Free Route Airspace Deployment 2.1

Gateway documentation: Stage 3 Consult

Step 3 Options Appraisal (Phase 2 - Full) including Safety Assessment

Roles

Action	Role	Date
Produced	Airspace Change Specialist NATS Future Airspace and ATM	19/11/2020
Reviewed Approved	Manger Airspace Evolution NATS Airspace and Future Operations	23/11/2020
Reviewed Approved	ATC Lead NATS Prestwick Development	20/11/2020
Reviewed Approved	FRA Project Manager L6234 Operations & Airspace Programme Delivery	20/11/2020

Publication History

Issue	Month/Year	Changes this issue
1.0	Jan 2021	

Contents

1. Introduction

1.1 This document forms part of the document set in accordance with the requirements of the CAP1616 airspace change process.

1.2 This document aims to provide adequate evidence to satisfy CAP1616 Stage 3 Consult Gateway, Step 3 Options Appraisal (Phase 2 Full), including Safety Assessment.

1.3 The implementation of Free Route Airspace (FRA) is a mandated change and as such is not benefits driven.

2. Change Level

2.1 The changes proposed in this ACP impact flights above FL245. Hence in accordance with the Levels as defined in CAP1616, this proposal has been categorised as a Level 2B change.

2.2 In line with the requirements for a Level 2B change the environmental impact assessment has been conducted on the basis of CO_2e emissions. There would be no perceptible change to noise impacts to stakeholders on the ground; hence no noise analysis has been undertaken.

2.3 ICCAN guidance related to noise impacts on stakeholders on the ground has been considered during options development. The changes proposed in all options are at FL245 and above, therefore the ICAAN guidance is not considered relevant for this ACP.

3. Options Appraisal (Phase 2 Full)

3.1 The baseline (do nothing) option was discounted during the design principles evaluation. It would not deliver any benefit or meet the mandated legal requirement to introduce FRA in the UK UIR.

3.2 This ACP proposes two alternative options which could be used to implement FRA in accordance with the mandated requirements.

- FRA Option 1. Implement FRA in accordance with Implementing Regulation EU716/2014, remove all ATS routes and rationalise waypoints in accordance with the DSNA Brest ACC FRA design in both the PEMAK Triangle and TAKAS Box (preferred option).
- FRA Option 2. Implement FRA in accordance with Implementing Regulation EU716/2014, remove all ATS routes and rationalise waypoints in accordance with the DSNA Brest ACC FRA design in the PEMAK Triangle but retain an ATS routes in the TAKAS Box.

3.3 FRA Option 1 – Implement FRA in accordance with Implementing Regulation EU716/2014, remove all ATS routes and rationalise waypoints in accordance with the DSNA Brest ACC FRA design in both the PEMAK Triangle and TAKAS Box (preferred option)

FRA Option 1 would remove all ATS routes and rationalise waypoints in accordance with the DSNA Brest ACC FRA design in both the PEMAK Triangle and TAKAS Box. Free route trajectories/traffic flows would be managed in the French RAD and Irish RAD. The CAP1616 Initial Options Appraisal analysis is given below.

<table>
<tr><th>Group</th><th>Impact</th><th>Level of Analysis</th><th>Description</th></tr>
<tr><td>Communities</td><td>Noise impact on health and quality of life</td><td>Qualitative</td><td>The proposed changes to air traffic patterns are all above FL245 (circa 24,500ft) and wholly over the sea. This is well above the 7,000ft threshold below which noise impacts are considered significant and analysis is required.
The potential noise impacts are neither measurable nor describable.</td></tr>
<tr><td>Communities</td><td>Air quality</td><td>N/A</td><td>No changes below 1,000ft</td></tr>
<tr><td>Wider society</td><td>Greenhouse gas impact</td><td>Quantitative</td><td>The proposed changes would enable a beneficial net reduction of CO2e emissions on implementation, which would increase in line with forecasted traffic growth.
The impact assessment indicates that 33,925 flights per year would be impacted by the change by 2021, rising to 43,255 in 2031.
WebTAG was used to assess the greenhouse gas impact over 10 years subsequent to the implementation of the proposed changes.
The proportion of flights with origin and destination within the EU is 49.9%, with the remaining 50.1% originating from or destined to airports outside of the EU. In accordance with CAA guidance the CO2e emissions for flights within the EU are accounted for in WebTAG as traded (49.9%) and flights whose origin or destination are outside the EU are non-traded (50.1%). The FRA Option 1 concept would yield a positive Net Present Value benefit due to the reduction in CO_2e emissions per flight.
The forecast reduction of CO2e emissions in the opening year (2021) is 2,001.7T (traded and non-traded) p.a. which would further decrease to 2,325.4T of CO2e saved p.a. in 2031.
The monetised NPV benefit calculated by WebTAG due to the reduction in per-flight GHG emissions is £464,673.
The additional benefit of reduced fuel uplift and reduced CO2e emissions due to the corresponding weight reduction have not been included. It must be noted that FRA will only enable this benefit. Actual trajectories planned within FRA will be determined by airspace users.
The WebTAG GHG worksheet outputs are shown at Appendix A.
Data used in compiling the WebTAG GHG results was as follows, using traffic figures from NATS analytics report:
<table>
<tr><th>Year</th><th>Number of Movements</th><th>Total fuel burn change (kT)</th><th>Total CO_2e Change (kT)</th></tr>
<tr><td>2017</td><td>31,977</td><td>-1,186.7</td><td>-3,773.6</td></tr>
<tr><td>2021</td><td>33,925</td><td>-1,259.0</td><td>-4003.5</td></tr>
</table>
Calculated fuel burn is converted to CO_2e emissions using the ratio 3.18.
Due to the uncertainty regarding how operators will react and flight-plan within FRA, a conservative approach has been taken and forecast savings have been halved. The figures have been grown year-on-year according to the NATS base traffic forecast figures to 2031 and these figures used as the WebTAG input.
This ACP proposes implementing FRA on the same AIRAC as FRA Deployment 1. Therefore traffic and forecast data published as part of FRA Deployment 1 ACP (ACP-2018-11) is used. Given the significant change in traffic as a result of the COVID-19 pandemic, this provides a consistent and equivalent comparison to data</td></tr>
</table>

			already in the public domain. This approach is consistent with guidance in CAP1616a.
Wider society	Capacity/ resilience	Qualitative	Increased flight planning flexibility would allow aircraft operators to flight plan more efficiently and would give them the option of avoiding capacity constrained areas. The ability to avoid restrictions by utilising alternative flight plan trajectories would reduce the likelihood of delay, thus improving the resilience of the wider network.
General Aviation	Access	Qualitative	GA access to the higher-level airspace above FL245 would be unchanged.
General Aviation/ commercial airlines	Economic impact from increased effective capacity	Qualitative	The introduction of FRA would not increase air transport movements, passenger numbers or cargo carried as an outcome of this proposal. The flight plan options this proposal would introduce could allow airlines to avoid capacity constrained areas and avoid consequential delay and cost. However, this is not quantifiable, and no specific capacity increase is assumed or claimed by this proposal.
General Aviation/ commercial airlines	Fuel burn	Quantitative	Analysis predicts a decrease in fuel burn, at a saving of £355,480 in 2021, increasing to become a saving of £412,948 in 2031 (both Net Present Value). This was based on the IATA jet fuel price of 16 November 2020, at $362 USD per tonne converted to GDP at 0.78$/£ and presumes a constant fuel price and exchange rate. The forecast used was NATS 2018 base-case Forecast for traffic growth.
Commercial airlines	Training cost	Qualitative	There is not expected to be any airline training cost associated with this FRA implementation.
Commercial airlines	Other costs	Qualitative	Updates to FMS and flight planning systems will be by the routine AIRAC updates. There are no other known costs which would be imposed on commercial aviation.
Airport/ Air navigation service provider	Infrastructure costs	Qualitative	Infrastructure costs to the UK would be minimal in line with the normal AIRAC process. The Shannon ACC system already operates FRA, therefore infrastructure costs to the IAA would be minimal in line with the normal AIRAC process. Brest ACC are deploying FRA within a large proportion of their AoR in French airspace and are updating their infrastructure accordingly. Therefore, there are minimal infrastructure costs associated specifically with the deployment of FRA within the region of delegated ATS airspace, other than those which are in line with the normal AIRAC process.
Airport/ Air navigation service provider	Operational costs	Quantitative and Qualitative	This proposal would not lead to changes in operational costs to the UK, Irish or French. Levels of complexity will be managed in the IAA and DSNA RAD so they are comparable with that of today's air traffic control systems. However, it is not proportionate to quantify this impact and no specific capacity benefit is assumed or claimed by this proposal.
Airport/ Air navigation service provider	Deployment costs	Quantitative and Qualitative	Deployment cost to the UK would be minimal in line with the normal AIRAC process. The overall cost estimate for the ANSP to complete the adaptation and to complete the required airspace change administrative process is approx. £320,000.

3.4 FRA Option 2 – Implement FRA in accordance with Implementing Regulation EU716/2014, remove all ATS routes and rationalise waypoints in accordance with the DSNA Brest ACC FRA design in the PEMAK Triangle but retain an ATS routes in the TAKAS Box

FRA Option 2 would remove the ATS route structure and rationalise waypoints within the PEMAK Triangle but retain a route structure in the TAKAS Box. Free route trajectories/traffic flows would be managed in the French RAD and Irish RAD.

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<tr><th>Group</th><th>Impact</th><th>Level of Analysis</th><th>Evidence</th></tr>
<tr><td>Communities</td><td>Noise impact on health and quality of life</td><td>Qualitative</td><td>(Same as FRA Option 1) The proposed changes to air traffic patterns are all above FL245 (circa 24,500ft) and wholly over the sea. This is well above the 7,000ft threshold below which noise impacts are considered significant and analysis is required.
The potential noise impacts are neither measurable nor describable.</td></tr>
<tr><td>Communities</td><td>Air quality</td><td>N/A</td><td>(Same as FRA Option 1) No changes below 1,000ft</td></tr>
<tr><td>Wider society</td><td>Greenhouse gas impact</td><td>Quantitative</td><td>The proposed changes could enable a beneficial net reduction of CO_2e emissions on implementation, which would increase in line with forecasted traffic growth. The impact assessment indicates that 33,925 flights per year would be impacted by the change by 2021, rising to 43,255 in 2031.
WebTAG was used to assess the greenhouse gas impact over 10 years subsequent to the implementation of the proposed changes. The proportion of flights with origin and destination within the EU is 49.9%, with the remaining 50.1% originating from or destined to airports outside of the EU. In accordance with CAA guidance the CO_2e emissions for flights within the EU are accounted for in WebTAG as traded (49.9%) and flights whose origin or destination are outside the EU are non-traded (50.1%). The FRA Option 2 concept would yield a positive Net Present Value benefit due to the reduction in CO_2e emissions per flight.
The forecast reduction of CO_2e emissions in the opening year (2021) is 1,726.3T (traded and non-traded) p.a. which would further decrease to 2,005.3T of CO_2e saved p.a. in 2031. The monetised NPV benefit calculated by WebTAG due to the reduction in per-flight GHG emissions is £400,719.
The additional benefit of reduced fuel uplift and reduced CO_2e emissions due to the corresponding weight reduction have not been included. It must be noted that FRA will only enable this benefit. Actual trajectories planned within FRA will be determined by airspace users.
The WebTAG GHG worksheet outputs are shown at Appendix A.
Data used in compiling the WebTAG GHG results was as follows, using traffic figures from NATS analytics report:
<table>
<tr><th>Year</th><th>Number of Movements</th><th>Total fuel burn change (kT)</th><th>Total CO_2e Change (kT)</th></tr>
<tr><td>2017</td><td>31,977</td><td>-1,023.3</td><td>-3,254.2</td></tr>
<tr><td>2021</td><td>33,925</td><td>-1,085.7</td><td>-3,453.5</td></tr>
</table>
Calculated fuel burn is converted to CO_2e emissions using the ratio 3.18. Due to the uncertainty regarding how operators will react and flight-plan within FRA, a conservative approach has been taken and forecast savings have been halved. The figures have been grown year-on-year according to the NATS base traffic forecast figures to 2031 and these figures used as the WebTAG input.
This ACP proposes implementing FRA on the same AIRAC as FRA D1. Therefore traffic and forecast data published as part of FRA D1 ACP (ACP-2018-11) is used. Given the significant change in traffic as a result of the COVID-19 pandemic, this provides a consistent and equivalent comparison to data already in the public domain. This approach is consistent with guidance in CAP1616a.</td></tr>
</table>

Wider society	Capacity/ resilience	Qualitative	The same evidence statement as Option 1 applies. The retention of some of the ATS route structure would assist in network resilience.
General Aviation	Access	Qualitative	(Same as FRA Option 1) GA access to the higher-level airspace above FL245 would be unchanged.
General Aviation/ commercial airlines	Economic impact from increased effective capacity	Quantitative	(Same as FRA Option 1) The introduction of FRA would not increase air transport movements, passenger numbers or cargo carried as an outcome of this proposal. The flight plan options this proposal would introduce could allow airlines to avoid capacity constrained areas and avoid consequential delay and cost. However, this is not quantifiable, and no specific capacity increase is assumed or claimed by this proposal.
General Aviation/ commercial airlines	Fuel burn	Quantitative	Analysis predicts a decrease in fuel burn, at a saving of £306,557 in 2021, increasing to become a saving of £356,116 in 2031 (both Net Present Value). This was based on the IATA jet fuel price of 16 November 2020, at $362 USD per tonne converted to GDP at 0.78$/£ and presumes a constant fuel price and exchange rate. The forecast used was NATS 2018 base-case Forecast for traffic growth.
Commercial airlines	Training cost	Qualitative	(Same as FRA Option 1) There is not expected to be any airline training cost associated with FRA implementation.
Commercial airlines	Other costs	Qualitative	(Same as FRA Option 1) Updates to FMS and flight planning systems will be by the routine AIRAC updates. There are no other known costs which would be imposed on commercial aviation.
Airport/ Air navigation service provider	Infrastructure costs	Qualitative	(Same as FRA Option 1) Infrastructure costs to the UK, Irish and French would be minimal in line with the normal AIRAC process
Airport/ Air navigation service provider	Operational costs	Qualitative	(Same as FRA Option 1) This proposal would not lead to changes in operational costs.
Airport/ Air navigation service provider	Deployment costs	Quantitative and Qualitative	(Same as FRA Option 1) Deployment cost to the UK would be minimal in line with the normal AIRAC process. The overall cost estimate for the ANSP to complete the adaptation and to complete the required airspace change administrative process is approx. £320,000.

Cost Benefit Comparison

The monetised benefits of each of the options have been compared in the cost benefit analysis below (note, there are no differences in the cost of implementation of the options).
The discount rate of 3.5% has been applied as per the standard rate given in the Treasury Green Book Annex A6.)

There is a significant degree of uncertainty in predicting how aircraft operators will use FRA. This has an impact on the relative magnitude of the benefit apportioned to each option. The justification for the allocation of benefits is described below:
Option 1 - Full FRA (100% benefit). With no route structure it is assumed that aircraft operators would flight plan direct great-circle routes where able, subject to RAD restrictions. This was the basis of the computer simulations and hence 100% benefit is apportioned.
Option 2 – An ATS route structure retained within the TAKAS Box (40% benefit within the TAKAS Box only). With an ATS route structure maintained, aircraft operators could flight plan via the existing routes or via direct great-circle routes, subject to RAD restrictions. Using ATC expertise and experience[1] it was considered that many flights would not utilise the FRA and as such that 40% of the benefit calculated for Full FRA would be likely to be realised by this option. The ATS routes have to be removed from the PEMAK Triangle and therefore 100% benefit is apportioned within this region.

[1] Particularly from experience of other ANSPs who have implemented FRA with all ATS routes in place.

CAP1616 cost-benefit example												
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	
Year	0	1	2	3	4	5	6	7	8	9	10	NPV
Discount factor	1	0.965	0.931	0.899	0.867	0.837	0.808	0.779	0.752	0.726	0.700	
Option 1 - Full FRA (100% benefit)												
Net community benefit (CO2)	£49,742	£54,440	£58,595	£62,447	£66,017	£69,954	£73,305	£76,383	£79,279	£82,170	£87,387	
Net airspace users benefit (Fuel)	£177,740	£182,111	£185,188	£187,909	£190,374	£194,420	£197,268	£199,875	£202,477	£205,010	£206,474	
Net sponsor benefit	-£320,000	£0	£0	£0	£0	£0	£0	£0	£0	£0	£0	
Present value	-£92,518	£228,272	£227,016	£224,977	£222,336	£221,236	£218,499	£215,281	£211,881	£208,401	£205,786	£2,091,169
Option 2 - Partial Routes (100% benefit in PEMAK; 40% benefit in TAKAS)												
Net community benefit (CO2)	£42,897	£46,949	£50,531	£53,850	£56,927	£60,328	£63,216	£65,871	£68,366	£70,863	£75,361	
Net airspace users benefit (Fuel)	£153,278	£157,048	£159,701	£162,048	£164,173	£167,663	£170,119	£172,367	£174,611	£176,796	£178,058	
Net sponsor benefit	-£320,000	£0	£0	£0	£0	£0	£0	£0	£0	£0	£0	
Present value	-£123,825	£196,857	£195,774	£194,013	£191,734	£190,789	£188,427	£185,653	£182,719	£179,721	£177,465	£1,759,328

In summary Option 1 is the preferred option with NPV benefits to 2031 of:

Option 1 NPV benefit = £2,091,169

Option 2 NPV benefit = £1,759,328

4. Safety Assessment

4.1 Options Appraisal Safety Assessment - Baseline

The current operation uses a published route structure and airline operators flight-plan to follow available ATS routes or flight plannable Directs (DCT) as published in the Irish and French Route Availability Documents (RAD). The routes also provide an operational framework that is conducive to Air Traffic Controllers' familiarity with traffic patterns, potential conflict points and practices for conflict avoidance/resolution. Flights into and out of the airspace volume (i.e. across boundaries with other Sectors and Air Traffic Control Units) are nominally managed via published waypoints.

In addition to flights following routes, some may be instructed to take a more direct path through the airspace. This is done in a tactical manner by Air Traffic Controllers based on their judgement that a different path can be followed safely.

4.2 Options Appraisal Safety Assessment – Current Position

The DSNA Brest ACC FRA airspace design[2] removes the ATS route structure and would manage traffic flows through the use of flight planning restrictions in the RAD. This approach is common with other FRA implementations within the ICAO EUR region. Therefore, a qualitative high-level safety appraisal for the two proposed options for FRA deployment in the region indicates that the existing level of safety performance would be maintained.

There is an extant process for safety assessing any change that may have an impact on neighbouring ANSPs through the ATS delegation agreement.

[2] The IAA already operate FRA (fulfilling the PCP mandate). The IAA have stated that they are content to change the airspace within the TAKAS Box in accordance with Brest ACC's airspace requirements and timeline.

5. Conclusion and Next Steps

5.1 This proposal has been developed following the submission of a Statement of Need. Its text was:

This ACP is part of the programme to introduce Free Route Airspace (FRA) in a phased manner across all UK upper airspace. This programme was initiated in response to SESAR PCP Implementing Regulation EU716/2014. The SESAR PCP ATM Functionality 3 (AF3) states that Free Route shall be provided and operated in the airspace for which the Member States are responsible at and above Flight Level 310 in the ICAO EUR region by 1st January 2022.
FRA aims to improve flight efficiency by enabling aircraft to flight-plan and fly user-preferred routes, where possible. FRA is being implemented internationally and is already in operation in several neighbouring states. It is also in accordance with the CAA's Airspace Modernisation Strategy (AMS) (Sections 4.5-4.11 refer specifically to FRA as a means to improving efficiency in the upper airspace). The introduction of FRA will enable environmental benefit by enabling airline operators to reduce CO2 emissions per flight, which in turn would produce economic benefit due to reduced operating costs.
This ACP proposes the introduction of FRA in the PEMAK triangle and TAKAS box areas of airspace (Defined in AIP ENR 2.2 1.7). Air Traffic Services are delegated to France and Ireland respectively in these areas.
The introduction of FRA in UK airspace will ensure that the UK upper airspace is harmonised with that of neighbouring states, enabling cross-border free routing. Specifically the objective of this ACP is to allow the harmonised introduction of FRA in the PEMAK triangle and TAKAS box, in coordination with FRA implementation in the adjoining French airspace.

5.2 This document describes options which address the Statement of Need by the proposed introduction of Free Route Airspace within airspace where the provision of Air Traffic Services has been delegated to the IAA and DSNA in the south west UK UIR. This will meet PCP mandated requirements for the implementation of FRA.

5.3 Additionally, the options have been developed thus far with significant assistance, input, feedback and effort from representatives of all bordering ANSPs, representatives from airlines and flight planning service providers.
NATS thanks all these stakeholders and looks forward to continuing the development of this proposal.

5.4 Two options have been appraised and feedback on these will be requested from stakeholders during consultation.

5.5 Subject to CAA approval at the Stage 3 Gateway Assessment, this proposal will move on to Stage 3C - Consultation.

6. Appendix A: WebTAG Calculations for FRA Deployment 2.1

The data used for the inputs to WebTAG are given below.

6.1 Traffic forecasts

	Base Forecast	
Year	Base Growth Flights (000's)	Base Growth Rate
2021	2669	2.27%
2022	2735	2.46%
2023	2781	1.69%
2024	2822	1.47%
2025	2859	1.31%
2026	2919	2.13%
2027	2962	1.47%
2028	3001	1.32%
2029	3040	1.30%
2030	3079	1.25%
2031	3101	0.71%

Table 1 Base Case forecast traffic growth 2021-2031

The figures in Table 1 give the standard NATS base case traffic growth forecast for 2021 to 2031.

6.2 Computer modelling results

Year	Flights per year in FRA D2.1 area	Simulated Fuel saving (T)	Simulated CO_2e saving (T)	CO_2e saving /2	CO_2e saving traded 40.9%	CO_2e saving non-traded 50.1%	Fuel saving /2 (USD)	Fuel saving /2 (GBP)
2021	33,925	1,259	4,003	2,002	999	1,003	227,872	177,740
2022	34,760	1,290	4,102	2,051	1,023	1,028	233,476	182,111
2023	35,614	1,312	4,171	2,086	1,041	1,045	237,420	185,188
2024	36,490	1,331	4,233	2,116	1,056	1,060	240,908	187,909
2025	37,388	1,348	4,288	2,144	1,070	1,074	244,069	190,374
2026	38,307	1,377	4,379	2,190	1,093	1,097	249,256	194,420
2027	39,249	1,397	4,443	2,222	1,109	1,113	252,908	197,268
2028	40,215	1,416	4,502	2,251	1,123	1,128	256,251	199,875
2029	41,204	1,434	4,561	2,280	1,138	1,142	259,586	202,477
2030	42,217	1,452	4,618	2,309	1,152	1,157	262,834	205,010
2031	43,255	1,462	4,651	2,325	1,160	1,165	264,710	206,474

Table 2 Computer simulation results for Option 1

Year	Flights per year in FRA D2.1 area	Simulated Fuel saving (T)	Simulated CO_2e saving (T)	CO_2e saving /2	CO_2e saving traded 40.9%	CO_2e saving non-traded 50.1%	Fuel saving /2 (USD)	Fuel saving /2 (GBP)
2021	33,925	1,085	3,453	1,726	861	865	196,511	153,278
2022	34,760	1,112	3,537	1,769	883	886	201,344	157,048
2023	35,614	1,131	3,597	1,799	897	901	204,745	159,701
2024	36,490	1,148	3,650	1,825	911	914	207,753	162,048
2025	37,388	1,163	3,698	1,849	923	926	210,478	164,173
2026	38,307	1,188	3,777	1,888	942	946	214,952	167,663
2027	39,249	1,205	3,832	1,916	956	960	218,101	170,119
2028	40,215	1,221	3,882	1,941	969	973	220,984	172,367
2029	41,204	1,237	3,933	1,967	981	985	223,860	174,611
2030	42,217	1,252	3,982	1,991	994	998	226,661	176,796
2031	43,255	1,261	4,011	2,005	1,001	1,005	228,289	178,058

Table 3 Computer simulation results for Option 2

Tables 2 & 3 show the results calculated by NATS Analytics for the fuel saving and CO_2e savings (columns 3 and 4.) Due to the uncertainties regarding how airlines will use the FRA, and to account for the use of tactical direct routings which occur in the current day operation, these figures have been halved in columns 5-9. This is to reduce any risk that benefits are over-stated.

6.3 WebTAG GHG Workbook Output – Option 1

Greenhouse Gases Workbook - Worksheet 1

Scheme Name: NATS FRA Deployment 2.1 Opt 1

Present Value Base Year 2010

Current Year 2020

Proposal Opening year: 2021

Project (Road/Rail or Road and Rail): road

Overall Assessment Score:

Net Present Value of carbon dioxide equivalent emissions of proposal (£): £464,673

*positive value reflects a **net benefit** (i.e. CO2E emissions reduction)

Quantitative Assessment:

Change in carbon dioxide equivalent emissions over 60 year appraisal period (tonnes): -23,976
(between 'with scheme' and 'without scheme' scenarios)

Of which Traded -11964

Change in carbon dioxide equivalent emissions in opening year (tonnes): -2,002
(between 'with scheme' and 'without scheme' scenarios)

Net Present Value of traded sector carbon dioxide equivalent emissions of proposal (£): £295,046
(N.B. this is not additional to the appraisal value in cell I17, as the cost of traded sector emissions is assumed to be internalised into market prices. See TAG Unit A3 for further details)

*positive value reflects a **net benefit** (i.e. CO2E emissions reduction)

Change in carbon dioxide equivalent emissions by carbon budget period:

	Carbon Budget 1	Carbon Budget 2	Carbon Budget 3	Carbon Budget 4
Traded sector	0	0	-2022.30	-5367.80
Non-traded sector	0	0	-2030.40	-5389.40

Qualitative Comments:

Sensitivity Analysis:

Upper Estimate Net Present Value of Carbon dioxide Emissions of Proposal (£): £697,009

Lower Estimate Net Present Value of Carbon dioxide Emissions of Proposal (£): £232,336

Data Sources:
NATS FRA emissions analysis using AirTop Simulation
Traffic data: EUROCONTROL's Network Strategic Tool (NEST)
Aircraft performance: BADA v3.13/v4.2

6.4 WebTAG GHG Workbook Output – Option 2

Greenhouse Gases Workbook - Worksheet 1

Scheme Name: NATS FRA Deployment 2.1 Option 2

Present Value Base Year	2010
Current Year	2020
Proposal Opening year:	2021
Project (Road/Rail or Road and Rail):	road

Overall Assessment Score:

Net Present Value of carbon dioxide equivalent emissions of proposal (£): £400,719

*positive value reflects a **net benefit** (i.e. CO2E emissions reduction)

Quantitative Assessment:

Change in carbon dioxide equivalent emissions over 60 year appraisal period (tonnes): -20,676
(between 'with scheme' and 'without scheme' scenarios)

Of which Traded -10317

Change in carbon dioxide equivalent emissions in opening year (tonnes): -1,726
(between 'with scheme' and 'without scheme' scenarios)

Net Present Value of traded sector carbon dioxide equivalent emissions of proposal (£): £254,441
(N.B. this is not additional to the appraisal value in cell I17, as the cost of traded sector emissions is assumed to be internalised into market prices. See TAG Unit A3 for further details)

*positive value reflects a **net benefit** (i.e. CO2E emissions reduction)

Change in carbon dioxide equivalent emissions by carbon budget period:

	Carbon Budget 1	Carbon Budget 2	Carbon Budget 3	Carbon Budget 4
Traded sector	0	0	-1744.00	-4629.00
Non-traded sector	0	0	-1751.00	-4647.60

Qualitative Comments:

Sensitivity Analysis:

Upper Estimate Net Present Value of Carbon dioxide Emissions of Proposal (£): £601,079

Lower Estimate Net Present Value of Carbon dioxide Emissions of Proposal (£): £200,360

Data Sources:
NATS FRA emissions analysis using AirTop Simulation
Traffic data: EUROCONTROL's Network Strategic Tool (NEST)
Aircraft performance: BADA v3.13/v4.2