Appendix C
Data Validation Review, Third Quarter 2022

AECOM

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Memorandum

To	Renee Knecht, Project Manager	Info	FINAL
Subject	Summary Data Quality Review Phillips 66 – D Street Terminal, Tacoma Washington 2022 Third Quarter Groundwater Sampling		
From	Amelia McArthur, Chemist Jennifer B. Garner, Chemist		
Date	September 28, 2022		

The summary data quality review of 31 groundwater samples and 3 trip blanks collected between August 1 and August 3, 2022, has been completed. The samples were analyzed at the Eurofins Spokane laboratory located in Spokane, Washington, for benzene, toluene, ethylbenzene, m,p-xylenes, o-xylenes, and total xylenes (BTEX) by EPA Method 8260D, total petroleum hydrocarbons (TPHs) by Washington State Department of Ecology (Ecology) Methods NWTPH-Gx (gasoline-range TPH) and NWTPH-Dx (diesel-range and heavy oil-range TPH), and/or naphthalenes (naphthalene, 1-methylnaphthalene, 2-methylnaphthalene) by EPA Method 8270E modified by selected ion monitoring (SIM). Eurofins Spokane subcontracted analyses for metals (total and/or dissolved lead and manganese) by EPA Method 6020B, anions (nitrate and sulfate) by EPA Method 300.0, and alkalinity by EPA Method 310.1 to the Eurofins laboratory located in Seattle, Washington. The laboratories provided summary reports containing sample results and associated quality assurance (QA) and quality control (QC) data for all samples. The following samples are associated with Eurofins laboratory groups 590-18206-1, 590-18225-1, and 590-18246-1:

Sample ID	Laboratory ID	Requested Analyses
E-22	590-18206-1	BTEX, TPH-Gx, TPH-Dx, Metals, Anions, Alkalinity
RW-5R	590-18206-2	BTEX, TPH-Gx, TPH-Dx, Metals, Anions, Alkalinity
RR-5	590-18206-3	BTEX, TPH-Gx, TPH-Dx, Metals, Anions, Alkalinity
RR-1	590-18206-4	BTEX, TPH-Gx, TPH-Dx, Metals, Anions, Alkalinity
RR-4	590-18206-5	BTEX, TPH-Gx, TPH-Dx, Metals, Anions, Alkalinity
RW-2	590-18206-6	BTEX, TPH-Gx, TPH-Dx, Metals, Anions, Alkalinity
G-8	590-18206-7	BTEX, TPH-Gx, TPH-Dx, Metals, Anions, Alkalinity
TB-1 (trip blank)	590-18206-8	BTEX
DMW-2	590-18225-1	BTEX, TPH-Gx, TPH-Dx, Metals, Anions, Alkalinity
FW-14	590-18225-2	BTEX, TPH-Gx, TPH-Dx, Naphthalenes, Metals, Anions, Alkalinity
FW-15	590-18225-3	BTEX, TPH-Gx, TPH-Dx, Metals, Anions, Alkalinity
FW-13	590-18225-4	BTEX, TPH-Gx, TPH-Dx, Metals, Anions, Alkalinity
B-25	590-18225-5	BTEX, TPH-Gx, TPH-Dx, Metals, Anions, Alkalinity
B-31	590-18225-6	BTEX, TPH-Gx, TPH-Dx, Metals, Anions, Alkalinity
E-21	590-18225-7	BTEX, TPH-Gx, TPH-Dx, Metals, Anions, Alkalinity
B-19	590-18225-8	BTEX, TPH-Gx, TPH-Dx, Metals, Anions, Alkalinity
T-2	590-18225-9	BTEX, TPH-Gx, TPH-Dx, Metals, Anions, Alkalinity
T-2-DUP (duplicate of T-2)	590-18225-10	BTEX, TPH-Gx, TPH-Dx, Metals, Anions, Alkalinity
RW-8	590-18225-11	BTEX, TPH-Gx, TPH-Dx, Metals, Anions, Alkalinity
T-3	590-18225-12	BTEX, TPH-Gx, TPH-Dx, Metals, Anions, Alkalinity
T-3-DUP (duplicate of T-3)	590-18225-13	BTEX, TPH-Gx, TPH-Dx, Metals, Anions, Alkalinity
FW-3	590-18225-14	BTEX, TPH-Gx, TPH-Dx, Metals, Anions, Alkalinity
RR-2	590-18225-15	BTEX, TPH-Gx, TPH-Dx, Naphthalenes, Metals, Anions, Alkalinity
RR-3	590-18225-16	BTEX, TPH-Gx, TPH-Dx, Naphthalenes, Metals, Anions, Alkalinity
TB-2 (trip blank)	590-18225-17	BTEX

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Laboratory Groups: 590-18206-1, 590-18225-1, and 590-18246-1

Sample ID	Laboratory ID	Requested Analyses
DMW-3	590-18246-1	BTEX, TPH-Gx, TPH-Dx, Metals, Anions, Alkalinity
G-18	590-18246-2	BTEX, TPH-Gx, TPH-Dx, Metals, Anions, Alkalinity
HC-111	590-18246-3	BTEX, TPH-Gx, TPH-Dx, Metals, Anions, Alkalinity
B-34	590-18246-4	BTEX, TPH-Gx, TPH-Dx, Metals, Anions, Alkalinity
FW-5R	590-18246-5	BTEX, TPH-Gx, TPH-Dx, Naphthalenes, Metals, Anions, Alkalinity
FW-4	590-18246-6	BTEX, TPH-Gx, TPH-Dx, Naphthalenes, Metals, Anions, Alkalinity
B-17B	590-18246-7	BTEX, TPH-Gx, TPH-Dx, Metals Anions, Alkalinity
DMW-1	590-18246-8	BTEX, TPH-Gx, TPH-Dx, Metals Anions, Alkalinity
TB-3 (trip blank)	590-18246-9	BTEX

Data were evaluated based on validation criteria established in the *National Functional Guidelines for Organic Superfund Methods Data Review*, dated November 2020, and *National Functional Guidelines for Inorganic Superfund Methods Data Review*, November 2020, as applied to the reported methodology.

The following data components were reviewed during the limited data validation procedure for compliance with method specific or laboratory control charted criteria where appropriate: chain of custody forms, holding times, field/method/trip/instrument blanks, surrogate recoveries, matrix spike/matrix spike duplicate recoveries, laboratory and field duplicate results, laboratory control sample/laboratory control sample duplicate recoveries, reporting limits, and electronic data deliverables.

A summary of qualifiers that were assigned to results in these laboratory groups are included in Table 1. Qualifiers that may be assigned to results include:

- U - The analyte was analyzed for but was not detected above the reported sample quantitation limit.

- J - The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

- UJ - The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.

- R - The sample results are rejected due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the analyte cannot be verified.

- DNR - Do Not Report. Another result is available that is more reliable or appropriate.

Sample Receipt

Upon receipt by the laboratories, the sample jar information was compared to the associated chain-of-custody (COC) and the cooler temperatures were recorded. Sample DMW-2 was incorrectly recorded on the sample containers as DW-2. The laboratory logged the sample using the identification recorded on the COC.

Two coolers associated with laboratory group 590-18206-1 were received by Eurofins-Seattle at temperatures exceeding the EPA-recommended limits of greater than 0°C and less than or equal to 6°C at 16.8°C, respectively. These coolers were hand-delivered by AECOM personnel within one day of

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sample collection and with ice present in the coolers; therefore, data were not qualified in laboratory group 590-18206-1 based on the elevated cooler temperatures.

Eurofins-Seattle shipped sample volume for BTEX, TPH, and naphthalenes analyses to Eurofins-Spokane. The coolers were received by Eurofins-Spokane at acceptable temperatures.

The cooler associated with laboratory group 590-18246-1 was received at a temperature outside the EPA-recommended limits of greater than 0°C and less than or equal to 6°C at 15.5°C due to a shipping delay. Results for BTEX and gasoline-range TPH in DMW-3, G-18, HC-111, B-34, FW-5R, FW-4, B-17B, DMW-1, and TB-3 were qualified as estimated and flagged 'J' or 'UJ' based on the elevated cooler temperature.

Organic Analyses

Samples were analyzed for BTEX, TPHs, and/or naphthalenes by the methods identified in the introduction of this report.

1. Holding Times – Acceptable

2. Blanks – Acceptable

3. Surrogates – Acceptable

4. Laboratory Control Sample/Laboratory Control Sample Duplicate (LCS/LCSD) – Acceptable

5. Matrix Spike/Matrix Spike Duplicate (MS/MSD) – Acceptable

    BTEX by Method 8260D – An MS/MSD was prepared using sample RW-8. Results were acceptable.

    NWTPH-Gx – An MS/MSD was prepared using sample RW-8. Results were acceptable.

    NWTPH-Dx – An MS/MSD was prepared using sample RW-8. Results were acceptable.

    Naphthalenes by Method 8270E-SIM – An MS/MSD was not performed in association with this analysis. Precision and accuracy were assessed using the LCS/LCSD results.

6. Field Duplicate (applicable to BTEX and TPH analyses only) – Acceptable where applicable

    General – Field duplicates were submitted for T-2 and T-3 and identified as T-2-DUP and T-3 -DUP, respectively. Results were comparable.

7. Reporting Limits – Acceptable except as noted below:

    General – One or more results in multiple samples were flagged 'J' by the laboratory to indicate a concentration that was less than the reporting limit, but above the method detection limit (MDL). Laboratory 'J'-flagged results are considered estimated. As the result is between the MDL and the reporting limit, there is a greater level of uncertainty associated with the numerical value.

8.   Other Items of Note:

NWTPH-Dx – The laboratory noted the following:

- Detected hydrocarbons in the diesel range appear to be due to weathered or heavily weathered diesel in DMW-2, FW-13, FW-15, E-21, T-3, T-3-DUP, RW-8, FW-3, FW-4, and DMW-1.

- Detected hydrocarbons in the diesel range appear to be due to gasoline overlap as well as weathered or heavily weathered diesel in B-31, B-19, DMW-3, G-18, HC-111, B-34, and FW-5R.

- Detected hydrocarbons in the diesel range appear to be due to gasoline overlap in B-25.

The laboratory noted that the percent difference (%D) for the surrogate n-triacontane-d62 was outside the method limits of ±20% (high) in the continuing calibration verification associated with analytical batch 590-37453. No data were qualified based on the n-triacontane-d62 surrogate %D.

Metals

Samples were analyzed for total and/or dissolved metals by the methods identified in the introduction to this report.

1.   Holding Times – Acceptable

2.   Blanks – Acceptable

3.   Laboratory Control Sample/Laboratory Control Sample Duplicate (LCS/LCSD) – Acceptable

4.   Matrix Spike/Matrix Spike Duplicate (MS/MSD) – Acceptable

Total Lead by Method 6020B – An MS/MSD for total lead was performed using RW-8. Results were acceptable.

Dissolved Lead and Manganese by Method 6020B – MS/MSDs for dissolved lead and manganese were performed using RW-8 and FW-5R. Results were acceptable.

5.   Laboratory Duplicate – Acceptable

Total Lead by Method 6020B – A laboratory duplicate for total lead was performed using RW-8. Results were comparable.

Dissolved Lead and Manganese by Method 6020B – Laboratory duplicates for dissolved lead and manganese were performed using RW-8 and FW-5R. Results were comparable.

6.   Field Duplicate – Acceptable

General – Field duplicates were submitted for T-2 and T-3 and identified as T-2-DUP and T-3 -DUP, respectively. Results were comparable.

7. Reporting Limits – Acceptable

    General – One or more results in multiple samples were flagged 'J' by the laboratory to indicate a concentration that was less than the reporting limit, but above the MDL. As noted above, laboratory 'J'-flagged results are considered estimated results.

    The reporting limits for total lead, dissolved lead, and/or dissolved manganese reported as not detected were elevated in multiple samples due to the dilutions required for matrix interferences. The elevated reporting limits do not impact the use of the data.

General Chemistry Parameters

Samples were analyzed for anions and alkalinity by the methods identified in the introduction to this report.

1. Holding Times – Acceptable except as noted below:

    Anions by Method 300.0 – Samples DMW-3, G-18, HC-111, and B-34 were reanalyzed for nitrate outside of the analytical holding time due to inadequate reproducibility in the initial analyses. The results for nitrate in these samples were qualified as estimated and flagged 'J' or 'UJ' based on holding time exceedance.

2. Blanks – Acceptable where applicable

3. Laboratory Control Sample/Laboratory Control Sample Duplicate (LCS/LCSD) – Acceptable

4. Matrix Spike/Matrix Spike Duplicate (MS/MSD) – Acceptable (applicable to anions only)

    Anions by Method 300.0 – MS/MSDs were performed using RW-2, RW-8, and B-17B. Results were acceptable.

5. Laboratory Duplicates – Acceptable

    Anions by Method 300.0 – A laboratory duplicate was not performed in association with this analysis. Accuracy was assessed using the LCS/LCSD, MS/MSD, and field duplicate relative percent differences.

    Alkalinity by Method 310.1 – A laboratory duplicate was performed using RW-8. Results were comparable.

6. Field Duplicate – Acceptable

    General – Field duplicates were submitted for T-2 and T-3 and identified as T-2-DUP and T-3 - DUP, respectively. Results were comparable.

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7. Reporting Limits – Acceptable

   Anions by Method 300.0 – One or more nitrate results in multiple samples were flagged 'J' by the laboratory. As noted above, laboratory 'J'-flagged results are considered estimated results.

Overall Assessment of Data

The data reported in these laboratory groups, as qualified, are usable for meeting project objectives. The completeness for Eurofins laboratory groups 590-18206-1, 590-18225-1, and 590-18246-1 is 100%.

Table 1 – Summary of Qualified Data

Sample ID	Laboratory ID	Analyte	Laboratory Result	Units	Final Result	Reason
DMW-3	590-18246-1	Benzene	0.093 U	ug/L	0.093 UJ	Temperature
DMW-3	590-18246-1	Ethylbenzene	0.20 U	ug/L	0.20 UJ	Temperature
DMW-3	590-18246-1	m,p-Xylene	0.28 U	ug/L	0.28 UJ	Temperature
DMW-3	590-18246-1	o-Xylene	0.40 J	ug/L	0.40 J	Temperature
DMW-3	590-18246-1	Toluene	0.31 U	ug/L	0.31 UJ	Temperature
DMW-3	590-18246-1	Xylenes, Total	0.44 U	ug/L	0.44 UJ	Temperature
DMW-3	590-18246-1	Gasoline	510	ug/L	510 J	Temperature
DMW-3	590-18246-1	Nitrate as N	0.030 U	mg/L	0.030 UJ	Holding Time
G-18	590-18246-2	Benzene	0.52	ug/L	0.52 J	Temperature
G-18	590-18246-2	Ethylbenzene	0.20 U	ug/L	0.20 UJ	Temperature
G-18	590-18246-2	m,p-Xylene	0.28 U	ug/L	0.28 UJ	Temperature
G-18	590-18246-2	o-Xylene	0.16 U	ug/L	0.16 UJ	Temperature
G-18	590-18246-2	Toluene	0.31 U	ug/L	0.31 UJ	Temperature
G-18	590-18246-2	Xylenes, Total	0.44 U	ug/L	0.44 UJ	Temperature
G-18	590-18246-2	Gasoline	260	ug/L	260 J	Temperature
G-18	590-18246-2	Nitrate as N	0.034 J	mg/L	0.034 J	Holding Time
HC-111	590-18246-3	Benzene	25	ug/L	25 J	Temperature
HC-111	590-18246-3	Ethylbenzene	92	ug/L	92 J	Temperature
HC-111	590-18246-3	m,p-Xylene	3.5	ug/L	3.5 J	Temperature
HC-111	590-18246-3	o-Xylene	1.4	ug/L	1.4 J	Temperature
HC-111	590-18246-3	Toluene	3.9	ug/L	3.9 J	Temperature
HC-111	590-18246-3	Xylenes, Total	4.9	ug/L	4.9 J	Temperature
HC-111	590-18246-3	Gasoline	2,500	ug/L	2,500 J	Temperature
HC-111	590-18246-3	Nitrate as N	0.032 J	mg/L	0.032 J	Holding Time
B-34	590-18246-4	Benzene	69	ug/L	69 J	Temperature
B-34	590-18246-4	Ethylbenzene	6.5	ug/L	6.5 J	Temperature
B-34	590-18246-4	m,p-Xylene	0.79 J	ug/L	0.79 J	Temperature
B-34	590-18246-4	o-Xylene	0.36 J	ug/L	0.36 J	Temperature
B-34	590-18246-4	Toluene	5.1	ug/L	5.1 J	Temperature
B-34	590-18246-4	Xylenes, Total	1.2 J	ug/L	1.2 J	Temperature
B-34	590-18246-4	Gasoline	2,600	ug/L	2,600 J	Temperature
B-34	590-18246-4	Nitrate as N	0.030 U	mg/L	0.030 UJ	Holding Time
FW-5R	590-18246-5	Benzene	0.47	ug/L	0.47 J	Temperature
FW-5R	590-18246-5	Ethylbenzene	0.27 J	ug/L	0.27 J	Temperature

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Laboratory Groups: 590-18206-1, 590-18225-1, and 590-18246-1

Sample ID	Laboratory ID	Analyte	Laboratory Result	Units	Final Result	Reason
FW-5R	590-18246-5	m,p-Xylene	0.28 U	ug/L	0.28 UJ	Temperature
FW-5R	590-18246-5	o-Xylene	0.16 U	ug/L	0.16 UJ	Temperature
FW-5R	590-18246-5	Toluene	0.33 J	ug/L	0.33 J	Temperature
FW-5R	590-18246-5	Xylenes, Total	0.44 U	ug/L	0.44 UJ	Temperature
FW-5R	590-18246-5	Gasoline	870	ug/L	870 J	Temperature
FW-4	590-18246-6	Benzene	0.093 U	ug/L	0.093 UJ	Temperature
FW-4	590-18246-6	Ethylbenzene	0.20 U	ug/L	0.20 UJ	Temperature
FW-4	590-18246-6	m,p-Xylene	0.28 U	ug/L	0.28 UJ	Temperature
FW-4	590-18246-6	o-Xylene	0.16 U	ug/L	0.16 UJ	Temperature
FW-4	590-18246-6	Toluene	0.31 U	ug/L	0.31 UJ	Temperature
FW-4	590-18246-6	Xylenes, Total	0.44 U	ug/L	0.44 UJ	Temperature
FW-4	590-18246-6	Gasoline	36 J	ug/L	36 J	Temperature
B-17B	590-18246-7	Benzene	0.093 U	ug/L	0.093 UJ	Temperature
B-17B	590-18246-7	Ethylbenzene	0.20 U	ug/L	0.20 UJ	Temperature
B-17B	590-18246-7	m,p-Xylene	0.28 U	ug/L	0.28 UJ	Temperature
B-17B	590-18246-7	o-Xylene	0.16 U	ug/L	0.16 UJ	Temperature
B-17B	590-18246-7	Toluene	0.31 U	ug/L	0.31 UJ	Temperature
B-17B	590-18246-7	Xylenes, Total	0.44 U	ug/L	0.44 UJ	Temperature
B-17B	590-18246-7	Gasoline	32 J	ug/L	32 J	Temperature
DMW-1	590-18246-8	Benzene	0.093 U	ug/L	0.093 UJ	Temperature
DMW-1	590-18246-8	Ethylbenzene	0.20 U	ug/L	0.20 UJ	Temperature
DMW-1	590-18246-8	m,p-Xylene	0.28 U	ug/L	0.28 UJ	Temperature
DMW-1	590-18246-8	o-Xylene	0.16 U	ug/L	0.16 UJ	Temperature
DMW-1	590-18246-8	Toluene	0.31 U	ug/L	0.31 UJ	Temperature
DMW-1	590-18246-8	Xylenes, Total	0.44 U	ug/L	0.44 UJ	Temperature
DMW-1	590-18246-8	Gasoline	31 U	ug/L	31 UJ	Temperature
TB-3	590-18246-9	Benzene	0.093 U	ug/L	0.093 UJ	Temperature
TB-3	590-18246-9	Ethylbenzene	0.20 U	ug/L	0.20 UJ	Temperature
TB-3	590-18246-9	m,p-Xylene	0.28 U	ug/L	0.28 UJ	Temperature
TB-3	590-18246-9	o-Xylene	0.16 U	ug/L	0.16 UJ	Temperature
TB-3	590-18246-9	Toluene	0.31 U	ug/L	0.31 UJ	Temperature
TB-3	590-18246-9	Xylenes, Total	0.44 U	ug/L	0.44 UJ	Temperature

Appendix D

GWSDAT Plots: Time vs. Concentration with Mann-Kendall

GWSDAT Summary/Legend

Black Solid Data Points	=	Detections
Orange Solid Data Points	=	Non-Detects
Black-Hollow Data Points	=	Groundwater Elevation
Solid Blue Line	=	Smoothed estimate of the mean trend
Dashed Blue Line	=	95% confidence interval around the estimated mean trend
Solid Green Line	=	Linear trend estimate (Mann-Kendall Analysis)
Dashed Green Line	=	95% confidence interval around linear trend estimate

Benzene in B−17B : Aquifer−Blank
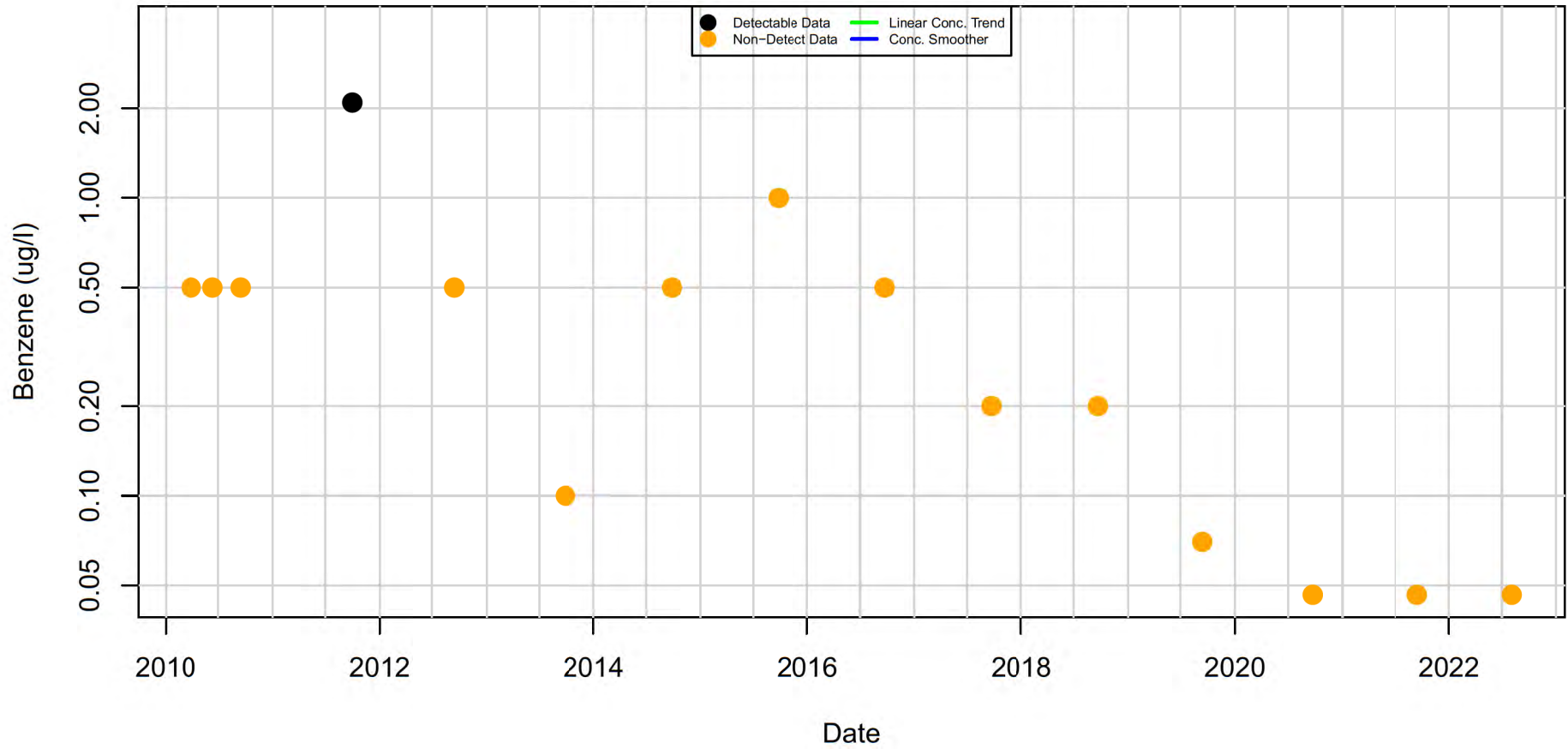
Benzene in B-30 : Aquifer-Blank
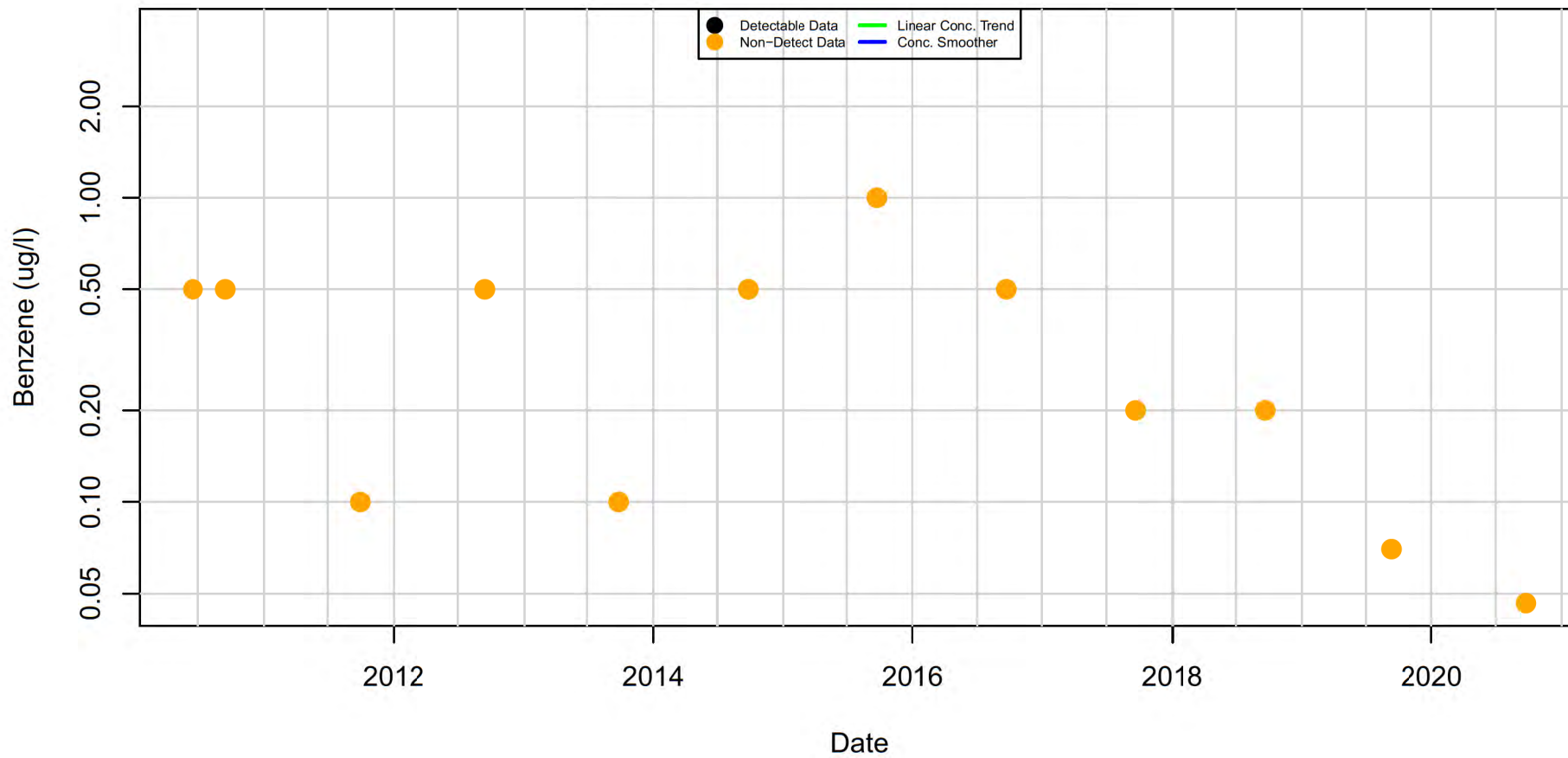
Benzene in B-31 : Aquifer-Blank

Mann-Kendall P.Value= 0.574; Half-Life= 1204 days
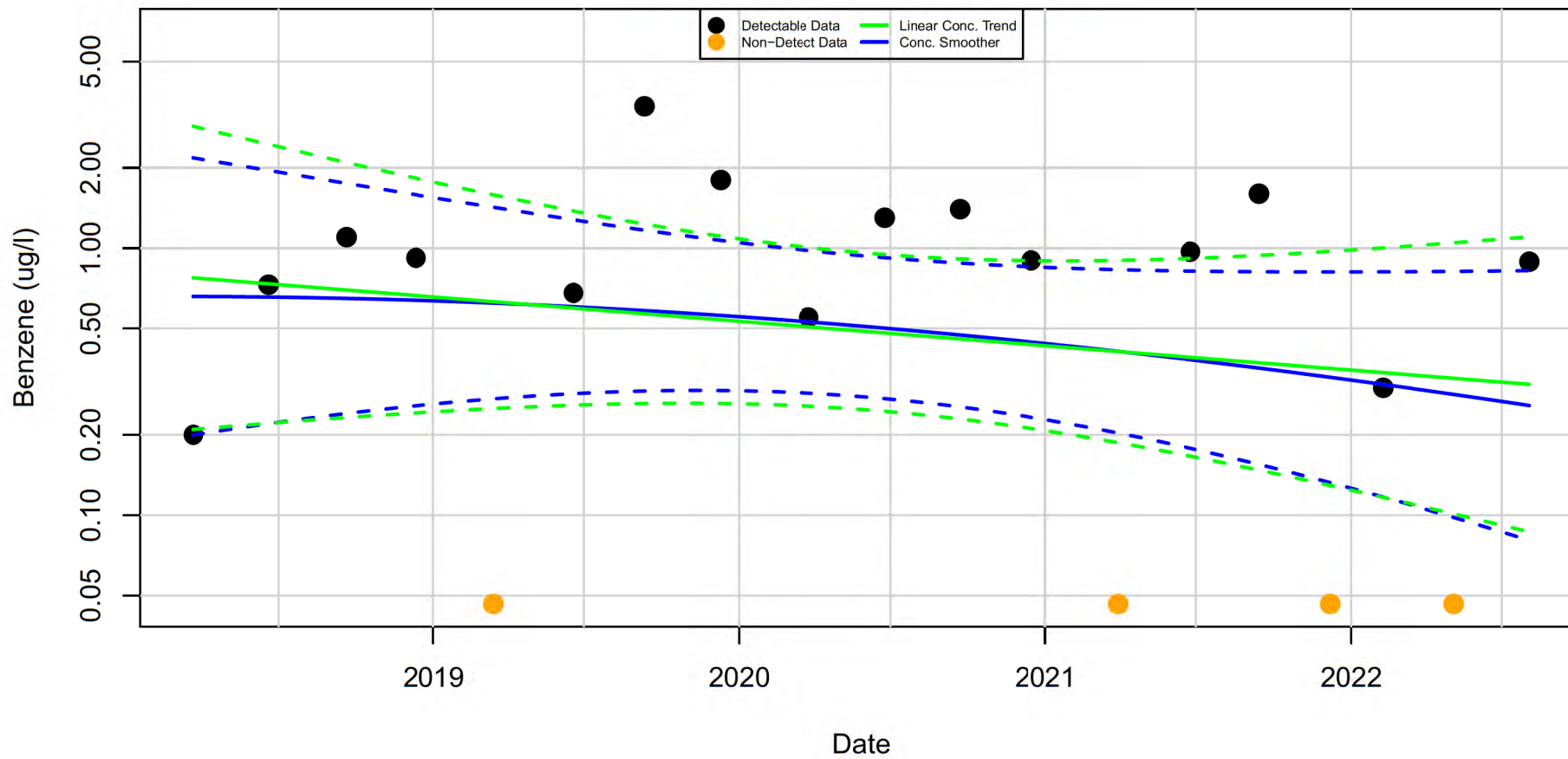
Benzene in E−21 : Aquifer−Blank

Mann−Kendall P.Value= 0.586; Half−Life> 5 Years
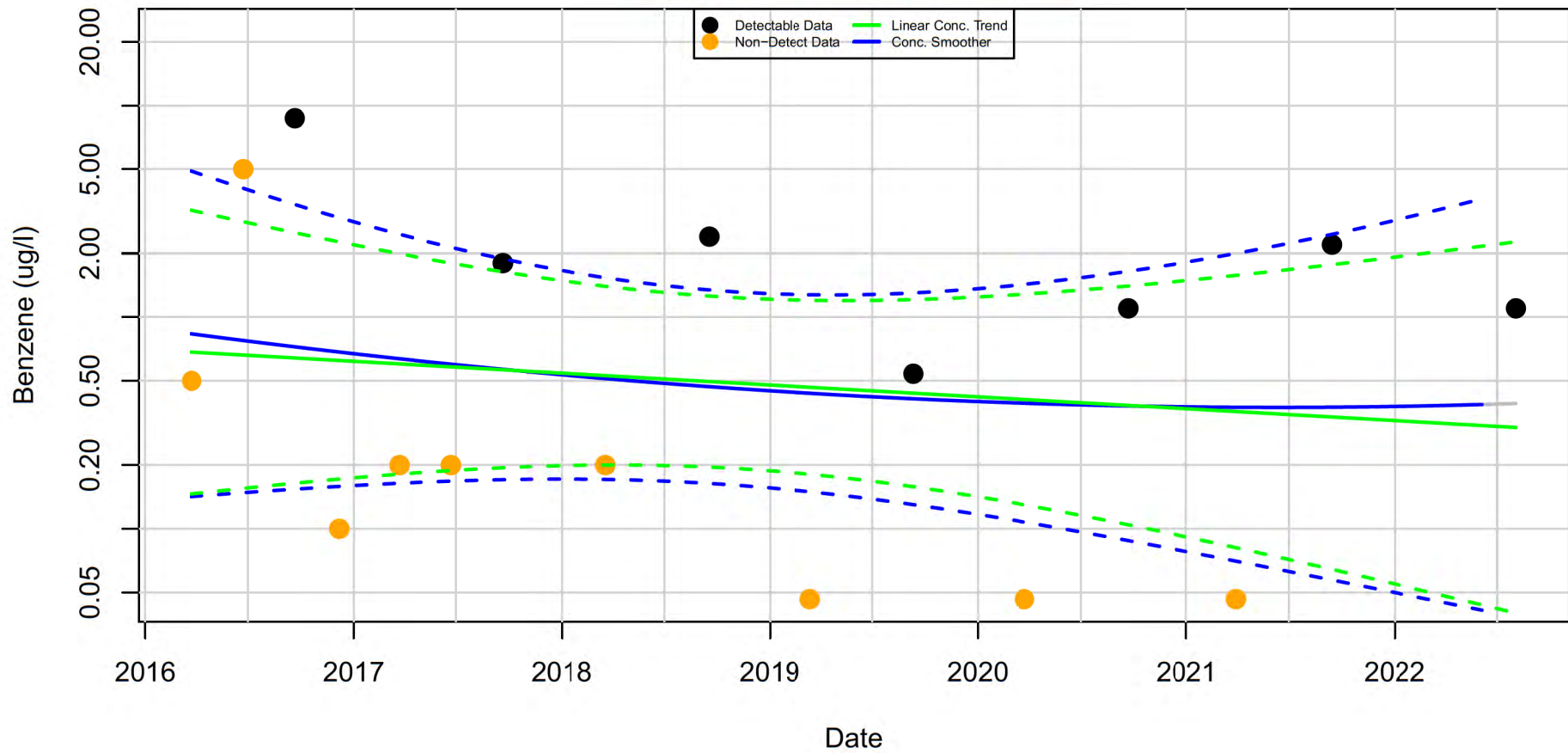
Benzene in B−19 : Aquifer−Blank

Mann−Kendall P.Value= 0.882; Half−Life> 5 Years
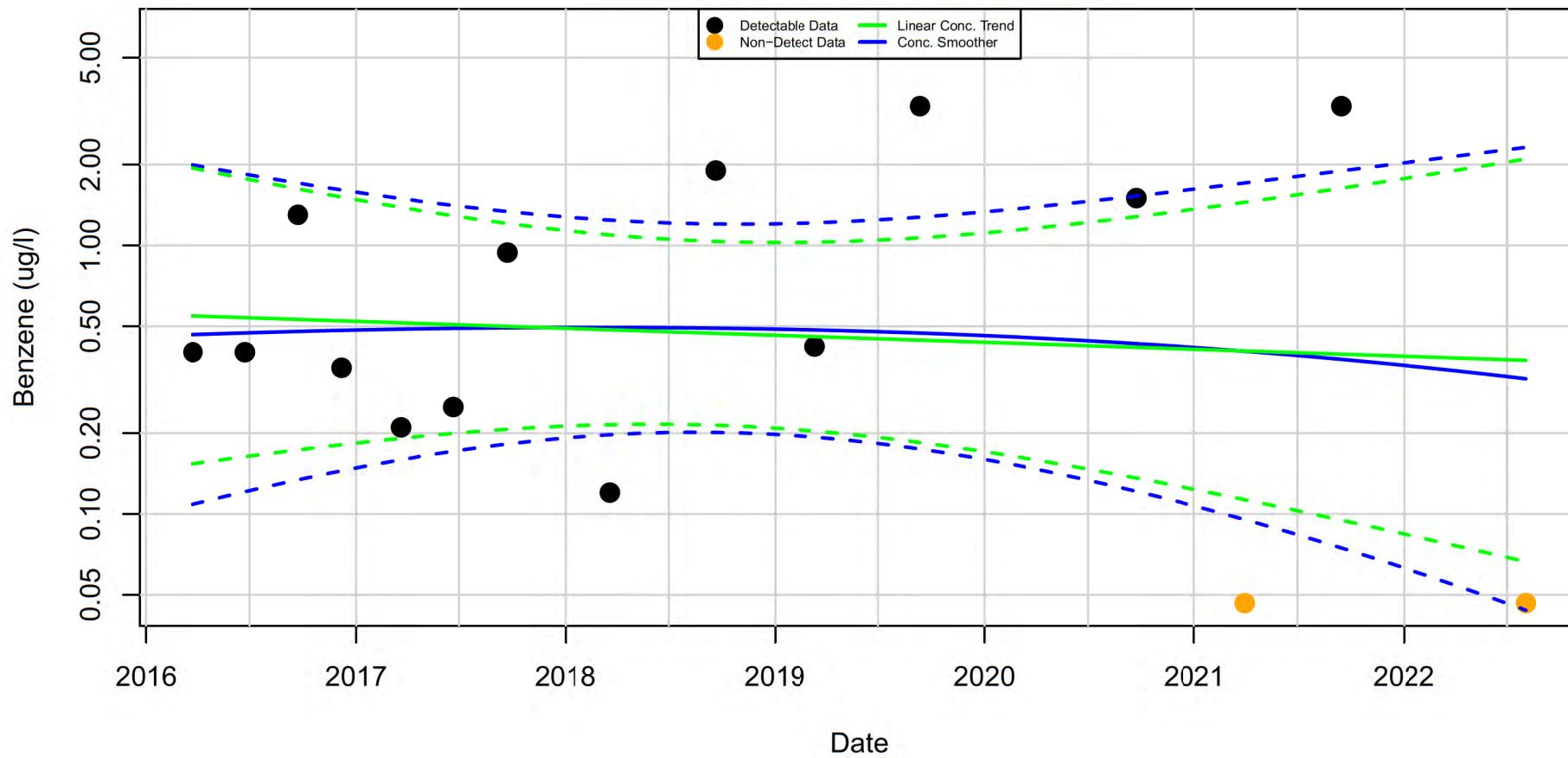
Benzene in B-25 : Aquifer-Blank

Mann-Kendall P.Value= 0.0802; Half-Life= 670 days
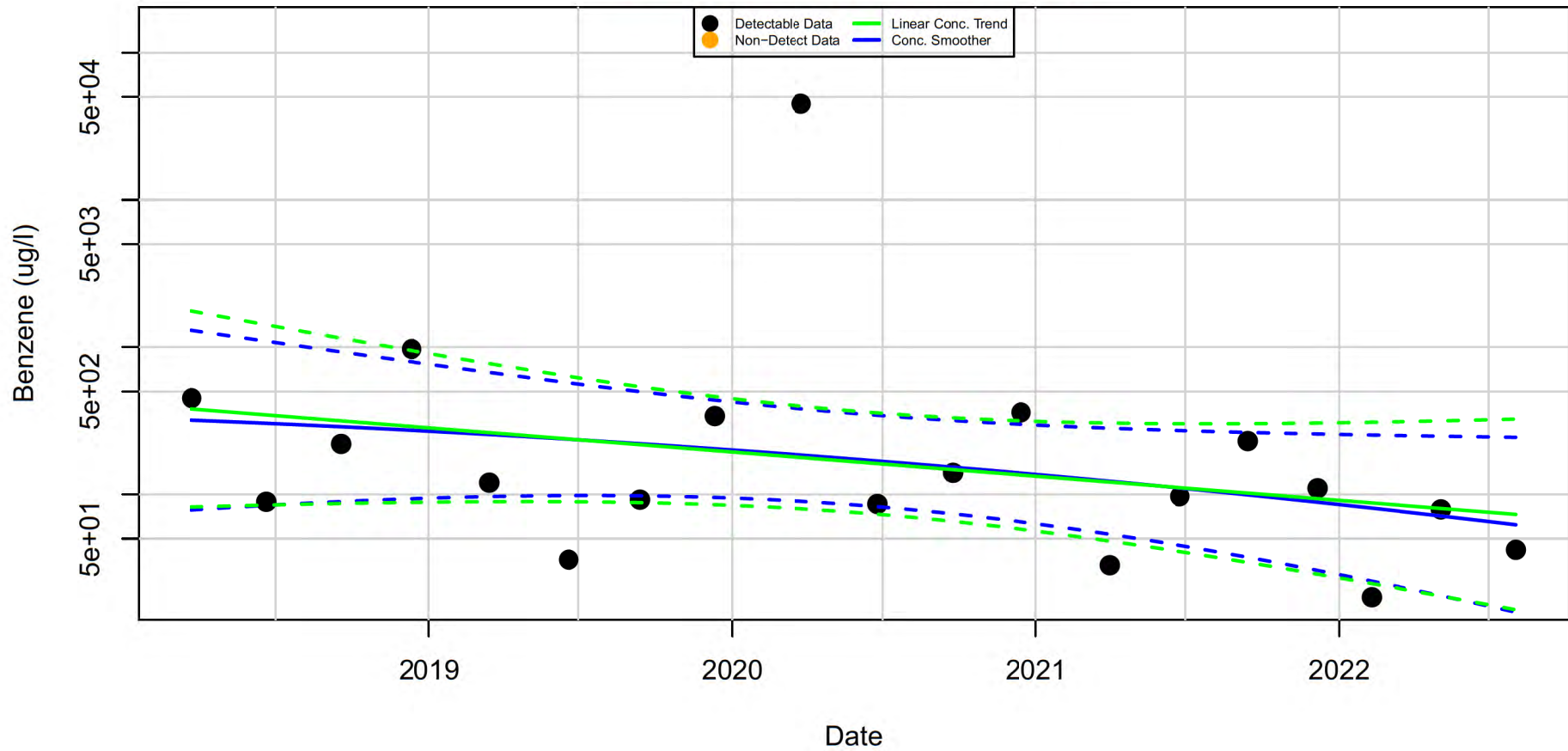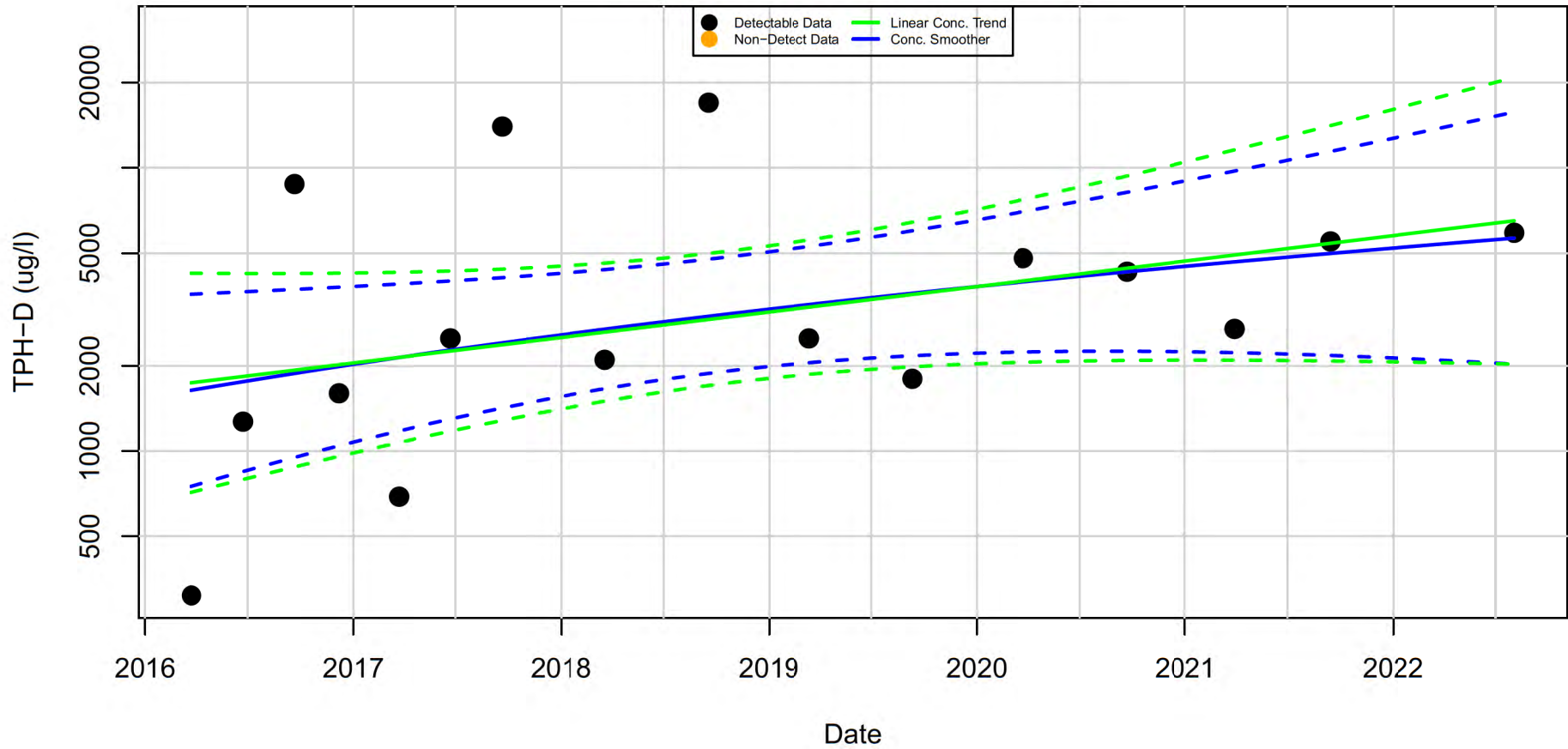
Benzene in B−34 : Aquifer−Blank

Mann−Kendall P.Value= <0.01; Half−Life= 729 days

Legend:
- Detectable Data
- Non−Detect Data
- Linear Conc. Trend
- Conc. Smoother

Y-axis: Benzene (ug/l)

X-axis: Date
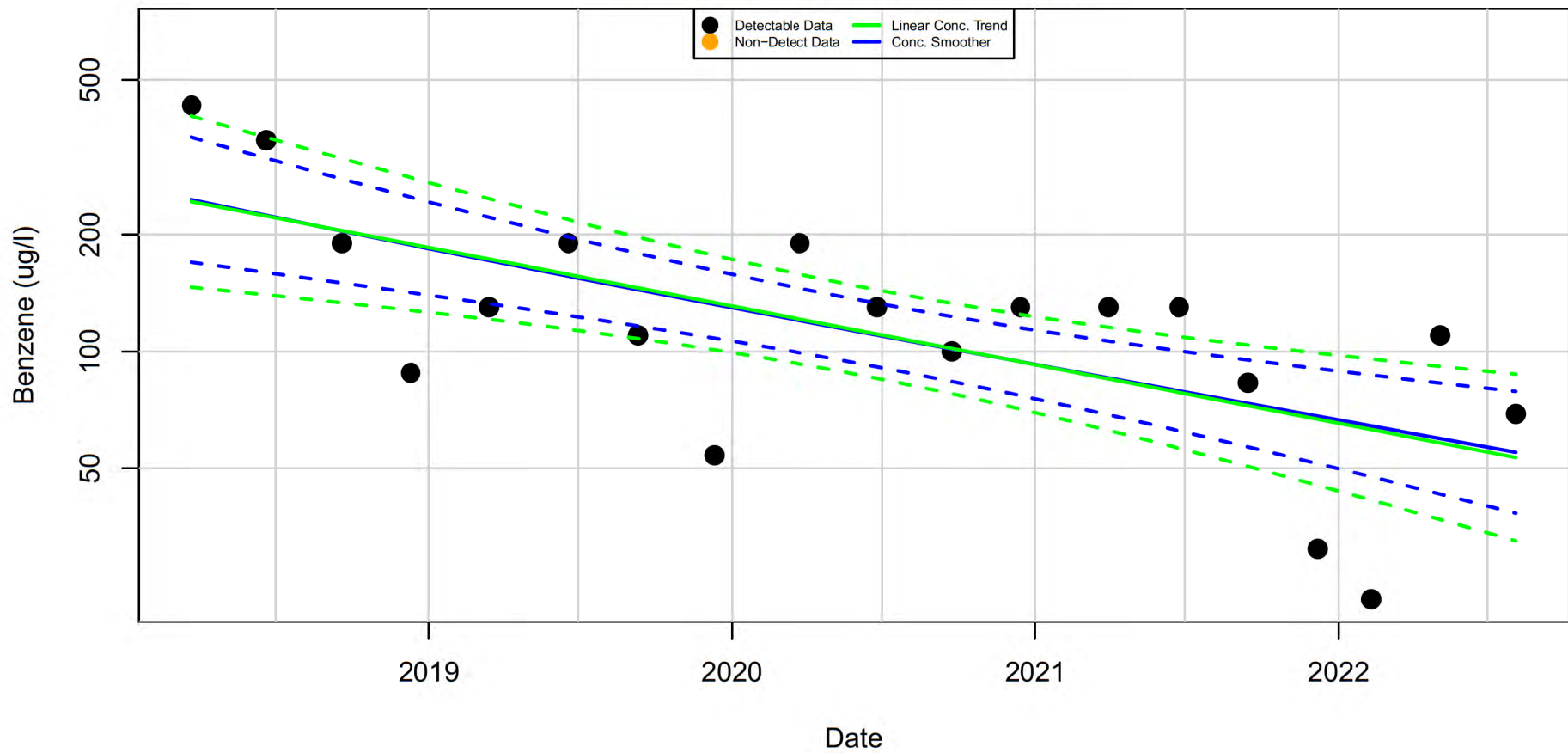
Benzene in G-8 : Aquifer-Blank

Mann-Kendall P.Value= 0.0211; Half-Life= 820 days

Benzene in G-16 : Aquifer-Blank
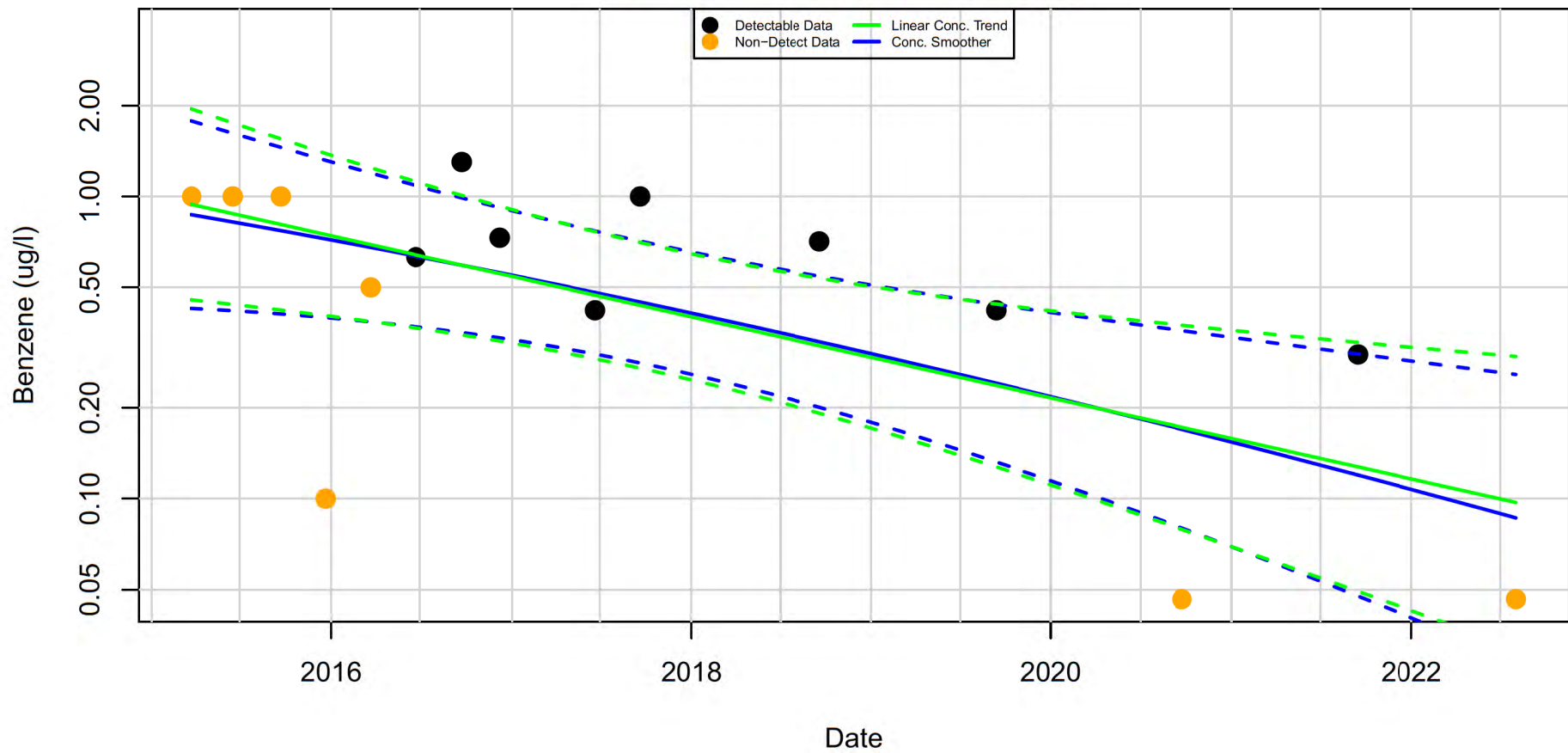
Mann−Kendall P.Value= 0.142; Half−Life= 1570 days

Legend:
- Detectable Data
- Non-Detect Data
- Linear Conc. Trend
- Conc. Smoother

Y-axis: Benzene (ug/l)

X-axis: Date
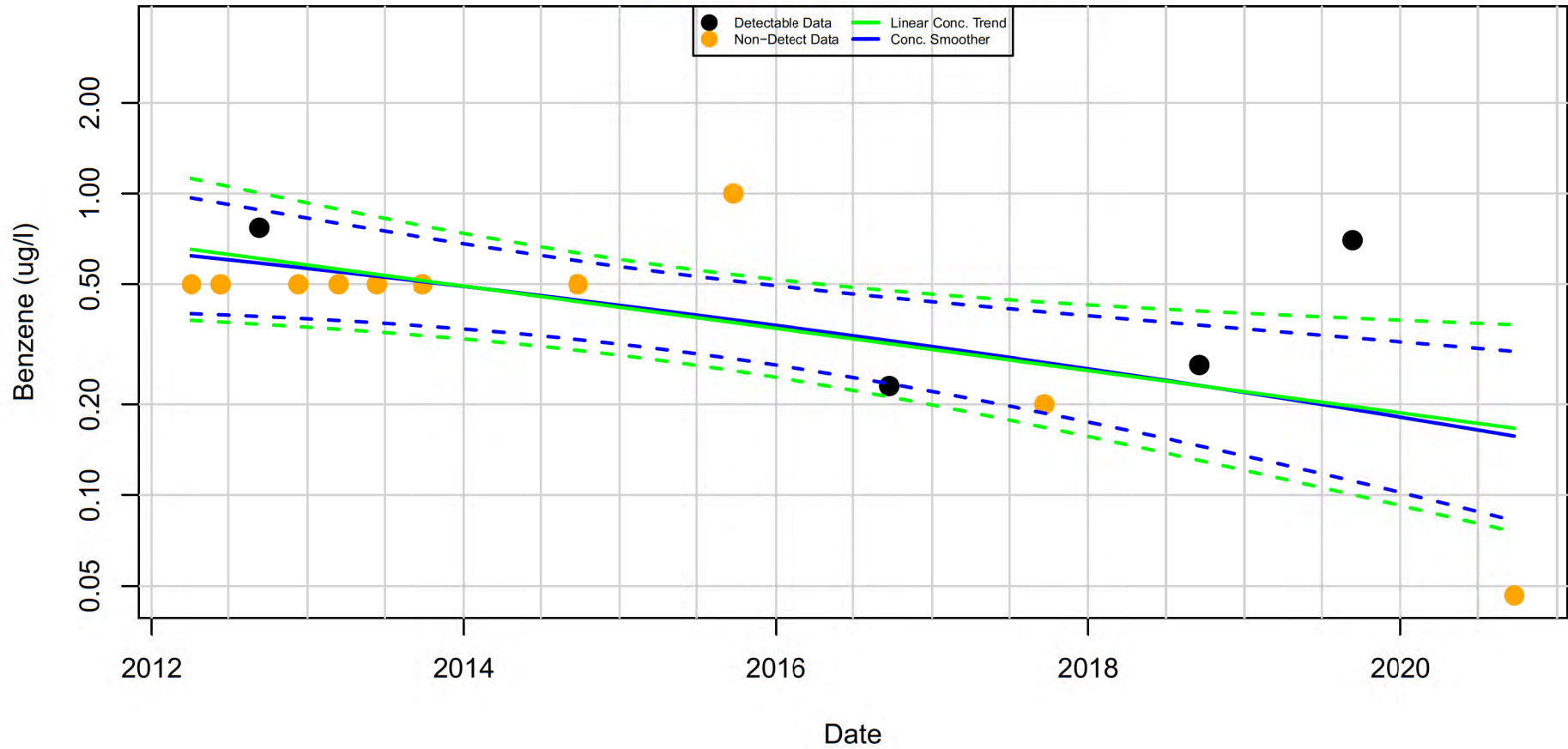
Benzene in G-18 : Aquifer-Blank

Mann-Kendall P.Value= 0.201; Half-Life= 1244 days

Legend:
- Detectable Data
- Non-Detect Data
- Linear Conc. Trend
- Conc. Smoother

Y-axis: Benzene (ug/l)

X-axis: Date
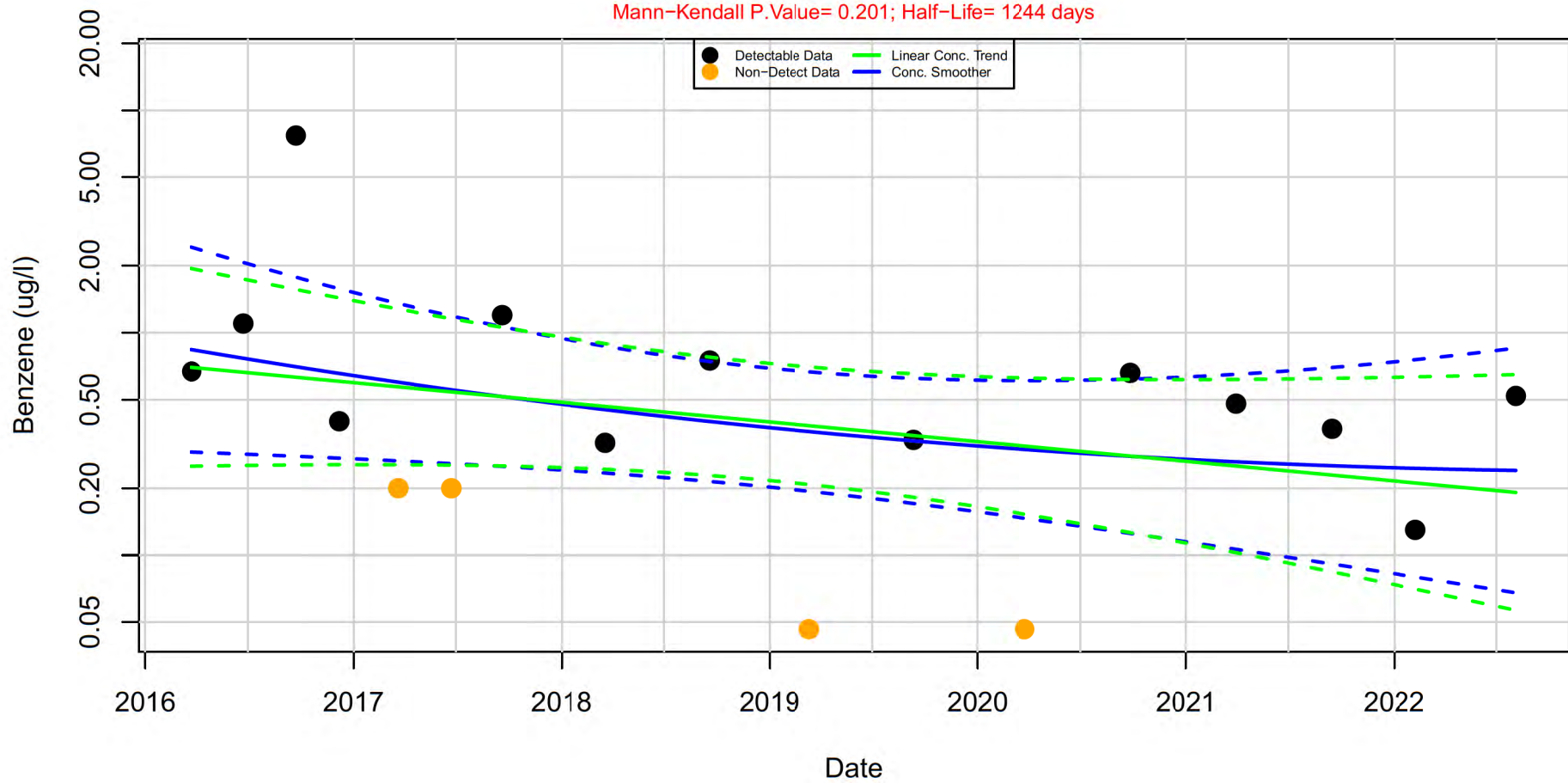
Benzene in HC−111 : Aquifer−Blank

Mann−Kendall P.Value= <0.01; Half−Life= 481 days
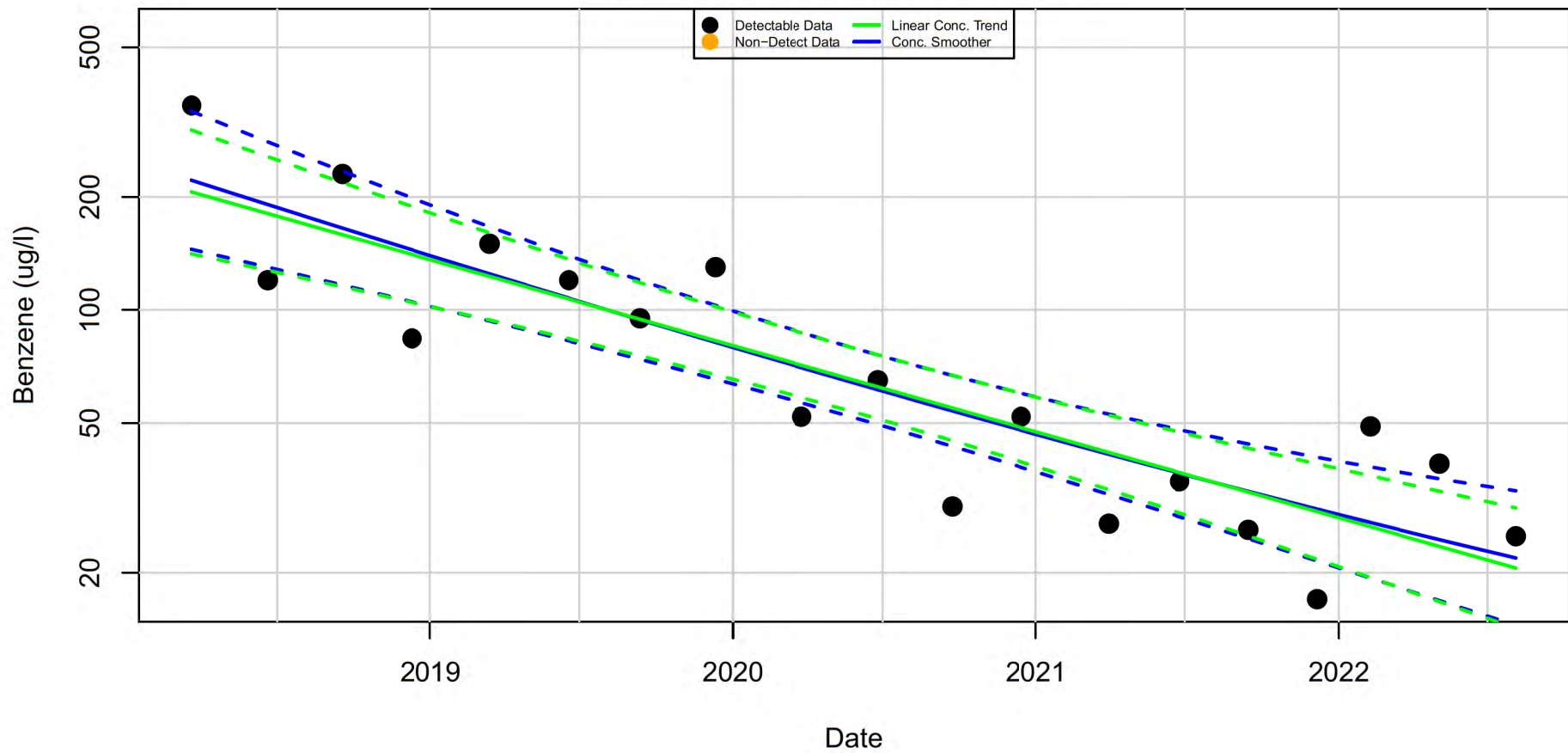
Benzene in RW-2 : Aquifer-Blank

Mann-Kendall P.Value= 0.652; Half-Life> 5 Years

Legend:
- Detectable Data
- Non-Detect Data
- Linear Conc. Trend
- Conc. Smoother

Benzene (ug/l)

Date
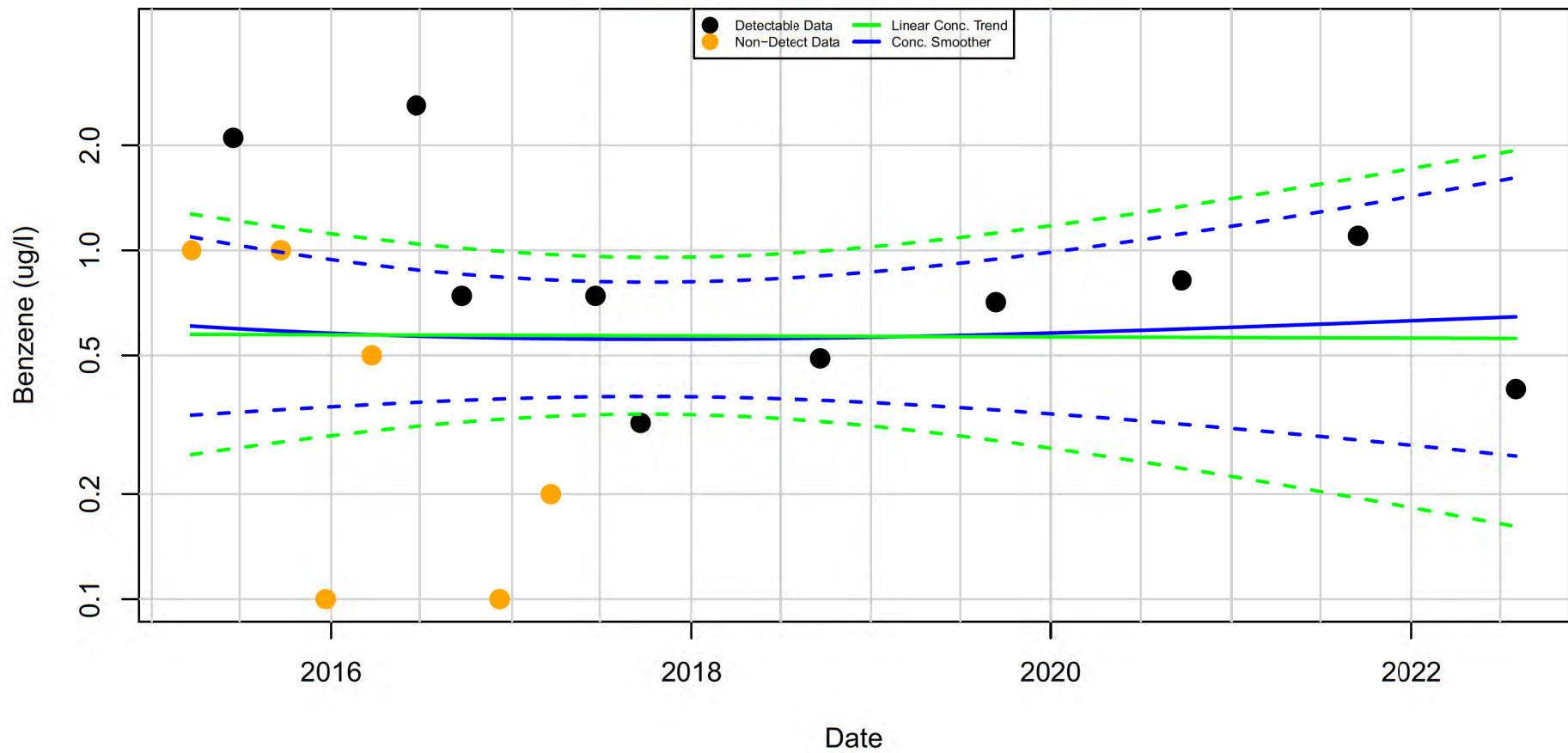
Benzene in RW-5R : Aquifer-Blank

Mann-Kendall P.Value= 0.861; Half-Life= 1642 days
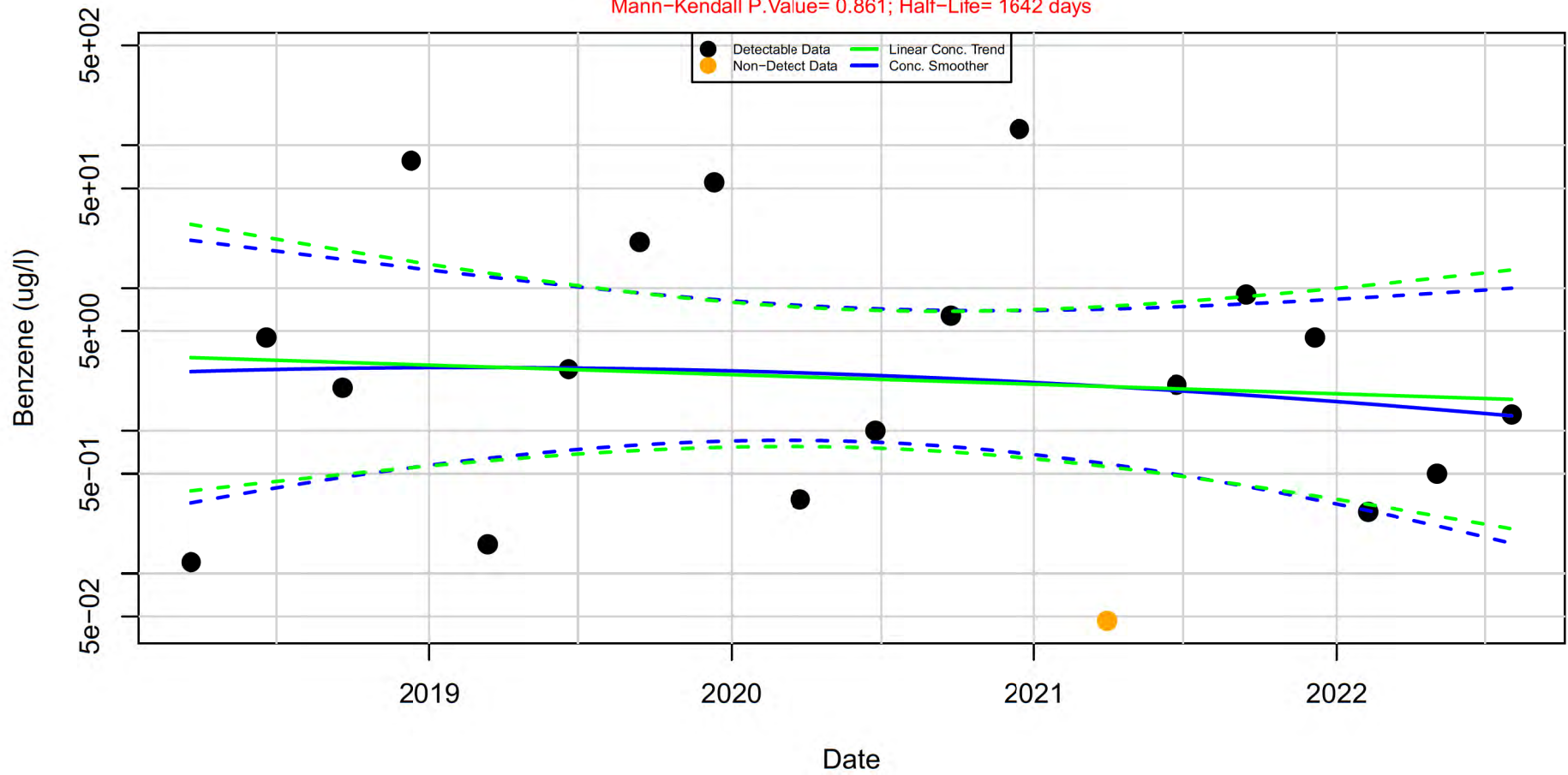
Benzene in RW-8 : Aquifer-Blank

Mann-Kendall P.Value= <0.01; Half-Life= 218 days

- Detectable Data
- Non-Detect Data
- Linear Conc. Trend
- Conc. Smoother
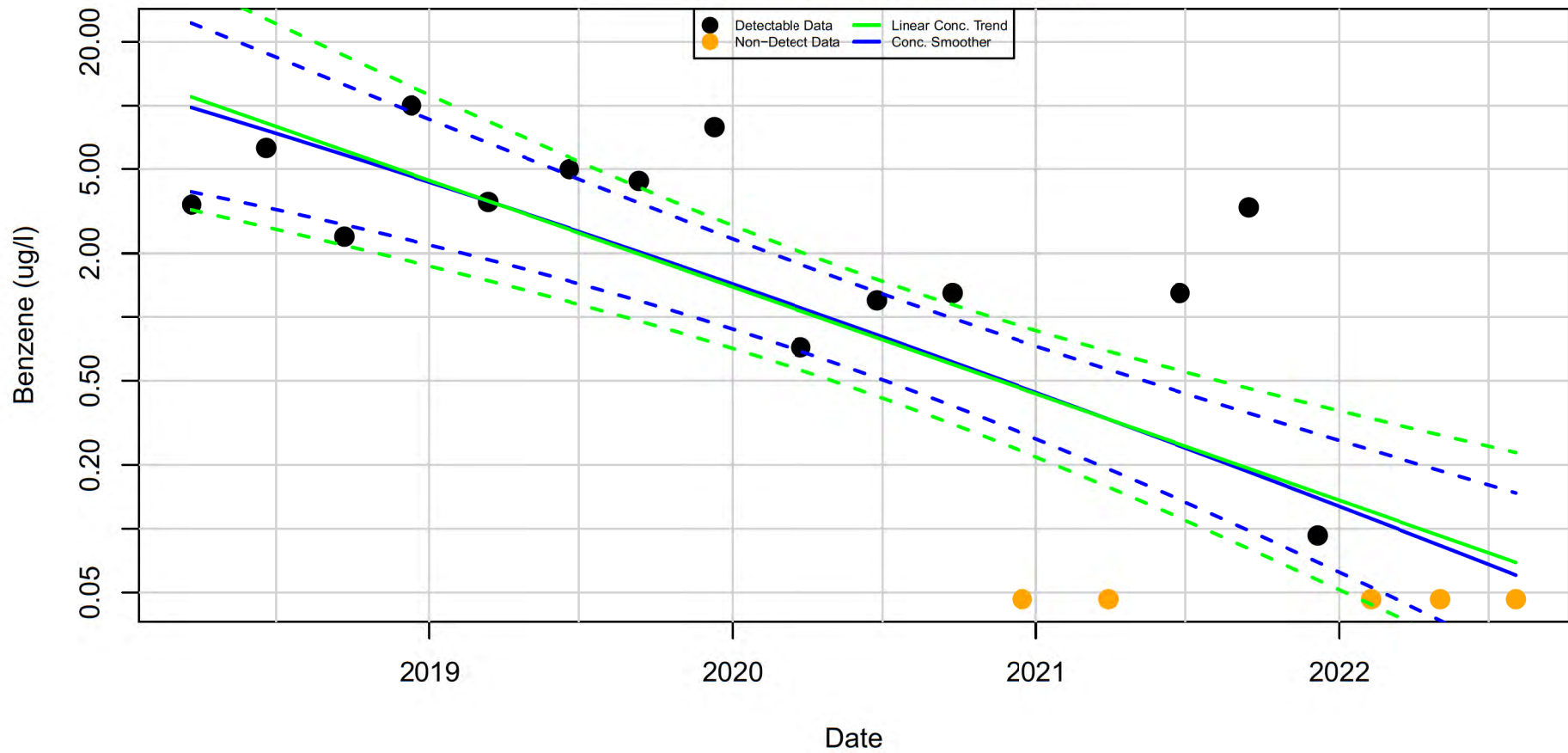
Benzene in T−3 : Aquifer−Blank

Mann−Kendall P.Value= 0.0519; Half−Life= 555 days
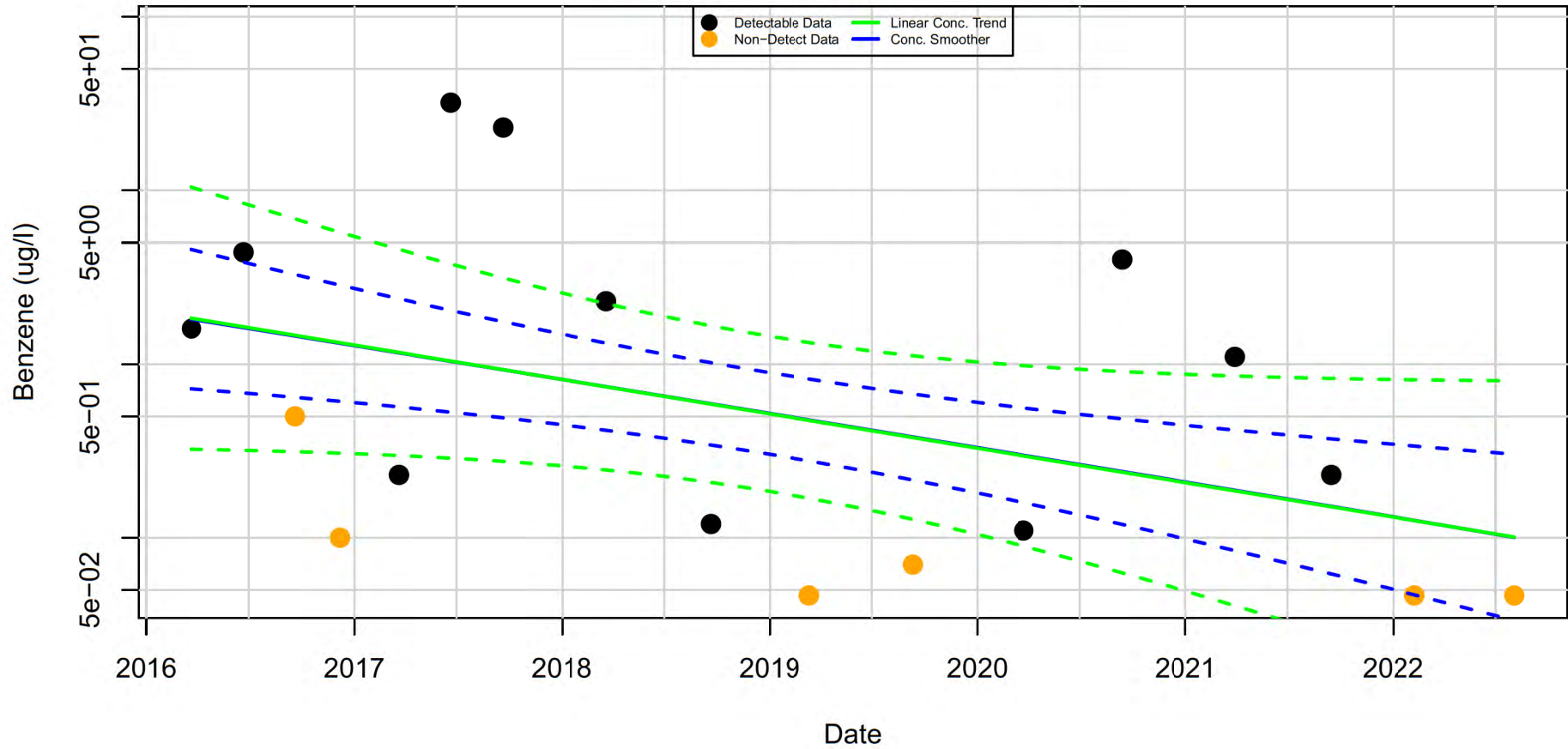
Benzene in E-22 : Aquifer-Blank

Mann-Kendall P.Value= 0.0931; Half-Life= -1323 days
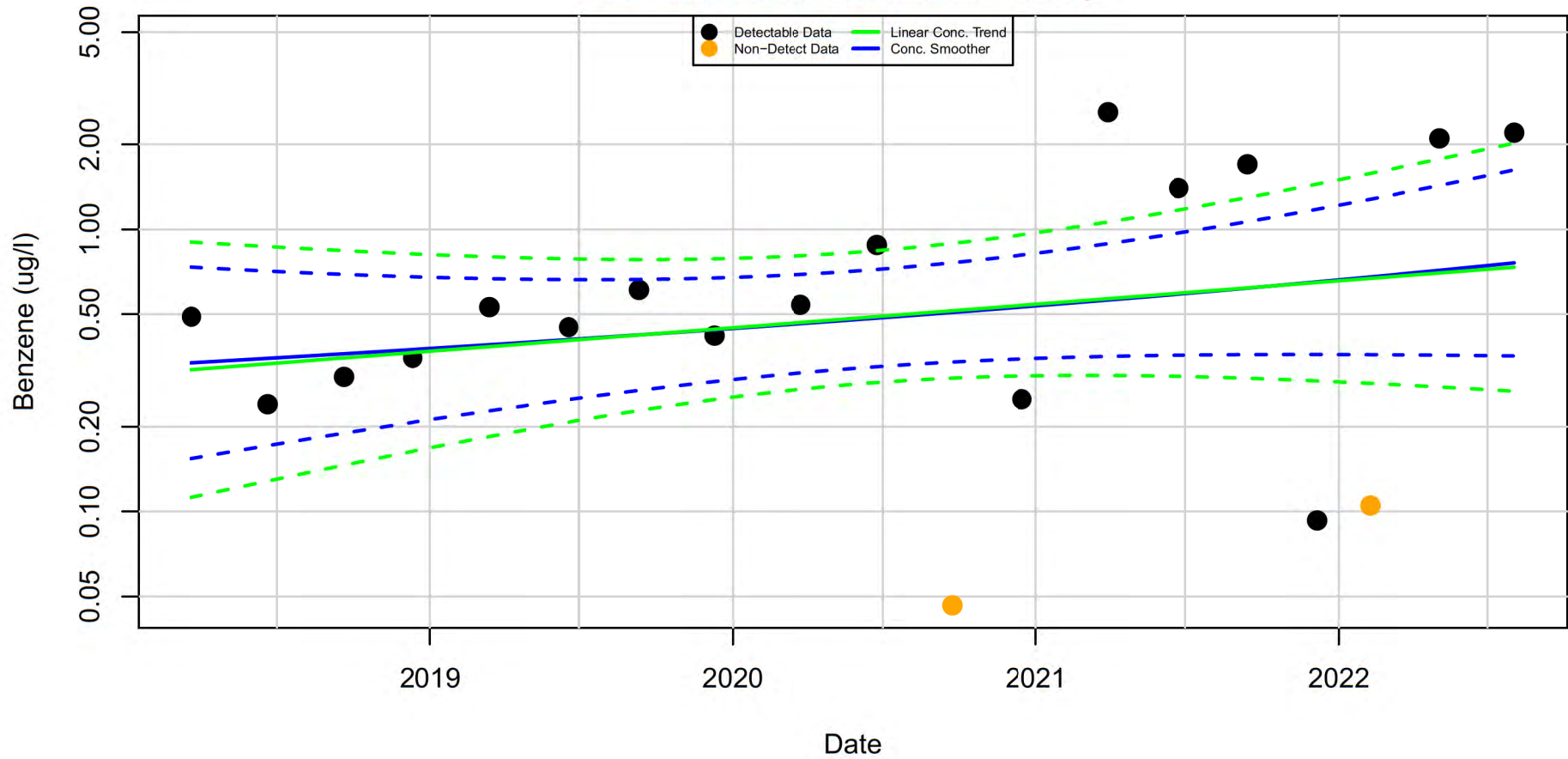
Benzene in FW-3 : Aquifer-Blank
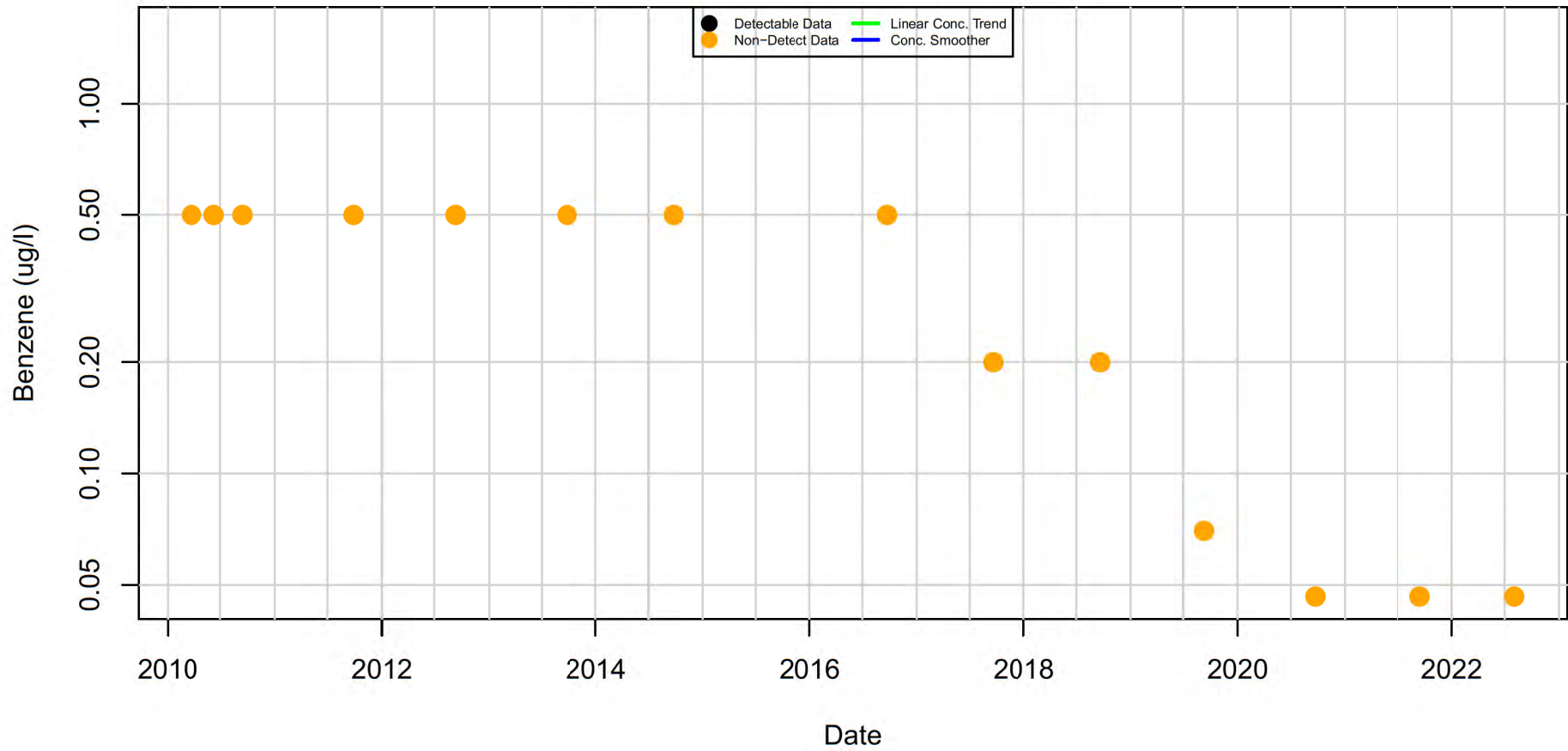
Benzene in FW−4 : Aquifer−Blank
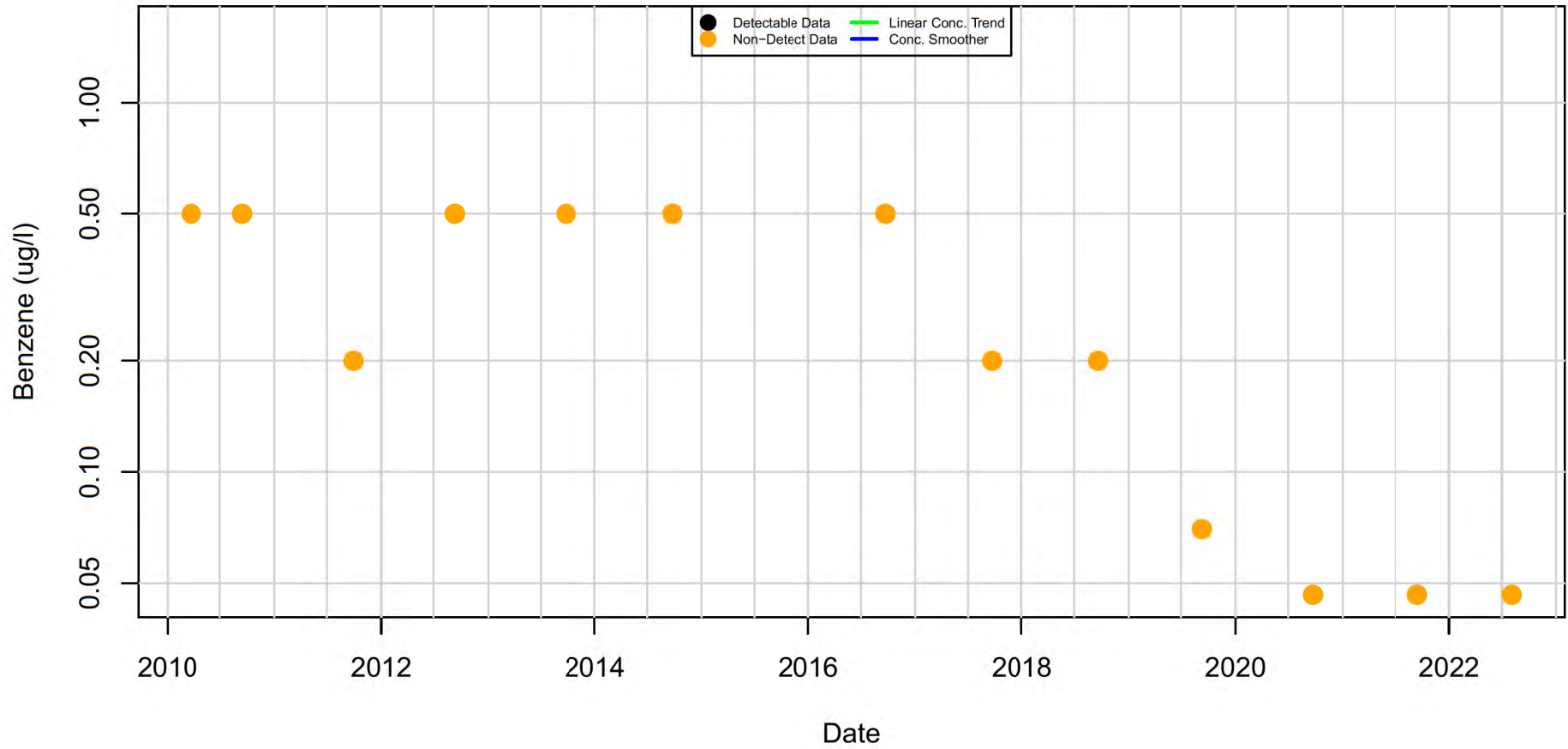
Benzene in FW-5R : Aquifer-Blank

Mann-Kendall P.Value= <0.01; Half-Life= 688 days

Legend:
- ● Detectable Data
- ● Non-Detect Data
- — Linear Conc. Trend
- — Conc. Smoother

Y-axis: Benzene (ug/l)

X-axis: Date (2019, 2020, 2021, 2022)
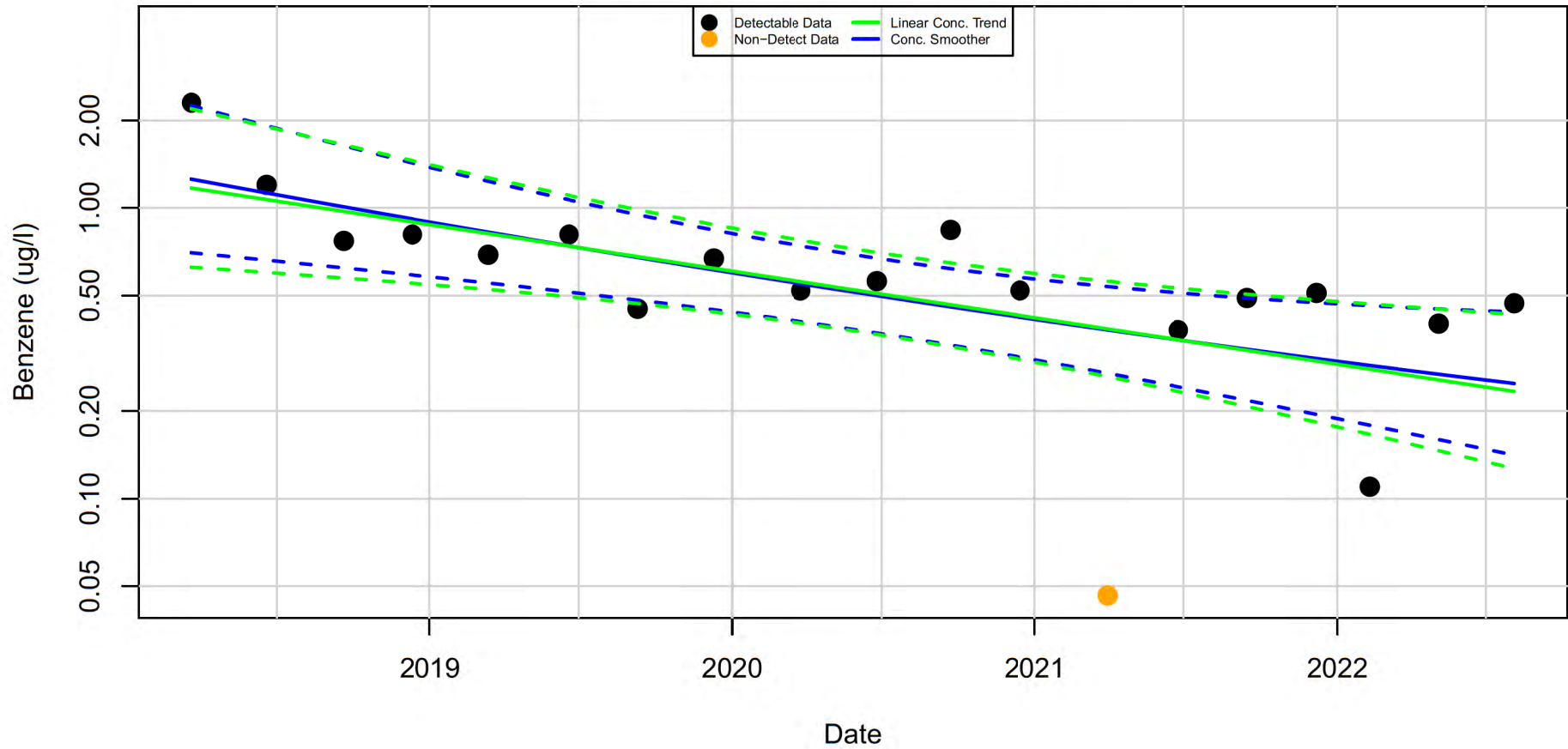
Benzene in FW−14 : Aquifer−Blank
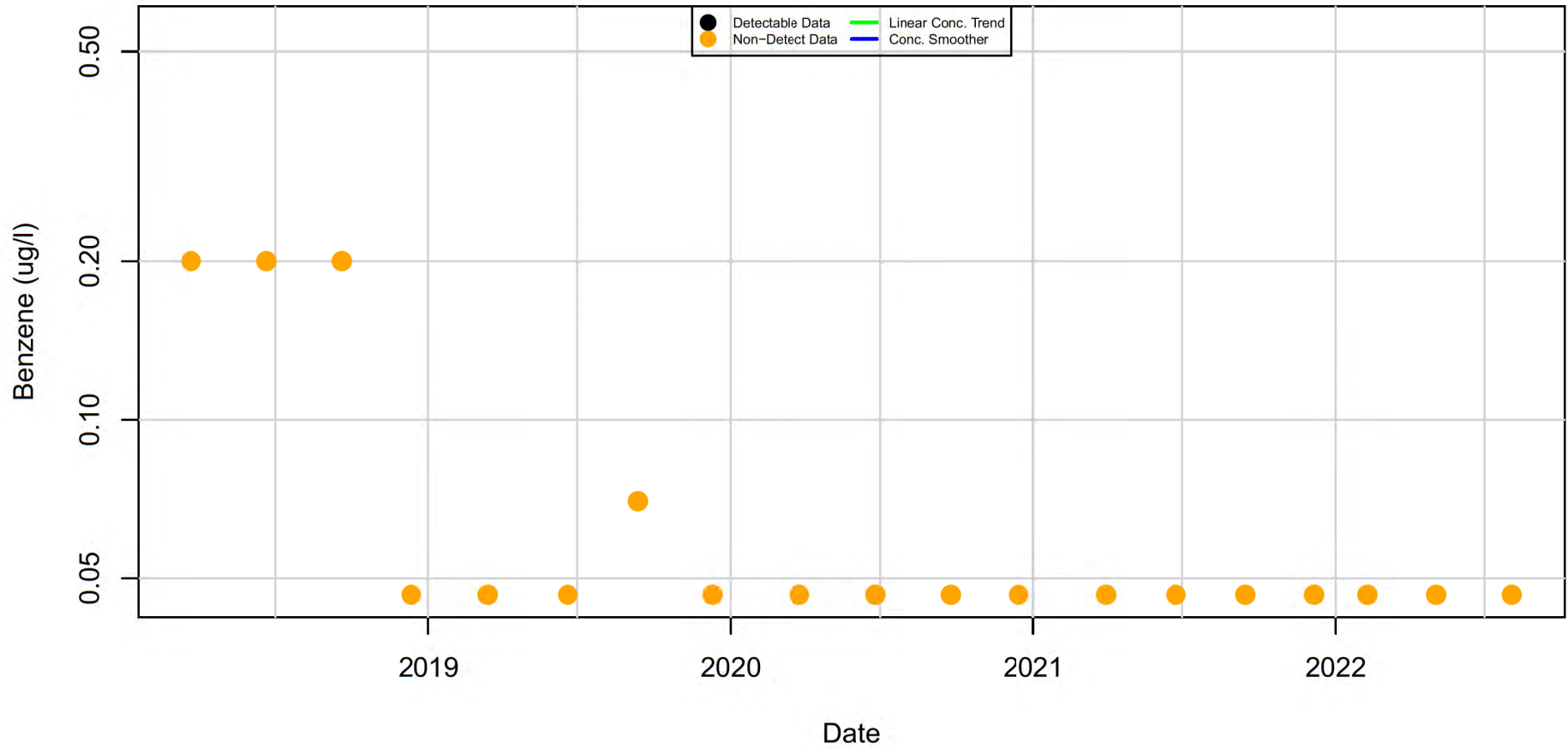
Benzene in FW-15 : Aquifer-Blank
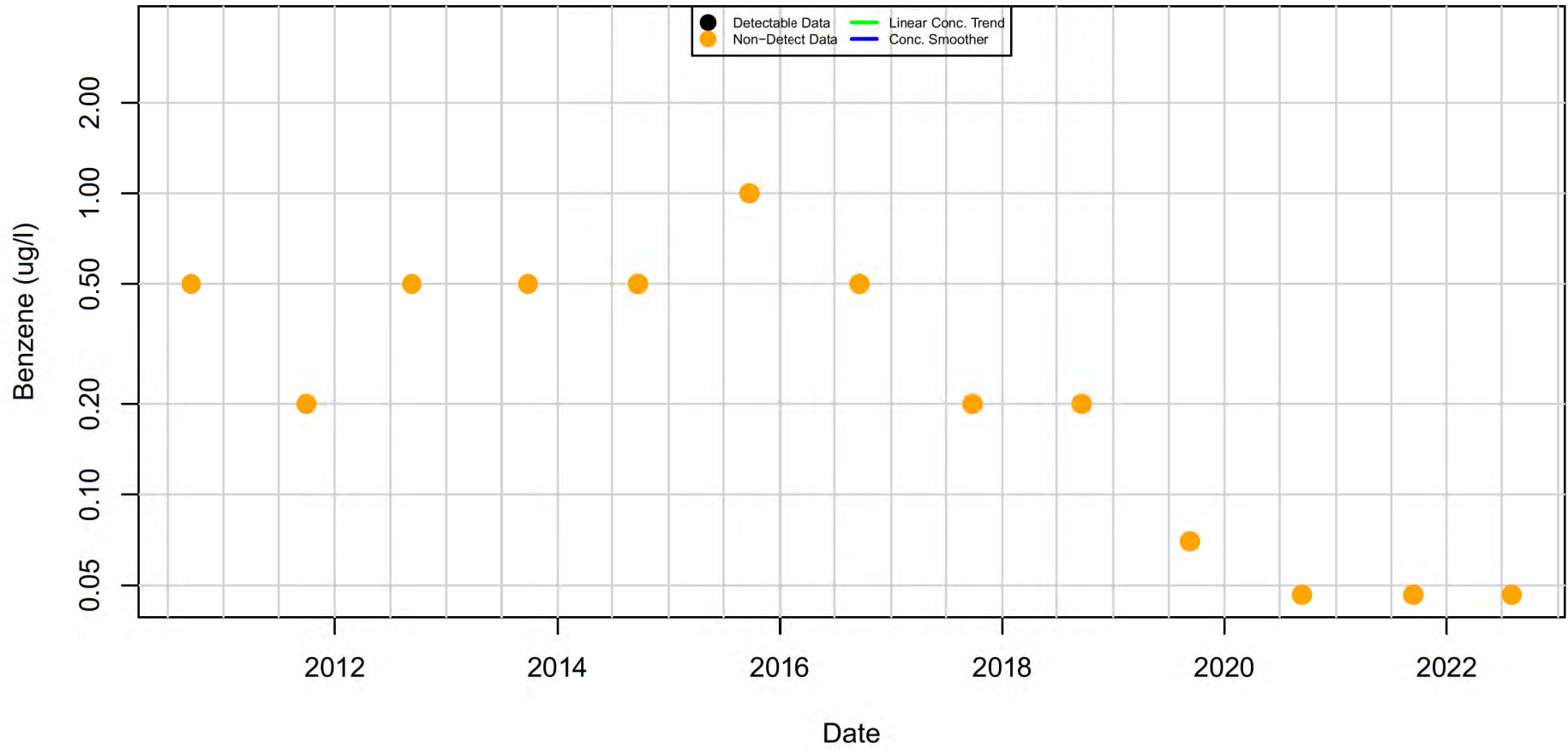
Benzene in RR-1 : Aquifer-Blank
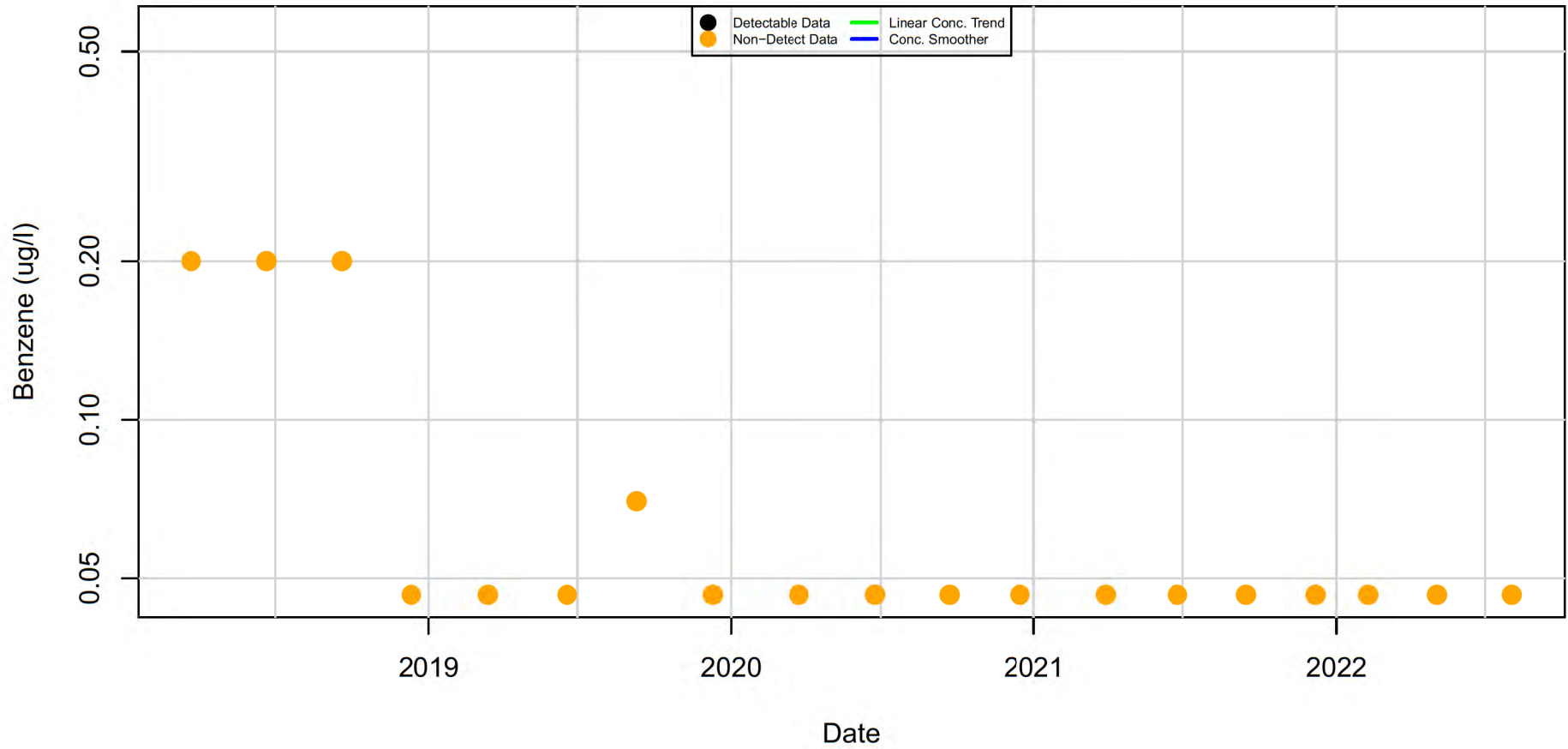
Benzene in RR-2 : Aquifer-Blank
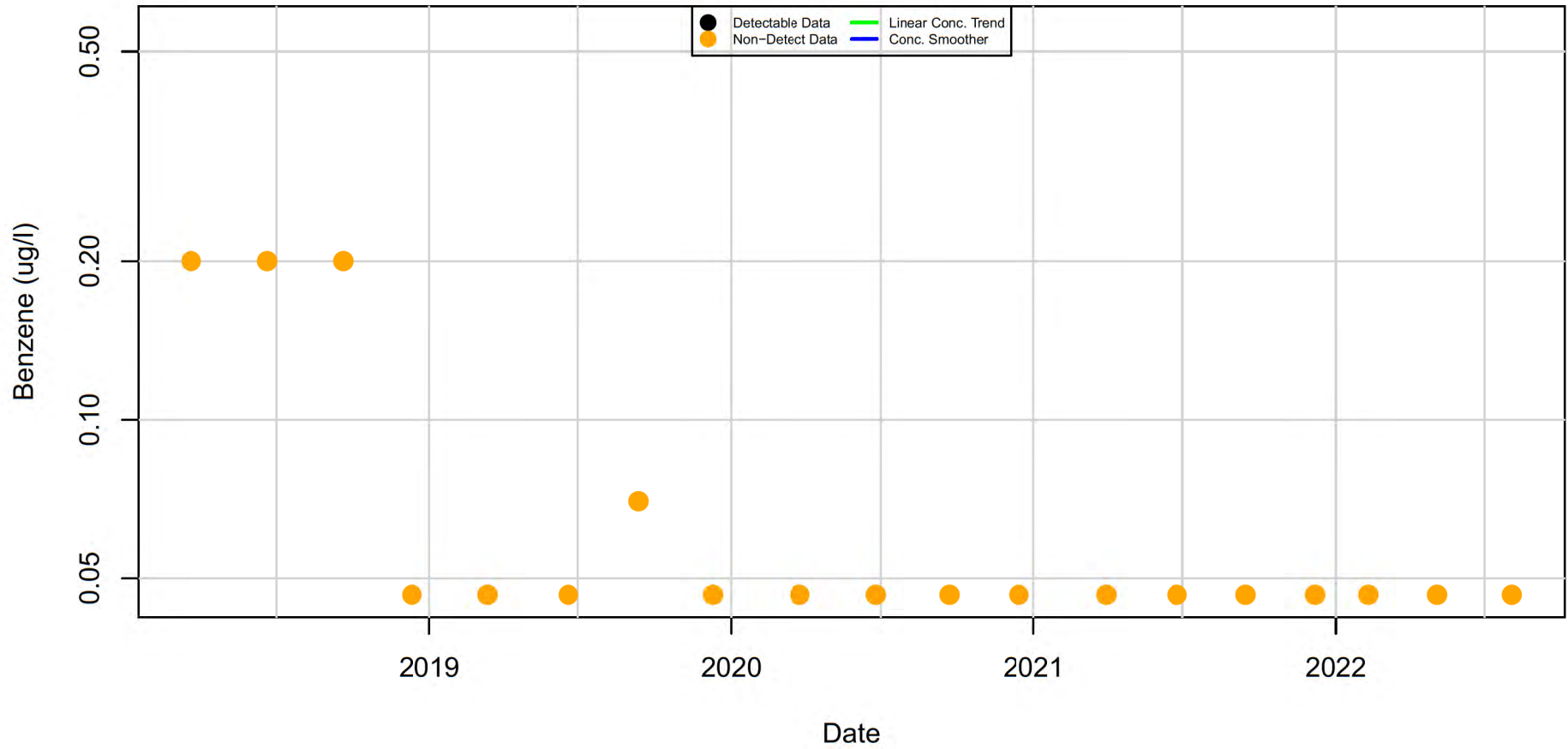
Benzene in RR-3 : Aquifer-Blank
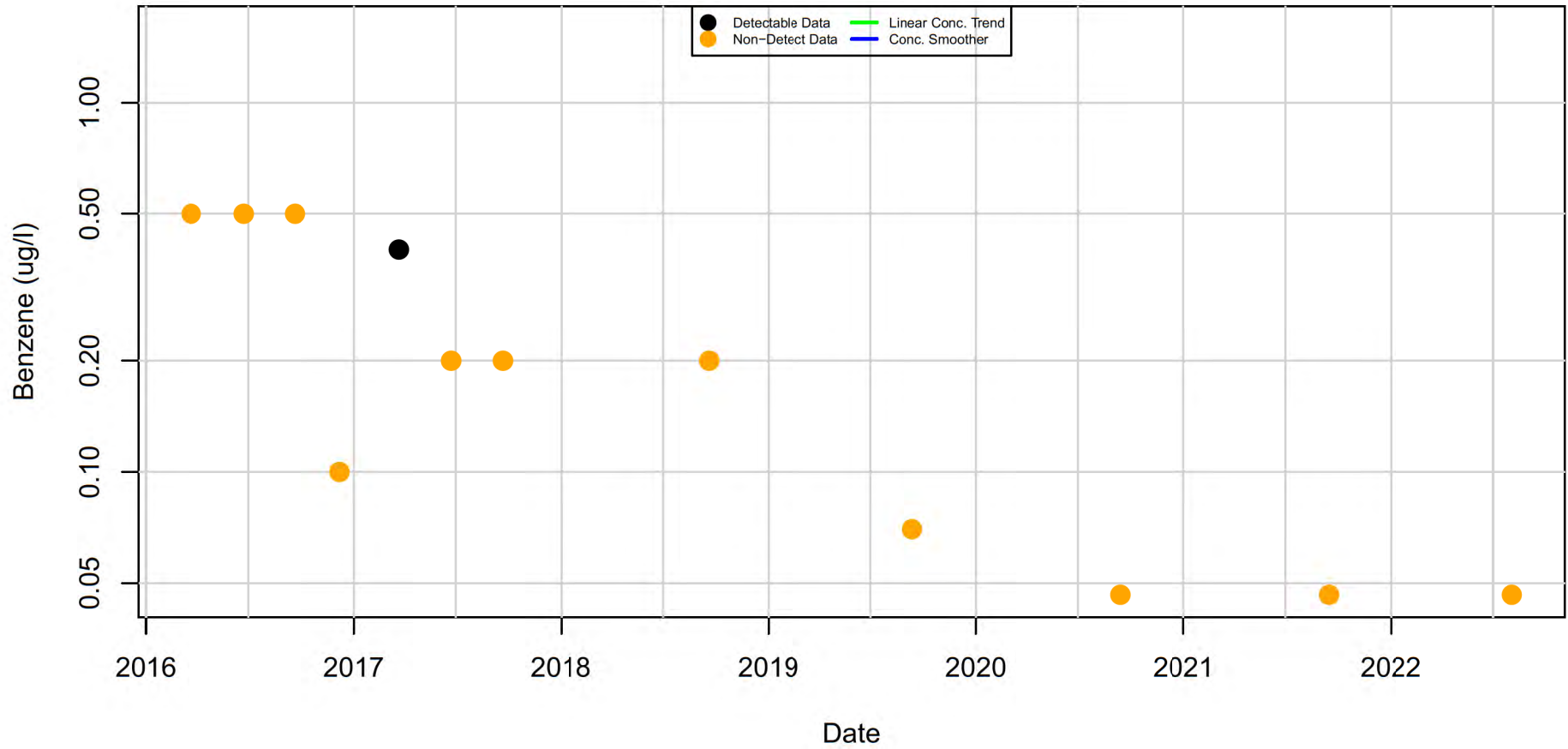
Benzene in RR-4 : Aquifer-Blank
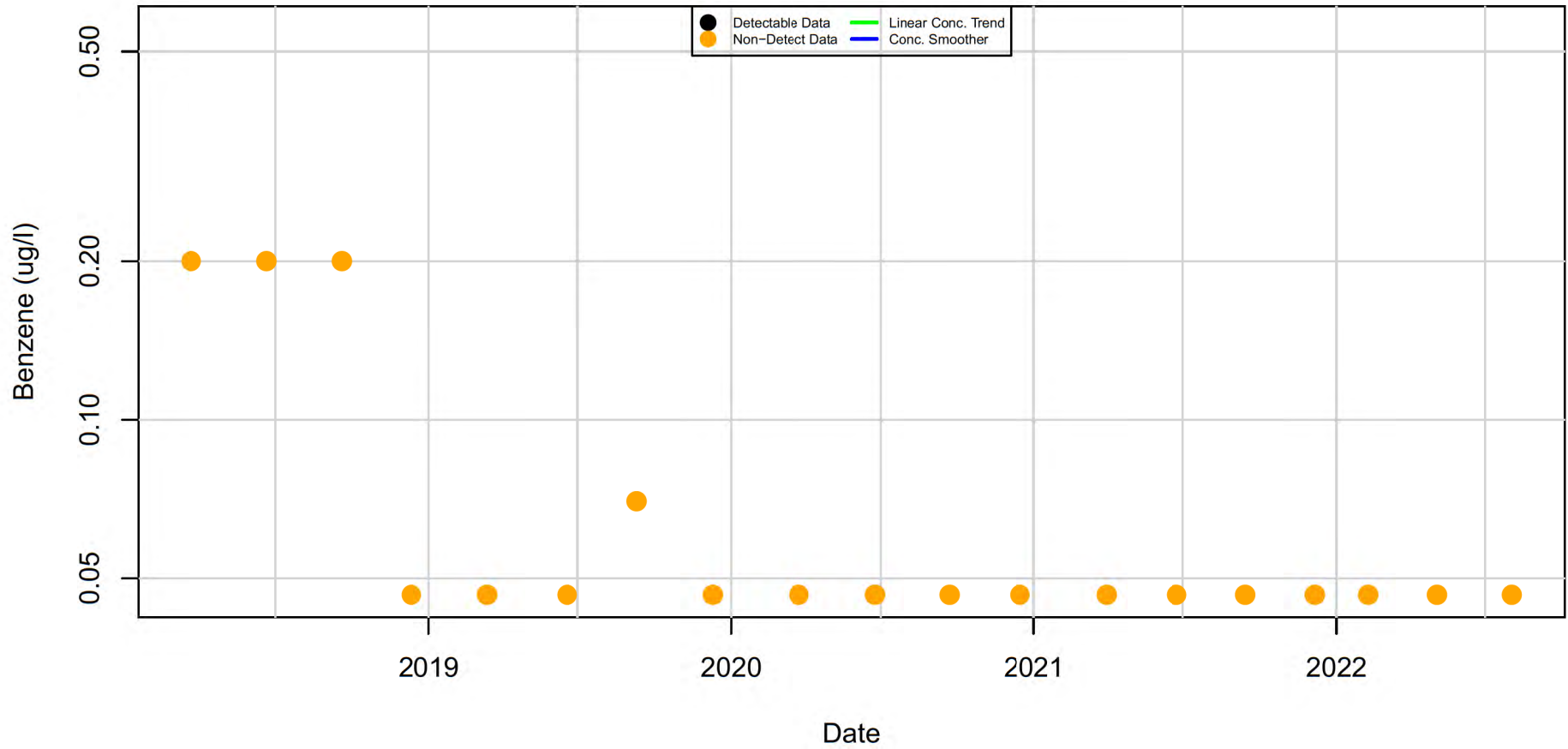
Benzene in RR-5 : Aquifer-Blank
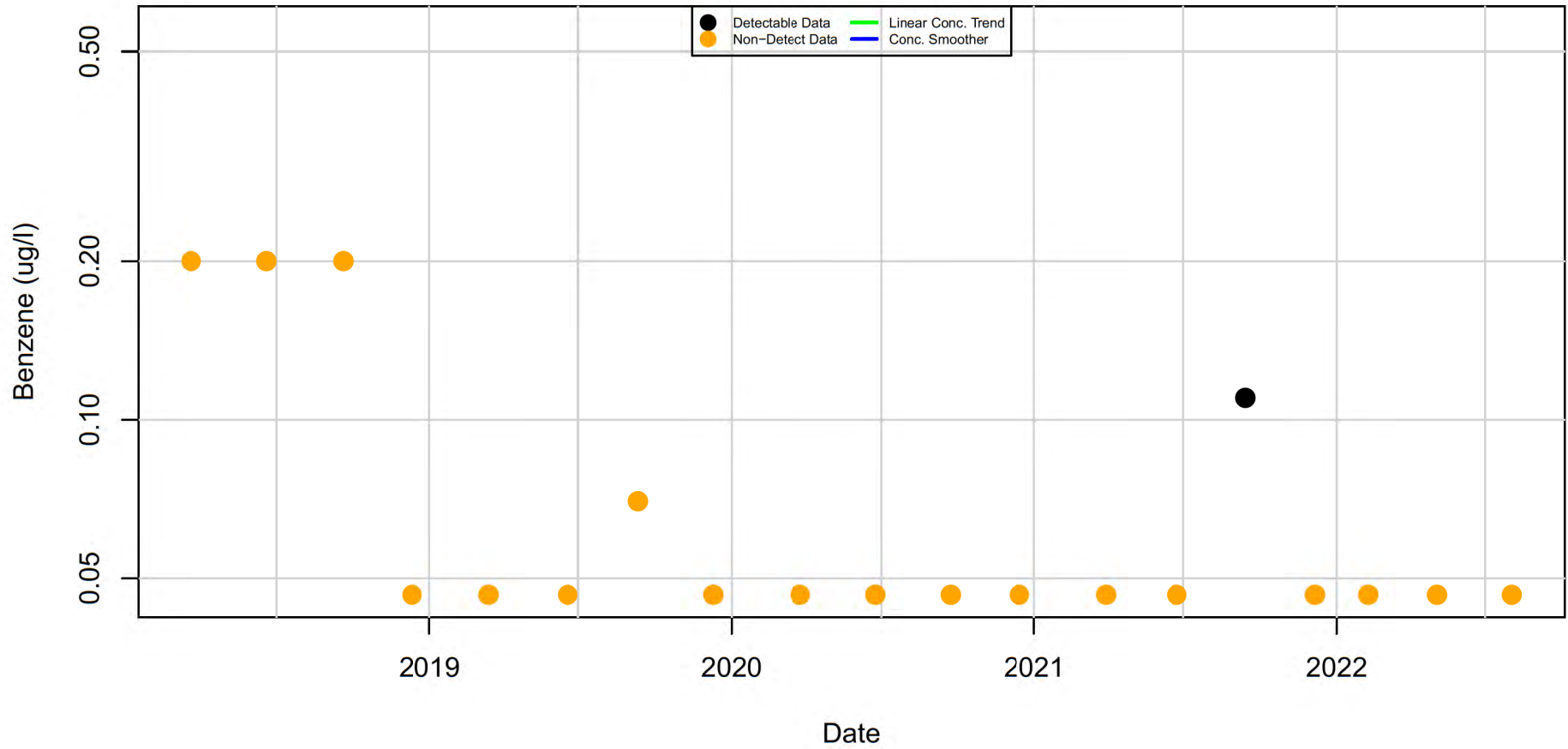
Benzene in T−2 : Aquifer−Blank
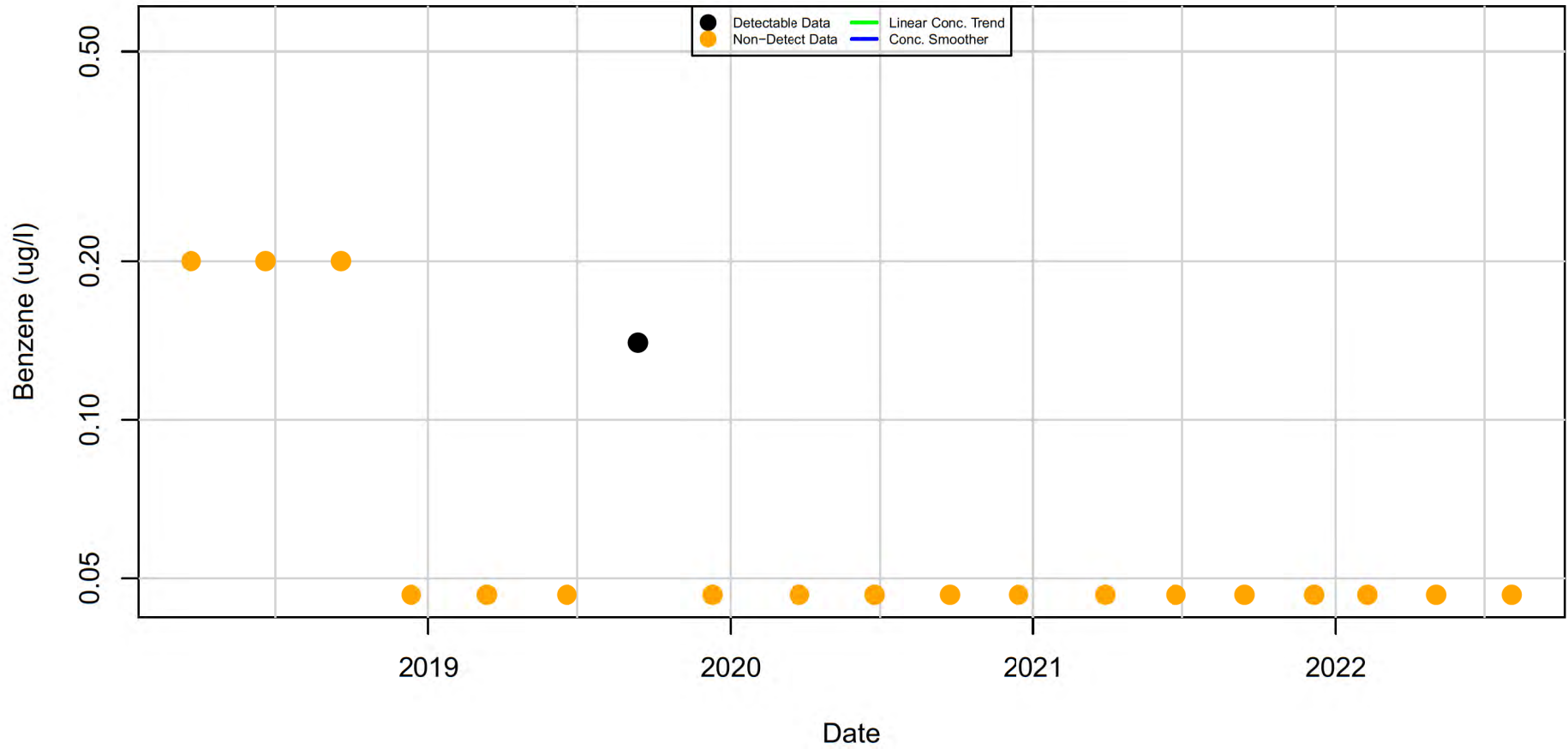
Benzene in DMW−1 : Aquifer−Blank
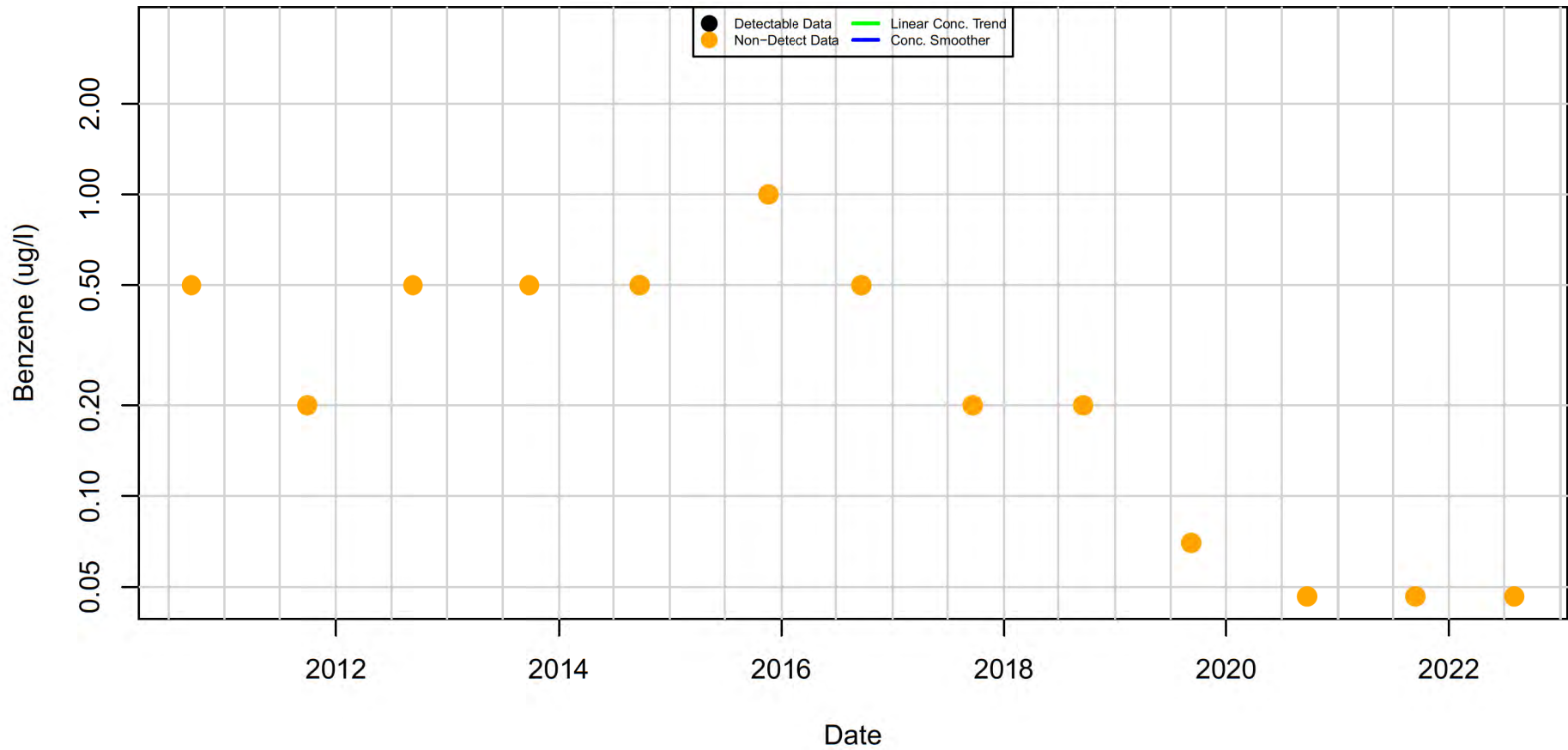
Benzene in DMW−2 : Aquifer−Blank

Mann−Kendall P.Value= 0.0139; Half−Life= 728 days
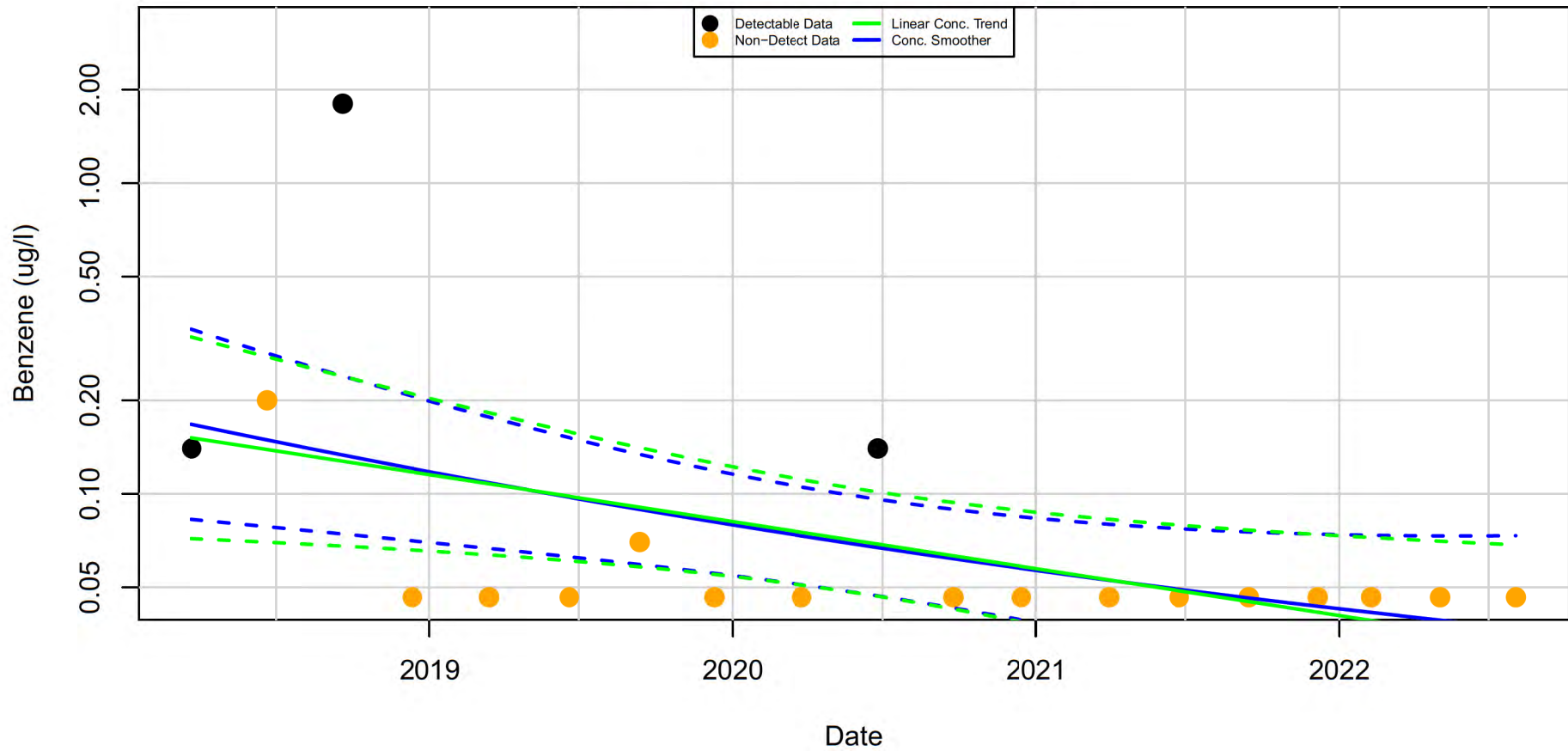
Benzene in DMW−3 : Aquifer−Blank
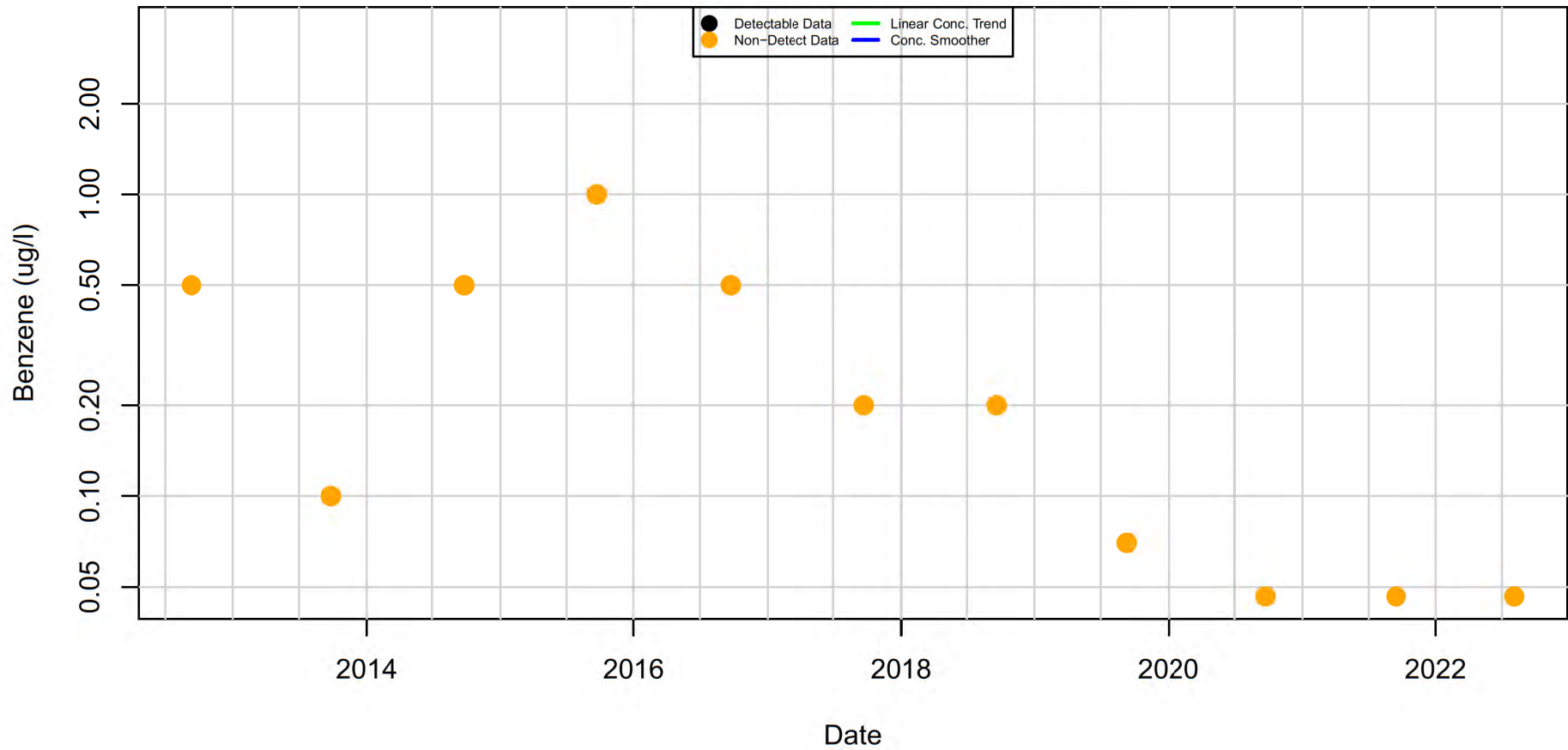
Benzene in DMW−4 : Aquifer−Blank
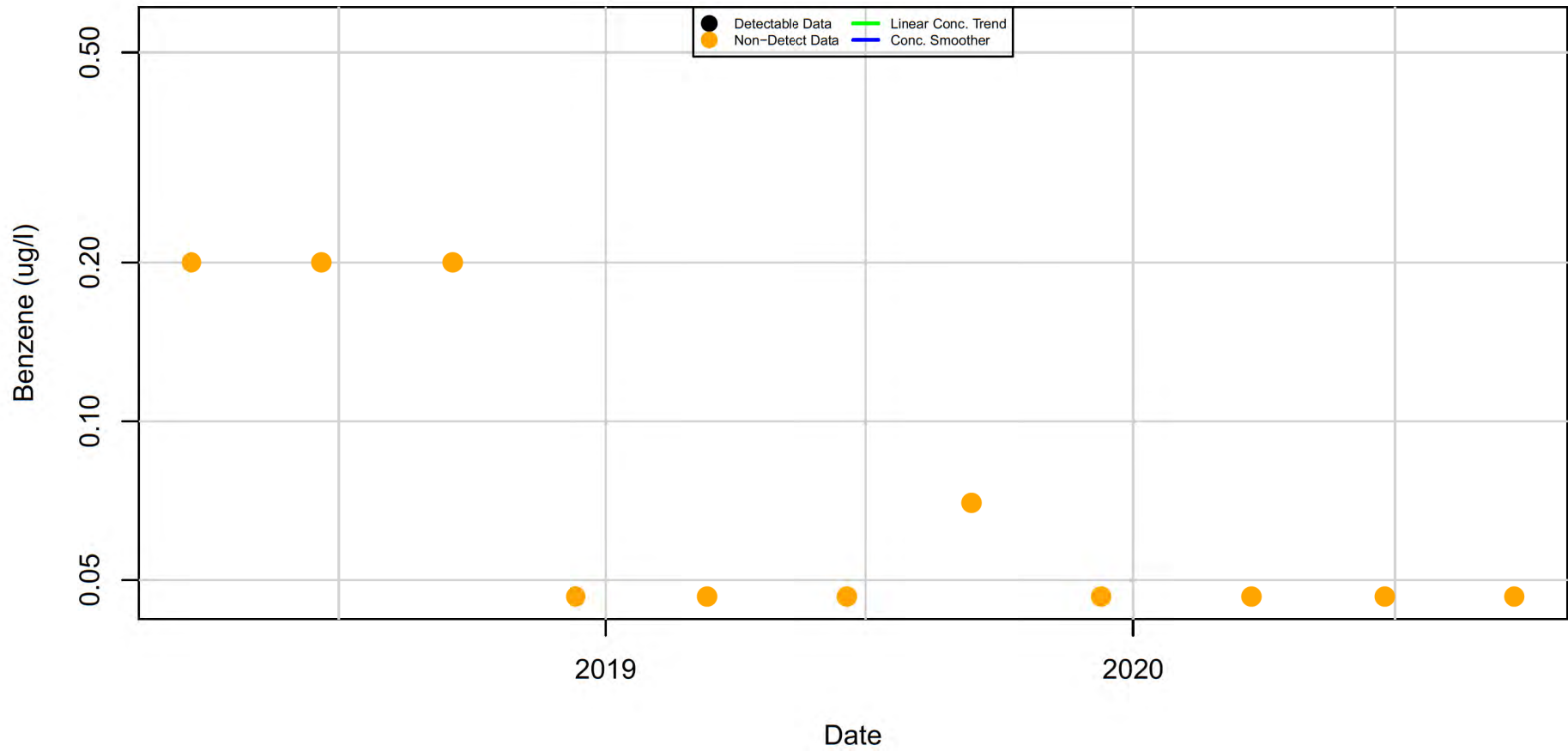
Benzene in FW−13 : Aquifer−Blank
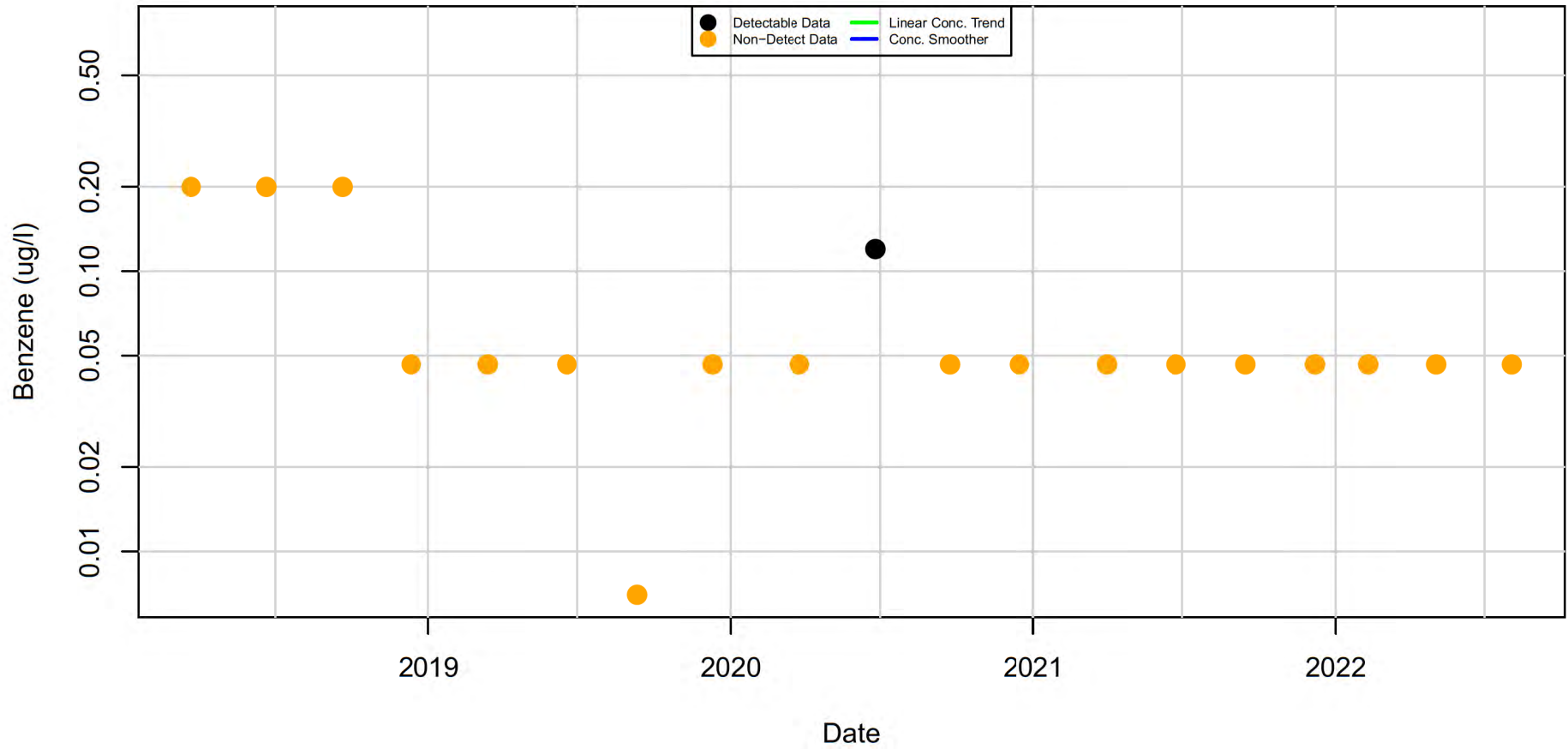
TPH-D in B-17B : Aquifer-Blank
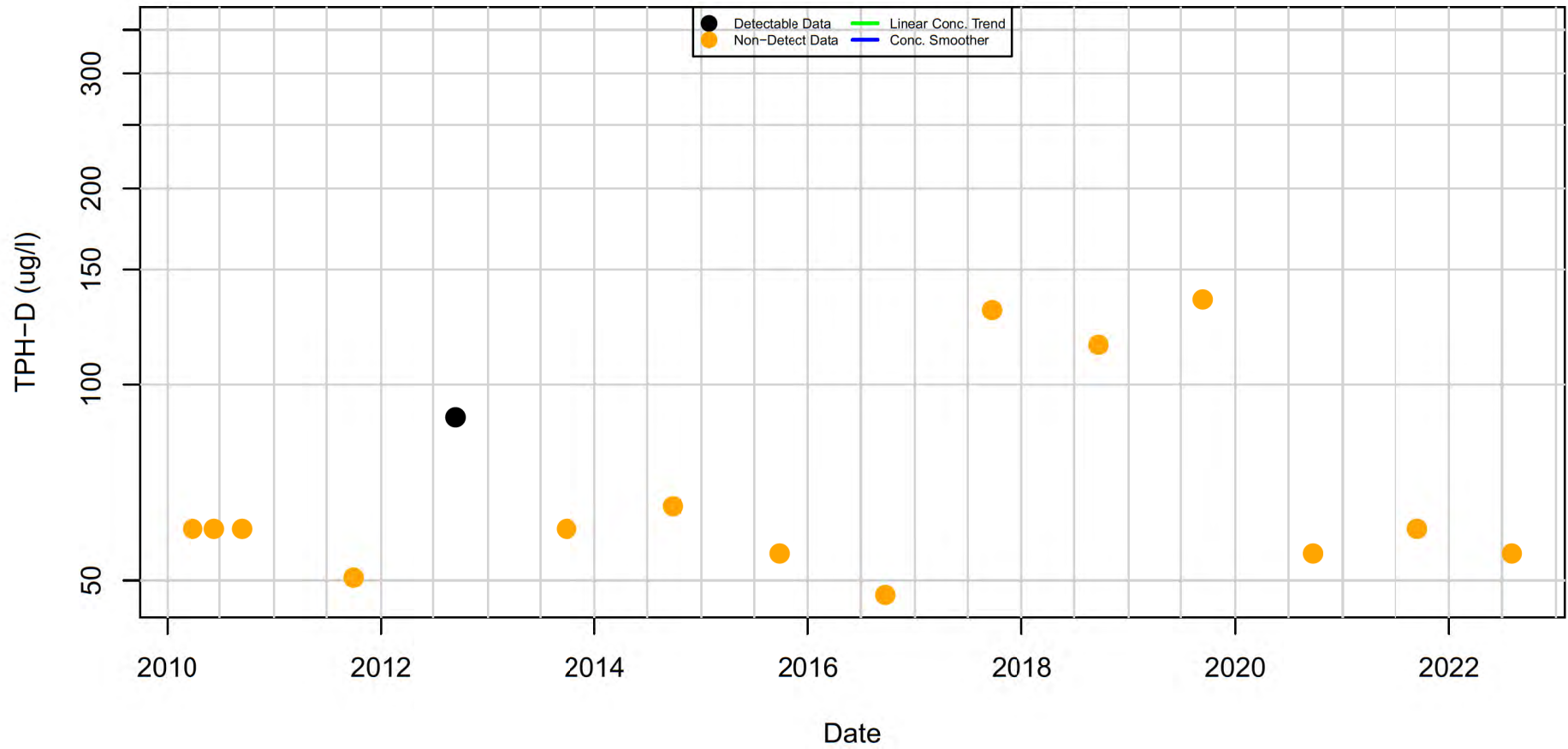
TPH-D in B-30 : Aquifer-Blank
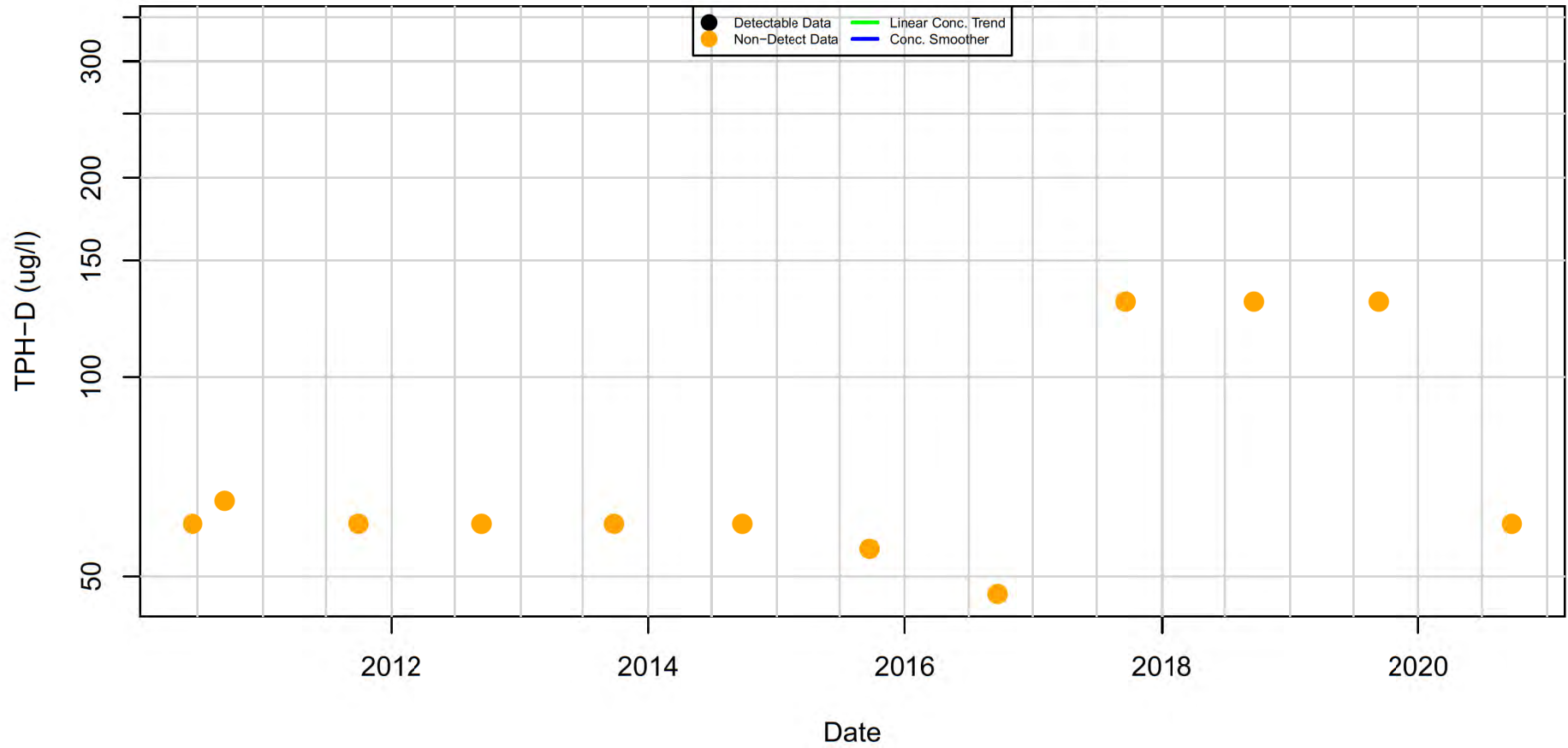
TPH-D in B-31 : Aquifer-Blank

Mann-Kendall P.Value= 0.0859; Half-Life> 5 Years

Legend:
- Detectable Data
- Non-Detect Data
- Linear Conc. Trend
- Conc. Smoother

Y-axis: TPH-D (ug/l)

X-axis: Date (2019, 2020, 2021, 2022)
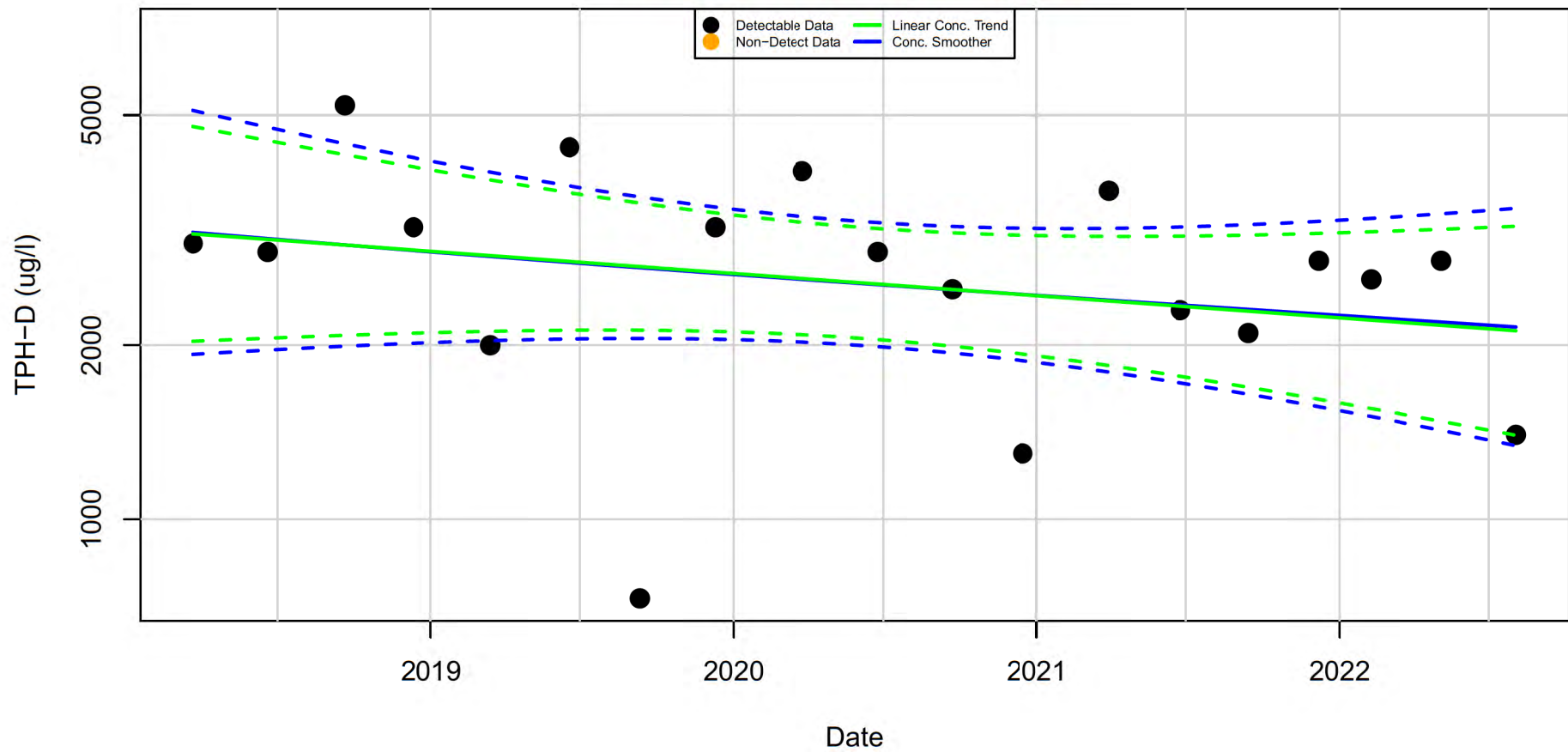
TPH-D in E-21 : Aquifer-Blank

Mann-Kendall P.Value= 0.0305; Half-Life= -1222 days

TPH−D in B−19 : Aquifer−Blank

Mann−Kendall P.Value= 0.215; Half−Life> 5 Years
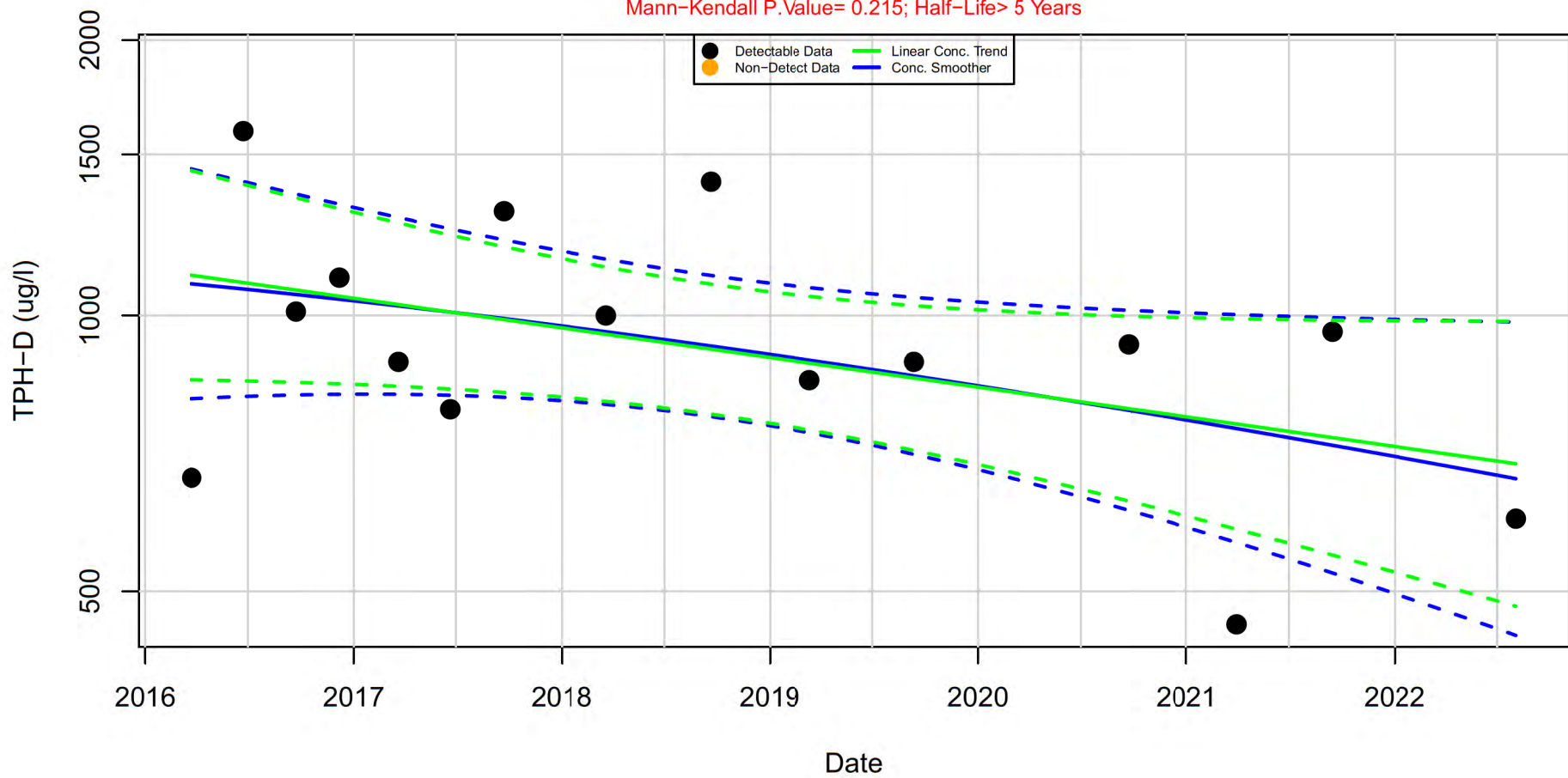
TPH-D in B-25 : Aquifer-Blank

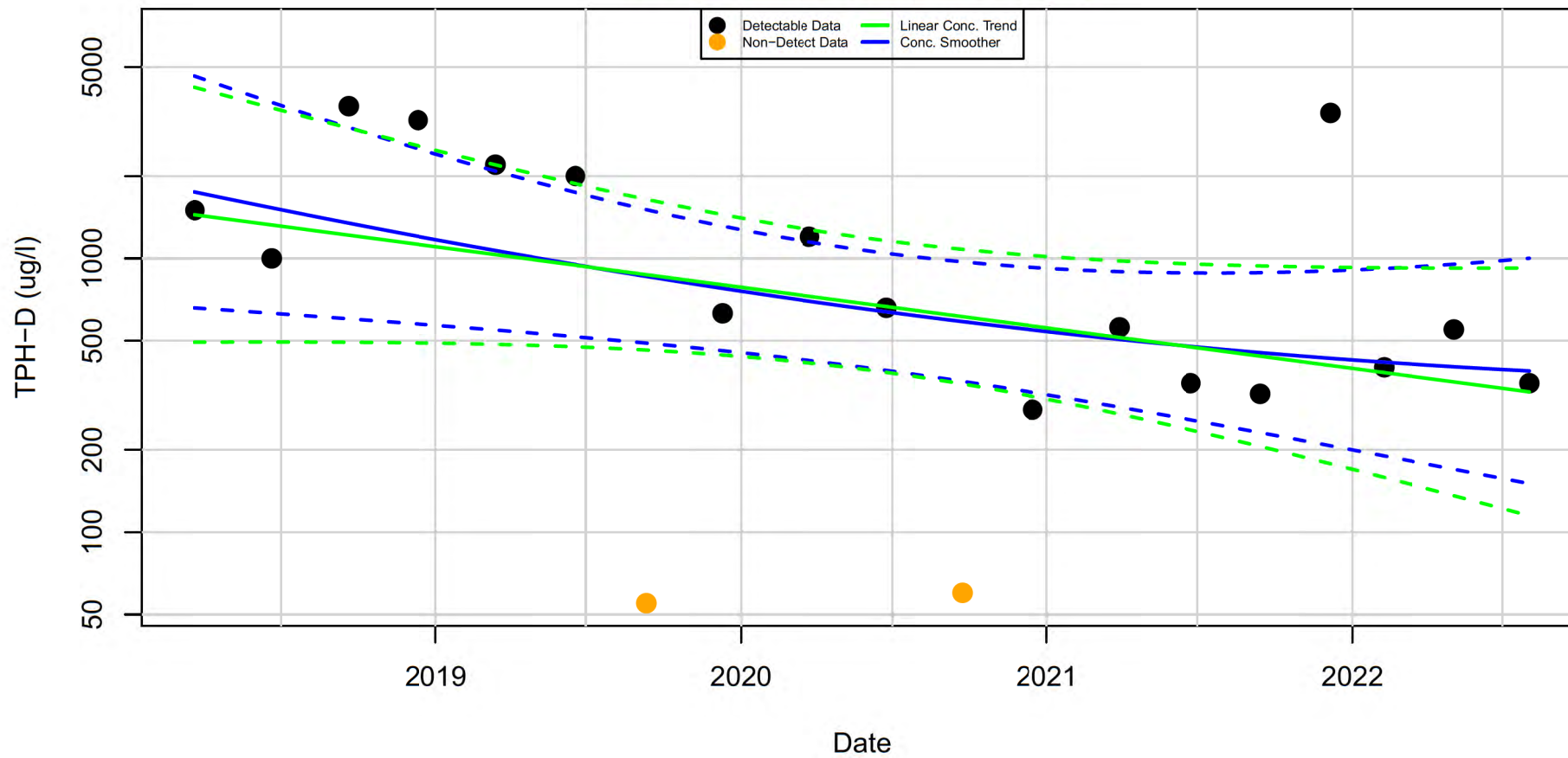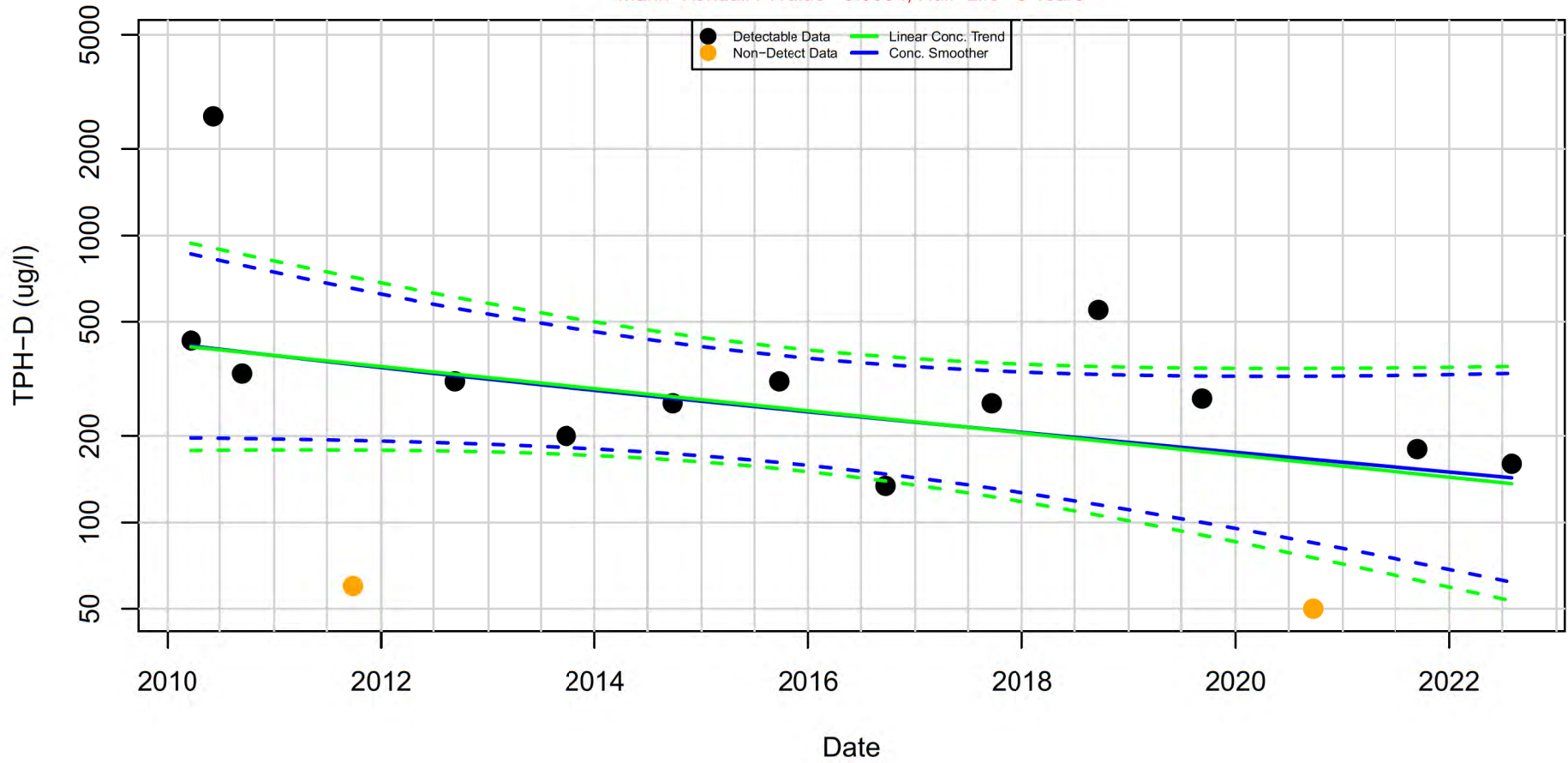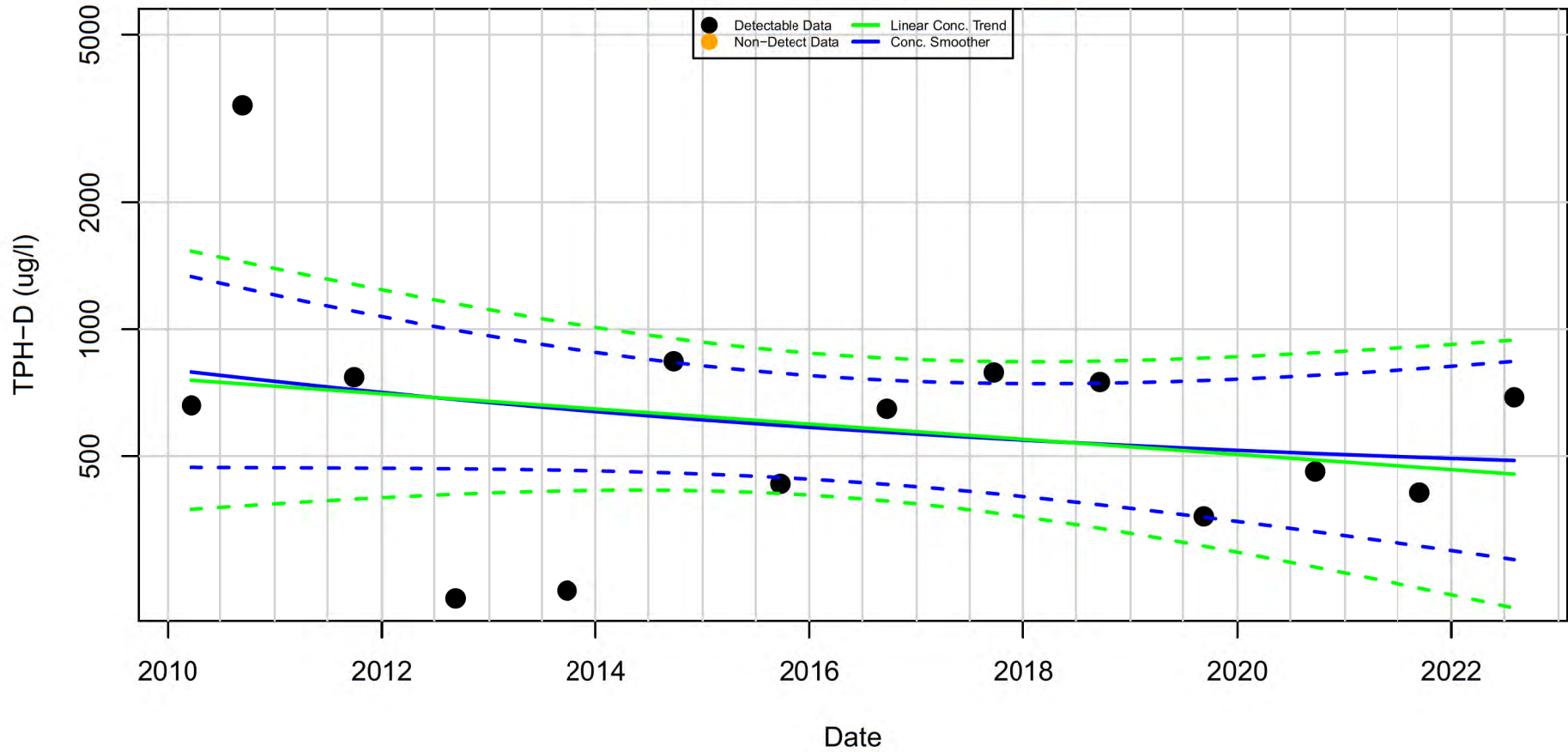Mann-Kendall P.Value= <0.01; Half-Life= 1360 days
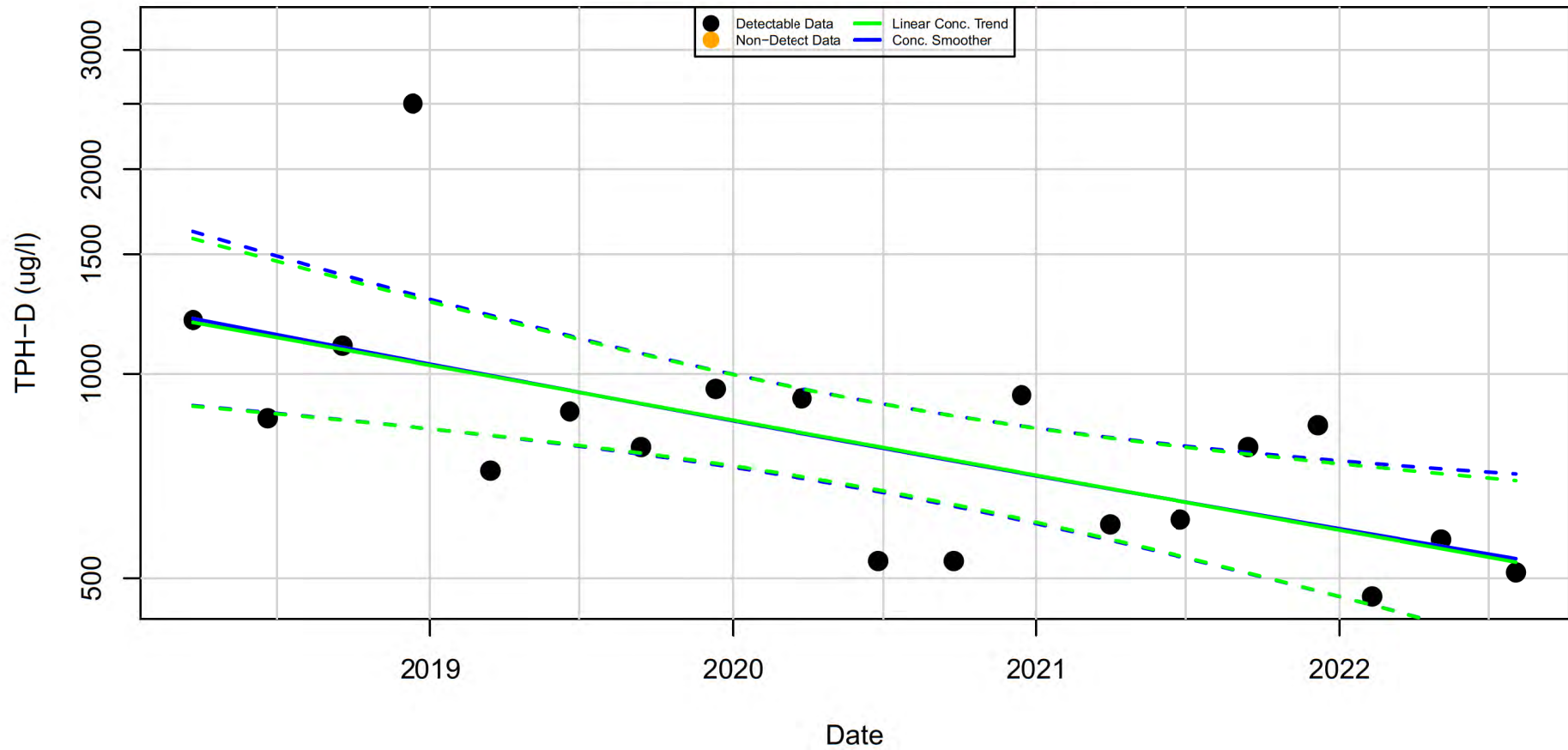
TPH-D in B-34 : Aquifer-Blank

Mann-Kendall P.Value= 0.649; Half-Life> 5 Years
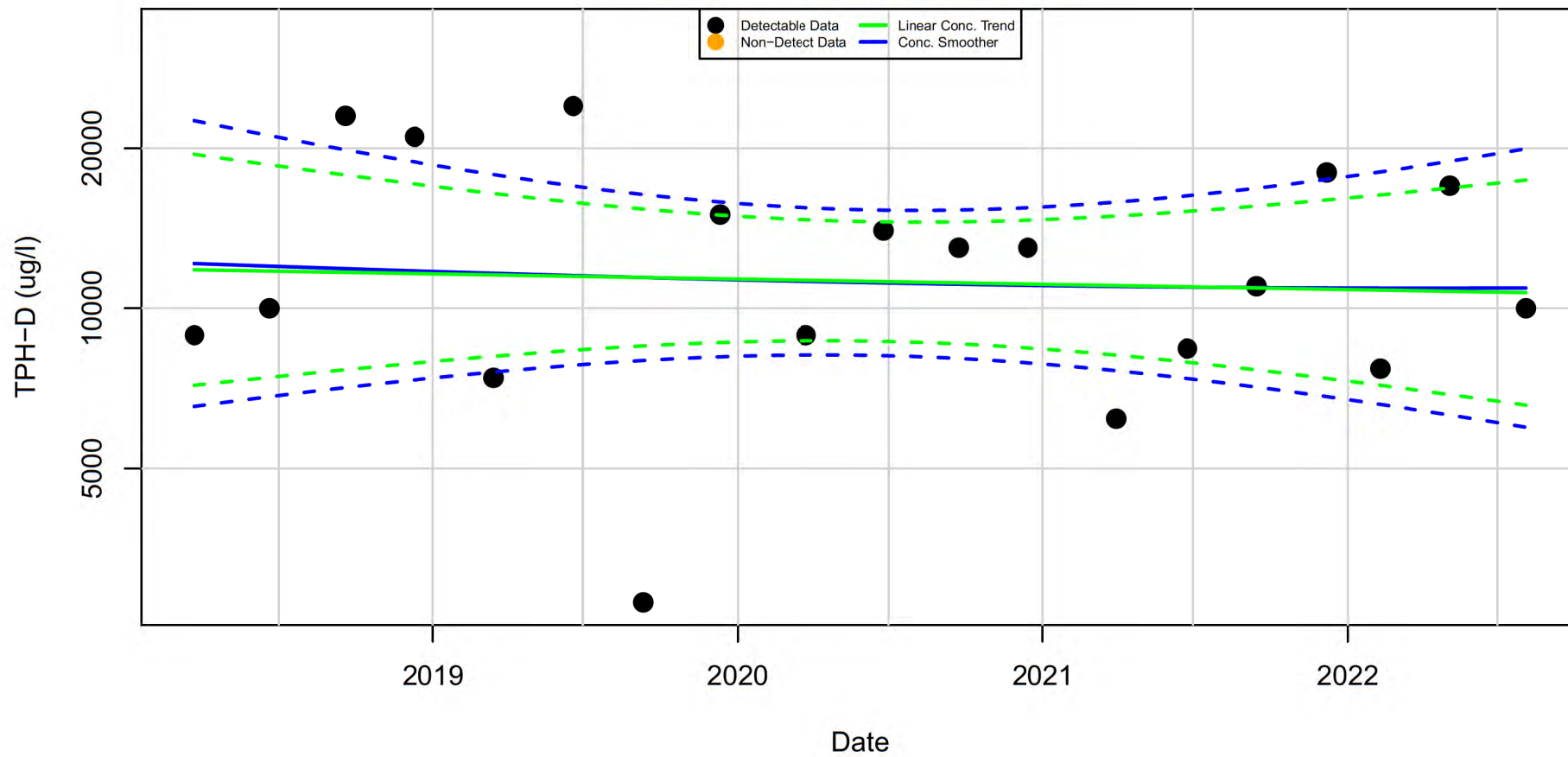
TPH-D in G-8 : Aquifer-Blank

Mann-Kendall P.Value= 0.17; Half-Life> 5 Years
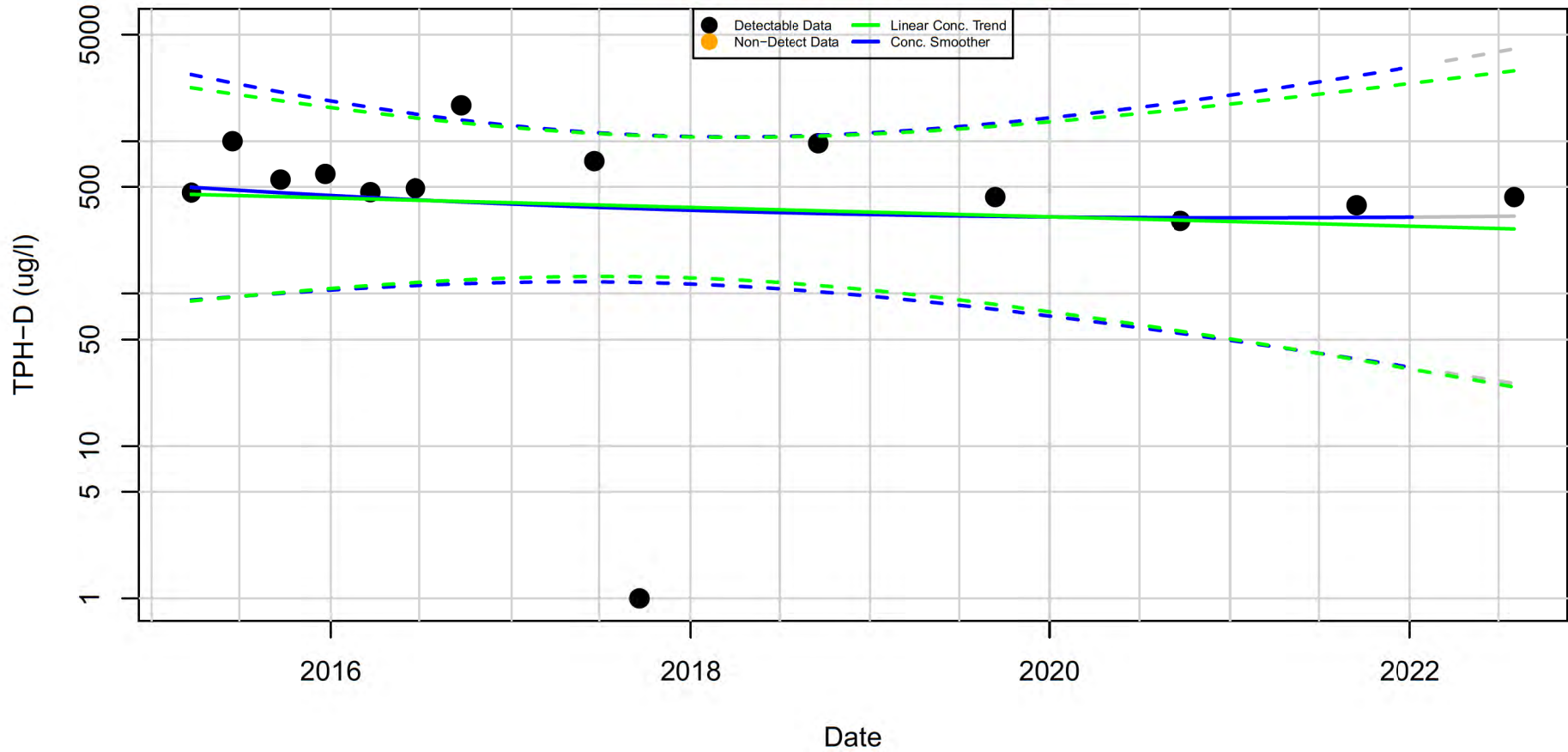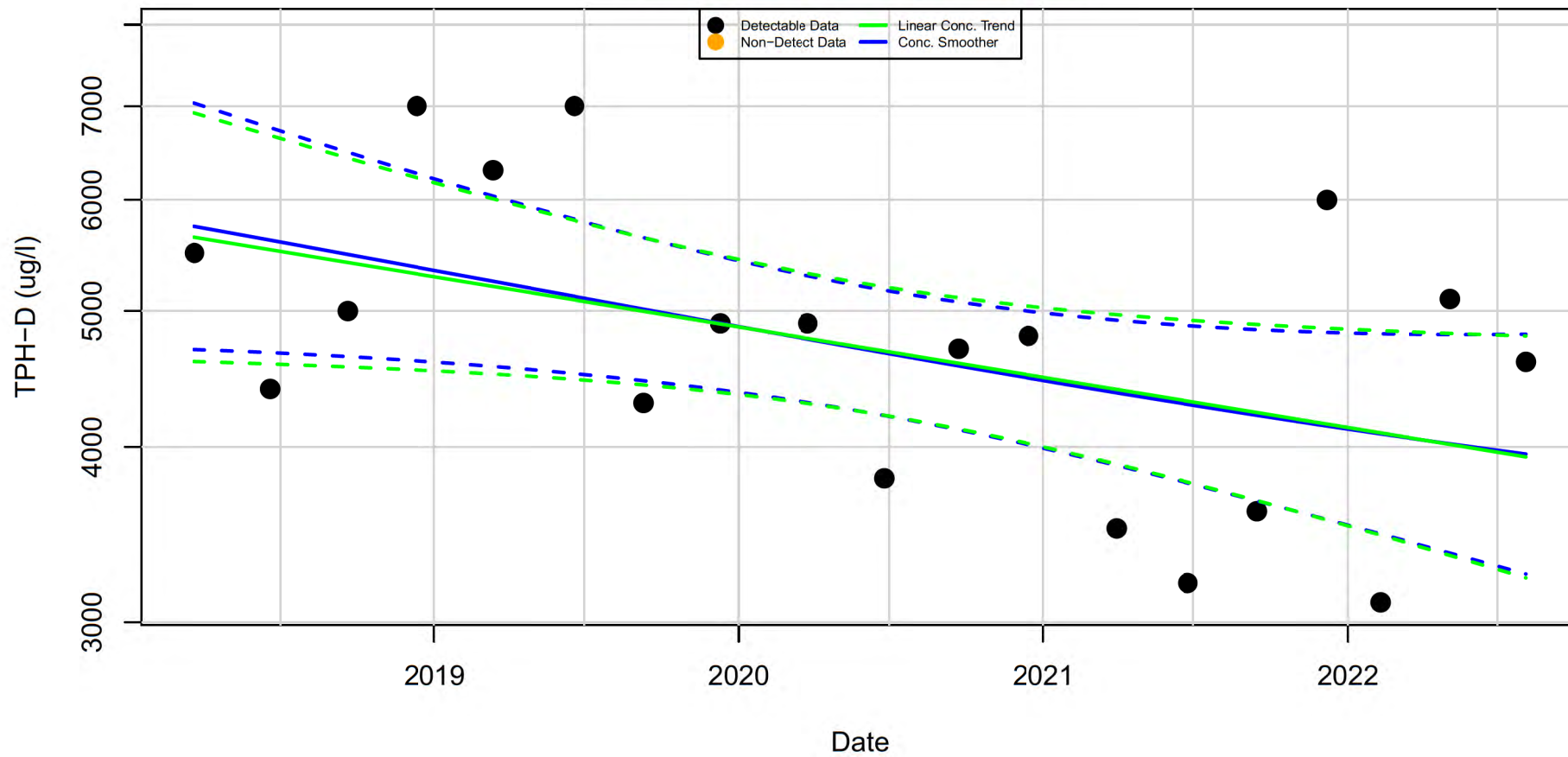
TPH-D in G-16 : Aquifer-Blank

Mann-Kendall P.Value= 0.411; Half-Life> -5 Years
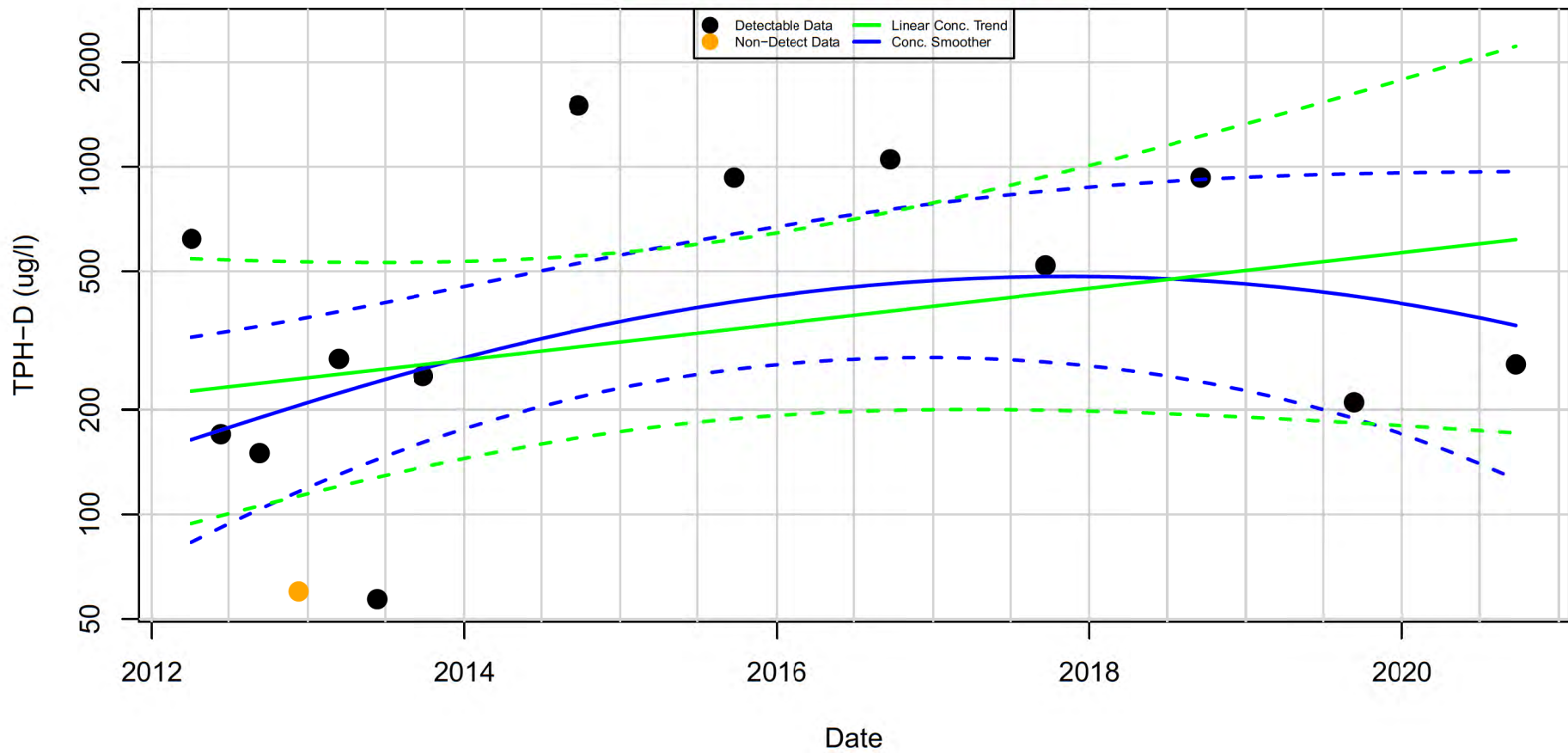
TPH-D in G-18 : Aquifer-Blank

Mann-Kendall P.Value= 0.837; Half-Life> 5 Years
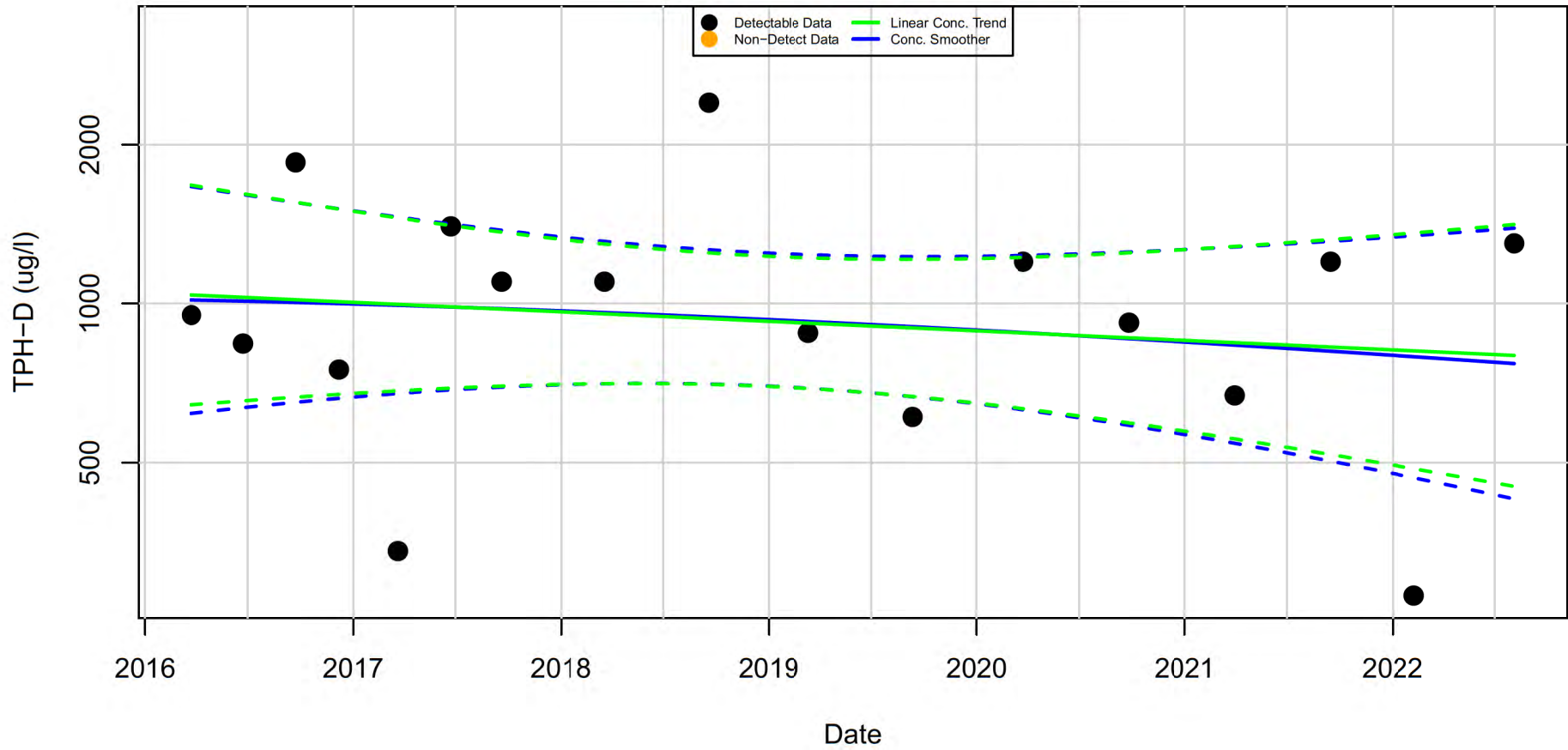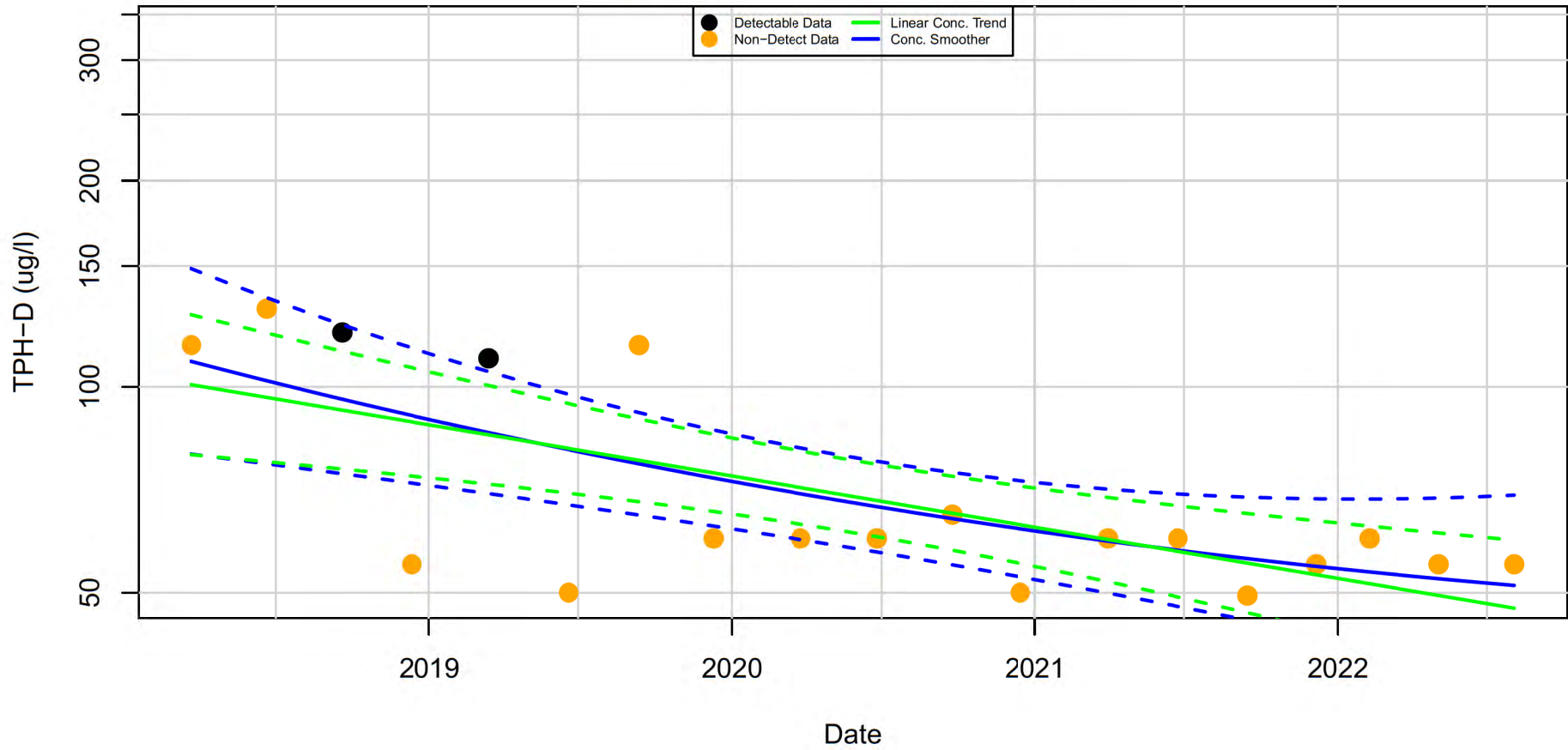
TPH-D in HC-111 : Aquifer-Blank

Mann-Kendall P.Value= 0.363; Half-Life> 5 Years
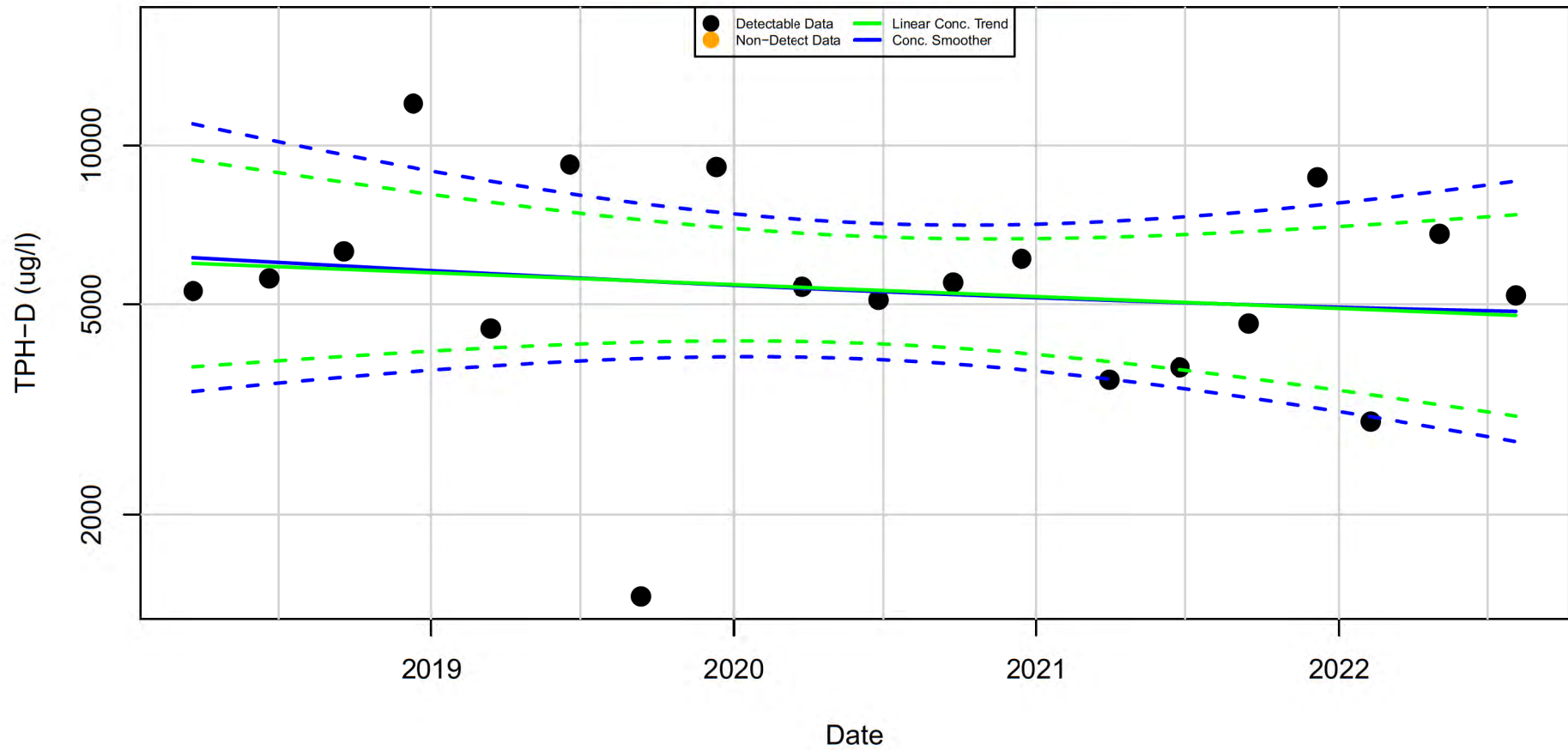
TPH-D in RW-2 : Aquifer-Blank

Mann-Kendall P.Value= 0.392; Half-Life> -5 Years

Legend:
- Detectable Data
- Non-Detect Data
- Linear Conc. Trend
- Conc. Smoother

X-axis: Date
Y-axis: TPH-D (ug/l)
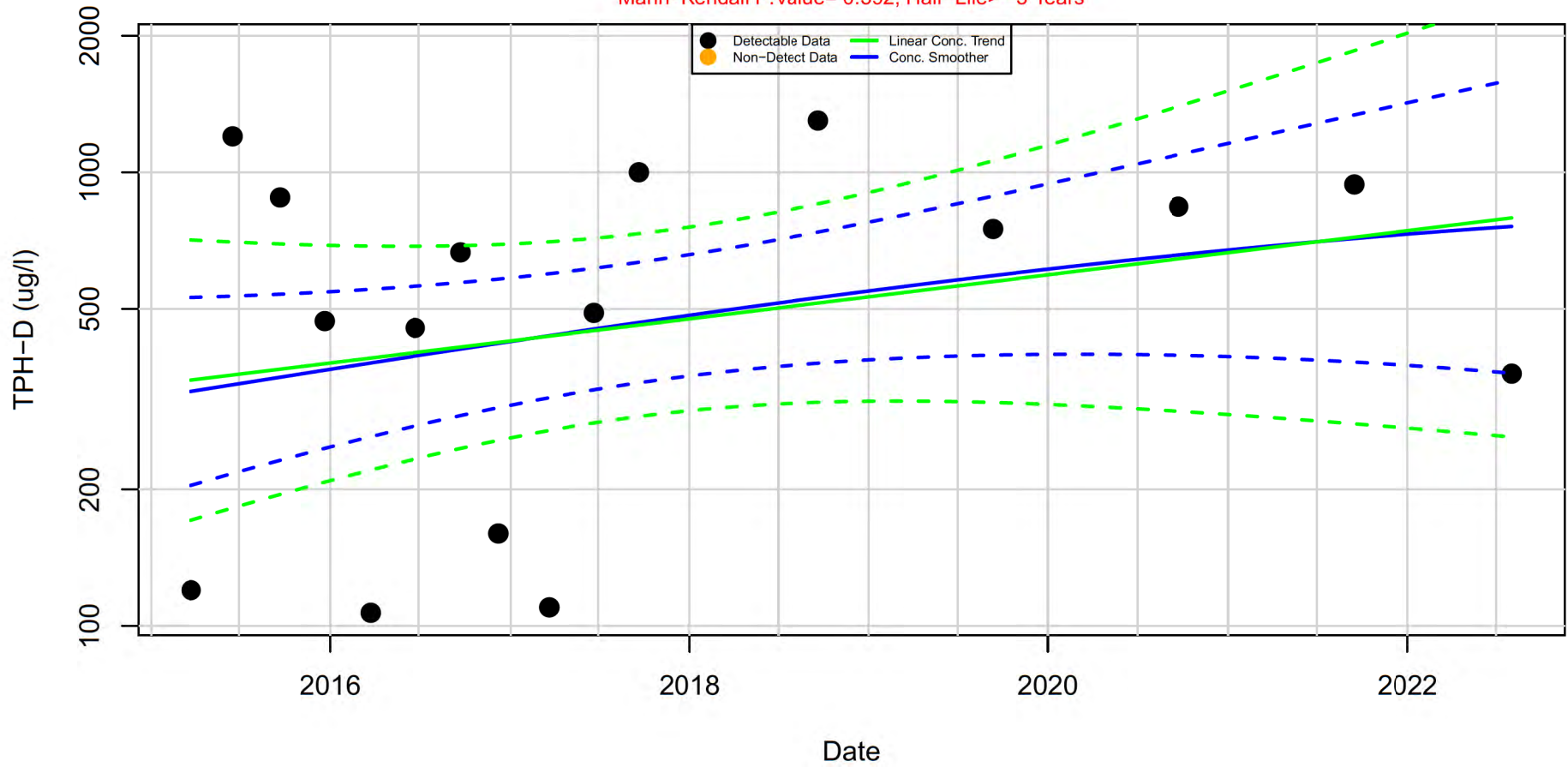
TPH-D in RW-5R : Aquifer-Blank

Mann-Kendall P.Value= 0.861; Half-Life> 5 Years
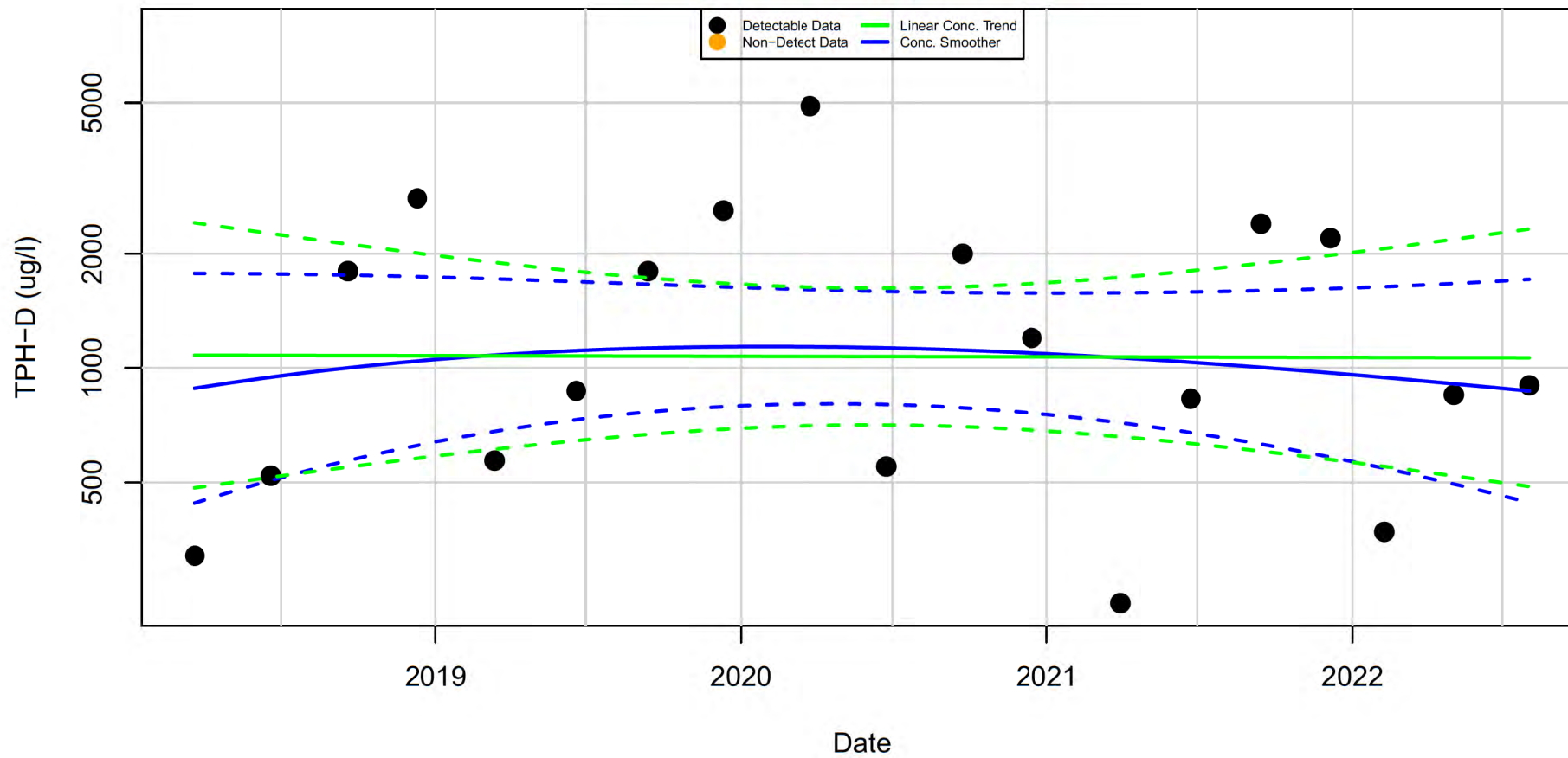
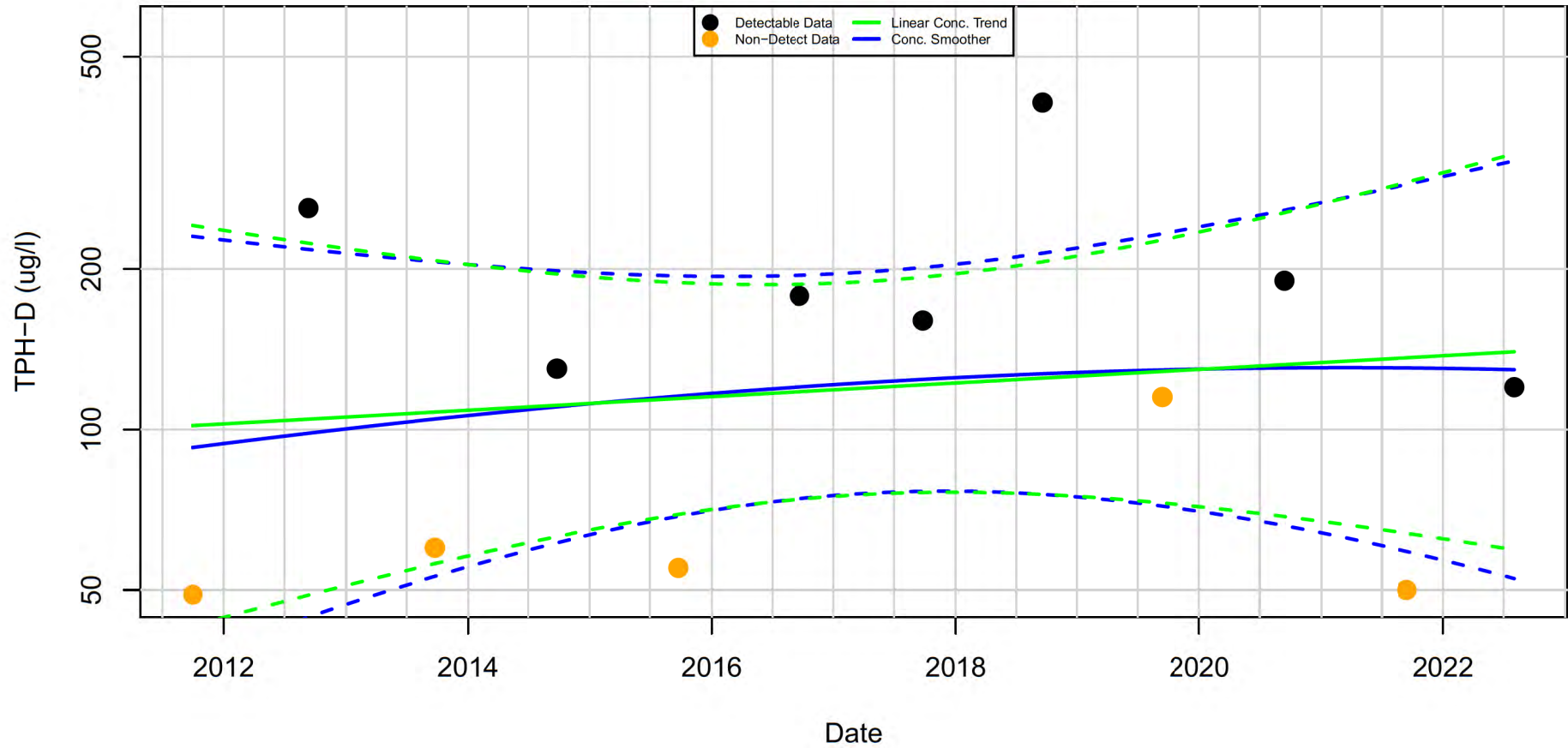**TPH-D in RW-8 : Aquifer-Blank**
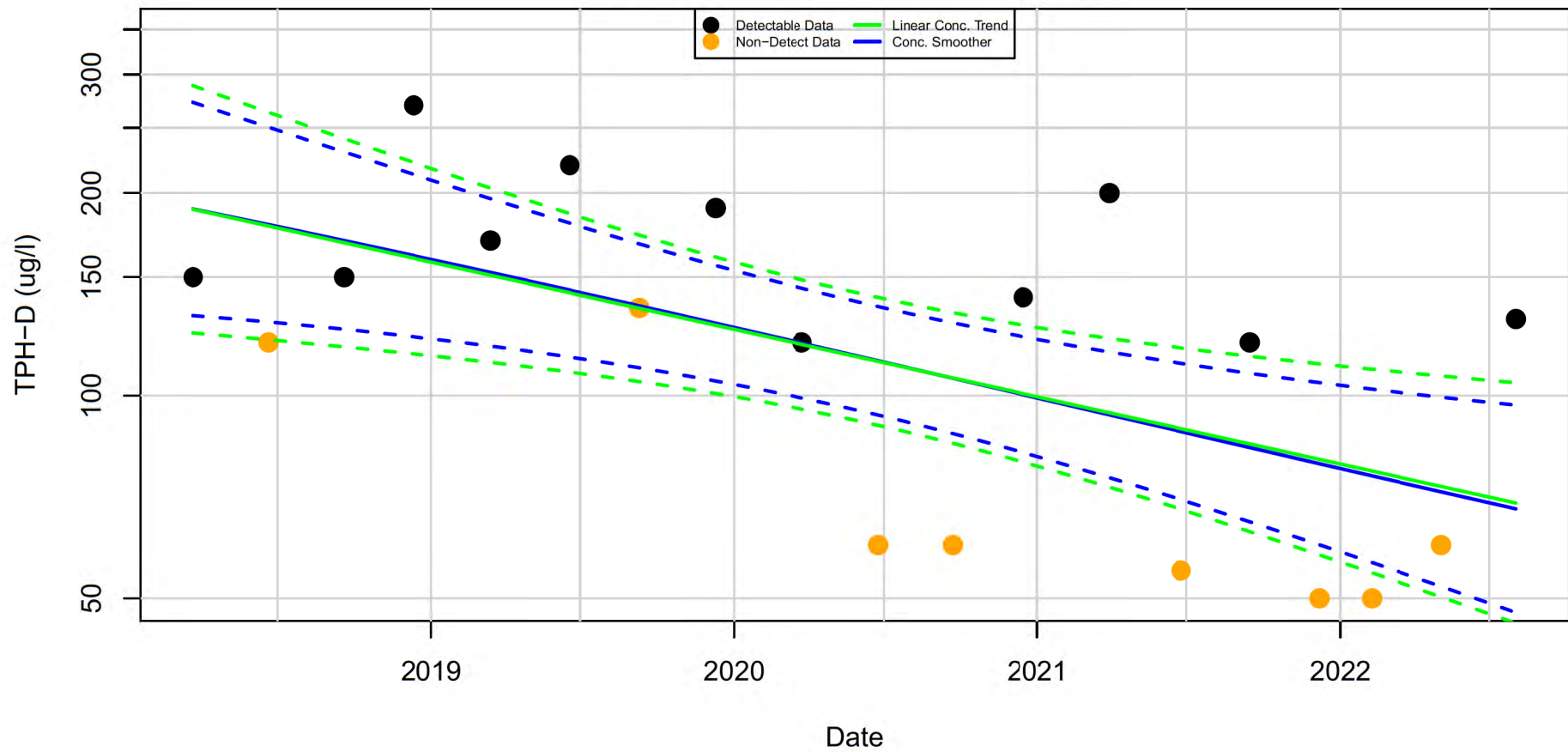
Mann-Kendall P.Value= <0.01; Half-Life= 896 days
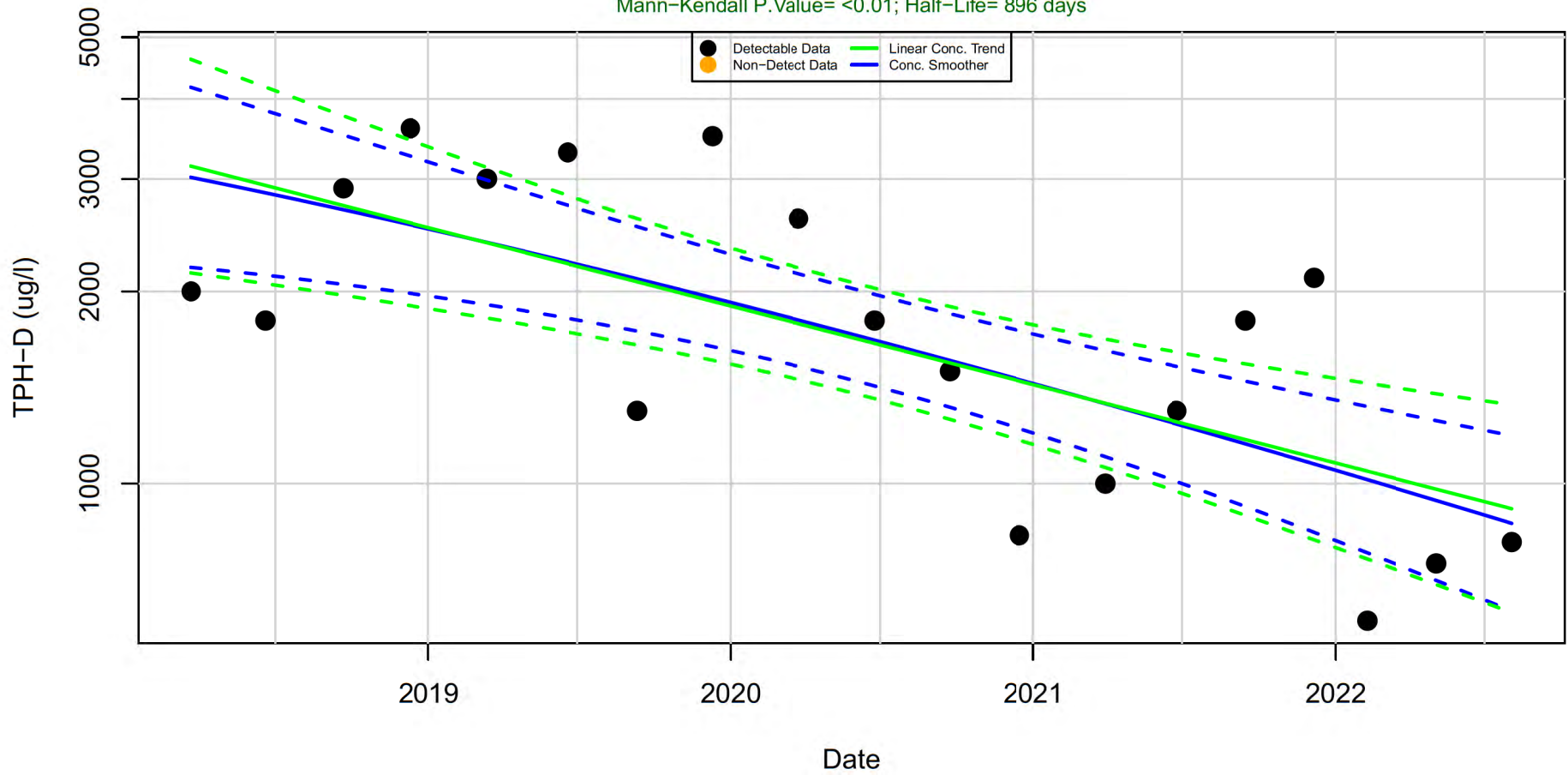
TPH−D in T−3 : Aquifer−Blank

Mann−Kendall P.Value= 0.433; Half−Life> 5 Years
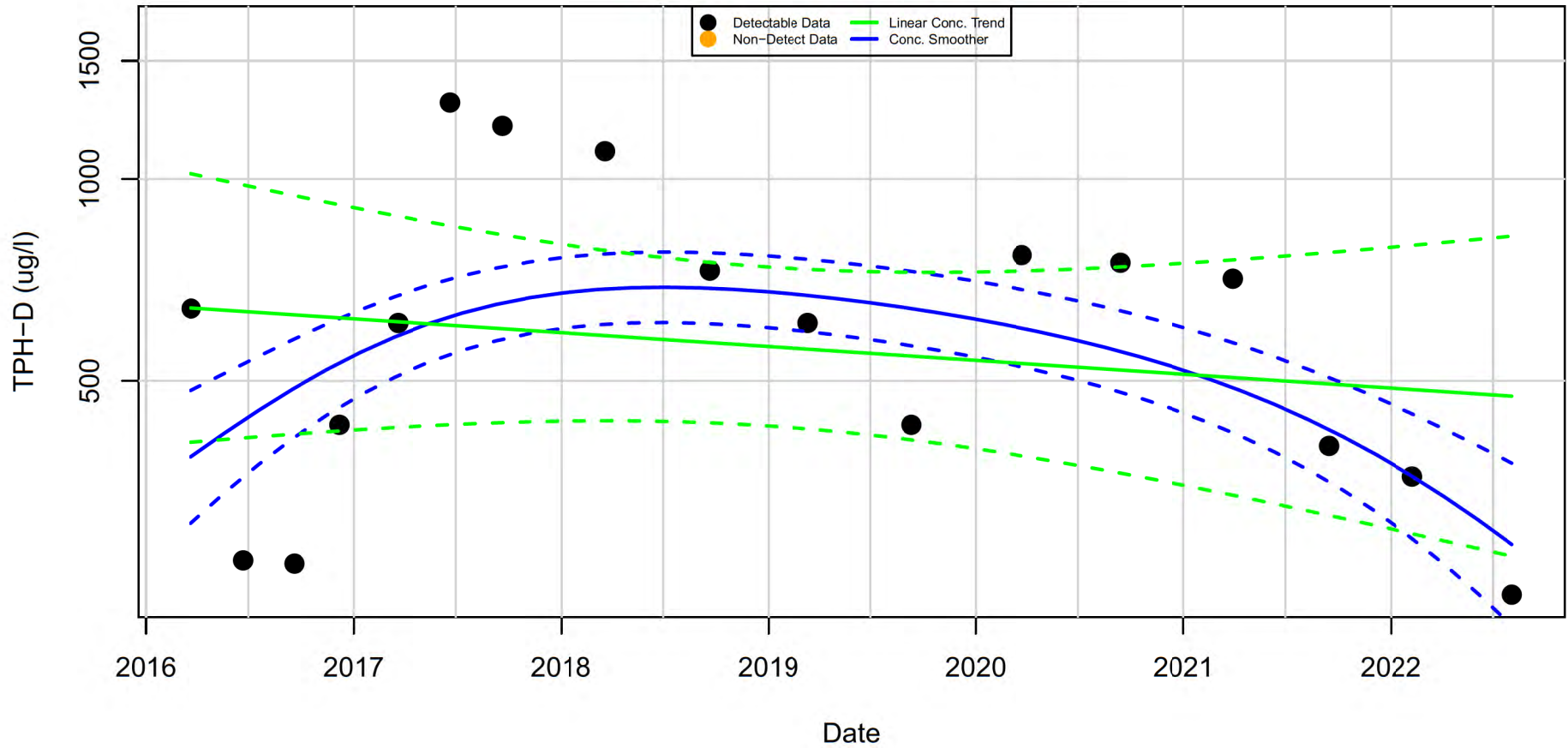
TPH−D in E−22 : Aquifer−Blank

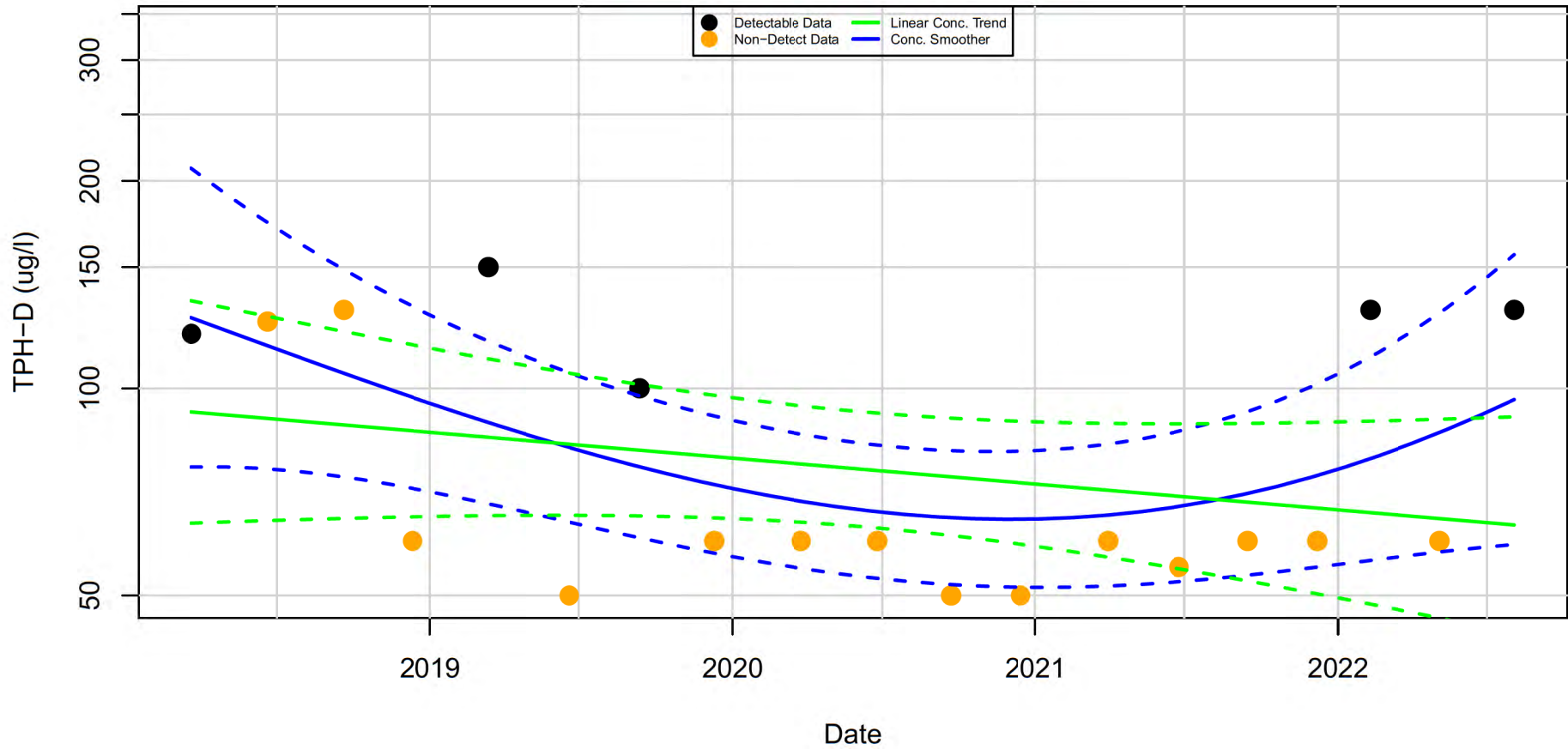Mann−Kendall P.Value= 0.0389; Half−Life= 742 days

TPH-D in FW-3 : Aquifer-Blank

Mann-Kendall P.Value= 0.0594; Half-Life> 5 Years

TPH-D in FW-4 : Aquifer-Blank

Mann-Kendall P.Value= 0.584; Half-Life> 5 Years

TPH-D in FW-5R : Aquifer-Blank

Mann-Kendall P.Value= 0.0422; Half-Life> 5 Years

TPH-D in FW-14 : Aquifer-Blank
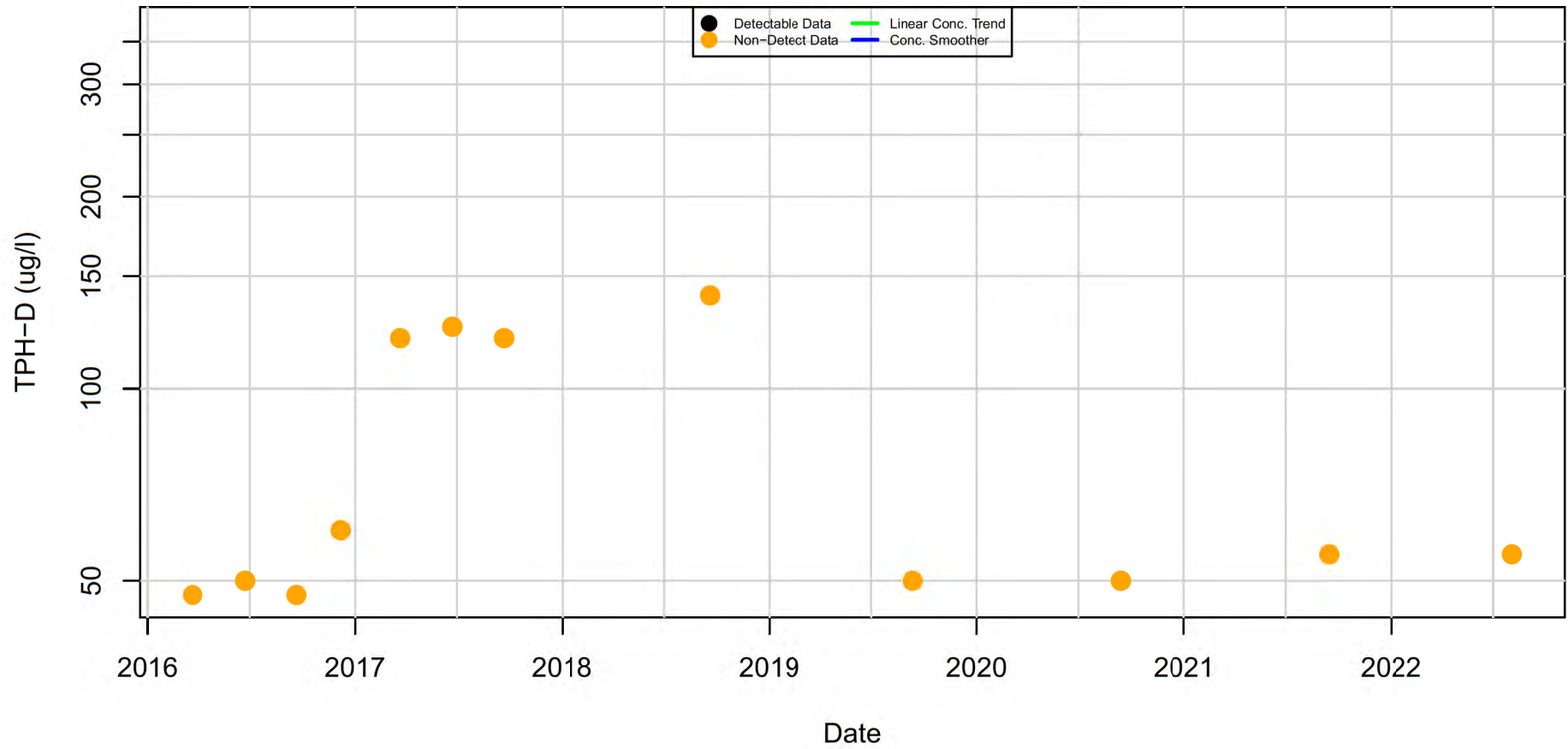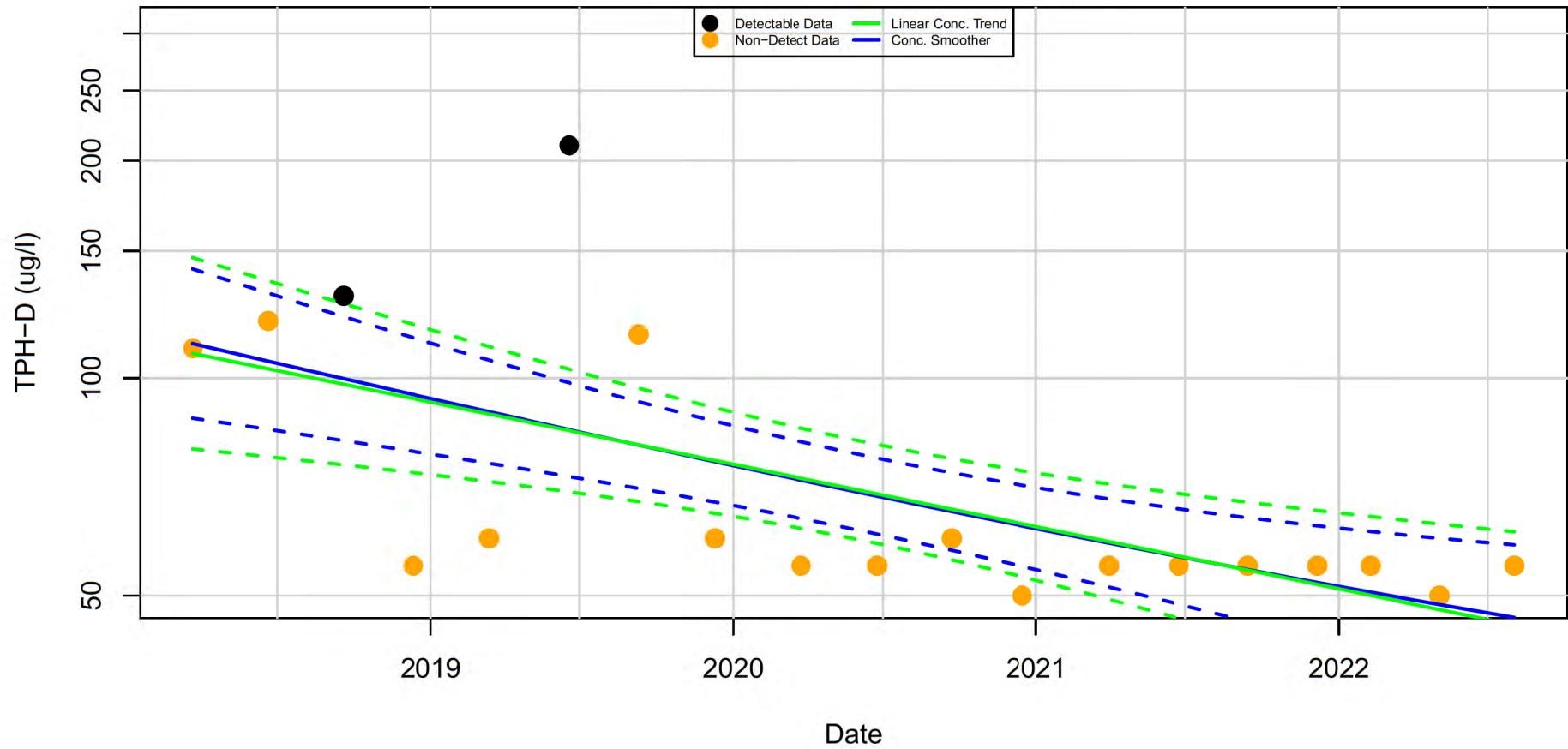
Mann-Kendall P.Value= <0.01; Half-Life= 1470 days

Legend:
- Detectable Data
- Non-Detect Data
- Linear Conc. Trend
- Conc. Smoother

Y-axis: TPH-D (ug/l)

X-axis: Date (2019, 2020, 2021, 2022)

TPH-D in FW-15 : Aquifer-Blank

Mann-Kendall P.Value= 0.732; Half-Life> -5 Years

Legend:
- Detectable Data
- Non-Detect Data
- Linear Conc. Trend
- Conc. Smoother

Y-axis: TPH-D (ug/l)

X-axis: Date

TPH-D in RR-1 : Aquifer-Blank

Mann-Kendall P.Value= 0.0167; Half-Life= 1100 days

Legend:
- Detectable Data
- Non-Detect Data
- Linear Conc. Trend
- Conc. Smoother

Y-axis: TPH-D (ug/l)

X-axis: Date (2019, 2020, 2021, 2022)

TPH−D in RR−2 : Aquifer−Blank

Mann−Kendall P.Value= 0.509; Half−Life> 5 Years

Legend:
- Detectable Data
- Non−Detect Data
- Linear Conc. Trend
- Conc. Smoother

Y-axis: TPH−D (ug/l)

X-axis: Date (2019, 2020, 2021, 2022)
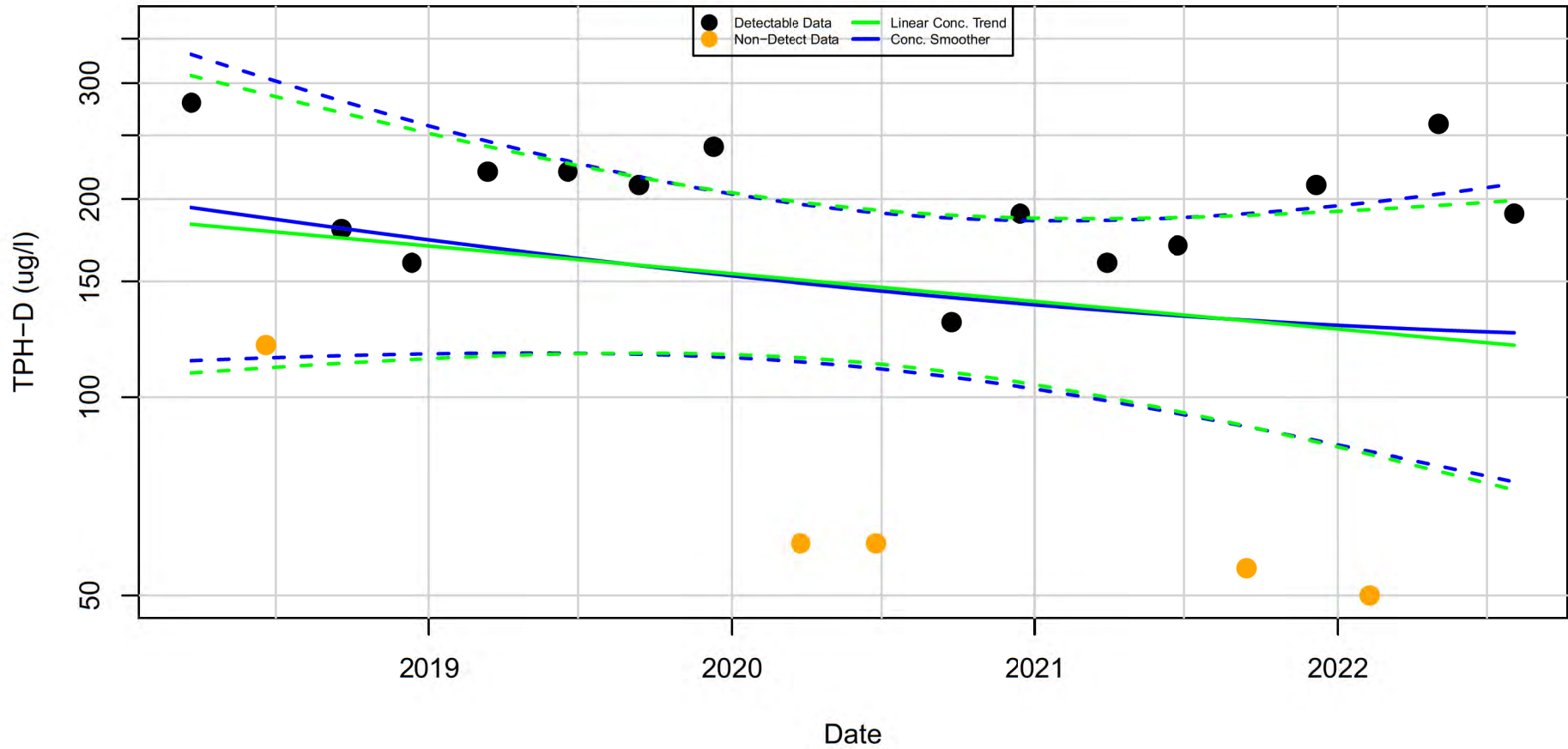
TPH-D in RR-3 : Aquifer-Blank

TPH−D in RR−4 : Aquifer−Blank

Mann−Kendall P.Value= <0.01; Half−Life= 1277 days

TPH-D in RR-5 : Aquifer-Blank

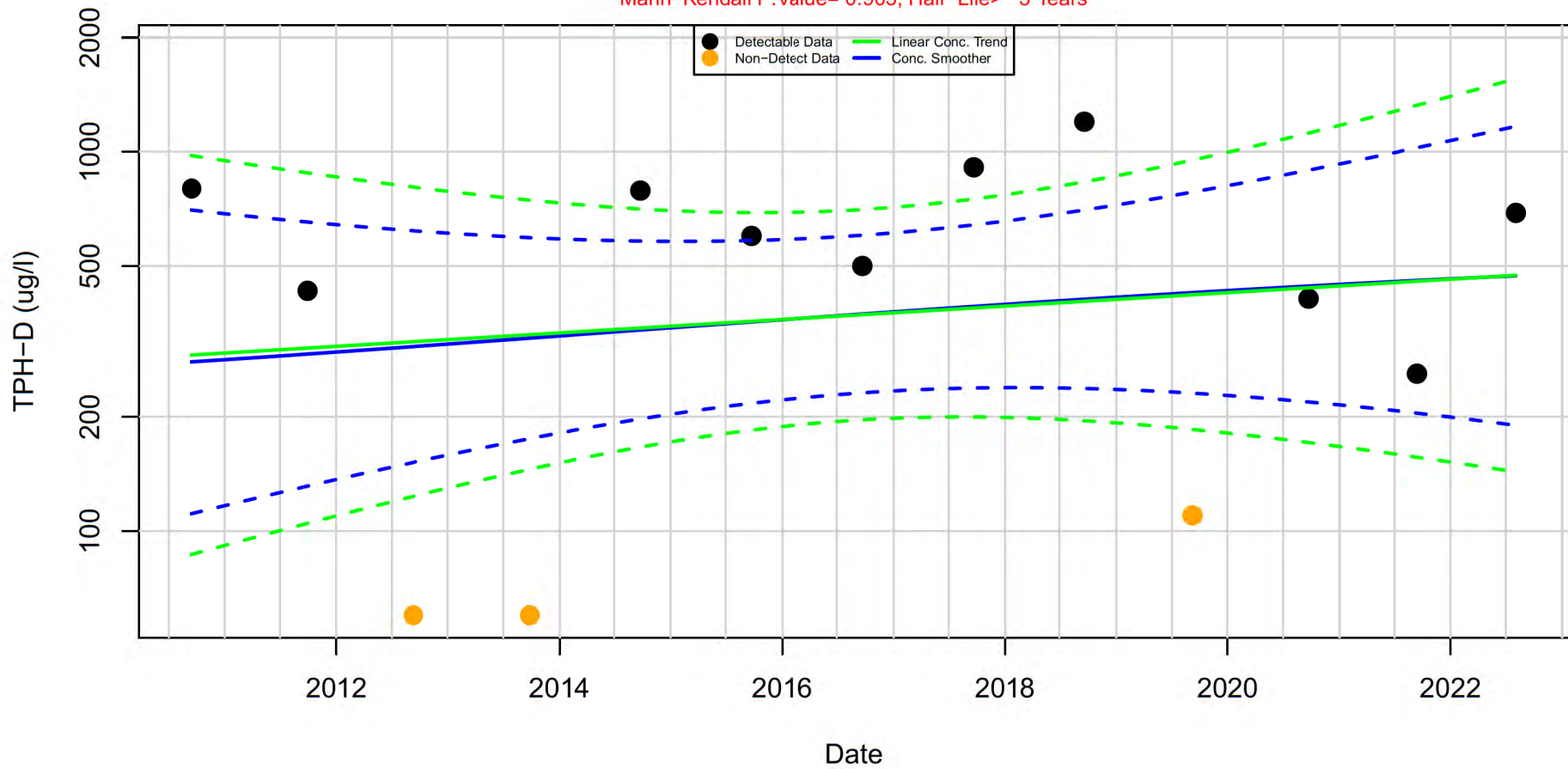Mann-Kendall P.Value= 0.0922; Half-Life= 1362 days
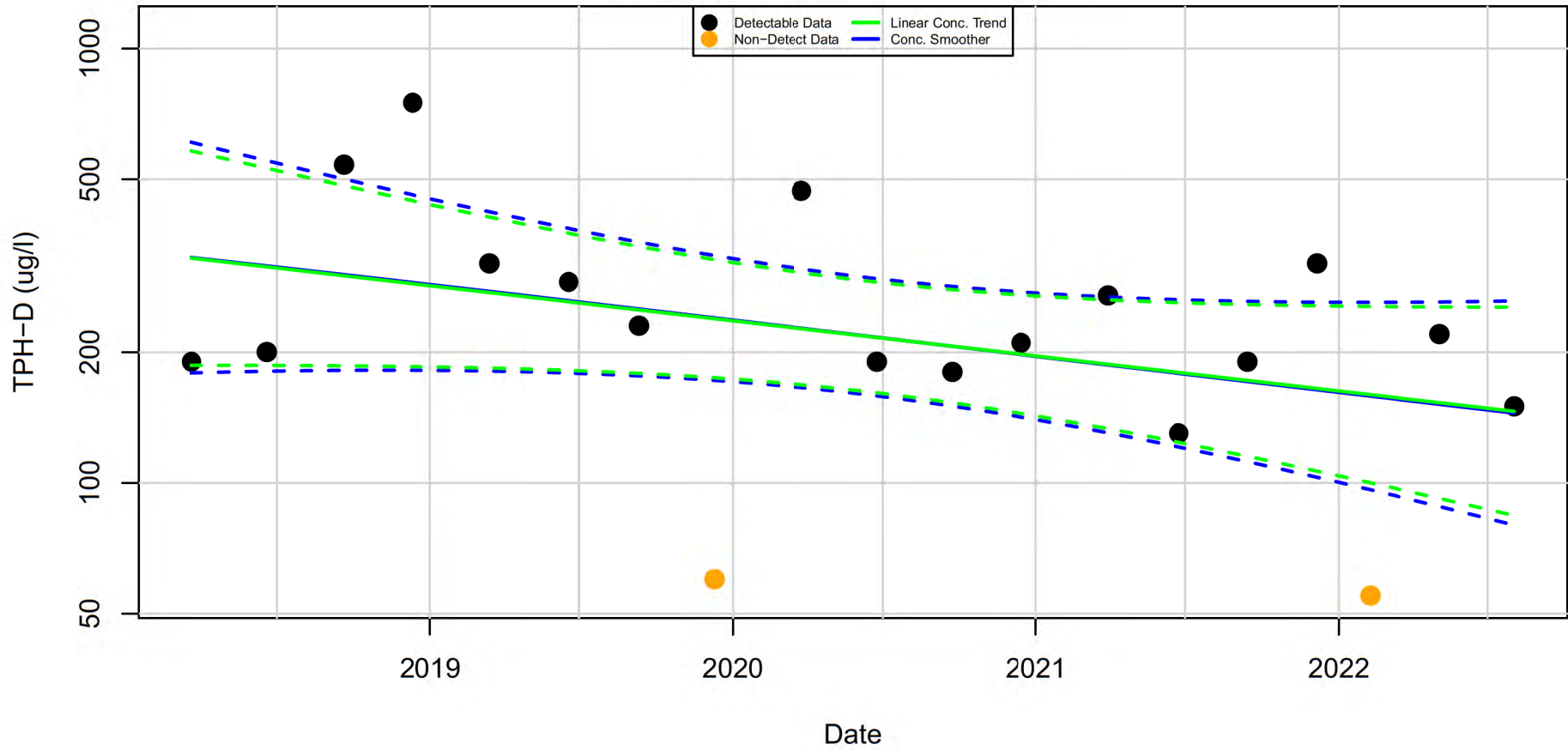
TPH−D in T−2 : Aquifer−Blank

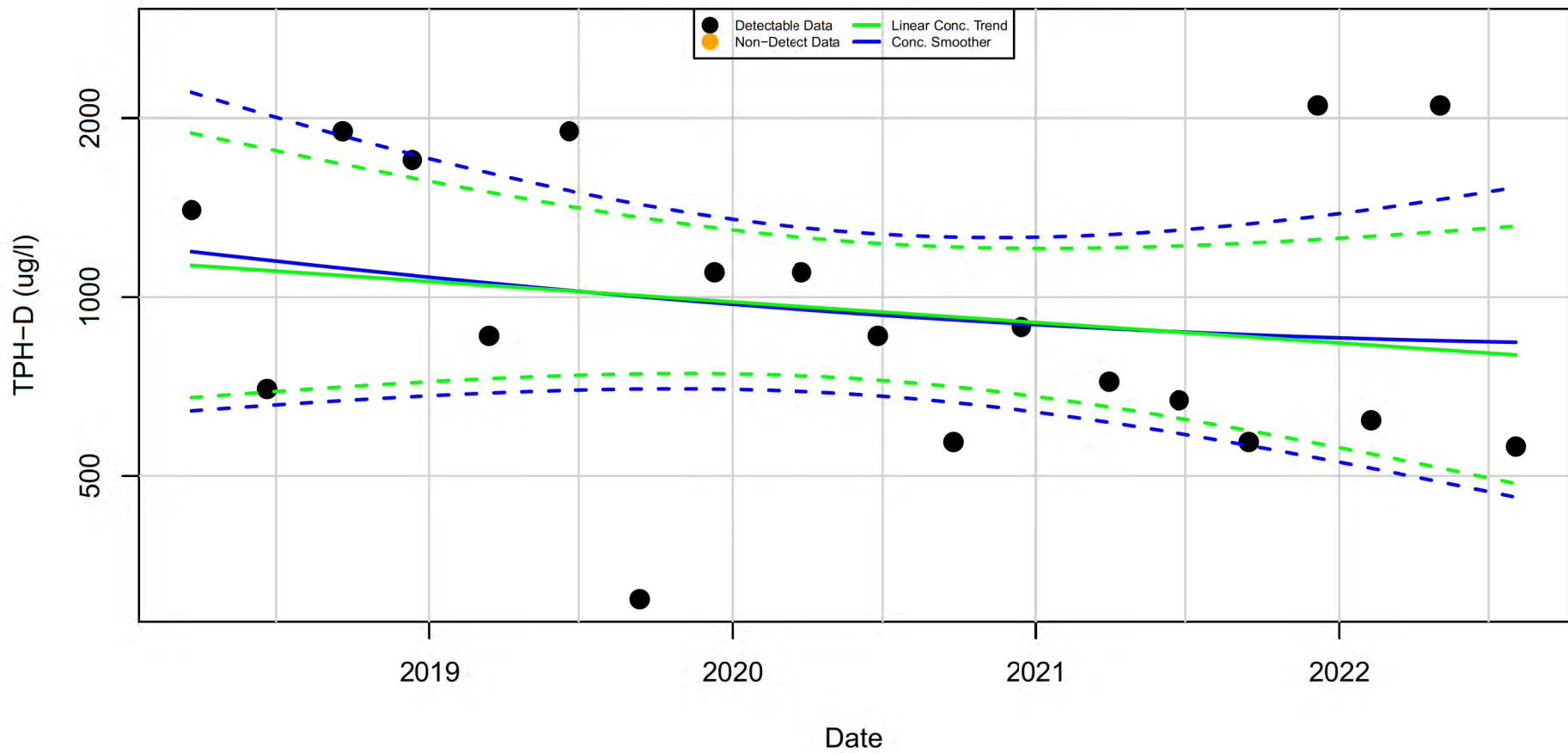Mann−Kendall P.Value= 0.461; Half−Life> 5 Years

TPH-D in DMW-1 : Aquifer-Blank

Mann-Kendall P.Value= 0.903; Half-Life> -5 Years
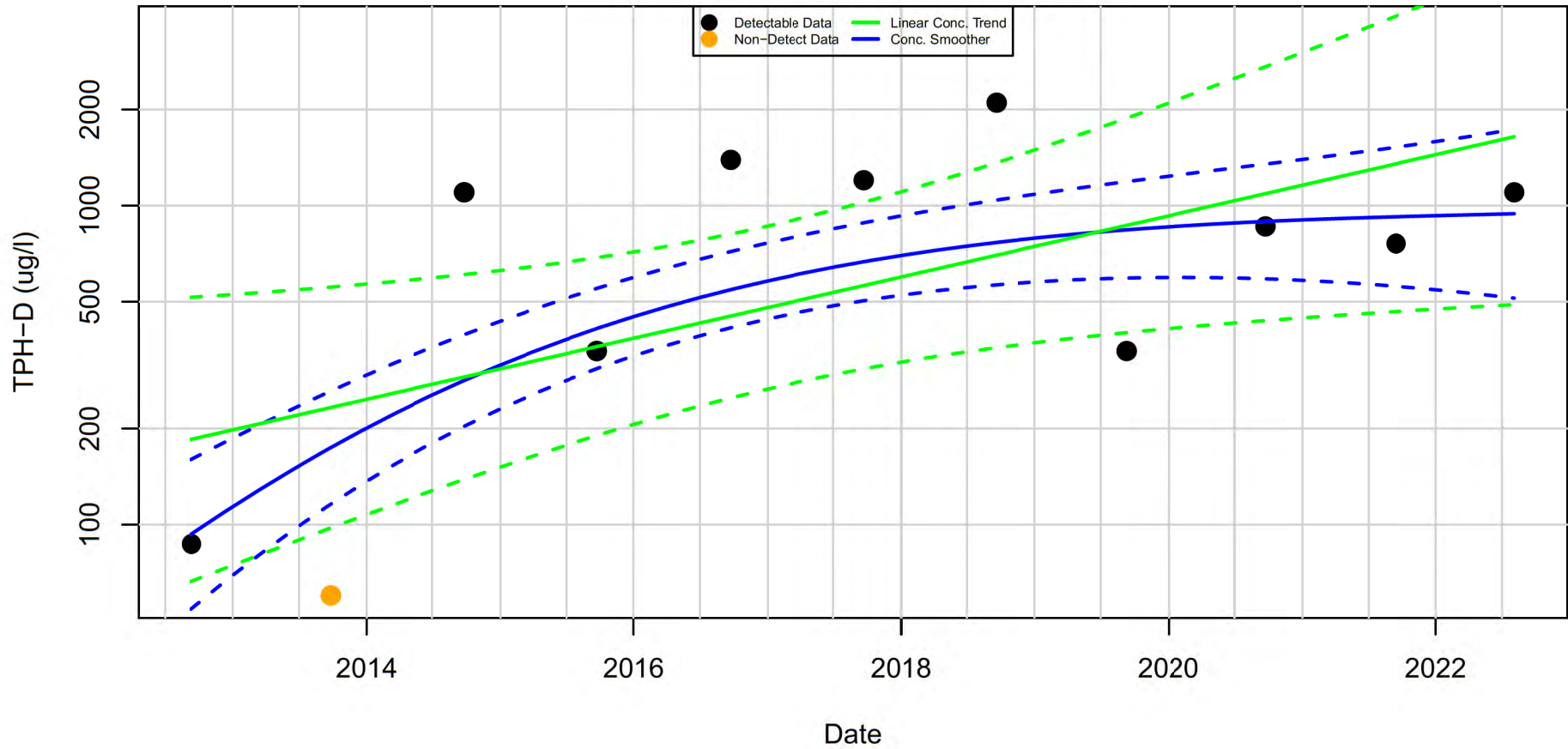
TPH-D in DMW-2 : Aquifer-Blank
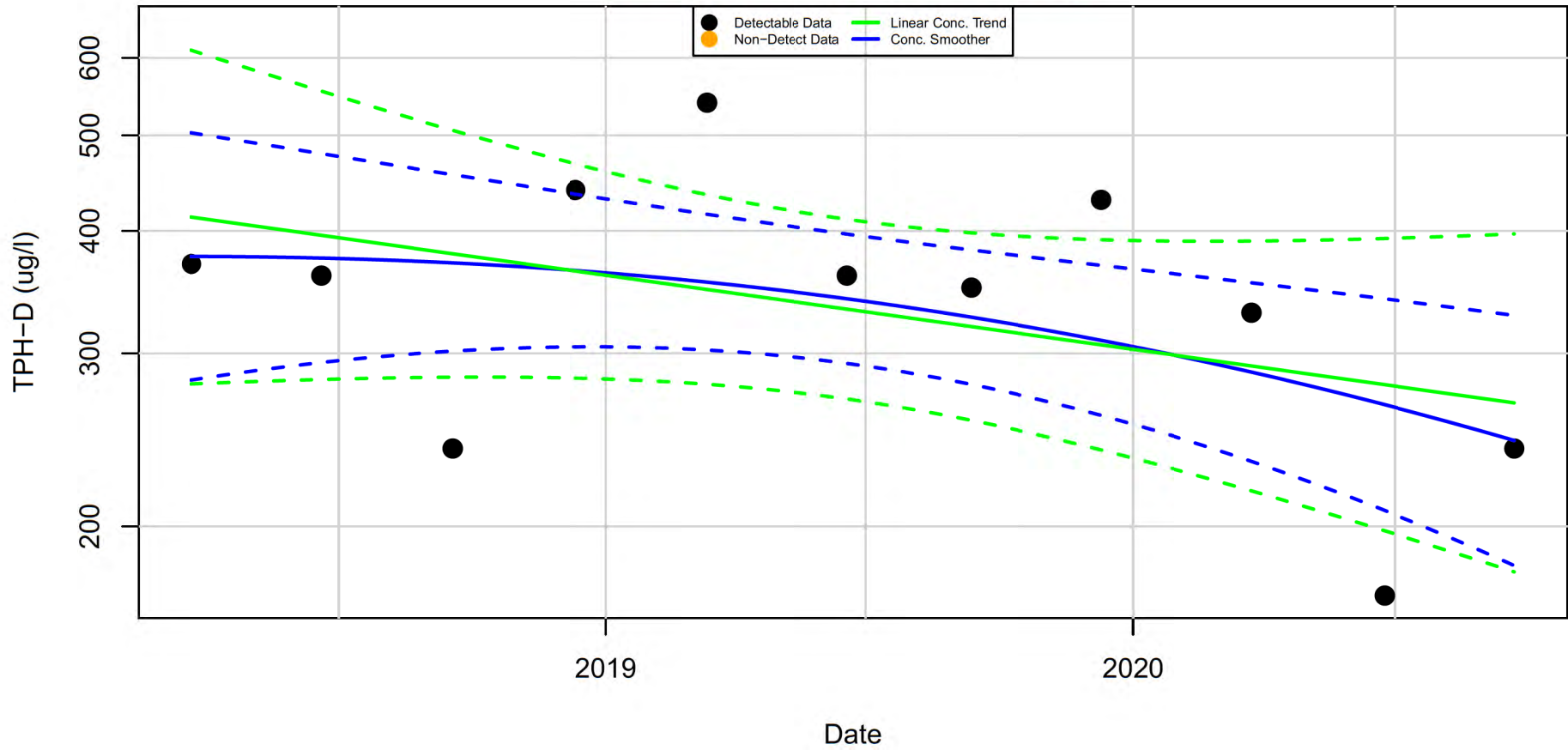
Mann-Kendall P.Value= 0.194; Half-Life> 5 Years

TPH−D in DMW−3 : Aquifer−Blank

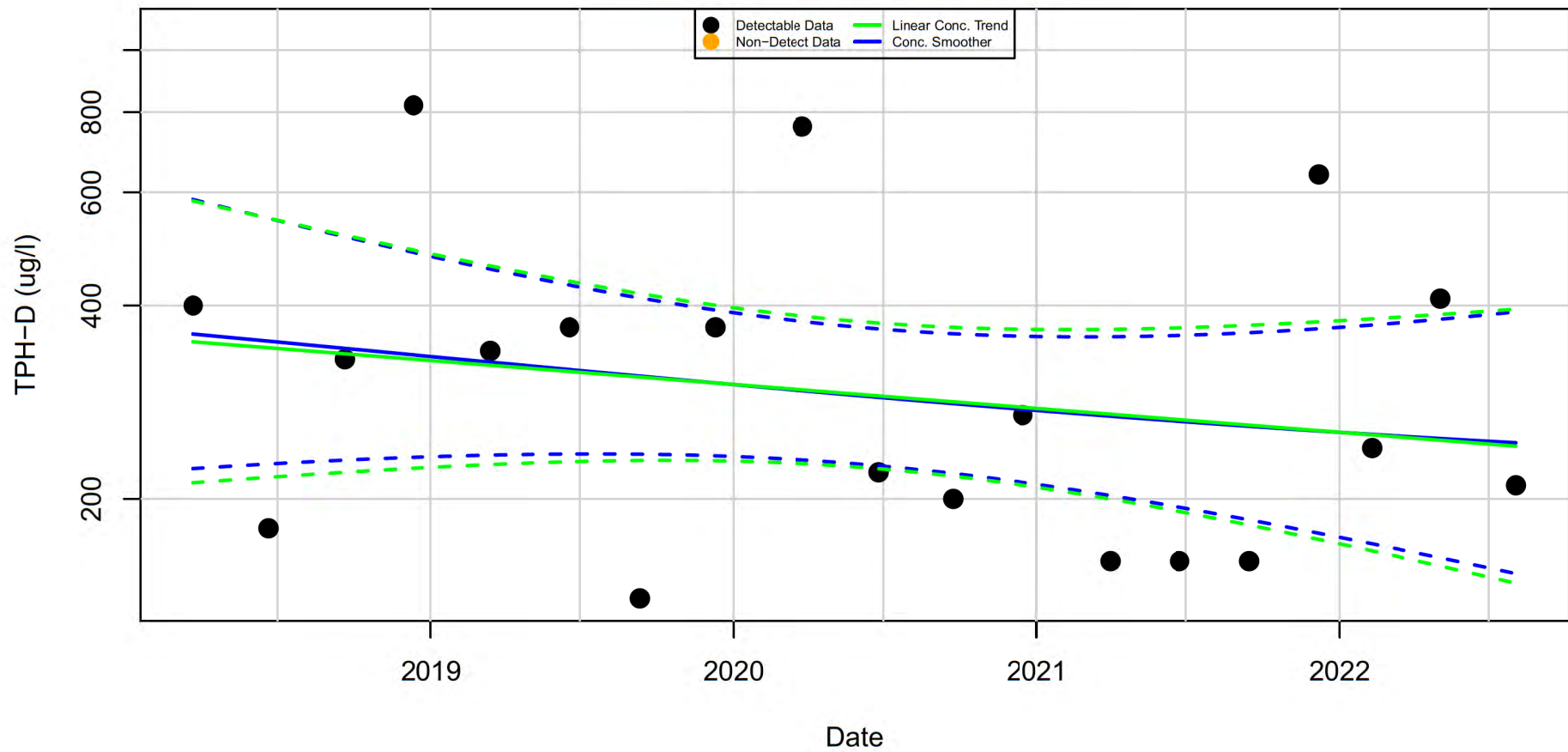Mann−Kendall P.Value= 0.0843; Half−Life= −1147 days

TPH-D in DMW-4 : Aquifer-Blank

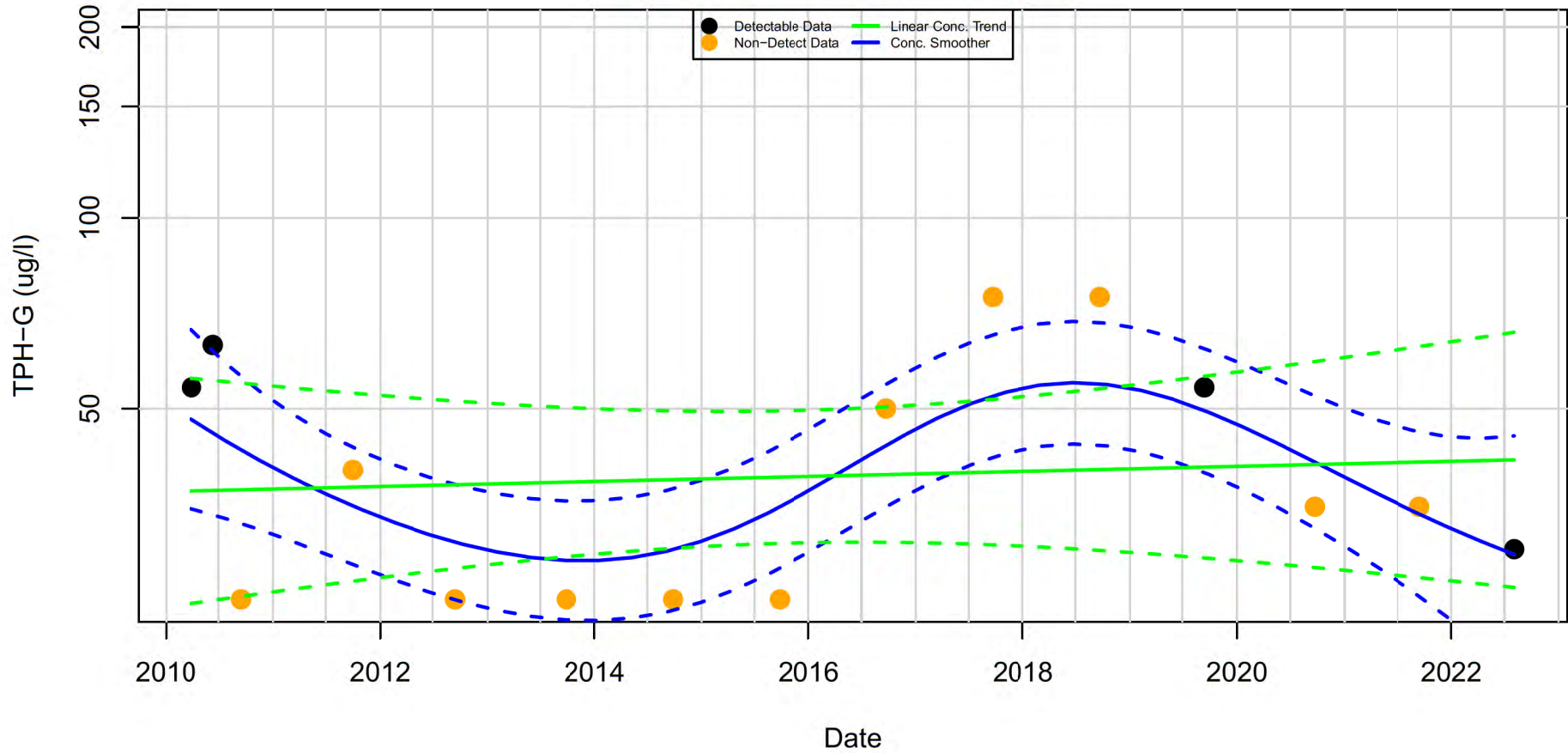Mann-Kendall P.Value= 0.117; Half-Life= 1457 days

TPH-D in FW-13 : Aquifer-Blank

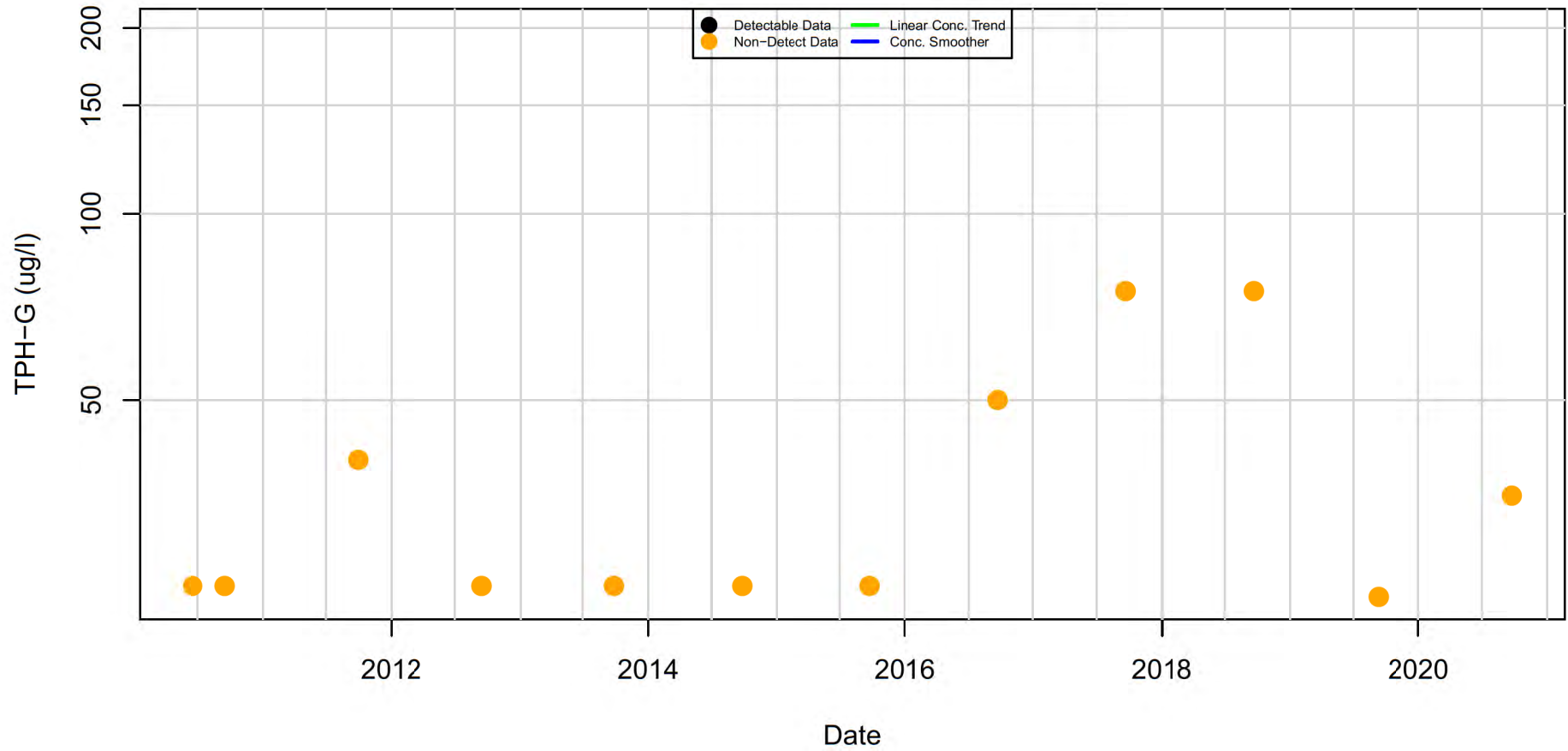Mann-Kendall P.Value= 0.4; Half-Life> 5 Years

Legend:
- Detectable Data
- Non-Detect Data
- Linear Conc. Trend
- Conc. Smoother

TPH-D (ug/l)

Date

TPH−G in B−17B : Aquifer−Blank

Mann−Kendall P.Value= 0.879; Half−Life> −5 Years

TPH-G in B-30 : Aquifer-Blank

TPH-G in B-31 : Aquifer-Blank

Mann-Kendall P.Value= 0.624; Half-Life> -5 Years

Legend:
- Detectable Data
- Non-Detect Data
- Linear Conc. Trend
- Conc. Smoother

Y-axis: TPH-G (ug/l)

X-axis: Date (2019, 2020, 2021, 2022)

TPH−G in E−21 : Aquifer−Blank

Mann−Kendall P.Value= 0.927; Half−Life> 5 Years

TPH−G in B−19 : Aquifer−Blank
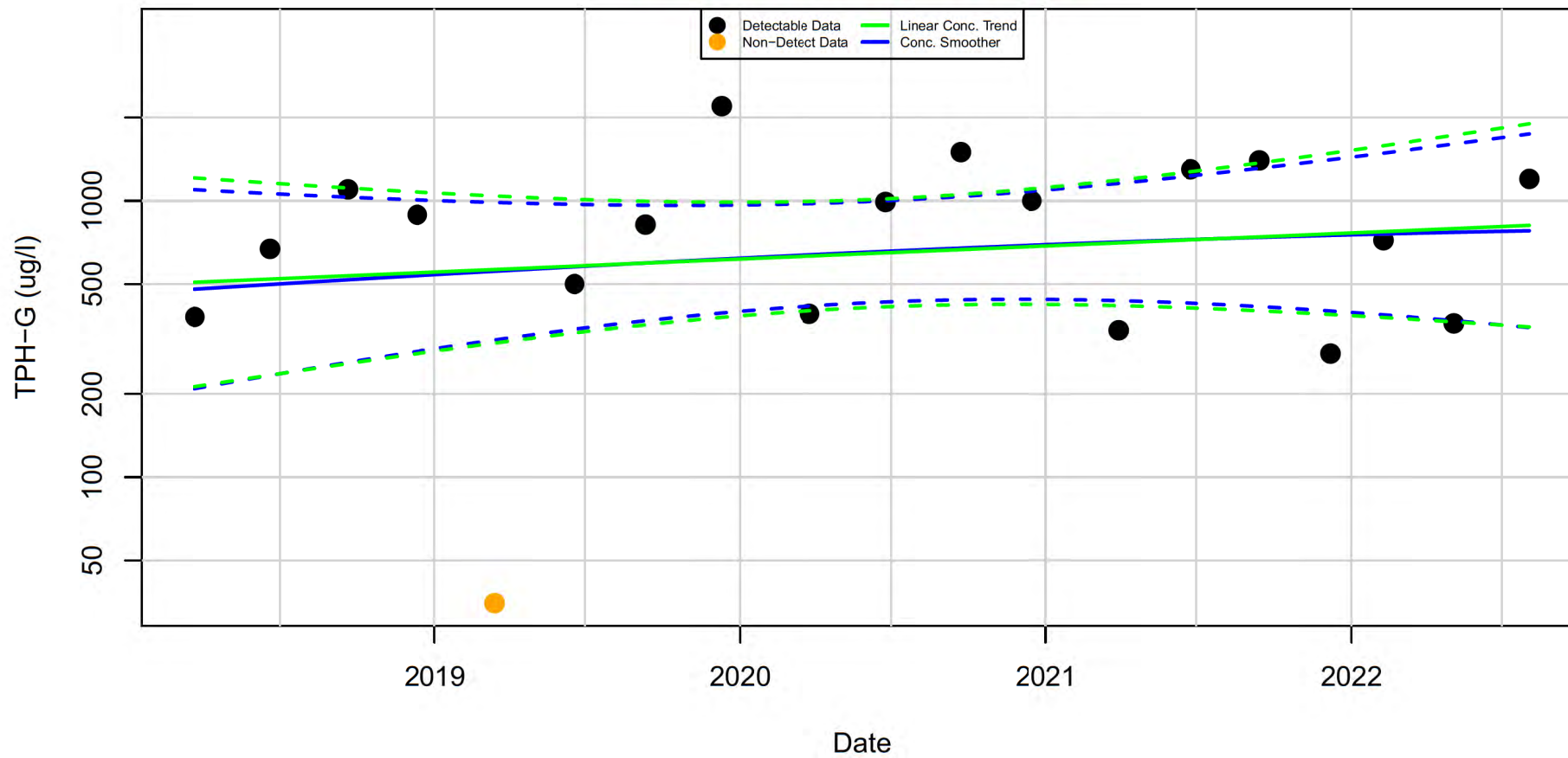
Mann−Kendall P.Value= 0.165; Half−Life> 5 Years

Legend:
- Detectable Data
- Non−Detect Data
- Linear Conc. Trend
- Conc. Smoother

Y-axis: TPH−G (ug/l)

X-axis: Date

TPH-G in B-25 : Aquifer-Blank

Mann-Kendall P.Value= 0.0962; Half-Life> 5 Years

Detectable Data   Linear Conc. Trend
Non-Detect Data   Conc. Smoother

TPH-G (ug/l)

Date

TPH-G in B-34 : Aquifer-Blank

Mann-Kendall P.Value= 0.944; Half-Life> 5 Years

TPH−G in G−8 : Aquifer−Blank

Mann−Kendall P.Value= 0.137; Half−Life> 5 Years
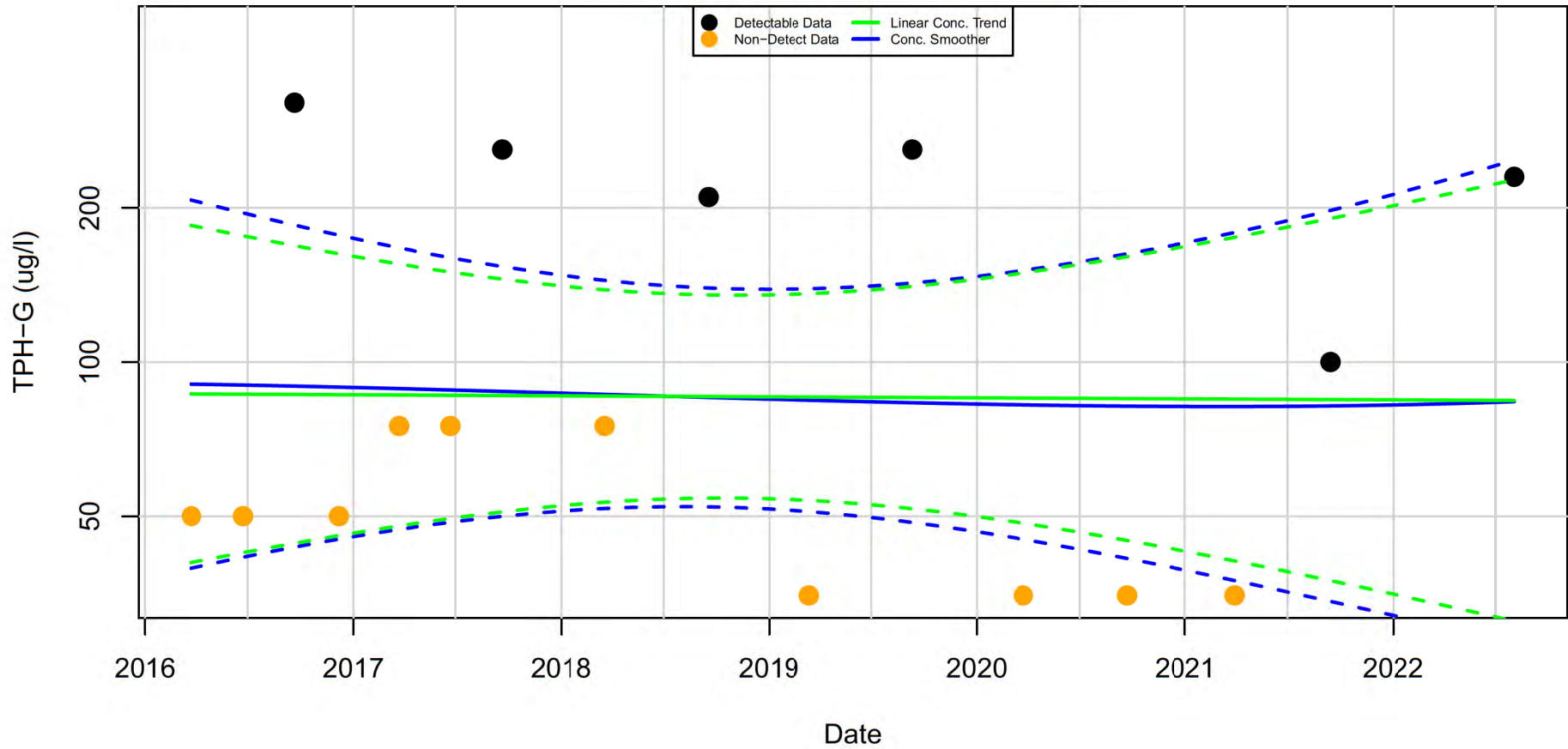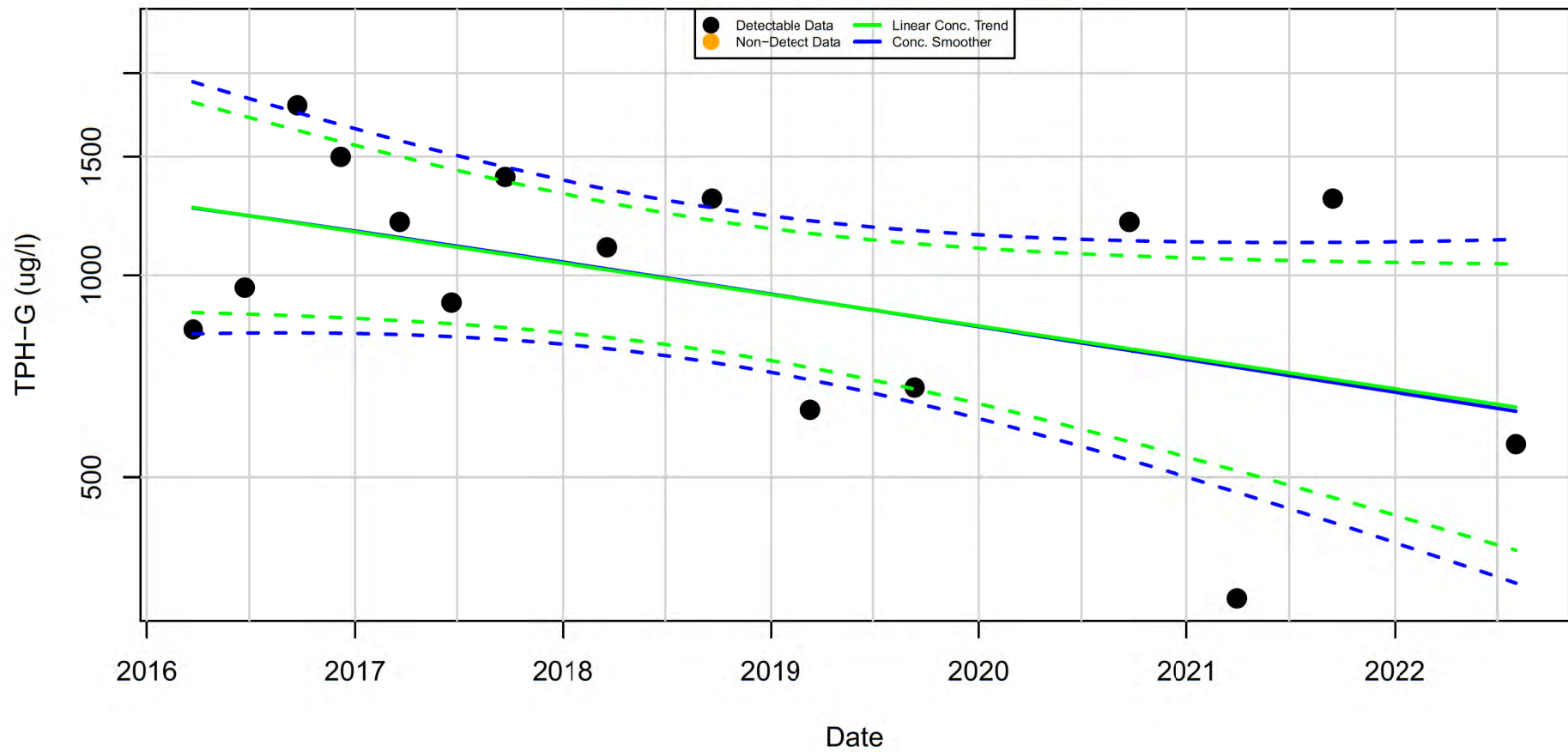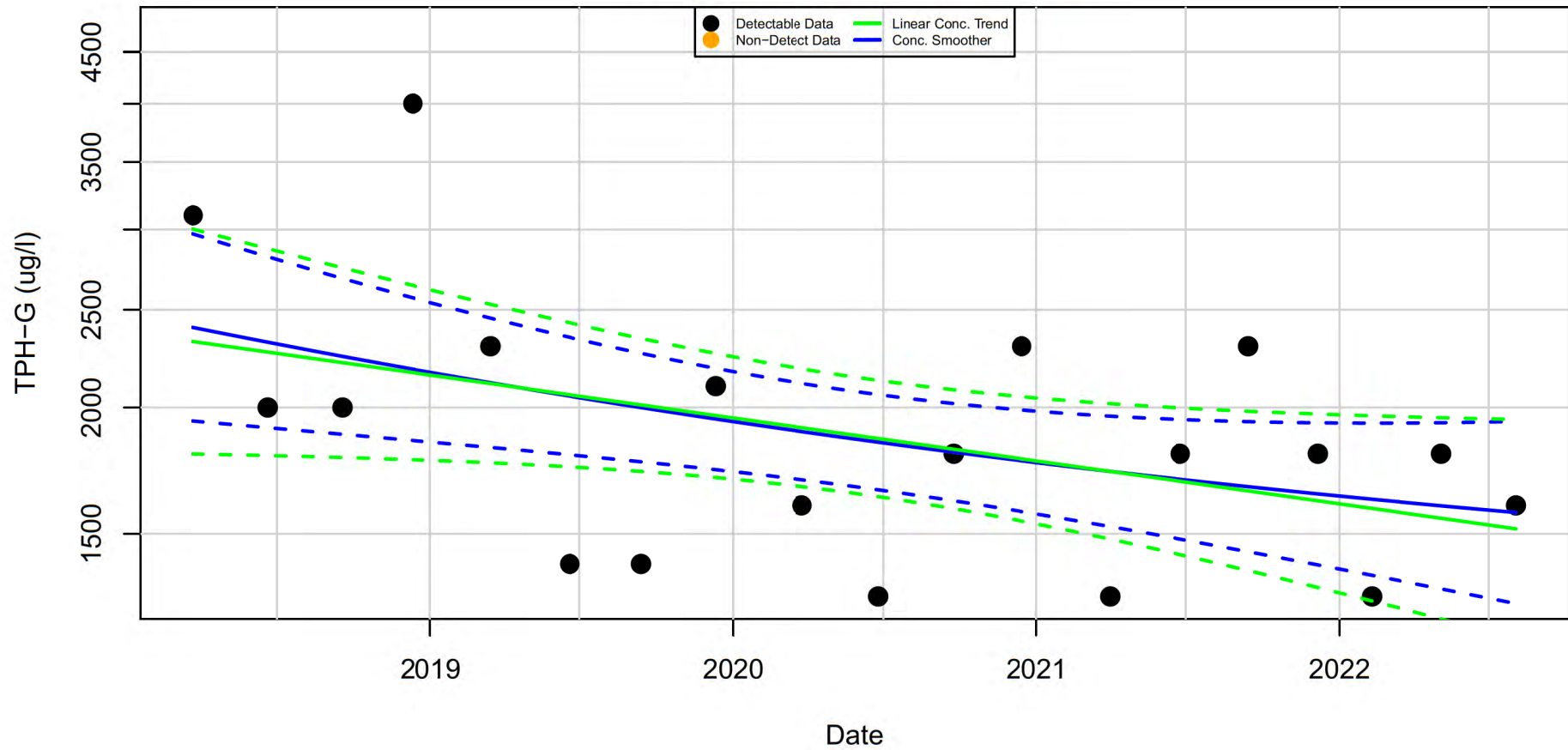
TPH−G in G−16 : Aquifer−Blank

Mann−Kendall P.Value= 0.194; Half−Life> −5 Years

Legend:
- Detectable Data
- Non−Detect Data
- Linear Conc. Trend
- Conc. Smoother

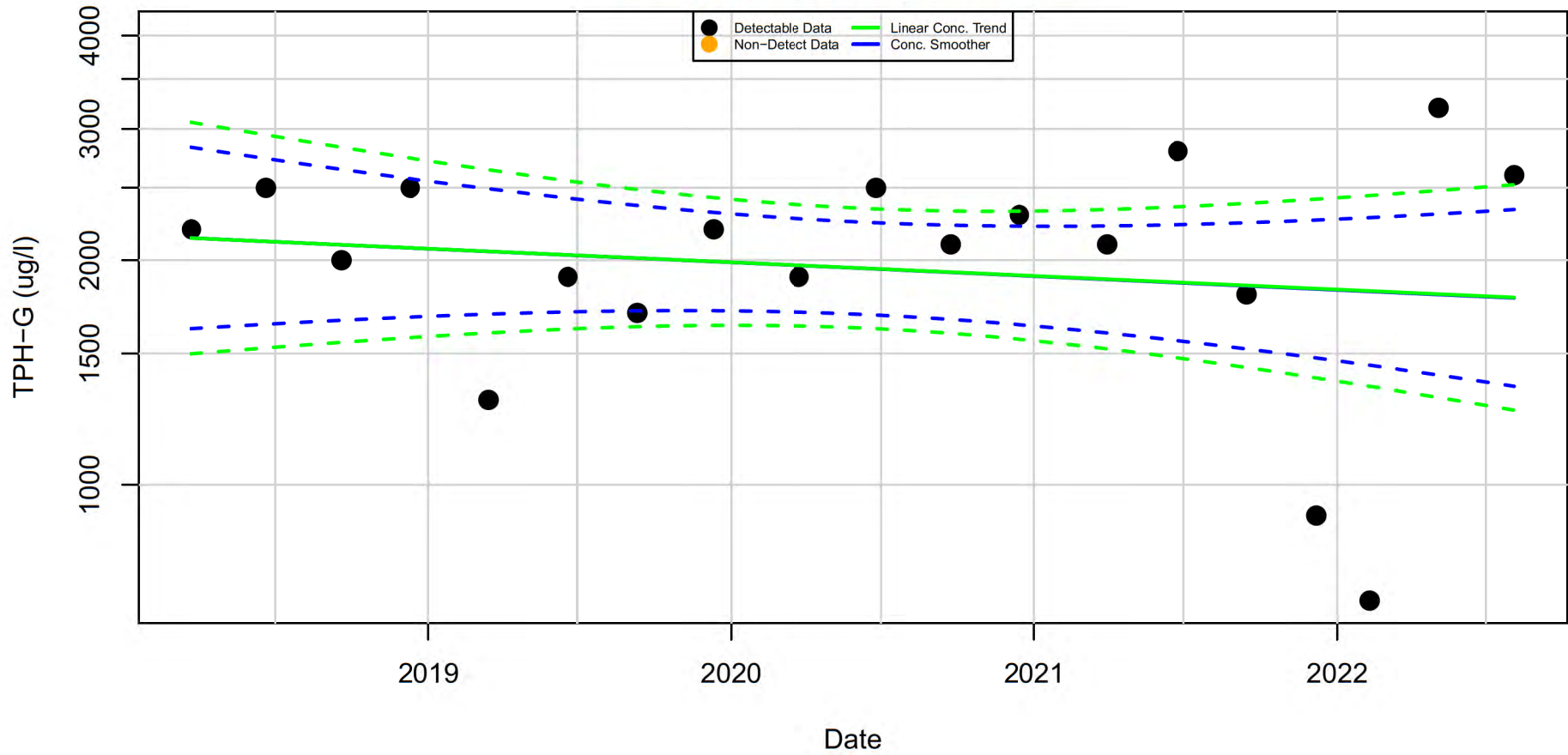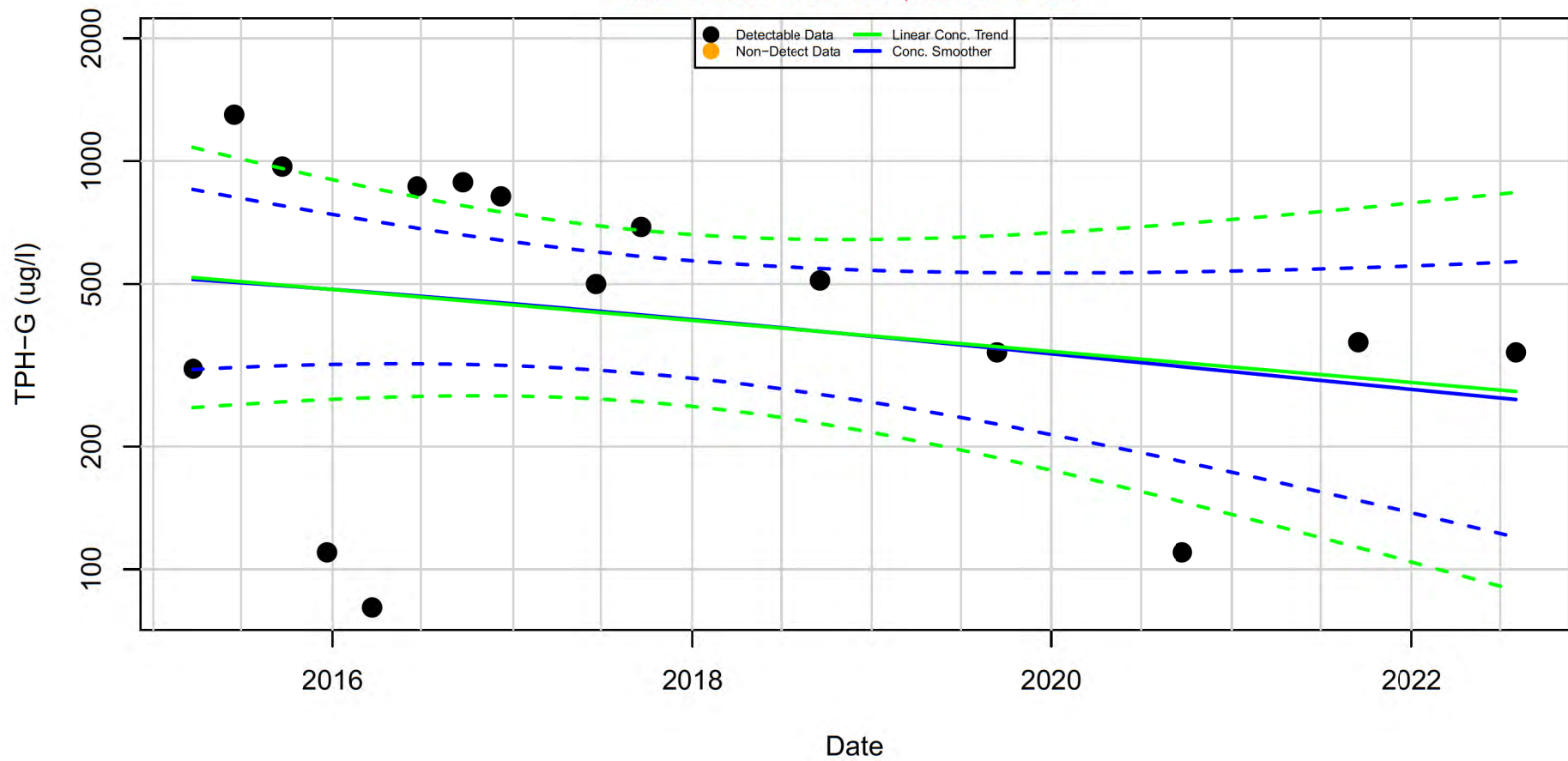Y-axis: TPH−G (ug/l)

X-axis: Date

TPH-G in G-18 : Aquifer-Blank

Mann-Kendall P.Value= 1; Half-Life> 5 Years

TPH-G in HC-111 : Aquifer-Blank

Mann-Kendall P.Value= 0.752; Half-Life> -5 Years

TPH-G in RW-2 : Aquifer-Blank

Mann-Kendall P.Value= 0.589; Half-Life= -1410 days

Legend:
- Detectable Data
- Non-Detect Data
- Linear Conc. Trend
- Conc. Smoother

Y-axis: TPH-G (ug/l)

X-axis: Date (2016, 2018, 2020, 2022)

TPH−G in RW−5R : Aquifer−Blank

Mann−Kendall P.Value= 0.278; Half−Life= −1748 days

TPH-G in RW-8 : Aquifer-Blank
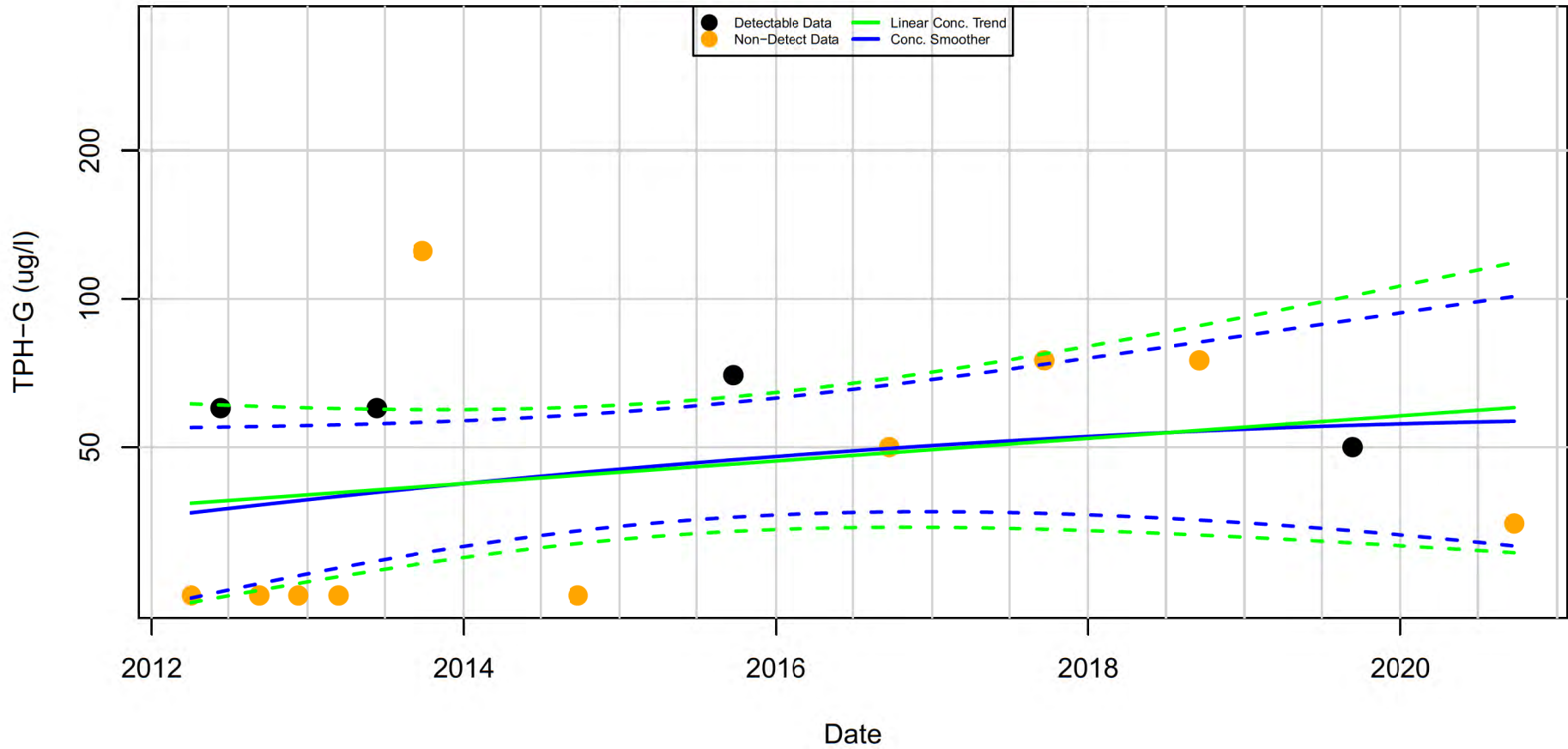
Mann−Kendall P.Value= <0.01; Half−Life= 553 days
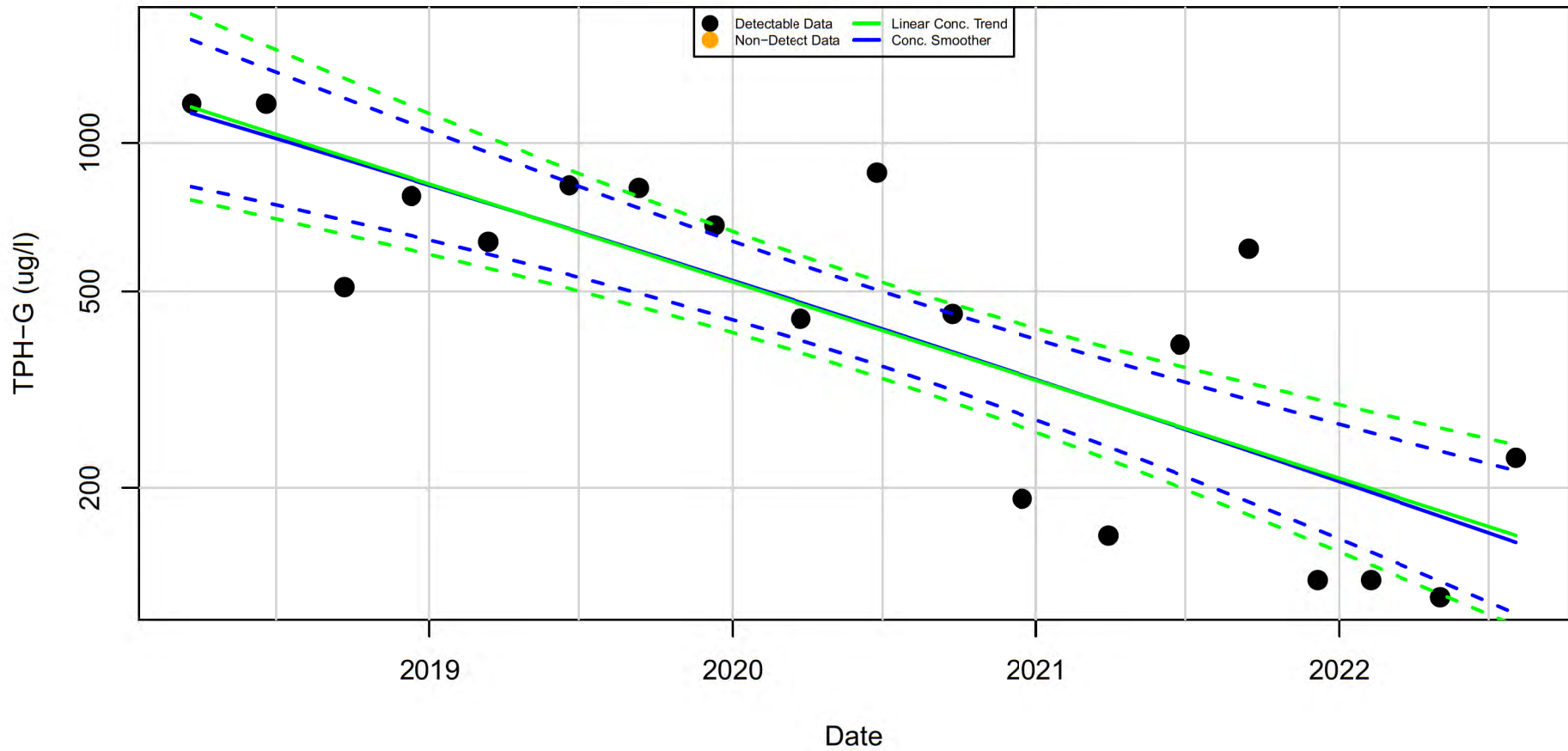
TPH-G in T-3 : Aquifer-Blank

Mann-Kendall P.Value= 0.869; Half-Life> 5 Years

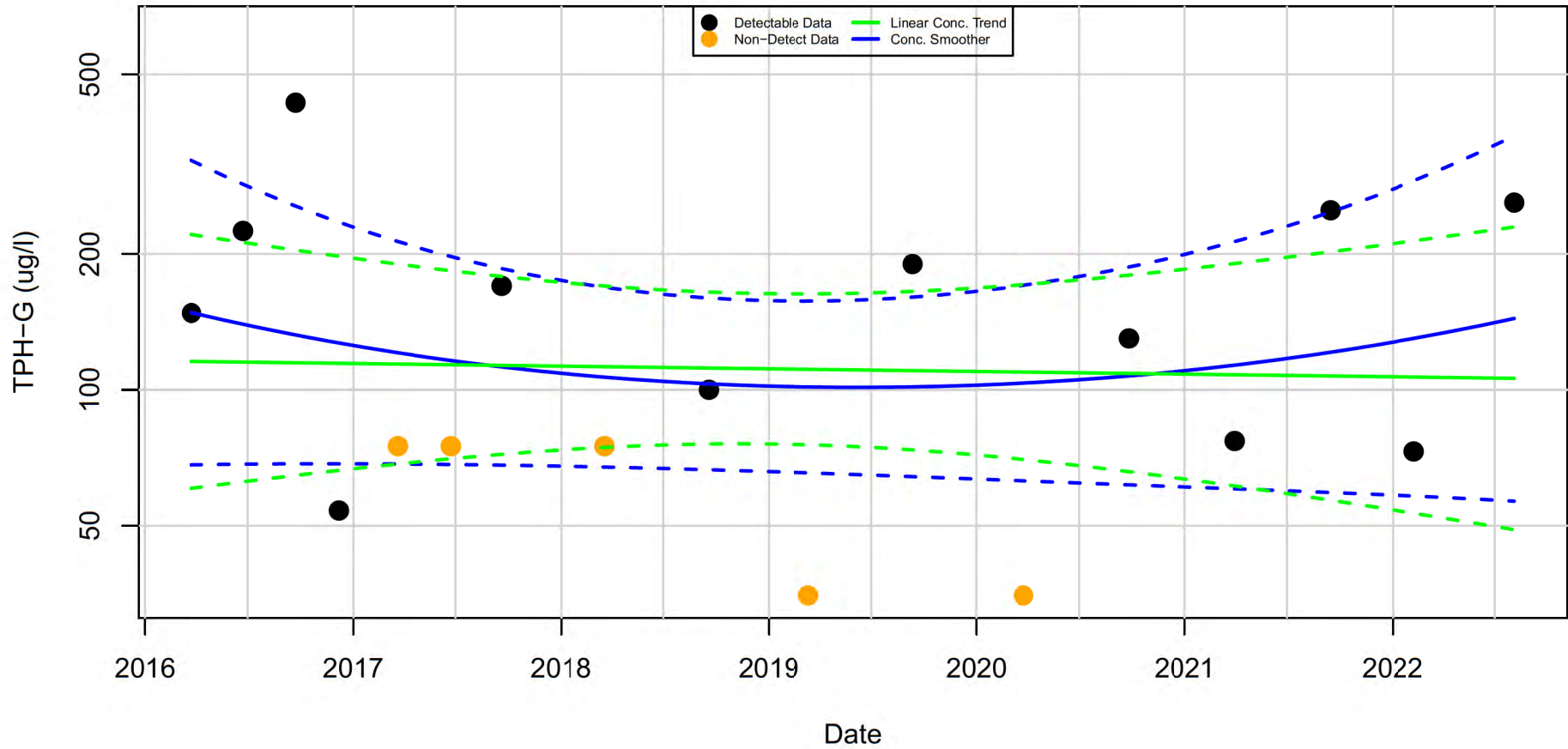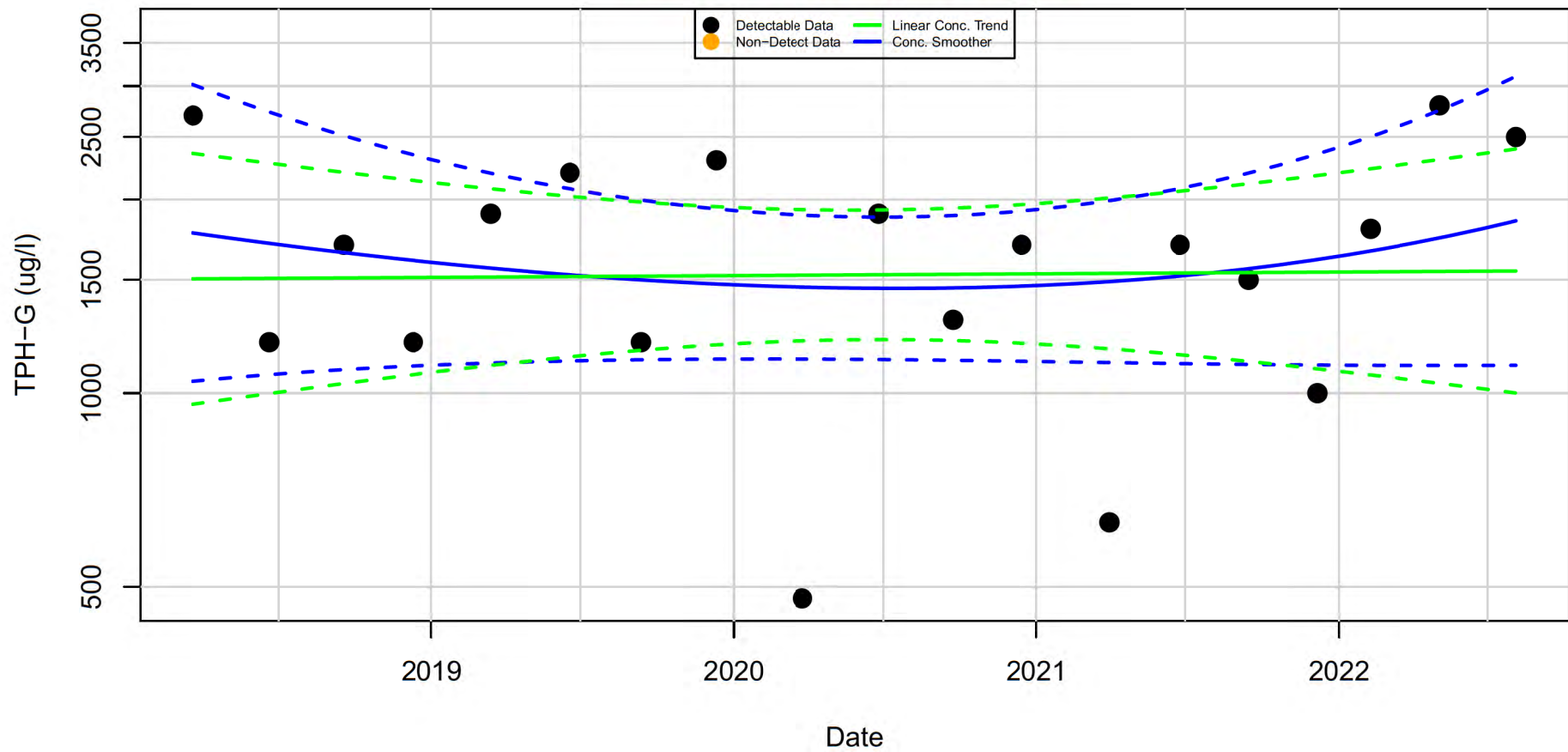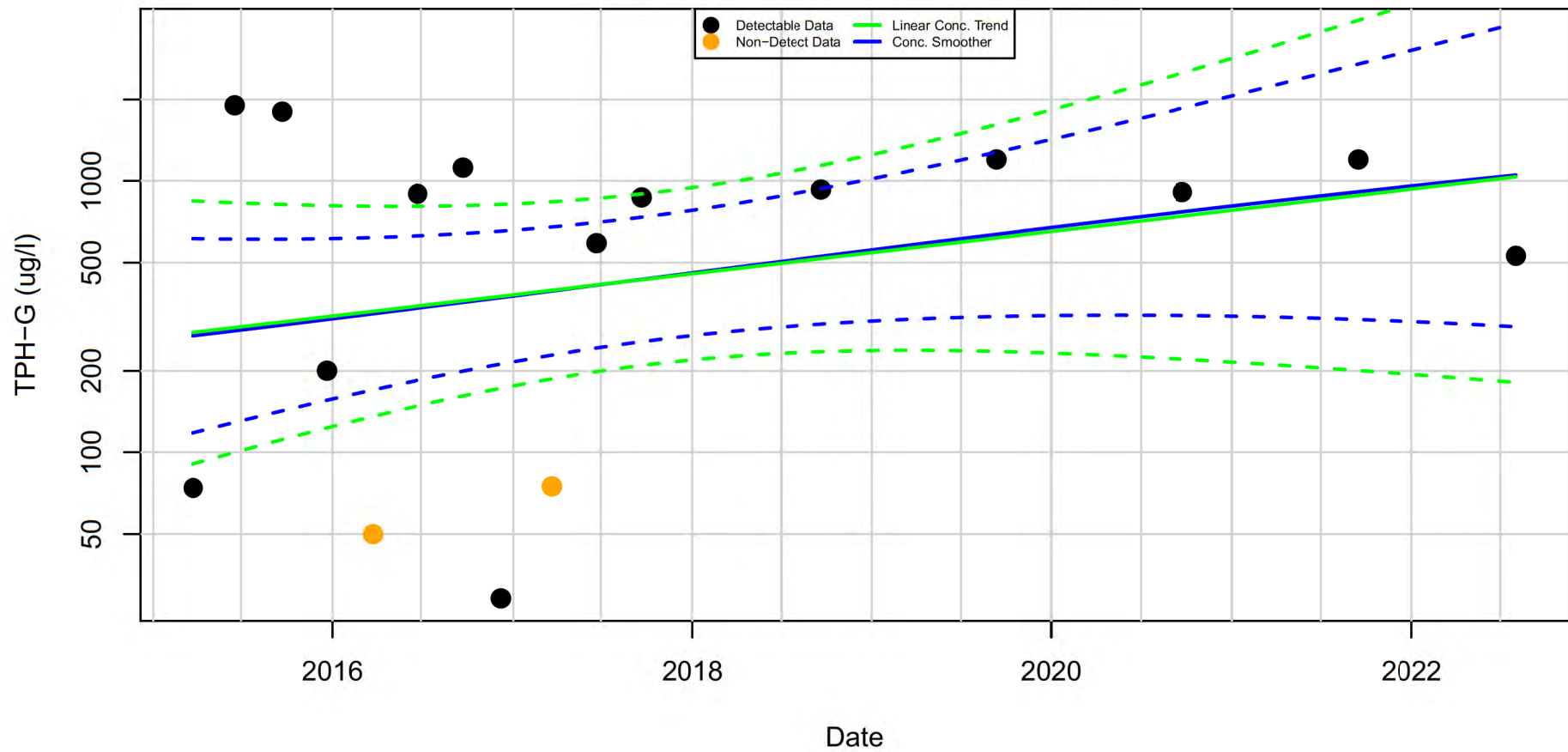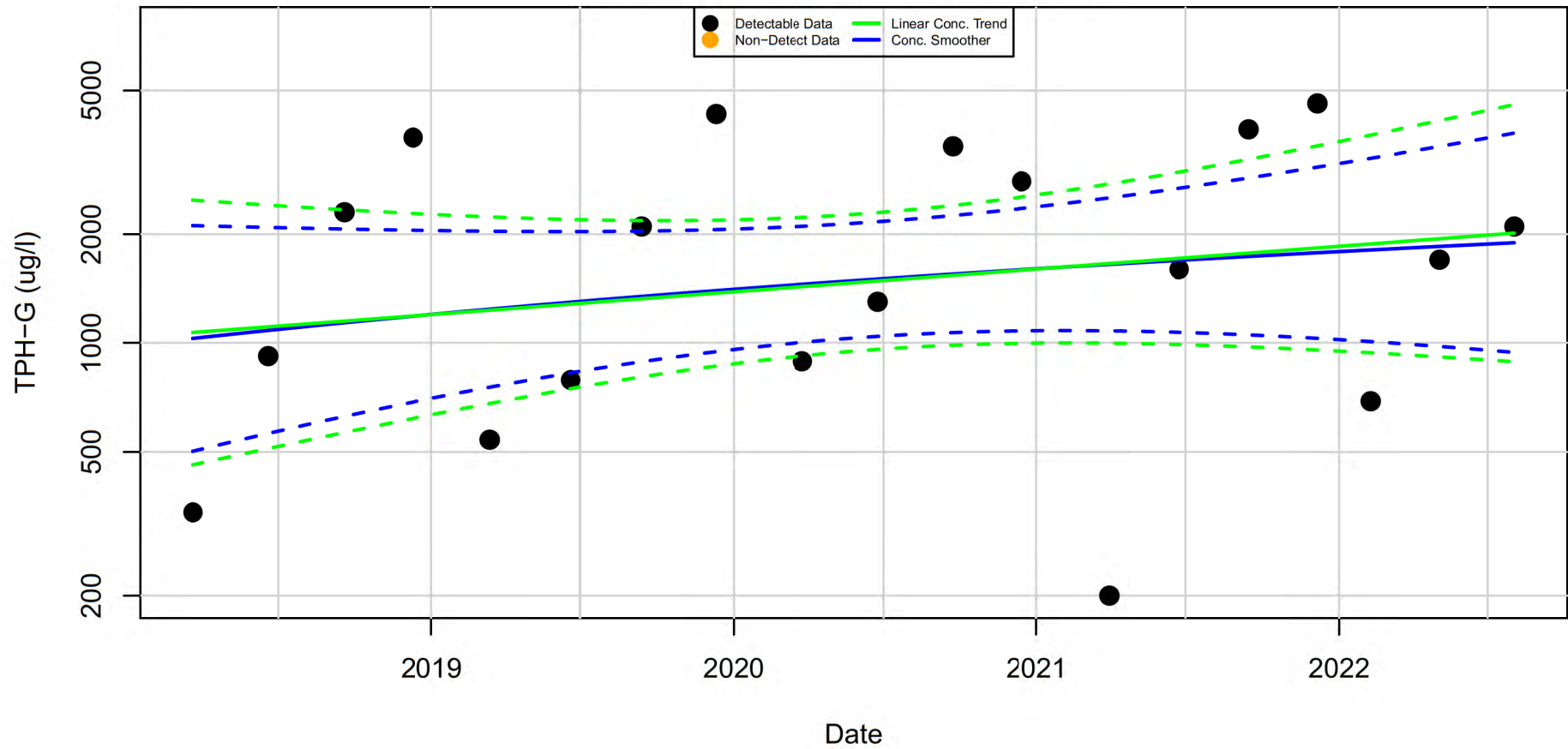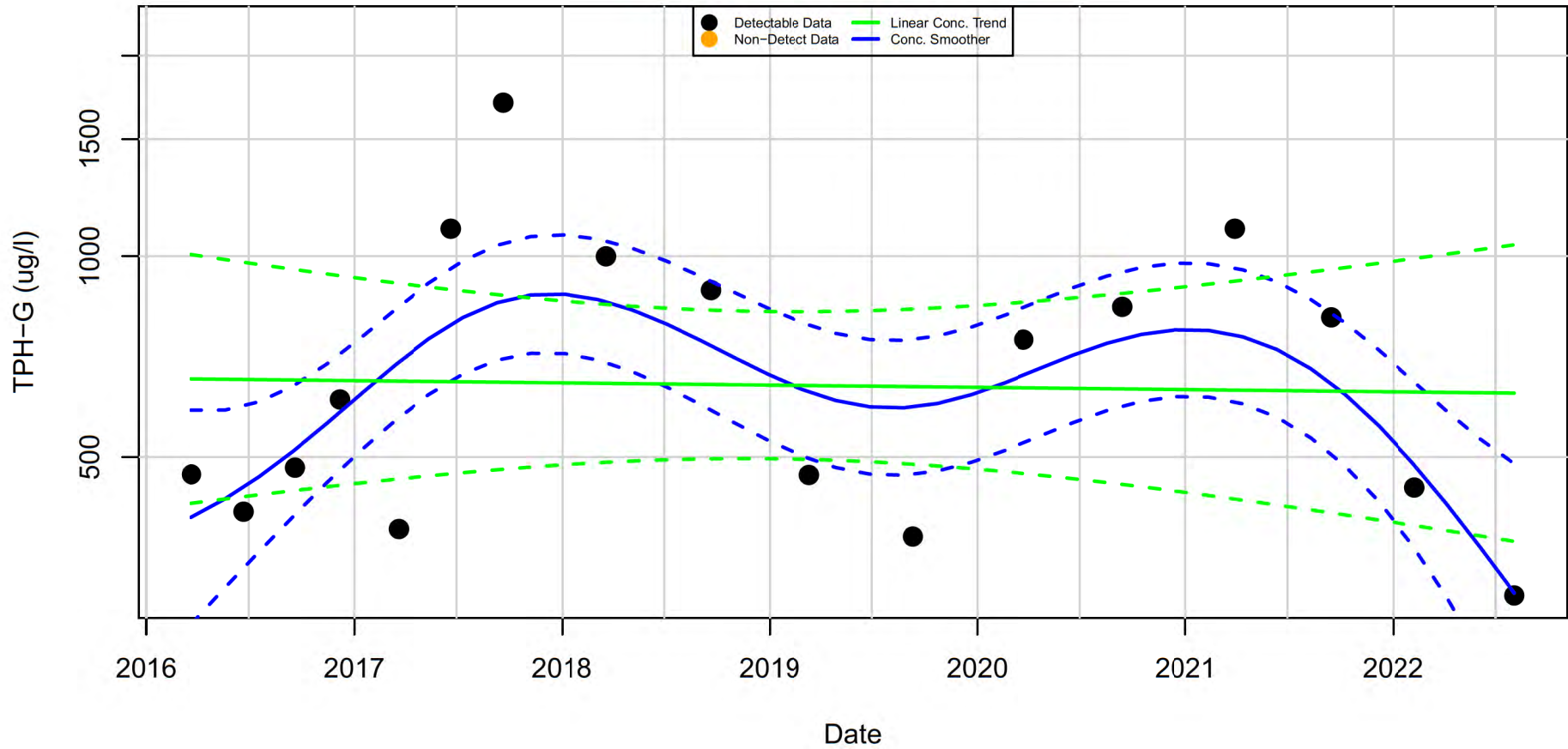**TPH-G in E-22 : Aquifer-Blank**

Mann-Kendall P.Value= 0.13; Half-Life= -1151 days

TPH−G in FW−3 : Aquifer−Blank

Mann−Kendall P.Value= 0.022; Half−Life> 5 Years

Legend:
- Detectable Data
- Non−Detect Data
- Linear Conc. Trend
- Conc. Smoother

Y-axis: TPH−G (ug/l)

X-axis: Date
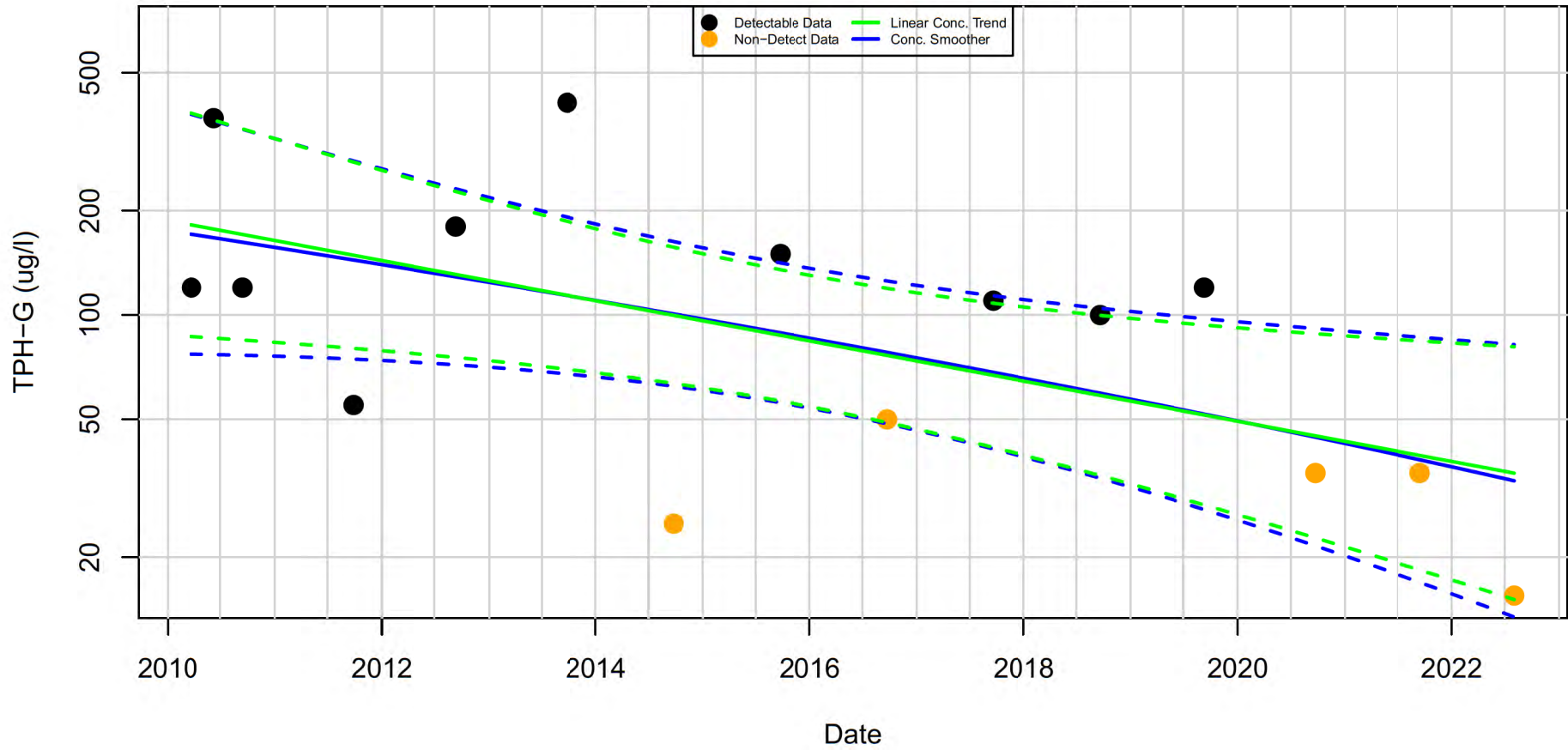
TPH−G in FW−4 : Aquifer−Blank

Mann−Kendall P.Value= 0.473; Half−Life> 5 Years

Legend:
- Detectable Data
- Non−Detect Data
- Linear Conc. Trend
- Conc. Smoother

Y-axis: TPH−G (ug/l)

X-axis: Date

TPH-G in FW-5R : Aquifer-Blank

Mann-Kendall P.Value= 0.183; Half-Life> −5 Years

TPH-G in FW-14 : Aquifer-Blank

TPH-G in FW-15 : Aquifer-Blank
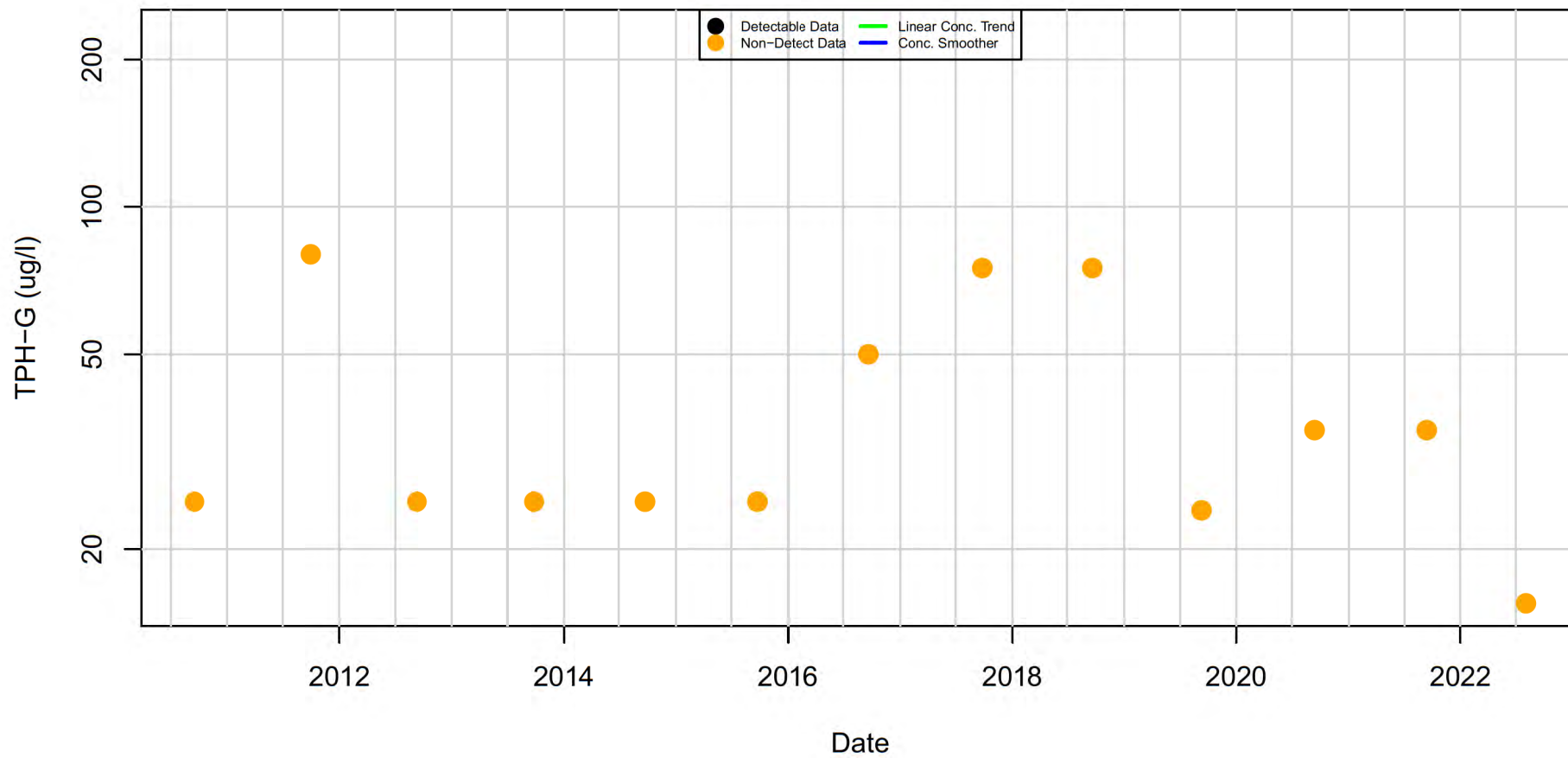
TPH-G in RR-1 : Aquifer-Blank

Mann-Kendall P.Value= 0.443; Half-Life> -5 Years

Legend:
- ● Detectable Data
- ● Non-Detect Data
- Linear Conc. Trend
- Conc. Smoother

Y-axis: TPH-G (ug/l)

X-axis: Date (2019, 2020, 2021, 2022)
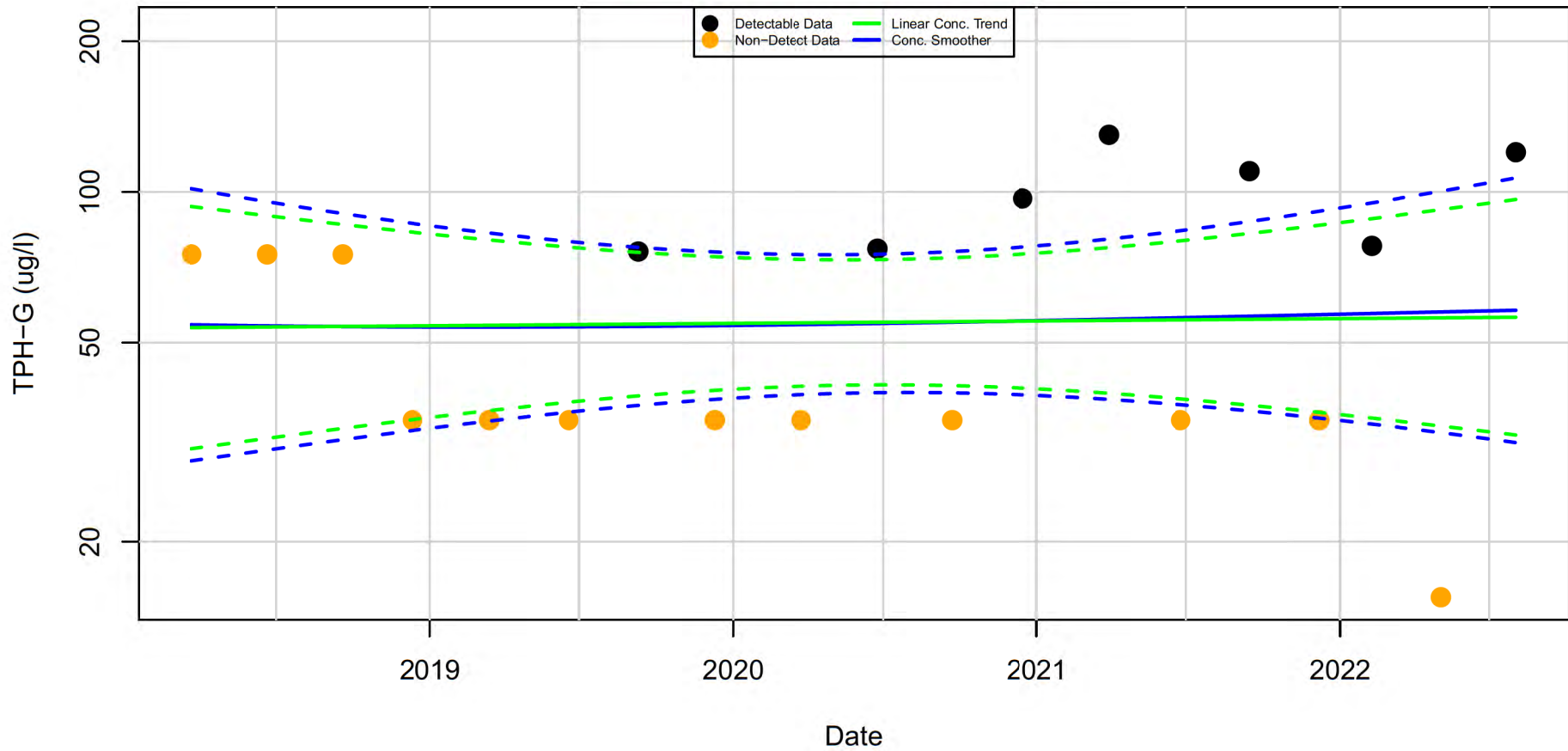
TPH−G in RR−2 : Aquifer−Blank

Mann−Kendall P.Value= 0.838; Half−Life> −5 Years

Legend:
- Detectable Data
- Non−Detect Data
- Linear Conc. Trend
- Conc. Smoother

Y-axis: TPH−G (ug/l)
X-axis: Date

X-axis labels: 2019, 2020, 2021, 2022
Y-axis labels: 50, 100, 200
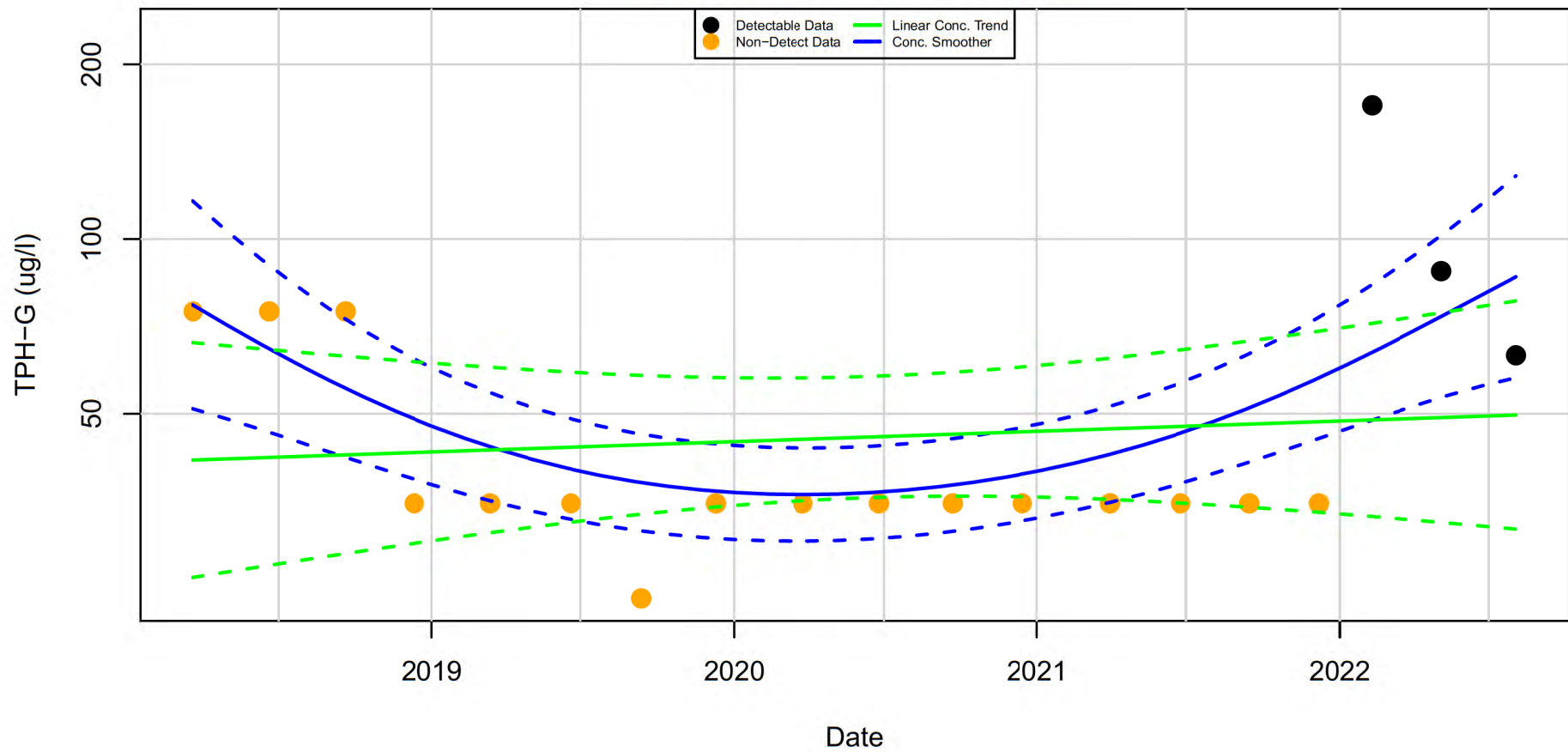
TPH-G in RR-3 : Aquifer-Blank

TPH−G in RR−4 : Aquifer−Blank
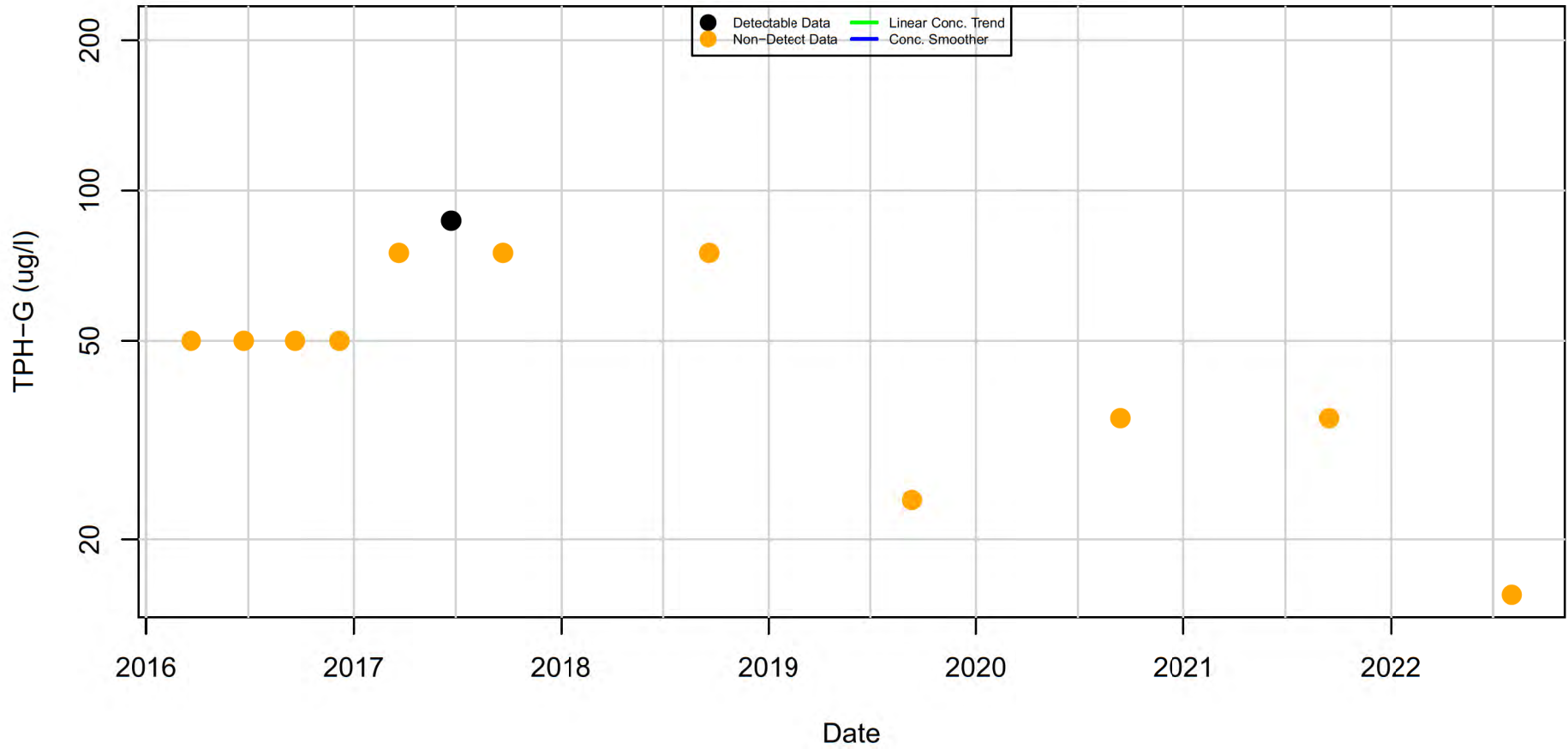
Mann−Kendall P.Value= 0.637; Half−Life> 5 Years
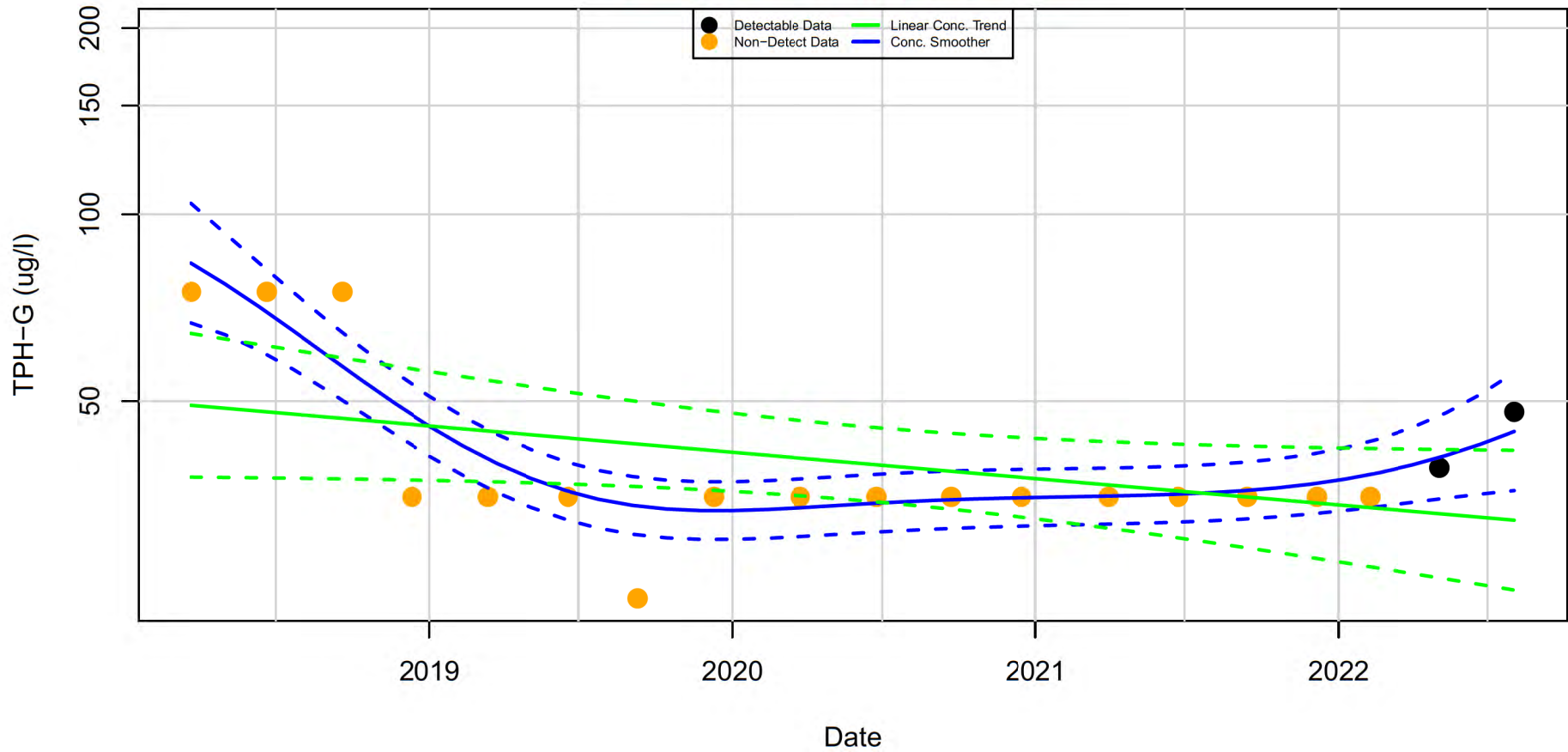
TPH-G in RR-5 : Aquifer-Blank
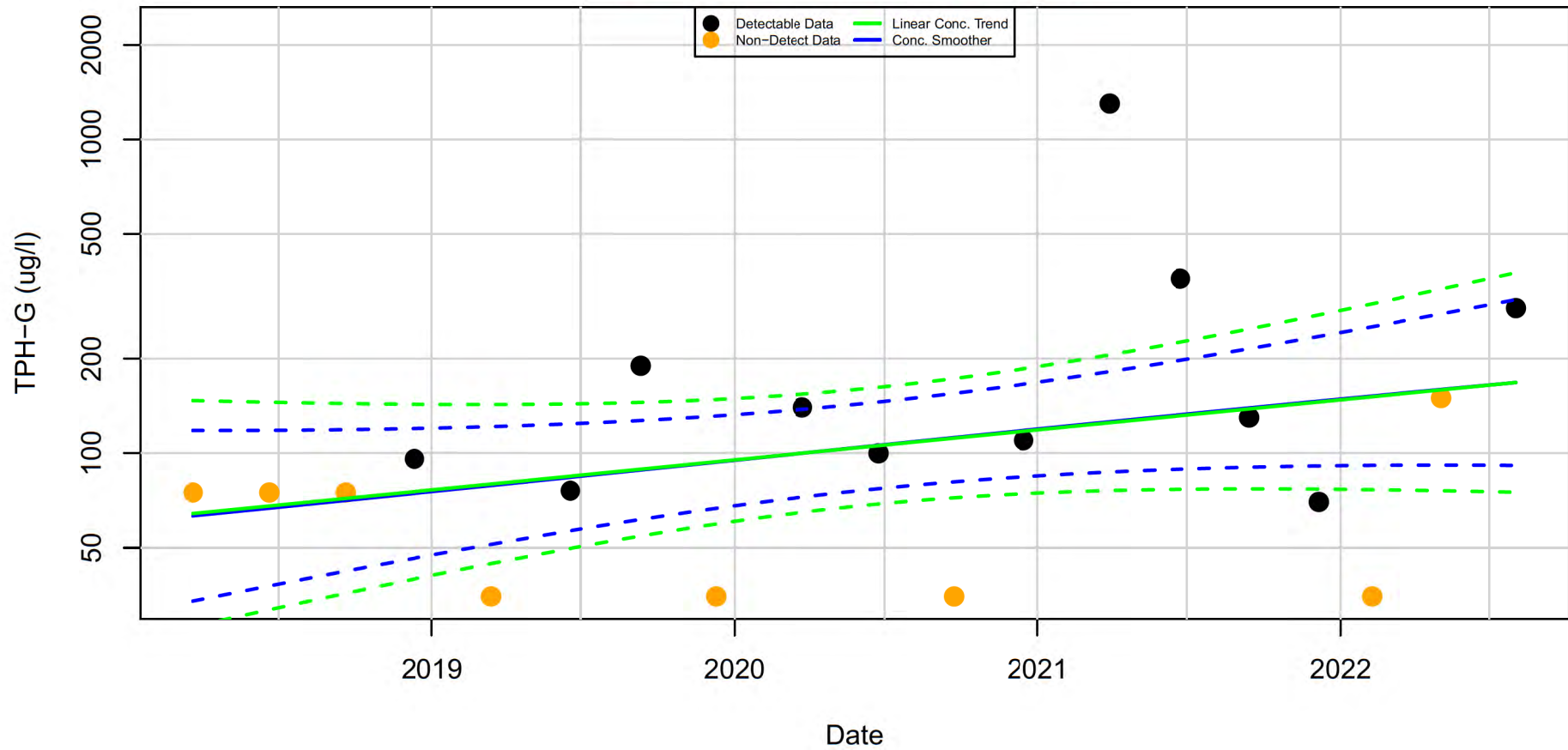
Mann-Kendall P.Value= 0.723; Half-Life> 5 Years
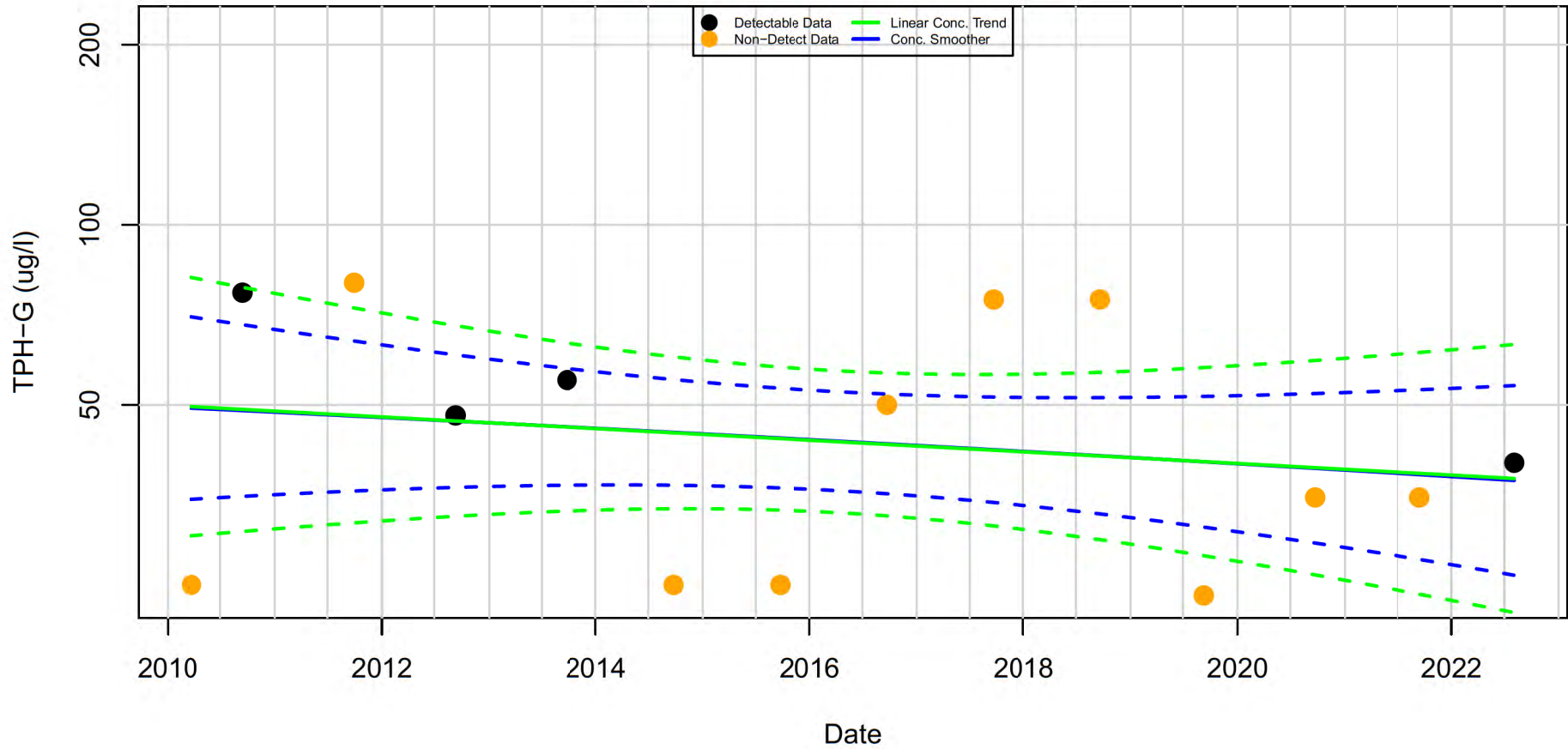
TPH−G in T−2 : Aquifer−Blank
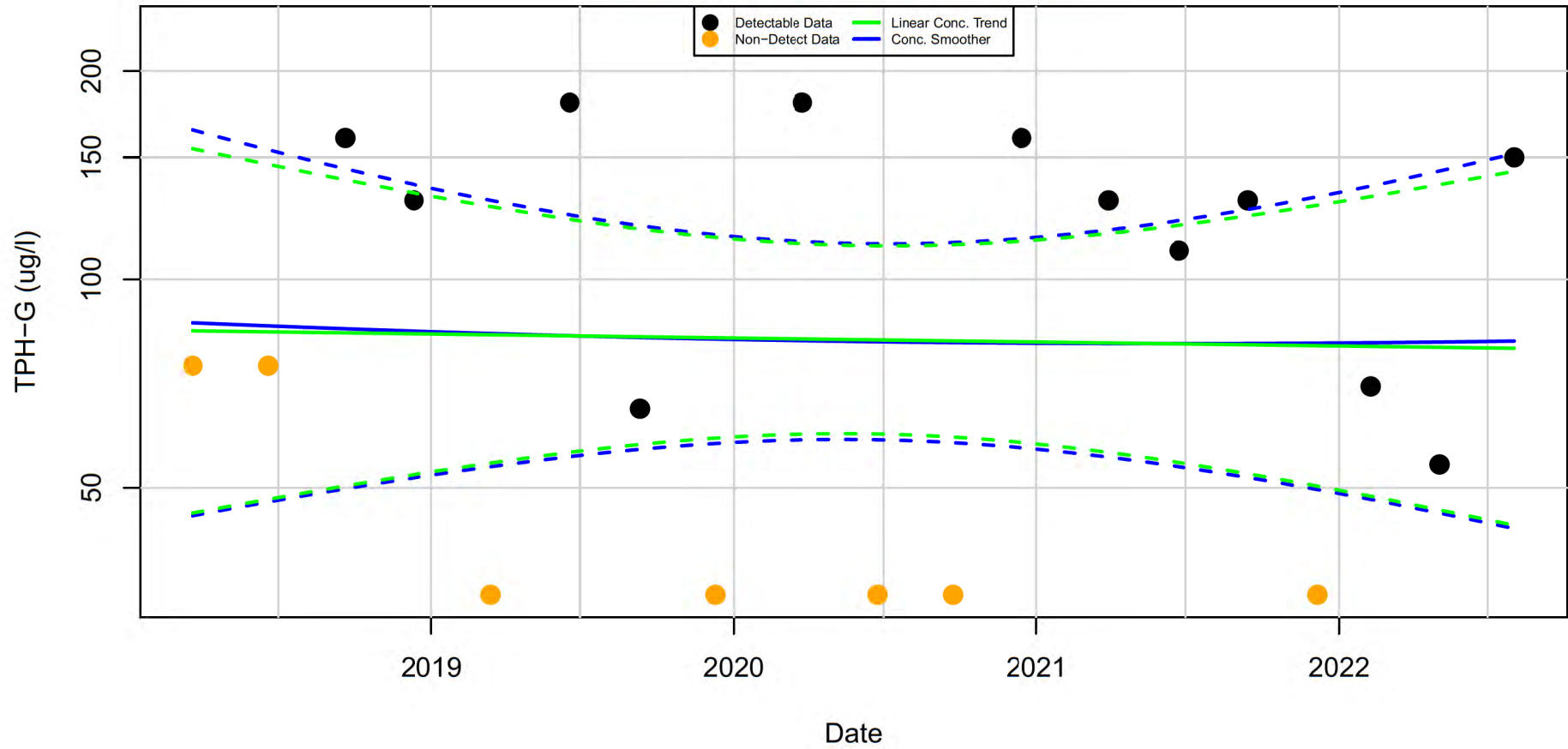
Mann−Kendall P.Value= 0.801; Half−Life> −5 Years

TPH-G in DMW-1 : Aquifer-Blank

Mann-Kendall P.Value= 0.267; Half-Life> 5 Years

● Detectable Data	━ Linear Conc. Trend
● Non-Detect Data	━ Conc. Smoother

TPH-G (ug/l)

Date

TPH-G in DMW-2 : Aquifer-Blank

Mann-Kendall P.Value= 0.0871; Half-Life= 918 days

TPH-G in DMW-3 : Aquifer-Blank

Mann-Kendall P.Value= <0.01; Half-Life= -814 days

TPH-G in DMW-4 : Aquifer-Blank

Mann-Kendall P.Value= 0.117; Half-Life= 1423 days

TPH-G in FW-13 : Aquifer-Blank
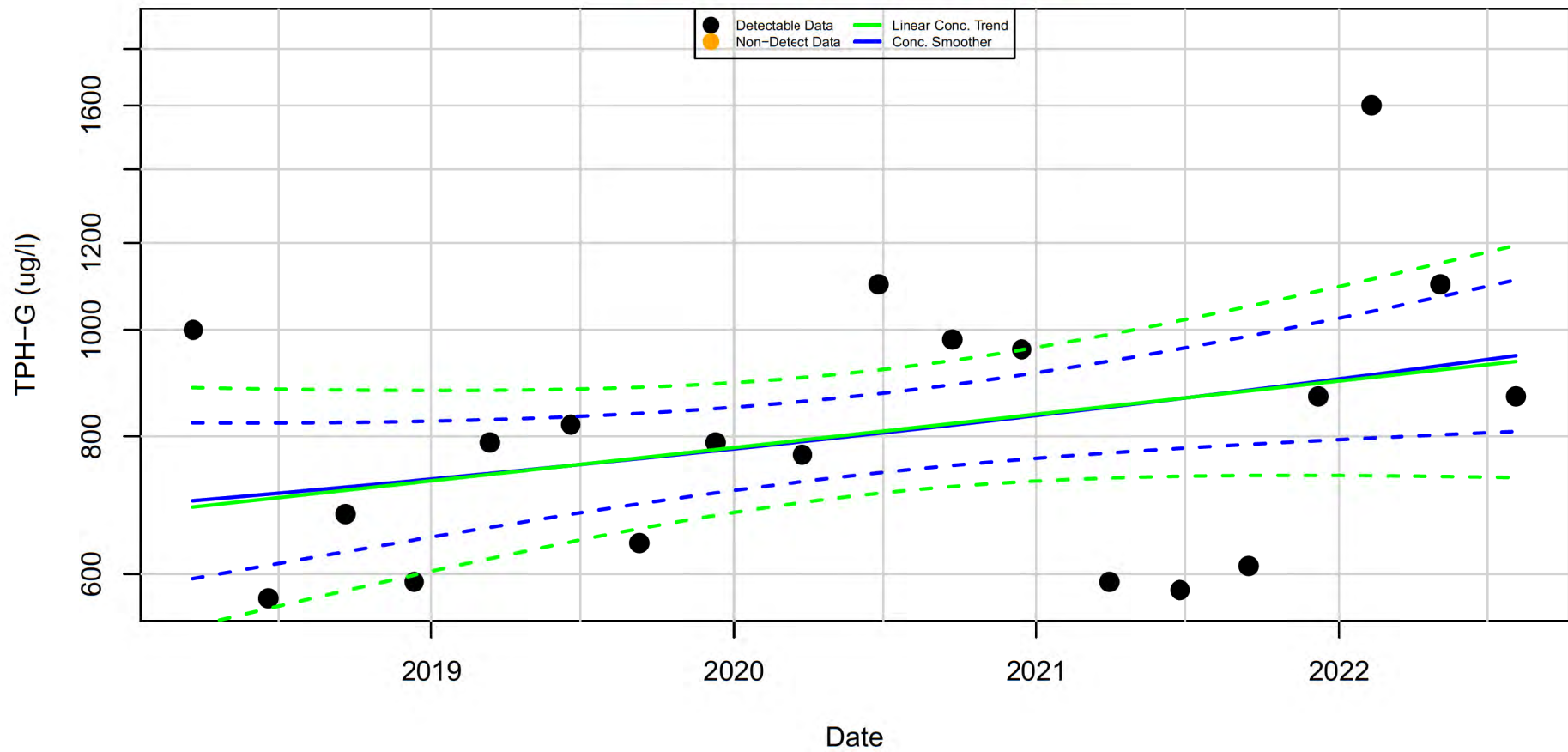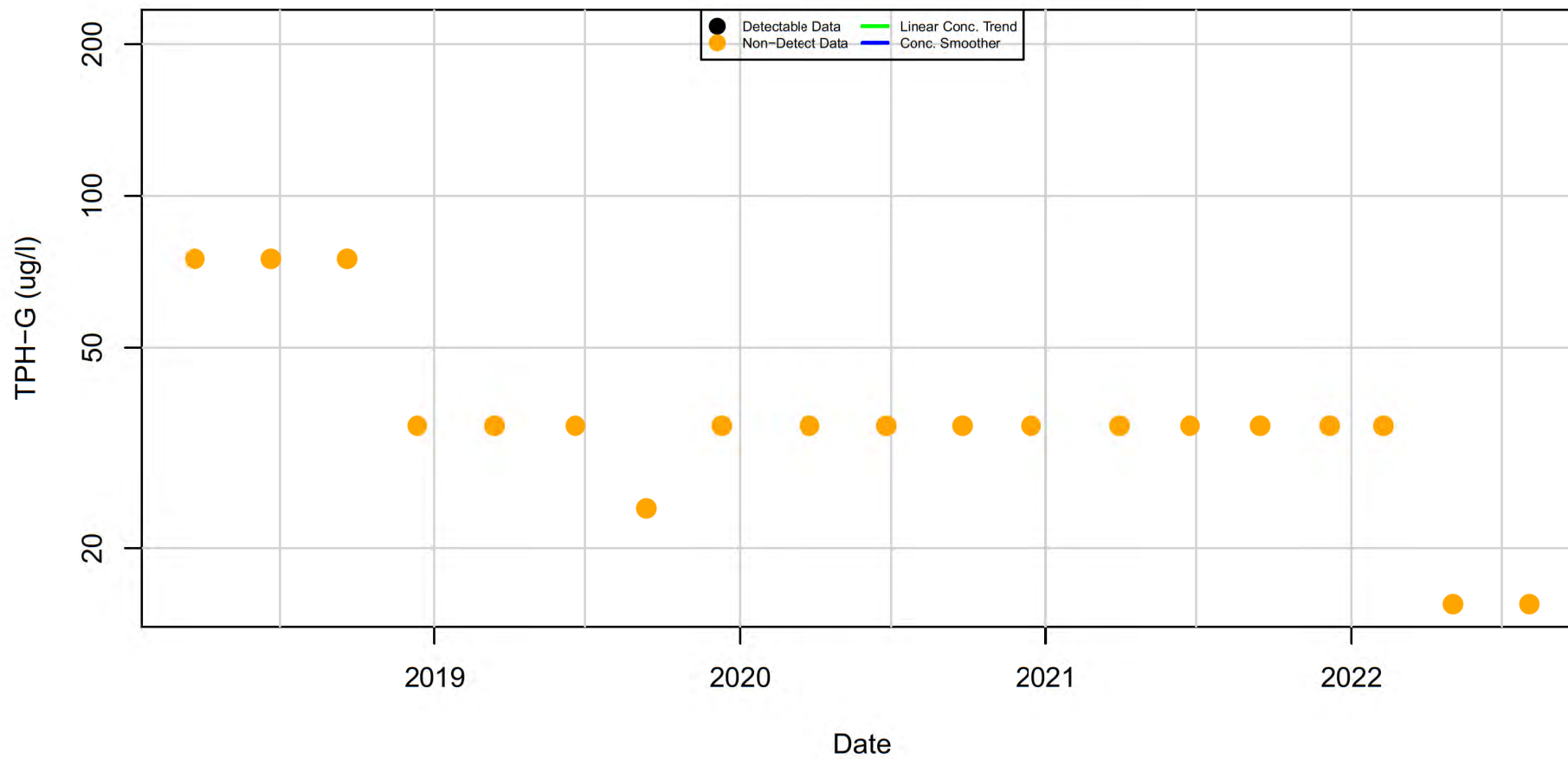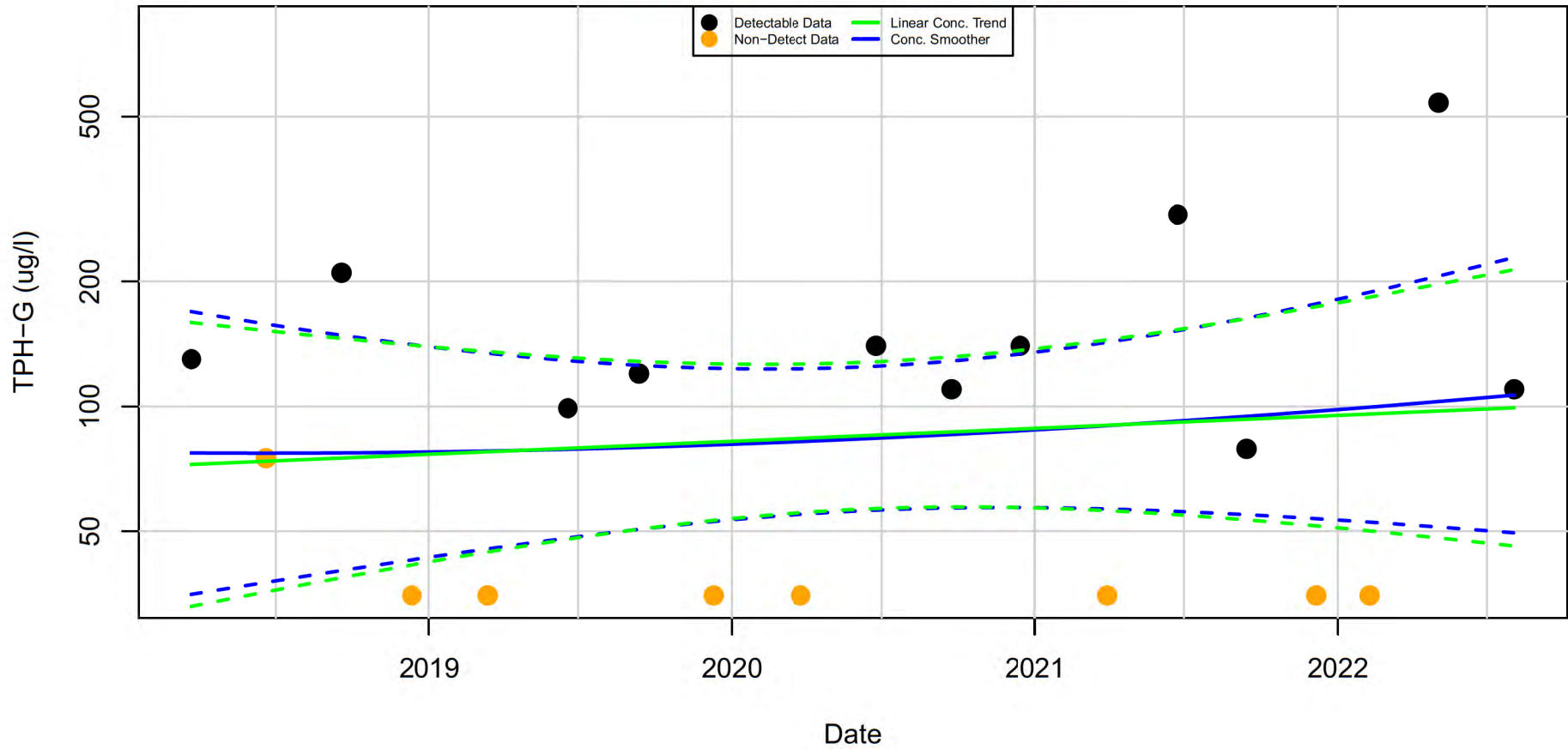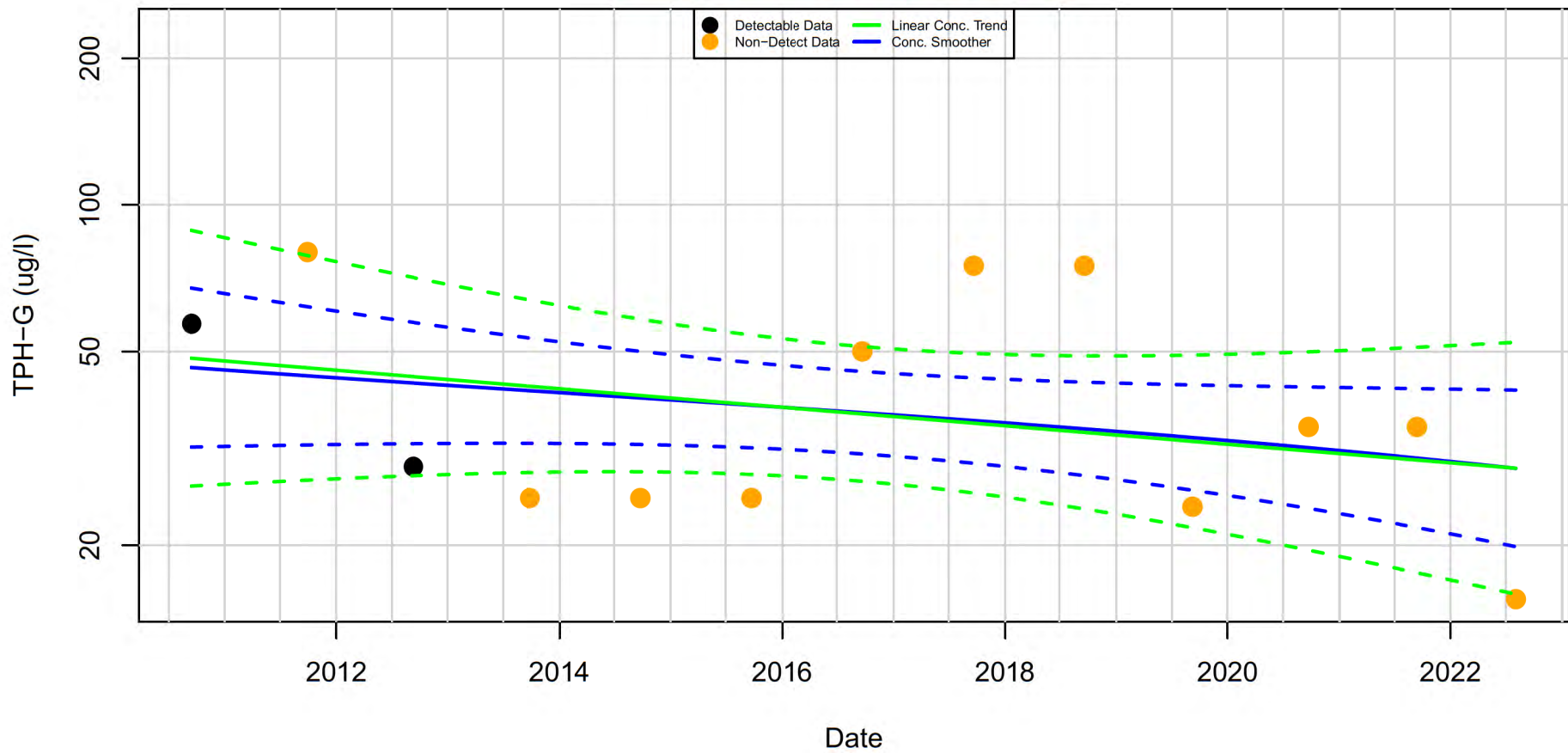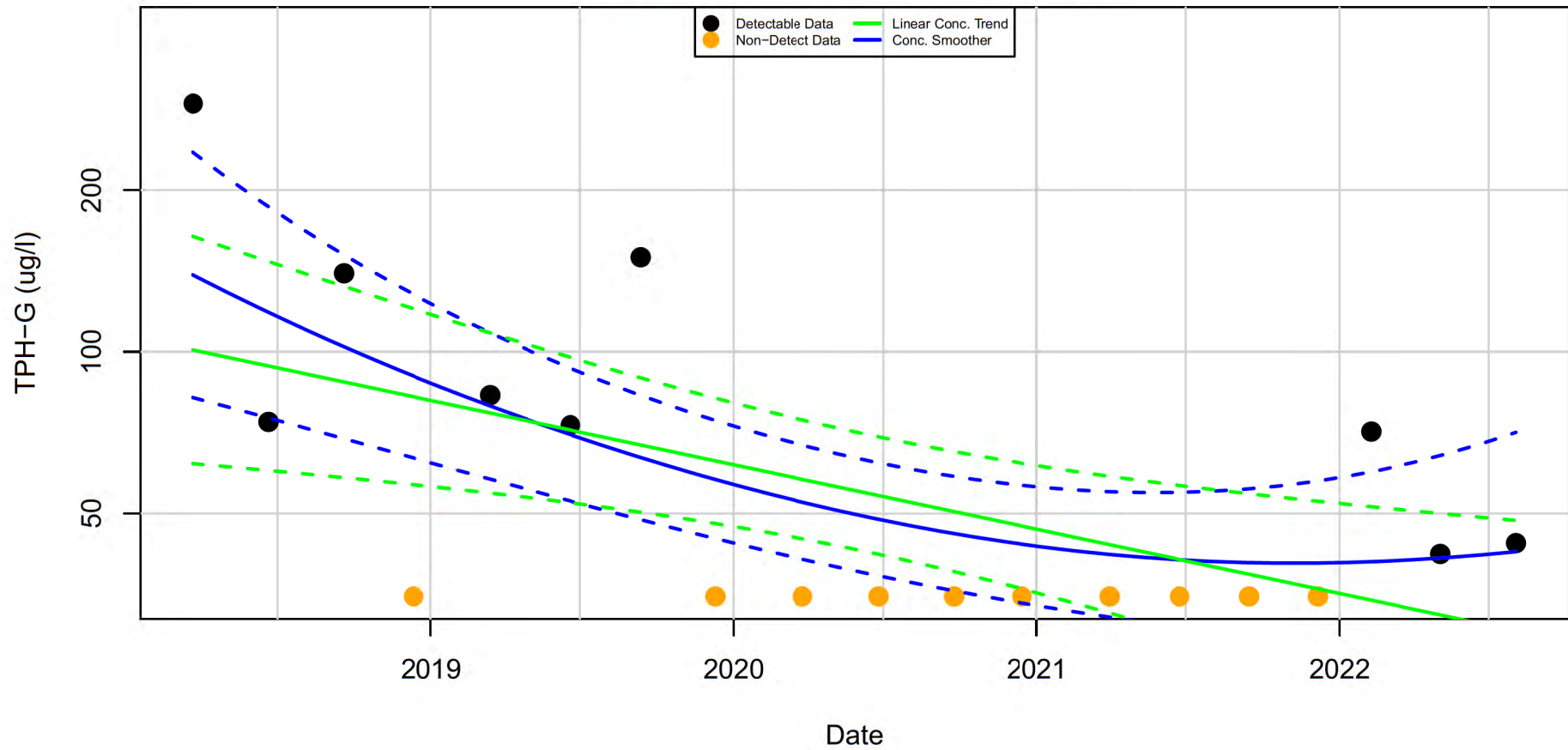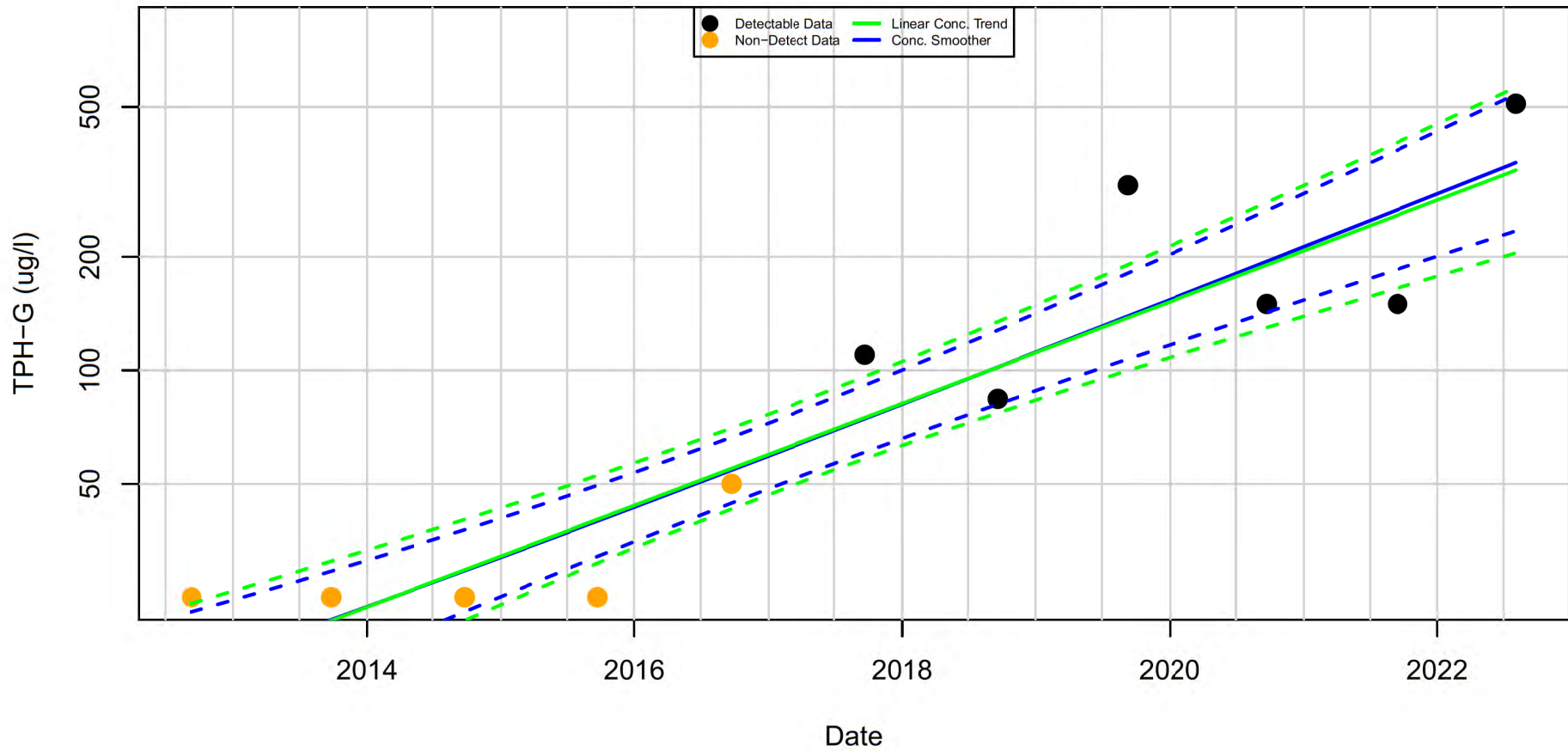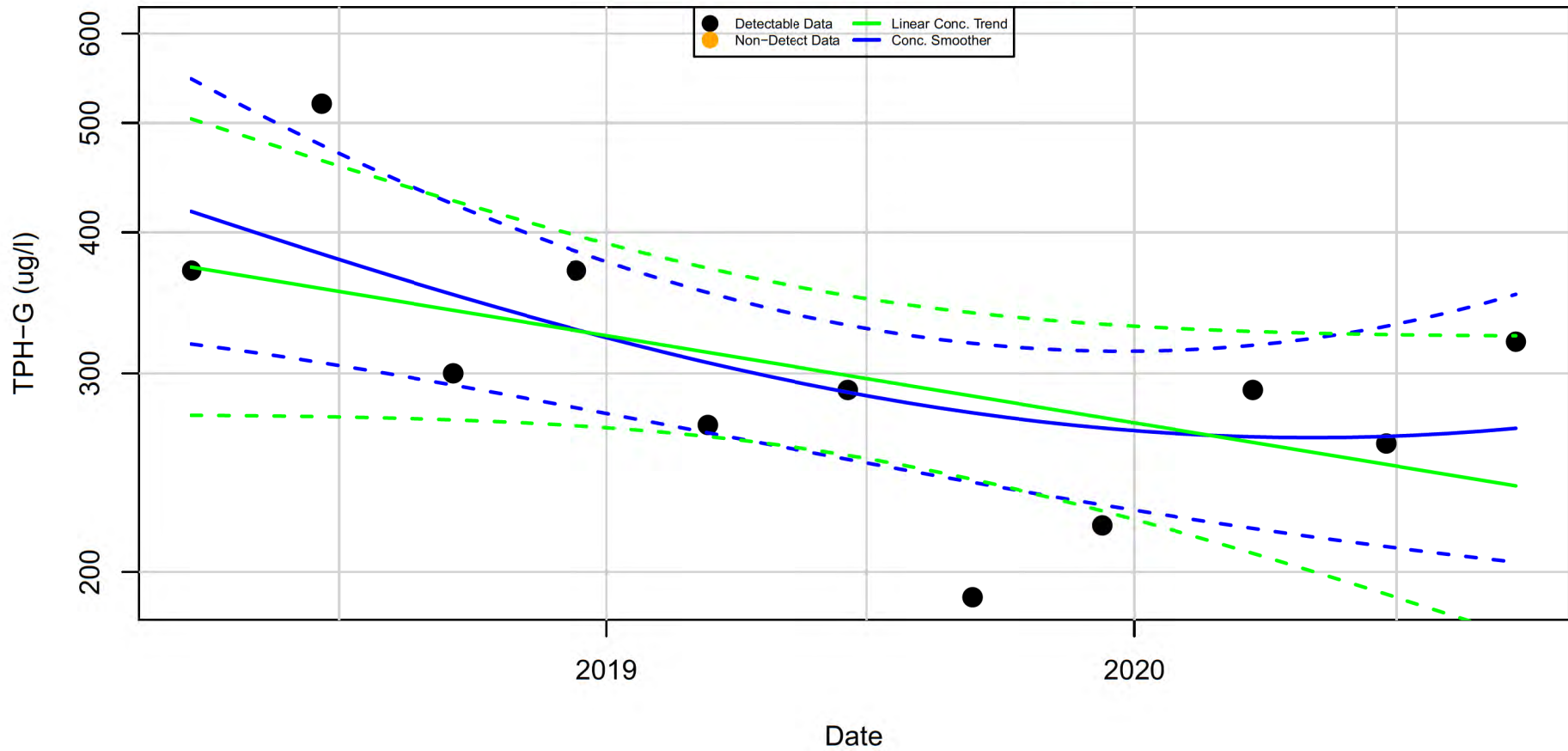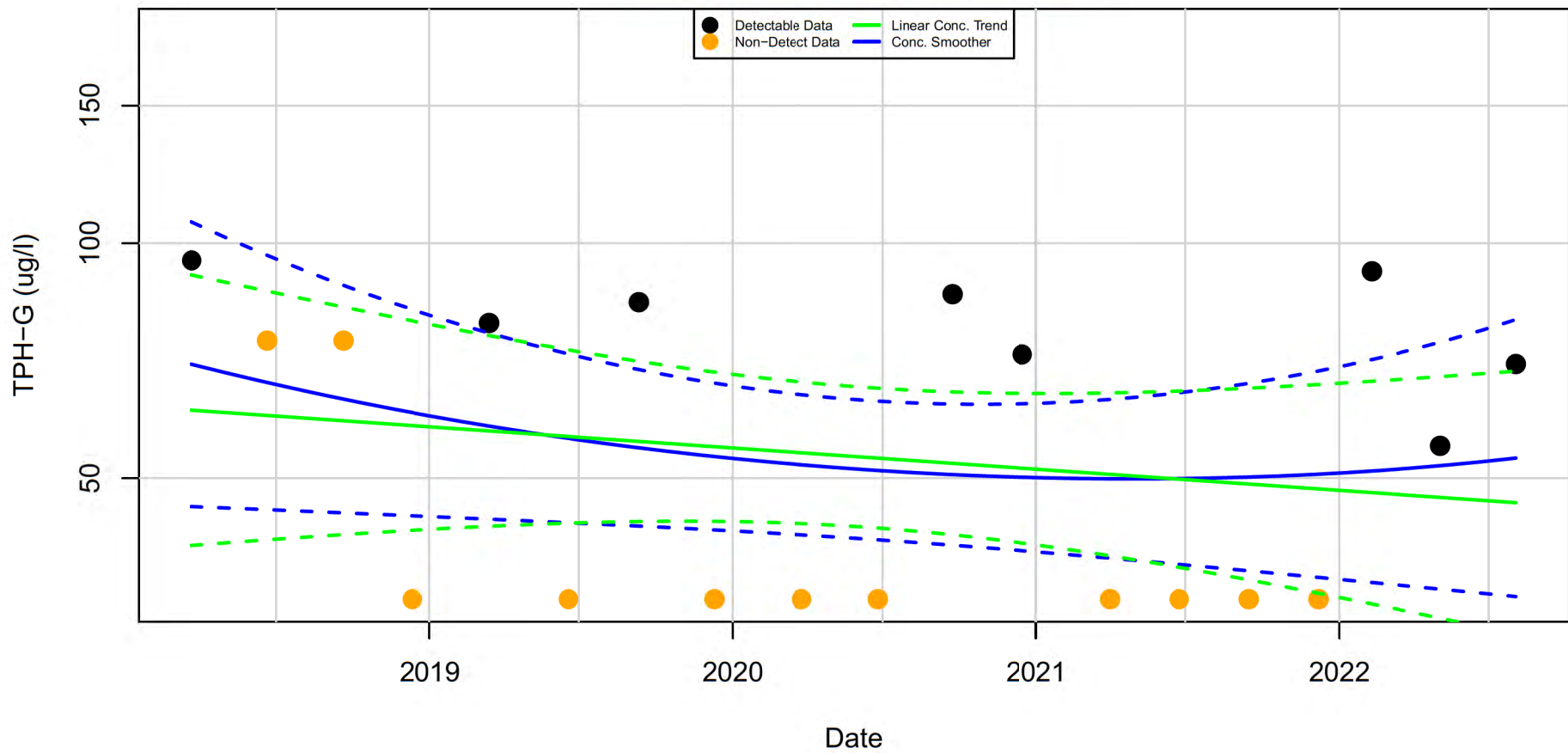
Mann-Kendall P.Value= 0.435; Half-Life> 5 Years

Legend:
- Detectable Data
- Non-Detect Data
- Linear Conc. Trend
- Conc. Smoother

Y-axis: TPH-G (ug/l)

X-axis: Date (2019, 2020, 2021, 2022)

Appendix E

Restoration Time Frame Results

Module 2: Temporal Analysis: Concentration of contaminant vs. time (Regression Analysis at each well)

Site Name: *D Street Petroleum Site*
Site Address: *Tacoma, WA*
Additional Description: *0*
Hazardous Substance *Benzene*

1. Level of Confidence (Decision Criteria)?   **85%**

2. Prediction: Calculation of Restoration Time and Predicted Concentration at Wells

Well Location		HC-111	G-18	B-34	RR-2	RR-3	B-25	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
A. Cleanup Level (Criterion) to be achieved?	ug/L	160	160	160	40	40	160										
A.1 Average (@50% CL[1] best-fitting values)																	
Time to reach the criterion	yr	0.69	NA	1.45	-17.20	-13.77	1.79	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Date when the Criterion to be achieved	date	8/19/18	NA	5/26/19	10/5/00	3/9/04	9/26/19	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
A.2 Boundary (@85% CL)																	
Time to reach the criterion[2]	yr	0.79	NA	1.79	-22.71	-24.60	3.00	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Date when the Criterion to be achieved	date	9/25/18	NA	9/28/19	4/1/95	5/14/93	12/12/20	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B Date of Prediction?	date	7/22/20	7/22/20	7/22/20													
B.1 Average conc predicted (@50% CL)	ug/L	59.52	NA	80.77	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B.2 Boundary conc predicted (@85% CL)	ug/L	70.81	NA	108.21	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

3. Log-Linear Regression Results

		HC-111	G-18	B-34	RR-2	RR-3	B-25	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Coefficient of Determination	r^2	0.790	0.003	0.637	0.517	0.709	0.292	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Correlation Coefficient	r	-0.889	0.054	-0.798	-0.719	-0.842	-0.540	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Number of data points	n	20	10	20	20	5	19	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

4. Statistical Inference on the Slope of the Log-Linear Regression Line with t-statistics

	HC-111	G-18	B-34	RR-2	RR-3	B-25	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
One-tailed Confidence Level calculated, %	100.000%	11.729%	99.998%	99.964%	92.635%	98.298%	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sufficient evidence to support that the slope of the regression line is significantly different from zero?	YES!	NO!	YES!	YES!	YES!	YES!	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Coefficient of Variation?	NA	0.615	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Plume Stability?	Shrinking	Stable	Shrinking	Shrinking	Shrinking	Shrinking	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

5. Calculation of Point Decay Rate Constant (k_{point})

			HC-111	G-18	B-34	RR-2	RR-3	B-25	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Slope: Point decay rate constant (k_{point})	@50% CL	yr⁻¹	0.514	0.028	0.591	0.294	0.345	0.370	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	@85% CL	yr⁻¹	0.447	NA	0.479	0.223	0.193	0.220	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Half Life for (k_{point})	@50% CL	yr	1.350	24.494	1.173	2.358	2.011	1.876	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	@85% CL	yr	1.551	NA	1.447	3.115	3.592	3.144	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Note: 1. CL : Confidence Level; UD= Undetermined

    2. The length of time that will actually be required is estimated to be no more
    than years calculated (@ 85% of confidence level.)