Appendix E: Tufa Springs Mitigation Requirements

1 Introduction

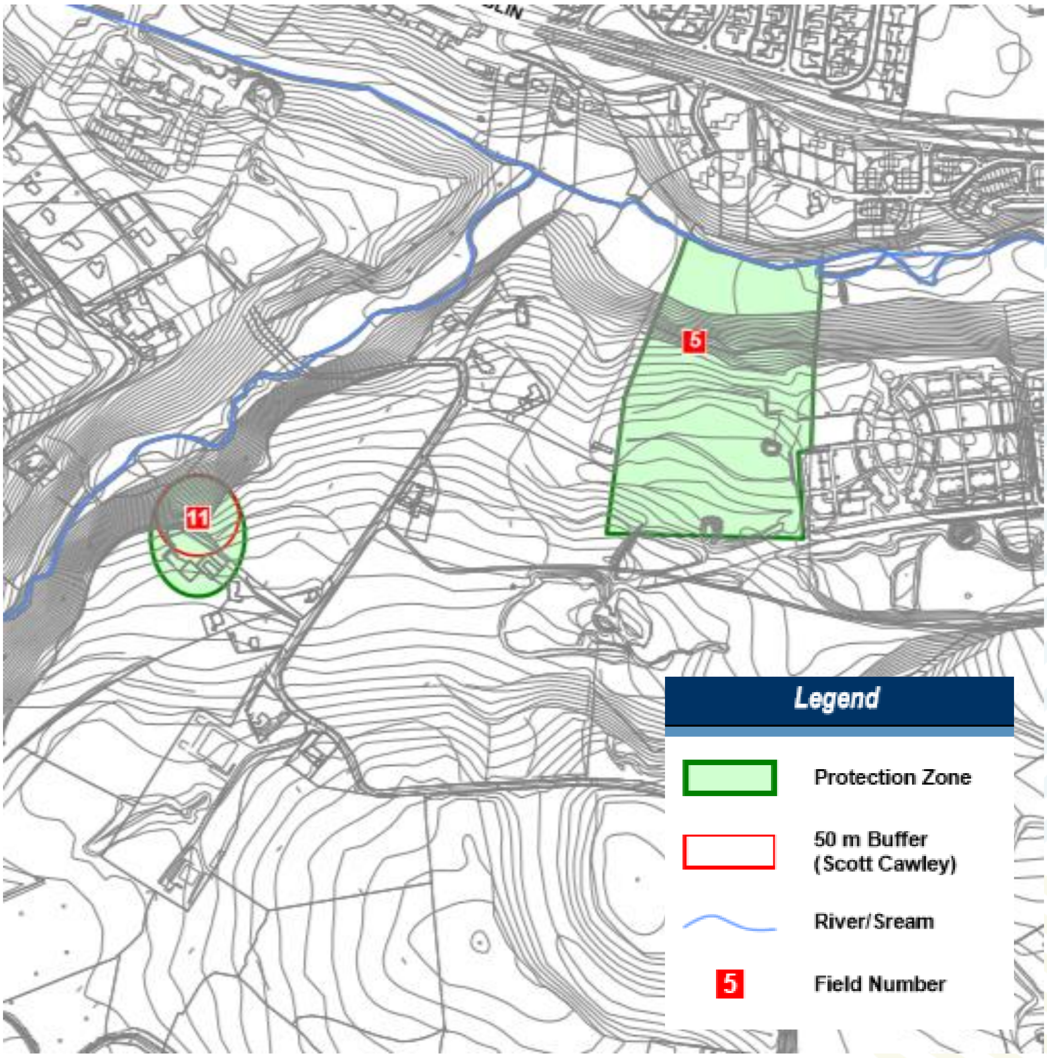
In September 2011, RPS produced a Phase 1 Hydrogeological Assessment of the Cherrywood Strategic Development Zone (SDZ) area (see Annex A-Original Appendix E) with a view to identifying potential sensitive tufa spring groundwater receptors that could be impacted by future development in the area.

The objectives of this study were to:

- Broaden the understanding of the tufa springs in the area;
- Highlight potential risks on the tufa springs;
- Recommend solutions and mitigation measures that may be needed to avoid negative impacts on the tufa springs.

This study identified two protection zone in which further assessment and mitigation measures would be required (see Figure 1-1).

Figure 1-1: RPS Protection Zones



Through an iterative site investigation and hydrogeological assessment processes, the understanding of mechanisms that support Tufa Spring No. 5 has increased and so the requirements of the Protection Zone associated Protection Zone require updating.

<u>Please note the advice regarding the Protection Zone 11, remains as the original Appendix (see Annex A).</u>

2 Current Understanding of the Hydrogeology of Tufa Spring 5

Since 2016, JBA Consulting have been commissioned by DLRCC to provide ongoing hydrogeological advice regarding the protection of the tufa spring. A range of further information has been made available to improve the understanding of the hydrogeological systems since 2011 including site investigations for particular developments within the Cherrywood Planning Scheme area.

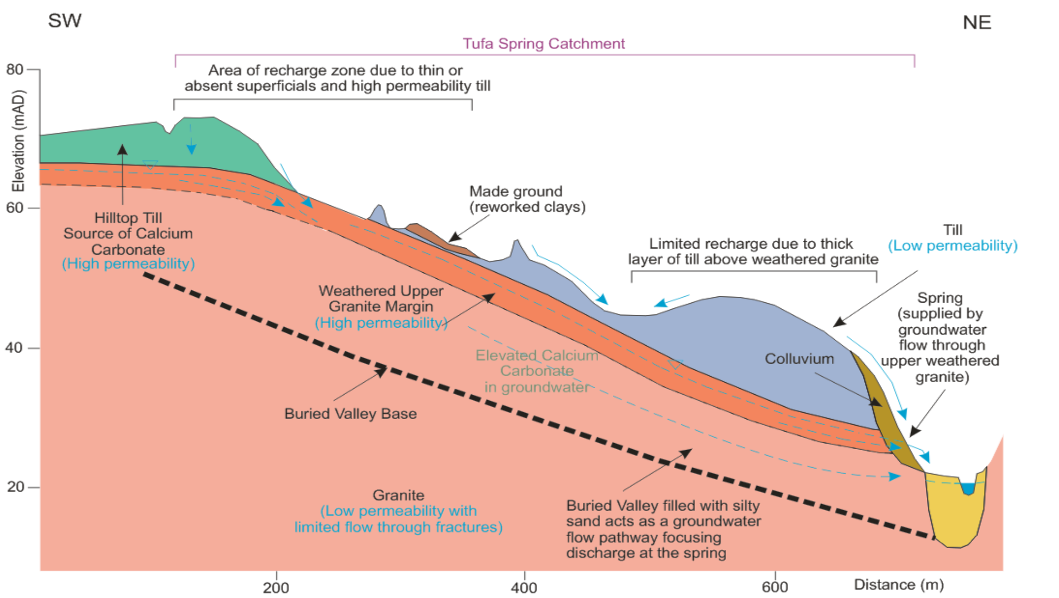
The current understanding of the hydrogeological system supporting Tufa Spring 5 is detailed in the JBA Catchment Study (see Annex B -JBA Catchment Study) and summarised in the Box below.

Box 1 - Tufa Spring Conceptualisation

The current hydrogeological conceptual model of the tufa spring has been developed from two reports previously produced by JBA Consulting and the additional site investigation data summarised in the section above. It has the following features:

- The tufa springs form and discharge where a buried valley filled with silty sand intersects with the valley side.
- The upper weathered margin of the granite bedrock which is observed in previous site investigations acts as a relatively high permeability layer which discharges groundwater to the buried valley from the surrounding area.
- The recharge is likely to be derived from an area of thinner/absent till which overlies the bedrock and higher permeability till deposits in the upper catchment. These high permeability tills are also likely to also be a key source of calcium carbonate for the spring.
- Recharge in the area immediately uphill of the spring is limited by a thick layer of low permeability till.

The updated conceptual site model is shown in figure below.



3 Potential Impacts and Catchment Sensitivity Zone

The JBA Catchment Study has divided the catchment into zones (see **Figure 3-1** below). These are based on the underlying geology and how the spring is supported by these areas.

For each Zone, there are two Potential Impact Classes described in **Table 3-1**.

<u>Any proposed development should not significantly change the nature or area of the catchment of the spring, through divergence of surface or groundwater away from the catchment</u>.

To note, Tufa Spring No. 5 is a mature developed tufa formation which is a priority EU Annex Habitat which is considered important at county level.

Table 3-1:Potential Impact Classes

Potential Impact Classes	Possible Mechanism	Spatial Locations Where Impact is Most Likely to Occur
Alteration of Recharge Characteristics	Reducing the permeability of the ground and infiltration of surface water through construction of extensive areas of hardstanding. Installation of drainage systems which change the spring catchment or lead to reduced recharge within the catchment.	Where groundwater recharge rates are likely to be higher, i.e. areas where till is relatively thin (or absent), or of relatively high permeability.
Alteration of Groundwater Flow Paths	Physical barriers to groundwater flow (secant piled walls, deep foundations for undercroft parking etc.) could be built through the upper weathered margin or buried valley. Deep permanent excavation below the local water table, or installation of deep service conduits.	In the lower part of the spring catchment, where till is thick, this impact mechanism is only likely to only occur with deeper excavations. Where till is thin or absent or higher permeability development works could have the potential to alter flow paths. It has been assumed that groundwater flow paths in the lower catchment will not be significantly affected by excavations and physical barriers in the upper catchment, i.e. all except very large excavations in the upper catchment will not change the groundwater catchment of the spring

In addition to the impact mechanisms identified above, direct damage to the spring could occur with developments close to the spring.

Figure 3-1: Catchment Sensitivity Classification

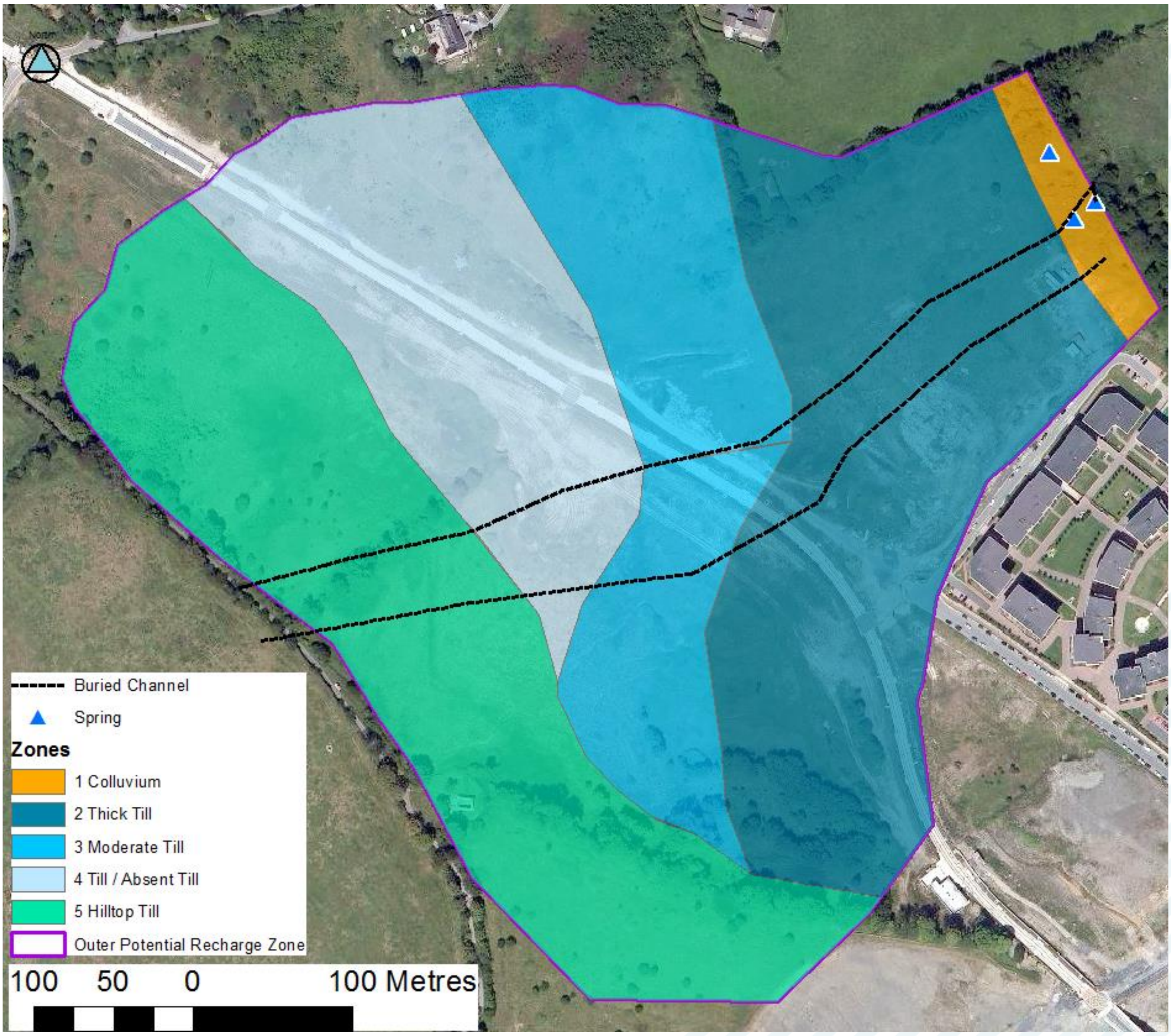


Table 3-2 provides a description of the potential development related impacts that could arise within each zone, and the outline recommended mitigation actions.

The last row of **Table 3-2** takes into account large scale development works such as extensive and deep excavations (more than 2.5m deep) which could fundamentally alter the groundwater system and therefore the future status of the springs.

<u>Such work</u>**<u>, anywhere within the Precautionary Spring Catchment</u>** <u>as defined in</u> **<u>Figure 3-1</u>**<u>, should be supported by a hydrogeological risk assessment and an appropriate level of site investigation</u>**<u>.</u>**

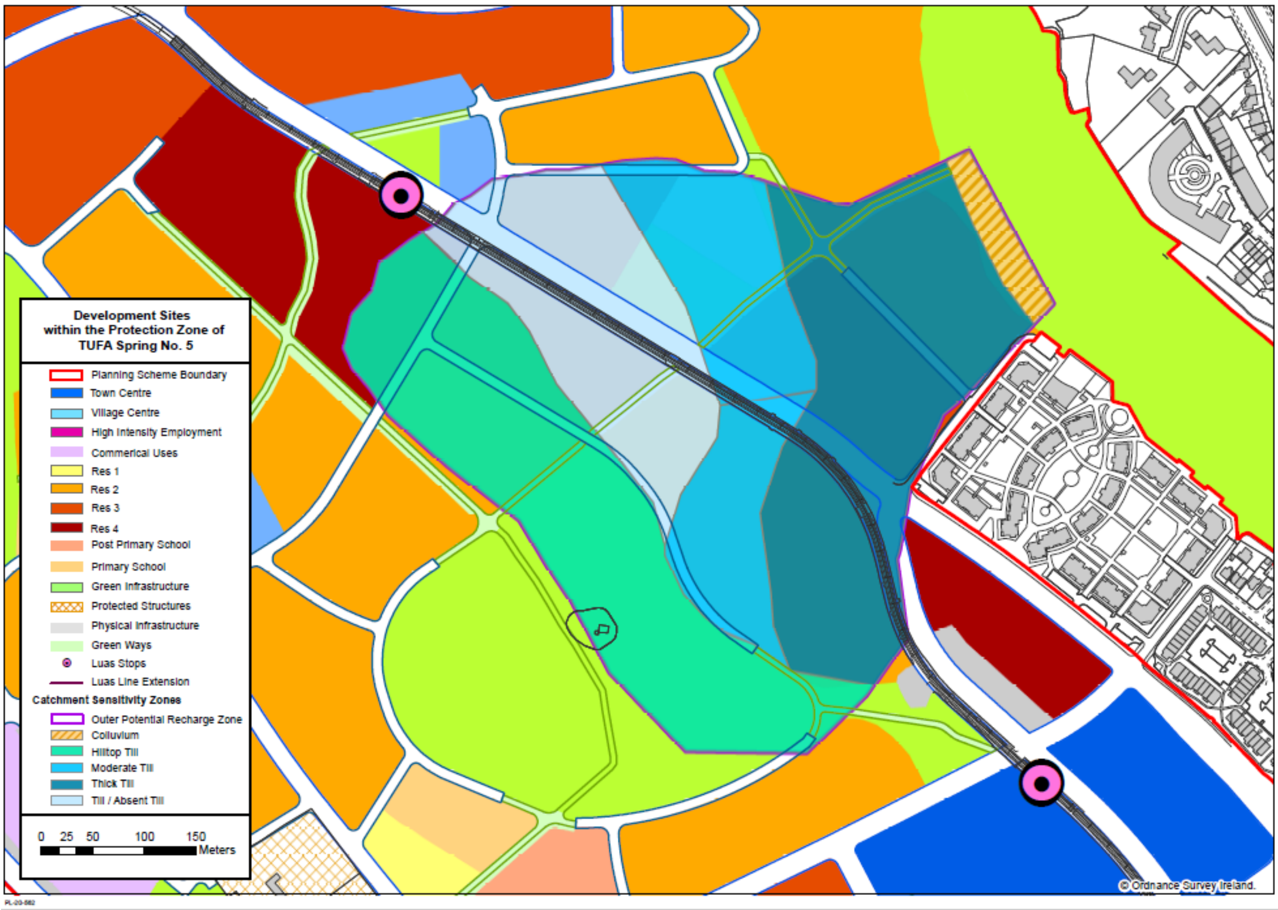
In certain zones, excavations less than 2.5m could be undertaken without further excavations, as they would occur entirely in low permeability till deposits.

Table 3-2: Sensitivity Zone Classification

Zone	Recharge Impact Potential	Flow Impact Potential
1 - Colluvium	Zone 1 represents the slope where spring flow occurs and should be avoided in all cases	
2 – Thick Till	Unlikely – No further analysis is likely to be required.	Unlikely - No further analysis is likely to be required. Note area may be more suitable for deeper excavations further analysis would be required.
3 – Moderate Till	Unlikely – No further analysis is likely to be required	Unlikely - No further analysis is likely to be required
4 Till / Absent	Likely – Areas of proposed hardstanding and other low permeability cover will require further analysis to establish the extent of impact on recharge to the spring. Where areas can be shown to have a significant layer of low permeability till no further analysis would be required.	Likely – Excavations that are expected to reach the gravel (weathered bedrock) and bedrock layers would require further analysis to establish the extent of impact on the groundwater flow to the spring.
5 Hilltop Till	Likely – Areas of proposed hardstanding and other low permeability cover will require further analysis to establish the extent of impact on recharge to the spring.	Likely – Excavations that are expected to reach saturated deposits would require further analysis to establish the extent of impact on the groundwater flow to the spring.
All Zones	Large scale excavations (>2.5m deep) - further analysis requirement	

The following map shows the Catchment Sensitivity Classification Zone overlaid over Map 2.2: Scale of Density taken from the Planning Scheme.

Figure 3-2: Catchment Sensitivity Classification Overlaid with Map 2.2: Scale of Density taken from the Planning Scheme.



4 Analysis Requirements

While **Table 3-2** above outlines what type of impact mechanism could occur in each zone and where further analysis is required, this section provides an initial framework which may lead to the requirement of further analysis to be carried out on site by the applicant.

Guidance on this process is outlined under Table 4-1 below. These assessments shall be carried out <u>prior to the design of the layout of the proposed design on site and prior to any pre-planning workshops been carried out with the DAPT or the Planning Authority</u>.

The process is an iterative one and should not be deemed to be complete until the Hydrogeological Analysis carried out by the applicant indicates that their proposed development:

- will not significantly impact on the Tufa Springs, noting that Tufa Spring No. 5 is a mature developed tufa formation which is a priority EU Annex Habitat which is considered important at county level and has been given a High Rating under the Draft National Level Assessment been carried out by NPWS (2020, in draft).
- and that sufficient evidence has been provided to inform the Ecological Impact Assessment accompanying any proposed development/planning application on the development sites within the protection zone shown in Figure 3-1, that the proposal will not cause significant impacts on the Tufa Spring.

Prior to the lodgement of a planning application on any of the sites within the protection zone of the Tufa Spring as identified on Figure 3-1, the applicant will need to demonstrate that they have carried out the following:

- Engaged and suitably qualified Hydrogeologist.
- Prepared an Ecological Impact Assessment prepared by the Applicant supported by a Hydrogeological Analysis carried out by a suitably qualified Hydrogeologist in consultation with a suitably qualified Tufa Spring Ecologist.
- Must ensure that the proposed development will pose no significant impact on the Tufa Springs.

All works within the catchment will require assessment. The scale of the work required to prove no significant effects on the tufa spring will be dependent on a number of factors:

- The scale and nature of the works.
- The location within the catchment and the role that location plays in supporting the spring.
- The rounds of iterative investigations required to provide a robust hydrogeological baseline understanding of the area.
- The scale and nature of the measures required to mitigate impacts.

Small works, such as the installation of paths on the existing ground surface, which shed runoff to the surrounding ground may only require a screening assessment.

Larger scale works such as sub terrain carparks which partly lie beneath the water table may need to be supported by a Hydrogeological Risk Assessment support by a groundwater model which has been developed by several rounds of Site Investigation.

Table 4-1 below provides a framework of the stages potentially required. The conclusions of the assessment process carried out by the applicant/developer will need to be presented to and agreed with DLRCC. It is recommended that this is done as part of the pre-application consultation process and the design of the development should be based on the results of these assessments. This will aid the process when a development on site is lodged as a formal planning application.

Table 4-1 – Framework of Studies Required

Stage	Activity	Consider if Enough Information has been gathered
1	**Screening assessment** Are there activities that might affect the tufa springs through changes in recharge or groundwater flow pattern?	If there is no potential source of impact no further assessment required <u>If potential impacts continue to stage 2</u>
2	Develop initial hydrogeological conceptual model based on available data	
3	Review nature of the development	
4	Review mitigation measures available Outline Hydrogeological Impact assessment	If no feasible impact linkage identified, no further assessment is required (only valid if conservative assumptions are made) <u>If potential impacts are possible continue to stage 5</u>
5	Design and conduct site investigation to improve conceptual model Depending on the mitigation measures require this may include ongoing monitoring to capture the range of groundwater conditions the site experiences, or quantitative (e.g. modelling) assessments.	
6	Develop the conceptual model, mitigation measures and risk assessment further Support the risk assessment with quantitative assessment if appropriate	If impact linkages can be demonstrated to lead to no significant impacts, no further assessment is required. If this is not possible repeat Stages 5 and 6 until no significant impacts can be demonstrated

The Environment Agency (2007), Hydrogeological impact appraisal for dewatering abstractions, although developed for and specifically for dewatering activities, provides further useful guidance on the iterative process which should underlie the assessment process and the tiers of evidence that can support a hydrogeological risk assessment.

https://www.gov.uk/government/publications/hydrogeological-impact-appraisal-for-dewatering-abstractions

4.1 Screening

All proposals within the catchment should be screened by the applicant to assess

- whether they include activities which could cause the impact mechanism detailed in **Table 3-1**.
- Assess whether those activities are appropriate to the zone.

If at the screening stage activities are identified that could potentially impact the spring, further assessment will be required as outlined in Table 4-1.

4.2 Further Assessment

If potential impacts are identified, developments will only be permitted where it can be demonstrated by the applicant that these can be successfully mitigated against.

This should be presented in the form of a hydrogeological risk assessment which can form the basis of the technical information to inform the Ecological Impact Assessment of the scheme.

The information contained within the hydrogeological risk assessment should reflect the sensitivity of the location and the scale of the works being undertaken, and the significance of the impact mechanism that may be affected. Depending on the initial finding of the hydrogeological risk assessment and design constraints, the process may be iterative, and may require a number of rounds of investigation.

Where the Hydrogeological Risk Assessment concludes that impact mechanisms can be eliminated through the design of the scheme[1], mitigation measures developed will need to be supported by additional quantitative assessments which show that the functions of the existing hydrogeological system will be replicated.

[1] Example of elimination - the depth of excavations are reduced to no change groundwater flood patterns

Annex A -Original Appendix E

Annex B - JBA Catchment Study Tufa Spring No. 5