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EVALUATION OF DATA FROM THE FIRST QUARTER OF SOIL VAPOR EXTRACTION AT MATERIAL DISPOSAL AREA L, SOLID WASTE MANAGEMENT UNIT 54 006, AT TECHNICAL AREA 54

Contract No.: 286642

Prepared for

LOS ALAMOS NATIONAL LABORATORY
Los Alamos, New Mexico

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List of Acronyms

1,1,1-TCA	1,1,1-trichloroethane
30x	30 times
3D	three dimensional
CME	Corrective Measures Evaluation
FY	fiscal year
kg	kilogram
LANL	Los Alamos National Laboratory
MDA L	Material Disposal Area L
NMED	New Mexico Environment Department
Q4FY14	fourth quarter of fiscal year 2014
Qbof	Otowi Member of the Bandelier tuff
Qct	Cerro Toledo interval
ROI	radius of influence
RSL	Regional Screening Level
SVE	soil vapor extraction
TA 54	Technical Area 54
Tb4	Cerros del Rio basalt
TCE	trichloroethene
VOCs	Volatile Organic Compounds

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1 INTRODUCTION

The objective of this report is to quantify and visualize the reductions in 1,1,1-trichloroethane (1,1,1-TCA) and trichloroethene (TCE) mass resulting from the first three months of soil vapor extraction (SVE) operation in the subsurface beneath Material Disposal Area L (MDA L) located within Technical Area 54 (TA 54) at Los Alamos National Laboratory (LANL) in Los Alamos, New Mexico. The plume distributions from the third quarter of fiscal year 2015 (Q3FY15) were compared to those of the Q4FY14 baseline sampling event prepared for the baseline report (Weston, 2015) and mass reductions were determined as the difference between the two events.

2 METHODOLOGY

Each of the contaminant plume interpretations and mass estimates presented in this report were derived using procedures established during the analysis of FY09 and FY10 data, which are detailed in Appendix E of the MDA L CME (LANL 2011, 205756) and summarized in the baseline report. The Q4FY14 plume distributions presented in this report are the same as those presented in the baseline report and were interpolated from soil vapor data collected from 85 sampling ports. The Q3FY15 distributions are based on data collected from a 46 port subset of the original 85 ports comprised of the borings closest to the SVE wells.

Because the ports near the plume margins were not sampled in Q3FY15, the corresponding plumes required additional procedures for dealing with extrapolation that have not been employed in the past. Failure to constrain the extrapolation yielded interpolated concentrations that were actually higher than the baseline predictions in many regions of the outer plume. Reusing baseline sample values at the plume margins alleviated some, but not all, of these problems. Reusing baseline data at all unsampled ports likewise did not alleviate all of the issues at the plume margins and caused additional problems in the vicinity of boring 54-24242, which is approximately halfway between the source areas. The approach that best solved the extrapolation problem was to reuse the outer portion of the interpolated baseline plume (as opposed to reusing baseline sample values). This technique was implemented by performing a three-dimensional (3D) radial distance calculation on the screen intervals of the SVE locations. The interpolation based upon Q3FY15 sample data was used within 215’ of the SVE wells and the baseline data interpolation was used beyond 225’. The plumes were averaged over the intermediate 10’ interval to prevent any discontinuities in the result. The 220’ distance threshold was selected because the 125’ SVE radius of influence (ROI) established by the pilot test (LANL 2006, 094152) was insufficient to fully encapsulate all of the Q3FY15 samples, much less allow their influence to be projected slightly beyond the data. The 220’ ROI precluded any influence of the Cerros del Rio sample at boring 54-24399 since changes at this port more likely reflect natural temporal variability than SVE influence.

3 RESULTS

This section includes images of the interpolated 3D vapor plume distributions and the resulting mass estimates using the same figure and table formats presented in the baseline report. Figures 3-1 and 3-2 depict the 1,1,1-TCA plume for the baseline (Q4FY14) and Q3FY15 rounds, respectively. Figures 3-3 and 3-4 present the TCE plumes in the same order. Figures 3-5 and 3-6 show the percent reductions from baseline concentrations for 1,1,1-TCA and TCE, respectively.

The Q3FY15 plume distributions of both contaminants exhibit lower concentrations in the source areas than their Q4FY14 counterparts. The size of the isoshell greater than or equal to ten times the Tier II Screening Level (≥10x) is much smaller for Q3FY15 than for Q4FY14 in the eastern source area and it has been completely eliminated in the western source area. The size of the ≥50x TCE isoshell has likewise been significantly reduced and the ≥100x TCE isoshell has been completely eliminated in the

western source area. As stated above, the Q3FY15 plumes are the same as the Q4FY14 plumes beyond 225' from the SVE wells.

The Q3FY15 percent reduction from baseline plumes were similar for the two contaminants and greater near SVE West than SVE East due to the lower baseline concentrations in the western source area. Reduction amounts decrease from >90% in the upper 50 feet of the western source area to zero at the 220' maximum ROI imposed on the interpolations. Increases of both compounds occurred at the 330' port of 54-27641 and the shallowest ports of 54-02089 and 54-24238 (46' and 64', respectively). The percent increase at the deep port of 54-27641 (~500%) was high for both compounds because the baseline concentrations were low there. The 1,1,1-TCA concentration increased at the two shallow eastern source area ports by only 10% to 30% but the TCE concentration doubled. There was a small region north of SVE West where the 220' distance threshold used to constrain the extrapolations extended beyond the baseline plume. The influence of the reduction at sample at 270' in 54-27641 was consequently extrapolated to the edge of the plume.

Table 3-1 summarizes the Q3FY15 plume mass estimates for the various phases of both contaminants accounting for the strata-specific distribution coefficients provided in Table 2-1. The distribution of mass among the various phases is similar to that of Q4FY14 since these ratios are dictated primarily by the partitioning coefficients. Table 3-2 provides the uncertainty estimates for Q3FY15. The ~10% error is lower than that associated with the baseline plume (~30%) due to the fact that the outer shell of the baseline plume was consistently applied for each of the Q3FY15 interpolation iterations. It consequently reflects only the region of the plume within 220' of the SVE wells.

Table 3-3 compares the Q3FY15 mass estimates with those of the baseline scenario. These comparisons are also depicted graphically in Figures 3-7 and 3-8. The mass reduction is greatest within the >10x region and within the Tshirege due to the proximity of these regions to the SVE wells. The mass increased slightly within the <10x isoshell for 1,1,1-TCA and the 10x - 25x isoshells for TCE due to the aforementioned higher concentrations at the two shallow eastern source area ports. However, the mass reductions within higher isoshells more than offset these small increases to produce a net reduction of 30% to 40% in the Tshirege. The large percent increase in concentration at the deep port of 54-27641 produced only a small increase in mass within the outermost isoshells below the Tshirege, yielding a net 10% reduction of both contaminants in the deeper zone and approximately 30% reduction overall. Lastly, Table 3-3 shows that the proportion of mass contained within the assumed 125' ROI of the SVE system was 11% lower than baseline for 1,1,1-TCA and 15% lower for TCE within the Tshirege. These values represent only a third of the overall Tshirege mass reduction, which suggests that the actual SVE ROI may be larger than 125' assumed for the calculations.

Figure 3-9 provides a comparison of the Q3FY15 results to Q4FY14 using scatterplots with a 1:1 line superimposed that reveals strong concentration reductions of both contaminants at the vast majority of sampled ports. The four exceptions were the aforementioned ports plus the 140' port at 54-02022, which experienced only a 10% to 15% increase from baseline concentrations. The Q3FY15 data were also added to the time-series vapor phase concentration plots from the baseline report that make up Figures 3-10 through 3-21. The magnitude of the concentration reductions in several of the source area ports exceed the magnitude of temporal variability historically observed at these ports. However, other ports located slightly further away from the source areas exhibit reductions that are similar in magnitude to historic temporal variability. It is currently unclear whether the slight reductions and the few observed increases near the presumed SVE ROI extents are the result of SVE induced plume modification or natural variability. Future quarters of SVE operational data may indicate trends for some ports that more strongly suggest one influence over the other.

4 CONCLUSIONS

A comparison of the Q3FY15 data and corresponding models and mass estimates to those of the Q4FY14 baseline suggests substantial (~30%) SVE induced reductions of both the 1,1,1-TCA and TCE plumes. The estimated differences within the Tshirege were 193-kg and 110-kg for 1,1,1-TCA and TCE, respectively, for comparison with calculations based on system performance data. Reductions were only 10% to 15% within the presumed 125' ROI for the SVE system, which suggests that the actual ROI might be larger. The true ROI could not be readily discerned from the data because of the more limited sampling network and the likelihood that natural variability is masking some of the impact of the SVE. A comparison of the recent concentration reductions with historical trends confirm that the reductions in the source areas are SVE induced but that the SVE ROI cannot yet be determined from the available data. Additional sampling may enable the ROI to be better determined in the future, which would likely lead to more accurate mass reduction estimates.

5 REFERENCES

LANL (Los Alamos National Laboratory), November 2006. "Summary Report: 2006 In Situ Soil Vapor Extraction Pilot Study at Material Disposal Area L, Technical Area 54, Los Alamos National Laboratory," Los Alamos National Laboratory document LA-UR-06-7900, Los Alamos, New Mexico. (LANL 2006, 094152)

LANL (Los Alamos National Laboratory), September 2011. "Corrective Measures Evaluation report for Material Disposal Area L, Solid Waste Management Unit 54-006, at Technical Area 54, Revision 2" Los Alamos National Laboratory document LA-UR-11-4798, Los Alamos, New Mexico. (LANL 2011, 205756)

Weston (Weston Solutions, Inc.), May 2015. "Baseline Data Evaluation for Soil Vapor Extraction at Material Disposal Area L, Solid Waste Management Unit 54-006, at Technical Area 54" Los Alamos National Laboratory, Los Alamos, New Mexico.

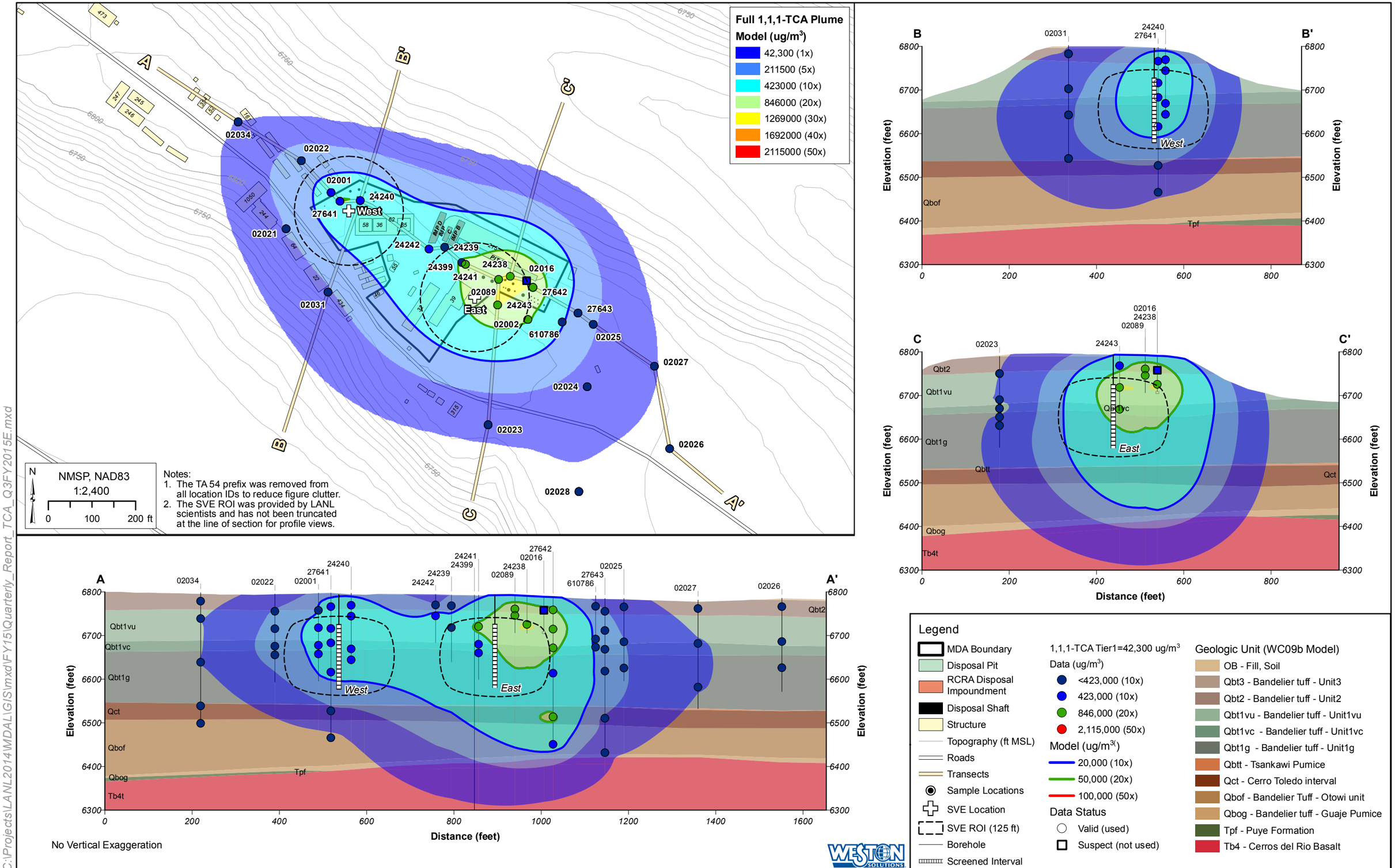

Figure 3-1 MDA L Subsurface 1,1,1-TCA vapor distribution for Q4FY14

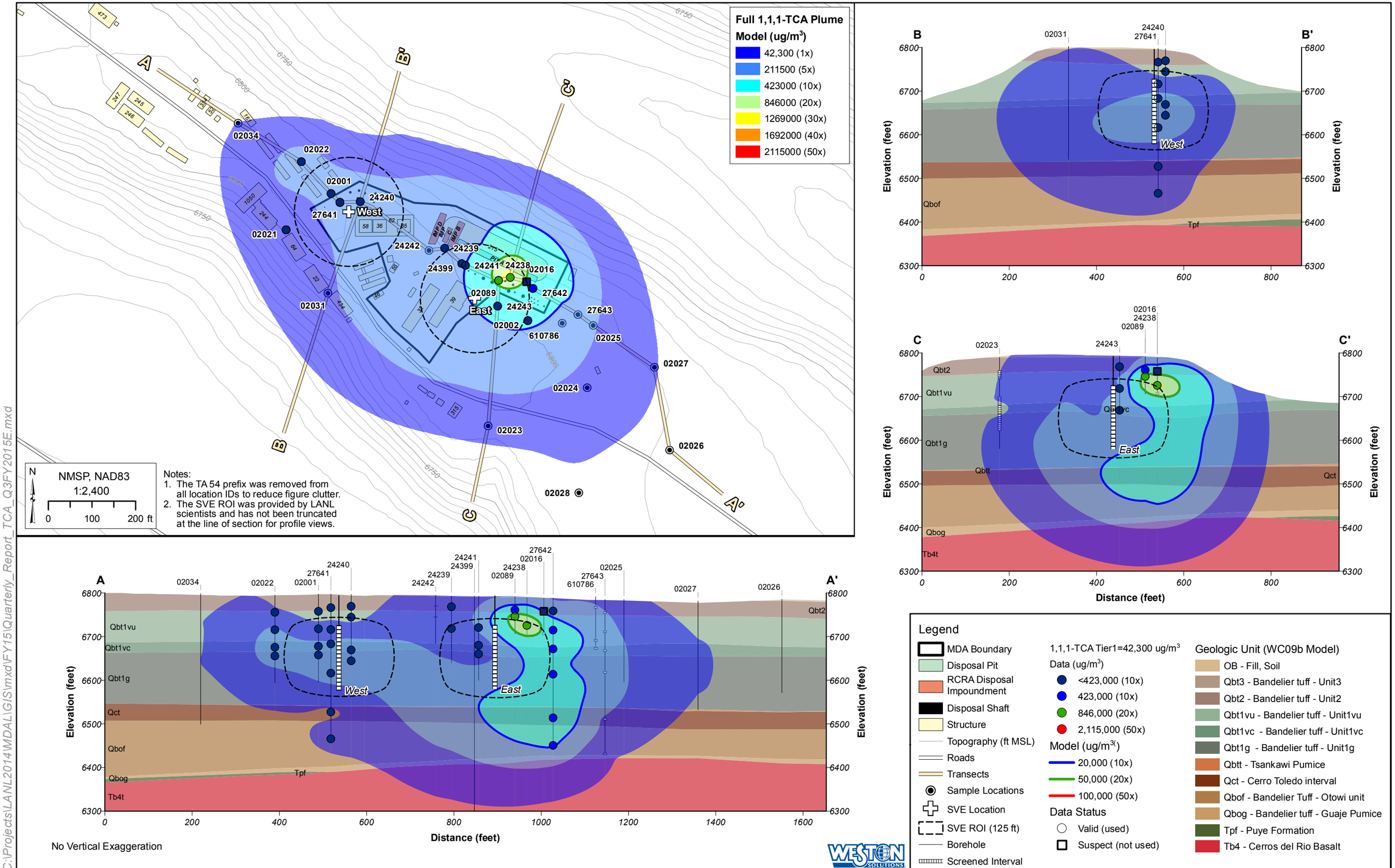

Figure 3-2 MDA L Subsurface 1,1,1-TCA vapor distribution for Q3FY15

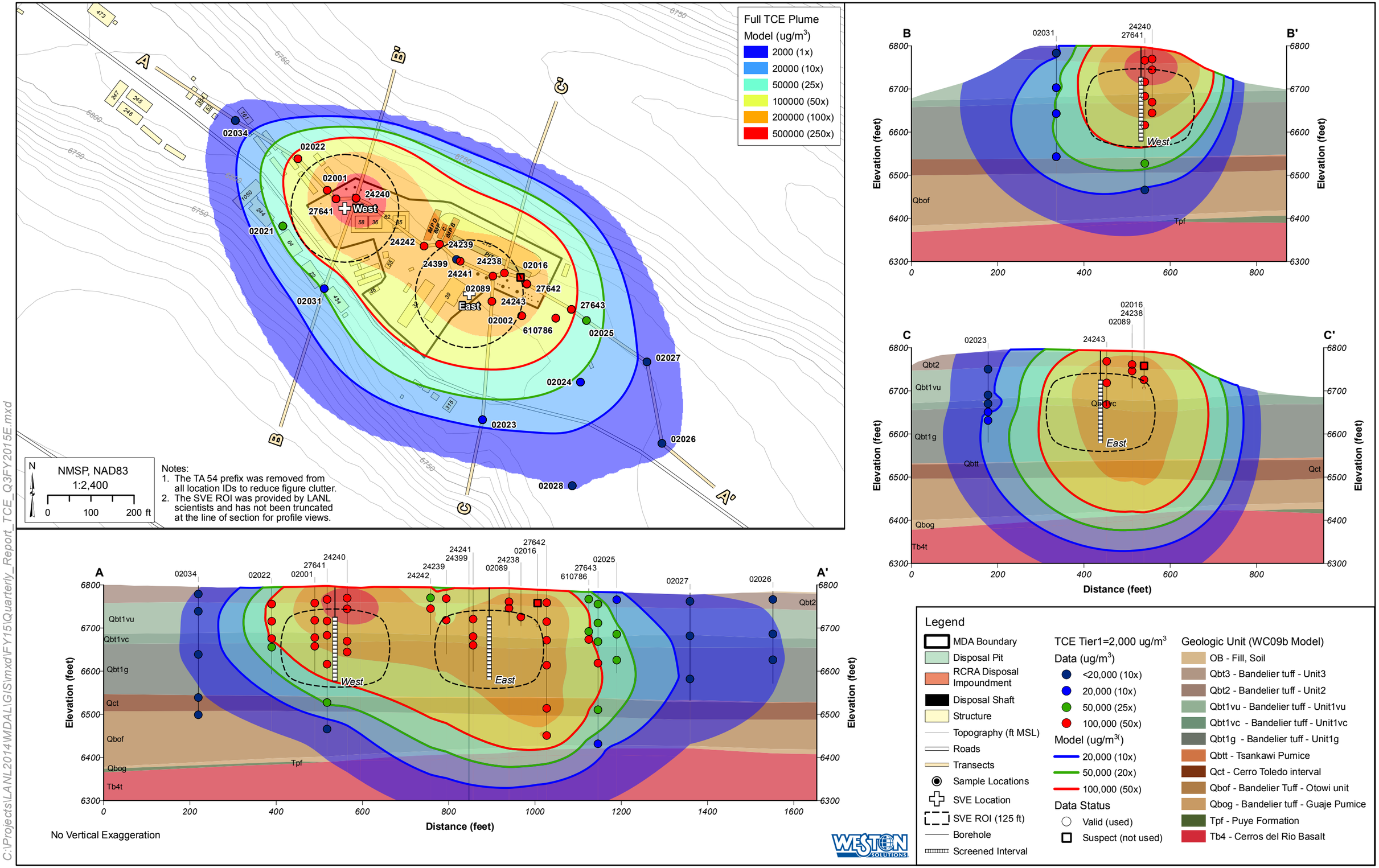

Figure 3-3 MDA L Subsurface TCE vapor distribution for Q4FY14

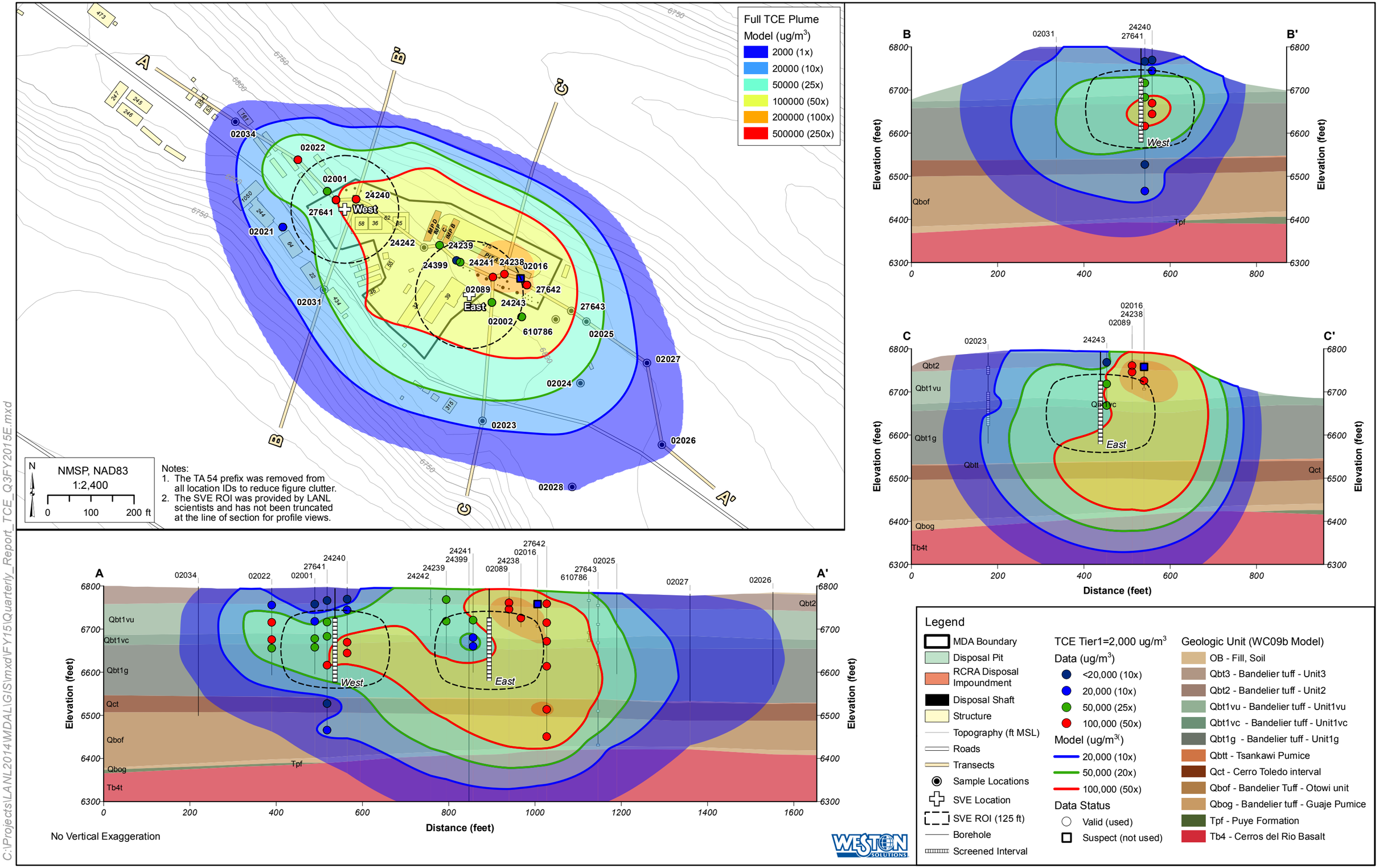

Figure 3-4 MDA L Subsurface TCE vapor distribution for Q3FY15

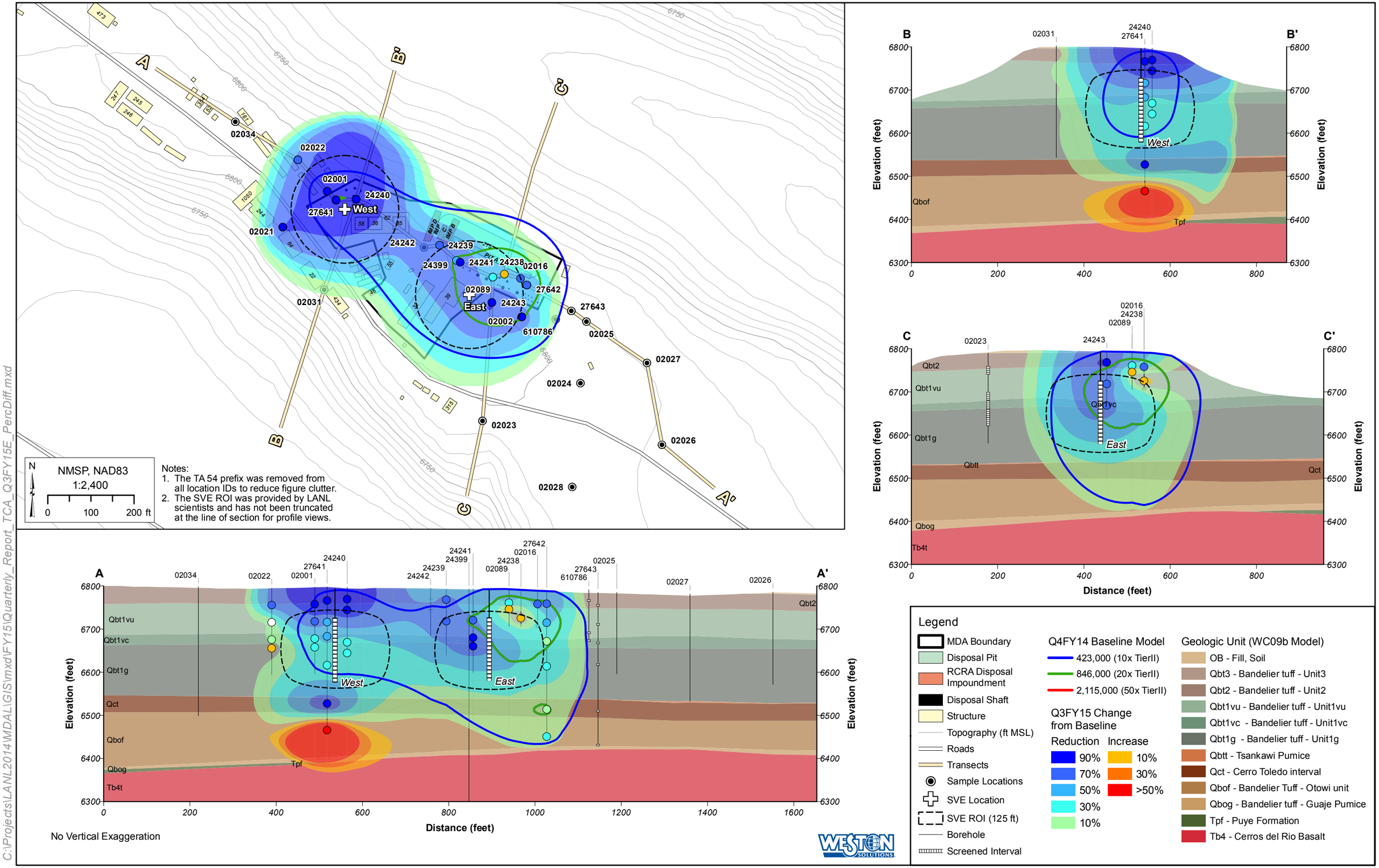

Figure 3-5 Q3FY15 Interpolated plume reduction for 1,1,1-TCA

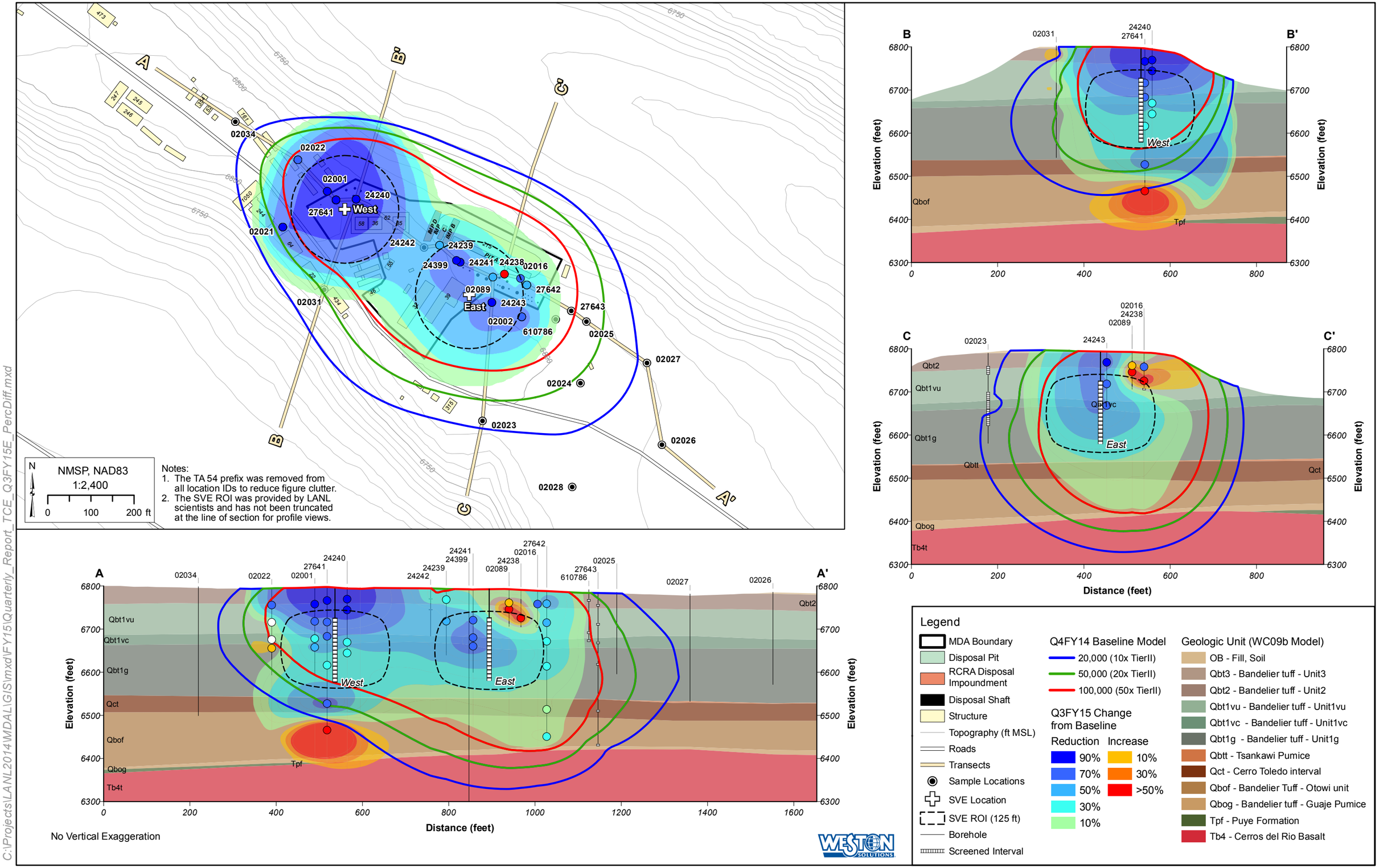

Figure 3-6 Q3FY15 Interpolated plume reduction for TCE

Figure 3-7
Comparison of Mass Distribution by Quarter

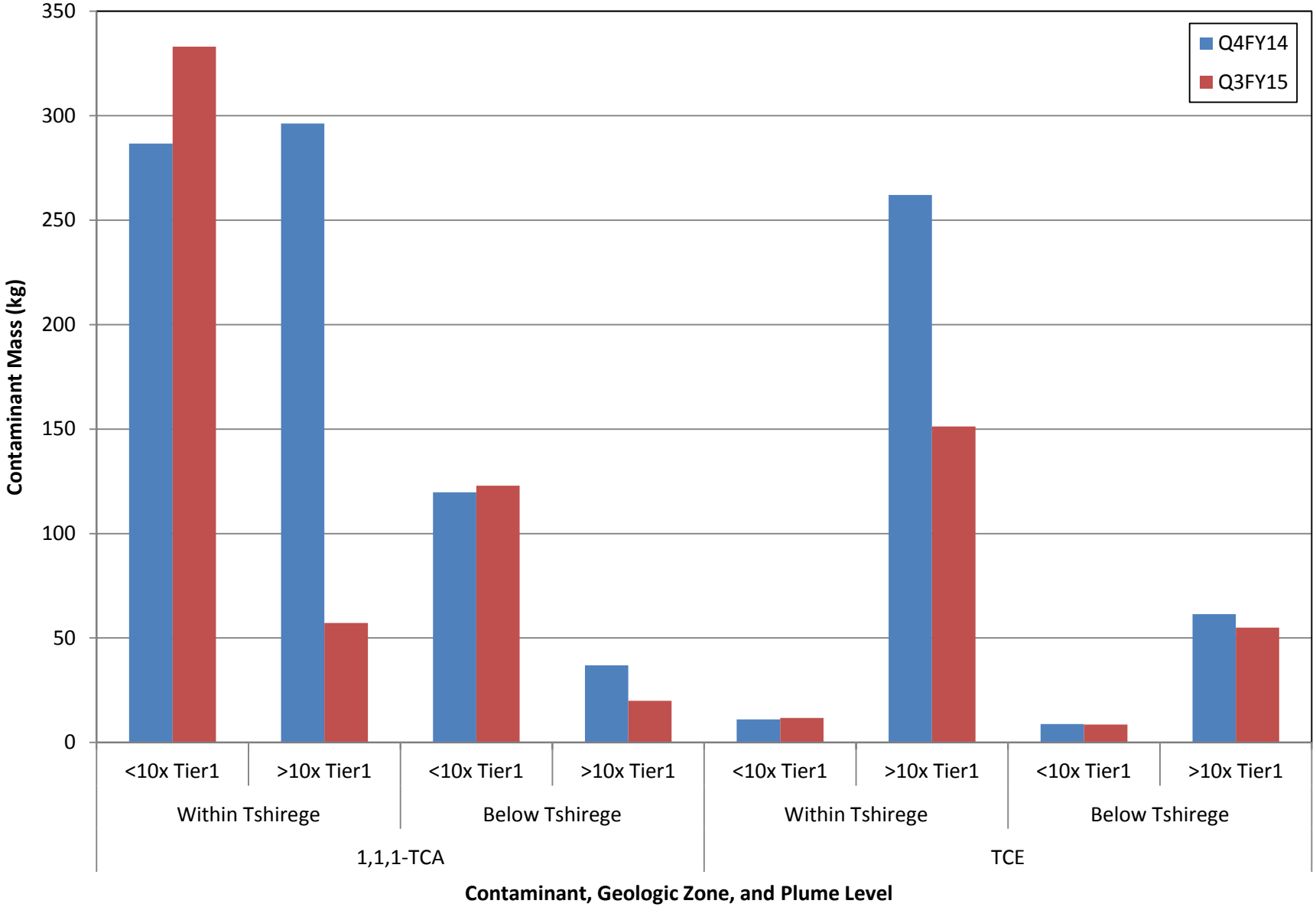

Figure 3-8
Comparison of Mass Distribution by Isoshell and Quarter Within the Tshirege

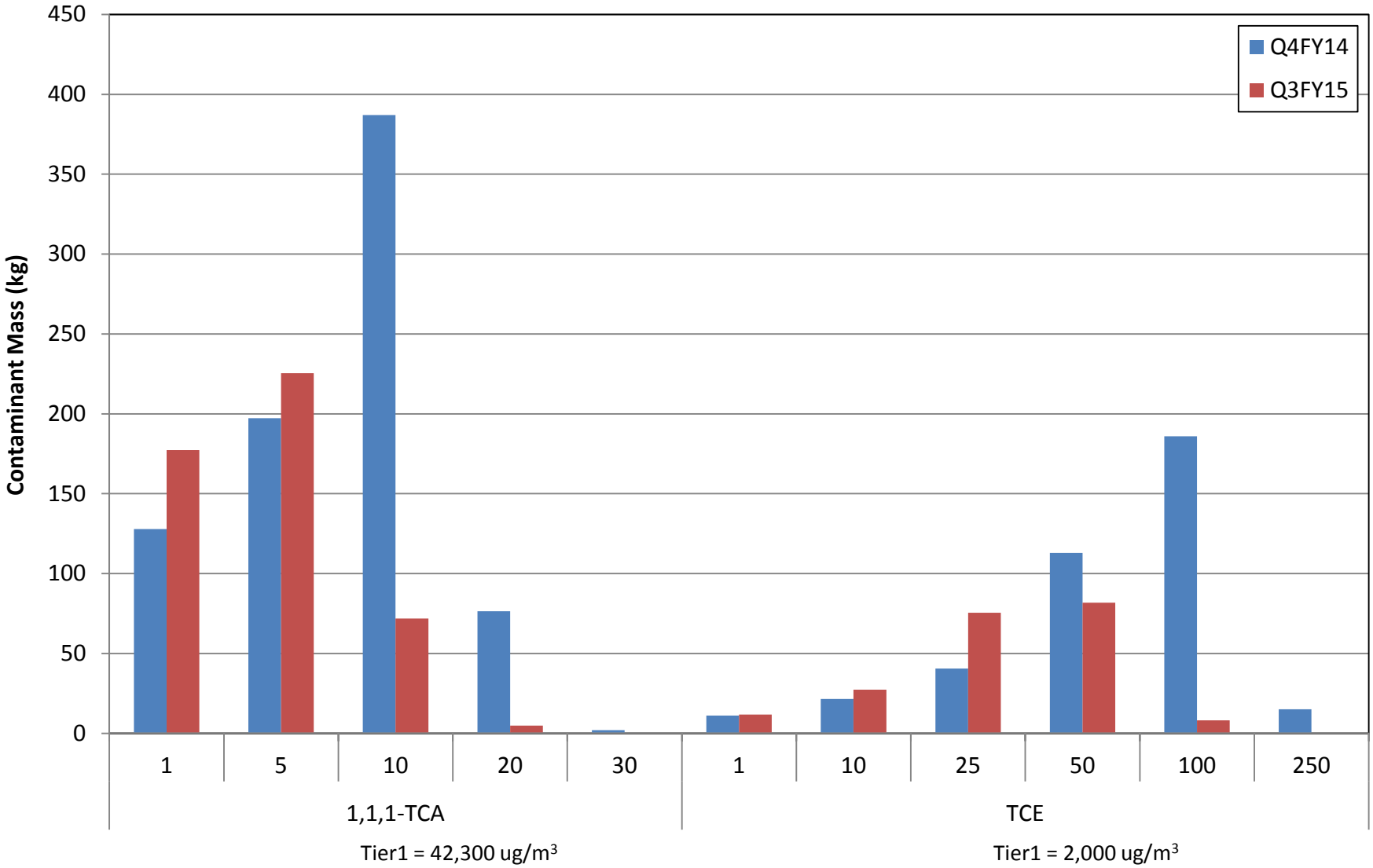

Figure 3−9
Comparison of Q3FY15 Results to Baseline

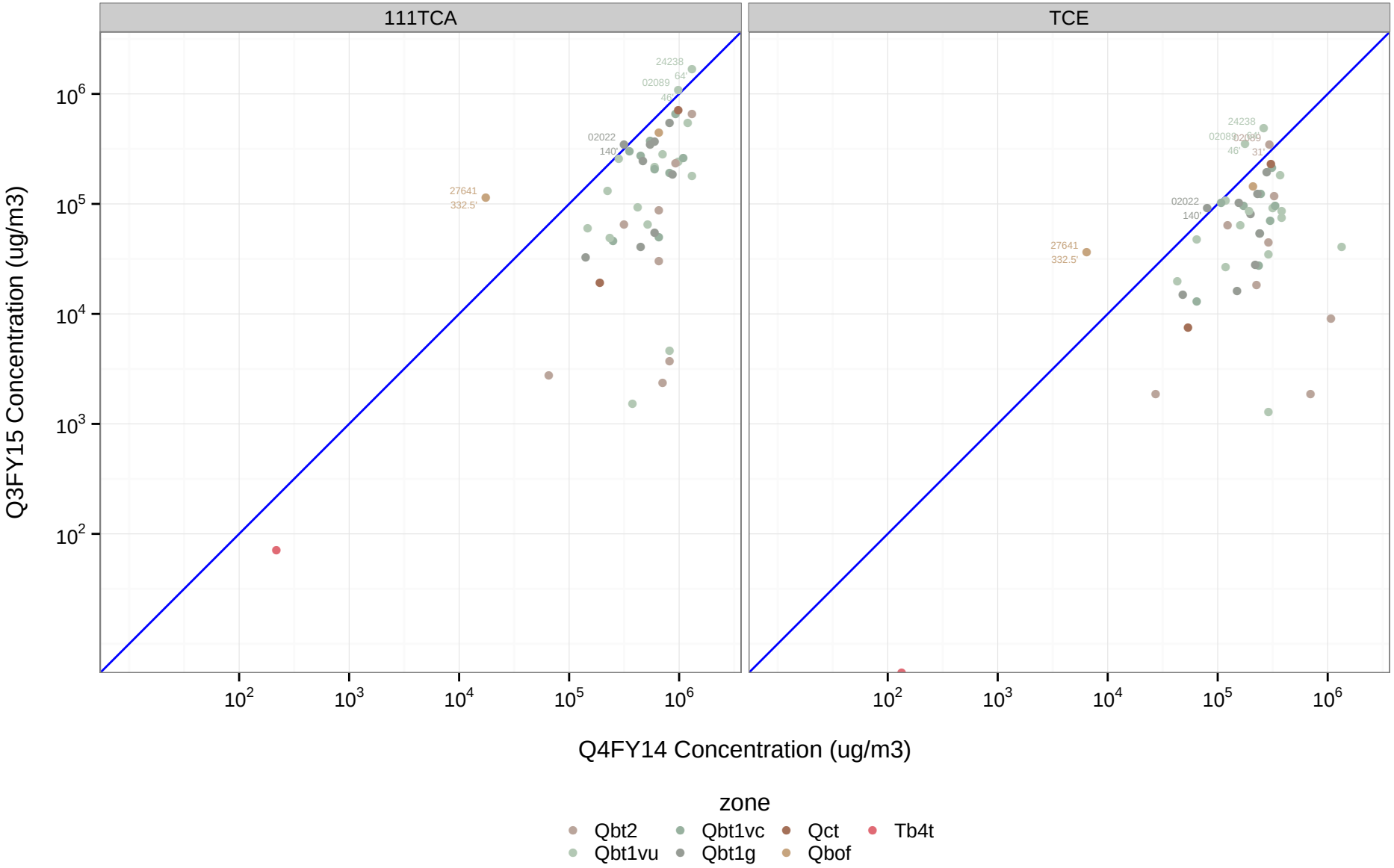

Figure 3−10

Recent Time History of VOC parent Compounds Within the Source Areas

Port Depth (feet bgs) and Year

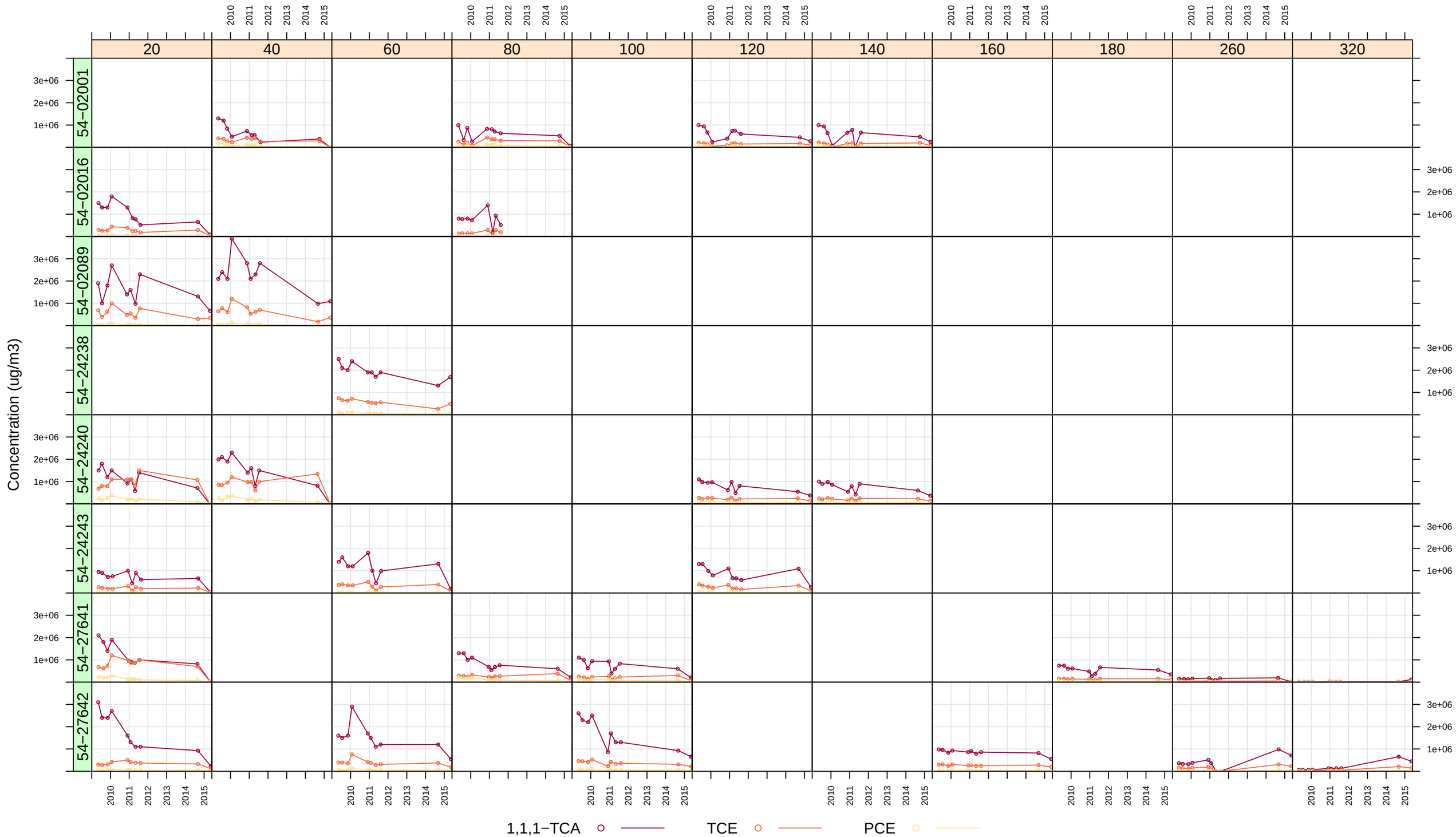

Figure 3−11

Recent Time History of VOC parent Compounds Within the Intermediate Areas

Port Depth (feet bgs) and Year

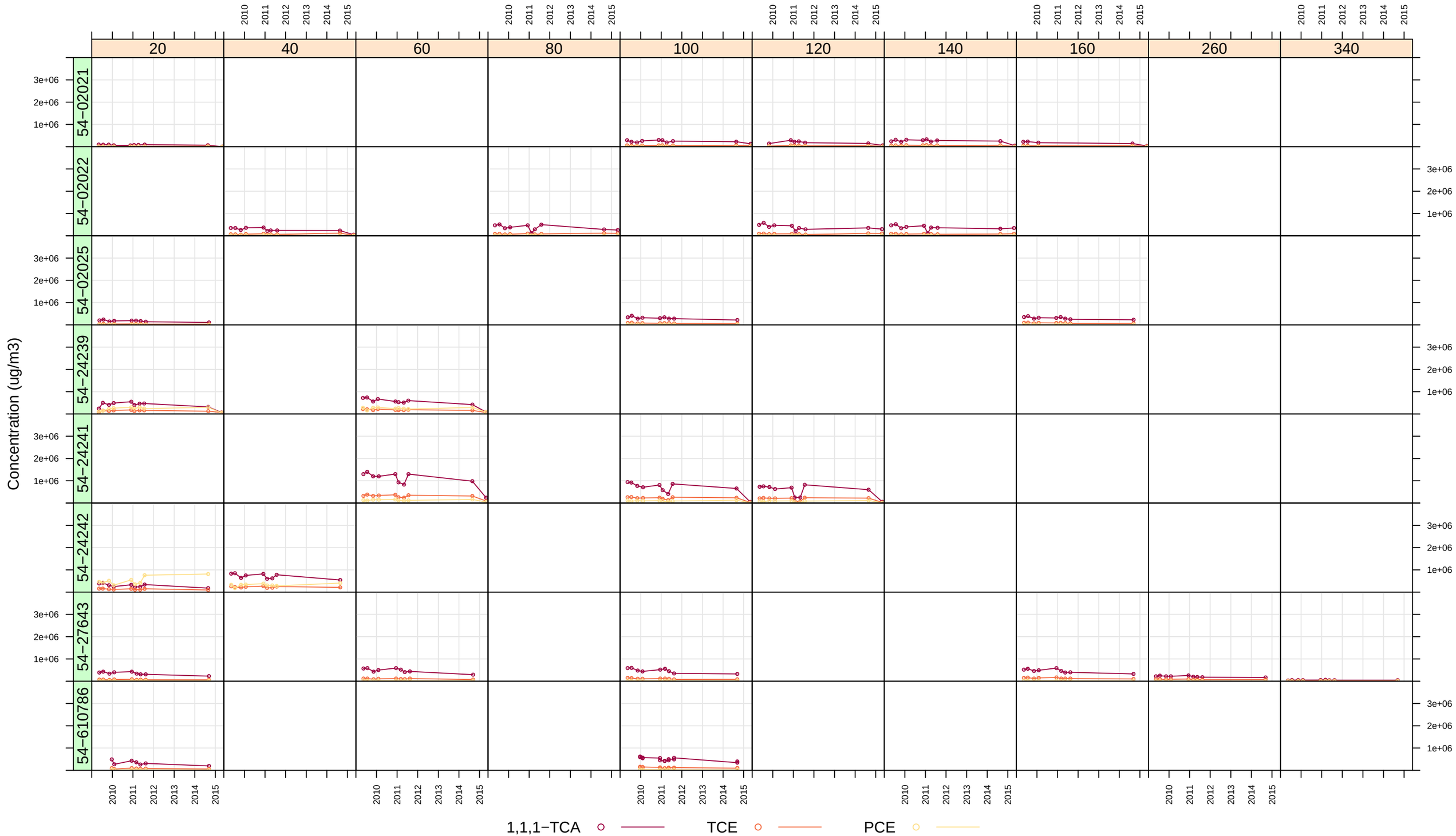

Figure 3−12

Recent Time History of VOC parent Compounds Within the Outer Areas

Port Depth (feet bgs) and Year

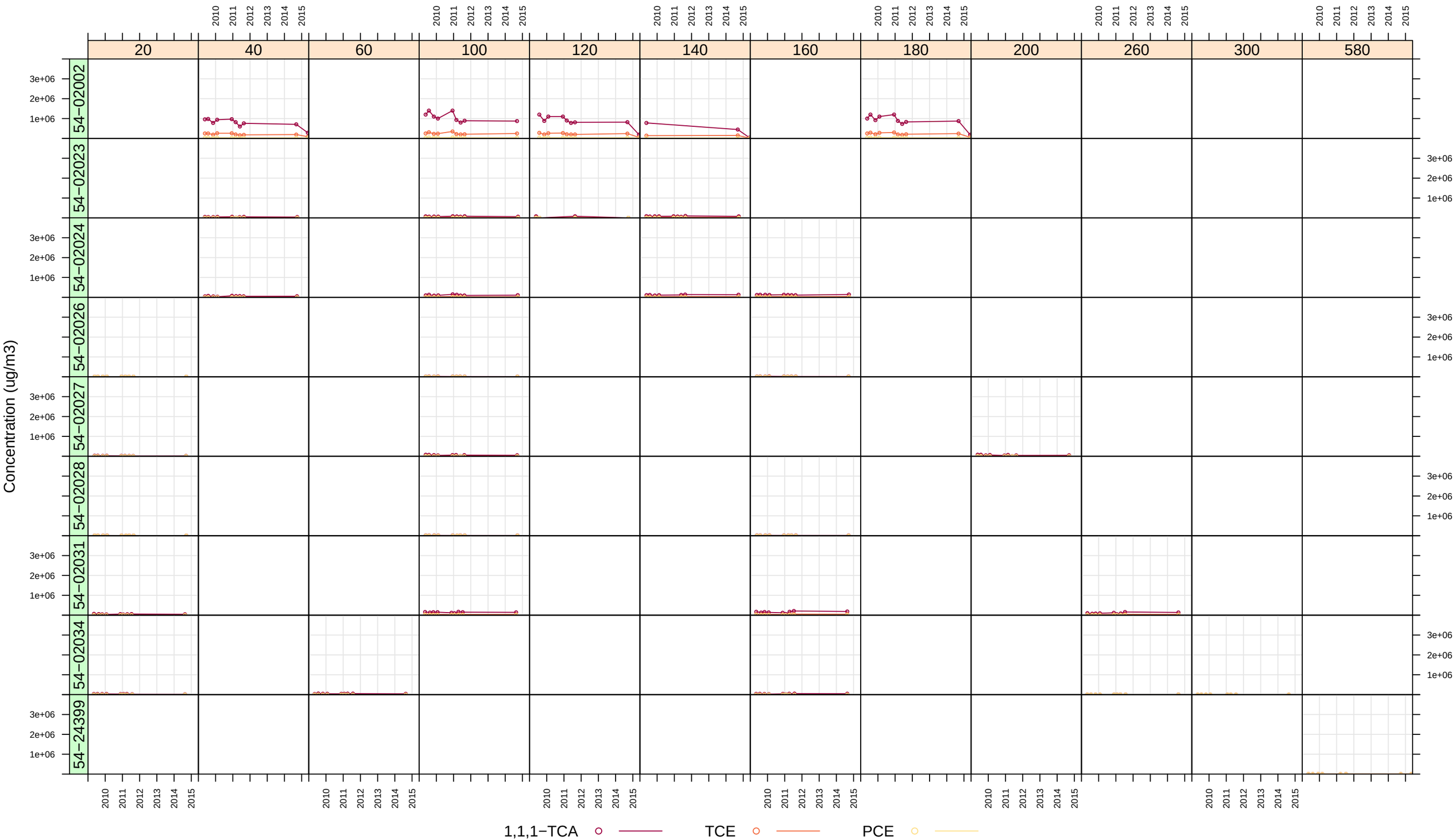

Figure 3−13

Recent Time History of VOC parent Compounds Within the Source Areas (log scale)

Port Depth (feet bgs) and Year

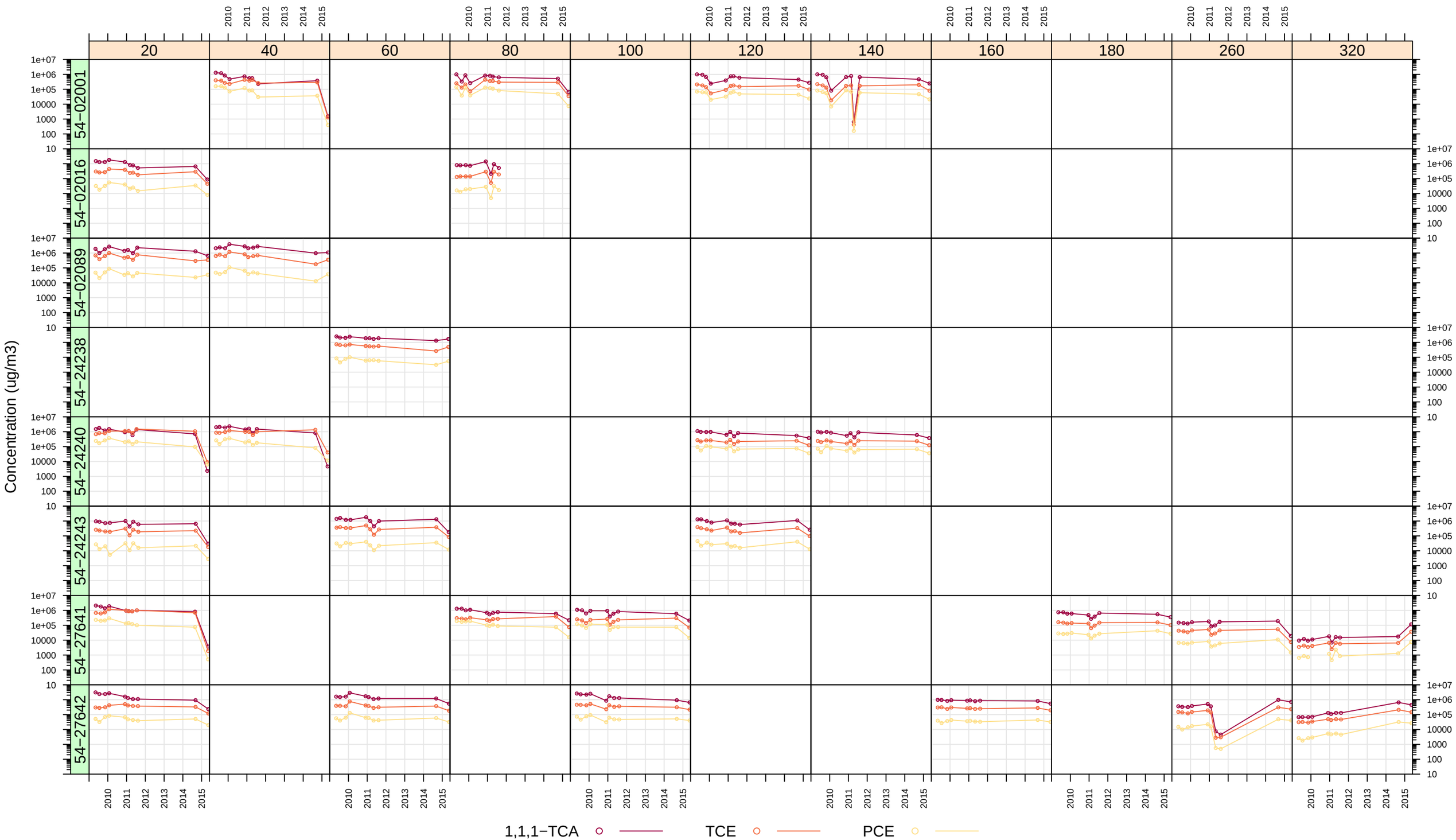

Figure 3−14

Recent Time History of VOC parent Compounds Within the Intermediate Areas (log scale)

Port Depth (feet bgs) and Year

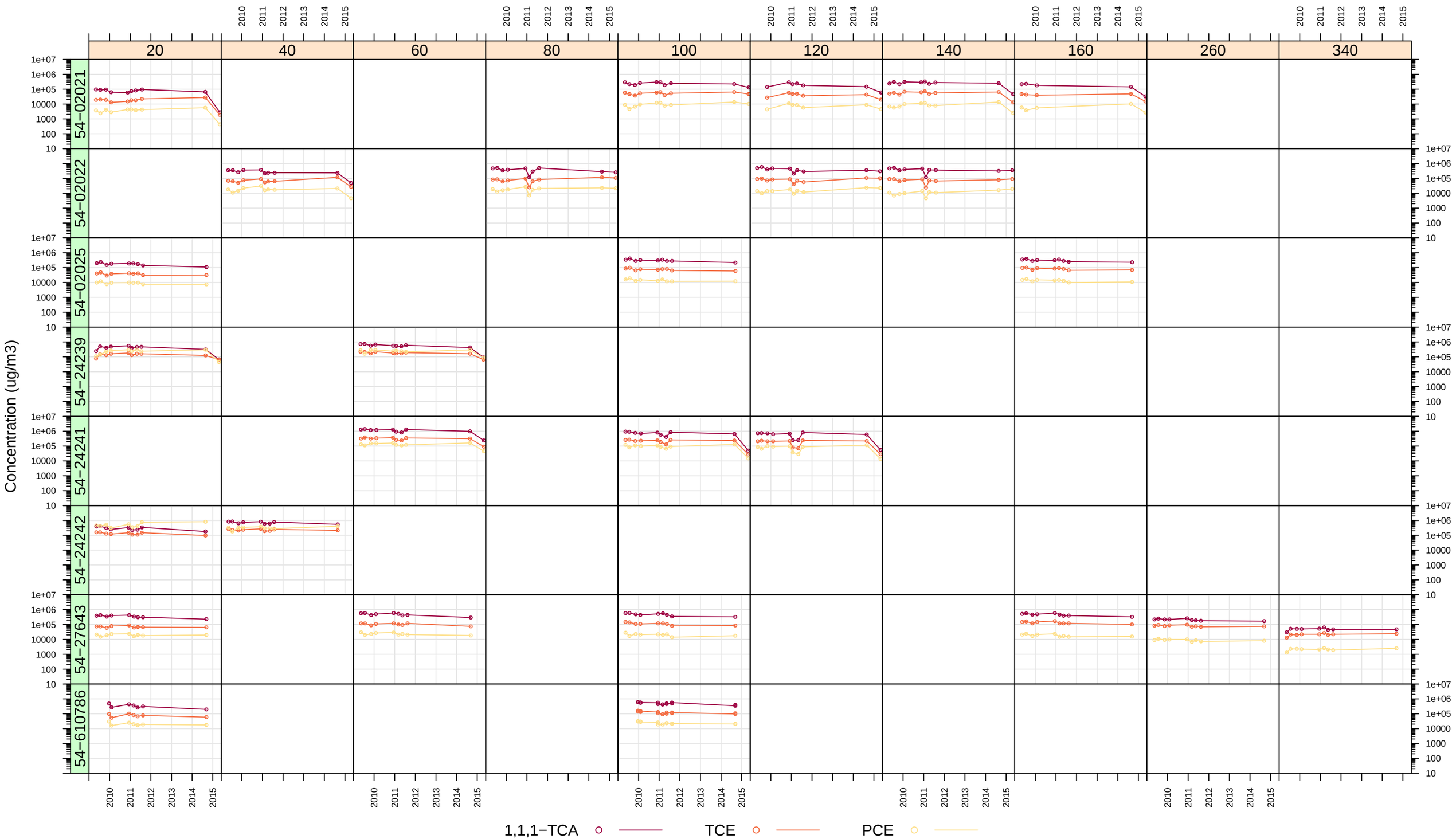

Figure 3−15

Recent Time History of VOC parent Compounds Within the Outer Areas (log scale)

Port Depth (feet bgs) and Year

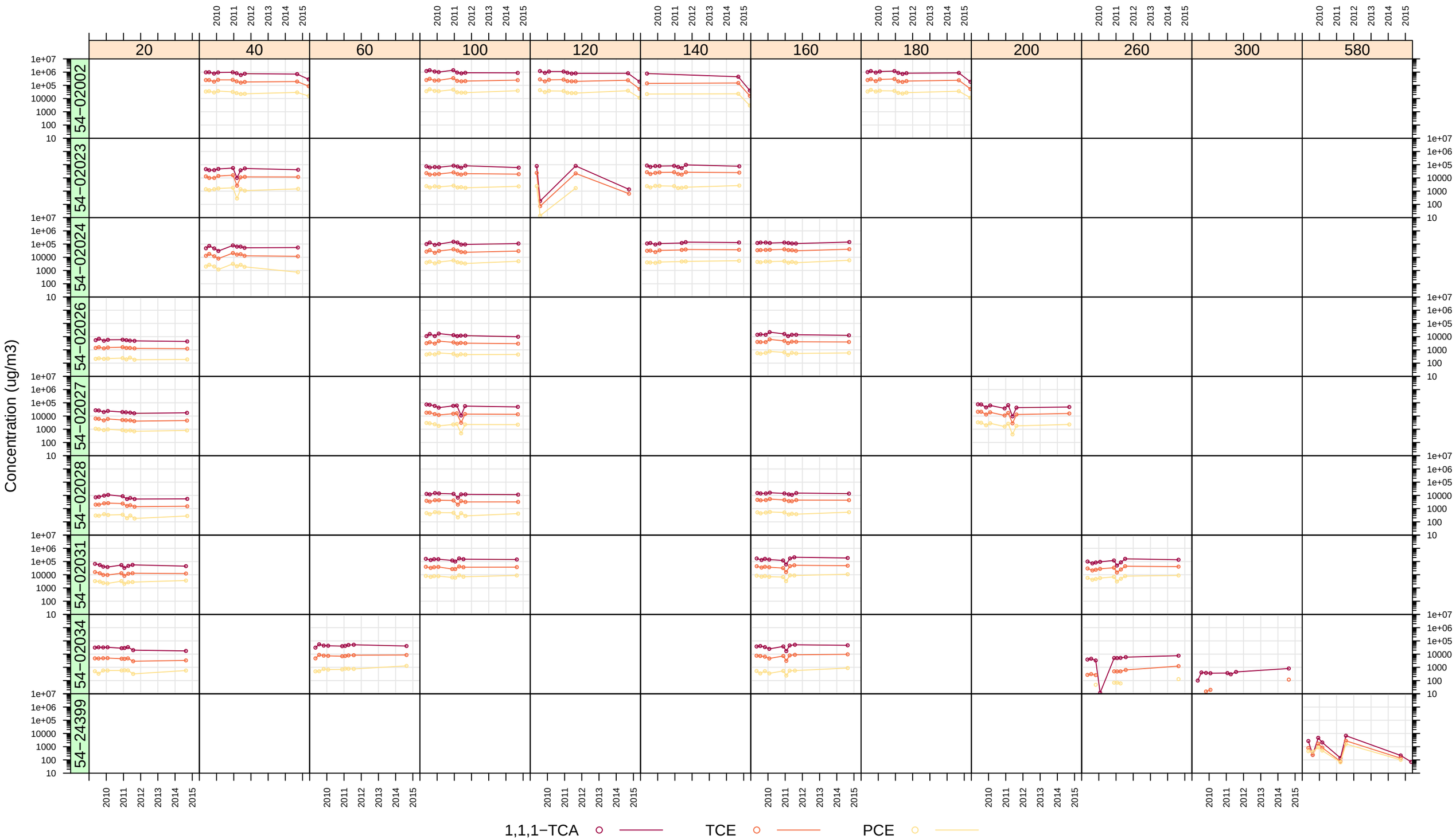

Figure 3−16

Recent Time History of VOC daughter Compounds Within the Source Areas

Port Depth (feet bgs) and Year

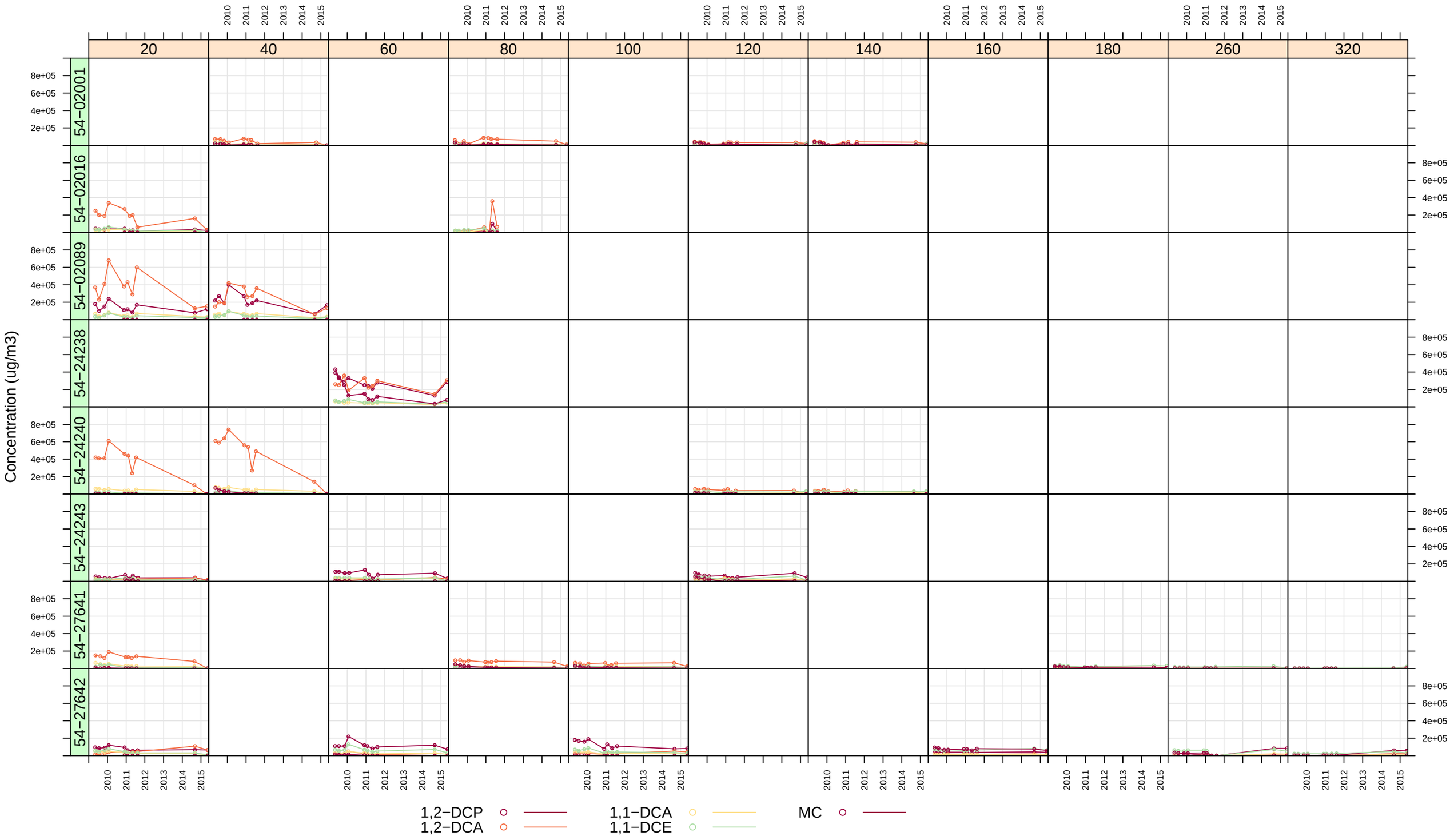

Figure 3−17

Recent Time History of VOC daughter Compounds Within the Intermediate Areas

Port Depth (feet bgs) and Year

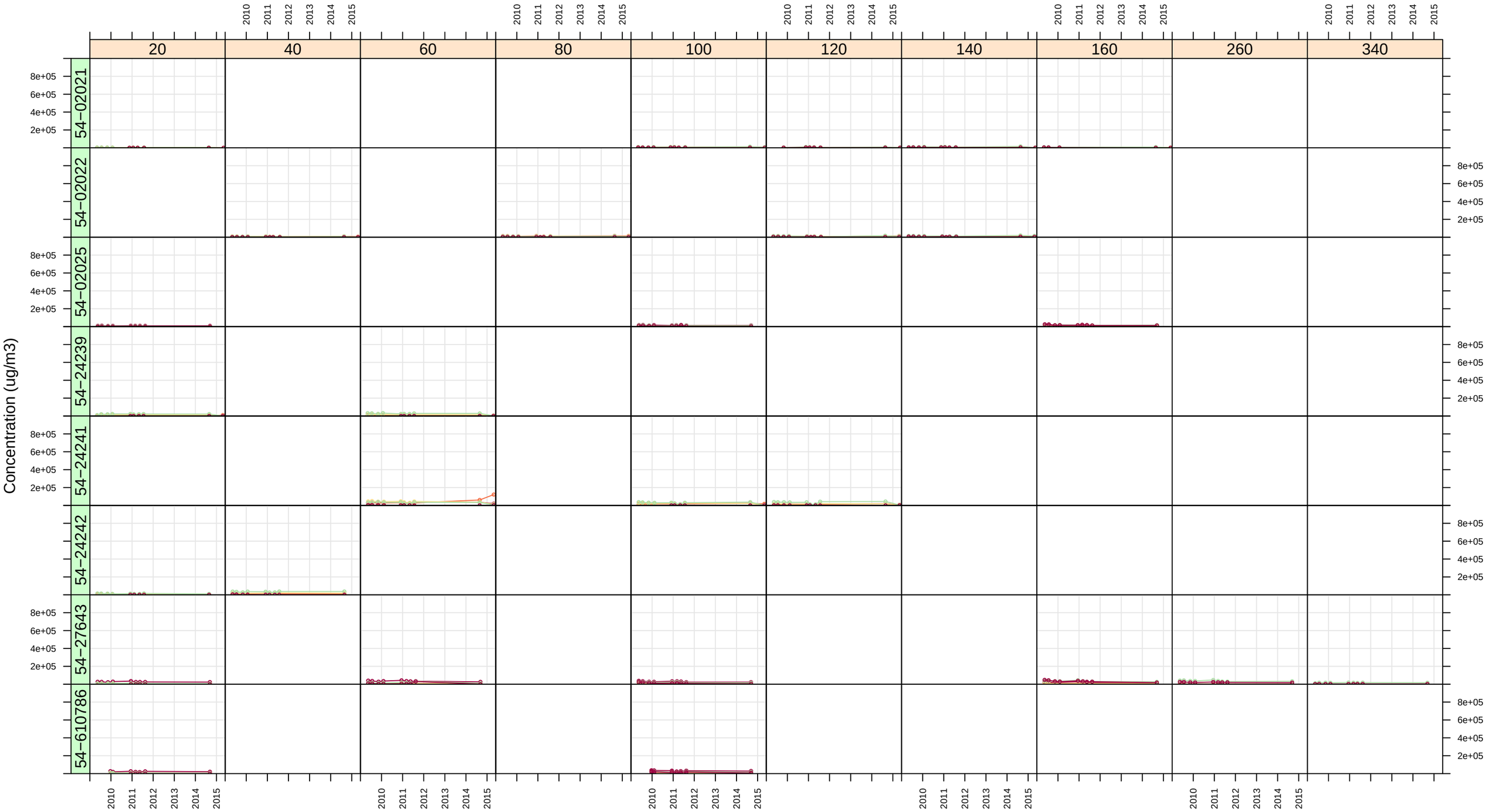

Figure 3−18

Recent Time History of VOC daughter Compounds Within the Outer Areas

Port Depth (feet bgs) and Year

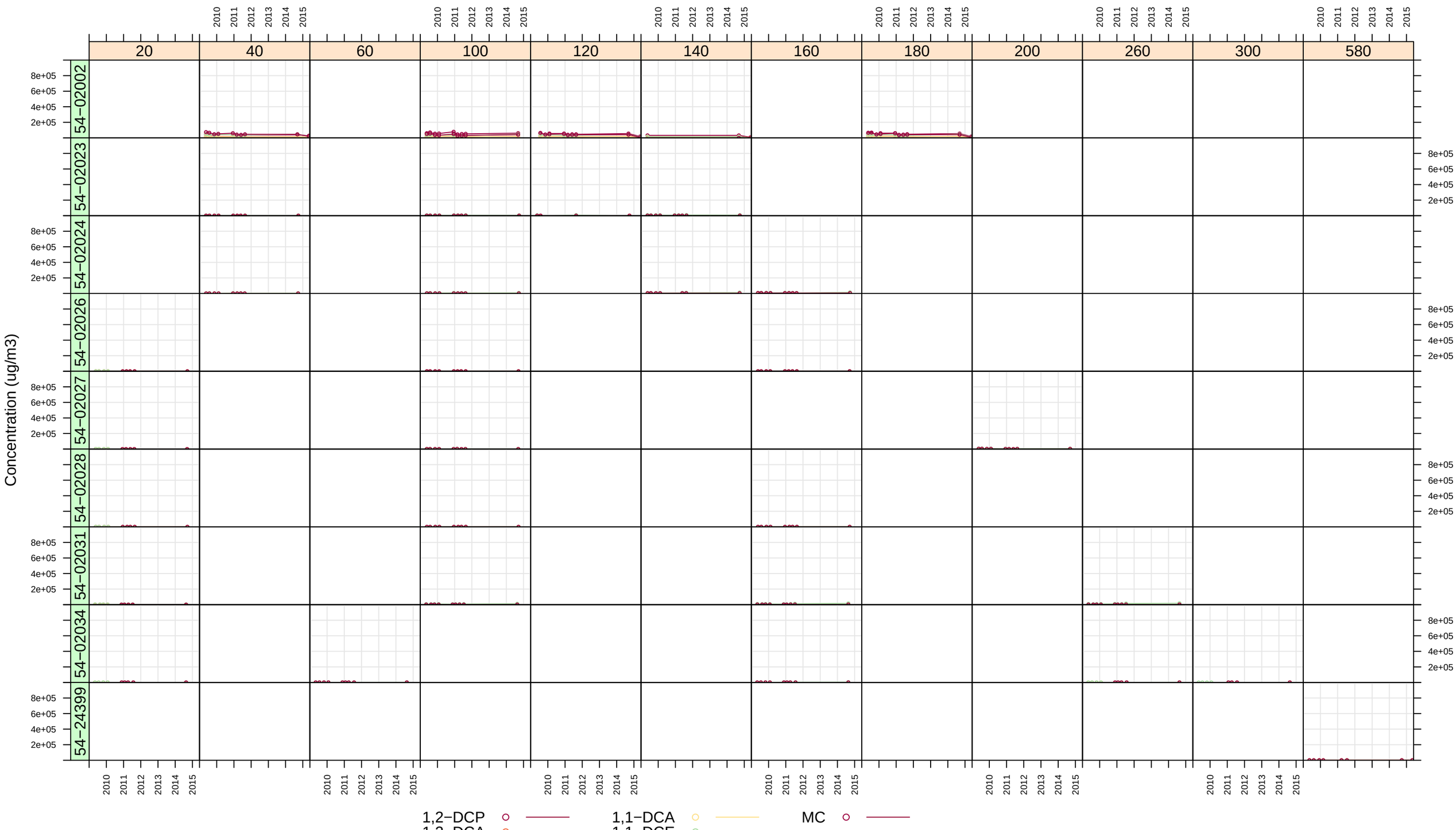

Figure 3−19

Recent Time History of VOC daughter Compounds Within the Source Areas (log scale)

Port Depth (feet bgs) and Year

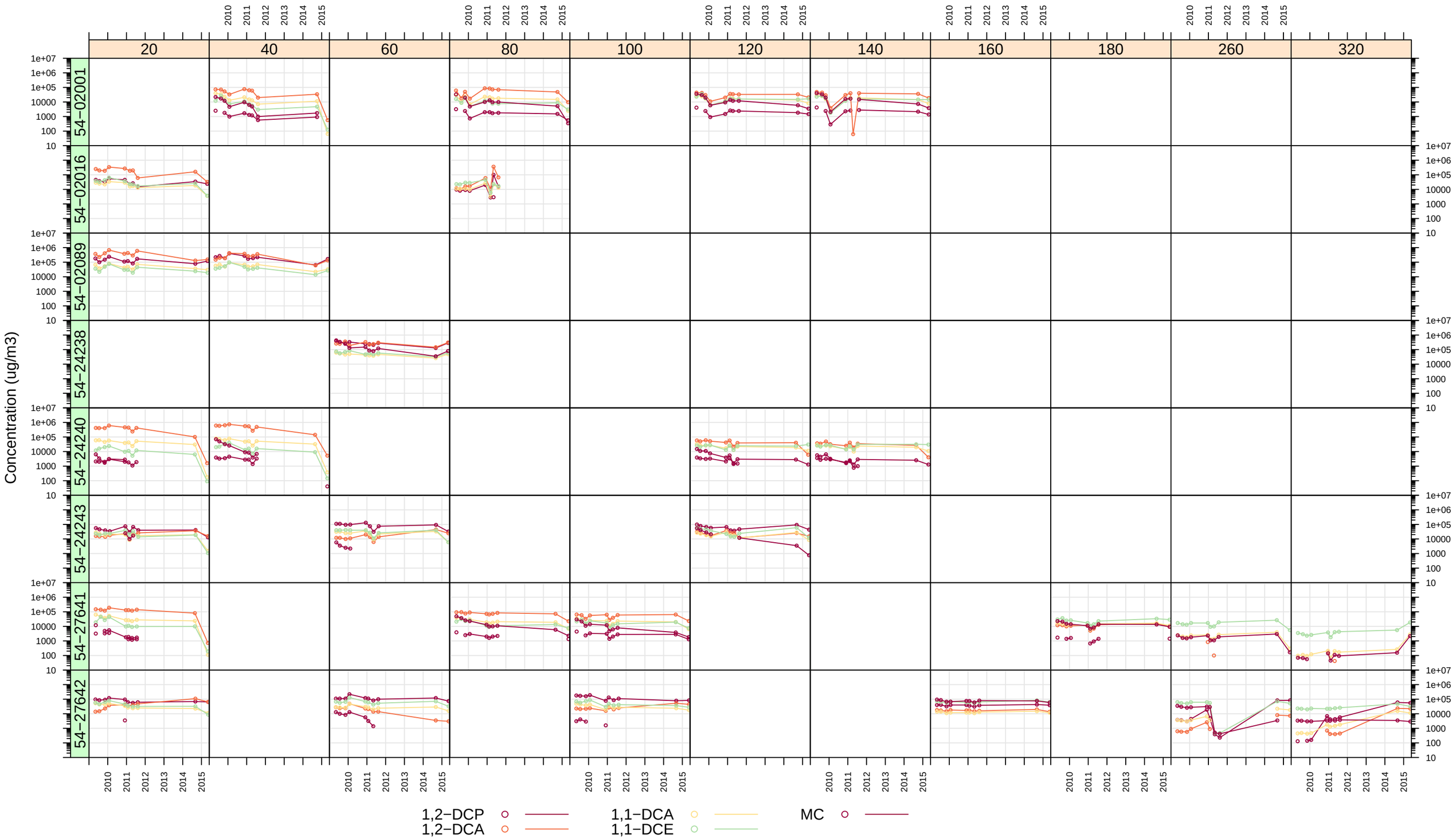

Figure 3−20

Recent Time History of VOC daughter Compounds Within the Intermediate Areas (log scale)

Port Depth (feet bgs) and Year

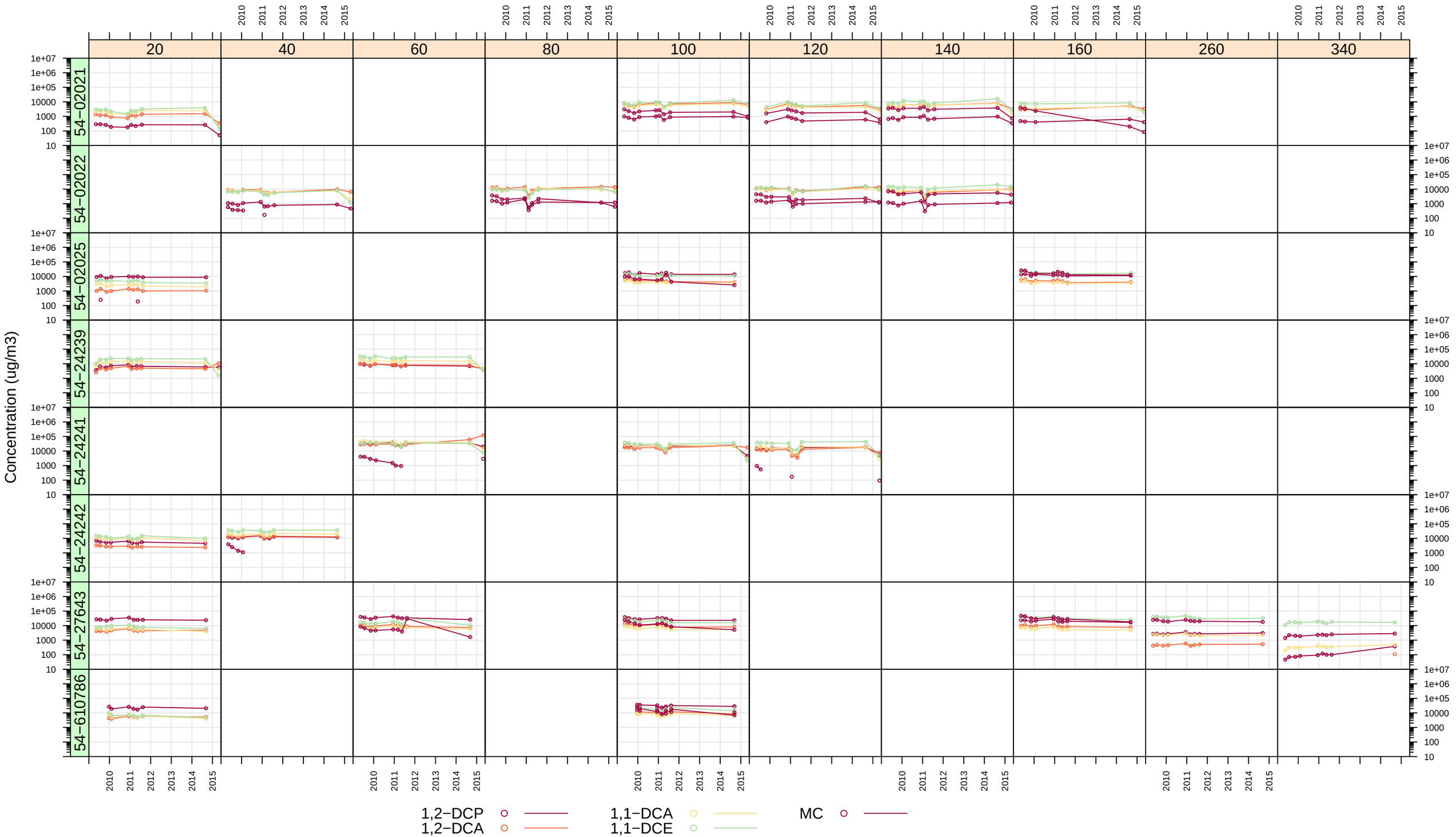

Figure 3−21

Recent Time History of VOC daughter Compounds Within the Outer Areas (log scale)

Port Depth (feet bgs) and Year

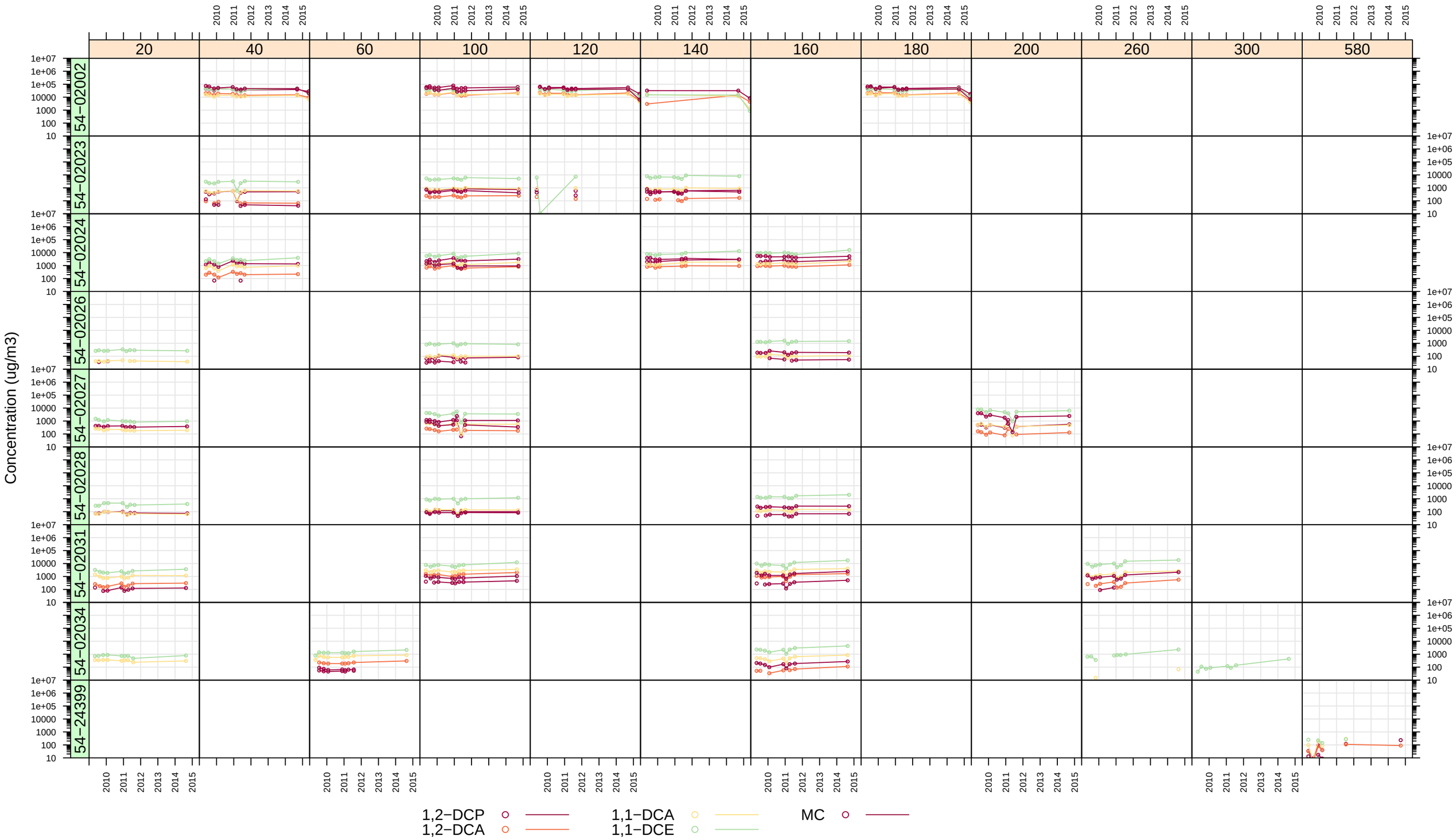

Table 2-1
Geologic Zone Characteristics

Geologic Zone	Porosity	Volumetric Water Content[a]	Air-filled Porosity	Bulk Density (g/cm^3)
Overburden	0.4	0.05	0.35	1.5
Qbt2	0.41	0.02	0.39	1.4
Qbt1vu	0.49	0.01	0.48	1.2
Qbt1vc	0.49	0.1	0.39	1.1
Qbt1g	0.46	0.08	0.38	1.2
Qbtt	0.45	0.14	0.31	1.2
Qct	0.45	0.14	0.31	1.2
Qbof	0.44	0.11	0.33	1.2
Qbog	0.67	0.2	0.47	0.8
Tpf	0.45	0.14	0.31	1.2
Tb4	0.001	0.0005	0.0005	2.7

[a] 2009 report "Moisture Monitoring at Area G, TA-54" and edits by Kay Birdsell

Table 3-1
Q3FY15 Contaminant Mass Distribution

Analyte (Tier1 ug/m^3)	*Strata*	*Tier1 Multiple*	*Contaminant Mass (kg)*				*% of Total Mass Within SVE ROI* [a]		
			Vapor	*Aqueous*	*Sorbed*	*Total*	*West*	*East*	*Total*
1,1,1-TCA (42,300)	Within Tshirege	>10x	44	8	4	57	0	4	4
		1x - 10x	253	54	26	333	6	7	13
	Total Within Tshirege		298	62	30	390	6	11	**17**
	Below Tshirege	>10x	12	7	2	20	0	2	2
		1x - 10x	71	39	13	123	2	5	6
	Total Below Tshirege		83	45	14	143	2	7	9
1,1,1-TCA Total			381	108	45	**533**	8	18	25
TCE (2,000)	Within Tshirege	>10x	94	33	24	151	6	12	18
		1x - 10x	8	2	2	12	0	0	0
	Total Within Tshirege		102	36	25	163	6	12	**18**
	Below Tshirege	>10x	23	23	9	55	1	7	8
		1x - 10x	3	3	3	9	0	0	1
	Total Below Tshirege		27	26	12	64	2	7	9
TCE Total			128	61	37	**227**	8	19	27

[a] SVE ROI is approximated as 125-ft within the Tshirege by LANL scientists.

Table 3-2
Q3FY15 Contaminant Mass Uncertainty Analysis

Analyte	*Tshirege*	*Lower Confidence*			*Best Estimate*	*Mean*	*Upper Confidence*		
		95%	*80%*	*65%*			*65%*	*80%*	*95%*
		Contaminant Mass in kg							
1,1,1-TCA	Within	366	381	390	390	397	405	415	430
	Below	135	140	143	143	145	148	151	155
1,1,1-TCA Total		501	521	533	533	542	553	565	585
TCE	Within	151	159	163	163	166	168	172	178
	Below	61	63	64	64	65	66	67	70
TCE Total		211	222	227	227	231	234	239	248
		% Difference from Best Estimate							
1,1,1-TCA	Within	-6	-2	0	0	2	4	6	10
	Below	-5	-2	0	0	2	3	5	9
1,1,1-TCA Total		**-6**	-2	0	0	2	4	6	**10**
TCE	Within	-8	-3	0	0	2	3	5	9
	Below	-5	-1	1	0	2	3	5	9
TCE Total		**-7**	-2	0	0	2	3	5	**9**

Table 3-3
Comparison of Total Contaminant Mass Among Sample Rounds

Total Contaminant Mass (kg)

Analyte (Tier1 ug/m^3)	*Strata*	*Tier1 Multiple*	*Sample Round*					*% of Total Mass Within SVE ROI [a]*				
			Q4FY14	*Q3FY15*	*Q4FY15*	*Q1FY16*	*Q2FY16*	*Q4FY14*	*Q3FY15*	*Q4FY15*	*Q1FY16*	*Q2FY16*
1,1,1-TCA (42,300)	Within Tshirege	>10x	296	57				23	4			
		1x - 10x	287	333				5	13			
	Total Within Tshirege		583	390				28	17			
	Below Tshirege	>10x	37	20				3	2			
		1x - 10x	120	123				4	6			
	Total Below Tshirege		157	143				7	9			
1,1,1-TCA Total			**740**	533				35	25			
TCE (2,000)	Within Tshirege	>10x	262	151				33	18			
		1x - 10x	11	12				0	0			
	Total Within Tshirege		273	163				33	18			
	Below Tshirege	>10x	61	55				7	8			
		1x - 10x	9	9				0	1			
	Total Below Tshirege		70	64				7	9			
TCE Total			**343**	227				40	27			

% Difference from Q4FY14

Analyte (Tier1 ug/m^3)	*Strata*	*Tier1 Multiple*	*Sample Round*					*Change in % of Total Mass Within SVE ROI [a]*				
			Q4FY14	*Q3FY15*	*Q4FY15*	*Q1FY16*	*Q2FY16*	*Q4FY14*	*Q3FY15*	*Q4FY15*	*Q1FY16*	*Q2FY16*
1,1,1-TCA (42,300)	Within Tshirege	>10x	0	-81				0	-19			
		1x - 10x	0	16				0	8			
	Total Within Tshirege		**0**	**-33**				**0**	**-11**			
	Below Tshirege	>10x	0	-46				0	-1			
		1x - 10x	0	3				0	2			
	Total Below Tshirege		**0**	**-9**				0	1			
1,1,1-TCA Total			**0**	**-28**				0	-10			
TCE (2,000)	Within Tshirege	>10x	0	-42				0	-15			
		1x - 10x	0	5				0	0			
	Total Within Tshirege		**0**	**-40**				**0**	**-15**			
	Below Tshirege	>10x	0	-10				0	2			
		1x - 10x	0	-2				0	0			
	Total Below Tshirege		**0**	**-9**				0	2			
TCE Total			**0**	**-34**				0	-13			

[a] SVE ROI is approximated as 125-ft within the Tshirege by LANL scientists.