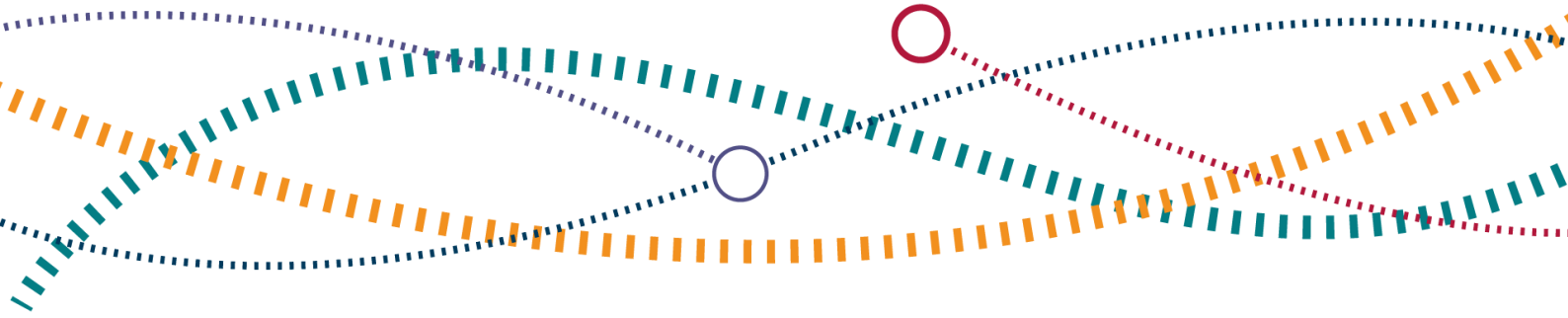
Supporting annexes

Periodic review of HS1 Ltd 2024 (PR24): Draft Determination

30 September 2024



Contents

Annex A: Asset management

A.1 Here we set out parts of HS1 Ltd's submission which were particularly important to our assessment against its General Duty, and formed the basis for our conclusions and key findings.

A.2 This annex also sets out a graphical approach we developed, to explain our opinion on the maturity of each asset group; and to highlight opportunities for improvement in CP4.

Key asset management documents:

A.3 HS1 Ltd's 5YAMS included Specific Asset Strategy (SAS) documents, each representing a different asset group:

- Signalling and Control Systems (SCS)
- Civil Engineering and Environmental (referred to in this document as "Route Civils")
- Track
- Overhead Catenary System (OCS)
- Mechanical & Electrical (M&E)
- Traction Power Supply (TPS) – in our Draft Determination conclusions, we refer to the OCS, TPS and M&E asset groups together as "Electrification"
- Stations – Civils
- Stations – Lifts & Escalators (L&E)
- Stations – Mechanical & Electrical Plant (MEP)
- Stations – Digital & Communications (D&C)

A.4 As well as the SASs, HS1 Ltd's submission included the following additional strategies:

- Safety Strategy
- Sustainability Strategy

- Joint Research & Development (R&D) Strategy
- Engineering Access Strategy
- Rail Plant Strategy
- Renewals Strategy
- Operations Strategy

A.5 HS1 Ltd presented a clear, logical structure of asset management documents that are in line with best practice (as defined by the ISO55000 series of standards) for structuring its asset management. The key components are:

- HS1 Ltd' s strategic objectives are brought together in the strategic asset management plan (SAMP);
- more detailed, long-term asset strategies are detailed by asset groups in separate specific asset strategies (SAS).
- detailed implementation is laid out in the 5YAMS for route; and the Life Cycle Reports (LCRs) for stations. These provide the granular plans for the next five-year control period, CP4.

A.6 The SASs all now have the same format which provides consistency and allowed us to undertake benchmarking of maturity between the asset groups. We concluded that the more mature asset groups (Track and Electrification) resulted in more concise, more effective SAS documents which clearly prioritised issues and were supported by robust data.

A.7 HS1 Ltd's asset management objectives are clearly linked to forecast use of the network and potential scenarios for growth. This is a major improvement since PR19 and is a useful tool for addressing uncertainty since the COVID-19 pandemic. This maps to best practice around strategy and planning in ISO55000. We think that there are opportunities for further improvement, by providing more detail behind the analysis for the chosen option and objectives. The way in which specific asset groups are sensitive to these changes is discussed, but there is more scope for laying out options which may have an overall system benefit.

A.8 The structure of the SAS documents maximises the potential for in-asset group plans to be explicit. This approach, however, is underdeveloped in the areas of asset interface and impact on each other, as well as not being explicit on how

system issues, and cost trade-offs between asset groups, are managed through the 40-year plan.

A.9 The system cost policy represents a significant step forward for allocating costs to the renewals plan. However, some asset groups have more mature plans than others. The mechanism of trade-off between asset intervention choice and forecast cost is not clear through the documents. Work through CP4 will be critical to understanding the costs of key investments in the network, and the asset data and information that is needed to support these decisions. Consideration of the trade-offs between access and intervention is another area of opportunity for maturing the planning process.

A.10 A system strategy would likely help to flush out system-level efficiency. Each SAS currently discusses its effect on other assets, but it is quite clunky and difficult to relate these to each other and see the line of sight to the costs. As the 40-year programme moves forward more renewal and more opportunity for integrated planning will undoubtedly give rise to bigger opportunities for efficiency.

A.11 The structure of each SAS is effective, although the Route Civils SAS could benefit as time moves on from being broken into multiple parts to represent the diversity of assets within that group. Earthworks, drainage and structures all have very different demands, and intervention needs through the 40-year plan.

A.12 Plans to address significant high-consequence, low-probability risks have opportunity to develop. The limited size of the HS1 network should allow for clear, concise, agile management of an unpredictable risk such as climate change. This opportunity is currently being missed by the omission of a specific climate change adaptation or weather resilience SAS.

A.13 Asset strategies focus heavily on ‘asset need’ and are very light on delivery, procurement or estimating. Separate delivery strategies are hard to align back to the specifics of estimating long-term asset interventions. The line-of-sight documents could benefit from showing clearly how multiple potential asset interventions are traded off against other constraints. It is not clear how whole-life costs have been developed for each asset group and how these have been traded to optimise the system cost. This represents an opportunity for future development and for long term cost reduction.

Asset Management Maturity

Line of Sight

A.14 The HS1 Ltd submission follows a structure in line with asset management best practice. Its strategic objectives are rolled into the SAMP for which the implementation is laid out in the five-year asset management plan for the next control period, and this is supported by the long-term asset strategies which are detailed by asset group in the SASs.

A.15 In a step forward since PR19, the asset management objectives are clearly linked to forecast use of the network and potential scenarios for growth. This maps to best practice in the strategy and planning subject areas from ISO55000. However, the detail behind the analysis for the chosen option and objectives is not given significant attention. The way in which specific asset groups are sensitive to these changes is discussed but there is more scope for laying out options which might have an overall system benefit.

A.16 System issues, integration through asset types and cost trade-offs through the approach to the 40-year plan represent some opportunity for further development of this line of sight through the next control period.

Opportunities identified in the Line of Sight

A.17 There has been some consultation with operators on the trade-off between access to the network and key strategic asset management renewals, notably the CP4 ballast renewal. These discussions need to continue as HS1 Ltd and its suppliers work through detailed delivery options. Further development of how renewals and access are traded against each other would benefit the whole system and 40-year costs and should be a high priority for further work.

A.18 The system cost policy represents a significant step forward for allocating costs to the renewals plan. However, some asset groups have more mature plans than others. The mechanism of trade-off between asset intervention choice and forecast cost is not clear through the documents. Work through CP4 will be critical to understanding network costs and ways of trading off costs between assets or between access and intervention is another area of opportunity for maturing the planning process.

A.19 A system asset strategy would likely help to flush out system level efficiency. Each SAS currently discusses its effect on other assets but it is quite clunky and difficult to relate these to each other and see the line of sight back to the costs. As the 40-

year programme moves forward more renewal and more opportunity for integrated planning will undoubtedly give rise to bigger opportunities for efficiency.

A.20 The level of each SAS is effective, although the Civils SAS could benefit as time moves on from being broken into multiple parts to represent the diversity of assets within that group. Earthworks, drainage and structures all have very different demands and intervention needs through a 40-year plan.

A.21 Plans to address significant high consequence, low probability risk have much opportunity to develop. Climate change adaptation and weather resilience as an example does not have a specific asset strategy. This appears an omission from the current submission.

A.22 Asset strategies focus heavily on 'asset need' and are very light on delivery, procurement or estimating. Separate delivery strategies are hard to align back to the specifics of estimating long term asset interventions. The line-of-sight documents could benefit from showing clearly how multiple potential asset interventions are traded off against other constraints. It is not clear how whole life costs have been developed for each asset group and how these have been traded to optimise the system cost. This represents an opportunity for future development and for long term cost reduction.

Items considered as best practice developments in this submission.

The alignment between AM objectives and scenario plans for network use/growth.

A.23 The updates to the SASs which all now have the same format which makes it helpful to understand how mature each asset group is. Strategies for assets with greater management maturity are clear in that they can articulate plans concisely and with clear timebound plans.

Assurance by HS1 Ltd

A.24 Details of assurance and challenge by HS1 Ltd on NR(HS)'s plans for CP4 were provided and contained a comprehensive summary of site visits, meetings and changes to the plan. While comprehensive and clearly showing evidence of challenge, these documents are not systematic assurance processes and a further step into greater maturity would be the inclusion of some independent challenge or sensitivity analysis on scenarios.

A.25 This will become more significant as the renewals workbank grows into CP5-8. Assurance on the workbank shared is almost exclusively about renewal intervention. Further assurance metrics could be developed to help understand data quality for asset modelling and for costs / estimating. The link between asset intervention and the trade off with estimates is also an area with limited assurance.

Graphical representation of ORR's maturity assessment

A.26 We found significant differences in the level of asset management maturity between different asset groups. In one of our deep-dive sessions, NR(HS) presented a useful figure, showing three key elements for improving maturity in CP4:

- improving how it gathers data, e.g. train-borne cameras, inspection drones etc;
- improving how it processes data, e.g. databases which allow asset managers to find data easily and to see trends between different datasets; and
- improving decision making, e.g. tools which forecast when each asset will need maintenance and renewals; and allow asset managers to estimate costs and risks for different scenarios.

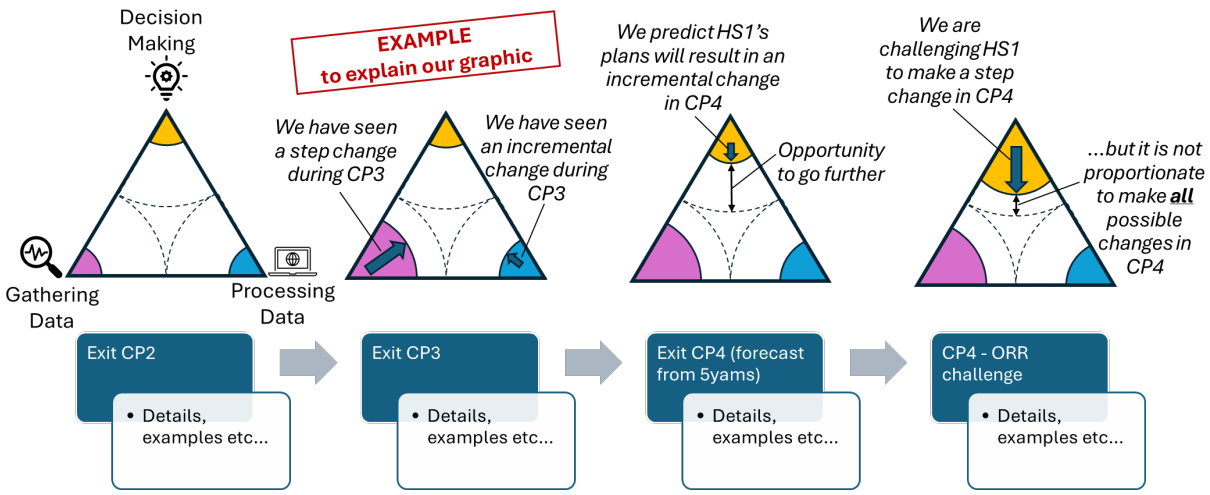
A.27 We agreed that these are the three fundamental changes which need to be made in order to move from simple, cyclic plans to more mature plans – where the right work is carried out, at the right time, for each asset. So, our review has focused on these three factors.

A.28 We have reviewed HS1 Ltd's PR24 submission and the details provided by NR(HS) in our deep-dive sessions, and we have looked back at evidence and discussions during CP3. We have looked for examples of successful changes in CP3; and examples of issues which we do not want to repeat. We have also looked for areas where there are opportunities for significant changes in CP4 – and whether we are satisfied that HS1 Ltd and NR(HS) are planning to seize all of these opportunities.

A.29 We are presenting our conclusions in a graphical form, as triangles, where each corner represents one of the three key factors listed above. These are qualitative and they represent the independent opinion of our subject-matter experts. This includes our independent opinion on the current status of each asset group; our prediction of how much improvement will result from the current plans; and whether any further improvement is possible. We recognize that our opinion may

differ from HS1 Ltd or NR(HS). The purpose of these triangles is **not** to try and agree an exact score for maturity in each asset area. **The sole purpose of these triangles is to compare the approaches in different asset groups – then to highlight the areas with the greatest opportunities to go further.** These opportunities should be the focus for our discussions in PR24 and throughout CP4. An example to explain our triangle graphic is shown below.

Figure A.1 Asset management graphic example



A.30 We recognise that within each asset group there are different assets with subtly different levels of maturity. For example: within the civils group, the drainage, structures and earthworks assets use different data and models. We have provided details and examples for each asset group, noting any particular differences within the asset group. But we concluded that the sub-assets are fundamentally similar in terms of the opportunity for a step change in the use of data and degradation models. So, we have only presented triangles for each asset group.

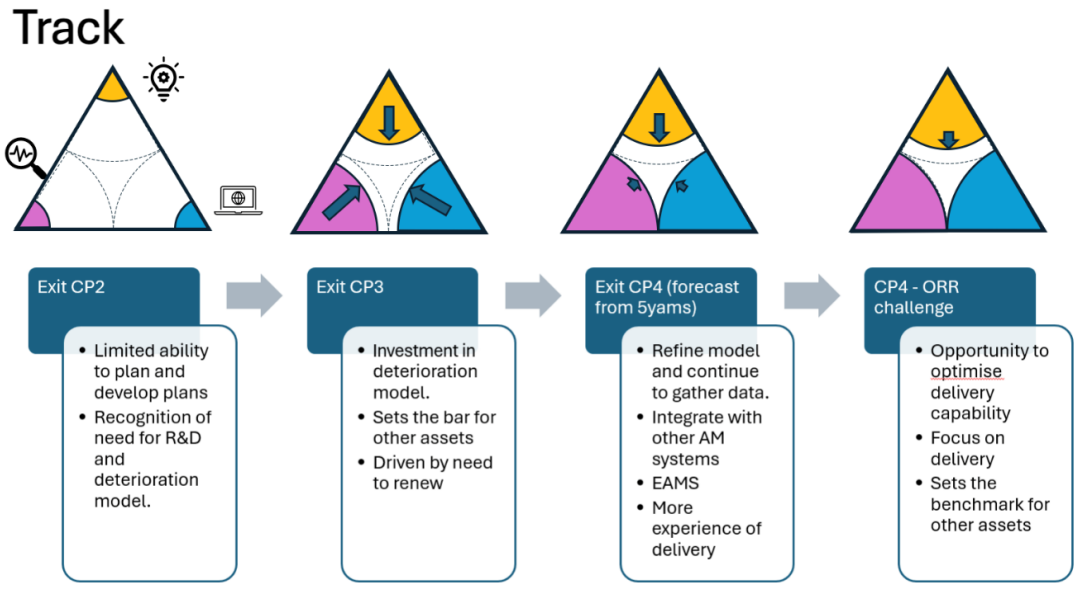
A.31 It should be noted that the unique way in which this railway is funded means that the maturity of plans extending 40 years into the future directly influences the charging for operators in the next five years. This means that opportunities to refine future plans, which include a lot of uncertainty, have an effect on the annual charges today. Our review considered how improving maturity in CP4 might affect both short- and long-term efficiency. years. This means that opportunities to refine future plans, which include a lot of uncertainty, have an effect on the annual charges today. Our review considered how improving maturity in CP4 might affect both short- and long-term efficiency.

Specific Asset Strategies – Maturity by Asset Group

Documents referred to: Appendices 3-9, NR(HS) 5YAMS, 26 January 2024

Track

Figure A.2 Track asset management maturity graphic



A.32 At the time of PR19, the needs of the Track assets were modelled in terms of theoretical time-based interventions. CP3 plans for renewals were not optimised as neither asset condition understanding or renewal delivery were mature enough. At PR19 this was recognised in the periodic review as not representing best practice asset management and we proposed an R&D fund to facilitate a step change in track deterioration modelling. This was successfully developed and used to enable a full workbank review in the mid-point of CP3 to identifying work that had the potential to be deferred into CP4, to allow for better workbank planning and further asset modelling.

Brief summary of position now, at end of CP3

A.33 The asset deterioration model for track has set the bar for other assets. As network renewals are funded by an annual charge that is the result of a 40-year plan, the ability of the model to take data on actual wear and deterioration and forecast over the 40 years is a big step forward. Not only did this allow reprofiling of renewals during CP3 when delivery options were still developing, it also allowed clear profiling of demand scenarios, in response to COVID and a drop in traffic.

A.34 At the end of CP3 track work is being delivered successfully but at a much-reduced volume to that identified in the PR19 planning process. The work undertaken on points and re-railing at St Pancras station has been successful at showing how work can be integrated. And over the last two years track asset delivery has increased to give confidence in the delivery of non-complex asset renewal and refurbishment. From years 4 and 5 of CP3, volume of delivery and certainty of cost has increased preparing the way for further step changes in the early part of CP4.

Summary of support for plan outlined in PR24 (5YAMS)

A.35 The track asset strategy focuses on the use of data, automation and technology to manage the balance of safety / risk and performance.

A.36 The development of a track plain line deterioration model has allowed a step change in planning and asset management efficiency to be released to the system without any imported risk. This is leading within the HS1 system and should be the base line for other asset groups. Plans to develop this are best practice – refining data inputs should be a priority.

A.37 Development of the track deterioration model is clear in its direction, benefit and need. Track represents the majority of the asset renewal spend at approximately 50% of the total 40-year spend, and 25% of the CP4 maintenance spend. Small changes in direction and refinement of the model will have significant benefits. Plans for further development are supported and proportionate.

A.38 Risks identified on NR(HS)'s 'road map' include the Enterprise Asset Management System (EAMS) and the capability of the workforce to execute data collection. The evolution programme is clear in its intent to deliver these foundational blocks.

A.39 During CP3 maintenance costs have been dominated by maintenance plant and labour. These costs will increase with time as the asset deteriorates. Further development of the deterioration model is essential to drive the right balance between maintenance costs and renewal costs. This balance is taken care of through the model with further refinement planned.

A.40 Example of initiatives driving efficiency include refinement of tamping programme and updated rail head treatment strategy.

A.41 The most significant cause of delay through CP3 has been from failure of insulated rail joints which remain a weakness in the system – extreme hot weather was the main cause of failure and plans for dealing with this in future are noted in the strategy. We are reassured that the maturity of the track model has helped and will

continue to help make agile changes, to mitigate hotter weather. This is one of a number of areas that would benefit from being rolled up into a specific plan for dealing with the effects of weather resilience and climate change.

A.42 The CP4 plan is heavily dependent on large volumes of ballast renewal which at this point has been placed in the later end of the CP in order to allow time to develop a procurement strategy. This work is the largest renewal activity ever undertaken on the network. The greatest opportunity to improve maturity of management of track assets in CP4 will be learning from this experience of large-scale procurement and delivery.

Key challenges – and opportunities to go further

A.43 The current plan depends heavily on delivery of ballast renewal activity in the last two years of the plan. The plans for this work are still in development. At the time of the review there were multiple options available and limited ability to be certain of costs and timing. Our review concluded that plans should be reviewed and the profile 'smoothed' to make it more realistic. HS1 Ltd and NR(HS)'s plans already recognise the opportunity to learn from this delivery experience. This will be a key area of focus for us during CP4, to ensure lessons are being learned quickly and shared with other asset groups.

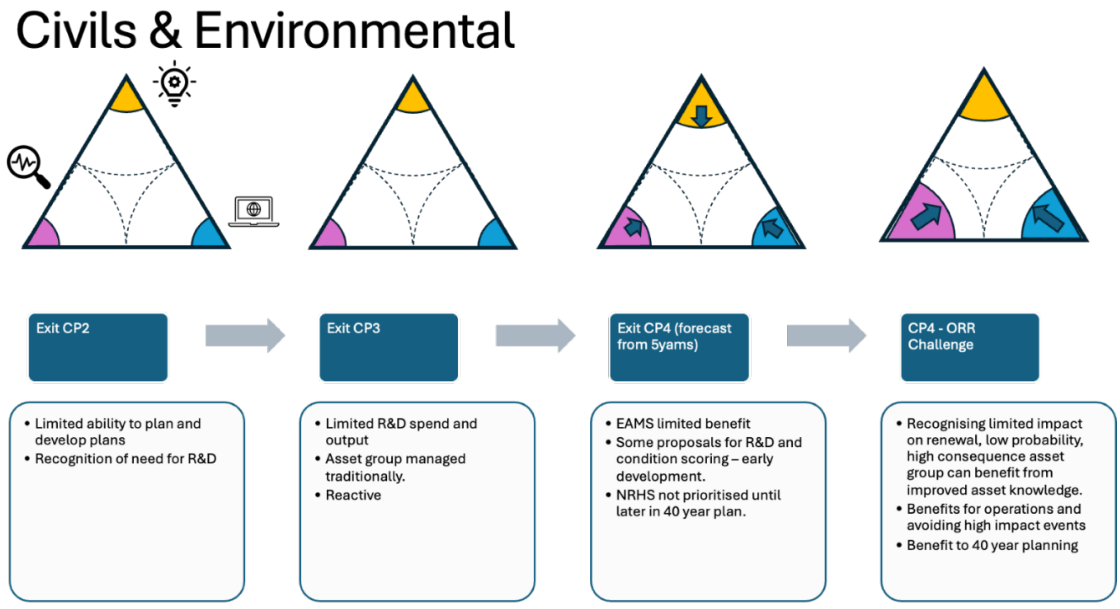
A.44 Gaps in data need to be systematically resolved and whilst the track model is best in class, work is needed to improve the quality of historic data. It is not clear what the size, scale and impact of this work is from the SAS. Plans for this iteration of the model should be prioritised to inform the 40-year plan.

A.45 The quality of train-borne data is identified as a risk and work is ongoing to improve the accuracy and repeatability of train-based collection. This work is identified and offers benefits to the 40-year plan costs.

A.46 Automation of data and controls on data quality are needed to leverage further benefit from the model. The 'one plan' evolution programme covers this, but it is not directly clear how the SAS roadmap and the 'one plan' relate. Opportunity exists to keep the momentum on the model development by pushing forward in CP4 with this next level.

Civils & Environmental SAS

Figure A.3 Civils & Environmental asset management maturity graphic



Brief summary of position at PR19

A.47 At the time of PR19, the needs of the Civils & Environmental assets (earthworks, structures and drainage) were understood in terms of their design life. The long-life nature of these assets meant that simple, traditional management approaches were appropriate. The main challenges at that time were condition issues with earthworks caused by burrowing of rabbits and water ingress to the tunnels. Some emerging issues with sound barriers were beginning to attract attention. All of this was relatively low spend. The risks with this asset group were rightly assessed as long term, low probability, high consequence risks. Through CP3 model development was simple and appropriate.

Brief summary of position now at end of CP3

A.48 Further work has been carried out to develop a simple model to allow planning into the future. This is based on traditional capture of information, judgement and a simple scale for deterioration.

A.49 Because the large civils renewals are still far in the future, there has been little urgency by HS1 Ltd/NR(HS) to gather data in CP3. However, when detailed degradation modelling is needed in future periodic reviews, there will be a lack of high-quality historic data – because data is not being routinely collected today.

Brief summary of support for plan outlined in PR24 (5YAMS)

A.50 The development of a simple model using asset data and judgement will provide some incremental benefits. Further developments to enable an understanding of this varied asset based would help develop a best practice 40-year plan. The plans provide a foundation, but more is needed to develop a roadmap to best-practice for these assets.

A.51 Thinking on approaches to asset management such as drones for inspection and sensors to show early movement within earthworks are being pursued through the R&D programme. These projects need to focus on delivering Pareto-optimised products, which can be put into use and deliver benefits immediately, in terms of maintenance prioritisation and optimising the 40-year plans.

Key challenges – and opportunities to go further.

A.52 Water ingress in tunnels has been a low-level challenge throughout CP3, but led to a significant issue when pumps were overwhelmed at the Thames Tunnel in December 2023. This highlighted opportunities for short-term benefits from better data and modelling, for example, better understanding where water enters the HS1 network and how the drainage system functions as a network with neighbours. While large renewals may still be several control periods in the future, there are significant opportunities for short-term performance and efficiency as well as optimising the 40-year renewals plan well in advance of the works.

A.53 There is opportunity to focus and accelerate basic understanding of this asset group such as completing an asset inventory for all drainage with condition data; and mapping the water network. Focus should be on reducing the potential for high consequence, low probability events. This can only be done by having complete inventories and system level understanding. The drainage asset is highlighted as in particular need of review in this light.

A.54 Assets are described as being modern and designed for weather resilience and climate change adaptation – however this is an area of significant uncertainty. There is opportunity to create a single cross asset plan for climate resilience. This would help avoid ‘spiky’ investment and enable the 40-year plan to be developed for climate change adaptation and mitigation.

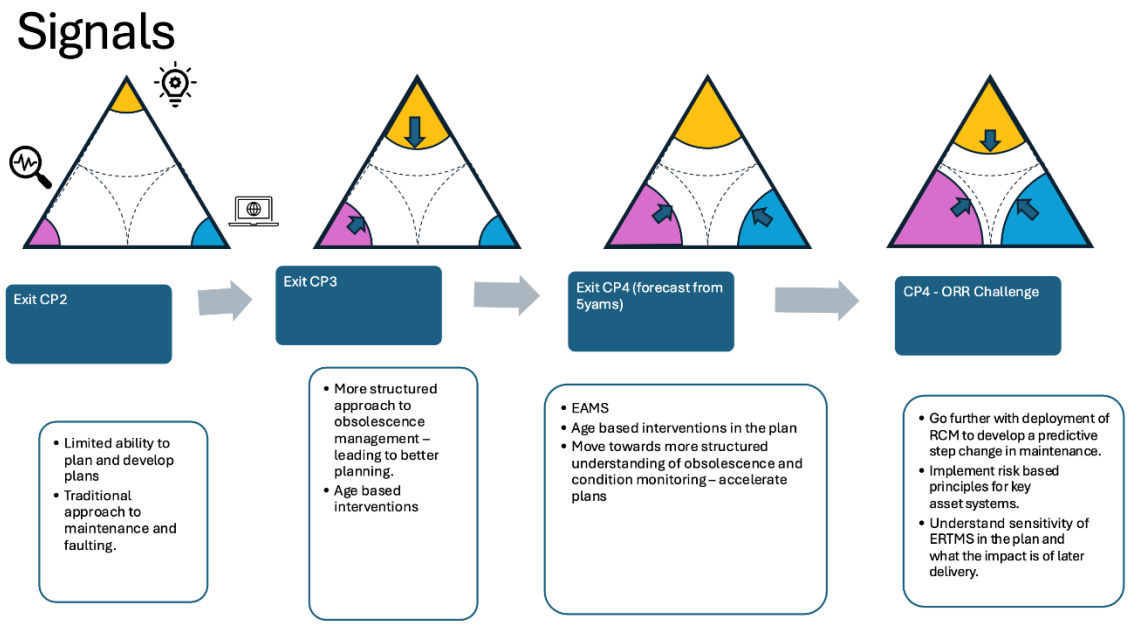
A.55 We have already seen in other asset groups, the short-term impact of climate change and the need to adapt quickly, e.g. extreme hot weather in CP3 caused issues with insulation joints. Having mature data and models is vital to enabling rapid, agile changes to plans in response to emerging environmental threats.

A.56 Earthworks show several assets in poor condition – there is recognition of rabbit burrowing as being a risk to several assets. It is not clear what actions are being taken to mitigate risks to the earthworks and there is opportunity to develop assessment information allowing a longer-term resilience to be understood.

A.57 In structures, establishing mature datasets now (well in advance of the large renewals) will provide robust historic data on degradation, sensitivities to traffic, axle loads, weather etc, which will allow more optimized plans in the future. This should not be put off until future control periods.

Signalling and Control Systems (SCS) SAS

Figure A.4 Signalling and control systems asset management maturity graphic



Summary of position at PR19

A.58 At the time of PR19, the needs of the SCS asset group were modelled in terms of manufacturers recommendations for component life. CP3 plans for signal renewal were not significant as most of the system is able to be maintained and is due for replacement in the next 10-20 years. Obsolescence has been a driver for renewal planning and work with NR(HS) to understand how assets are performing and extending design lives has proved a reasonable strategy.

Brief summary of position now at end of CP3

A.59 At the end of CP3, renewal of the fixed signalling system at St Pancras has been deferred into CP4 to allow better integration with other works and better planning.

A.60 Work with NR(HS) continues to manage obsolescence and track asset performance. Plans for the specified upgrade of European Rail Traffic Management System (ERTMS) have started which is a significant system wide change affecting rolling stock and infrastructure.

Brief summary of support for plan outlined in PR24 (5YAMS)

A.61 The identification of obsolescence as a key driver for future renewals and the detailed analysis of this stands out as a best practice example of how data and information can drive interventions. It is also helpful that HS1 Ltd see obsolescence as a network issue (not just one asset type) and the approaches in all asset areas are similar.

A.62 Agile approaches outlined in the SAS for using real time asset performance on points equipment show how improvements to asset management can improve performance and safety risk – and reduce costs from delays and reactive work. This approach of analysis and action across the network has led to benefits to the whole system. This agile way of working should be considered for all asset groups.

A.63 Analysis of NR(HS) forecast end of life versus manufacturers design life highlights the potential for cost savings in the long term and for the better smoothing of renewal activity. We support this work which matches the direction of the track asset, but we concluded that the benefits to the 40-year renewals plans have not yet been worked through.

Key challenges – and opportunities to go further.

A.64 The renewals programme contains several ‘spikes’ in investment, based on simple assumptions (either through obsolescence, or end of life analysis). There is opportunity to smooth this through more mature data and modelling, to undertake renewals only when they are needed; and continued focus on finding more *solutions* for obsolescence risks (through design, or maintenance capability), as opposed to simply cataloguing obsolescence risks. These should be the focus of CP4 asset management maturity discussions.

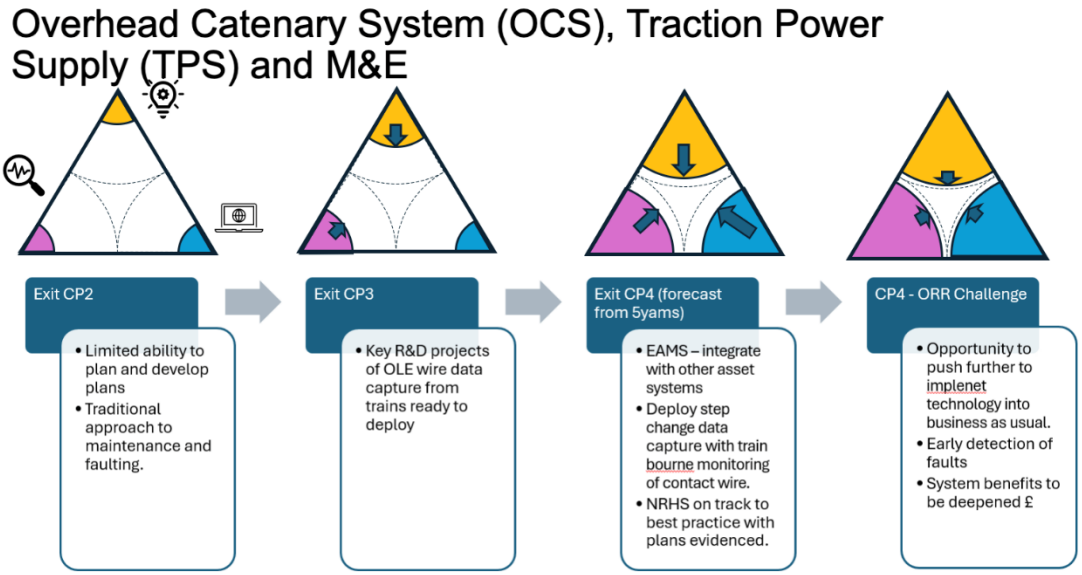
A.65 Care around the interface with specified upgrades like ERTMS is needed to make sure the existing critical asset base is resilient to changes in the plan. Further detailed analysis is needed to understand sensitivity to this programme to

understand the risk of asset failures. Again, having mature databases and models may prove critical, if HS1 Ltd ends up having to look at alternative scenarios for the timing of ERTMS versus life-extending some assets.

A.66 There is opportunity to improve the way in which track maintenance data for the maintenance of track around S&C is used to prevent failure of points equipment. The trade-off and interface between asset groups is an area for development through the control period.

SASs - OCS, TPS and M&E – referred to in our conclusions as "Electrification"

Figure A.5 OCS, TPS and M&E (electrification) asset management maturity graphic



Brief summary of position at PR19

A.67 The OCS asset group and the M&E asset group were both in relatively good condition. These asset groups maintained a very low level of impact on train performance. Renewal of M&E equipment is generally driven by obsolescence and plans to better understand asset life and obsolescence risk were proposed at this stage. Management and maintenance processes were in line with other similar asset owners.

A.68 TPS assets are in generally good condition and are long life assets. Some challenges exist and continue to exist with obsolescence.

Brief summary of position now at end of CP3

A.69 Significant, agile development has led to a number of R&D projects realising their value and going from initial trials to full implementation on a cross-network basis, within a short space of time. LiDAR and optical recognition equipment has been developed with partners and has the ability to transform the asset management from reactive to proactive and system / data-driven. Other asset groups should learn positive lessons from this work, to accelerate their plans for asset management technology.

Brief summary of support for plan outlined in PR24 (5YAMS)

A.70 Plans to automate visual inspections is a leading area with clear development and learning from CP3, leading to a clear plan into CP4. The plan to have this in place prior to the start of CP4 is a good example of what can be achieved by developing technology with system partners (Southeastern and Hitachi). Roll out onto Cl 395 trains in CP4 is likely to lead to a step change in understanding the contact wire system. Benefits are expected to roll through into the long-term asset plan.

A.71 The general direction of the OCS asset management is driving out manual inspection, doing more in shorter access and improving accuracy and predictability of asset life. This approach could be seen as best practice asset management.

A.72 Current asset performance (at 0.64 delay seconds per train) is shown in the SAS as due to analysis and understanding of the asset group. This also highlights the importance of mature models for delivering short-term efficiencies, not just savings in the 40-year plan.

A.73 Capability and improvement enhancement plans for M&E equipment represent an evolution of the asset management approach which offers real cost savings through targeted maintenance.

A.74 There is traffic capacity on HS1 allowing for increases in volume and the TPS assets have capability to deliver against foreseeable rolling stock and traffic volume changes. HS1 is continuing to review this with UK Power Networks (UKPN) which has undertaken power modelling for the current timetable. Any significant changes to the timetable (not thought likely in the scenarios modelled in this 5YAMS) would require remodelling with UKPN.

Key challenges – and opportunities to go further

A.75 Noting that the OCS has been designed with a tensioning system for wire expansion or contraction in extreme temperatures, it is not clear what plans HS1

Ltd has to understand the sensitivity of these and other risks to the contact wire (such as high winds) in a system-level weather resilience plan.

A.76 As part of integrating asset management system-thinking and the forthcoming large ballast renewal programme, there is an opportunity to understand how the gap to the OCS can be maintained rather than constantly reduced because tamping only ever lifts track. Asset management trade-offs between gap / time-to-tamp and the strategic design of re-ballasting could be integrated in this way.

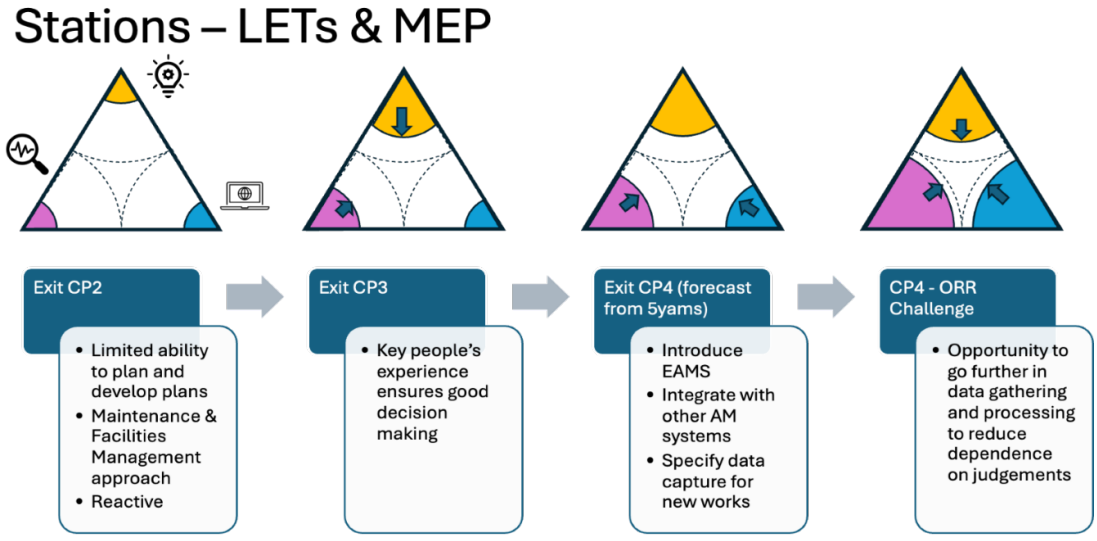
A.77 The work to date on obsolescence shows the growing difficulty of keeping on top of the changes manufacturers make to supported equipment. The challenge of extending life for best practice asset management versus obsolescence presents opportunity for an improved business case.

A.78 Roll out of EAMS needs to effectively store and track asset performance.

A.79 Points heating equipment and potential for overheating of equipment: it is not clear how these systems might perform when stress-tested under further extreme weather. This would benefit from being part of a weather resilience strategy.

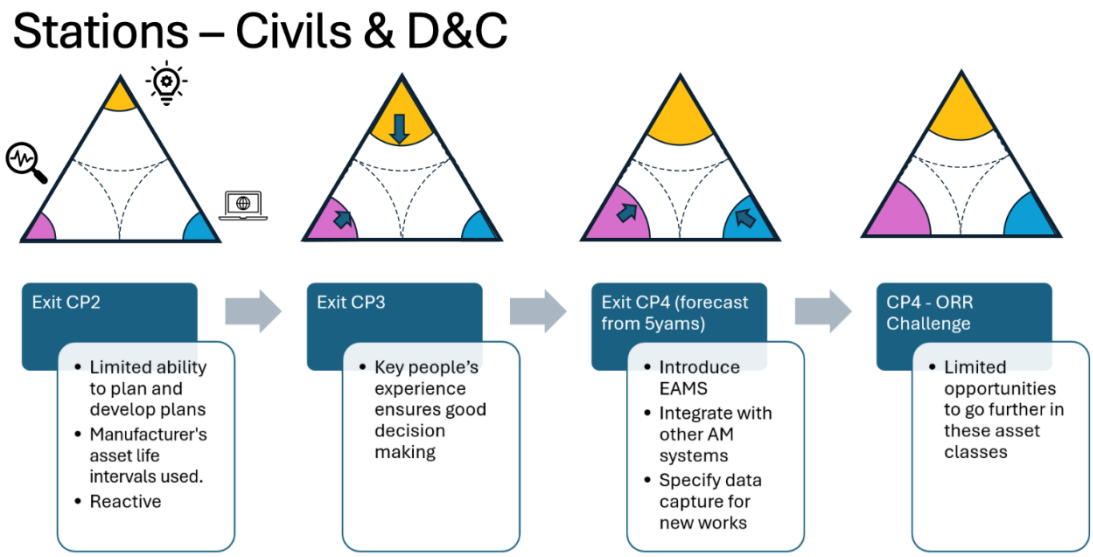
Stations L&E SAS and MEP SAS

Figure A.6 Lifts, Escalators and Travelators (LETs) & MEP asset management maturity graphic



Stations Civils and Data and Communications

Figure A.7 Civils & D&C asset management maturity graphic



Brief summary of position at PR19

A.80 This is the first time that we have regulated station renewals. During PR24 all stations were visited and the history of previous approaches reviewed. There were three visits to St Pancras International station, and one to each of Stratford International, Ebbsfleet International and a day at Ashford International.

A.81 We note that since PR19 the use of stations and the demand from operators has changed significantly. At PR19 a reactive repair and maintenance approach was the primary basis for interventions with renewals often based on manufacturers timelines for asset life.

Brief summary of position now at end of CP3

A.82 Throughout CP3 there have been challenges with the availability of lifts, escalators and travelators. Obsolescence and availability of suppliers has also affected plans for maintenance and renewal.

A.83 Civils assets were the subject of developing understanding particularly around the transition roof at St Pancras International. Delivery of the plan generated a significant number of change controls to cost or timing. We concluded that these were symptomatic of immature planning and estimating, based on simple models of design life. Actual condition / degradation was different from the assumptions, leading to short-notice changes and reactive works.

A.84 HS1 Ltd recognised challenges in NR(HS)'s contractor management and has put in place relationship management to help steer this work towards better performance.

Brief summary of support for plan outlined in PR24 (5YAMS)

A.85 The SAS represents a step forward and starts the journey of bringing the stations assets in line with the route asset management approach. It is hoped that this will lead to ISO55000 accreditation by NR(HS) during CP4.

A.86 Plans for the assets in CP4 have all been developed to have a timed renewal for every asset in the 40-year plan. Deterioration has been based on simplified judgements of condition. The next step is to develop better understanding of asset condition and degradation, such that 40-year plans can be made more efficient – and asset outages can be reduced.

A.87 CP4 is seen by HS1 Ltd and NR(HS) as a transitional period, allowing gradual evolution of EAMS and asset data systems to start gathering and integrating asset data.

A.88 Asset management decisions are currently led by expertise, to ensure risk and investment are traded-off. CP4 will start to see more reliance on data and models, rather than expert judgement. However, we consider that this change will be incremental, rather than a step change in the ways of working.

A.89 HS1 Ltd and NR(HS) plan to install monitoring / data capture on assets when they are renewed. There are only limited renewals planned in CP4, this means that improvements in data gathering will only be incremental.

A.90 The TOTEX model and work type mix has been developed since CP3 based on an allocation of risk score to every asset.

Key challenges – and opportunities to go further

A.91 Asset data forming and underpinning decision making: Incrementally installing monitoring on assets as part of renewals, will take several control periods to build up a complete dataset. We see an opportunity to accelerate this by actively seeking ways to gather data earlier, e.g. from cameras, power consumption data etc. The opportunities for this are much greater in LETs and MEP, than in Civils and D&C assets, hence why we have shown these assets differently in our triangles. We would encourage the use of R&D projects to accelerate this, but we note that stations O&M funding (and hence stations R&D) is outside the scope of our determination.

A.92 The first application of a cost policy has some innovative ideas within it, but is still limited by the simple, cyclic plans for renewal volume. We are assuming efficiencies in the 40-year volumes through better asset knowledge, but HS1 Ltd will need better data and models to test this assumption and optimise the 40-year plans at the next periodic review.

A.93 The roadmap for stations assets does not have a clear link to NR(HS)'s 'evolution one plan'.

A.94 The work type mix and number of assets invested in has changed since PR19, but overall investment is similar to CP3. This could yield similar challenges, until data and models are available to provide more assurance to the plans.

A.95 Several areas of concern, such as metal fatigue in LETs is noted in the SAS, as well as the higher-than-expected wear rates. These are technical issues which lend themselves to analysis using asset data and sensitivity modelling, which would likely yield significant efficiencies in the long-term plans.

Annex B: Efficient cost review

B.1 The costs for CP4 fall into several broad categories. Table B.1 summarises the key CP4 cost lines and their origin.

Table B.1 Key cost lines in CP4

Key cost line	Category	Estimate produced by	Cost £m (February 2023 prices)
Renewals	Station	NR(HS)	48.80
Renewals	Route	NR(HS)	178.39
Renewals to maintenance	Route	NR(HS)	37.53
Operation & maintenance	Route	NR(HS)	251.96
Other (Management and overhead)	Route	HS1 Ltd	73.70
Pass-through	Route	HS1 Ltd	121.70
Contract Risk	Route	NR(HS)	6.69
R&D	Route	NR(HS)	4.04

Source: HS1 Ltd 5YAMS and supporting documents

B.2 Below we detail the assessments undertaken on these costs and our conclusions.

Cost categories

O&M costs

B.3 NR(HS) provides resources to operate and maintain the infrastructure for HS1 Ltd. The resource level required is based on the service level agreed with the operators that will allow HS1 Ltd to deliver its obligations and manage its concession. PR24 O&M costs consist of HS1 Ltd costs of £73.7m and NR(HS) costs of £252.0m. Costs for CP4 are forecast to be 4% lower than the CP3 budget for NR(HS) and 7% lower for HS1 Ltd. The former is the result of efficiency challenges including contract risk reduction, the latter is a result of structural changes made to HS1 Ltd's organisational structure during CP3.

B.4 NR(HS) costs have been assured by HS1 Ltd. We met with HS1 Ltd and NR(HS) and challenged them on the O&M costs. Additional material was developed and provided by HS1 Ltd which highlighted the specific areas where HS1 Ltd has challenged NR(HS). HS1 Ltd's assurance covered appropriate areas and has encouraged efficiencies. However, we have carried out our own independent assessment of NR(HS) costs and identified opportunities for further efficiency. There has also been an independent review of the cost model by Turner & Townsend covering validation of input figures (these have since changed adding a minor risk) and arithmetic checks. This adds a degree of confidence in the model.

B.5 Regarding HS1 Ltd's own costs, we agree that there are some unique challenges to providing operational support to a suitable level, particularly in critical roles. There is a recognised limitation afforded by the size of the network which means that staff cover for leave, vacancies or overtime is difficult to manage optimally. This is likely to need innovative solutions to address.

B.6 For NR(HS) maintenance teams, HS1 Ltd was able to validate the link between staffing levels and the expected level of performance. The Rebel benchmarking study indicated that NR(HS) staff costs in this area were higher than other comparable systems. However, it is not possible to ascertain the level of service comparable systems used for benchmarking were required to meet. A less demanding performance requirement or level of penalty would allow a more balanced level of resourcing in this area.

B.7 HS1 Ltd indicated that there was potentially an opportunity to have a more efficient resourcing level for maintenance but this would increase NR(HS)'s risk exposure. The balance between additional cost related to resource versus financial penalties at a system level is complex and stakeholders may wish to consider whether they wish to rebalance as part of future planning rounds.

B.8 HS1 Ltd's review of NR(HS)'s maintenance team identified a high ratio of indirect to direct staff. This analysis was conducted before the revised target operating model was implemented and should be checked early in CP4 to ensure the CP3 changes are having the desired effect. HS1 Ltd has also identified during its site visits that there is scope to increase productivity of maintenance teams at a working level and it was able to confirm NR(HS) was actively targeting improvements in this area.

B.9 Absence rates in NR(HS) in both the operations, and support and maintenance, teams should be monitored by NR(HS) and HS1 Ltd through CP4. We recommend that action plans are developed by NR(HS) to understand and address staff

absence levels. We also suggest NR(HS) considers innovative solutions to address the issues associated with finding resources with suitable competences to cover leave and vacancies while maintaining agreed levels of safety and performance.

B.10 Overall, we found the O&M base costs, that is, number of staff and salaries at the start of CP4, to be appropriate.

Renewals costs

B.11 Keeping the railway operational requires regular renewal of assets in line with asset management policies and processes.

B.12 HS1 Ltd's CP4 plans have been created based on volume and unit rate data supplied by NR(HS). These workbank estimates then have factors applied for indirect costs such as design, project management and project (workbank) risk. These factors are aligned with Network Rail Infrastructure Ltd's (NRIL's) internal standards for estimating costs in use across the mainline rail network.

B.13 It is not reasonable within PR24 to review each individual unit rate; however, we have reviewed a selection, chosen based on value and significance or availability of comparable data. We found that unit rates were, on the whole, higher than NRIL rates. This is to be expected to some extent, as the opportunities to provide long-term security of volumes and work on HS1 are fewer than on the larger network operated by NRIL. Although competing for smaller work packages does potentially open the market up to a wider subcontractor base, the economies of scale and efficiency opportunities may not be available.

B.14 Provision is made for renewals in PR24, with variance in actual cost from forecast of individual work packages being subject to review by a governance panel (including HS1 Ltd, DfT and ORR) ahead of drawdown from the escrow account.

B.15 Given the information supplied and the responses received to our challenges, we concluded that the methodology to determine volumes was reasonable, but we have identified opportunities to improve asset management maturity in CP4, which we expect to allow volume plans to be optimised further in future plans.

Unit Rates

B.16 As the majority of the HS1 network is relatively new, there is limited information available on unit rates for tasks. To cost CP4, unit rates were derived by NR(HS) based on estimates obtained from NRIL or the supply chain. In some cases, these

were adapted for the complexity of the HS1 system or rounded up to cover unknown risk elements.

B.17 Once unit costs had been estimated, these were combined with volume information derived from asset management policies. The combined volume & unit cost information (referred to as the base estimate) also contains provision for design costs, contractor costs including profit, risk and mark-up. These are all added in line with NRIL standard practice or as per the HS1 Ltd commercial arrangements.

B.18 We recognise the issues with developing unit rates for what is essentially new work. We also note that the HS1 Ltd arrangements for drawing funds from the escrow account will add an additional level of scrutiny for each item in the workbank once funds are ready to be committed. The use of existing NRIL rates, which are based on historic project outturn, means that the unit rates include an element of realised risk which it would not have been possible to remove from the unit rates. We recognise that it is standard practice in NRIL's estimating practices to include a further provision for project risk, however, when combined with risk-inclusive unit rates and the potential for rounding up of rates there is a concern that there is the possibility of excessive provision, that is, double-counting risk and mark-ups. This is compounded by the additional mark-up levied by NR(HS) on top of the costs. We would therefore anticipate actual costs to be slightly lower once detailed HS1-specific workbank plans have been developed.

Benchmarking

O&M

B.19 Rebel was commissioned by HS1 Ltd to conduct a benchmarking review of the O&M costs of HS1 Ltd and NR(HS). We have reviewed the report and found that the process followed was robust and appropriate given the constraints in data. Rebel identified four areas where efficiencies could potentially be achieved by adopting best practice:

- **reduce the size of the signalling maintenance organisation and management organisation:** this would entail reducing the size of the OMR support team, signalling team and changing the approach to rapid response, saving approximately £2.3-£4.5m per year;
- **optimise HS1 Ltd and NR(HS) indirect staffing:** this would entail reducing the number of indirect staff in NR(HS), saving approximately £0.8-£2.0m per year;

- **lower management fee for NR(HS):** reducing the NR(HS) management fee from 8% saving approximately £1.4-2.2m per year; and
- **provide a better framework for cost reductions over time that reduces consistent outperformance:** this would entail changing the framework for outperformance, noting that NR(HS) has consistently outperformed in years where there has been no sharing, saving approximately £1.8-£3.6m per annum.

B.20 In total these proposed efficiency initiatives would result in an annual spend reduction of £6.3-£12.3m. The HS1 Ltd response identified £4m in annual spend reduction. This included £0.4m reduction in fees paid as a byproduct of other spend reductions.

B.21 We recognise the good work already done by HS1 Ltd to improve the efficiency of the system. We also recognise that not all the areas identified by Rebel are fully achievable, partly as some activities have already been undertaken in CP3 and partly as the impacts would be considered unpalatable to other stakeholders. However, our review independently concluded that there are opportunities for further efficiency in some of the same areas that Rebel identified, for example in fees and mark-up.

B.22 Additionally, outside of the determination, more could be done to reduce O&M spend but this would require a holistic view of risk ownership. For example, NR(HS)'s Contract Risk provision could be reduced, if operators were willing to take on more risk from delay payments themselves.

Stations – Rebel benchmarking

B.23 Rebel was also commissioned to conduct a benchmarking study of stations costs which reported in September 2023. We have reviewed the report and found that the process followed was robust and appropriate given the constraints in data and the number of available comparators.

B.24 In summary, the Rebel study found that HS1 Ltd has a logical and robust process for developing its planning assumptions and that renewals estimates (based on cost and asset information) are broadly consistent with comparators. However, although on-cost assumptions fall within the range of the comparators, they tend towards the higher end. Streamlining the escrow process and portfolio-level decision making could leverage efficiencies. Furthermore, HS1 Ltd could benefit from discussions with comparators about whether the underlying activities to achieve longer asset lives, for example, additional maintenance, might provide

value for money for HS1 Ltd. We have taken these factors into consideration in our review.

B.25 In 2019, HS1 Ltd commissioned Pell Frischmann to develop an asset cost projection report on its stations.

B.26 The report considered:

- cost (fluctuations in labour, material, adverse effects, fuel costs, budget cuts);
- scope (changes in product application, standards, methodology); and
- quantum (changes in aesthetics and materials, enhancements).

B.27 The report recommends the use of the Retail Price Index (RPI) to capture the expected fluctuations in rail-related inflation. At that point in time, RPI was still being used by NRIL for the majority of its contracts. This changed through NRIL's CP6 (2019-2024) plans and the latest periodic review of NRIL (PR23) determined that the Cost Price Index (CPI) was now more appropriate.

B.28 The report also identified that the key assets for stations will also be cost drivers, for example, station roofs, minor works, communications systems. Asset stewardship of these items will therefore need to be optimised to maximise efficiency in CP4 and beyond.

B.29 Pell Frischmann identified the overall skew of uncertainty based on cost risk an opportunity to reduce costs within its report. Its report noted that, at that time, there had been limited adjustment to on-costs for asset stewardship, which suggests more opportunities may exist than presented in their report.

B.30 Overall, this report, although five years old, contained some useful information. However, there are areas which are overtaken by events: for example, the railway industry has moved away from using RPI as a forecast for inflation to CPI. The observations on asset stewardship are well made and the observation on the skew of uncertainty aligns with the application of the cost policy. However, there is no quantification of the likely level of skew in the benchmarking, and the application of the cost policy to stations required a judgement call on the level applied. In the absence of historical evidence, a generic set of multipliers would be the default, however, this is a crude estimate and needs improving.

Inflation and indexation

B.31 Inflation has been a key concern of the UK economy during PR24, reaching a 40-year high during the current control period. However, inflation rates are now reducing. The Office of National Statistics recommended a move away from RPI to CPI in 2016. In general, RPI tends to be around 1 percentage point above CPI. Our PR23 final determination for NRIL was based on CPI, however there was also an element of input prices to reflect the variance in inflation experienced by different elements of the organisation.

B.32 NR(HS) contracts are in general based on RPI, however this indexation is being phased into CPI in the near future with the introduction of the Consumer Prices Index for housing costs (CPIH, see table below). We would expect NR(HS) to be moving to CPI-based indexation in all future contracts. If NR(HS) intends to utilise any element of input prices in future control periods it would be expected to fully justify this with evidence gathered through CP4.

Table B.2 Inflation rates for CP4

Period	RPI	CPI	Basis of Forecast
2025/26	3.01%	1.90%	Forecasts used internally by HS1 Ltd compiled from forecasts of UK banks, HM Treasury and Bank of England (BoE) as at January 2024.
2026/27	2.79%	1.83%	As above.
2027/28	3.26%	2.09%	As above.
2028/29	2.75%	2.00%	BoE's forecast of 2.00% CPI. For RPI, HS1 Ltd accounts for the wedge of 75 to 100 basis points between CPI and RPI, assuming the bottom of this range. Consistent with HS1 Ltd's internal forecasting principles.
2029/30	2.75%	2.00%	As above.
Long-term	2.00%	2.00%	Assumes CPI at BoE target. RPI moves to CPIH methodology in 2030.

Source: HS1 Ltd 5YAMS

B.33 HS1 Ltd applies a mark-up of 1.1% above RPI to NR(HS) costs as a protection against inflationary impacts. This factor is applied after NR(HS) costs have had inflation applied and is not compounded.

B.34 NRIL uses CPI, combined with input prices, to produce what it considers to be a more representative inflationary estimate for its future costs. We recognise that HS1 Ltd is smaller and will not be able to leverage the long-term cost reductions that NRIL should be able to achieve, however as RPI is above CPI there is already provision for this scenario. Noting that RPI is above the standard index used in NRIL, we have identified an inefficiency in the use of an indexation further above RPI.

B.35 Our review concluded that there is scope for challenge on inflation at RPI+1.1%. Removing this +1.1% would result in a cost reduction of £2.9m over CP4.

Mark-up and profit

B.36 In addition to the 1.1% mark-up above RPI, the concession agreement and Operator Agreement allow HS1 Ltd and NR(HS) to charge mark-up and profit on areas of cost on the network. This is charged on the total cost inclusive of risk.

B.37 NR(HS) commissioned Oxera in May 2023 to benchmark its management fee against levels of profit and mark-up in comparable infrastructure managers. HS1 Ltd commissioned Frontier Economics in November 2023 to review NR(HS)'s proposal of maintaining the management fee at 8% for CP4, including providing comment on the Oxera report.

B.38 The Oxera report goes into detail on both the methodology and mechanics of benchmarking. It recognises the uniqueness of the HS1 Ltd infrastructure and organisation, including the asymmetric nature of the risk impact of managing the infrastructure. The Frontier report raises a number of questions and challenges for NR(HS) and Oxera, but also recognises the asymmetric risk impact profile. Only the Oxera report results in a clear conclusion; when the impact of COVID-19 is removed from the calculation, a management fee in the range 7.2%-8.7% would be expected. The midpoint of this range is 7.95% and is slightly below the 8% proposed by NR(HS). The Oxera report concludes that, without the asymmetry in the pain/gain share, a lower range with a midpoint of 6.6% would be appropriate.

B.39 As maintenance costs (8%) have a lower levy than renewals (10%), the CP4 asset management strategy to undertake some renewal activities as maintenance interventions has reduced the spend in the control period by £0.8m in reduced mark-up costs. If a similar level of activity was able to be undertaken as maintenance in the future, the reduction in the annuity funding requirement would be significant. We think that this is a future opportunity that HS1 Ltd should explore.

B.40 Given the supplied information and the responses received to our challenges we recognise that HS1 Ltd considers itself to be within the boundaries of comparators. However, as indicated by the Oxera report a management fee of 8% is above the midpoint of the expected range because of the imbalance of the 'outperformance mechanism'. We have concluded that the current outperformance mechanism is not effective or efficient and there is support from HS1 Ltd, NR(HS) and operators to change this mechanism.

B.41 Having reviewed the available evidence, we recognise HS1 Ltd's desire to maintain the management fee at 8% however, noting the intention to change the outperformance mechanism, we have concluded that the efficient value for this element is 6.6%.

Efficiency

O&M

B.42 All businesses need to improve their efficiency. This is particularly important for businesses that have a limited customer base. Overall NR(HS) is proposing a 10% gross efficiency in route O&M in CP4, however these are offset by enablers to the efficiencies, headwinds and tailwinds.

Table B.3 CP4 Efficiencies summary

Efficiencies (£m)	25/26	26/27	27/28	28/29	29/30	29/30 (% of CP4 pre-efficient)
Gross efficiencies	-2.8	-3.9	-4.6	-4.8	-4.9	-10%
Enablers	4.7	3.8	3.1	1.8	1.2	3%
Headwinds	0.4	0.4	0.4	0.4	0.4	1%
Tailwinds	-0.1	-0.1	-0.1	-0.2	-0.3	-1%
Net Efficiencies	**2.3**	**0.3**	**-1.1**	**-2.7**	**-3.4**	**-7%**

Notes: Net & Gross efficiencies are inclusive of risk efficiency. Figures are rounded.

Source: NR(HS) 5YAMS, Table 10

B.43 NR(HS) is proposing a number of initiatives to improve efficiency within the system; these schemes include activities such as adoption of new technology and training of staff. We have analysed these in detail, informed by documentation and

a supplementary challenge session with NR(HS). Overall, the logic for quantifying the values seems sound and there is a developing plan which is underpinned by good assumptions and strategies.

B.44 However, given the supplied information and the responses received to our challenges we consider that there is scope for a challenge on the enablers of the efficiency. We recognise that NR(HS) has indicated a gross efficiency of 10% on its O&M activities from start to end of CP4, however, within route this is funded by £14.7m of enablers. Our review concluded that efficient spend should be limited to the enablers which provide a direct benefit and will be retained by the system, such as software.

B.45 We do not support enabler spend which is primarily of benefit to NR(HS), such as training of its staff up to the level we would expect from comparators. We recognise the importance of the people aspects of the enablers and expect these to be undertaken, but we expect funding for these elements to be covered by NR(HS)'s management fee. Removing training-related costs would reduce the funded element of enablers from £14.75m to £8.25m. This will increase the efficiency net of enablers headwinds and tailwinds from £4.6m to around £11.1m.

Renewals

B.46 In addition to O&M efficiency, there exists the opportunity for efficiency within the renewals work in the form of volume, scope and base rates. HS1 renewals activity is not as repeatable as the work of other infrastructure managers. As such, there is no overall efficiency target for renewals (e.g. a percentage saving compared to similar renewals in the previous control period), however, the individual work items in the next control period are assessed for efficiency as part of our periodic review; and final cost estimates are reviewed again for efficiency by HS1 Ltd, ORR and the Department for Transport (DfT) as part of the renewals governance process, before funding is drawn from escrow.

B.47 As noted above, we identified a double-count of risks and mark-ups in the base rates. To understand the expected level of this double-count, we looked at the NRIL Southern region delivery plan for 2024-29. This data showed that, across all asset types there was a range of 4.3%-7.0% difference in the total value of efficiency expected. When compared with the other NRIL regions, the level of expected efficiency was lower in Southern than in other regions. We consider Southern to be the closest comparator to HS1, not just geographically but also noting that the micro-economic conditions would be similar. HS1 is far smaller than NRIL's Southern region so its potential for efficiencies (and risks) is smaller. Hence the lower end of the range (around 4%) is considered more appropriate as

an indication of potential reductions in spend that will be achieved due to efficiencies.

Pass-through costs

B.48 Pass-through costs relate to activity and projects commissioned and contracted by HS1 Ltd on behalf of the wider system. These costs do not receive any mark-up and the associated costs are passed through directly to the operators. Table B.4 shows the budgeted costs for CP4 compared with the CP3 expected outturn.

Table B.4 Pass-through costs

Item	CP3 Expected outturn £m	CP4 budget £m	Difference £m
Non-traction electricity	14.0	11.6	-2.4
Insurance	19.2	18.8	-0.4
UKPNS O&M renewals	36.6	36.8	+0.2
Rates	53.4	54.3	-0.1
Other costs	0	0.6	+0.6
Total	**123.1**	**122.2**	**-0.9**

Source: HS1 Ltd 5YAMS, Tables 8 and 41

B.49 Other costs include:

- N-1 cost recovery (scheme to reduce traction electricity costs);
- investments in carbon saving technology (schemes which will also benefit operators through reduced costs); and,
- monies associated with recovering the legal costs for changing the authorised investments in the concession agreement.

B.50 HS1 Ltd has limited control over these costs, however, the schemes that it is investing in appear reasonable and proportionate.

Contract Risk

B.51 In addition to risk embedded within NR(HS) estimates for renewal activities, there is provision within the system for contract risk. These are cost items which are out

of NR(HS) or HS1 Ltd's control but which may impact the delivery of a service and cannot be fully mitigated. These fall into two categories:

- O&M cost risks – risks associated with delivery of O&M activity on the railway; and,
- Performance Risk – risks associated with delay payments which fall outside the control of NR(HS).

B.52 Cost risk is forecast at £2.5m and performance risk at £4.1m, both funded at the P80 level. Unused contract risk provision from the first two years of a control period is reinvested into NR(HS). Unused risk provision from years 3-5 is split with 50% retained by NR(HS), 30% is returned to the operators and 20% is allocated to HS1 Ltd.

B.53 We analysed the information provided by NR(HS) and were able to calculate (using a weighted ratio based on a pert analysis of the three-point estimate inputs) and identify the confidence levels associated with the level of risk:

Table B.5 Contract risk levels for CP4

Confidence level	Cost Risk (£m)	Performance Risk (£m)
P(80)	£2.535	£4.086
P(70)	£2.131	£2.840
P(60)	£1.727	£1.911
P(50)	£1.322	£1.198

Source: NR(HS) PR24 Annual Fixed Price Model (v107, dated 21 May 2024)

B.54 We recognise that there will be occasions where the network is unavailable due to circumstances outside NR(HS)'s control. However, noting that the full value of risk has not always been spent in recent control periods, we do not believe this is the most efficient way of funding the impact of this risk. Additionally, the benchmarking work and the activity to set the management fee was built upon a recognition of the asymmetrical nature of the risk in the system with a large number of low probability, high impact risks.

B.55 Taking these factors into account, we conclude that funding at the P80 is considered disproportionate and introduces an inefficiency into the system. Similarly, noting the asymmetrical profile of the risk impact, funding at a P50 or

P60 level would mean that should low probability high-impact risks occur NR(HS) would be exposed. We are therefore reducing the level of spend associated with contract risk provision by £1.65m in CP4. This value sits between the P60 and P80. If NR(HS) sets itself a more stretching efficiency target, there may be a justification for retaining a higher level of risk funding.

Split between variable and fixed costs

B.56 HS1 Ltd's charging models split renewals and maintenance costs between "wear and tear related" costs and "non wear and tear related". HS1 Ltd determined this split for different asset types based on engineering judgement. We reviewed each asset type and provided our own engineering judgement on the split, as follows:

Table B.6 ORR adjustment of variable and fixed costs

NR(HS) category	Example workbank elements	ORR Agree /Comments	NRHS Variable	NRHS Fixed	ORR Variable	ORR Fixed
Track - Wear and Tear Related	All Track assets (i.e. plain line rail / ballast / sleepers, S&C) except the below	Agree	100%		100%	
Track - non-Wear and Tear Related	Wheel impact load detectors, Rail management products	Agree		100%		100%
Civils - non-Wear and Tear Related	Underbridges	Assets are degraded by traffic over the longer term.		100%	25%	75%
Civils - mostly Wear and Tear Related	Overbridges	Agree		100%		100%
	Earthworks (cuttings)	Agree		100%		100%
	Retaining walls	Agree		100%		100%
	Security fencing	Agree		100%		100%

NR(HS) category	Example workbank elements	ORR Agree /Comments	NRHS Variable	NRHS Fixed	ORR Variable	ORR Fixed
	Acoustic Barriers	Design should be robust enough to sustain much of the impact of traffic	75%	25%	50%	50%
Civils - mostly non-Wear and Tear Related	Embankments	Assets are degraded by traffic over the longer term.	25%	75%	50%	50%
SC&C - Equally Wear and Tear / non-Wear and Tear Related	Points operating equipment	Obsolescence is more likely than wear	50%	50%	40%	60%
SC&C - non-Wear and Tear Related	EMMIS, VCS, RCCS	Agree		100%		100%
	Telecoms components	Agree		100%		100%
SC&C - Fixed Costs	EMMIS, VCS, RCCS	Agree		100%		100%
	Ashford route telecoms systems / CCTV	Agree		100%		100%
E&P - non-Wear and Tear Related	All assets in sub-asset class M&E (Mechanical and electrical) except Singlewell Heating System	Agree		100%		100%
	Section insulators and other assets in sub-asset class Overhead Catenary System (OCS)	Agree		100%		100%

NR(HS) category	Example workbank elements	ORR Agree /Comments	NRHS Variable	NRHS Fixed	ORR Variable	ORR Fixed
	except for the Contact Wire.					
E&P - Wear and Tear Related	Contact wire	Some non-traffic-related degradation of contact wire (e.g. extreme weather).	100%		90%	10%
E&P - Fixed	Singlewell Heating System	Agree		100%		100%
E&P - Rail Plant	Multipurpose Vehicles (MPVs), Road to Rail Vehicles (RRVs), Modules (for the vehicles), Handling gantries	Agree		100%		100%
Provisional sums		Agree		100%		100%
Management Fee		Agree		100%		100%
Project Partner		Agree		100%		100%

Annex C: HS1 Ltd cost policy

C.1 For PR24, HS1 Ltd has introduced a new cost policy to improve the robustness of forward estimates above the flat percentage increase applied in PR19. The policy used experts, who discussed the likely trajectory of key cost drivers. This qualitative output was then converted to a quantitative output using factors developed from the Association for the Advancement of Cost Engineering International (AACEI) estimating guide.

C.2 Realistically, when considering cost impacts over 40 years, precision is unlikely. It is imperative that the processes, and input data, are as robust as is possible and are able to capture areas of uncertainty. There are several areas where we feel improvements could be made to the robustness and also to reduce the inherent uncertainty in the estimate. However, in the context of previous estimates of 40-year costs at PR19, the PR24 cost policy should be seen as a positive step. Below we review the application of the cost policy in detail and highlight where opportunities exist to improve the policy and its application.

C.3 The outputs from the policy estimate the cost for the network over the next 40 years with an additional cost added for the expected risk and opportunity impacts over the period.

C.4 HS1 Ltd's application of the cost policy on Route costs created a model with a large cost increase in CP5-7 (where risks outweighed opportunities), but a large cost reduction in CP8-11 (where opportunities outweighed risks). In the stations model the level of risk and opportunity impacts was more balanced.

C.5 The modelling was based on an uncertainty of the level of impact of a series of events identified and categorised by a panel of experts. However, there exists the possibility that not all the events will occur. We do not consider that this has been adequately catered for within the estimate and, as a result, the total risk value and the total opportunity value are likely to be overstated.

C.6 We carried out an analysis to test the magnitude of these over-estimations. We concluded that, for the Route model, the effects roughly cancel each other out; so, we are not proposing any adjustment to the Route annuity. The Stations model did not include as many opportunity impacts in the long-term. Our analysis indicated that there was a small, but still material, skewing of the cost estimate, increasing it by approximately 0.5%. This skew does not affect Renewal costs in CP4, and we are assuming this skew will be corrected in future Periodic Reviews. So, our Draft

Determination is applying a 0.5% reduction to Station renewals costs starting in CP5, to correct for this skew effect.

C.7 The skew can be corrected by the inclusion of probabilistic risk, i.e. including within the modelling the probability of risks and opportunities not occurring.

Cost Policy

Overview

C.8 For PR24, HS1 Ltd has introduced a new cost policy to improve the robustness of forward estimates above the flat percentage increase applied in PR19. The policy has taken into account government cost estimating guidance published by the Infrastructure and Projects Authority to implement a six stage process:

- Sourcing the base estimate: Deriving a base cost estimate based on NR(HS) assumed volumes and unit rates.
- Rolling up the workbanks: Consolidating individual projects into generic and aligned categories against a consistent work breakdown structure.
- Develop adjustment levers: Generate an understanding of uncertainty and risk drivers which are anticipated to occur in the future.
- Adjustment levers analysis: Generate an understanding of the cost impact of future uncertainty and risks drivers.
- Determining uncertainty: Assess the cumulative impact of the adjustment levers' impacts.
- Validation: The estimate is compared with points of triangulation to check its robustness.

Cost lever workshops

Technical context

C.9 A key element of a cost estimate is to understand the potential drivers on future costs. This is often done by using a risk and uncertainty identification process, which will also capture project cost assumptions and data sources etc. The results of this are captured in a Risk, Issues and Opportunities Management Plan (RIOMP) and a Cost Data Assumptions List (CDAL). The RIOMP and CDAL, together with the Master Data Assumptions List (MDAL) are key parts of the document suite which are used in project management.

C.10 The process of identifying risk is ongoing throughout a project's lifecycle, however, in the early stages of compiling an estimate, expert input is invaluable. The process of getting a team of experts together to help generate input to the RIOMP and CDAL (and MDAL) is often a form of the Delphi-method called a Delphi-poll. Delphi-polls are useful to generate potential risks & opportunities, however, they have some limitations; particularly when used for forecasting potential new technology.

C.11 A Delphi-poll is a powerful technique that enables experts to discuss and form a consensus on the most likely outcome of a project. To produce good results, it is imperative that the expert panel is sufficiently informed, has current knowledge and recognises its own limitations. The level of confidence in a panel's decisions, including any contra views, is important as these will impact the breadth of uncertainty the modeller apportions to the decision. These should be documented as part of the Delphi-poll write-up.

C.12 The psychology surrounding the panel is also important. With any estimate, one of the biggest issues is anchoring – where the first number suggested acts as a benchmark that all future numbers that are suggested are compared against. This has the effect of making people who are suggesting numbers change their estimate to be closer to the first number verbalised. A technique known as a blind-Delphi can help prevent anchoring. Rather than stating their views out loud, initial thoughts are written down by the experts and passed to the chair who reads them out. Outliers are then discussed as a group to reach a consensus.

C.13 The personalities of participants are also important. The experts must be willing to listen to the views of others, be willing to take on board new evidence (to avoid personal anchoring), be articulate enough to make their point and hold their ground but also be able to compromise. Existing personal and professional relationships must also be set aside so as not to influence the discussions and a strong chair is required to control any dominant personalities to ensure a fair voice for all. The chair and participants must also be able to recognise their own natural biases (optimism or pessimism). As an example, an engineer will often over-estimate time and cost of a project as a precautionary measure for future unknown risks, however, senior managers will often be driven by optimism and higher expectations so will often under-estimate the time & cost of the same project.

HS1 Ltd Method

C.14 As part of its Cost Policy, HS1 Ltd conducted two sets of expert panels in November 2023 and December 2023 (Route) and April 2024 (Stations); these were called cost lever workshops and are akin to Delphi-polls. The aim of the

workshops was to discuss and then form an estimate of the expected impact of cost levers on the HS1 network over the next 40 years. These were assessed in three planning horizons:

- Horizon 1 – covering CP5 (2031-2035)
- Horizon 2 – covering CP6 and CP7 (2036-2045)
- Horizon 3 – covering CP8 to CP11 (2046 – 2065)

C.15 For Route the panel considered the impact on key asset groups (Track, Civils, Electrification and Signalling and Control Systems (S&CS)) across four groups of scoring factors each with its own subgroups:

- Delivery factors – covering Constructability, Complexity and Confidence;
- Lifecycle factors – covering Deterioration Confidence, Integration Factors and Novelty Factors;
- Market Factors – covering Market Sentiment, Operating Delivery Models and Cost Base Normalisation; and,
- Sustainability Factors – Covering Natural Capital Factors, Resilience Factors and Carbon Factors.

C.16 For Stations the panel considered the impact on the key workbanks (Civils, MEP, D&C and LETs for each of the four HS1 stations. These were assessed across the horizons detailed above used the same group and sub-group scoring factors used for Route.

C.17 The panel used its expertise to derive it's view on factors to be applied to base estimates. These were on a scale from -4 to +4; where -4 was an expected high value of opportunities to reduce current spend and +4 was an expectation of a high impact of risk. Factors were discussed and generated for the groupings detailed above split by horizon, asset group / station and by sub-group. This allowed a degree of delineation for time horizons as emerging technology, or other opportunities, developed and influence costs over future control periods.

Factor weightings

Technical context

C.18 Once factors which will impact future costs are understood, these can be applied to the base estimate. The outputs from the Delphi-poll may be in a number of

forms dependent on the maturity of the project, the data that is available and the timescales which the forecast is covering.

C.19 At the highest level of maturity and robustness the outputs will be a set of risks and opportunities with estimates for impact (potentially a range for the impact) and associated probabilities of occurrence. These risks / opportunities will form part of the project plan and be used to manage the project. They will be specific risks and opportunities which will lead to the development of clear project management plans. The output is also likely to include an understanding of the likeliness of occurrence of the risks and opportunities.

C.20 At a lower level of robustness of input data, or for a longer timeframe, the output will be a derived set of quantitative impact factors which can then be applied to base estimates and refined over time as data matures. This maturation process allows biases (unconscious or conscious) introduced in the estimating process to be removed. These quantitative factors will be derived from similar projects or from within the same industry.

C.21 At the lowest level of maturity, or for extreme timescales, the output would be a relative set of qualitative factors which indicate how costs might vary in relation to each other or to a base case. Before these can be applied to the base estimate, they will need to have weightings applied to them to convert them into factors which can be used in adjusting the base estimate for risk. Ideally these factors would be from a similar project or industry or would be calibrated for the application.

HS1 Ltd Method

C.22 The factors generated by the cost lever workshops were qualitative and a weighting was allocated which was applied to the base estimate. The documentation provided by HS1 Ltd indicated that the weightings were derived from AACE Cost Estimating Recommended Practice 18R-97, however, this was later corrected to the generic AACE Cost Estimate Classification Matrix.

C.23 Table C.1 shows the weighting that was applied to base estimates in the cost modelling. As can be seen, there is a skew between opportunity & risk at a ratio of 1:2. This means that a scoring for risk would have twice the impact of the equivalent (negative) scoring for opportunity. Note: These factors relate to the cost impact of risks / opportunities and not the volume, or their probability of occurrence.

Table C.1 Weighting applied to uncertainty factors from Cost lever workshops

Scoring from Cost Lever Workshop	-4	-3	-2	-1	0	1	2	3	4
Weighting Applied	-25%	-13%	-5%	-3%	0	5%	15%	25%	50%

Source: HS1 Ltd 40-year plan – estimating policy

C.24 The workshops identified "Realistic Optimistic", "Probable" and "Realistic Pessimistic" scores for each factor. This output captures the inherent uncertainty in the expected level of impact of the risk / opportunity.

Modelling

Technical context

C.25 Once there is an understanding of the risk and opportunities, these are applied to base estimates. To factor uncertainty into estimates, techniques such as Monte Carlo simulations are available. This is a complex methodology with numerous nuances that, when primed by good input data and used by trained operators, can provide statistically robust outputs.

C.26 Although it is possible to develop a Monte Carlo toolkit within MS Excel, this is time consuming and complex. It requires an intimate knowledge of the workings of MS Excel in order to prevent bias and to ensure the output is statistically robust. There are also limitations on how important factors such as correlation can be incorporated. Correlation is the linkage between the uncertainty of cost drivers. As an example, it might be reasonable to correlate the cost of cement and the cost of concrete. This would have the effect, when modelled, of producing a more robust output. There are third party plug-ins to MS Excel which perform Monte Carlo simulations. These tools often have additional functionality such as the ability to correlate input variables and select different distributions both of which enable an improved robustness of output.

C.27 Monte Carlo is most powerful when used on a finite number of input variables, usually under 200, to limit the effect of Central Limit Theorem (CLT, that is, that the distribution of a normalised version of the sample mean converges to a standard normal distribution). It is also important to isolate the cost drivers you are trying to model. Costs should be rolled up to an appropriate level so that granularity in key cost drivers is maintained whilst reducing the possibility of CLT. However, when using weighting factors, these should be applied at the lowest level possible, the greater the granularity the greater the estimate robustness. It is

a difficult balance that requires skilled operation. Once created and populated all cost models should undergo an appropriate level of quality checks – ideally a full independent verification of formulae logic and coding and validation of data inputs and interpretations should be conducted.

HS1 Ltd Method

C.28 HS1 Ltd used the output from the qualitative assessment of risks conducted by the cost lever workshop and, combined with the weighting factors and the associated uncertainty, used these elements as part of a probabilistic assessment.

C.29 HS1 Ltd conducted an exercise to roll up costs for estimates for the future cost of work on the system, to an appropriate level. These were developed using direct unit rates combined with volume forecasts and multipliers added for indirect costs. The unit rates used are pre-efficient (as confirmed in our deep-dive session) and exclude potential volume & scope efficiency, but expert panels have taken into account the potential efficiency from technology etc as part of their cost lever analysis.

C.30 HS1 Ltd then used the outputs from the workshop, which were applied to the rolled-up costs. This costing was then used as the basis for a probabilistic assessment using a purpose-built model within MS Excel. The outputs were analysed and a validation exercise was conducted.

C.31 As the probabilistic analysis was conducted using early estimates, HS1 Ltd used the ratio of the inputs to the outputs to modify updated cost information. This ratio is used as part of the calculation for the renewals costs which generate the annuity figures.

Cost Policy Application Review – summary of findings

Cost lever workshops

C.32 Delphi-polls such as the cost lever workshops, are a good way of developing an understanding of cost drivers, uncertainty and risks beyond the normal planning horizons. However, there are limitations in their application. We are satisfied that the workshops appear to have been well controlled, however, it would have been better to conduct a blind Delphi-poll to prevent anchoring of lever estimates. This methodology would also limit some of the afore-mentioned “personality” factors; help to avoid group think; and identify potential pessimism / optimism early in the process.

C.33 Furthermore, once uncertainty ranges were identified, it would have been useful to conduct a similar exercise to ascertain the probability of occurrence of the specific risks & opportunities identified by the expert panel.

C.34 However, overall, we find that the qualitative estimation process undertaken by HS1 Ltd via its cost lever workshops was good. The outputs appear reasonably robust and are a good starting point for building the estimate. HS1 Ltd and its estimating team were able to provide good assurance through the challenge session about the cost lever workshop and the control / challenge exerted by the chairperson.

C.35 We also believe that the process HS1 Ltd has undertaken to roll up the costs is sound. The basis for a strong modelling activity is therefore in place, albeit there are opportunities to improve.

Factor weightings

C.36 The application of weighting factors to generate three-point estimates is a valid methodology where data is limited but is not ideal, being significantly less robust than the other methodologies described above. The factors used were mislabelled as coming from the AACE Cost Estimating Recommended Practice 18R-97; this standard is more applicable to the chemical industry. The equivalent rail standard does not have any weighting factors. We met with HS1 Ltd and its modelling team, who stated that the factors used were based on the AACE estimate classification matrix; see Figure C.1. However, this matrix is more suited to ascertaining the maturity of the outputs rather than setting the inputs. The expected accuracy range specified in the table is defined on the AACE terminology website as: “A probabilistic assessment of how far a project’s final actual cost or duration can be expected to vary from the estimate. The range of values is driven by the risks and uncertainties associated with the estimated cost or duration.” In other words, the expected accuracy range is the result of the analysis and not a component.

Figure C.1 AACE estimate classification matrix

	Primary Characteristic	*Secondary Characteristic*		
ESTIMATE CLASS	**MATURITY LEVEL OF PROJECT DEFINITION DELIVERABLES** Expressed as % of complete definition	**END USAGE** Typical purpose of estimate	**METHODOLOGY** Typical estimating method	**EXPECTED ACCURACY RANGE** Typical variation in low and high ranges at an 80% confidence interval
Class 5	0% to 2%	Concept screening	Cost/length factors, parametric models, judgment, or analogy	L: -20% to -50% H: +30% to +100%
Class 4	1% to 15%	Study or feasibility	Cost/length, factored or parametric models	L: -15% to -30% H: +20% to +50%
Class 3	10% to 40%	Budget authorization or control	Semi-detailed unit costs with assembly level line items	L: -10% to -20% H: +10% to +30%
Class 2	30% to 75%	Control or bid/tender	Detailed unit cost with forced detailed take-off	L: -5% to -15% H: +5% to +20%
Class 1	65% to 100%	Check estimate or bid/tender	Detailed unit cost with detailed take-off	L: -3% to -10% H: +3% to +15%

C.37 Notwithstanding the derivation of the weighting factors, in the absence of rail specific factors the use of generic factors would be the next best thing. The quoted factors appear to be reasonable. However, without statistical support or a strong heritage they must be considered indicative and not representative. This reduces the robustness of the estimate but, as the majority of the impact is in later years, there is time to mature the estimate between now and PR29. The weighting factors quoted are skewed and will output a greater risk impact then opportunity impact in a ratio of 2:1. It is appropriate, when modelling, to skew inputs to generate more risk than opportunity; this produces a more representative output. However, the level of skew is important and the default factors that have been used need to be developed to improve the robustness of the estimate.

C.38 The use of the output of the qualitative assessment to apply blanket uncertainties to future costs, without associated impact probabilities, is likely to overstate the cost impact. Given that the analysis conducted by the subject matter experts in the qualitative assessment would be based on professional judgement, there remains a possibility that these risks / opportunities do not materialise. It would therefore be appropriate to apply these as discrete risks which turn off / on when modelling these; this would reduce the cost impact at the P50 and the P80.

C.39 We recognise that moving to specific risk / opportunity identification and quantification linked to a MDAL and a CDAL would be a large first step for HS1 Ltd. We also agree that data was not readily available to enable the creation of HS1 Ltd specific factors, however, the use of generic factors to modify the outputs from the qualitative analysis is considered sub-optimal. To improve the robustness of this part of the estimating process ready for PR29, HS1 Ltd will need to move to specific risk / opportunity identification and quantification. This will particularly

benefit the robustness of the near / medium term horizons estimates. An investment in the creation of industry specific factors for PR29 would also increase the estimates robustness. These could be used to estimate future costs in Horizon 3 but would also act as a useful secondary check of one of the more robust methodologies that should be used in Horizons 1 and 2.

Modelling

C.40 As detailed above, undertaking robust Monte Carlo modelling is complex and requires skilled operation; it is recognised that specialist staff and / or training is hard to find. In this context the following observations should be seen as opportunities for improvement and not criticism.

C.41 The use of MS Excel to conduct Monte Carlo analysis requires intimate knowledge of the workings of MS Excel. Although it is possible for a user to create a Monte Carlo tool in MS Excel it must be considered a pseudo-Monte Carlo tool in the majority of cases. The use of MS Excel by HS1 Ltd for its Monte Carlo modelling will therefore have some limitations. These can be overcome in the future by using a proprietary MS Excel plug-in tool.

C.42 Proprietary tools also allow the modeller to apply correlation to take account of the linkage between cost drivers. As an example, there is likely to be a linkage between the “Market Sentiment” factors such as “Supply Chain Confidence” and the “Cost Base Normalisation” factors such as “Inflation”.

C.43 The inputs to a cost model are of vital importance and the adage of “garbage in / garbage out” is true. To maximise the robustness of the modelling, it is best practice that the modeller sits in the Delphi Poll – this will limit that possibility of double counting. It is also best practice that the modelling is conducted on the most mature costs possible; in this case it should have been the final CP4 costs. The use of ratios of inputs to output is statistically inaccurate and reduces the robustness of the output. Similarly the summation of P50 values is not recommended. It is more accurate to capture the total project cost and amortise this across the categories using the ratio of total deterministic output to modelled output.

C.44 Finally, the creation of a cost model is complex and it is to be expected that there will be errors within the arithmetic and the inputs. It is essential that a full Verification and Validation exercise is conducted on any cost model as part of the project QA activity. This should be conducted before the model outputs are used.

C.45 None of these issues in themselves are significant, but we note the volume of issues that have been identified. However, recognising the journey HS1 Ltd is on, it is a significant improvement from PR19 and there is an opportunity for improvement in PR29.

C.46 It is also important to note that the level of opportunity modelled is high and to realise the spend reduction, HS1 Ltd will need to invest significant effort and resources from CP4 onwards. This will be a key part of our monitoring in CP4.

Conclusions

C.47 The development and implementation of the cost policy is a positive step – HS1 Ltd has taken on board our feedback from PR19 and improved its forecasting. However, this is the first step on a journey and significant effort will be required to develop the estimates.

C.48 We have reviewed the cost policy, its application and the associated modelling process in detail. The principle of the qualitative analysis is sound, however, more detail could have been recorded on how the chair limited anchoring, inherent biases and double counting.

C.49 Converting an output from a qualitative assessment to a quantitative assessment is complex. The application of conversion factors, such as applied by HS1 Ltd, can be an appropriate methodology which will produce a reasonably robust initial output, proving the adjustment factors are sound. If a level of ambiguity exists within the factors, this will be reproduced and amplified in the output.

C.50 The factors selected to convert the qualitative assessment to a quantitative assessment are generic factors based on the AACE estimating methodology. These factors are more normally associated with assessing the robustness of an estimate once complete rather than used as inputs to the estimating process. In the absence of rail specific factors, or those of analogous industries, generic factors are acceptable. However, given that the factors used were output based rather than input, overall, we must consider the future costs as indicative and significant effort will be required to improve the long-term estimation for the next planning round.

C.51 Noting the limitations of the estimate, we have analysed the underlying data to understand if the issues impact the estimate. It is not possible to ascertain if there were any biases or anchoring and therefore, we cannot be certain if these would result in an under or over estimation of the cost. The factors themselves are biased to result in a greater level of risk impact than opportunity impact. This is

appropriate and aligns with the majority of project outcomes, however, the level of bias should be calibrated for the railway environment. The factors were applied as cost uplifts to the base rates without an associated probability. i.e. as modelled, the risks and opportunity costs are included as impacts which will definitely happen.

C.52 Noting the intended bias towards risk impacts above opportunity impacts, it is interesting that in later periods of the planning window (CP7-CP11) more opportunities (by volume) for route have been identified than risks by the expert panel. When modelled, this means that the combination of the volume and impact of opportunities in later years has a greater influence than the combined volume and impact of near-term risk. Overall, this effect, when applied to the renewals, reduces the 40-year cost. It is imperative that HS1 Ltd and NR(HS) use the output from the cost policy to guide their asset management improvements and R&D work in the coming control period. They will need to invest time and effort to reduce the likelihood and impact of cost risks and to improve the likelihood and impact of opportunities in the longer-term.

C.53 For stations, there were fewer opportunities identified and the effect is less marked. As a result, the impact of cost pressures outweighs the opportunities over the 40-year costing period leading to a small (around 0.5%) cost increase from the application of the cost policy.

Annex D: Environmental sustainability

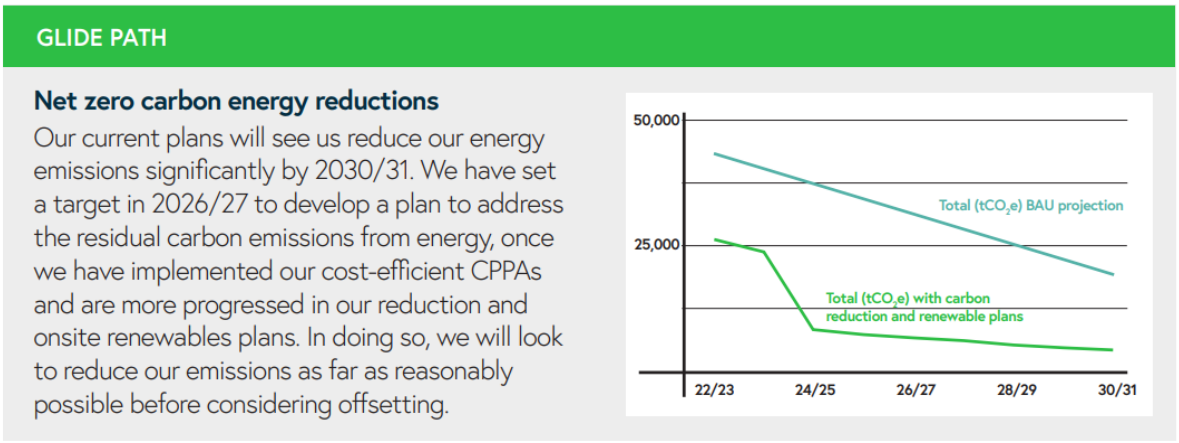
D.1 Our review of environmental sustainability focussed on climate change mitigation / decarbonisation (covering scope 1, 2 and 3 emissions), the circular economy and nature and biodiversity.

D.2 HS1 Ltd published its corporate sustainability strategy in 2023. Alignment between strategies and plans is a key principle of asset management best practice, so our review sought to understand HS1 Ltd's corporate strategy and review whether the other documents submitted in PR24 are aligned to it.

Decarbonisation – scope 1 & 2 emissions

D.3 HS1 Ltd's corporate sustainability strategy set out a target for all HS1 Ltd's energy to be net zero by 2030, with a glidepath and strategy priorities as set out below.

Figure D.1 Net zero carbon energy reductions glidepath



Source: HS1 Ltd corporate sustainability strategy: 'Our Green Gateway', 2023

D.4 Other priorities in the corporate strategy include implementation of corporate power purchase agreements (CPPAs) for 80% of electricity demand by 2025/26; a residual carbon reduction plan developed by 2027/28; and gas boilers replaced by heat pumps by 2029/30.

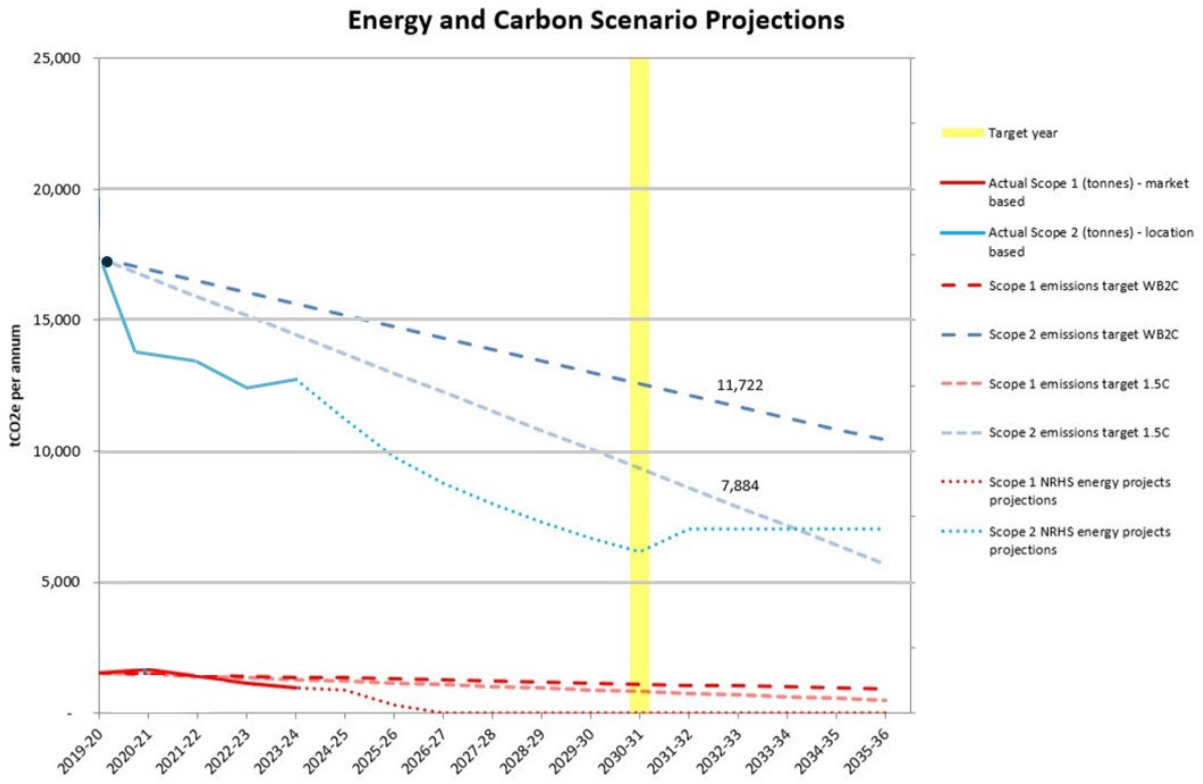
D.5 HS1 Ltd's submission for PR24 included a high-level benefits statement and targets for climate change and low carbon energy, in its route and station sustainability strategies. High level targets include: delivering net zero for all Scope 1 and 2 emissions by 2040 where practicable, having its carbon impact

externally verified and quantitative target established prior to CP4, reducing energy per passenger by 25% by 30/31 versus a 19/20 base, reducing traction energy per train journey by 10% by 30/31 versus a 19/20 base, and having all energy to be net zero carbon by 2030/3.

D.6 HS1 Ltd's sustainability strategies for both stations and route provide additional detail on the initiatives undertaken during CP3, as well as the following proposed initiatives in CP4: a review of a previously completed feasibility study for installing solar panels at stations with NR(HS) and agreement of future steps and an approach for CP4; development of an approach for installation of wind turbines; and understanding the feasibility of installing hydroelectric generators.

D.7 Our initial assessment of HS1 Ltd's CP4 sustainability strategies indicated that these strategies did not provide sufficient detail to show how the scope 1 & 2 emissions glidepath for CP4 will be achieved through constituent decarbonisation programmes covering CPPAs, gas boiler replacement, and energy efficiency measures / investment. This additional information was requested, and provided by HS1 Ltd. See below for the glidepaths for scope 1 and 2 emission reductions for CP4 provided by HS1 Ltd. Please note that this includes Science Based Target Institute (SBTi) targets for well below 2 degrees and 1.5 degrees warming scenarios.

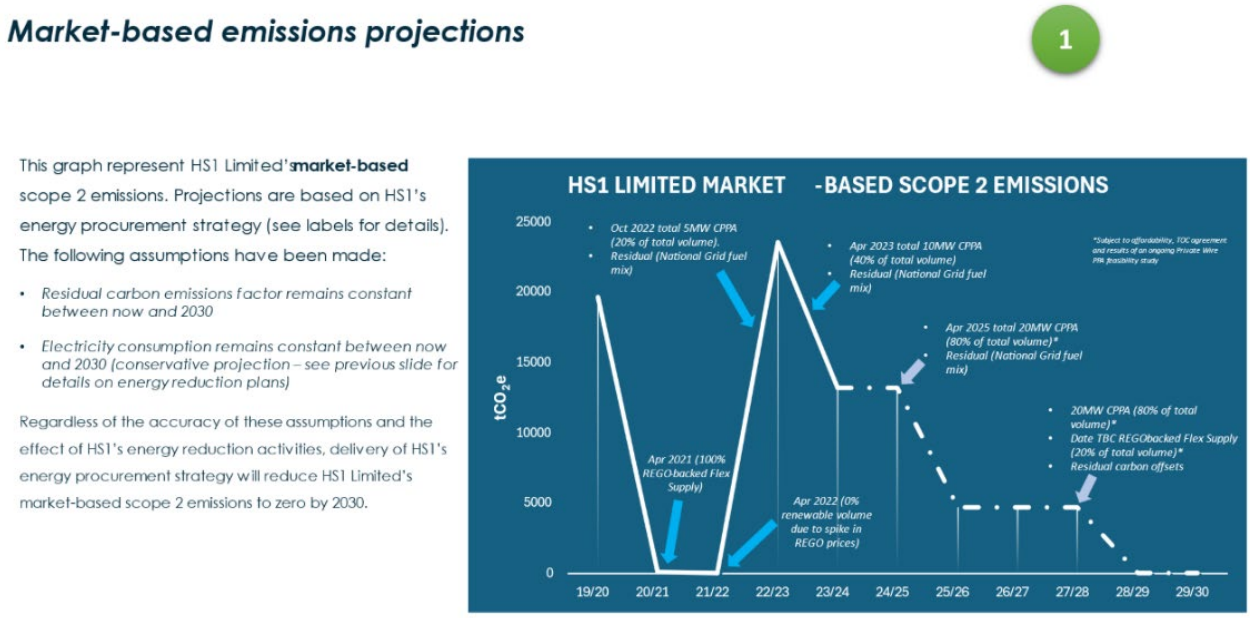
Figure D.2 Energy and carbon scenario projections



Source: supplementary information provided by HS1 Ltd in response to ORR clarification questions on HS1 Ltd's annex 9 and 11 station and route sustainability strategies

D.8 HS1 Ltd has also provided a waterfall chart following a clarification request, to show the constituent measures to deliver reductions in scope 2 emissions during CP4. This includes a summary of HS1 Ltd's energy reduction / efficiency initiatives planned for CP4. Please see Figure D.3 for information provided on scope 2 emissions forecast for CP4.

Figure D.3 Market-based emissions forecast



Source: supplementary information provided by HS1 Ltd in response to ORR clarification questions on HS1 Ltd's annex 9 and 11 station and route sustainability strategies

D.9 Our assessment of this indicates that HS1 Ltd's plans for CP4 are aimed at reductions in scope 1 & 2 emissions, which are well below the 1.5 degrees warming scenario target for scope 1 emissions, and well below the 2 degrees warming scenarios target for scope 2 emissions. We would consider these plans, which are aligned to the SBTi approach, to be robust and align with short-term and longer-term UK priorities for decarbonisation. We have also seen evidence of energy management programmes and constituent elements that drive carbon reductions through adopting low carbon technologies, which also show efficiencies in operation following investment. We consider these plans to be robust and well informed.

D.10 Our assessment of HS1 Ltd's level of ambition for transitioning its vehicle fleet away from internal combustion engine are set out in the section below. This is primarily delivered through its supply chain partner NR(HS).

Decarbonisation – scope 3 emissions

D.11 HS1 Ltd's corporate sustainability strategy specified improvements to refine its scope 3 emission understanding and measurement. These include reviewing results of the Rail Carbon Tool by 2023/24, setting an 'embodied carbon' target by 2024/25, and a scope 3 reduction plan implemented 2026/27.

D.12 HS1 Ltd has provided a high-level benefits statement and targets for climate change in its route and station sustainability strategies for CP4, which includes a target to deliver a quantitative target for Scope 3 established during CP4. Annexes attached to these plans indicate that during CP3 HS1 Ltd has committed to understanding its carbon footprint and reducing it throughout its supply chain, by adopting the Rail Carbon Tool on all projects over £1 million; and to develop a template approach to add to tender documents to check suppliers' paperwork during the tender period, to reduce the amount of emissions related to the HS1 system, contributing to HS1 Ltd's carbon neutral goal.

D.13 HS1 Ltd's sustainability strategies also set out a proposed CP4 initiative to transition all of the network's road vehicle fleet to Ultra Low Emission by 2035. Our review of HS1 Ltd's plans to transition the road fleet are set out separately below.

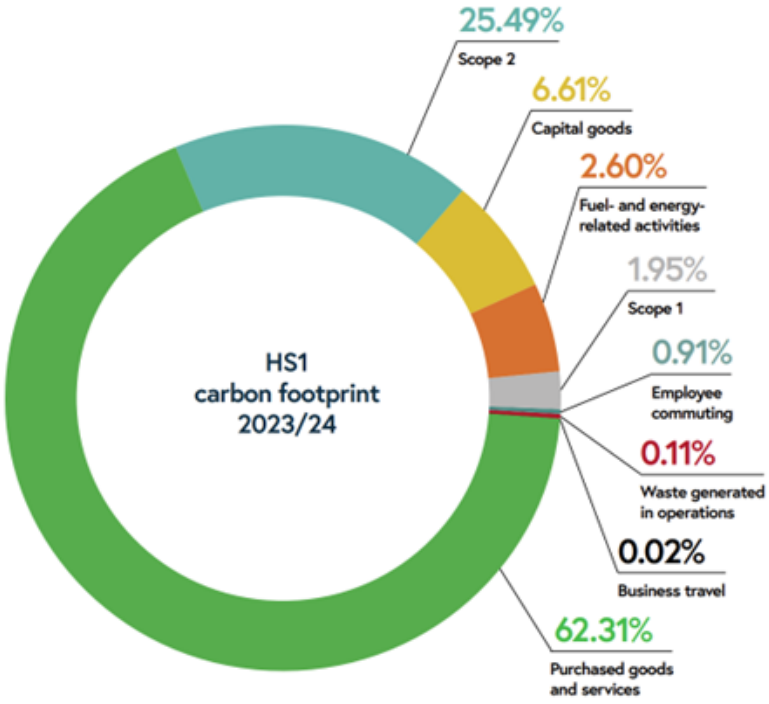
D.14 Our initial review of the sustainability strategies indicated that there is not complete clarity on HS1 Ltd's implementation of the corporate strategy milestones for scope 3 emissions into its 5YAMS and LCRs. We asked for further clarification on HS1 Ltd's timeline for refining its scope 3 emissions baseline, producing forecast targets for reducing scope 3 emissions over CP4, and what boundaries / categories will be included in this approach. We also encouraged HS1 Ltd in to explore the best options and timeline that would work for its principal supply chain contractor. HS1 Ltd provided the following additional information:

- A summary of HS1 Ltd's current baseline for scope 3 emissions, including a breakdown of spend categories, based on an analysis of spend data;
- Confirmation that emissions from 'purchased goods and services' and 'capital goods' account for almost 70% of HS1 Ltd's total carbon footprint, and that these two categories will be the focus of HS1 Ltd's data refinement activity and scope 3 emissions reduction activities in CP4;
- Although NR(HS) Scope 1, 2 and 3 emissions are not captured within NRIL Southern region's emissions baseline or infrastructure carbon forecast, NR(HS) stated it is keen to work with HS1 Ltd to obtain an approach best suited for reporting scope 3 emissions from the HS1 route;
- Refining the scope 3 calculation methodology is a priority for HS1 Ltd, so that it can be in a position to set 'absolute' scope 3 reduction targets. HS1 Ltd's ambition is to transition away from a spend-based methodology by 2025, incorporating more supplier-specific data into the analysis. A key step in this transition is trialing the Rail Carbon Tool from conception to completion of a

project, which NR(HS) has included as a delivery milestone for the 2024-25 financial year (which will influence both purchased goods and services and capital goods emission sources). At the end of that year, NR(HS) will evaluate outputs from the Rail Carbon Tool, and will regularly implement the tool on its projects from 2025 onwards. This will increase the accuracy of HS1 Ltd's CFA, and help HS1 Ltd to transition away from a spend-based analysis to a hybrid approach. NR(HS) is also investigating implementing a spend-based analysis approach during CP4 to determine its own scope 3 emissions.

- In line with SBTi's updated target validation criteria, HS1 Ltd will commit to developing 'supplier engagement' targets, one of four target-setting methods for companies to formulate scope 3 targets ('Setting science-based, as opposed to other types of greenhouse gas reduction targets, ensures that the targets are meaningful and that their ambition is in line with climate science"). Alongside continued data refinement, HS1 Ltd will liaise with key suppliers and develop supplier engagement targets by April 2025. Examples might include: "Ensure *X*% of our suppliers by emissions / spend covering purchased goods and services and capital goods have science-based targets by *X* date".

Figure D.4 HS1 carbon footprint 23/24



Source: supplementary information provided by HS1 Ltd in response to ORR clarification questions on HS1 Ltd's annex 9 and 11 station and route sustainability strategies

D.15 Our assessment of HS1 Ltd's programme to quantify its scope 3 emissions baseline, develop scope 3 emissions forecasts for CP4 and develop 'supplier engagement' targets (by April 2025 for the latter) indicates a sound approach using some aspects of best practice, such as an approach informed by SBTi targets, although we do have some concerns, as detailed below, around the fleet transition plan.

D.16 We have encouraged HS1 Ltd to progress as quickly as possible with developing a more up to date scope 3 emissions baseline based on supplier bill of quantities data, assessing tools such as the 'Rail Carbon Tool', and incorporating initiatives being undertaken by NR(HS)'s parent company (NRIL). We have also encouraged HS1 Ltd to develop its approach to showing how reductions in scope 3 emissions could deliver financial efficiencies; or could be delivered alongside its strategy for 'circular depot' initiatives and 'circular station' initiatives during CP4.

D.17 We recognise HS1 Ltd's work to establish baselines and targets in this area is ongoing and we have encouraged HS1 Ltd to include any available updates in its final 5YAMS.

Fleet transition

D.18 One particular area we have assessed is HS1 Ltd's ambition for transitioning the network's fleet of vehicles away from internal combustion engines to zero emission vehicles (ZEV). Our assessment of the sustainability strategies indicated that HS1 Ltd's strategy for undertaking this was not clear. We asked for more clarity from HS1 Ltd on this matter, including contractual and practical arrangements / challenges that will impact on the speed of fleet transition, and how these can be overcome.

D.19 HS1 Ltd's response has indicated that NR(HS) has committed to transition all fleet vehicles to electric by 2035 and have undertaken work to understand fleet usage and the EV market. This has indicated risks around EV vehicle range and completion of successful EV journeys. The target date has been chosen to ensure technology reflects the fleet requirements; and ensure a continuous and effective fleet service. NR(HS) has also indicated that it will monitor the EV market and the company will expedite the transition of the fleet to electric vehicles as the market grows and costs become more competitive.

D.20 NR(HS) has also set out that it is in its best interest to ensure it can supply an operational resilient service with a 24/7 response and that EV technology would have to reflect the usage of the fleet. Commitments NR(HS) has made to be completed by the end of CP4 to facilitate this transition include: undertaking depot preliminary surveys to assess electrical capacity and required DNO upgrades, as well as all associated security and safety requirements, undertaking the Civils and Electrical Design (PACE 0/1) of all sites that will store fleet vehicles, upgrading the DNO to satisfy fleet requirements, undertaking an EV trial to assess efficiency and effectiveness, installing at least 50% of the required charging infrastructure, and transition 50% of the fleet to equivalent EVs (subject to funding decision and trials demonstrating that technological advances will achieve its operational output requirements).

D.21 HS1 Ltd has provided more information on challenges, which include:

- technological constraints (including battery technology will impact vehicle range and charging time);
- vehicle availability and model variety needing to reflect suitable electric models for specific fleet needs are acquired;
- grid capacity;

- funding decisions on total cost of ownership focusing on high capital costs for installing the required infrastructure and associated discussions on asset upgrades and asset ownership; and
- guaranteeing system funders (operators) a return on investment.

D.22 HS1 Ltd has indicated that it will work with NR(HS) to address the highlighted concerns by investigating opportunities to phase the implementation of EV infrastructure and leveraging public EV infrastructure, upgrading the grid capacity and investing in solar renewable energy at depots, engaging with manufactures as well as monitoring the EV market, and obtaining specialist advice when required.

D.23 In addition, NR(HS) has said it will continue to collaborate with NRIL Southern Region to obtain lessons learnt through periodic workshops. HS1 Ltd has also indicated that although energy-related activities only contribute to 2.6% of HS1 Ltd's extended scope carbon footprint analysis, NR(HS) is committed to addressing primary challenges and concerns in this area.

D.24 Our conclusion following assessment of this aspect of HS1 Ltd's plans for fleet decarbonisation (including further clarification responses) is that there is an opportunity for HS1 Ltd to show a higher level of ambition. But we accept that this opportunity will require an integrated approach from HS1 Ltd, NR(HS) and DfT.

D.25 The challenges indicated by HS1 Ltd and NR(HS) are challenges that we would consider are common to all infrastructure managers with vehicle fleets that can be overcome through more robust market assessment, programme management, and addressing cultural barriers / misconceptions for vehicle users, balanced with timely capital investment. Unless the HS1 system can find solutions to these challenges, there is a risk that HS1 Ltd's plans in this particular area of decarbonisation will not align to the ambitious objectives of its corporate strategy.

Circular Economy

D.26 HS1 Ltd's corporate sustainability strategy set out proposed improvements to minimise its resource use and waste impacts. This included identifying further opportunities to reduce consumption of resources and prevent waste, which will involve influencing traveller / customer behaviour and supply chains including retailers and operators. Targets included:

- development of a circularity and minimisation plan for stations and depot by the end of 2023/24, and to implement this plan by 2024/25; and

- to understand hazardous waste and waste indirect to landfill, and to include these waste streams within its waste minimisation strategy by 2024/25.

D.27 Our assessment of the CP4 strategy documents indicates that HS1 Ltd has not provided the same level of detail or initiatives under the 'Waste and Resources' priority theme as it has done for other priority themes such as 'Climate Change' and 'Low Carbon Energy'. Without this information, HS1 Ltd has not clearly set out a benefits statement or targets for CP4. Targets set out in the CP4 sustainability strategies for both stations and routes indicate the following targets for the end of CP4: recycling of waste at stations by 90% and waste reduction of 20%. Other targets for waste to landfill and hazardous waste are yet to be confirmed.

D.28 We could not see any evidence in the submissions to show how HS1 Ltd's approach to circularity will drive the reduction in scope 3 emissions, or any approaches to how this will be quantified in financial savings, other than references to use of the Rail Carbon Tool. We have also not seen any evidence of how HS1 Ltd's plans for resource use and waste impacts go beyond 'circular operations' approaches to incorporate best practice around wider aspects of circular economy such as 'circular design' and 'sustainable procurement' approaches.

D.29 We challenged HS1 Ltd on these items. In response, HS1 Ltd provided more detail on work it is progressing to develop a Circular Economy Implementation Plan, including options assessment work to inform development of a joint implementation plan, containing initiatives that have been grouped into two categories: 'circular depot' initiatives and 'circular station' initiatives. It has also indicated that it will work with NR(HS) and specialist advisors to create initiatives and metrics for its circular economy ambitions and will investigate the opportunities for sustainable procurement and circular design.

D.30 We consider HS1 Ltd's high-level CP4 business plan, performance measures and commitment to further develop measures around aspects of waste management to be robust, however further refinement will be required to align to the ambitions of its corporate strategy.

D.31 We have encouraged HS1 Ltd to extend its CP4 plans and agreed performance targets into other aspects of circularity, including 'circular design' and 'sustainable procurement'. The work published by the Rail Safety Standards Board (RSSB) in 2024 to develop metrics for circular operations, circular design and sustainable procurement Zero Waste Metrics could act as useful guidance for HS1 Ltd to develop metrics, including best practice and class leading (progressive) metrics.

We have encouraged HS1 Ltd to review its joint implementation plan, circular depot initiatives and circular station initiatives to develop additional measures to report 'circular design' and 'sustainable procurement'.

D.32 We have also highlighted to HS1 Ltd a number of circular economy performance measures agreed between ORR and NRIL following the publication of our PR23 Final Determination; and we would encourage HS1 Ltd to explore these with NR(HS) in CP4.

Nature and Biodiversity

D.33 HS1 Ltd's corporate sustainability strategy set out improvements to:

- better consider how its biodiversity plans are sensitive to climate adaptation needs, including species loss and resilience; and
- consider the possibility of carbon 'insetting' aligned with the net gain ambition.

D.34 This strategy update has also reaffirmed a target to achieve 20% biodiversity net gain (BNG) on the 135 lineside tiles by 2030/31 compared with a 2021 baseline.

D.35 Our initial assessment of the Stations and Route Sustainability strategy documents submitted as part of HS1 Ltd's 5YAMS indicates that HS1 Ltd had not provided any benefits statement or headline targets for CP4 to support delivery of the corporate sustainability strategy objectives for nature and biodiversity. We challenged HS1 Ltd on this and a useful update has been provided on nature and biodiversity initiatives that have been implemented in CP3. These plans still do not provide clear information on nature and biodiversity initiatives planned for CP4; and did not provide a clear figure for the amount of BNG set as a target for CP4.

D.36 We have encouraged HS1 Ltd to consider setting a clear target for BNG for CP4 before the Final Determination, including a glidepath for achieving this target year-by-year through CP4.

D.37 HS1 Ltd has provided some further information indicating that it is currently in the process of undertaking UK Habitat Classification (UKHAB) surveys across its estate, including 135 nature reserves on the estate, between St Pancras and Folkestone. During the 2024 survey season it aims to complete the required BNG (biodiversity net gain) calculation and associated reports by the end of 2024. Following review, it anticipates having scientifically backed BNG performance indicators by the end of January 2025.

D.38 HS1 Ltd has also provided some further information on how it is working with NR(HS) and wider stakeholders to obtain specialist knowledge. NR(HS) is working in partnership with the Bumblebee Conservation Trust to create a BNG Hotspot site adjacent to the Singlewell Infrastructure Maintenance Depot, transforming a poor semi-improved grassland to a lowland meadow suitable for a range of pollinators. The pollinators will be a flagship species and HS1 Ltd anticipate that biodiversity will significantly improve at this site.

D.39 Our assessment of HS1 Ltd's CP4 plans and additional information indicate that its work in this area is ongoing, but it is expected to have robust plans in place before the start of CP4. This should include documenting how HS1 Ltd's plans for CP4 will deliver against its corporate sustainability strategy target (20% biodiversity net gain by 2030 compared to its baseline).

D.40 We have encouraged HS1 Ltd to consider inclusion of the following additional aspects of nature and biodiversity into its stations and route sustainability strategies going forwards, to demonstrate best practice;

- Opportunities to show how biodiversity and habitat improvement during CP4 can deliver against priorities set out in the government's Environmental Improvement Plan;
- The approach HS1 Ltd will take to work with wider stakeholders to deliver local and regional biodiversity and habitat priorities which will be set through the county based Local Nature Recovery Strategies that will be developed during CP4;
- Consideration of other 'management process' and 'outcome' measures to track performance in this area. These could include measures to track what percentage of the HS1 route has effective and well governed Habitat Management Plans in place, or measures to show how biodiversity hotpots are delivering improvements; and
- Consideration of how nature-based solutions could provide potential for achieving biodiversity and resilience improvements, and if so, how these can be reported through a performance measure.

Annex E: Station cost allocation

E.1 PR24 is our first periodic review to include stations renewals. Funding for renewals (and maintenance) at stations is complex, because the stations are split into many different zones. In each zone, there are different stakeholders (including HS1 train operators, mainline train operators, retailers and other infrastructure managers), with different obligations to plan and fund works in their zones.

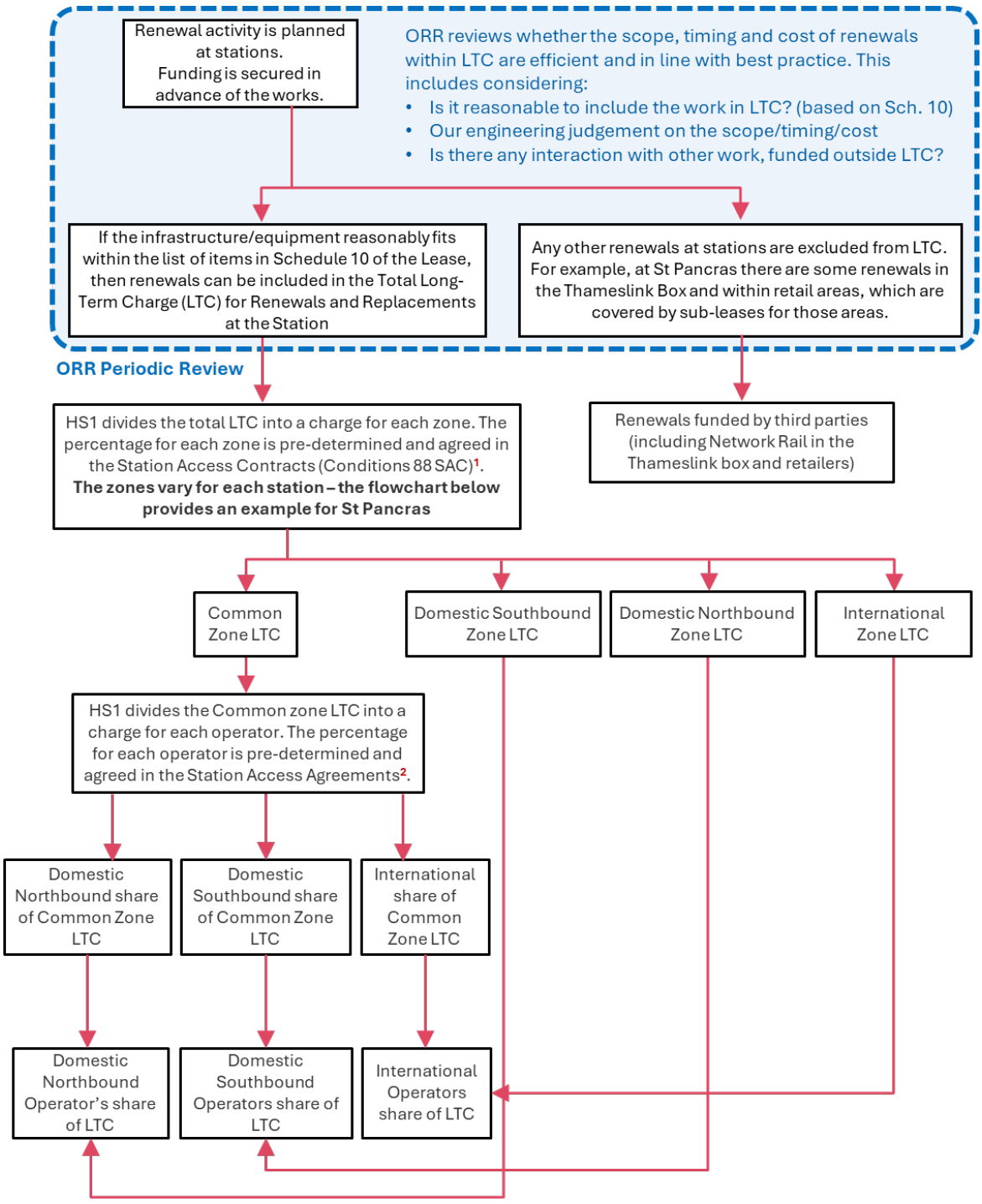
E.2 So, in 2023 we reviewed the relevant HS1 contracts, to understand the obligations of different stakeholders; and how HS1 Ltd allocates costs between them. The contracts we reviewed were:

- The concession agreement, between HS1 Ltd and Secretary of State for Transport;
- The station leases for the four HS1 stations, between HS1 Ltd and Secretary of State;
- station access agreements between HS1 Ltd, Eurostar, Southeastern and EMR; and
- The sub-lease for the Thameslink Box, between HS1 Ltd and NRIL.

E.3 As part of our review, we commissioned consultants with expertise in property contracts (DAC Beachcroft) to support our review and provide a summary of how costs are allocated. A concise version of DAC Beachcroft's summary is illustrated in the flow charts below. These are intended to provide transparency for all stakeholders on our interpretation, which is the basis for our PR24 determination. We hope that these flowcharts will also be useful to stakeholders as a point of reference for future discussions, e.g. if new operators join the HS1 network, there will be discussions between HS1 Ltd and operators about re-allocation of station costs. The executive summary of the DAC Beachcroft report is also annexed.

Long Term Charge (LTC)

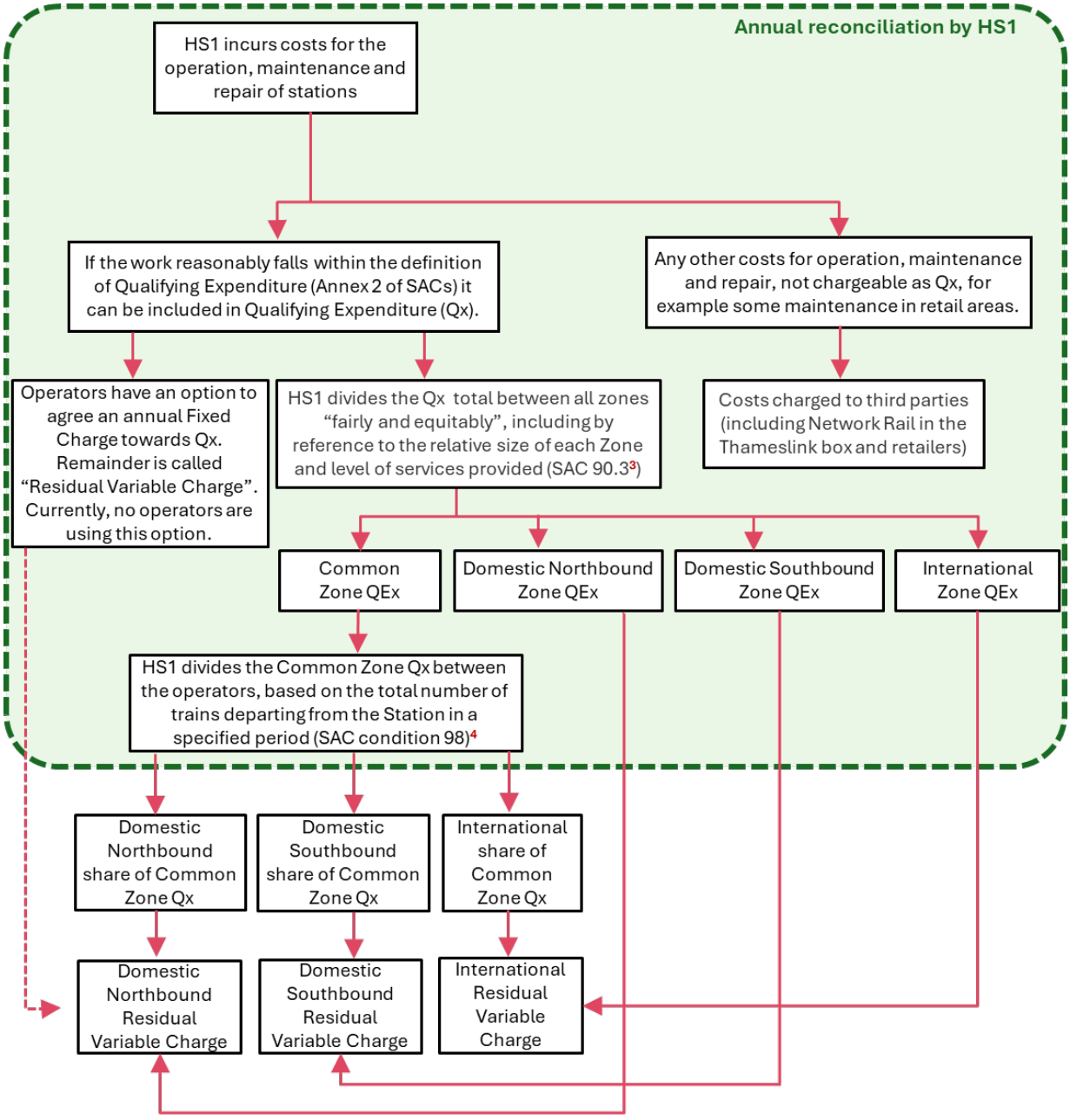
Figure E.1 Stations LTC summary of contractual split of charges



Source: Adapted from DAC Beachcroft review of HS1 stations cost allocation

Qualifying Expenditure (QX)

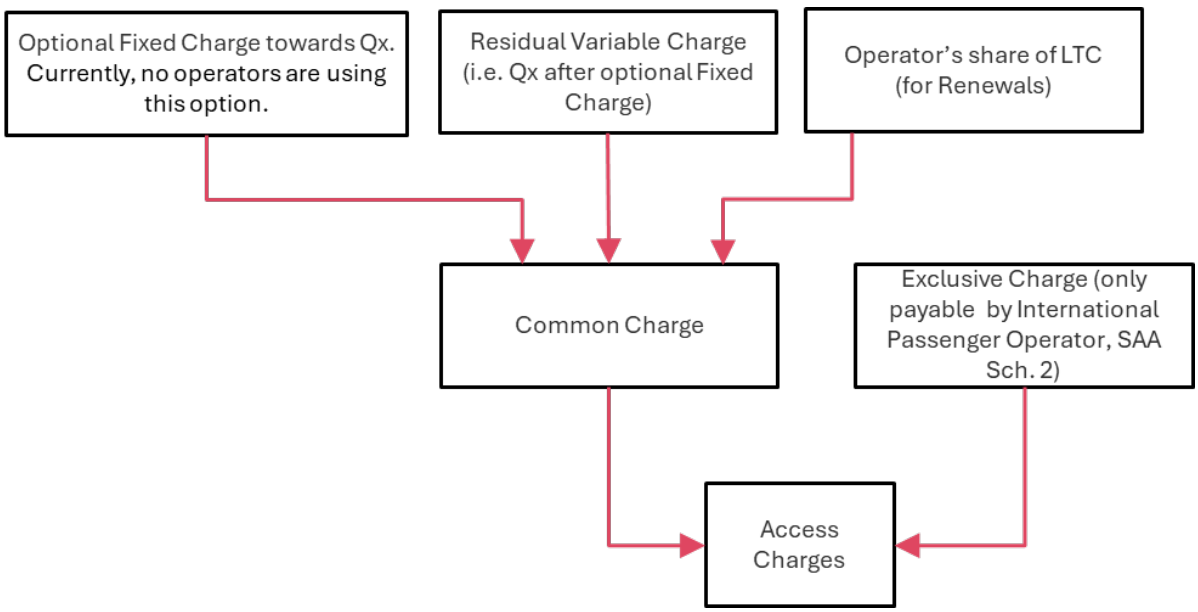
Figure E.2 Stations QX summary of contractual split of charges



Source: Adapted from DAC Beachcroft review of HS1 stations cost allocation

Access Charges

Figure E.3 Constituent parts of stations access charges



Source: Adapted from DAC Beachcroft review of HS1 stations cost allocation

Notes to figures:

1. The percentages are contained in SAC Condition 88, definitions and are as follows for St Pancras:
   (a) Common Zone LTC = 39.5% of total Long-Term Charge
   (b) Domestic Northbound Zone LTC = 9.42% of total Long-Term Charge
   (c) Domestic Southbound Zone LTC = 7.55% of total Long-Term Charge
   (d) International Zone LTC = 43.53% of total Long-Term Charge
2. The percentages for each operator are contained in each individual Station Access Agreement at Schedule 1 and are not publicly available.
3. Station Access Condition (SAC) 90.3 provides that full details of the methodology used to attribute each individual element of Qualifying Expenditure between the Zones must be provided. The Qualifying Expenditure costs should be allocated between the Zones by such methods as may be fair and equitable including by reference to the relative size of each Zone and level of services provided within each Zone.

4. SAC Condition 98 provides a method for calculating the Passenger Operator Proportion for each Passenger Operator each year. This is based on the total number of trains departing from the Station for a Passenger Operator in specified sample periods when compared with the total number of trains departing from the Station for all Passenger Operators in the same period.

Annex F: Charges for operating, maintaining and renewing the network

F.1 A key aspect of HS1 Ltd's 5YAMS is the regulated access charges that HS1 Ltd proposes to levy on passenger and freight operators for operating on its network during CP4. Under the Access and Management Regulations 2016 (as amended), the general principle is that charges should be designed to reflect the costs that they are intended to recover. In this way charges can significantly influence the provision and use of the infrastructure. This in turn should drive efficient use of resources both in terms of existing infrastructure and the provision of new capacity, and provide incentives to reduce costs where possible.

F.2 We have a number of statutory duties which we must balance when exercising our economic functions. Our statutory duties are mostly set out in Section 4 of the Railways Act 1993. Our duties are not in any order of priority and it is for us to decide how to weigh these when reaching our decisions. In reaching the recommendations and draft conclusions outlined in the Draft Determination, we have carefully balanced our statutory duties, including considering the scale of the impact of charges on operators against a range of other outputs of the periodic review, in particular the need to ensure HS1 Ltd can recover its efficient costs and meet its asset stewardship commitments under the Concession Agreement and station leases.

ORR's Draft Determination CP4 charge for each operator

F.3 We reviewed HS1 Ltd's proposed charges and made several adjustments. In table F.1, we outline our Draft Determination combined total charges for all operators, for both route and stations and show the cumulative effect of our proposed adjustments across freight and passenger operators

Table F.1 Draft Determination combined charges for passenger and freight operators (total combined route OMRC, Station LTC and QX)

February 2023 prices £m	CP3	CP4	CP4		
		5YAMS combined charges	Draft Determination	Change from 5YAMS	Change CP3 to CP4
EIL	338.5	329.5	312.3	-5.2%	-7.7%
Southeastern	517.0	485.5	461.2	-5.0%	-10.8%
EMR	48.5	51.5	50.0	-2.8%	3.2%
Freight	2.0	1.5	0.7	-54.7%	-66.0%
Total	**905.5**	**868.0**	**824.3**	**-5.0%**	**-9.0%**

F.4 In Table F.2 we outline our Draft Determination charges for passenger operators on the route.

Table F.2 Draft Determination CP4 route charge rates for passenger operators

February 2023 prices	CP3 (Int.)	5YAMS (Int.)	Draft Determination (Int.)	CP3 (Dom.)	5YAMS (Dom.)	Draft Determination (Dom.)
OMRCA1 £ per train km	5.16	5.91	5.64	2.07	2.38	2.27
OMRCA2 £ per train minute	15.56	12.42	11.55	3.17	2.79	2.59
OMRCB £ per train minute	36.76	36.72	34.03	40.00	39.47	36.6
OMRCC £ per train minute	13.15	13.74	13.73	13.15	13.74	13.73

F.5 In Table F.3 we outline the Draft Determination charges for stations.

Table F.3 Draft Determination CP4 charges for stations

February 2023 prices £m	CP3	5YAMS	Draft Determination
St Pancras	37.8	31.9	26.0
Stratford International	7.7	8.2	6.5
Ebbsfleet International	8.1	7.4	6.1
Ashford International	4.4	3.5	2.7
Combined	**57.9**	**50.9**	**41.1**
EIL	31.6	24.7	19.8
EMR	7.8	6.5	5.3
Southeastern	18.6	19.8	16.1
Combined	**57.9**	**50.9**	**41.1**

F.6 In accordance with the station access conditions, when EIL ceased stopping at Ebbsfleet International station, the common zone LTC costs were reallocated 100% to Southeastern. If EIL resumes stopping at the station, this would trigger another reallocation. For Stratford International station, Southeastern pays 100% of the LTC and EIL does the same at Ashford International.

F.7 In table F.4 we outline our adjustments to freight charges.

Table F.4 Draft Determination CP4 charge rates for freight operators

February 2023 Prices	CP3 charge per train km	5YAMS	Draft Determination
OMRCA1 (variable) £	6.15	7.06	6.74
OMRCA2 (avoidable) £	4.97	7.83	1.00
Total OMRC £	**11.12**	**14.89**	**7.74**

Charges section structure

F.8 In this section of the technical annex we:

- Outline the legal framework in which HS1 Ltd levies charges, then discusses the structure of HS1 Ltd's charges and the modelling used to determine the charges.
- Discuss our policy decisions related to charges.
- Outline HS1 Ltd's final 5YAMS proposed charges for CP4 and stakeholder responses to the draft 5YAMS.
- Outline our Draft Determination for charges during CP4.

Legal framework

F.9 The principles governing the charges that train operators must pay to use HS1 Ltd's infrastructure are outlined in the Access and Management Regulations.

F.10 The track access and station access charges that each operator pays are calculated in accordance with these Regulations; the charging framework for the HS1 network set out in the concession agreement and the specific charging rules established by HS1 Ltd.

F.11 The overarching charging principle for track access is set out in paragraph 1(4) of Schedule 3 to the Access and Management Regulations and requires charges to be set at the cost that is directly incurred as a result of operating the train service (the direct cost). This is assessed by reference to Commission Implementing Regulation 2015/909 (the Implementing Regulation).

F.12 In order for an infrastructure manager to recover its full costs, that is, costs above direct costs (expenses that can be directly attributable to a specific activity, such as the track maintenance or renewal costs directly linked to the operation of trains on a particular section of track), the Access and Management Regulations allow for two exceptions to the charging principles:

- The first exception allows an infrastructure manager to "levy mark-ups on the basis of efficient, transparent and non-discriminatory principles". However, the effect of the mark-up must not be to exclude the use of infrastructure by market segments which can pay at least the cost that is directly-incurred as a

result of operating the railway service, plus a rate of return which the market can bear.

- The second exception allows the infrastructure manager to set, or continue to set, higher charges on the basis of the long-term costs of the project provided that the project has been completed since 1988 or following the coming into force of the Regulations, and that the following two conditions are met:
  - the project must increase efficiency or cost-effectiveness; and
  - the project must be one that could not otherwise have been undertaken without the prospect of such higher charges.

F.13 The principle for charging for station access is set out in paragraph 1(6) of Schedule 3 to the Access and Management Regulations, which states that the charges for access to stations must not exceed the cost of providing them, plus a reasonable profit. A reasonable profit is defined as "a rate of return on own capital that takes account of the risk, including that to revenue, or the absence of such risk, incurred by the operator of the service facility and is in line with the average rate for the sector concerned in recent years".

HS1 Ltd's charging structure

F.14 HS1 Ltd's charging framework for route and station is established in its Concession Agreement with the Secretary of State. HS1 Ltd is responsible for establishing the specific charging rules governing the determination of the charges to be charged in accordance with that charging framework, and the Access and Management Regulations.

F.15 HS1 Ltd's operating, maintenance and renewals charges (OMRCs) seek to recover HS1 Ltd's operating, maintenance and renewals costs including pass-through costs for route. HS1 Ltd levies a separate pass-through charge for traction electricity, as this is not included in the OMRCs.

F.16 The OMRCs consist of the following categories to cover route:

- OMRCA1: the direct variable costs, mainly track costs, reflecting wear and tear of additional trains on the common track;
- OMRCA2: the avoidable costs on a long-run (40-year) incremental cost basis where the costs of infrastructure specific to a class of operator would be avoided (that is not required) if that a specific class of operator ceased operating. An example is the section of infrastructure from Ashford

International to the Channel Tunnel, which is not used by domestic train operators;

- OMRCB: common costs, which include head office costs as well as infrastructure costs that vary with the length of track, but not the volume of traffic; and
- OMRCC: pass-through costs. These are common costs that in the Concession Agreement are deemed to be largely beyond HS1 Ltd's control, such as non-traction electricity and insurance. For this category of cost there is an annual wash-up process to adjust for differences between forecast and actual costs.

F.17 Passenger operators are charged all four categories of OMRC, whereas freight operators, due to their small share of overall traffic, are only charged for the additional costs incurred as a result of operating freight services (OMRCA1 and OMRCA2).

F.18 Passenger operators are also charged to recover the cost of the four stations:

- Long Term Charge (LTC) which recovers repair and renewal costs at the four stations.
- Qualifying Expenditure (QX) is a charge to recover actual operating and maintenance costs at the four stations. We do not regulate QX as the station operations and maintenance charges do not fall within Schedule 10 of the leases.

F.19 As part of PR19, HS1 Ltd committed to an in-depth review of the structure of its charges. The conclusions and next steps of the report are published in August 2022 and are detailed in HS1 Ltd's 5YAMS. Some of the review's conclusions led to proposed changes to charges for CP4:

- HS1 Ltd proposed contractual amendments to passenger access terms, which mainly related to the volume reopener (VRO) provisions, the wash-up arrangements and for certain charges. These are discussed in the main charges chapter. This affects the way charges are set and under what circumstances they can be changed over the control period.
- HS1 Ltd has stated that it does not intend to introduce a new capacity reservation charge, which is a charge on capacity that is requested and not used. Although, it might introduce one if there is a material change to

capacity usage, such as the introduction of a new operator with substantial volumes.

- HS1 Ltd revised the split between direct and indirect costs with a more granular assessment of the cost drivers. We have reviewed this and agree with the assessment subject to some adjustments on the split for Underbridges, Acoustic Barriers, Embankments, Points Operating Equipment and Contact Wire. This split affects the magnitude of costs recovered under OMRCA1 and OMRCA2 and hence who bears these costs.

HS1 Ltd's charging structure and the legal framework

F.20 This section examines HS1 Ltd's charging structure and the legal framework within which it operates. Initially it covers the route direct and indirect costs, then stations and finally its modelling.

Route direct and indirect costs

F.21 HS1 Ltd's proposed charging structure, and methodology remain largely the same as in PR19, which complies with the legal requirements and sent appropriate price signals. This includes both direct costs and indirect costs. Indirect costs are costs that are not tied to a specific activity, such as general office overheads or costs associated with the management and support of the entire rail network, rather than a specific section. HS1 Ltd has not made any changes to the way it intends to recover its costs through charges.

Station renewals

F.22 The Access and Management Regulations do not require station charges to make a distinction between direct and indirect costs for the purpose of determining the regulatory basis of cost recovery for renewals.

F.23 We are satisfied that the way HS1 Ltd is proposing to recover station costs in CP4 is consistent with the regulatory requirements around the setting of such charges and that proposed station charges do not exceed their forecast costs of providing renewals at stations, plus a reasonable profit. There is no profit on station renewals and we do not regulate the QX. We note that we have made adjustments to the forecast cost and hence the charge.

HS1 Ltd's modelling

F.24 In order to convert HS1 Ltd's total costs into charges, HS1 Ltd uses two models. One for route and one for stations.

F.25 HS1 Ltd commissioned management consultants CPCS to quality assure its route charges model. In summary CPCS found the model consistent with both the rules and assumptions set out in HS1 Ltd's model and the relevant legislation.

F.26 Station costs are converted to charges through a station LTC annuity model that sets the annuity for calculating LTCs for each of the four stations. HS1 Ltd has internally assured the model.

F.27 We are satisfied HS1 Ltd has had its modelling quality-assured and received assurance that it complies with the regulatory requirements for the setting of such charges.

Decisions related to charges

Capacity reservation charge

F.28 In its 5YAMS, HS1 Ltd proposes to maintain the capacity reservation charge suspension. The 2016 Regulations allow an infrastructure manager to levy a charge for capacity that is requested, but not used. In its 5YAMS, HS1 Ltd said it reserved the right to reactivate the charge in CP4 under the following conditions:

- a potential new entrant planning to operate train services on its network;
- any material change in capacity usage; or
- a material increase in capacity reservation in comparison with current levels.

F.29 EIL stated it "does not think there is a strong case to justify reintroducing the capacity reservation charge in CP4". Southeastern stated that "the capacity reservation charge should be revisited as part of any Interim Review" if a new operator will commence services in CP4. HS1 Ltd stated that no new party has yet committed to starting operation on HS1, although significant interest exists from several prospective operators.

F.30 A capacity reservation charge disincentivises operators from reserving more capacity than they intend to use. As there is currently spare capacity on the network, we are minded to accept HS1 Ltd's proposal to maintain the suspension of the capacity charge.

Carbon charge

F.31 HS1 Ltd can recover costs related to the Government's Carbon Reduction Commitment (CRC) Energy Efficiency Scheme. As the scheme closed in 2019, HS1 Ltd proposed removing this provision since it is no longer needed. Southeastern agreed to the removal of this provision and no other operators commented.

F.32 We note HS1 Ltd are progressing proposals to remove the recovery of carbon costs for the reasons provided by HS1 Ltd and Southeastern above.

Station access charges and common costs

F.33 In the 5YAMS HS1 Ltd does not discuss recovery of costs from the retailers that also benefit from common zones at stations.

F.34 EIL stated it has "very serious concerns about the allocation of all common costs to train operators" and that "HS1 should set out the specific provisions that it can operate a dual till model at St Pancras".

F.35 Southeastern stated "retailers are benefitting from the use of common zone areas and assets such as walkways, lifts, escalators along with large scale renewals and therefore should be contributing to LTC". Southeastern "would like to see retailer contributions to running costs of HS1 stations and urge consideration to fair apportionment of these costs to be considered".

F.36 We recognise these concerns. We undertook a detailed review of the contractual obligations around cost allocation at stations. For CP4, we have reviewed each planned renewals project to confirm that the scope considers any works which should be funded by third parties.

HS1 Ltd 5YAMS proposed charges

F.37 This section details HS1 Ltd's 5YAMS proposed charges, followed by stakeholders' responses to their draft 5YAMS.

HS1 Ltd's proposed OMRCs for passenger operators

F.38 The charges set out in HS1 Ltd's 5YAMS charges represent a reduction for passenger operators of approximately 13% for domestic operators and 18% for international operators relative to charges at the end of CP3, which account for volume reopener apportionment of fixed costs. Prior to the volume reopener the difference to HS1 Ltd's 5YAMS is a reduction of 0.2% for international services and a small increase for domestic services of less than 1%. Table F.5 shows the

changes in charge per train, relative to both the end of CP3 after the volume reopener and the charge at PR19.

Table F.5 HS1 Ltd's proposed charges per train

February 2023 prices	CP3 at PR19	End CP3 (after the volume reopener)	5YAMS	Change from PR19	Change since end CP3
International £	2,605	3,168	2,599	-0.20%	-18.00%
Domestic					
Ashford- St Pancras £	1,935	2,234	1,954	0.90%	-12.50%
Springhead Junction- St Pancras £	1,011	1,170	1,018	0.70%	-13.00%
St Pancras-Ebbsfleet (Up) £	870	1,005	878	0.90%	-12.60%
St Pancras-Ebbsfleet (Down) £	927	1,071	934	0.80%	-12.80%

F.39 The key drivers of the difference between CP3 and CP4 are:

- the efficiencies achieved by NR(HS) in its Annual Fixed Price for O&M, and HS1 Ltd in its internal costs (both the subcontracted and pass-through costs);
- a lower renewals annuity than PR19; and
- the lower overall train volumes forecast to operate compared with PR19. As the per-train charges are subject to volume effects, this offsets the reduction in the overall cost stack in value terms.

HS1 Ltd proposed station charges

F.40 Each station's LTC is based on HS1 Ltd's proposed renewals cost profile. Following HS1 Ltd's review of station renewals costs and the application of its cost policy along with more efficient service contracts, the proposed LTC has decreased at all stations except Ebbsfleet where it remains mostly unchanged.

This was due the aforementioned factors not having much impact on Ebbsfleet's renewal requirements due to a range of station specific factors. The combined LTC for CP4 is £50.85m, a decrease from £57.9m in CP3.

F.41 HS1 Ltd outlined its proposed station charges in the 5YAMS, as shown in Table F.6.

Table F.6 HS1 Ltd's proposed station LTC for CP4

Station (February 2023 prices £m)	CP3	CP4	£m change	% change
St Pancras International	37.8	31.9	-5.9	-15%
Ebbsfleet International	8.1	8.2	0.05	0%
Stratford International	7.7	7.4	-0.4	-4%
Ashford International	4.4	3.5	-0.9	-22%
Total	**57.9**	**50.9**	**-7.1**	**-12%**

F.42 Table F.7 shows the 5YAMS LTC for each operator. The LTC has decreased for EIL and EMR compared to PR19. Southeastern's LTC has increased due to its larger share of LTC at Ebbsfleet compared to the PR19 determination. Once EIL ceased operating at Ebbsfleet, Southeastern was allocated 100% of the common station costs.

Table F.7 HS1 Ltd's proposed station LTC by operator for CP4

February 2023 £m	CP3	CP4	£m change	% change
EIL	31.6	24.7	-6.9	-22%
EMR	7.8	6.5	-1.3	-16%
Southeastern	18.6	19.8	1.2	6%
Total	**57.9**	**50.9**	**-7.1**	**-12%**

HS1 Ltd's proposals for freight operator charges

Proposed OMRCA1 and OMRCA2

F.43 Freight charges cover:

- Freight variable costs (OMRCA1); and
- Freight long-term avoidable costs (OMRCA2), made up of two elements:
  - track-dependent avoidable costs (net of mothballing costs); and
  - other freight avoidable costs e.g. staff costs.

F.44 These charges are shown in Table F.8, which details the changes to total freight charges and the effects of lower freight volumes relative to PR19 and end CP3.

Table F.8 HS1 Ltd's proposed changes to total freight charges in CP4, relative to CP3

February 2023 prices (£m)	PR19	End CP3	PR24 5YAMS	Change since PR19	Change since end CP3
Total OMRC to be recovered (5 years)	2.0	2.0	1.3	-33%	-33%
OMRC per train	981	1,424	1,313	34%	-8%
Total volume forecast (per annum)	454	200	200	-56%	0

F.45 Compared with the PR19 final determination, HS1 Ltd proposed total ORMC charges for freight fall by 33%. However, due to a 56% decrease in the forecast CP4 freight volumes, forecast OMRC per train charge increases by 34%.

Passenger operators' responses to HS1 Ltd's draft 5YAMS route access charges

F.46 HS1 Ltd collated stakeholder responses to its draft 5YAMS which we have reviewed.

F.47 HS1 Ltd's summary of Southeastern's response on route charges stated "HS1 charges remain excessive and whilst any reduction against December 2023 prices is welcomed, it is somewhat misleading given the catch-up for costs under-recovered that they are included within today's prices. The draft 5YAMS proposals

still result in an increase in costs compared to CP3 for route and stations HS1 (and NRHS) need to be more ambitious in seeking efficiencies and ways to reduce costs further".

F.48 EIL's summarised response stated they, "welcome steps to reduce costs back to charges at the start of CP3 in real terms, but this is not enough and there are further opportunities to go further in a range of areas. HS1 needs to carefully review HS1 costs and NRH' O&M proposals". EIL also stated "for CP3 HS1 note a £1.2m spend on route specific PR and marketing". They requested "HS1 confirm what this is related to" because "if this was connected to new entrants, such expenditure must not be included in the regulated budget for CP4".

F.49 We note Southeastern's and EIL's concerns and based on our own detailed assessment of costs, have applied an efficiency challenge and made reductions to O&M costs. We are satisfied that no expenditure relates to the introduction of new entrants.

Responses to HS1 Ltd's draft 5YAMS station access charges

F.50 In its response to the draft 5YAMS EIL stated "it is important HS1 implements a cost policy for stations for CP4". EIL stated, "HS1 made some specific changes to the calculation methodology for the route annuity" and "there is no a priori reason why these changes should not also be appropriate for the calculation of the stations renewal annuity. HS1 should be able to generate long term train volumes" to "generate a train volume weighted annuity".

F.51 We have considered the issues around the weighting of renewals costs by traffic volumes, and made adjustments to HS1 Ltd's proposed LTC accordingly.

F.52 We consider that HS1 Ltd's charges, after our adjustments, reflect a reasonable estimate of the efficient costs of passenger services operating on the network in CP4. This takes into account both our assessment of the impact on passenger operators and feedback from stakeholders.

Freight operator's response to route access charges

F.53 DB Cargo stated, "while recognising the reduction in costs and decline in freight volumes, the 34% increase in per train charges will place the remaining HS1 freight flow at very real risk and is unlikely to be able to bear this magnitude of cost increase. There is a strong likelihood that implementing these charges would mean the remaining freight volumes cease, with HS1 incurring mothballing costs and a transfer to road freight".

F.54 We considered this response and based on our own detailed assessment of costs have made an adjustment to HS1 Ltd's proposed freight specific costs.

Our Draft Determination on charges

F.55 This section presents our Draft Determination of HS1 Ltd's operator charges for CP4. The precise charges will need to be modelled by HS1 Ltd in its revised 5YAMS, which must be submitted to us by 29 November 2024.

F.56 In our view, HS1 Ltd's charges, after our adjustments, provide a reasonable estimate of the efficient costs of passenger and freight services operating on the network in CP4. This takes into account our assessment of the responses from stakeholders.

F.57 We made a number of adjustments to HS1 Ltd's charging structure and charges that are common to both passenger and freight:

- **operating and maintenance adjustment;**
- **renewals annuity adjustments;**
- **freight common cost adjustment**: the reallocation of costs previously classified as freight-specific fixed costs, to common costs recoverable from passenger operators;
- **direct / indirect cost split**: reapportioning the split between directly-incurred and non-directly incurred costs for underbridges, acoustic barriers, embankments, points operating equipment and contact wire; and
- **cost of capital**: we found HS1 Ltd's WACC to be excessive and inconsistent with regulatory best practice as outlined in the earlier discussion on the WACC. This resulted in a range of changes to the OMRC charges for all categories of traffic, as detailed in the following tables.

F.58 After our adjustments HS1 Ltd's total income from charges will be £164.9m per year and £824.3m in total over CP4, without the traction electricity charge. Table F.9 shows the cumulative adjustment of total charges in CP4.

Table F.9 Draft Determination cumulative adjustments to charges in CP4

February 2023 prices £m	Change to 5YAMS-passenger operators	Total passenger operator charge	Change to 5YAMS freight operators	Total freight operator charge
5YAMS	0.0	866.5	0.0	1.5
Freight Common Cost Adjustment	0.6	867.1	-0.8	0.7
Renewals Adjustment	-28.4	838.1	-0.1	1.4
O&M Adjustment	-14.7	851.8	0.0	1.5
Direct / Indirect Cost Adjustment	0.0	866.5	0.0	1.5
Cost of capital	-0.3	866.2	0.0	1.5
Cumulative adjustment	**-42.9**	**823.6**	**-0.8**	**0.7**

F.59 In addition to the charges outlined in Table F.9, operators are also charged at cost for their traction electricity usage. Table F.10 gives a breakdown of HS1 Ltd's forecast charges revenue over CP4. This includes QX (which recovers the stations O&M) and traction electricity, which is passed through at cost.

Table F.10 Draft Determination forecast of HS1 Ltd's total charges revenue, including route OMRC, station LTC, QX and the traction electricity charge

Total income (February 2023 prices £m)	2025-26	2026-27	2027-28	2028-29	2029-30	CP4 Total
International services	62.5	62.5	62.5	62.5	62.5	312.31
Domestic services	102.3	102.3	102.3	102.3	102.3	511.3
Freight	0.1	0.1	0.1	0.1	0.1	0.7
Total	**164.9**	**164.9**	**164.9**	**164.9**	**164.9**	**824.3**

Total income (February 2023 prices £m)	2025-26	2026-27	2027-28	2028-29	2029-30	CP4 Total
Traction electricity charge	34.7	29.6	28.7	28.0	27.3	148.3
Total charges income	**199.6**	**194.5**	**193.6**	**192.9**	**192.2**	**972.6**

F.60 HS1 Ltd's total revenue for CP4 from charges is estimated to be £972.6m.

Charges for passenger operators

F.61 We have made a number of changes to HS1 Ltd's calculation of charges, as described above.

F.62 Tables F.11 and F.12 show the cumulative impact of all the changes on passenger operator charges, relative to the 5YAMS.

Table F.11 Draft Determination of OMRC for international passenger operators

February 2023 prices	5YAMS	Draft Determination	Change from 5YAMS	Change from CP3
OMRCA1 £ per train km	5.91	5.64	-5%	9%
OMRCA2 £ per train minute	12.42	11.55	-7%	-26%
OMRCB £ per train minute	36.72	34.03	-7%	-7%
OMRCC £ per train minute	13.74	13.74	0%	4%

Table F.12 Draft Determination of OMRC for domestic passenger operators

February 2023 prices	5YAMS	Draft Determination	Change from 5YAMS	Change from CP3
OMRCA1 £ per train km	2.38	2.27	-5%	10%

February 2023 prices	5YAMS	Draft Determination	Change from 5YAMS	Change from CP3
OMRCA2 £ per train minute	2.79	2.59	-7%	-18%
OMRCB £ per train minute	39.47	36.60	-7%	-9%
OMRCC £ per train minute	13.74	13.73	0%	4%

F.63 Table F.13 shows the effect of each of our adjustments to the charges paid by international passenger operators. It also shows the cumulative effect of all of the adjustments.

Table F.13 Draft Determination of route charges for international passenger operators

February 2023 prices	5YAMS	Renewals	O&M	Direct indirect/ cost split	Cost of capital	Freight common cost	Draft Determination
OMRCA1 £ per train km	5.91	-0.67	N/A	0.28	0.12	N/A	**5.64**
OMRCA2 £ per train minute	12.42	-0.34	N/A	-0.35	-0.18	N/A	**11.55**
OMRCB £ per train minute	36.72	-0.63	-1.66	-0.32	-0.14	0.06	**34.03**
OMRCC £ per train minute	13.74	N/A	N/A	N/A	-0.01	N/A	**13.73**

F.64 Table F.14 shows the effect of each of ORR's adjustments to the charges paid by domestic passenger operators. It also shows the cumulative effect of all of the adjustments.

Table F.14 Draft determination of route charges for domestic passenger operators

February 2023 Prices	5YAMS	Renewals	O&M	Direct indirect/ cost split	Cost of capital	Freight common cost	Draft Determination
OMRCA1 £ per train km	2.38	-0.27	N/A	0.12	0.04	N/A	**2.27**
OMRCA2 £ per train minute	2.79	-0.08	N/A	-0.08	-0.04	N/A	**2.59**
OMRCB £ per train minute	39.47	-0.71	-1.65	-0.4	-0.18	0.07	**36.60**
OMRCC £ per train minute	13.74	N/A	N/A	N/A	-0.01	N/A	**13.73**

F.65 We consider that after our adjustments HS1 Ltd's charges reasonably estimate the efficient costs of passenger services operating on the network in CP4. This conclusion also considers the responses from stakeholders to HS1 Ltd's draft plans.

Charges for stations

F.66 A number of stakeholders did not agree to HS1 Ltd's proposed charges in the draft Life Cycle Reports (LCRs) and consequently in the 5YAMS. We considered the responses from stakeholders to HS1 Ltd's draft LCRs and 5YAMS whilst making our determination of station costs. HS1 Ltd revised its estimates of station charges between its draft and final submissions. Passenger operators' comments on station charges were based on the draft LCRs and 5YAMS. In the final submission, station charges were lower than those for the previous control period for three of the four stations.

F.67 We have reviewed HS1 Ltd's plans for renewals funding and expenditure, and made a number of adjustments. Our adjustments reduce the total annual station LTC by 19% compared to the LCRs and 5YAMS, resulting in an overall reduction of 29% relative to CP3. Table F.15 provides an estimate of the cumulative impact

of our revised renewals annuity.

Table F.15 Draft Determination of total LTC for CP4

February 2023 prices £m	5YAMS/LCRs	Draft Determination	Change from 5YAMS	Change from CP3
St Pancras	31.9	25.9	-19%	-31%
Stratford International	8.2	6.5	-20%	-20%
Ebbsfleet International	7.4	6.1	-18%	-21%
Ashford International	3.5	2.7	-23%	-39%
Combined	**50.9**	**41.1**	**-19%**	**-29%**
EIL	24.7	19.8	-20%	-37%
EMR	6.5	5.2	-19%	-32%
Southeastern	19.8	16.1	-19%	-14%
Combined	**50.9**	**41.1**	**-19%**	**-29%**

Charges for freight operators

F.68 Our review found some costs being treated by HS1 Ltd as freight-specific were also incurred through the activities of other operators. HS1 Ltd's 5YAMS included £685k of freight specific costs - our review of these costs has found that £596k of these costs should not be allocated to freight.

F.69 We have therefore decided to allocate these costs to passenger operators as part of OMRCB, as they are not freight-specific. Only the £0.089m of Ripple Lane costs remain as a freight-specific cost.

F.70 After our adjustments we consider that our Draft Determination of HS1's charges for freight services will reflect a reasonable estimate of the efficient costs of freight services operating on the network in CP4.

F.71 Our assessment shows the cumulative effect of these adjustments would reduce freight OMRC per train km by 48%, relative to the 5YAMS. Table F.16 shows the percentage change in freight OMRCs relative to the 5YAMS.

Table F.16 Draft Determination of freight OMRCs in CP4

February 2023 prices	Charge per train km	Charge per train km		
	5YAMS	Draft Determination	Change from 5YAMS	Change from CP3
OMRCA1 (variable) £	7.06	6.74	-5%	10%
OMRCA2 (avoidable) £	7.83	1.00	-87%	-80%
Total OMRC £	**14.89**	**7.74**	**-48%**	**-30%**

F.72 Our Draft Determination of the cumulative impact of our revised renewals annuity, O&M expenditure assumptions and our proposals to reallocate certain freight-specific costs as common costs is illustrated in Table F.17.

Table F.17 Draft Determination for freight operator charges

February 2023 prices	5YAMS	Freight common costs	Renewals	Direct indirect/ cost split	Cost of capital	Draft Determination
OMRCA1 £ per train km	7.06	0.00	-0.8	0.48	0.14	6.74
OMRCA2 £ per train km	7.83	-6.83	0.00	0.00	0.00	1.00
Total	**14.89**	**-6.82**	**-0.80**	**0.48**	**0.13**	**7.74**

F.73 Tables F.18 and F.19 show how HS1 Ltd's proposed costs flow through to the charges in our Draft Determination by replacing renewals costs for the 5 years with annuity payments considering 40 years; and by applying ORR's adjustments.

Table F.18 Breakdown of HS1 Ltd's proposed total OM&R costs

£m, February 2023 prices	Route	Stations	Total
HS1 Ltd			
HS1 Ltd operating costs	72.9	n/a	72.9
HS1 Ltd O&M financing costs	0.3	n/a	0.3
NR(HS)			
Total Operations & Maintenance costs	230.7	n/a	230.7
Management fee	18.5	n/a	18.5
Contract risk premium	6.6	n/a	6.6
NR(HS) Total Annual fixed price	**255.8**	**n/a**	**255.8**
1.1% inflation uplift	2.8	n/a	2.8
Total NR(HS) costs	**258.6**	**n/a**	**258.6**
Other costs			
Pass-through	122.2	n/a	122.2
Freight-specific	0.4	n/a	0.4
R&D	4.0	n/a	4.0
Renewals	218.7	51.9	270.6
Total regulated costs	**677.1**	**51.9**	**729.0**

F.74 In line 3 of Table F.18 the HS1 Ltd financing cost is the financing element of the O&M charge.

Table F.19 Conversion of total OM&R costs to charges, including ORR adjustments

£m, February 2023 prices	Route	Stations	Total
Total costs, before ORR adjustments	677.1	51.9	729.1
ORR O&M adjustments	-14.5	n/a	-14.5

£m, February 2023 prices	Route	Stations	Total
Total renewals costs	-218.7	-51.9	-270.6
Renewals Annuity	139.0	41.1	180.1
Total costs funded by charges	**583.0**	**41.1**	**624.1**

F.75 Total regulated charges income is £624.1m. With the addition of traction electricity charges (£148.3m) and QX (£200.2m), that equals the total charges income of £972.6m, stated in table F.10. The traction electricity charge is a charge to operators for electricity used in traction, which is passed on at cost. The £180.1m shown in this table is the total annuity payments for the control period, as set out in the Charges chapter.

Annex G: Access terms proposals

G.1 The table below summarises proposals for changes to the access terms for the network, made by HS1 Ltd in its 5YAMS, and by operators, alongside our proposed minded-to position. Full draft red-line proposals of these documents are annexed for stakeholders' comments.

Table G.1 Access terms determinations for consultation

Proposal	Proposer	ORR position
Performance Regime: Include a provision that gives HS1 Ltd the ability to invoice the operator for the external costs of a performance regime recalibration when they are the party that requests it (Section 18.1).	HS1 Ltd	Minded not to approve
Performance Regime: Include a provision so HS1 Ltd may amend and reapportion the OMRCA2 and OMRCB to reflect the adjustment in performance risk costs from a recalibration (Section 18.1).	HS1 Ltd	Minded to approve, but only for recalibration that has been deferred from PR24
Possessions Regime: Update the Possessions Allowance definition to reflect the extended and standard possession allowance for CP4. (Section 18.2.2)	HS1 Ltd	Minded to approve
VRO: Update the definition of a subsequent Review Event threshold to refer to the volume forecast for the relevant year in the preceding VRO (Section 18.3).	HS1 Ltd	Minded to approve
VRO: Changes to simplify the definition of a VRO and clarify approach (Section 18.3).	HS1 Ltd	Minded to approve
VRO: Include a provision that, if freight ceases operating on HS1, it triggers a reapportionment of remaining freight fixed costs across passenger operators (Section 18.3).	HS1 Ltd	Minded to approve
Pass-through wash up: Change the definition of the pass-through costs wash up term so the wash up applies to the total pass-through costs in the year (Section 18.4).	HS1 Ltd	Minded to approve

Proposal	Proposer	ORR position
Pass-through cost definitions: update existing pass-through cost categories to include additional items. These are: success fees in business rates; insurance broking fees and professional costs; management and bill checking fees for non-traction energy; and REGOs in non-traction energy (Section 18.7.2).	HS1 Ltd	Minded to approve energy management and REGOs. Minded not to approve remaining items.
Pass-through cost definitions: Update to include the new pass-through cost categories for the REACT scheme, N-1 scheme and the escrow investment project (Section 18.7.2).	HS1 Ltd	Minded to approve
AIRC: Include provisions to expressly clarify the billing of AIRC on spot bid services and consequential changes (Section 18.9).	HS1 Ltd	Minded to approve
FAT: Implement the N-1 Scheme for consistency with the PAT (Section 18.9).	HS1 Ltd	Minded to approve
Minor corrections for consistency and clarification in provisions within scope of PR24.	HS1 Ltd	Minded to approve
A wash up of OMRCA2 and OMRCB to allocate fixed costs on actual train volumes. SETL suggests an annual wash up. EIL proposes this only occurs when actual volumes deviate by 10%.	EIL and SETL	Minded to approve with no trigger level
The APAt term in the wash up provisions is restricted to inflation indexation differences only.	EIL	Minded to approve
Change the trigger for a VRO from 4% difference in train volumes to 10%.	EIL	Minded not to approve
Operators should approve volume forecasts HS1 Ltd uses to execute a VRO if these are above the FWT.	EIL	Minded to approve
Include dedicated terms for OMRCA2 and OMRCB so these are not washed up through APAt term. EIL proposes the wash up of OMRCA2/B occurs only when volumes deviate by 10%.	EIL	Minded to approve

Proposal	Proposer	ORR position
The OMRCA1 wash up approach is changed so OMRCA1 applies to the ex-post volume of trains; that OMRCA1 is refunded if volumes are below FWT.	EIL	Minded to approve where difference between actual trains and FWT trains is positive - but not in cases below FWT
Remove the floor to inflation indexation for OMRC so negative inflation (deflation) is passed on to the operators' charges.	EIL	Minded to approve
The DAB is used as the relevant dispute resolution body for delay attribution disputes to improve the efficiency and effectiveness of dispute handling.	EIL	Minded not to approve
The timeframes for reviewing performance incidents should be extended to allow reasonable time to review, and the governance for the process outlined.	SETL	Minded not to approve
Performance Regime: Include a provision that allows for recalibration during CP4, commencing by September 2025 (Section 18.1)	HS1 Ltd	Minded to approve
Possessions Regime: Change the number of possessions within the Possessions Allowance (Section 18.2.1)	HS1 Ltd	Minded to approve
Possessions Regime: Allow unused Extended Possessions Allowance to roll over between years	HS1 Ltd	Minded to approve, subject to use of Engineering Access Statement as change control mechanism for rollover
AIRC: Amend the term 'Further IRC' to Additional IRC to be consistent with the PAT (Section 18.9).	HS1 Ltd	Additional IRC is within scope of the review. This includes the consequential amendments.

G.2 The following proposals were considered outside the scope of our review and will be taken forward by consultation between the parties to the access terms:

Table G.2 Access terms proposals outside the scope of PR24

Area	Section	Proposal	Proposer	Explanation
PAT and FAT	Section 7 (Track Charges)	Carbon costs: Remove the provisions related to carbon costs and charges (Section 18.5).	HS1 Ltd	This is to reflect a change in law. The amendments can be made following the process in paragraph 5.2 of Section 9 of the PATs.
PAT and FAT	Various	Updates to reflect: • Removal of references to EU licences which no longer apply since Brexit. • The Corporate Insolvency and Governance Act 2020. (Section 18.9)	HS1 Ltd	This is to reflect a change in law. The amendments can be made following the process in paragraph 5.2 of Section 9 of the PATs.
PAT and FAT	Section 7 (Track Changes)	Update to the Outperformance Sharing to reflect CP4 dates (Section 18.8).	HS1 Ltd	This is out of scope. The amendments can be made following the process in paragraph 5.2 of Section 9 of the PATs.
FAT	Section 7 (Track Charges)	Implement On-train Metering for consistency with the PAT (Section 18.9).	HS1 Ltd	This is out of scope. The amendments can be made following the process in paragraph 5.2 of Section 9 of the PATs.
PAT and FAT	Various	Minor amendments to update dates and addresses and for clarifications, cross-referencing and typos.	HS1 Ltd	HS1 Ltd has confirmed that these are minor changes to sections of the PATs that fall outside those defined as “Review Provisions” and are therefore out of scope. The amendments can be made following the process in paragraph 5.2 of Section 9 of the PATs.
	Invoicing	Proposals so that: • An operators’ payment period only starts after all necessary and accurate	EIL and SETL	Invoicing arrangements are out of scope of the review.

Area	Section	Proposal	Proposer	Explanation
		invoices and supporting documents are received, to allow reasonable time to review. • Operators' may withhold amounts of an invoice they dispute to incentivise HS1 Ltd to improve invoicing accuracy. Currently operators must pay the invoice in full and then dispute. • There is specific reference to accurate and timely invoicing in the general standard for performance for HS1 (EIL only). • Reciprocal charging of interest applies on late payments by HS1 Ltd to operators (SETL only).		
	Outperformance	The current Outperformance Regime should be changed as it drives perverse incentives for NR(HS).	EIL and SETL	This is out of scope. The amendments can be made following the process in paragraph 5.2 of Section 9 of the PATs.
	IRC wash up	The IRC wash up approach is changed so IRC applies to the ex-post volume of trains run; that IRC is refunded if volumes are below FWT.	EIL	IRC is excluded from the scope of ORR's review by the concession agreement which takes precedence over the PATs.
	Interim Review trigger	Introduce a new trigger for an Interim Review when train volumes deviate by more than 25% from forecasts so the potential impact of large changes in train volumes on charges is subject to regulatory review.	EIL	The triggers for an Interim Review are set out in the concession agreement and are therefore out of scope of the review.

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