in evening period' and it's got 18 in relation to the train pass-bys. Do you know how that figure is arrived at?

228. MR SUMMERS: That, I understand, is the prediction of events from HS2 in the future, which as I said I think is out by – We should double that figure.

229. MR HENDRICK: Yesterday we were told that it was going to be 18 trains an hour. Where has the number 36 come from?

230. MISS LIEVEN QC: It's 18 in each direction, sir, so in terms of noise impact it's 36.

231. MR HENDRICK: All right.

232. MISS LIEVEN QC: I think that's the peak. My recollection from the litigation is that's the peak number of trains when Phase 2 is built and at full operation. That's why Mr Summers says 'up to 36'. I don't think it will be 36 on day one of opening. Mr Mould will tell me if I've got that wrong. Thank you very much, Mr Summers.

233. Sir, we're doing our best, I think, is the best that I can say. Hydrogeology next. There are quite a lot of slides. I won't go through Mr Johnson's qualifications and expertise, but he is a hydrogeological expert. Just by flicking through the slides, Mr Johnson, you're going to have to try and get your point across exceedingly fast.

234. MR JOHNSON: Okay, fine. So if we start with the second slide, please. This is the natural system as it exists at the moment in Wendover. We're standing to the north of Wendover and looking south. Rain falls on the chalk hills to Coombe Hill, to the south of Wendover, percolates into the chalk aquifer and flows towards Wendover and then discharges through the natural discharges in Wendover along a spring line. Spring one, to the left-hand side, which is towards the Chiltern Scarp, feeds into the Wendover Arm of the Grand Union Canal and that's the feeder that goes into the Grand Union Canal at the Tring Summit and provides the water at the Tring Summit, or a significant proportion of water at the Tring Summit, to keep those locks on both sides of the flight working. The second spring is Castle Brook and that feeds into Weston Turville Reservoir, which is an SSSI and a lake used for sailing. The third spring feeds into Wendover Brook, which flows off to the Thames. The fourth and

fifth springs go into the brook, which flows off towards Aylesbury and that way. So if we go on to the next slide, what I've done now is taken –

235. SIR PETER BOTTOMLEY: Are the 12-month springs reliable?

236. MR SUMMER: They're incredibly reliable. We've got a flow record – one of the best global flow records – and so we know exactly how reliable they are. They're incredibly reliable.

237. So I've taken the lid off the groundwater system now. We can see the groundwater in blue flowing down the gradient towards those springs. What we're effectively doing by putting the Wendover green tunnel and the Wendover north cutting in there is we're creating a drain that moves across east-west, draining towards the west and, about that, there's no disagreement between myself and HS2.

238. What we don't know is how much water is going to be drained out there and therefore, how much water will be taken away from the five natural water features in that environment. So, if we go onto the next slide.

239. This is a cross section, so through the proposed route, which enables us to see the relation to the geology and the groundwater, so the red line is the bottom of the proposed route, the blue dotted line is the inferred normal groundwater table, so that's typically where the groundwater will be and this is from the Department for Transport report. What I've coloured in in blue is the area where the Wendover green tunnel and Wendover north cutting will act as a drain and they will depress the groundwater level and the water will flow into them and they'll act as a drain taking the water away. So, if we go to the next slide.

240. The methodology that HS2 have used is necessarily quite a high level methodology, and it includes a number of assumptions which lead it to miss some of the key impacts of what's going to happen to the hydrogeology in Wendover. So, if we go onto the next slide.

241. And what that means is, now I've put in flow in black, and impact in red. So, there's no estimate of the level of flow in – that will be drained out of the aquifer, but what the report says is that there'll be no impact on the Wendover arm of the Grand

Union Canal, so no mitigation required, and the same for Castle Brook, flowing into the Grand Union Canal, so no mitigation required, minimum impact on to Wendover Brook, but that can – but it's not significant. There will be a significant impact on the downstream springs four and five, but that can be mitigated by returning the drain flow from the cutting, back into Stoke Brook, so the net effect is minimal. So, that's the conclusion of the HS2 report.

242. If we then redo the impact assessment, using Department for Transport's data, so I only use data from their report, but I use the best practice guide published by the Environment Agency for hydrogeology assessments…

243. MISS LIEVEN QC: Can I just stop you there? I think it's worth the Committee knowing you were actually one of the authors of that best practice guide, so you do know what you're talking about.

244. MR JOHNSON: Thank you. And then if we then go onto slide 8. Now we can put some numbers to the issue. So, the 24 mega litres a day, 24 million litres a day, is the typical drainage that we predict coming out of that construction, so during construction, so that's the temporary impact. And then the permanent impact, when the green tunnel is being constructed and backfill, will be about 13 mega litres a day. Above and below that, I've put 47 and six mega litres a day and that's because as a hydro-geologist, I always like to put error bands around any of my calculations, so you can see how big it could get and how small it might be, and I've used different types of coefficients from different streams in the area for that.

245. And if we go down to the actual springs themselves, the black numbers are the flow from those streams, and the red numbers are the impacts. The black numbers are from some spot gazing I did, in February this year, so it's one day, spot gazing, just to give myself a feel for what the sort of flow was coming out of each one of those springs. So, I could see how significant that 24 mega litres a day is. And you can see that the impact, the potential impact of minus four on a flow of five, is profound. And the same for Weston Turville, and the same for Stoke Brook, so we're talking about profound impacts on the water features of Wendover. If we then go onto the next slide.

246. It's a very uncomfortable question to ask as a hydro-geologist but you have to ask it, what would the world have to look like for my calculations to be wrong, so in other

words, how could I be making a misleading prediction? Not based on mistakes, this is based on what I don't know about the area, and so there are three things that I identified here. One was, if the flows, out of all the springs, were actually enormous, compared to the impact, then the relative importance of the HS2 construction would be small. That's why I did the spot gazing, so that was to try and tie down that particular problem.

247. Groundwater is a big store of water and it can smooth and delay impacts, so all the impacts that I've shown won't happen instantaneously, there will be a delay and it's a question of how big that delay is, and the only way you can work that out is with a groundwater model and that's the only way you can really work that out. My sense is that it probably won't take that long for that impact to be felt. Of course, for the permanent impact of the north cutting, that's irrelevant, the impact will happen.

248. MR HENDRICK: Just before you go any further, what are the implications of these flows? What's going to happen that people locally would notice?

249. MR JOHNSON: So, if that impact is right, on the Wendover arm of the canal, then there would be 20% of the flow in the canal other than what's previously, so 75% reduction.

250. MR HENDRICK: So there will be a drop in the level?

251. MR JOHNSON: Canals are funny because the level is controlled by the outlet structures. The biggest impact will be to do with the amount of flow that goes into Tring reservoir and is then available to fill up the flight of locks at the Tring Summit, so that's the biggest impact of that one. For Weston Turville, the impact is very much, you've got 20% of the flow going in, you'd expect to see very depressed levels in the SSSI.

252. MR HENDRICK: So you're saying, it's going to reduce the water availability to the local people?

253. MR JOHNSON: The amenity value of those two, yeah definitely, absolutely.

254. So, the next question is, would a tunnel be any better? Sorry, the third point that I was going to come to was that, how else could the forecast be wrong? If the groundwater level is below the level of the proposed scheme, for the whole year, there would be no impact, so if the groundwater table is below the level, you don't – no water

will flow into the cutting and then there will be no impact.

255. I've used the normal levels from the DfT report, so that's again, that just points you where the fieldwork needs to go in order to tie that particular issue down. The next question is about would a tunnel be any better and I'm just going to summarise that by saying, yes, it will, it will significantly reduce the risk to the water features in Wendover. If we go onto the next slide.

256. This is just a case study from a similar situation in Ireland, which was written up; it's been constructed now and it was written up in 2006. It calls it a cautionary tale because the costs of that work tripled over the construction time, simply because they hadn't appreciated quite how big the impact would be and how significant they would be, and they were always playing catch up on the design. So, it's a – that's why I include that, and if we go onto the next slide, please.

257. So, if those impacts happen, what will be – it's my shopping list of mitigation that would be required. There needs to be a pumping station to the west end of the cutting, to receive that drainage water and pump the amount back up that's required to mitigate spring 1 into Wendover canal, so that's about a two and a half metre wide stream, into the Wendover canal. Stream 2, which is about a one and a half to two metre wide stream, and stream 3, Wendover Brook, so you need three discharges to fully replenish the lost streams.

258. We also have to consider what happens at high flows. I've only predicted what's happening at average flows. At high flows, of course, there will be more water going into each of those resources, and if I was the Canal and Rivers Trust, I'd want the full annual flow to be available to me, to fill up my reservoir, so again, the pumps may need to be sized for more than just that average flow that I've said.

259. We need to get the drainage under the road, so we need to get under the road and under the railway, and we're going to need to work with the local community because even though we can mitigate, so we can pump all that water back up the hill, and discharge it into those three locations, in the village, when you actually go and look at these springs, there may be a whole number of springs, so you may discharge you're your main stream, but that means you lose one or two little springs and ponds and so forth, and you just have to be honest with the local community, and say that's a likely

impact. And if we just go onto my final slide.

260. This is background flooding, so what happens, how are we going to mitigate the situation when there's ground water flooding. It's a rare event, the last time it happened was in 2000, 2001 and groundwater table then gets to the surface. So when you first look at this, these cross sections, which come from HS2 publication, my first reaction to it was that that cutting would just fill up with water and you'd have trains into water, and of course, that's ridiculous, that's not what's going to happen in this case because the cutting slopes off and so that cutting can act as a river and can actually drain huge amounts of water so you don't need to worry about that, but we do need to make sure that this cutting can cope with groundwater flooding and therefore acts as a very efficient drain. If we design it as a very efficient drain, for groundwater flooding purposes, it will continue to be a very efficient drain, all year round and that just means that the impacts that I've predicted are that bit more likely.

261. MISS LIEVEN QC: Thank you. Can I just ask you one question, just to clarify something, the next topic we were going to cover is the ecology of the Wendover arm canal. If your assumptions are right, about the impact of the HS2 proposal, what will be the likely impact on the water flows in the Wendover arm canal?

262. MR JOHNSON: So the flows will be reduced by 75%, so that's the flow. That doesn't mean a level, that's the flow. It functions, as I understand it, ecologically, as a low level river, as lowland river, I beg your pardon. Typically, if you reduce flows, you – that's not a good thing to do but I can't tell you what's…

263. MISS LIEVEN QC: That's fine, that's all I wanted to be clear about.

264. MR HENDRICK: Could I ask you, obviously, you've made an assessment and I dare say you've done calculations as well, how confident, or how likely is it that the impact you see will take place on the reservoir, for example, will take place?

265. MR JOHNSON: I'm veering on the sort of 85% confidence, I would say, at the moment. Because, when I looked at this situation – when I looked at this set up for the first time around, what I saw was a 19 metre wide river being created to the west – to the south of Wendover, versus a few small one to two metre wide streams coming out of the chalk. To me, that's ringing a lot of alarm bells. Now, I've said that there's a number of

circumstances where it doesn't have to do it, and they'll all less likely than my prediction, so that's why I'm saying it's a sort of 85% chance, but the key thing that will protect Wendover, is if the route is above the groundwater table all year round, then there will be no impact. That's the main thing, but I mean, just looking at last slide, where you see groundwater flooding, you know that can't be true, so you know it has to have an impact, at high water levels. Of course, that impact will be on flow, there will be a significant flow, but it will be smaller percentage of the total flow it's leaving.

266. MR HENDRICK: And in terms of the mitigation and the pumping station that you talked about, how usual is that and is it a big deal?

267. MR JOHNSON: I can't say how usual it is, this is the only – I mean, I'm actually a chartered civil engineer as well, and you can design pumping stations to pump water back up hills. I've done it, I've designed plenty of pumping stations, so you can do that. You just have to do it for the full life of the scheme and you're pumping effectively, you know, three streams back up. It's all doable, and that's why in that, engineers can always come up with mitigation measures – you can always mitigate to some extent what happened, but it's clearly a reasonable mitigation, and if you compare that with what HS2 is currently planning for, which is no mitigation. So, I would argue that it's a reasonable amount of mitigation, compared to what they're planning for at the moment.

268. MR HENDRICK: Okay.

269. MISS LIEVEN QC: Thank you.

270. CHAIR: Mr Mould?

271. MR MOULD QC (DfT): We're aware of these potentialities and risks as we are with a whole host of things along the route. We've assessed them in the Environmental Statement as far as we are able to at this stage in the project, we've indicated how we would expect to go forward with them. We've been discussing these matters with the Environment Agency and with the Canal and Rivers Trust; they have given us some ideas as to what we need to build into the arrangements going forward. What I'm proposing to do, rather than take time now, is, if it's convenient to you, we will write a note in response to the points that have been made, we will share that with Mr Johnson and if he wants to comment on it, he can and we will obviously provide that to the

Committee.

272. CHAIR: Okay.

273. MISS LIEVEN QC: I'm content with that, sir.

274. CHAIR: Okay. Thank you very much, Mr Johnson.

275. MR JOHNSON: Thank you.

276. MISS LIEVEN QC: So, sir, the next slide is on the ecology of the Wendover arm canal; I think the slide is self evident. I was going to have a local resident speak to it but the point is clear, which is that if the flows fall, as Mr Johnson expects them to do, there will be a significant impact on the ecology of that arm of the canal and then knock on effects on the Grand Union, so I was going to take that slide as read and move on to the green – to the extension proposals and ask Mr Thompson to come back to the box – or to the seat, to talk through those proposals.

277. MR THOMPSON: Hello again.

278. CHAIR: Hello.

279. MR THOMPSON: If I start, I should just say, I'm not a civil engineer, so what you've got here is just a common sense approach we think of how we can mitigate Wendover. The numbers shown here, financial numbers, I think are all derived from HS2 numbers and I'll talk those through as we go. So, just to remind you, the background is we really want, as a first and second choice, a long tunnel through the Chilterns, and this is just our fallback position.

280. So, what I will now do is talk about it in three elements: the north of Wendover, the south of Wendover and the London Road. So, if I could have the next slide please.

281. So, looking at the north. The basic proposal here is to move the current green tunnel, make it 500 metres longer, so it moves the portal away from the corner of Wendover town. What that would do is obviously help in terms of noise. Not changing the alignment means that the green tunnel would slowly rise, so it would be obvious as a hump, as it comes up, but we're using spoil, it would be possible to smooth that into the landscape, so it's not too obvious.