There are 3 main "drivers" behind the proposal to review how modelling can inform monitoring design:

1. **Advent of new ambient monitoring technologies**. These technologies include low-cost sensors, passive directional samplers and monitoring networks - which allow more flexible positioning of monitors and higher-frequency data. So there is now scope to put monitors where they give clearer and more frequent evidence on the performance of source(s) of interest. Previously, the positions and numbers of monitors were more constrained by the size, cost and mains-power needs of conventional instruments, so the evidence available on individual source performance was less distinct and frequent. The extra flexibility provided by new technologies means it is now more realistic to use modelling to design monitoring schemes that are optimally positioned and effective, and that such designs are now more feasible to implement in practical monitoring campaigns.

2. **Extra reasons and objectives for ambient monitoring**. Traditionally, monitors have been put where exposure to pollution (or complaints from residents) was considered to be greatest, in order to check on basic compliance with ambient standards – especially for human health. But, increasingly there are additional questions and objectives for monitoring to address, beyond basic compliance:

* Estimation of emission rates e.g. based on inverse modelling;
* Triangulation of leaks or other unintended releases within a complex site;
* Fence-line monitoring to check on pollutant imports/exports across site boundaries e.g. between adjoining industrial sites cf. USEPA 325B regulation;
* Monitoring for public information/reassurance at high-profile sites involving new technologies or complaints e.g. shale-gas sites; landfills.
* Monitoring to measure "whole site" emissions of greenhouse gases (as compared with local "hot spots" of air toxics).
* Monitoring to target improvement measures, or to confirm they are working.
* Monitoring to distinguish between individual source contributions in complex multi-source situations e.g. steelworks.
* Monitoring over a limited time period (e.g. 4-6 months) so the data can be extrapolated (e.g. with modelling) to estimate air-pollution statistics for a longer period (e.g. 12 months).

3. **"Lessons Learned" and "Challenges".** Large air-quality studies at industrial sites often use both monitoring and modelling. Typically, monitoring is started before modelling e.g. because monitoring equipment is available and because it is a priority to acquire field data which show the site is being investigated promptly. By contrast, modelling is often started later e.g. because it takes time to prepare emission scenarios and inventories. But there are sometimes "Lessons Learned" from the later modelling which show that it would have been preferable to have done that modelling earlier, so that model outputs could have been used to inform the monitoring design. For example, earlier modelling could have shown that the interpretation of data from a particular monitor position would be compromised by impacts from confounding sources that would obscure the signals there from the industrial site of interest.

Also, monitoring data that has been collected for reasons of public information and reassurance is sometimes challenged by public interest groups and communities e.g. on the grounds that:
(a) The monitor(s) was not put in the most appropriate or representative location(s), or
(b) Ad hoc measurements by community groups do not agree with the data reported from the monitoring site.
When answering these "Challenges", it would help to be able to show that a systematic and auditable modelling procedure was used beforehand to design the monitoring.

The situations with "Lessons Learned" and "Challenges" are essentially ones where the statistical representativeness of monitoring and its ability to resolve sources needs to be demonstrated i.e. where the adequacy of monitoring design needs to be explained. Modelling can be used to check and explain the adequacy of monitoring design. For example, it would help to have a protocol for monitoring design that uses modelling <u>prospectively</u> to optimise the placement of monitors for a given monitoring purpose. Such a protocol would avoid situations that currently arise, where modelling is only used <u>retrospectively</u> to investigate sub-optimal features in a monitoring design that was not informed by modelling.

The above 3 "drivers" affect a wide range of regulated sites and pollution situations, and are not confined to specific types of industrial sites, pollutants or locations.

The overall aim of the proposal is to "R*eview how dispersion modelling can be applied to inform the design of ambient monitoring schemes, and to recommend next steps for improved applications*". The proposal is essentially a "pilot study" to scope the potential and process for using modelling to design monitoring *in advance of ambient measurements*, so that monitoring campaigns are seen to be pre-optimised, representative and statistically robust. If the "pilot study" is successful then the "next steps" could include developing a model-based protocol for monitoring design, and demonstrating its applicability and effectiveness in different dispersion situations.