

Determining Net Explosive Quantity (NEQ) from Crater Diameter

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Project Outline:

The project built on previous work done by The United States Army Engineering Research and Development Center (ERDC) [sic] on creating a tool for measuring NEQ from crater diameter. The purpose of the tool is as a light-weight calculator to provide timely information on NEQ to personnel in the field. Specifically the tool is for the objective analysis of the post-detonation damage caused by vehicle borne improvised explosive devices (VBIED).

The project successfully emulated the US methodology and compared this to relevant open-source information in order to give an assessment of its accuracy.

Project Objectives

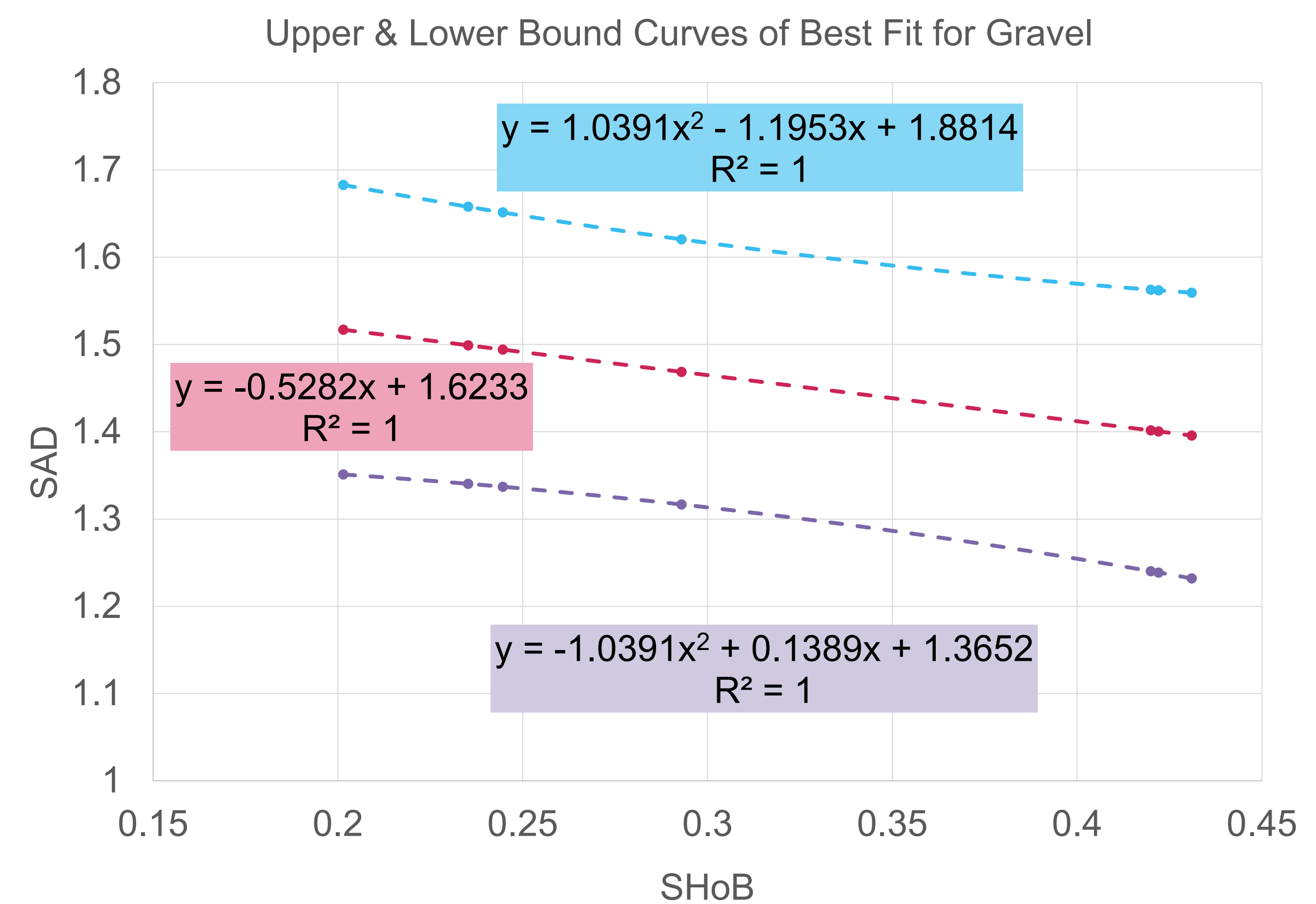
- Objective 1: Examine the relationship between cratering and explosive output.
- Objective 2: Analyse the current ERDC tool.
- Objective 3: Assess the tool against open-source data and suggest an alternative approach.
- Objective 4: Use the alternative approach to validate the original tool.

Objective	Completed ✓ or not X?	Notes
Objective 1.	✓	
Objective 2.	✓	
Objective 3.	X	An accurate alternative method to derive NEQ from crater dimensions was not found.
Objective 4.	X	Could not be completed as it relied on outputs from objective 3.

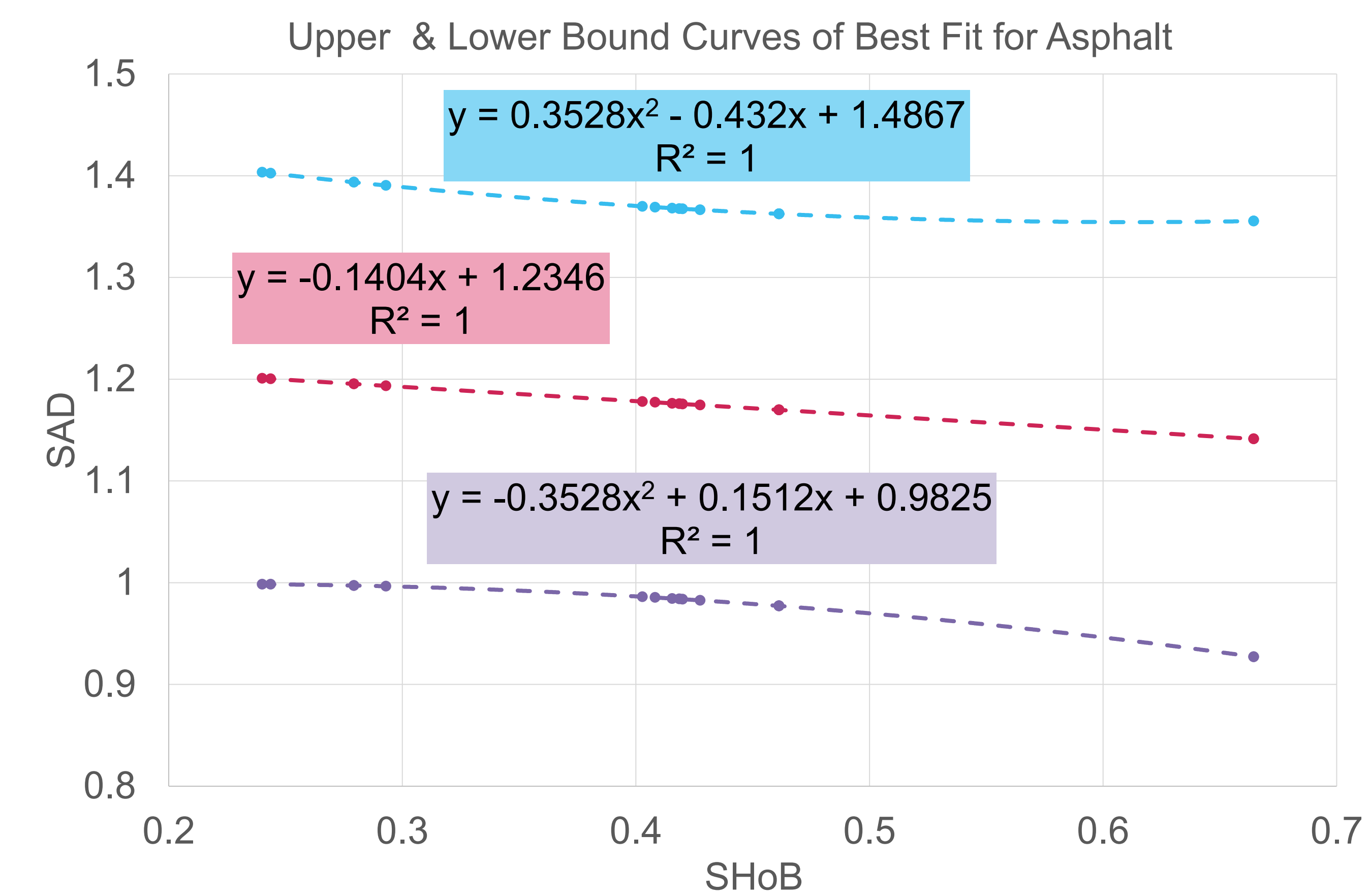
Objective 1 Results:

The literature review provided the background on the parameters important for understanding cratering.

The two graphs quantify the relationship between crater diameter, height of burst and explosive quantity. They were created from data provided by ERDC, but then organised to remove any discrepancies. The graphs are therefore derived by the author, and not from the original data.



Graph showing the relationship between scaled apparent diameter (SAD) and scaled height of burst (SHoB) for gravel. Note R^2 for original curve is 0.2082.



Graph showing the relationship between scaled apparent diameter (SAD) and scaled height of burst (SHoB) for asphalt. Note R^2 for original curve is 0.0174.

Event	Explosive	Weight (lbs)	Crater Diameter (ft)	HoB (ft)	NEW Predicted Asphalt (lbs)	NEW Predicted Transition (lbs)	% Difference to Asphalt	% Difference to Transition
St Marys [1] [2]	CAN/IS	2204	14.76	3.20	2482.71	2042.44	12.65	-7.33
				4.61	2581.32	2169.41	17.12	-1.57
Bishopsgate [1] [3]	CAN/IS	2204	15.00	4.61	2701.94	2238.15	22.59	1.55
				6.44	2837.16	2415.70	28.73	9.61

Objective 2 Results:

The table above shows two of the open-source incidents investigated and their favourable comparison to the predicted NEQ values. The transition equation is the most appropriate for comparison as the apparent diameters for the craters lie within the observed 12-30ft range.

The table below shows a series of incidents where the predictions were not as accurate.

Event	Explosive	Weight (lbs)	Crater Diameter (ft)	HoB (ft)	% Difference to Gravel	% Difference to Asphalt	% Difference to Transition
Alfred P. Murrah [1] [3]	AN/NM	5000	28.00	4.50	31.86	231.06	41.33
Alfred P. Murrah [3]	AN/NM	4000	28.00	4.50	64.83	313.82	76.67
Arndale [1] [4]	CAN/IS	3300	49.21	4.61	882.01	2548.87	474.56
				6.44	938.15	2590.01	520.74
South Quay [1] [5]	CAN/IS	3000	32.81	4.61	243.25	780.27	213.09
				6.44	272.26	800.69	241.49
British Consulate [1] [6]	AN/AI	2000	9.84	3.20	-81.97	-61.57	-54.73
				4.61	-78.23	-59.30	-53.40
				6.44	-72.67	-56.23	-51.54

Discussion:

The tool was able with a reasonable degree of error to predict the NEQs of the devices used. The project examined the less accurate results suggesting that they may be due to explosive type (Alfred P. Murrah and British Consulate), reporting (Arndale) or location (South Quay).

Further work:

Research should continue to refine the dataset to gain a better understanding of material properties of both the surfaces and the explosives. The work could highlight other open-source methods for calculating NEQ from craters, which would serve to validate the method adopted in this report.

Conclusion:

It was concluded that the tool derived from the ERDC data and approach was more accurate than the open-source equations. The method therefore provides the best low-resource solution for analysts to calculate NEQ from craters currently available.

References:

- [1] Committee on Reducing the Threat of Improvised Explosive Device Attacks by Restricting www.milliyet.com.tr/gundem/olenlerden-biri-cocuk-5140000. [Accessed 18 06 2025]. Access to Chemical Explosive Precursors, Reducing the Threat of Improvised Explosive Device Attacks by Restricting Access to Chemical Explosive Precursors, Washington DC, National Academies Press, 2018.
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- [3] D. Dodman, "The Bishopsgate Bombing," 2020. [Online]. Available: https://www.dandodmanhistory.co.uk/bishopsgate-bombing. [Accessed 18 06 2025]. Federal emergency Management Agency (FEMA), "The Oklahoma City Bombing: Improving Building Performance Through Multi-Hazard Mitigation," FEMA, [Accessed Online 15/06/2025], 1996.
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- [5] T. Harnden, Bandit Country: the IRA and South Armagh, London: Coronet, 2000.
- [6] Milliyet, "One of the dead is a child," Milliyet, 16 11 2003. [Online]. Available: https://www.milliyet.com.tr/gundem/olenlerden-biri-cocuk-5140000.



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