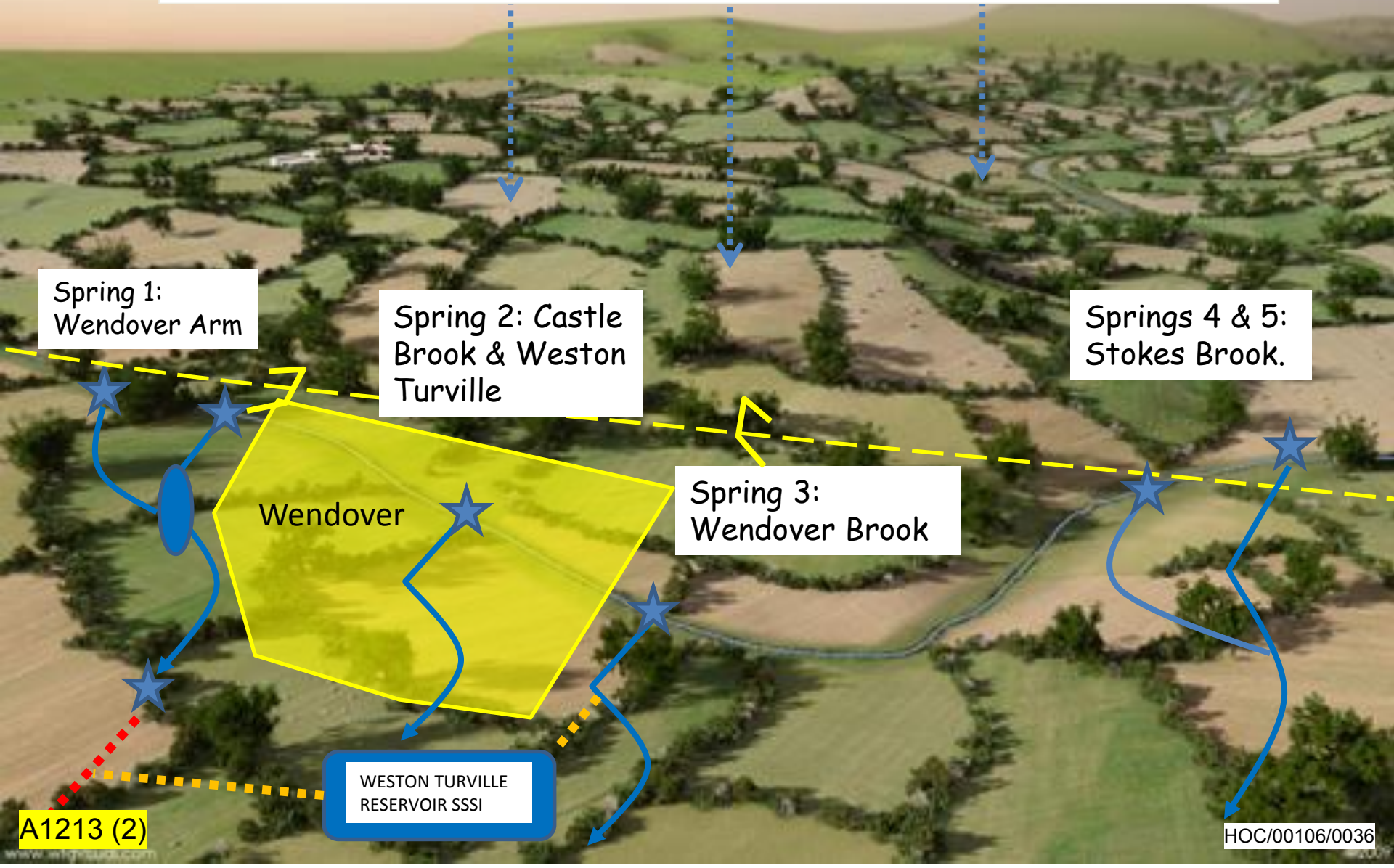


Hydrogeology

Schematic of Wendover (in yellow) showing the 5 springs identified in the DfT reports and the surface water features they support.



Spring 1:
Wendover Arm

Spring 2: Castle
Brook & Weston
Turville

Springs 4 & 5:
Stokes Brook.

Spring 3:
Wendover Brook

Wendover

WESTON TURVILLE
RESERVOIR SSSI

A1213 (2)

HOC/00106/0036

The Wendover Green Tunnel and North Cutting have a similar impact to 'building' a new chalk stream south of Wendover.

Government's preferred scheme

HS2 GREEN TUNNEL

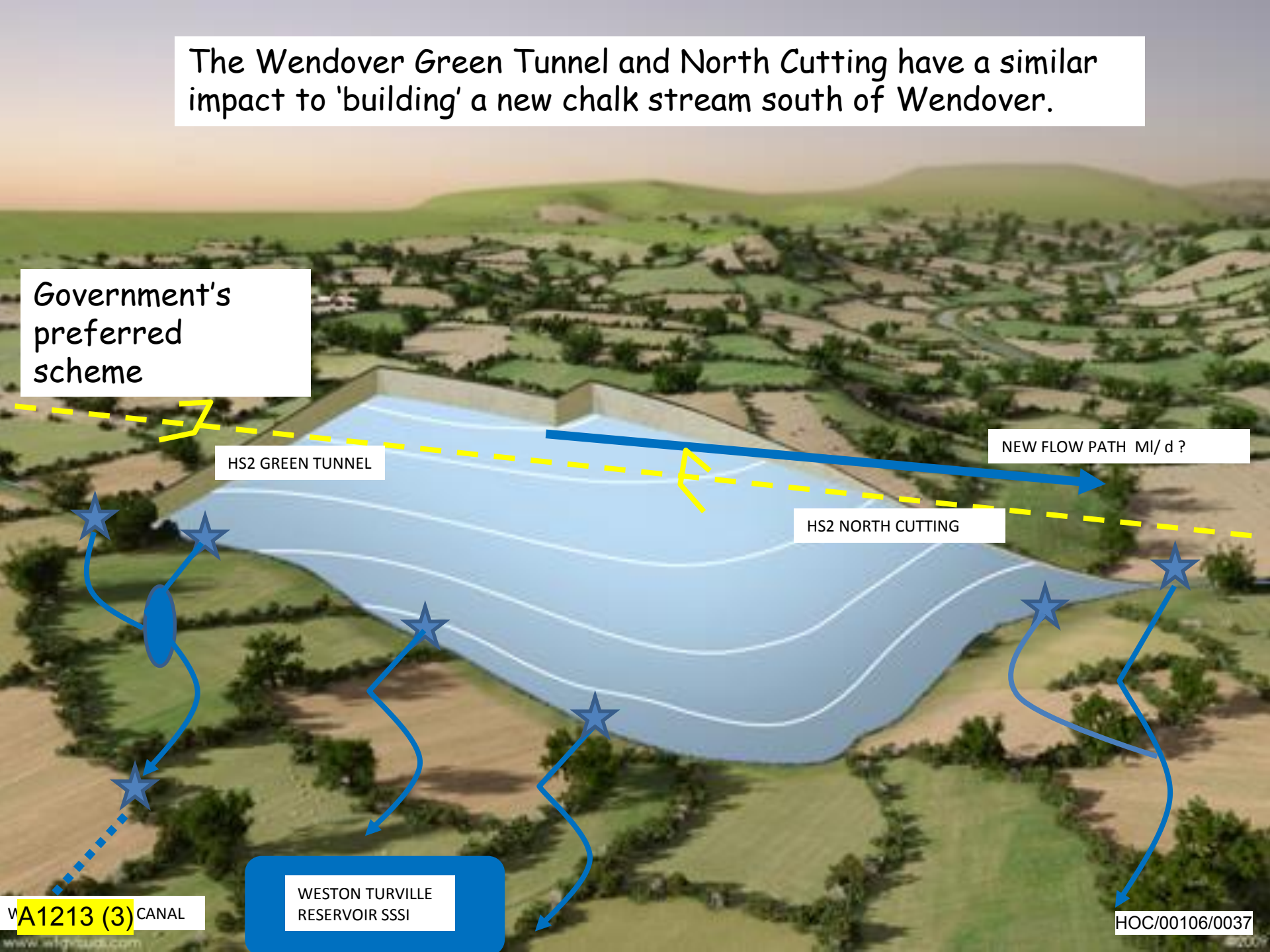
NEW FLOW PATH MI/d ?

HS2 NORTH CUTTING

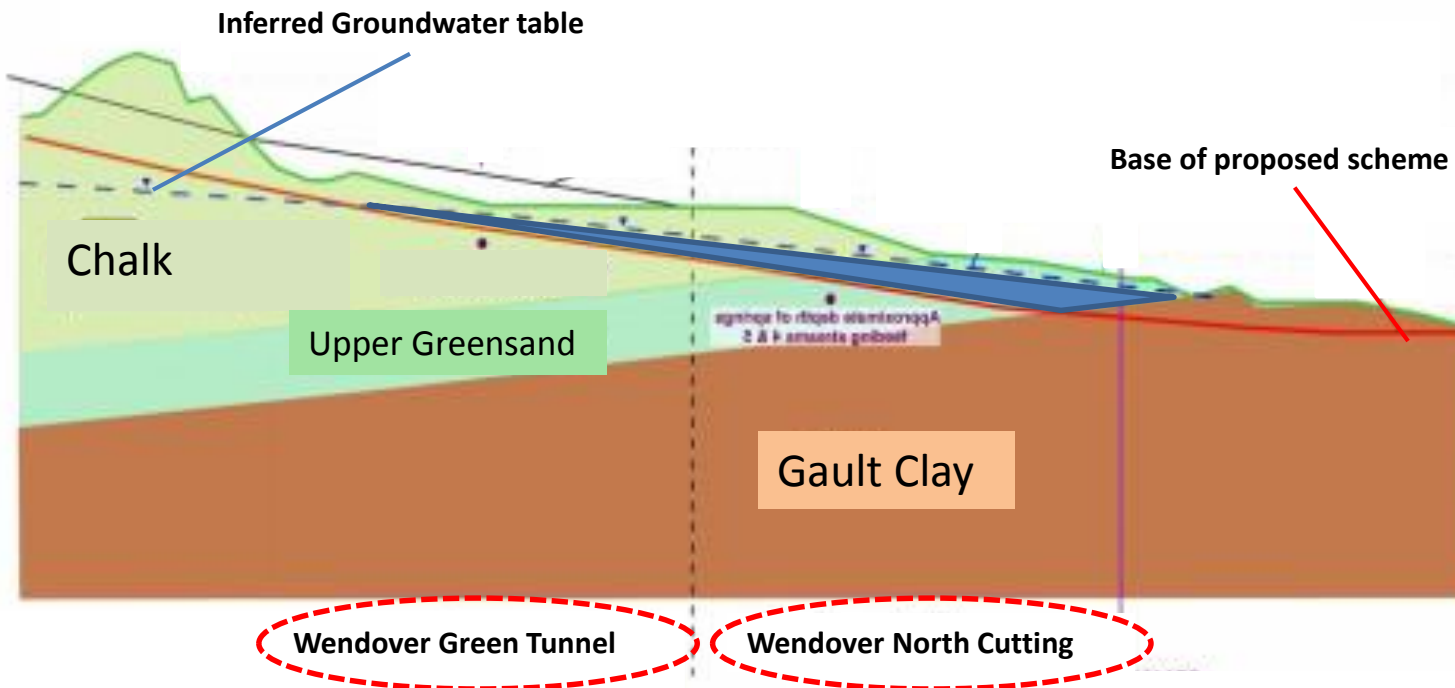
WESTON TURVILLE RESERVOIR SSSI

VA1213 (3) CANAL

HOC/00106/0037



DfT identify that Wendover Green Tunnel (WGT) & Wendover North Cutting (WNC) will be excavated below "normal" groundwater level.



5.2.8 The inferred water table elevations under normal conditions and the route are compared on Figure 3 and Figure 4.

DfT methodology contains one omission & four mistakes,

Omission

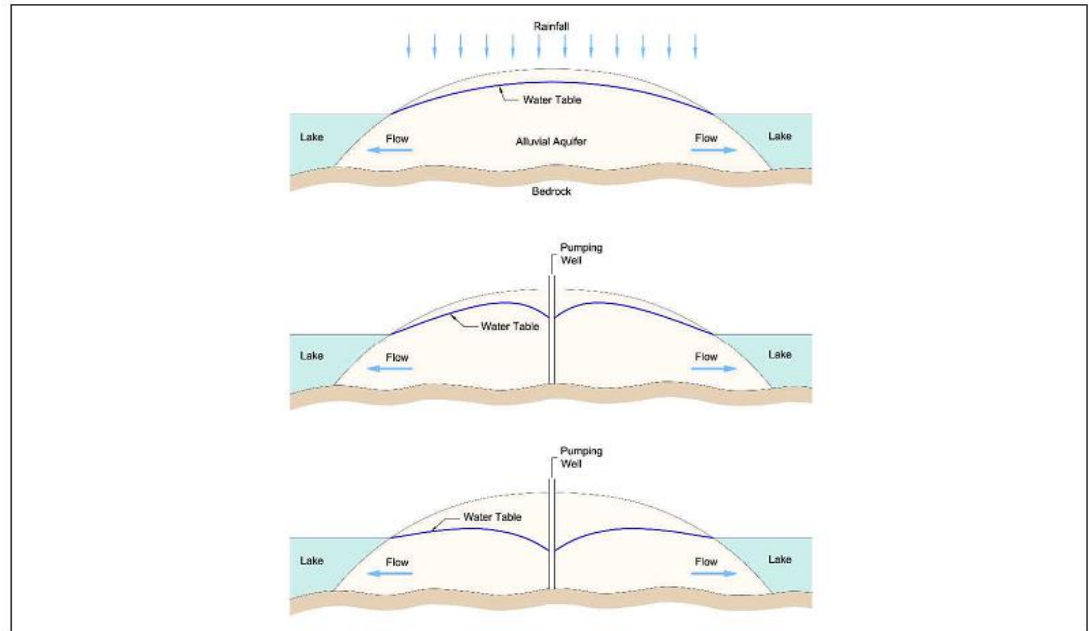
➤ No estimate of the flow intercepted.

Mistakes

- Sichardt's formula for identifying the zone of influence for flow impacts.
- Spring catchments define whether flows will be impacted by WGT/WNC.
- Flow impacts only occur down gradient.
- The depth of aquifer below the base of the WGT/WNC has an effect on the flow impact.

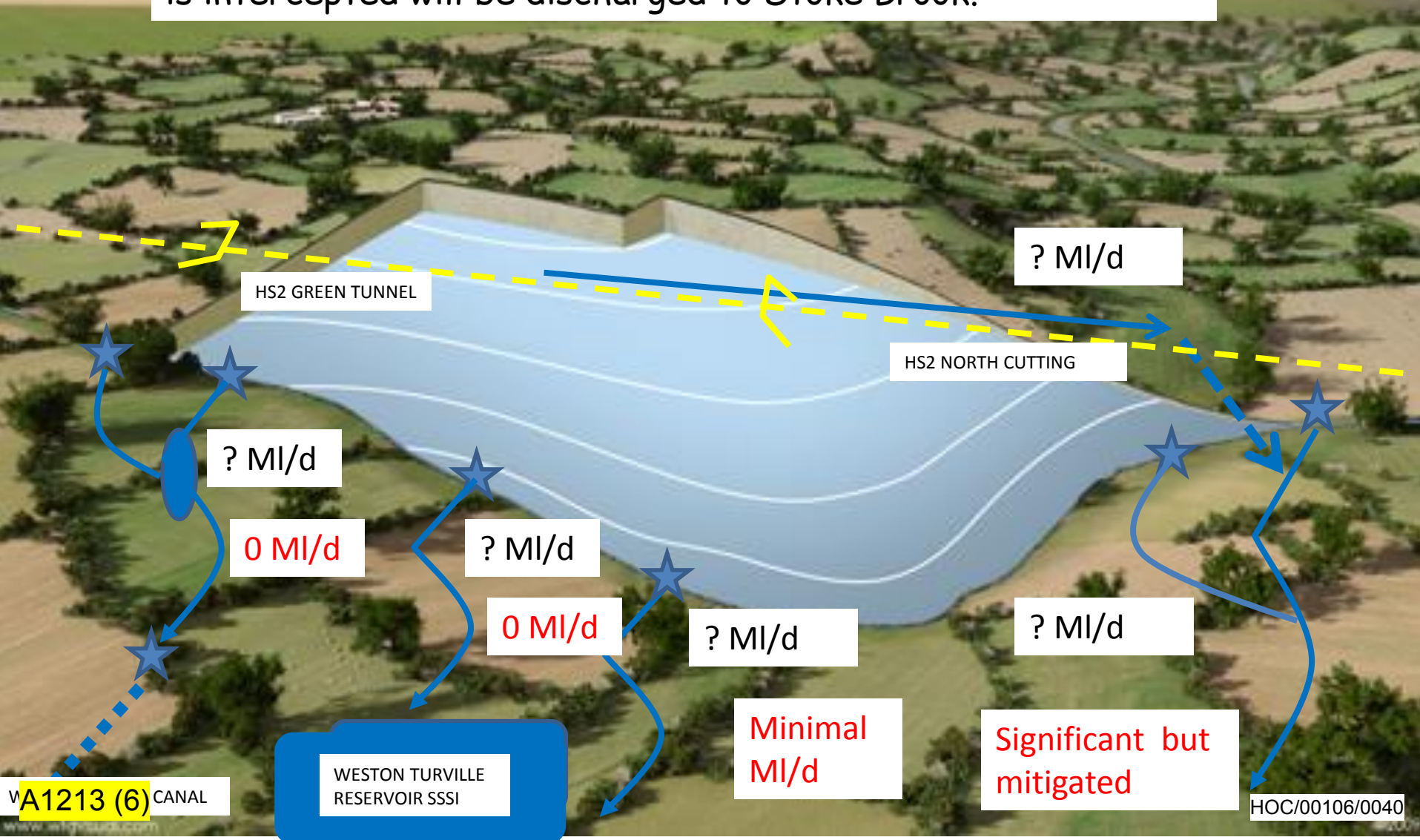
References

- CFA10 | Dunsmore, Wendover and Halton Water resources assessment (WR-002-010) Water resources
- Hydrogeological impact appraisal of dewatering abstractions. Environment Agency. SC040020/SR1



Bredehoeft et al 1982

The flawed EIA produced by DfT identifies minimal impact from Hs2 on the five springs in Wendover. There is no estimate of how much flow will be intercepted & any flow that is intercepted will be discharged to Stoke Brook.



Alternative Approach in line with EA Best Practice

Estimate flow intercepted

➤ River aquifer equation used in MODFLOW Ruston (2003),

$$Q_{RIV} = C_{RIV}(h - H_{RIV})$$

Where:

➤ C_{RIV} is river coefficient

Not conservative!

➤ h is groundwater level at "normal conditions"

Not conservative!

➤ H_{RIV} is level of base of Wendover Green Tunnel and North Cutting

Conservative!

➤ We can make an estimate of the flow drained by HS2 profile based on the information in the DfT report

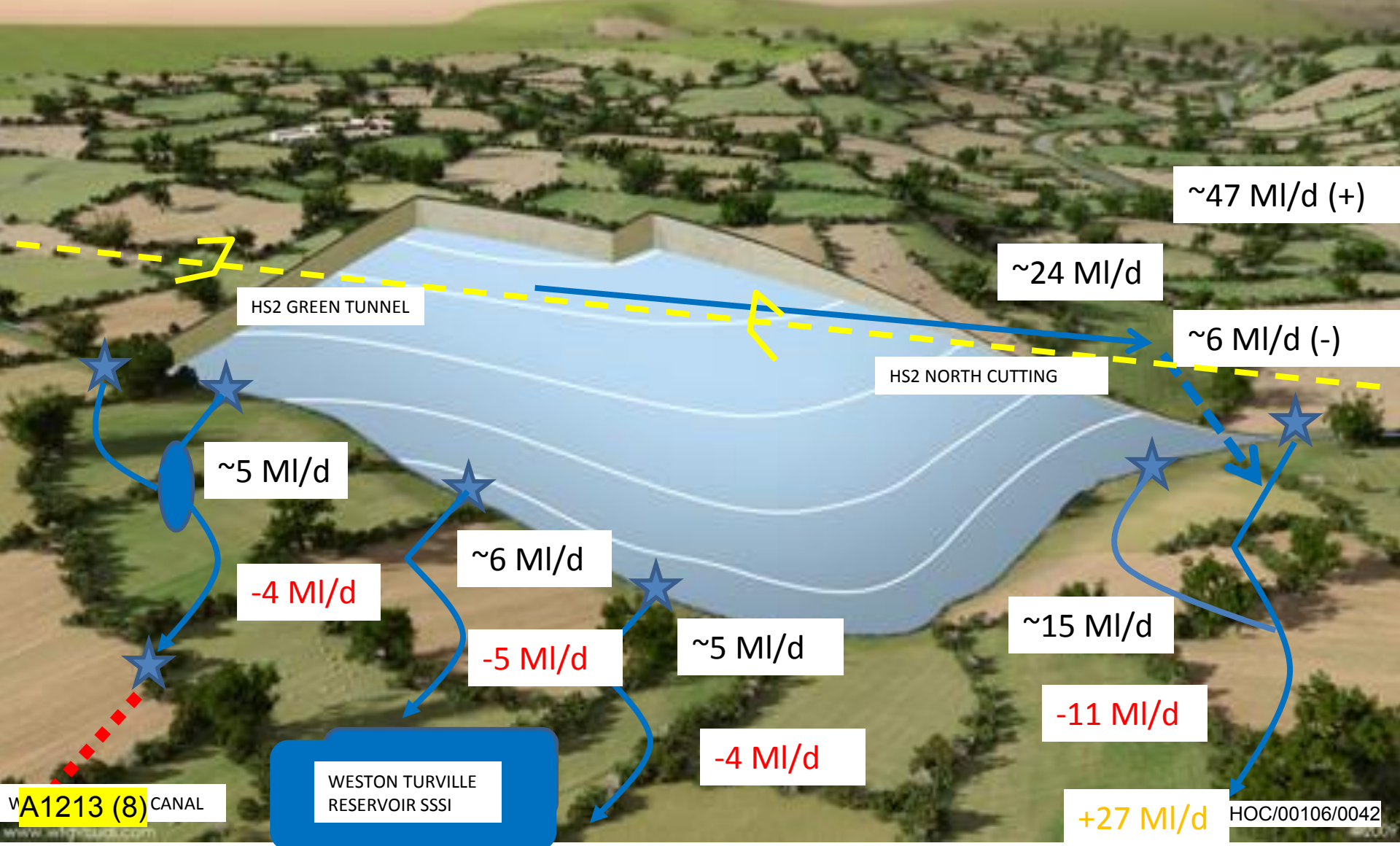
But HS2 cutting will be ~19m wide? So these estimates may well be on the low side. Very unlikely to be conservative.



Box 4.1: The HIA methodology

- Step 1:** Establish the regional water resource status.
- Step 2:** Develop a conceptual model for the dewatering operation and the surrounding area.
- Step 3:** Based on the conceptual model, identify all potential water features which are susceptible to flow impacts.
- Step 4:** Apportion the likely flow impacts to the water features, again based on the conceptual model.
- Step 5:** For the relevant water features, allow for the mitigating effects of any discharges associated with the abstraction, to arrive at net flow impacts.
- Step 6:** Assess the significance of the net flow impacts.
- Step 7:** Define the search area for drawdown impacts.
- Step 8:** Identify all the features within the search area which could potentially be impacted by drawdown.
- Step 9:** For all these features, predict the likely drawdown impacts.
- Step 10:** For the relevant water features, allow for the effects of any measures being taken to mitigate the drawdown impacts.
- Step 11:** Assess the significance of the net drawdown impacts.
- Step 12:** Assess the water quality impacts.
- Step 13:** If necessary, redesign the mitigation measures to minimise the flow and drawdown impacts.
- Step 14:** Develop a monitoring strategy, focussing on the features likely to experience flow or drawdown impacts.

HIA (Boak et al 2007) & Rushton (2003) estimates a profound **temporary** impact from HS2 on the 5 springs in Wendover (treating "Green Tunnel" and Cutting as 5-10m wide chalk stream with "normal groundwater levels")



Q1: How could we have got it wrong?

Scenario based risk assessment

- Defra 2011.
- (1) The predicted flow impact is small compared to GW flow in Wendover
 - That is why we did the spot gauging.
- (2) Seasonality. Groundwater storage could delay and smooth the impact of WGT on Wendover springs during construction.
 - WNC is a permanent impact.
 - Groundwater model required.
- (3) Real groundwater levels along the route of the government's proposed scheme are much lower than suggested in DfT reports.
 - Unlikely given the levels of the 5 springs.
 - Additional fieldwork required.

Q2: Would a tunnel be any better?

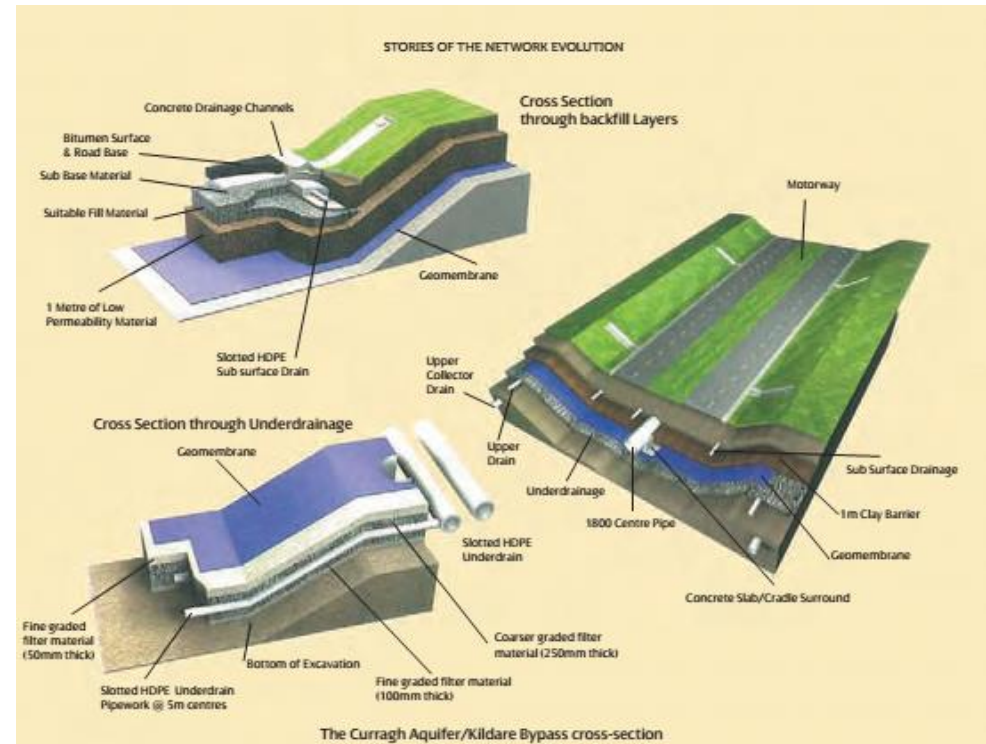
Minimal flow intercepted

- Intercept GW at cutting face only.
- Positive pressure maintained during tunnelling to reduce water ingress.
- Tunnel sections pressure grouted to prevent preferential flow path developing.
- Tunnel goes through highly permeable chalk layer twice at start and end. WGT & WNC are constructed in highly permeable chalk.
- Northern terminal in Gault formation (non aquifer)

What is the impact of a weak EIA?

Kildare Bypass

- “A cautionary tale.....”
- O Donnell (2006)



"The bypass was initially estimated to cost €55million and the tanking system was estimated to cost €6.35million. The final cost was €160million. Presumably much of the increase in cost is accounted for by the delays involved in finding a solution to the potential [hydrogeological] damage the project may have caused to Pollardstown Fen."

Will it be possible to mitigate if required?

- “Not considered likely....”
- Pumping water back up the hill and under the road to mitigate impacts on springs 1, 2 and 3 for the life of the project.
- “un-desirable due to sustainability reasons”

Ref:Wendover Green Tunnel and North Cutting Hydrogeological Impact Assessment - Technical Note Document Number: C252-ETM-EV-NOT-020-000161

Shopping list:

- Pumping station at bottom of WNC.
- Three pumps rising mains to discharge to springs 1, 2 and 3 plus discussion with community about ‘lost’ streams.
- Need to be able to pump high and low flows? Q_{10} is $\sim 2X Q_{50}$ at Wendover
- Need to get drainage under the road.
- May need to upgrade drainage under road and through meadows for spring 1?
- May need to upgrade feeders from Wendover Arm to Weston Turville?
- Need to check WQ implications.
- Need to coordinate with design to prevent groundwater flooding.
- Agree seasonal flow target discharges with EA/ NE and C&RT.

What about when GW levels are at their maximum?

- Ref. Groundwater Flooding in Buckinghamshire Document Number: C252-ETM-EV-NOT-020-000017
- Will the pumping station be able to cope?
- It may not be possible to mitigate this?

Engineers can always come up with mitigation measures but ... (Kildare)

Figure 5 - Schematic representation of potential for groundwater flooding near Wendover North Cutting under current conditions

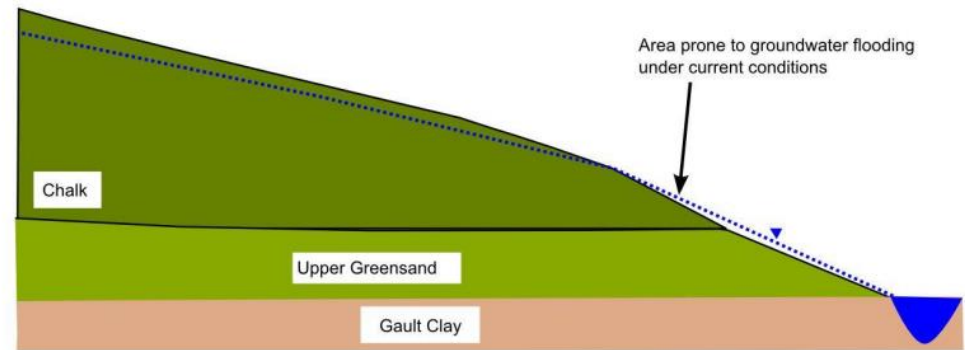


Figure 6 - Schematic representation of impact of proposed cutting on groundwater flooding without mitigation

