

Appendix 11.3

Flood Risk Assessment Part 3

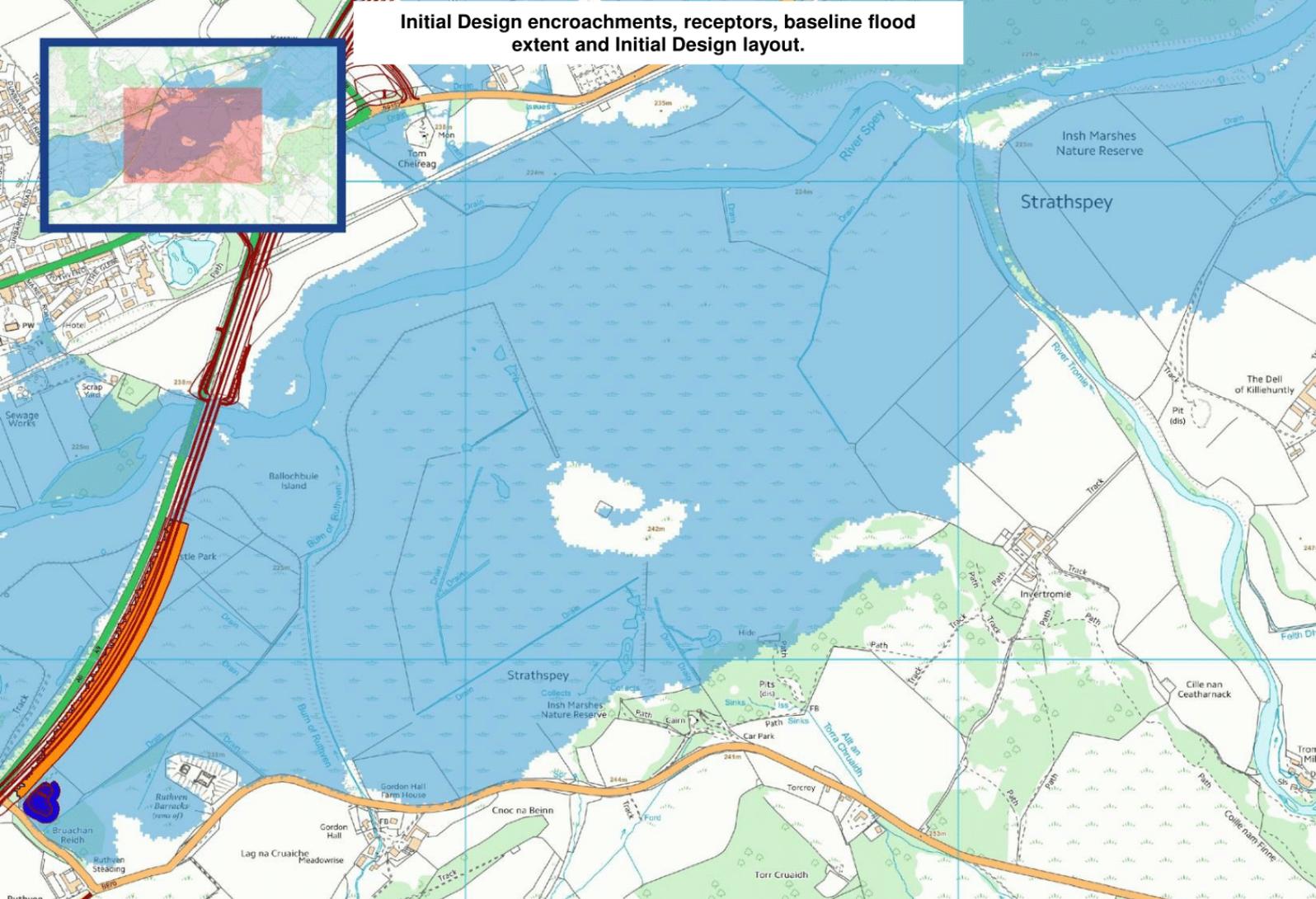
Appendix 11.3

Flood Risk Assessment

Annex C: Assessment Supporting Information

(Continued)

Initial Design encroachments, receptors, baseline flood extent and Initial Design layout.



Initial Design Encroachment Details

Encroachment occurs as a result of a SUDS pond being located within the flood plain on the south east side of the road. Which must be protected to the 1:30 year levels as per planning guidance.

The flood plain storage which is encroached into is the result the Spey exceeding its channel capacity and flooding the low lying areas adjacent to it.

Further encroachment occurs as a result of the realignment of the A9 Spey embankment. In part this will be offset by the removal of the existing embankment. This results in a net encroachment of approximately 7000m³.

The flood plain storage which is encroached into on the downstream side is the result the Spey exceeding its channel capacity and flooding the low lying areas adjacent to it.

Initial Design – Encroachment Summary

Component	Area (m ²)	Volume (m ³)	No. Downstream Receptors Affected
Mainline + Access Tracks	N/A	~7000	Cumulative Spey Impacts
SUDS Pond Embankments	4630	6940	Cumulative Spey Impacts
Total	N/A	~13940	Cumulative Spey Impacts

Receptor Impact Details

There are a large number receptors downstream which are impacted in part as a result of lost flood plain storage within the Spey flood plain.

The increases in water level vary between 0mm and 40mm.

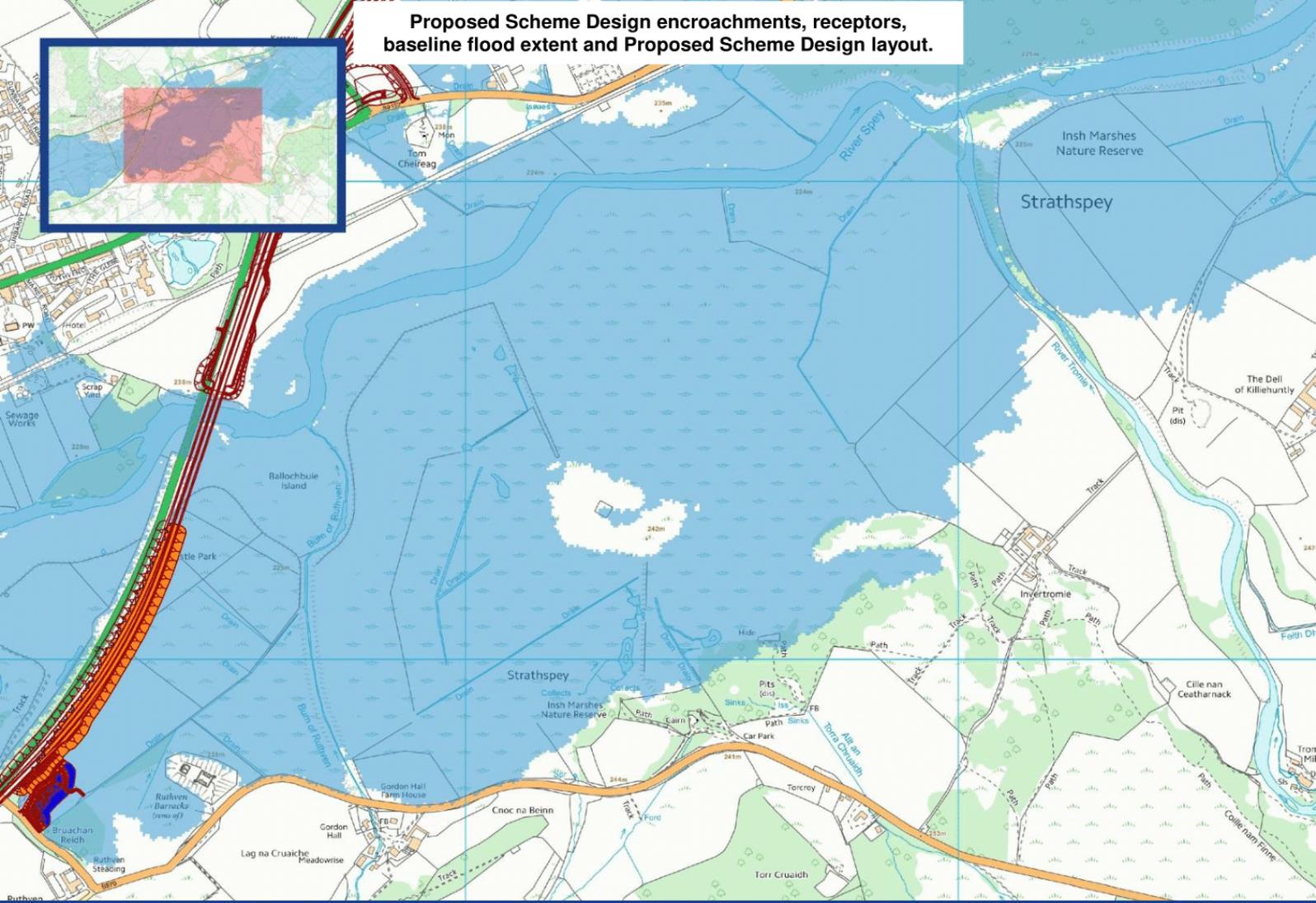
The impacts at the receptors cannot be attributed to a single area of encroachment and the impacts of all the encroachments are likely limited relative to the impact of increasing the width of the Spey crossing opening.

CSA ID Number: 5 + 6

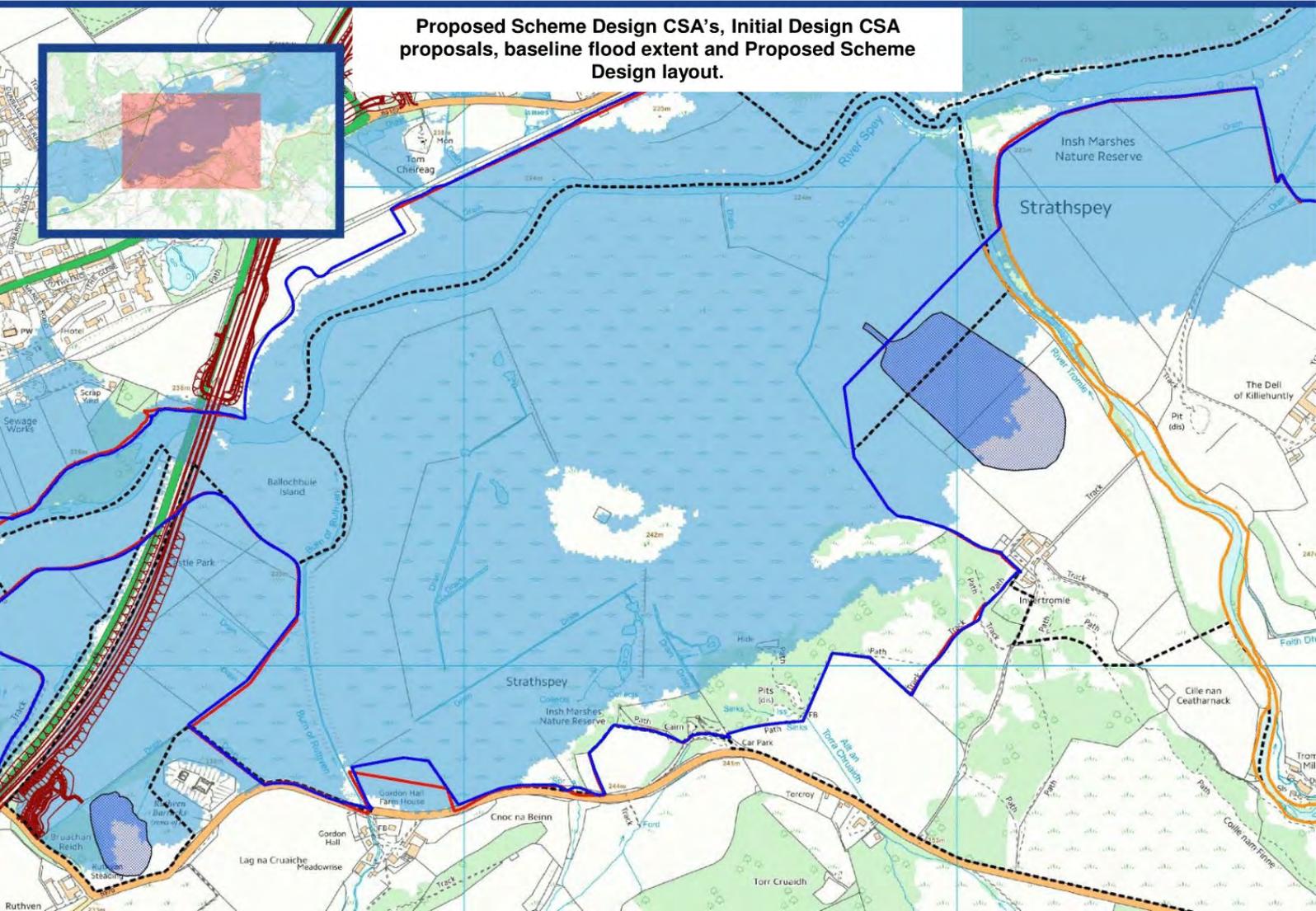
Chainage: Ch.49+400

Location: 276140E, 799810N

Proposed Scheme Design encroachments, receptors, baseline flood extent and Proposed Scheme Design layout.



Proposed Scheme Design CSA's, Initial Design CSA proposals, baseline flood extent and Proposed Scheme Design layout.



Changes: Initial Design – Proposed Scheme Design

The plan area of the SUDS pond and access tracks have increased the however the protection standard of the SUDS ponds have been reduced therefore they will become submerged above the 30 year event. In this area unavoidable design pressures have resulted in an increase in the total encroachment volume between the Initial Design and the Proposed Scheme Design as a result of the introduction of a layby and raised access track to the SUDS pond.

Proposed Scheme Design – Encroachment Summary

Component	Area (m ²)	Volume (m ³)	No. Downstream Receptors Affected
Mainline + Access Tracks	N/A	~11880	Cumulative Spey Impacts
SUDS Pond Embankments	4830	7200	Cumulative Spey Impacts
Total	N/A	~19080	Cumulative Spey Impacts

Initial Design CSA Mini Assessment Comments

CSA ID5

Ecology: Would result in habitat change within the NNR. This could affect habitat availability for breeding and wintering birds displaced from the NNR and the adjoining Natura sites. Impacting on Alder woodland (Annex I habitat which is rare across Europe). Remove completely.

Landscape: Potential changes in landscape pattern due to altered drainage (removing the higher ground in the NNR). Remove completely.

Visual: Construction stage visual effects on views to and from the Ruthven Barracks. Remove completely.

C&PA: Area is within NNR. RSPB would need to be consulted as they own and manage the area. This area of high ground is used by livestock.

Geology: Adjacent to/ partially located on area of peat (up to 1.5m), also encroaches W7 alder woodland and M23 mire. Reshape to avoid local habitats and woodland.

Cultural Heritage: Impact on the setting of Ruthven Barracks, which is a Scheduled Monument and Category A Listed Building. Cumulative impact of CFS and Proposed Scheme features would make the impact on the Barracks significant. Likely objection from Historic Environment Scotland. Potential for buried archaeological remains due to topsoil removal and excavation. As surrounding area is wetland, buried archaeological remains could be organic material, including wood, leather etc. This would increase costs and programme risk substantially. Also, if remains found are considered to be part of, or associated with, the Scheduled Monument, the buried archaeology could also be Scheduled which would require Scheduled Monument Consent to excavate. Remove completely.

CSA ID6

Ecology: Impacts on River Spey - Insh Marshes Ramsar/ SPA/ SSSI and River Spey SAC and Insh Marshes SAC. Reshape to avoid above sites at northern tie in extent. If this cannot be reshaped, it will result in Likely Significant Effect (LSE) in the Habitats Regulations Appraisal (HRA) and an appropriate assessment, a more stringent assessment compared to EIA, will have to be carried out.

Would result in habitat change within the NNR. This could affect habitat availability for breeding and wintering birds displaced from the NNR and the adjoining Natura sites. Reshape to avoid NNR at northern extent.

Geology: No information available - significantly distanced from the Proposed Scheme, unable to comment.

Buildability: There is no direct access to CFS No 6. The only access goes through the middle of a steading which we would regard as an unacceptable route for heavy plant. So one other significant impact of this option is a requirement to create an access just to get the heavy plant and machinery in to undertake the excavation work. Afterwards there would be the question of reinstatement. That to one side, consideration of CFS at a distance of the works, while it may work from a flood risk and policy perspective lacks promotable credibility when it impacts on unsuspecting third parties. TS may not want to promote CFS too remote from the works as they would asking a lot of landowners, who living at some distance from the A9, would be asking why me?

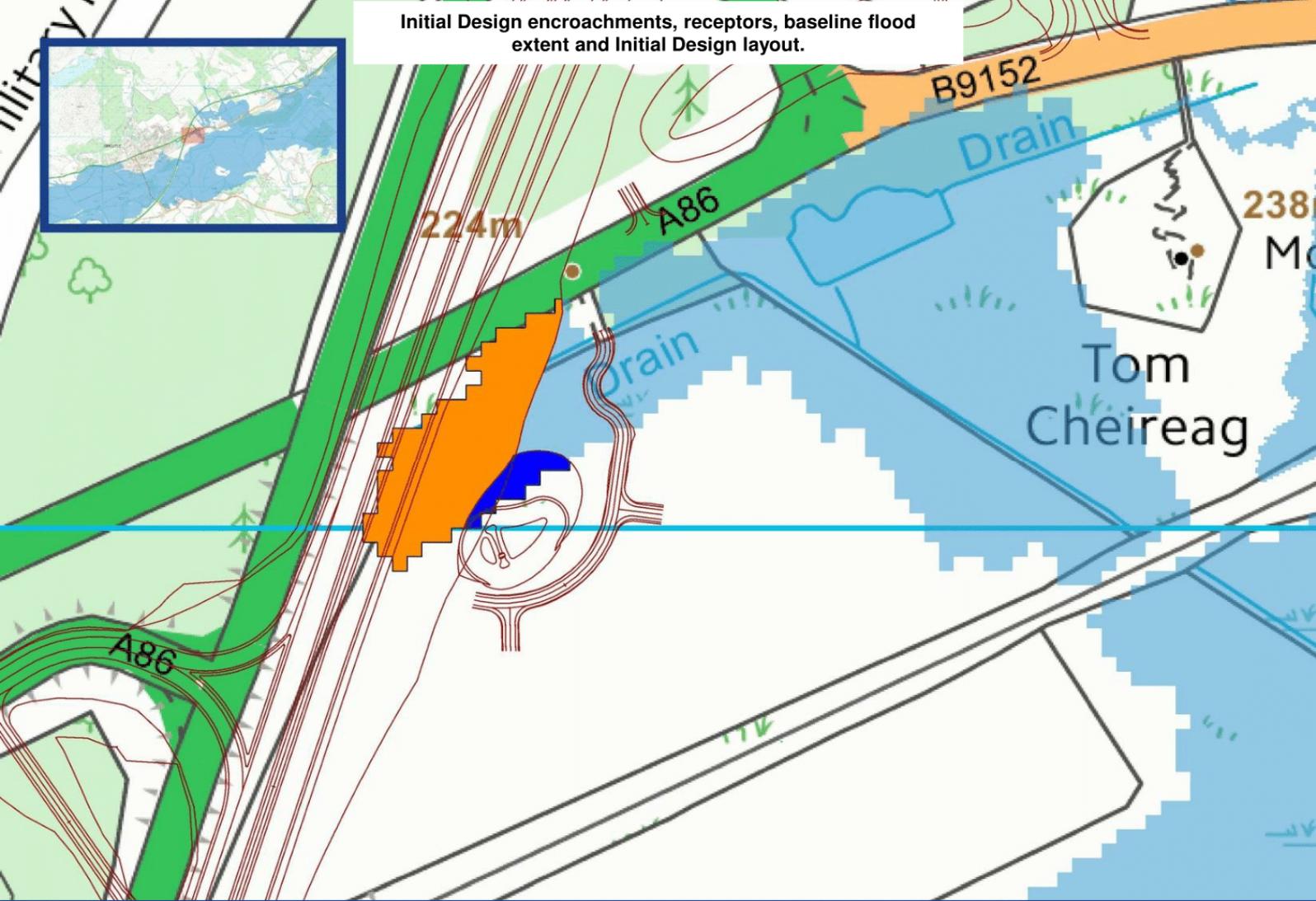
Mitigation Options Developed Following Initial Design

Option (Preferred Options)	Discussion	Viable
Avoid flood plain encroachment	Not possible due to alignment of A9 Mainline and requirement for SUDS.	No
Reduce Encroachment through design.	Though the plan area of the SUDS pond and access tracks have increased the protection standard of the SUDS ponds have been reduced therefore they will become submerged above the 30 year event. In this area unavoidable design pressures have resulted in an increase in the total encroachment volume between the Initial Design and the Proposed Scheme Design as a result of the introduction of a layby and raised access track to the SUDS pond.	No
Accept changes in water level at local receptors.	The impacts at the receptors cannot be attributed to a single area of encroachment and the impacts of all the encroachments are likely limited relative to the impact of increasing the width of the Spey crossing opening.	Yes
Compensatory storage through excavation.	CSA ID5 - An area of high ground to the south east of the encroachment could be excavated to provide like for like compensatory storage. Due to its proximity to Ruthven Barracks there may be visual impacts which are not acceptable. CSA ID6 - An area to the east of the encroachment can be excavated to provide compensatory storage for the encroachment.	Yes
Combine CSA ID5 and ID6 in the location of CSA ID6.	Adding CSA ID5 into CSA ID6 minimises the required land used and the volume of earthworks. It also prevents visual and cultural heritage issues.	Yes

Final CSA Proposed Scheme Design Comment:

The final option selected is for compensatory storage not to be provided for these encroachments. Through discussion with SEPA it has been concluded that the impact of the floodplain encroachment on water levels downstream is minimal and the non-flood risk impacts of providing the compensation outweigh the benefits of providing it.

Initial Design encroachments, receptors, baseline flood extent and Initial Design layout.



Initial Design Encroachment Details

Encroachment occurs as a result of the A9 mainline earthworks and a SUDS pond being located within the river Spey flood plain on the south east side of the road.

The flood plain storage which is encroached into is the result of the Spey exceeding its channel capacity and flooding the low lying areas on the other side of the highland main line adjacent to it.

Receptor Impact Details

There are a large number receptors downstream which are impacted in part as a result of lost flood plain storage within the Spey flood plain.

The increases in water level vary between 0mm and 40mm.

The impacts at the receptors cannot be attributed to a single area of encroachment and the impacts of all the encroachments are likely limited relative to the impact of increasing the width of the Spey crossing opening.

Initial Design – Encroachment Summary

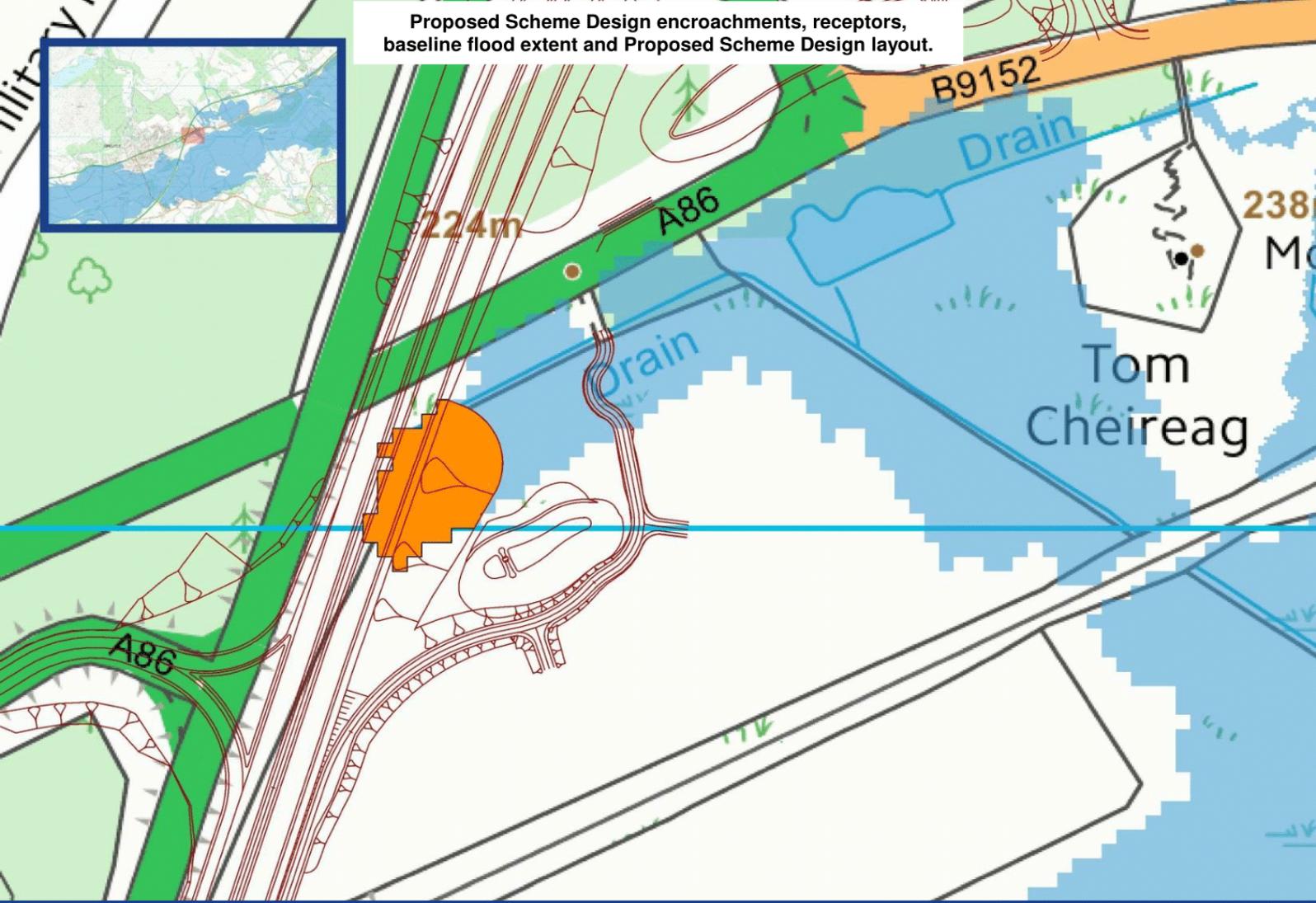
Component	Area (m ²)	Volume (m ³)	No. Downstream Receptors Affected
Mainline + Access Tracks	2600	1620	Cumulative Spey Impacts
SUDS Pond Embankments	330	200	Cumulative Spey Impacts
Total	2930	1820	Cumulative Spey Impacts

CSA ID Number: 7

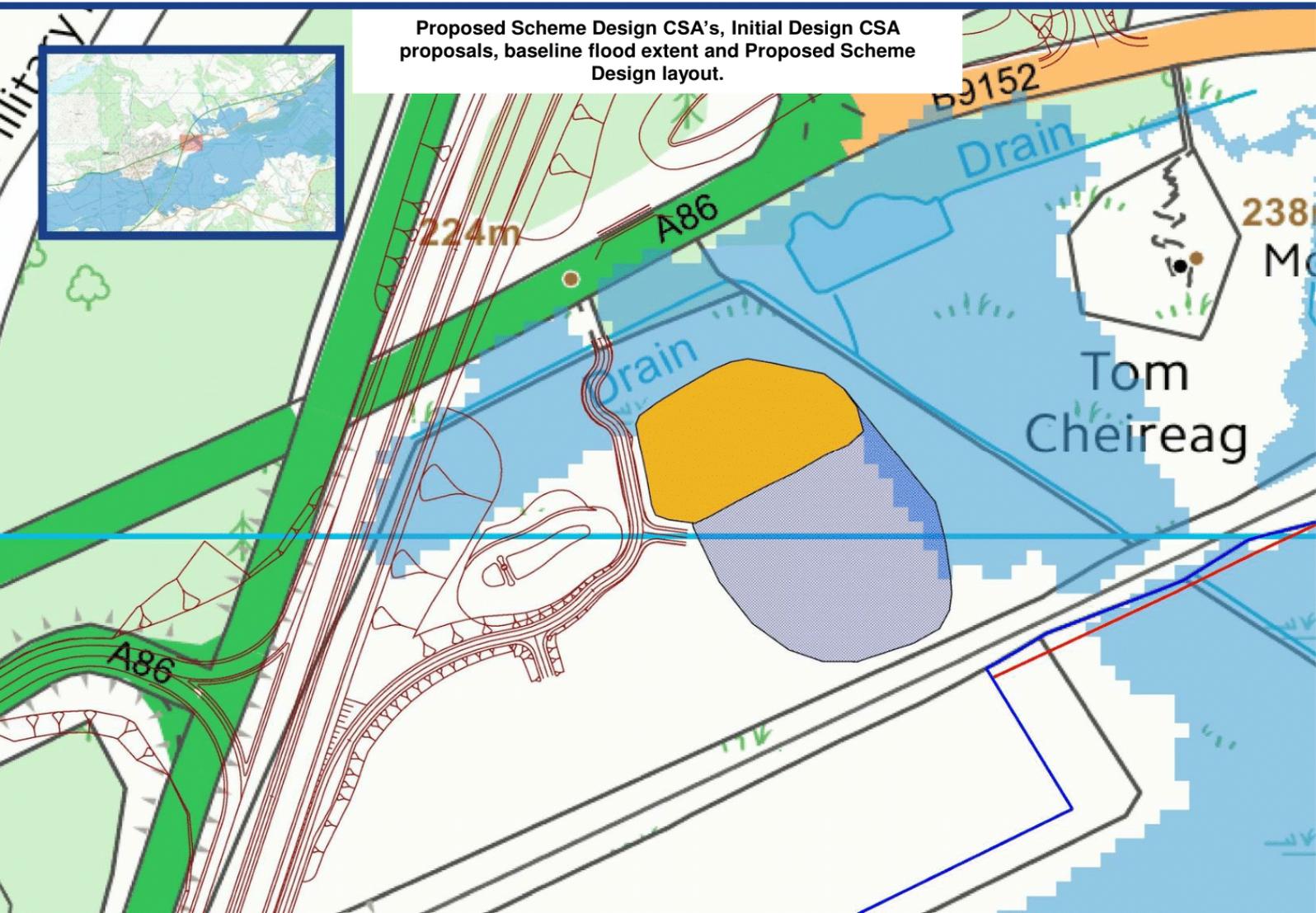
Chainage: Ch.50+700

Location: 276640E, 801010N

Proposed Scheme Design encroachments, receptors, baseline flood extent and Proposed Scheme Design layout.



Proposed Scheme Design CSA's, Initial Design CSA proposals, baseline flood extent and Proposed Scheme Design layout.



Changes: Initial Design – Proposed Scheme Design

SUDS pond has been reshaped to remove from the floodplain. Headwall of A86 road crossing extended to decrease mainline encroachments.

Proposed Scheme Design – Encroachment Summary

Component	Area (m ²)	Volume (m ³)	No. Downstream Receptors Affected
Mainline + Access Tracks	1760	1070	Cumulative Spey Impacts
SUDS Pond Embankments	N/A	N/A	N/A
Total	1760	1070	Cumulative Spey Impacts

Initial Design CSA Mini Assessment Comments

No Comments

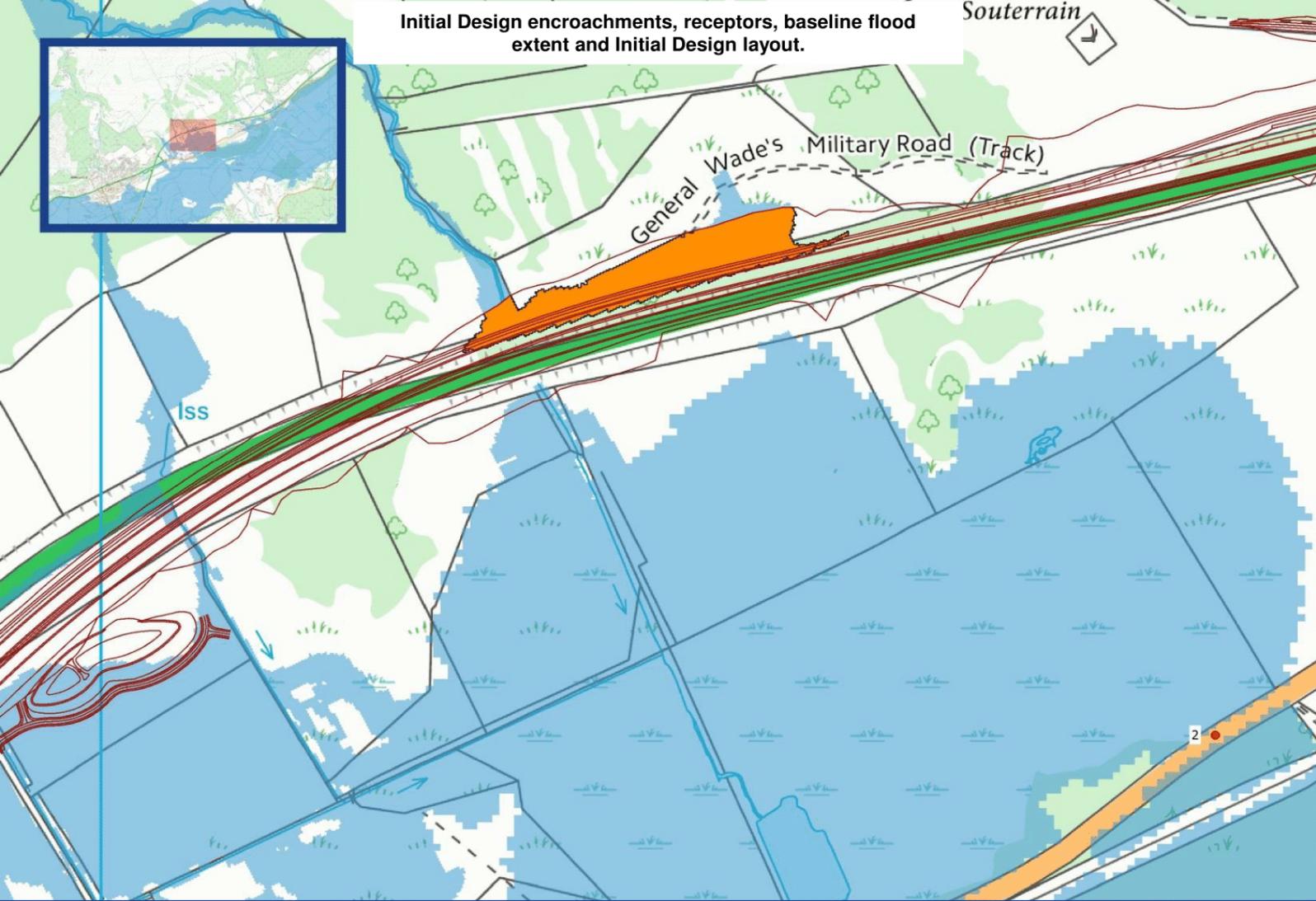
Mitigation Options Developed Following Initial Design

Option (Preferred Options)	Discussion	Viable
Avoid flood plain encroachment	Avoidance of flood plain encroachment is not possible due the requirement for SUDS ponds and the alignment of the A9 mainline.	No
Reduce Encroachment through design.	The Encroachment has been reduced significantly in the 5 th iteration design by increasing the length of the A86 bridge headwall and repositioning the SUDS pond slightly to remove it from the flood plain.	Yes
Accept changes in water level at local receptors.	Downstream receptors experience variable increases in water levels however the opening of the Spey crossing is the primary reason for this and the encroachment volumes are very small relative to the lost upstream storage at the Spey crossing and the volume of floodplain storage the Spey has. Impacts of significant excavation for CSA's may be greater than that of the lost storage.	Yes
Compensatory storage through excavation.	An area of high ground to the east of the encroachment could be excavated to provide like for like compensatory storage. There are no environmental or physical complexities to this.	Yes

Final CSA Proposed Scheme Design Comment:

The final option selected is for compensatory storage to be provided locally though excavation.

Initial Design encroachments, receptors, baseline flood extent and Initial Design layout.



Initial Design Encroachment Details

Encroachment occurs as a result of the A9 mainline earthworks encroaching into the upstream floodplain of watercourse ID157 and ID158 where the A9 mainline has been realigned to the north.

The flood plain storage which is encroached into is the result these tributaries surcharging their culverts and backing up against the existing A9 embankment.

Receptor Impact Details

There is now significant increase or decrease in water level adjacent to the B9152 and the Highland Main Line. Neither of these are currently inundated and in the existing condition are >1.7m above the existing flood level

The modelling shows a slight decrease in water levels however this is attributable to a complex interaction of the overland flow between ID157 and 158 in the existing and not in the proposed and the downstream ponding area upstream of the B9152. The changes resulting from the loss of flood plain storage are absorbed into this effect and are therefore not measurable.

Initial Design – Encroachment Summary

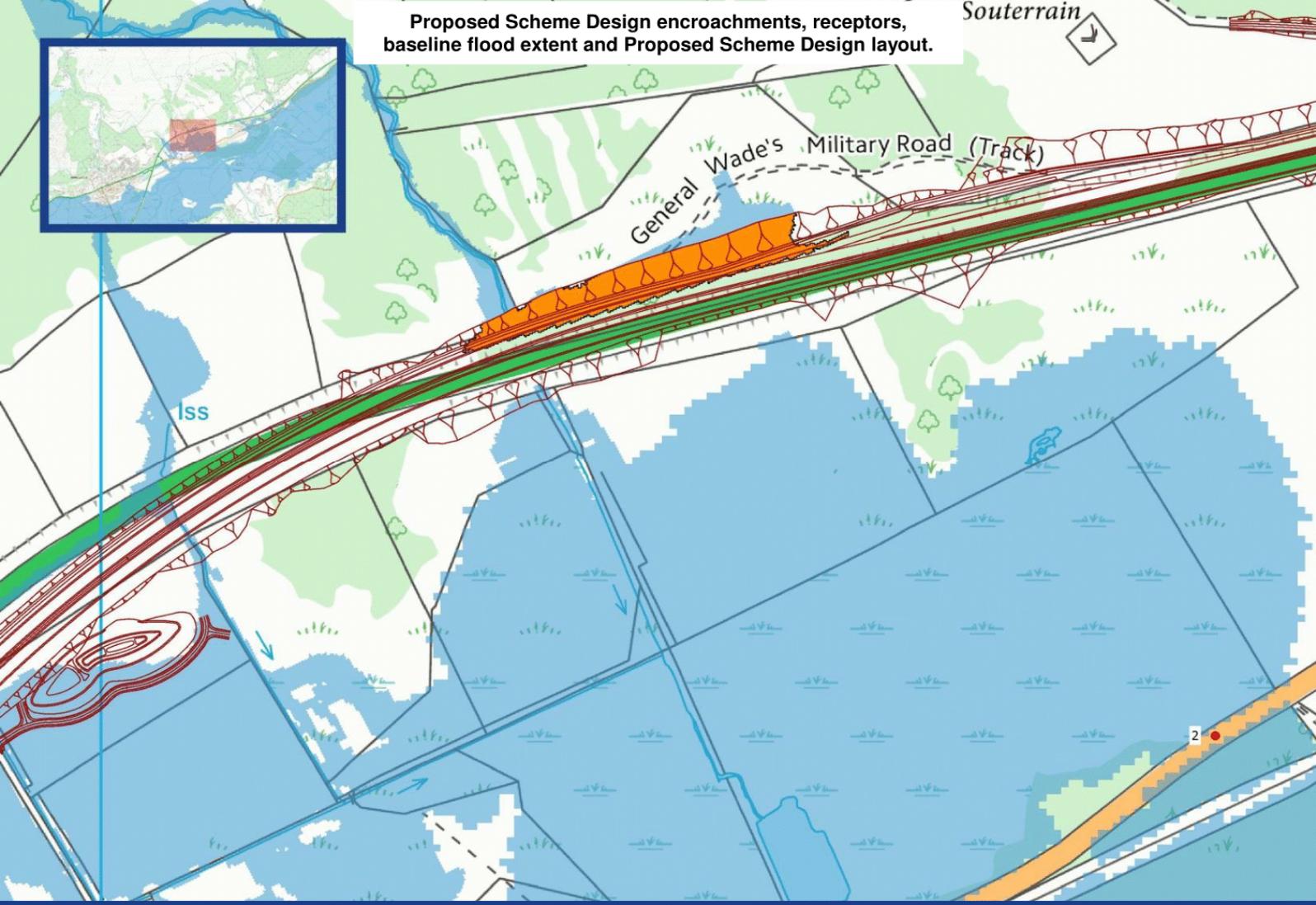
Component	Area (m ²)	Volume (m ³)	No. Downstream Receptors Affected
Mainline + Access Tracks	6890	9630	0
SUDS Pond Embankments	N/A	N/A	N/A
Total	6890	9630	0

CSA ID Number: 13

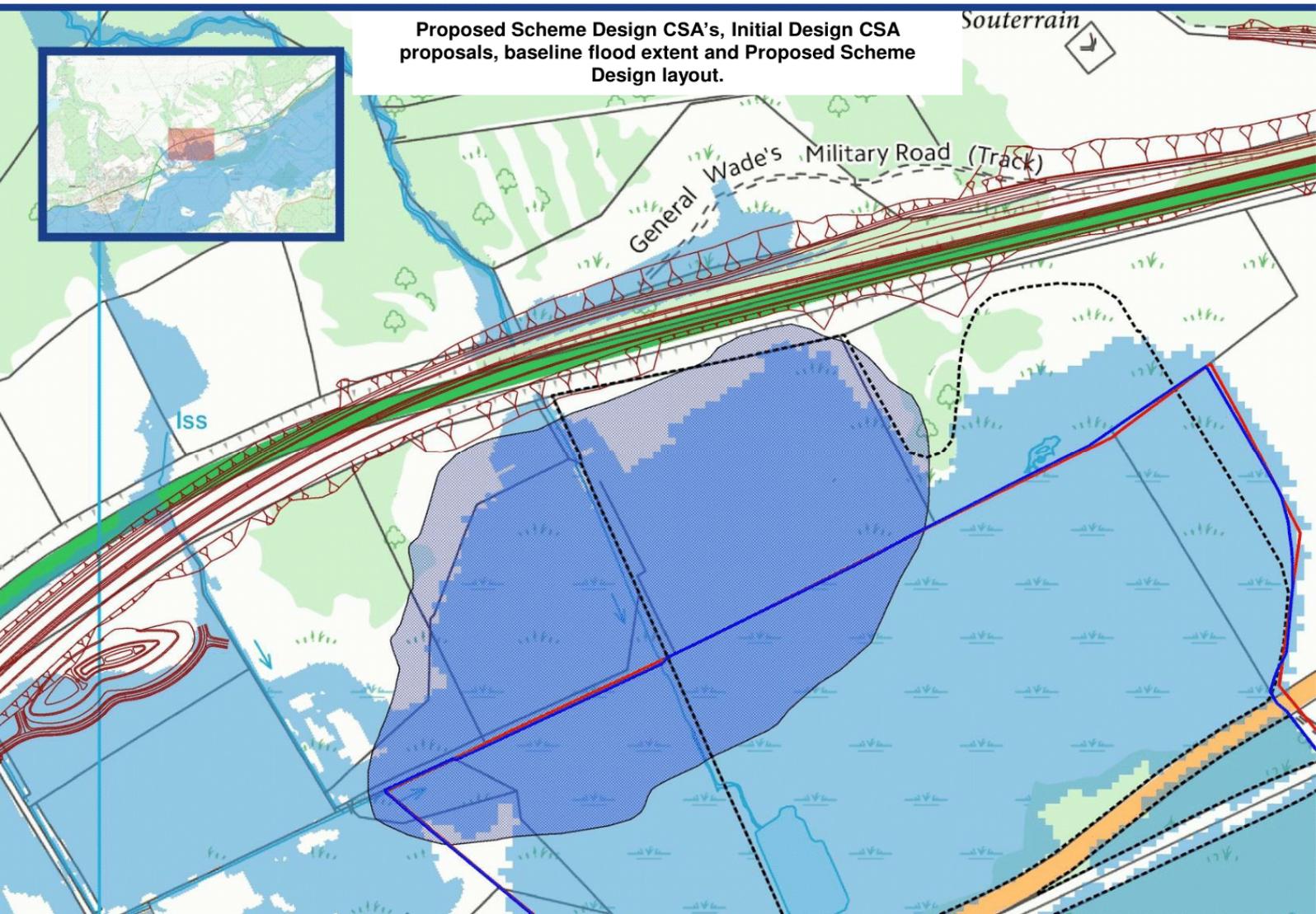
Chainage: Ch.51+700

Location: 277270E, 801690N

Proposed Scheme Design encroachments, receptors, baseline flood extent and Proposed Scheme Design layout.



Proposed Scheme Design CSA's, Initial Design CSA proposals, baseline flood extent and Proposed Scheme Design layout.



Changes: Initial Design – Proposed Scheme Design

The mainline earthworks have been steepened as far as practicable thereby reducing the encroachment volume.

Proposed Scheme Design – Encroachment Summary

Component	Area (m ²)	Volume (m ³)	No. Downstream Receptors Affected
Mainline + Access Tracks	5890	9040	0
SUDS Pond Embankments	N/A	N/A	N/A
Total	5890	9040	0

Initial Design CSA Mini Assessment Comments

Ecology: Impacts on River Spey - Insh Marshes Ramsar/ SPA/ SSSI and River Spey SAC and Insh Marshes SAC. Reshape to avoid above sites. If this cannot be reshaped, it will result in Likely Significant Effect (LSE) in the Habitats Regulations Appraisal (HRA) and an appropriate assessment, a more stringent assessment compared to EIA, will have to be carried out. Impacts on areas of wet heath/ blanket bog (Annex I habitat which, whilst relatively common in Scotland, is rare across Europe and irreplaceable; blanket bog is also a priority habitat across Europe). Reduce extent from areas of wet heath/ blanket, or remove completely. Would result in habitat change within the NNR . This could affect habitat availability for breeding and wintering birds displaced from the NNR and the adjoining Natura sites. Reshape to avoid NNR.

Visual: Construction stage visual effects for road users.

C&PA: Area is partially within NNR. RSPB would need to be consulted as they own and manage the NNR. Other landowner consultation would be required for the area not in NNR.

Geology: Partially located on area of peat (up to 1.5m). Reshape to avoid above areas or remove completely.

Cultural Heritage: Impacts on a large part of the old settlement of Kingussie, through excavation. This would require archaeological evaluation and likely archaeological excavation. This would increase programme risks and costs. Preservation in situ is the preferred option by national planning policy. Remove completely.

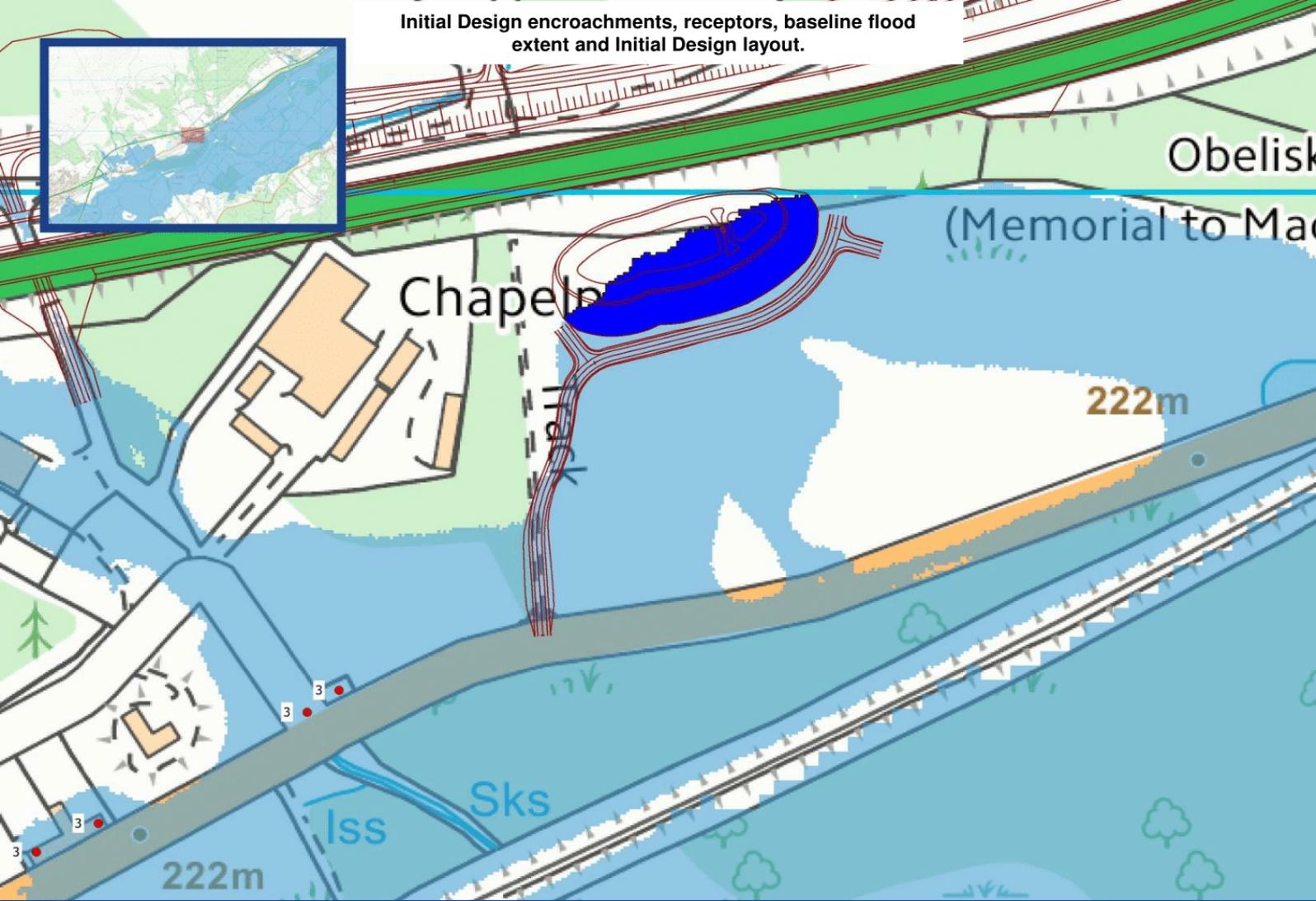
Mitigation Options Developed Following Initial Design

Option (Preferred Options)	Discussion	Viable
Avoid flood plain encroachment	Avoidance of flood plain encroachment is not possible due alignment of the A9 mainline.	No
Reduce Encroachment through design.	Earthworks have been steepened on the upstream side to the steepest slope practical thereby reducing the encroachment.	Yes
Accept loss of storage has no impact on water levels at local receptors.	No increase in water levels attributed to the loss of floodplain storage as a result of complex hydraulics around the two crossings in the existing and proposed cases. Impacts of significant excavation for CSA's may be greater than that of the lost storage.	Yes
Compensatory storage through excavation.	An area of high ground to the south east of the encroachment could be excavated to provide like for like compensatory storage. Due to its proximity to Ruthven Barracks there may be visual impacts which are not acceptable.	Yes

Final CSA Proposed Scheme Design Comment:

The final option selected is for compensatory storage not to be provided. Through discussion with SEPA it has been concluded that the lack of impact of the floodplain encroachment on water levels downstream is realistic and the non-flood risk impacts of providing the compensation outweigh the benefits of providing it.

Initial Design encroachments, receptors, baseline flood extent and Initial Design layout.



Initial Design Encroachment Details

Encroachment occurs as a result of a SUDS pond being located within the flood plain on the south side of the A9 Mainline. Which must be protected to the 1:30 year levels as per planning guidance. The flood plain storage which is encroached into is the floodplain of the River Spey.

Receptor Impact Details

There are a large number receptors downstream which are impacted in part as a result of lost flood plain storage within the Spey flood plain. The increases in water level vary between 0mm and 40mm.

The impacts at the receptors cannot be attributed to a single area of encroachment and the impacts of all the encroachments are likely limited relative to the impact of increasing the width of the Spey crossing opening.

Initial Design – Encroachment Summary

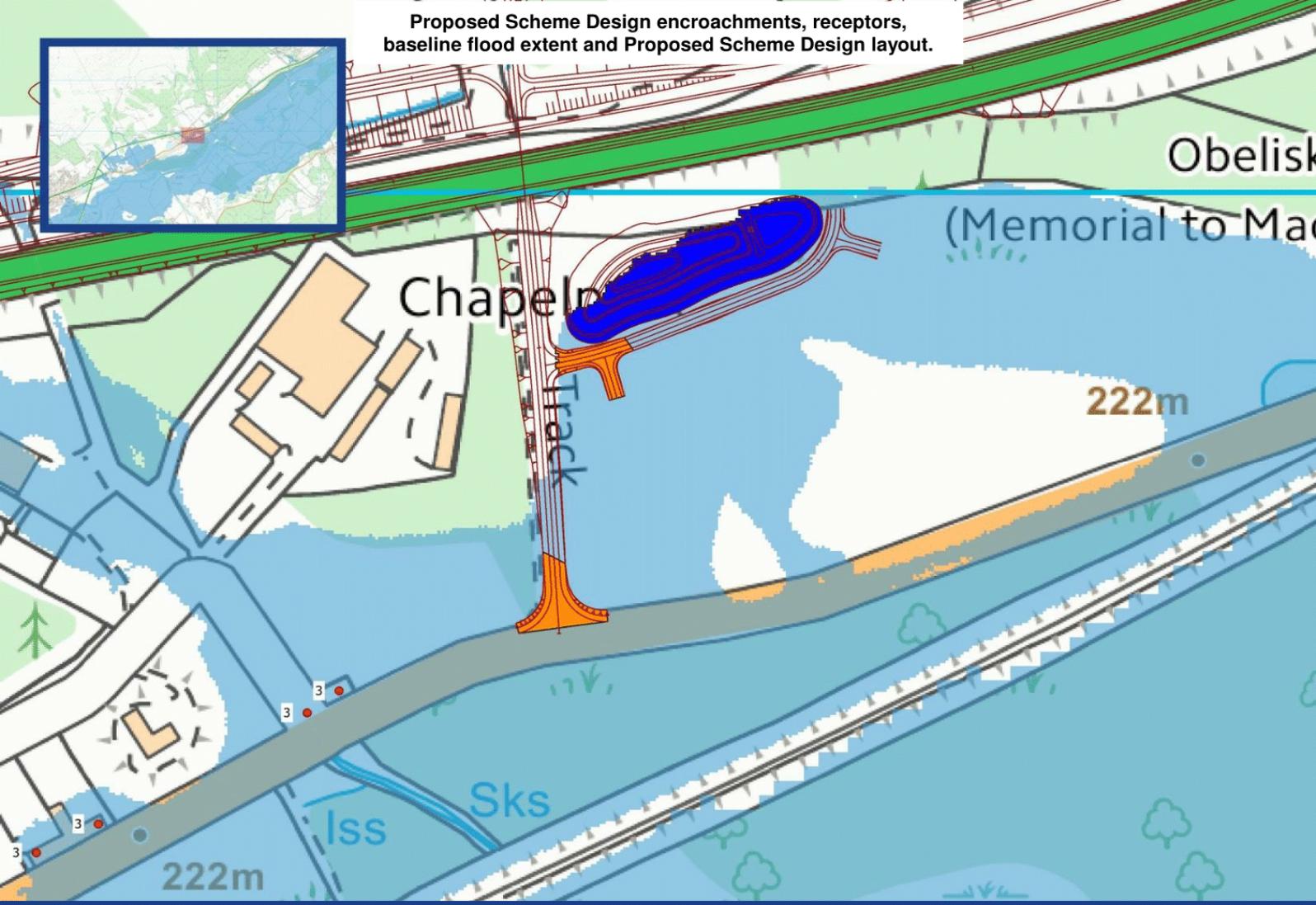
Component	Area (m ²)	Volume (m ³)	No. Downstream Receptors Affected
Mainline + Access Tracks	N/A	N/A	N/A
SUDS Pond Embankments	2080	1040	Cumulative Spey Impacts
Total	2080	1040	Cumulative Spey Impacts

CSA ID Number: 9

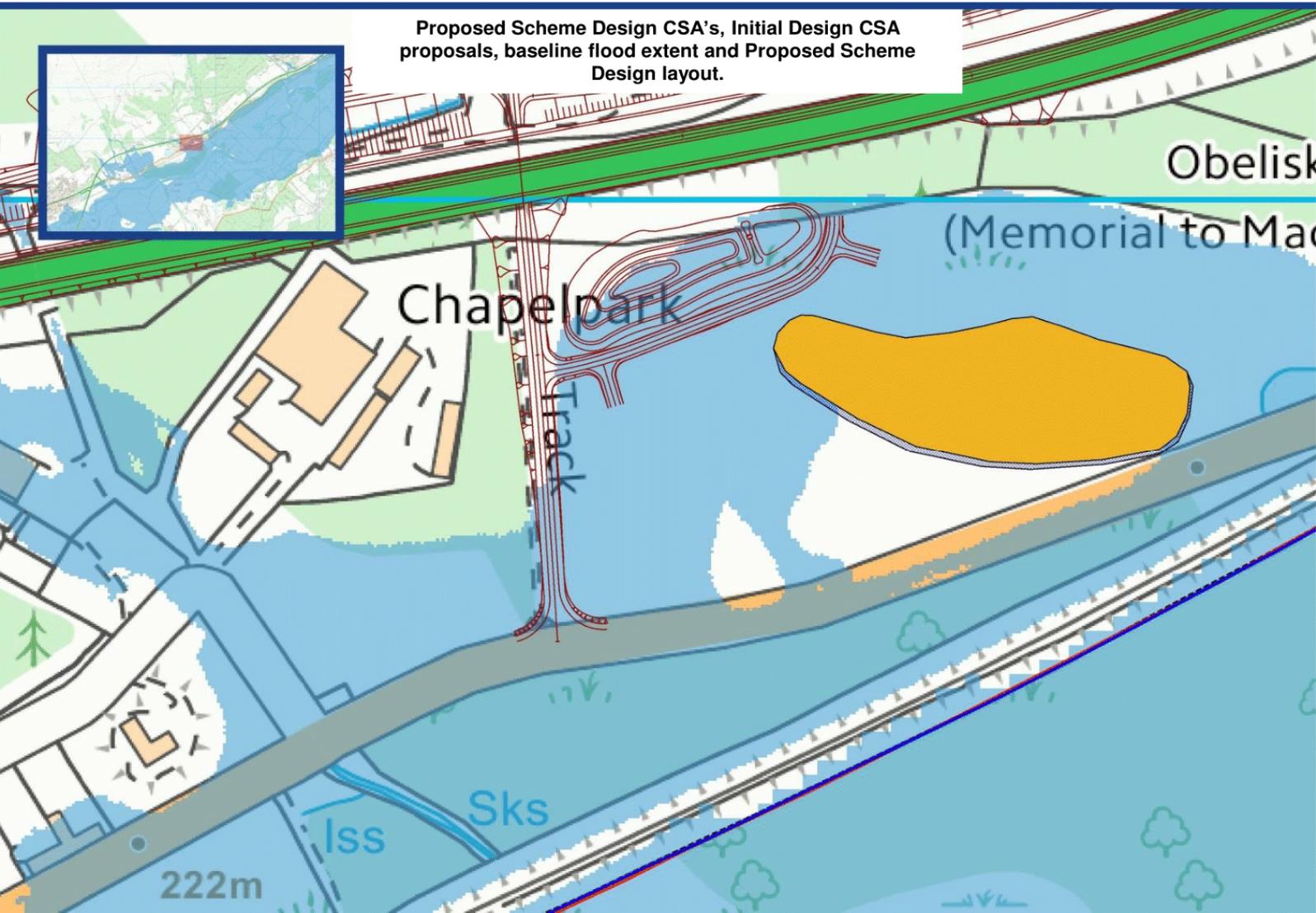
Chainage: Ch.53+050

Location: 278580E, 801990N

Proposed Scheme Design encroachments, receptors, baseline flood extent and Proposed Scheme Design layout.



Proposed Scheme Design CSA's, Initial Design CSA proposals, baseline flood extent and Proposed Scheme Design layout.



Changes: Initial Design – Proposed Scheme Design

The underpass has been moved from the west to the east of Chapelpark Farm. As a result raised sections of track have been introduced within the floodplain. The SUDS pond earthworks have been pulled back a little out of the floodplain therefore the encroachment has only slightly increased.

Proposed Scheme Design – Encroachment Summary

Component	Area (m ²)	Volume (m ³)	No. Downstream Receptors Affected
Mainline + Access Tracks	600	590	Cumulative Spey Impacts
SUDS Pond Embankments	1800	790	Cumulative Spey Impacts
Total	2400	1380	Cumulative Spey Impacts

Initial Design CSA Mini Assessment Comments

Cultural Heritage: Potential impact on the setting of Chapelpark and Balavil Obelisk and Burial ground; the obelisk is a Category B Listed Building. Remove if possible

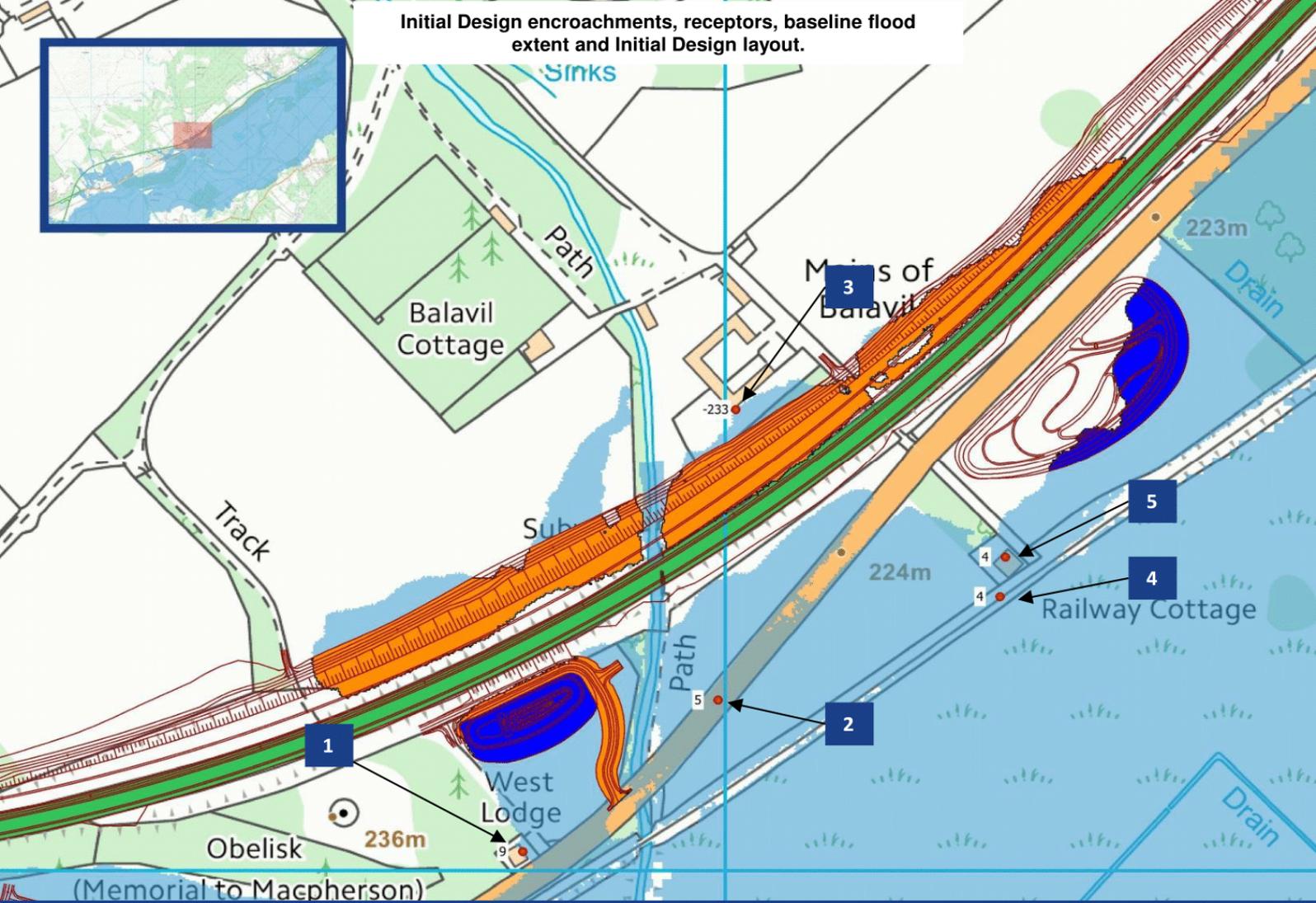
Mitigation Options Developed Following Initial Design

Option (Preferred Options)	Discussion	Viable
Avoid flood plain encroachment	Avoidance of flood plain encroachment is not possible due the requirement for SUDS ponds and the limited low ground adjacent to the mainline.	No
Reduce Encroachment through design.	SUDS earthworks have been pulled back a little out of the flood plain however general design changes have resulted in a slight increase in encroachment	No
Compensatory storage through excavation.	An area of high ground to the south east of the encroachment could be excavated to provide like for like compensatory storage.	Yes

Final CSA Proposed Scheme Design Comment:

The final option selected is for compensatory storage to be provided locally though excavation.

Initial Design encroachments, receptors, baseline flood extent and Initial Design layout.



Initial Design Encroachment Details

Encroachment occurs as a result of A9 Mainline earthworks, access track earthworks, and SUDS ponds being located within flood plain.

The flood plain storage which is encroached into is the result of watercourse ID 162 exceeding its channel capacity and flooding the low lying areas adjacent to it.

Areas occur on both the upstream and downstream side of the A9 mainline.

Initial Design – Encroachment Summary

Component	Area (m ²)	Volume (m ³)	No. Downstream Receptors Affected
Mainline + Access Tracks	15440	6500	5
SUDS Pond Embankments	5220	4000	5
Total	20620	10500	5

Receptor Impact Details

There are 5no. receptors downstream and adjacent the lost flood plain storage within the flood plain of ID 162. The lost floodplain storage results in increases in flood level downstream and decreases in flood level upstream.

The impacts at the receptors cannot be attributed to a single area of encroachment and are considered to be a result of the combination of all of the encroachments.

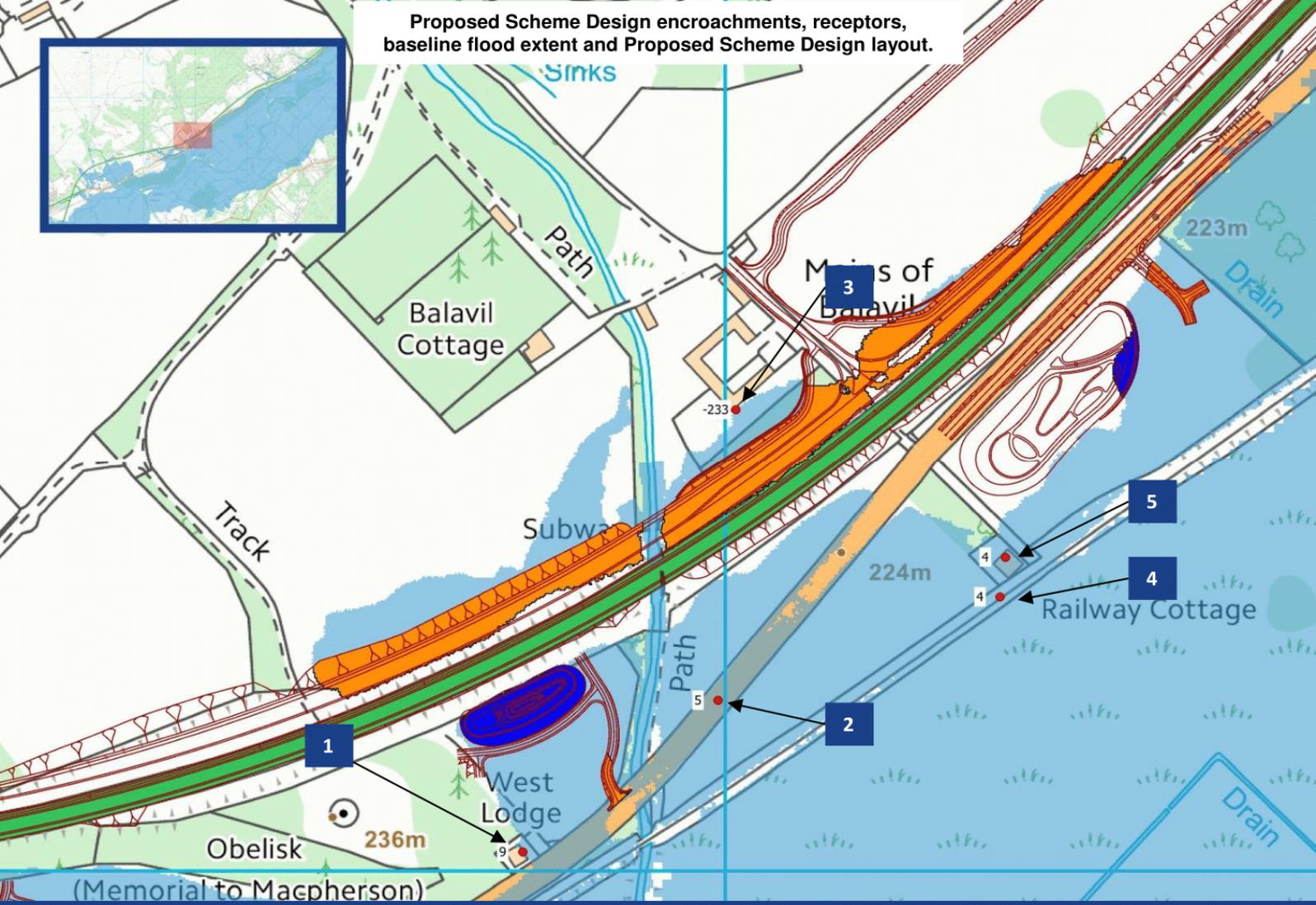
Receptor type and location ID	Assessment Design Change in water level	Watercourse crossing relating to receptor impact
Residential [1]	9mm	ID162
Local Road [2]	5mm	ID162
Residential [3]	-233mm	ID162
HML [4]	4mm	ID162
Residential [5]	4mm	ID162

CSA ID Number: 10

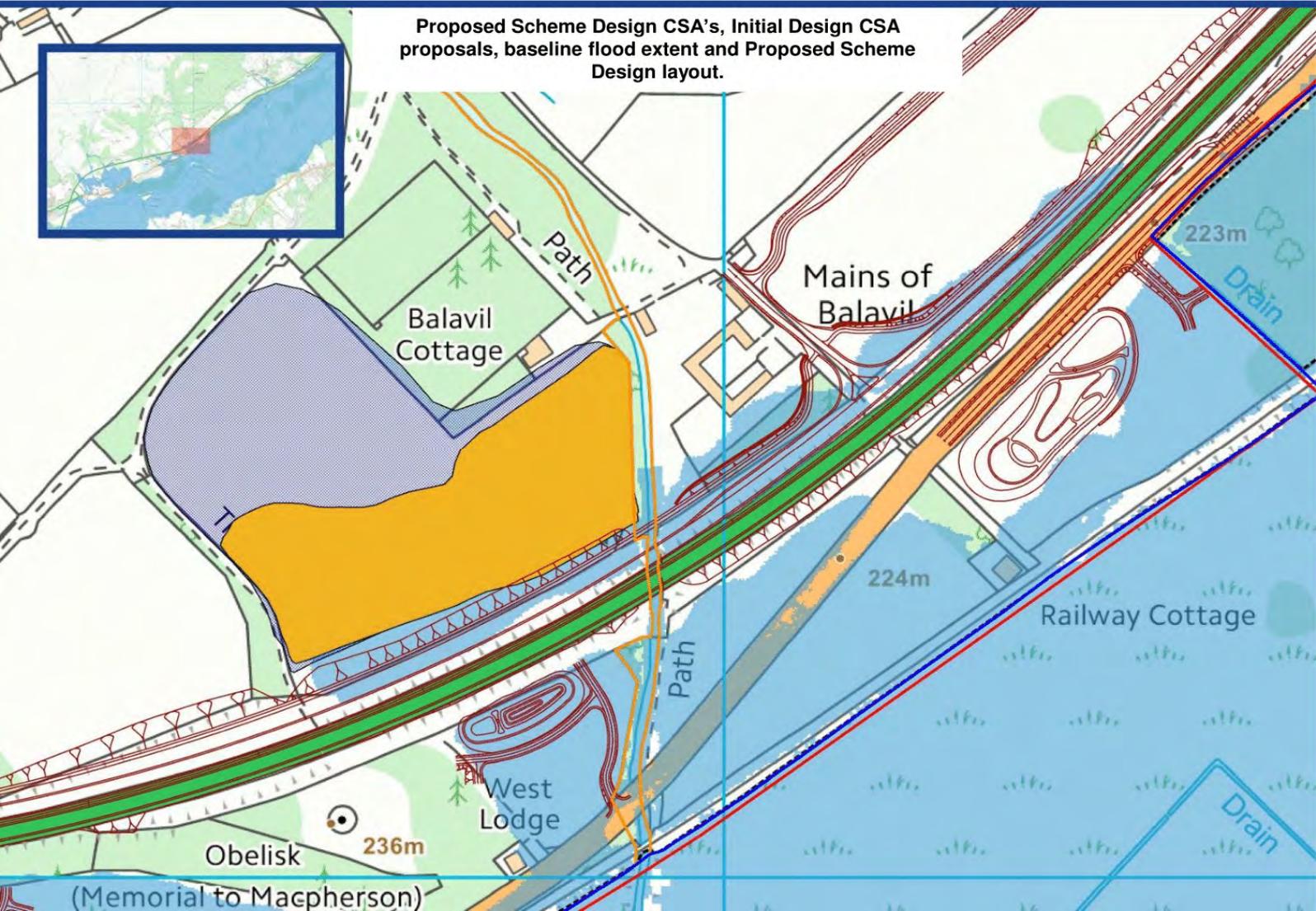
Chainage: Ch.53+400

Location: 278920E, 802120N

Proposed Scheme Design encroachments, receptors, baseline flood extent and Proposed Scheme Design layout.



Proposed Scheme Design CSA's, Initial Design CSA proposals, baseline flood extent and Proposed Scheme Design layout.



Changes: Initial Design – Proposed Scheme Design

Access track has been pulled tighter against the mainline reducing the encroachment volume. Culvert size has been informed by hydraulic modelling and CSA design to maximise upstream storage potential.

Proposed Scheme Design – Encroachment Summary

Component	Area (m ²)	Volume (m ³)	No. Downstream Receptors Affected
Mainline + Access Tracks	11810	4980	5
SUDS Pond Embankments	2250	2060	5
Total	14060	7040	5

Initial Design CSA Mini Assessment Comments

Ecology: Impacts on River Spey SAC. Reshape to avoid River Spey SAC at eastern extent. If this cannot be reshaped, it will result in Likely Significant Effect (LSE) in the Habitats Regulations Appraisal (HRA) and an appropriate assessment, a more stringent assessment compared to EIA, will have to be carried out. Impacts on woodland cover. Reshape to avoid tree loss.

Landscape: Impacts on trees. Reshape to avoid tree loss.

Visual: Impacts on trees. Reshape to avoid tree loss.

C&PA: Direct impact on Balavil Cottage garden. Reshape to avoid garden. Potential impact on Mains of Balavil land and planning permission; would require consultation with Balavil.

Cultural Heritage: Potential impact on Balavil Manse and Estate which is a Category B Listed Building. Reshape to avoid tree loss. Impact would lessen if landscaping isn't changed and field is just allowed to flood. Details of required excavation depths/ detail will determine final assessment outcome.

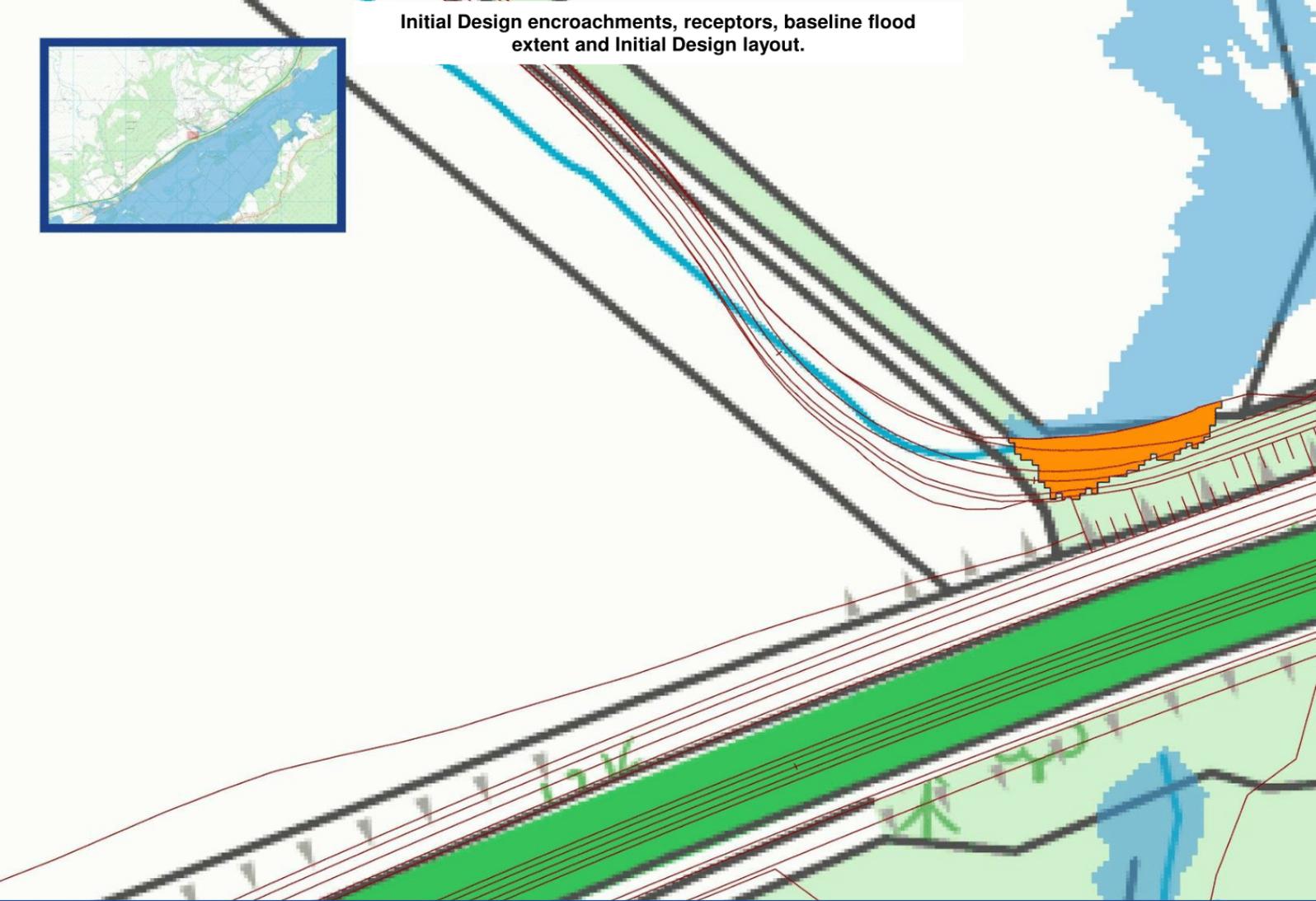
Mitigation Options Developed Following Initial Design

Option (Preferred Options)	Discussion	Viable
Avoid flood plain encroachment	Avoidance of flood plain encroachment is not possible due to the alignment of the mainline and the need for SUDS and access tracks.	No
Reduce Encroachment through design.	Earthworks for access track and mainline steeped as much as practical. Access track on upstream side of mainline brought close to A9. SUDS access track to be lowered to reduce encroachment.	Yes
Offline compensatory storage on upstream side of watercourse.	The area to the west of the watercourse on the upstream side of the mainline is proposed to be used as an offline storage area to compensate the lost flood plain storage. Through design of embankment levels, outfall from the area and excavation the area will have the capacity at the right return periods to compensate for the full encroachment volume. There is a risk that this area may be considered to be a reservoir however as the encroachment volume is less than 10000m all attempts will be made at the detailed design stage to keep the volume stored as close to the volume lost.	Yes

Final CSA Proposed Scheme Design Comment:

The final option selected is for there to be an upstream offline CSA which will compensate for the lost floodplain storage and will fill via a spill from the perched watercourse into the lower storage area. This will mitigate the impacts resulting from the loss of floodplain storage.

Initial Design encroachments, receptors, baseline flood extent and Initial Design layout.



Initial Design Encroachment Details

Encroachment occurs as a result of a access track being located within the flood plain on the north side of the road. The flood plain storage which is encroached into is the result of the overland flow from ID168 and the flow from ID166 interacting and backing up off the culvert.

Receptor Impact Details

There is one receptor downstream that sees a 59mm decrease in flood levels in the proposed case. This is due to the reduction in overland flow from ID168. The impact of the encroachment is dwarfed by this reduction.

Initial Design – Encroachment Summary

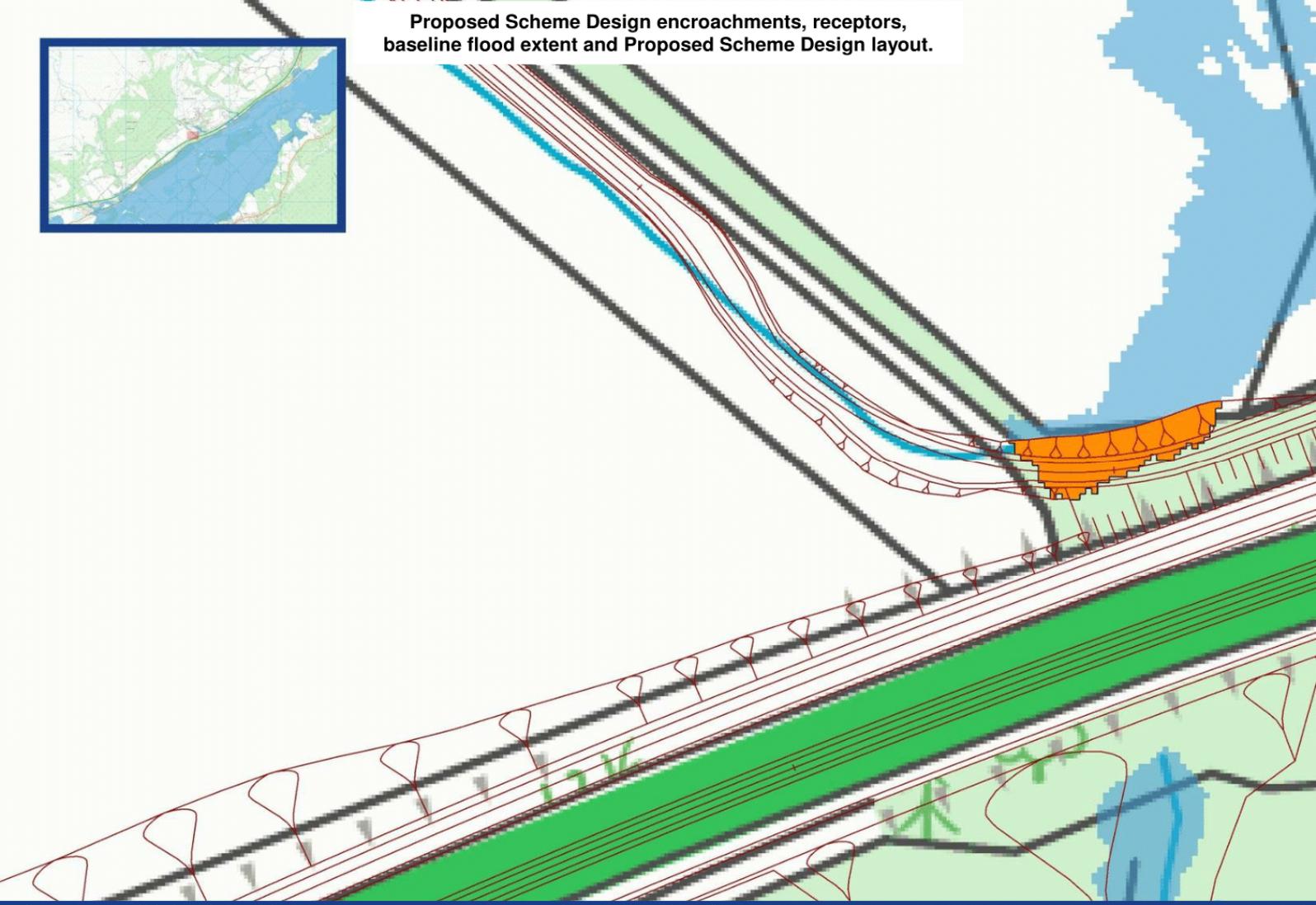
Component	Area (m ²)	Volume (m ³)	No. Downstream Receptors Affected
Mainline + Access Tracks	260	110	1
SUDS Pond Embankments	N/A	N/A	N/A
Total	260	110	1

CSA ID Number: 11

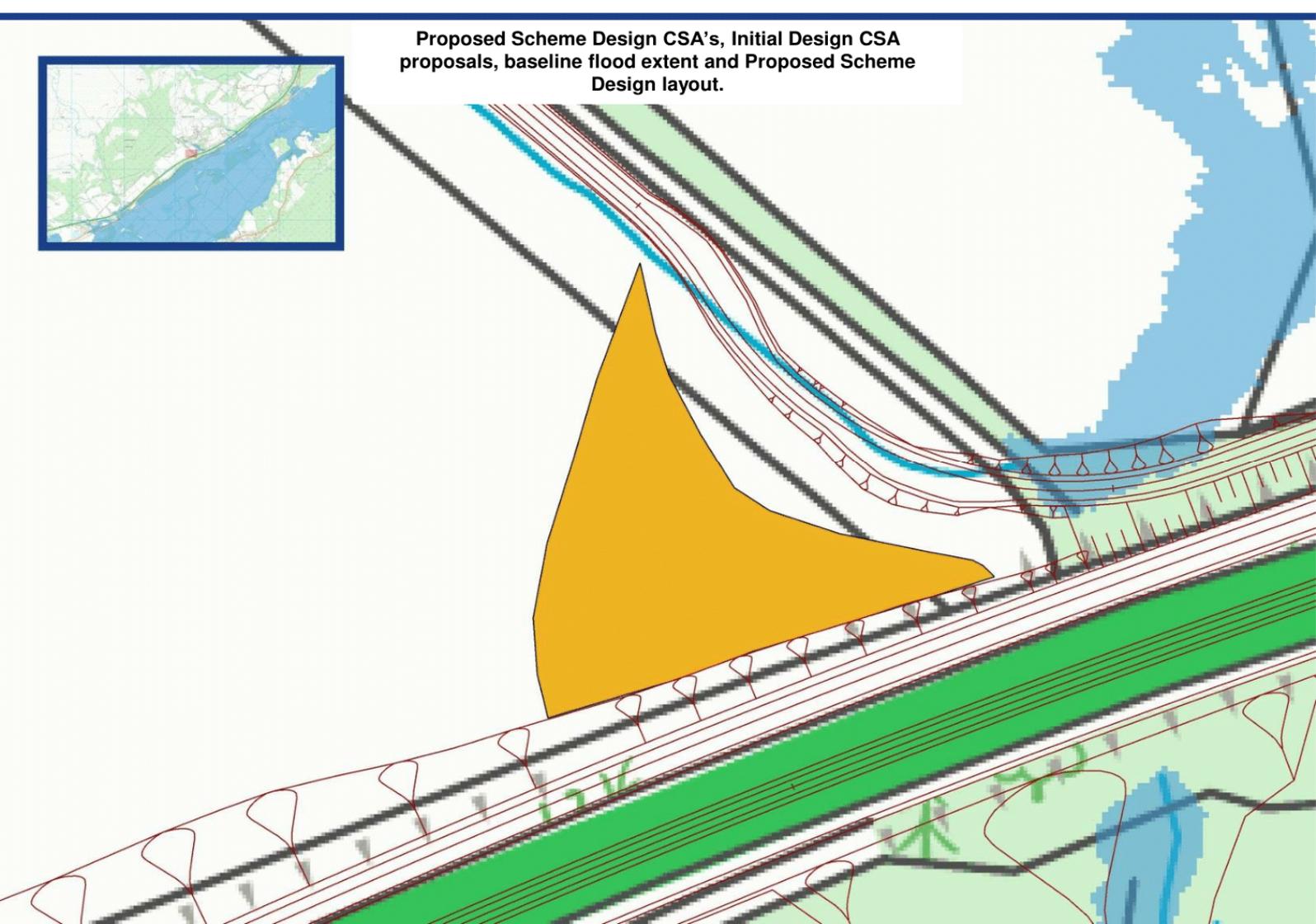
Chainage: Ch.55+250

Location: 280360E, 803240N

Proposed Scheme Design encroachments, receptors, baseline flood extent and Proposed Scheme Design layout.



Proposed Scheme Design CSA's, Initial Design CSA proposals, baseline flood extent and Proposed Scheme Design layout.



Changes: Initial Design – Proposed Scheme Design

None

Proposed Scheme Design – Encroachment Summary

Component	Area (m ²)	Volume (m ³)	No. Downstream Receptors Affected
Mainline + Access Tracks	260	110	1
SUDS Pond Embankments	N/A	N/A	N/A
Total	260	110	1

Initial Design CSA Mini Assessment Comments

No Comments

Mitigation Options Developed Following Initial Design

Option (Preferred Options)	Discussion	Viable
Avoid flood plain encroachment	Avoidance of flood plain encroachment is not possible due to the requirement for an access track to be provided.	No
Reduce Encroachment through design.	Not possible to reduce earthworks extents.	No
Accept changes in water level at local receptors.	Downstream receptors experience a reduction in water levels and the extra flow passed downstream into the Spey at the peak is negligible.	Yes
Compensatory storage through excavation.	An area to the west of the encroachment can be excavated to provide compensatory storage for the encroachment.	Yes

Final CSA Proposed Scheme Design Comment:

The final option selected is for compensatory storage to be provided upstream of the crossing on the west bank of the watercourse. This will provide mitigation for the loss of flood plain storage.

Initial Design encroachments, receptors, baseline flood extent and Initial Design layout.



Initial Design Encroachment Details

Encroachment occurs as a result of the A9 mainline earthworks encroaching into the flood plain.

The flood plain storage which is encroached into on the downstream side is the result the Spey exceeding its channel capacity and flooding the low lying areas adjacent to it. The flood plain storage which is encroached into on the upstream side is there result of ID170 backing up off and undersized crossing.

Receptor Impact Details

There are 2no. receptors downstream which are impacted in part as a result of lost flood plain storage within the Spey flood plain and ID170.

In addition a large number of receptors downstream may be impacted on by a cumulative impact of all the Spey encroachments. The increases in water level for these vary between 0mm and 40mm.

The impacts at the receptors cannot be attributed to a single area of encroachment and the impacts of all the encroachments are likely limited relative to the impact of increasing the width of the Spey crossing opening.

Initial Design – Encroachment Summary

Component	Area (m ²)	Volume (m ³)	No. Downstream Receptors Affected
Mainline + Access Tracks	1360	1210	2
SUDS Pond Embankments	N/A	N/A	N/A
Total	1360	1210	2

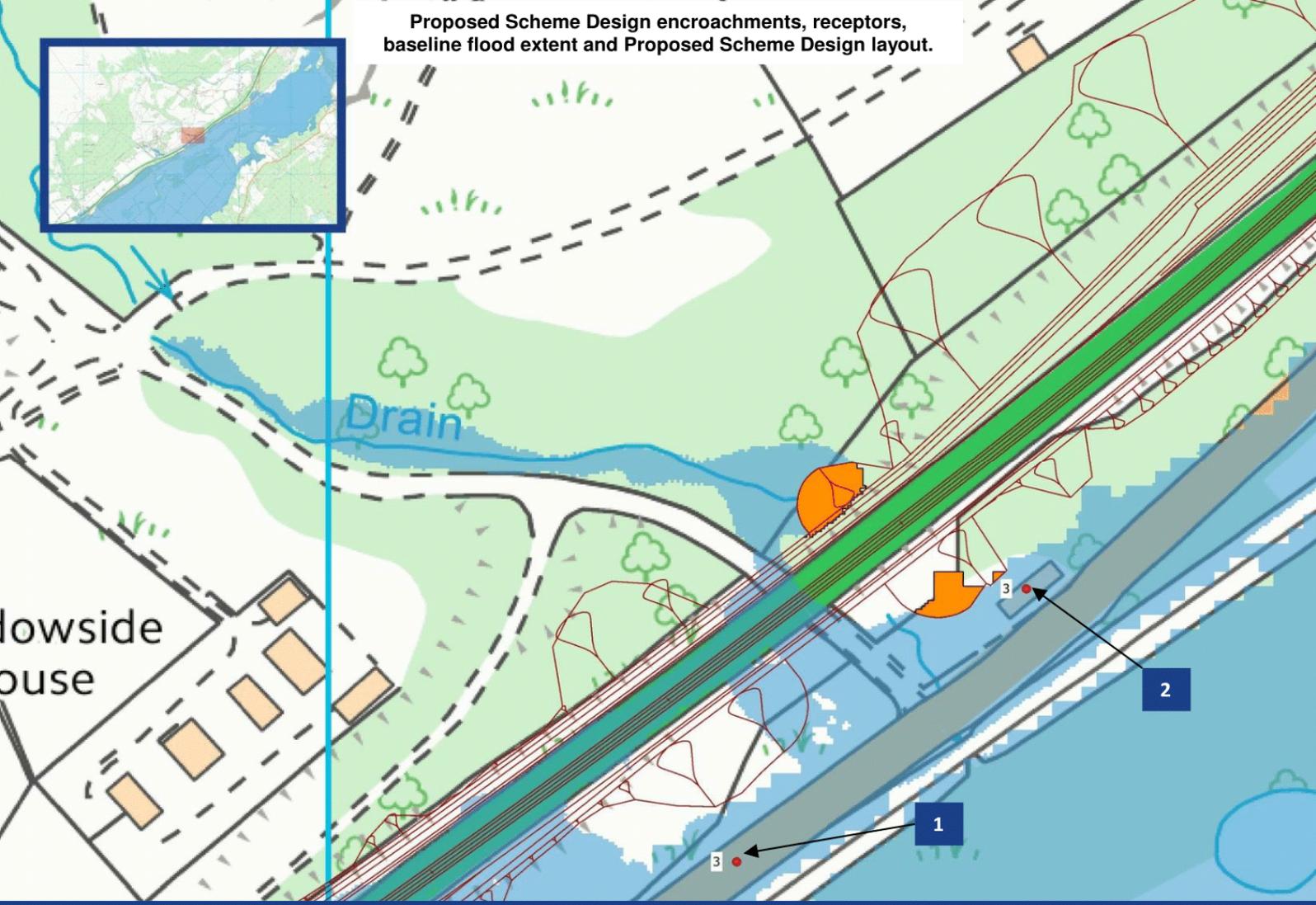
Receptor type and location ID	Assessment Design Change in water level	Watercourse crossing relating to receptor impact
Local Road [1]	3mm	Spey/ID170
Residential [2]	3mm	Spey/ID170

CSA ID Number: 12

Chainage: Ch.56+200

Location: 281190E, 803710N

Proposed Scheme Design encroachments, receptors, baseline flood extent and Proposed Scheme Design layout.



Proposed Scheme Design CSA's, Initial Design CSA proposals, baseline flood extent and Proposed Scheme Design layout.



Changes: Initial Design – Proposed Scheme Design

The introduction of a headwall around the Highland Wildlife Park access road crossing has reduced the encroachment on the upstream and downstream side.

Proposed Scheme Design – Encroachment Summary

Component	Area (m ²)	Volume (m ³)	No. Downstream Receptors Affected
Mainline + Access Tracks	600	650	2
SUDS Pond Embankments	N/A	N/A	N/A
Total	600	650	2

Initial Design CSA Mini Assessment Comments

Ecology: Impacts on juniper formations/ Ancient Woodland Inventory (AWI) site; AWI is an irreplaceable resource in the short term. Reduce extent to permanent assessment boundary, or remove completely.

Landscape: Changes in topography of local area. Impacts on trees. Remove completely.

Visual: Visual effects for road users due to change in topography. Impacts on trees. Remove completely.

C&PA: Impact on access track to Meadowside Quarry; potential for flooding and access issues. Reshape area to avoid track.

Cultural Heritage: Impact on General Wades Military Road and in proximity to KinCraig, Former Meadowside Hospital. If the military road is removed, then archaeological survey and excavation would be required. No impact likely on KinCraig, which is a Category B Listed Building. Reshape to avoid the military road.

Mitigation Options Developed Following Initial Design

Option (Preferred Options)	Discussion	Viable
Avoid flood plain encroachment	It has been shown during design development that the encroachment can be fully removed through the extension of the headwall to the east of the HWP crossing.	Yes

Final CSA Proposed Scheme Design Comment:

During design development the encroachment was fully removed through the introduction of a headwall along the full length of the encroachment. This headwall was reduced in length in the Proposed Scheme Design and hence the encroachment was not fully removed. As the topography around the crossing prevents full compensatory storage from being feasible the only option is to avoid the encroachment by extending the headwall back to its full length.

C.5 CSA Design Refinement

CSA ID Number 3

- C.5.1 Compensatory storage by displacement is the preferred option for mitigating the encroachment upstream and downstream of crossing ID147. Extensive hydraulic modelling was carried out to determine the most appropriate culvert size under the A9 to prevent the peak flow downstream of the scheme increasing and hence inherently mitigate the impact resulting from lost floodplain storage.
- C.5.2 The optimum size was found to be a twin 3.6m x 4.2m box culvert arrangement which passes no more flow downstream in the rising limb of the hydrograph and at the peak. This results in approximately 250mm lift in flood levels upstream of the crossing thereby accommodating the lost floodplain volume.
- C.5.3 As no excavation is required to achieve compensatory storage in this way, no specific area has been allocated within the Proposed Scheme Design.

CSA ID Number 5 and 6

- C.5.4 Earlier in the design process it was proposed that CSA 5 would be merged into CSA 6.
- C.5.5 Comments from the environmental teams showed concern about the environmental impacts of the scale of CSA 6 and its distance from the A9 mainline corridor.
- C.5.6 Through discussion with SEPA it was concluded that the environmental impacts of providing the compensatory storage area outweighed the negligible impact it would have on flood levels downstream and as a result it is removed from the Scheme Design.

CSA ID Number 13

- C.5.7 Following the initial sizing of the compensatory storage area downstream of crossing ID157 concerns were raised that it encroached into several areas with environmental designations including Ramsar, SPA, SSSI, SAC and NNR.
- C.5.8 Further design refinements have therefore been made to, as far as possible, remove the CSA earthworks from the areas with special designations.
- C.5.9 Ground modelling was carried out to establish the minimum plan area into which the encroachment volume slices would fit based on the return period depth slices in the ponding area upstream of the B9152. It was found that the critical return period in terms of the area required to compensate was the 50y – 100y slice.
- C.5.10 Through various iterations of earthworks design a solution was found that allowed the full volume of encroachment to be compensated for at each return period without the earthworks extending into areas of Ramsar, SPA, SSSI or SAC environmental designation or into the ancient woodland to the east and west of the crossing. It is not possible to minimise the extents to out with the NNR.
- C.5.11 The final suggested earthworks extent is shown in **Figure C5-1** below where the NNR is shown as a black dashed line and the extent of the other environmental designations are shown by the solid blue line.

- C.5.12 Following discussion with SEPA and further hydraulic modelling and analysis documented in Annex B compensatory storage area ID13 has been removed from the design as it was concluded that as a result of the unusual hydraulics of the flow routes upstream and downstream of the A9 mainline in the existing and proposed case it there was no increase in water levels downstream and hence the other impacts of providing compensatory storage were unacceptable.



Figure C5-1: Earthworks extents of refined CSA ID number 13.

CSA ID Number 10

- C.5.13 The gradient of the watercourse at crossing ID162 prohibited the provision of standard 'online' level-for-level, volume-for-volume, compensatory storage. An alternative 'offline' solution to provide compensatory storage for the encroachments into the floodplain around crossing ID162 on a return period slice basis has therefore been developed.
- C.5.14 The total encroachment volume (Proposed Scheme Design) to be compensated is ~7,038m³. This has been broken down into volumes between return period levels with the breakdown shown in **Table C5-1** below.

Table C5-1: Estimated encroachment volumes for return period slices.

Return Period Slice	Encroachment Volume (m ³)
0 - 5 y	0
5 - 10 y	125
10 -30 y	1534
30 - 50 y	463
50 - 100 y	1563
100 -200 y	3353
Total	7038

- C.5.15 These volumes are based on the total base plan area projected vertically up therefore the estimates are conservative.
- C.5.16 The compensatory storage has to be able to achieve full compensation at each return period slice. Utilising the lift in water levels at the upstream end of the A9 crossing alone would result in an area of ~42,000m² + earthworks slopes to achieve this.
- C.5.17 One alternative to this is to use a lateral spill to control the flow of water from the channel into a deeper storage area with a lower plan area. The storage area would then drain through a culvert beneath the A9 embankment back into the watercourse downstream of the crossing. The practicality of designing a spill that conveys the exact volumes of water at the correct return periods to properly compensate for the encroachment is such that a significant factor of safety has to be applied to the volumes to provide confidence that the storage will compensate encroachments as intended. With a factor of safety of 2 applied to the encroachment volumes it is possible to reduce the plan area of the storage to between 15,000m² and 25,000m² depending on the earthworks side slopes used.

