Department for Environment Food & Rural Affairs

Development of new $PM_{2.5}$ Targets for England

EMEP meeting, 14 September 2022

Acknowledgements: Imperial College London, UK Centre for Hydrology and Ecology, Ecometrics Research and Consulting, Wood Plc. and Ricardo Plc.

Environment Agency

Forestry Commission

NATURAL ENGLAND

Agenda

1. The proposed targets
2. Modelling and analysis carried out to inform the target setting
3. Assessment of target impacts
4. Summary and main evidence challenges

1. Environment Act

- The Environment Act 2021 which came into force in November 2021, requires the UK government to set new legally binding air quality targets for England.
- The duty to set a $PM_{2.5}$ target is specified in the Act. In addition a minimum of one other air quality target is required as part of the targets framework. The framework identifies four priority areas for environmental targets, one of which is air quality.
- Both air quality targets will be set in secondary legislation defining the targets details and how they will be assessed.

"A duty to set a target on $PM_{2.5}$ as an annual average concentration in ambient air" – Clause 2

A duty to set a long-term air quality target through the targets framework – Clause 1

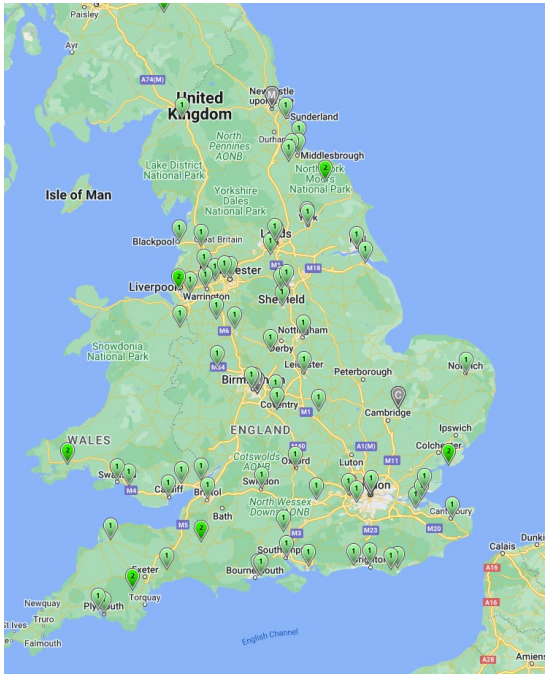
Proposed target values and dates

- The two targets proposed both relate to $PM_{2.5}$, these are:
  - An annual mean concentration target of 10 µg m^{-3} by 2040
  - A population exposure reduction target of 35% by 2040 compared to 2018
- The annual mean concentration target (AMCT) and population exposure reduction target (PERT) will work together to drive improvements in $PM_{2.5}$ concentrations.
- The AMCT will set a maximum concentration to protect those living in the areas of highest concentration.
- The PERT will reduce average exposure across the country, benefiting all.
- There is strong support from health experts for this dual target approach.

Assessing the targets

- The national monitoring network will be used to assess whether or not the targets are met.
- For the AMCT to be achieved all $PM_{2.5}$ monitoring sites in England need to be at or below 10 µg m^{-3} by 2040.
- For the PERT the average of monitoring sites representative of population exposure (urban and suburban background) is calculated, this is then averaged over 3 years to reduce the influence of weather variations. The % reduction between 2018 and 2040 must be 35% or greater for the PERT to be met.
- The number of $PM_{2.5}$ monitoring sites in England is being increased to support assessment of the targets. 17 new sites have already been added to the existing 63, with plans to double the number of sites over the next three years.
- Additional supplementary monitoring to support policy development is also being introduced (e.g. speciation, BC)

Current $PM_{2.5}$ monitoring sites



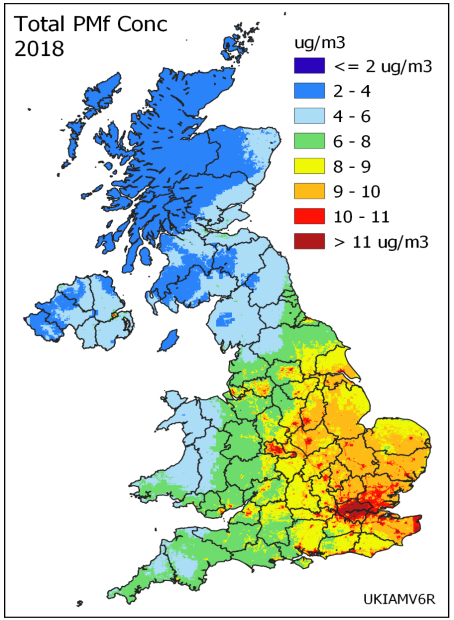
2. Evidence-led target development

- Over the past 2-3 years we have been working with experts in modelling, monitoring and health to:
  a) Define the target metrics and determine how they will be measured and calculated
  b) Understand what targets are achievable by when and what drives changes in $PM_{2.5}$ concentrations
  c) Quantify health benefits, economic cost and impact on exposure disparities
- Throughout this programme of work advice was sought from independent expert groups AQEG and COMEAP, along with other individual experts through technical workshops, a call for evidence and bilateral discussions.
- During this period the WHO air quality guidelines have also been updated.

Air quality modelling

- Air quality modelling was commissioned to:
  a) Understand what target levels are achievable
  b) Feed into the impact assessment
  c) Understand the key sources to inform policy
- The majority of the modelling was carried out using UKIAM, a framework model developed by ICL which uses emissions data and dispersion modelling to produce pollutant concentrations in 1km^2 grids across the UK.
- A second model EMEP4UK was used to validate the simpler UKIAM (particularly with respect to SIA non-linearities) and investigate the impact of meteorology.
- Expert review was used as a means to challenge and ground the modelling approach throughout.

$PM_{2.5}$ concentration (2018, modelled by UKIAM)



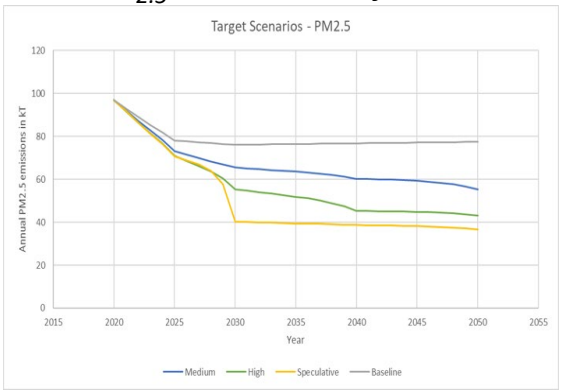
Scenario development

1. Sector workshops, interviews and literature review were used to gather information on potential technical and behavioural measures, future trends etc.
2. Measures were assigned to different scenarios representing different levels of ambition/optimism with appropriate timelines and uptakes
3. The measures were put into a scenario modelling software tool which applies changes in emission factor and activity to baseline emissions (the national emission inventory projections)
4. The tool produced emission trajectories up to 2050 for $PM_{2.5}$ and precursors. These formed the basis for UK emissions model input.

Emissions Scenarios

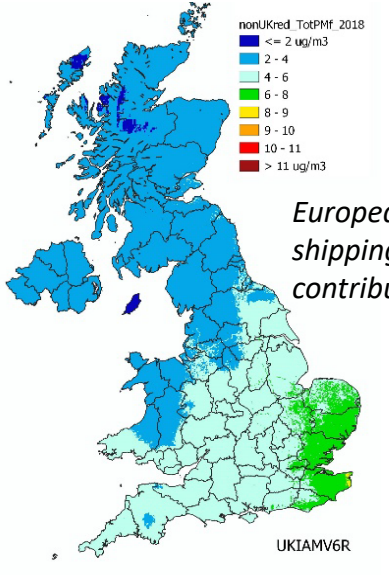
Target baseline	•Based on existing interventions and policies •Natural technology turnover •NAEI 2018 projections with some adjustments to account for recent legislation and updated data
Medium	•Based on measures/activity identified by the sector review • Implementation of proven technology and modest behaviour change, typical timescales and uptakes
High	•Based on measures/activity identified by the sector review •Technology considered likely to be implementable in the future by stakeholders, increased behaviour change and more rapid timescales
Speculative	•Based on measures/activity identified by the sector review •All feasible measures including emerging technology and significant behaviour change, optimistic timescales and uptakes

$PM_{2.5}$ emissions trajectories

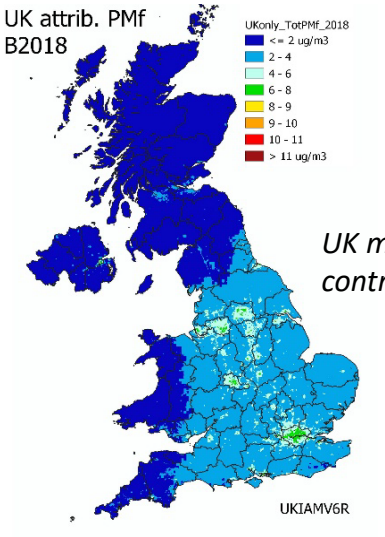


Other modelling inputs

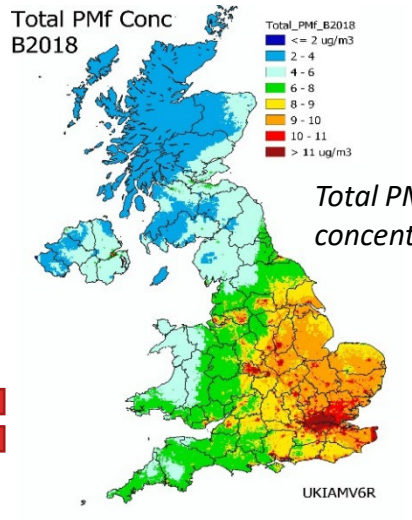
- Natural (sea salt, pollen, soil, resuspension, SOA), international shipping and transboundary (IIASA scenarios) were combined with the UK emission scenarios to give the overall $PM_{2.5}$ concentration



European, international shipping and natural contributions

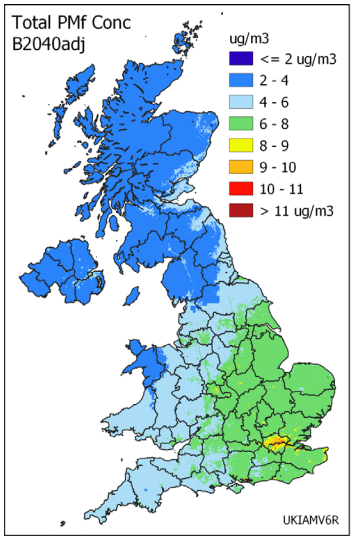


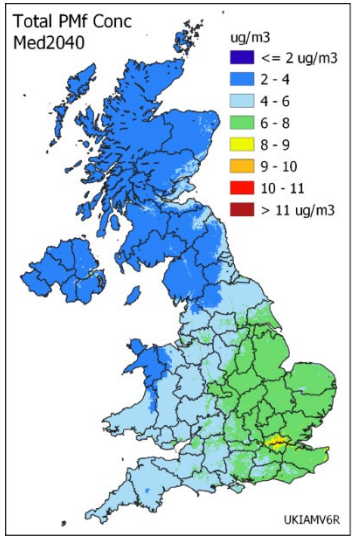
UK manmade contribution

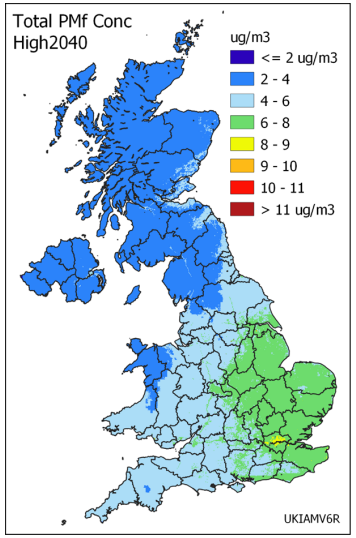


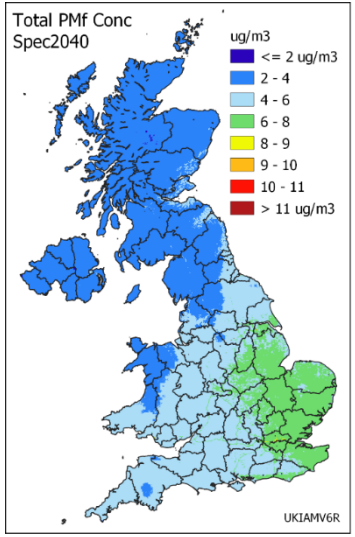
Total $PM_{2.5}$ concentration

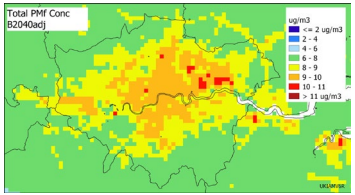
Example outputs: 2040 scenarios

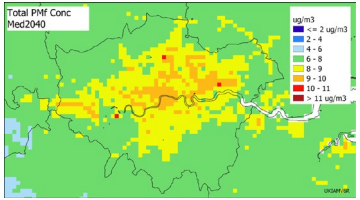


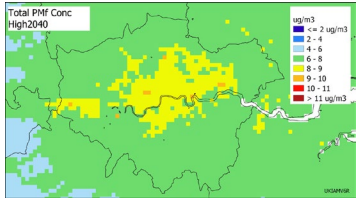


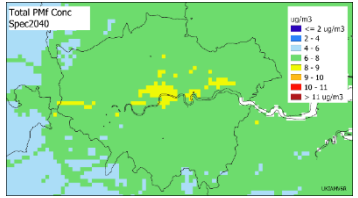


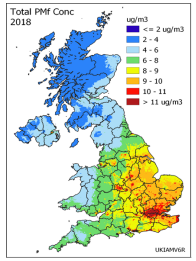


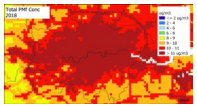






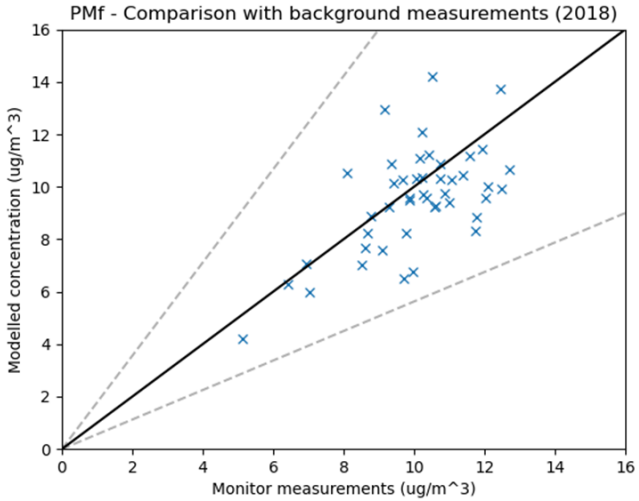


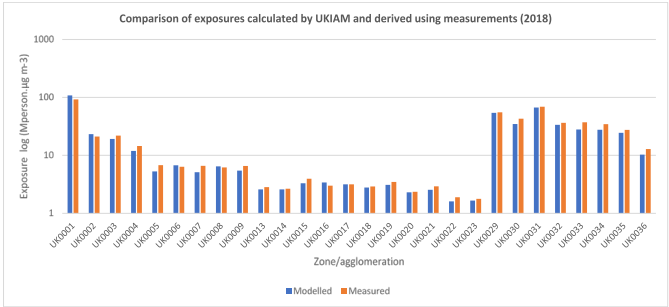




Model verification

- Modelling grid values were compared to relevant background (not near-source) measurements for 2018:
  - Modelled and measured averages are similar, with little bias – for England and individual zones/agglomerations
  - Individual monitoring stations differed by an average of 1.7µg m^{-3}
- Measurements may not be representative of the grid average and are affected by weather
- There are uncertainties in measurements as well as modelling





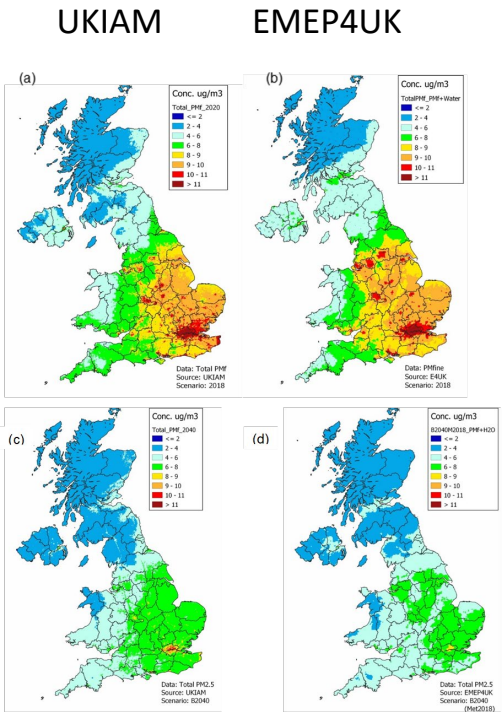
UK0001	Greater London Urban Area
UK0002	West Midlands Urban Area
UK0003	Greater Manchester Urban Area
UK0004	West Yorkshire Urban Area
UK0005	Tyneside
UK0006	Liverpool Urban Area
UK0007	Sheffield Urban Area
UK0008	Nottingham Urban Area
UK0009	Bristol Urban Area

UK0014	The Potteries
UK0015	Bournemouth Urban Area
UK0016	Reading/Wokingham Urban Area
UK0017	Coventry/Bedworth
UK0018	Kingston upon Hull
UK0019	Southampton Urban Area
UK0020	Birkenhead Urban Area
UK0021	Southend Urban Area
UK0022	Blackpool Urban Area

UK0023	Preston Urban Area
UK0029	Eastern
UK0030	South West
UK0031	South East
UK0032	East Midlands
UK0033	North West & Merseyside
UK0034	Yorkshire & Humberside
UK0035	West Midlands
UK0036	North East

Uncertainties and assumptions

- Sensitivity analysis was undertaken to understand the impact if emissions were varied for key uncertainties e.g. different estimates of domestic wood burning, changing assumptions in relation EVs
- Meteorological influence and SIA assumptions were explored by comparing the results from UKIAM with EMEP4UK
  - EMEP4UK produced the same England PWMC for 2018 and a PWMC 0.6 µg m^{-3} lower for 2040
  - Applying the more unfavourable 2003 meteorology increased the PWMC by around 1-2 µg m^{-3}
  - Including a SIA non-linearity factor in UKIAM produced similar results to the EMEP4UK

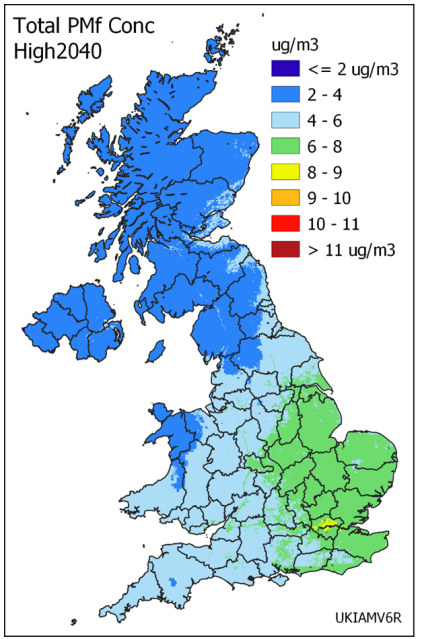


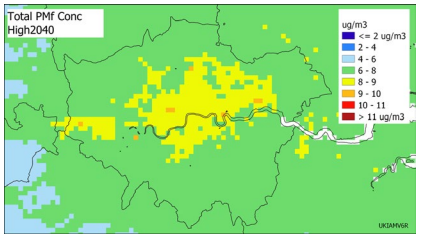
Interpretation of the modelling

- AMCT:
  - The highest concentration needs to be below the proposed target value for it to be achievable. i.e. the accumulated exceedance across all grid squares needs to be negligible.
  - As modelling produces the average of a km grid square and there are variations within the square, a 1 μg m^{-3} margin was applied to the modelled value. i.e. if the exceedance of 9 μg m^{-3} was negligible 10 μg m^{-3} was considered a viable target.
- PERT:
  - The populated weighted average concentration of all the grid squares in England was calculated for each scenario.
  - The % reduction in this value compared to 2018 was used as an indicator of the maximum PERT which can be achieved under that scenario.

Achievability of targets

- The modelling suggested that reaching 10 µg m^{-3} is possible in most locations by 2030, but challenging to achieve in London. It could be possible under the speculative scenario, but this includes emerging technology and significant behaviour change.
- It was also noted that many actions to reduce emissions require time to put in place and have impact.
- The modelling results fed into ministerial decision making, along with other sources of information such as the impact assessment and focus group findings.
- The proposed targets most closely follow the high scenario and setting both targets for 2040 was the most appropriate approach.
- The high scenario suggests an AMCT of 10 µg m^{-3} and a PERT of 35% can be achieved by 2040.

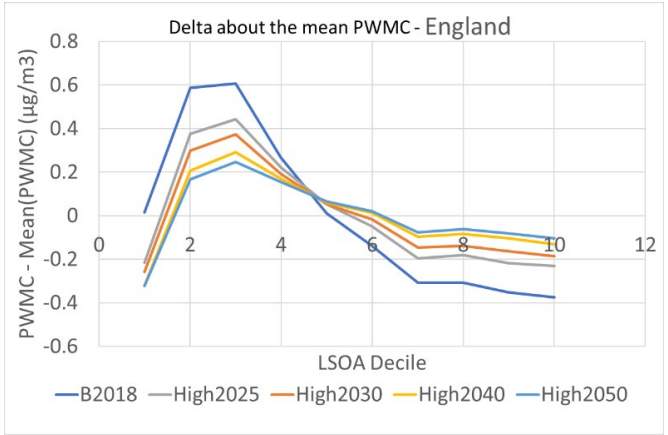




3. Target benefits

- The modelling outputs were used to assess the target benefits:
  - Achieving the target population exposure is estimated to result in 214,000 fewer cases of coronary heart disease, 56,500 strokes, 70,000 cases of asthma and 23,000 lung cancers over the following 18 years.
  - Achieving the targets will also reduce disparities in exposure. By 2040 the difference between the average exposure and that in areas of high deprivation is halved compared to 2018.
  - Other air quality benefits include reduced damage to labour productivity, ecosystems and soiling of buildings. Co-benefits include significant carbon savings.
  - The total benefits are equivalent to £135 billion over the target timeframe.

Monetised Benefits	2023-2040 Discounted 2020, £bn
Air Quality	£37.9
Greenhouse Gas Emissions	£97.1
Total Benefits	**£135.0**



LSOA decile 1 has the highest deprivation level.

Economic costs

- The costs of delivering the targets depends on the specific actions taken to reduce emissions of $PM_{2.5}$ and its precursors.
- The hypothetical scenario which reaches the target (the high scenario) has costs of £27 billion (over 2023 – 2040) giving a benefit cost ratio of 5.1.
- Not all the measures included in the scenario are cost-effective, as no prerequisites were applied. So the cost could be less, for little difference in emissions.
- Around 75% of the actions in the scenario also reduces GHG emissions, and this is likely to be the main driver for these actions.
- Individual measures to deliver the target need to be considered on their own merit including carrying out separate impact assessments as appropriate.

4. Summary

- Two air quality targets are proposed, both addressing $PM_{2.5}$ the pollutant of most harm to health. Together they act to protect those living in areas of the highest concentration and reduce exposure throughout the country.
- The targets were informed by an extensive programme of modelling and analysis. This included modelling a number of future emissions scenarios, each consisting of a package of plausible hypothetical measures to reduce $PM_{2.5}$ and precursor emissions.
- The model outputs were validated by comparing them with measurements and an alternative model. Sensitivity analysis was also carried out.
- The outputs were also used to assess the impact of the targets. This included estimating health benefits, economic cost and the impact on disparities and ecosystems.
- The modelling and impact assessment informed ministers' decision-making, along with other considerations such as stakeholder views.

Evidence challenges

- Uncertainty in current and future emissions especially domestic wood burning a key source of $PM_{2.5}$
- Estimating the impact of individual measures on emissions, and interacting measures acting on the same source
- Spatial elements – not just the magnitude of reduction, but where it occurs is important
- Interpretation - using modelling to understand the achievability of the AMCT is more challenging than the PERT
- Assessing the costs and benefits of the targets when measures have multiple drivers e.g. carbon reduction and national emission ceilings
- Emerging health evidence – uncertainty around quantifying benefits
- Communicating complex modelling to stakeholders

Department
for Environment
Food & Rural Affairs

Thank you

Evidence report: *https://consult.defra.gov.uk/natural-environment-policy/consultation-on-environmental-targets/supporting_documents/Air%20quality%20targets%20%20Detailed%20Evidence%20report.pdf*

Impact assessment*: https://consult.defra.gov.uk/natural-environment-policy/consultation-on-environmental-targets/supporting_documents/Air%20quality%20targets%20%20Impact%20Assessment.pdf*