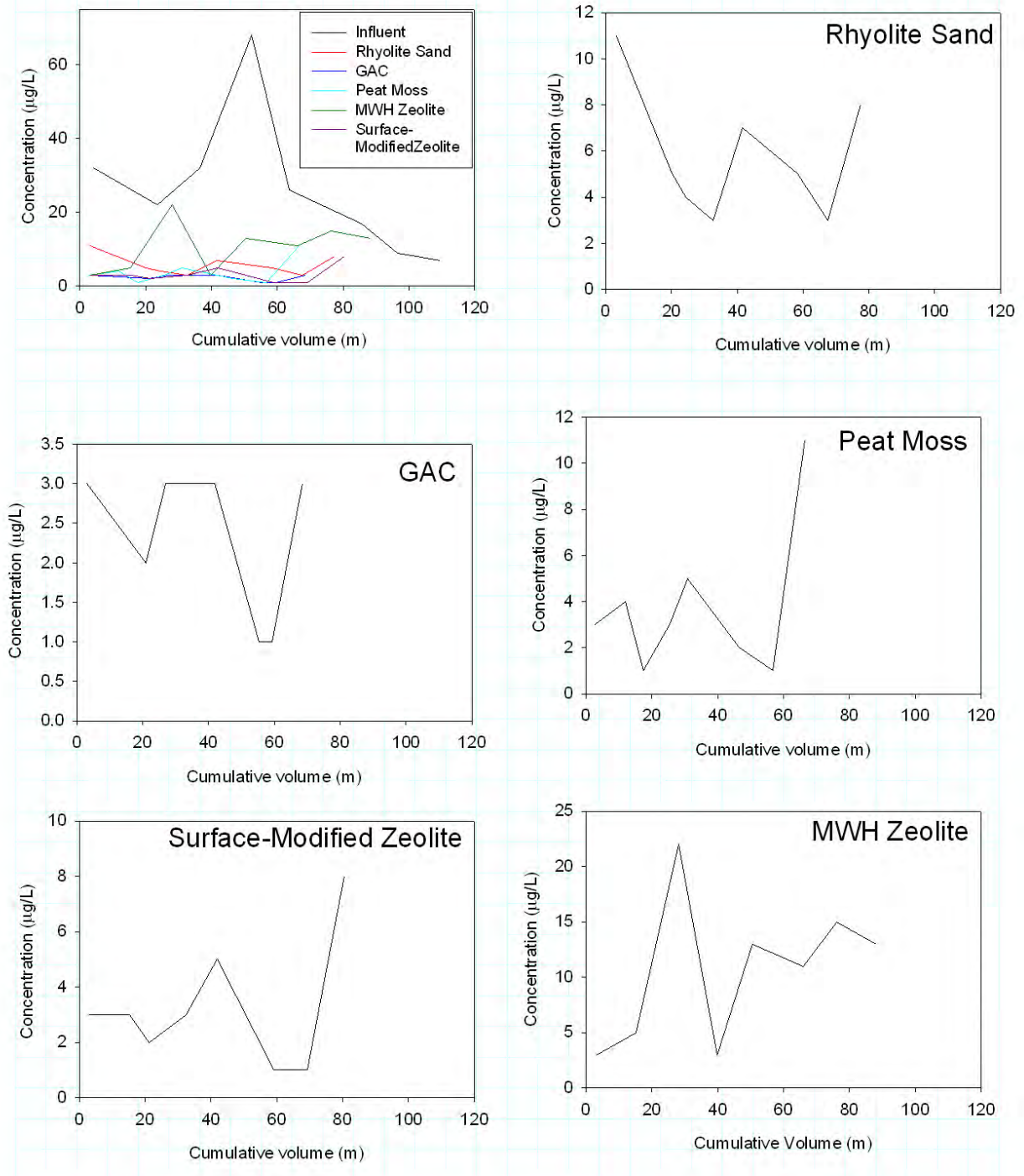


Figure A3-32. Breakthrough plots for filtered nickel.

Nickel, Filtered: Column Breakthrough Testing

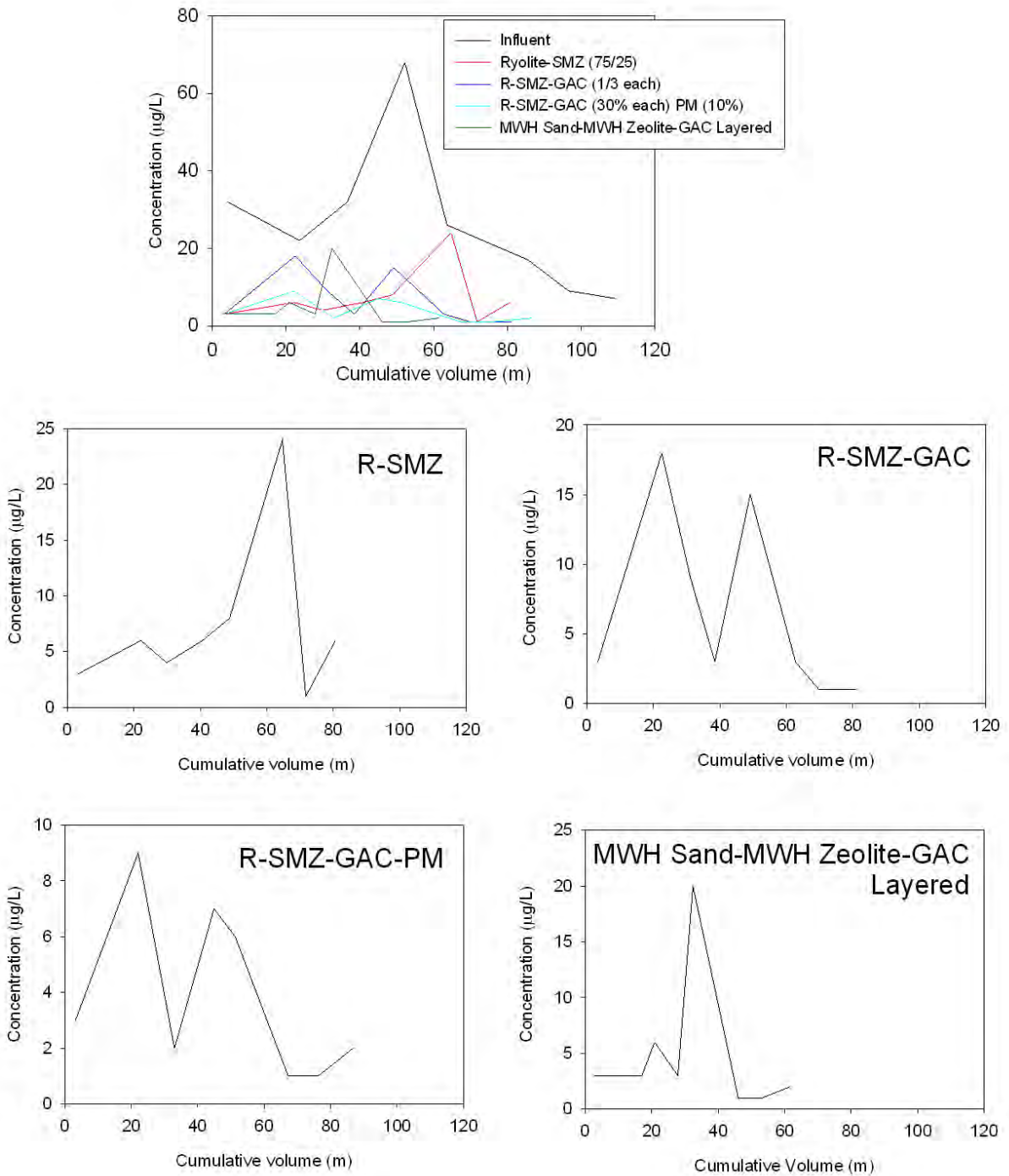


Figure A3-32. Breakthrough plots for filtered nickel (cont.).

Nitrate-N: Column Breakthrough Testing

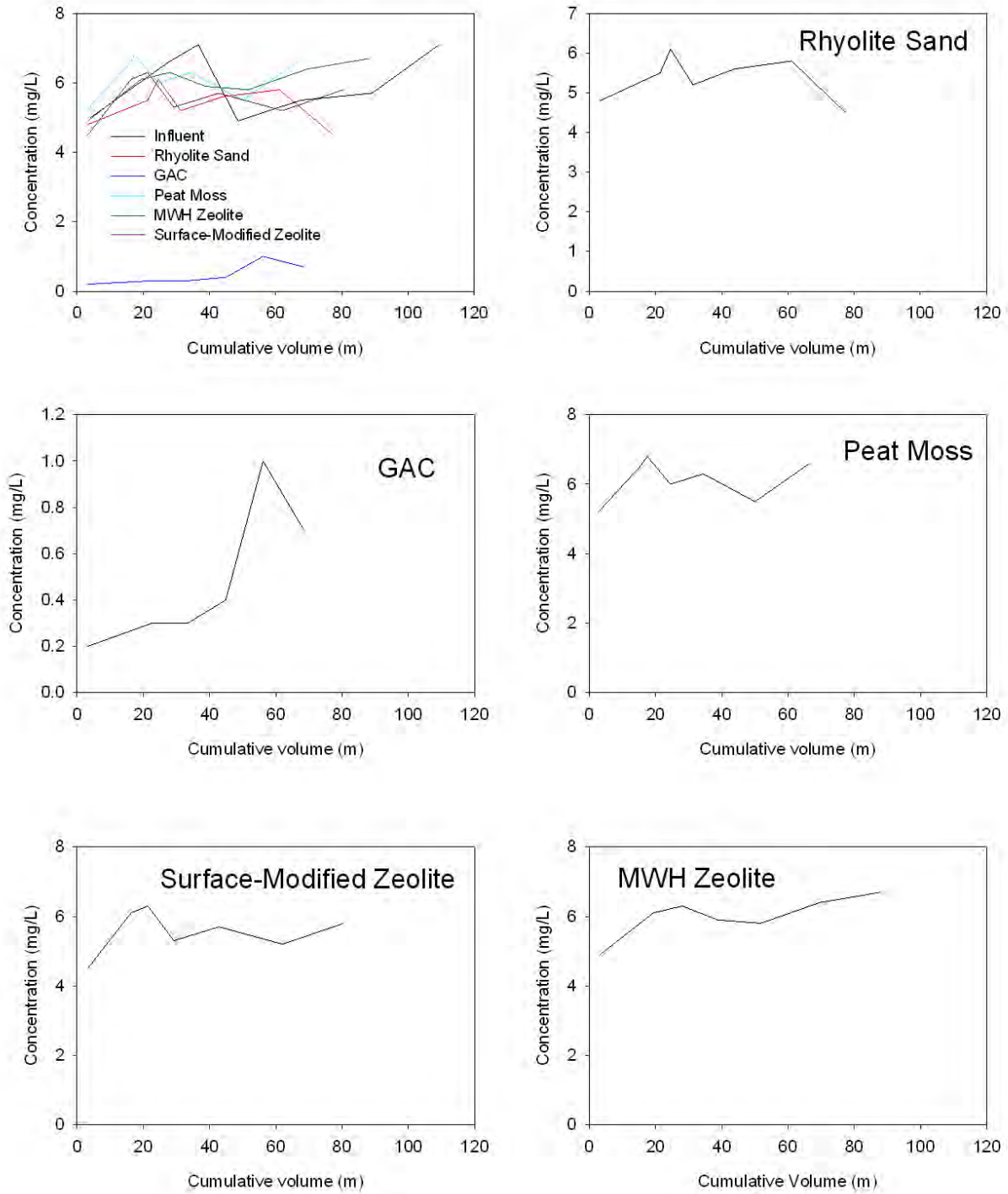


Figure A3-33. Breakthrough plots for nitrate nitrogen.

Nitrate-N: Column Breakthrough Testing

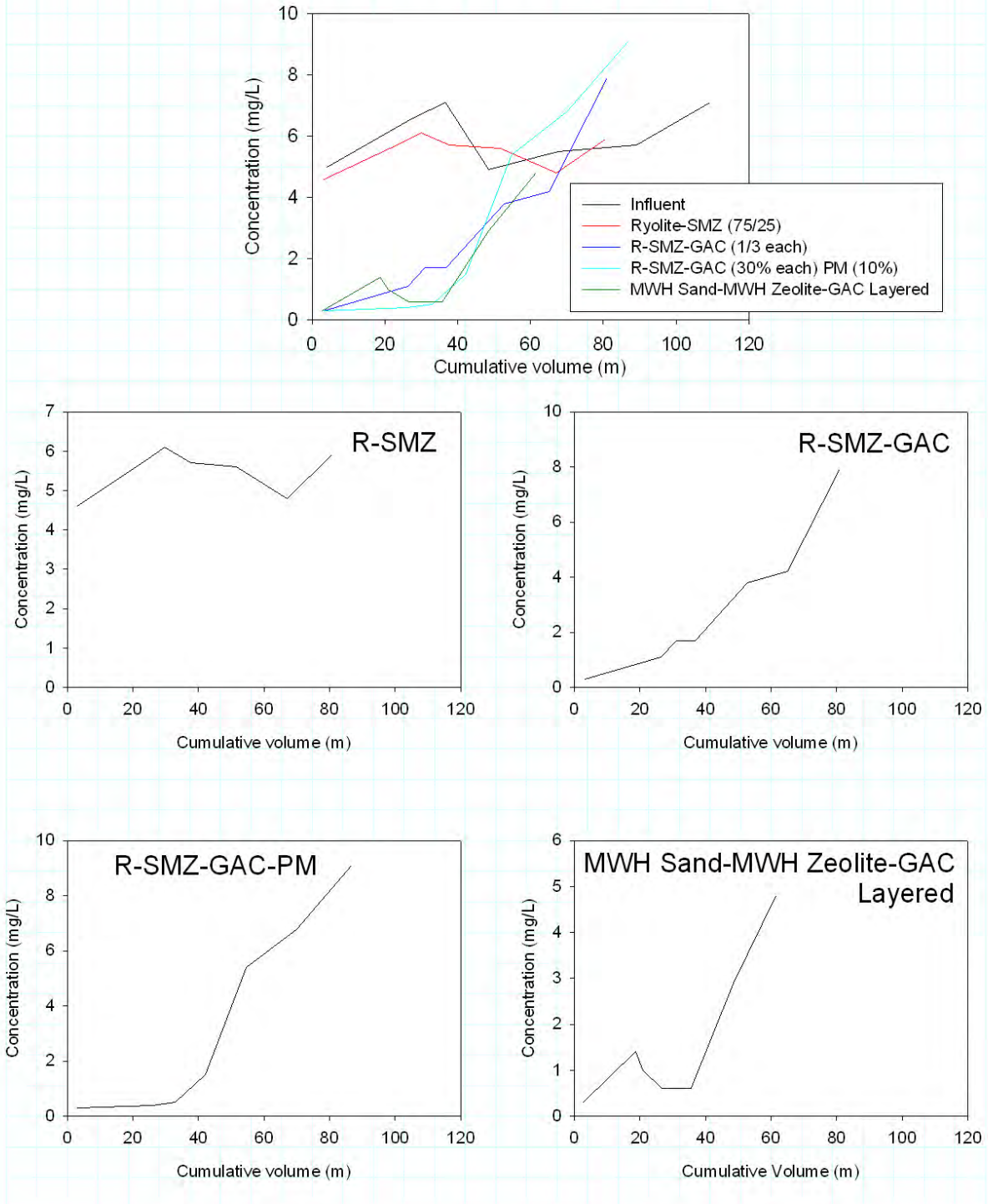


Figure A3-33. Breakthrough plots for nitrate nitrogen (cont.).

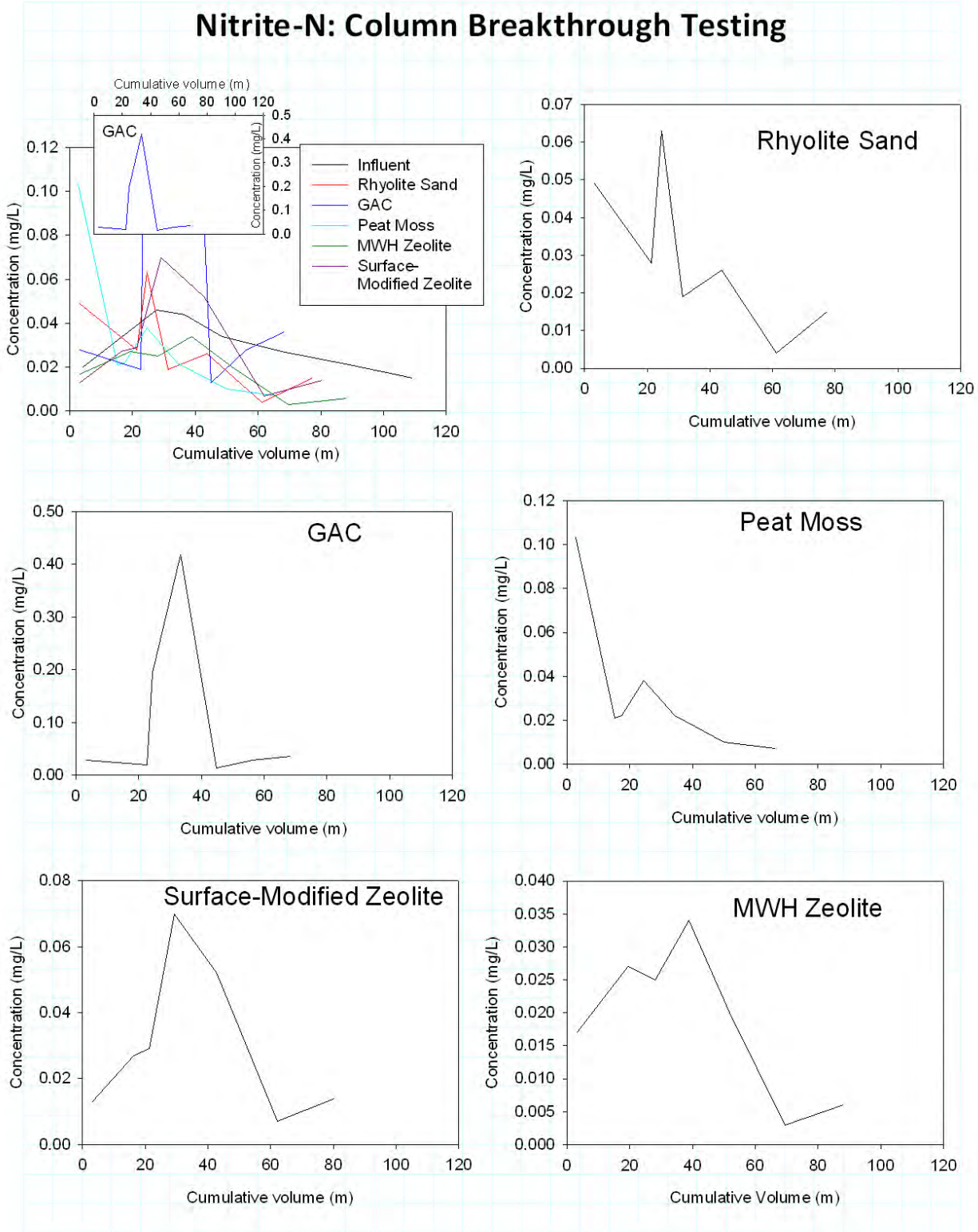


Figure A3-34. Breakthrough plots for nitrite nitrogen.

Nitrite-N: Column Breakthrough Testing

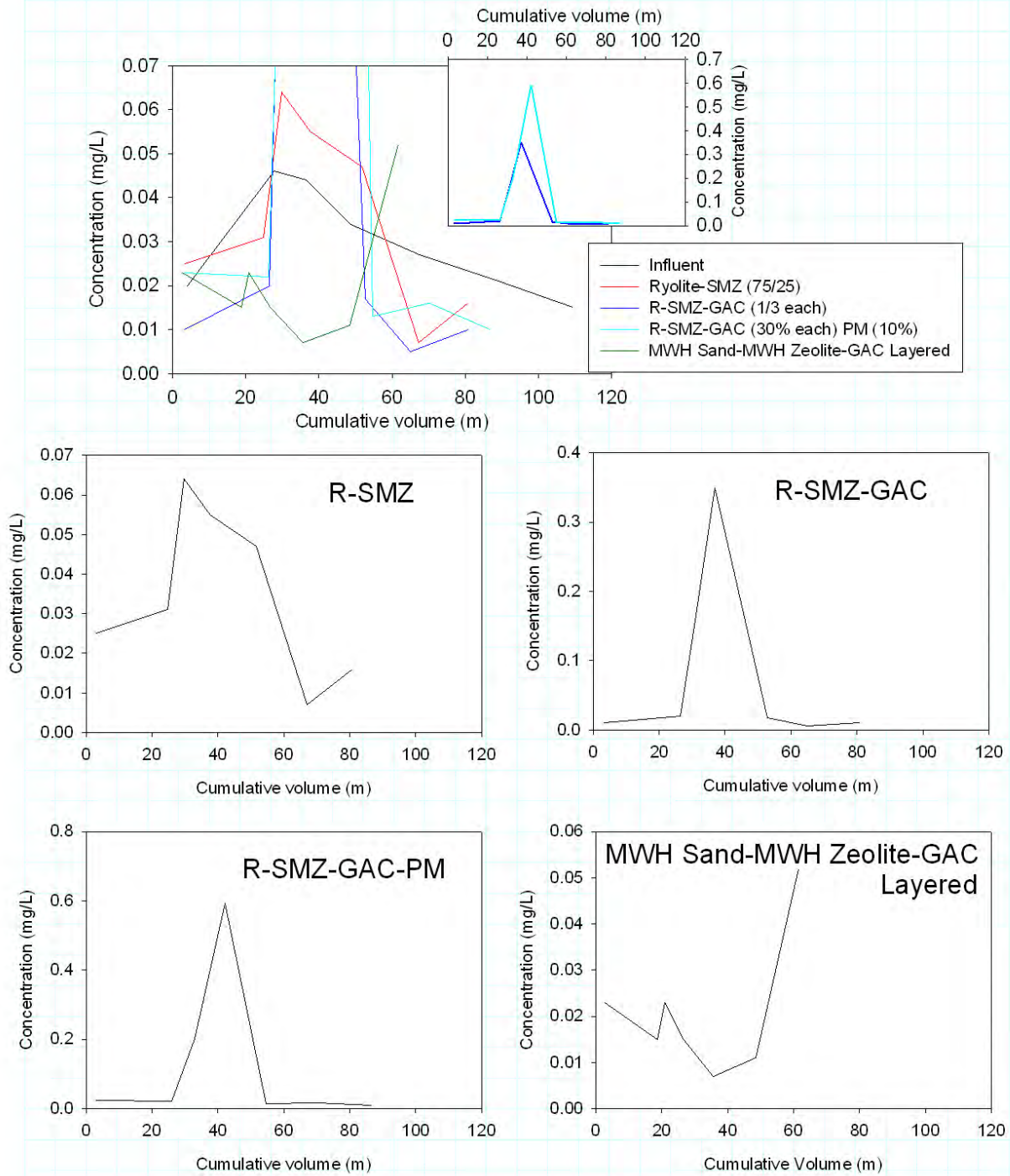


Figure A3-34. Breakthrough plots for nitrite nitrogen (cont.).

Nitrite + Nitrate: Column Breakthrough Testing

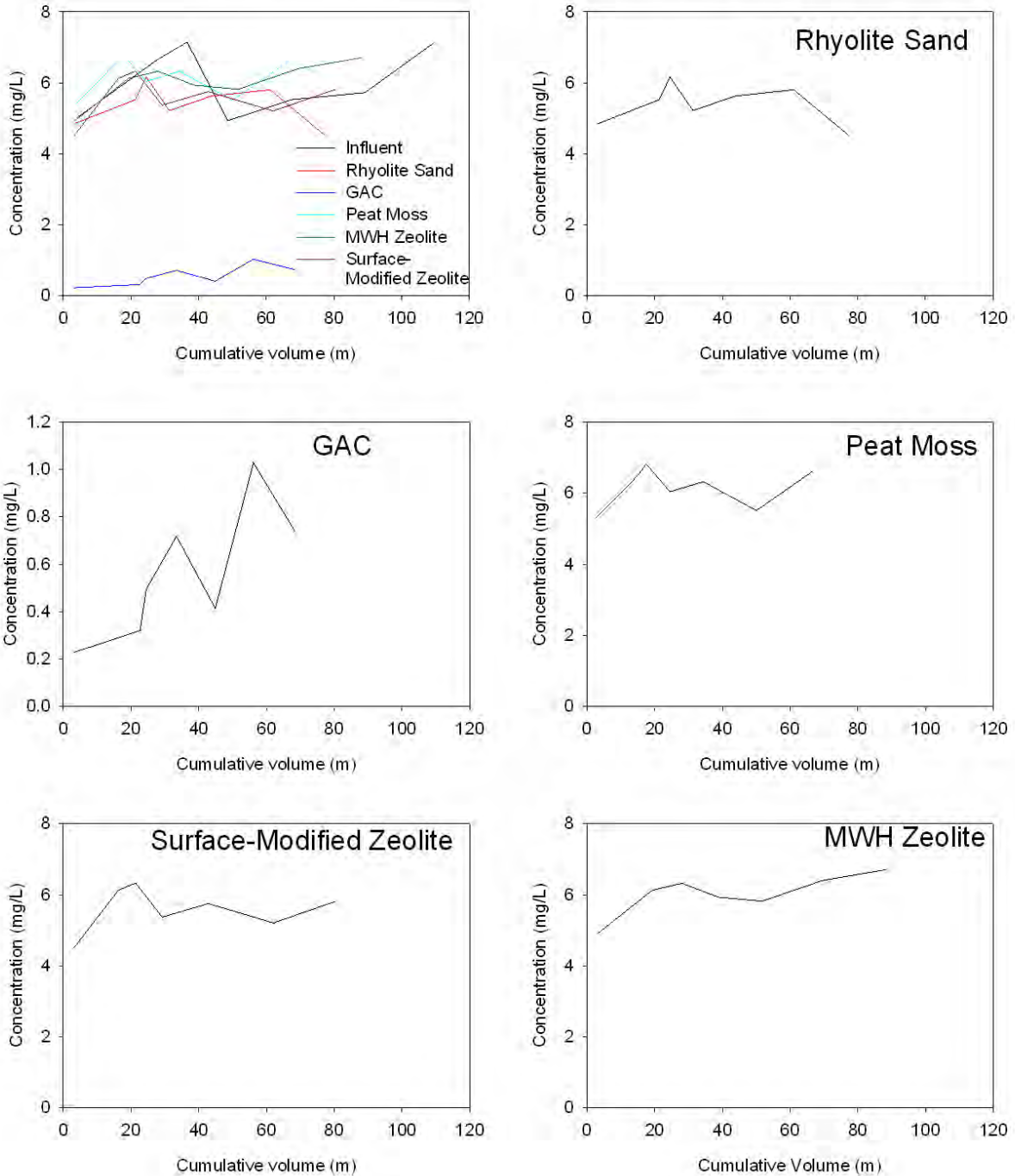


Figure A3-35. Breakthrough plots for nitrite plus nitrate nitrogen.

Nitrite + Nitrate: Column Breakthrough Testing

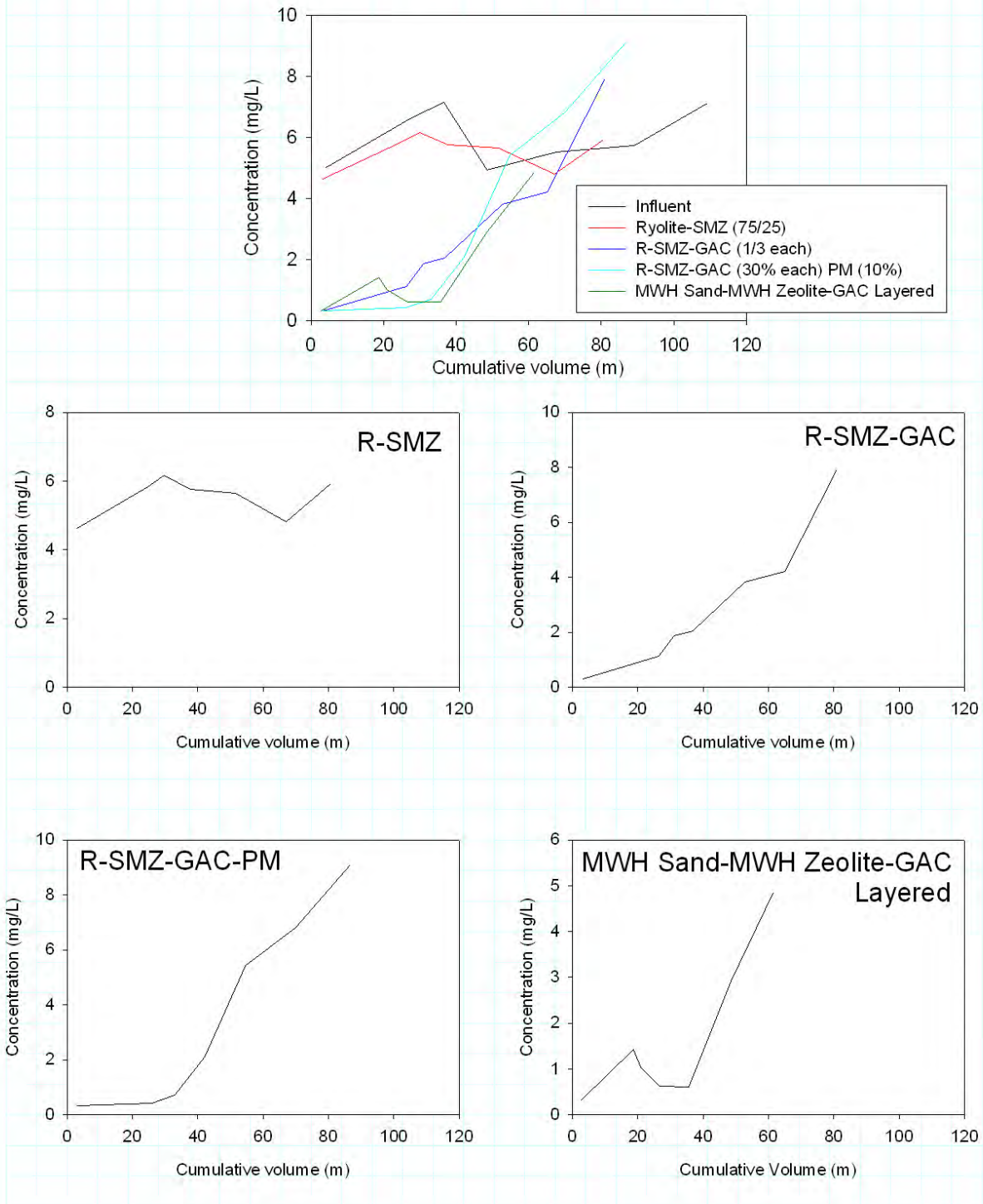


Figure A3-35. Breakthrough plots for nitrite plus nitrate nitrogen (cont.).

Oxidation-Reduction Potential: Column Breakthrough Testing

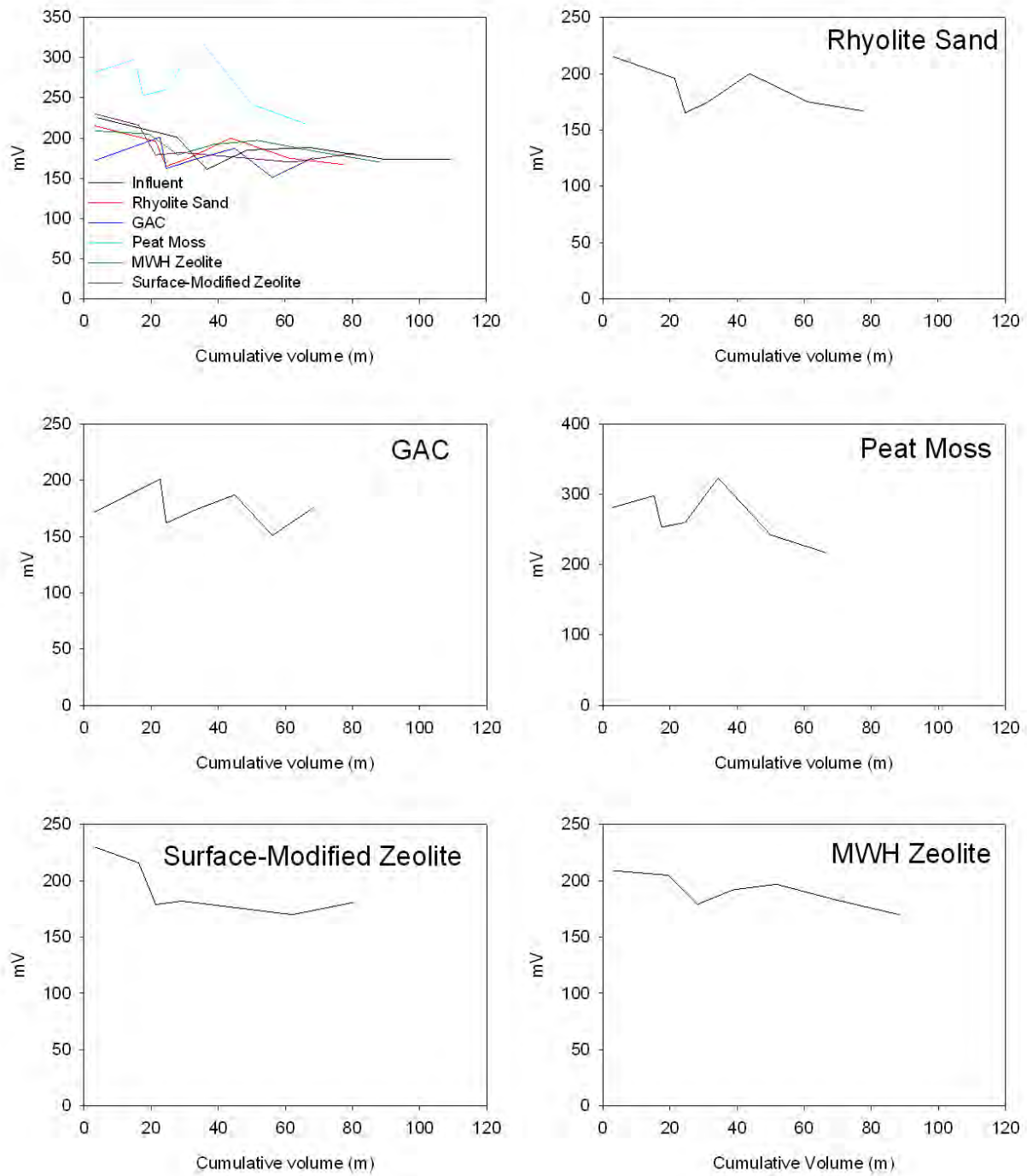


Figure A3-36. Breakthrough plots for oxidation reduction potential (ORP).

Oxidation-Reduction Potential: Column Breakthrough Testing

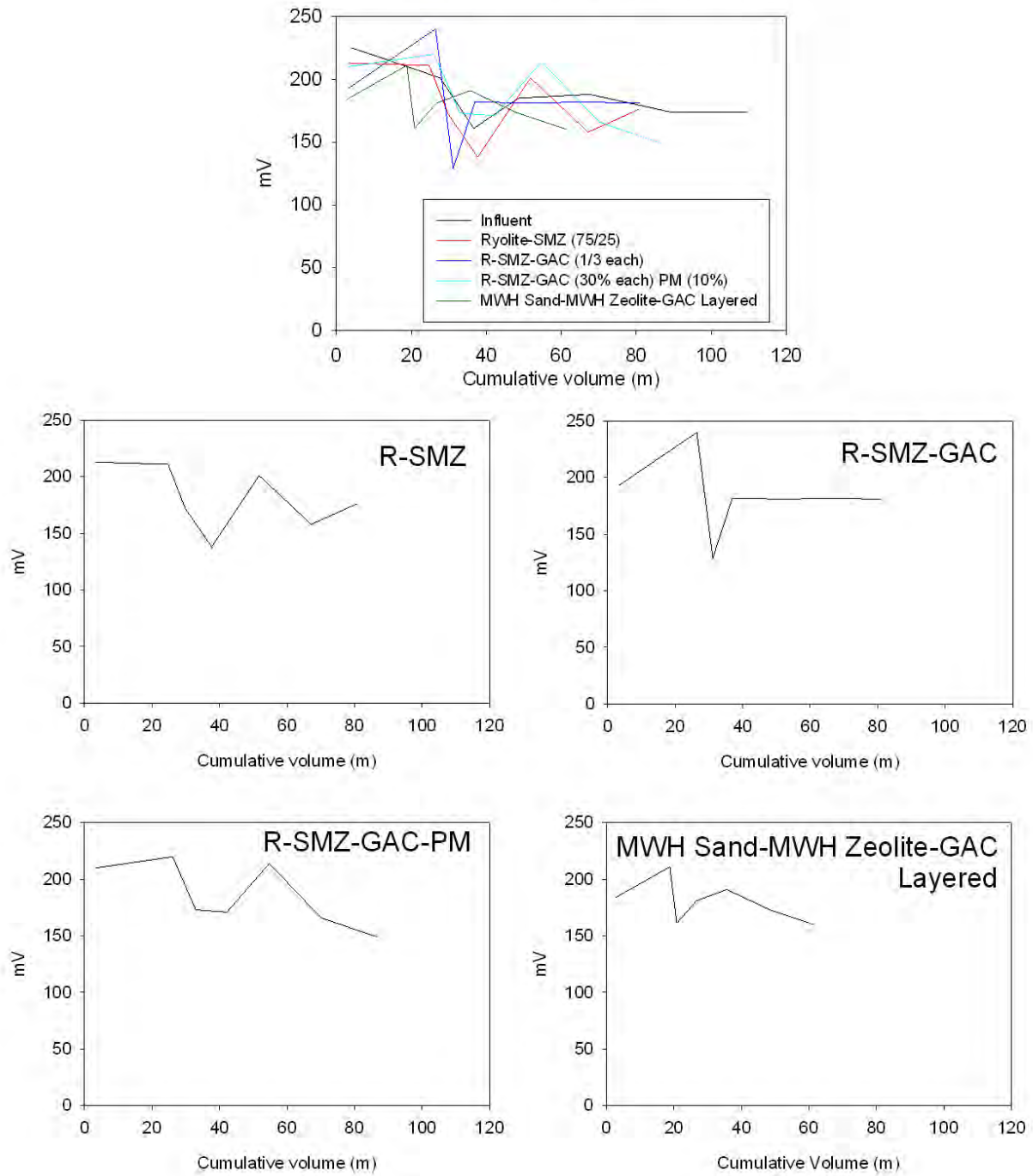


Figure A3-36. Breakthrough plots for oxidation reduction potential (ORP) (cont.).

pH: Column Breakthrough Testing

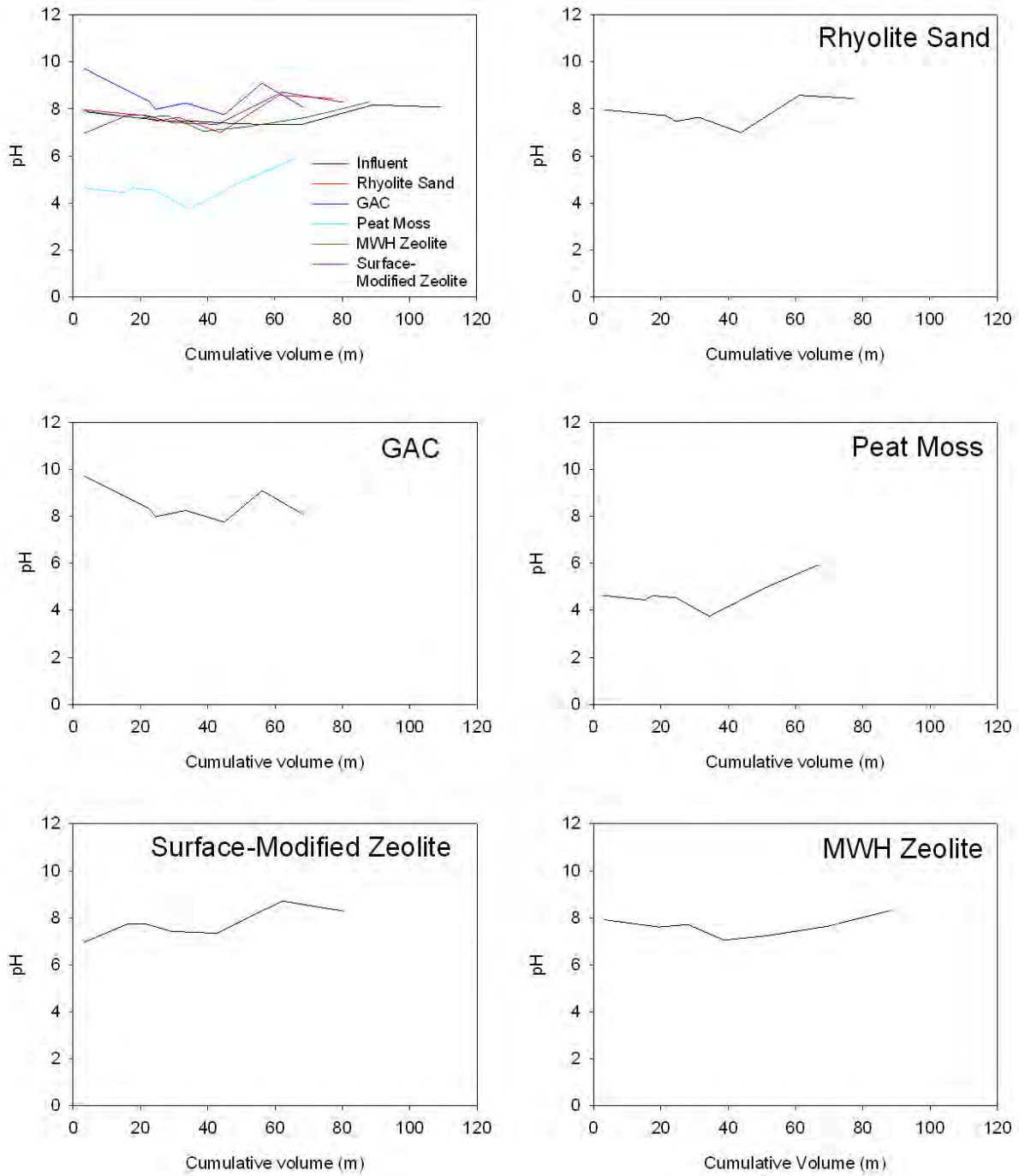


Figure A3-37. Breakthrough plots for pH.

pH: Column Breakthrough Testing

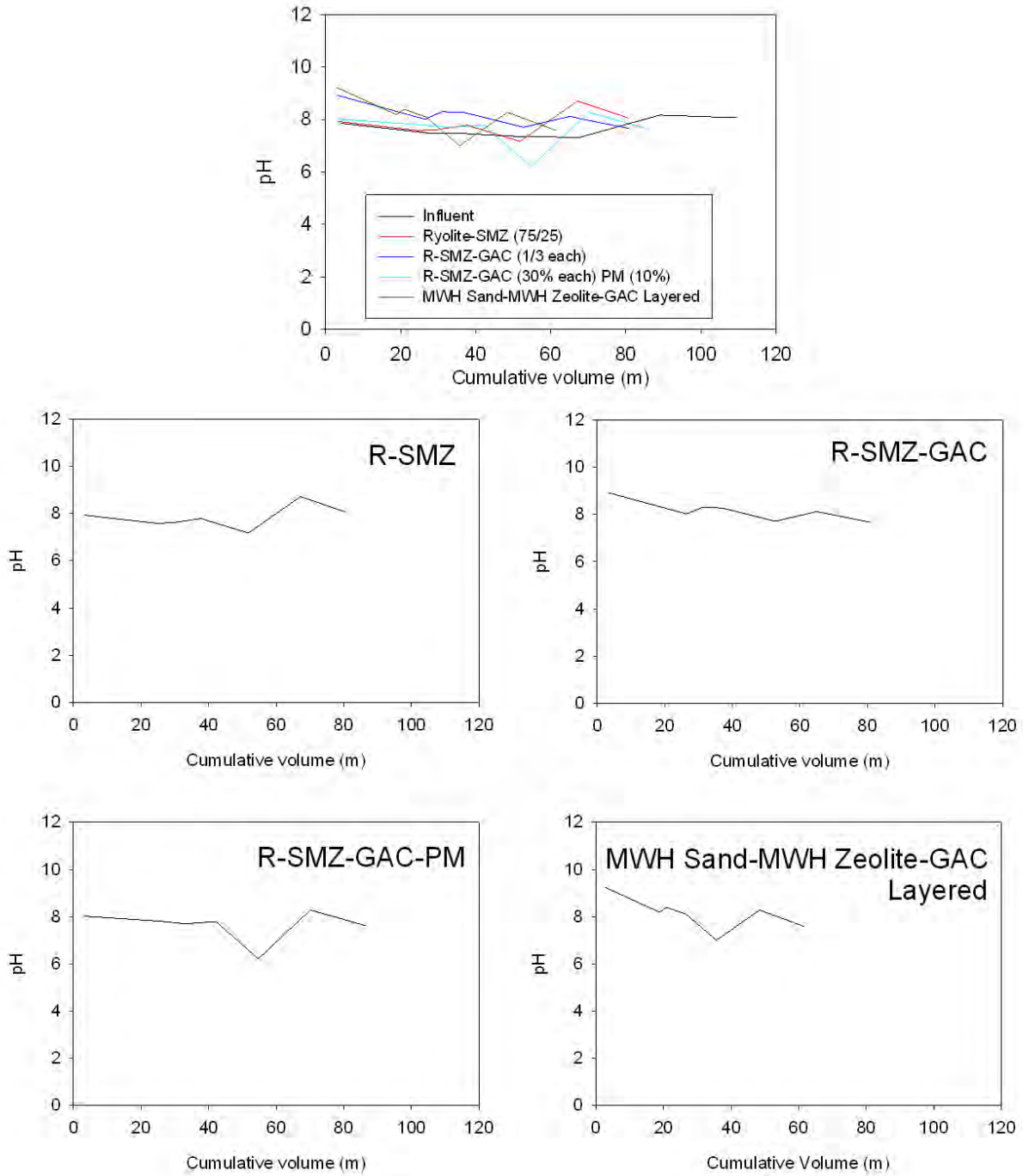


Figure A3-37. Breakthrough plots for pH (cont.).

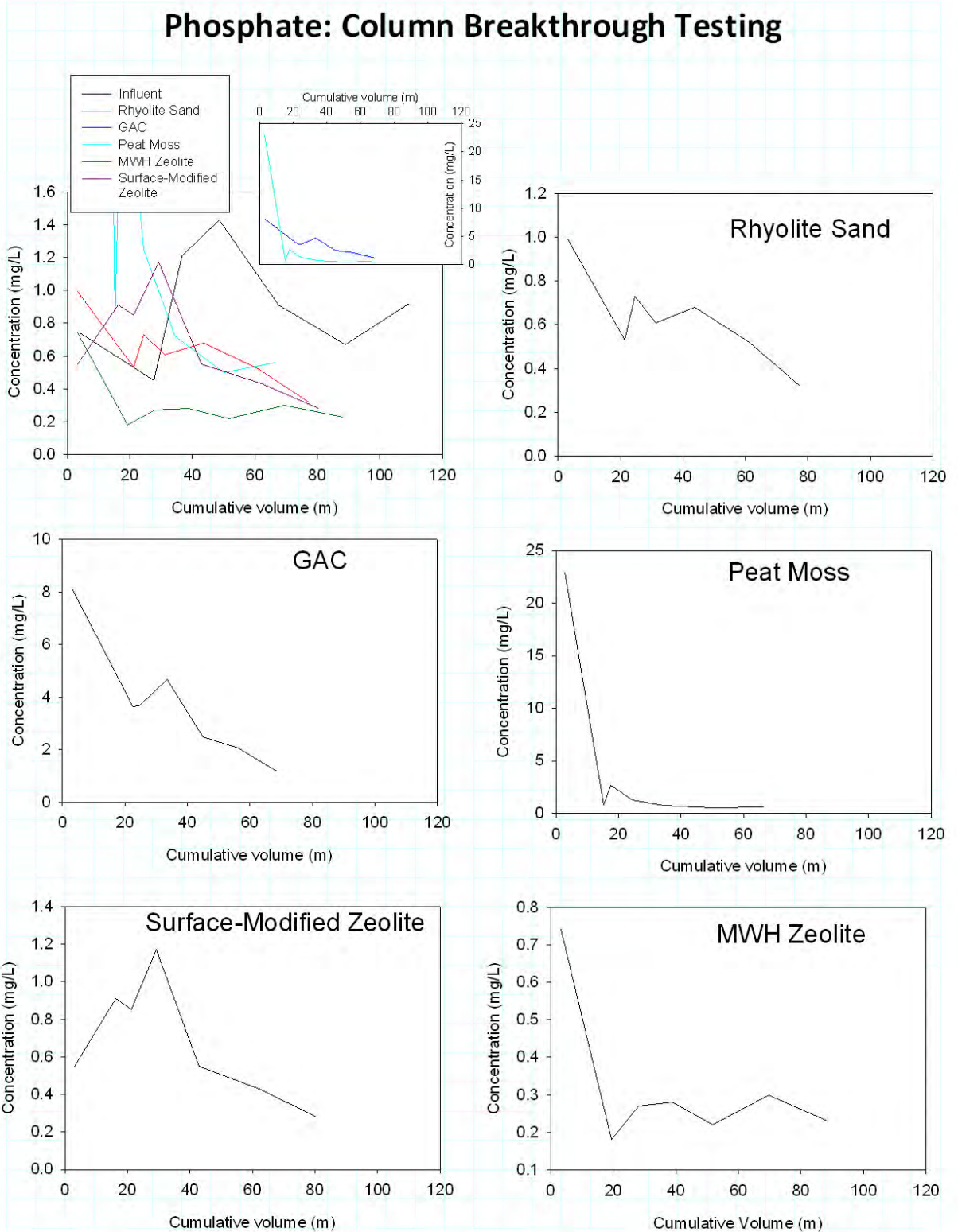


Figure A3-38. Breakthrough plots for phosphate.

Phosphate: Column Breakthrough Testing

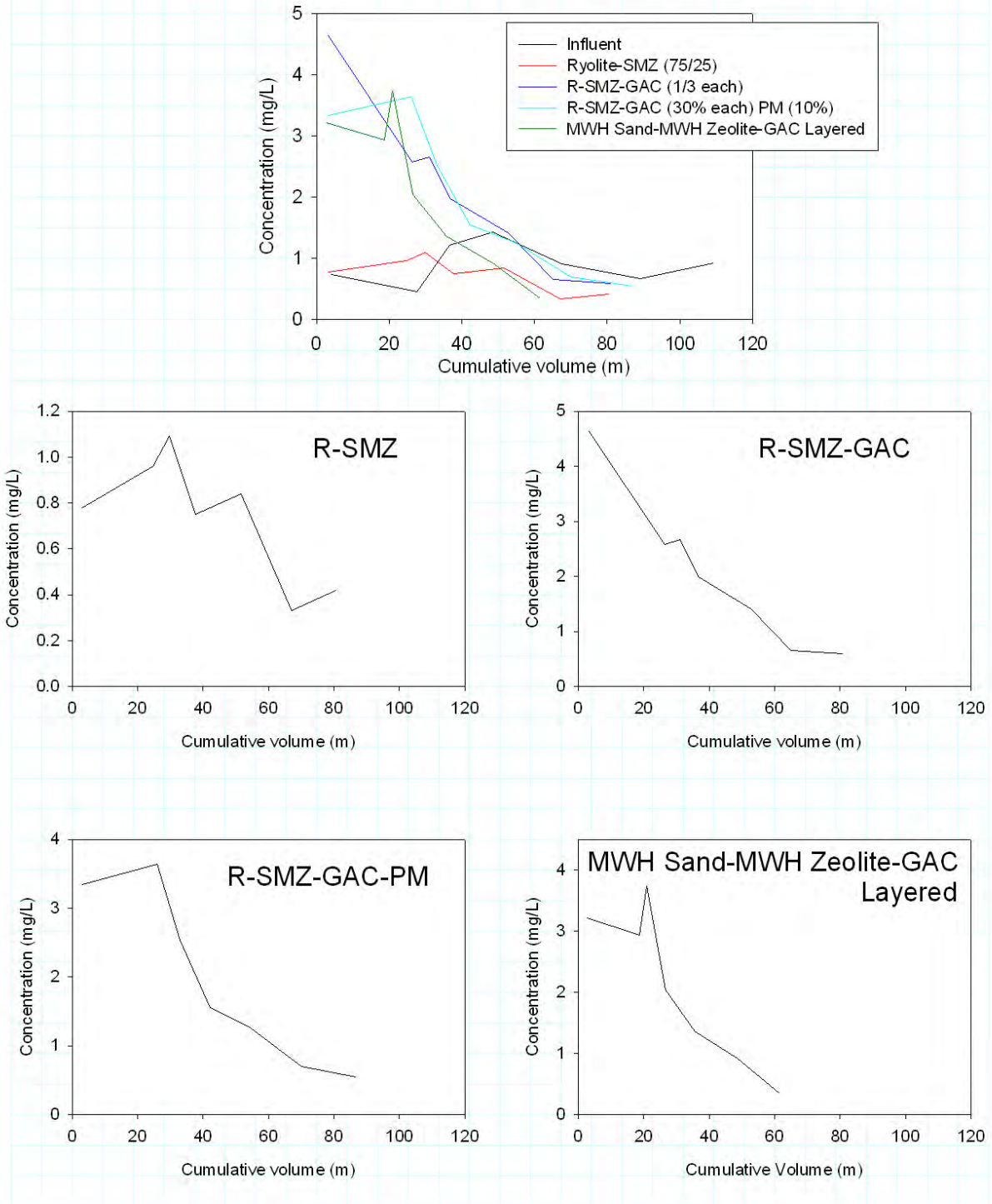


Figure A3-38. Breakthrough plots for phosphate (cont.).

Potassium, Total: Column Breakthrough Testing

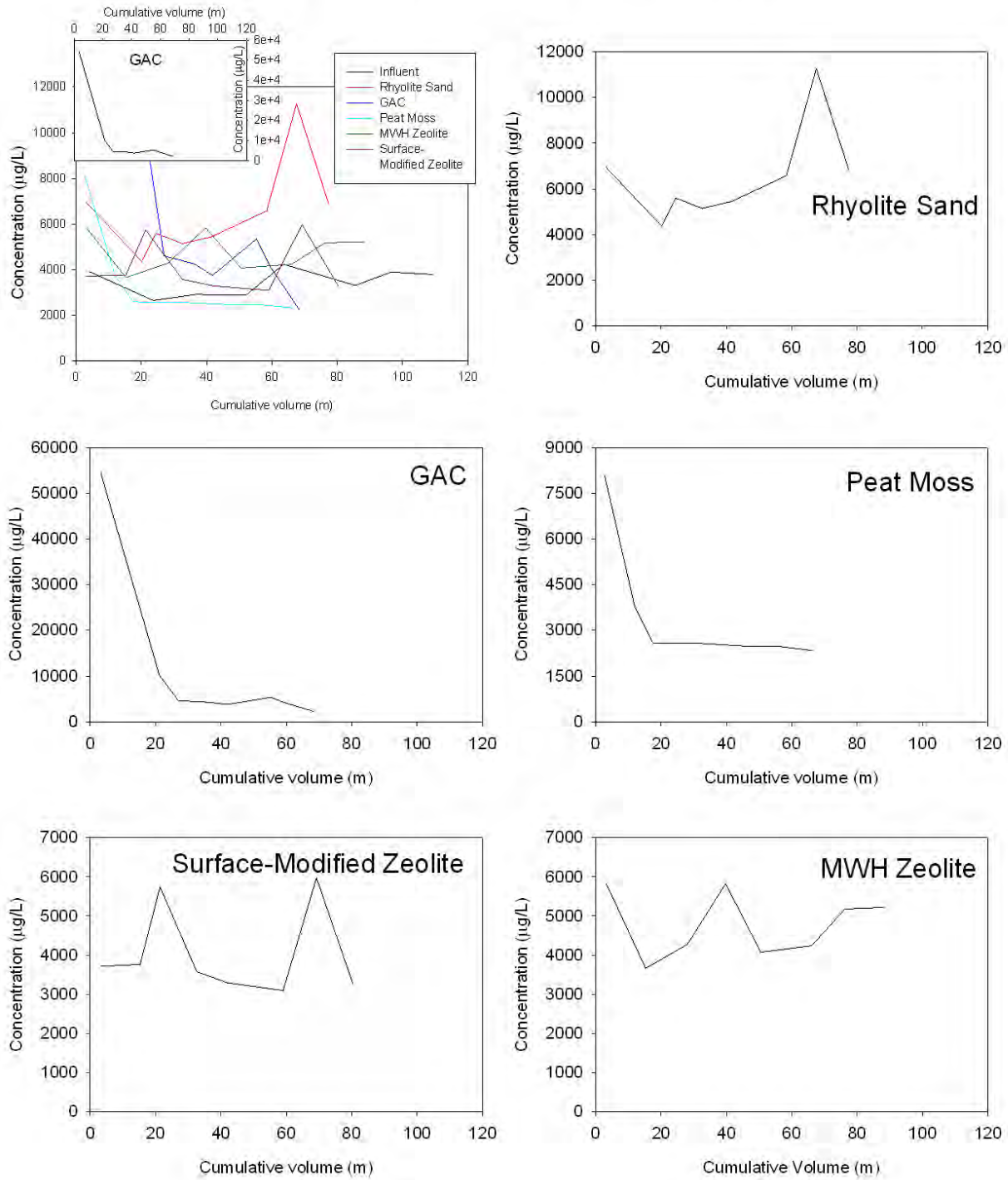


Figure A3-39. Breakthrough plots for total potassium.

Potassium, Total: Column Breakthrough Testing

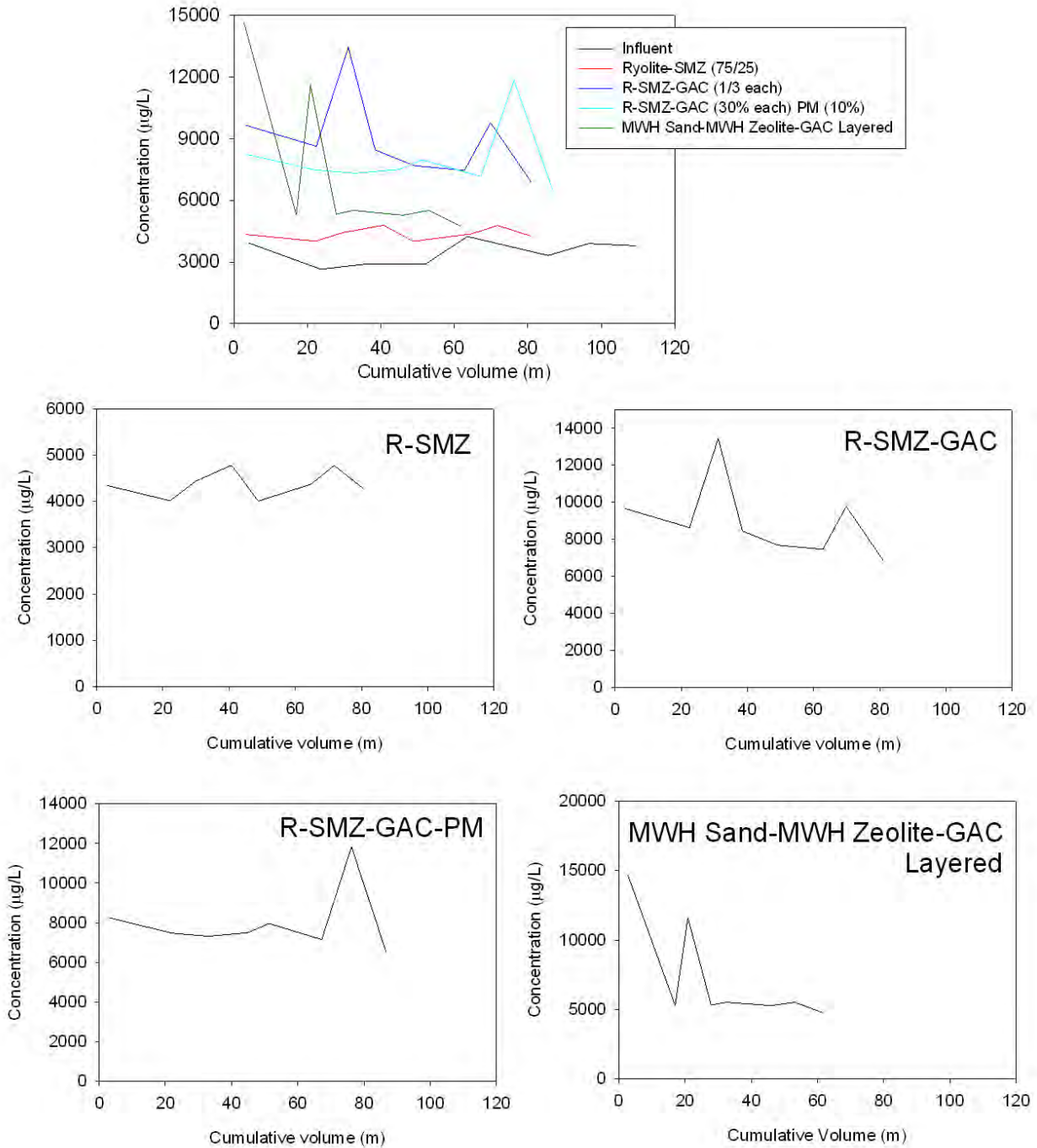


Figure A3-39. Breakthrough plots for total potassium (cont.).

Potassium, Filtered: Column Breakthrough Testing

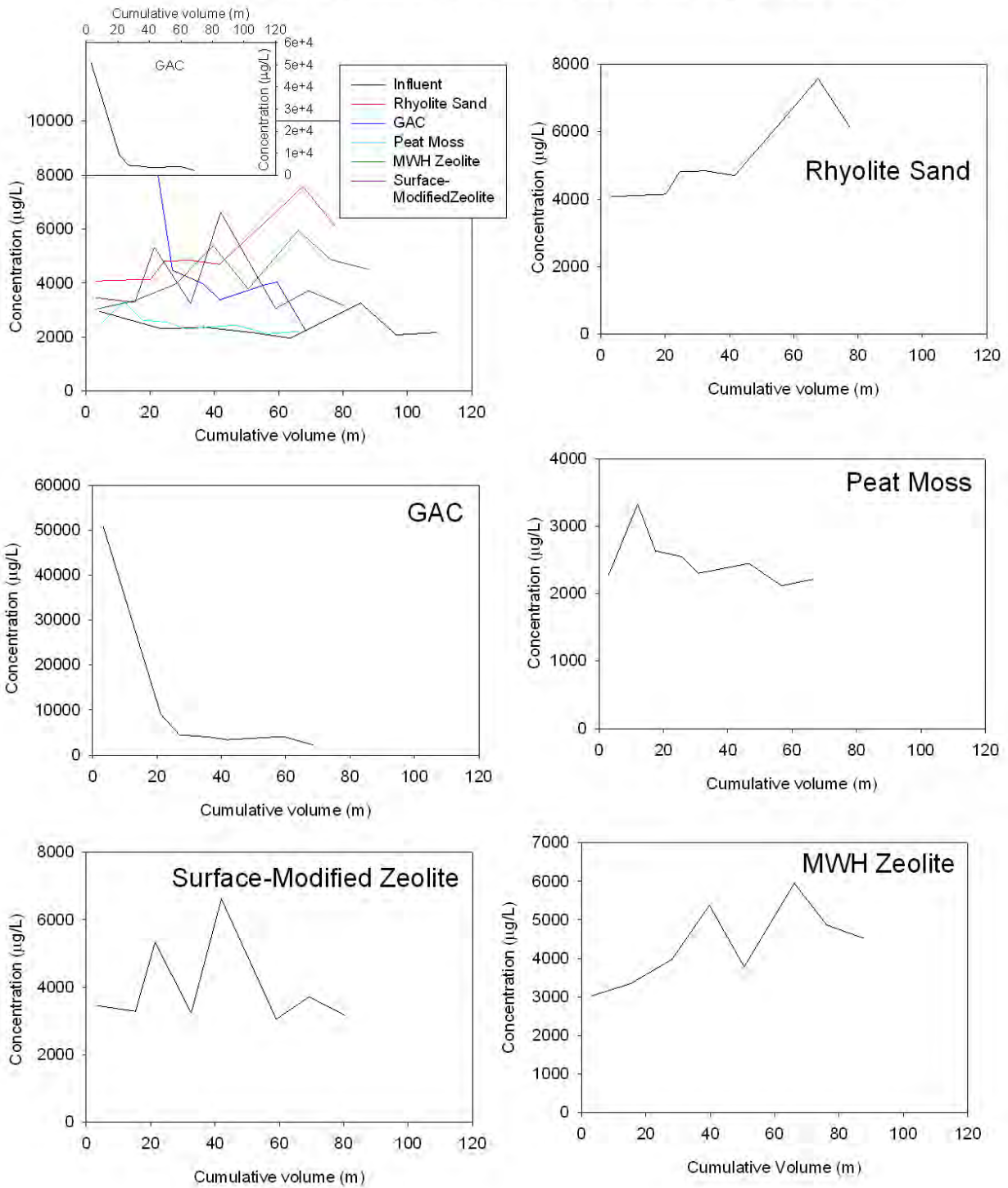


Figure A3-40. Breakthrough plots for filtered potassium.

Potassium, Filtered: Column Breakthrough Testing

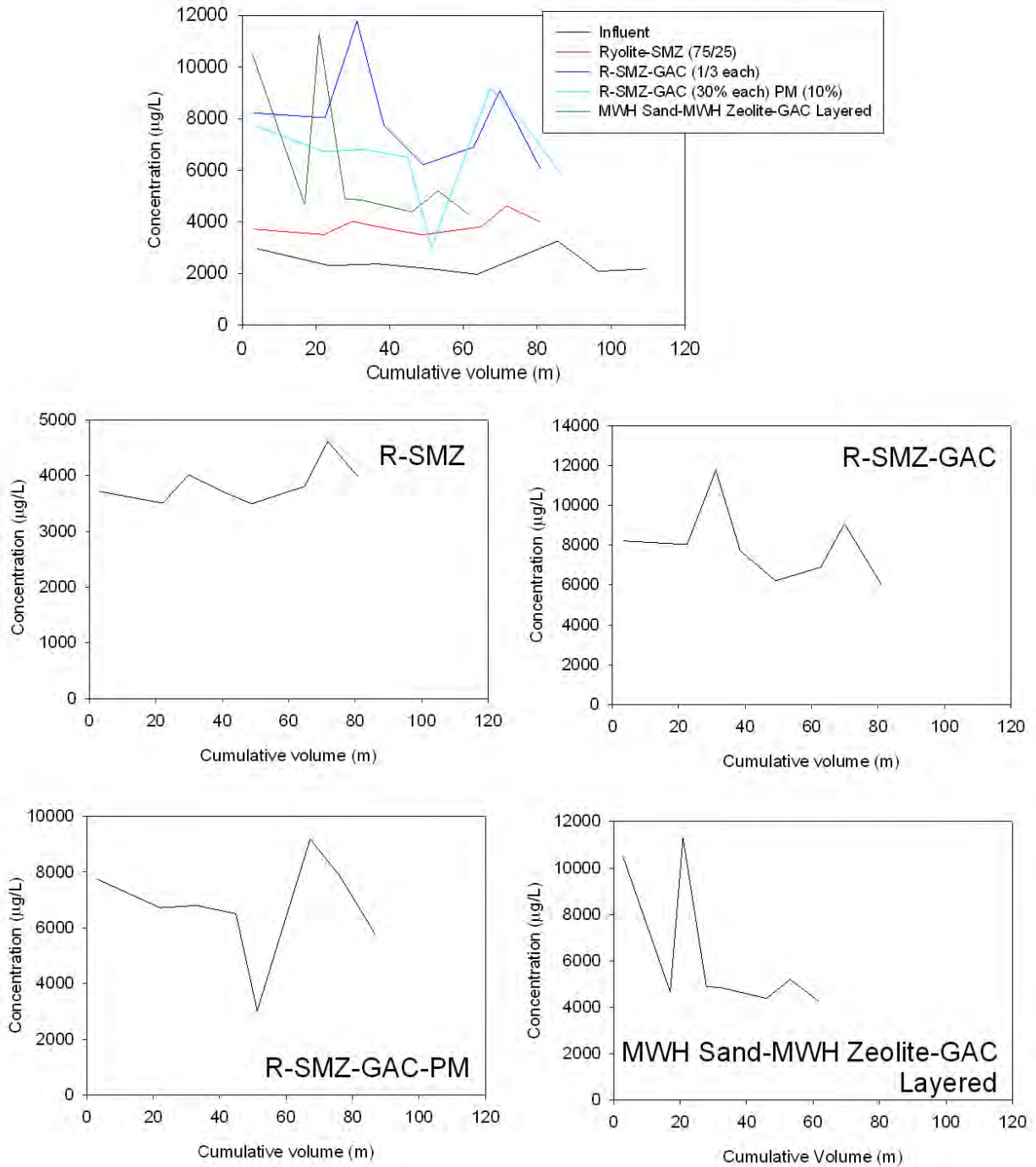


Figure A3-40. Breakthrough plots for filtered potassium (cont.).

Sodium, Total: Column Breakthrough Testing

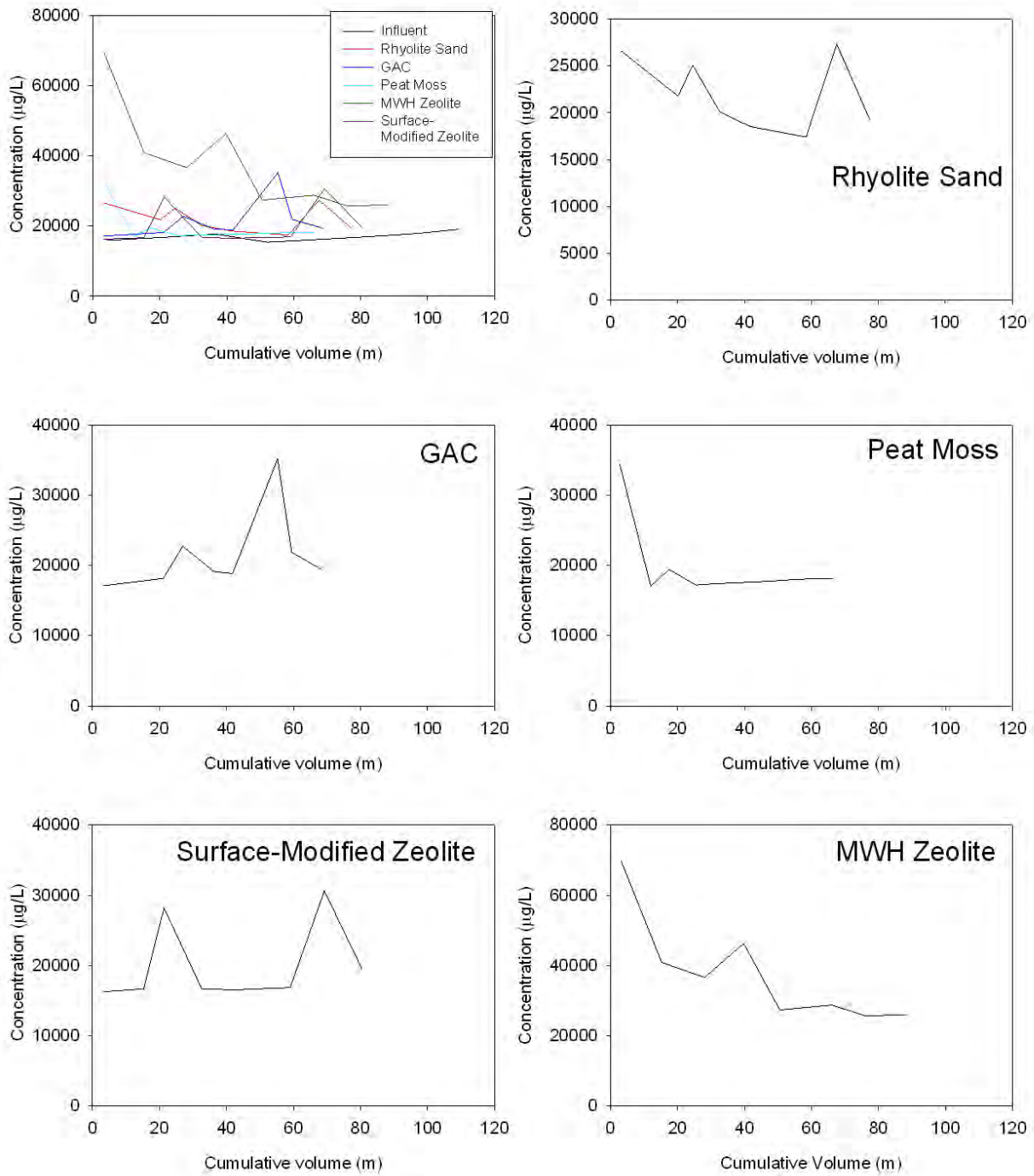


Figure A3-41. Breakthrough plots for total sodium.

Sodium, Total: Column Breakthrough Testing

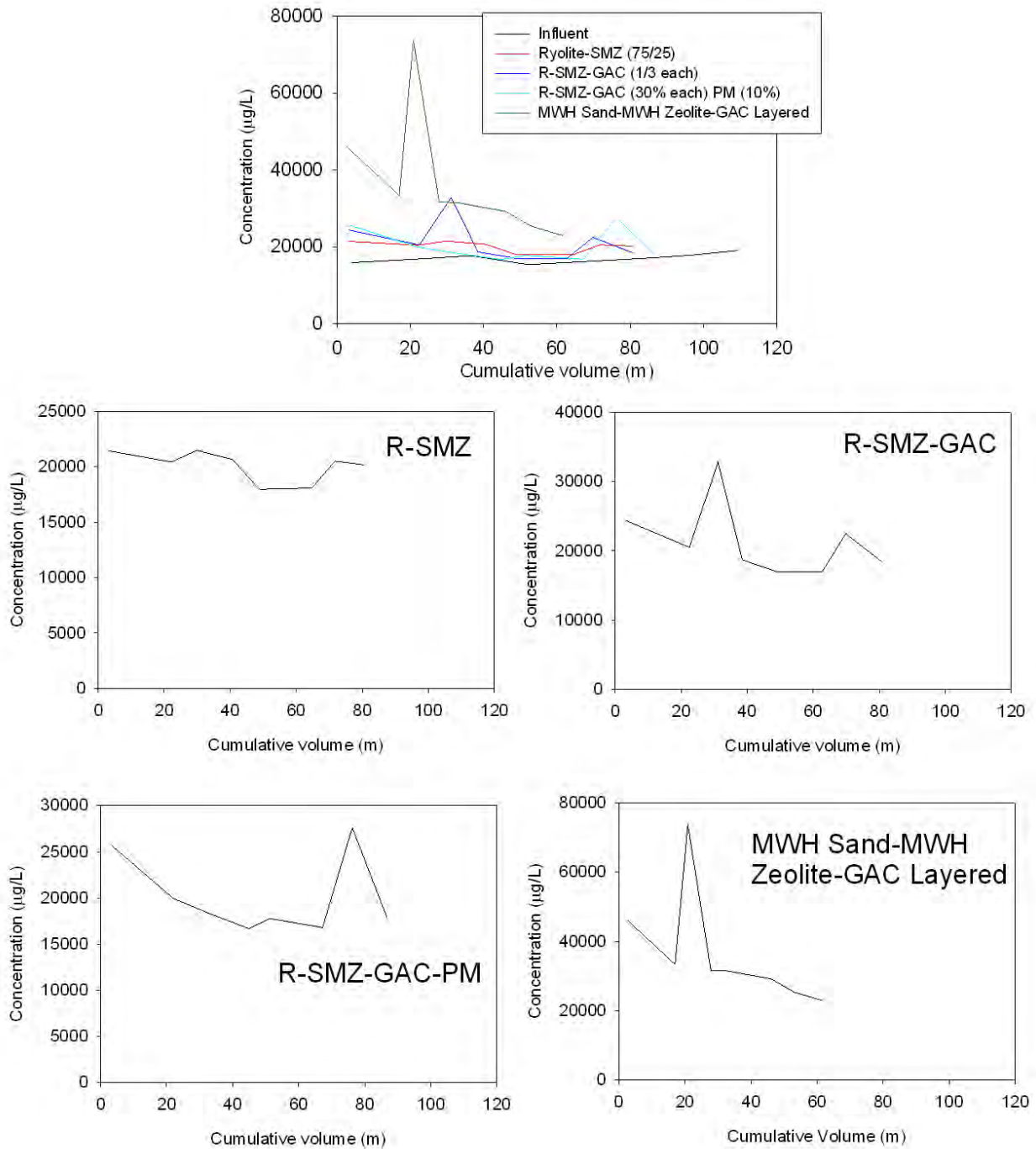


Figure A3-41. Breakthrough plots for total sodium (cont.).

Sodium, Filtered: Column Breakthrough Testing

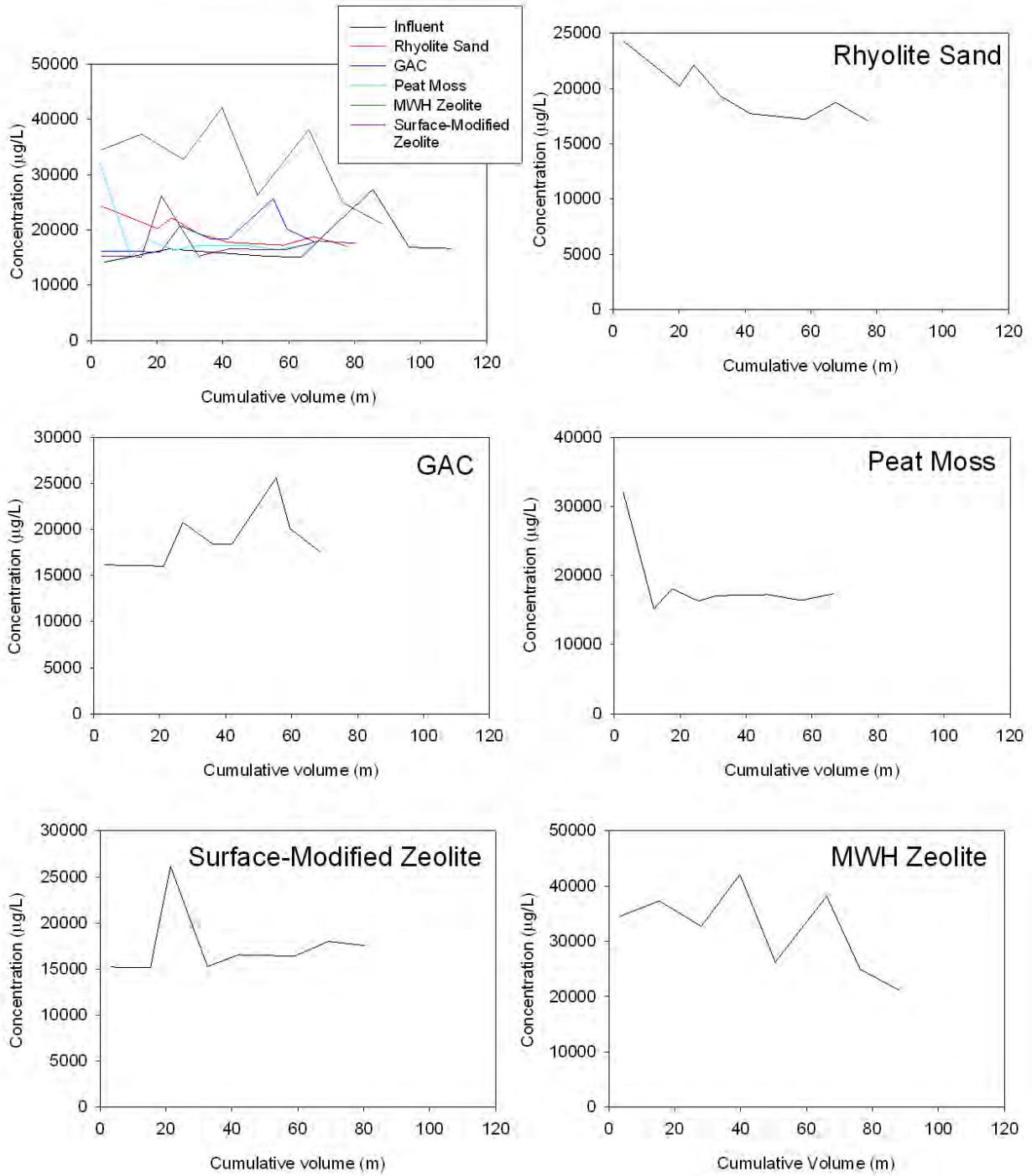


Figure A3-42. Breakthrough plots for filtered sodium.

Sodium, Filtered: Column Breakthrough Testing

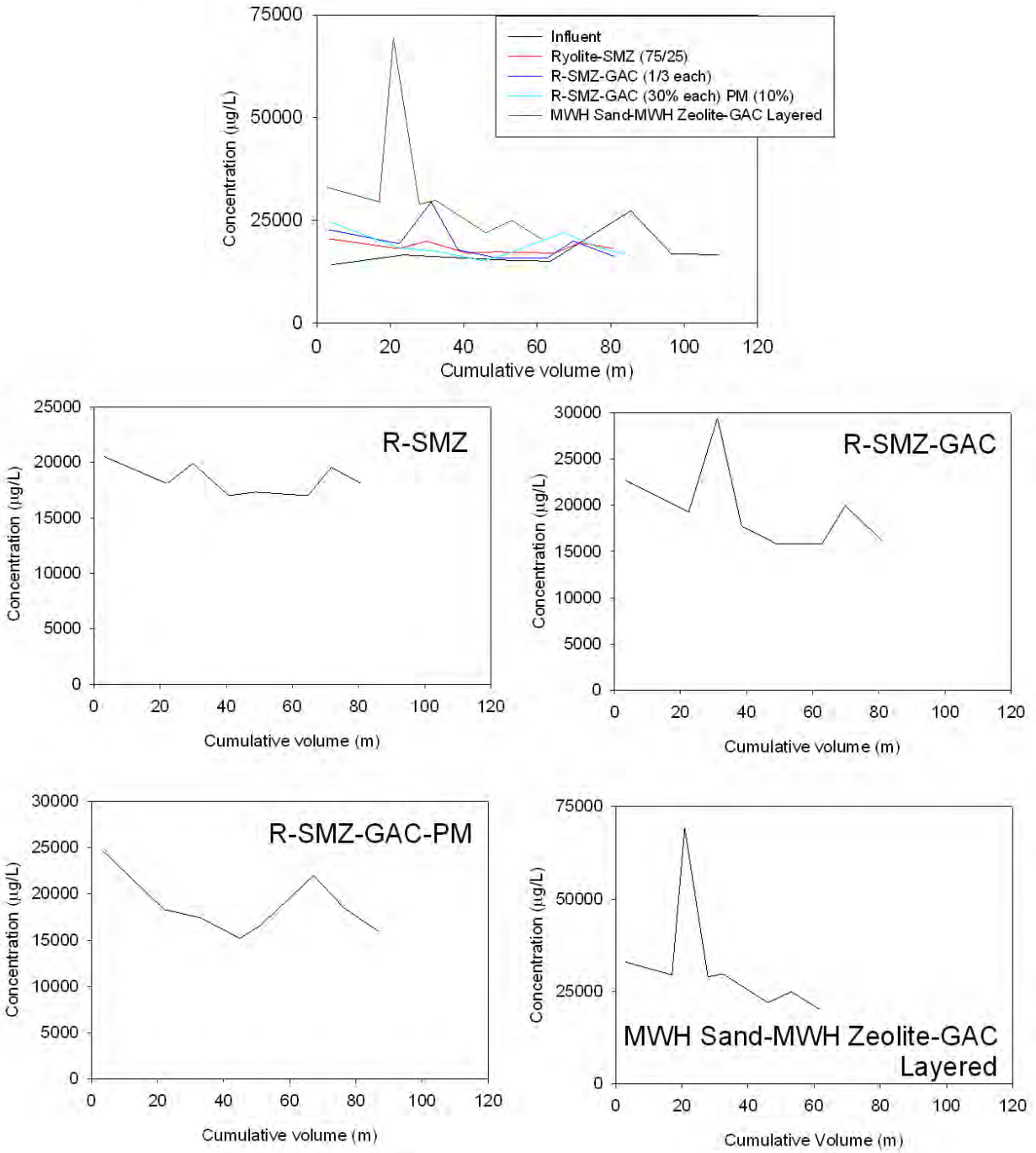


Figure A3-42. Breakthrough plots for filtered sodium (cont.).

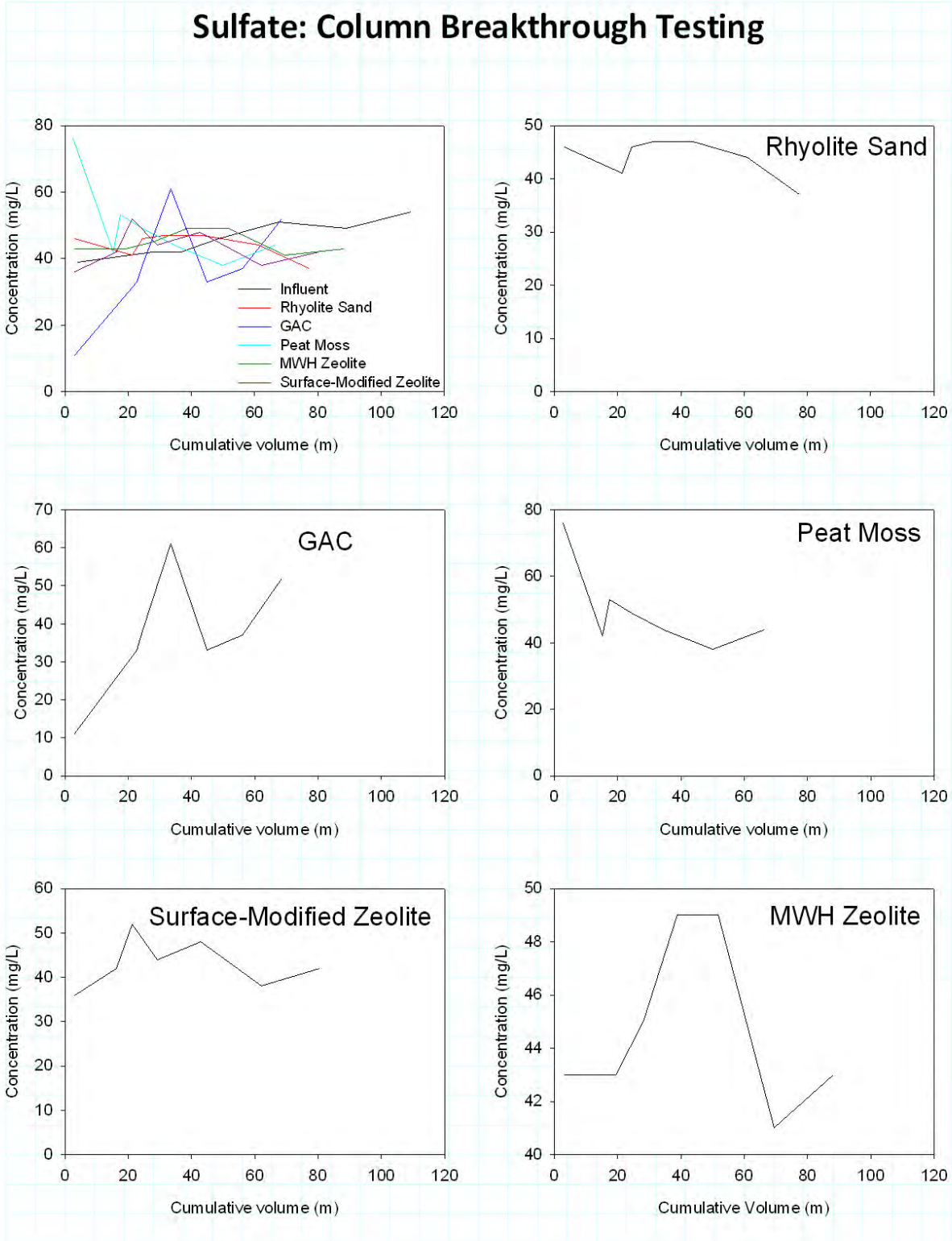


Figure A3-43. Breakthrough plots for sulfate.

Sulfate: Column Breakthrough Testing

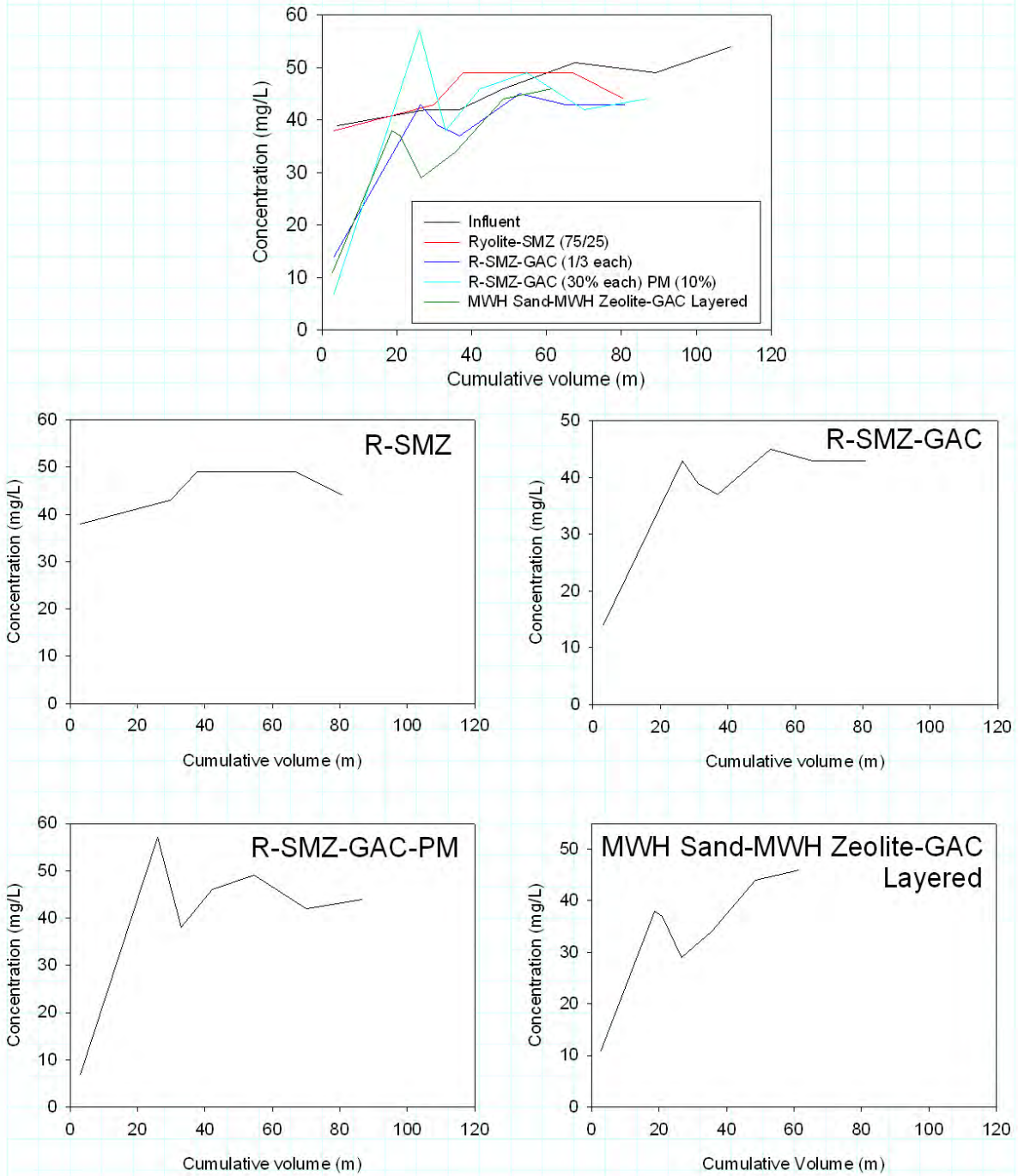


Figure A3-43. Breakthrough plots for sulfate (cont.).

Suspended Solids Concentration: Column Breakthrough Testing

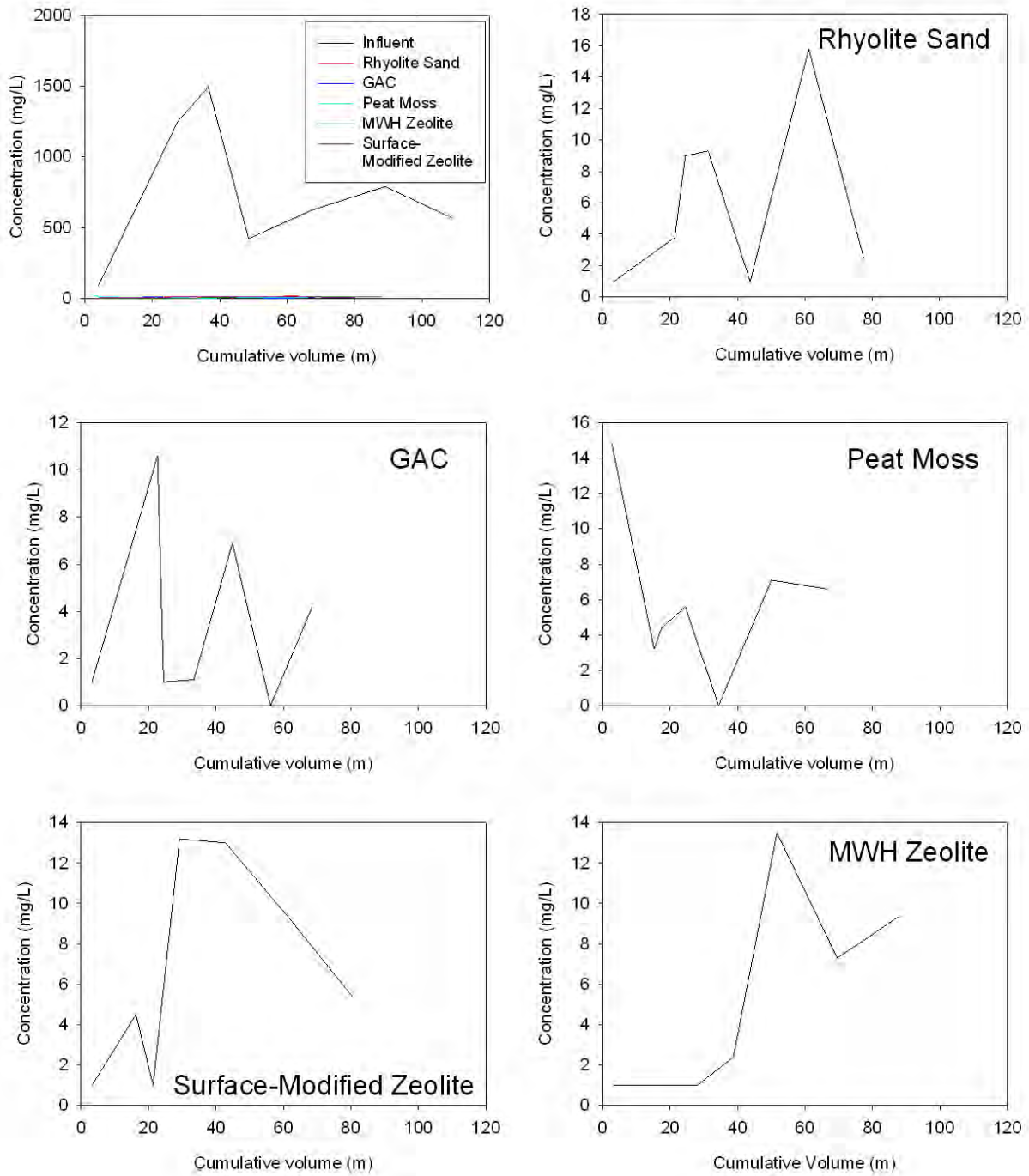


Figure A3-44. Breakthrough plots for total suspended solids.

Suspended Solids Concentration: Column Breakthrough Testing

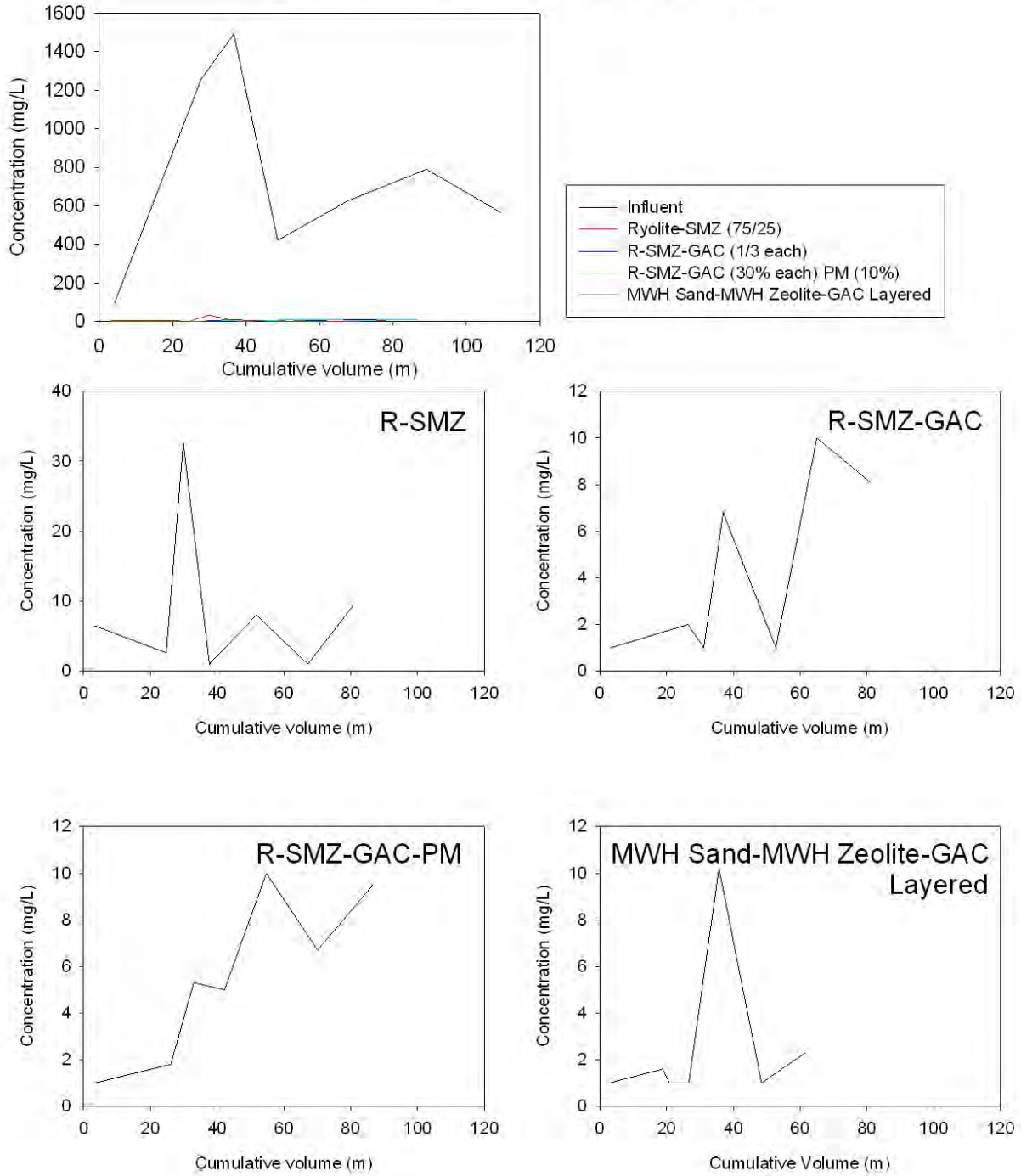


Figure A3-44. Breakthrough plots for total suspended solids (cont.).

Thallium, Total: Column Breakthrough Testing

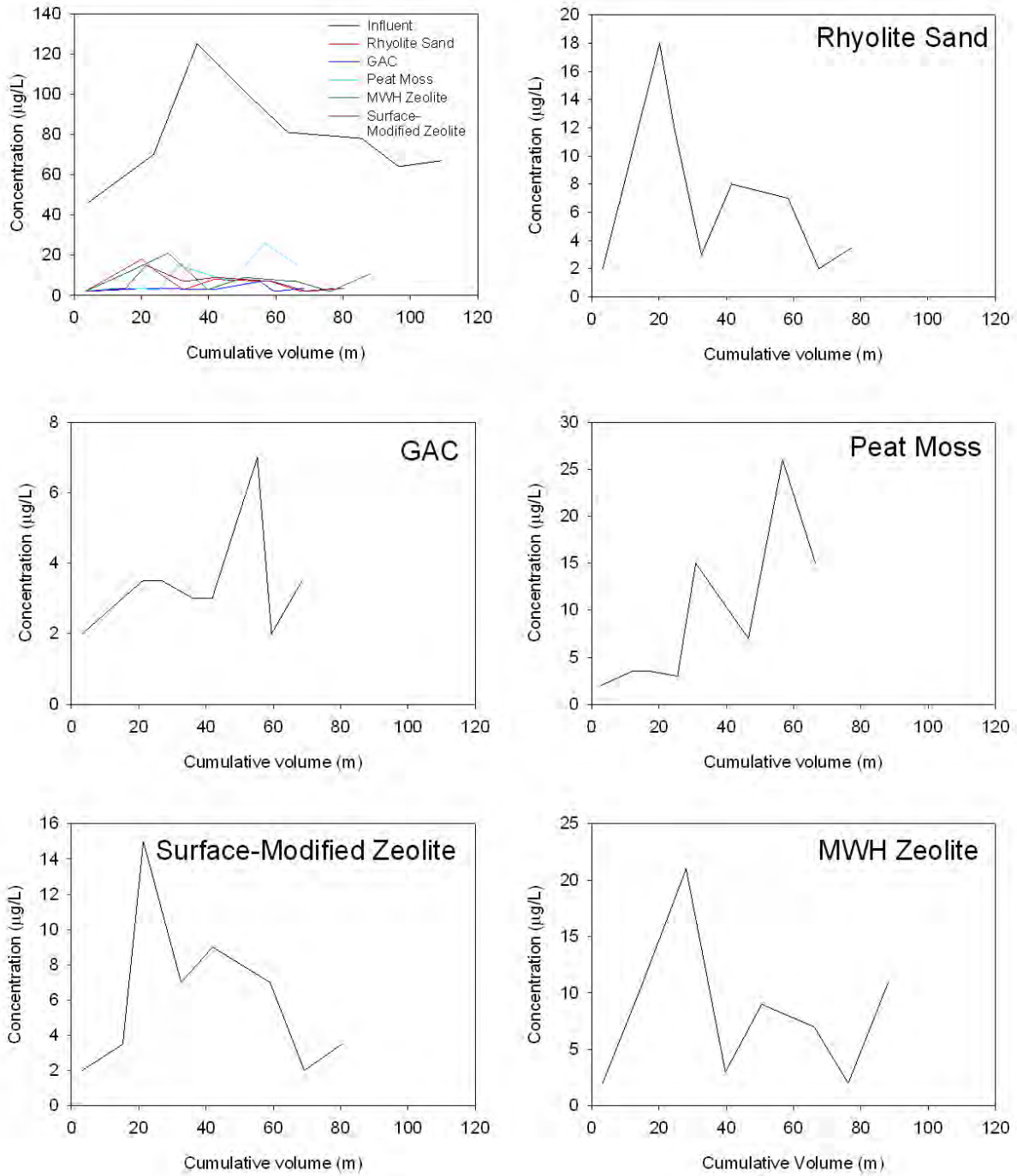


Figure A3-45. Breakthrough plots for total thallium.

Thallium, Total: Column Breakthrough Testing

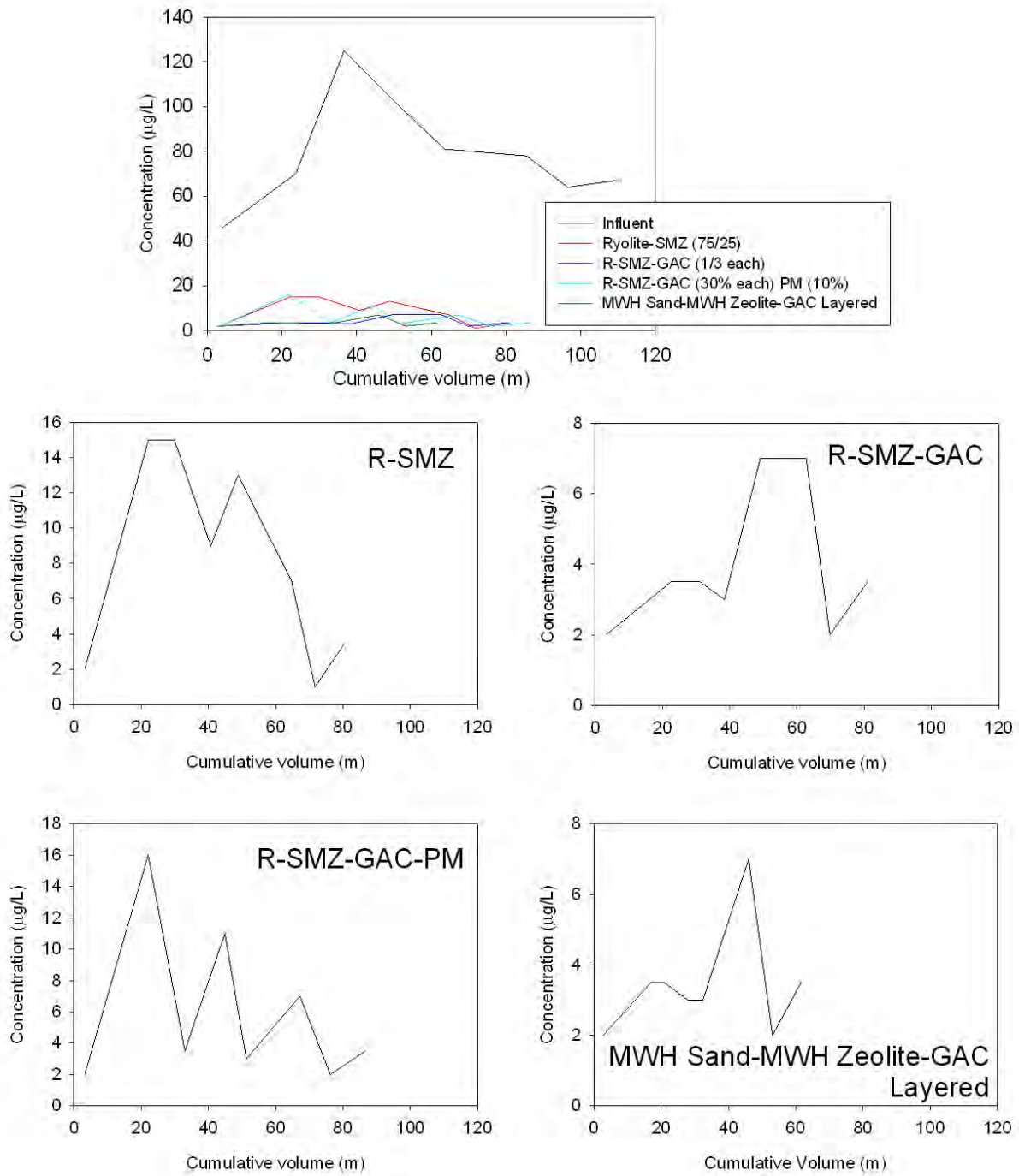


Figure A3-45. Breakthrough plots for total thallium (cont.).

Thallium, Filtered: Column Breakthrough Testing

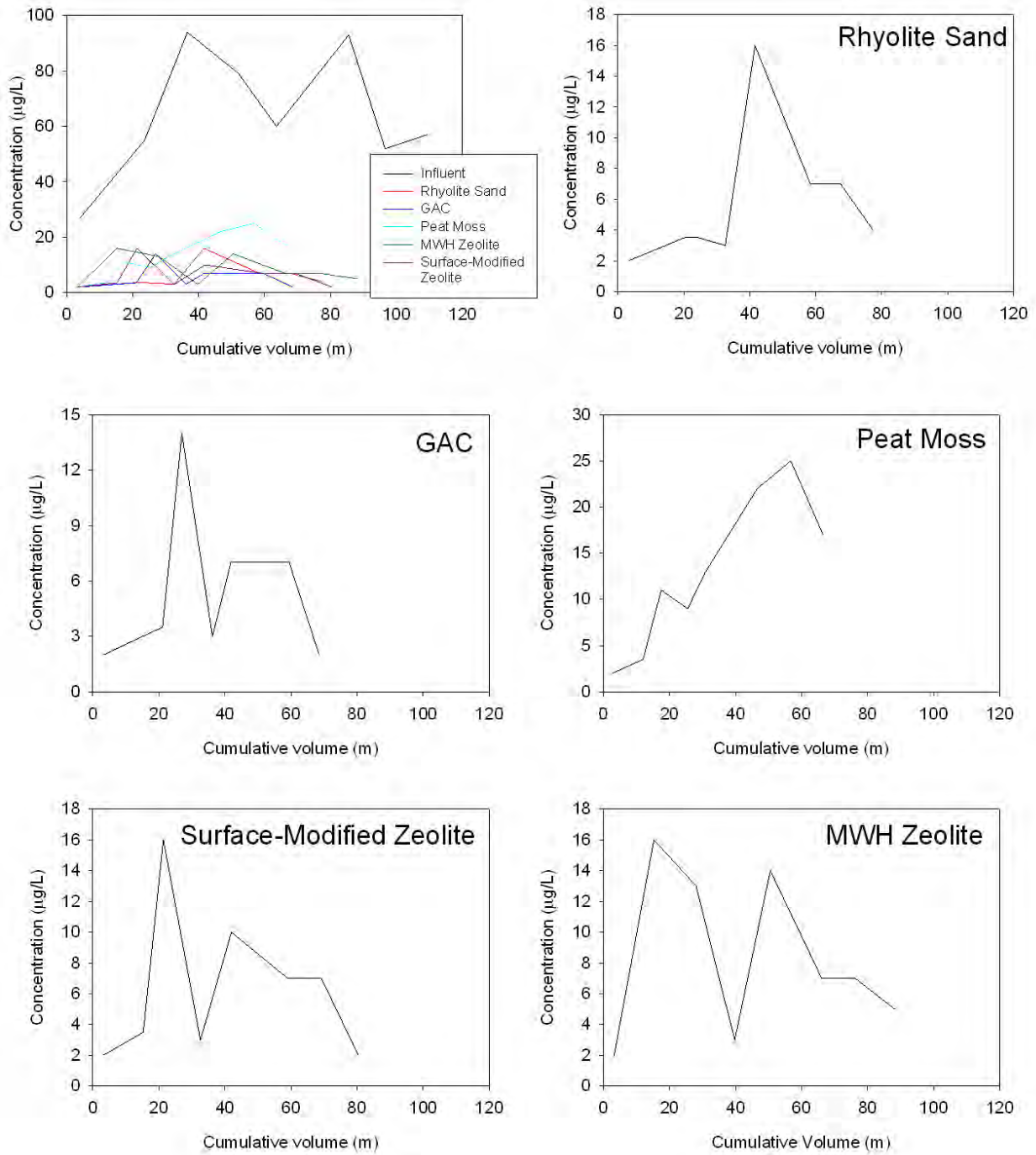


Figure A3-46. Breakthrough plots for filtered thallium.

Thallium, Filtered: Column Breakthrough Testing

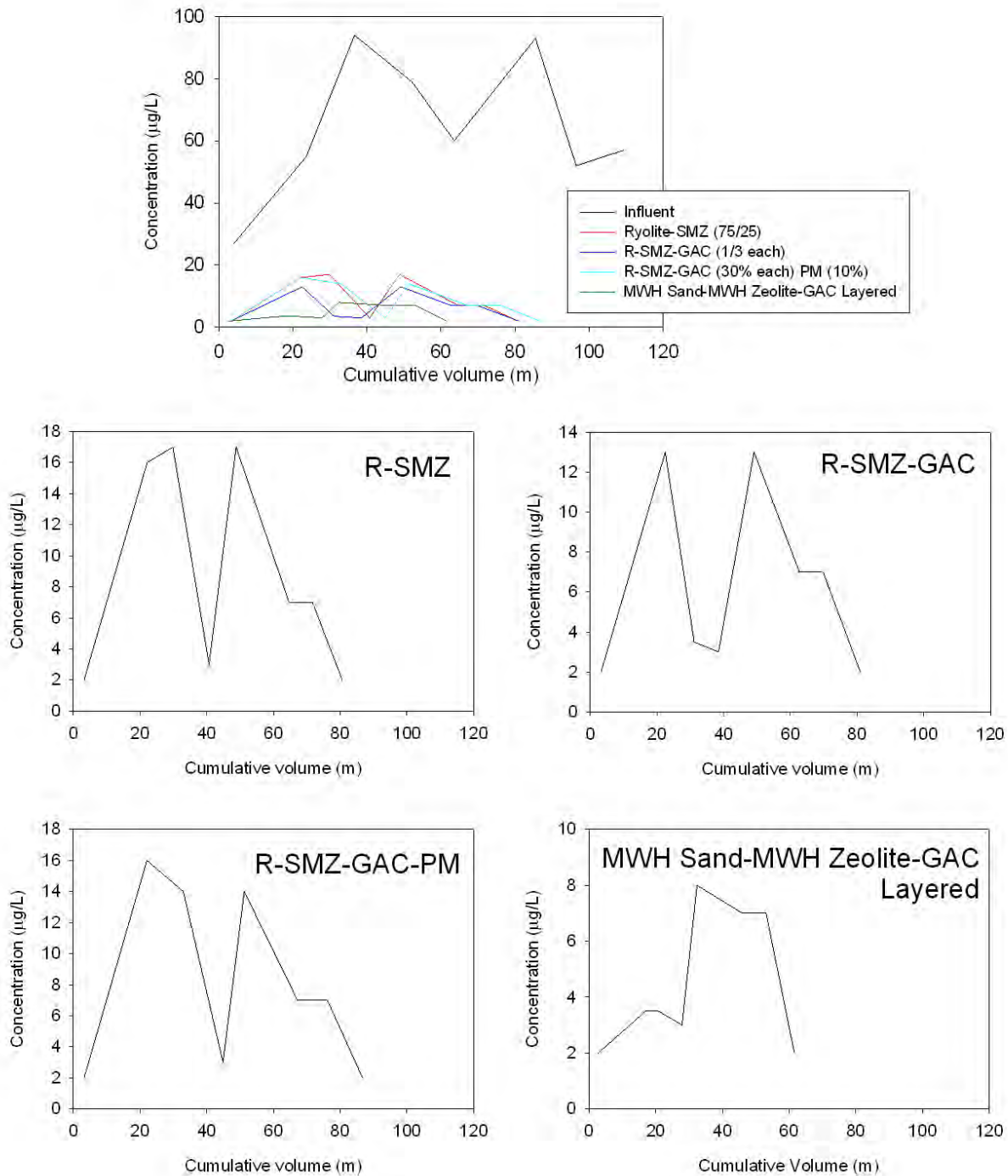


Figure A3-46. Breakthrough plots for filtered thallium (cont.).

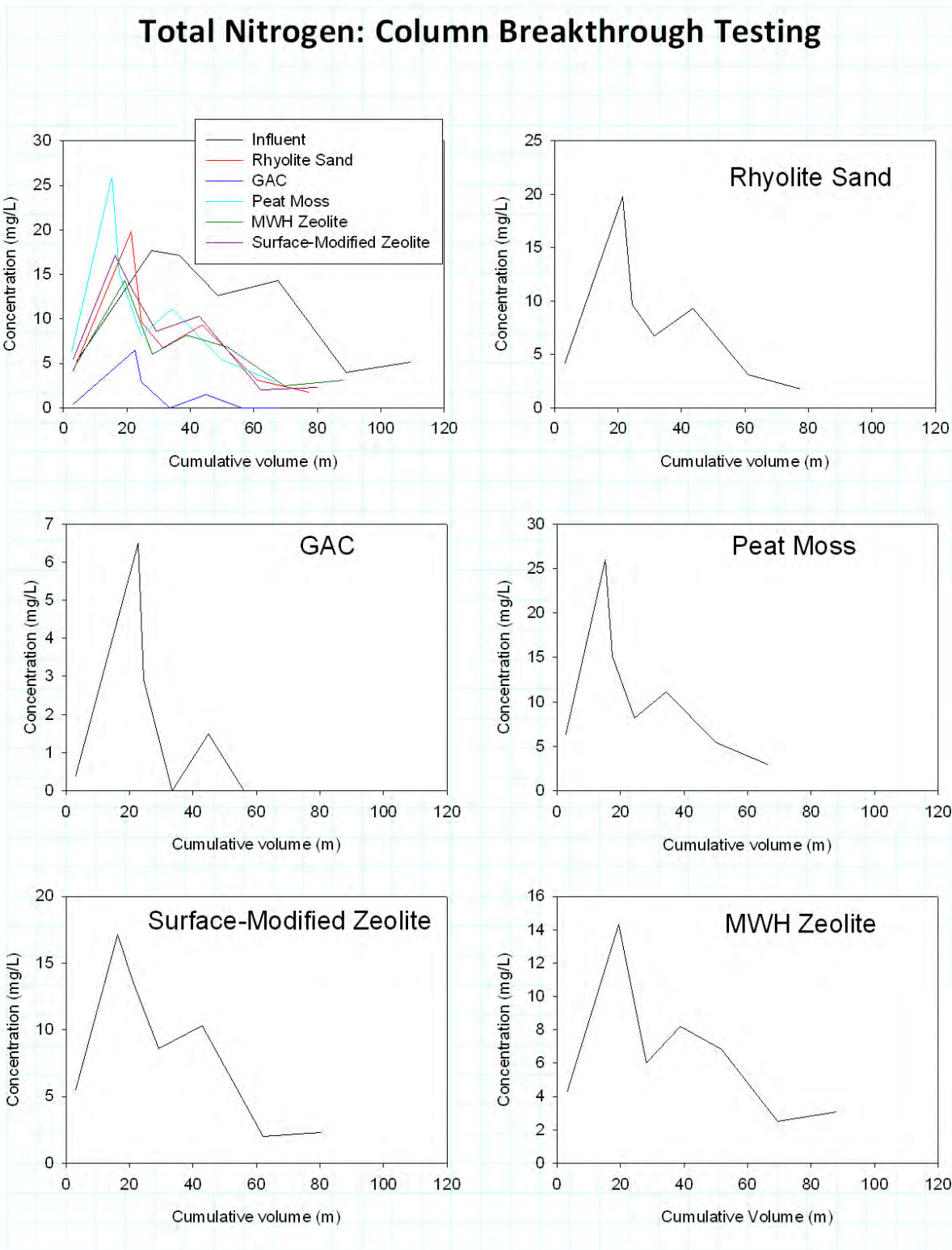


Figure A3-47. Breakthrough plots for total nitrogen.

Total Nitrogen: Column Breakthrough Testing

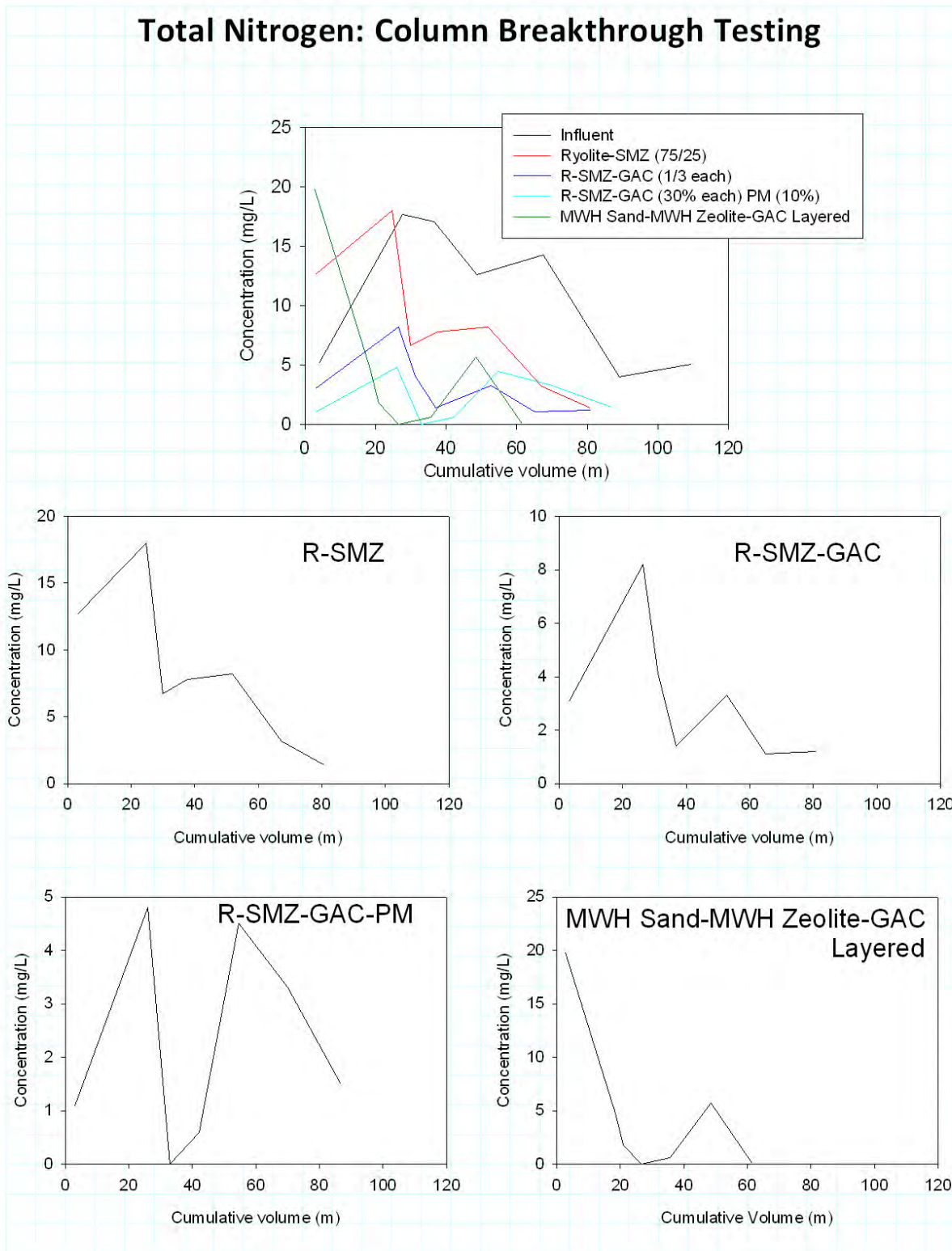


Figure A3-47. Breakthrough plots for total nitrogen (cont.).

Total Phosphorus: Column Breakthrough Testing

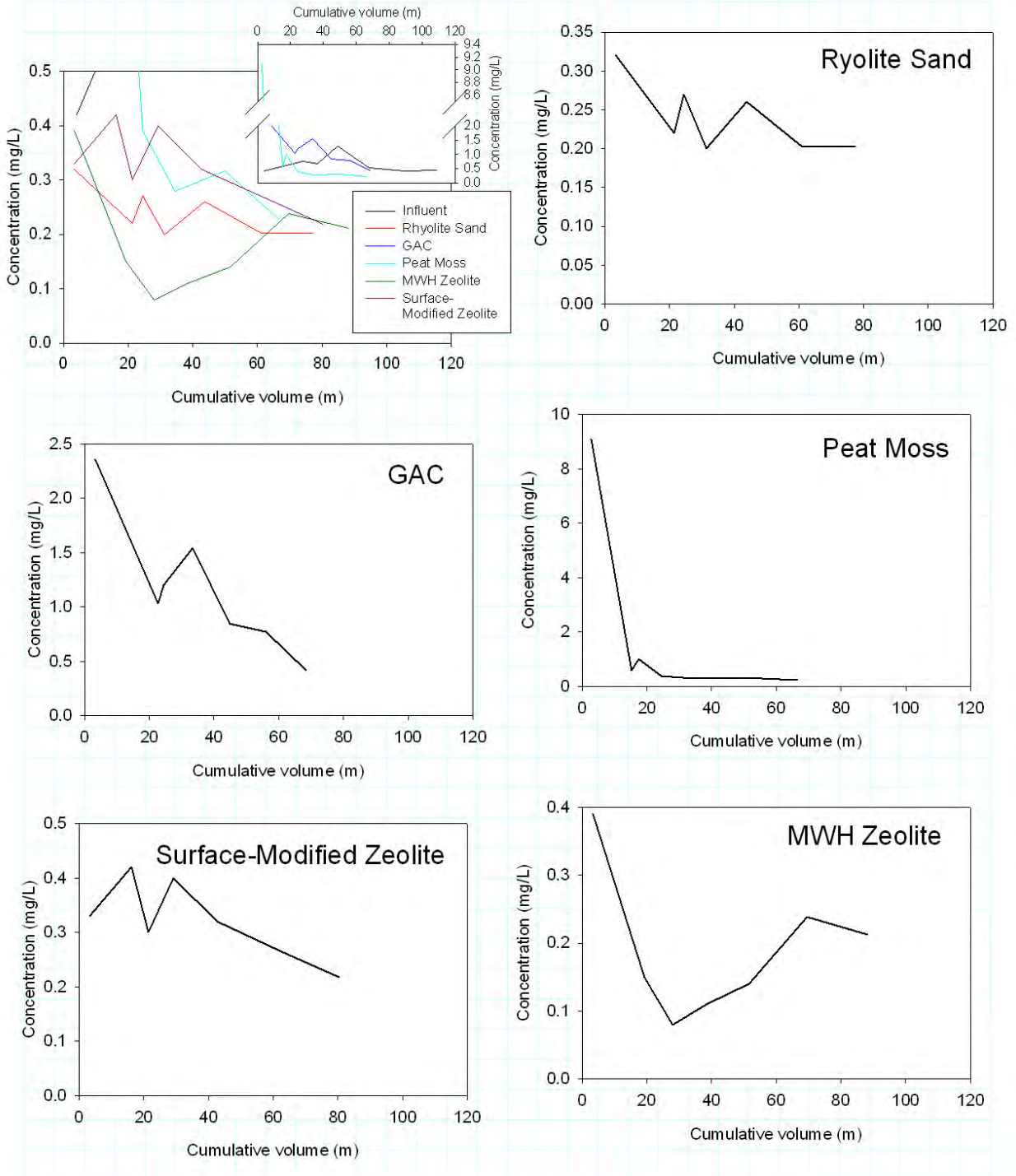


Figure A3-48. Breakthrough plots for total phosphorus.

Total Phosphorus: Column Breakthrough Testing

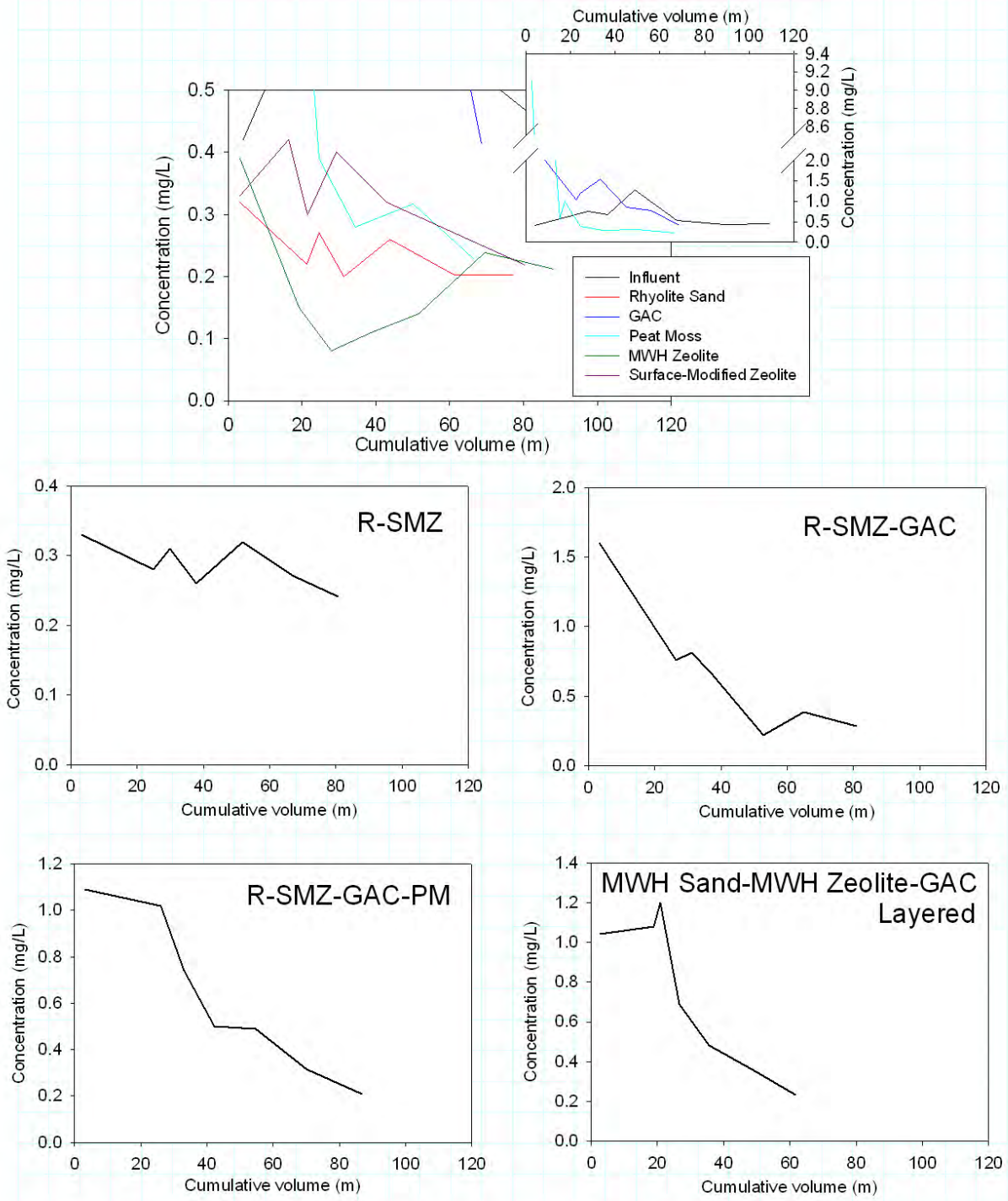


Figure A3-48. Breakthrough plots for total phosphorus (cont.).

UV-254 Absorbance: Column Breakthrough Testing

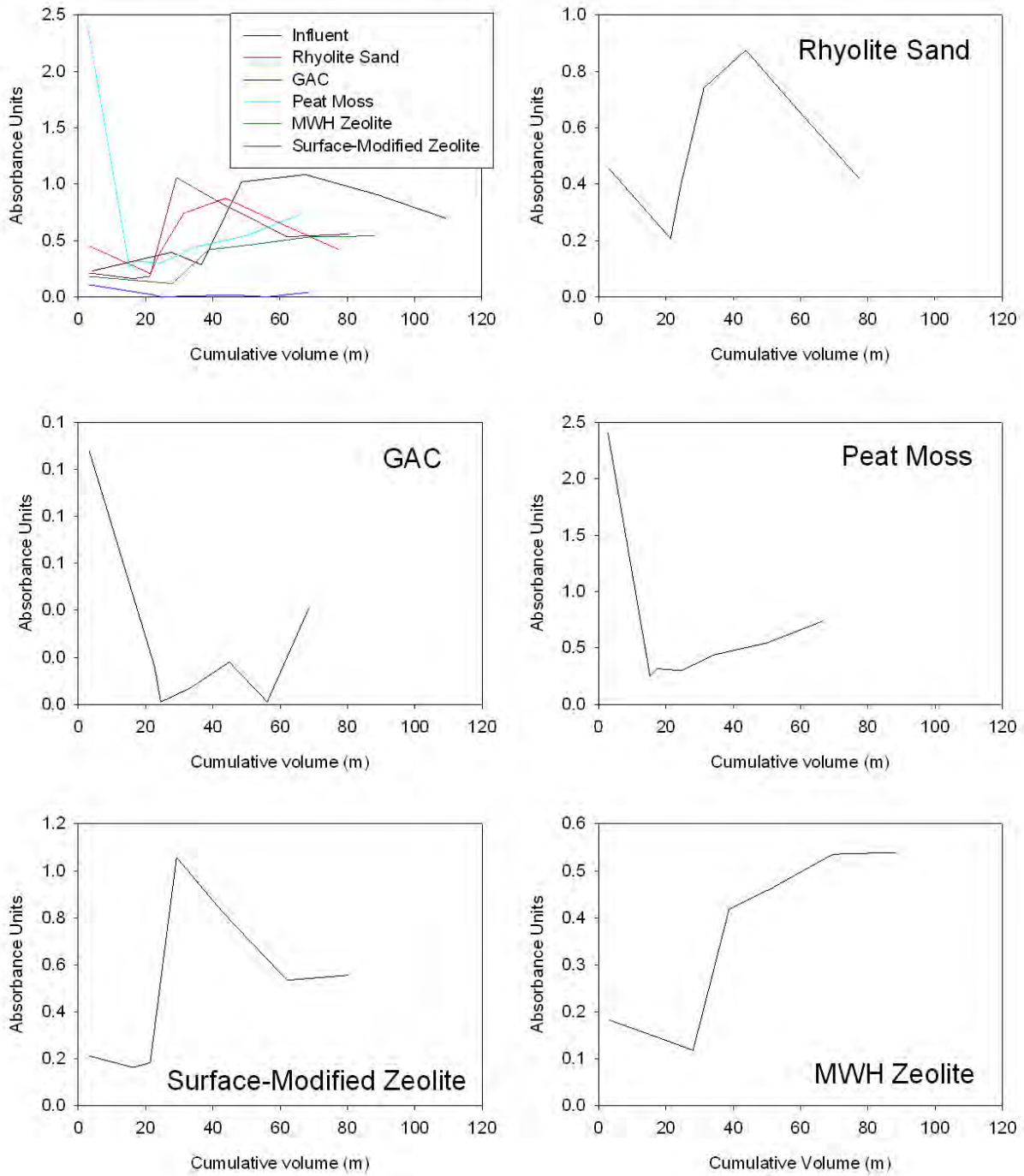


Figure A3-49. Breakthrough plots for UV-254.

UV-254 Absorbance: Column Breakthrough Testing

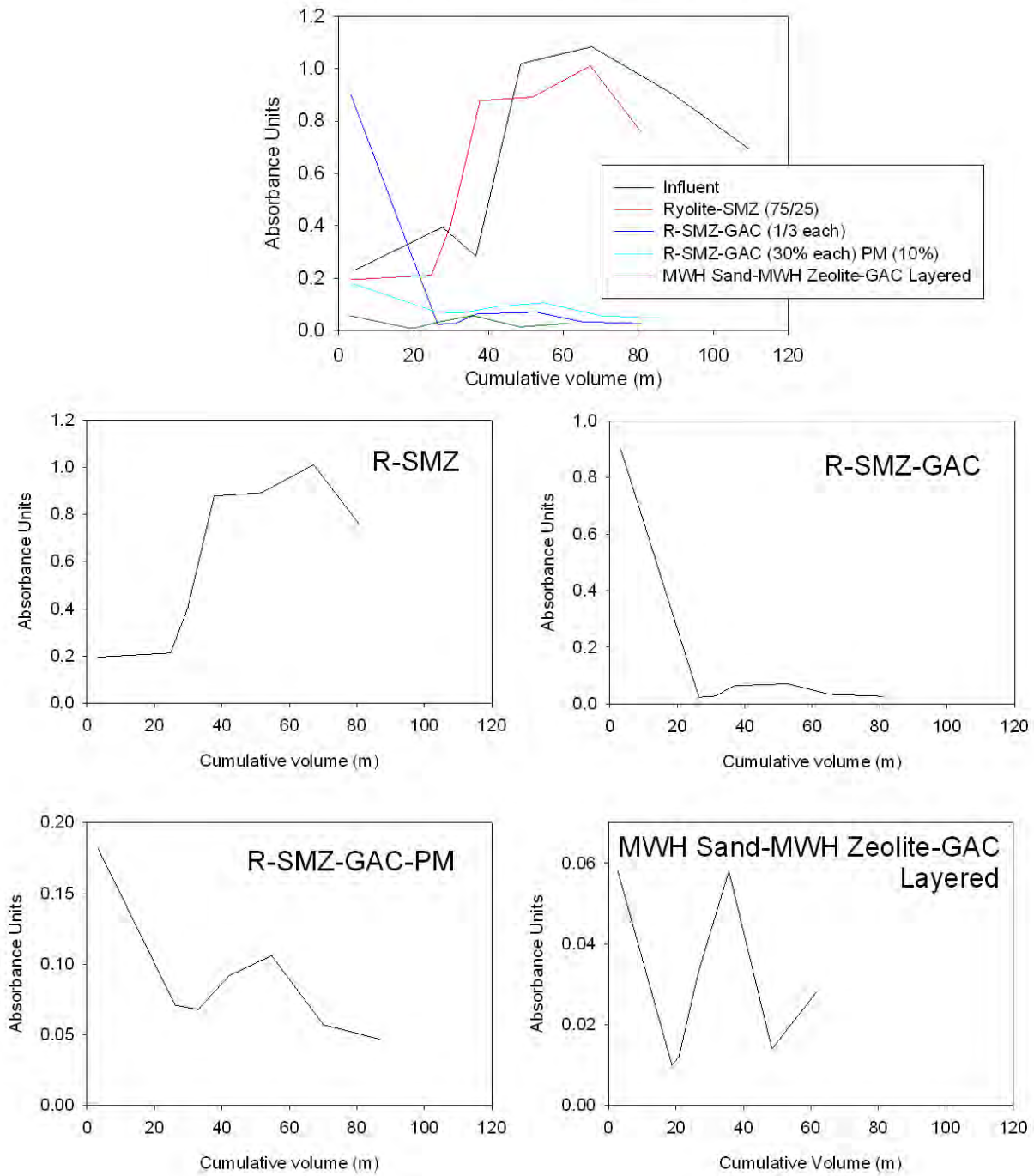


Figure A3-49. Breakthrough plots for UV-254 (cont.).

Zinc, Total: Column Breakthrough Testing

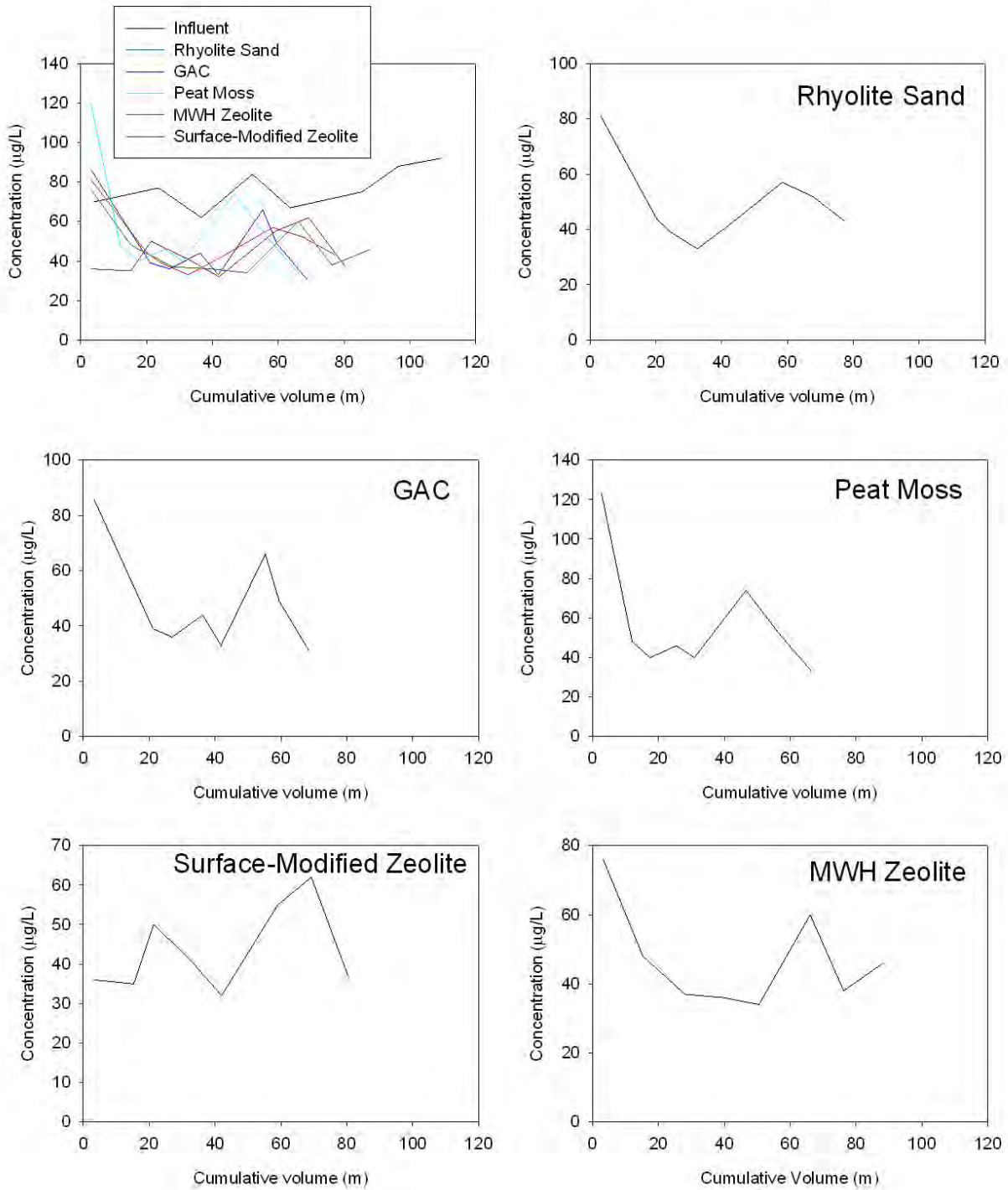


Figure A3-50. Breakthrough plots for total zinc.

Zinc, Total: Column Breakthrough Testing

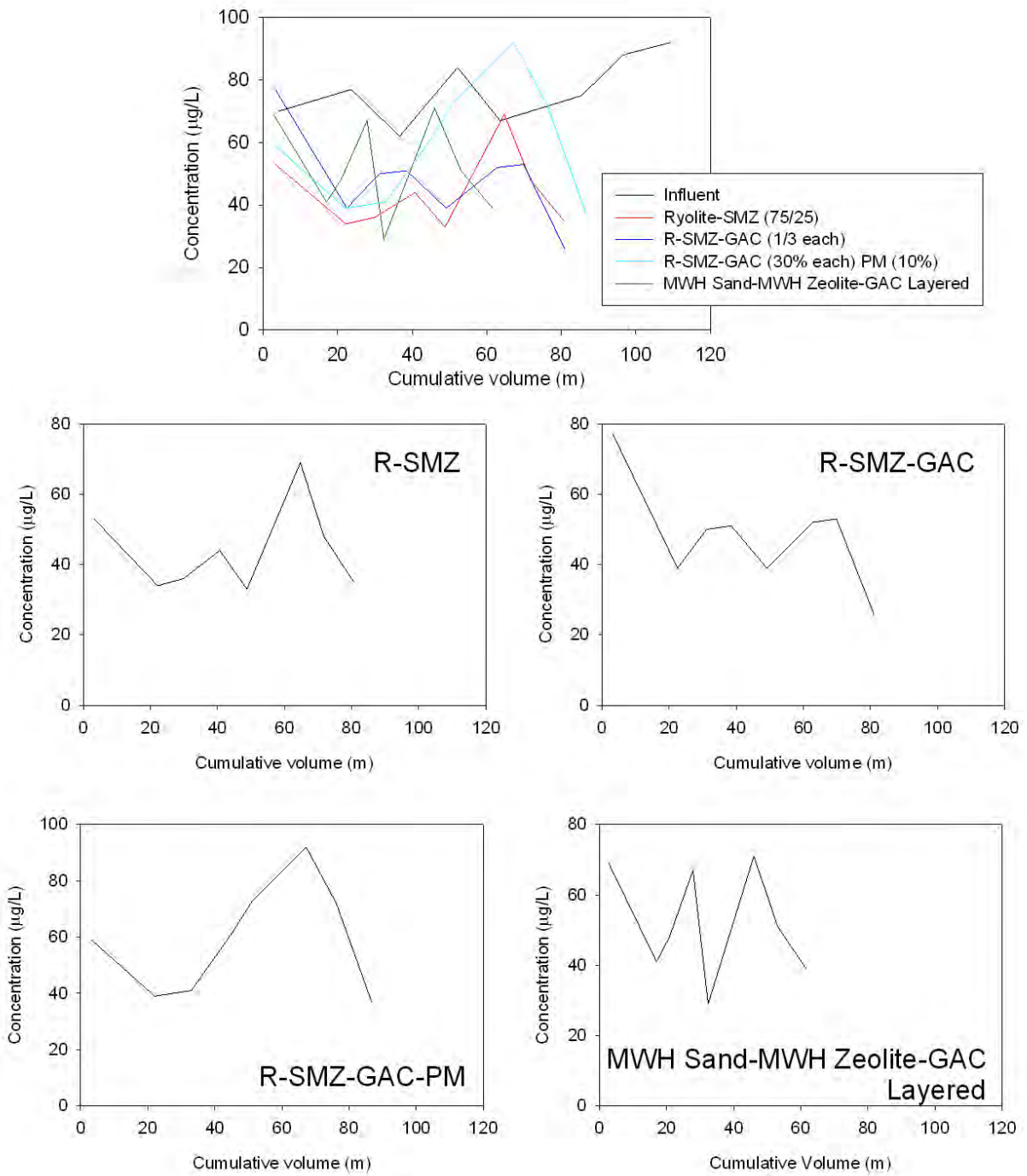


Figure A3-50. Breakthrough plots for total zinc (cont.).

Zinc, Filtered: Column Breakthrough Testing

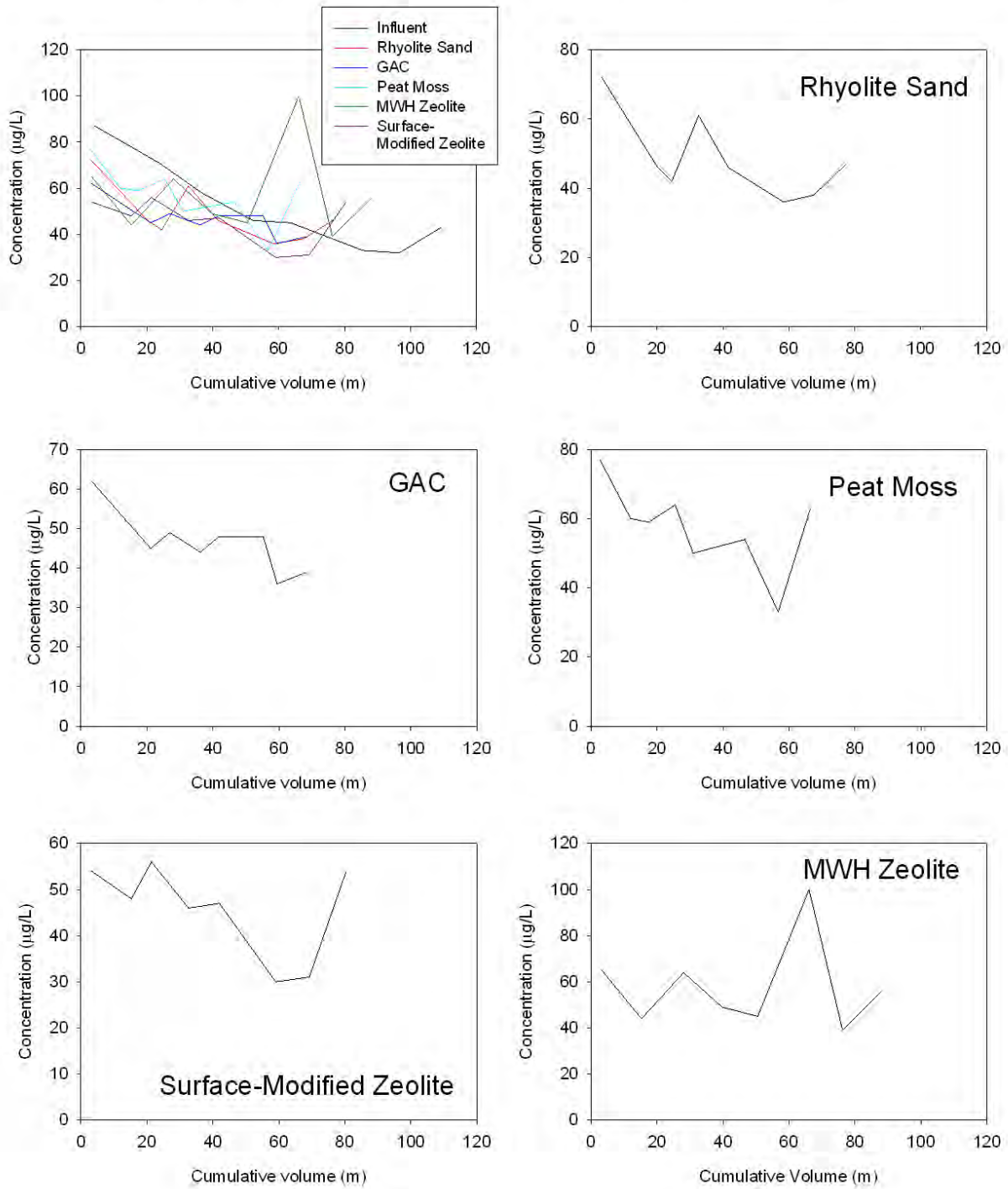


Figure A3-51. Breakthrough plots filtered total zinc.

Zinc, Filtered: Column Breakthrough Testing

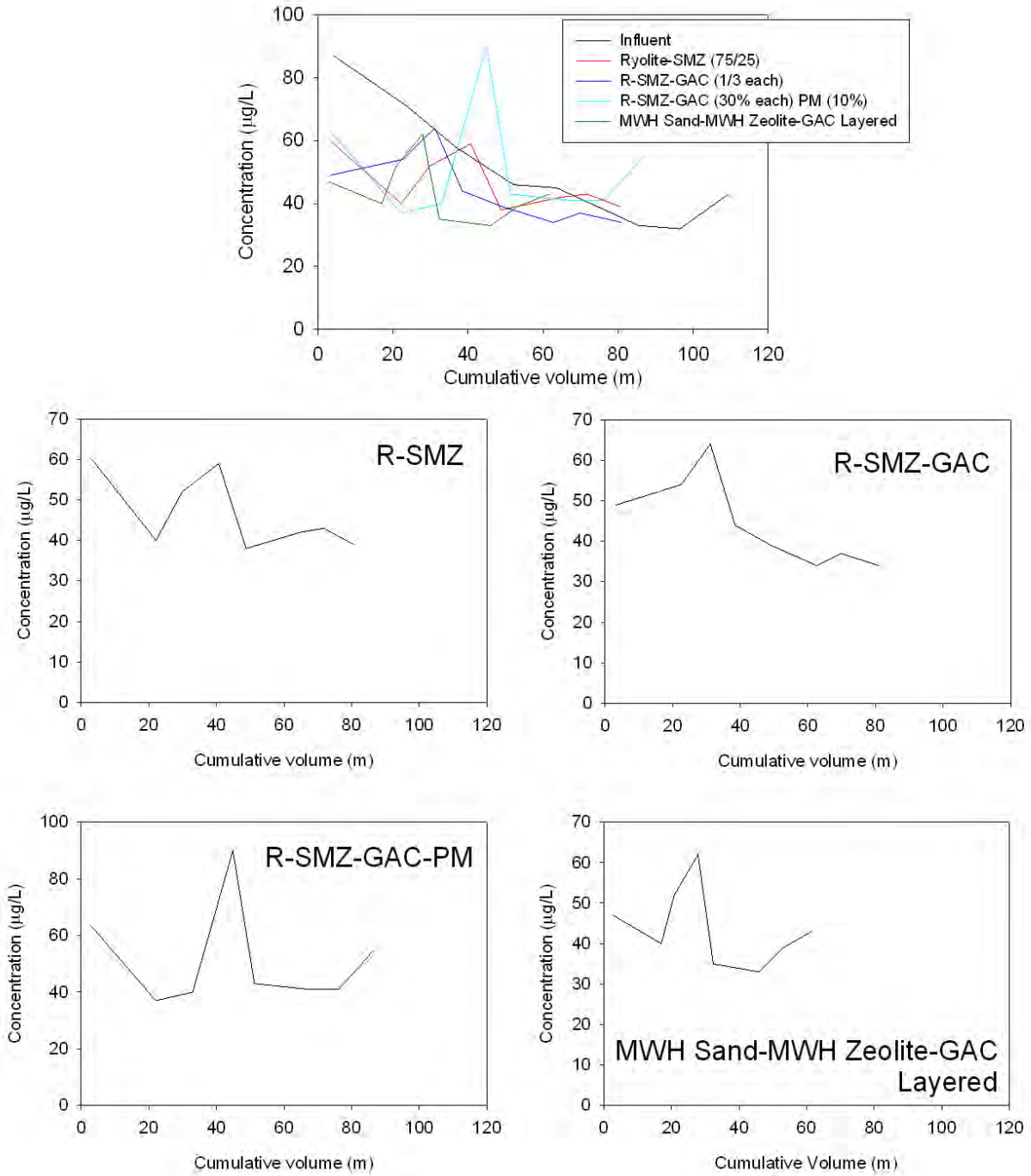


Figure A3-51. Breakthrough plots filtered total zinc (cont.).