We put science to work.™
Savannah River National Laboratory™
OPERATED BY SAVANNAH RIVER NUCLEAR SOLUTIONS
A U.S. DEPARTMENT OF ENERGY NATIONAL LABORATORY • SAVANNAH RIVER SITE • AIKEN, SC

Impacts of Updated GSA Groundwater Flow Models on the FTF, HTF and SDF PAs

G. P. Flach
T. Hang

September 6, 2017
SRNL-STI-2017-00445, Revision 0

SRNL.DOE.GOV

DISCLAIMER

Printed in the United States of America

Prepared for
U.S. Department of Energy

SRNL-STI-2017-00445
Revision 0

Keywords: *Performance Assessment PORFLOW*

Retention: *Permanent*

Impacts of Updated GSA Groundwater Flow Models on the FTF, HTF and SDF PAs

G. P. Flach
T. Hang

September 6, 2017

Prepared for the U.S. Department of Energy under contract number DE-AC09-08SR22470.

Savannah River National Laboratory™
OPERATED BY SAVANNAH RIVER NUCLEAR SOLUTIONS

REVIEWS AND APPROVALS

AUTHORS:

9/6/2017

G. P. Flach, Environmental Modeling — Date

9/6/17

T. Hang, Environmental Modeling — Date

TECHNICAL REVIEW:

9/6/2017

T. L. Danielson, Environmental Modeling, Reviewed per E7 2.60 — Date

9/6/2017

S. P. Hommel, Closure and Disposal Assessment, Review of Conceptual Approach — Date

APPROVAL:

9/6/17

D. A. Crowley, Manager
Environmental Modeling — Date

9-6-2017

T. O. Oliver, Acting Director, Environmental Restoration Technologies — Date

9/6/2017

K. H. Rosenberger, Manager
Closure and Disposal Assessment — Date

EXECUTIVE SUMMARY

Savannah River Remediation (SRR) requested that the Savannah River National Laboratory (SRNL) evaluate the impacts of an updated General Separations Area (GSA) groundwater flow model on the F-Area Tank Farm (FTF), H-Area Tank Farm (HTF) and Saltstone Disposal Facility (SDF) Performance Assessments (PAs)[1]. For each facility, PORFLOW simulations were performed using both the 2004 GSA/PORFLOW (i.e., GSA_2004) and GSA2016 (i.e., GSA_2016) flow models.

Overall, GSA_2004 and "_reference" (i.e., the archived data) results are practically identical, indicating GSA_2004 simulations reproduce the archived data very well. Compared with GSA_2004 data, the PEST.47 GSA_2016 results (with PORFLOW harmonic averaging at cell faces and diagonal terms in the dispersion tensor) support the following findings:

<u>SDF</u>

- Slower groundwater speed in east Z-area, resulting in higher I-129 concentrations at 100-meter boundary and at the Upper Three Runs seepline.

<u>HTF</u>

- Groundwater flow more toward north H-area.
- About the same peak I-129 concentrations at 100-meter boundary.
- Peak seepline I-129 concentrations along Upper Three Runs are higher in the early period (< 10,000 years), and about the same in the later period.

<u>FTF</u>

- Slower flows more toward the northwest F-area.
- Peak I-129 concentrations at 100-meter boundary are about the same in the early period (< 10,000 years), and lower in the later period for Sector E.
- About the same peak I-129 concentrations at the Upper Three Runs seepline.

Additionally, the impacts of all four calibrated GSA2016 flow models were assessed in this study using updated transport simulations: upwind properties at cell faces and all terms in the dispersion tensor. The four calibrated GSA2016 flow models are:

1. PEST.47 or "GSA2016.LU" (<u>L</u>ayer-cake K field, <u>U</u>nweighted optimization)
2. PEST.51 or "GSA2016.LW" (<u>L</u>ayer-cake K field, <u>W</u>eighted optimization)
3. PEST.52 or "GSA2016.HU" (<u>H</u>eterogeneous K field, <u>U</u>nweighted optimization)
4. PEST.53 or "GSA2016.HW" (<u>H</u>eterogeneous K field, <u>W</u>eighted optimization)

The revised PORFLOW transport settings produce more accurate plume simulations. The additional transport simulations are denoted:

- GSA_2016_impact.LU (Runs using PEST.47 flow field with PORFLOW upwinding at cell faces and using the full dispersion tensor)
- GSA_2016_impact.LW (Runs using PEST.51 flow field with PORFLOW upwinding at cell faces and using the full dispersion tensor)
- GSA_2016_impact.HU (Runs using PEST.52 flow field with PORFLOW upwinding at cell faces and using the full dispersion tensor)
- GSA_2016_impact.HW (Runs using PEST.53 flow field with PORFLOW upwinding at cell faces and using the full dispersion tensor)

The results of all four calibrated GSA flow models are summarized below:

SDF

- In general, slower groundwater speed for L- than H-optimized flows, resulting in higher I-129 concentrations at the Upper Three Runs seepline.

HTF

- Slower groundwater speed for L- than H-optimized flows
- No significant difference in the peak I-129 concentrations at 100-meter boundary and along the Upper Three Runs seepline after 10,000 years.

FTF

- No significant difference in peak I-129 concentrations at 100-meter boundary and along the Upper Three Runs seepline.

Design check of PORFLOW modeling has been performed and documented[2].

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

FACT	Subsurface Flow and Contaminant Transport code
FTF	F-Area Tank Farm
GSA	General Separations Area
HTF	H-Area Tank Farm
LFRG	Low- Level Waste Disposal Facility Federal Review Group
LLW	Low-Level Waste
PA	Performance Assessment
PEST	Parameter Estimation code
SA	Special Analysis
SDF	Saltstone Disposal Facility
SDU	Saltstone Disposal Unit
SRNL	Savannah River National Laboratory
SRR	Savannah River Remediation

1.0 Introduction

A groundwater flow model, referred to as the "GSA/PORFLOW" model, was developed in 2004 by porting an existing General Separations Area (GSA) groundwater flow model from the Subsurface Flow and Contaminant Transport (FACT) code to the PORFLOW code[3]. The preceding "GSA/FACT" model was developed in 1997 using characterization and monitoring data through the mid-1990's[4]. Both models were manually calibrated to field data.

Significant field data have been acquired since the 1990's and model calibration using mathematical optimization software has become routine and recommended practice. The GSA/PORFLOW model was recently updated using selected field data acquired in the late 1980's through at least 2015[5], whereas the preceding model was developed with data through approximately 1993. Well water level calibration targets were restricted to the time frame 2004 to 2014, a period experiencing rainfall approximating the long-term average and avoiding pump-and-treat operations at the F- and H-Seepage Basins and other large scale remedial actions affecting groundwater levels. Watermark Numerical Computing's Parameter Estimation (PEST) code was used to calibrate the model and quantify parameter uncertainty. PEST is the industry standard software package for parameter estimation and uncertainty analysis of complex environmental models. This updated GSA groundwater model is named "GSA2016" in reference to the year in which most development occurred. The GSA2016 model update addresses issues raised by the DOE Low-Level Waste (LLW) Disposal Facility Federal Review Group (LFRG) in a 2008 review of the E-Area Performance Assessment, and by the Nuclear Regulatory Commission in reviews of tank closure and Saltstone Performance Assessments. The model update involved the following tasks:

- Re-evaluation of the model with new data acquired since 1997
- Recalibration of the GSA flow model using automated inverse modeling procedures
- Estimation of uncertainty in model input and output parameters.

In the past, the GSA/PORFLOW groundwater flow model was applied to support F-Area Tank Farm (FTF), H-Area Tank Farm (HTF), and Saltstone Disposal Facility (SDF) Performance Assessments (PAs) and Special Analyses (SAs)[6,7,8]. Hence, Savannah River Remediation (SRR) requested that the Savannah River National Laboratory (SRNL) evaluate the impacts of the updated GSA2016 model on the FTF, HTF and SDF PAs[1]. The present report summarizes the FTF, HTF and SDF results using the GSA2016 model in comparison with the previous GSA/PORFLOW-based results.

2.0 PORFLOW Modeling

PORFLOW (http://www.acricfd.com/software/porflow/), a porous-medium flow and solute transport simulation code, was used to model subsurface radionuclide transport. In this study, for consistency with the previous modeling, PORFLOW version 6.30.2 was retained for numerical SDF and HTF simulations, while PORFLOW version 6.10.3 was used for FTF simulations. Because the updated GSA2016 model impacts only the flow simulation in the aquifer zone, the same vadose fluxes from the previous studies were re-used as source inputs to the aquifer.

As specified by SRR's Technical Assistance Request[1], for each facility (i.e., SDF, HTF, and FTF), the following flow and transport simulations based on the GSA/PORFLOW and GSA2016 were compared:

1. Streamtraces with timing markers (every 5 years for SDF, 10 years for FTF, and 20 years for HTF) that highlight the direction and speed of the flow field in each facility.
2. Tracer plume simulations:
    a. Steady-state source: Tracer source was generated at a constant rate (i.e., 1 Ci/yr); plume was recorded at 2000 years to assure the steady-state condition.
    b. Transient/pulsed source: Tracer source was generated to have an initial inventory of 1 Ci.
3. Evaluation case transport simulations:
    a. 100-meter concentrations
    b. Seepline concentrations

For simplicity, the results based on GSA/PORFLOW and GSA2016 flow models are referred to as GSA_2004 and GSA_2016, respectively. The notation "_reference" refers to the archived results of the most recent SAs. The GSA_2004 results were compared to the "_reference" data to ensure that the archived results were satisfactorily reproduced by contemporary simulations, before switching the flow field to GSA_2016. Because the objective of this study is to evaluate the impact of the newly updated GSA flow field, the configuration of PORFLOW model inputs (i.e., geometry, meshes, time steps, time periods, timing markers etc.) in GSA_2004 was maintained in GSA_2016 for a consistent comparison.

Due to a vast amount of data resulting from PORFLOW simulations, results are presented only for the main sources or a few representative sources, and only for a conservative tracer or I-129. I-129 was selected because, due to its transport characteristics (low distribution coefficient, very long half-life, no decay products), it effectively functions as a tracer, hence adequately highlighting the impact of the new flow field. Table 1 provides hyperlinks to locations where all simulation data are stored.

There are actually four calibrated GSA2016 flow models available for consideration. In the first part of this report (Section 3.0), the impacts of the PEST.47 (Layer-cake K field, Unweighted optimization) GSA_2016 flow model on FTF, HTF and SDF will be shown. The second part (i.e., Sections 4.0 and 5.0) will discuss the impacts of all four GSA_2016 flow models, using revised transport numerical settings.

Solute transport was initially simulated with harmonic averages applied to cell interfaces and only the diagonal terms retained in the dispersion tensor, to be consistent with past simulations using the GSA_2004 flow field. Diagonal-only terms were used previously to avoid numerical instabilities, but the incomplete dispersion tensor occasionally causes plumes to appear truncated on an upgradient side, for example, Tank01 in Figure 23. Recent PORFLOW testing indicated that the full dispersion tensor could be combined with upwind interfacial properties to achieve stable and more accurate transport simulations. Thus the second round of transport simulations using all four calibrated GSA_2016 flow fields was performed using the upwind value at cell interfaces and the full dispersion tensor. Transport simulations using the PEST.47 / GSA_2016.LU flow field differ somewhat between the first and second round due to the different numerical settings.

Table 1. Project Data Locations for PEST.47 Flow Field based Simulations

Facility	Tasks	Subtasks	Hyperlinked Location
Saltstone			\Saltstone
	GSA 2004 Reproduction		\Saltstone\Reproduction
		Streamtraces	\Saltstone\Reproduction\Streamtraces
		Plumes (steady-state sources)	\Saltstone\Reproduction\SteadyStateSources
		Pulsed sources	\Saltstone\Reproduction\PulsedSources
		Aquifer Transport (100-meter)	\Saltstone\Reproduction\100mAquiferTransport
		Aquifer Transport (Seepline)	\Saltstone\Reproduction\SeeplineAquiferTransport
	GSA 2016 Simulations		\Saltstone\GSA2016
		Streamtraces	\Saltstone\GSA2016\Streamtraces
		Plumes (steady-state sources)	\Saltstone\GSA2016\SteadyStateSources
		Pulsed sources	\Saltstone\GSA2016\PulsedSources
		Aquifer Transport (100-meter)	\Saltstone\GSA2016\100mAquiferTransport
		Aquifer Transport (Seepline)	\Saltstone\GSA2016\SeeplineAquiferTransport
HTF			\HTF
	GSA 2004 Reproduction		\HTF\Reproduction
		Streamtraces	\HTF\Reproduction\Streamtraces
		Plumes (steady-state sources)	\HTF\Reproduction\SteadyStateSources
		Pulsed sources	\HTF\Reproduction\PulsedSources
		Aquifer Transport (100-meter)	\HTF\Reproduction\100mAquiferTransport
		Aquifer Transport (Seepline)	\HTF\Reproduction\SeeplineAquiferTransport
	GSA 2016 Simulations		\HTF\GSA2016
		Streamtraces	\HTF\GSA2016\Streamtraces

Facility	**Tasks**	**Subtasks**	**Hyperlinked Location**
		Plumes (steady-state sources)	\HTF\GSA2016\SteadyStateSources
		Pulsed sources	\HTF\GSA2016\PulsedSources
		Aquifer Transport (100-meter)	\HTF\GSA2016\100mAquiferTransport
		Aquifer Transport (Seepline)	\HTF\GSA2016\SeeplineAquiferTransport
FTF			\FTF
	GSA 2004 Reproduction		\FTF\Reproduction
		Streamtraces	\FTF\Reproduction\Streamtraces
		Plumes (steady-state sources)	\FTF\Reproduction\SteadyStateSources
		Pulsed sources	\FTF\Reproduction\PulsedSources
		Aquifer Transport (100-meter)	\FTF\Reproduction\100mAquiferTransport
		Aquifer Transport (Seepline)	\FTF\Reproduction\SeeplineAquiferTransport
	GSA 2016 Simulations		\FTF\GSA2016
		Streamtraces	\FTF\GSA2016\Streamtraces
		Plumes (steady-state sources)	\FTF\GSA2016\SteadyStateSources
		Pulsed sources	\FTF\GSA2016\PulsedSources
		Aquifer Transport (100-meter)	\FTF\GSA2016\100mAquiferTransport
		Aquifer Transport (Seepline)	\FTF\GSA2016\SeeplineAquiferTransport

3.0 Comparison of GSA_2004 Flow Model to GSA_2016.LU Flow Model Prior to Revised Transport Numerical Settings

As noted earlier, preceding Performance Assessment simulations for tank farm closures and the Saltstone Disposal Facility used the GSA_2004 flow field and certain numerical transport settings. Specifically, harmonic property averaging was applied at cell faces and only the diagonal terms of the dispersion tensor (matrix) used in numerical differencing. Harmonic averaging together with the full dispersion tensor was found to produce numerical instabilities, whereas the diagonal-only approximation was stable. When groundwater flow is aligned with a coordinate axis, the diagonal-only and full tensors produce about the same result. The maximum difference occurs when the flow direction is oriented at 45 degrees to the axes (for a 2D simulation).

Future PA simulations are expected to use a GSA_2016 flow field and the full dispersion tensor, the latter to minimize artifacts of grid orientation to the flow field. To avoid numerical instabilities, material properties at cell faces will be those from the upwind cell, instead of harmonic averaging. As an intermediate exercise, this section assesses the impact of only changing the flow field from GSA_2004 to GSA_2016 (PEST optimization run #47). In Section 5.0, the combined impact of changing the flow field and transport settings is investigated.

3.1 Saltstone Disposal Facility

3.1.1 Streamtraces with Timing Markers

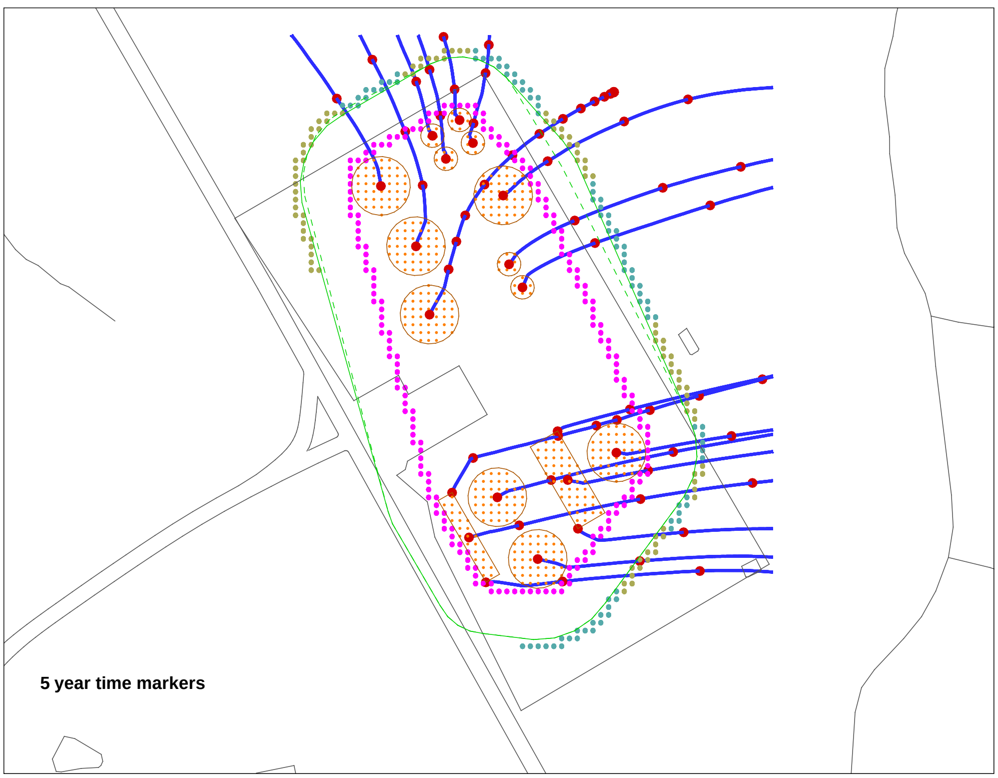


Figure 1. SDF GSA_2004 Streamtraces with Timing Markers

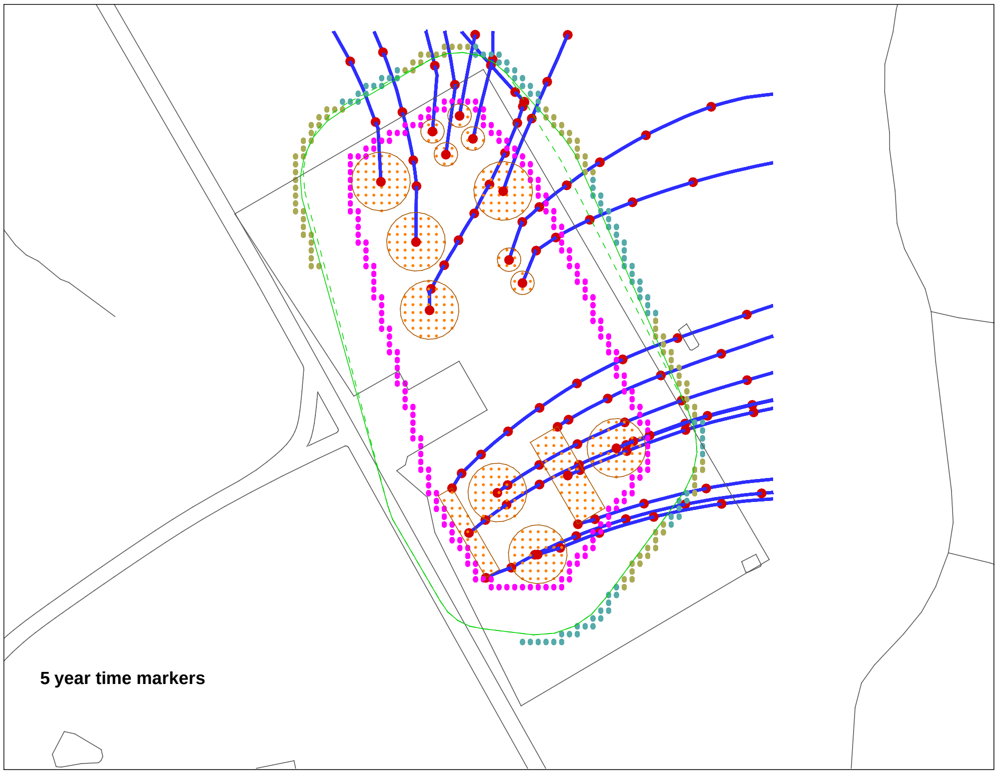


Figure 2. SDF GSA_2016 Streamtraces with Timing Markers

3.1.2 Tracer Plume Simulations

3.1.2.1 Steady-State Sources

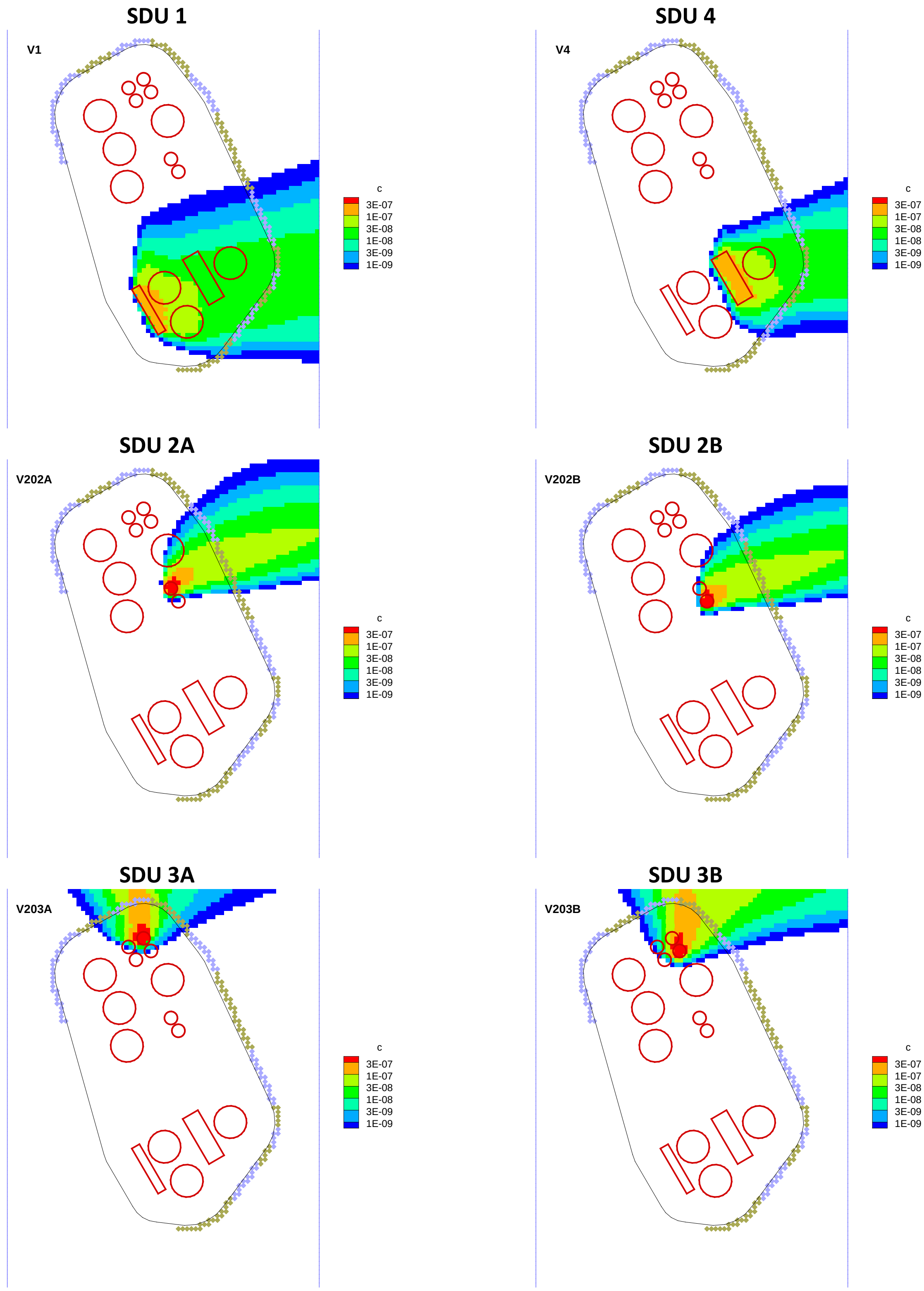


Figure 3. SDF GSA_2004 Tracer Plume Simulation of Steady-State Sources (concentration, C in Ci/L)

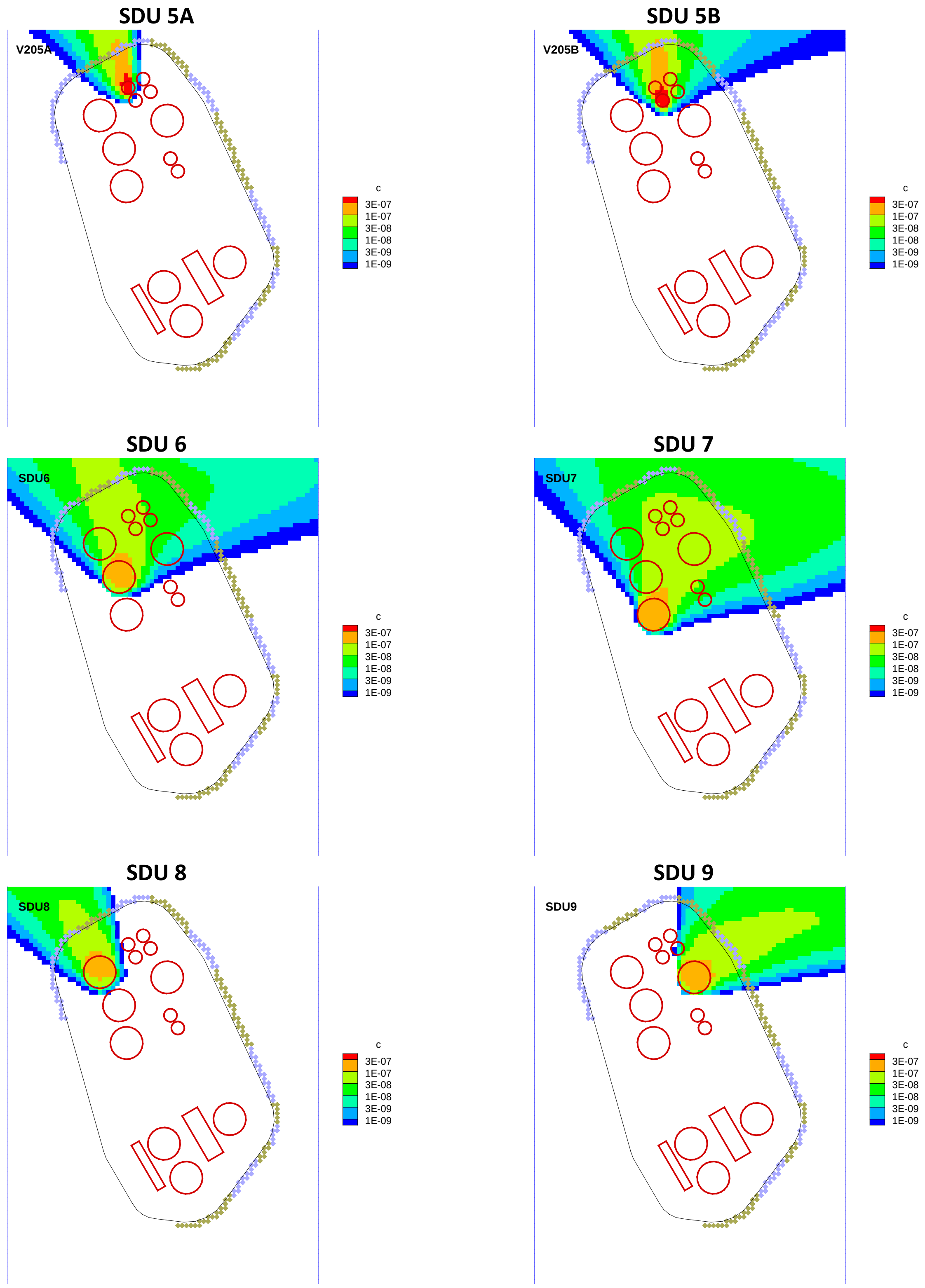


Figure 3. SDF GSA_2004 Tracer Plume Simulation of Steady-State Sources (concentration, C in Ci/L) (cont'd)

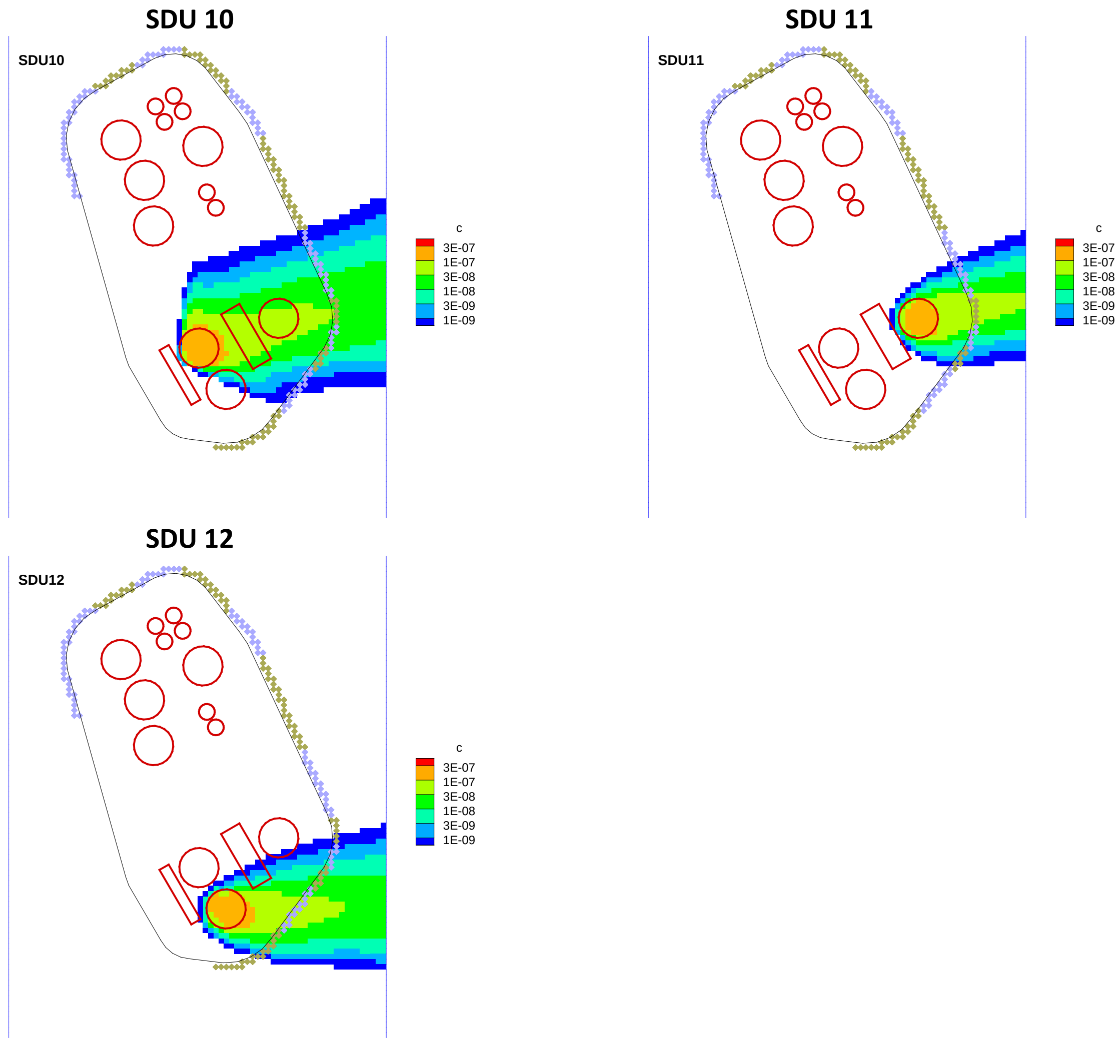


Figure 3. SDF GSA_2004 Tracer Plume Simulation of Steady-State Sources (concentration, C in Ci/L) (cont'd)

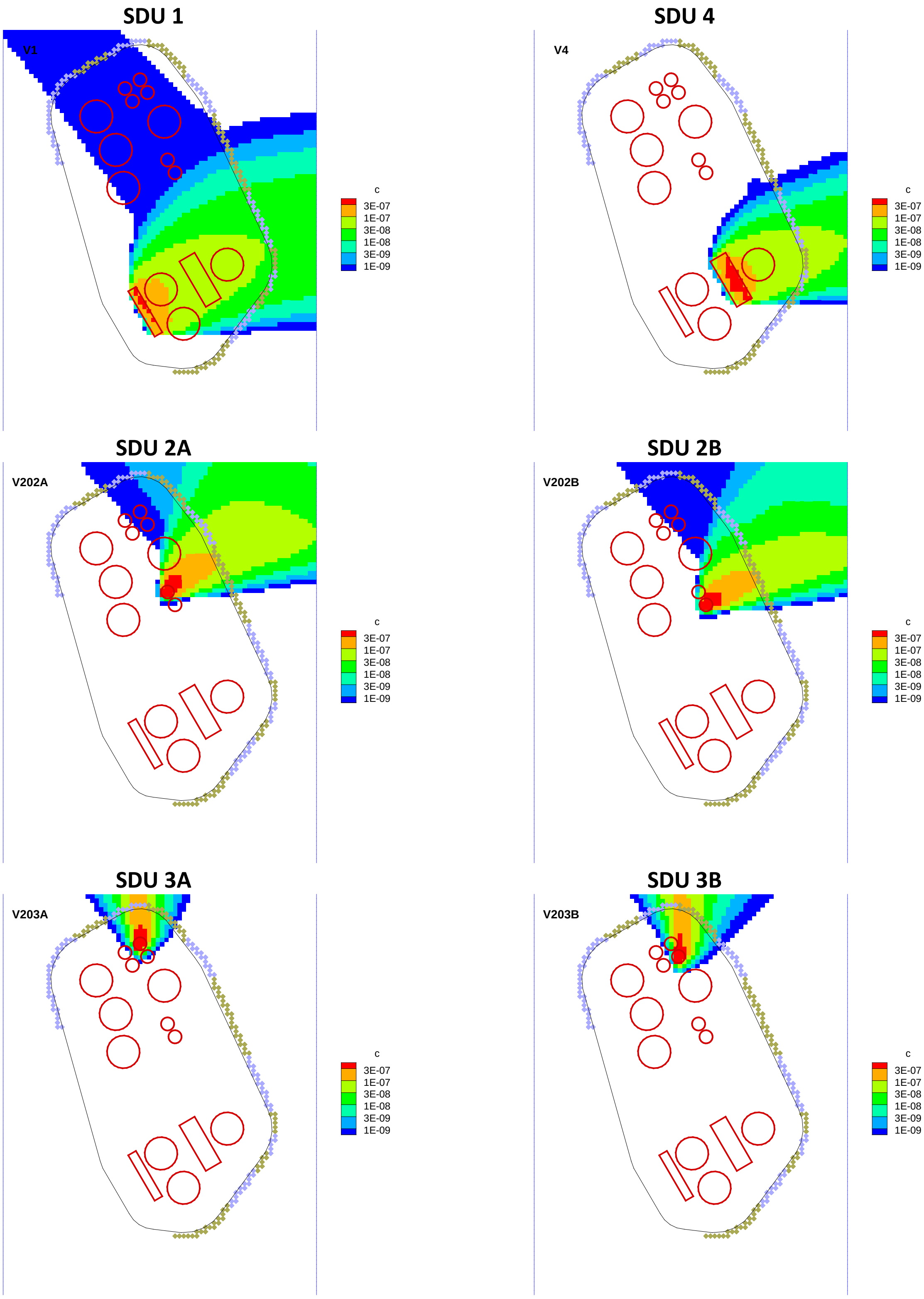


Figure 4. SDF GSA_2016 Tracer Plume Simulation of Steady-State Sources (concentration, C in Ci/L)

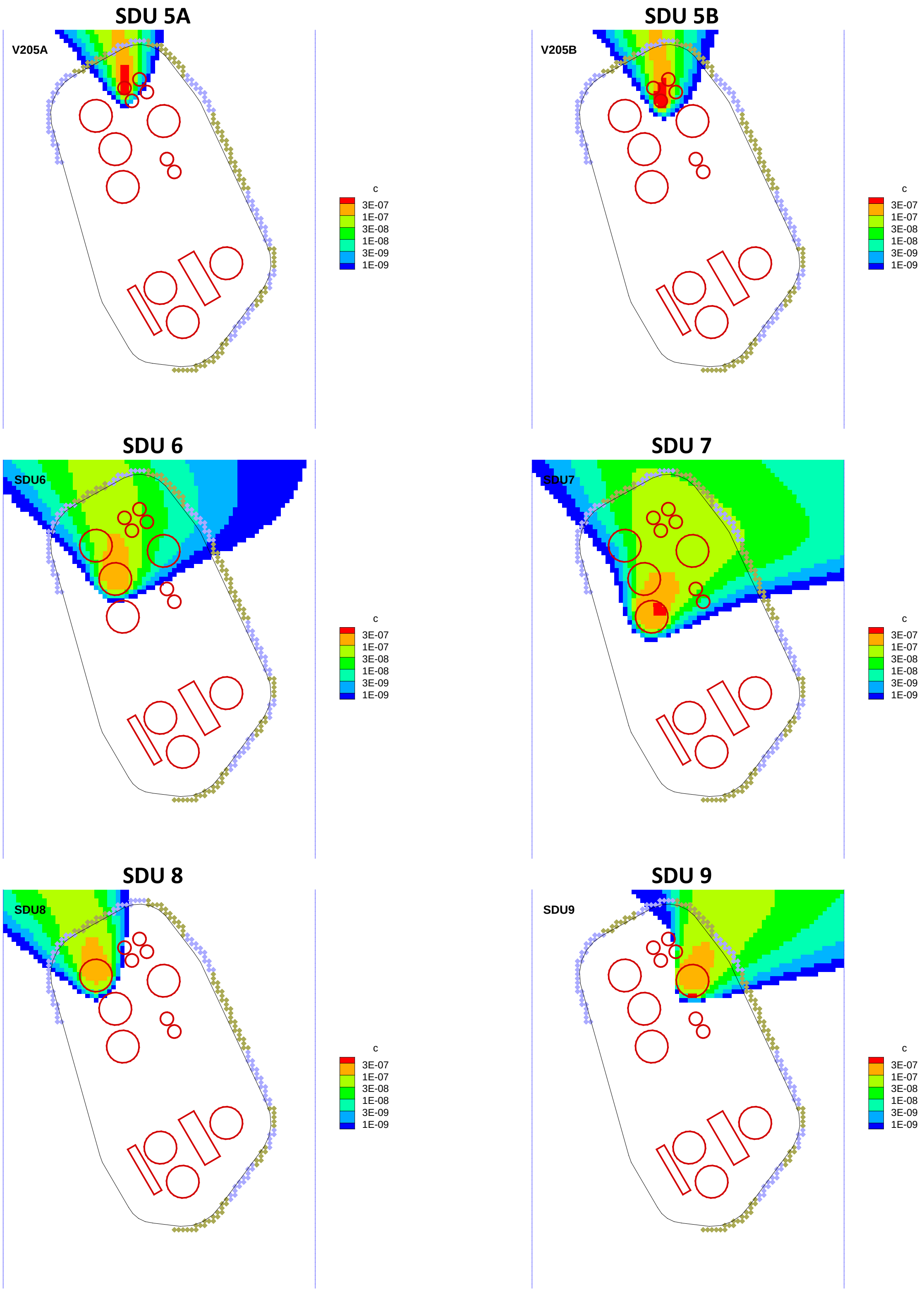


Figure 4. SDF GSA_2016 Tracer Plume Simulation of Steady-State Sources (concentration, C in Ci/L) (cont'd)

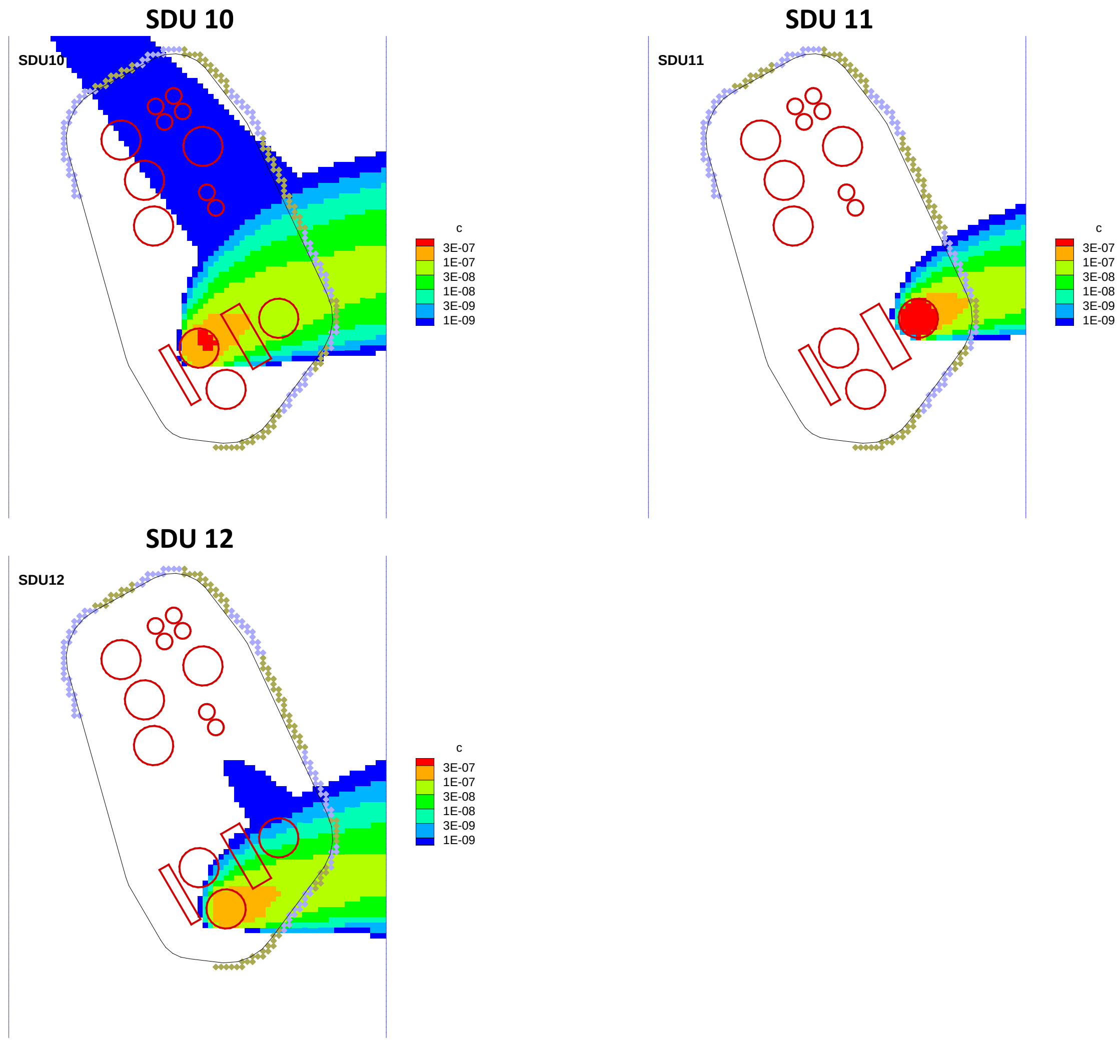


Figure 4. SDF GSA_2016 Tracer Plume Simulation of Steady-State Sources (concentration, C in Ci/L) (cont'd)

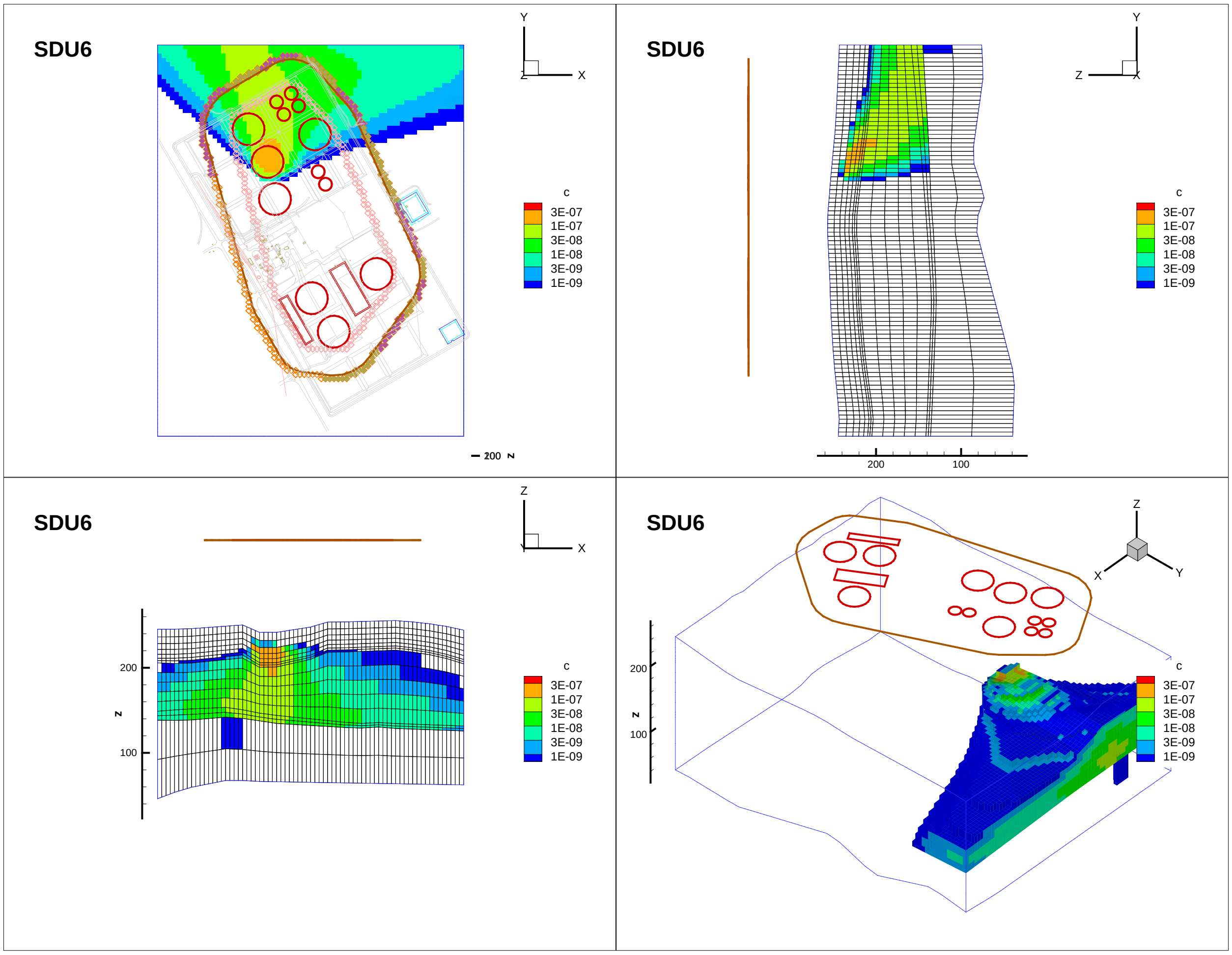


Figure 5. GSA_2004 Steady-State Plumes for SDU6 (concentration, C in Ci/L)

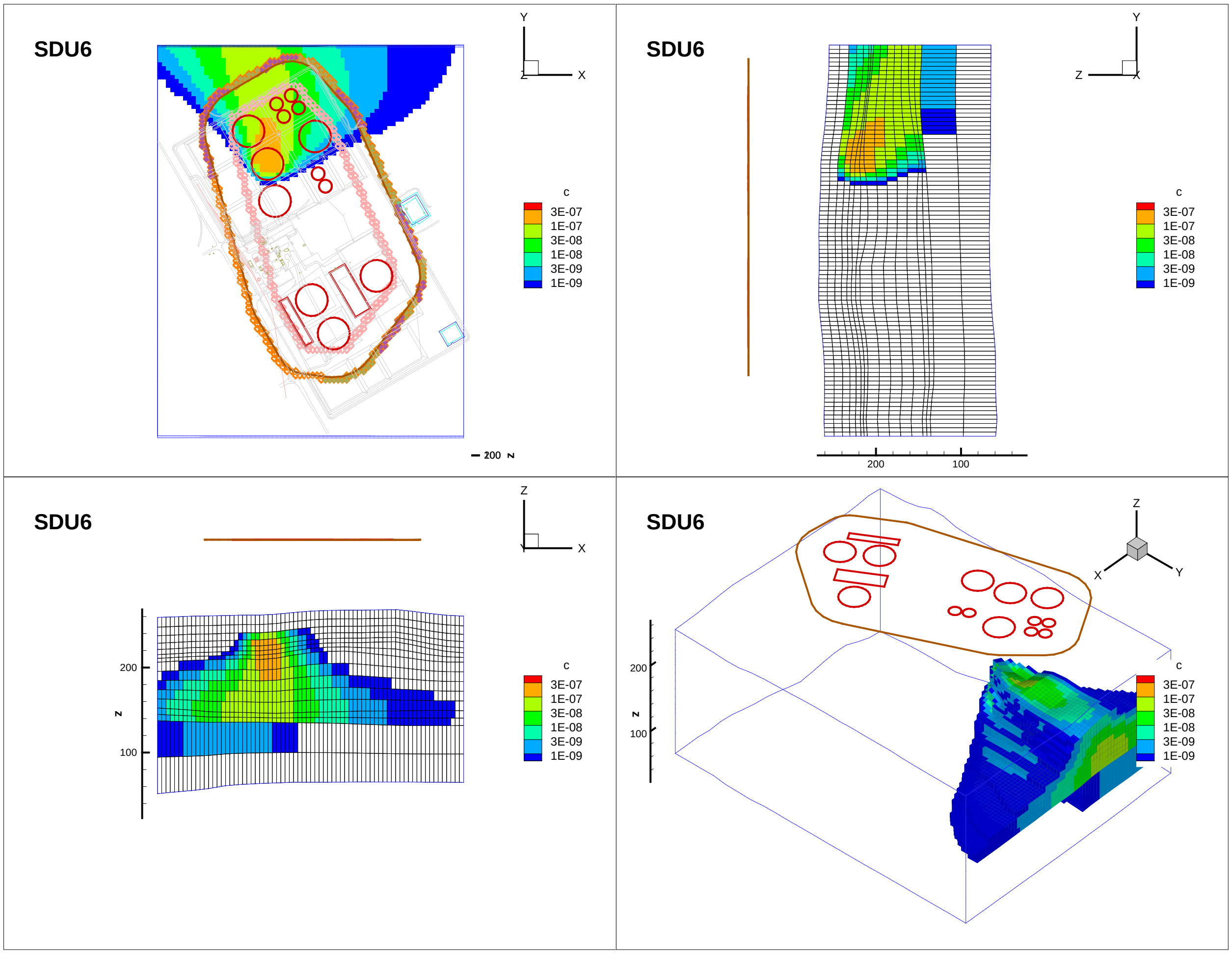
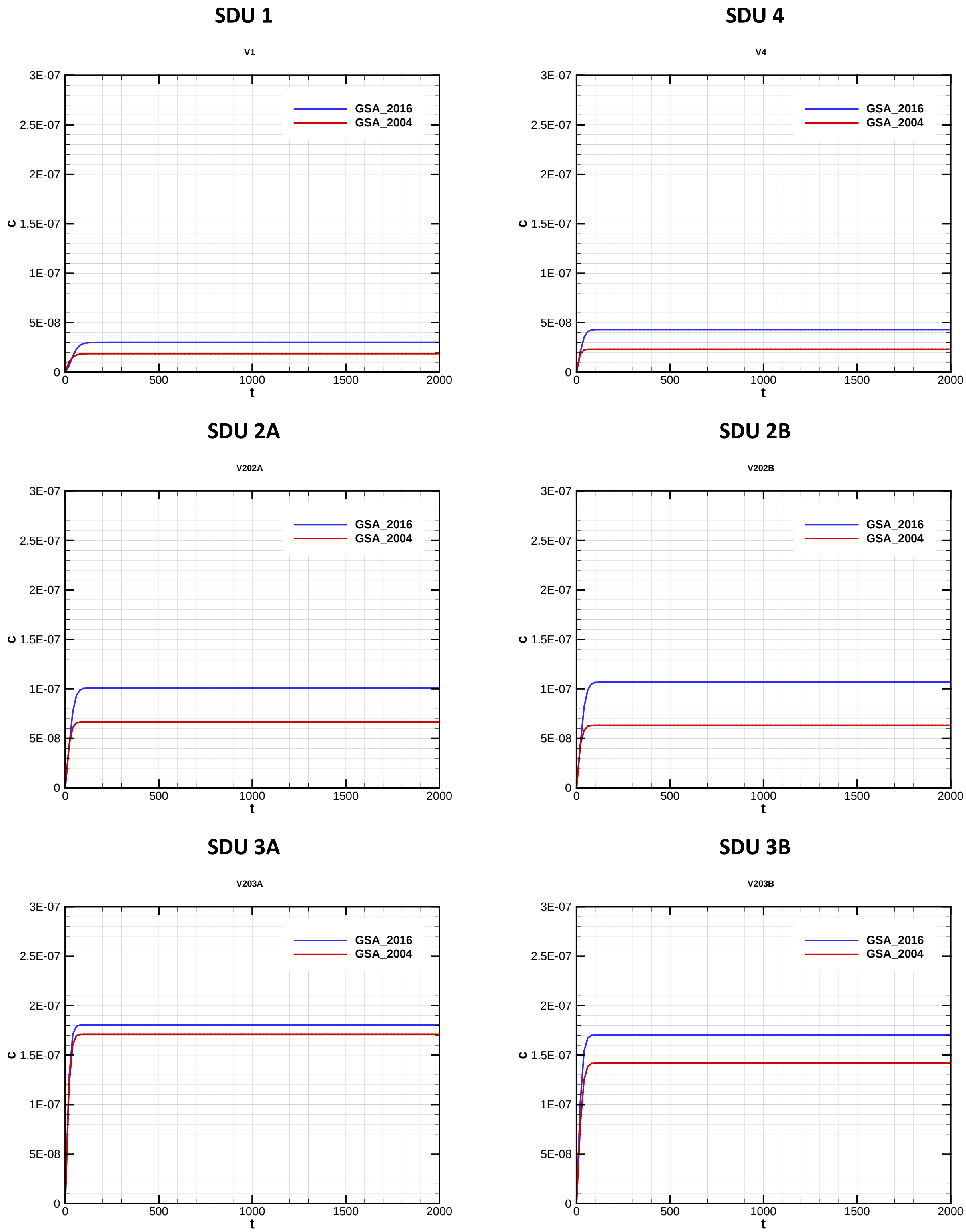
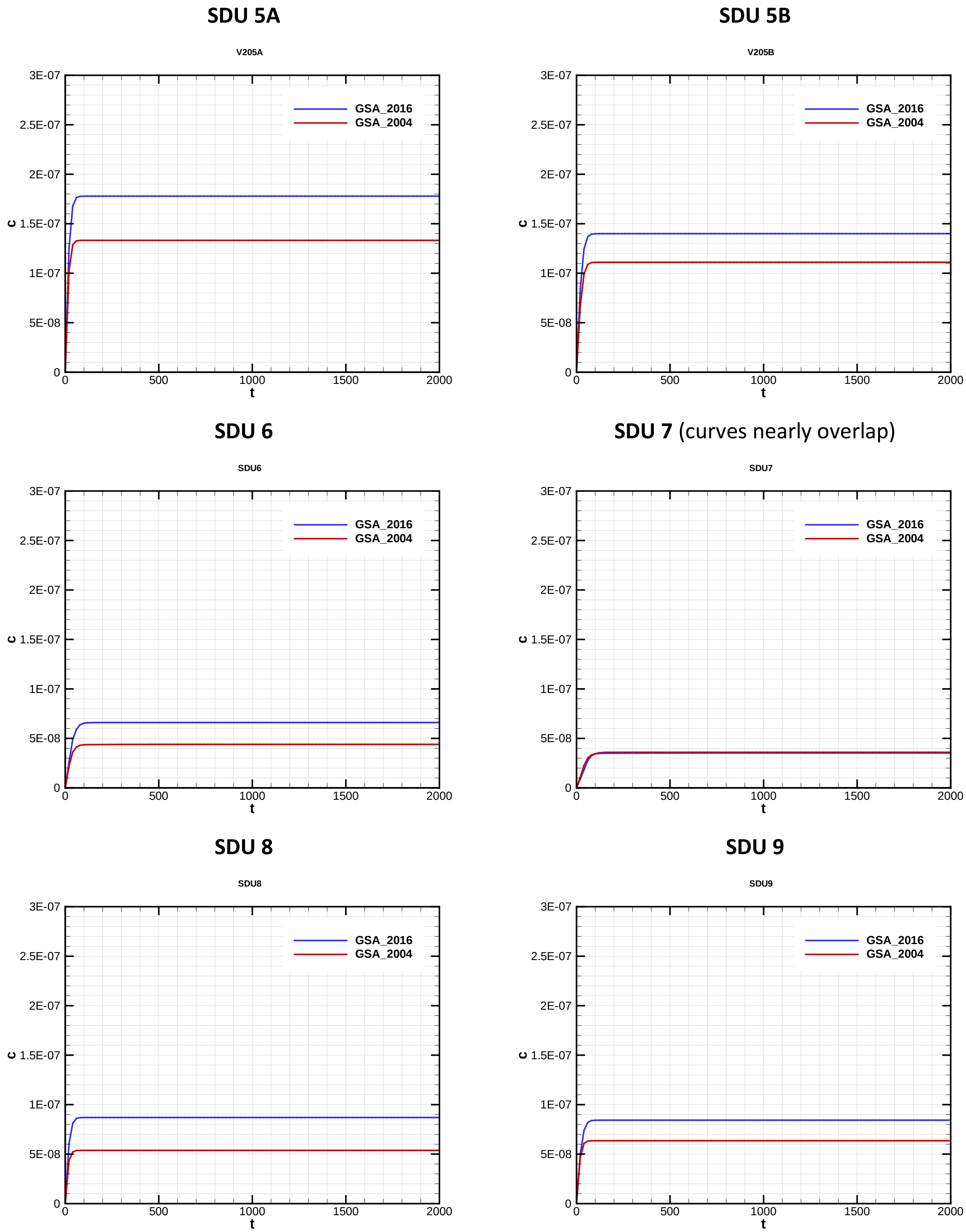


Figure 6. GSA_2016 Steady-State Plumes for SDU6 (concentration, C in Ci/L)



Note: Concentrations are monitored at 100-meter boundary

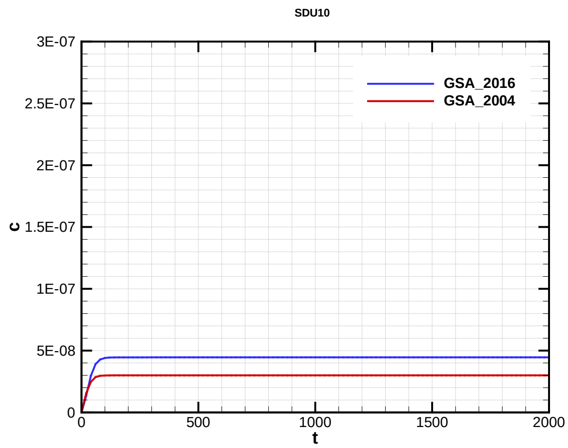
Figure 7. Comparison of SDF Steady-State Source Concentrations (concentration, C in Ci/L, time, t in years)



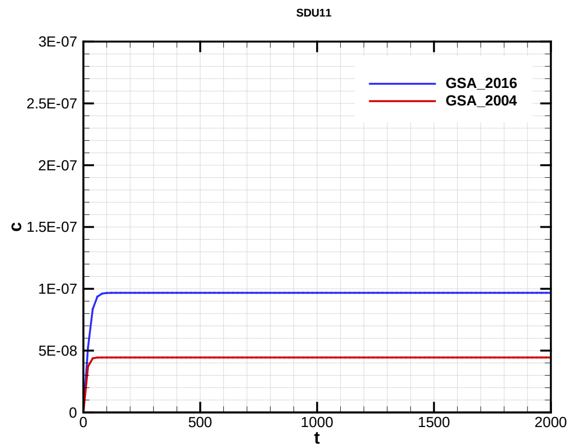
Note: Concentrations are monitored at 100-meter boundary

Figure 7. Comparison of SDF Steady-State Source Concentrations (concentration, C in Ci/L, time, t in years) (cont'd)

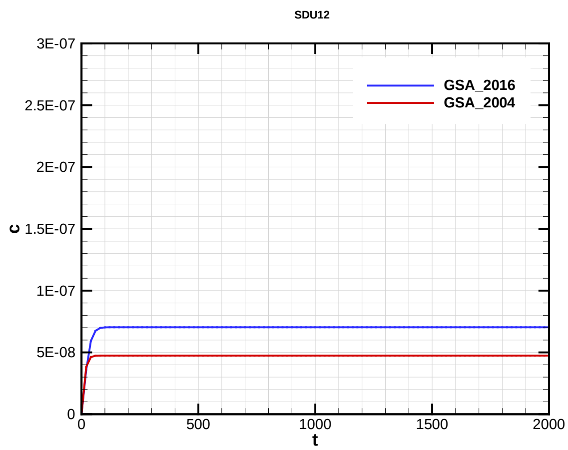
SDU 10



SDU 11



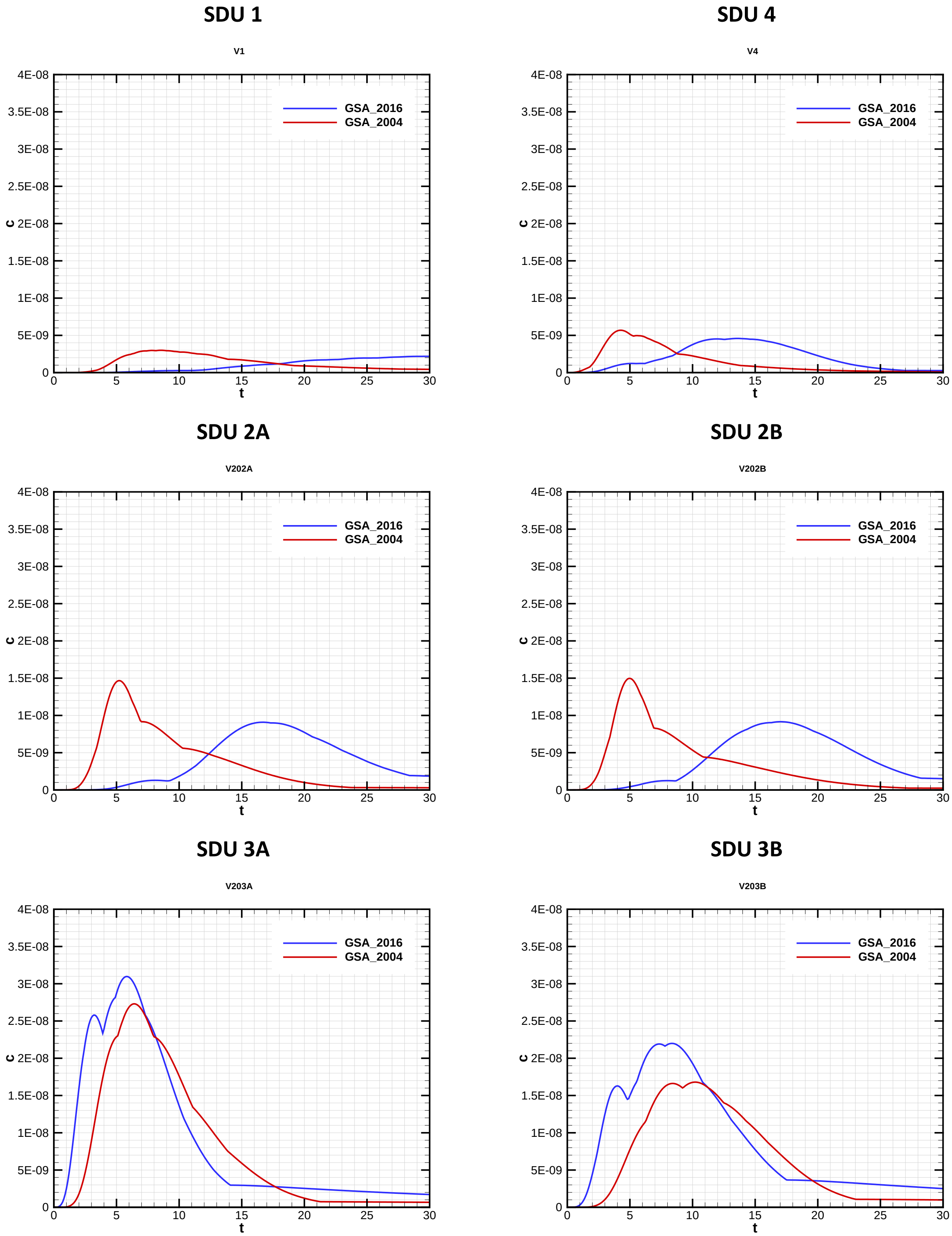
SDU 12



Note: Concentrations are monitored at 100-meter boundary

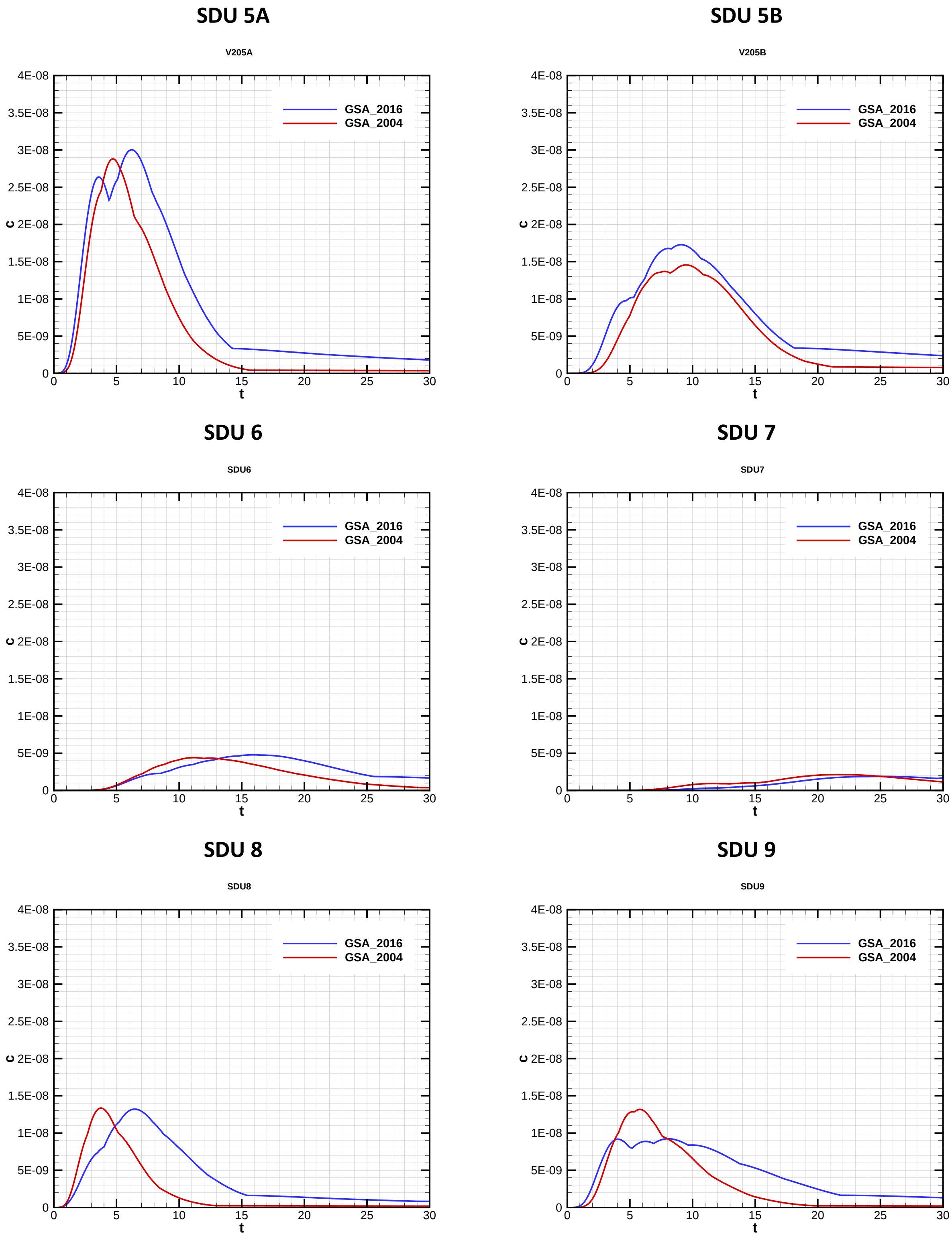
Figure 7. Comparison of SDF Steady-State Source Concentrations (concentration, C in Ci/L, time, t in years) (cont'd)

3.1.2.2 Transient/Pulsed Sources



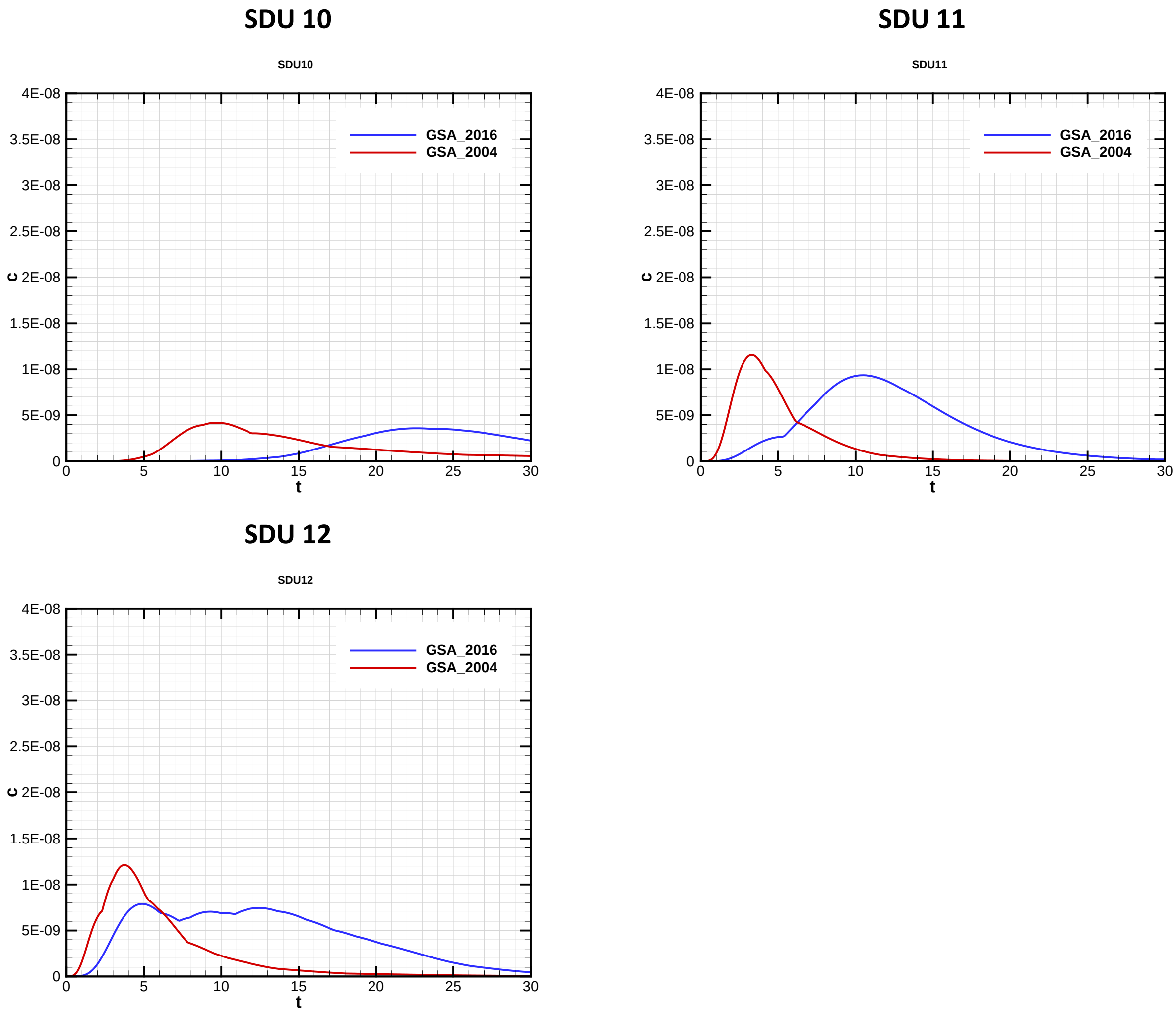
Note: Concentrations are monitored at 100-meter boundary

Figure 8. Comparison of SDF Pulsed Source Concentrations (concentration, C in Ci/L, time, t in years)



Note: Concentrations are monitored at 100-meter boundary

Figure 8. Comparison of SDF Pulsed Source Concentrations (concentration, C in Ci/L, time, t in years) (cont'd)



Note: Concentrations are monitored at 100-meter boundary

Figure 8. Comparison of SDF Pulsed Source Concentrations (concentration, C in Ci/L, time, t in years) (cont'd)

3.1.3 Evaluation Case Transport Simulations

3.1.3.1 Concentrations at 100-meter Boundary

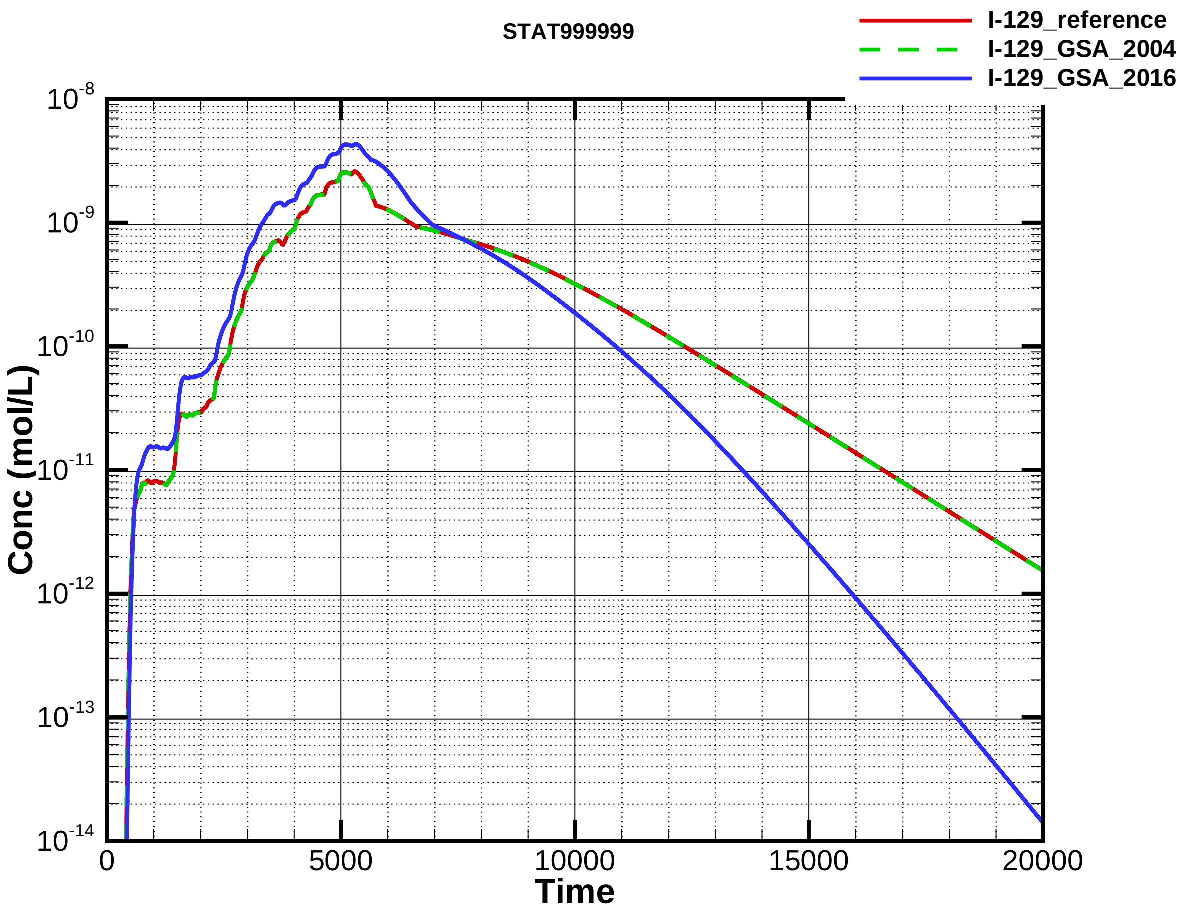


Figure 9. SDF I-129 Concentrations at 100-meter Boundary (Time in years)

3.1.3.2 Concentrations at the Seepline

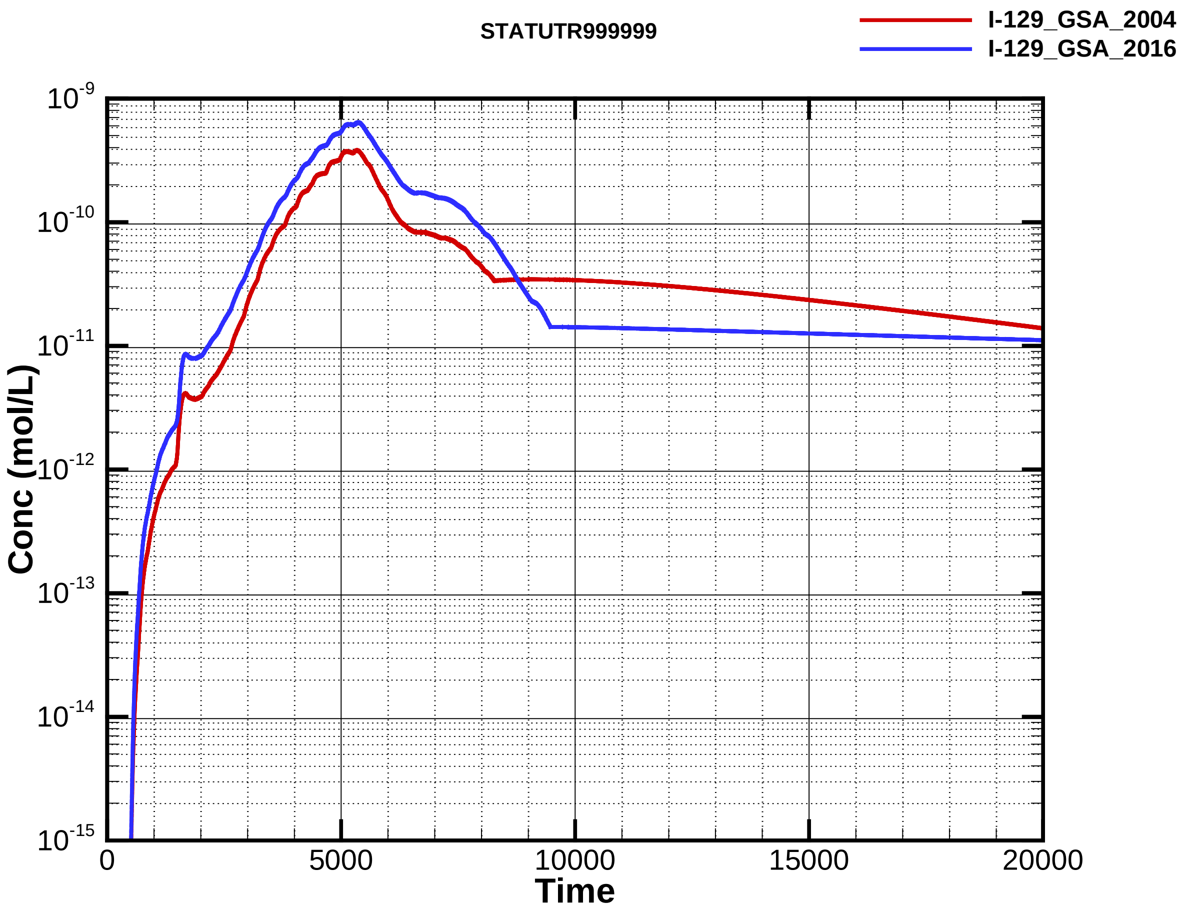


Figure 10. SDF I-129 Concentrations at the Seepline (Time in years)

3.2 H-Area Tank Farm

3.2.1 Streamtraces with Timing Markers

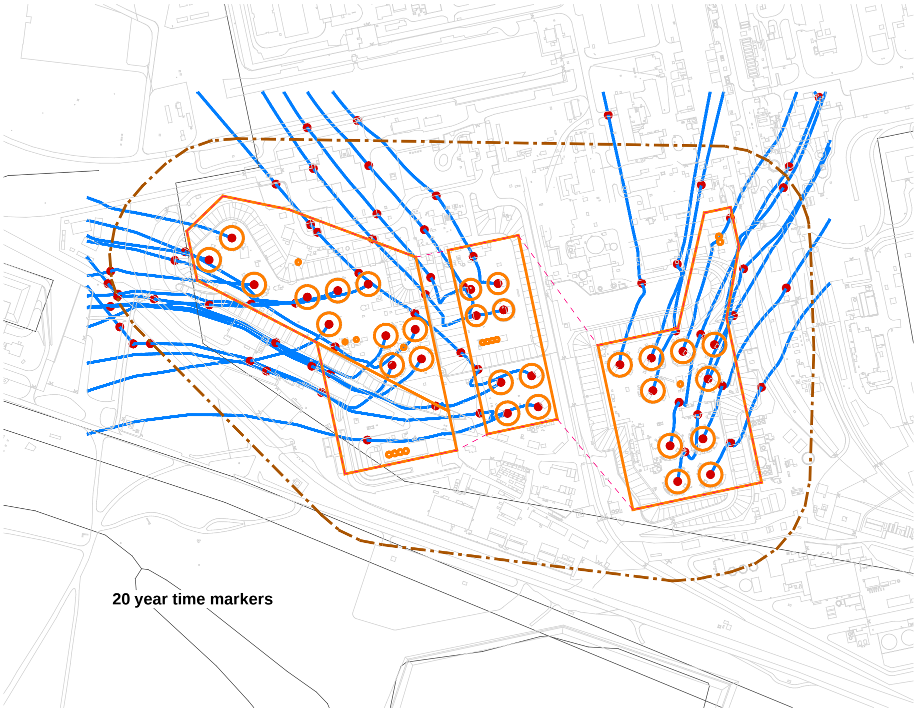


Figure 11. HTF GSA_2004 Streamtraces with Timing Markers

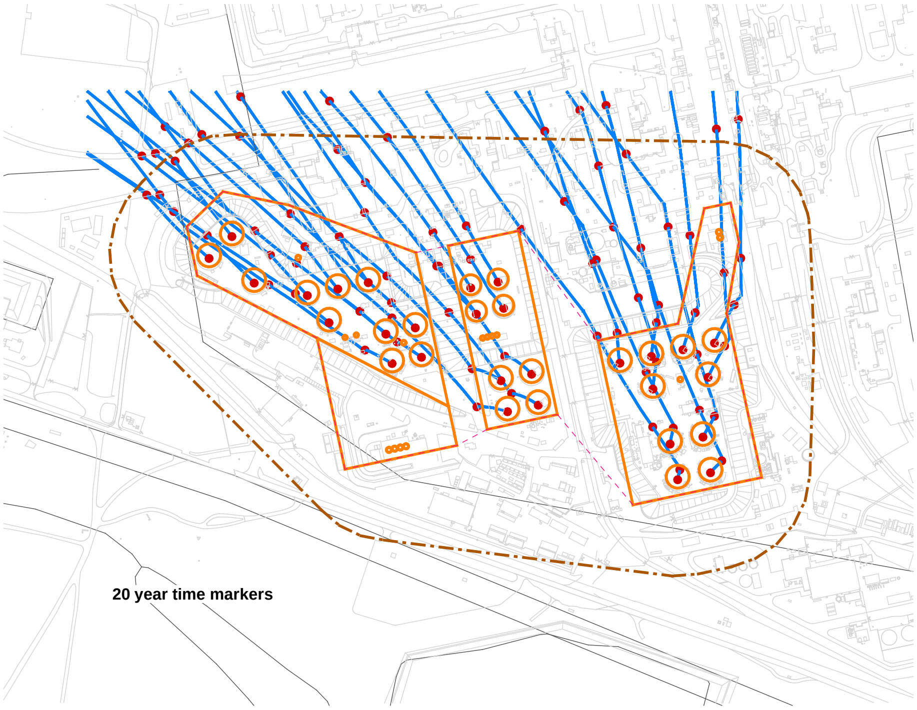


Figure 12. HTF GSA_2016 Streamtraces with Timing Markers

3.2.2 Tracer Plume Simulations

3.2.2.1 Steady-State Sources

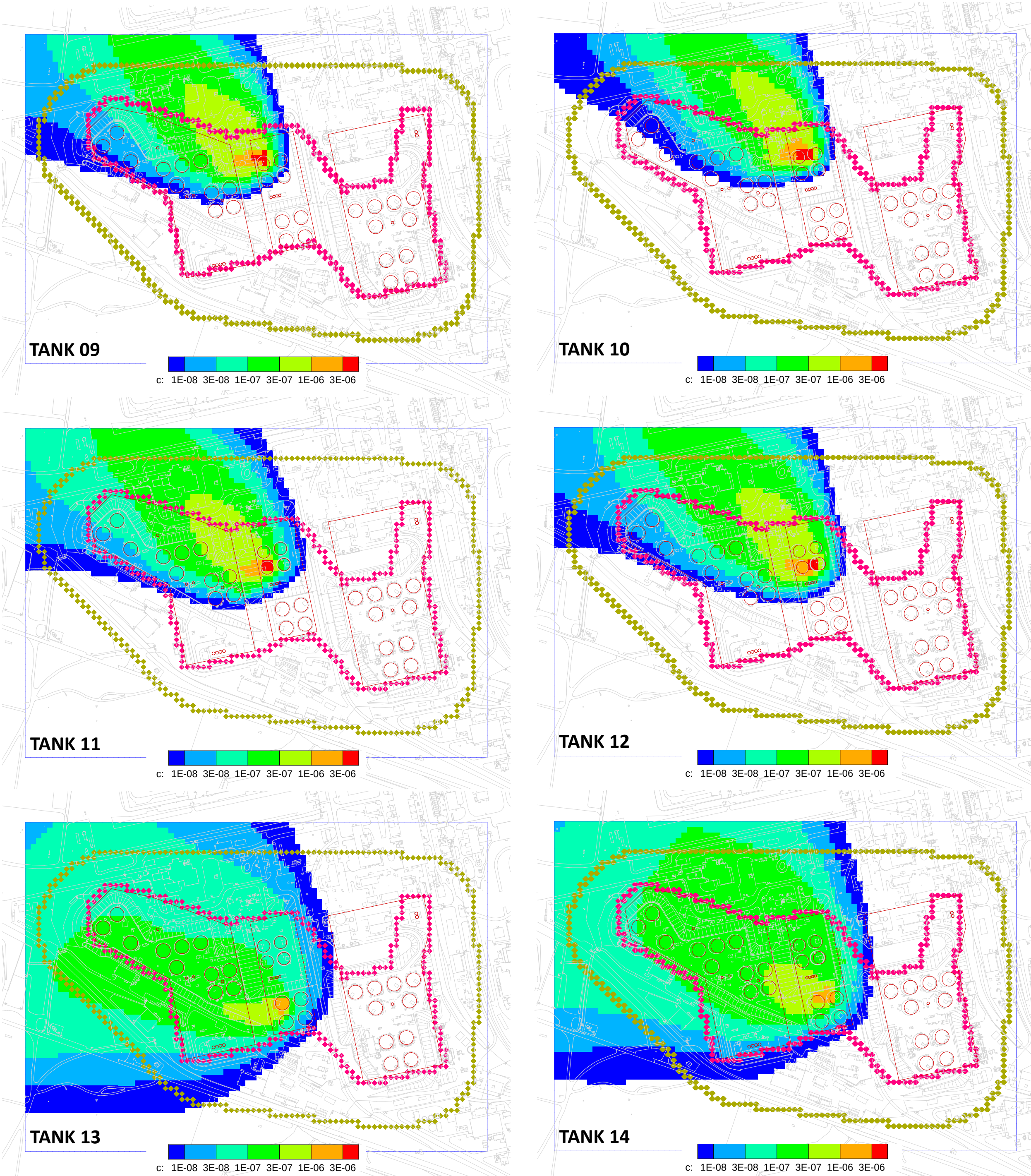


Figure 13. HTF GSA_2004 Tracer Plume Simulation of Steady-State Sources (concentration, C in Ci/L)

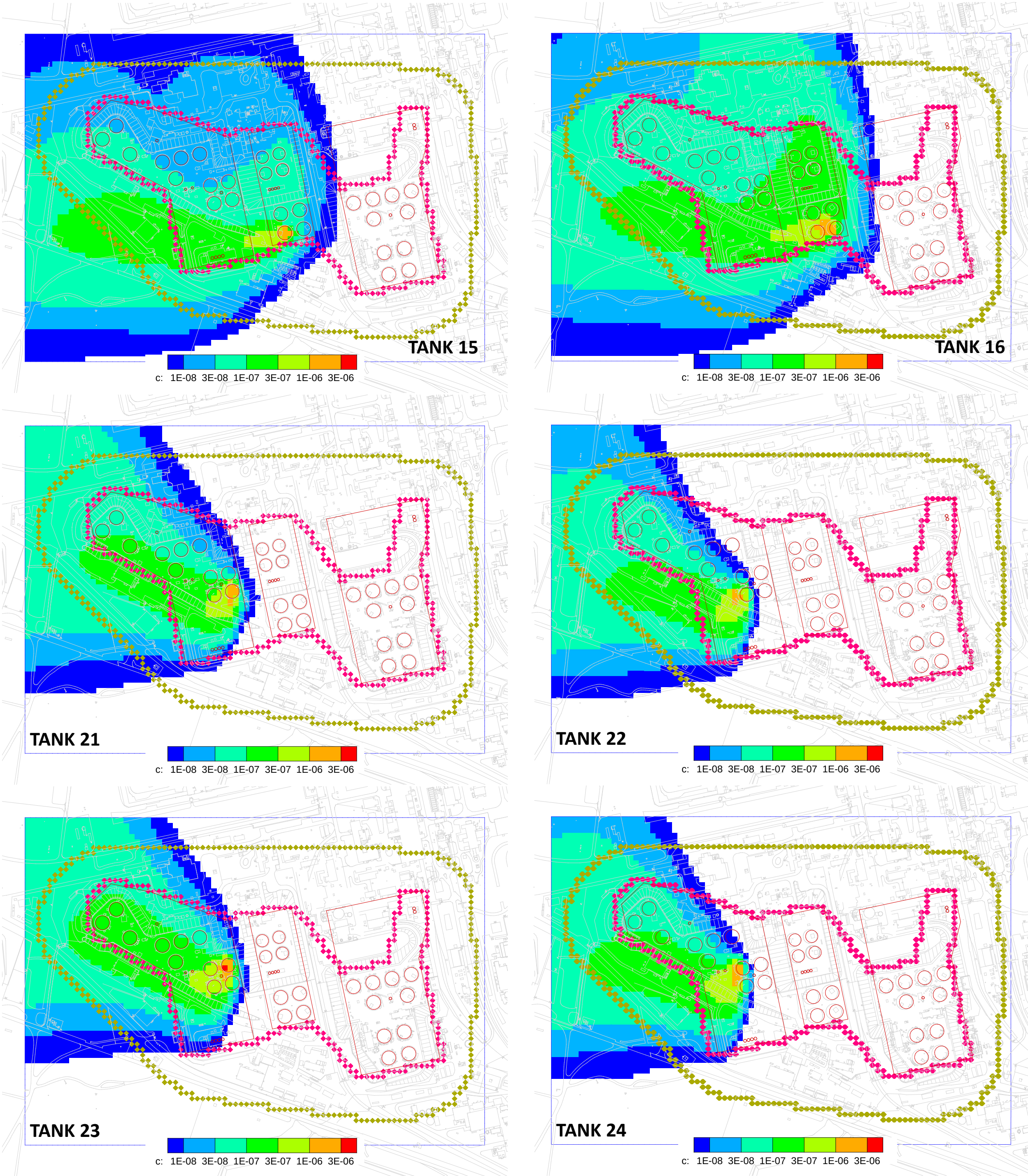


Figure 13. HTF GSA_2004 Tracer Plume Simulation of Steady-State Sources (concentration, C in Ci/L) (cont'd)

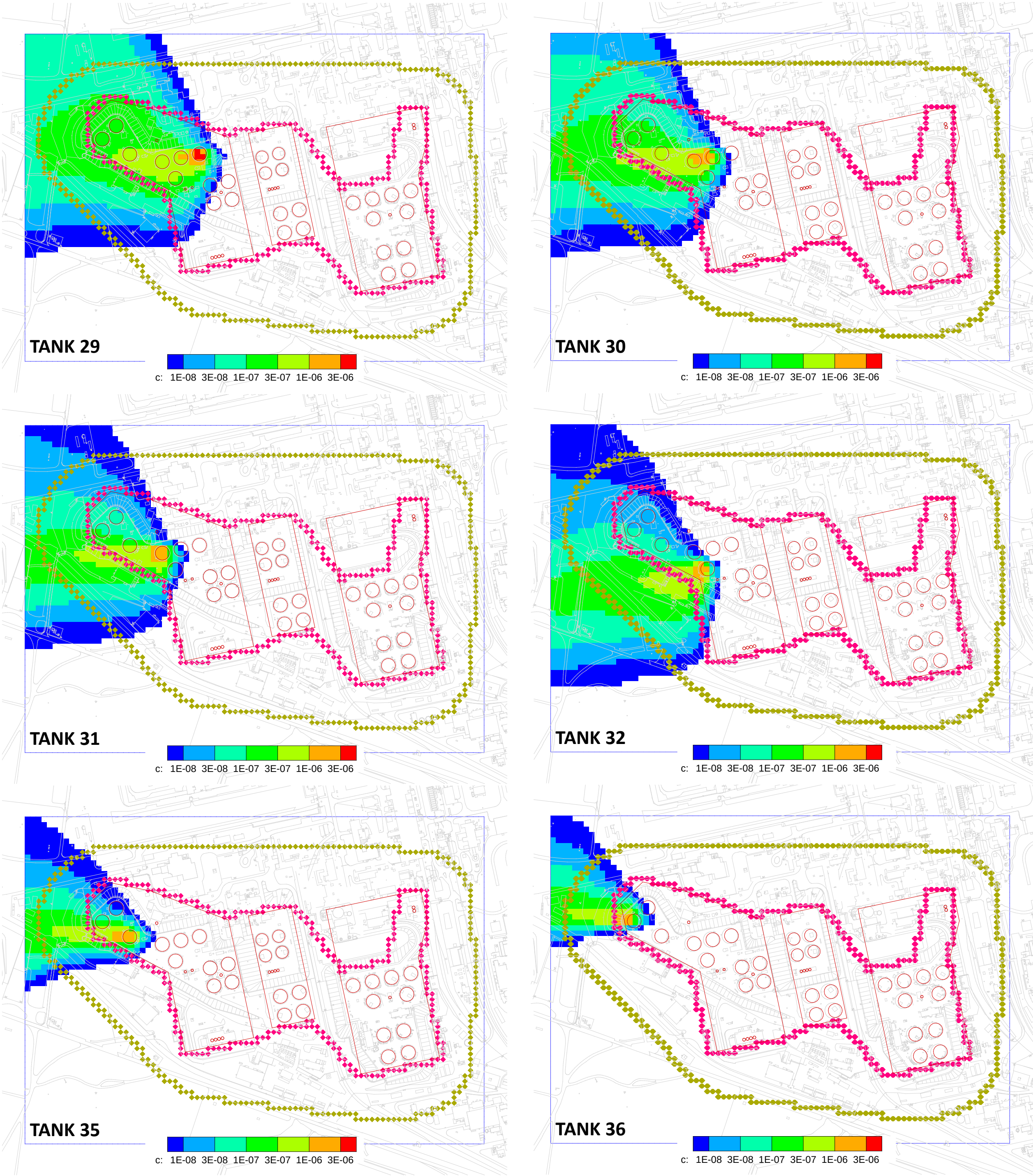


Figure 13. HTF GSA_2004 Tracer Plume Simulation of Steady-State Sources (concentration, C in Ci/L) (cont'd)

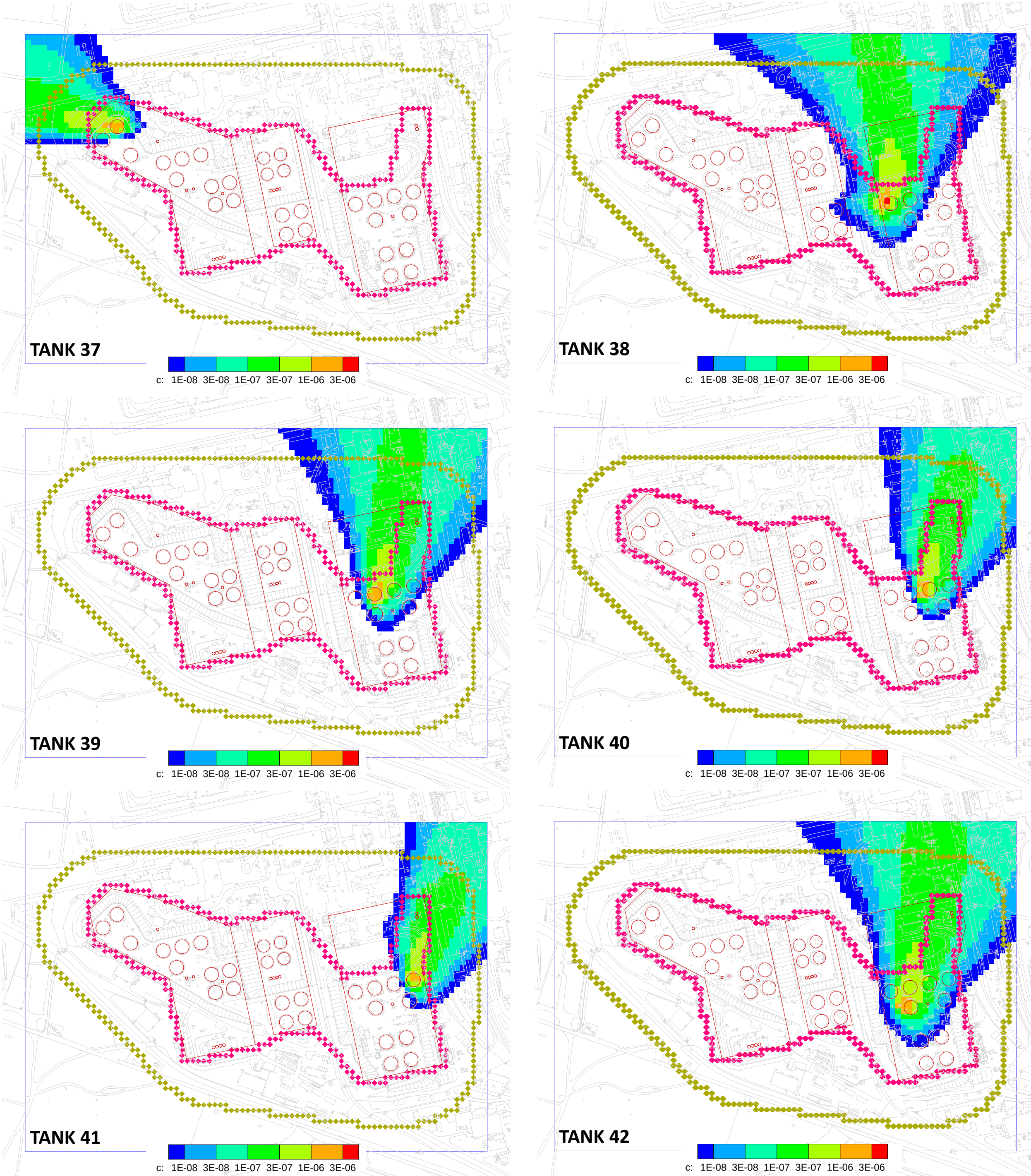


Figure 13. HTF GSA_2004 Tracer Plume Simulation of Steady-State Sources (concentration, C in Ci/L) (cont'd)

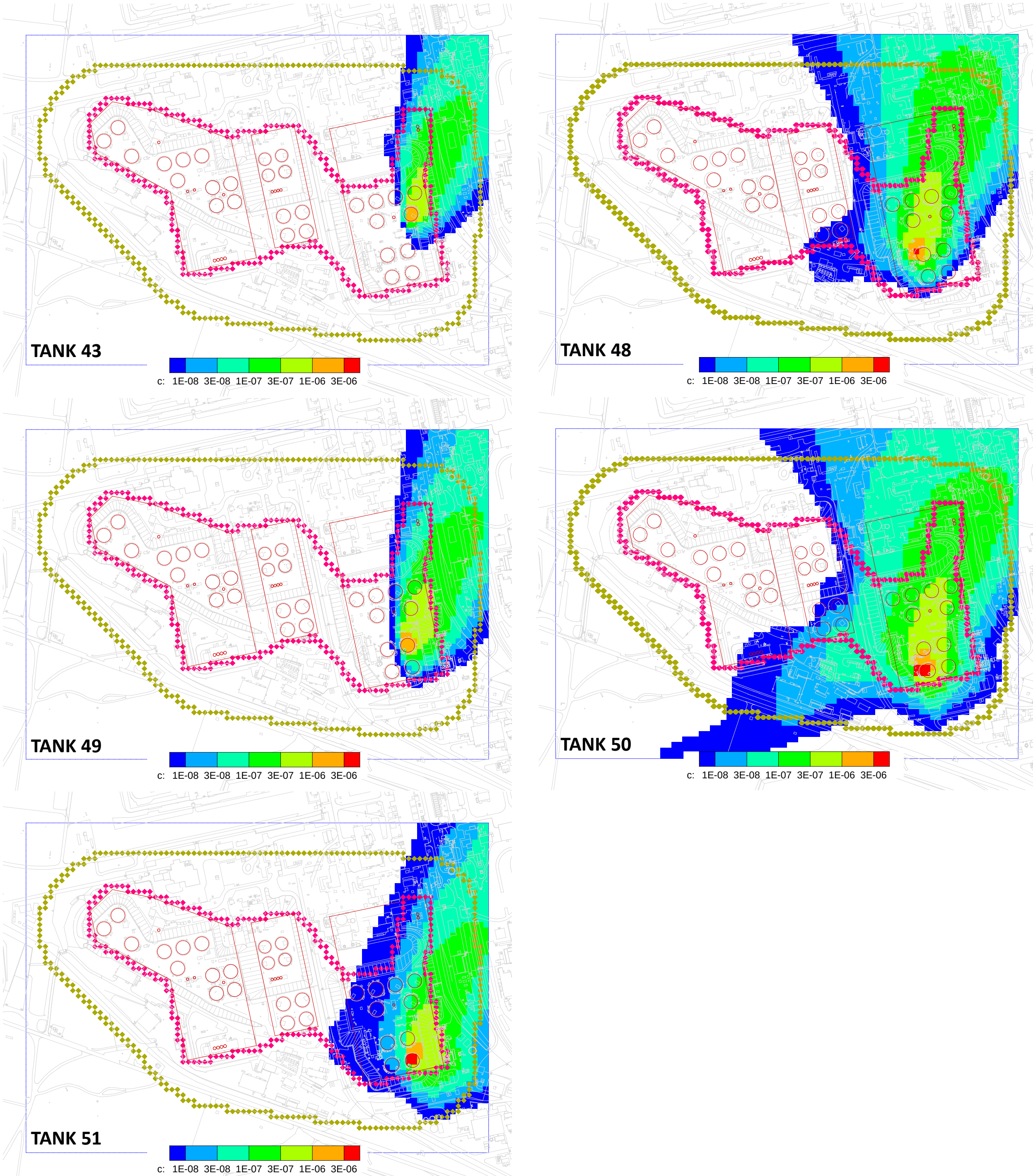


Figure 13. HTF GSA_2004 Tracer Plume Simulation of Steady-State Sources (concentration, C in Ci/L) (cont'd)

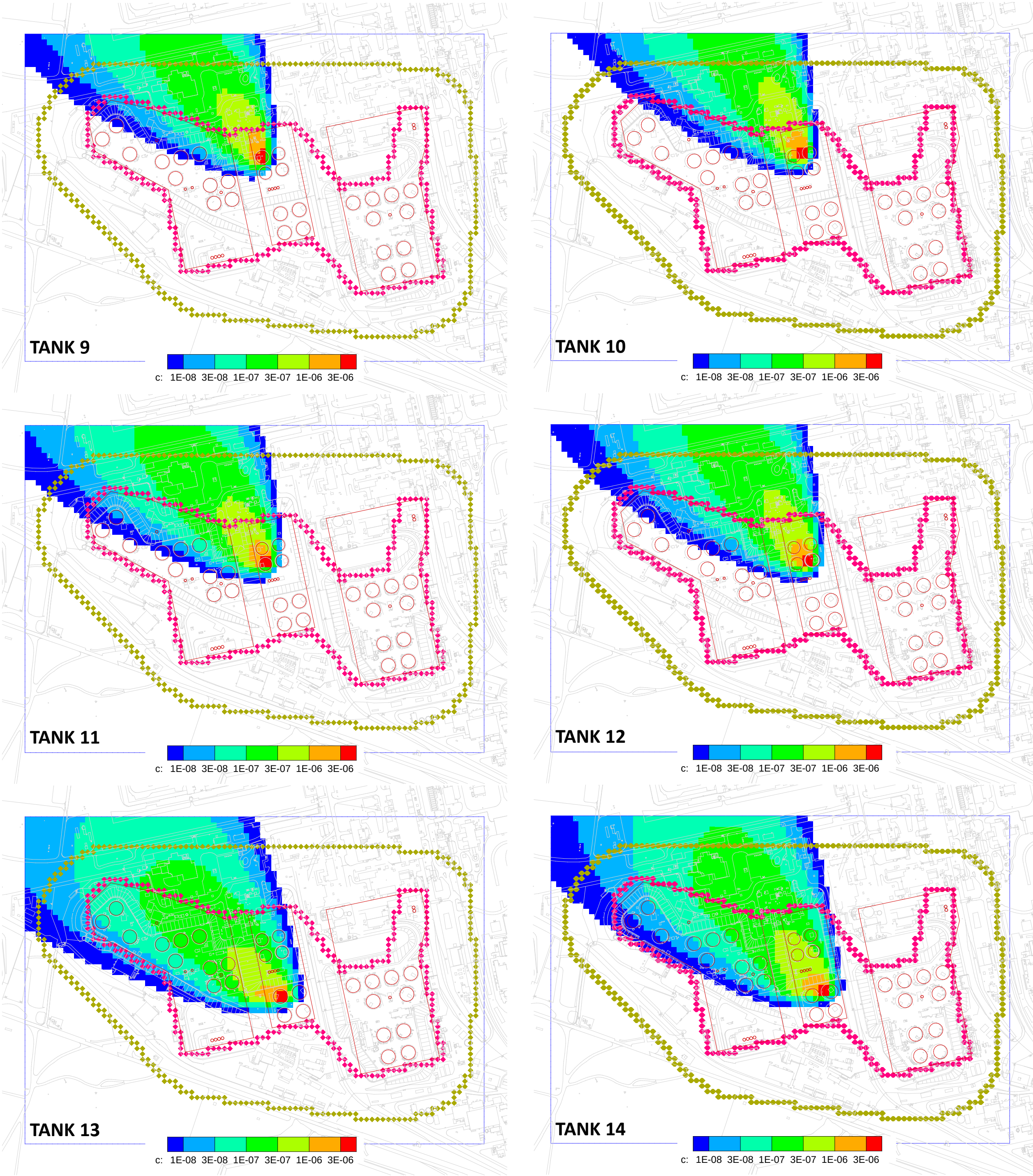


Figure 14. HTF GSA_2016 Tracer Plume Simulation of Steady-State Sources (concentration, C in Ci/L)

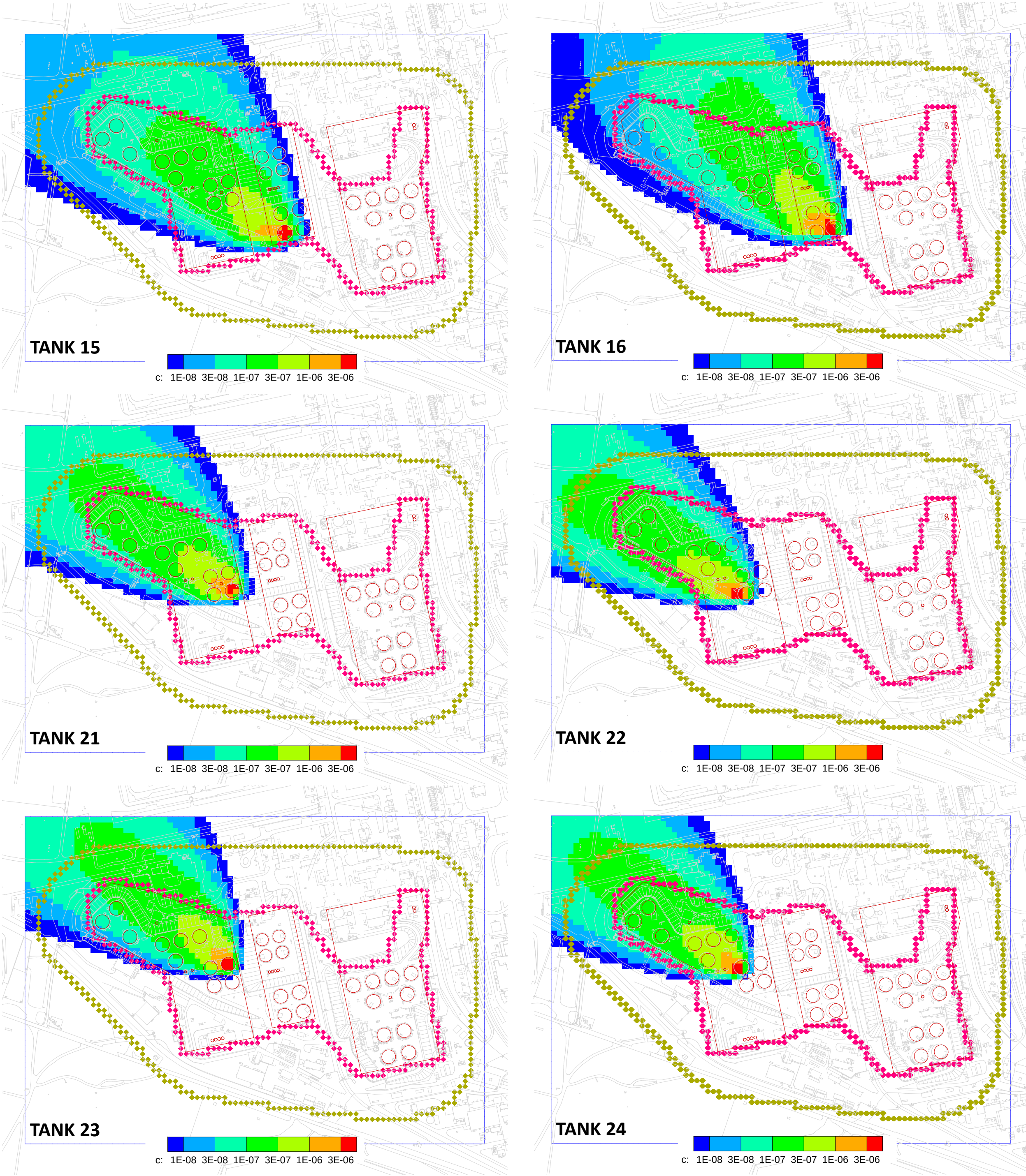


Figure 14. HTF GSA_2016 Tracer Plume Simulation of Steady-State Sources (concentration, C in Ci/L) (cont'd)

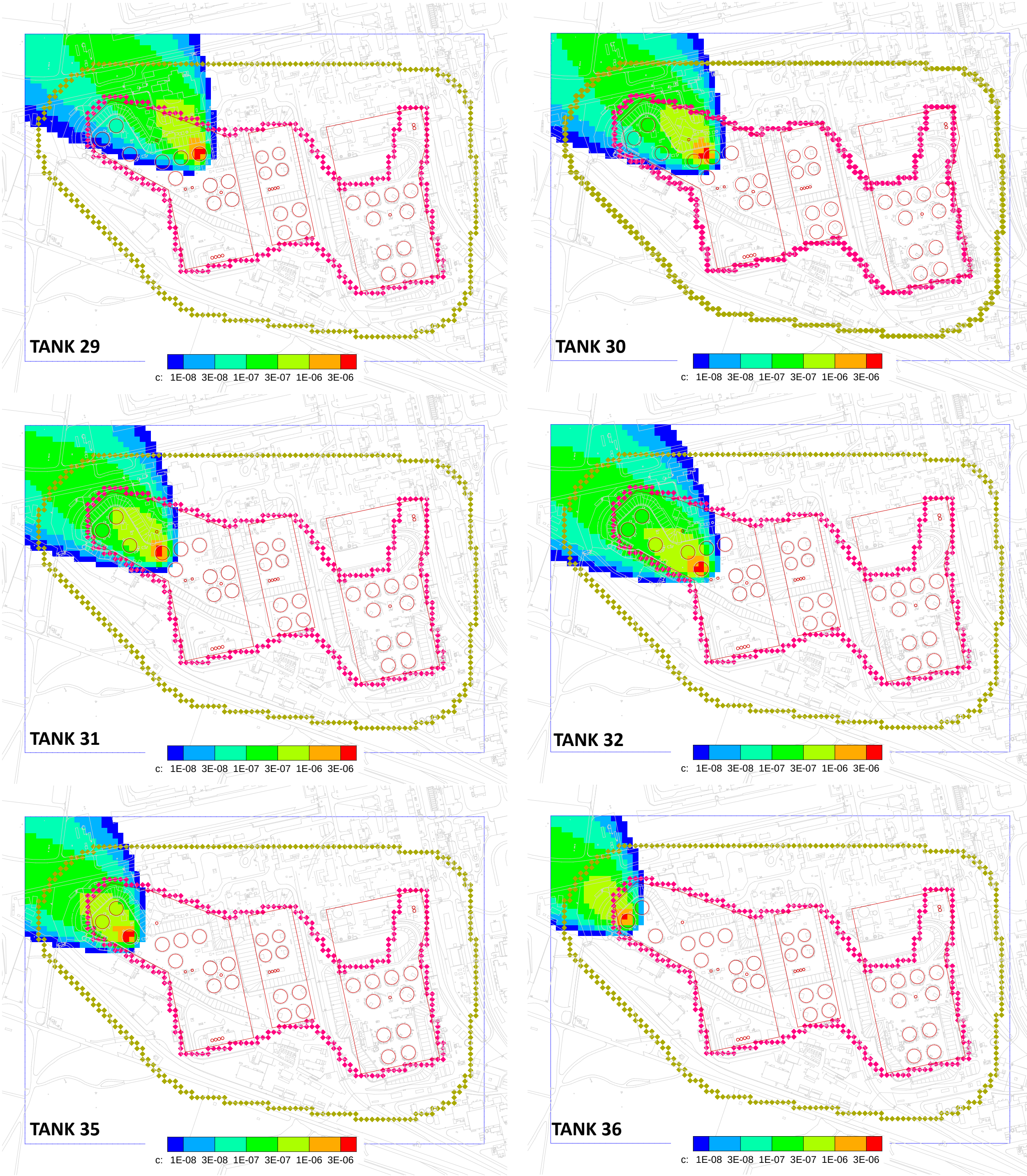


Figure 14. HTF GSA_2016 Tracer Plume Simulation of Steady-State Sources (concentration, C in Ci/L) (cont'd)

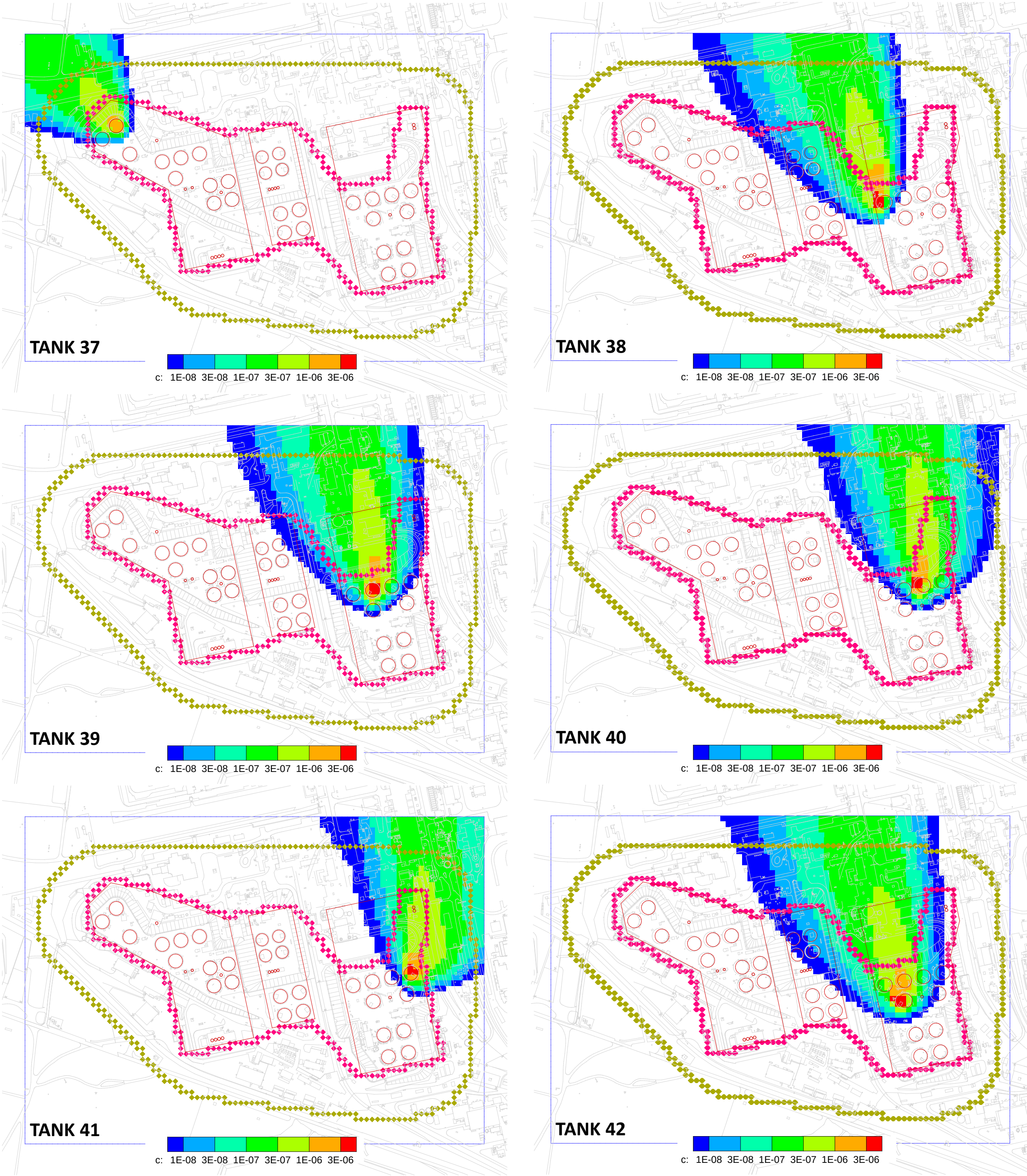


Figure 14. HTF GSA_2016 Tracer Plume Simulation of Steady-State Sources (concentration, C in Ci/L) (cont'd)

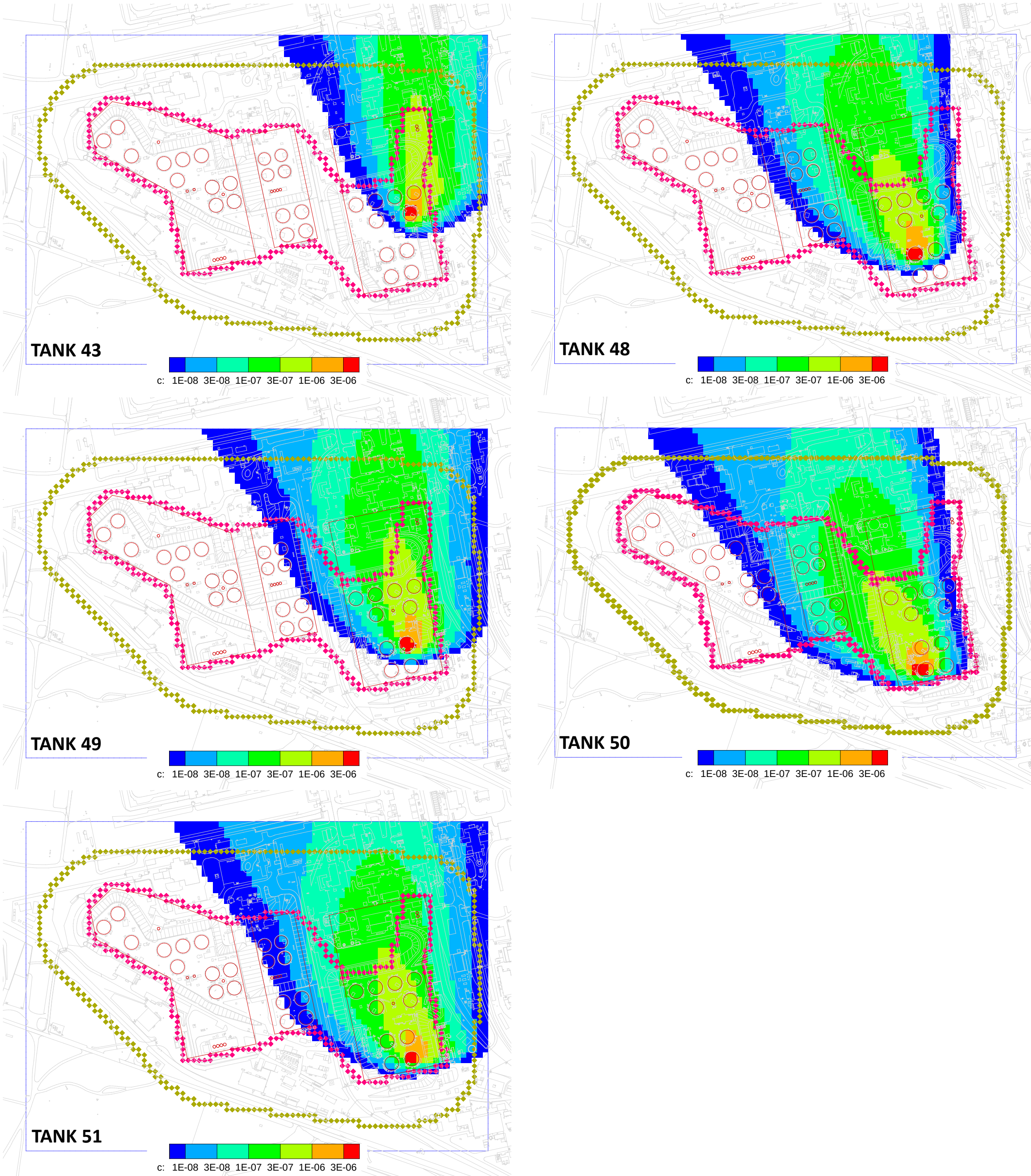
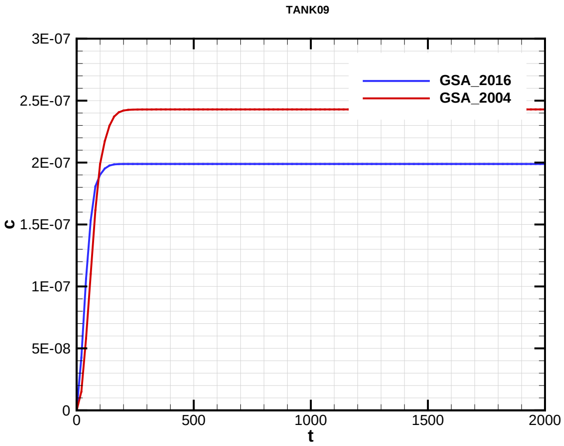


Figure 14. HTF GSA_2016 Tracer Plume Simulation of Steady-State Sources (concentration, C in Ci/L) (cont'd)

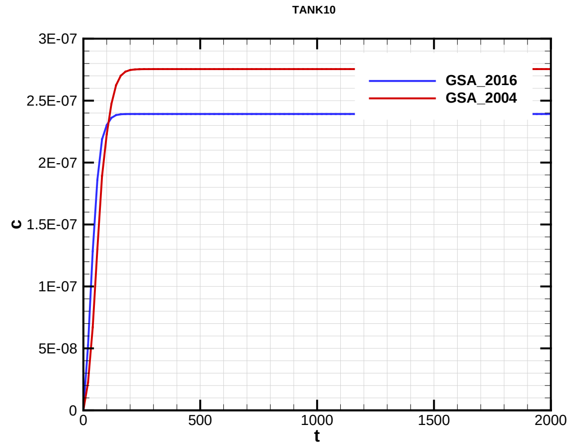
Figure 15. GSA_2004 Steady-State Plumes for Tank 48 (concentration, C in Ci/L)

Figure 16. GSA_2016 Steady-State Plumes for Tank 48 (concentration, C in Ci/L)

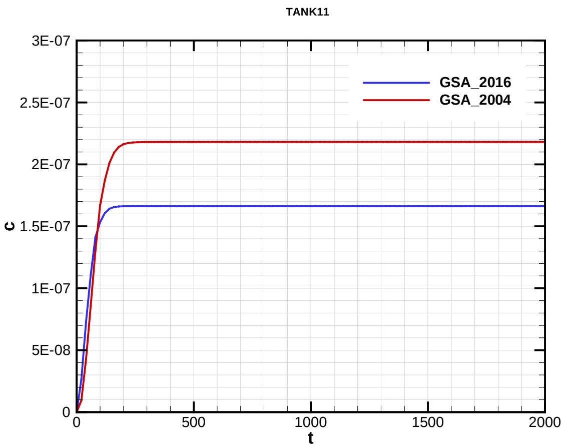
TANK 9



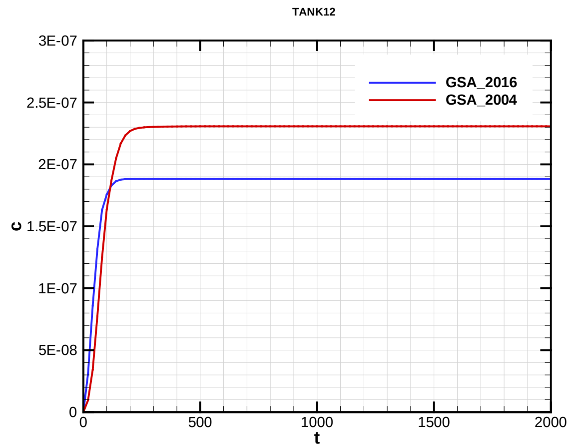
TANK 10



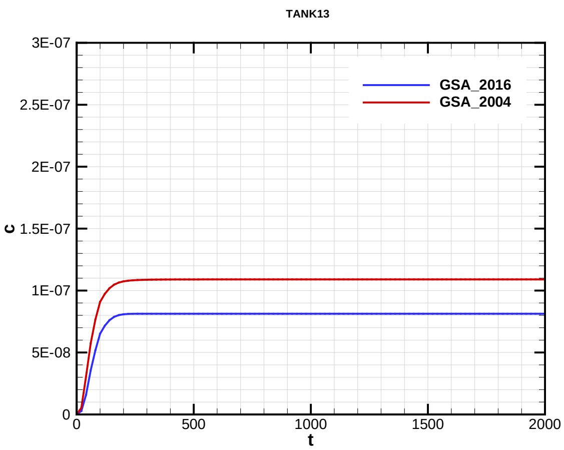
TANK 11



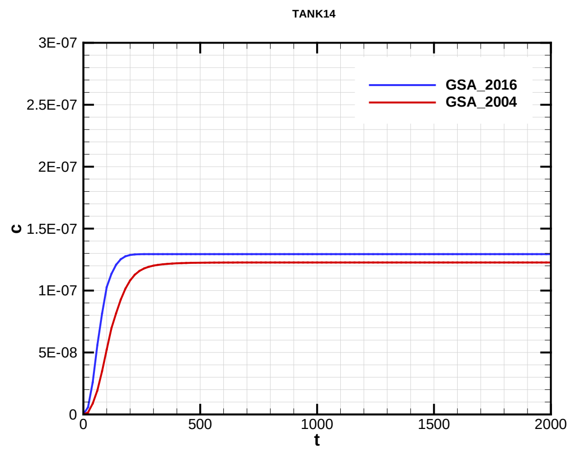
TANK 12



TANK 13



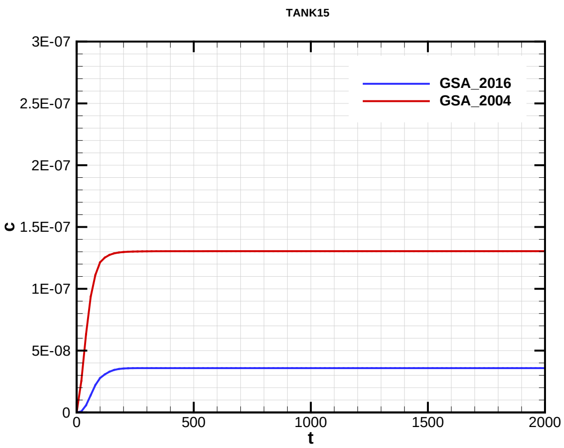
TANK 14



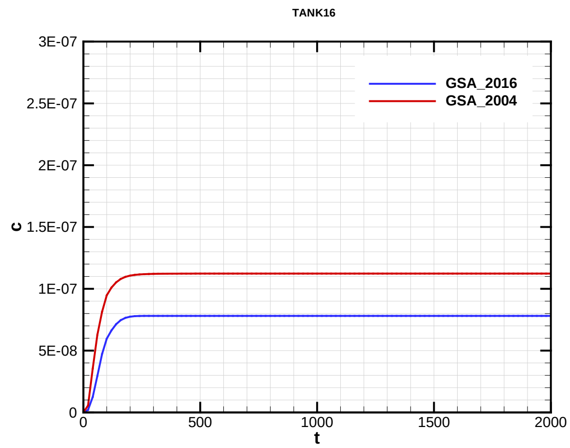
Note: Concentrations are monitored at 100-meter boundary

Figure 17. Comparison of HTF Steady-State Source Concentrations (concentration, C in Ci/L, time, t in years)

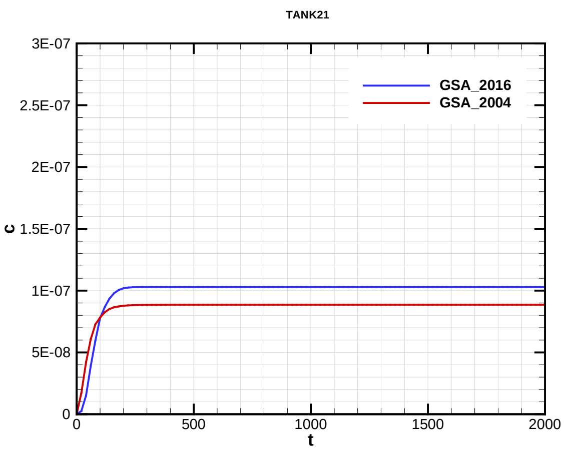
TANK 15



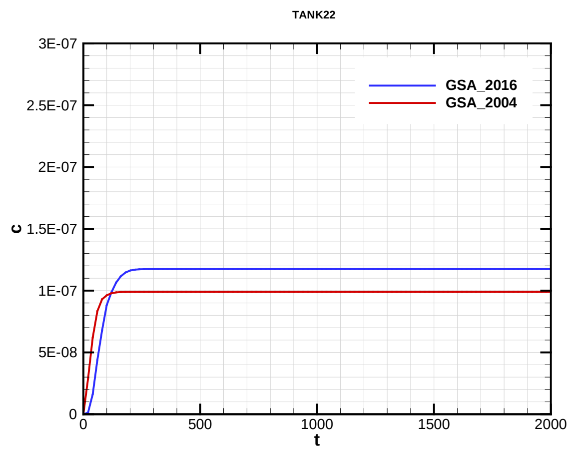
TANK 16



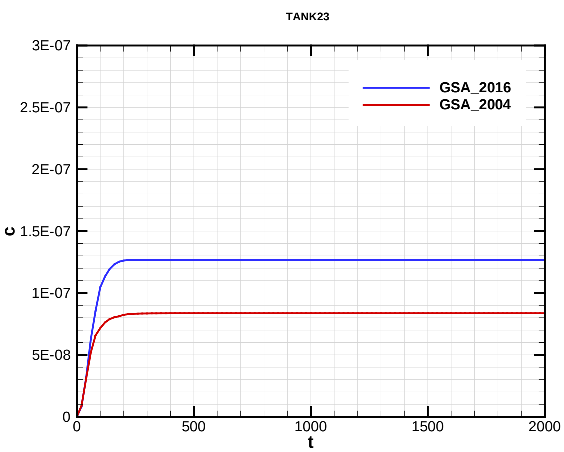
TANK 21



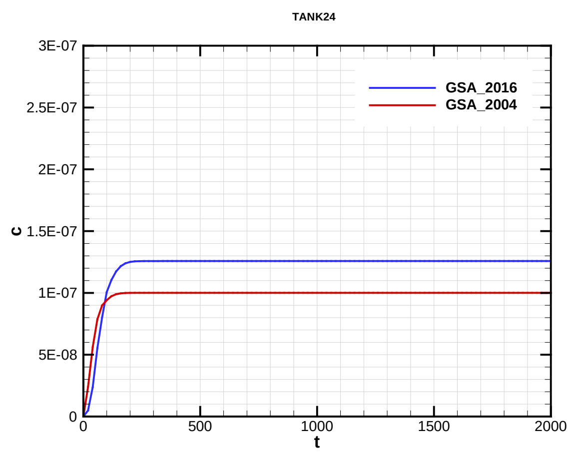
TANK 22



TANK 23

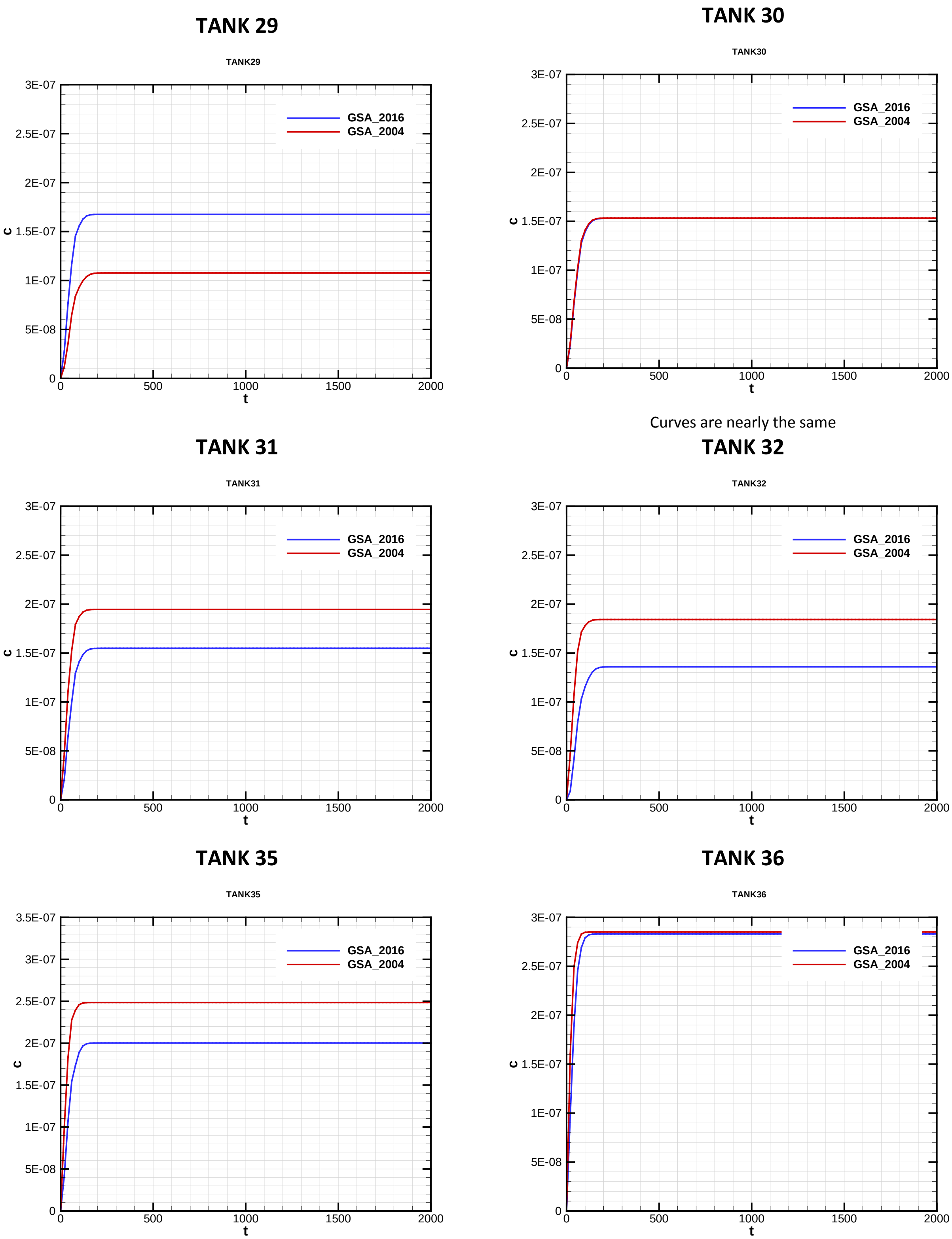


TANK 24



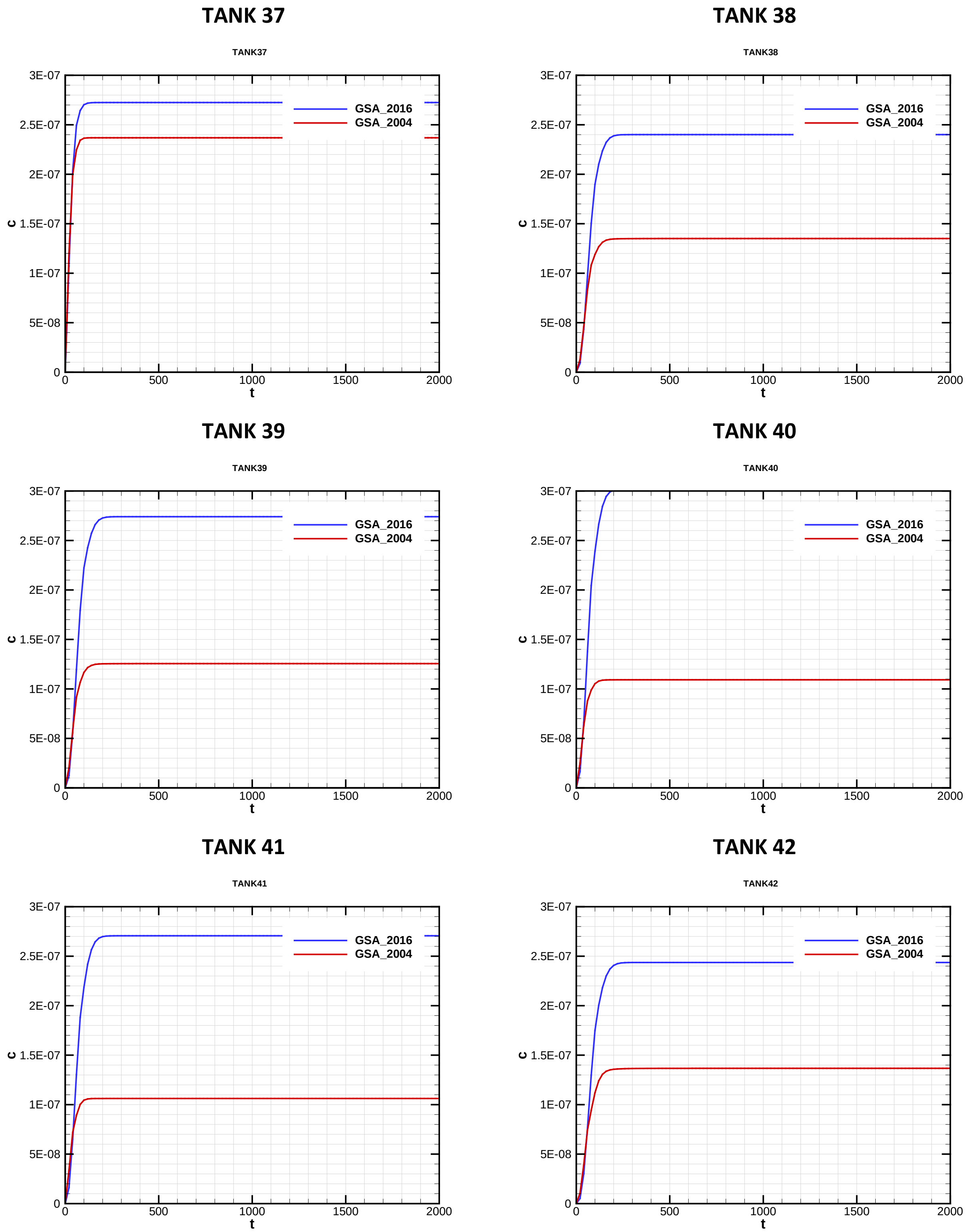
Note: Concentrations are monitored at 100-meter boundary

Figure 17. Comparison of HTF Steady-State Source Concentrations (concentration, C in Ci/L, time, t in years) (cont'd)



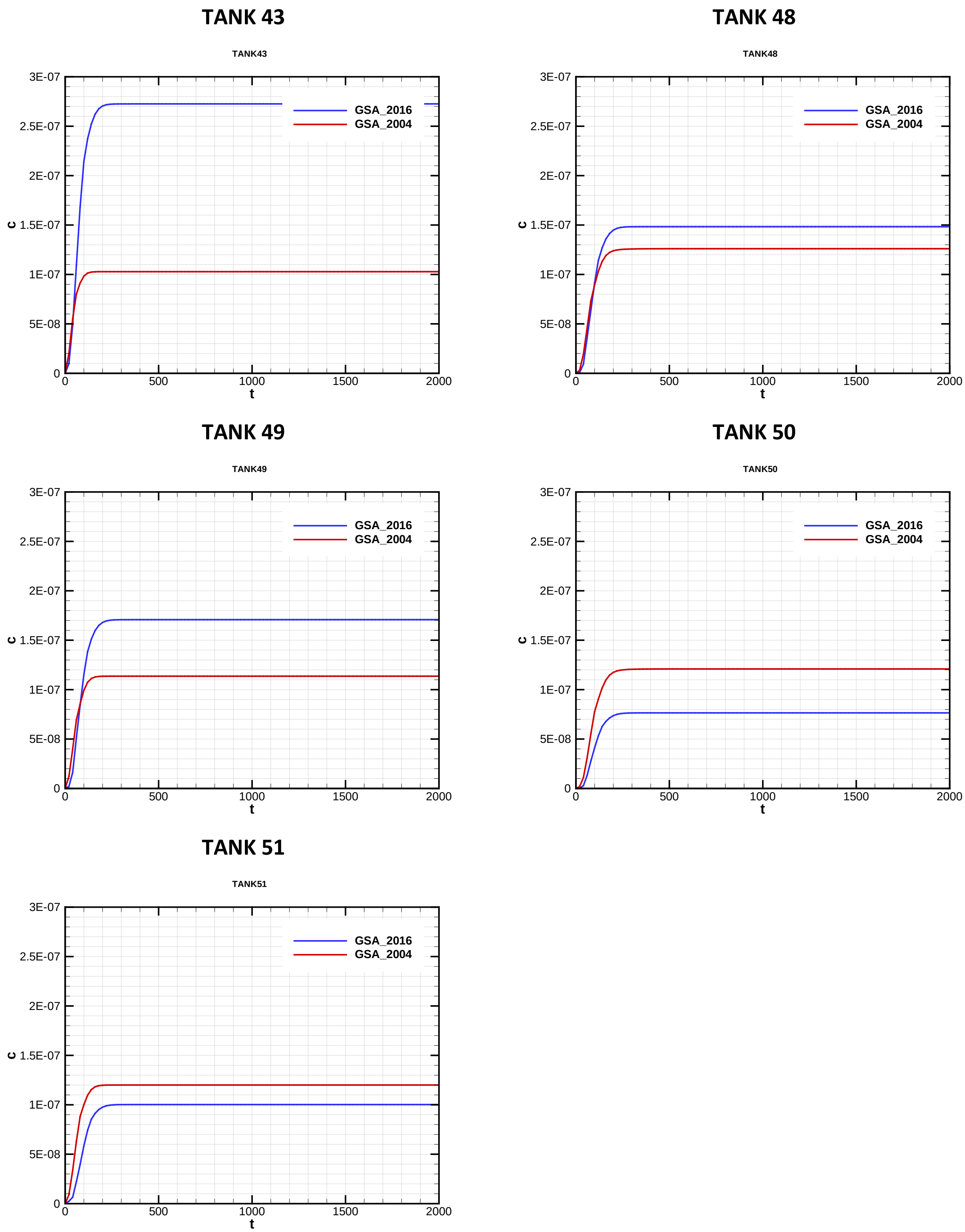
Note: Concentrations are monitored at 100-meter boundary

Figure 17. Comparison of HTF Steady-State Source Concentrations (concentration, C in Ci/L, time, t in years) (cont'd)



Note: Concentrations are monitored at 100-meter boundary

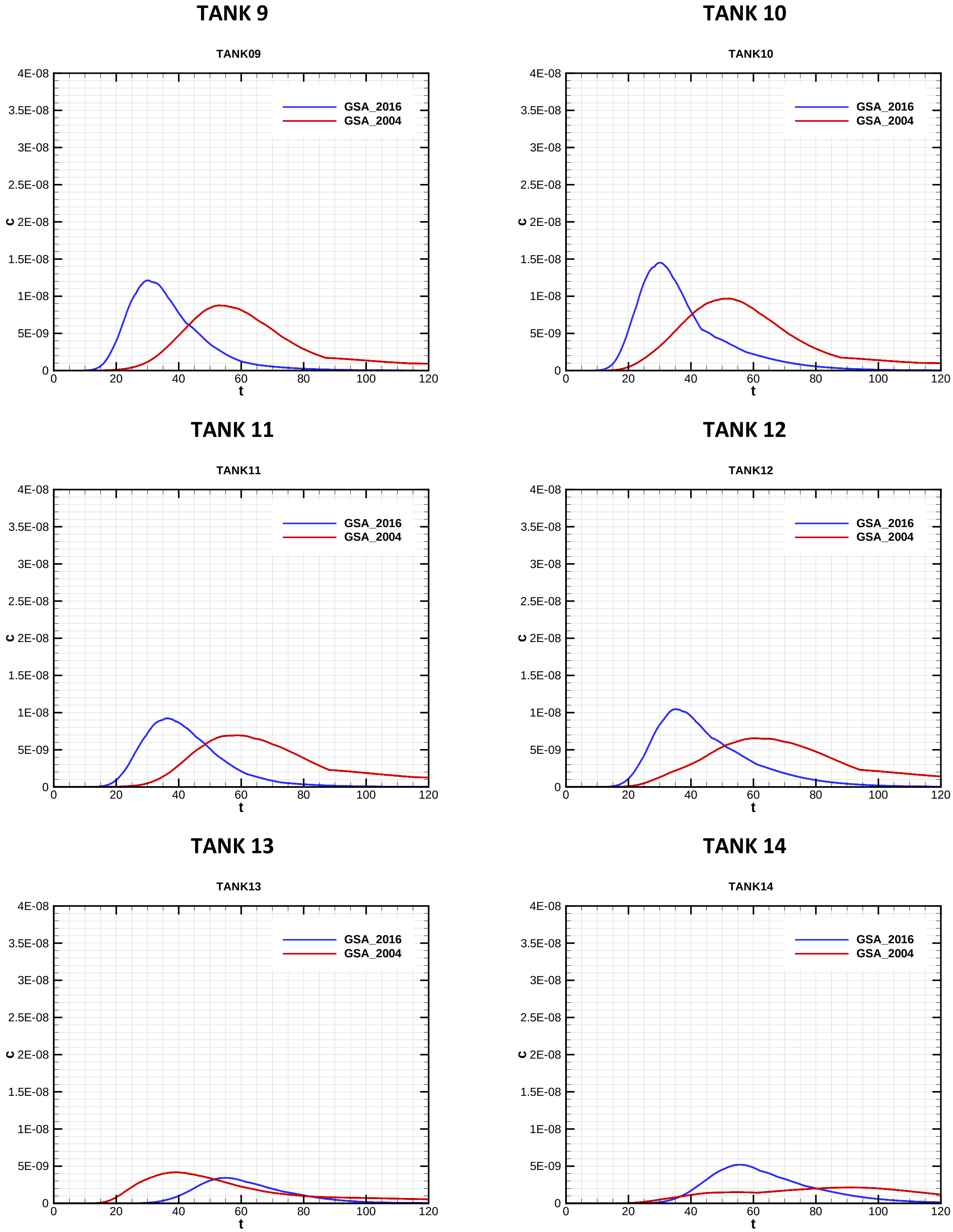
Figure 17. Comparison of HTF Steady-State Source Concentrations (concentration, C in Ci/L, time, t in years) (cont'd)



Note: Concentrations are monitored at 100-meter boundary

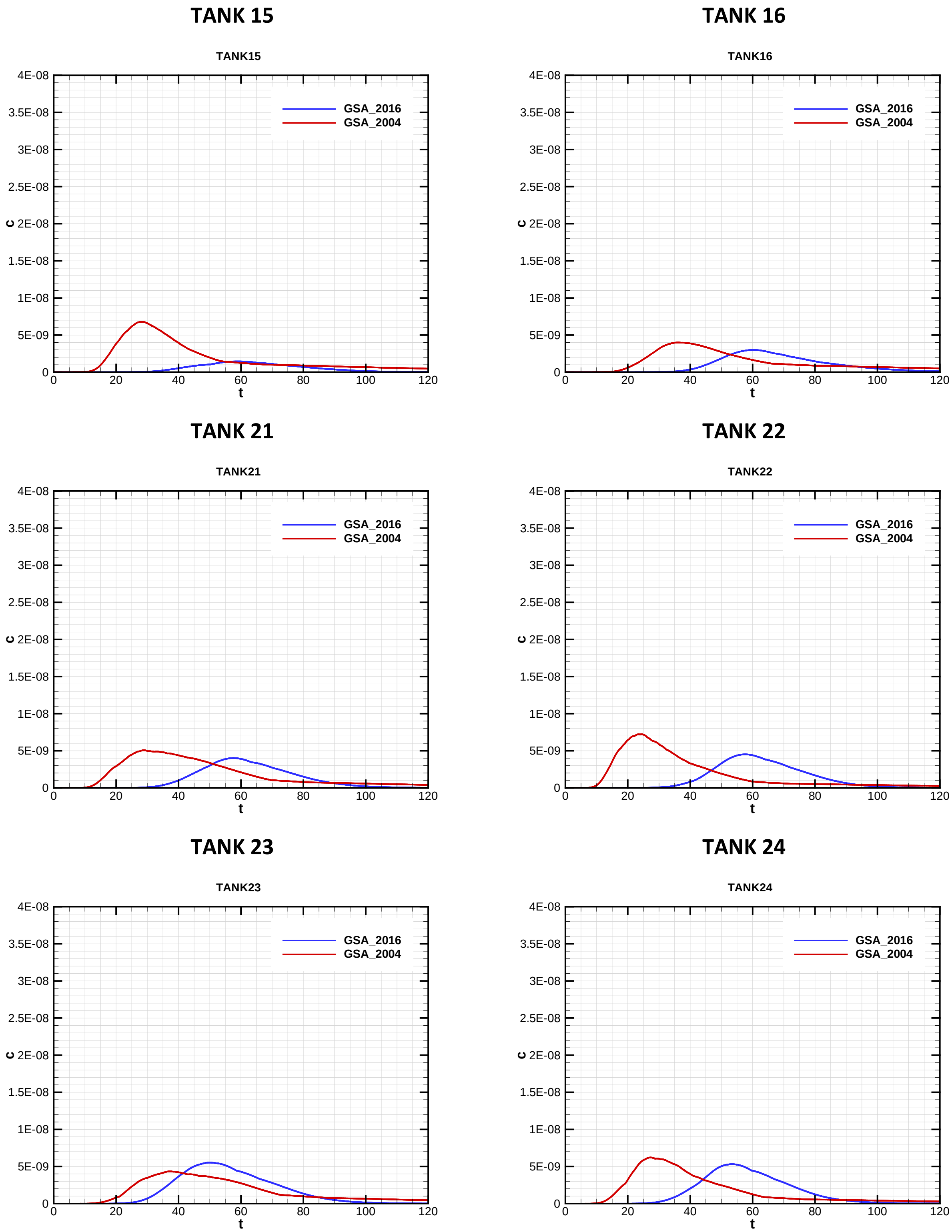
Figure 17. Comparison of HTF Steady-State Source Concentrations (concentration, C in Ci/L, time, t in years) (cont'd)

3.2.2.2 Transient/Pulsed Sources



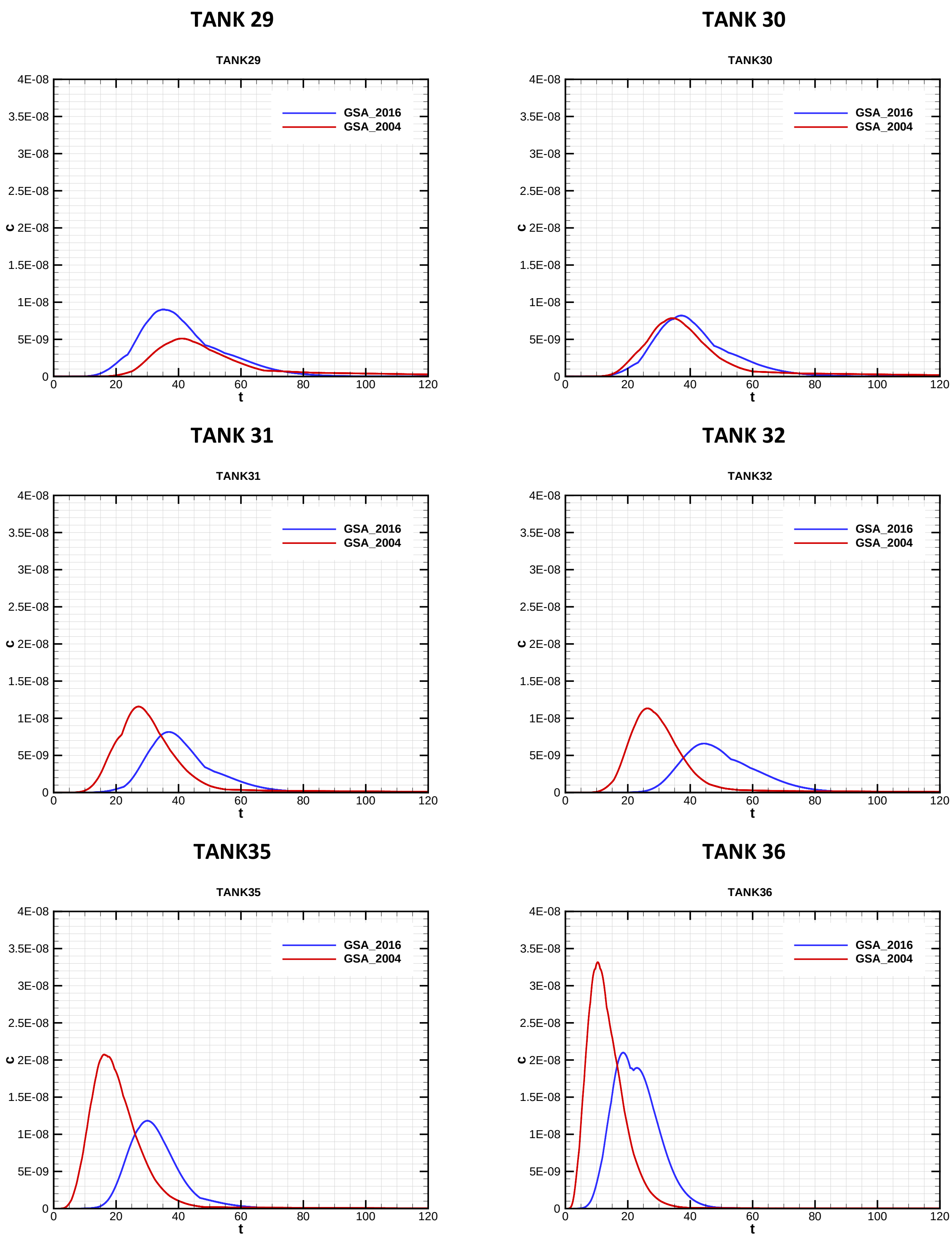
Note: Concentrations are monitored at 100-meter boundary

Figure 18. Comparison of HTF Pulsed Source Concentrations (conc., C in Ci/L, time, t in years)



Note: Concentrations are monitored at 100-meter boundary

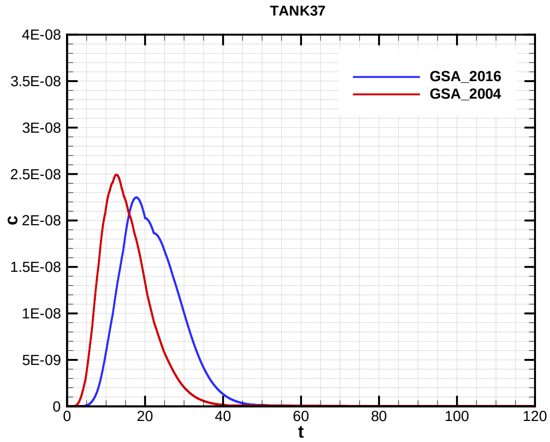
Figure 18. Comparison of HTF Pulsed Source Concentrations (concentration, C in Ci/L, time, t in years) (cont'd)



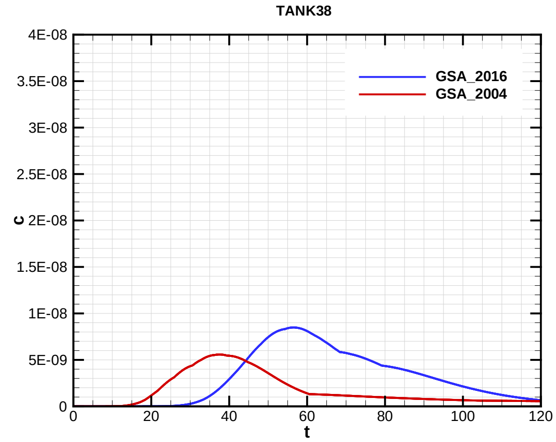
Note: Concentrations are monitored at 100-meter boundary

Figure 18. Comparison of HTF Pulsed Source Concentrations (concentration, C in Ci/L, time, t in years) (cont'd)

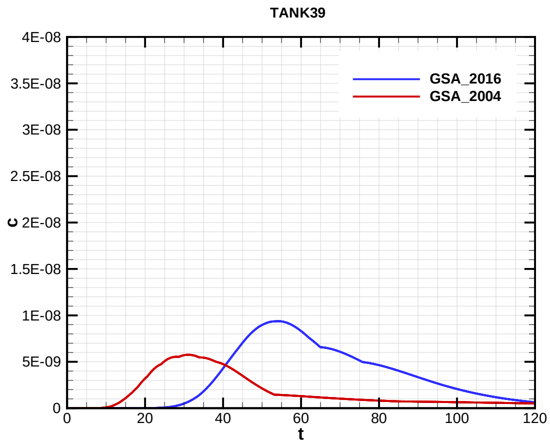
TANK 37



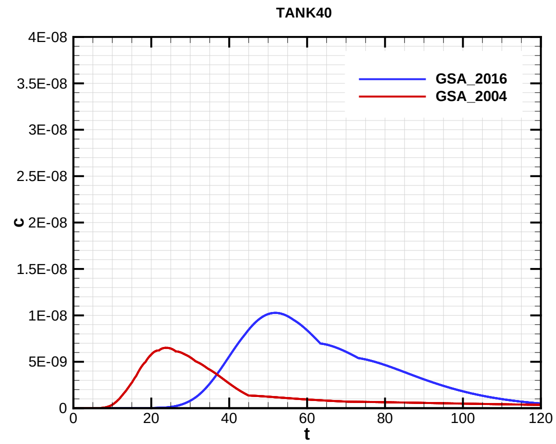
TANK 38



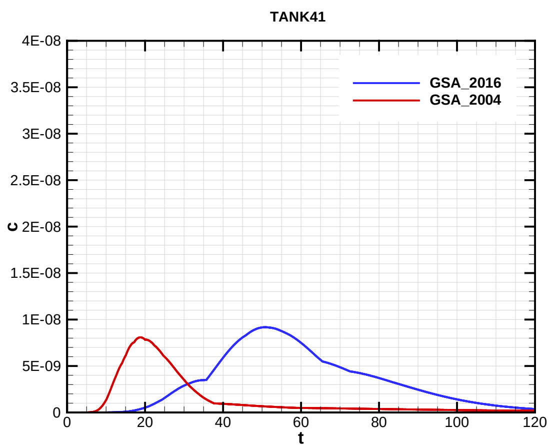
TANK 39



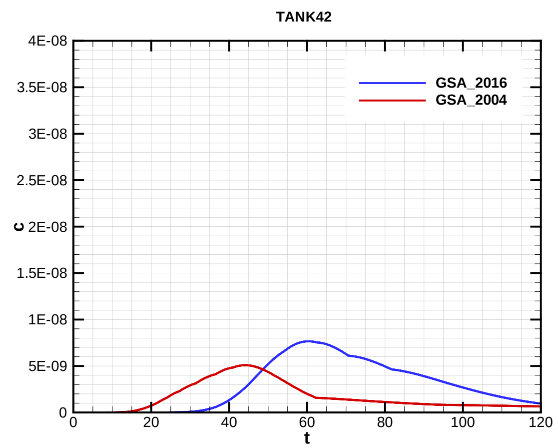
TANK 40



TANK 41



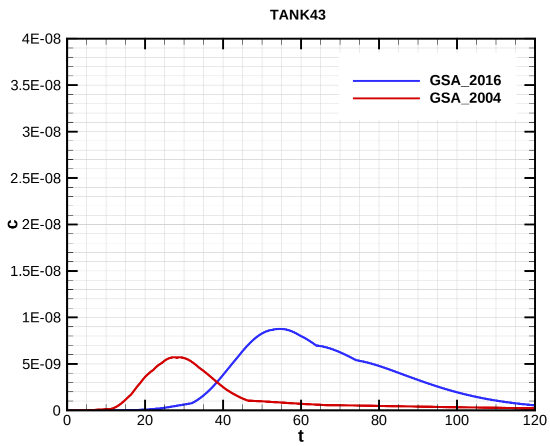
TANK 42



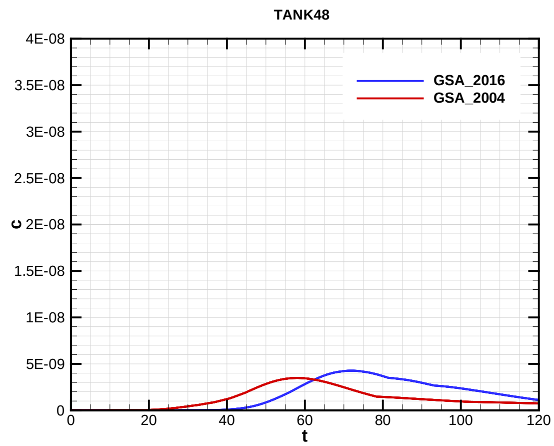
Note: Concentrations are monitored at 100-meter boundary

Figure 18. Comparison of HTF Pulsed Source Concentrations (concentration, C in Ci/L, time, t in years) (cont'd)

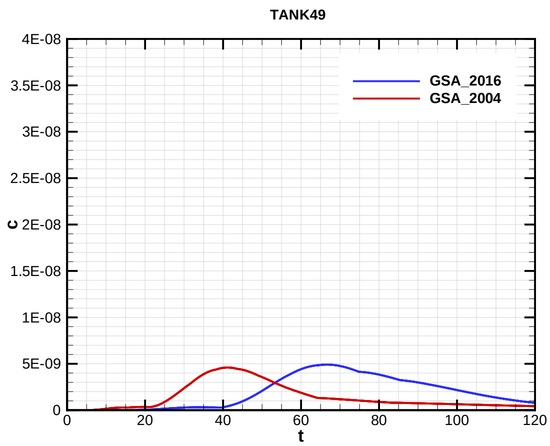
TANK 43



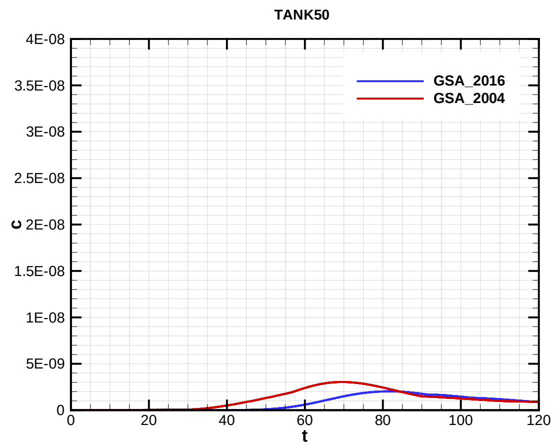
TANK 48



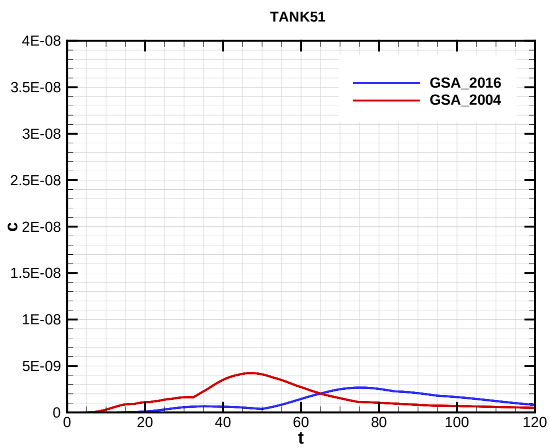
TANK 49



TANK 50



TANK 51



Note: Concentrations are monitored at 100-meter boundary

Figure 18. Comparison of HTF Pulsed Source Concentrations (concentration, C in Ci/L, time, t in years) (cont'd)

3.2.3 Evaluation Case Transport Simulations

3.2.3.1 Concentrations at 100-meter Boundary

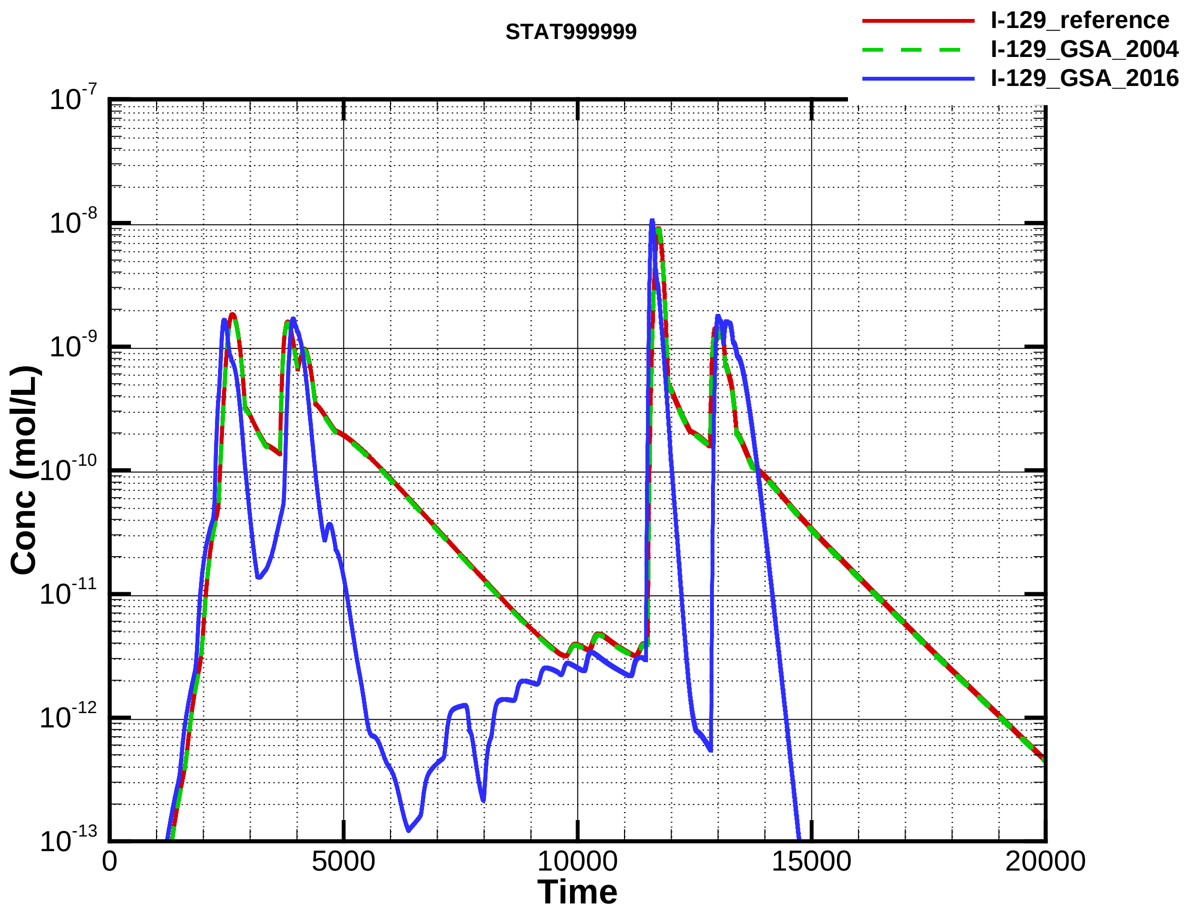


Figure 19. HTF I-129 Concentrations at 100-meter Boundary (Time in years)

3.2.3.2 Concentrations at the Seepline

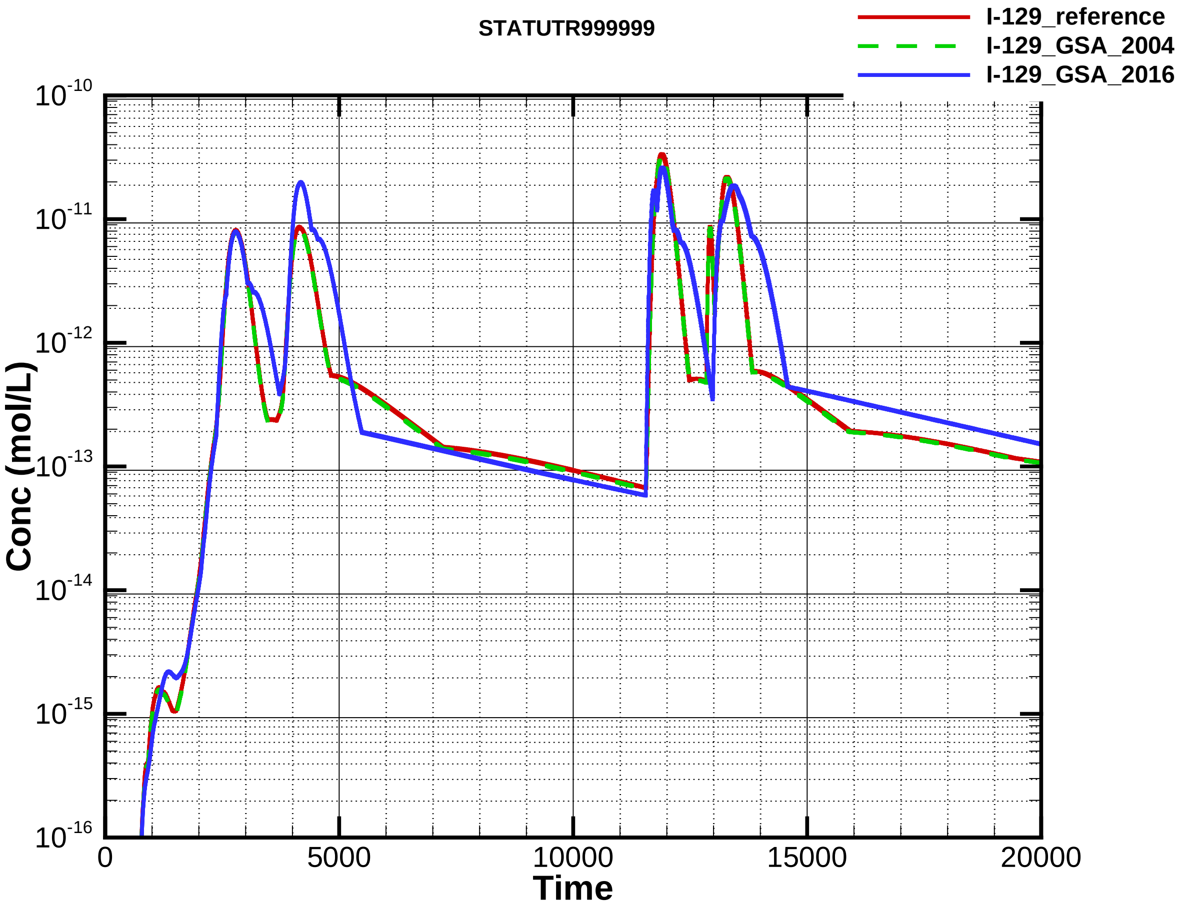


Figure 20. HTF I-129 Concentrations at the Seepline (Time in years)

3.3 F-Area Tank Farm

3.3.1 Streamtraces with Timing Markers

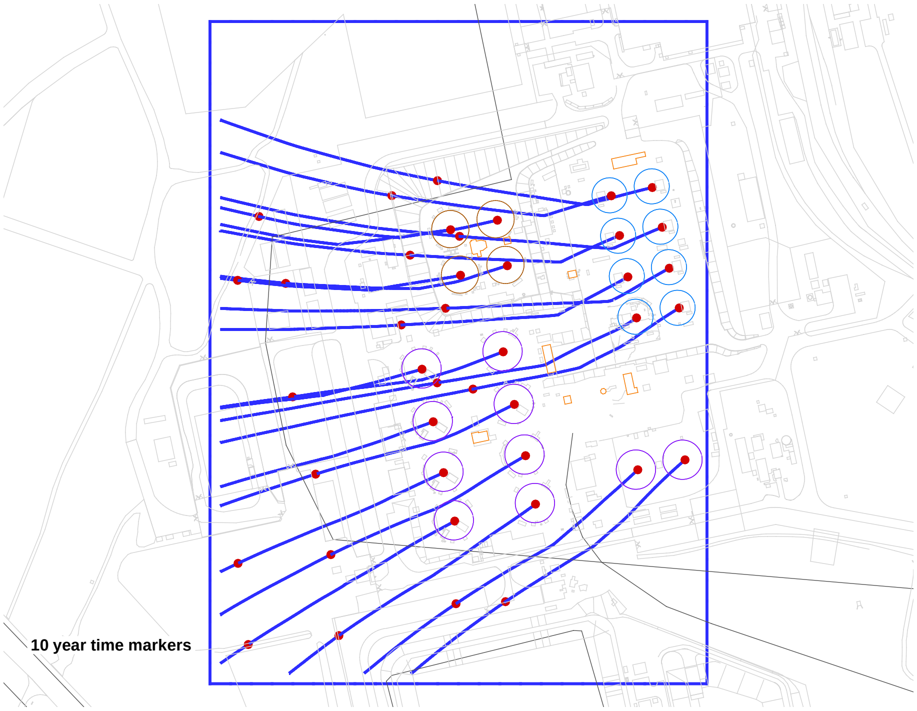


Figure 21. FTF GSA_2004 Streamtraces with Timing Markers

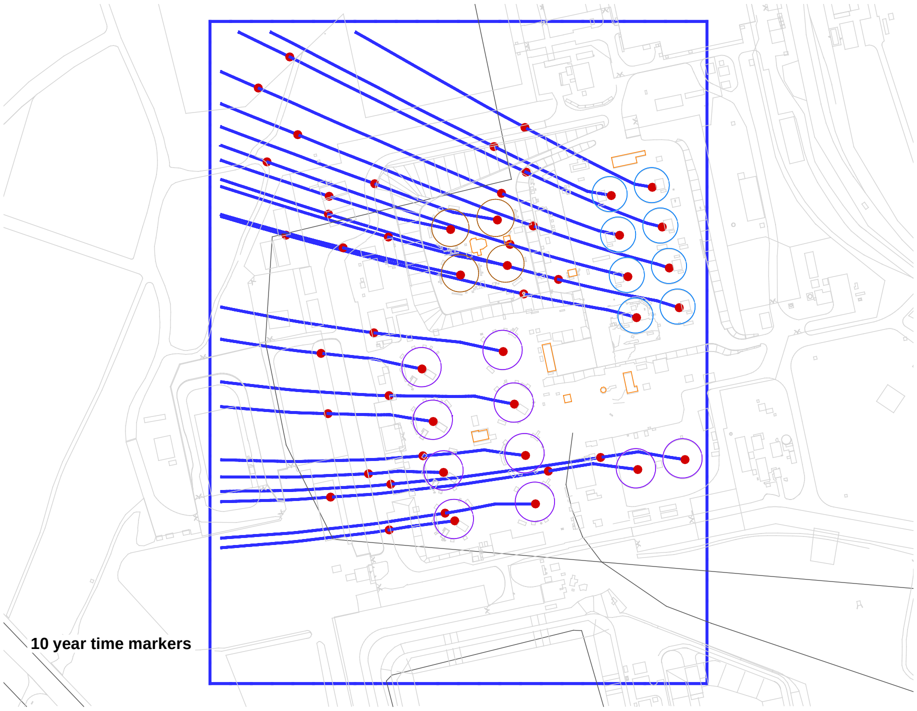


Figure 22. FTF GSA_2016 Streamtraces with Timing Markers

3.3.2 Tracer Plume Simulations

3.3.2.1 Steady-State Sources

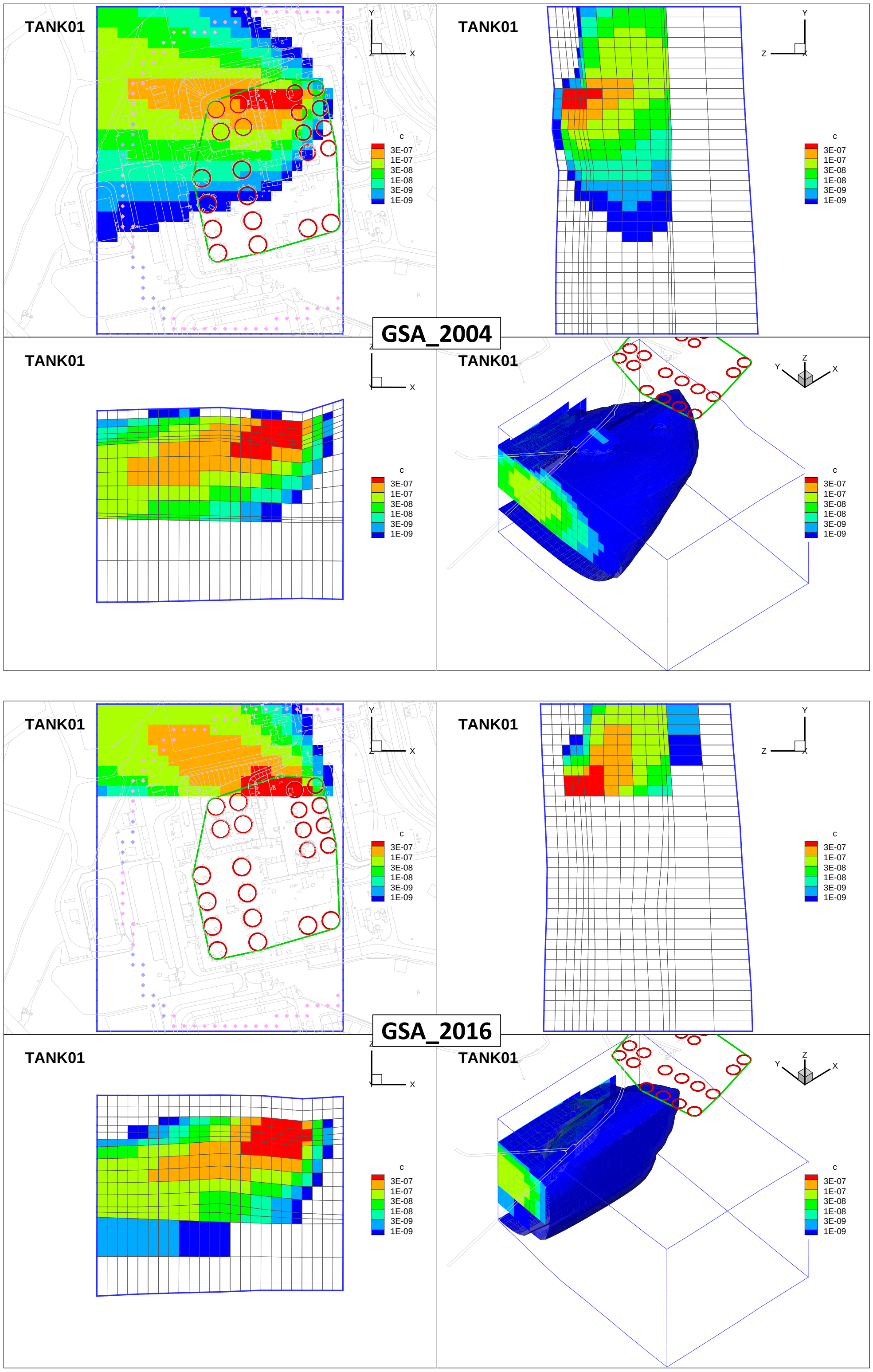


Figure 23. Steady-State Plumes for Tank 01 (concentration, C in Ci/L)

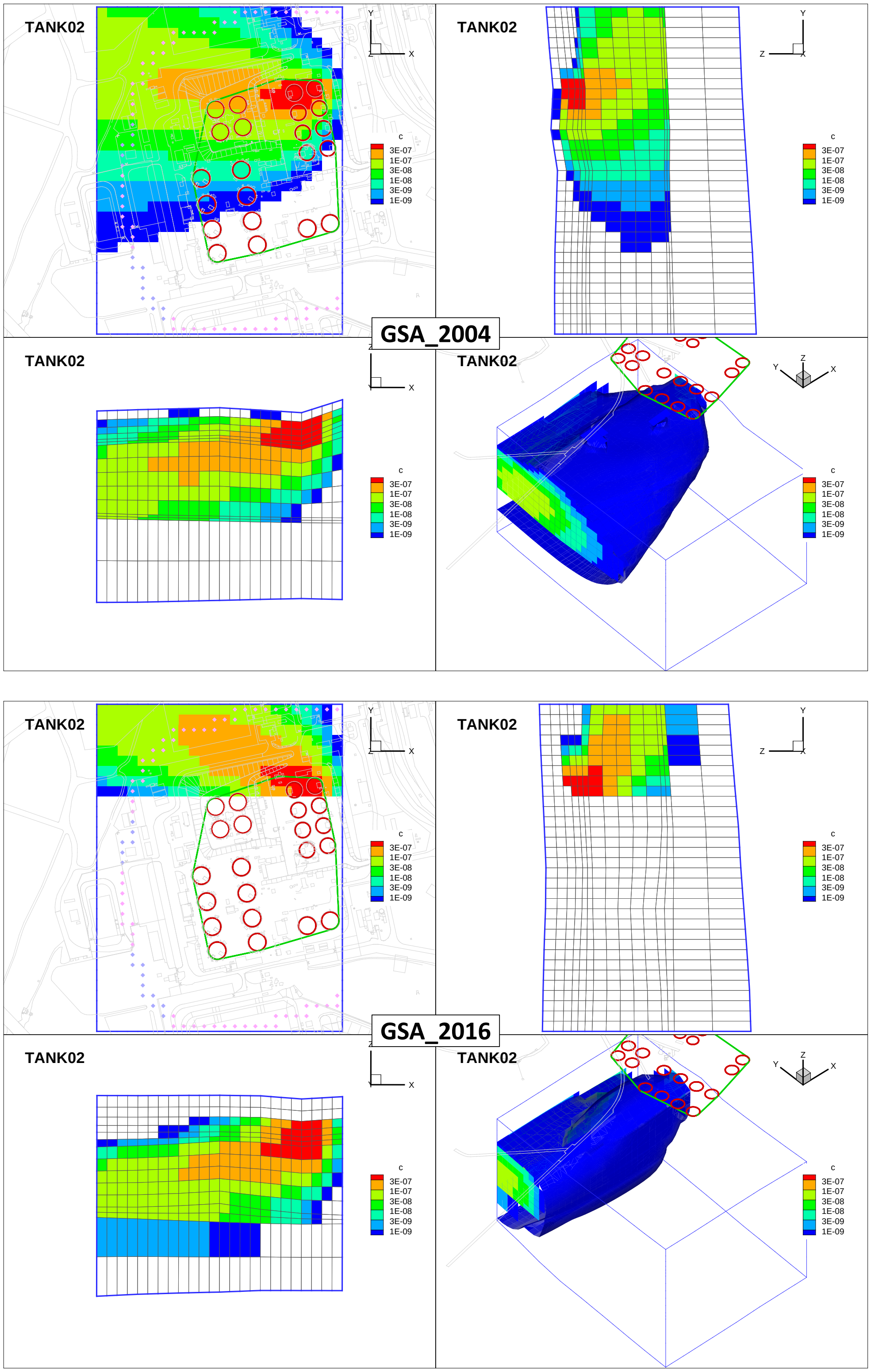


Figure 24. Steady-State Plumes for Tank 02 (concentration, C in Ci/L)

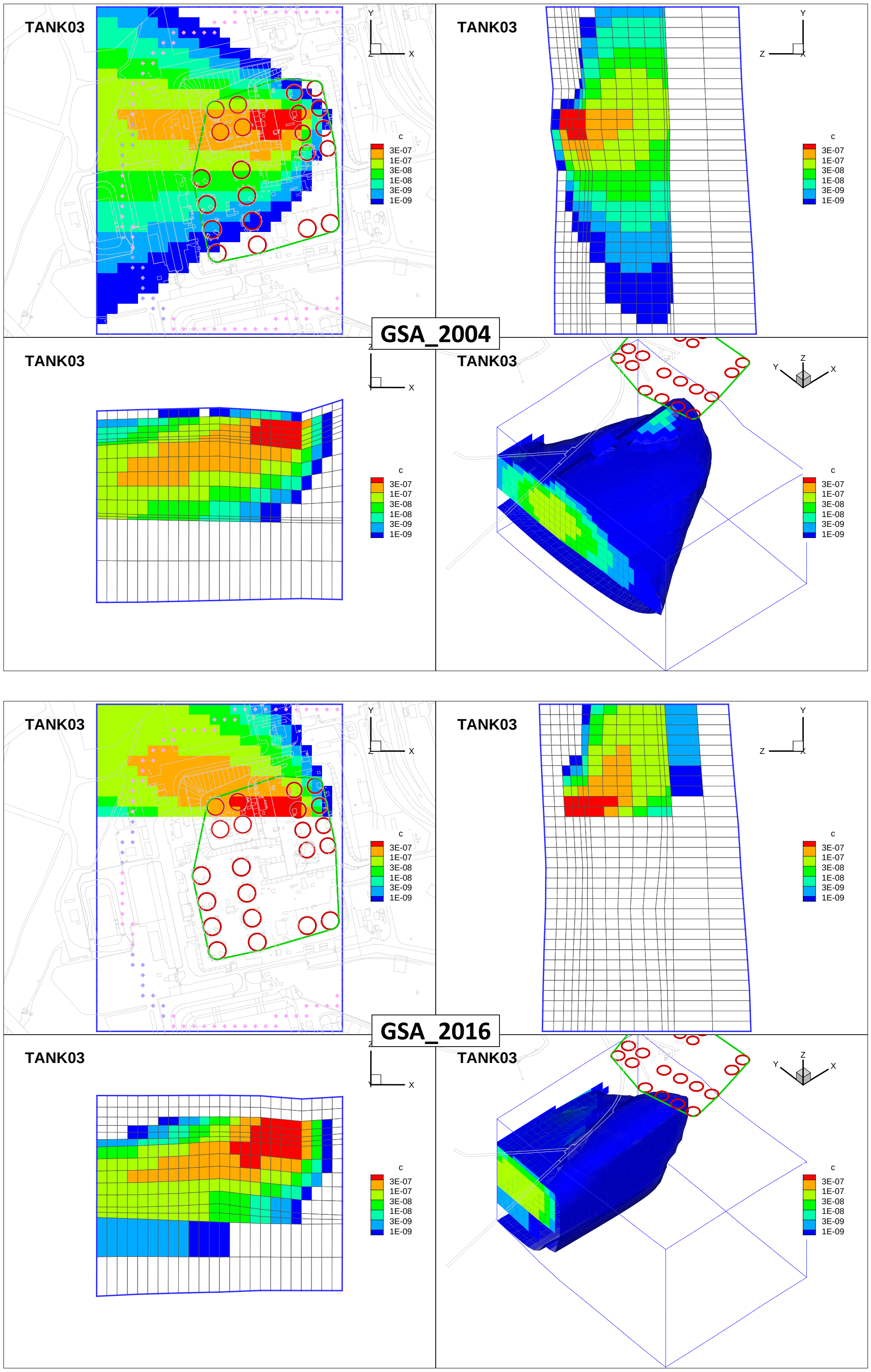


Figure 25. Steady-State Plumes for Tank 03 (concentration, C in Ci/L)

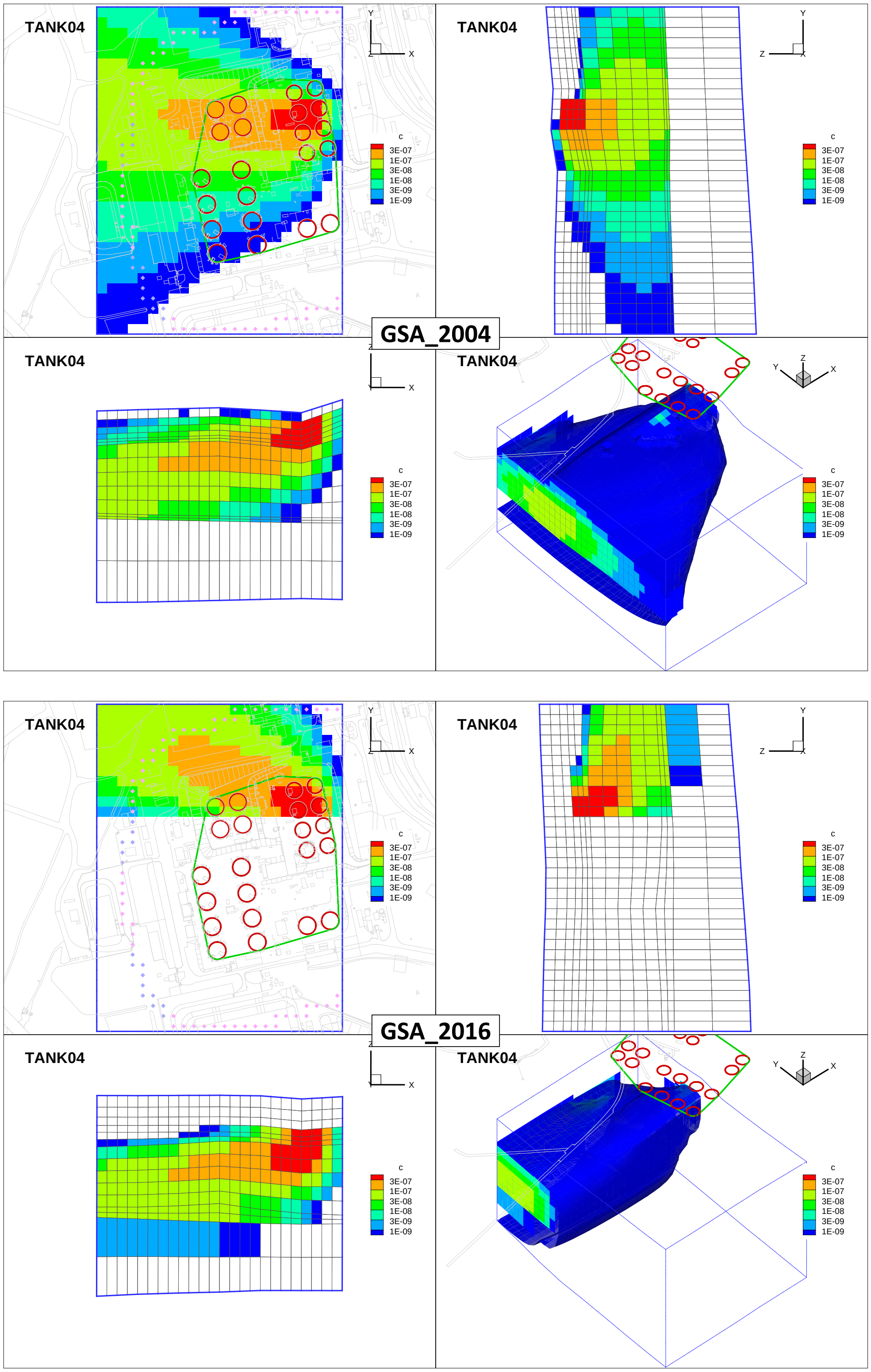


Figure 26. Steady-State Plumes for Tank 04 (concentration, C in Ci/L)

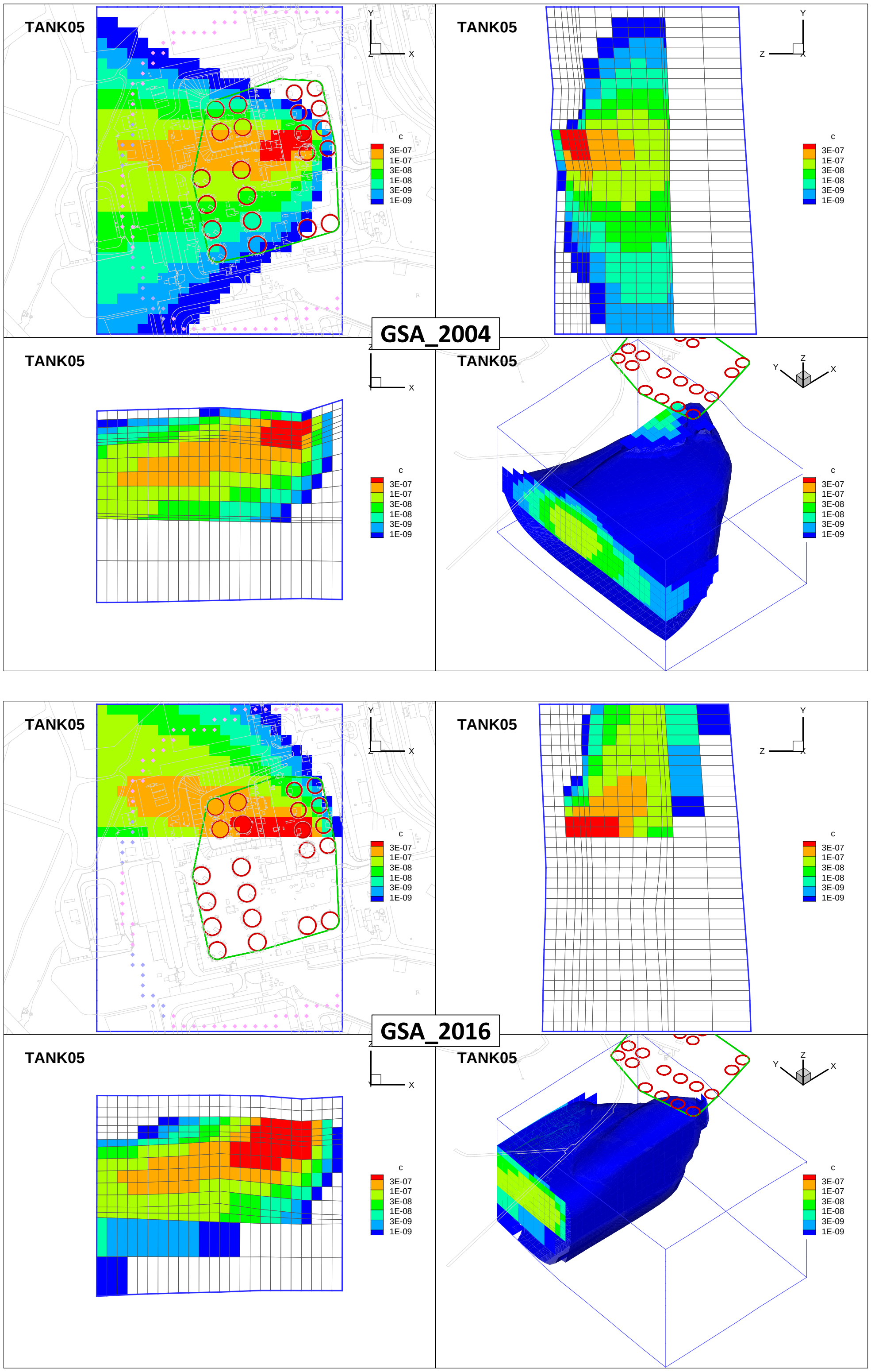


Figure 27. Steady-State Plumes for Tank 05 (concentration, C in Ci/L)

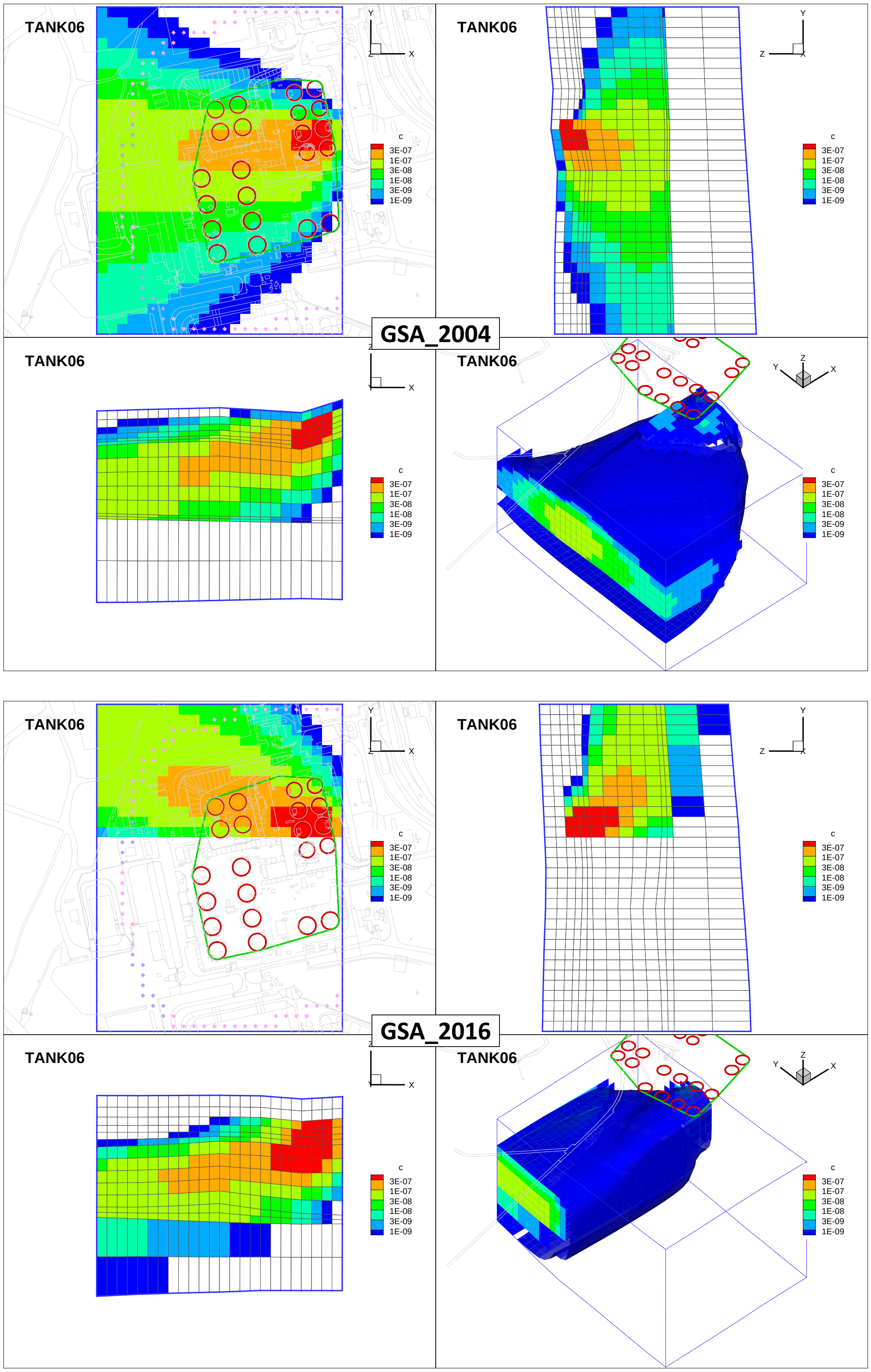


Figure 28. Steady-State Plumes for Tank 06 (concentration, C in Ci/L)

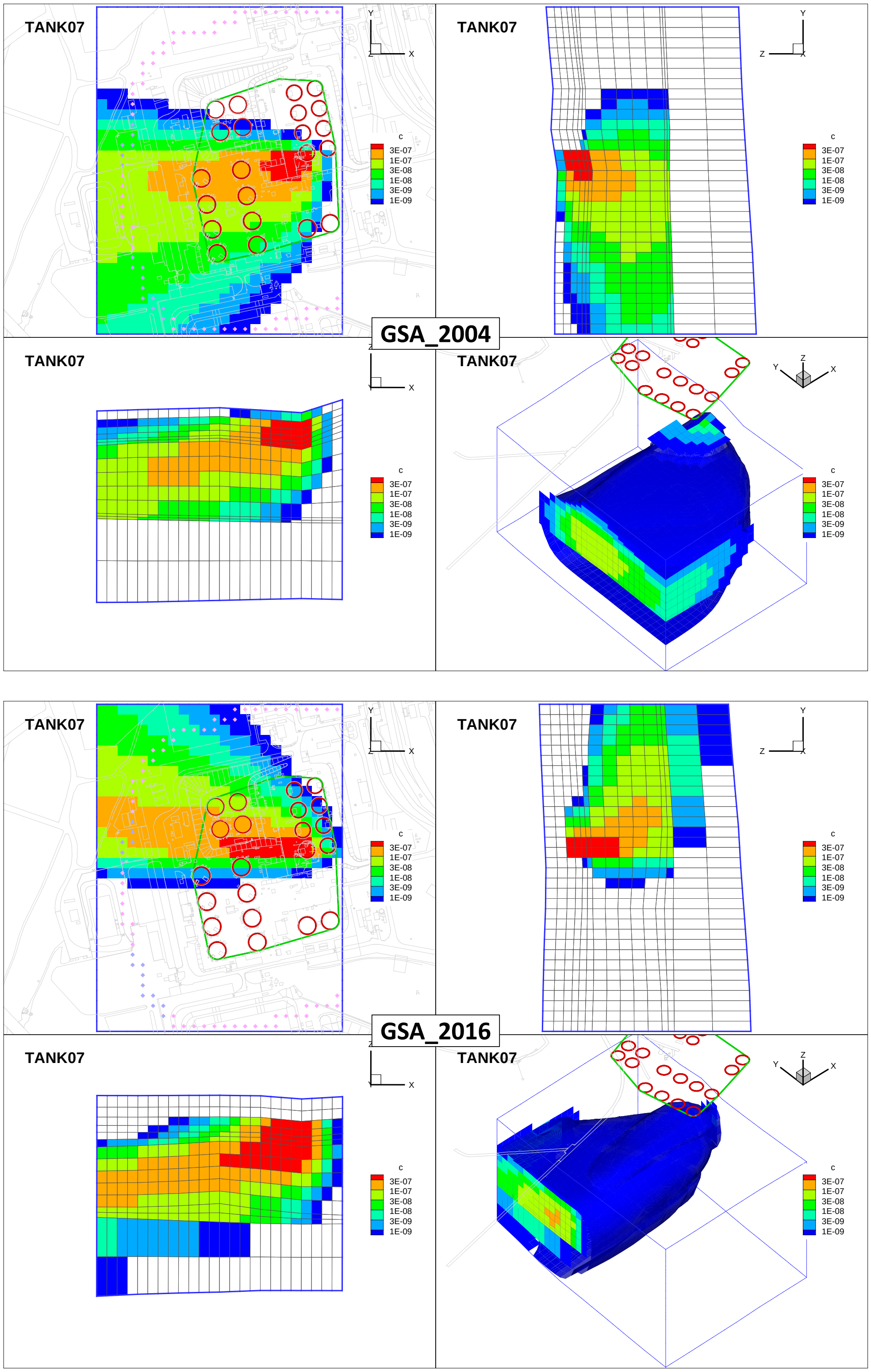


Figure 29. Steady-State Plumes for Tank 07 (concentration, C in Ci/L)

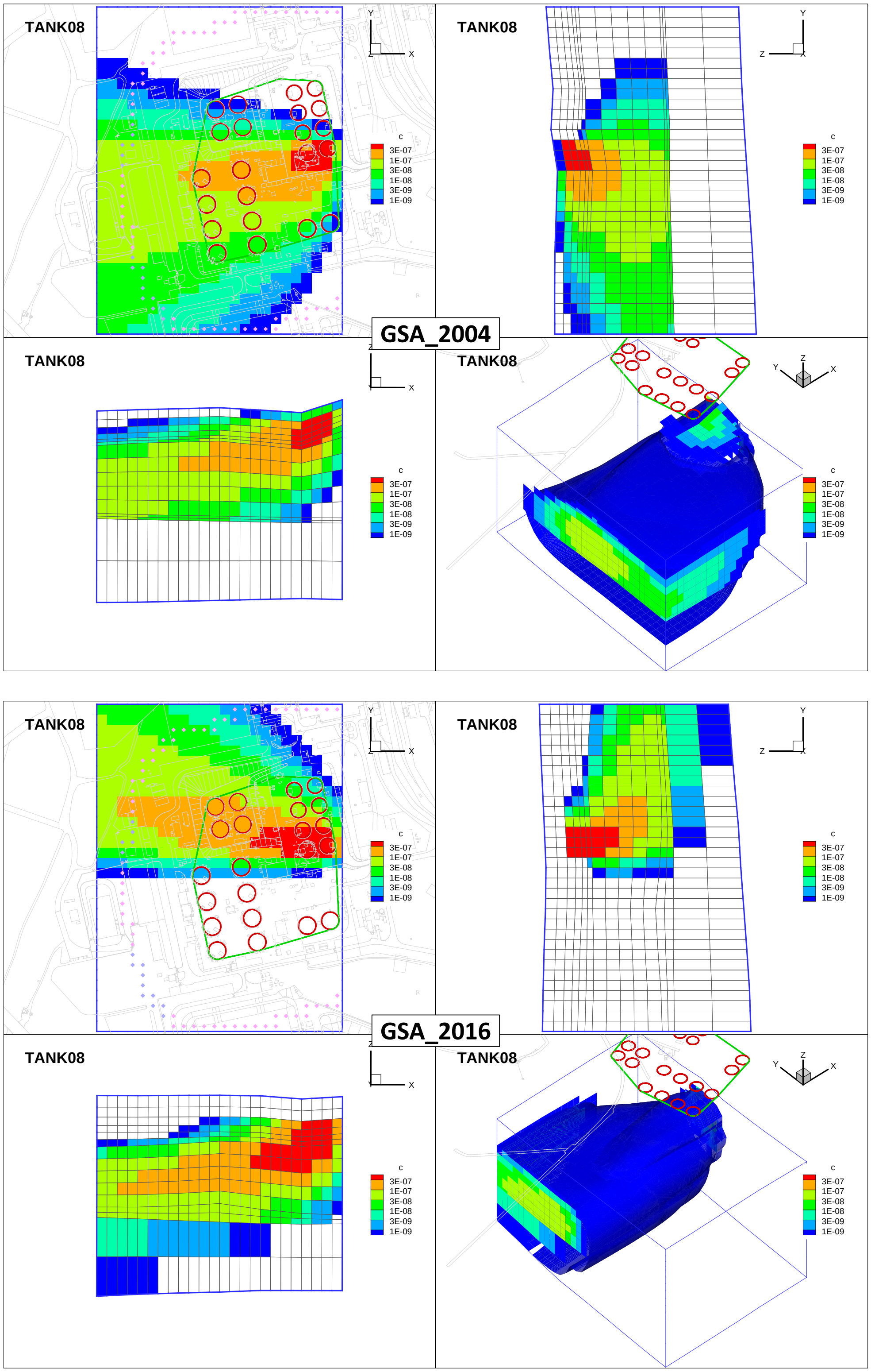


Figure 30. Steady-State Plumes for Tank 08 (concentration, C in Ci/L)

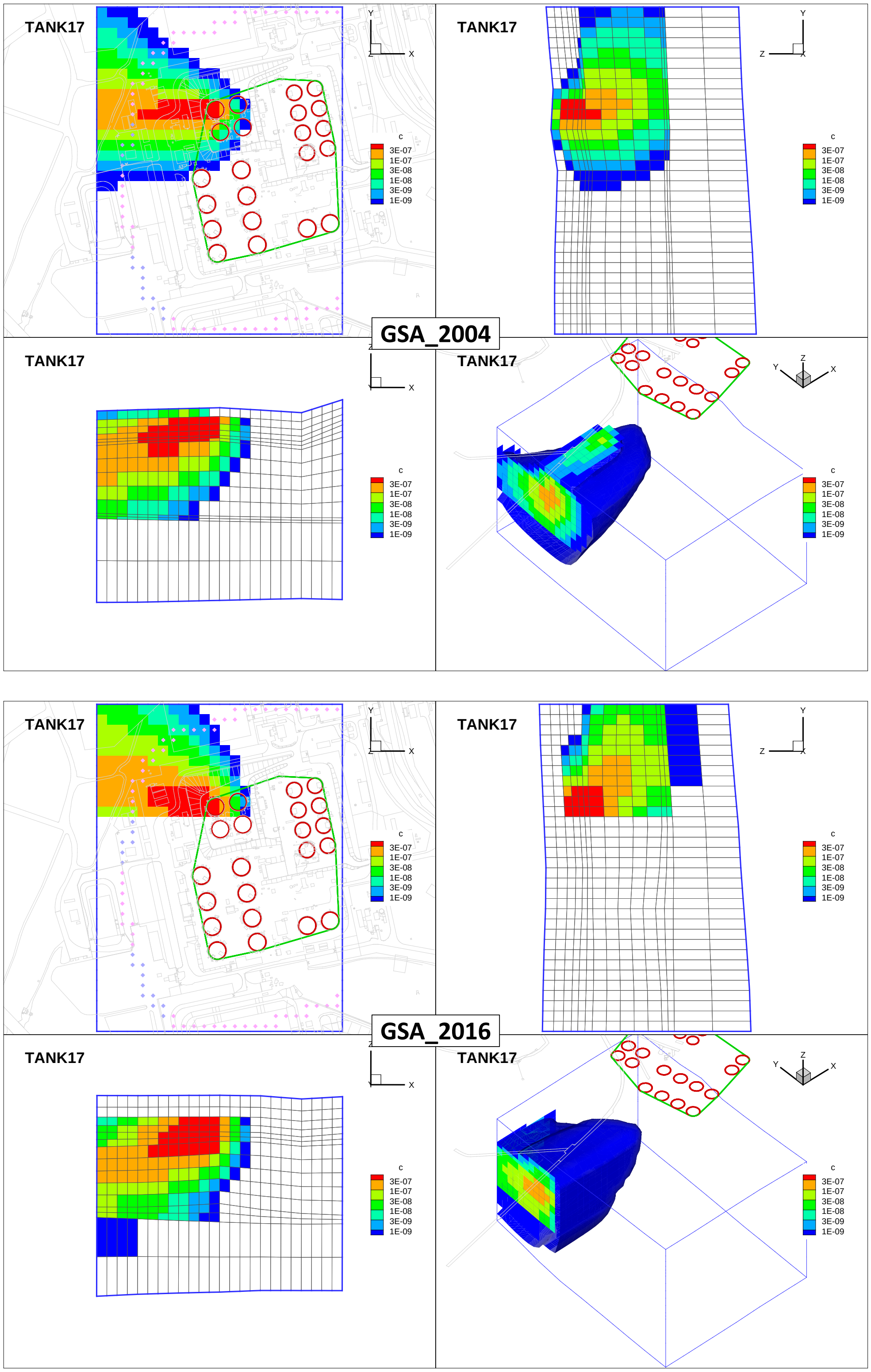


Figure 31. Steady-State Plumes for Tank 17 (concentration, C in Ci/L)

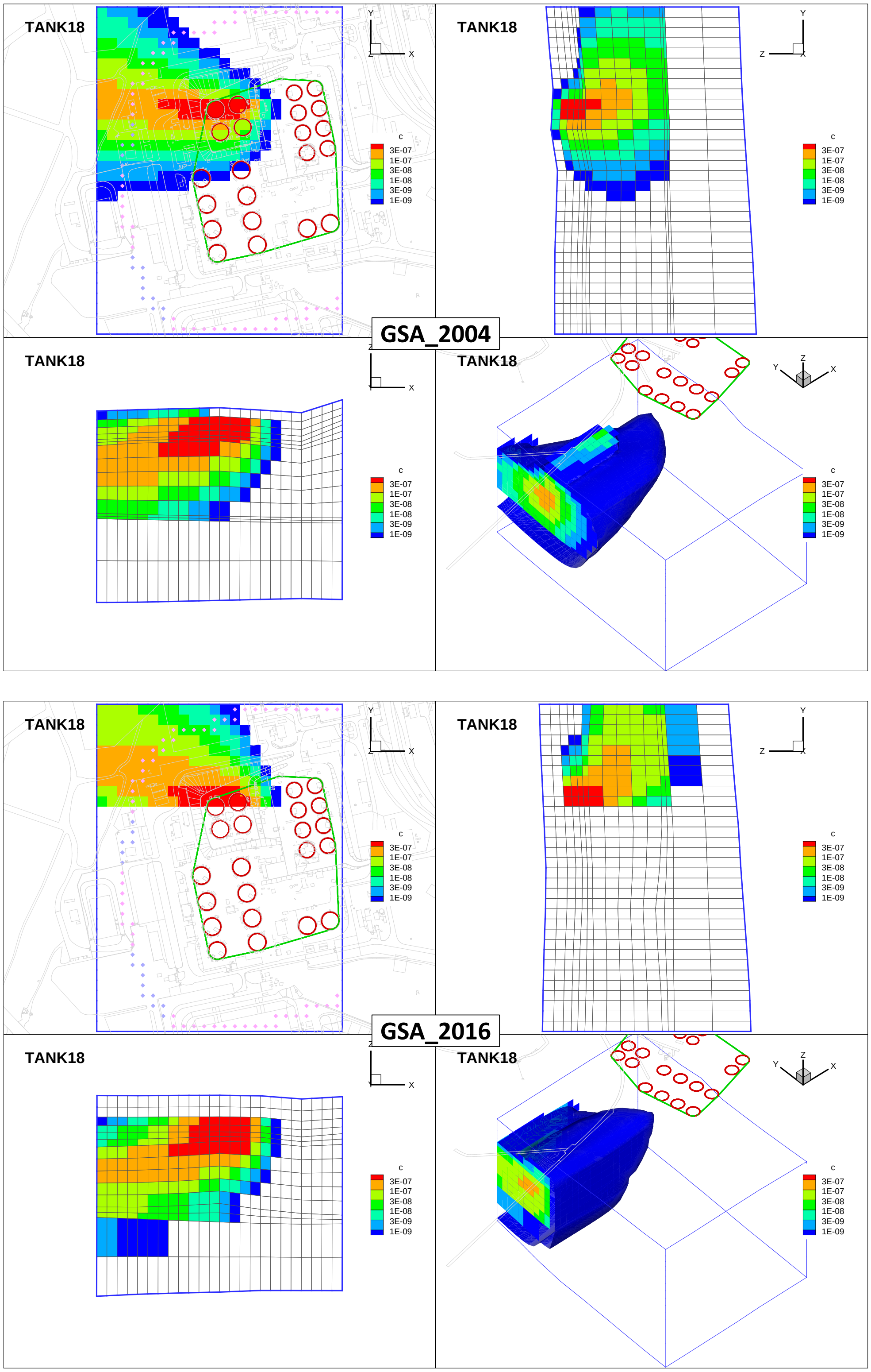


Figure 32. Steady-State Plumes for Tank 18 (concentration, C in Ci/L)

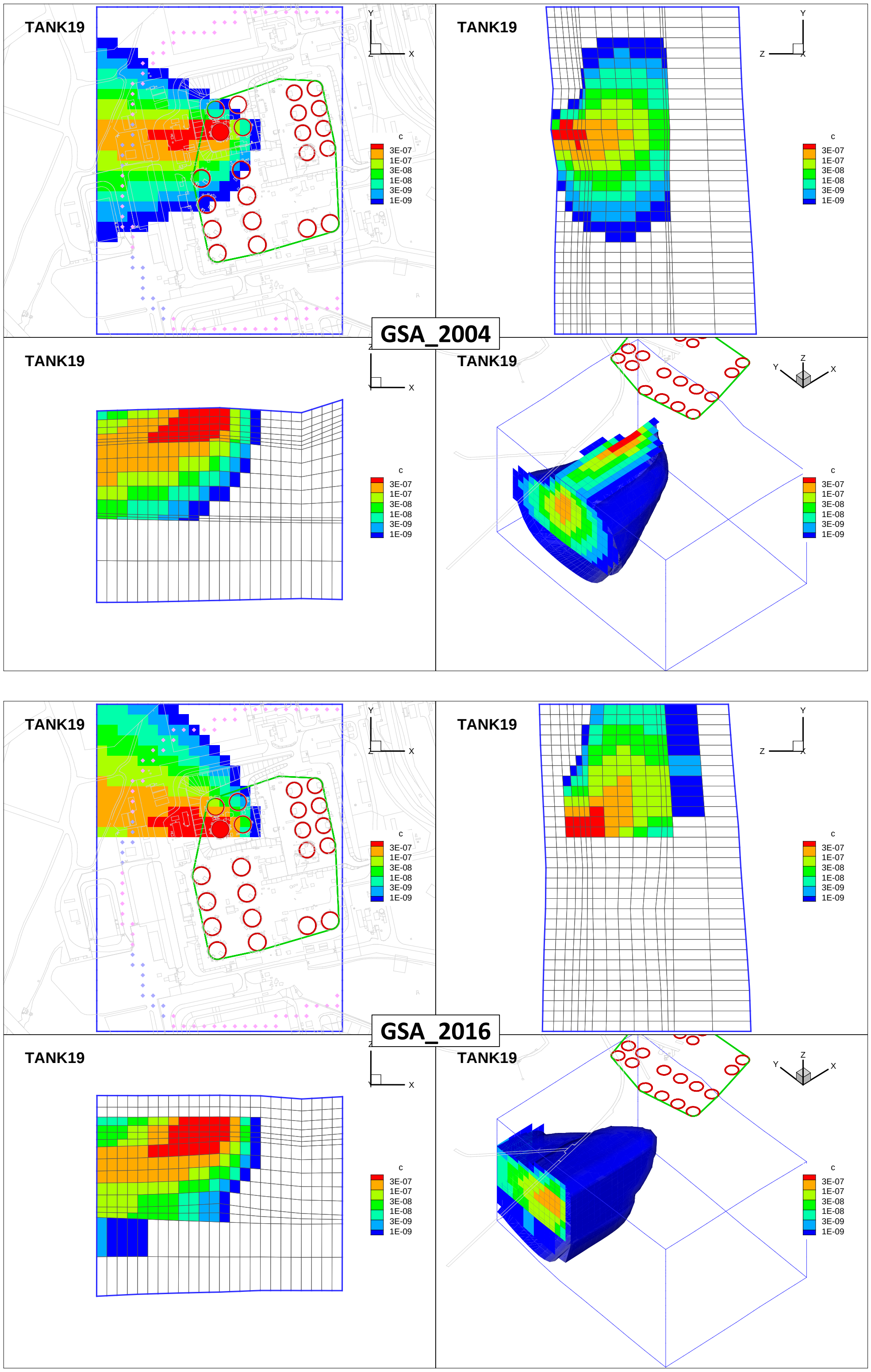


Figure 33. Steady-State Plumes for Tank 19 (concentration, C in Ci/L)

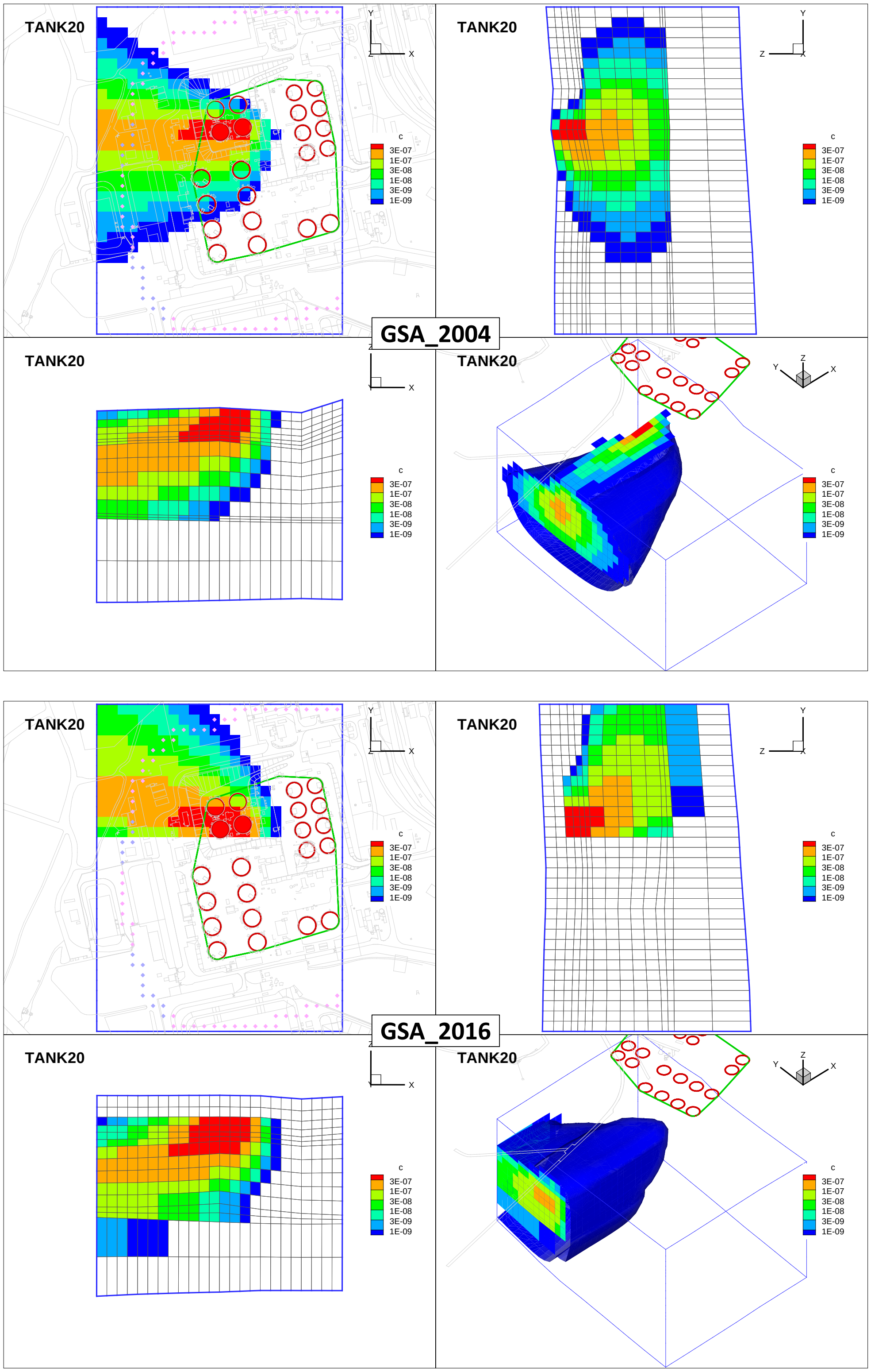


Figure 34. Steady-State Plumes for Tank 20 (concentration, C in Ci/L)

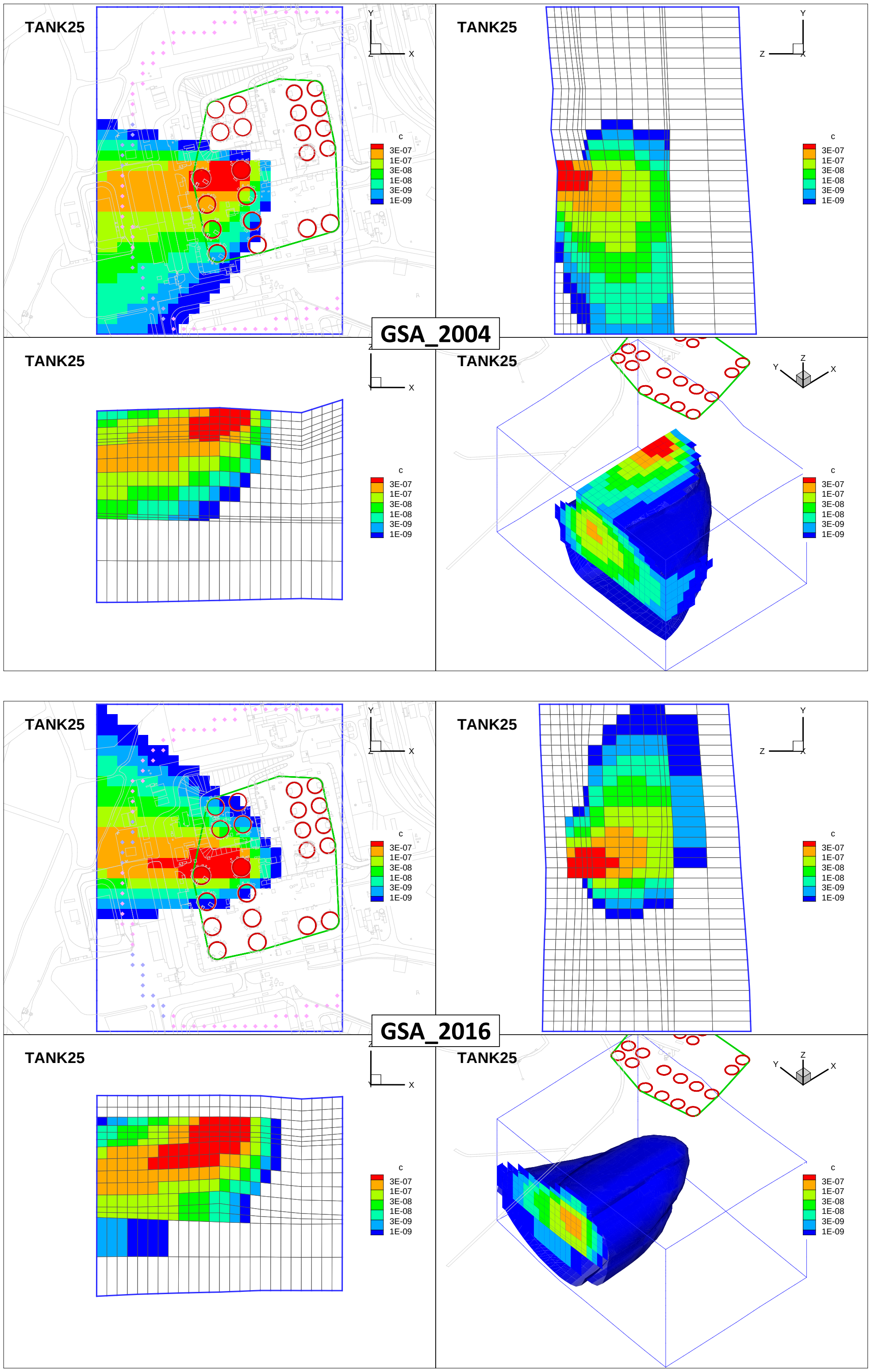


Figure 35. Steady-State Plumes for Tank 25 (concentration, C in Ci/L)

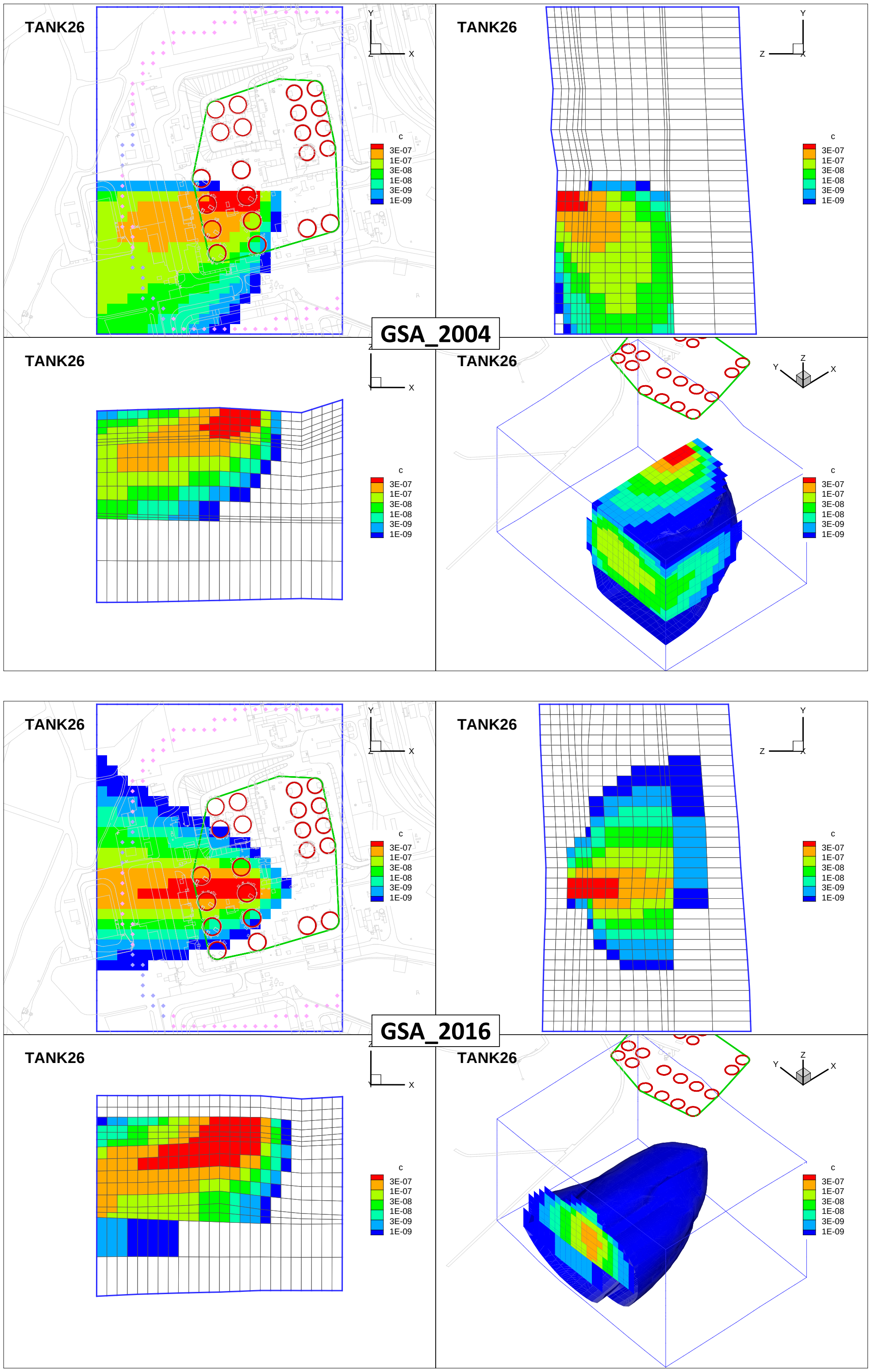


Figure 36. Steady-State Plumes for Tank 26 (concentration, C in Ci/L)

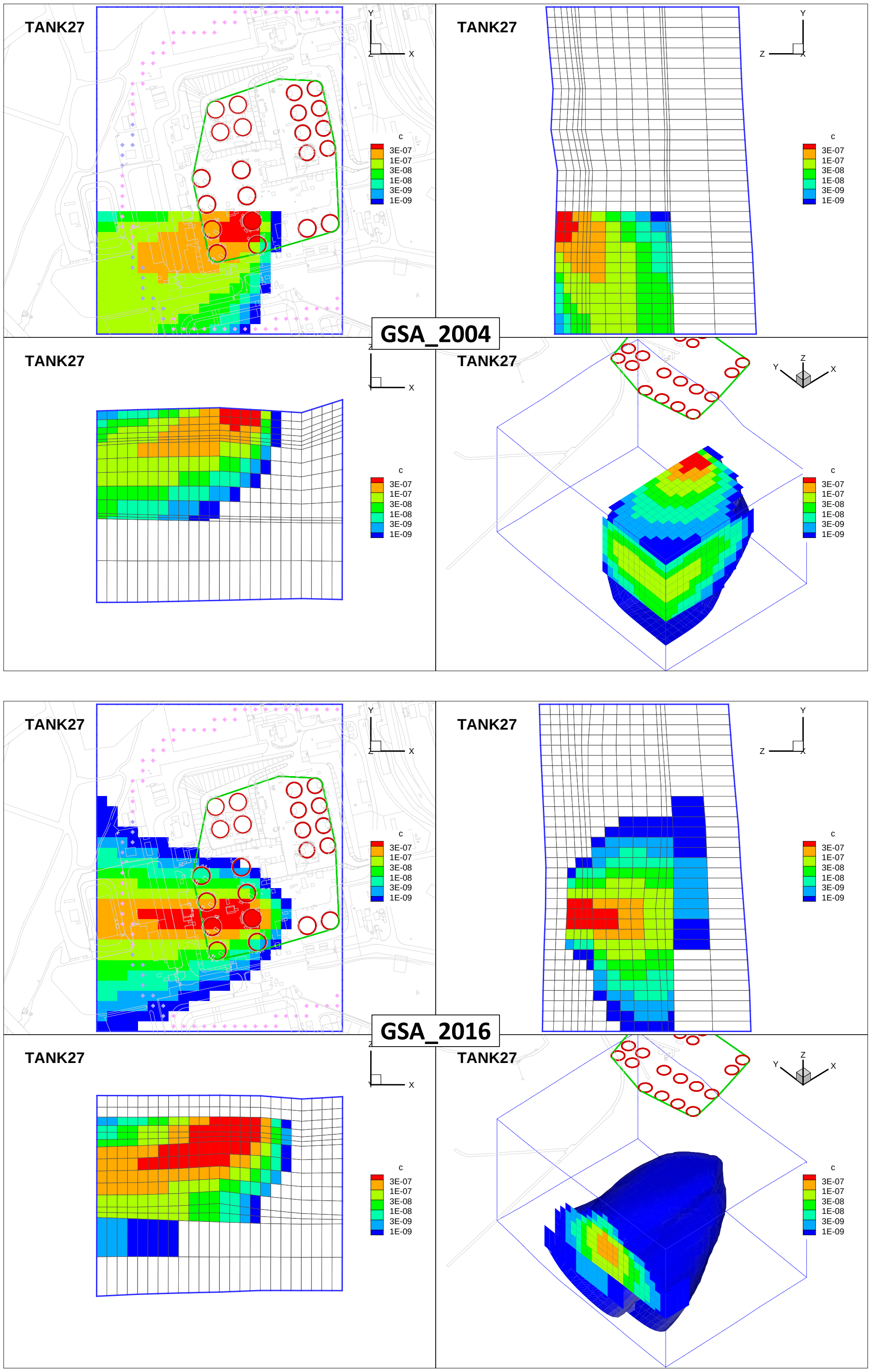


Figure 37. Steady-State Plumes for Tank 27 (concentration, C in Ci/L)

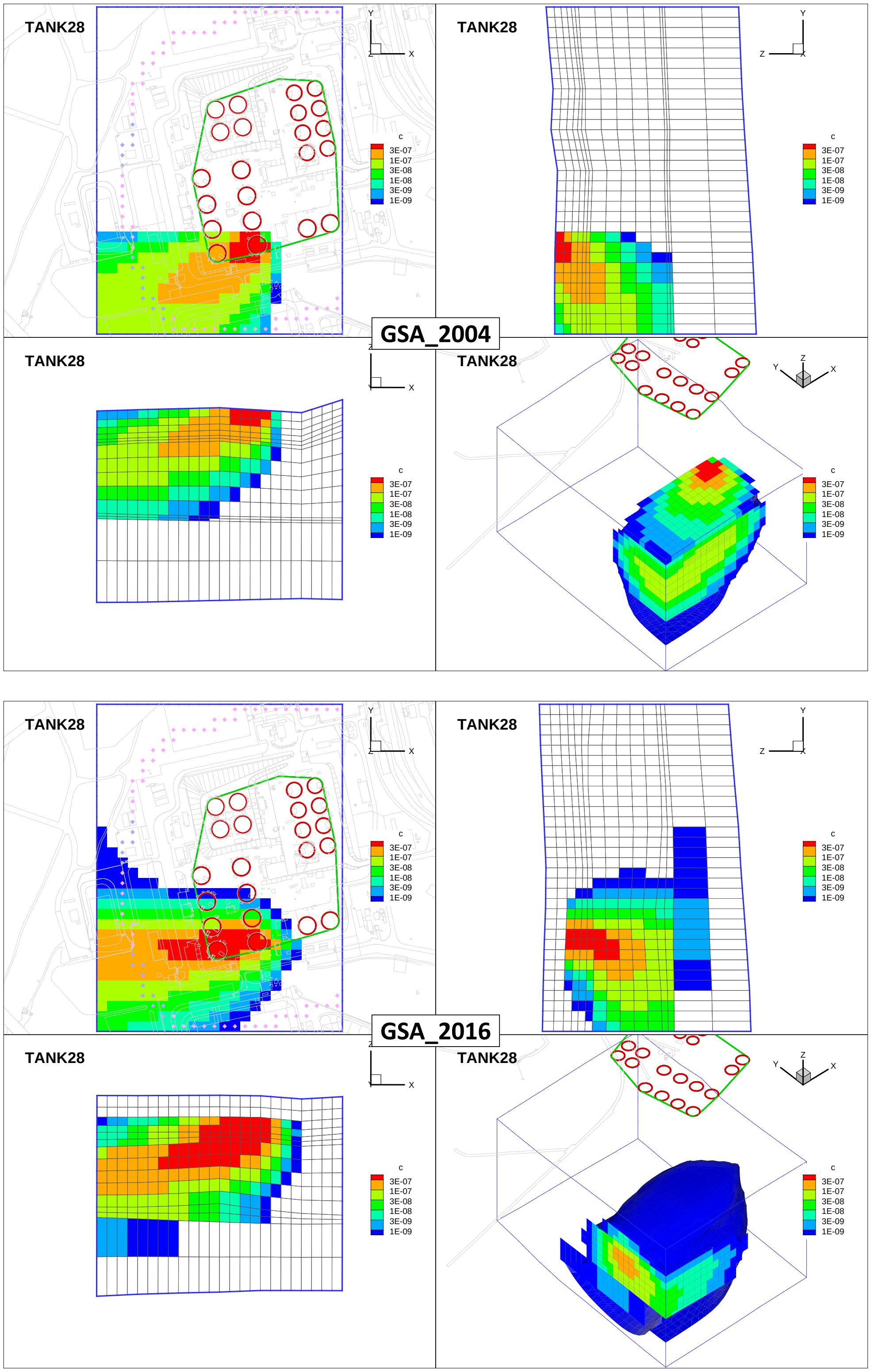
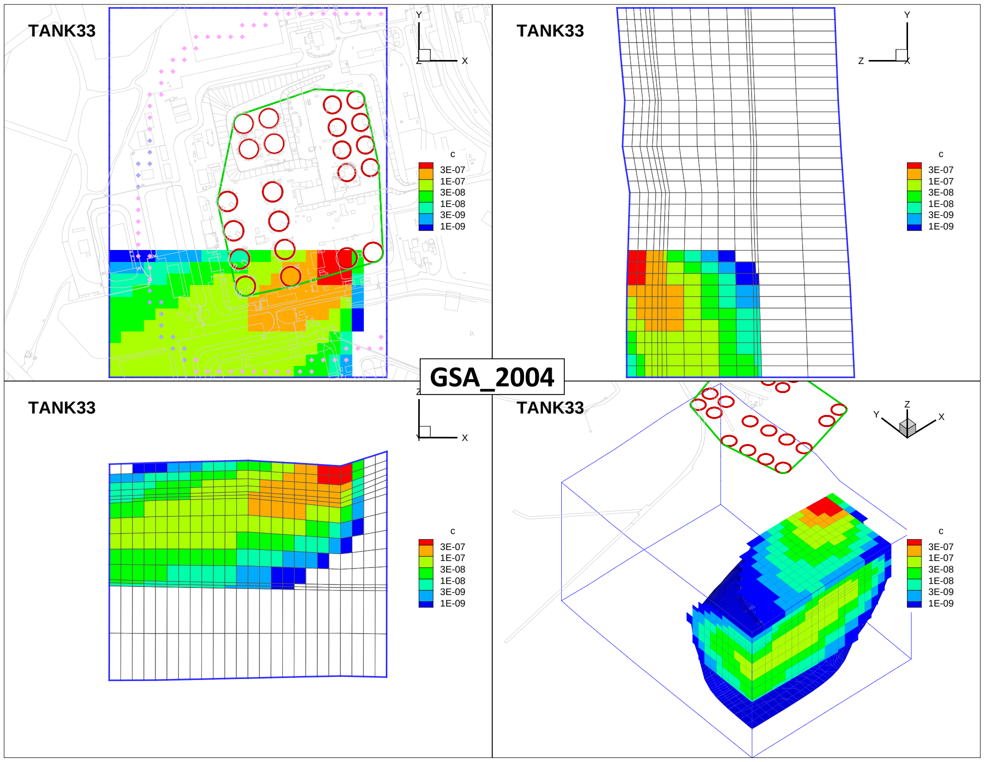


Figure 38. Steady-State Plumes for Tank 28 (concentration, C in Ci/L)



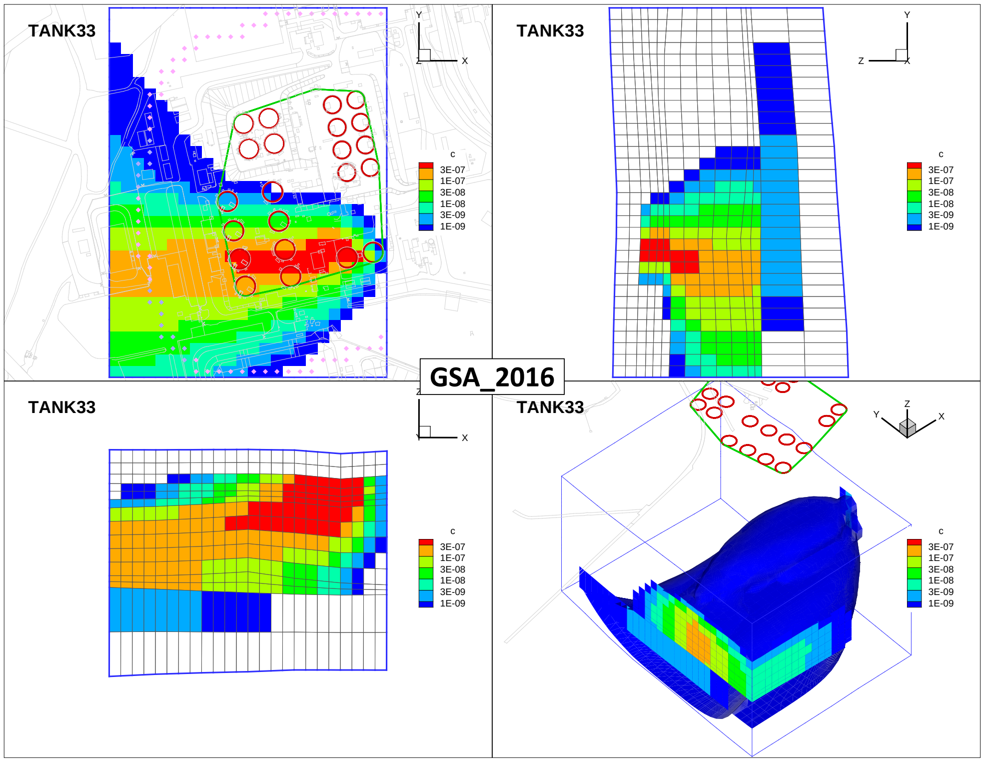


Figure 39. Steady-State Plumes for Tank 33 (concentration, C in Ci/L)

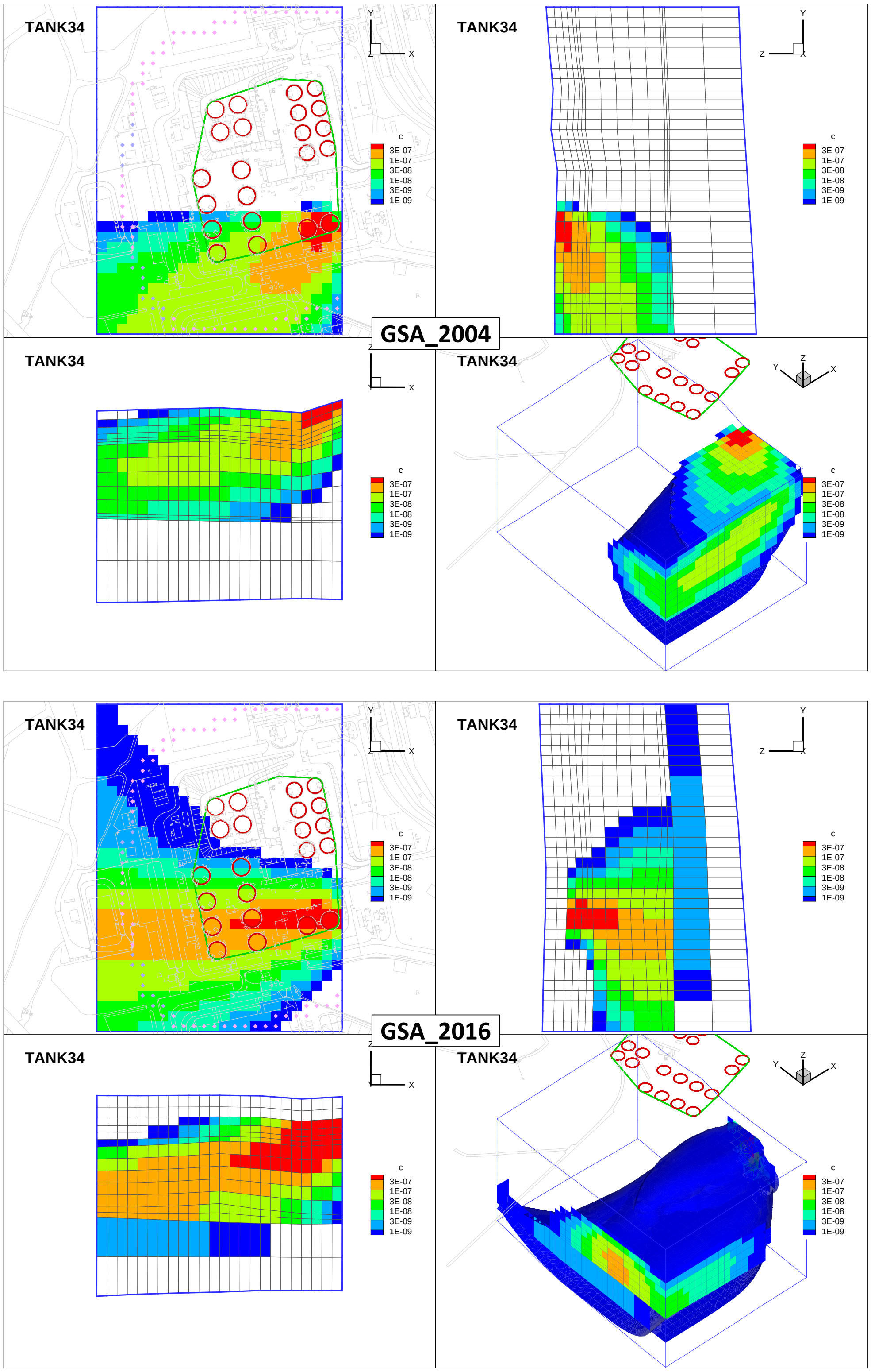


Figure 40. Steady-State Plumes for Tank 34 (concentration, C in Ci/L)

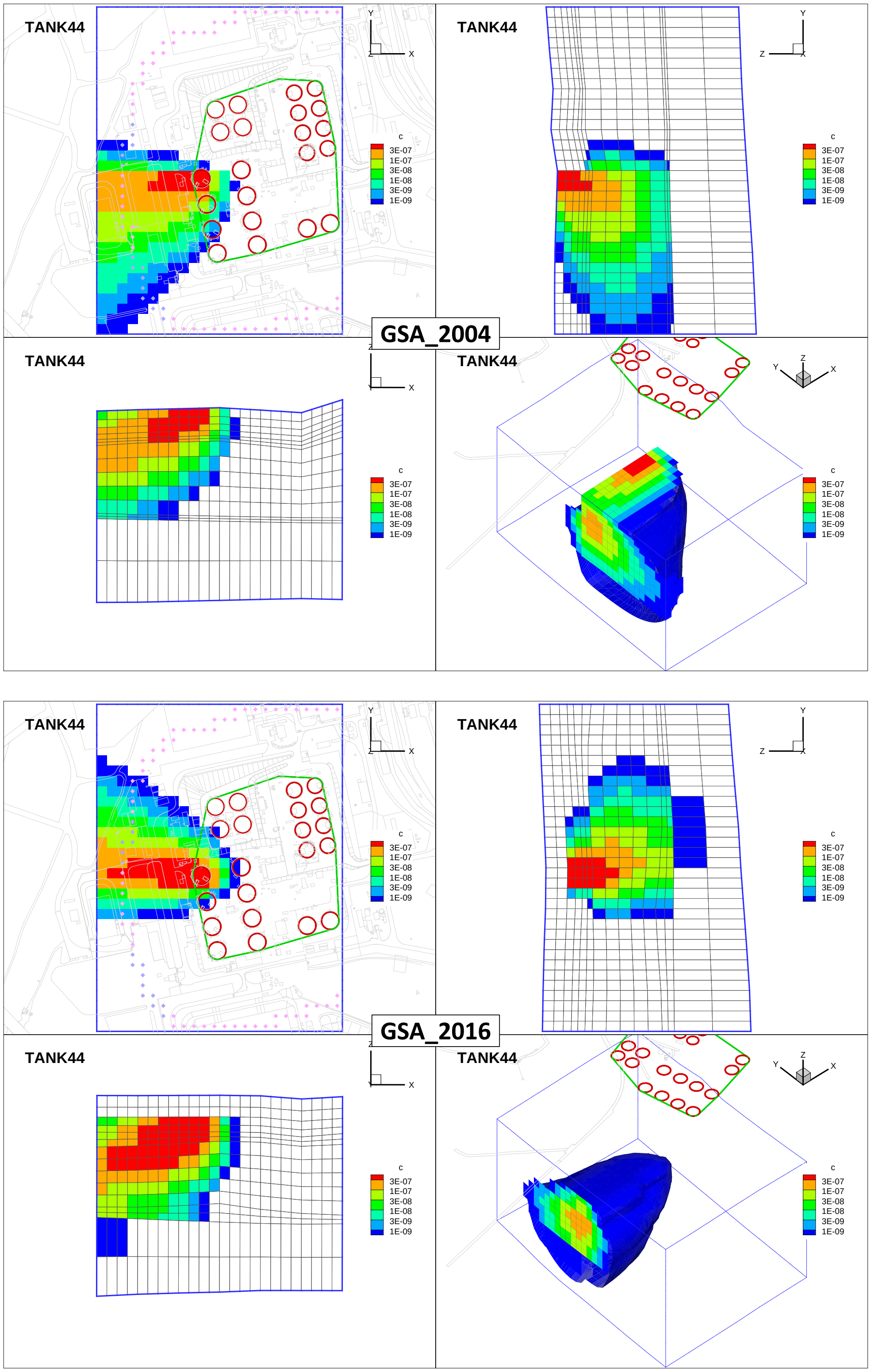


Figure 41. Steady-State Plumes for Tank 44 (concentration, C in Ci/L)

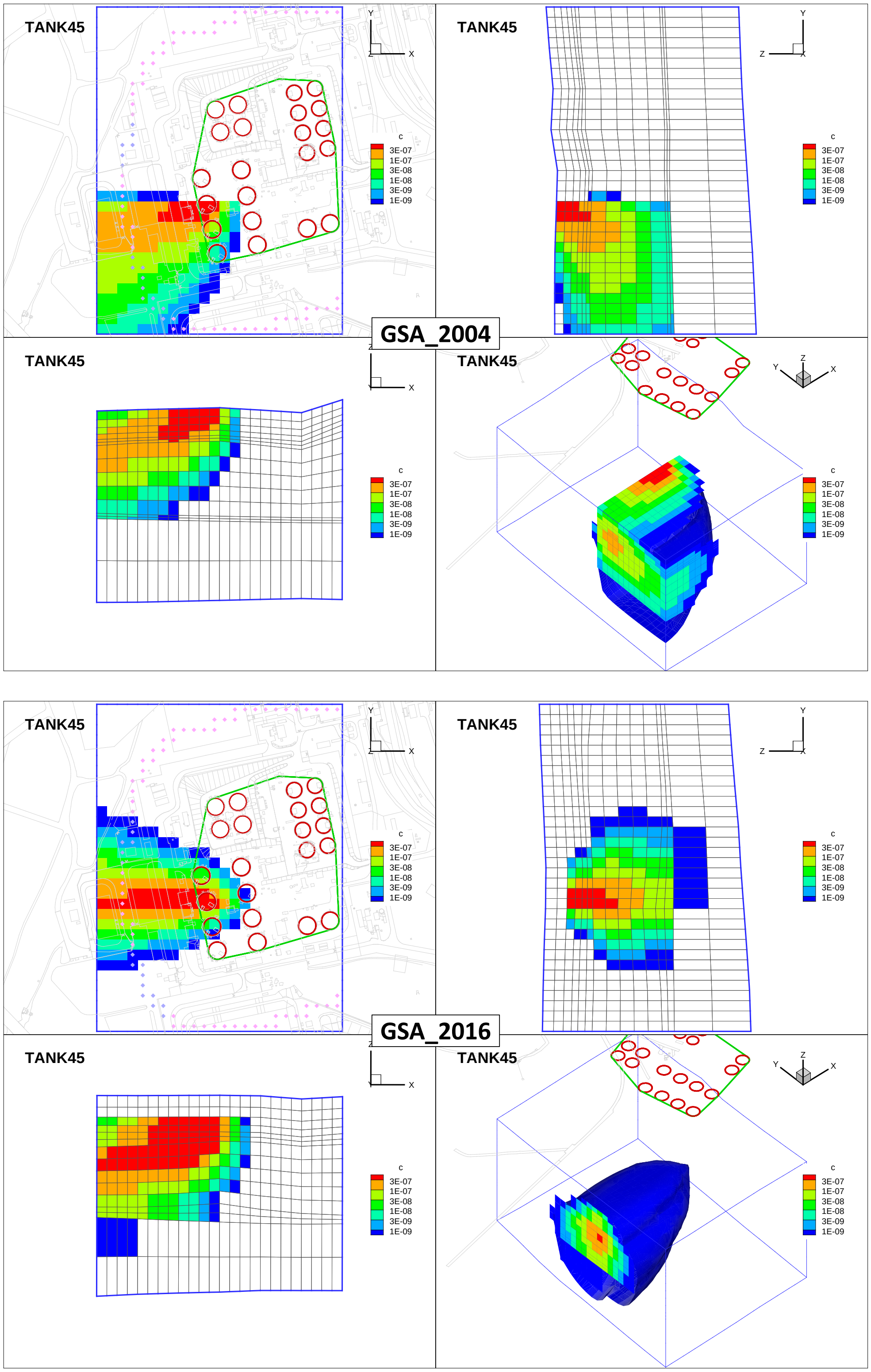


Figure 42. Steady-State Plumes for Tank 45 (concentration, C in Ci/L)

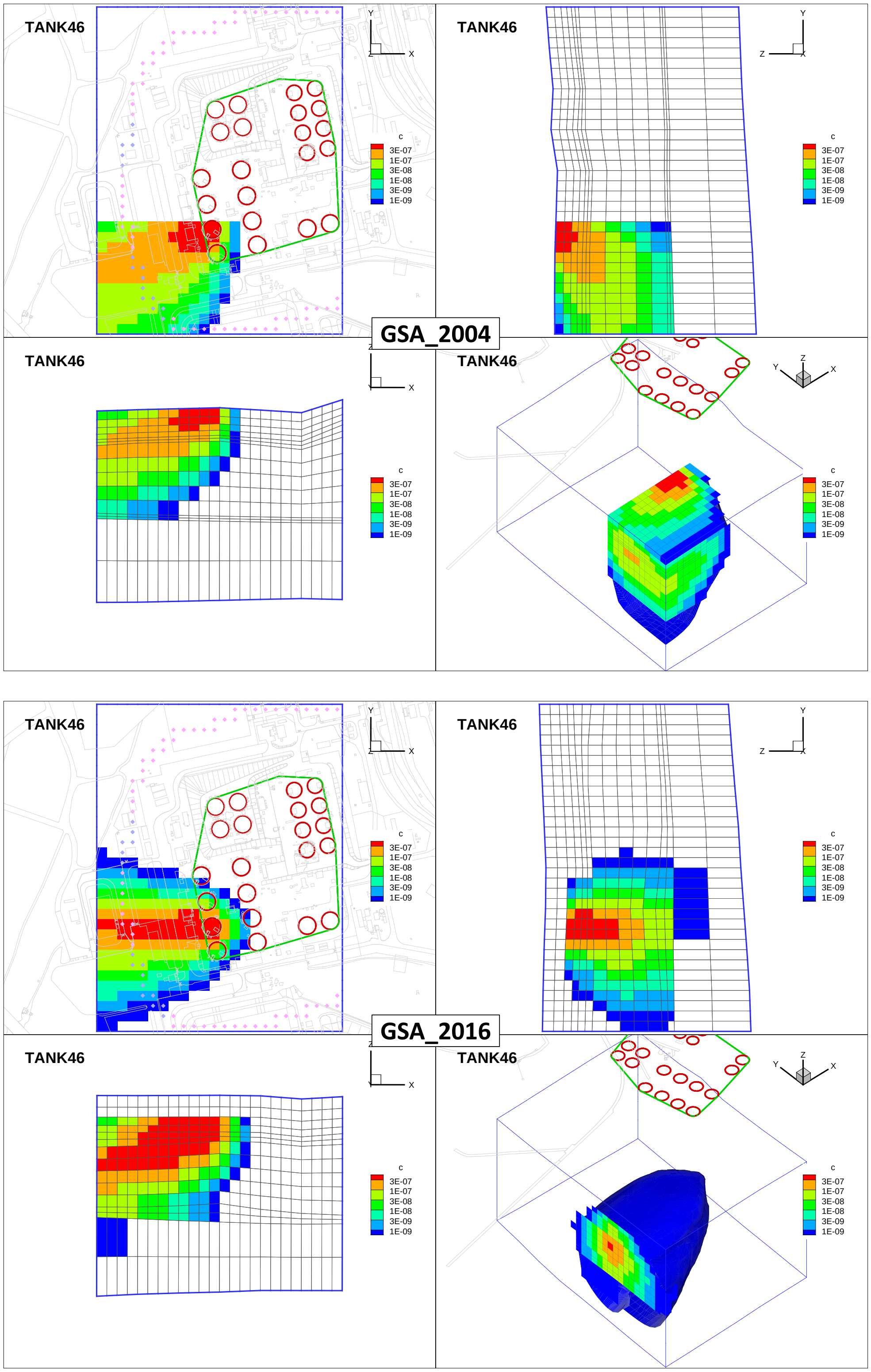


Figure 43. Steady-State Plumes for Tank 46 (concentration, C in Ci/L)

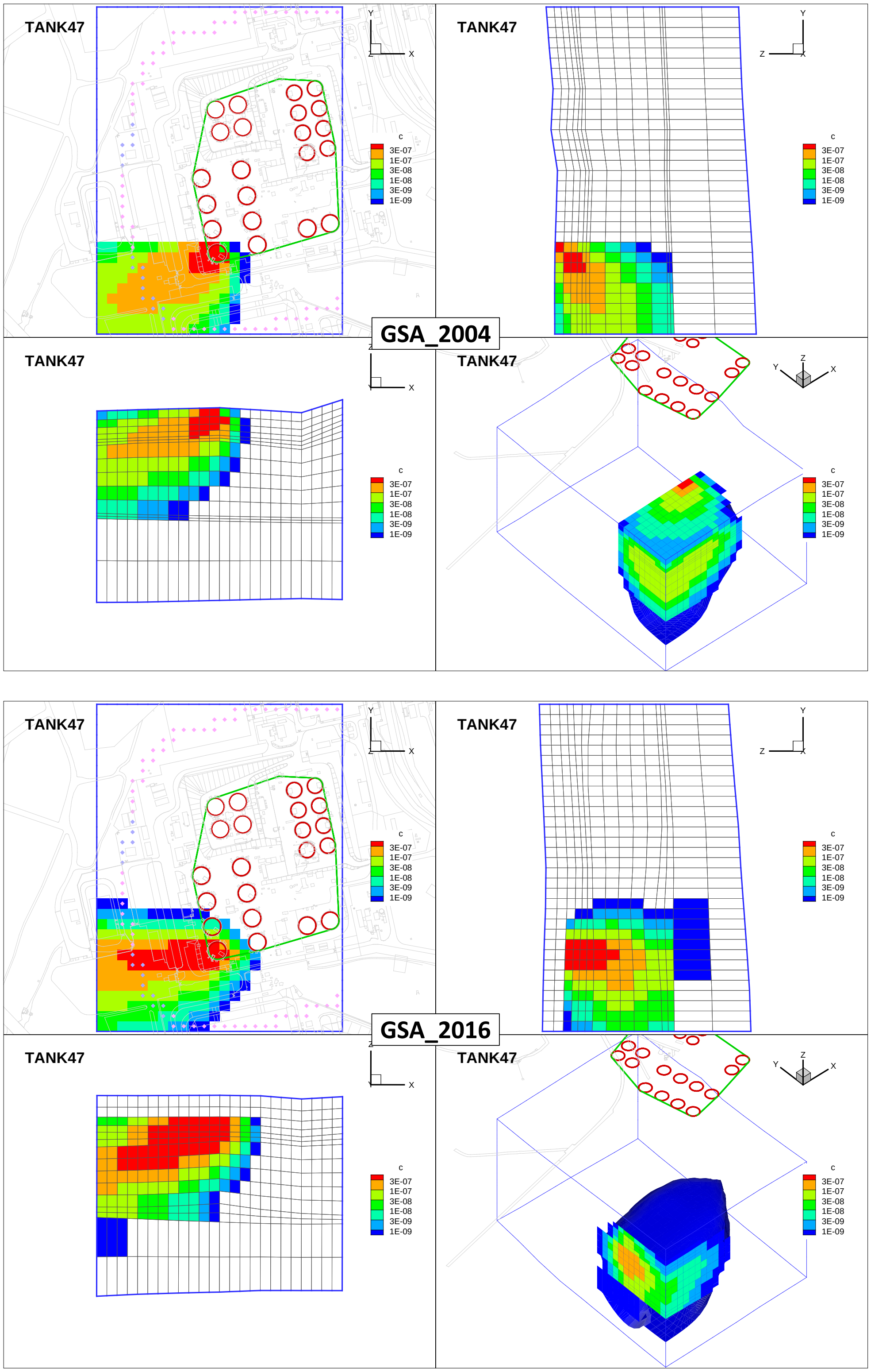
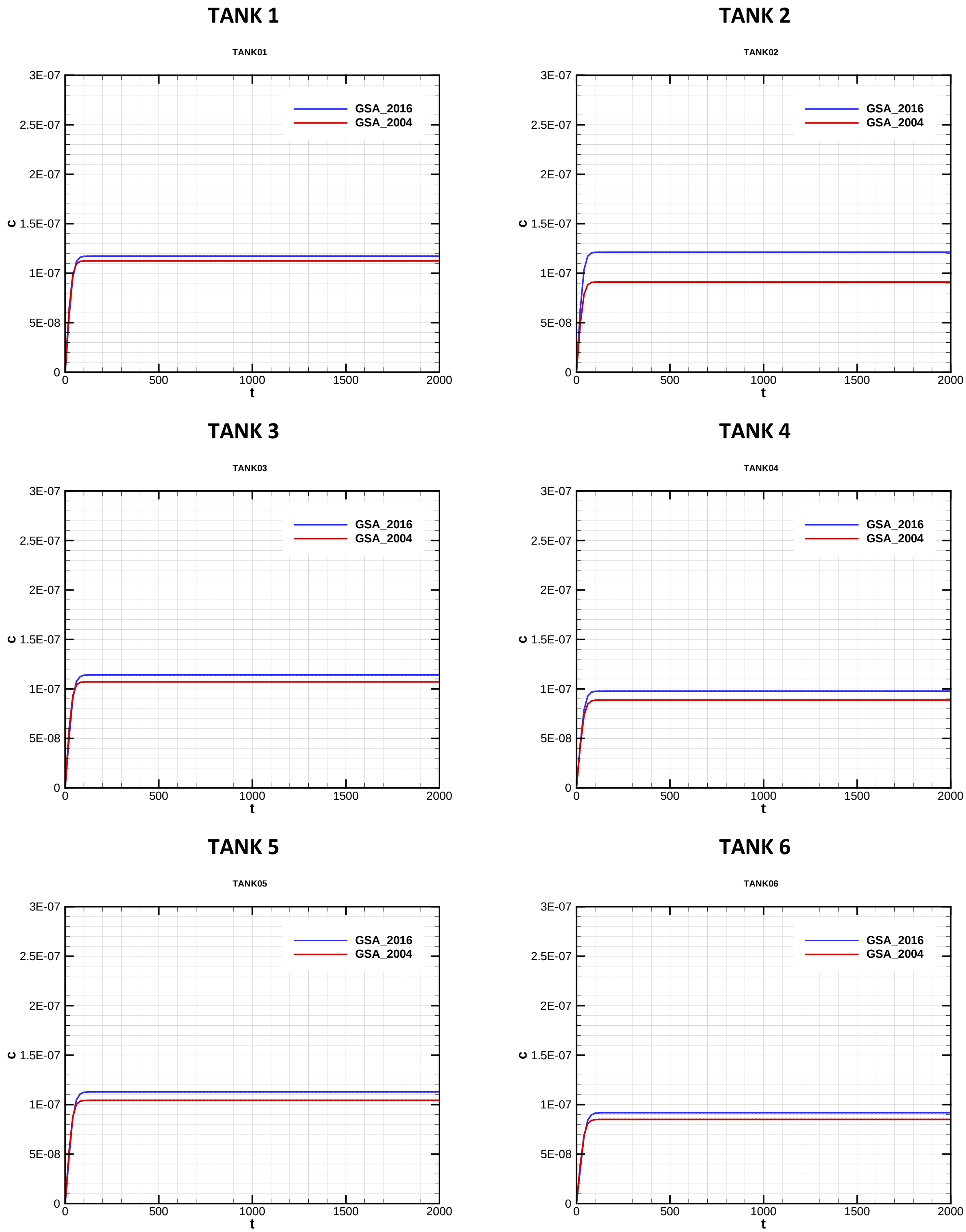
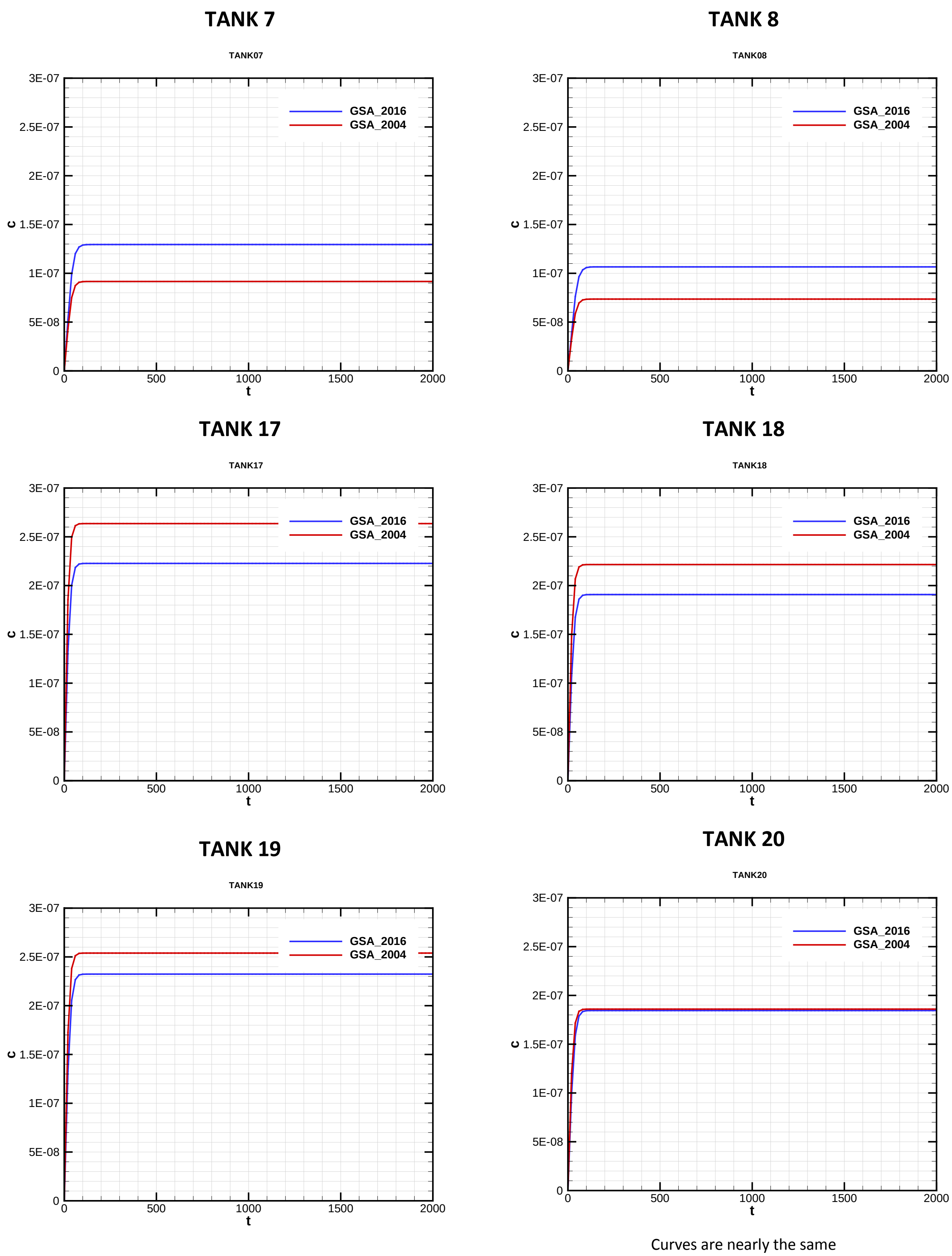


Figure 44. Steady-State Plumes for Tank 47 (concentration, C in Ci/L)



Note: Concentrations are monitored at 100-meter boundary

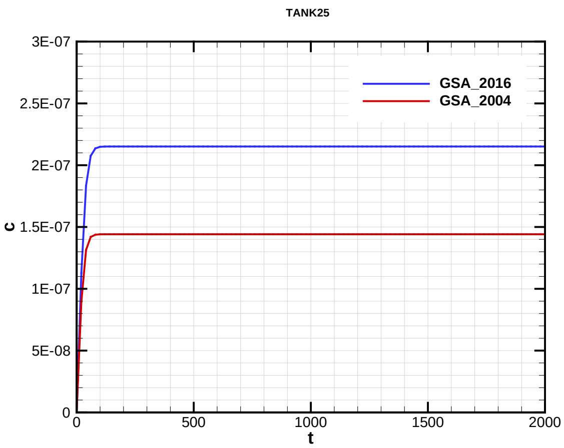
Figure 45. Comparison of FTF Steady-State Source Concentrations (concentration, C in Ci/L, time, t in years)



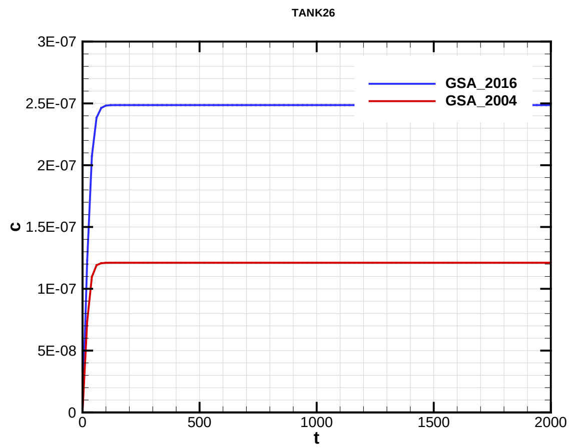
Note: Concentrations are monitored at 100-meter boundary

Figure 45. Comparison of FTF Steady-State Source Concentrations (concentration, C in Ci/L, time, t in years) (cont'd)

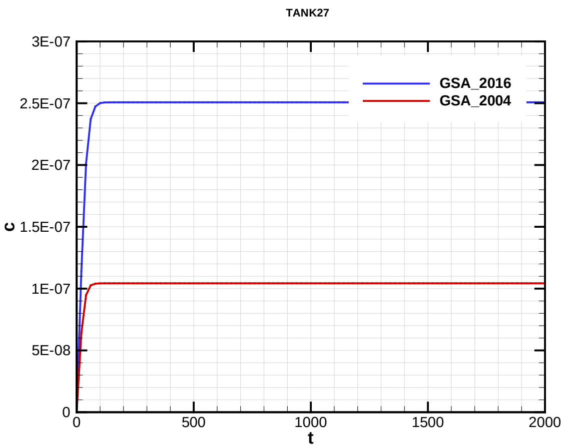
TANK 25



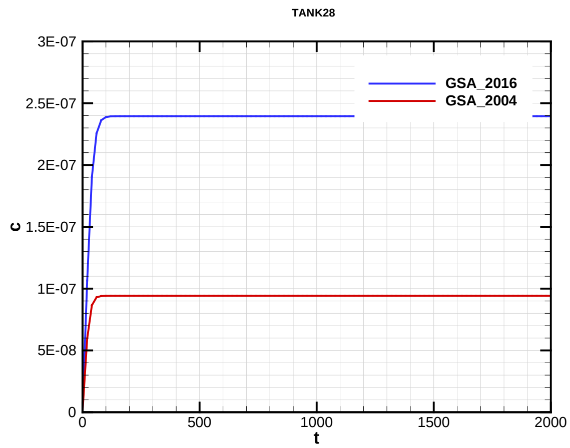
TANK 26



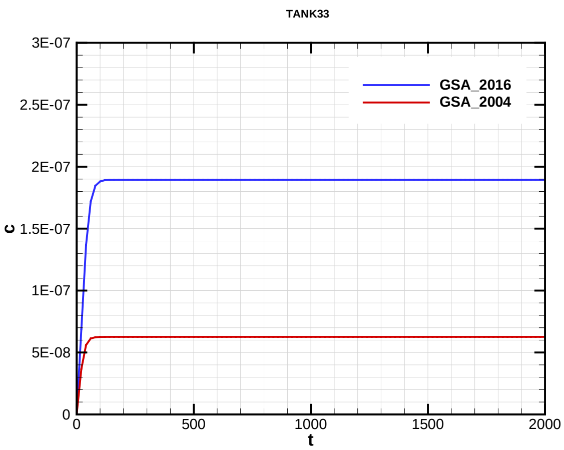
TANK 27



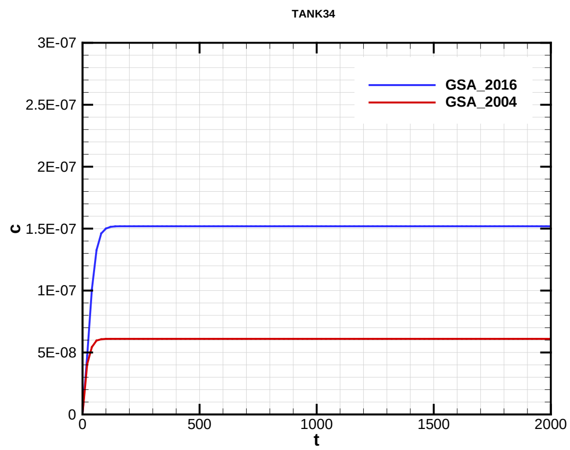
TANK 28



TANK 33

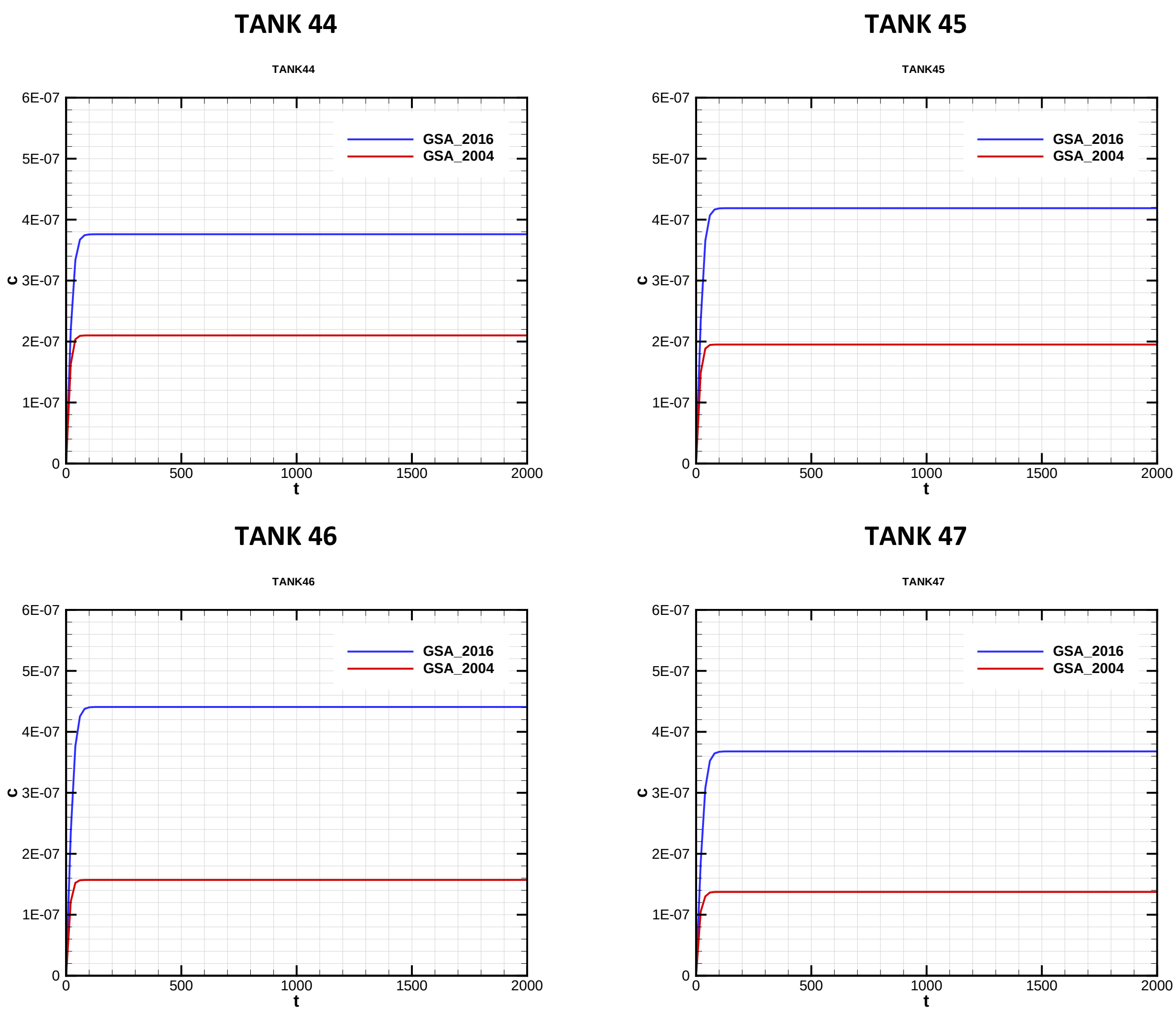


TANK 34



Note: Concentrations are monitored at 100-meter boundary

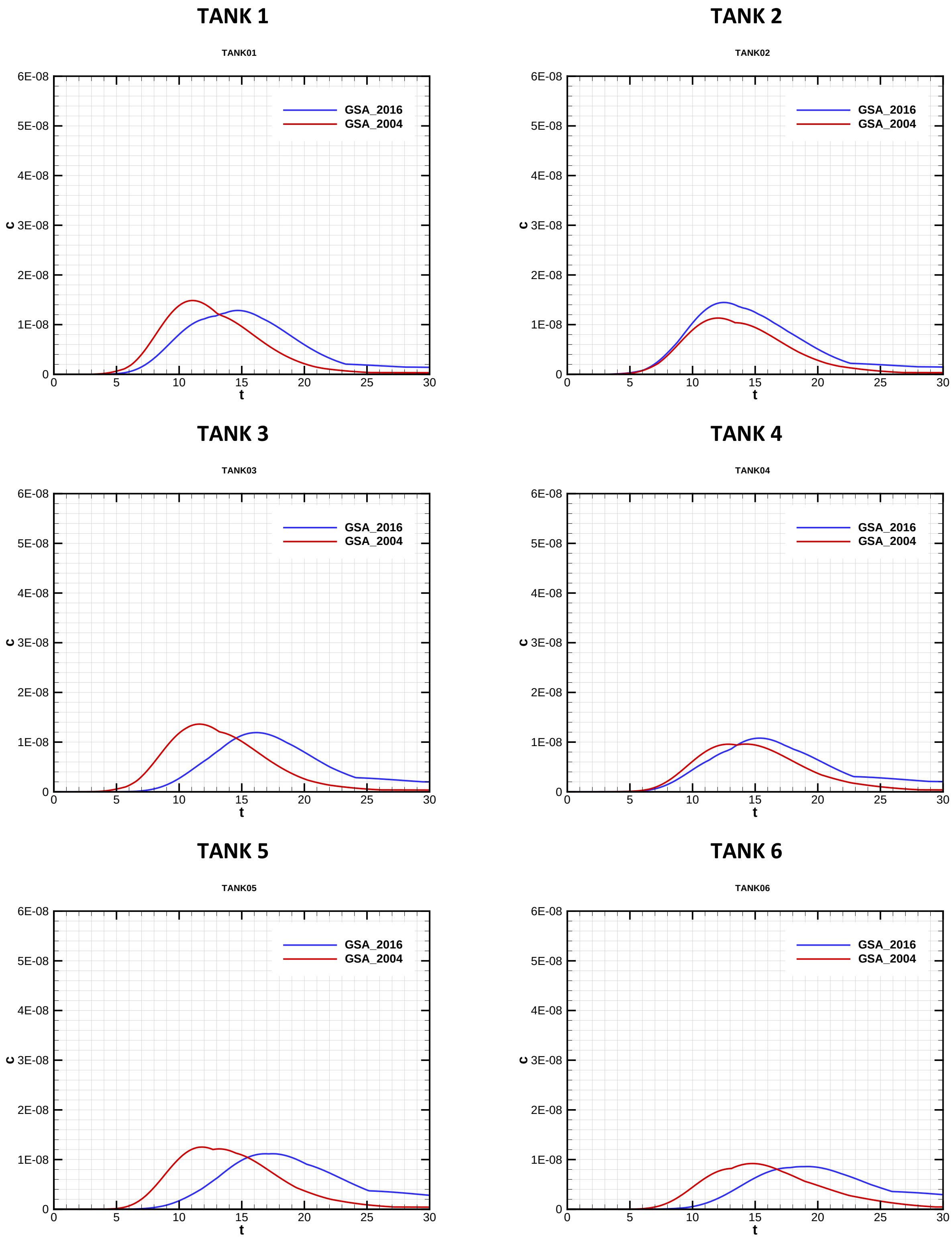
Figure 45. Comparison of FTF Steady-State Source Concentrations (concentration, C in Ci/L, time, t in years) (cont'd)



Note: Concentrations are monitored at 100-meter boundary

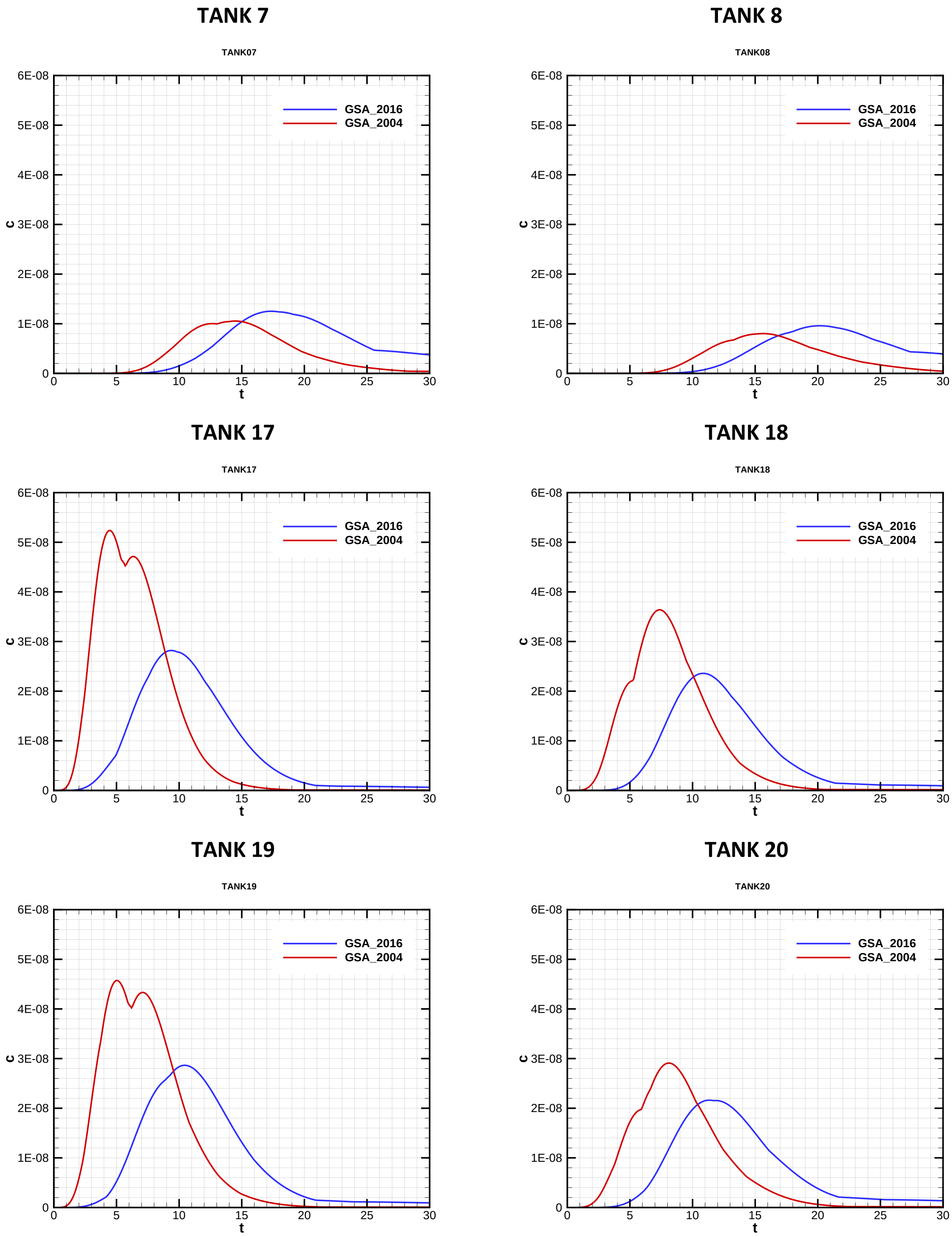
Figure 45. Comparison of FTF Steady-State Source Concentrations (concentration, C in Ci/L, time, t in years) (cont'd)

3.3.2.2 Transient/Pulsed Sources



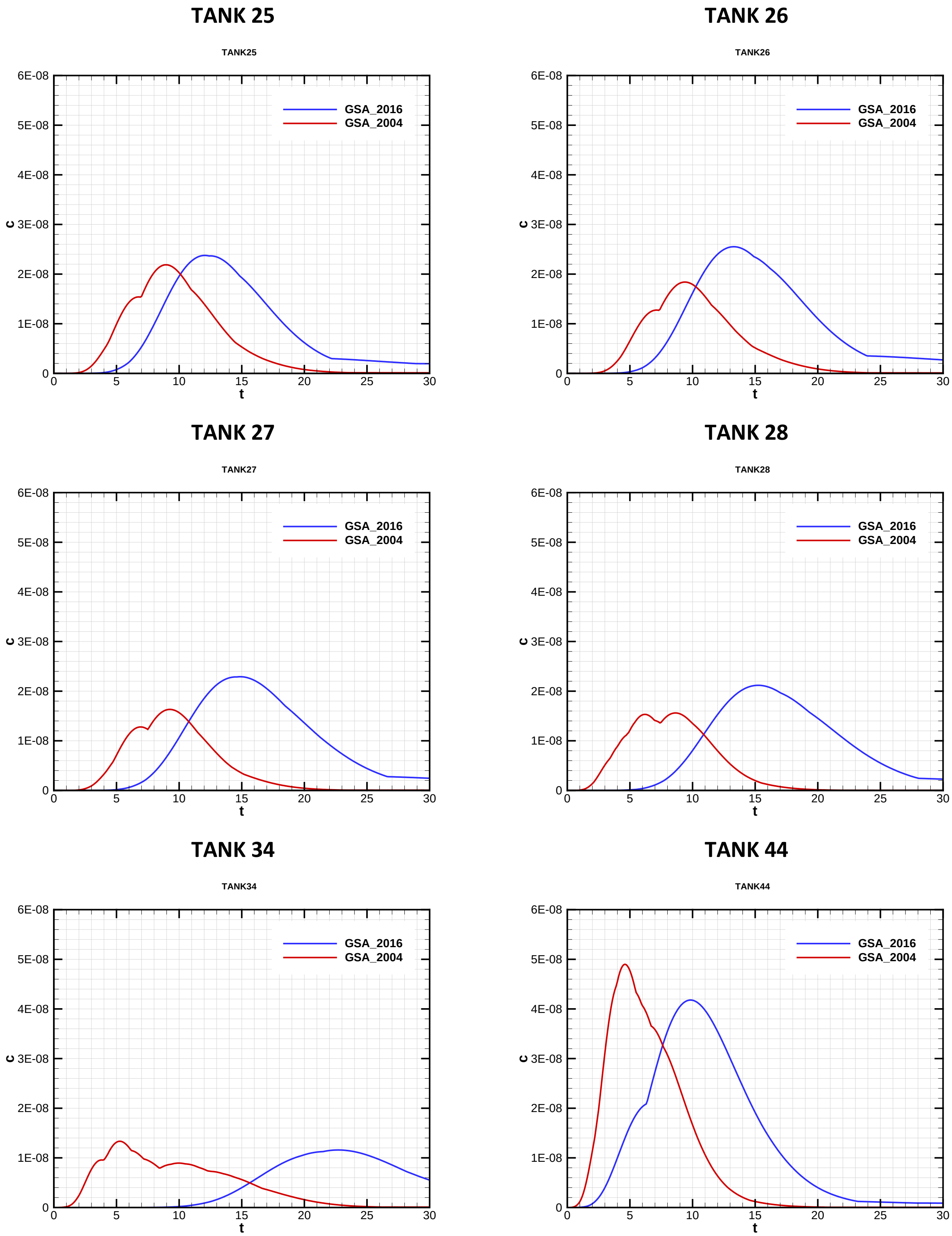
Note: Concentrations are monitored at 100-meter boundary

Figure 46. Comparison of FTF Pulsed Source Concentrations (concentration, C in Ci/L, time, t in years)



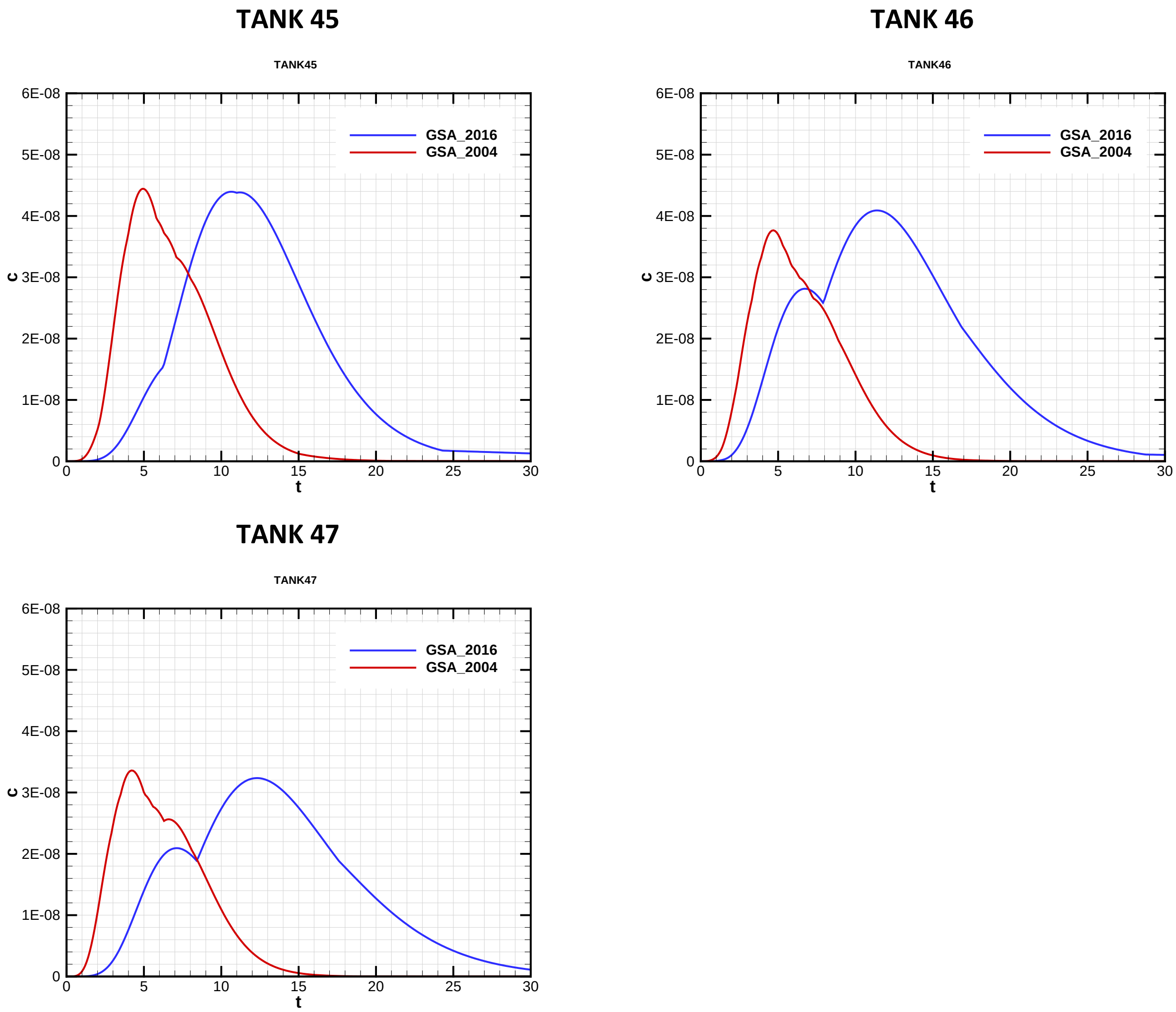
Note: Concentrations are monitored at 100-meter boundary

Figure 46. Comparison of FTF Pulsed Source Concentrations (concentration, C in Ci/L, time, t in years) (cont'd)



Note: Concentrations are monitored at 100-meter boundary

Figure 46. Comparison of FTF Pulsed Source Concentrations (concentration, C in Ci/L, time, t in years) (cont'd)



Note: Concentrations are monitored at 100-meter boundary

Figure 46. Comparison of FTF Pulsed Source Concentrations (concentration, C in Ci/L, time, t in years) (cont'd)

3.3.3 Evaluation Case Transport Simulations

3.3.3.1 Concentrations at 100-meter Boundary

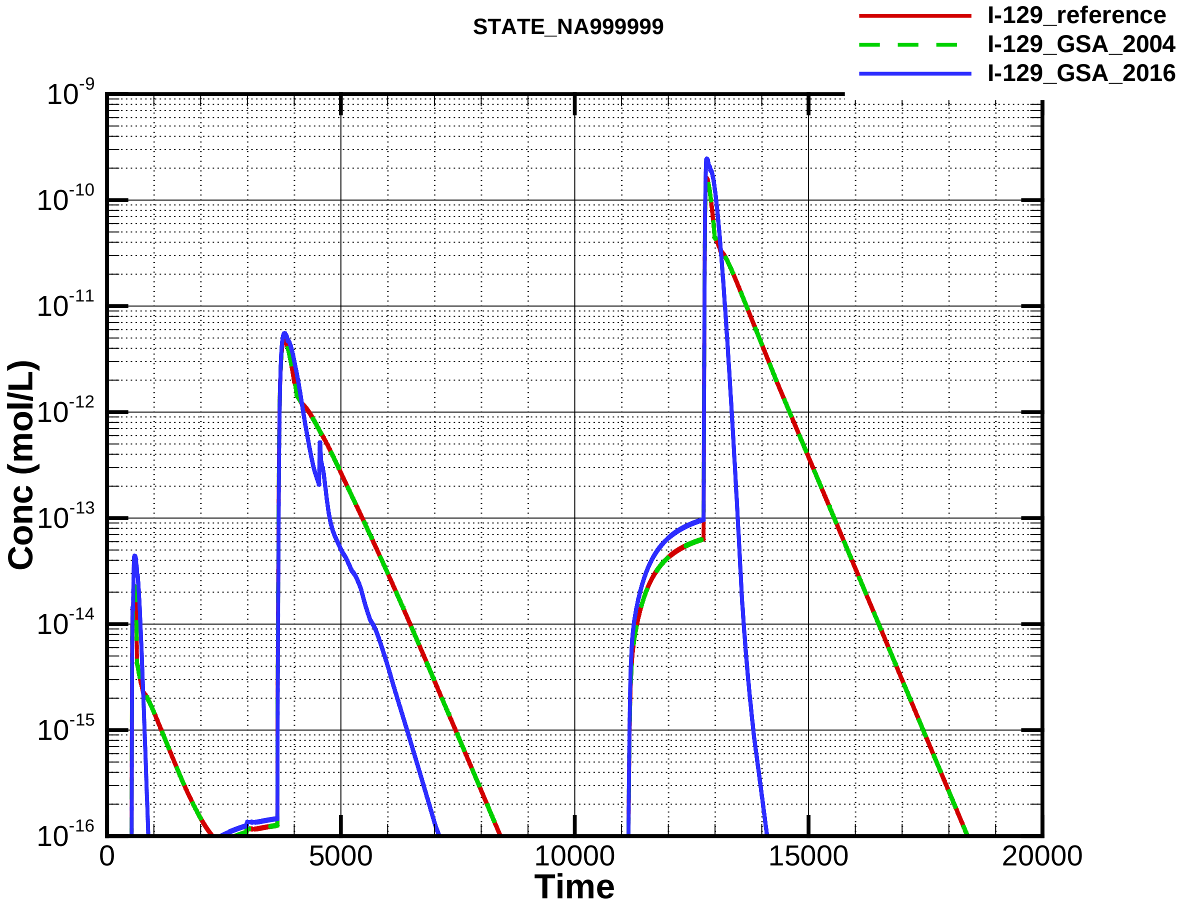


Figure 47. FTF I-129 Concentrations at 100-meter Boundary for 100,000-yr Sector E Simulation (Time in years)

3.3.3.2 Concentrations at the Seepline

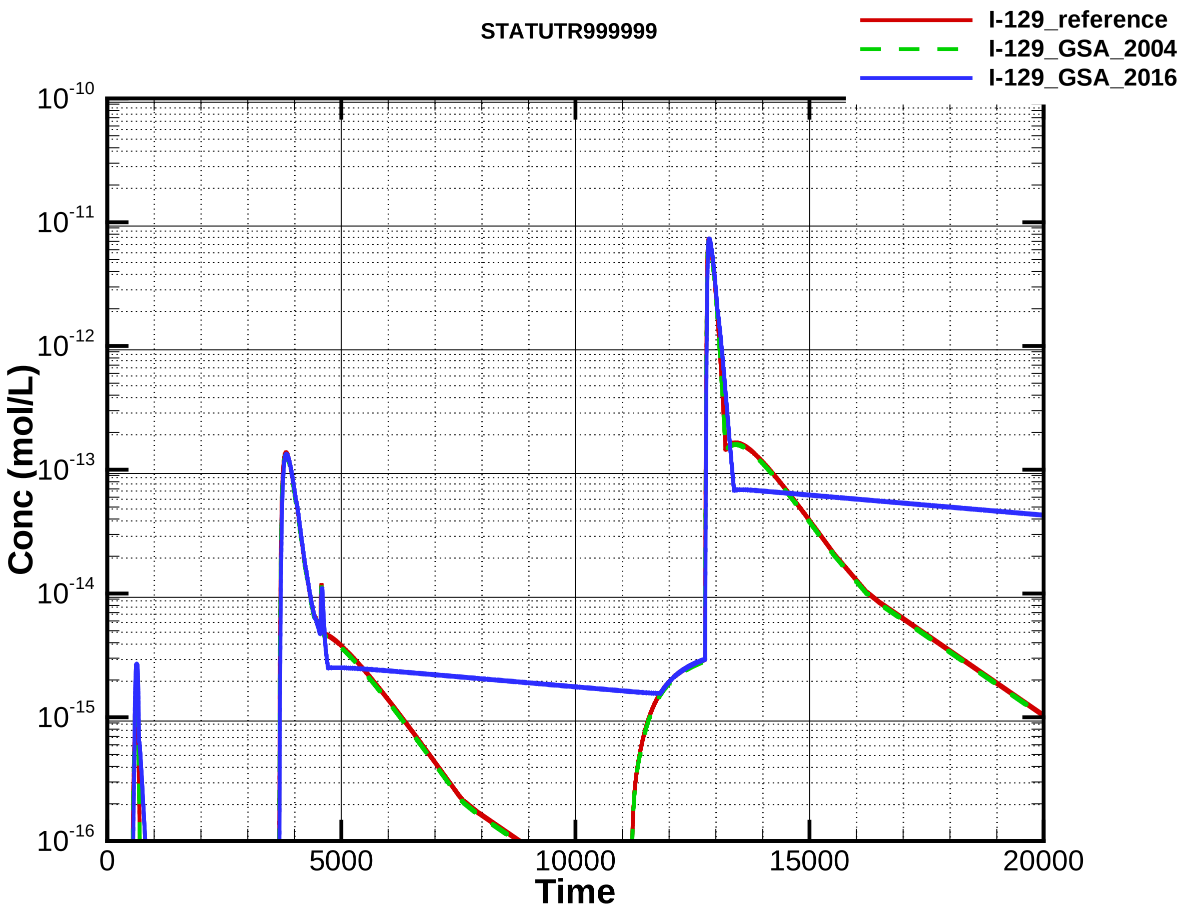


Figure 48. FTF I-129 Concentrations at the Seepline for 100,000-yr Simulation (Time in years)

4.0 Alternative GSA_2016 Flow Models

The GSA_2016 update produced four calibrated GSA flow models that are considered credible:

1. PEST.47 (Layer-cake K field, Unweighted optimization)
2. PEST.51 (Layer-cake K field, Weighted optimization)
3. PEST.52 (Heterogeneous K field, Unweighted optimization)
4. PEST.53 (Heterogeneous K field, Weighted optimization)

Detailed descriptions of these flow models are provided by Flach et al[5]. The second round of transport simulations assesses the impact of all four models, using alternative numerical settings intended to produce more accurate simulations. The following notations are used to refer to the applied GSA flow field and PORFLOW numerical scheme used in the first and second rounds of transport simulations:

- GSA_2016_impact (Runs using PEST.47 flow field with PORFLOW harmonic averaging at cell faces and diagonal terms in the dispersion tensor)
- GSA_2016_impact.LU (Runs using PEST.47 flow field with PORFLOW upwinding at cell faces and using the full dispersion tensor)
- GSA_2016_impact.LW (Runs using PEST.51 flow field with PORFLOW upwinding at cell faces and using the full dispersion tensor)
- GSA_2016_impact.HU (Runs using PEST.52 flow field with PORFLOW upwinding at cell faces and using the full dispersion tensor)
- GSA_2016_impact.HW (Runs using PEST.53 flow field with PORFLOW upwinding at cell faces and using the full dispersion tensor)

Note that GSA_2016_impact includes all of the first round results shown in Section 3.0. Section 5.0 displays the remaining second round simulation results obtained from all four GSA flow fields with revised transport settings. As before, due to a vast amount of data resulting from PORFLOW simulations, only limited main sources or a few representative sources and a conservative tracer or I-129 will be presented. Complete plots for each facility are stored on the *hpcfs* server as shown in Table 2 that provides hyperlinks to locations of the second round simulation data for the four GSA flow fields.

Table 2. Project Data Locations for All Simulations

Facility	Tasks	Subtasks	Hyperlinked Location
Saltstone			\Saltstone
	All plots		\Saltstone\Plots
	GSA_2016_impact.LU		\Saltstone\GSA2016_LU
		Streamtraces	\Saltstone\GSA2016_LU\Streamtraces
		Plumes (steady-state sources)	\Saltstone\GSA2016_LU\SteadyStateSources
		Pulsed sources	\Saltstone\GSA2016_LU\PulsedSources
		Aquifer Transport (100-meter)	\Saltstone\GSA2016_LU\100mAquiferTransport
		Aquifer Transport (Seepline)	\Saltstone\GSA2016_LU\SeeplineAquiferTransport
	GSA_2016_impact.LW		\Saltstone\GSA2016_LW
		Streamtraces	\Saltstone\GSA2016_LW\Streamtraces
		Plumes (steady-state sources)	\Saltstone\GSA2016_LW\SteadyStateSources
		Pulsed sources	\Saltstone\GSA2016_LW\PulsedSources
		Aquifer Transport (100-meter)	\Saltstone\GSA2016_LW\100mAquiferTransport
		Aquifer Transport (Seepline)	\Saltstone\GSA2016_LW\SeeplineAquiferTransport
	GSA_2016_impact.HU		\Saltstone\GSA2016_HU
		Streamtraces	\Saltstone\GSA2016_HU\Streamtraces
		Plumes (steady-state sources)	\Saltstone\GSA2016_HU\SteadyStateSources
		Pulsed sources	\Saltstone\GSA2016_HU\PulsedSources
		Aquifer Transport (100-meter)	\Saltstone\GSA2016_HU\100mAquiferTransport
		Aquifer Transport (Seepline)	\Saltstone\GSA2016_HU\SeeplineAquiferTransport
	GSA_2016_impact.HW		\Saltstone\GSA2016_HW

Facility	Tasks	Subtasks	Hyperlinked Location
		Streamtraces	\Saltstone\GSA2016_HW\Streamtraces
		Plumes (steady-state sources)	\Saltstone\GSA2016_HW\SteadyStateSources
		Pulsed sources	\Saltstone\GSA2016_HW\PulsedSources
		Aquifer Transport (100-meter)	\Saltstone\GSA2016_HW\100mAquiferTransport
		Aquifer Transport (Seepline)	\Saltstone\GSA2016_HW\SeeplineAquiferTransport
HTF			\HTF
	All plots		\HTF\Plots
	GSA_2016_impact.LU		\HTF\GSA2016_LU
		Streamtraces	\HTF\GSA2016_LU\Streamtraces
		Plumes (steady-state sources)	\HTF\GSA2016_LU\SteadyStateSources
		Pulsed sources	\HTF\GSA2016_LU\PulsedSources
		Aquifer Transport (100-meter)	\HTF\GSA2016_LU\100mAquiferTransport
		Aquifer Transport (Seepline)	\HTF\GSA2016_LU\SeeplineAquiferTransport
	GSA_2016_impact.LW		\HTF\GSA2016_LW
		Streamtraces	\HTF\GSA2016_LW\Streamtraces
		Plumes (steady-state sources)	\HTF\GSA2016_LW\SteadyStateSources
		Pulsed sources	\HTF\GSA2016_LW\PulsedSources
		Aquifer Transport (100-meter)	\HTF\GSA2016_LW\100mAquiferTransport
		Aquifer Transport (Seepline)	\HTF\GSA2016_LW\SeeplineAquiferTransport
	GSA_2016_impact.HU		\HTF\GSA2016_HU
		Streamtraces	\HTF\GSA2016_HU\Streamtraces
		Plumes (steady-state sources)	\HTF\GSA2016_HU\SteadyStateSources
		Pulsed sources	\HTF\GSA2016_HU\PulsedSources

Facility	Tasks	Subtasks	Hyperlinked Location
		Aquifer Transport (100-meter)	\HTF\GSA2016_HU\100mAquiferTransport
		Aquifer Transport (Seepline)	\HTF\GSA2016_HU\SeeplineAquiferTransport
	GSA_2016_impact.HW		\HTF\GSA2016_HW
		Streamtraces	\HTF\GSA2016_HW\Streamtraces
		Plumes (steady-state sources)	\HTF\GSA2016_HW\SteadyStateSources
		Pulsed sources	\HTF\GSA2016_HW\PulsedSources
		Aquifer Transport (100-meter)	\HTF\GSA2016_HW\100mAquiferTransport
		Aquifer Transport (Seepline)	\HTF\GSA2016_HW\SeeplineAquiferTransport
FTF			\FTF
	All plots		\FTF\Plots
	GSA_2016_impact.LU		\FTF\GSA2016_LU
		Streamtraces	\FTF\GSA2016_LU\Streamtraces
		Plumes (steady-state sources)	\FTF\GSA2016_LU\SteadyStateSources
		Pulsed sources	\FTF\GSA2016_LU\PulsedSources
		Aquifer Transport (100-meter)	\FTF\GSA2016_LU\100mAquiferTransport
		Aquifer Transport (Seepline)	\FTF\GSA2016_LU\SeeplineAquiferTransport
	GSA_2016_impact.LW		\FTF\GSA2016_LW
		Streamtraces	\FTF\GSA2016_LW\Streamtraces
		Plumes (steady-state sources)	\FTF\GSA2016_LW\SteadyStateSources
		Pulsed sources	\FTF\GSA2016_LW\PulsedSources
		Aquifer Transport (100-meter)	\FTF\GSA2016_LW\100mAquiferTransport
		Aquifer Transport (Seepline)	\FTF\GSA2016_LW\SeeplineAquiferTransport
	GSA_2016_impact.HU		\FTF\GSA2016_HU

Facility	Tasks	Subtasks	Hyperlinked Location
		Streamtraces	\FTF\GSA2016_HU\Streamtraces
		Plumes (steady-state sources)	\FTF\GSA2016_HU\SteadyStateSources
		Pulsed sources	\FTF\GSA2016_HU\PulsedSources
		Aquifer Transport (100-meter)	\FTF\GSA2016_HU\100mAquiferTransport
		Aquifer Transport (Seepline)	\FTF\GSA2016_HU\SeeplineAquiferTransport
	GSA_2016_impact.HW		\FTF\GSA2016_HW
		Streamtraces	\FTF\GSA2016_HW\Streamtraces
		Plumes (steady-state sources)	\FTF\GSA2016_HW\SteadyStateSources
		Pulsed sources	\FTF\GSA2016_HW\PulsedSources
		Aquifer Transport (100-meter)	\FTF\GSA2016_HW\100mAquiferTransport
		Aquifer Transport (Seepline)	\FTF\GSA2016_HW\SeeplineAquiferTransport

5.0 Impact of All Four GSA_2016 Flow Models Coupled With Revised Transport Settings

While Section 3.0 is confined to one GSA_2016 flow field, GSA_2016.LW, this section presents simulation results for all four GSA_2016 flow fields. Transport simulations also use the full dispersion tensor and upwinding at cell faces, whereas Section 3.0 results are based on a diagonal only tensor and harmonic averaging. Therefore GSA_2016.LW transport simulations differ between Section 3.0 and here because of different transport settings.

5.1 Saltstone Disposal Facility

5.1.1 Streamtraces with Timing Markers

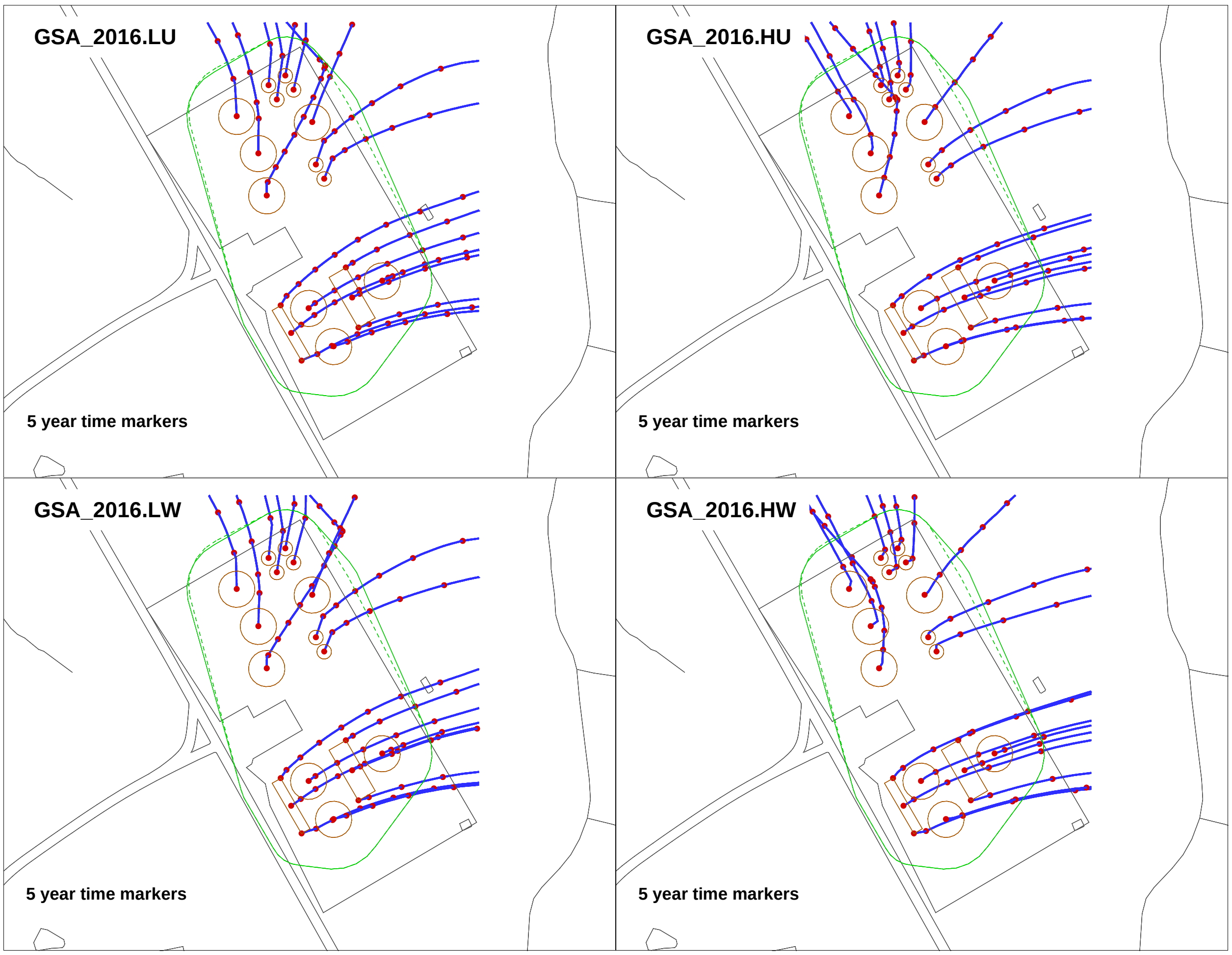


Figure 49. SDF Streamtraces with Timing Markers

5.1.2 Tracer Plume Simulations

5.1.2.1 Steady-State Sources

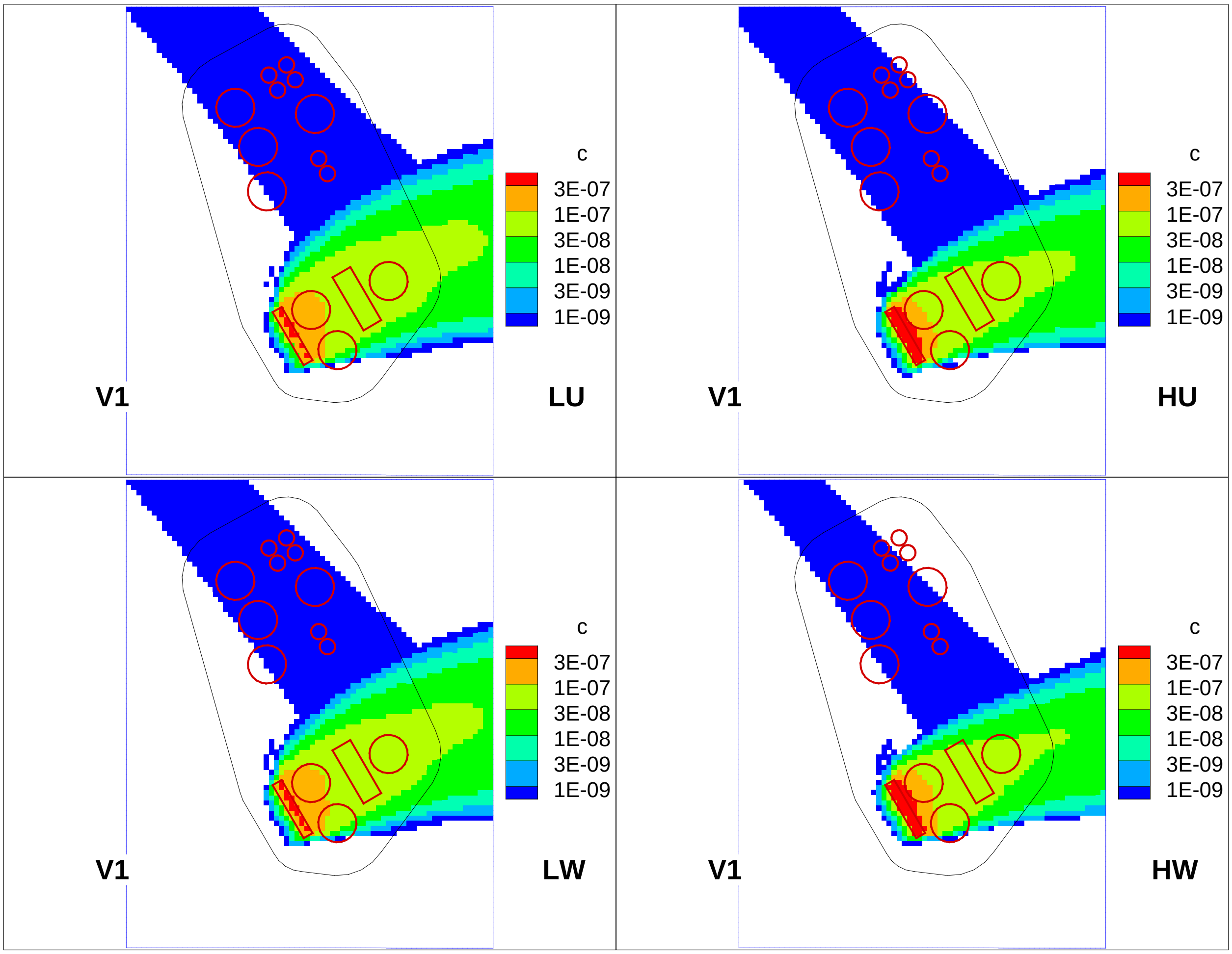


Figure 50. SDU 1 Tracer Plume Simulation of Steady-State Sources (concentration, C in Ci/L)

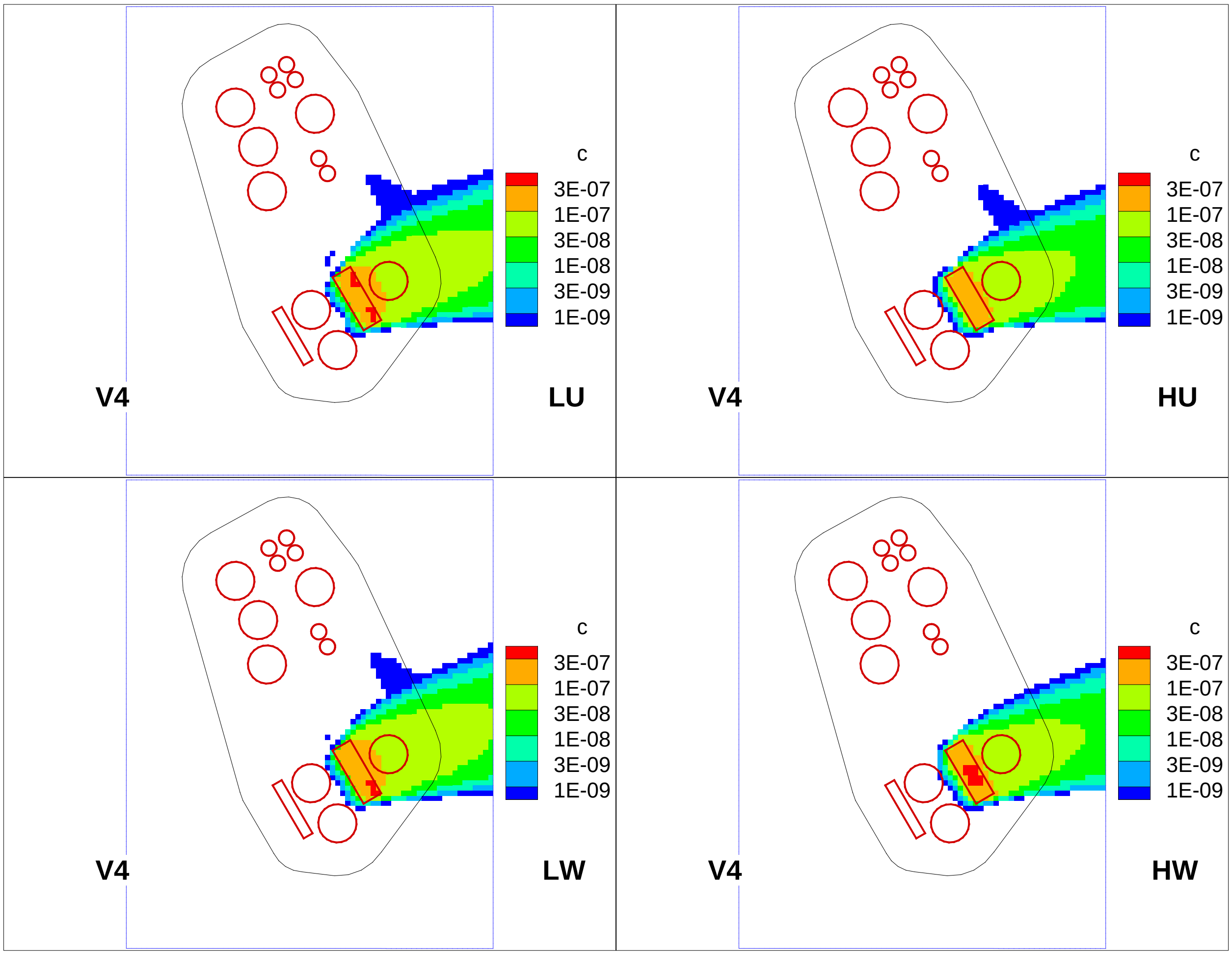


Figure 51. SDU 4 Tracer Plume Simulation of Steady-State Sources (concentration, C in Ci/L)

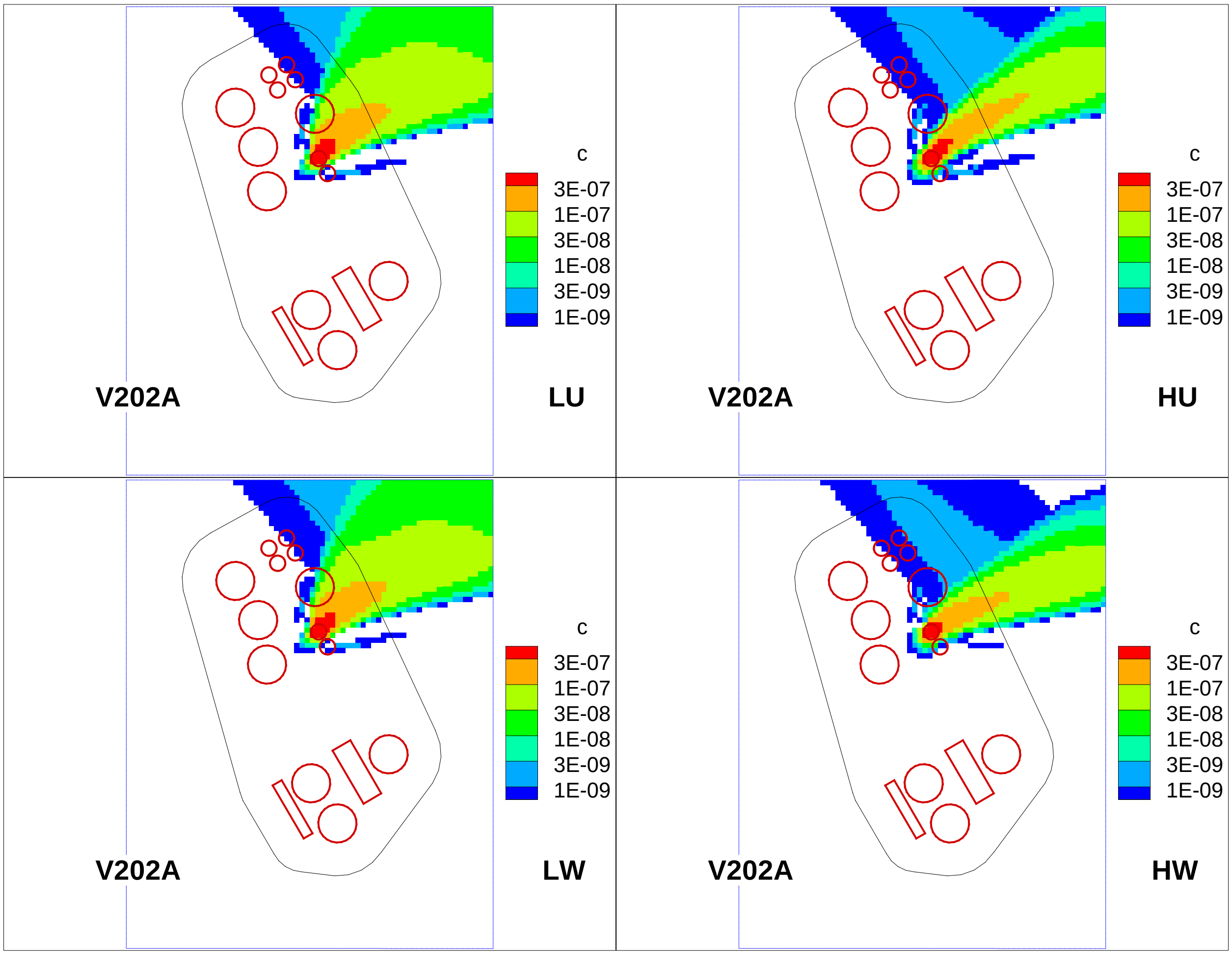


Figure 52. SDU 2A Tracer Plume Simulation of Steady-State Sources (concentration, C in Ci/L)

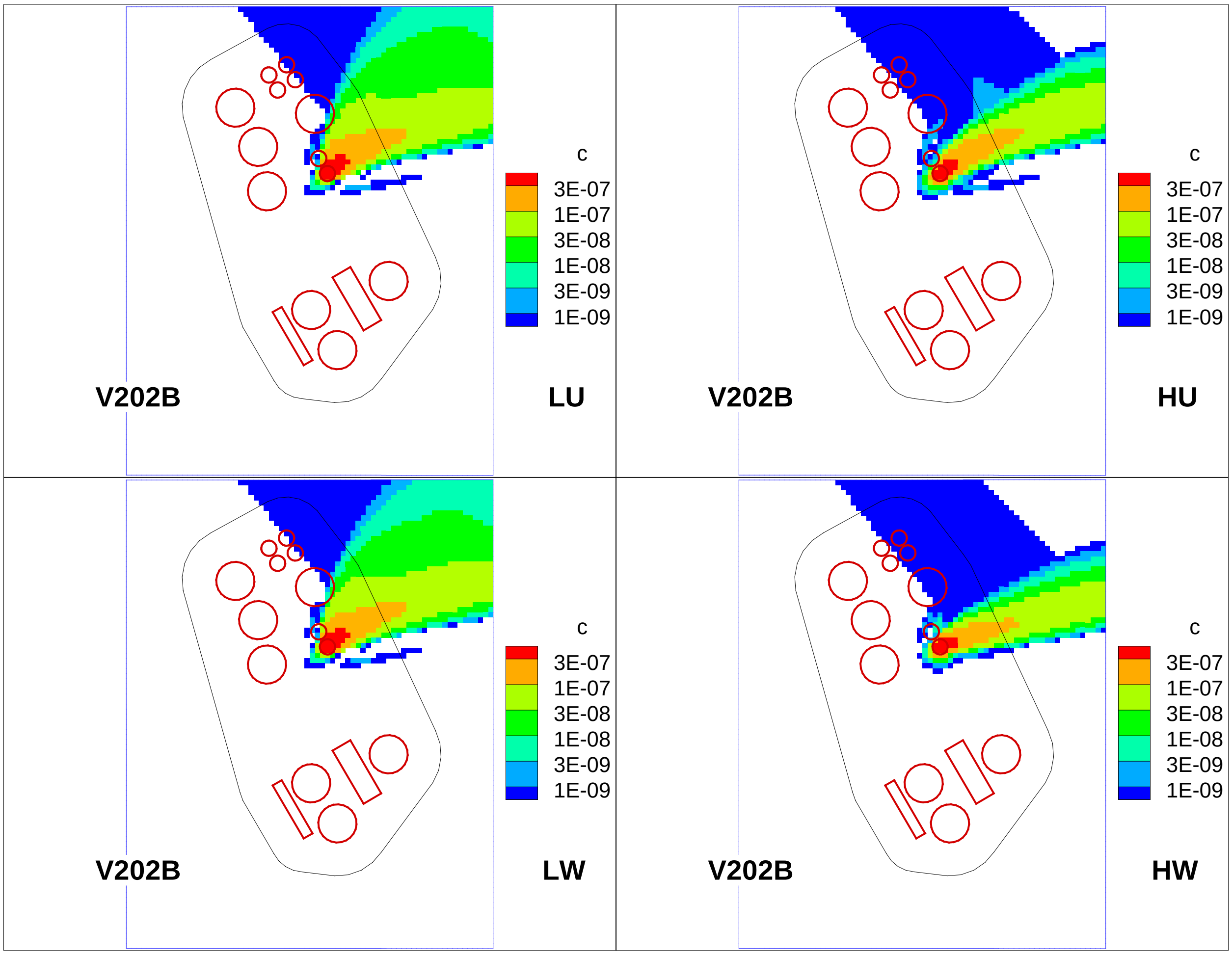


Figure 53. SDU 2B Tracer Plume Simulation of Steady-State Sources (concentration, C in Ci/L)

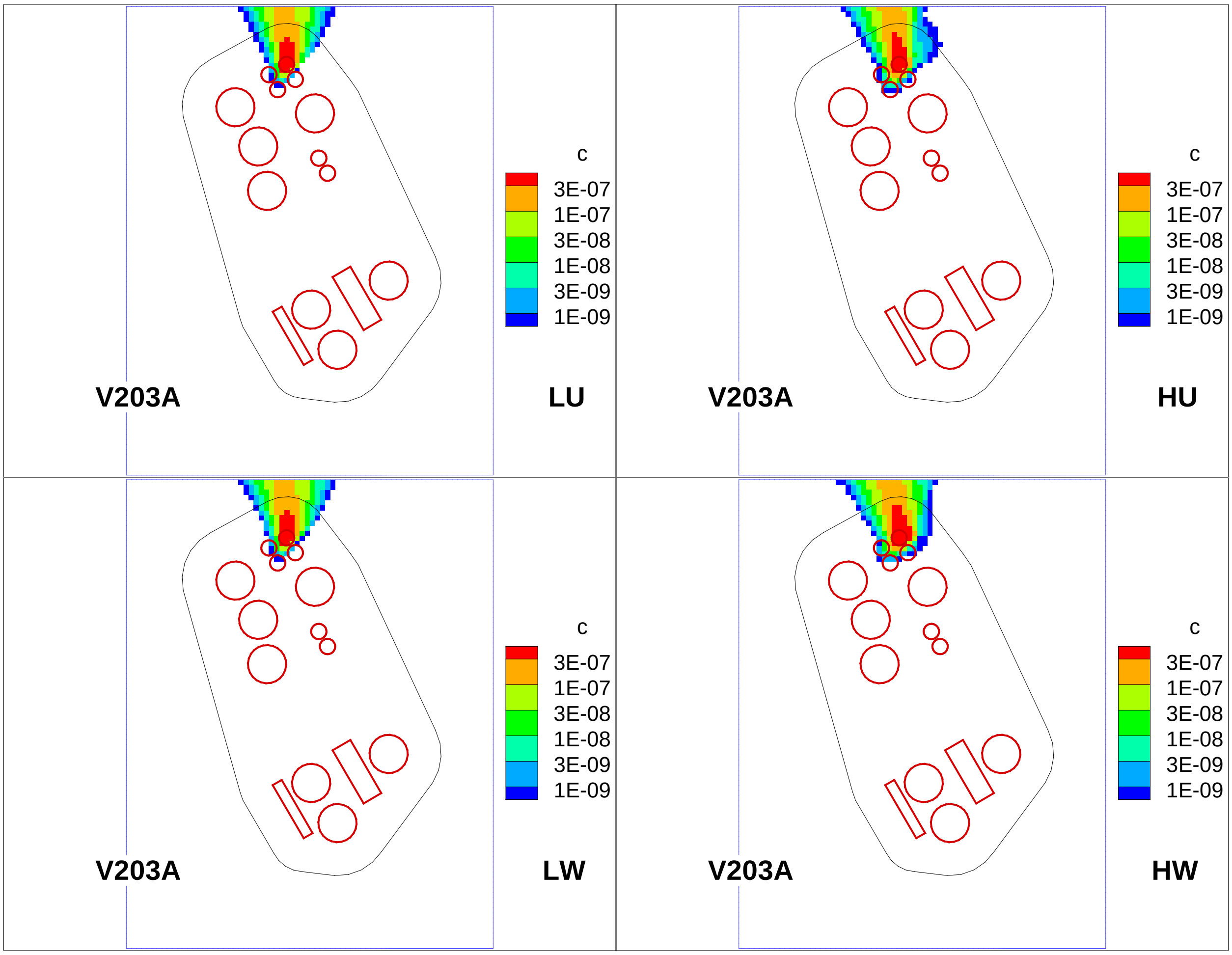


Figure 54. SDU 3A Tracer Plume Simulation of Steady-State Sources (concentration, C in Ci/L)

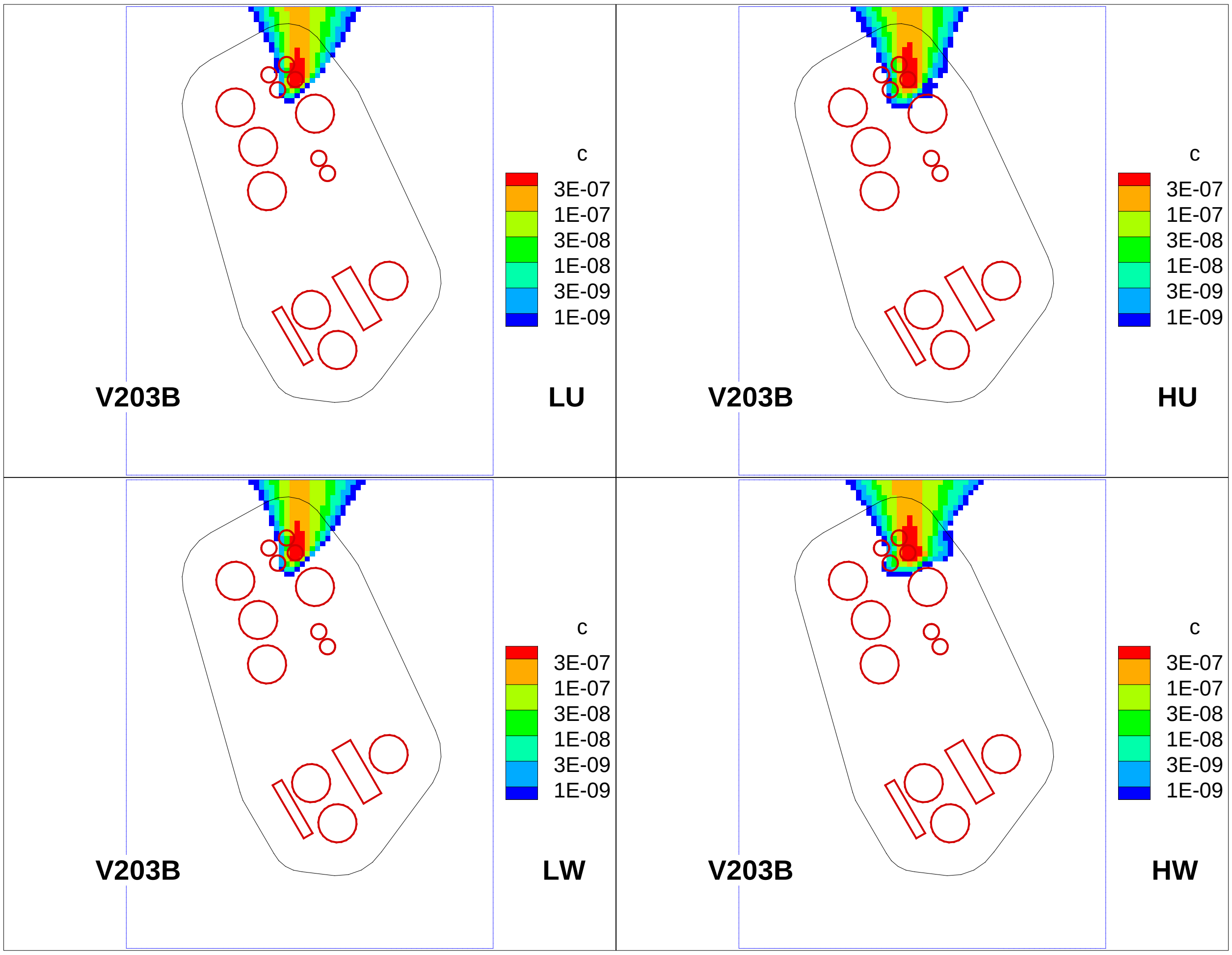


Figure 55. SDU 3B Tracer Plume Simulation of Steady-State Sources (concentration, C in Ci/L)

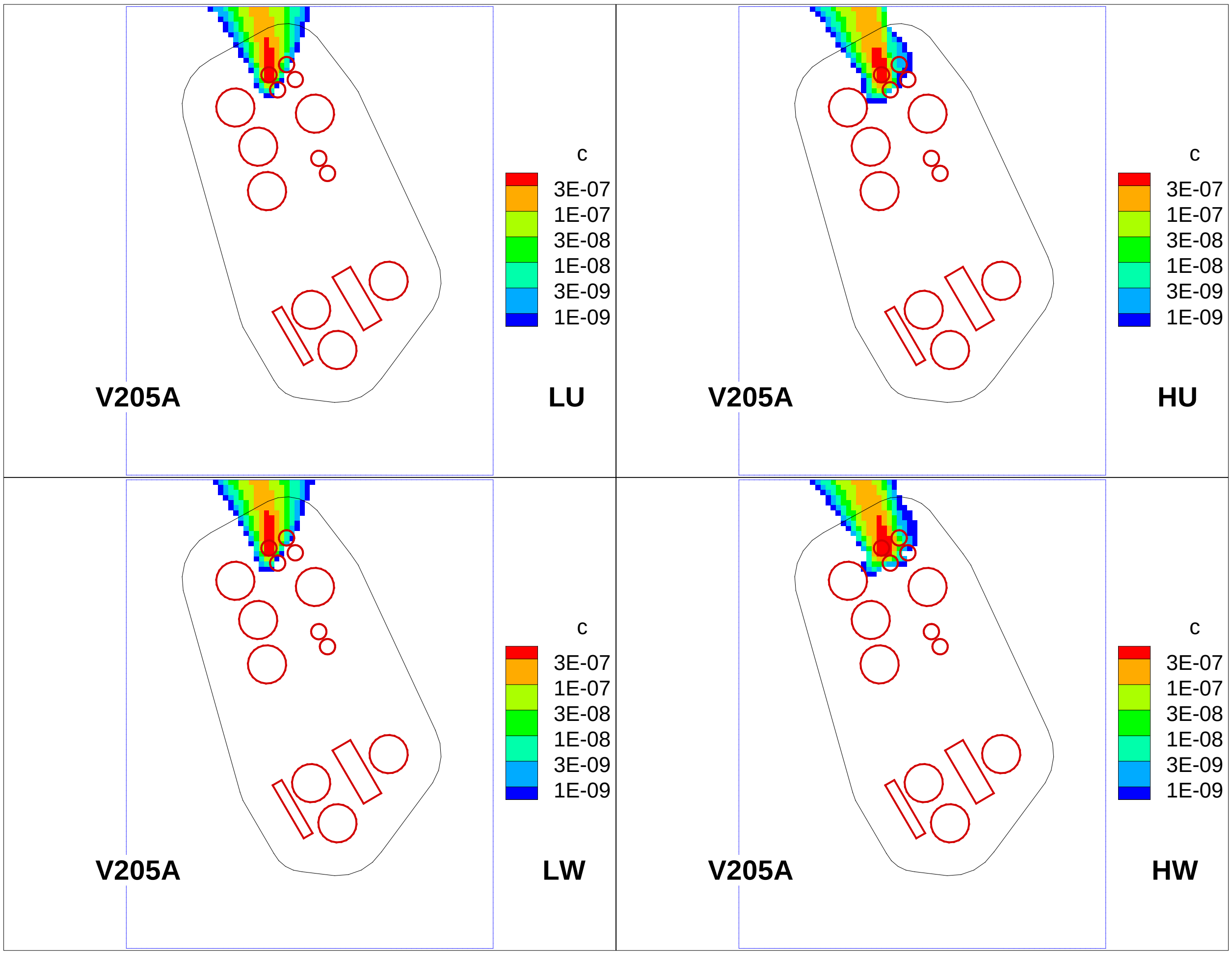


Figure 56. SDU 5A Tracer Plume Simulation of Steady-State Sources (concentration, C in Ci/L)

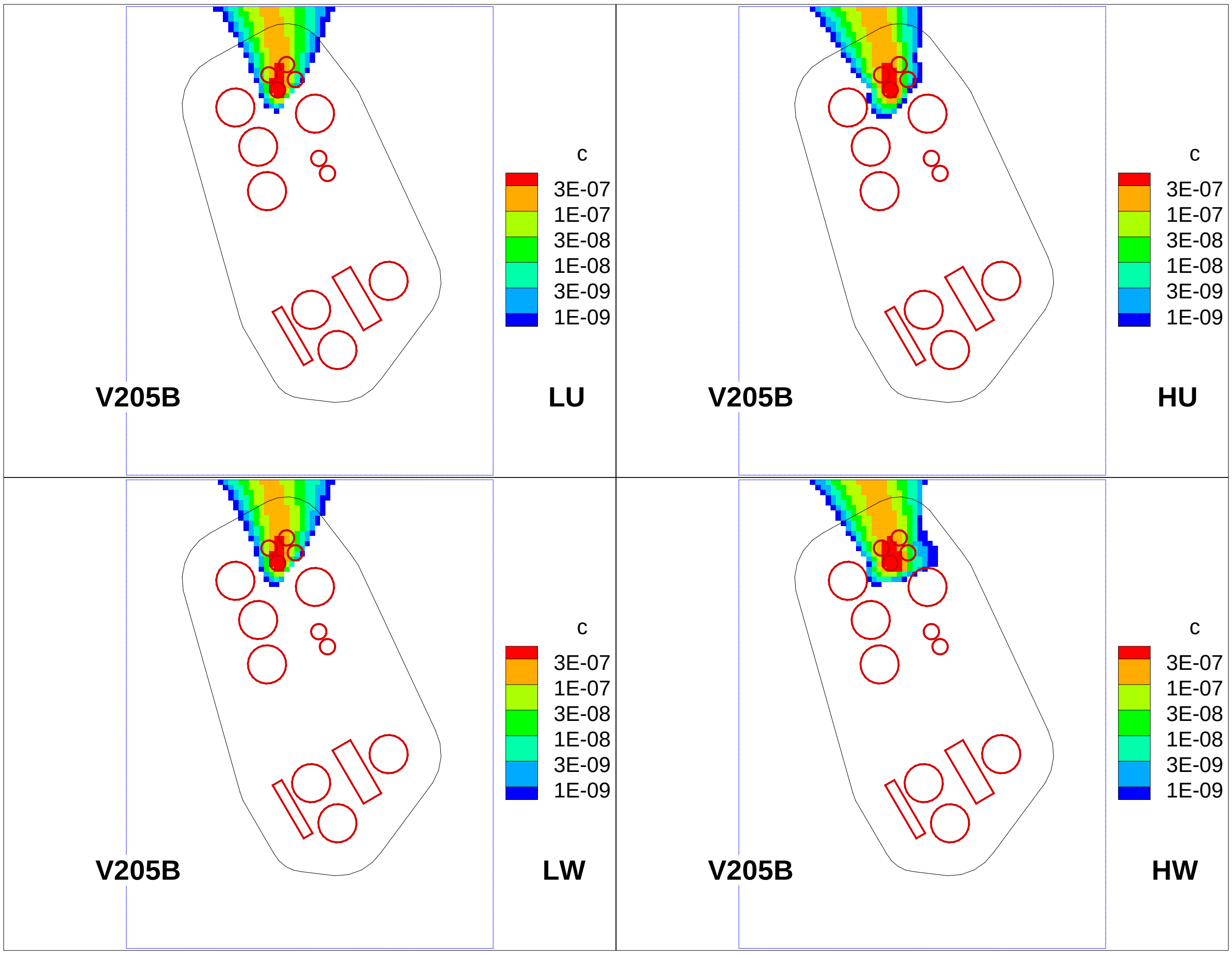


Figure 57. SDU 5B Tracer Plume Simulation of Steady-State Sources (concentration, C in Ci/L)

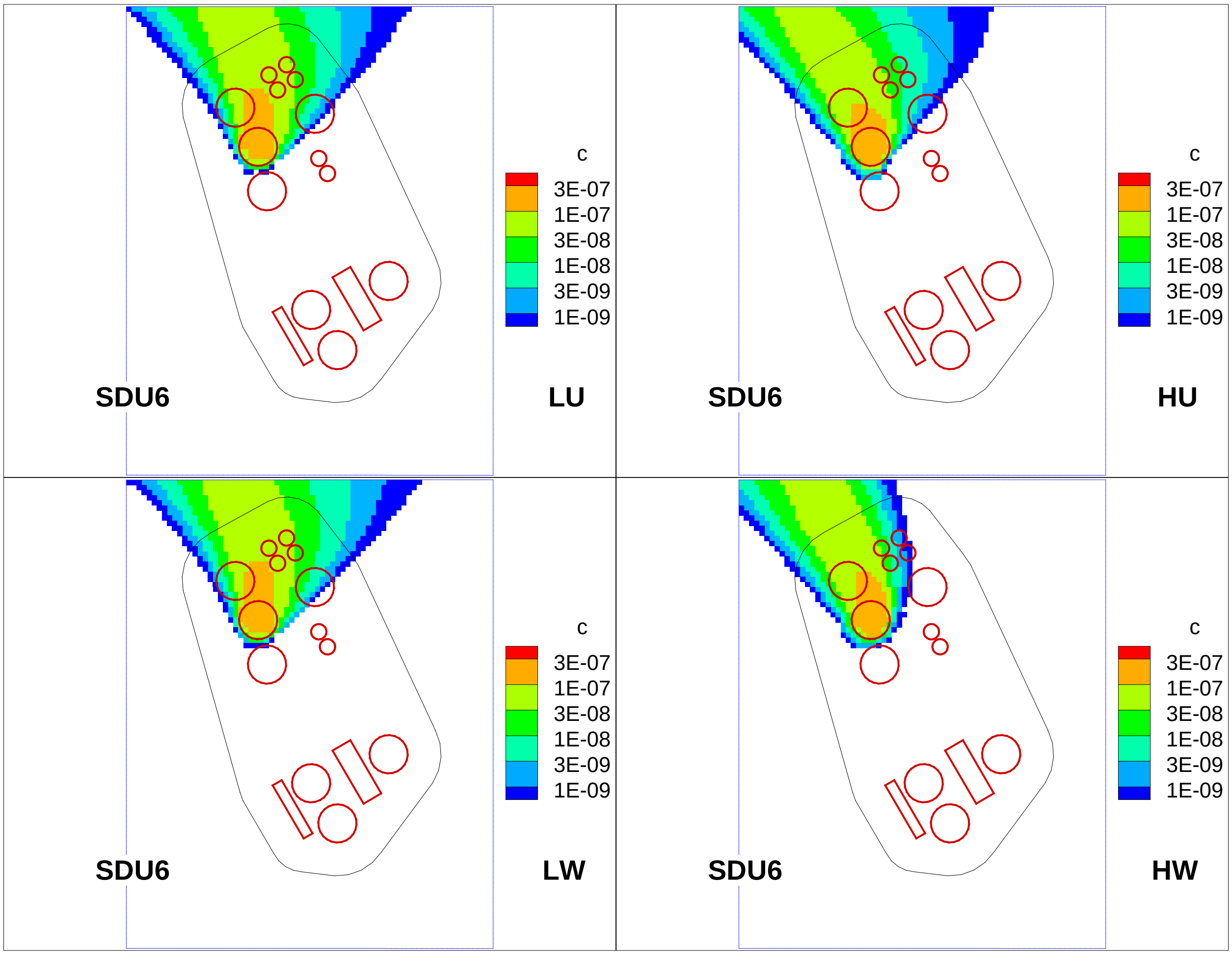


Figure 58. SDU 6 Tracer Plume Simulation of Steady-State Sources (concentration, C in Ci/L)

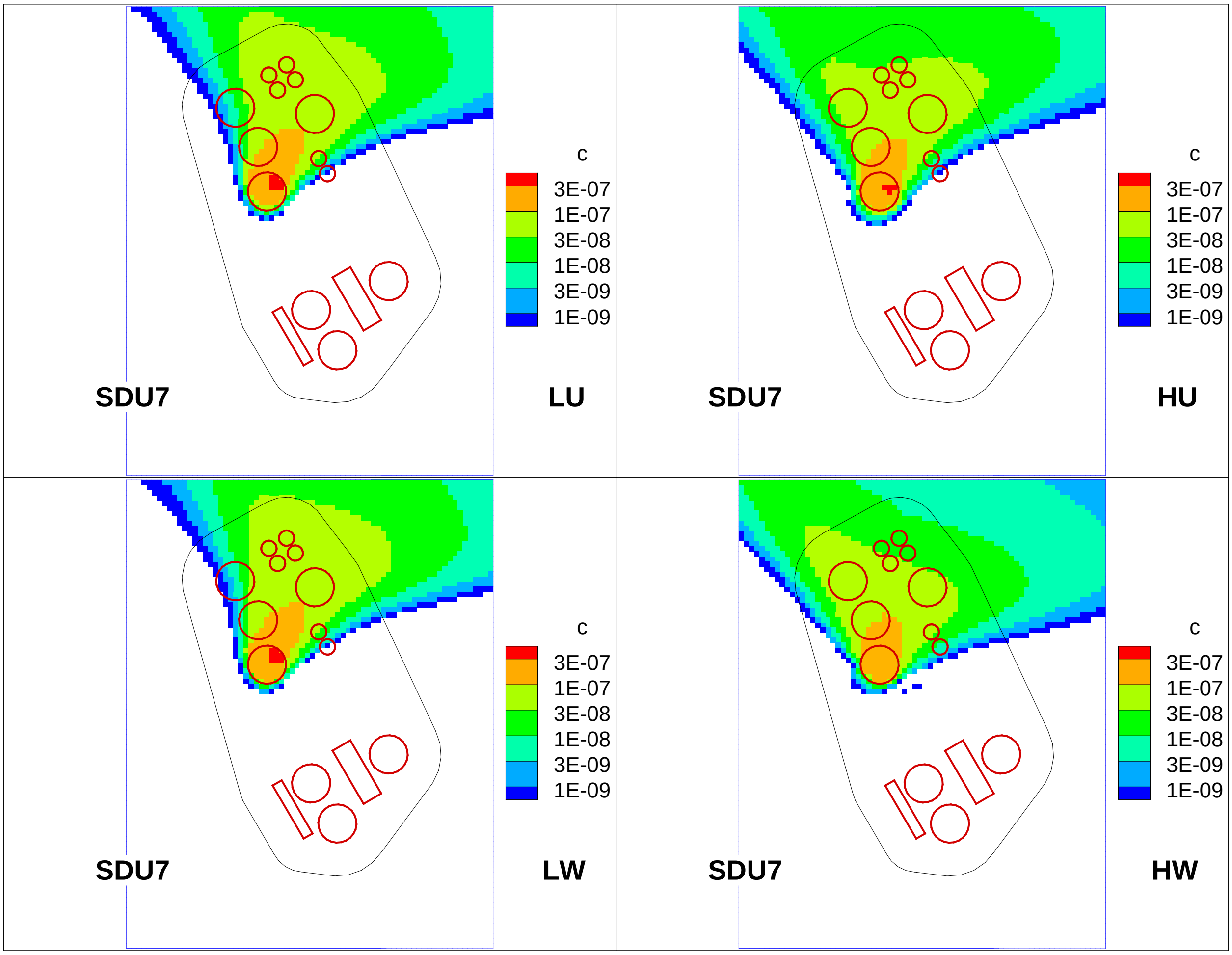


Figure 59. SDU 7 Tracer Plume Simulation of Steady-State Sources (concentration, C in Ci/L)

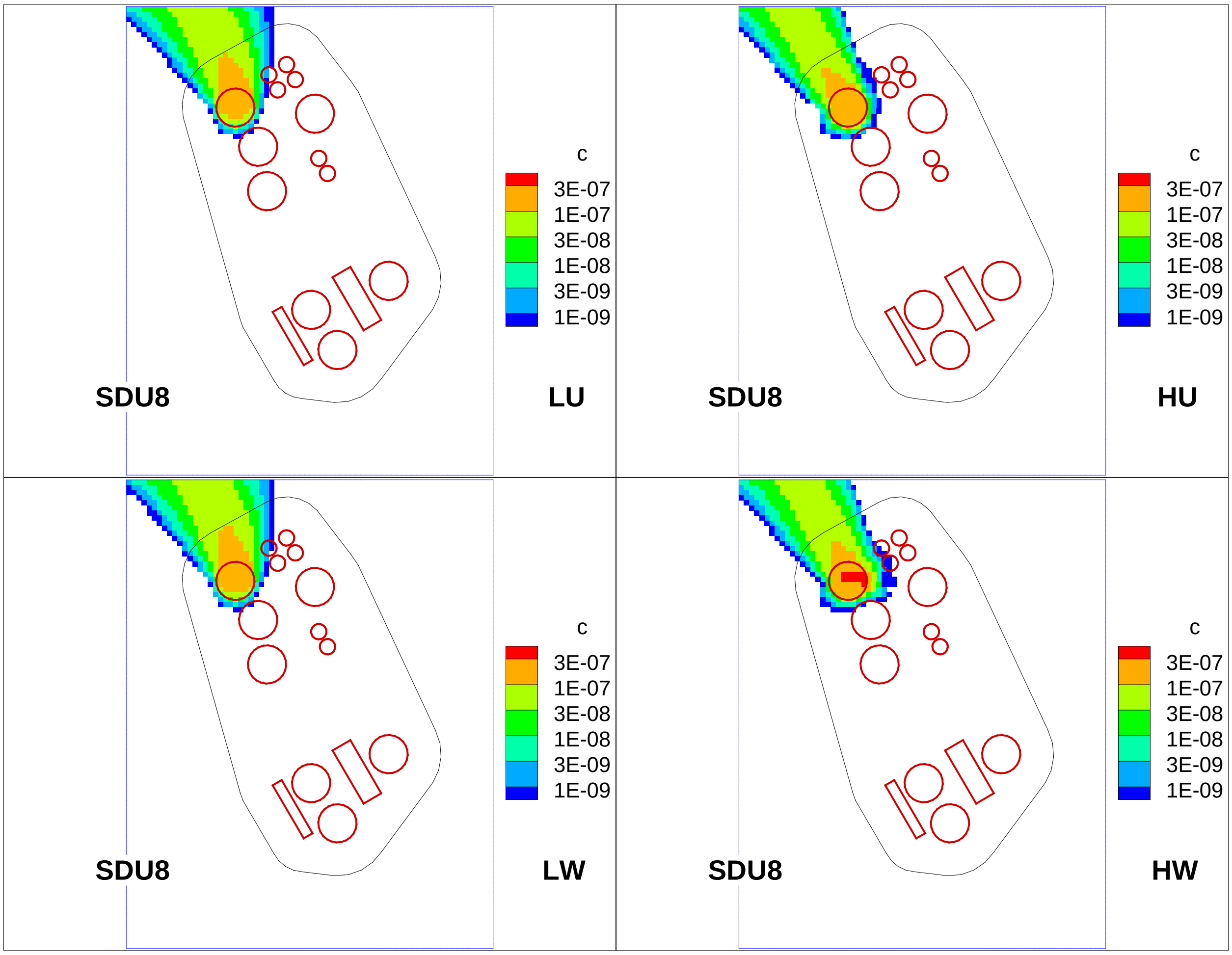


Figure 60. SDU 8 Tracer Plume Simulation of Steady-State Sources (concentration, C in Ci/L)

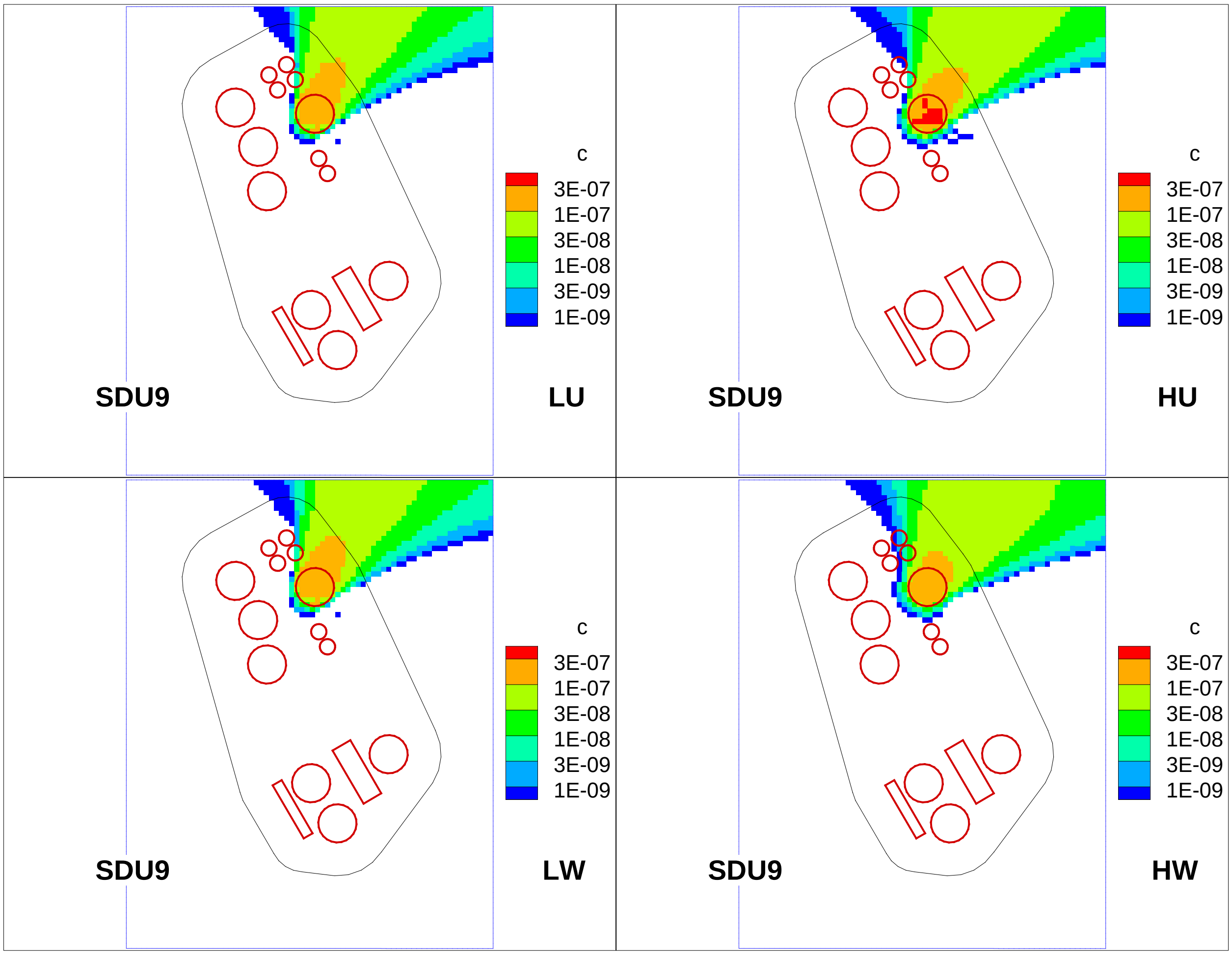


Figure 61. SDU 9 Tracer Plume Simulation of Steady-State Sources (concentration, C in Ci/L)

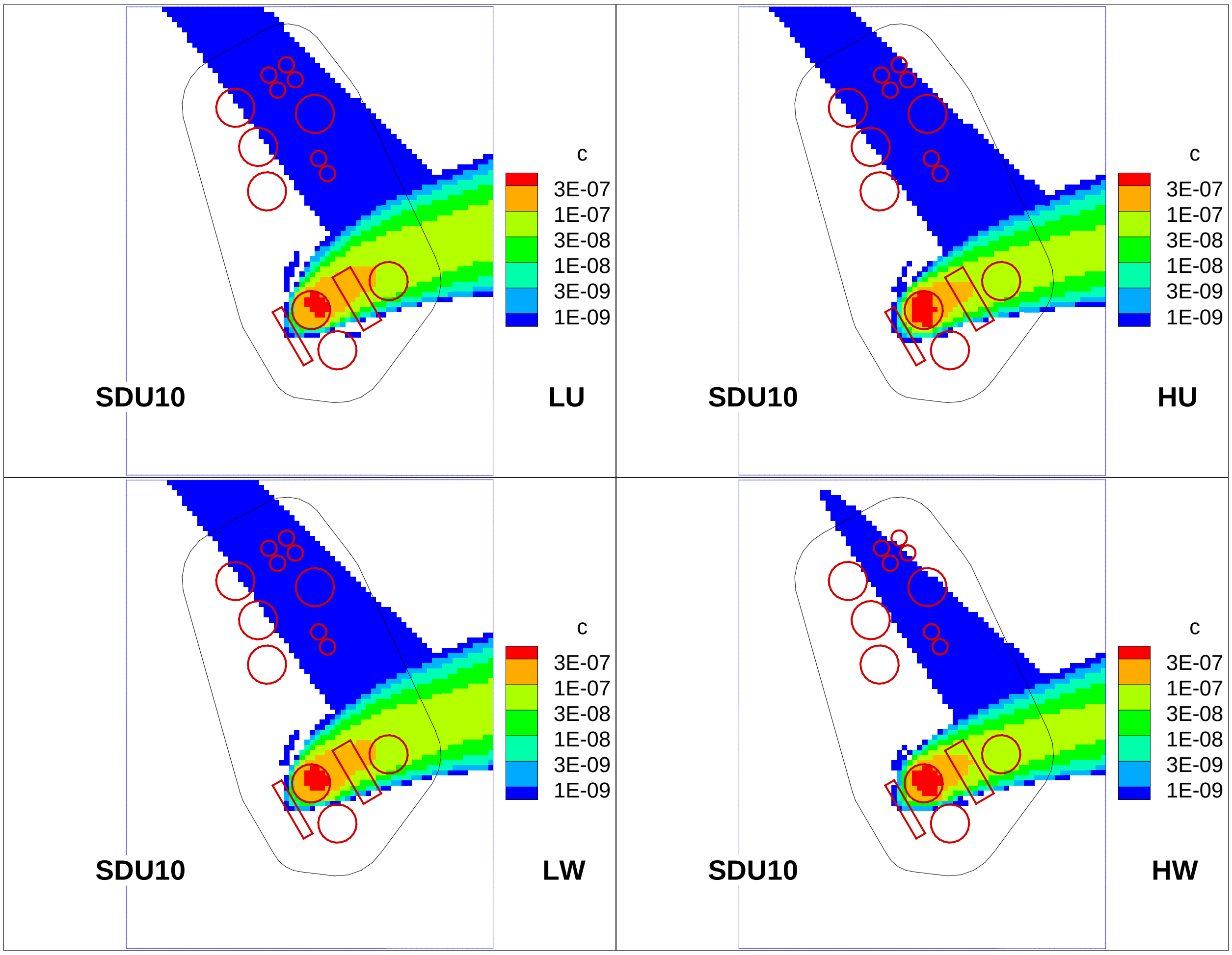


Figure 62. SDU 10 Tracer Plume Simulation of Steady-State Sources (concentration, C in Ci/L)

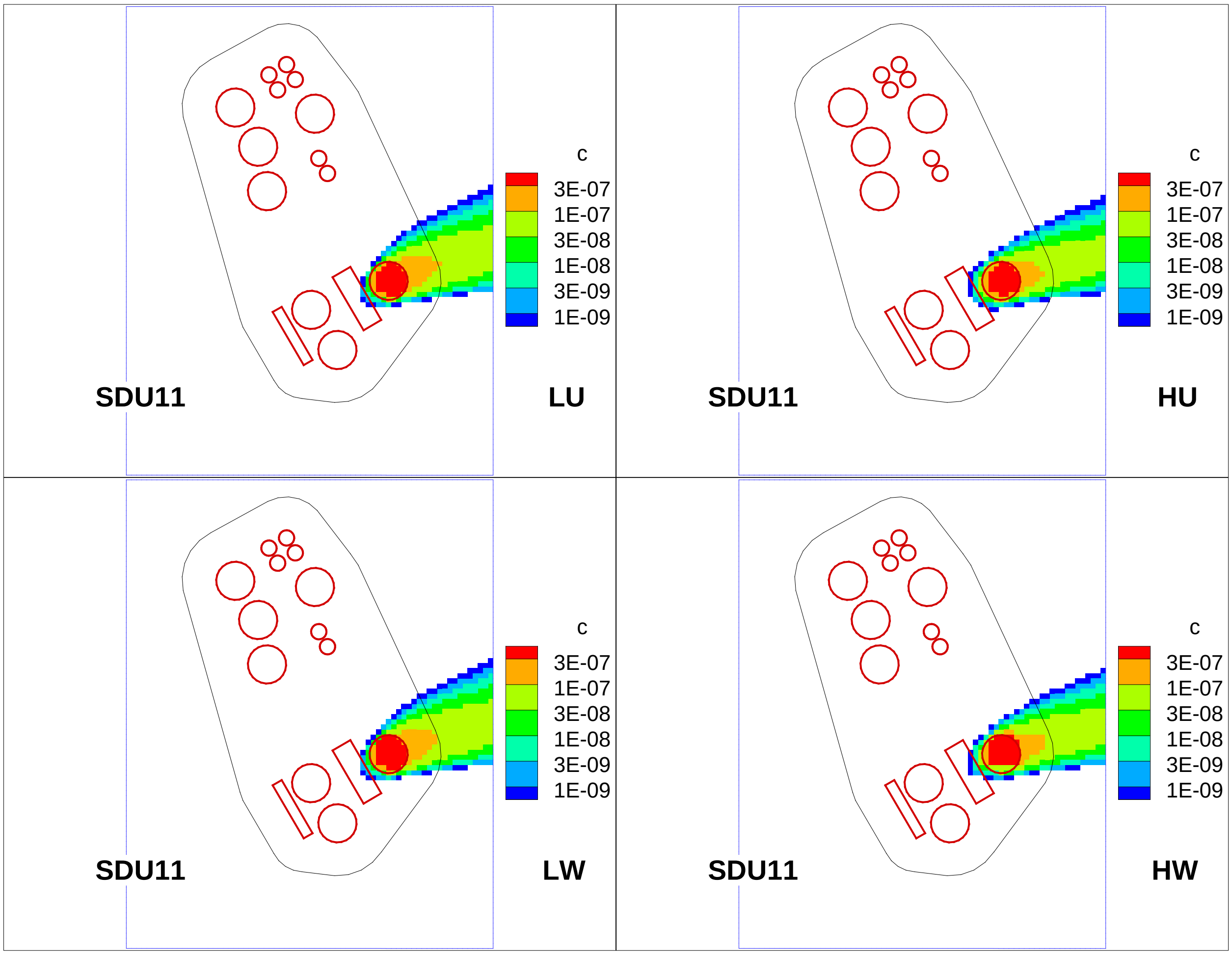


Figure 63. SDU 11 Tracer Plume Simulation of Steady-State Sources (concentration, C in Ci/L)

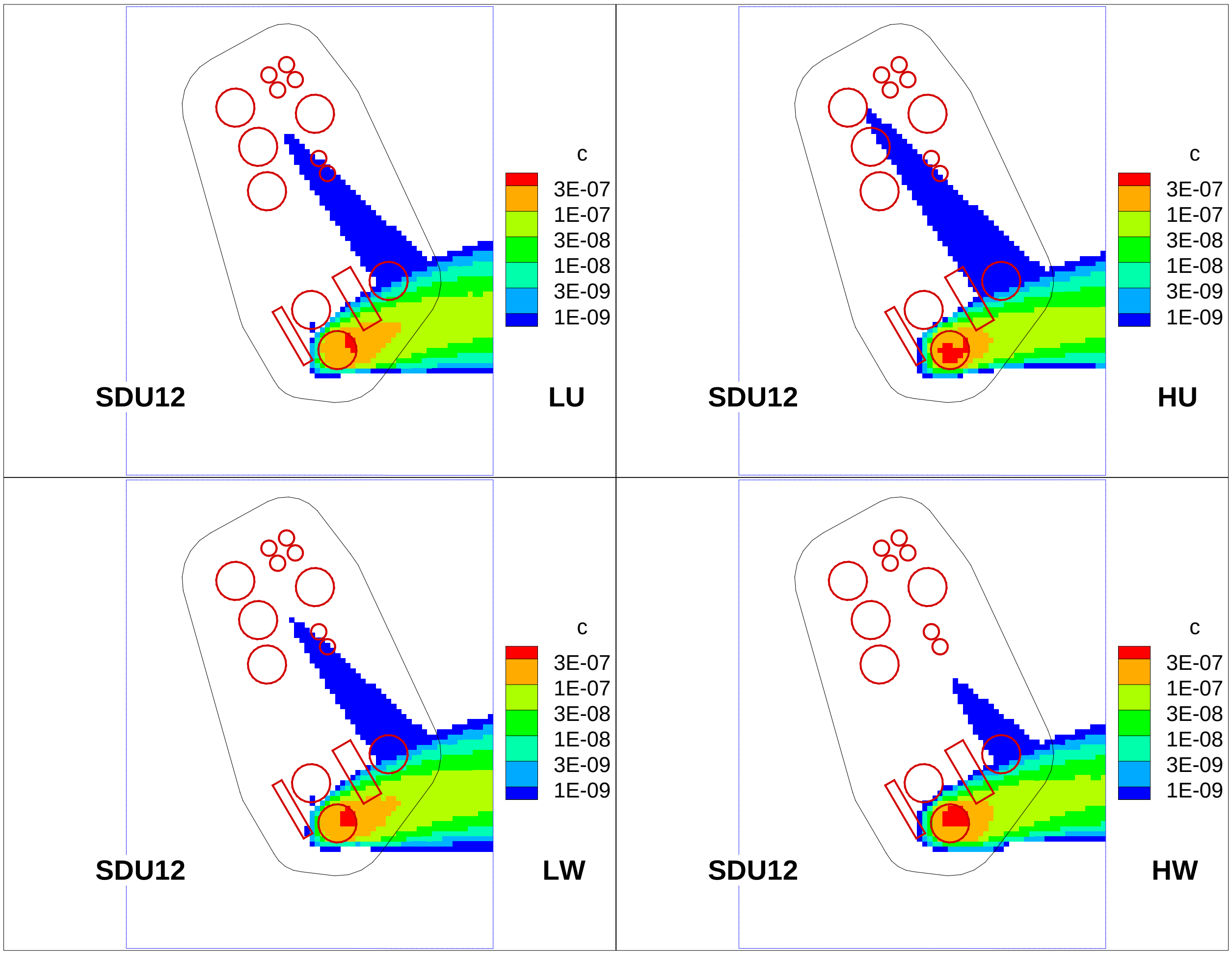


Figure 64. SDU 12 Tracer Plume Simulation of Steady-State Sources (concentration, C in Ci/L)

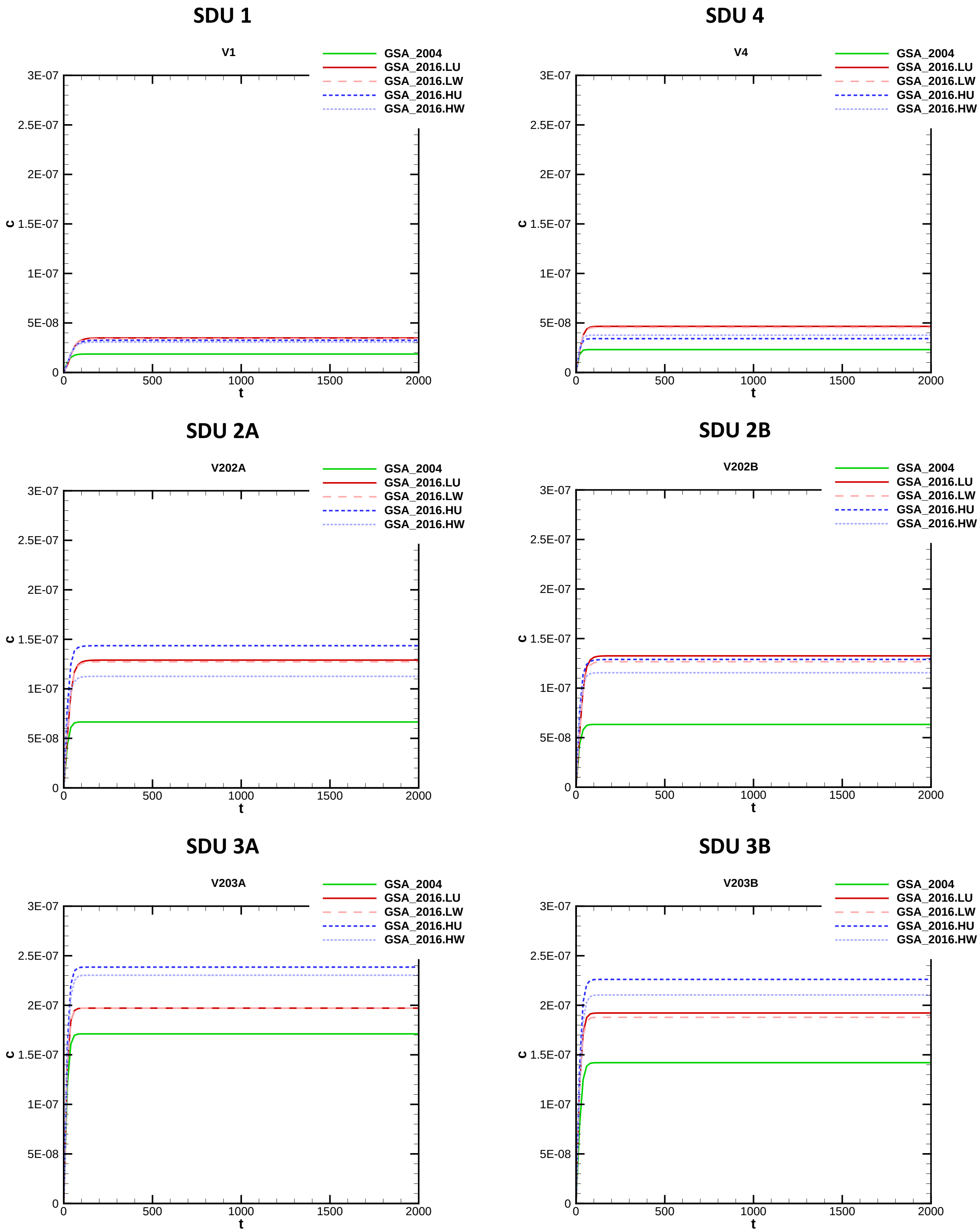


Figure 65. SDF Steady-State Source Concentrations (concentration, C in Ci/L, time, t in years)

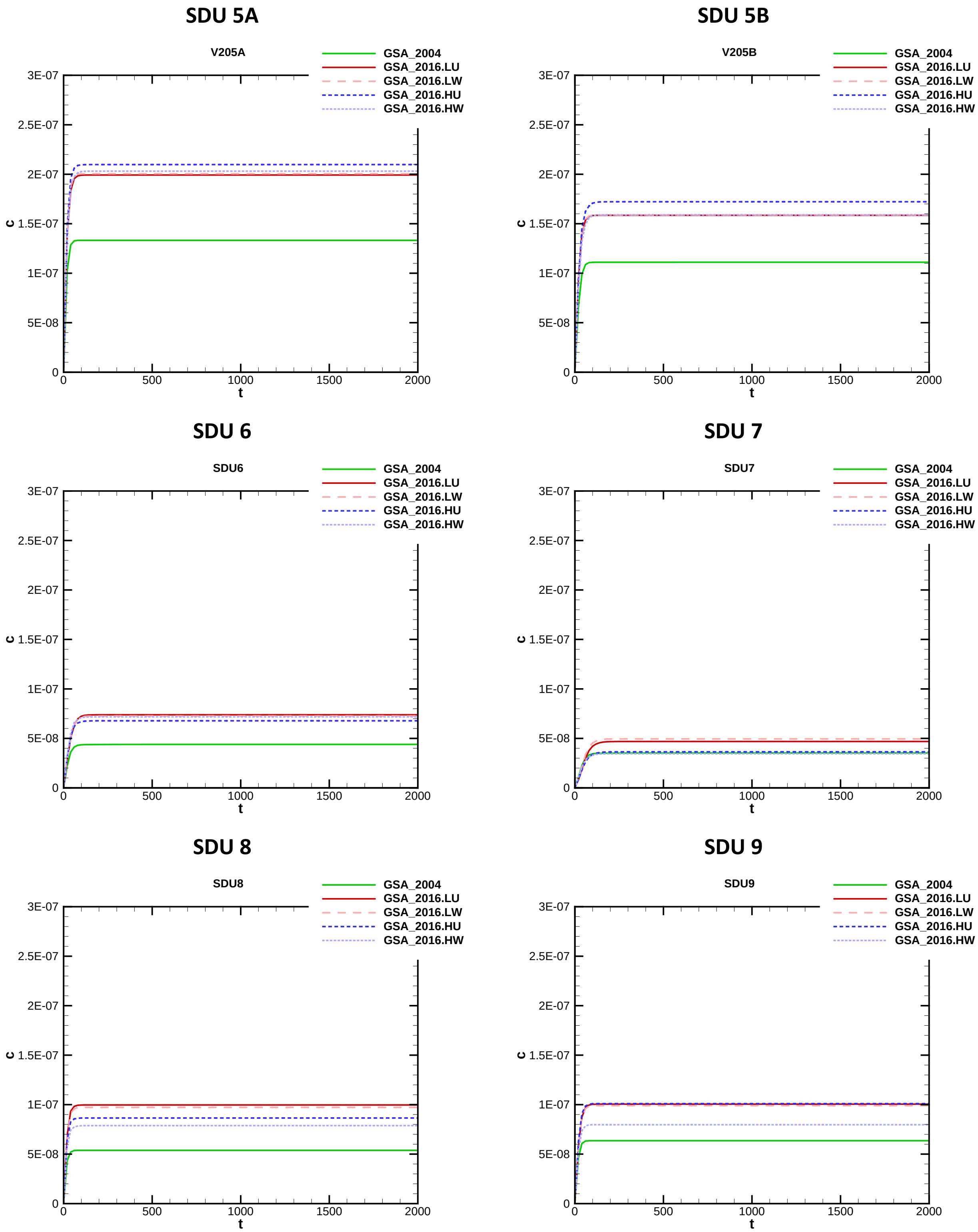


Figure 65. SDF Steady-State Source Concentrations (concentration, C in Ci/L, time, t in years) (cont'd)

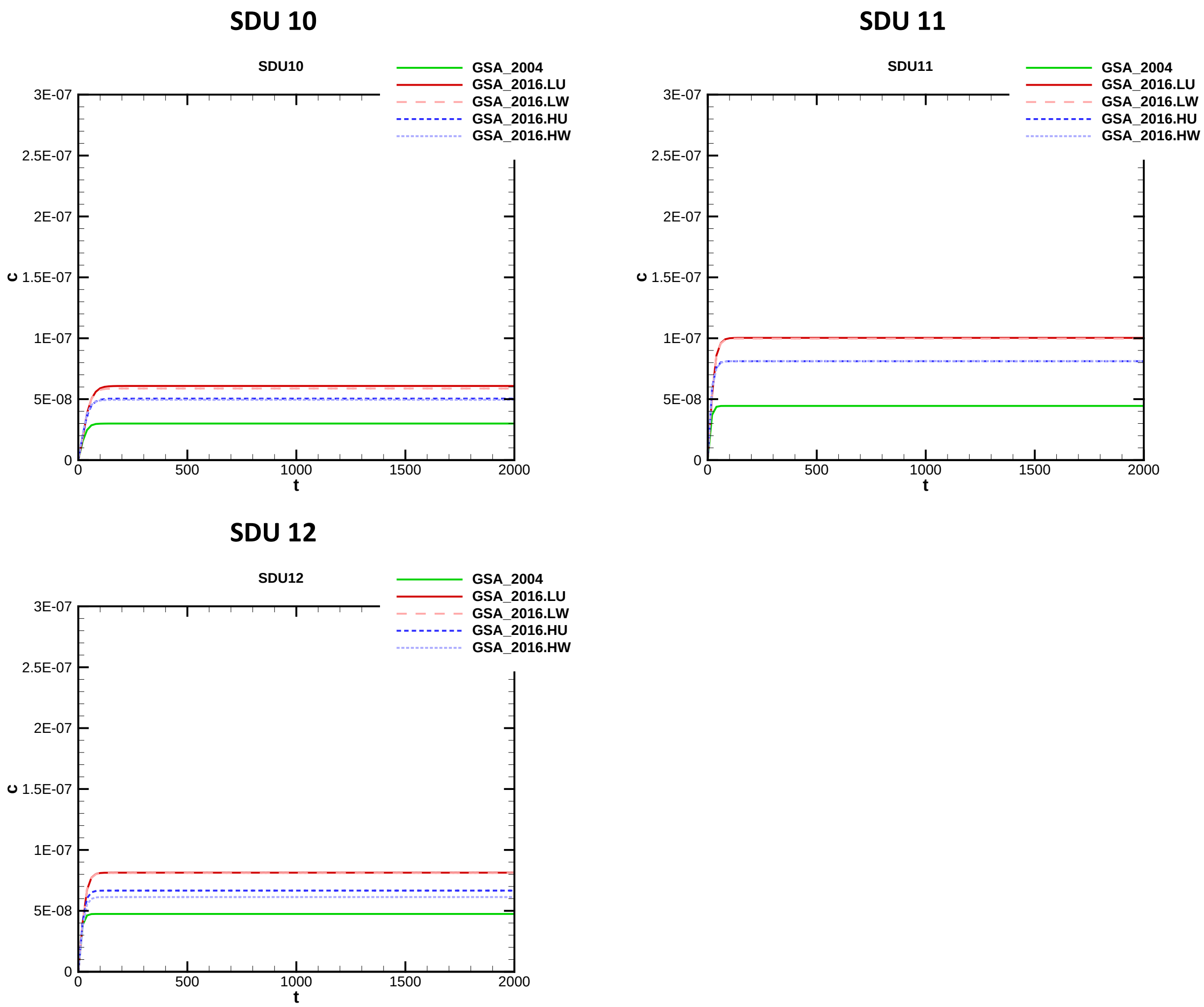
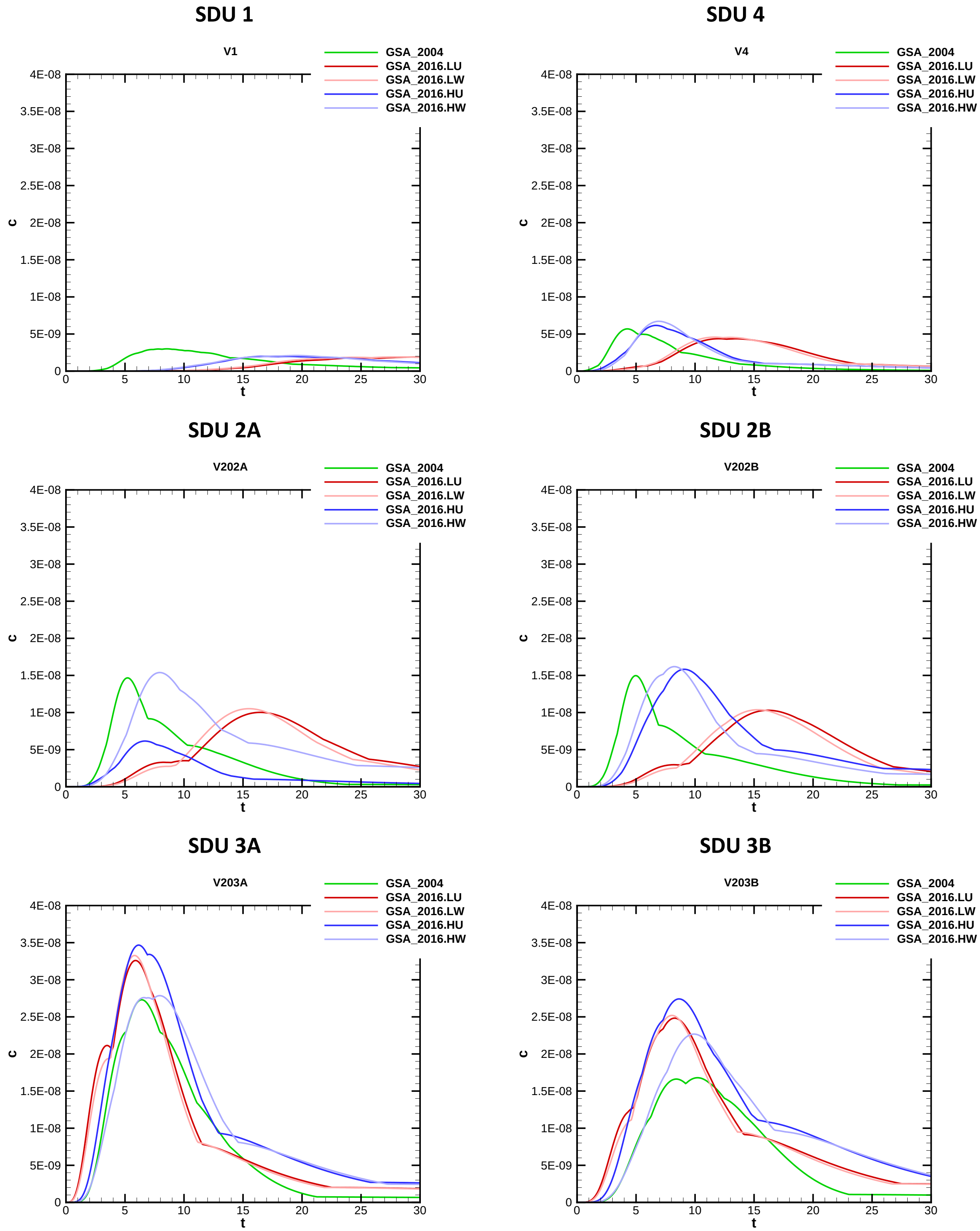


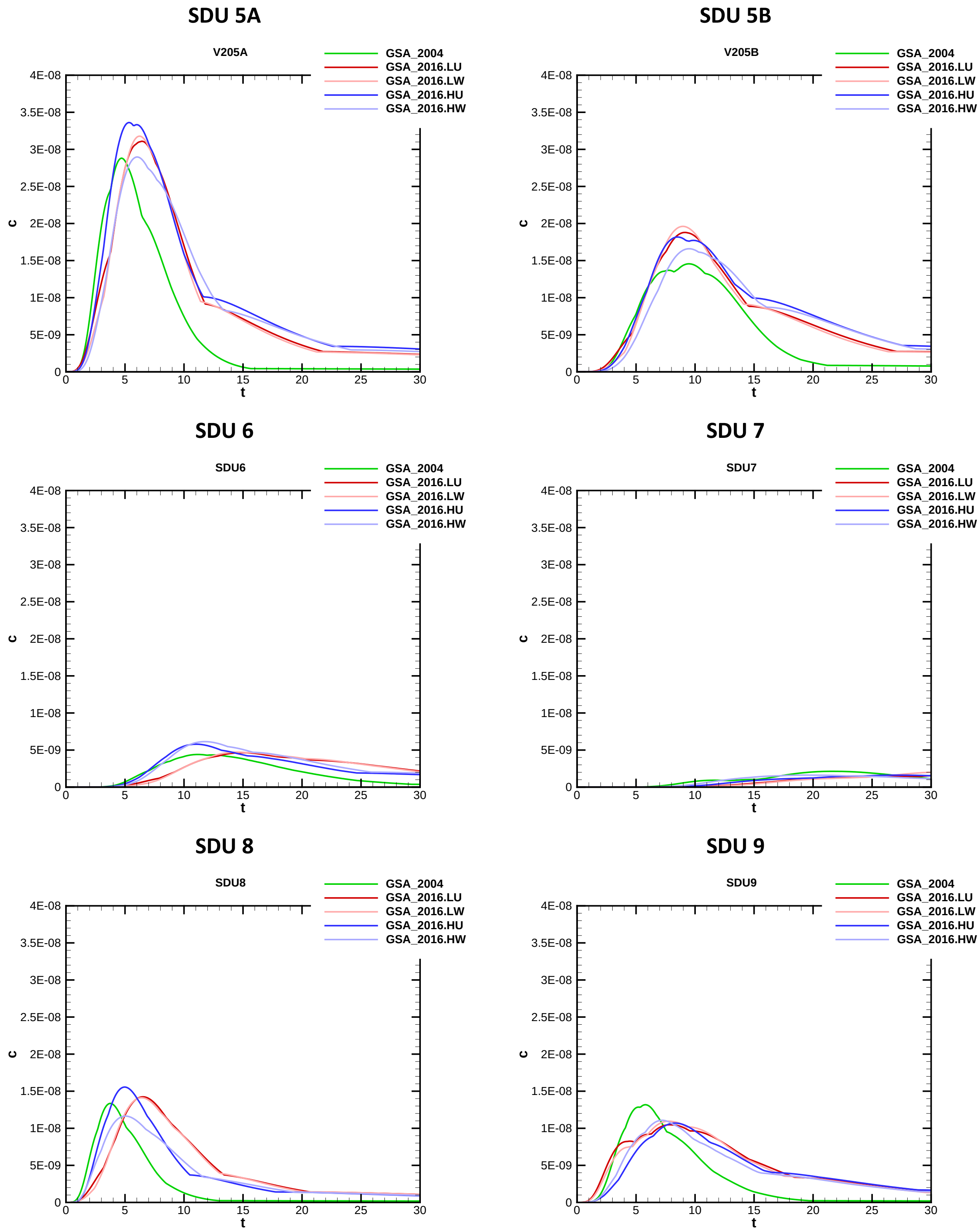
Figure 65. SDF Steady-State Source Concentrations (concentration, C in Ci/L, time, t in years) (cont'd)

5.1.2.2 Transient/Pulsed Sources



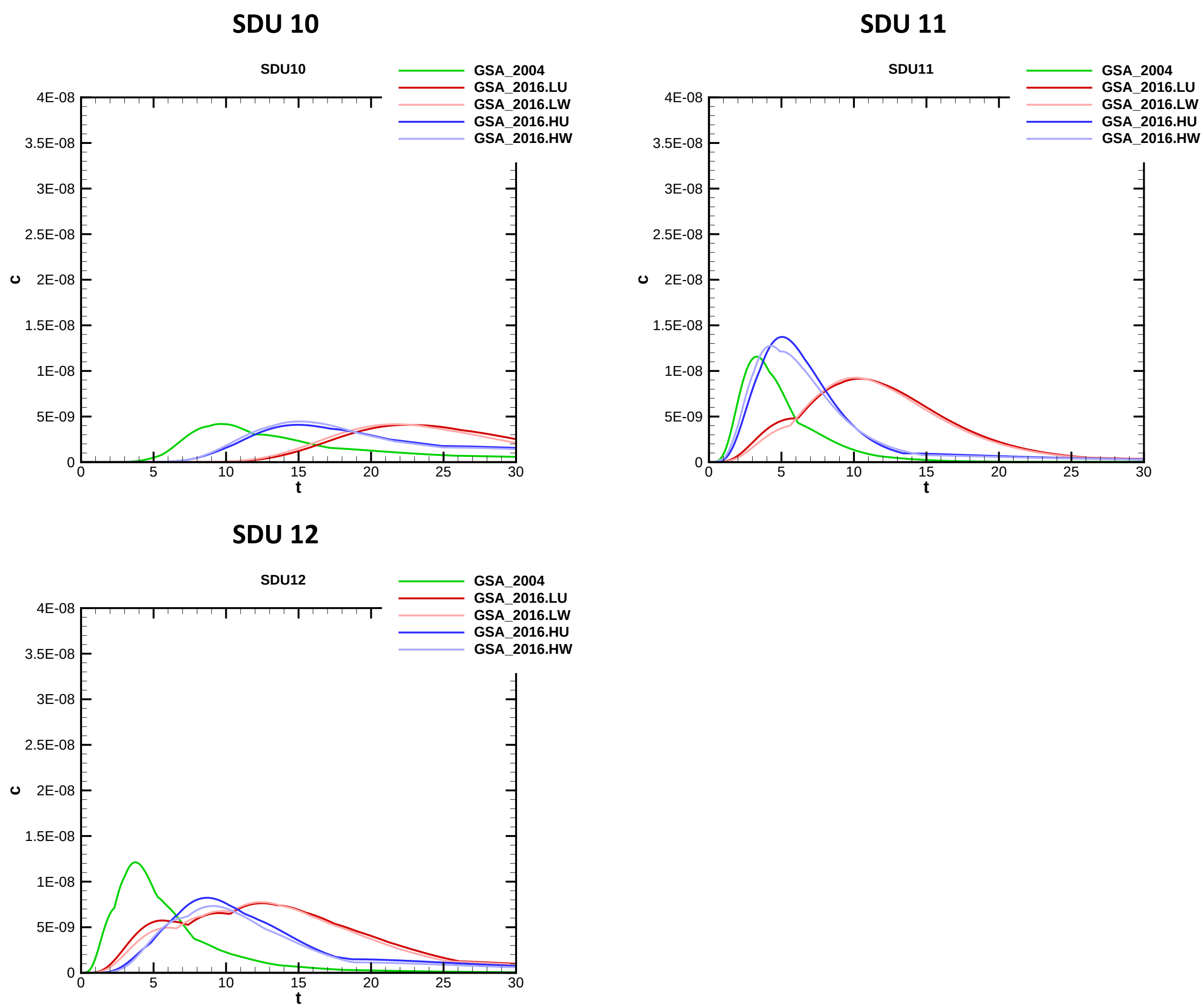
Note: Concentrations are monitored at 100-meter boundary

Figure 66. SDF Pulsed Source Concentrations (concentration, C in Ci/L, time, t in years)



Note: Concentrations are monitored at 100-meter boundary

Figure 66. SDF Pulsed Source Concentrations (concentration, C in Ci/L, time, t in years) (cont'd)



Note: Concentrations are monitored at 100-meter boundary

Figure 66. SDF Pulsed Source Concentrations (concentration, C in Ci/L, time, t in years) (cont'd)

5.1.3 Evaluation Case Transport Simulations

5.1.3.1 Concentrations at 100-meter Boundary

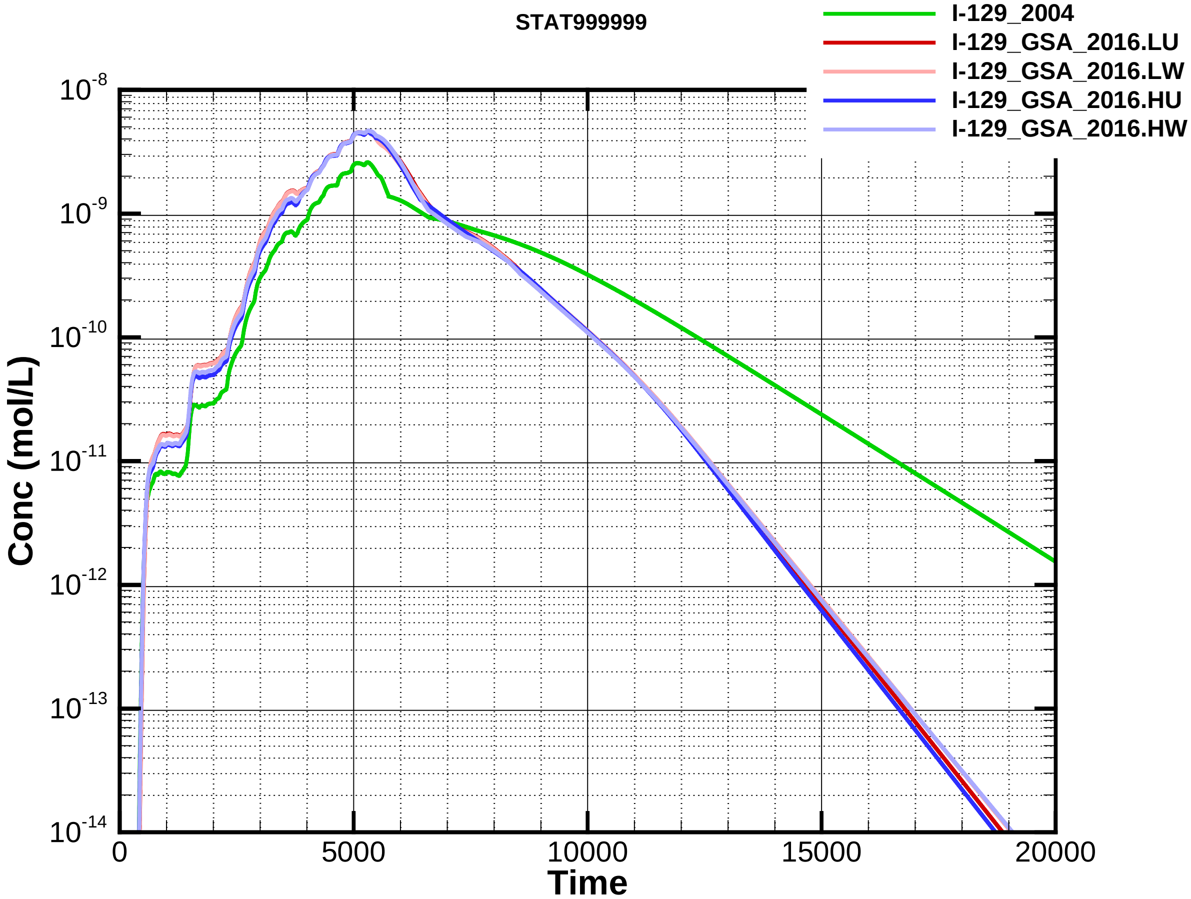


Figure 67. SDF I-129 Concentrations (for all GSA_2016 Flows) at 100-meter Boundary (Time in years)

5.1.3.2 Concentrations at the Seepline

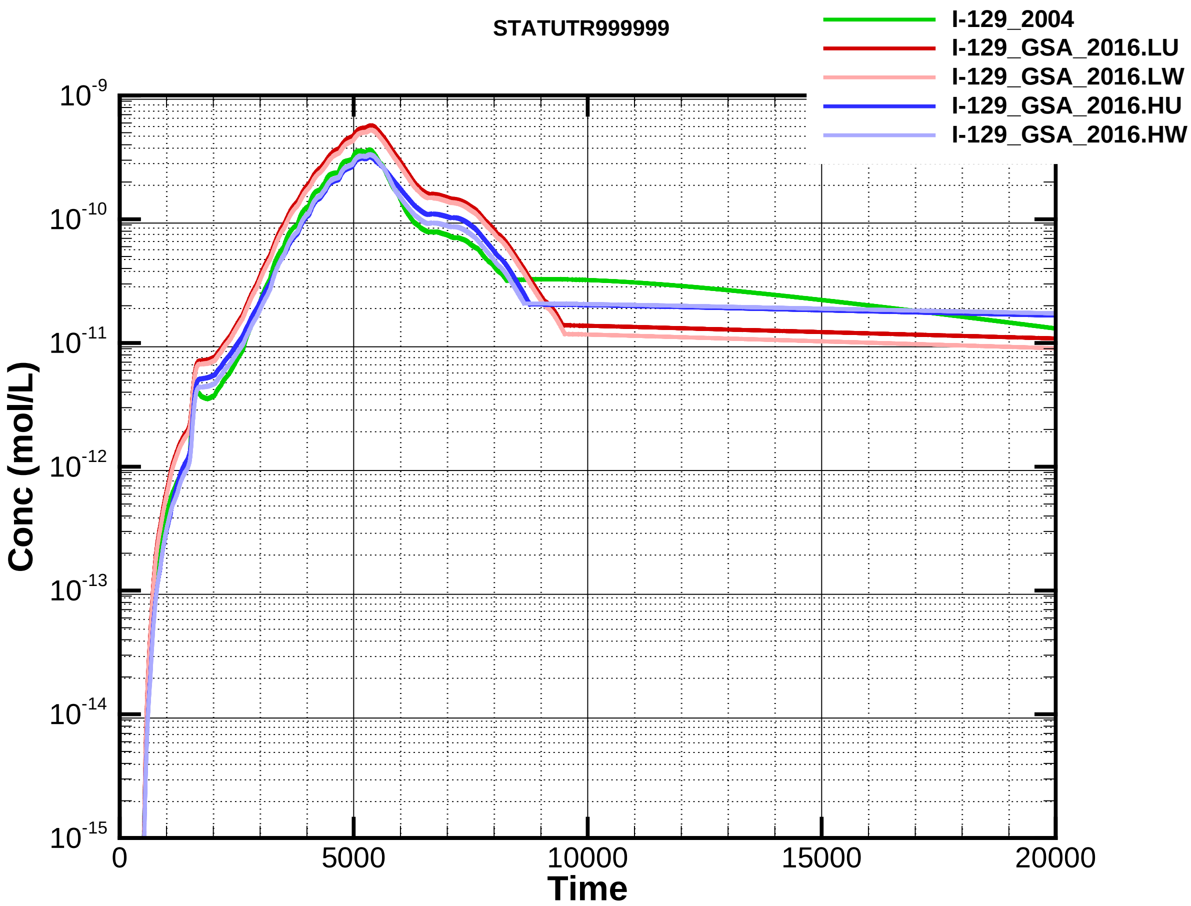


Figure 68. SDF I-129 Concentrations (for all GSA_2016 Flows) at the Seepline (Time in years)

5.2 H-Area Tank Farm

5.2.1 Streamtraces with Timing Markers

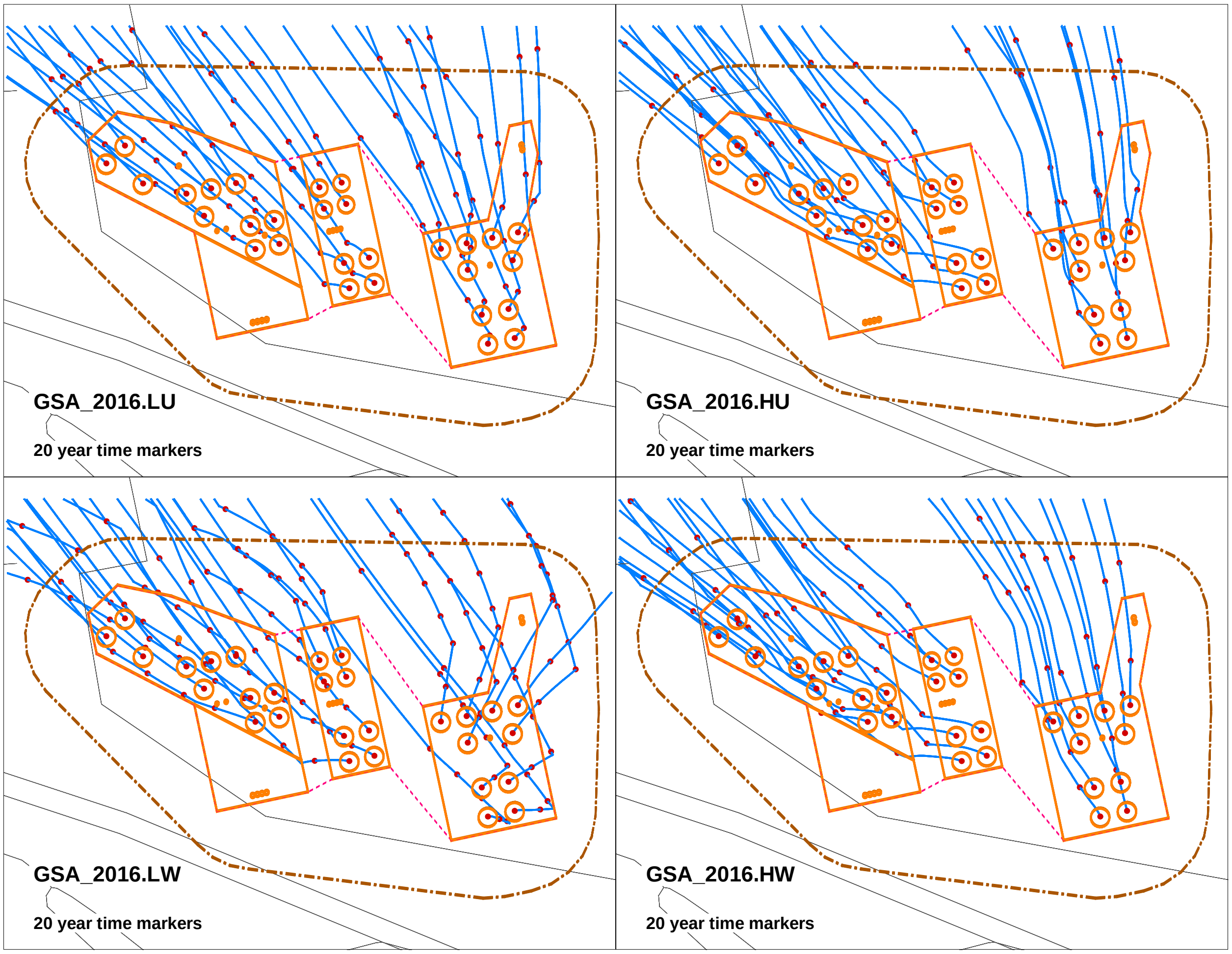


Figure 69. HTF Streamtraces with Timing Markers

5.2.2 Tracer Plume Simulations

5.2.2.1 Steady-State Sources

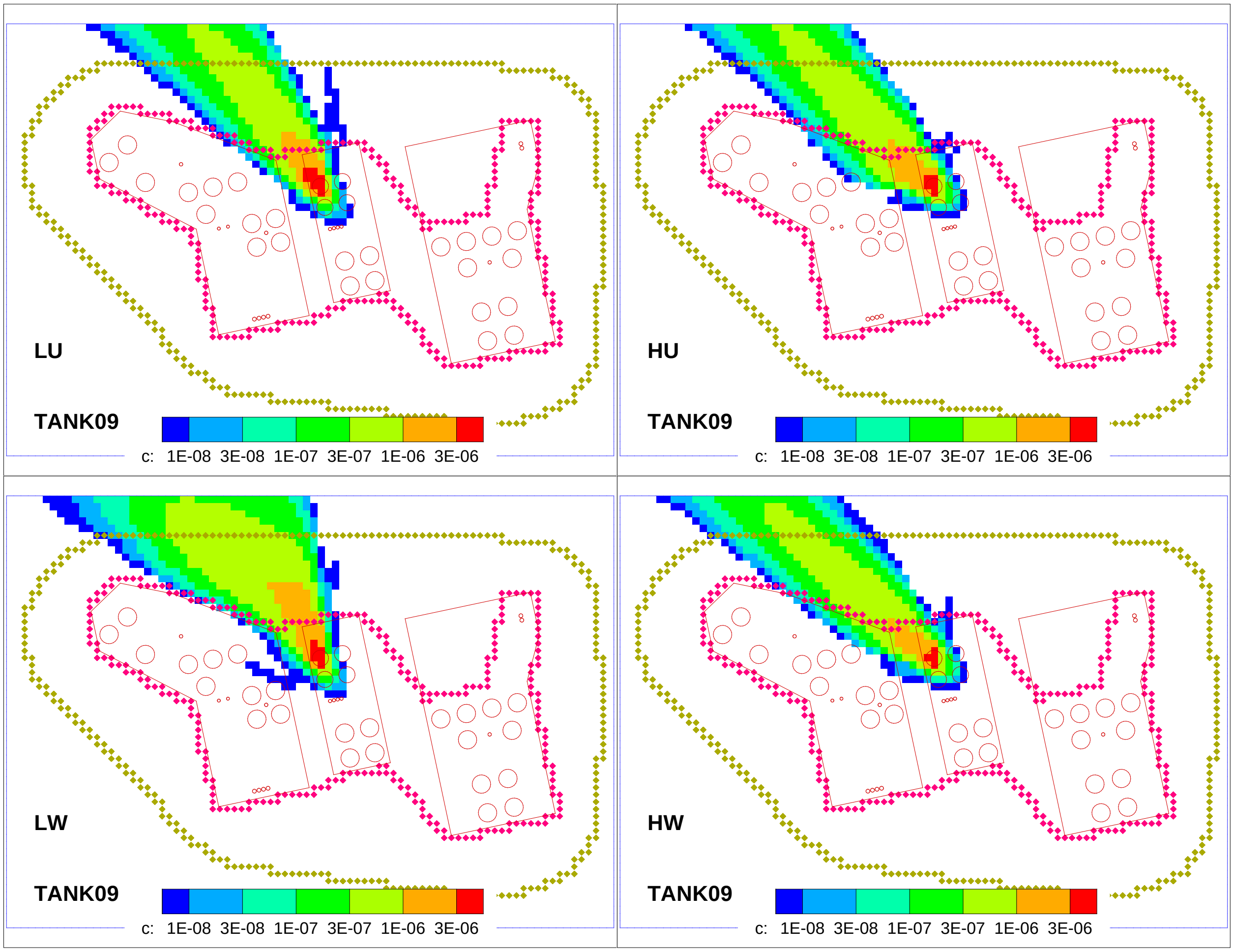


Figure 70. HTF Tank 09 Tracer Plume Simulation of Steady-State Sources (concentration, C in Ci/L)

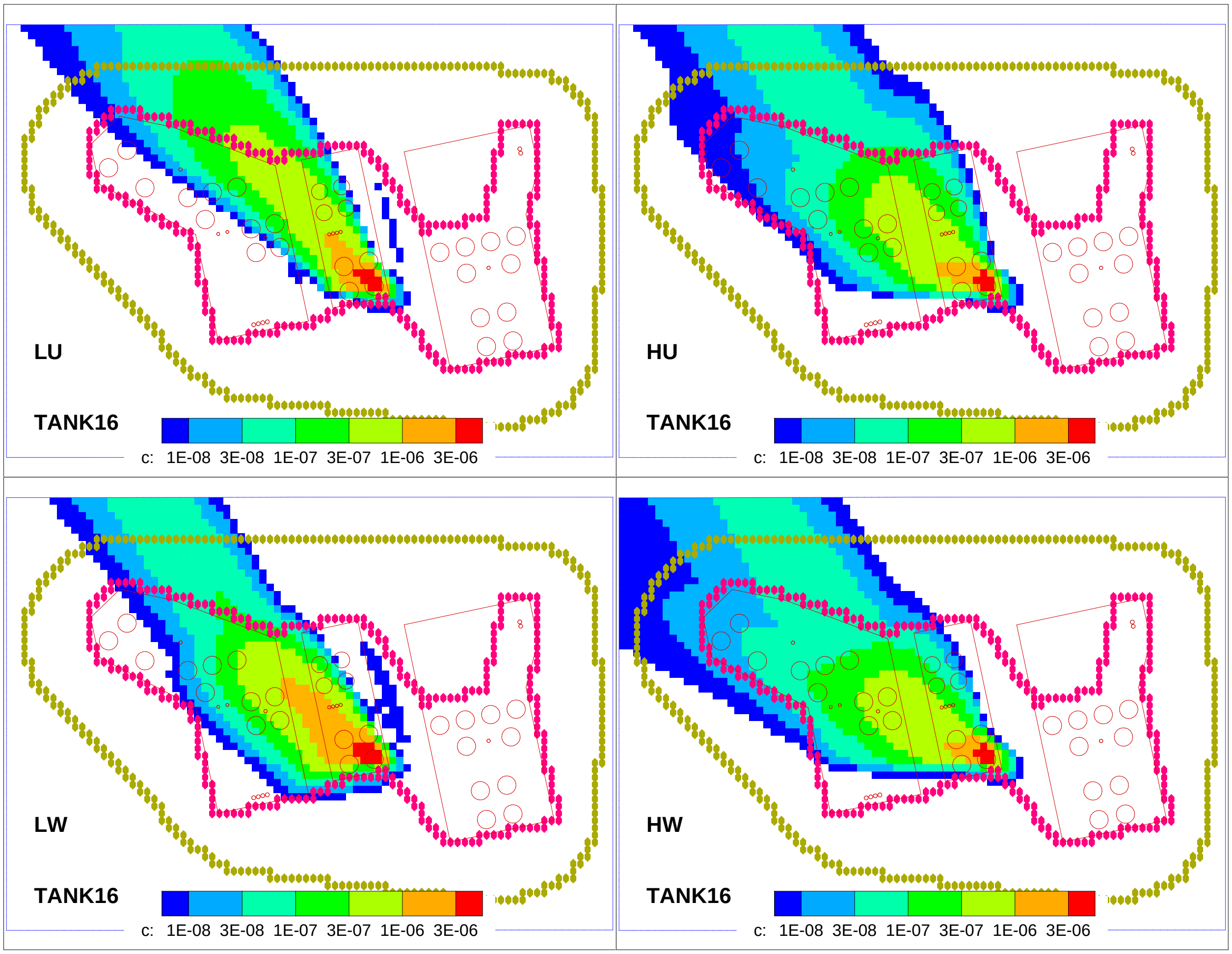


Figure 71. HTF Tank 16 Tracer Plume Simulation of Steady-State Sources (concentration, C in Ci/L)

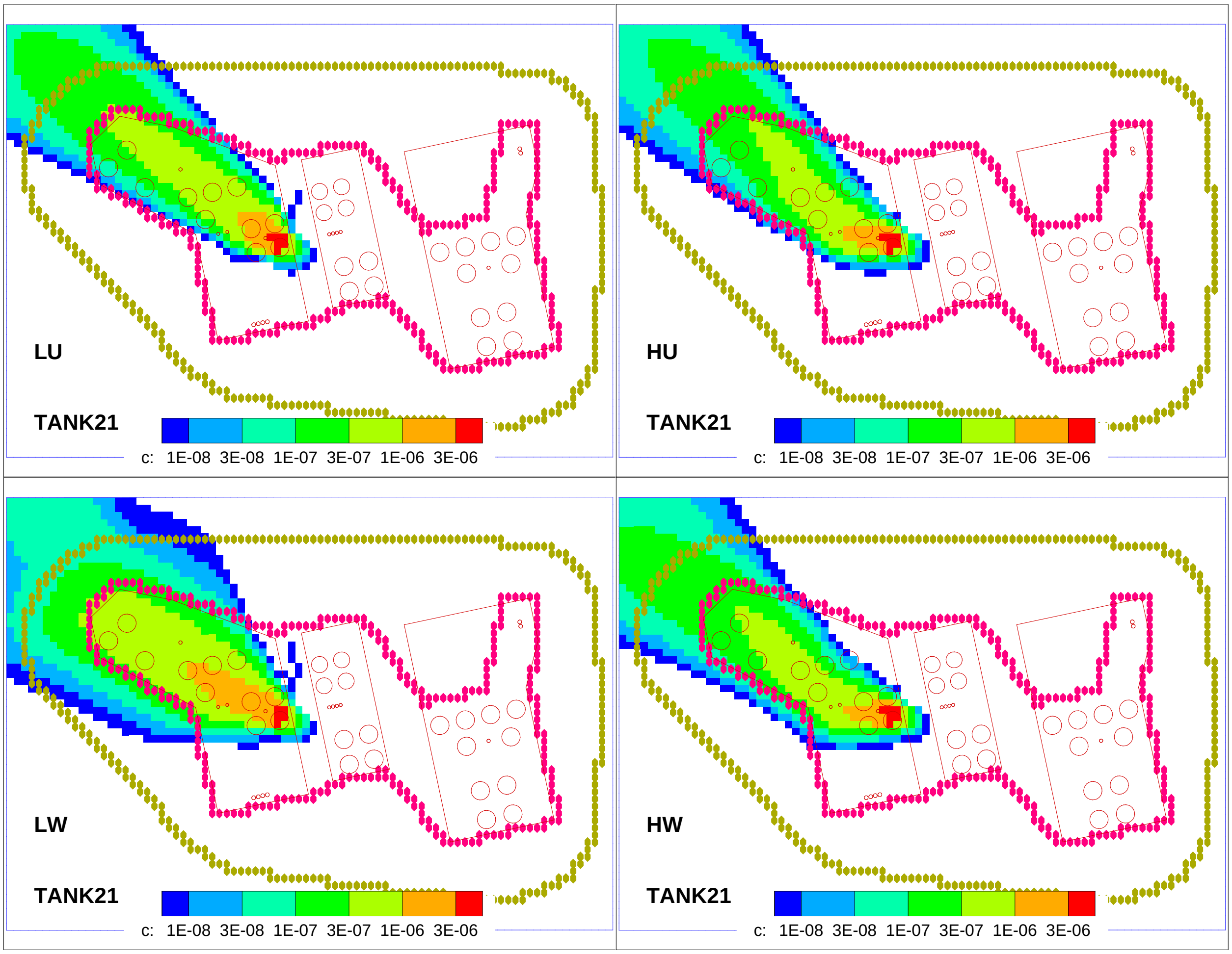


Figure 72. HTF Tank 21 Tracer Plume Simulation of Steady-State Sources (concentration, C in Ci/L)

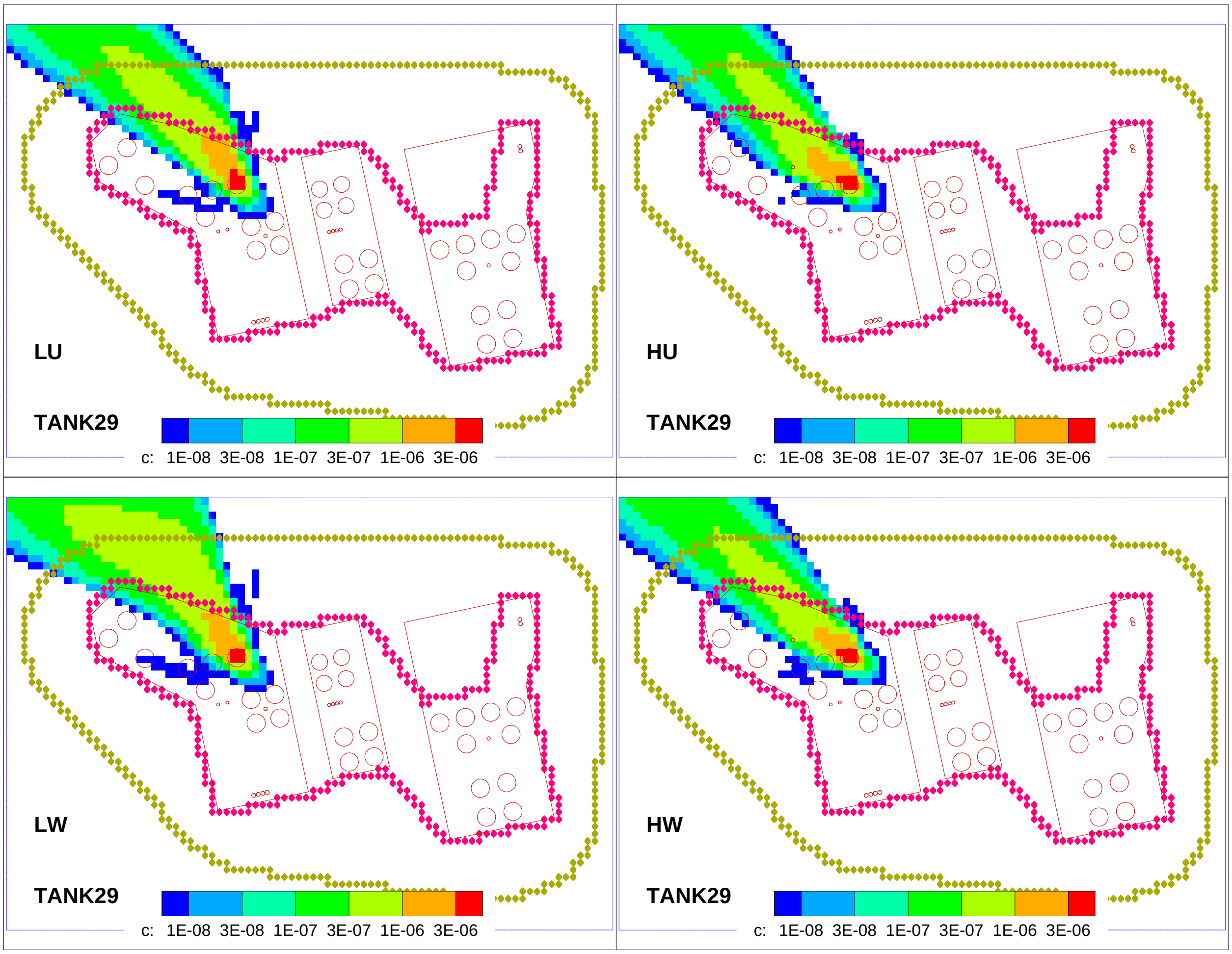


Figure 73. HTF Tank 29 Tracer Plume Simulation of Steady-State Sources (concentration, C in Ci/L)

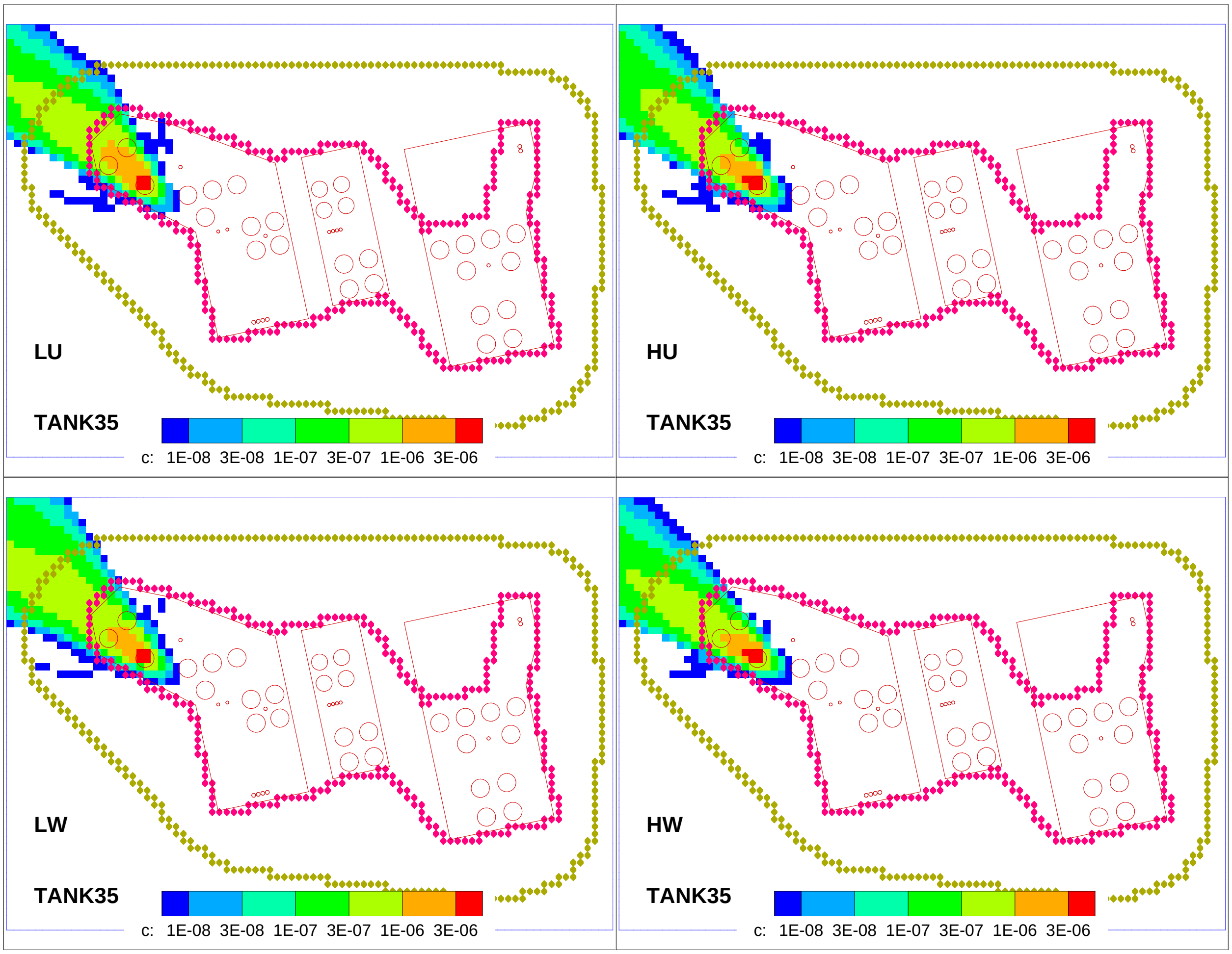


Figure 74. HTF Tank 35 Tracer Plume Simulation of Steady-State Sources (concentration, C in Ci/L)

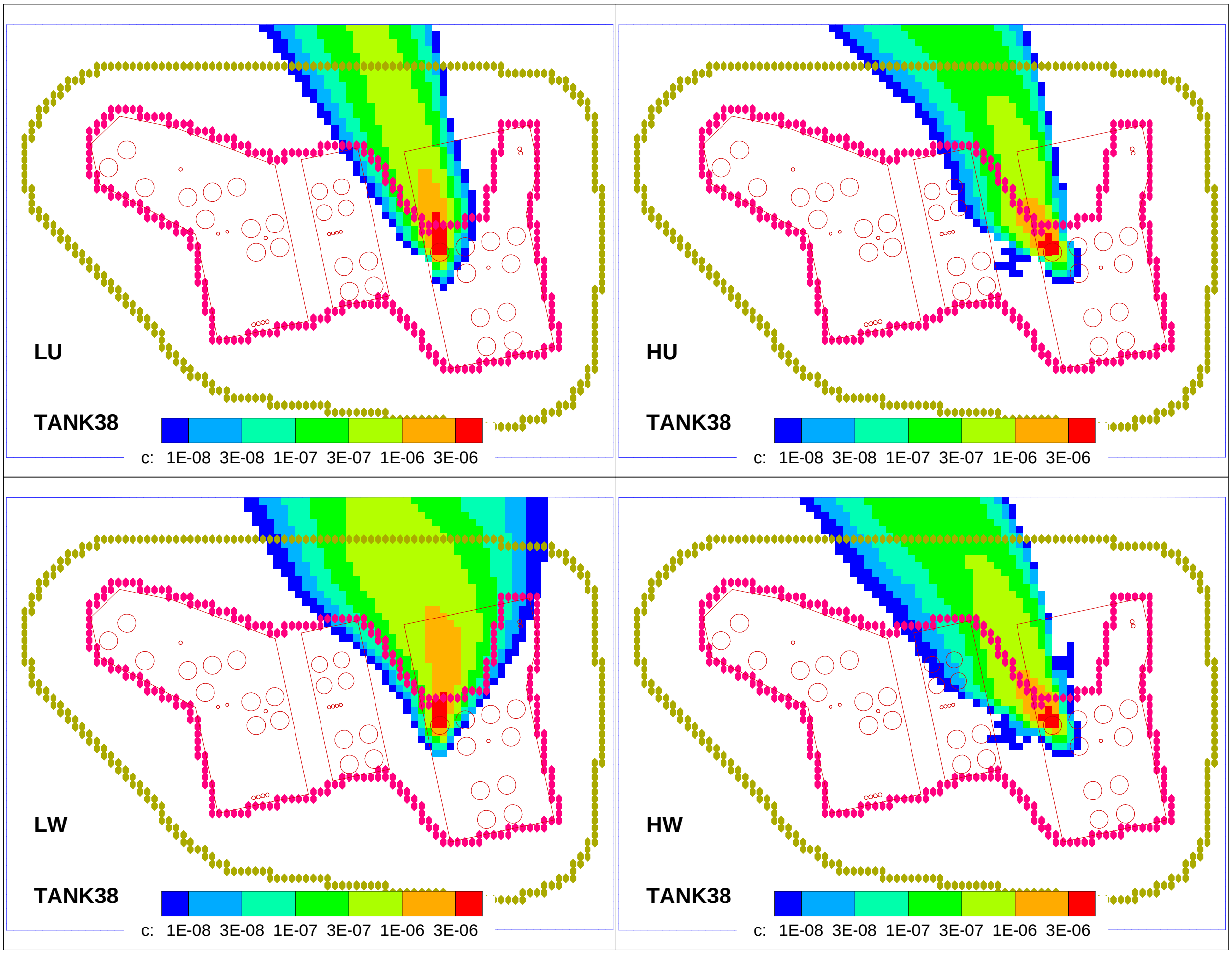


Figure 75. HTF Tank 38 Tracer Plume Simulation of Steady-State Sources (concentration, C in Ci/L)

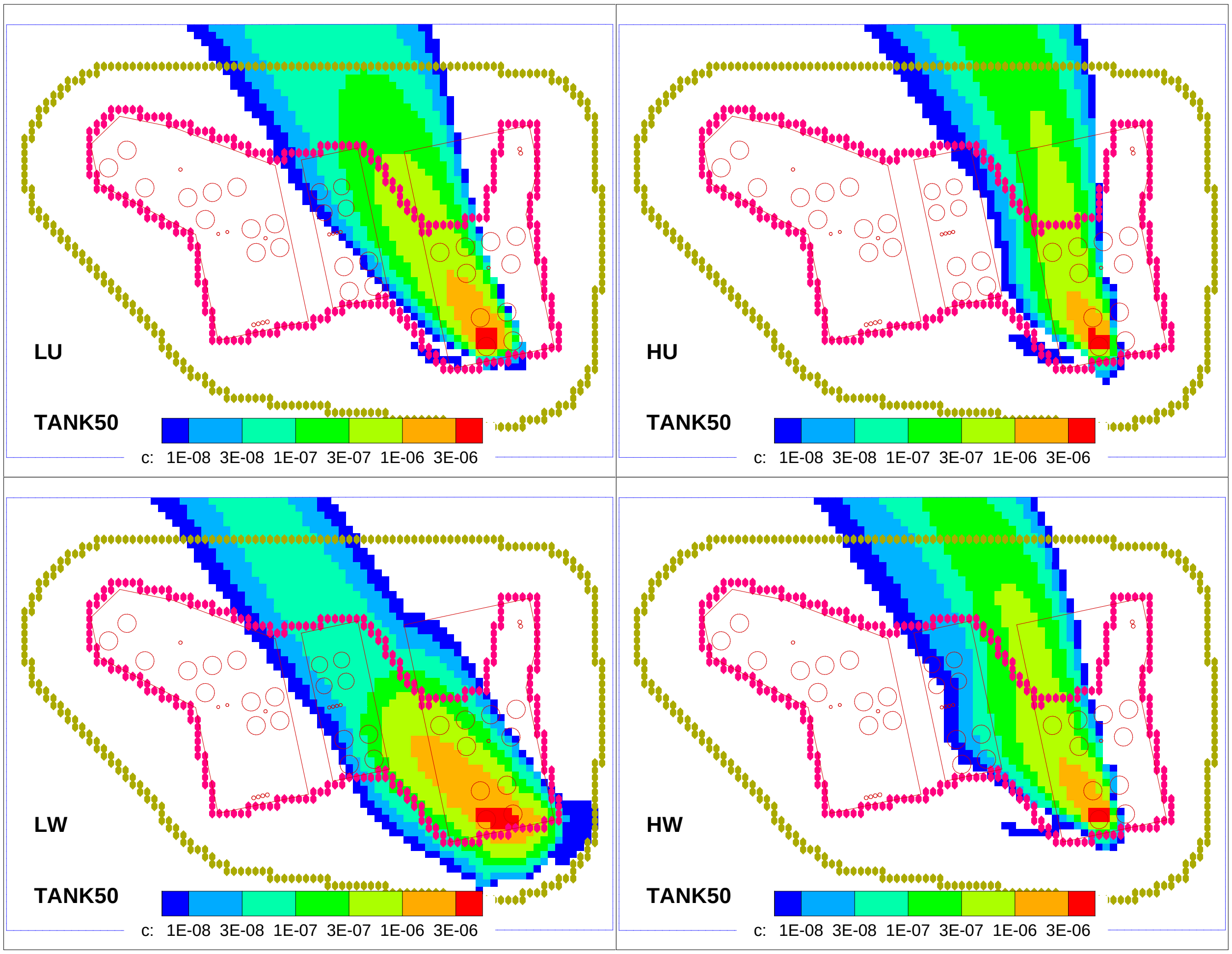


Figure 76. HTF Tank 50 Tracer Plume Simulation of Steady-State Sources (concentration, C in Ci/L)

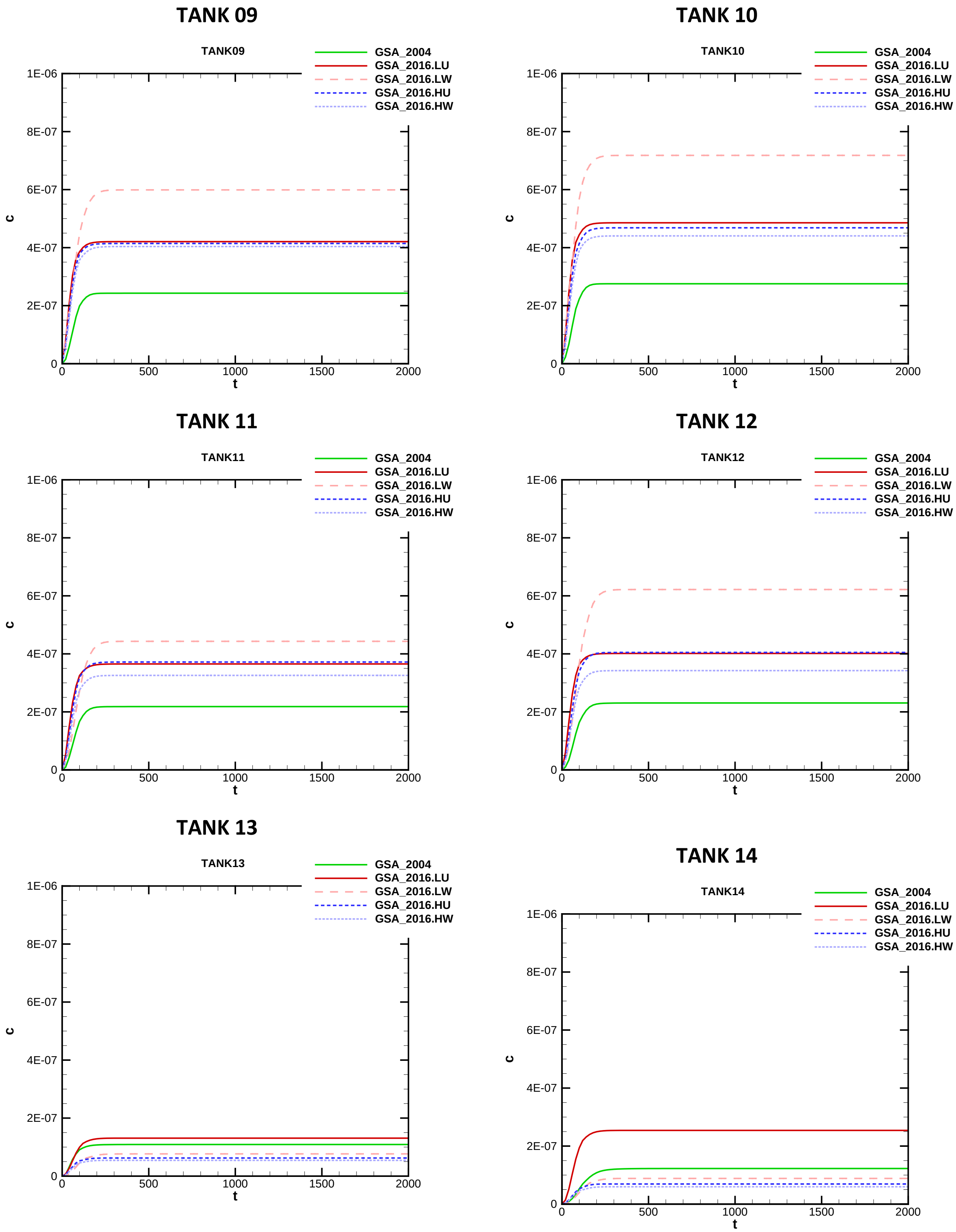


Figure 77. HTF Steady-State Source Concentrations (concentration, C in Ci/L, time, t in years)

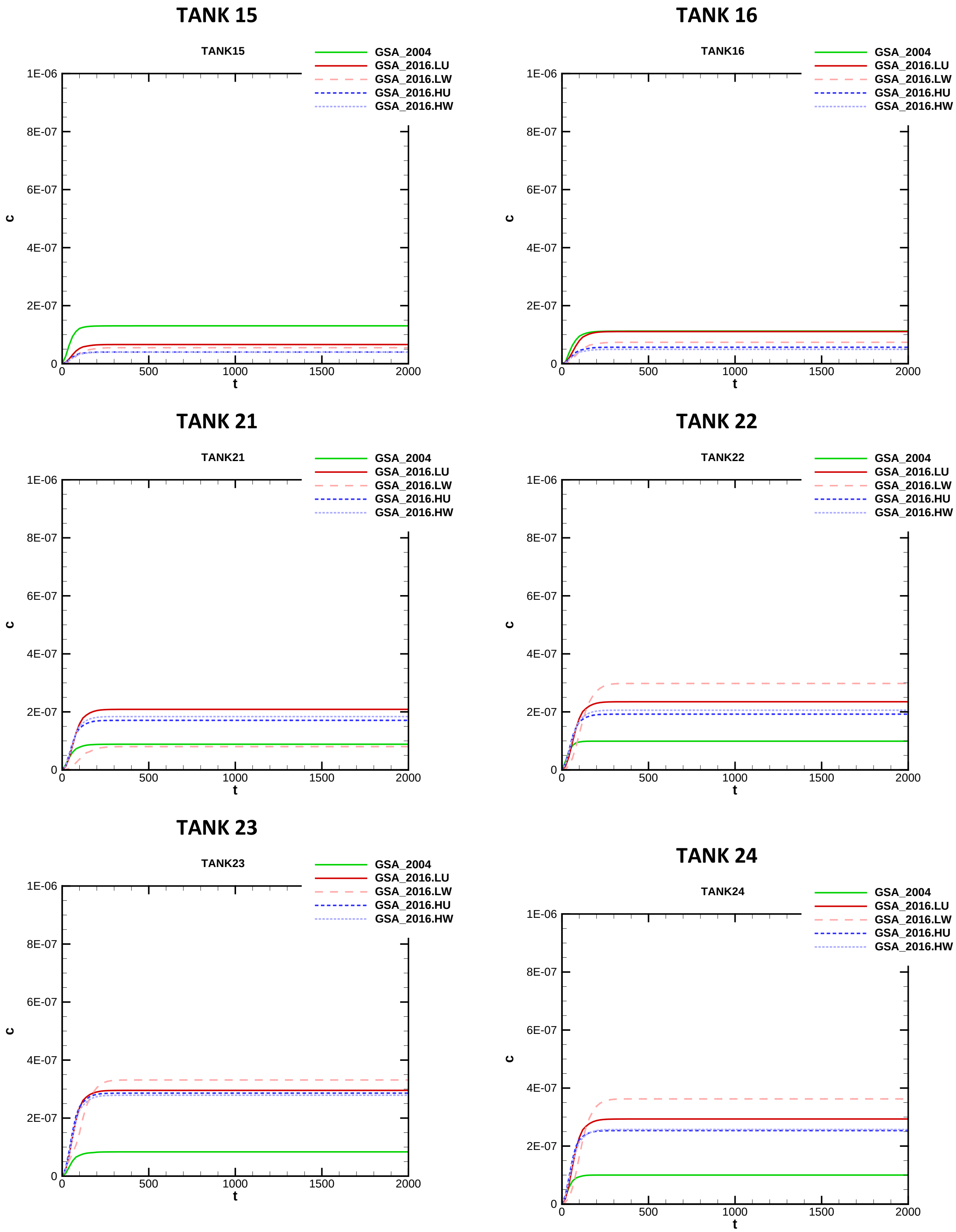


Figure 77. HTF Steady-State Source Concentrations (concentration, C in Ci/L, time, t in years) (cont'd)

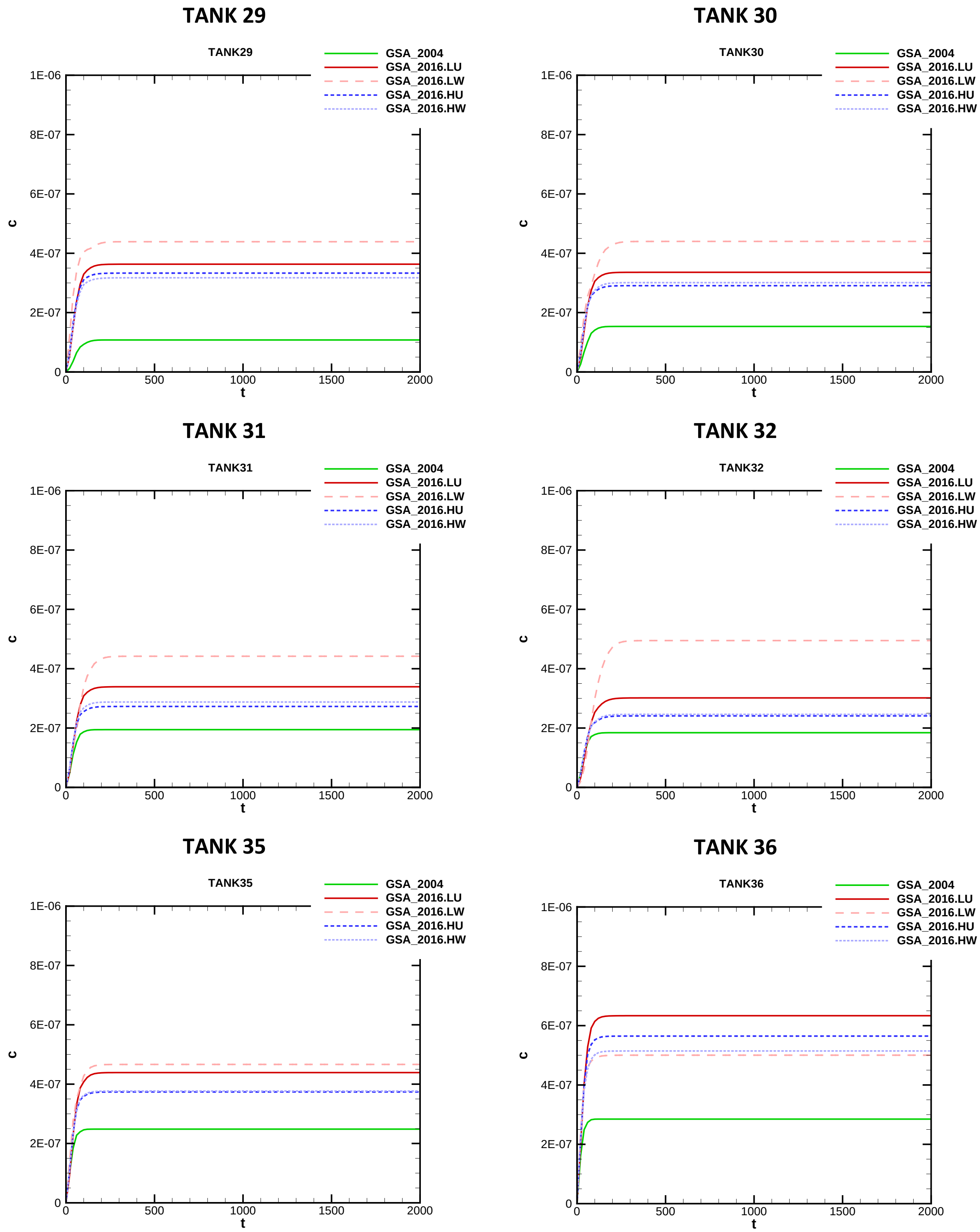


Figure 77. HTF Steady-State Source Concentrations (concentration, C in Ci/L, time, t in years) (cont'd)

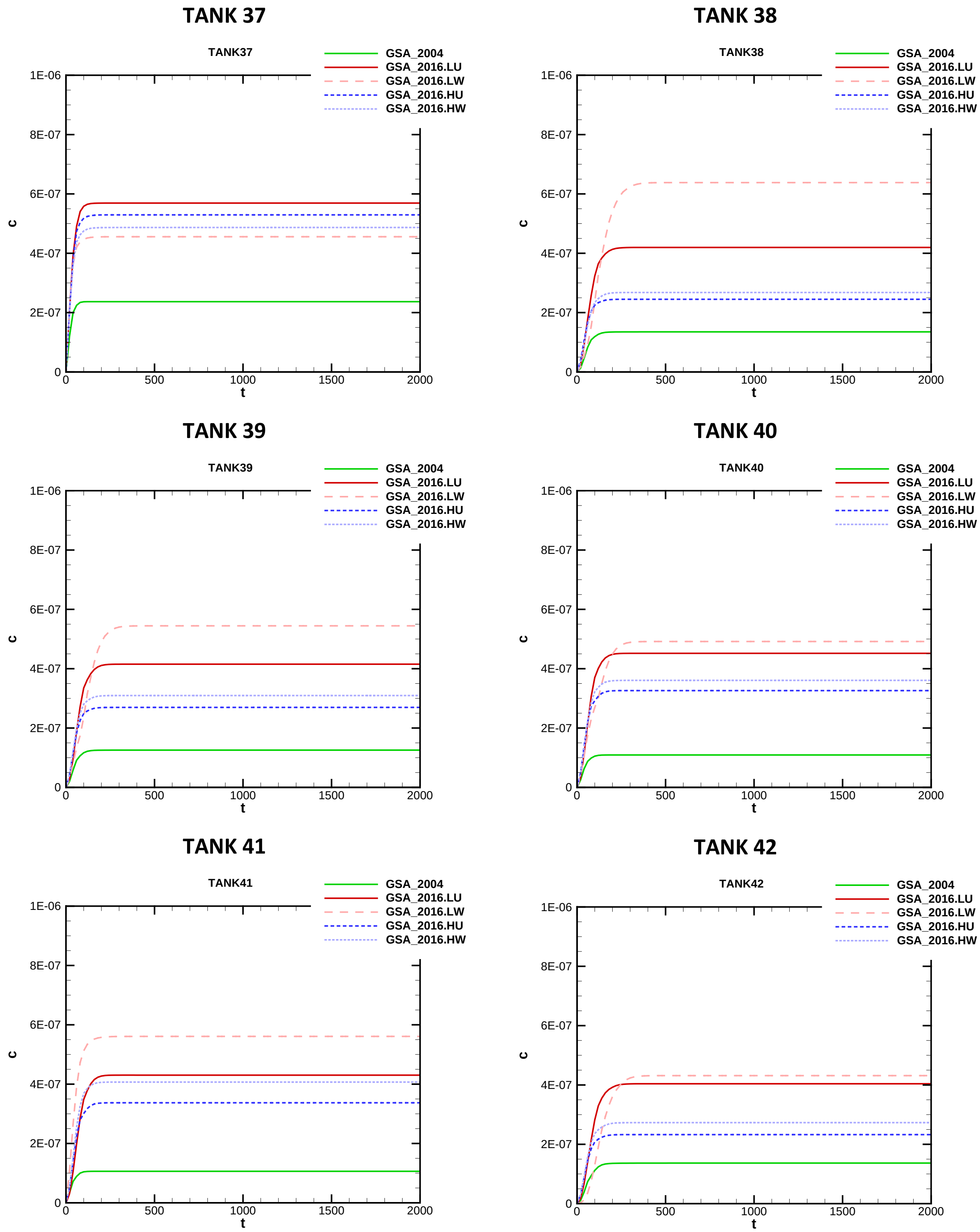


Figure 77. HTF Steady-State Source Concentrations (concentration, C in Ci/L, time, t in years) (cont'd)

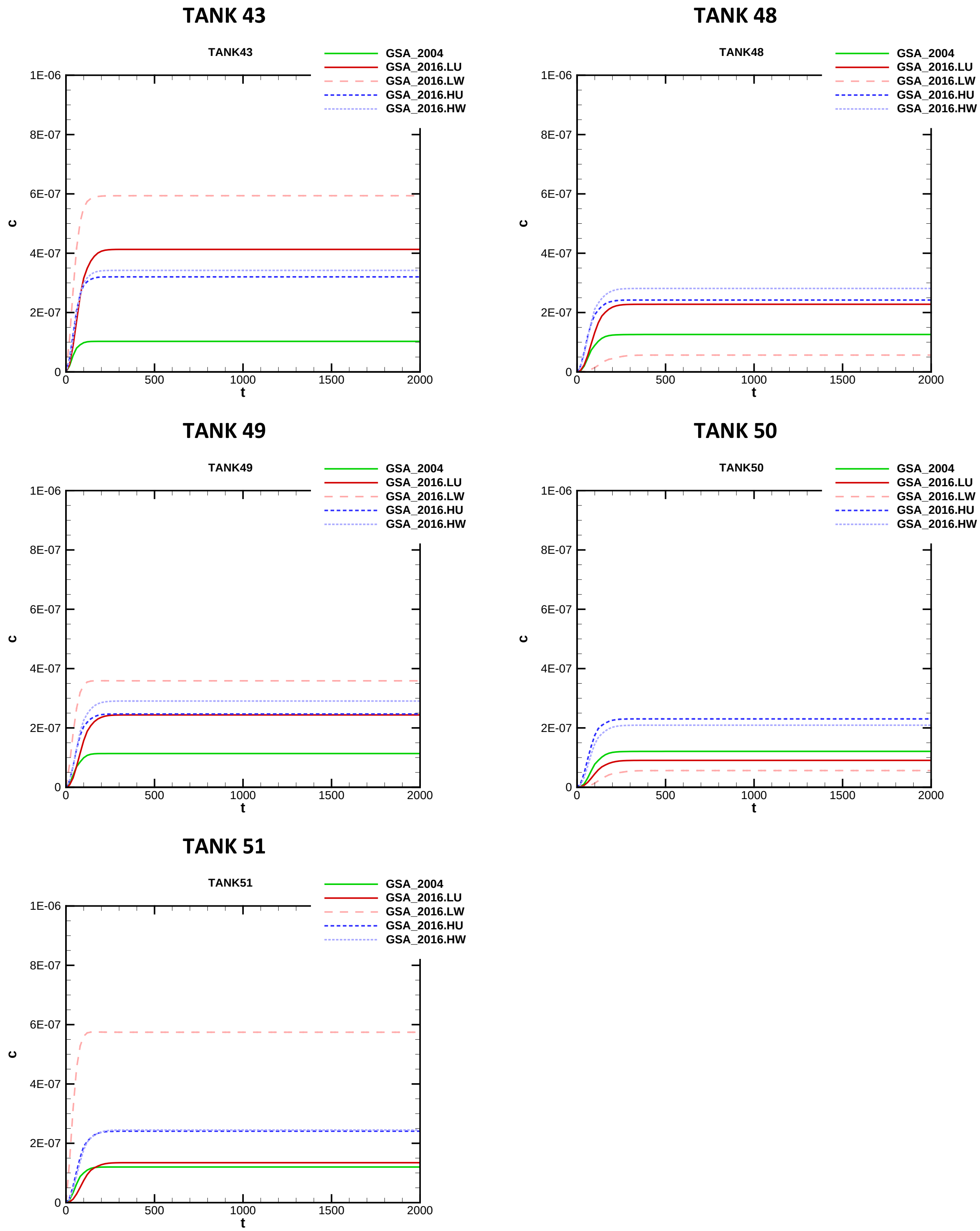
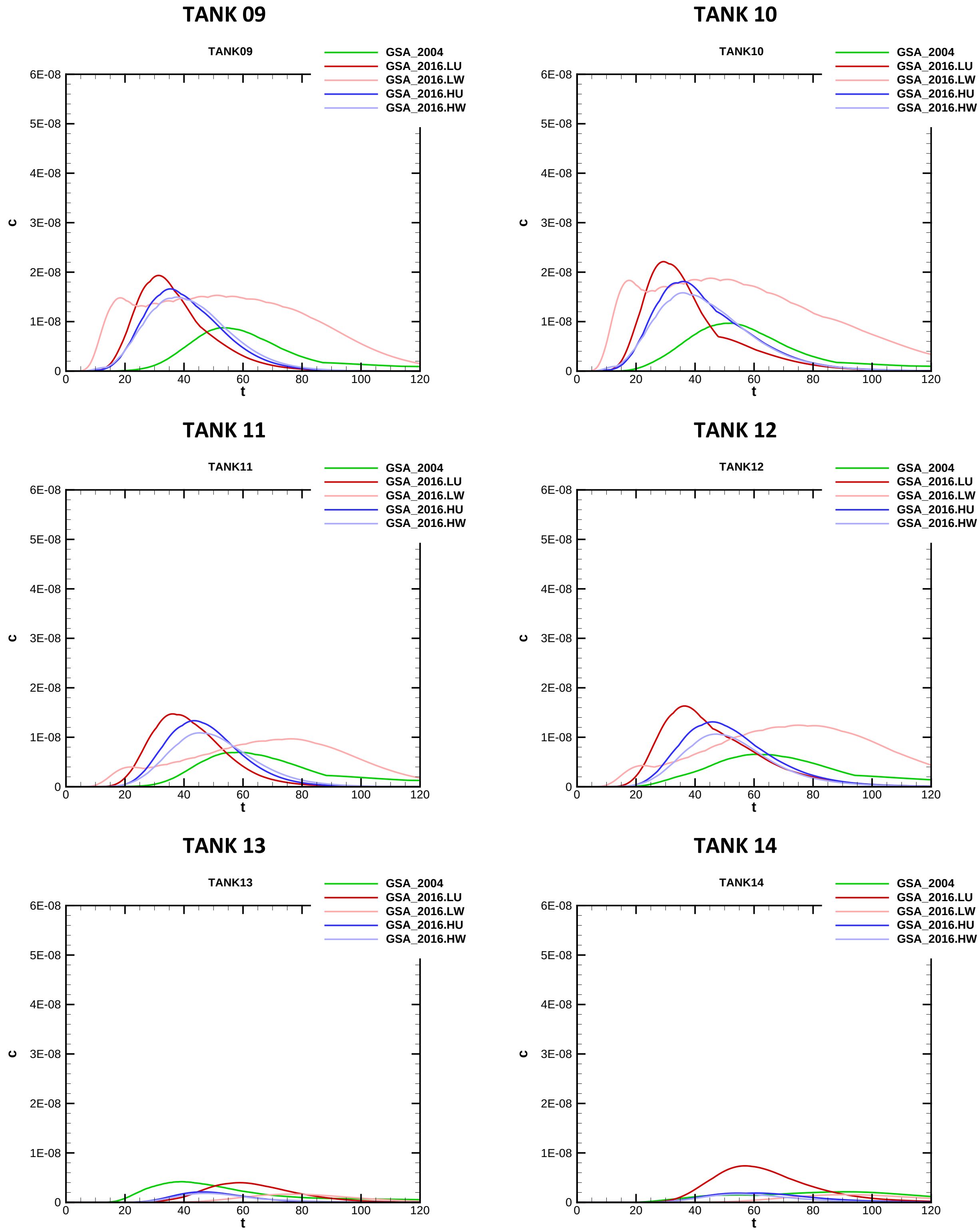


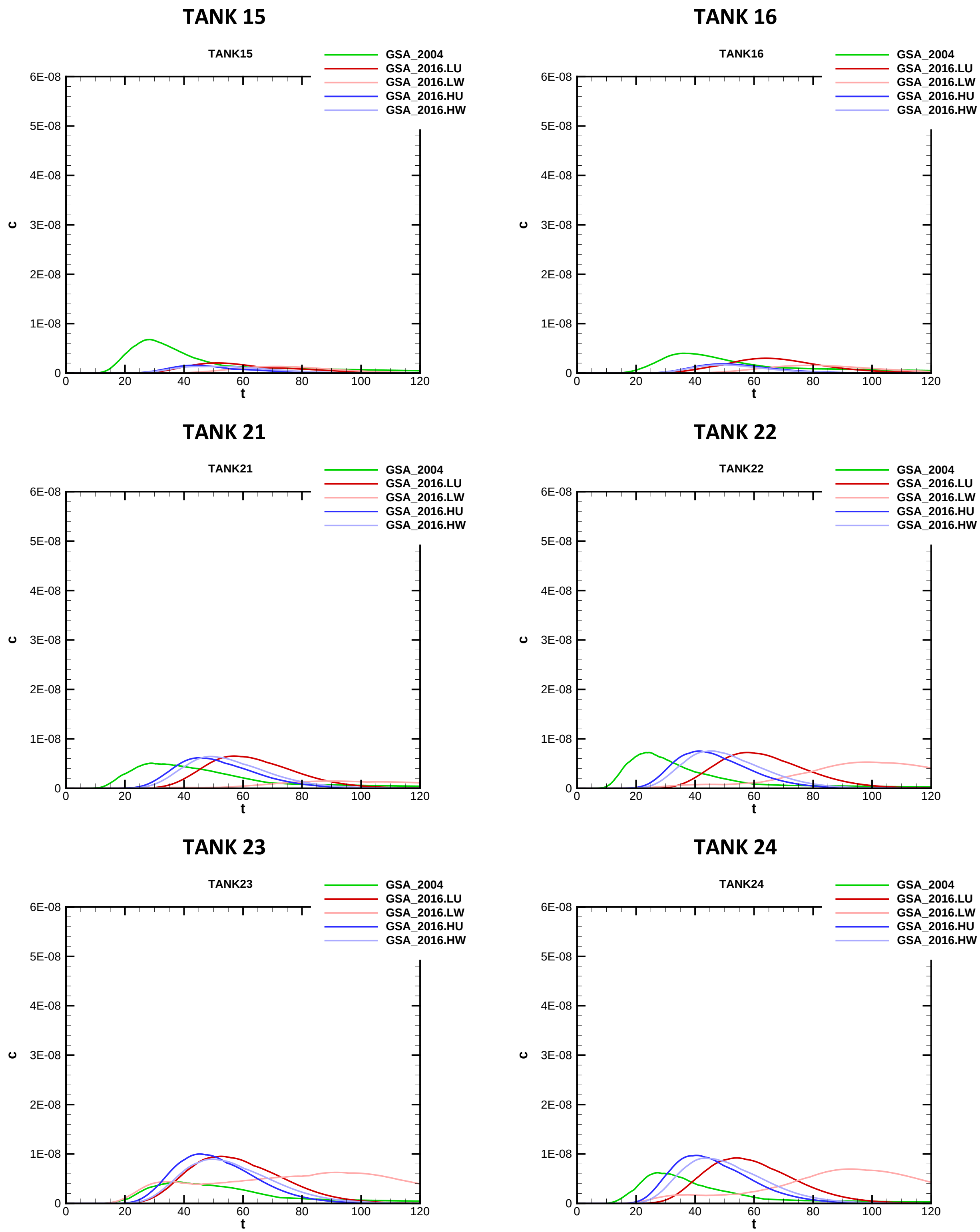
Figure 77. HTF Steady-State Source Concentrations (concentration, C in Ci/L, time, t in years) (cont'd)

5.2.2.2 Transient/Pulsed Sources



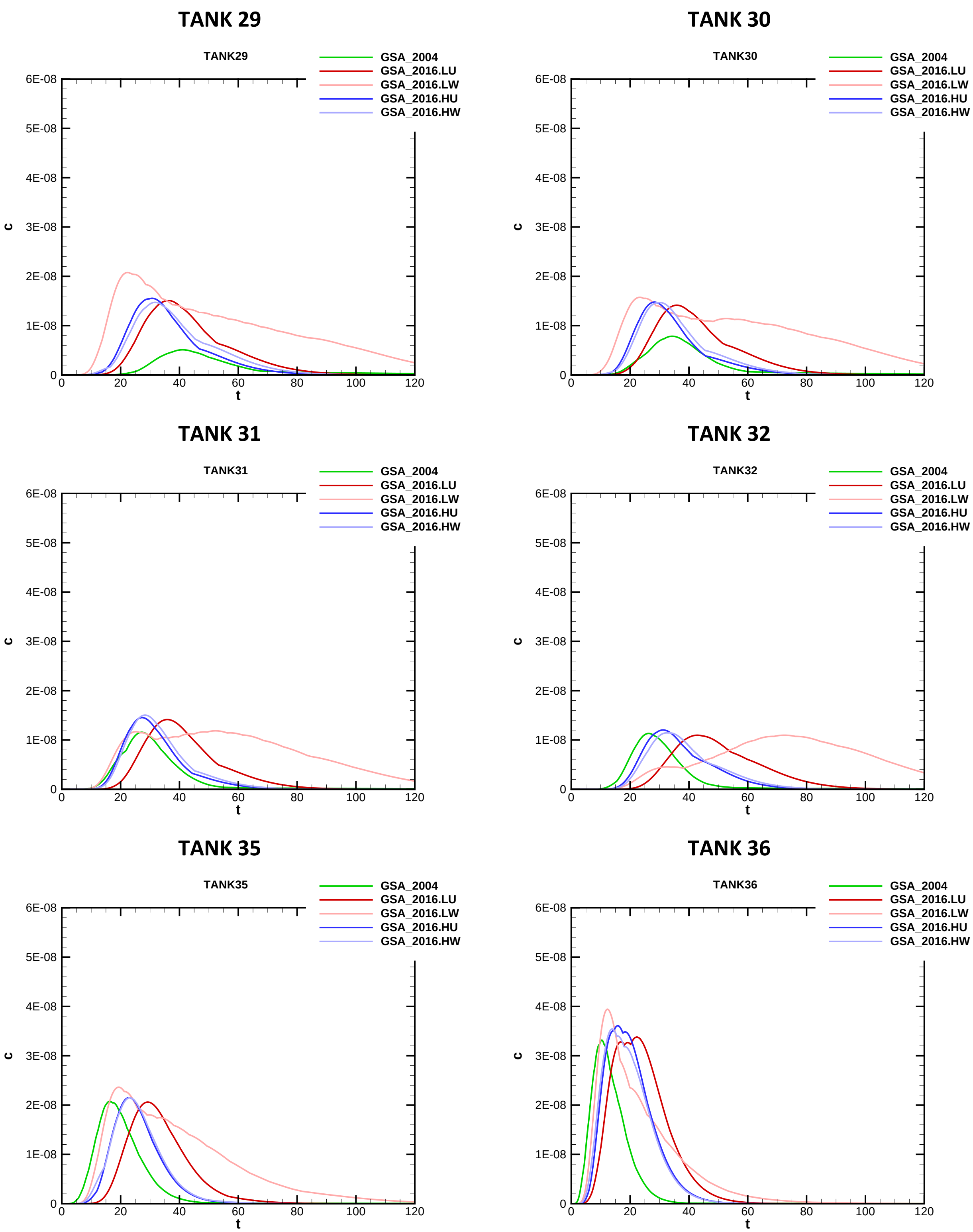
Note: Concentrations are monitored at 100-meter boundary

Figure 78. HTF Pulsed Source Concentrations (concentration, C in Ci/L, t in year)



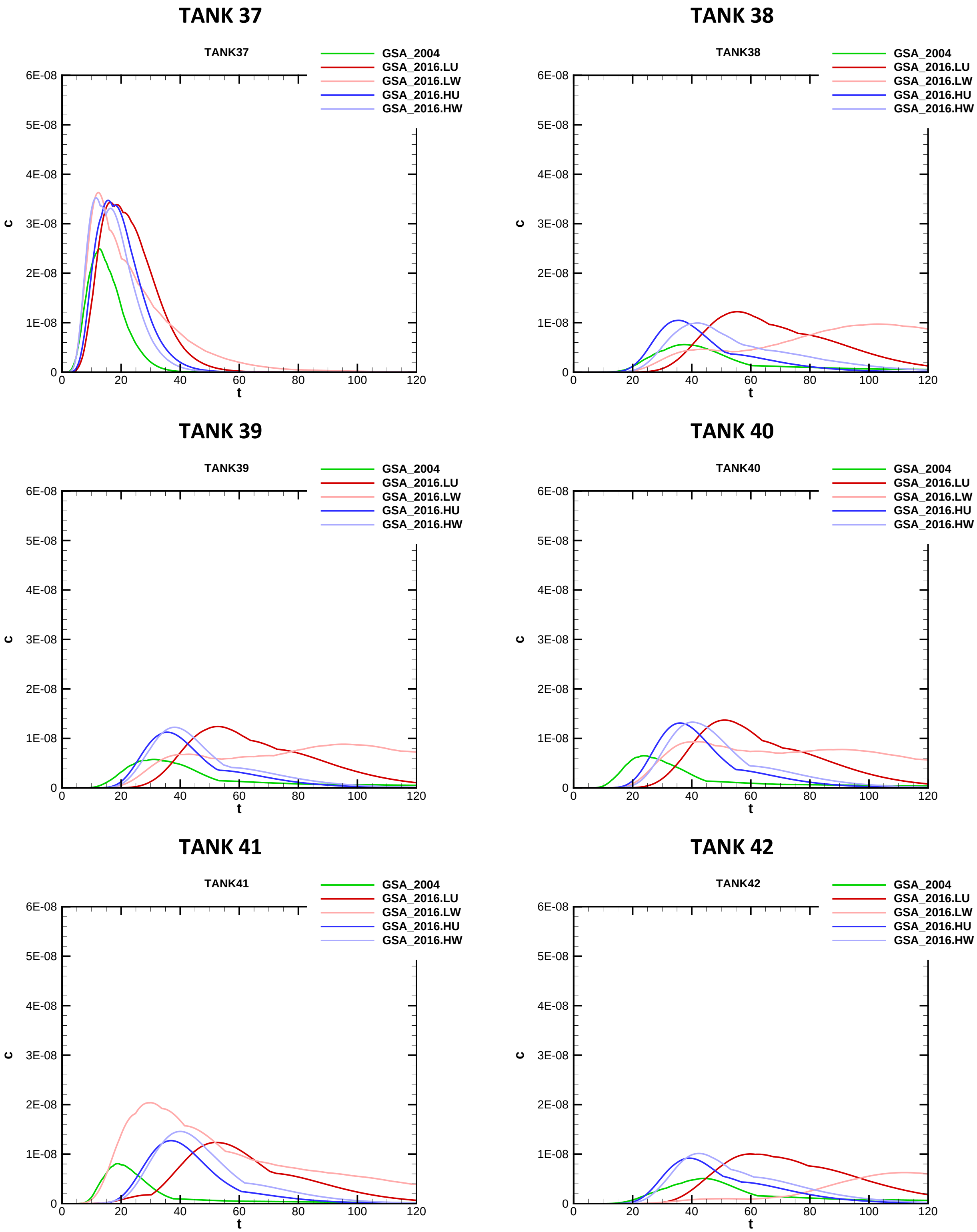
Note: Concentrations are monitored at 100-meter boundary

Figure 78. HTF Pulsed Source Concentrations (concentration, C in Ci/L, t in year) (cont'd)



Note: Concentrations are monitored at 100-meter boundary

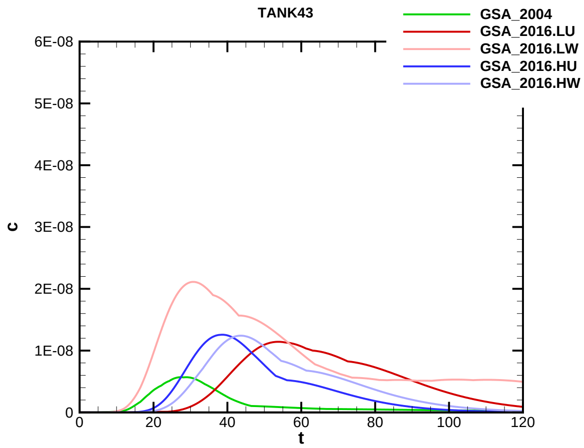
Figure 78. HTF Pulsed Source Concentrations (concentration, C in Ci/L, t in year) (cont'd)



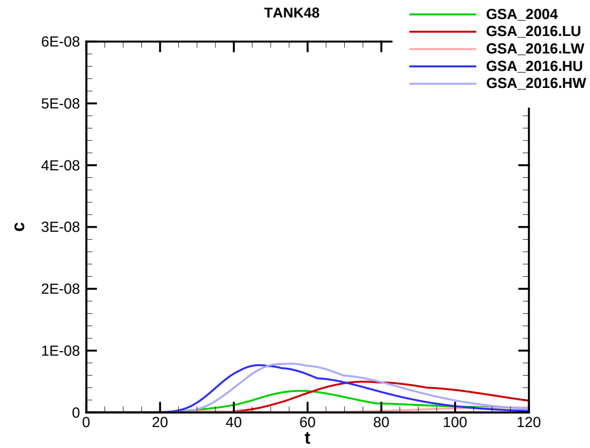
Note: Concentrations are monitored at 100-meter boundary

Figure 78. HTF Pulsed Source Concentrations (concentration, C in Ci/L, t in year) (cont'd)

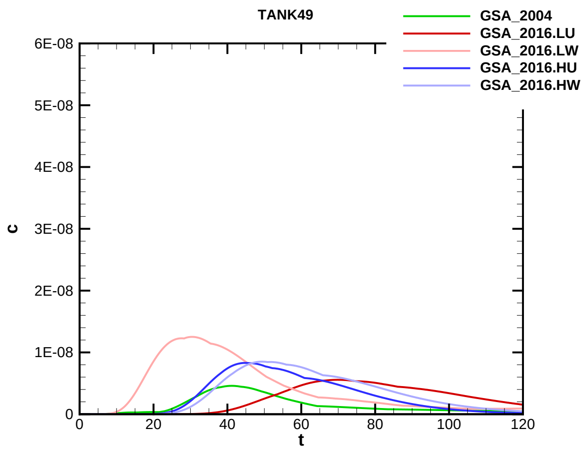
TANK 43



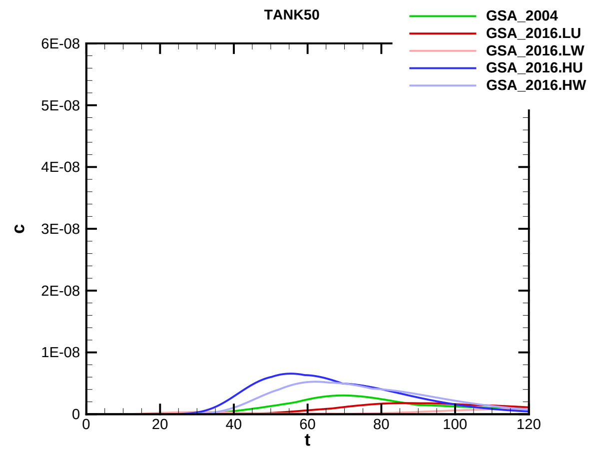
TANK 48



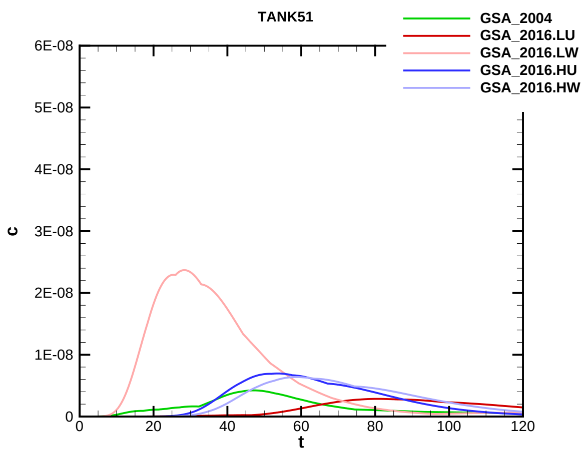
TANK 49



TANK 50



TANK 51



Note: Concentrations are monitored at 100-meter boundary

Figure 78. HTF Pulsed Source Concentrations (concentration, C in Ci/L, t in year) (cont'd)

5.2.3 Evaluation Case Transport Simulations

5.2.3.1 Concentrations at 100-meter Boundary

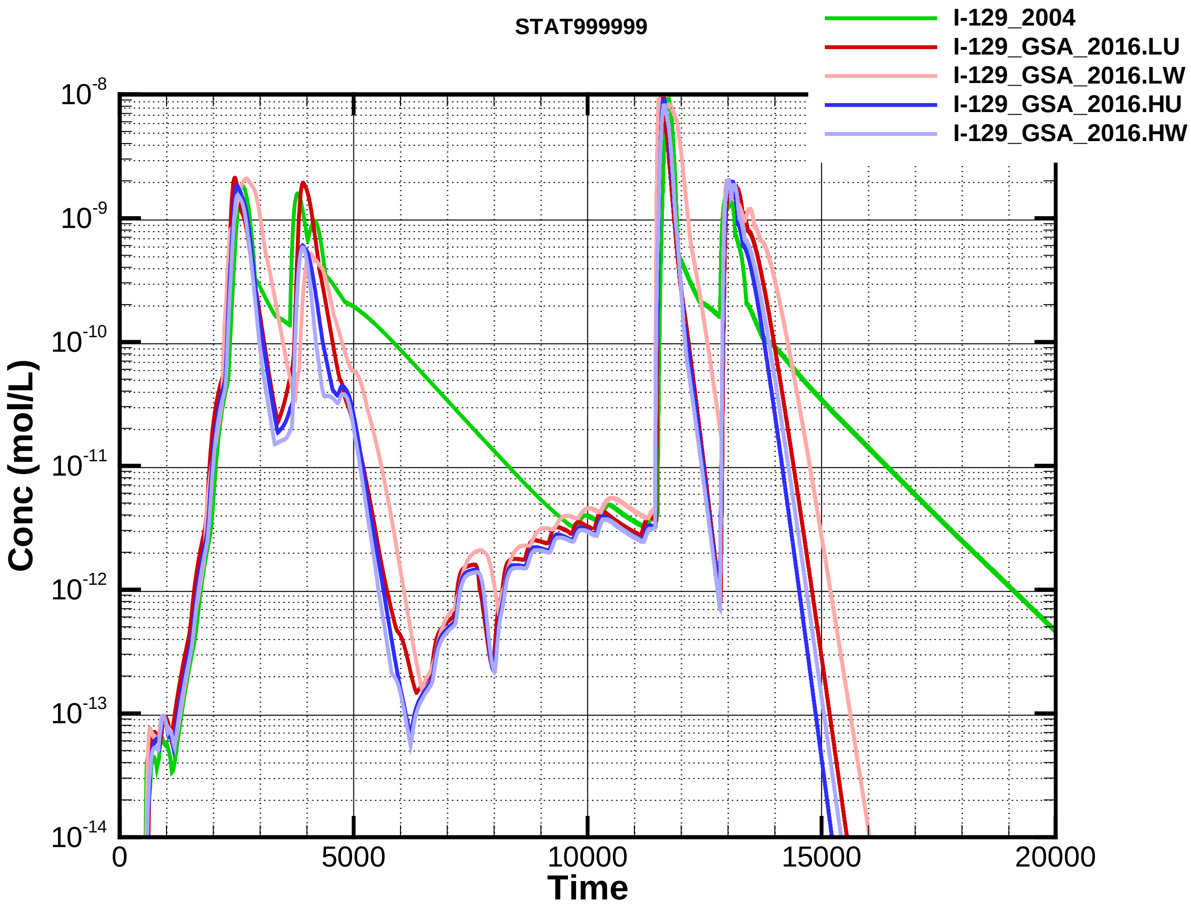


Figure 79. HTF I-129 Concentrations (for all GSA_2016 Flows) at 100-meter Boundary (Time in years)

5.2.3.2 Concentrations at the Seepline

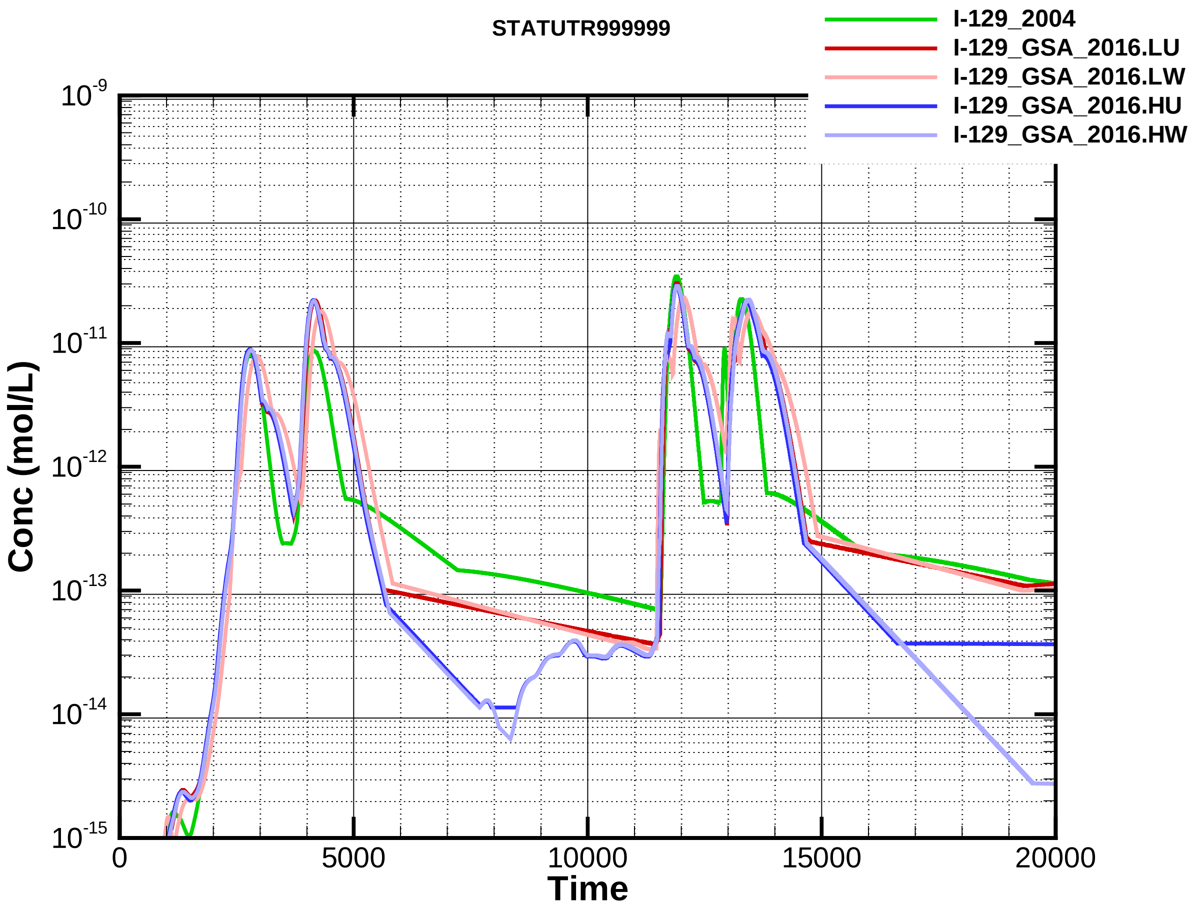


Figure 80. HTF I-129 Concentrations (for all GSA_2016 Flows) at the Seepline (Time in years)

5.3 F-Area Tank Farm

5.3.1 Streamtraces with Timing Markers

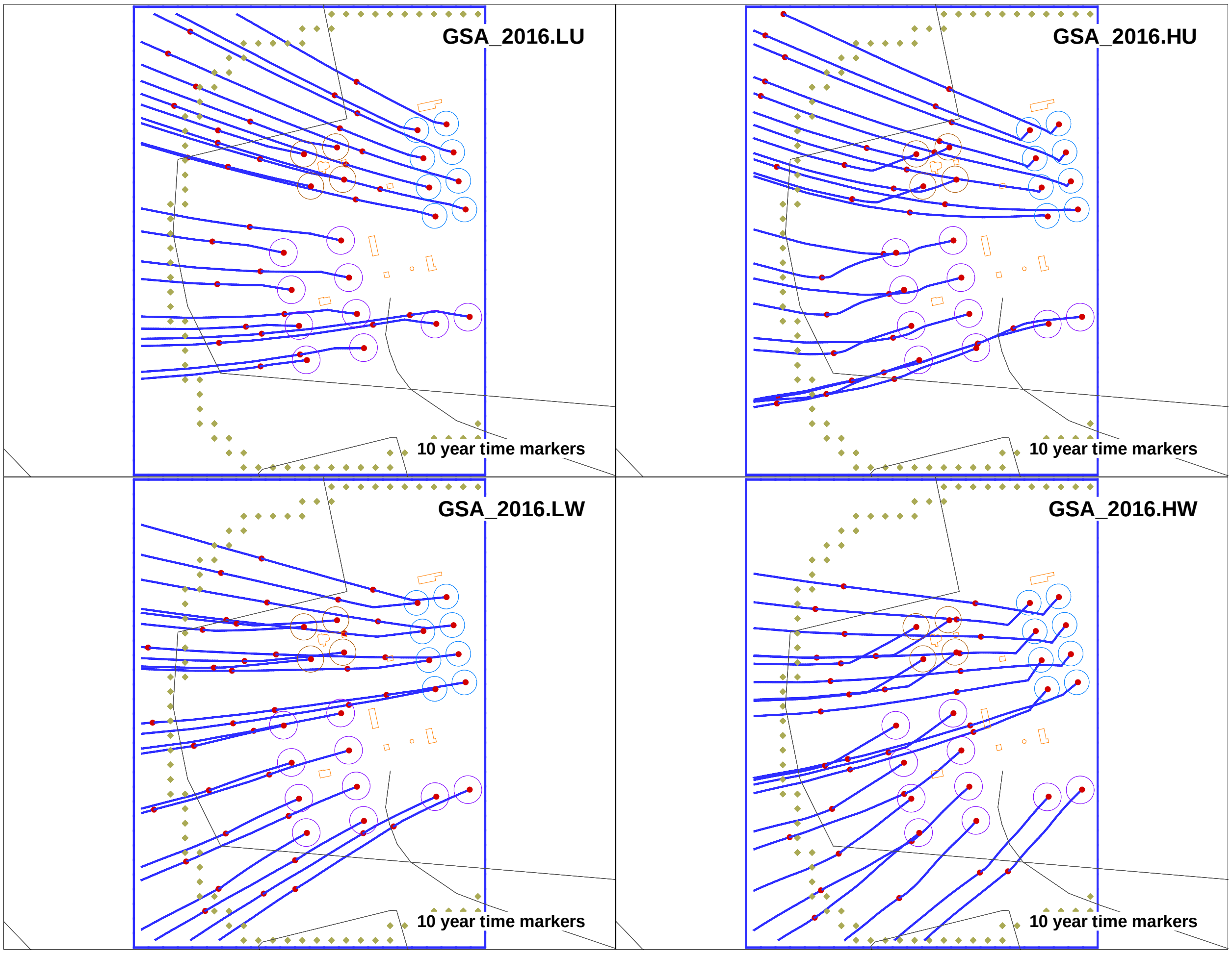


Figure 81. FTF Streamtraces with Timing Markers

5.3.2 Tracer Plume Simulations

5.3.2.1 Steady-State Sources

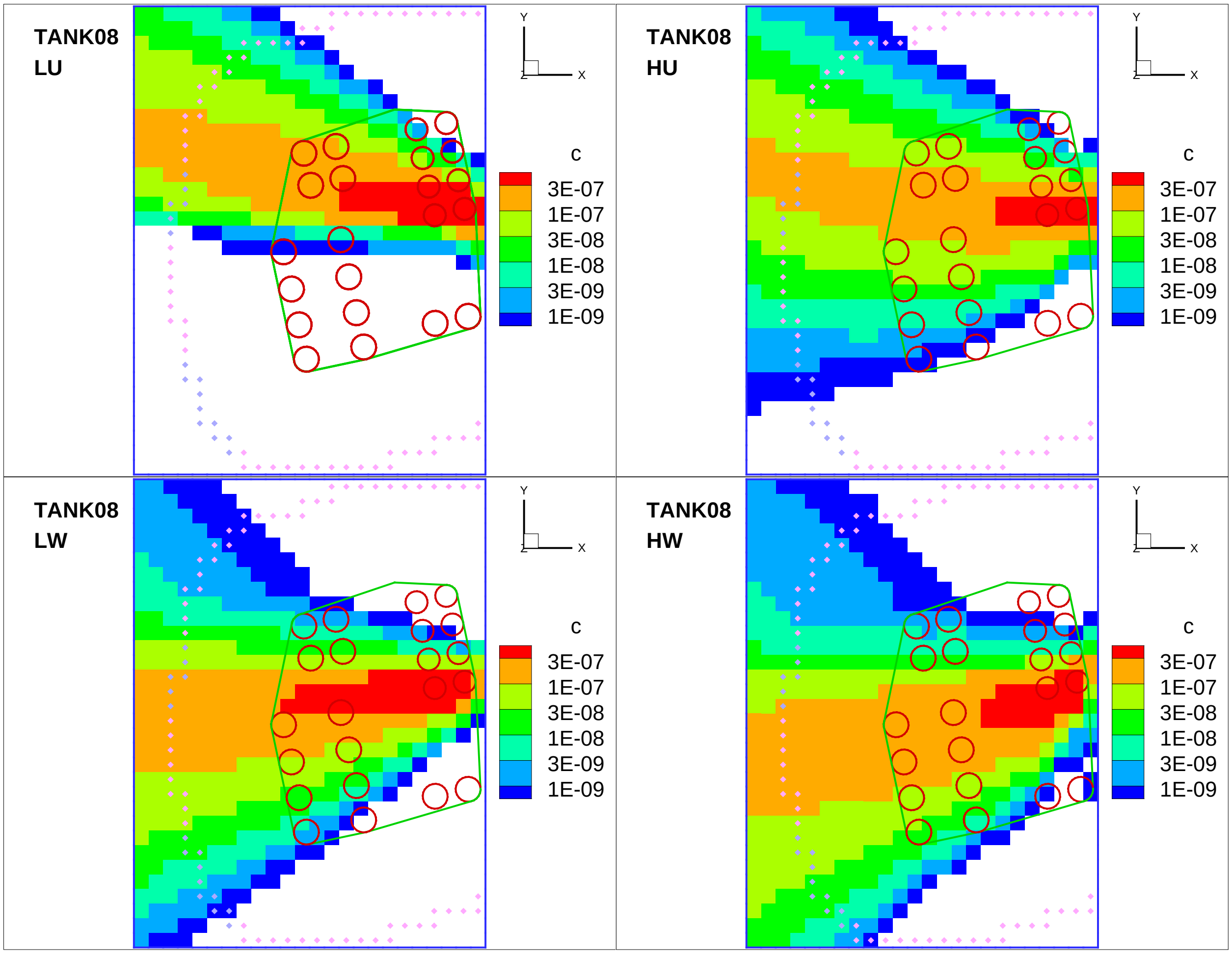


Figure 82. FTF Tank 08 Tracer Plume Simulation of Steady-State Sources (concentration, C in Ci/L)

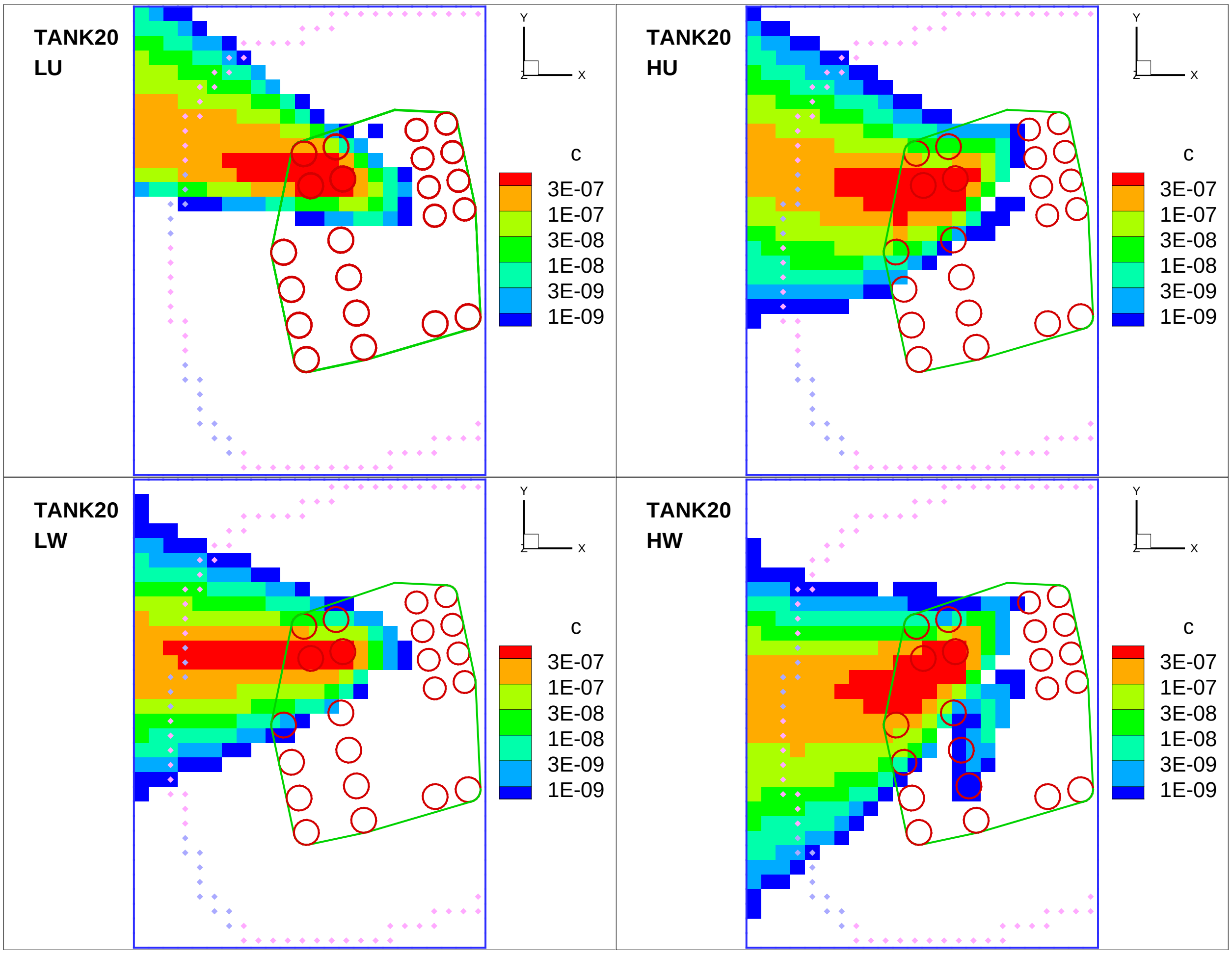


Figure 83. FTF Tank 20 Tracer Plume Simulation of Steady-State Sources (concentration, C in Ci/L)

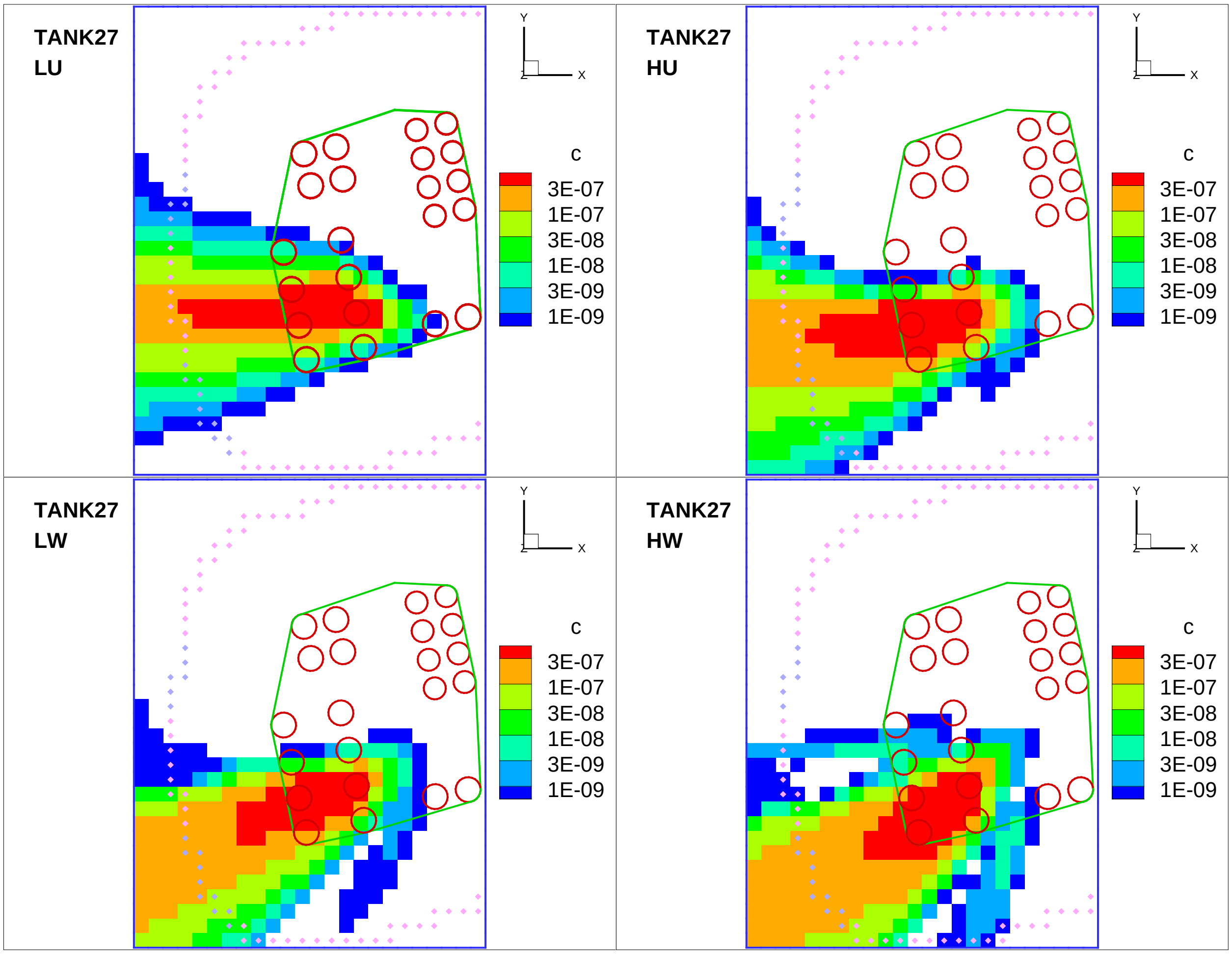


Figure 84. FTF Tank 27 Tracer Plume Simulation of Steady-State Sources (concentration, C in Ci/L)

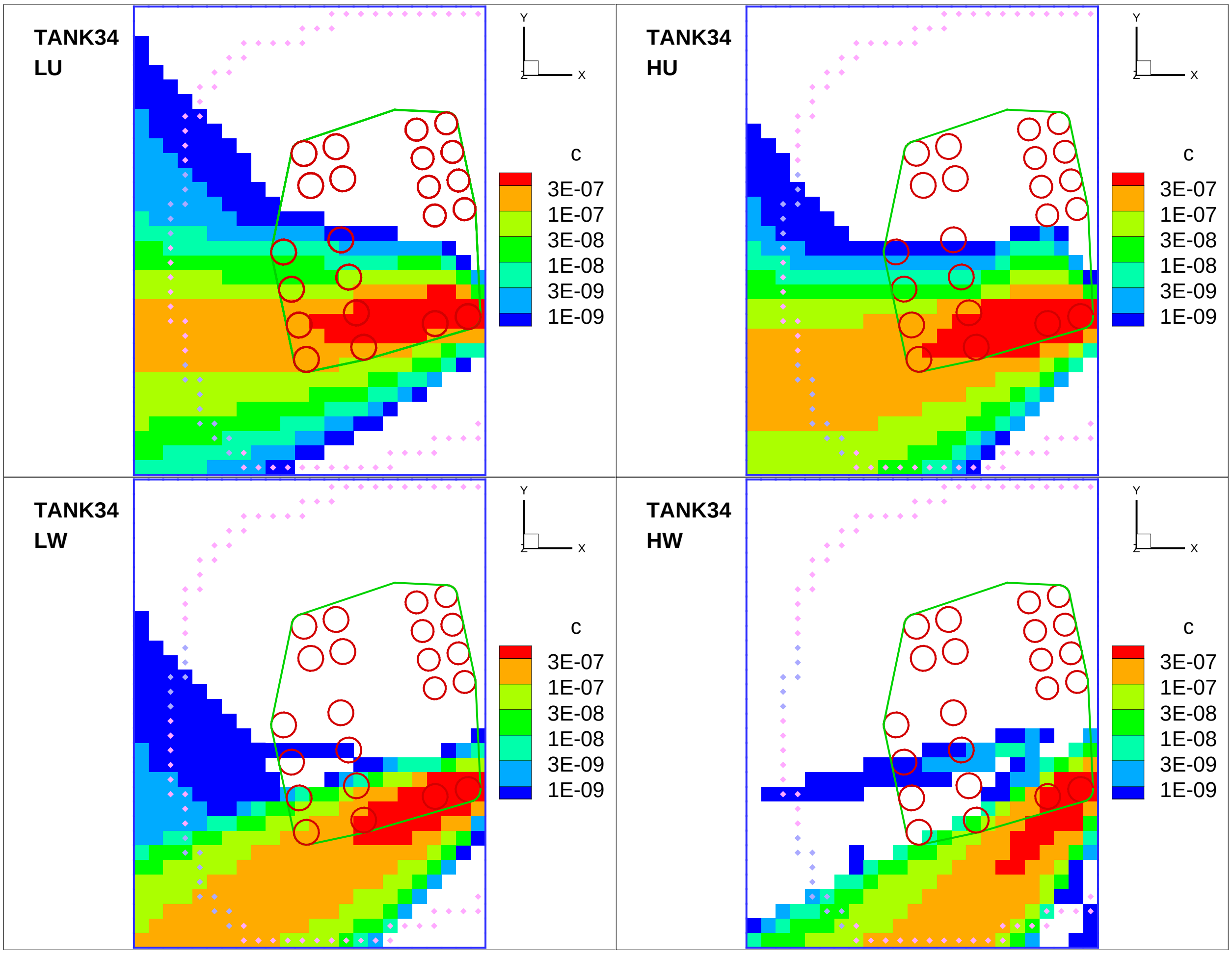


Figure 85. FTF Tank 34 Tracer Plume Simulation of Steady-State Sources (concentration, C in Ci/L)

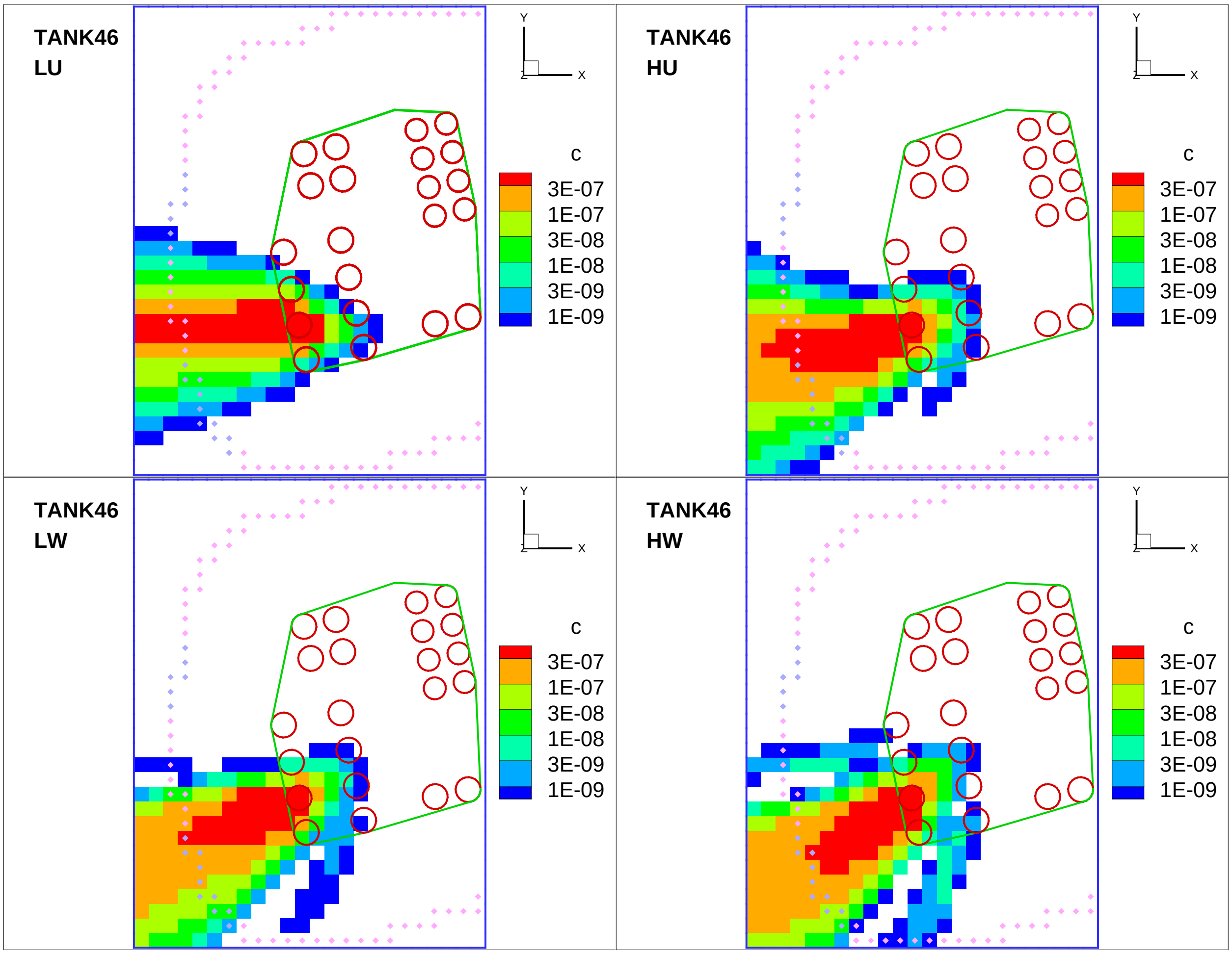


Figure 86. FTF Tank 46 Tracer Plume Simulation of Steady-State Sources (concentration, C in Ci/L)

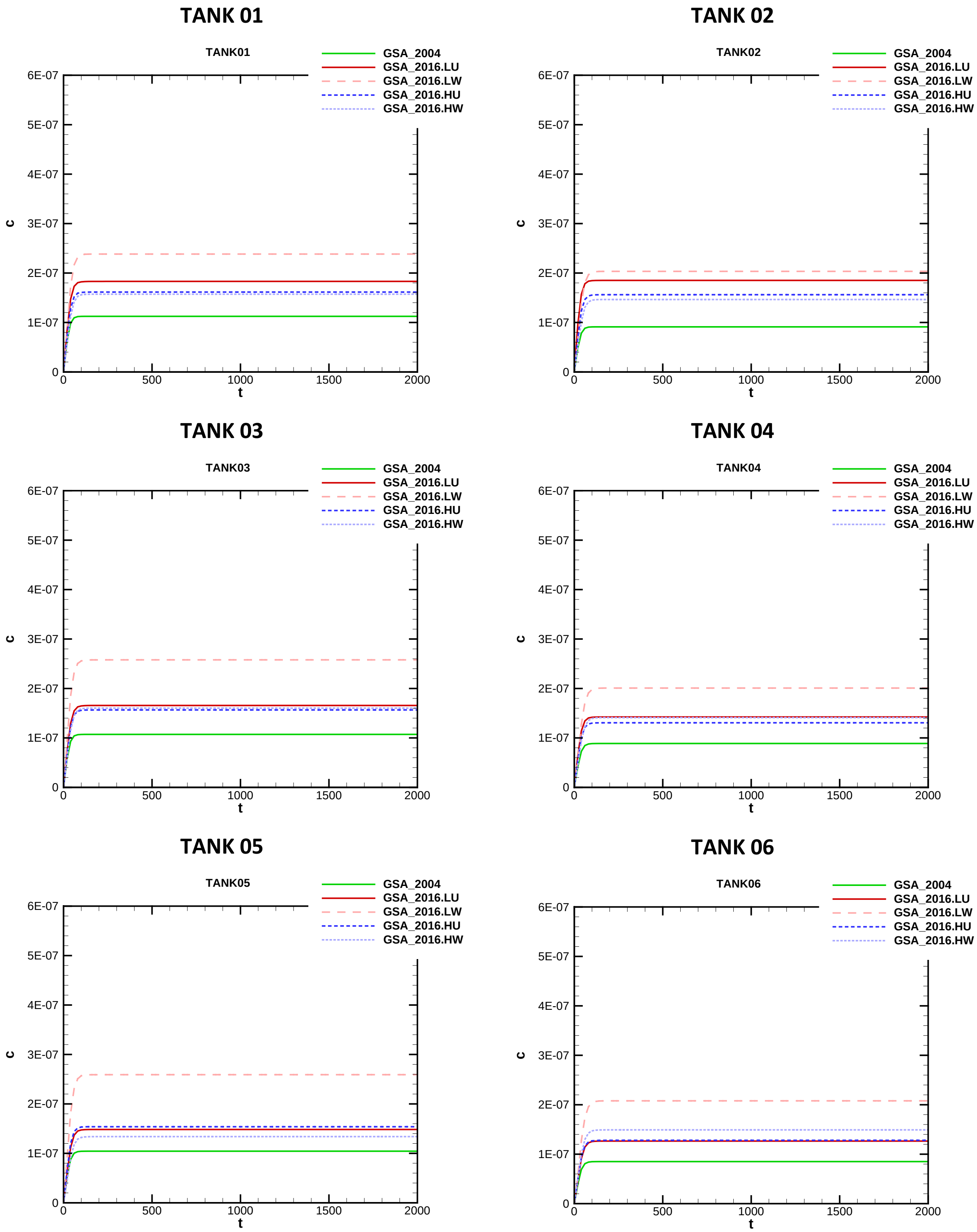
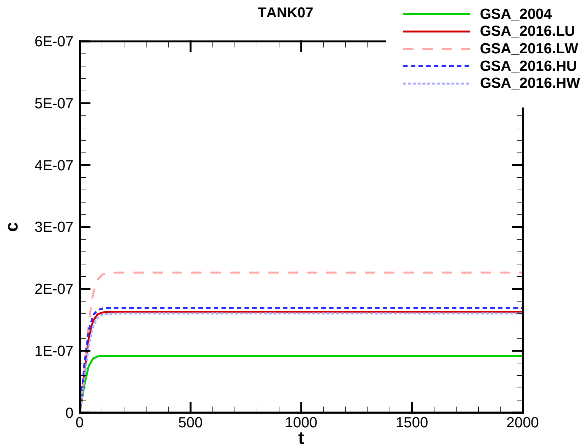
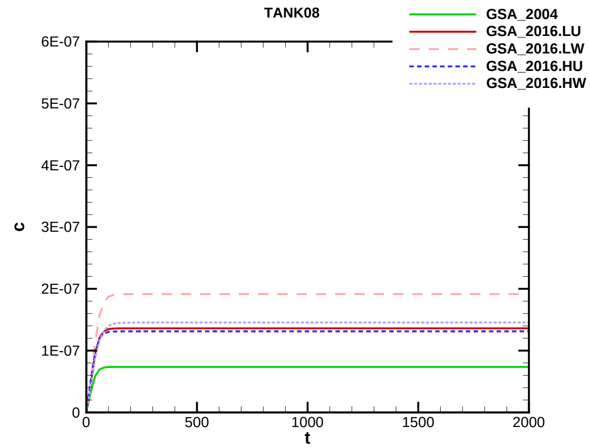


Figure 87. FTF Steady-State Source Concentrations (concentration, C in Ci/L, time, t in years)

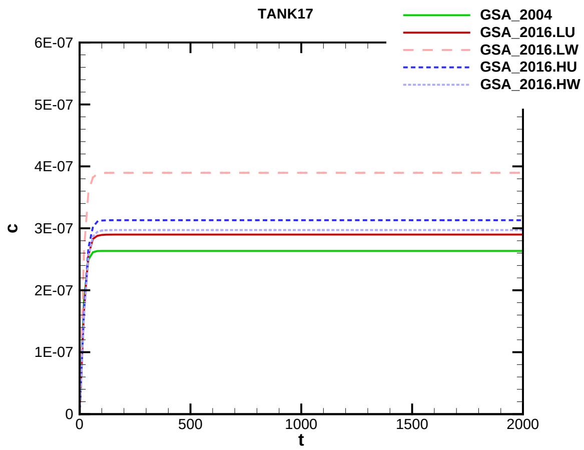
TANK 07



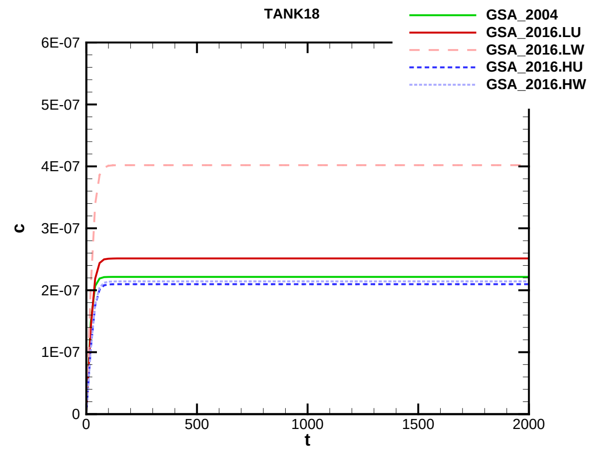
TANK 08



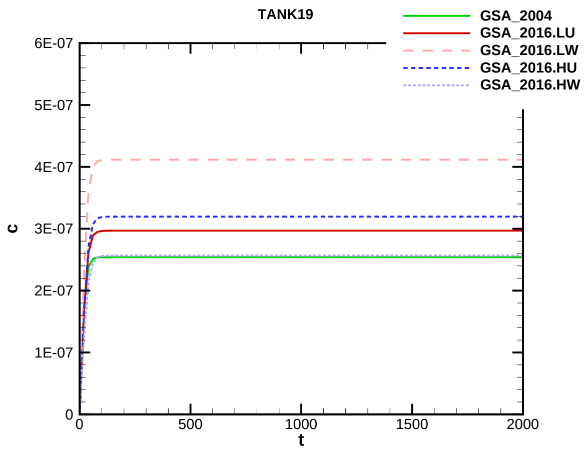
TANK 17



TANK 18



TANK 19



TANK 20

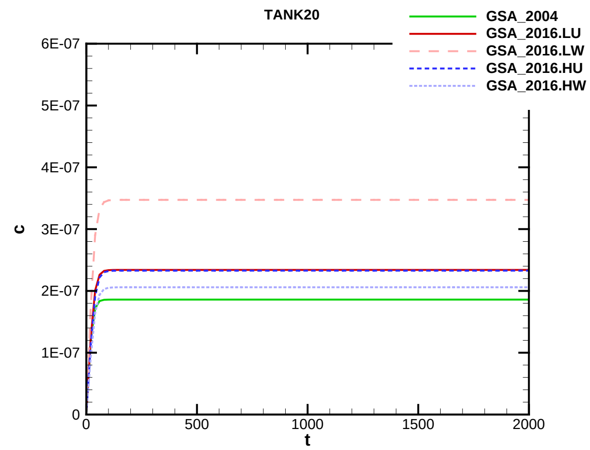


Figure 91. FTF Steady-State Source Concentrations (concentration, C in Ci/L, time, t in years) (Cont'd)

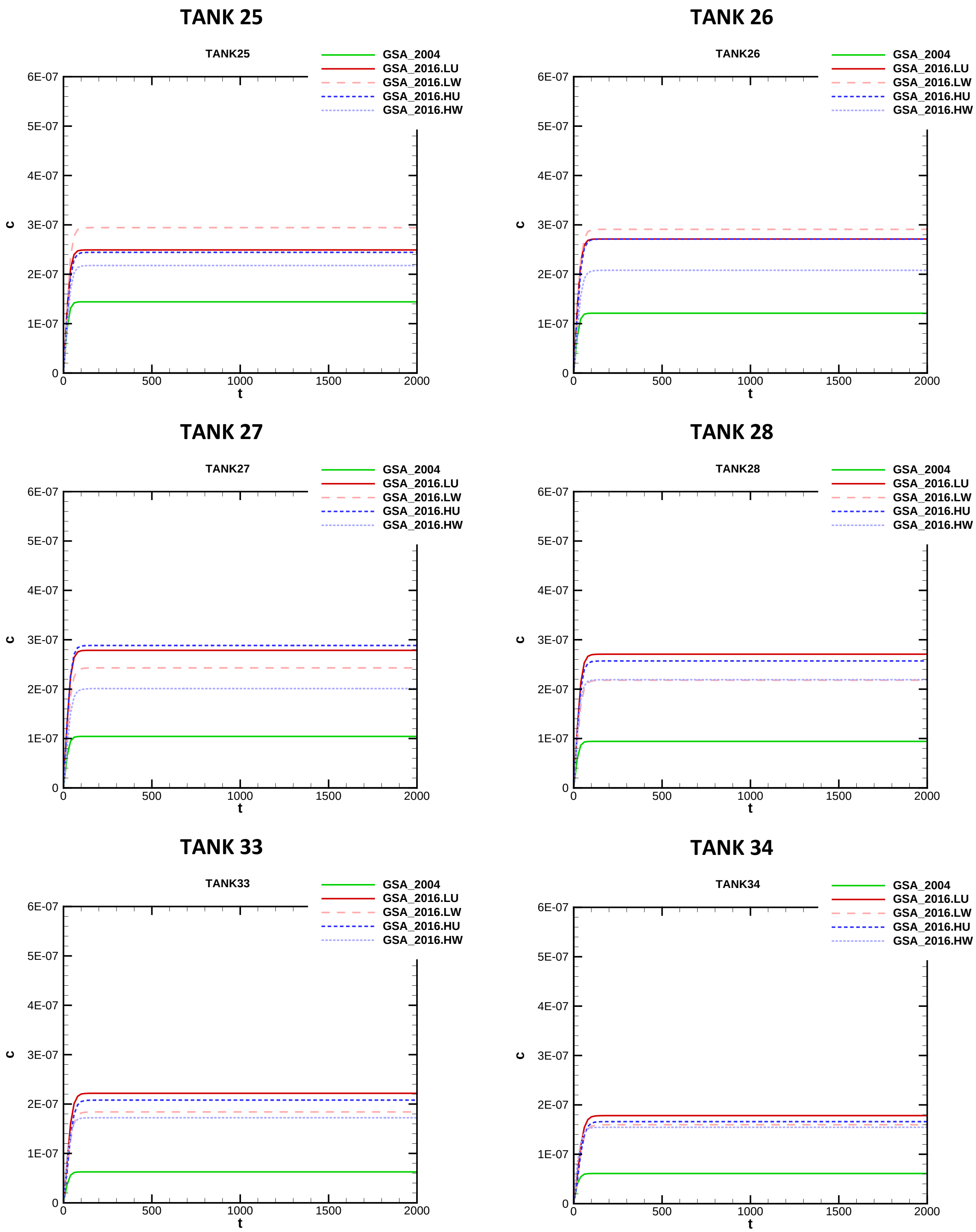
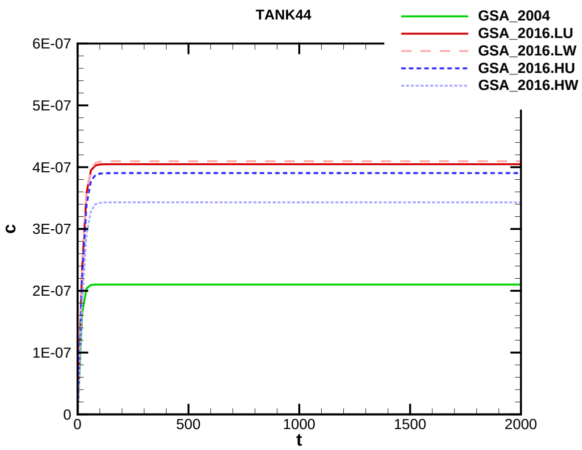
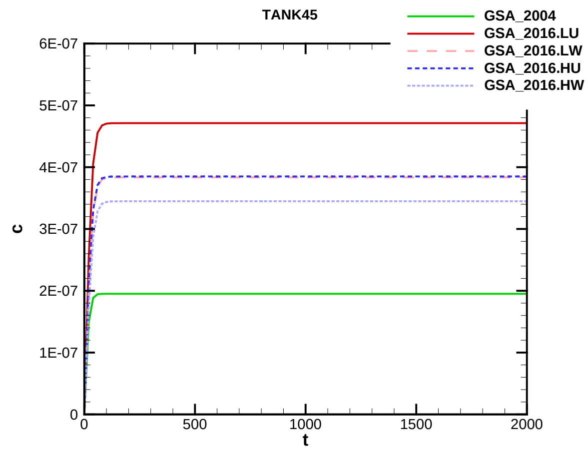


Figure 91. FTF Steady-State Source Concentrations (concentration, C in Ci/L, time, t in years) (Cont'd)

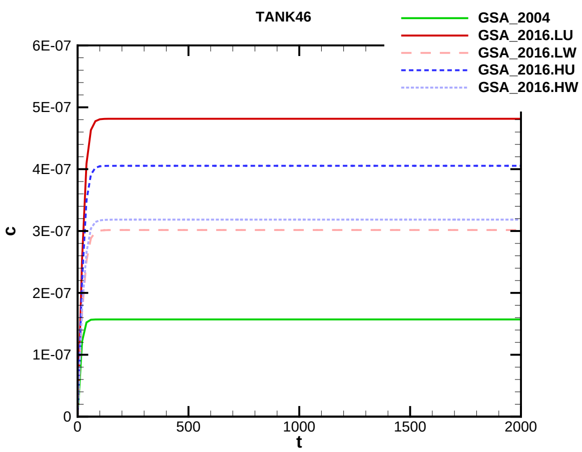
TANK 44



TANK 45



TANK 46



TANK 47

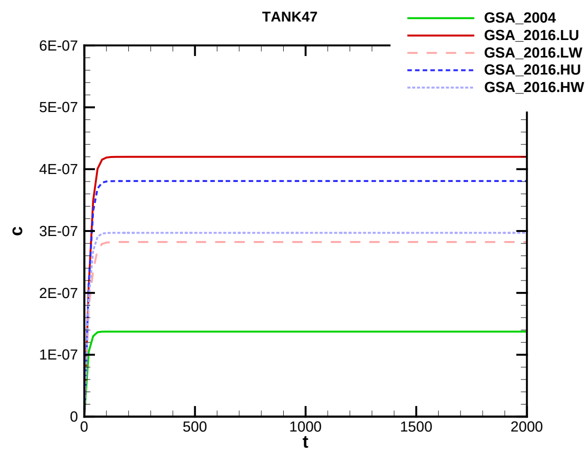
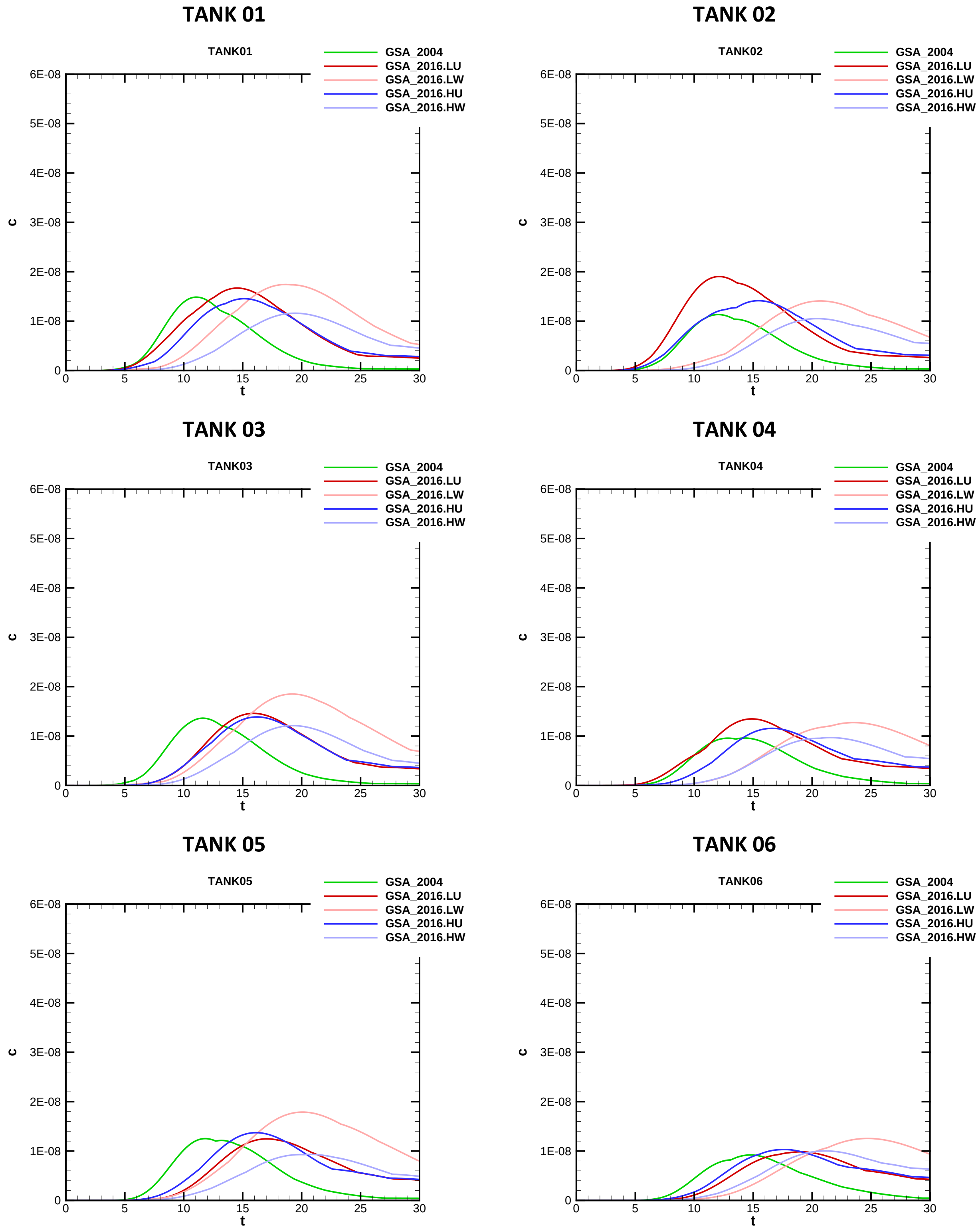


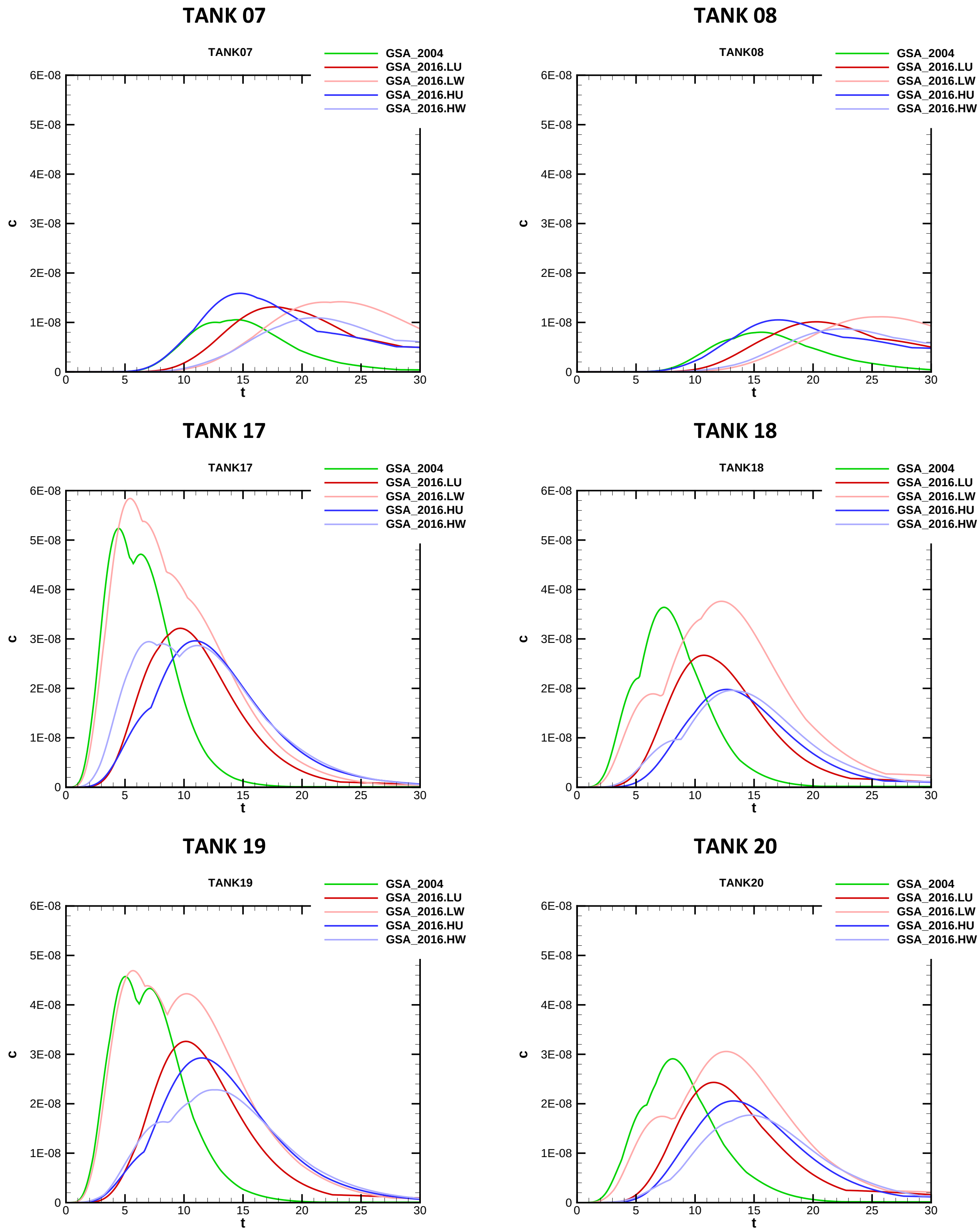
Figure 91. FTF Steady-State Source Concentrations (concentration, C in Ci/L, time, t in years) (Cont'd)

5.3.2.2 Transient/Pulsed Sources



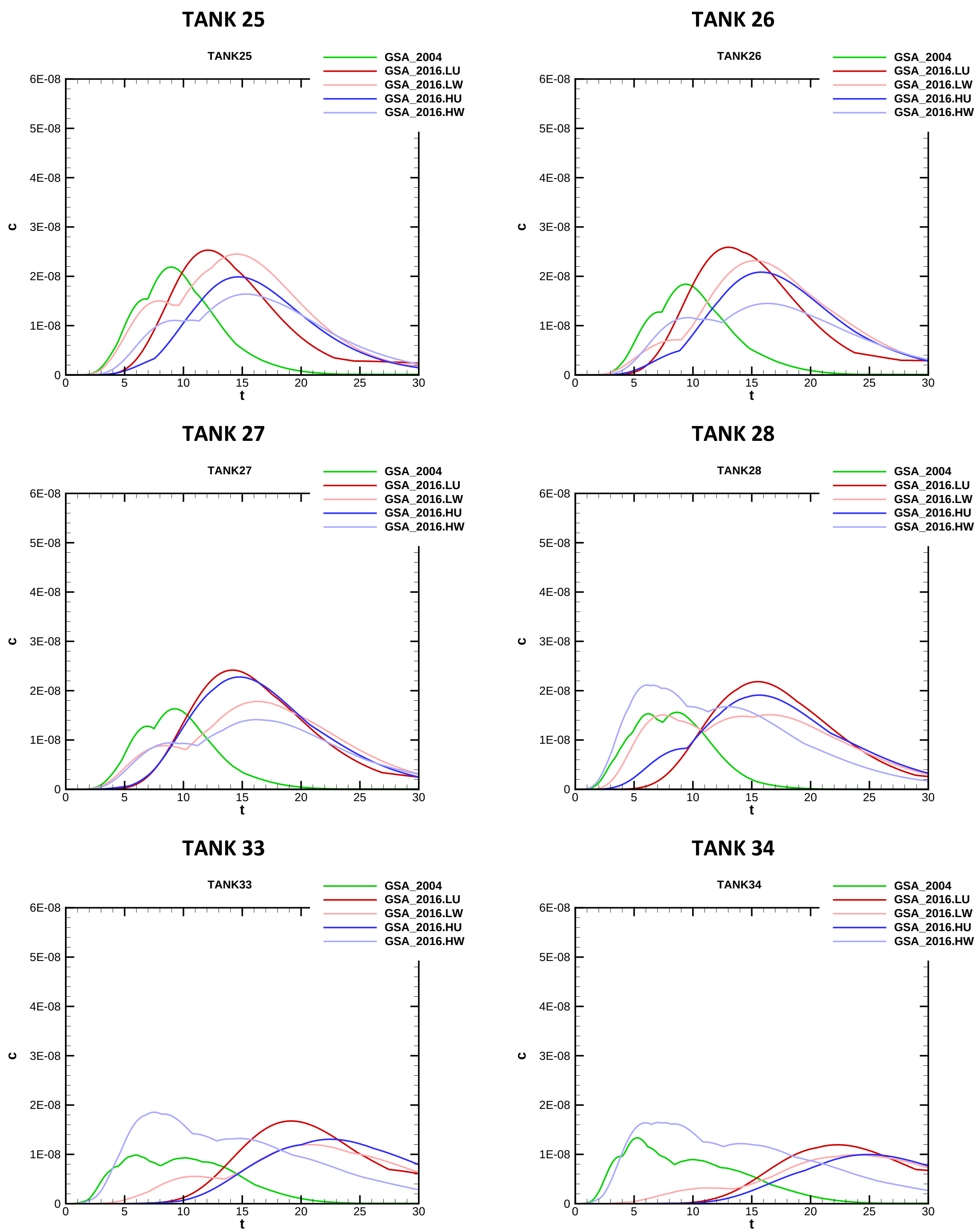
Note: Concentrations are monitored at 100-meter boundary

Figure 88. FTF Pused Source Concentrations (concentration, C in Ci/L, time, t in years)



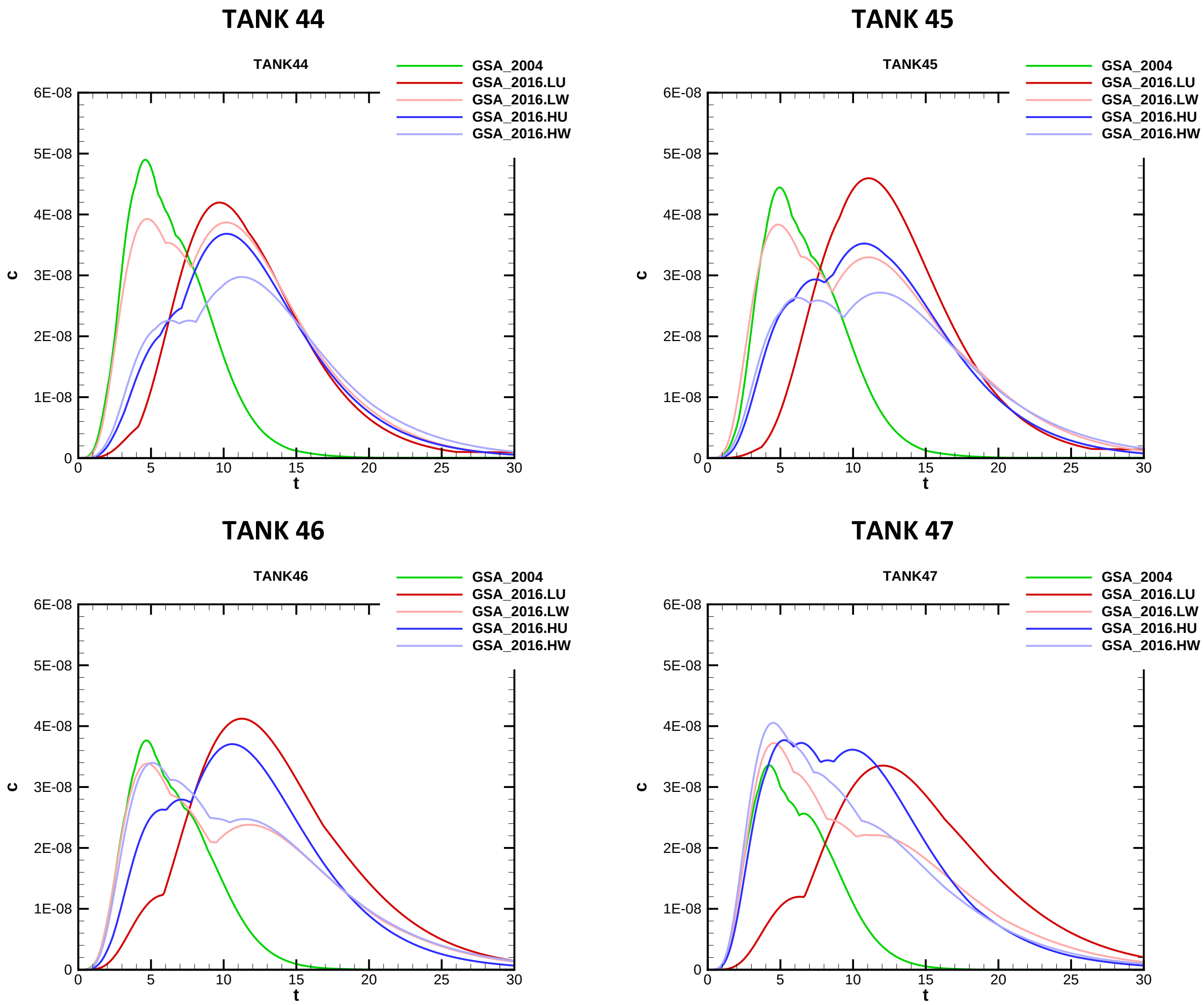
Note: Concentrations are monitored at 100-meter boundary

Figure 88. FTF Pused Source Concentrations (concentration, C in Ci/L, time, t in years) (Cont'd)



Note: Concentrations are monitored at 100-meter boundary

Figure 88. FTF Pused Source Concentrations (concentration, C in Ci/L, time, t in years) (Cont'd)



Note: Concentrations are monitored at 100-meter boundary

Figure 88. FTF Pused Source Concentrations (concentration, C in Ci/L, time, t in years) (Cont'd)

5.3.3 Evaluation Case Transport Simulations

5.3.3.1 Concentrations at 100-meter Boundary

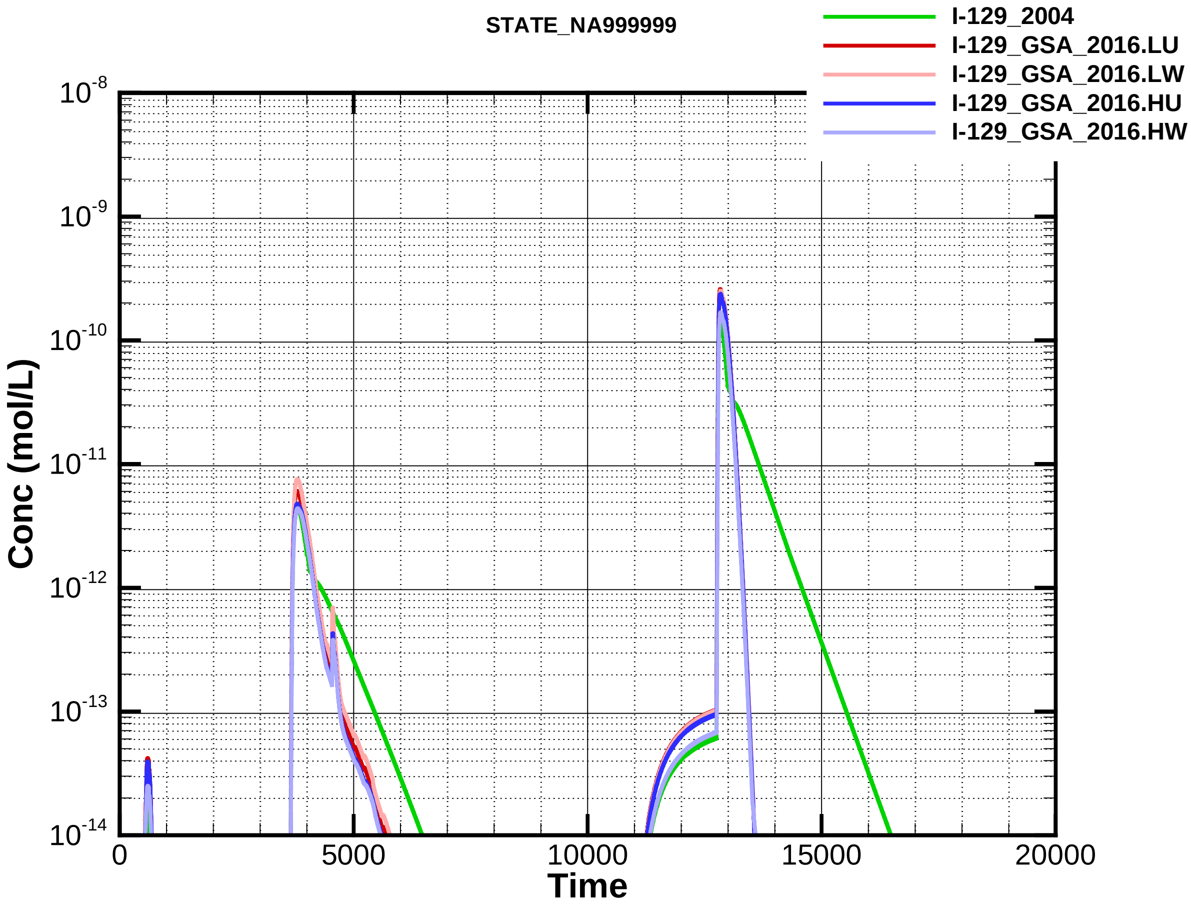


Figure 89. FTF I-129 Concentrations (for all GSA_2016 Flows) at 100-meter Boundary (Time in years)

5.3.3.2 Concentrations at the Seepline

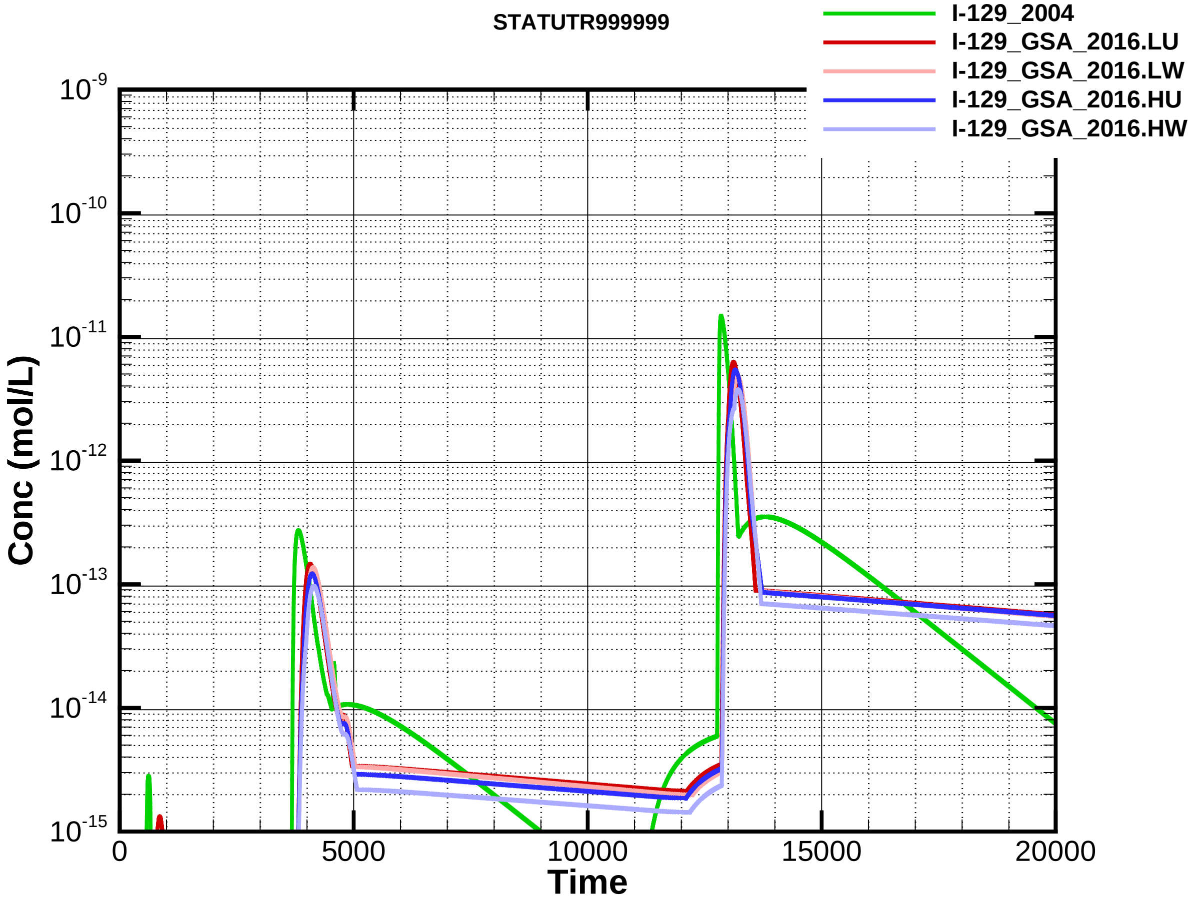


Figure 90. FTF I-129 Concentrations (for all GSA_2016 Flows) at the Seepline (Time in years)

6.0 Conclusions

Compared with GSA_2004 data, the PEST.47 GSA_2016 results (with PORFLOW harmonic averaging at cell faces and diagonal terms in the dispersion tensor) presented herein show the following findings:

<u>SDF</u>

- Slower groundwater speed in east Z-area (see Figure 1 and Figure 2), resulting in higher I-129 concentrations at 100-meter boundary (Figure 9) and at the Upper Three Runs seepline (Figure 10).

<u>HTF</u>

- Groundwater flows more toward north H-area (see Figure 11 and Figure 12).
- About the same peak I-129 concentrations at 100-meter boundary (Figure 19).
- Peak seepline I-129 concentrations along Upper Three Runs are higher in the early period (< 10,000 years), and about the same in the later period (Figure 20).

<u>FTF</u>

- Slower flows more toward the northwest F-area (see Figure 21 and Figure 22).
- Peak I-129 concentrations at 100-meter boundary are about the same in the early period (< 10,000 years), and somewhat higher in the later period for Sector E (Figure 47).
- About the same peak I-129 concentrations at the Upper Three Runs seepline (Figure 48).

Additionally, more accurate transport numerical settings coupled with all four calibrated GSA flow models were considered in a second phase of this study:

1. PEST.47 (<u>L</u>ayer-cake K field, <u>U</u>nweighted optimization)
2. PEST.51 (<u>L</u>ayer-cake K field, <u>W</u>eighted optimization)
3. PEST.52 (<u>H</u>eterogeneous K field, <u>U</u>nweighted optimization)
4. PEST.53 (<u>H</u>eterogeneous K field, <u>W</u>eighted optimization)

The additional transport simulations are denoted:

- GSA_2016_impact.LU (Runs using PEST.47 flow field with PORFLOW upwinding at cell faces and using the full dispersion tensor)
- GSA_2016_impact.LW (Runs using PEST.51 flow field with PORFLOW upwinding at cell faces and using the full dispersion tensor)
- GSA_2016_impact.HU (Runs using PEST.52 flow field with PORFLOW upwinding at cell faces and using the full dispersion tensor)
- GSA_2016_impact.HW (Runs using PEST.53 flow field with PORFLOW upwinding at cell faces and using the full dispersion tensor)

The results of all four calibrated GSA flow models with updated transport settings are summarized below:

<u>SDF</u>

- In general, slower groundwater speed for L- than H-optimized flows, resulting in higher I-129 concentrations at the Upper Three Runs seepline (Figure 68).

<u>HTF</u>

- Slower groundwater speed for L- than H-optimized flows
- No significant difference in the peak I-129 concentrations at 100-meter boundary (Figure 79) and along the Upper Three Runs seepline (Figure 80) after 10,000 years.

<u>FTF</u>

- No significant difference in peak I-129 concentrations at 100-meter boundary (Figure 89) and along the Upper Three Runs seepline (Figure 90).

7.0 References

1. Savannah River Remediation LLC. *Evaluation of Impacts from Updated GSA (General Separations Area) Database Groundwater Flow Model*. Technical Assistance Request, G-TAR-Z-00005, Revision 2. July 24, 2017.

2. Danielson, T. L. *Design check for "Impacts of Updated GSA Groundwater Flow Model on the FTF, HTF and SDF PAs" Study*, SRNL-L3200-2017-00086, August 31, 2017.

3. Flach, G. P. *Groundwater Flow Model of the General Separations Area Using PORFLOW (U)*, WSRC-TR-2004-00106, Revision 0. July 2004.

4. Flach, G. P. and M. K. Harris. *Integrated Hydrogeological Model of the General Separations Area (U); Volume 2: Groundwater Flow Model (U)*. WSRC-TR-96-0399 Rev. 1. Westinghouse Savannah River Company, Aiken, South Carolina. 1999.

5. Flach, G. P., L. A. Bagwell, and P. L. Bennett. *Groundwater Flow Simulation of the Savannah River Site General Separations Area,* SRNL-STI-2017-00008, Revision 0. May 2, 2017.

6. SRR Closure & Waste Disposal Authority. *Performance Assessment for the Saltstone Disposal Facility at the Savannah River Site*, SRR-CWDA-2009-00017 Revision 0. October 2009.

7. Savannah River Remediation, LLC. *Performance Assessment for the F-Tank Farm at the Savannah River Site*, SRS-REG-2007-00002, Revision 1. March 2010.

8. Savannah River Remediation, LLC. *Performance Assessment for the H-Area Tank Farm at the Savannah River Site*, SRR-CWDA-2010-00128, Revision 1. November 2012.

Distribution:

D. A. Crowley, 773-42A
T. L. Danielson, 703-41A
G. P. Flach, 773-42A
T. Hang, 703-41A
S. P. Hommel, 705-1C
T. O. Oliver, 773-42A
M. H. Layton, 705-1C
B. H. Lester, 705-1C
J. E. Mangold, 705-1C
K. H. Rosenberger, 705-1C
F. M. Smith, 705-1C
S. A. Thomas, 705-1C

Records Administration (EDWS)
H. M. Cardona, 773-42A, Room 243