



Forensic Isotope Investigation Distinguishes Petroleum Sources in Groundwater

Site Type: Petroleum-impacted soil and groundwater in Ontario

Project Type: DIC isotope analysis and compound-specific isotope analysis (CSIA)

PROJECT SUMMARY

Location: Ontario

Client: Confidential

Contaminants: Petroleum hydrocarbons (BTEX; F1 and F2 fractions)

Project Practice Area: Environmental forensics and petroleum source attribution

Services Provided: Isotope interpretation and remote technical support

Our Contribution:

- Evaluated whether groundwater impacts were consistent with two petroleum releases.
- Interpreted DIC isotope data from eight monitoring wells alongside historical hydrocarbon records.
- Used CSIA for ethylbenzene and xylene isomers at two wells.

Highlights:

Eight monitoring wells sampled

Two distinct well groups identified

Natural DIC baseline estimated at approximately -17‰
CSIA signatures at MW-2 and MW-13 consistent with a common petroleum source

Site Description and Challenge

A historical petroleum hydrocarbon release affected soil and groundwater at an Ontario site. A second release was suspected within the area of the original impact. Because extensive biodegradation had occurred, conventional concentration data alone could not readily distinguish the potential releases. The investigation sought independent isotopic evidence of separate petroleum sources.

Tersus Approach

Groundwater was sampled on June 30 and July 1, 2026 from MW-2, MW-3, MW-4, MW-7, MW-13, MW-18M, MW-19M, and MW-19S. The consulting team collected samples with remote technical support from Tersus. Analyses included $\delta^{13}\text{C}$ of

dissolved inorganic carbon (DIC), BTEX, and petroleum hydrocarbon fractions F1 (C₆–C₁₀) and F2 (C₁₀–C₁₆). CSIA of ethylbenzene, m,p-xylene, and o-xylene was feasible in MW-2 and MW-13.

Tersus integrated isotope signatures with historical petroleum concentrations and well locations to evaluate whether spatially distinct signatures supported separate release events.

Results and Interpretation

DIC isotope interpretation distinguished Group A (MW-3, MW-4, MW-7, MW-18M, MW-19M, and MW-19S) from Group B (MW-2 and MW-13). Group B formed a small contiguous area within the broader Group A impact, consistent with a second petroleum source. The estimated natural DIC isotopic composition was approximately –17‰, a reasonable regional background value.

CSIA was possible only for Group B wells. Ethylbenzene and xylene isotope compositions were consistent with a common petroleum source affecting MW-2 and MW-13. These lines of evidence supported the interpretation of two petroleum impacts, rather than proving the timing or identity of individual releases.

Project Value and Conclusions

The forensic investigation provided additional source-attribution evidence to complement existing site characterization. Distinguishing the broad historical impact from the localized second signature can inform subsequent investigation, responsibility discussions, and remediation planning. The report does not quantify cost savings, establish regulatory closure, or document any completed remedial action.

Original Site Maps, Charts and Analytical Tables

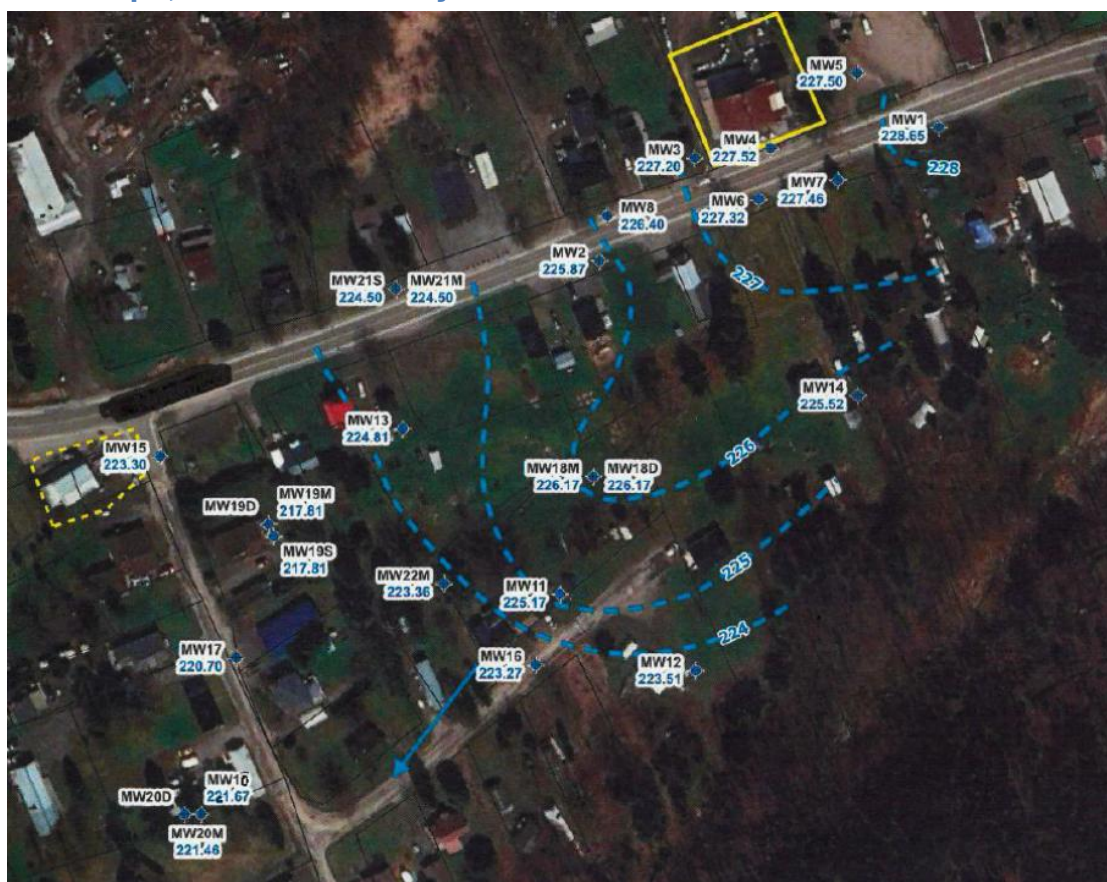


Figure 1. Original site map showing monitoring wells and groundwater elevation contours.

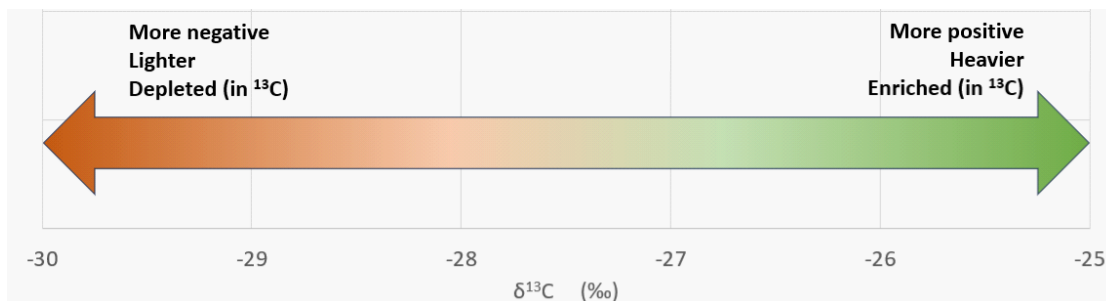


Figure 2. Original isotope composition reference graphic.

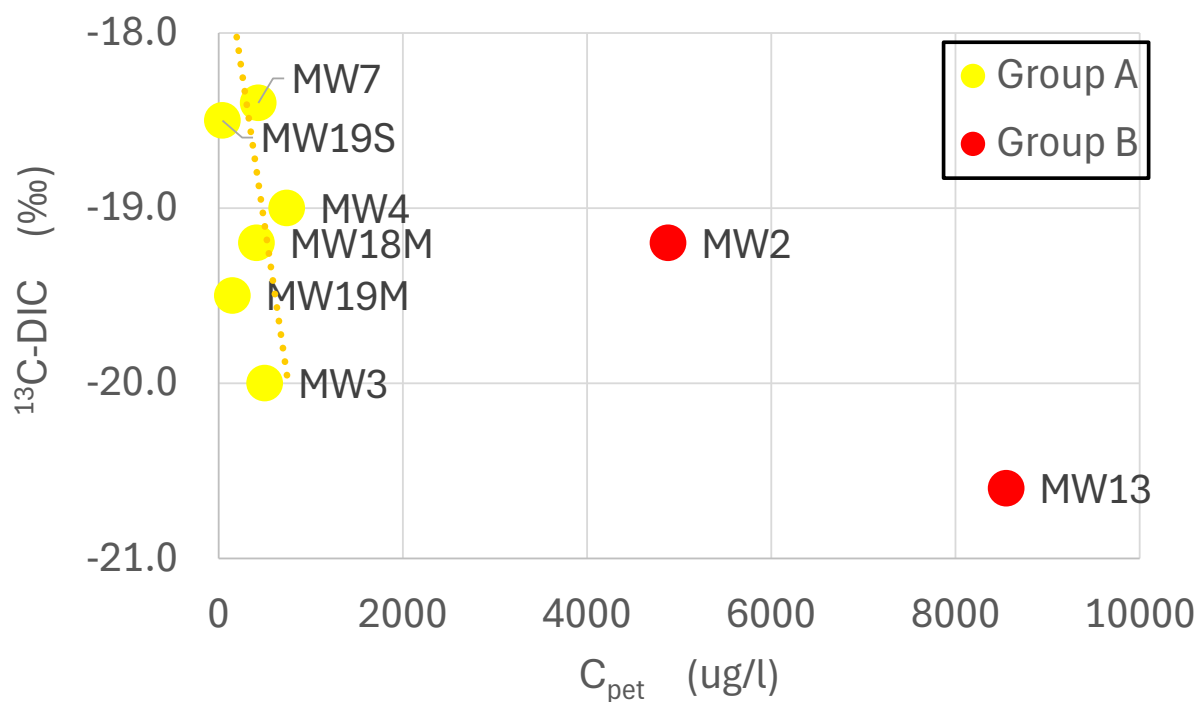


Figure 3. Relationship between carbon isotope ratios of dissolved inorganic carbon ($\delta^{13}\text{C-DIC}$) and petroleum hydrocarbon concentrations, showing two distinct monitoring well groups consistent with separate petroleum impacts.



Figure 4. Original site map showing isotope-based well groups.

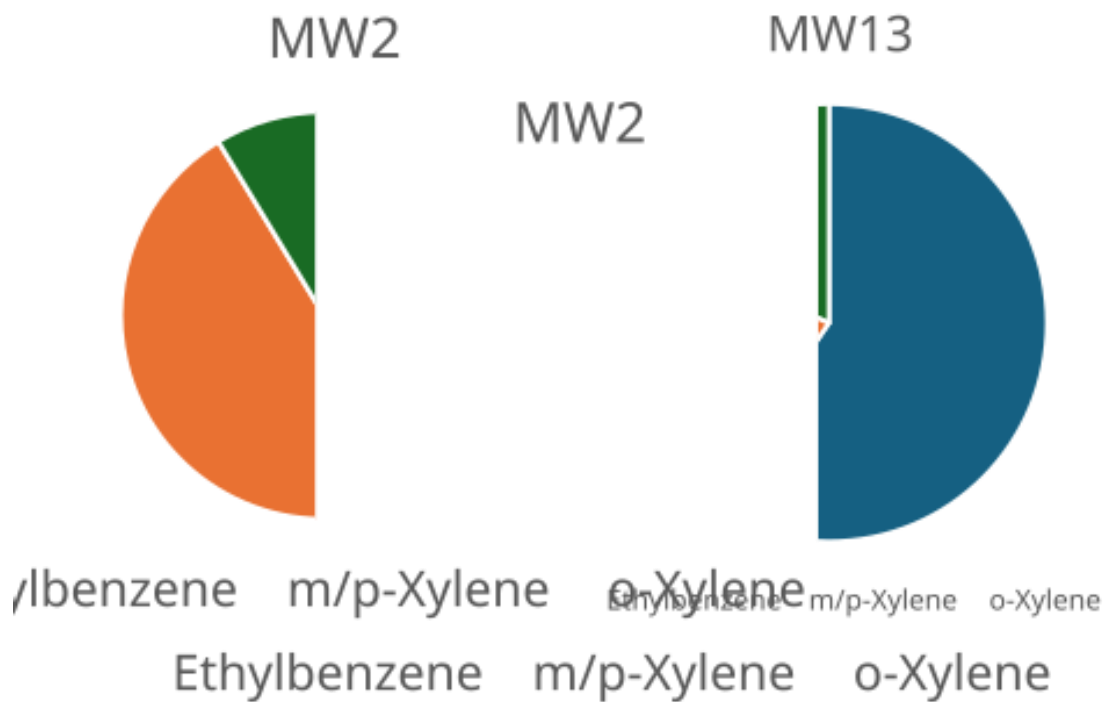


Figure 5. Original relative concentration comparison for ethylbenzene and xylenes.

Table 1. Typical natural DIC carbon sources

CO2 type	δ range (‰)	Comment
atmospheric	-7 to -12	
C3 plants	-20 to -30	makes up ~95% of plant matter
C4 plants	-5 to -18	more prevalent in hotter areas

Table 2. DIC and historical petroleum hydrocarbon results

	DIC	Max(F1+F2)	Max Date	Current F1+F2 (date)	Cpet
MW2	-19.2	5800	5/24/2023	920 (10/28/2025)	4880
MW13	-20.6	8790	5/4/2010	240 (10/28/2025)	8550
MW4	-19.0	740	5/7/2010	<200 (10/28/2025)	740
MW7	-18.4	430	9/2/2009	<200 (3/7/2025)	430
MW3	-20.0	500	9/2/2009	<200 (10/28/2025)	500
MW18M	-19.2	410	11/30/2011	<200 (10/28/2025)	410
MW19S	-18.5	41	10/29/2014	<200 (10/28/2025)	41
MW19M	-19.5	150	10/12/2023	<200 (10/22/2025)	150

Table 3. CSIA results for MW-2 and MW-13

	Ethylbenzene	Ethylbenzene	m/p-Xylene	m/p-Xylene	o-Xylene	o-Xylene
MW	Conc.	δ	Conc.	δ	Conc.	δ
MW2	100	-27.7	330.0	-28.4	41.0	-24.9
MW13	59	-28.8	22.0	-26.6	18.0	-25.7

Table 4. Current and historical analyte concentrations

	Ethylbenzene	Ethylbenzene	Ethylbenzene	Total Xylenes	Total Xylenes	Total Xylenes
	Cur.	Max.	F	Cur.	Max.	F
MW-2	100	470	0.21	371	2500	0.15
MW-13	59	570	0.10	40	1600	0.03