# A417 Missing Link
# TR010056

## 6.4 Environmental Statement
## Appendix 13.10 Drainage Report

Planning Act 2008

APFP Regulation 5(2)(a)
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**The Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009**

# A417 Missing Link

## Development Consent Order 202[x]

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**6.4 Environmental Statement**
**Appendix 13.10 Drainage Report**

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# 1 Introduction

## 1.1 Purpose of this document

1.1.1 A drainage strategy and preliminary drainage design have been developed to support the Environmental Statement (ES) for the A417 Missing Link (referred to herein as ‘the scheme’).

1.1.2 This report describes the baseline environment, the existing drainage and the proposed drainage design principles and parameters for the scheme.

The Annex G Ground and surface water management plan of the Environmental Management Plan (EMP) in Appendix 2.1 Environmental Management Plan (Document Reference 6.4) includes details of measures to protect the water environment during construction of the scheme and thus construction issues are not considered in this report.

# 2 Site description

## 2.1 Existing watercourses

2.1.1 The scheme interacts with ordinary watercourses in four river catchments:

- River Churn
- River Frome
- Norman’s Brook (see Section 3.3)
- Horsbere Brook

2.1.2 There are no main rivers affected by the scheme.

2.1.3 The River Churn is part of the River Thames catchment, the other watercourses are within the River Severn catchment.

## 2.2 Topography

2.2.1 The site can be split in to two topographic areas. The central and east sections of the project are located on the rolling high wold (predominantly limestone) interspersed with steep valleys.

2.2.2 To the east the ground drops away steeply towards the flat Severn Vale forming an escarpment with characteristic limestone outcrops. Crickley Hill is the part of this ridge traversed by the existing A417.

## 2.3 Geology and soils

2.3.1 The bedrock underlying the region is generally comprised of Oolitic Limestone.

2.3.2 Superficial deposits are located in discrete areas relative to the scheme including, the Cotswold escarpment (west of the escarpment crest), the Churn Valley (near Shab Hill Farm) and the Frome Valley (near Stockwell-Nettleton). These comprise mass movement deposits, alluvial deposits and Cheltenham sand and gravel.

2.3.3 The existing A417 crosses the top of the Cotswold escarpment where the Inferior Oolite Group outcrops and descends to the Vale of Gloucester within the outcrop of the Lower Lias. To the south-east of the scheme (Parsons pitch to Cowley roundabout) landslip material is encountered in the valleys and bottoms, together with some deposits of Fullers Earth.

2.3.4 Previous studies indicate that almost all of the A417 route below the escarpment (Brockworth bypass to Air Balloon roundabout) is within land-slipped material (colluvium). Over this section the Upper and Middle Lias Formations, together with the upper horizons of the Lower Lias, are mantled by the colluvial deposits.

2.3.5 In many places the slopes below the escarpment exhibit evidence of past ground movements with features such as soil lobes, back scars and springs dominating. Many areas are hummocky in appearance indicating the possible existence of secondary land-slipping masking the deeper-seated historic failures.

2.3.6 Available data indicates that the soil types across the scheme are lime-rich loamy soils.

2.3.7 A complete description of the geological and topological context is provided in ES Appendix 13.7 Hydrogeological Impact Assessment (Document Reference 6.4).

# 3 Existing drainage

## 3.1 Data sources

3.1.1 The understanding of existing drainage systems has been developed from the following sources:

- Highways Agency Drainage Data Management System (HADDMS) database and as-built drawings (see Annex A Highway Drainage Records).
- Drainage maintenance record drawings from Area 31 Design Build Finance Operator (DBFO), 2020 (see Annex A Highway Drainage Records)
- OS mapping
- Topographic survey (Malcolm Hughes/Highways England), 2019
- Planning applications for developments in the project area (13-00764, 15-00751, 16_00123)
- Preceding Highways England drainage reports and studies, including:
  - A417 Cowley to Brockworth Bypass Improvement, Drainage Strategy Report, WSP, Jan 2005[1]
  - A417 Missing Link, Drainage Strategy Report, MMSJV, PCF Stage 2, March 2019[2]
  - A417 Normans Brook Tracer Test (HE551505-MMSJV-EWE-000-RP-LX-00003), 22 March 2019[3]
  - ES Appendix 13.11 Water Features Survey (Document Reference 6.4)

3.1.2 In addition, site visits and informal surveys have been undertaken:

- Supplementary topographic (culvert) survey by Highways England, Dec 2019
- Site visits and informal surveys: 6 August 2019, 14 January 2020, 16 February 2020 and 10 March 2020

## 3.2 Existing highway drainage

3.2.1 The existing highway systems, outfalls and catchments are summarised in Annex B Existing Highway Drainage and ES Figure 13.18 Existing Drainage Plan (Document Reference 6.3). Relevant record drawings from HADDMS and the DBFO are in Annex A Highway Drainage Records

3.2.2 The topographic survey identifies above ground surface drainage elements (gullies, manhole covers etc) and hydraulic structures (weirs, headwalls etc), but does not include the survey of any below ground buried drainage and services.

3.2.3 Records are available for the existing highway drainage for most of the relevant sections of the existing A417. Note that, with the exception of the Brockworth Bypass section, this data does not contain any level information (invert and cover levels) for the buried drainage systems, nor details of soakaways, and only limited pipe size data.

3.2.4 Based on available records it is thought that the existing A417 between Parsons Pitch and the current Air Balloon roundabout drains predominantly to groundwater via soakaways.

3.2.5 The as built records suggest that the section of the existing A417 south of Cowley/Nettleton Roundabout may include infiltration features, although there is insufficient evidence to confirm this conclusively.

3.2.6 Record drawings received from the DBFO and site visits confirm the presence of soakaways at the Ullenwood Cricket Club and the existing junction of the A436/Leckhampton Hill. These soakaways serve that junction and the Air Balloon roundabout, plus the bottom section of the existing A417 Birdlip Hill, north of Four Winds.

3.2.7 Record drawings from the DBFO also confirm that the existing A417 Crickley Hill is collected by kerb and gulley systems that outfall to the tributary of Norman's Brook between Grove Farm and Crickley Hill Farm.

3.2.8 Away from the existing A417 and junctions, existing minor rural roads appear to be predominantly served by informal drainage systems discharging into field ditches and adjacent agricultural land.

3.2.9 Asset data provided by Highways England has indicated the presence of, isolation valves, petrol interceptors and a lagoon serving the existing A417 near Nettleton roundabout (existing catchment E9).

3.2.10 Based on available information there are no other pollution treatment or control measures provided on the sections of the existing A417 affected by the scheme.

## 3.3 Tributary of Norman's Brook

3.3.1 The tributary of Norman's Brook (Crickley Hill stream) is the principal watercourse receiving flows from the western part of the scheme area.

3.3.2 The tributary runs from east to west and connects to the Norman's Brook main channel west of the A46 Shurdington Road.

3.3.3 The stream is a distinguishable feature and is continuously flowing, fed by land drainage systems and springs on the south and east of Grove Farm and the A417 highway drainage system to the north.

3.3.4 Between its source and the existing A417 culvert near Crickley Hill Farm the tributary of Norman's Brook has an irregular and steep course interrupted by short culverts and other features such as informal dams and a cascade.

3.3.5 A number of public data sources including the Digital River Network and the EA Water Framework Directive (WFD) catchment explorer still report that the watercourse connects to the Horsbere Brook catchment.

3.3.6 However, a tracer test[3] confirmed that the watercourse is in fact a tributary of Norman's Brook and crosses under the existing A417 Mainline via a culvert located near Crickley Hill Farm.

3.3.7 The watercourse enters the culvert just east of Crickley Hill Farm. The available information indicates that this culvert cranks north west, crossing diagonally under the existing A417, and then continues west along Dog Lane and Bentham Lane before discharging to an open ditch just north of Bentham County Club on the western side of Bentham Lane. The total length of culvert, including the section under the existing A417, is approximately 1.04km.

3.3.8 Information about the line, level and conduit size is not complete, particularly in the lower sections west of Holly Brae, but information from surveys, as built records and site visits has enabled an adequate understanding of the existing culvert to inform the preliminary design.

3.3.9 The total level drop over its length is approximately 30m with an overall average gradient of 3%.

3.3.10 The available data indicates that the upper reaches are a 600mm diameter pipe. Where the culvert crosses diagonally under the existing A417 the gradient is approximately 3%, but the sections immediately upstream and downstream have a gradient of approximately 5%.

3.3.11 Between Holly Brae and the Bentham Road/Dog Lane junction the culvert flattens to around 1% and the diameter reduces to only 450mm.

3.3.12 The section downstream of Holly Brae is constructed in a mixture of materials Estimated gradients downstream of the Bentham Road/Dog Lane junction are approximately 2.5% overall.

3.3.13 The upper end of the culvert near Crickley Hill Farm is served by a well-designed, modern headwall and trash screen. At the headwall there is a section of 1m diameter pipe, which tapers to 600mm a short distance inside the culvert.

### 3.4 Surface water flood risk

3.4.1 The Risk of Flooding from Surface Water Flood Maps[4] give an indication of principal overland flow paths and areas of low ground at risk of surface water flooding.

3.4.2 These do not necessarily take account of buried drainage infrastructure such as culverts, soakaways and highway drainage systems.

## 4 Scheme drainage design

### 4.1 Proposed drainage infrastructure

4.1.1 The scheme highway drainage basins, outfalls, culverts and perimeter drainage features are shown on General arrangement and section plans (Document Reference 2.6) and described in ES Chapter 2 The project (Document Reference 6.2).

4.1.2 Proposed highway catchments, asset ownership and preliminary surface water management storage provisions are summarised in Annex C Scheme Highway Drainage and ES Figure 3.19 Scheme Highway Drainage - Plan (Document Reference 6.3).

## 4.2 Design criteria

### Highway drainage – general

4.2.1 The scheme mainline and junction slip road drainage would be adopted and maintained by Highways England. All other highway drainage would be adopted by Gloucestershire County Council (GCC).

4.2.2 The highway drainage systems have been designed in accordance with Design Manual for Roads and Bridges[5] (DMRB) CG 501 Design of highway drainage systems and DMRB LA 113 Road drainage and the water environment (LA 113). For local roads the drainage design has incorporated GCC's requirements.

4.2.3 Wherever possible, separate drainage networks and attenuation/infiltration basins will be provided for each adopting authority.

4.2.4 Reconfiguration of the existing local roads will require new drainage to connect into existing networks at some locations. The proposals will provide a like for like or reduction of impermeable area into the existing networks, and the design assumes that the existing networks have sufficient capacity to convey the flows from the new drainage.

4.2.5 If there is a net increase in paved area contributing to an existing system attenuation is provided.

4.2.6 The highway drainage pipes will be sized to convey a 1 in 1-year return period event including climate change without surcharging.

4.2.7 The design will ensure that there is no surface water flooding on the highway for a 1 in 5-year return period event including climate change.

4.2.8 For Highways England roads, the design will ensure no surcharge of the road foundation (formation level, or sub-formation level where capping is present) in the 1 in 5-year return period event including climate change.

### Climate change

4.2.9 The design life of drainage assets would be 60 years and assets that qualify as Structures would be 120 years. Based on the predicted opening date of no later than 2025, the scheme assets will reach the end of their design life in 2085 and 2125, respectively.

4.2.10 The catchments affected by the scheme, including both highway drainage systems and external land drainage, are less than 5 $km^2$ so peak rainfall intensity (direct rainfall) allowances apply[6]

4.2.11 Therefore, the upper end and central increases that apply are 40% and 20% respectively.

4.2.12 The highway drainage carriageway collection networks are sized and tested for the return periods in section 5 of DMRB CG 501 Design of highway drainage systems, with a 20% allowance for climate change (DMRB CG 501 Design of highway drainage systems, section 4).

4.2.13 The highway drainage systems overall are designed to manage a 1 in 100-year return period event plus 40% climate change within the site (DMRB CG 501 Design of highway drainage systems, clause 5.3 & section 4).

**Surface water management**

4.2.14 Surface water management proposals have been developed in accordance with the policy requirements of the Lead Local Flood Authority (LLFA) which is Gloucestershire County Council (GCC)[7], and national policy guidance[8].

4.2.15 The design will ensure that the post development run off will be managed within the site up to 1 in 100-year event with a 40% allowance for climate change.

4.2.16 GCC, national policy guidance and DMRB CG 501 Design of highway drainage systems all require that destinations for discharge from road drainage systems are selected according to the following hierarchy:

- Groundwater
- Surface watercourse
- Surface water sewer

4.2.17 Where infiltration is not possible, the runoff to surface waters will be attenuated to Green Field Runoff Rates (GFRR) and volumes.

4.2.18 The greenfield run off rates have been calculated using the Institute of Hydrology 124 method (IH124) with adaptations in the Interim Code of Practice (ICoP) for Sustainable Drainage Systems for catchments less than 50ha[9].

4.2.19 A minimum control flow rate of 5l/s is applied to ensure ease of maintenance and reduce risk of blockage.

4.2.20 Where the proposed catchment includes reconfiguration of existing carriageways, or removal of existing pavements, the allowable run-off rates for the developed site may be increased versus the GFRR to take account of the previously developed paved areas.

4.2.21 GCC standing advice[7] states:

*"For developments which were previously developed, the peak runoff rate from the development to any drain, sewer or surface water body up to the 1 in 100 year rainfall event + 40% for climate change should reduce the surface water discharge by 40% of that existing or be as close as is reasonably practicable to the greenfield runoff rate from the development for the same rainfall event, but in any event should never exceed the rate of discharge from the development prior to redevelopment for that event".*

## 4.3 Highway drainage collection – A417 and slip lanes (Highways England)

4.3.1 Pavement edge and central reserve drainage solutions for the A417 mainline and for slip lanes at junctions would be selected in line with the recommended solutions flow charts in DMRB CG 501 Design of highway drainage systems (Table 3.5.1 and 3.5.2). The mainline carriageway generally is not kerbed. Likely solutions are outlined below.

4.3.2 In cuttings, the preferred verge design would be combined grass lined surface water channels and/or filter drains.

4.3.3 In sections with steep longitudinal gradients the grassed surface water channels may need to be either replaced with concrete or employ special details to counter erosion issues.

4.3.4 Where practicable, and it is economic do so, systems draining paved road surfaces would be kept separate from those intercepting groundwater and run-off from earthworks slopes.

4.3.5 This approach is necessarily adopted in wide verges in cuttings where rock trap walls are present, and carriageway drainage has been placed in front of the walls to minimise maintenance activities in proximity to potential falling rocks.

4.3.6 On embankments, the preferred verge design would be surface water channels.

4.3.7 Over the edge details may be an alternative for mainline embankments, subject to earthwork stability checks, and if it is considered allowable not to direct flows to a single outfall location to facilitate spillage containment.

4.3.8 Where kerbs are required, the surface water runoff would be drained via gully outlets or combined kerb and drainage units to carrier pipes.

4.3.9 The preferred central reserve detail for super elevated carriageways would be concrete surface water channel.

4.3.10 Where there are widened central reserves which are unpaved, there may be opportunities to employ filter strips and grass or hybrid grass/concrete surface water channels.

4.3.11 The design of the A417 mainline would include filter drains or narrow filter drains in the verges and in the central reserves of super elevated carriageways, to ensure performance and longevity of the road pavement and pavement foundations.

4.3.12 In cuttings filter carrier drains would also intercept slope drainage and serve a function lowering groundwater to ensure stability of the adjacent cutting.

## 4.4 Highway drainage collection – Local roads (GCC)

### General

4.4.1 For local roads that would be adopted by GCC the highway drainage in cuttings would typically comprise combined filter drains and grassed surface water channels. On shallow embankments the default would be over the edge drainage with swales or ditches.

4.4.2 The default approach for rural roads would be for there to be no kerbs. Where there are footways, in the vicinity of junctions and roundabouts, or if spillage containment is required, conventional gullies or combined kerb and drainage systems would typically be employed.

4.4.3 The outline proposals for certain roads are outlined below and would be refined at detailed design.

### Cold Slad Lane

4.4.4 A filter carrier drain (FCD) would drain and stabilise the slopes on the north side and would intercept flows from slope drainage measures.

4.4.5 The paved areas would be served by a grassed surface water channels (GSWC) or swales, providing local attenuation and storage (source control)

### A436 link road

4.4.6 On the low side of carriageway, a grassed surface water channel or swale would intercept highway runoff.

4.4.7 On the east side where a rock trap wall is employed, there would be separate drainage systems that drain the carriageway and rock slopes.

### Roundabouts and junctions

4.4.8 The roundabouts and junctions at Shab Hill, Ullenwood and Cowley would be predominantly served by kerb and gullies.

### B4070

4.4.9 The B4070 east of Barrow Wake would be wholly in cutting, so filter carrier drains and grassed surface water channels would be required to intercept runoff from the road and cutting slopes. Over the edge solutions, swales and informal dispersal would be proposed along the existing reused section of carriageway between Birdlip and at Barrow Wake, but this would be dependent on GCC and may require agreements with adjacent landowners. This section of road is currently served by kerb and gullies.

4.4.10 The existing section of highway under the Barrow Wake underbridge is served by soakaways with an overflow to the Barrow Wake car park. The scheme would include a storage tank to manage flows from the increase in paved areas, but it is anticipated that this could be wholly or partly substituted with soakaway solutions, once ground characteristics are confirmed.

## 4.5 Groundwater

4.5.1 In areas where the interception of groundwater impacts on springs or excessive groundwater is encountered, there would be separate systems put in place to maintain the springs and manage groundwater under the road infrastructure.

4.5.2 This would be the case where new highway embankments submerge watercourse and flow paths at valley bottoms, such as the tributary of Norman's Brook and the dry valley under Shab Hill junction.

## 4.6 Drainage basins

4.6.1 Where highway drainage discharges into suitable adjacent watercourses or dry valleys, run-off would be attenuated according to the principles outlined in section 4.2.

4.6.2 Discharge rates would be controlled by a flow device immediately downstream of each basin, with an overflow weir to convey the 100-year return period plus 40% climate change flow.

4.6.3 The details of flow controls will be developed at detailed design.

4.6.4 The proposed outfalls, green field run-off rates and estimated basin volumes are shown in Annex C, and ES Figure 3.19 Scheme Highway Drainage - Plan (Document Reference 6.3).

4.6.5 The volumes have been calculated on the precautionary assumption of no infiltration, but there would be an opportunity optimise basin sizes taking into account infiltration when further ground investigation (GI) data is available during the detailed design.

4.6.6 The volumes would be subject to change as the level of detail in the design develops and input parameters (infiltration rates, ground conditions) are validated by surveys and site tests.

4.6.7 Attenuation basins/infiltration basins would typically have a maximum storage depth of 1.5m with 0.3m freeboard to the top of the basin. Side slopes would be 1H:3V for maintenance with a localised ramp at 1H:5V for access and to allow mammal escape. The design will be in accordance with the requirements of DMRB CD 532 Vegetated drainage systems for highway runoff.

4.6.8 Detailed groundwater quality assessments will be undertaken at detailed design. Once completed, there is a possibility that attenuation/infiltration basins and highway drainage systems in some locations could require lining or other mitigations to prevent pollution of vulnerable groundwaters.

## 4.7 Cross drainage & watercourses

4.7.1 The scheme crosses several watercourses and dry valleys. Flows in these watercourses/dry valleys would be maintained within their catchment through culverts, wherever possible.

4.7.2 Dry valleys are natural features which may give rise to surface water flows in certain circumstances (e.g. during periods of exceptional rainfall and in the event of melting snow).

4.7.3 The scheme does not cross any EA designated main rivers.

4.7.4 Culverts would be designed in accordance with DMRB CD 529 Design of outfall and culvert details[10], and the requirements of the LLFA (GCC).

4.7.5 The proposed cross drainage culverts would be, as a minimum, sized to convey the 1 in 50-year event plus a 40% allowance for climate change. The 50 year design return period is appropriate for culverts which are servicing agricultural land of high value or isolated properties (CIRIA C786[10], chapter 10.1.2).

4.7.6 A sensitivity check has also been undertaken for the 1 in 100yr+40% cc event to ensure the safe management of exceedance flows and surface water flooding.

4.7.7 Allowance would be included in the cross sections for embedment and freeboard (CIRIA C786[10]).

4.7.8 Peak design flows have been estimated using the IH124 (Institute of Hydrology Report 124) and FEH (Flood Estimation Handbook) methods for rural catchments. For the Crickley Hill stream catchment this has been further validated with the RefH2 (Revitalised Flood Hydrograph) method and software.

4.7.9 The minimum diameter of culverts over 12m in length would be 1.2m in accordance with DMRB CD 529 Design of outfall and culvert details.

4.7.10 In addition to the main crossings and culverts there would be numerous minor culverts intercepting field drainage and conveying flows from cut-off ditches under tracks, public rights of way (PROW), field entrances and private accesses

4.7.11 Minor culverts under 12m in length may be smaller than 1.2m diameter and would be subject to an absolute minimum of 450mm diam.

4.7.12 Residual risks associated with the existing culvert near Crickley Hill Farm in exceedance and blockage events are discussed in section 5.2.

4.7.13 Table 4-1 summarises the principal proposed cross drainage culverts under the scheme mainline, and culverts conveying watercourses or dry valleys:

**Table 4-1 Principal culverts**

| Approximate chainage | Location | Type | Catchment area (Ha) | 1 in 100yr+cc flow ($m^3/s$) | Length (m) | Indicative Size height /diameter (m) |
|---|---|---|---|---|---|---|
| 0+530 | Existing culvert near Crickley Hill Farm (extension)* | Watercourse | 173* | 1.34* | 300 | 1.35 |
| 1+450 | Grove Farm culvert | Watercourse | 68 | 0.86 | 195 | 1.2 |
| 3+200 | Shab Hill culvert | Dry Valley | 83 | 1.02 | 290 | 1.2 |
| 4+775 | Stockwell culvert | Dry valley/land drainage | 13 | 0.16 | 160 | 1.2 |
| 5+220 | Cowley Junction culvert | Dry valley/land drainage | 8 | 0.10 | 320 | 1.2 |

* Note: the catchment area and peak flow of the existing culvert near Crickley Hill Farm is reported at a point on the north side of the A417 at Dog Lane.

## 4.8 Earthworks drainage

4.8.1 The design would include filter drains or other features at the toes of new cuttings and embankments to lower groundwater, intercept surface water run-off and ensure stability of the earthworks.

4.8.2 Similar provisions would also made for existing slopes, where necessary, to ensure the stability of the slopes and to intercept new geotechnical drainage features (counterfort drains etc).

## 4.9 Land drainage

4.9.1 Where adjacent land falls towards the new road cuttings and embankments the design would include perimeter ditches to intercept overland flows and field drainage systems, and to convey these flows to the nearest cross drainage culvert or watercourse. The design drawings indicate ditches, but the perimeter drainage may take the form of swales or filter drains, depending on local drainage flows, landscape context and the intended land use.

4.9.2 Perimeter drainage would be sized for 1 in 100-year storm plus 40% climate change (DMRB CD 522 Drainage of runoff from natural catchments, Cl 5.1).

4.9.3 Perimeter ditches provided at the top of cuttings to intercept overland flow may require lining where the adjacent slope is sensitive to concentrated ingress of water.

4.9.4 Perimeter drainage would be offset by a suitable distance to ensure stability of the adjacent earthwork.

4.9.5 Ditches with steep longitudinal gradients would include rock dams and or linings to reduce flow velocities, manage erosion and fulfil surface water management objectives.

4.9.6 Where the perimeter ditch traverses the escarpment near Grove Farm and the existing A417 Birdlip Hill cutting near Emma's Grove, cascades would be provided to manage velocities and dissipate kinetic energy.

4.9.7 If the natural topography falls away from the road corridor, cut off ditches would not generally be provided at the toe of earthworks, other than if required to mitigate local flooding risk, or for slope stability reasons.

## 4.10 Impacts on catchments

4.10.1 Although the design attempts, wherever possible, to maintain existing catchments and not interfere with existing flow paths, due to the presence of significant new earthworks cuttings, some redistribution of catchments would be unavoidable.

4.10.2 Surface water from land south-west of the scheme's cutting between the Air Balloon roundabout and Shab Hill junction currently flows to the River Churn catchment via dry valleys at Leckhampton Hill and Ullenwood, which converge at the National Star College (NSC) golf course.

4.10.3 As a result of the scheme there would be a net increase of up to 23 ha in the catchment area to the tributary of Norman's Brook and a corresponding reduction in the catchment area to the River Churn.

4.10.4 This includes 16ha of hillside at Emma's Grove which based on most sources is part of the tributary of Norman's Brook catchment – see ES Figure 13.3 WFD Surface Waterbodies (Document Reference 6.3). However, hydraulic analysis of overland flow paths has indicated that run-off from this area is intercepted by the existing A417 Birdlip Hill cutting and is collected in the highway drainage systems.

4.10.5 These systems rely partially upon infiltration, but flow to a terminal soakaway at the Cricket Club north of the existing Air Balloon roundabout. Analysis of flow paths indicates that in exceedance events the overland flow routes are also north west to the soakaway and hence towards Leckhampton Hill and the National Star College golf course.

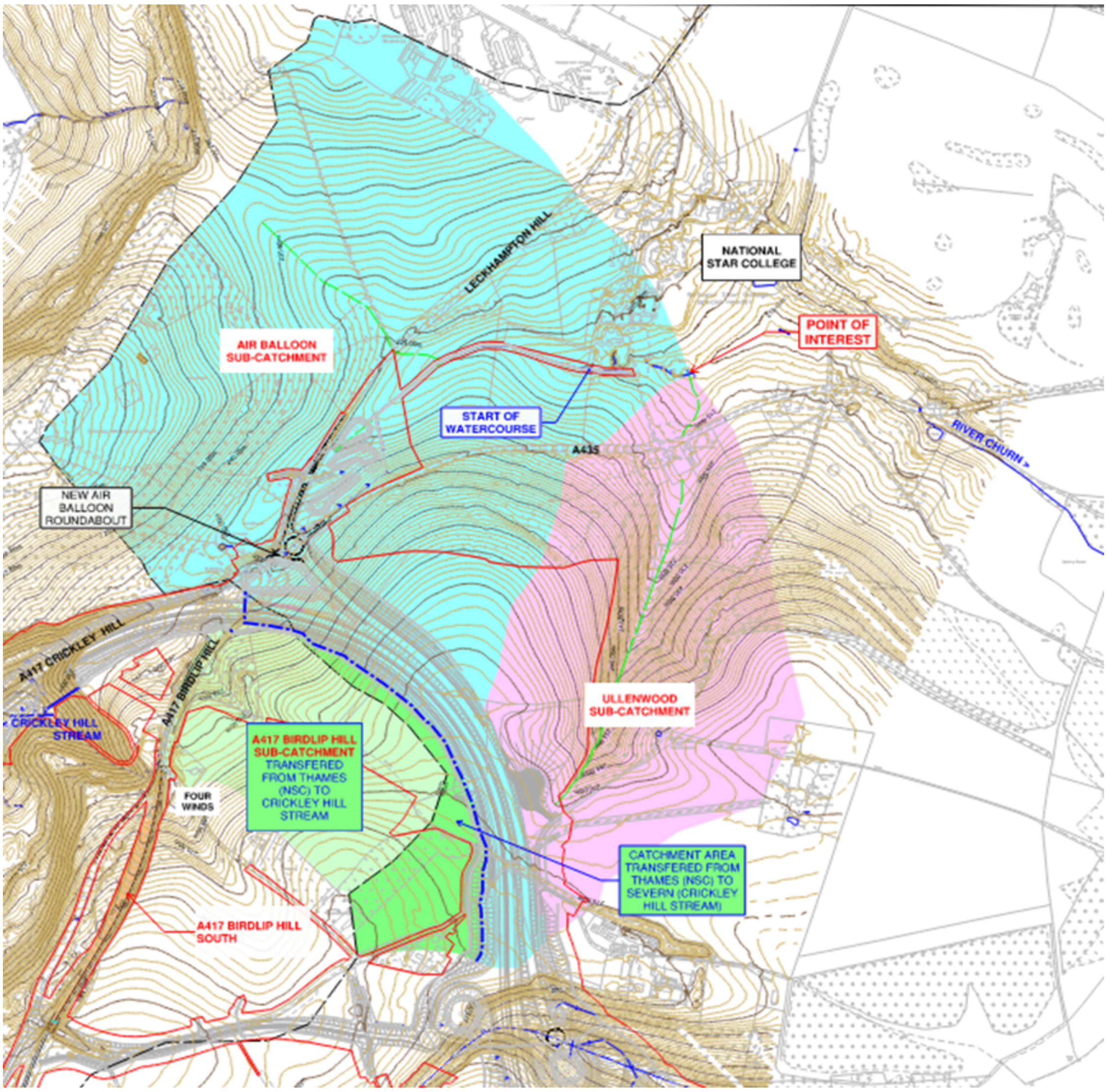
4.10.6 The scheme would return the catchments to a situation closer to the natural delineation that existed before the A417 Birdlip Bypass scheme was constructed (1987), and closer to existing catchment mapping as shown on ES Figure 13.3 WFD Surface Waterbodies (Document Reference 6.3).

4.10.7 The impacts of the scheme on flows arriving at the tributary of Norman's Brook would be mitigated by:

- The removal of paved areas within the catchment along the old A417 Birdlip Hill cutting between the Air Balloon and Barrow Wake.
- The introduction of natural flood management measures (infiltration and storage) within the old A417 Birdlip Hill cutting.
- The provision of attenuation storage within the perimeter land drainage ditches along the south side of the Crickley Hill cutting.
- The removal of paved areas from the former A417 Crickley Hill between Bentham Lane and the Air Balloon roundabout, and their replacement with new highway drainage systems attenuated to greenfield run off rates.

## Table 4-2 Impact on existing catchments

| | River Churn (a) Air Balloon/ Leckhampton Hill sub-catchment | River Churn (b) Ullenwood sub-catchment | Tributary of Norman's Brook |
|---|---|---|---|
| Point on catchment | Unnamed watercourse NSC Golf Course | Unnamed watercourse NSC Golf Course | Tributary of Norman's Brook downstream of the scheme's basin no 3c at Grove Farm |
| Existing catchment area (baseline) | 108 ha | 49 ha | 61ha |
| Post development catchment area | 94 ha | 39 ha | 84ha |
| Catchment redistribution vs baseline | -13.6 ha | -9.7 ha | +23 ha |
| Catchment redistribution vs pre 1987 (A417 Birdlip Bypass scheme) | -7ha | | +7ha |




## Figure 4-1 Impact on existing catchments

## 4.11 Changes to existing A417

4.11.1 The existing A417 highway drainage outfalls between Witcombe Court underbridge and the Air Balloon roundabout would be removed by the scheme.

4.11.2 Between the Air Balloon roundabout and the Cowley Lane junction near Stockwell, the existing A417 highway pavement would be largely removed and the land reinstated as a green corridor/ walking cycling and horse-riding (WHCR) route.

4.11.3 Between Cowley Lane junction near Stockwell and Cowley junction, the highway would be retained but transferred from Highways England to GCC.

4.11.4 The majority of these carriageways currently discharge highway run-off to watercourses or groundwaters with no treatment or spillage control.

4.11.5 Between Air Balloon and Stockwell there would be benefits to water quality due to the complete removal of highway run-off.

4.11.6 Between Stockwell and Cowley junction there would be benefits due to the reduced traffic and pollution loads.

## 4.12 Exceedance routes[11]

4.12.1 In the extreme rainfall events when the capacity of drainage systems is exceeded (typically 1 in 5 year events for piped highway drainage systems) the design would ensure that flow paths to the basins are maintained, up to the 1 in 100year event plus climate change.

4.12.2 In most locations the proposed ground morphology ensures that exceedance flows would be directed to the basins. However, in some locations additional measures would be required.

4.12.3 For the networks associated with basins 9,10 and 11, overflow flood culverts would be provided through the landscape bunds to create an exceedance event flow route.

4.12.4 At basin 2 the terminal pipe from the highway drainage network to the basin would be sized to convey the 1 in 100-year event plus climate change flow.

4.12.5 See Section 5 for details of the management of exceedance routes at the existing culvert near Crickley Hill Farm.

# 5 Tributary of Norman's Brook

## 5.1 Realignment of the tributary of Norman's Brook

5.1.1 The widening of the A417 embankment west of the escarpment would introduce an earthwork into the bottom of the existing valley at Crickley Hill, which would submerge the existing stream. This would require a realignment of the stream on the south side of the new A417 embankment between Grove Farm and the existing culvert near Crickley Hill Farm.

5.1.2 The scheme would also require the existing culvert near Crickley Hill Farm to be replaced and extended under the raised and widened A417 embankment.

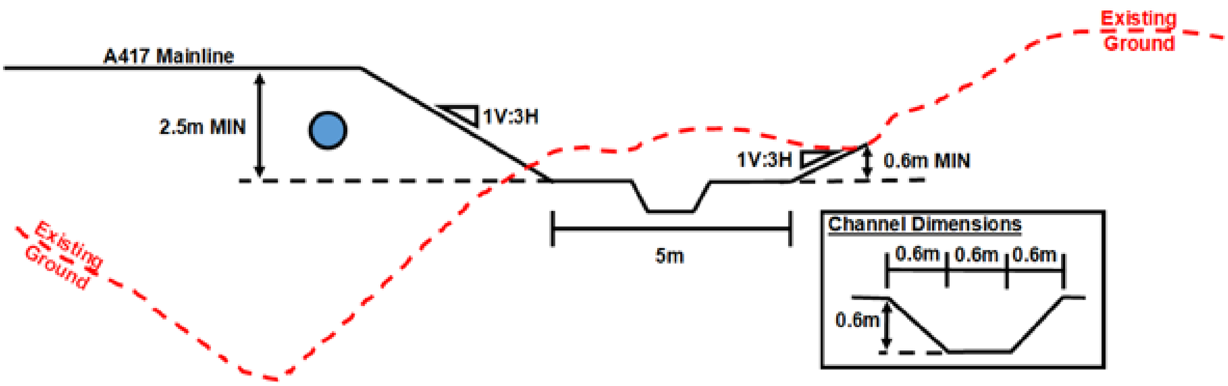



**Figure 5-1 Tributary of Norman's Brook - cross section**

5.1.3 The watercourse realignment would comprise a 5m wide earthwork platform, within which there will be a smaller irregular, meandering channel to convey the habitual flows in the watercourse.

5.1.4 The platform would be a minimum depth of 2.5m below the A417 mainline verge level to minimise ingress from the watercourse into the highways drainage system, although the road embankment would be up to 10m high in this area. On the southern side the platform would be a minimum depth of 0.6m below the existing ground, to provide capacity when the flow surcharges out of channel during extreme rainfall events.

5.1.5 The channel within the platform has been simplistically represented as 0.6m deep with a 1 in 1 side slope and a 0.6m base. The location and form of the central channel in the earthworks model is indicative, and this would be meandered and naturalised within the 5m wide platform.

5.1.6 The 5m wide platform (flood channel) would be designed to contain the 1 in 100yr plus climate change flow.

5.1.7 The resultant vertical alignment of the stream would be irregular but the overall gradient between Grove Farm and the culvert headwall at Crickley Hill Farm would be approximately 7%, which is similar to the existing.

5.1.8 The scheme would aim to replicate the character and geomorphology of a typical upland stream, and there would be space within the 5m wide platform to accommodate natural flood management and features such as step pools, cascades, informal steps and irregular meanders.

5.1.9 Where these features or structures have a function to manage flood risk and run-off from the reconfigured upstream catchments, they may be designated by the LLFA (GCC) under the FWMA (Flood and Water Management Act).

5.1.10 The realigned stream would minimise the introduction of new culverted sections, wherever possible.

5.1.11 The environmental impacts on the watercourse are assessed and reported in ES Chapter 13 Road drainage and the water environment (Document Reference 6.2) and ES Appendix 13.5 Hydromorphology Assessment (Document Reference 6.4).

## 5.2 Culvert near Crickley Hill Farm.

5.2.1 Hydraulic analysis of the existing culvert near Crickley Hill Farm has provided estimates of the peak flow thresholds for various events:

**Table 5-1 Thresholds - culvert near Crickley Hill Farm**

| Event | Flow (l/s) | Correlation to Storm Return Period (345 min Winter Storm)<br>Peak flow at upstream headwall* |
|---|---|---|
| First flooding at Dog Lane (Holly Brae) | 370 | 1 in 1yr peak flow approx. 233 l/s<br>1 in 5yr peak flow approx. 564 l/s |
| First flooding at MH south side of A417 | 1280 | 1 in 100yr peak flow approx. 1100 l/s |
| Surcharge at culvert headwall (near Crickley Hill Farm) | 1330 | 1 in 100yr+cc peak flow approx. 1365 l/s |

*These peak flow values don't take account of flows entering the culvert on the north side of the A417 from Dog Lane.

5.2.2 The existing culvert can convey in bore a flow corresponding to a storm with a return period of approximately one to two years. Beyond this threshold the watercourse floods out of the manholes in Dog Lane on the north side of the A417, near Holly Brae.

5.2.3 The exceedance flow route in these events is west along Dog Lane and then south along Bentham Lane/Cirencester Road under the A417 at Witcombe Court underbridge and towards Little Witcombe. Flood flows may also cut the corner south west through the field west of Holly Brae.

5.2.4 It is estimated that the 1 in 100yr return period event can be conveyed through the upper sections of the culvert between Crickley Hill Farm and Dog Lane.

5.2.5 At rainfall events beyond the 1 in 100yr return period when the capacity in the upper section is exceeded, or if the culvert headwall becomes blocked, flooding can occur at the headwall and manholes on the southern side of the existing A417.

5.2.6 The overland flow routes for these exceedance events are west along the concrete access track serving the Crickley Hill Farm along the south side of the existing A417 and then to Cirencester Road.

5.2.7 Modelling indicates ambiguity about these flow paths, and it is possible that a proportion of this overland flow on the south side of the existing A417 may bifurcate south towards Green Lane.

5.2.8 To meet current design standards the design would replace the existing 600mm diameter pipe with a new culvert which is 1.35m minimum diameter/height.

5.2.9 To maintain the existing balance of flood risk on either side of the A417, the scheme would include overflows at the culvert headwall and manholes on the south side of the A417.

5.2.10 The weirs and overflows would be designed to ensure that the modified culvert replicates the hydraulic performance of the existing culvert.

There is a degree of residual risk associated with the modelling due to the incomplete information about the existing culvert and the existing highway drainage systems in the upstream catchments.

# 6 Water quality

6.1.1 Assessments of the scheme road drainage have been undertaken in accordance with DMRB LA 113 and the Highways England Water Risk Assessment Tool (HEWRAT).

6.1.2 Reference is made to the Memorandum of Understanding between the Environment Agency and the Highways Agency Annex 1 - Water Environment, March 2011[12] and the England National Application Annex to DMRB LA 113, E/1.3:

*"NOTE: The Environment Agency has approved the method of assessment used by HEWRAT and has agreed that the outputs from the tool can be used when undertaking an assessment of potential impacts of surface water quality"*

6.1.3 Each highway drainage catchment and outfall has been assessed using the HEWRAT methodology in DMRB LA 113, to ensure water quality characteristics and spillage risk are within acceptable limits, taking in to account the sensitivity and (WFD) status of the receiving groundwaters and watercourses. This has resulted in additional treatment measures being included in the highway drainage design.

6.1.4 The highway drainage design would include measures to manage the quality of run-off to surface and ground water bodies, including swales, grass channels, treatment strips, filter drains, soakaways, infiltration basins and settlement basins.

**Water quality assessment**

6.1.5 ES Appendix 13.4 Water Quality Assessment (Document Reference 6.4) reports the assessment of pollution impacts from routine run-off on surface water and groundwater.

**Surface water quality assessment**

6.1.6 All outfalls passed the surface water sediment assessment, but a number failed the Step 2 soluble pollutant assessment.

6.1.7 DMRB CG 501 Design of highway drainage systems outlines indicative treatment efficiencies of different pollution removal techniques, and this concludes that a treatment train of two or more pollution removal measures is adequate to meet the requirements of the HEWRAT assessment in most locations.

6.1.8 All networks on the scheme include at least two levels of treatment comprising a basin (pond) along with at least one other measure. The assessment indicates that an additional level of treatment is required for the networks connecting to basins 2, 3a and 3c.

6.1.9 Additional mitigation (treatment) is therefore included within the drainage design to reduce the soluble pollutant load, and for this stage this would be provided in the form of a forebay within the basins.

6.1.10 The exact type and configuration of the basins would depend heavily on the specific ground conditions (suitability for infiltration) at each location and the preferred maintenance regime of the adopting body (Highways England or GCC).

6.1.11 This surface water quality assessment is based on a precautionary assumption that no infiltration would take place within the drainage systems and at the basins. When ground investigation data is available and the detailed groundwater quality assessments are completed at detailed design, there would be opportunities to introduce infiltration techniques and optimise the basin designs. Infiltration would also significantly improve the pollutant removal performance of the highway drainage systems.

6.1.12 The new highway drainage outfalls would not be provided with Oil Interceptors. This is consistent with both DMRB (CG 501 Design of highway drainage systems clause 8.7) for Highways England roads, and GCC's preferred maintenance practices for local roads.

**Groundwater quality assessment**

6.1.13 A simple assessment has been undertaken following the procedures set out in Appendix C of DMRB LA 113. This is reported in ES Appendix 13.4 Water Quality Assessment (Document Reference 6.4), which identifies that there would be a medium risk of impact and that a detailed assessment should be undertaken.

6.1.14 The monitoring and baseline data required to inform a detailed groundwater assessment has not been undertaken. The site-specific information required to complete these assessments, such as local infiltration rate through the ground and ground conditions specific to the basin locations, would be undertaken to inform the detailed design. Baseline groundwater level and quality monitoring will continue and would inform these assessments.

6.1.15 The specific mitigation measures required in the design of drainage systems and basins would therefore be refined at detailed design. This could include measures to separate carriageway drainage systems from groundwater, the lining of basins, and limitations on the disposal of surface water through infiltration.

6.1.16 The western boundary of the scheme overlaps with a Source Protection Zone 3 (SPZ 3), but this does not place any limitations on the drainage design.

**Accidental spillage**

6.1.17 Accidental spillages risk is assessed in accordance with Appendix D of DMRB LA 113 and reported in ES Appendix 13.6 Spillage Risk Assessment (Document Reference 6.4). This concludes that the risk is acceptable without mitigation measures.

Notwithstanding the results of the assessment, in accordance with good practice, it is proposed that carriageway outfalls from the A417 mainline, slip lanes (Highways

England) and junctions with the A417 (GCC) would be served by shut-off valves. This may also be extended to selected local roads with high traffic flows (such as the A436), if it is required by GCC. It is noted that isolation valves depend on dedicated points of discharge and this is less practicable for over the edge and SuDS solutions, that rely on diffused disposal of run-off.

# 7 Access and maintenance

7.1.1 The proposed A417 mainline and junction slip road drainage would be adopted and maintained by Highways England. All other highway drainage would be adopted by GCC.

7.1.2 Vehicular maintenance access would be provided to the Highways England and GCC basins.

7.1.3 Wherever possible, for the Highways England basins, this would be via local roads and the use of third-party tracks, rather than from the A417 mainline carriageway.

7.1.4 New tracks would typically be 2-3m wide (including room for turning where necessary) and constructed from unbound material.

7.1.5 GCC maintained basins and outfalls may be accessed either via dedicated accesses or laybys off the adjacent public highway.

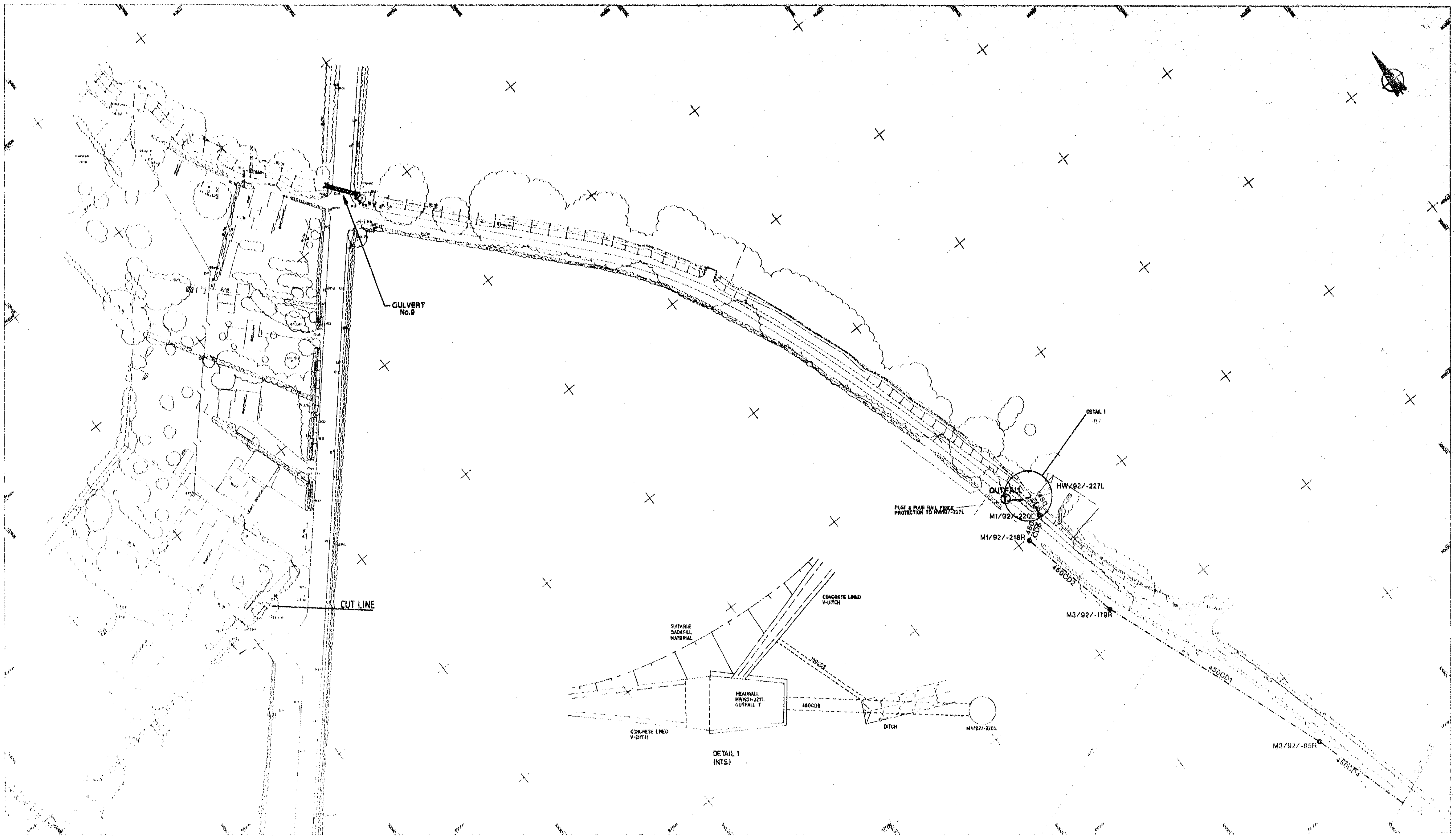
7.1.6 GCC have published a SuDS Design & Maintenance Guide[13] which outlines maintenance regimes for sustainable drainage assets including basins and ponds.

# References

[1] A417 Cowley to Brockworth Bypass Improvement, Drainage Strategy Report, WSP for Highways England, Jan 2005
[2] A417 Missing Link Drainage Strategy Report, MMSJV for Highway England, PCF Stage 2, March 2019
[3] A417 Normans Brook Tracer Test (HE551505-MMSJV-EWE-000-RP-LX-00003), MMSJV for Highways England, PCF Stage 2, 22 March 2019
[4] Environment Agency, Risk of Surface Water Flooding Maps: https://flood-warning-information.service.gov.uk/long-term-flood-risk/map
[5] DMRB – Design Manual for Roads and Bridges, Highways England https://www.standardsforhighways.co.uk/dmrb/
[6] UK Government, Flood risk assessments: climate change allowances, March 2020: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances
[7] Gloucestershire County Council (Lead Local Flood Authority): Standing Advice and Development Guidance, March 2015; and FRA Guidance for Surface Water in all developments, March 2015: https://www.gloucestershire.gov.uk/planning-and-environment/flood-risk-management/surface-water-drainage-and-major-planning-applications/
[8] UK Government, Non-statutory technical standards for sustainable drainage systems, March 2015, Defra: https://www.gov.uk/government/publications/sustainable-drainage-systems-non-statutory-technical-standards
[9] CIRIA Report C753, 2015 - SuDS Manual
[10] CIRIA Report C786, 2020 – Culvert, Screen and Outfall Manual
[11] CIRIA Report C635, 2006 - Designing for Exceedance in Urban Drainage
[12] Memorandum of Understanding between the Environment Agency and the Highways Agency - Annex 1 Water Environment: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/341286/MoU_HA_and_EA_ANNEX_1_Water_latest_version_March_2011.pdf
[13] Gloucestershire County Council SuDS Design & Maintenance Guide, Nov 2015: https://www.gloucestershire.gov.uk/planning-and-environment/flood-risk-management/surface-water-drainage-and-major-planning-applications/

# Annexes

# Annex A Highway Drainage Records




KEY

| LINETYPE | TYPICAL IDENTIFIER | DESCRIPTION | DRAWING No. | APPENDIX No. |
|---|---|---|---|---|
| | 525CD8 | Carrier Drain | H.C.D. F1 | A5/1/1 & A5/1/3 |
| | 600FC11 | Filter Carrier | H.C.D. F2 | A5/1/2 & A5/1/3 |
| | N/A | Fin or Narrow Filter Drain | H.C.D. B8 (Type10),9107/05/114 | A5/4/1 |
| | SL150 | Starter Layer Drain | 9107/05/102,103 | A5/1/8 |
| | N/A | Slope Drain Collector | 9107/05/113 | A5/4/2 |
| | FG150 | Fan Gravel Cut-off Drain | 9107/05/109 | A5/1/7 |
| | N/A | Combined Drainage & Kerb System | N/A | A5/5 |
| | SW1200 | Surface Water Channel including Fin or Narrow Filter Drain | H.C.D. B2,B3,B6,B7, B11,B12,B14 | A5/3 & A5/4/1 |
| | N/A | Channel Block B including Fin or Narrow Filter Drain | H.C.D. B4 | A5/3 & A5/4/1 |
| | N/A | Culvert | (See Appendix A1/10) | A1/10 |

| SYMBOL | TYPICAL IDENTIFIER | DESCRIPTION | DRAWING No. | APPENDIX No. |
|---|---|---|---|---|
| | MX/22/93L | Existing Manhole | N/A | A5/1/4 |
| | M3/05/5040L | Manhole | H.C.D. F3,F4,F5,F6 | A5/1/4 |
| | C8/05/5155RO | Catchpit | H.C.D. F12,9107/05/115 | A5/1/4 |
| | G4E | Gully and Apron for Surface Water Channels | 9107/05/101,102,103,104, 105,106,117,118 119,120,121,122 | A5/1/5 |
| | N/A | Gully Type G1 | H.C.D. F13 | A5/1/5 |
| | N/A | Gully Type G2 | 9107/05/100 | A5/1/5 |
| | HW/05/5044LO | Headwall or Outfall | 9107/05/110,111,112,123 | A5/1/4 |
| | SW1200 SW1300 | Surface Water Channel Transition | 9107/05/107 | A5/3 |
| | N/A | Drainage Grip | 9107/05/108 | N/A |
| | | Measurement Boundary | N/A | N/A |

Notes

1. For details of drainage to structures see relevant bridgeworks miscellaneous drawing.
2. This drawing is to be used in conjunction with the relevant Appendices and Drawings referred to in the Key.
3. For location of Slope Drains see Drawing numbers 9107/05/1 to 10 inclusive and details shown on 9107/05/105.

ORIGINAL SCALE 1:500

THE DEPARTMENT OF TRANSPORT
SOUTH WEST CONSTRUCTION PROGRAMME DIVISION

FRANK GRAHAM CONSULTING ENGINEERS

Z AS BUILT checked by M C Jones

AMENDMENT DETAILS

# A417 BROCKWORTH BYPASS

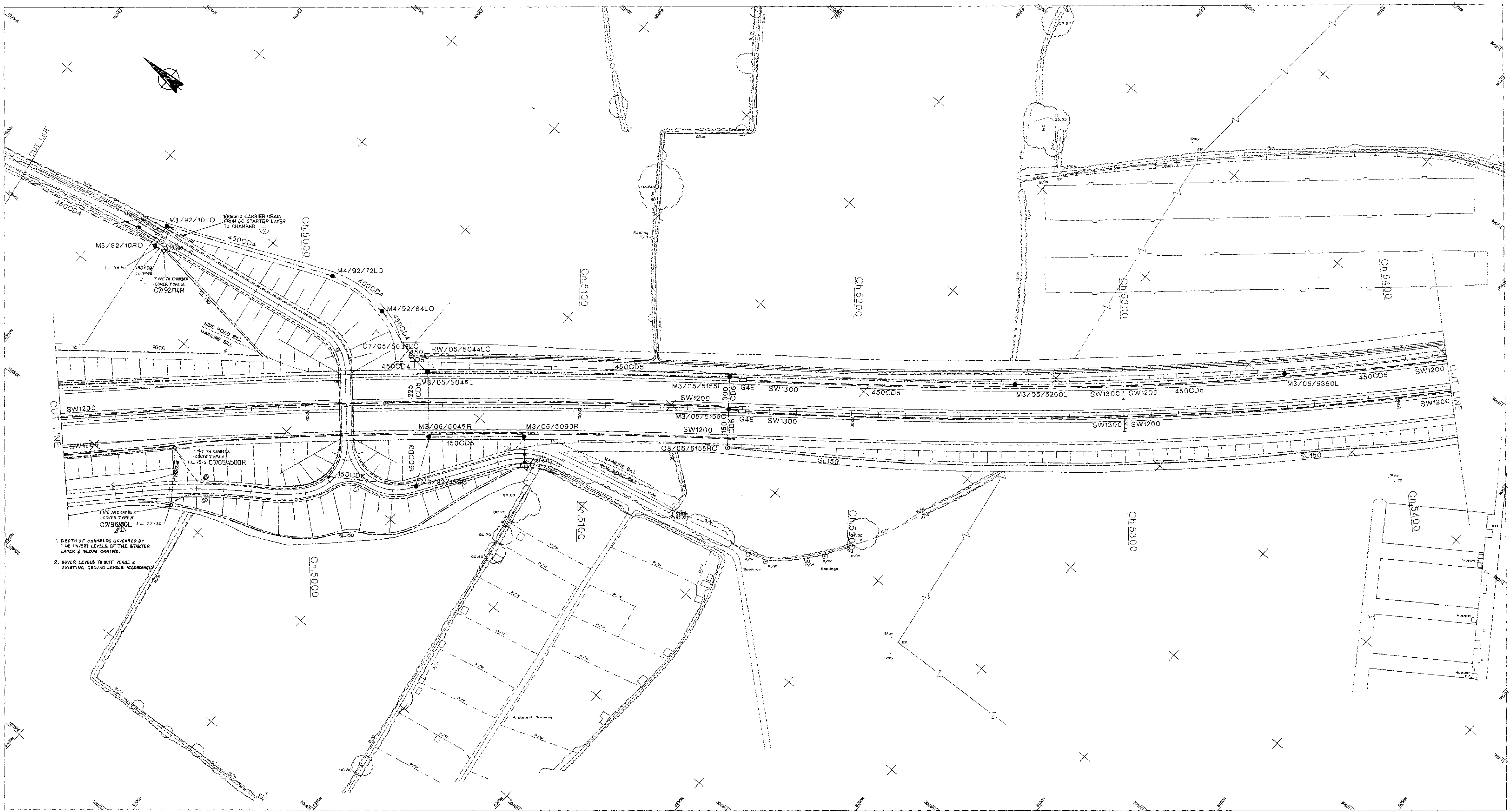
# DRAINAGE DETAILS OUTFALL T - OLD COACH ROAD

| DRAWN | DATE |
|---|---|
| N.T.C. | 5/93 |
| CHECKED Ae. | 6/93 |
| APPROVED H.G.I. | 5.93 |

9/1/37

C 9107/05/17 Z

DRAWING No. 9107/05/9

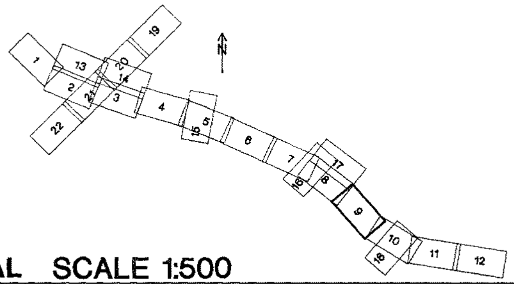



| KEY LINETYPE | TYPICAL IDENTIFIER | DESCRIPTION | DRAWING No. | APPENDIX No. |
|---|---|---|---|---|
| | 525CD6 | Carrier Drain | H.C.D. F1 | A5/1/1 & A5/1/3 |
| | 600FC11 | Filter Carrier | H.C.D. F2 | A5/1/2 & A5/1/3 |
| | N/A | Fin or Narrow Filter Drain | H.C.D. B8 (Type16),9107/05/114 | A5/4/1 |
| | SL150 | Starter Layer Drain | 9107/06/102,103 | A5/1/6 |
| | N/A | Slope Drain Collector | 9107/05/113 | A5/4/2 |
| | FG150 | Fan Gravel Cut-off Drain | 9107/05/109 | A5/1/7 |
| | N/A | Combined Drainage & Kerb System | N/A | A5/5 |
| | SW1200 | Surface Water Channel including Fin or Narrow Filter Drain | H.C.D. B2,B3,B6,B7, B11,B12,B14 | A5/3 & A5/4/1 |
| | N/A | Channel Block B including Fin or Narrow Filter Drain | H.C.D. B4 | A5/3 & A5/4/1 |
| | N/A | Culvert | (See Appendix A1/10) | A1/10 |

| SYMBOL | TYPICAL IDENTIFIER | DESCRIPTION | DRAWING No. | APPENDIX No. |
|---|---|---|---|---|
| ○ | MX/22/93L | Existing Manhole | N/A | A5/1/4 |
| ● | M3/05/5040L | Manhole | H.C.D. F3,F4,F5,F6 | A5/1/4 |
| ⊙ | C8/05/5155RO | Catchpit | H.C.D. F12,9107/05/115 | A5/1/4 |
| ▭ | G4E | Gully and Apron for Surface Water Channels | 9107/05/101,102,103,104, 105,106,117,118,119,120,121,122 | A5/1/5 |
| | N/A | Gully Type G1 | H.C.D. F13 | A5/1/5 |
| | N/A | Gully Type G2 | 9107/05/100 | A5/1/5 |
| | HW/05/5044LO | Headwall or Outfall | 9107/05/110,111,112,123 | A5/1/4 |
| | SW1200 SW1300 | Surface Water Channel Transition | 9107/05/107 | A5/3 |
| | N/A | Drainage Grip | 9107/05/108 | N/A |
| | MAINLINE BILL INTERCHANGE BILL | Measurement Boundary | N/A | N/A |

Notes

1. For details of drainage to structures see relevant bridgeworks miscellaneous drawing.
2. This drawing is to be used in conjunction with the relevant Appendices and Drawings referred to in the Key.
3. For location of Slope Drains see Drawing numbers 9107/06/1 to 10 inclusive and details shown on 9107/06/106.



ORIGINAL SCALE 1:500

THE DEPARTMENT OF TRANSPORT

SOUTH WEST CONSTRUCTION PROGRAMME DIVISION

FRANK GRAHAM CONSULTING ENGINEERS

| No. | AMENDMENT DETAILS | | | DATE |
|---|---|---|---|---|
| Z | AS BUILT checked by M C Jones | | MY | OCT 97 |
| C | SIR 098 FG150 o/s 2.9 m FROM TOP OF EMBANKMENT Ch.4910-4990 M009. SIR 375 100 mm Ø CD FROM STARTER LAYER TO M3/92/10 LO. SIR 425 2 No. GULLIES REPOSITIONED Ch.0 M092. | | | FEB 96 |
| B | SIR.106 M3/05/5040L & M3/05/5040R & DRAIN RUNS MOVED 5m UPCHAINAGE, C7/05/5037LO MOVED 2m UPCHAINAGE. SIR 365 FILTER DRAINS ADDED TO APPROACHES ON OLD COACH ROAD BRIDGE. | | | MAR 95 |
| A | 2x SLOPE DRAINS, 3x TYPE 7A CHAMBERS, 2x CARRIER DRAINS & NOTES 1 & 2 ADDED | | ST | 8-94 |

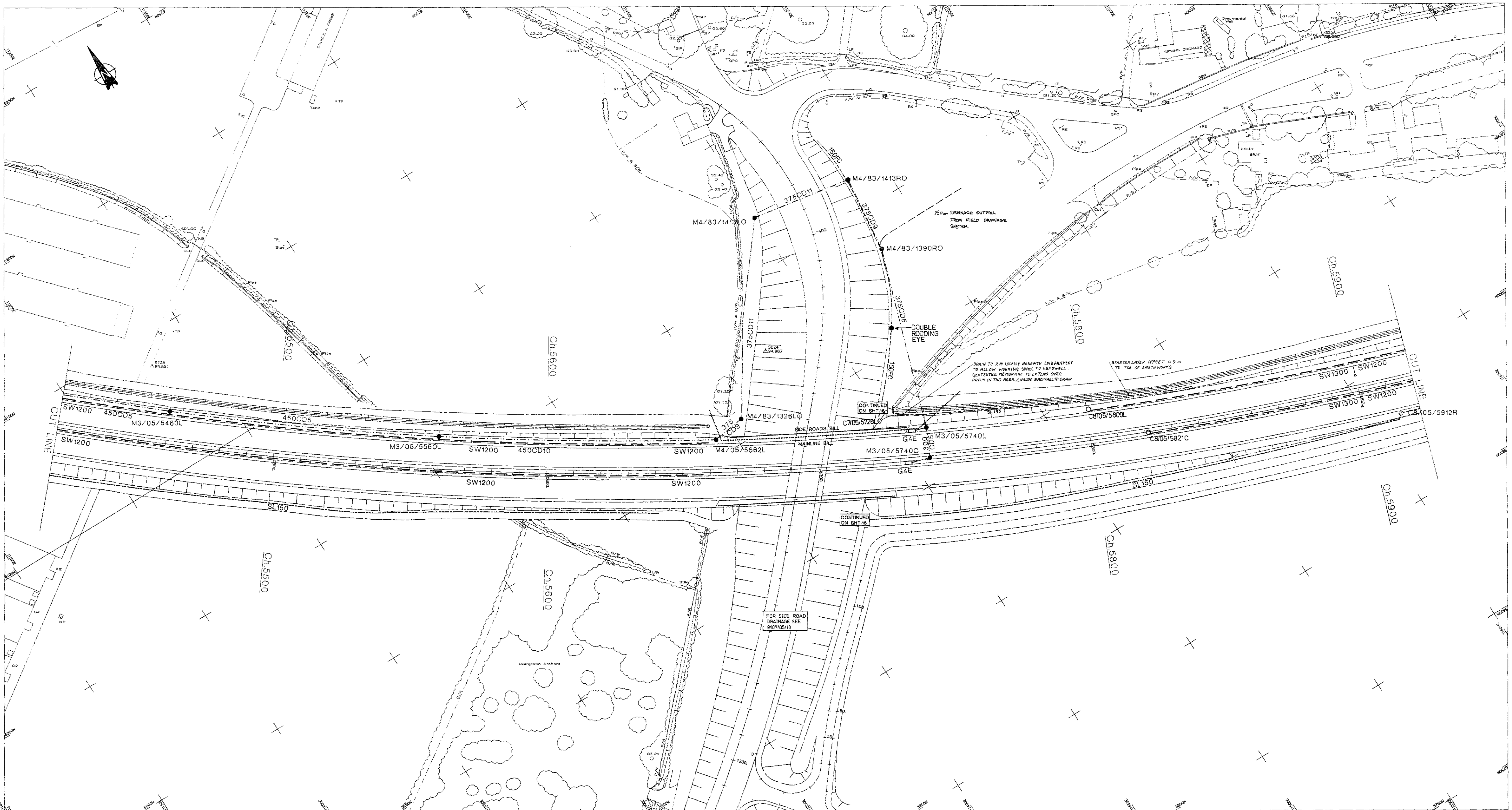
A417 BROCKWORTH BYPASS

DRAINAGE DETAILS
CHAINAGE 4910m TO 5420m

| ORIGINAL DRG. SIZE 841 x 1189 (A0) | DRAWN N.T.C. | DATE 5/93 | DOC SHEET No. 9/1/29 |
|---|---|---|---|
| | CHECKED A.E. | DATE 5.93 | DRAWING No. C 9107/05/9Z. |
| | APPROVED M.G.L. | DATE 5.93 | |

9107/05/10

DRAWING No.

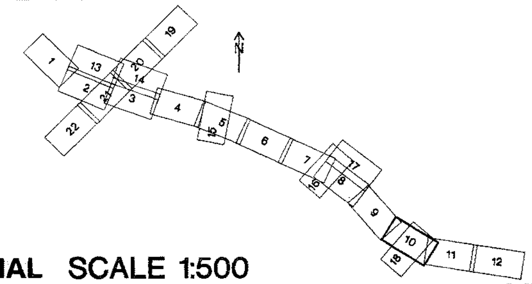



| KEY LINETYPE | TYPICAL IDENTIFIER | DESCRIPTION | DRAWING No. | APPENDIX No. |
|---|---|---|---|---|
| | 525CD6 | Carrier Drain | H.C.D. F1 | A5/1/1 & A5/1/3 |
| | 600FC11 | Filter Carrier | H.C.D. F2 | A5/1/2 & A5/1/3 |
| | N/A | Fin or Narrow Filter Drain | H.C.D. B8 (Type16),9107/05/114 | A5/4/1 |
| | SL150 | Starter Layer Drain | 9107/06/102,103 | A5/1/6 |
| | N/A | Slope Drain Collector | 9107/05/113 | A5/4/2 |
| | FG150 | Fan Gravel Cut-off Drain | 9107/05/109 | A5/1/7 |
| | N/A | Combined Drainage & Kerb System | N/A | A5/5 |
| | SW1200 | Surface Water Channel Including Fin or Narrow Filter Drain | H.C.D. B2,B3,B6,B7, B11,B12,B14 | A5/3 & A5/4/1 |
| | N/A | Channel Block B including Fin or Narrow Filter Drain | H.C.D. B4 | A5/3 & A5/4/1 |
| | N/A | Culvert | (See Appendix A1/10) | A1/10 |

| SYMBOL | TYPICAL IDENTIFIER | DESCRIPTION | DRAWING No. | APPENDIX No. |
|---|---|---|---|---|
| ○ | MX/22/93L | Existing Manhole | N/A | A5/1/4 |
| ● | M3/05/5040L | Manhole | H.C.D. F3,F4,F5,F6 | A5/1/4 |
| ⊙ | C8/05/5155RO | Catchpit | H.C.D. F12,9107/05/115 | A5/1/4 |
| ▭ | G4E | Gully and Apron for Surface Water Channels | 9107/05/101,102,103,104, 105,106,117,118,119,120,121,122 | A5/1/5 |
| ▪ | N/A | Gully Type G1 | H.C.D. F13 | A5/1/5 |
| ⊠ | N/A | Gully Type G2 | 9107/05/100 | A5/1/5 |
| ) | HW/05/5044LO | Headwall or Outfall | 9107/05/110,111,112,123 | A5/1/4 |
| | SW1200 SW1300 | Surface Water Channel Transition | 9107/05/107 | A5/3 |
| \ | N/A | Drainage Grip | 9107/05/108 | N/A |
| | MAINLINE BILL INTERCHANGE BILL | Measurement Boundary | N/A | N/A |

Notes

1. For details of drainage to structures see relevant bridgeworks miscellaneous drawing.
2. This drawing is to be used in conjunction with the relevant Appendices and Drawings referred to in the Key.
3. For location of Slope Drains see Drawing numbers 9107/06/1 to 10 inclusive and details shown on 9107/06/106.




**ORIGINAL SCALE 1:500**

THE DEPARTMENT OF TRANSPORT
SOUTH WEST CONSTRUCTION PROGRAMME DIVISION

FRANK GRAHAM CONSULTING ENGINEERS

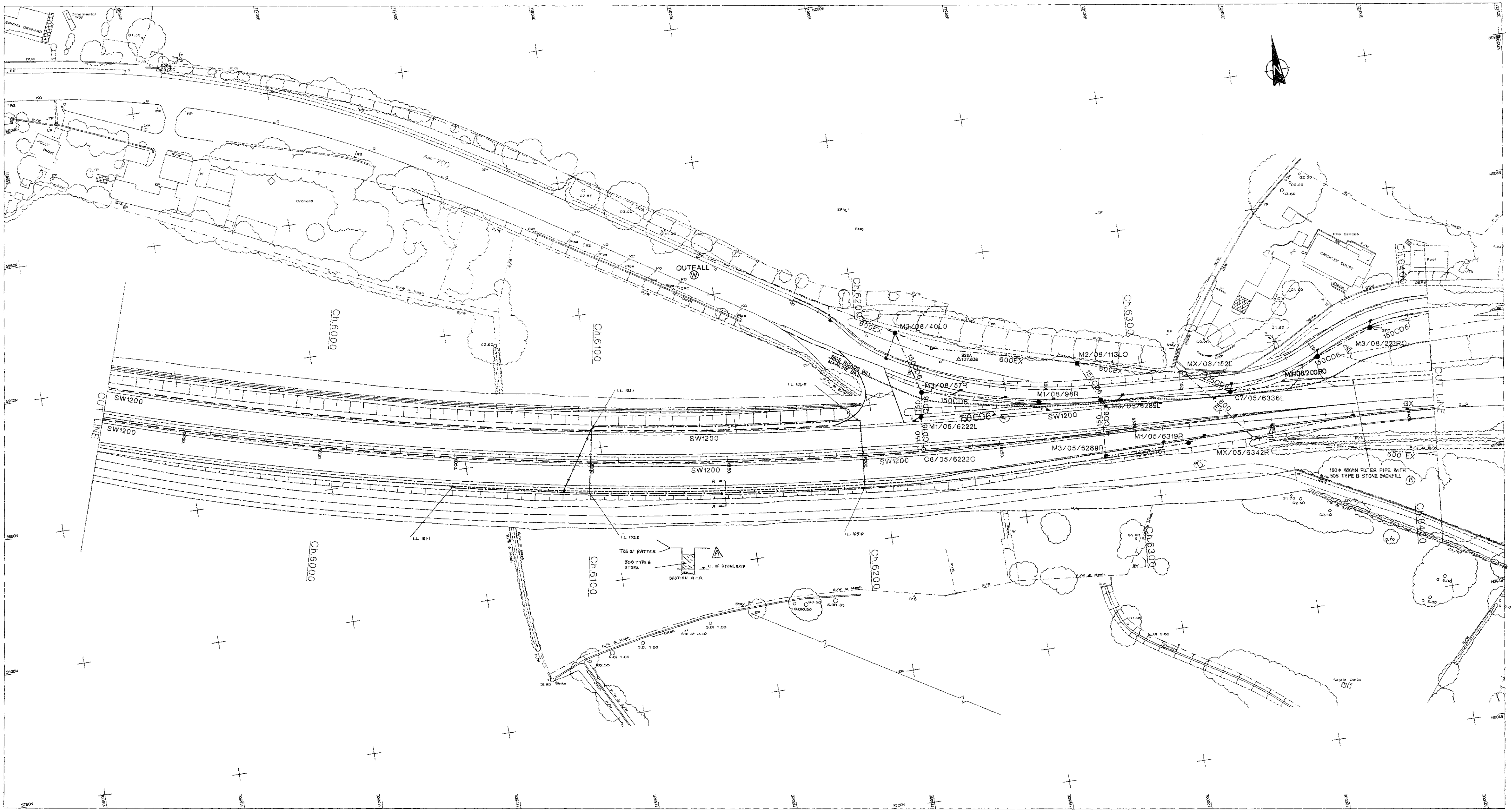
| No. | AMENDMENT DETAILS | BY | DATE |
|---|---|---|---|
| Z | AS BUILT checked by M C Jones | MJ | Oct97 |
| B | [illegible] ADD CATCHPIT [illegible] | | |
| A | S.I. R134 SL150 CH.5725-5840 & NOTES ADDED. S.I. R147 NARROW FILTER DRAIN CHANGED TO 150 CARRIER DRAIN. CH5733-5820 CL & CH5733-5900 & 2x TYPE 3 CHAMBERS. | ST | 8-94 |

# A417 BROCKWORTH BYPASS

# DRAINAGE DETAILS CHAINAGE 5420m TO 5920m

| ORIGINAL DRG. SIZE 841 x 1189 (A0) | DRAWN N.T.C. | DATE 5/93 | DOC SHEET No. 9/1/30 |
|---|---|---|---|
| | CHECKED A.E. | DATE 5.93 | DRAWING No. C 9107/05/10Z |
| | APPROVED M.G.L. | DATE 5.93 | |

DRAWING No. 9107/05/11

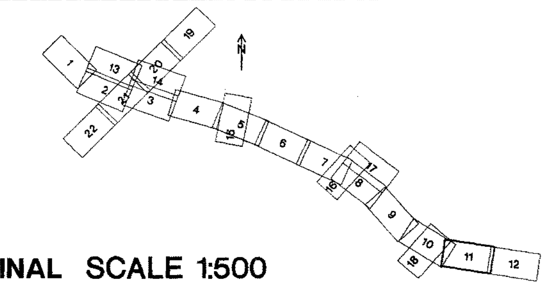



| KEY LINETYPE | TYPICAL IDENTIFIER | DESCRIPTION | DRAWING No. | APPENDIX No. |
|---|---|---|---|---|
| — · — · — · — | 525CD6 | Carrier Drain | H.C.D. F1 | A5/1/1 & A5/1/3 |
| — — — — — — | 600FC11 | Filter Carrier | H.C.D. F2 | A5/1/2 & A5/1/3 |
|  | N/A | Fin or Narrow Filter Drain | H.C.D. B8 (Type16),9107/05/114 | A5/4/1 |
|  | SL150 | Starter Layer Drain | 9107/06/102,103 | A5/1/6 |
|  | N/A | Slope Drain Collector | 9107/05/113 | A5/4/2 |
|  | FG150 | Fan Gravel Cut-off Drain | 9107/05/109 | A5/1/7 |
| ——— – ——— | N/A | Combined Drainage & Kerb System | N/A | A5/5 |
| — — — — — | SW1200 | Surface Water Channel including Fin or Narrow Filter Drain | H.C.D. B2,B3,B6,B7, B11,B12,B14 | A5/3 & A5/4/1 |
| –·–·–·–·– | N/A | Channel Block B including Fin or Narrow Filter Drain | H.C.D. B4 | A5/3 & A5/4/1 |
| ═══════ | N/A | Culvert | (See Appendix A1/10) | A1/10 |

| SYMBOL | TYPICAL IDENTIFIER | DESCRIPTION | DRAWING No. | APPENDIX No. |
|---|---|---|---|---|
| ○ | MX/22/93L | Existing Manhole | N/A | A5/1/4 |
| ● | M3/05/5040L | Manhole | H.C.D. F3,F4,F5,F6 | A5/1/4 |
| ⊙ | C8/05/5155RO | Catchpit | H.C.D. F12,9107/05/115 | A5/1/4 |
| ▭ | G4E | Gully and Apron for Surface Water Channels | 9107/05/101,102,103,104, 105,106,117,118,119,120,121,122 | A5/1/5 |
| ▪ | N/A | Gully Type G1 | H.C.D. F13 | A5/1/5 |
| ⊠ | N/A | Gully Type G2 | 9107/05/100 | A5/1/5 |
| ) | HW/05/5044LO | Headwall or Outfall | 9107/05/110,111,112,123 | A5/1/4 |
|  | SW1200 SW1300 | Surface Water Channel Transition | 9107/05/107 | A5/3 |
| \ | N/A | Drainage Grip | 9107/05/108 | N/A |
|  | MAINLINE BILL INTERCHANGE BILL | Measurement Boundary | N/A | N/A |

Notes

1. For details of drainage to structures see relevant bridgeworks miscellaneous drawing.
2. This drawing is to be used in conjunction with the relevant Appendices and Drawings referred to in the Key.
3. For location of Slope Drains see Drawing numbers 9107/06/1 to 10 inclusive and details shown on 9107/06/106.




**ORIGINAL SCALE 1:500**

| No. | AMENDMENT DETAILS | CHECKED | APPR'VD | DATE |
|---|---|---|---|---|
| Z | AS BUILT checked by M C Jones | MJ |  | OCT 97 |
| F | [illegible] INCREASE DRAIN ø TO 225 FROM 150 BETWEEN MX/08/152L AND M3/05/6336L ... CHANGE MH M3/08/113RO M3/05/6289L ... [illegible] |  |  |  |
| E | SIR 670. INSTALL 150 GULLIES CARRIER DRAIN AS SHOWN TO M1/05/6222L OUTFALL. |  |  | Oct'96. |
| D | CHANGE ALIGNMENT OF ACCESS TRACK TO CROCKLEY FARM (AS BUILT). |  |  |  |
| C | SIR.584. SNOW CLOSURE ARRANGEMENT. |  |  |  |
| B | SIR 122 (CV1179) STONE FILLED DRAIN EXTENDED Ch6200-6310 M009. NFD SHOWN Ch6090-6200 M005. SIR344 150 ø STONE FILTER DRAIN & NOTE ADDED Ch6336-6400 M005 SIR 586 SW1200 DELETED Ch6190-6290 M005, 3 No. G1 GULLIES ADDED. |  | TOS | FEB 96 |
| A | SIR122 300mm STONE FILLED DRAINAGE TRENCH ADDED, PLAN & SECTION A-A. SIR 298 M3/08/192RO & GULLY ADDED, MH MOVED TO M3/08/223RO. | MJ | MJ | FEB 95 |

THE DEPARTMENT OF TRANSPORT
SOUTH WEST CONSTRUCTION PROGRAMME DIVISION

FRANK GRAHAM
CONSULTING ENGINEERS

# A417 BROCKWORTH BYPASS

# DRAINAGE DETAILS CHAINAGE 5920m TO 6410m AND TIE-IN

| | | | |
|---|---|---|---|
| ORIGINAL DRG. SIZE 841 x 1189 (A0) | DRAWN N.R.C. | DATE 5/93 | DOC SHEET No. 9/1/31 |
| | CHECKED A.E. | DATE 5.93. | DRAWING No. C 9107/05/11Z |
| | APPROVED M.G.L. | DATE 5.93 | |

9107/05/12
DRAWING No.

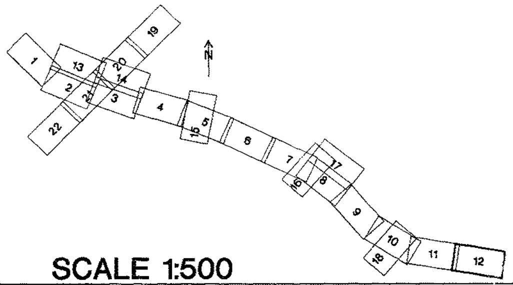

KEY

| LINETYPE | TYPICAL IDENTIFIER | DESCRIPTION | DRAWING No. | APPENDIX No. |
|---|---|---|---|---|
| | 525CD6 | Carrier Drain | H.C.D. F1 | A5/1/1 & A5/1/3 |
| | 600FC11 | Filter Carrier | H.C.D. F2 | A5/1/2 & A5/1/3 |
| | N/A | Fin or Narrow Filter Drain | H.C.D. B8 (Type16),9107/05/114 | A5/4/1 |
| | SL150 | Starter Layer Drain | 9107/06/102,103 | A5/1/6 |
| | N/A | Slope Drain Collector | 9107/05/113 | A5/4/2 |
| | FG150 | Fan Gravel Cut-off Drain | 9107/05/109 | A5/1/7 |
| | N/A | Combined Drainage & Kerb System | N/A | A5/5 |
| | SW1200 | Surface Water Channel including Fin or Narrow Filter Drain | H.C.D. B2,B3,B6,B7, B11,B12,B14 | A5/3 & A5/4/1 |
| | N/A | Channel Block B including Fin or Narrow Filter Drain | H.C.D. B4 | A5/3 & A5/4/1 |
| | N/A | Culvert | (See Appendix A1/10) | A1/10 |

| SYMBOL | TYPICAL IDENTIFIER | DESCRIPTION | DRAWING No. | APPENDIX No. |
|---|---|---|---|---|
| ○ | MX/22/93L | Existing Manhole | N/A | A5/1/4 |
| ● | M3/05/5040L | Manhole | H.C.D. F3,F4,F5,F6 | A5/1/4 |
| ⊙ | C8/05/5155RO | Catchpit | H.C.D. F12,9107/05/115 | A5/1/4 |
| ▭ | G4E | Gully and Apron for Surface Water Channels | 9107/05/101,102,103,104, 105,106,117,118,119,120,121,122 | A5/1/5 |
| | N/A | Gully Type G1 | H.C.D. F13 | A5/1/5 |
| | N/A | Gully Type G2 | 9107/05/100 | A5/1/5 |
| | HW/05/5044LO | Headwall or Outfall | 9107/05/110,111,112,123 | A5/1/4 |
| | SW1200 SW1300 | Surface Water Channel Transition | 9107/05/107 | A5/3 |
| | N/A | Drainage Grip | 9107/05/108 | N/A |
| | MAINLINE BILL INTERCHANGE BILL | Measurement Boundary | N/A | N/A |

Notes

1. For details of drainage to structures see relevant bridgeworks miscellaneous drawing.
2. This drawing is to be used in conjunction with the relevant Appendices and Drawings referred to in the Key.
3. For location of Slope Drains see Drawing numbers 9107/06/1 to 10 inclusive and details shown on 9107/06/106.



SCALE 1:500

THE DEPARTMENT OF TRANSPORT
SOUTH WEST CONSTRUCTION PROGRAMME DIVISION

FRANK GRAHAM
CONSULTING ENGINEERS

| No. | AMENDMENT DETAILS | CHECKED | APPROVED | DATE |
|---|---|---|---|---|
| A | SIR 296 MH REMOVED CH249 MCC1. SIR 344 150mmφ STONE FILTER DRAIN ADDED CH6400-6440 M007. SIR 570 GULLY OUTFALL AMENDED CH146 M001. | | | FEB. 96. |
| B | Alignment change of Dog Lane. | | MY | |
| Z | AS BUILT checked by M C Jones | | MY | Oct 97 |

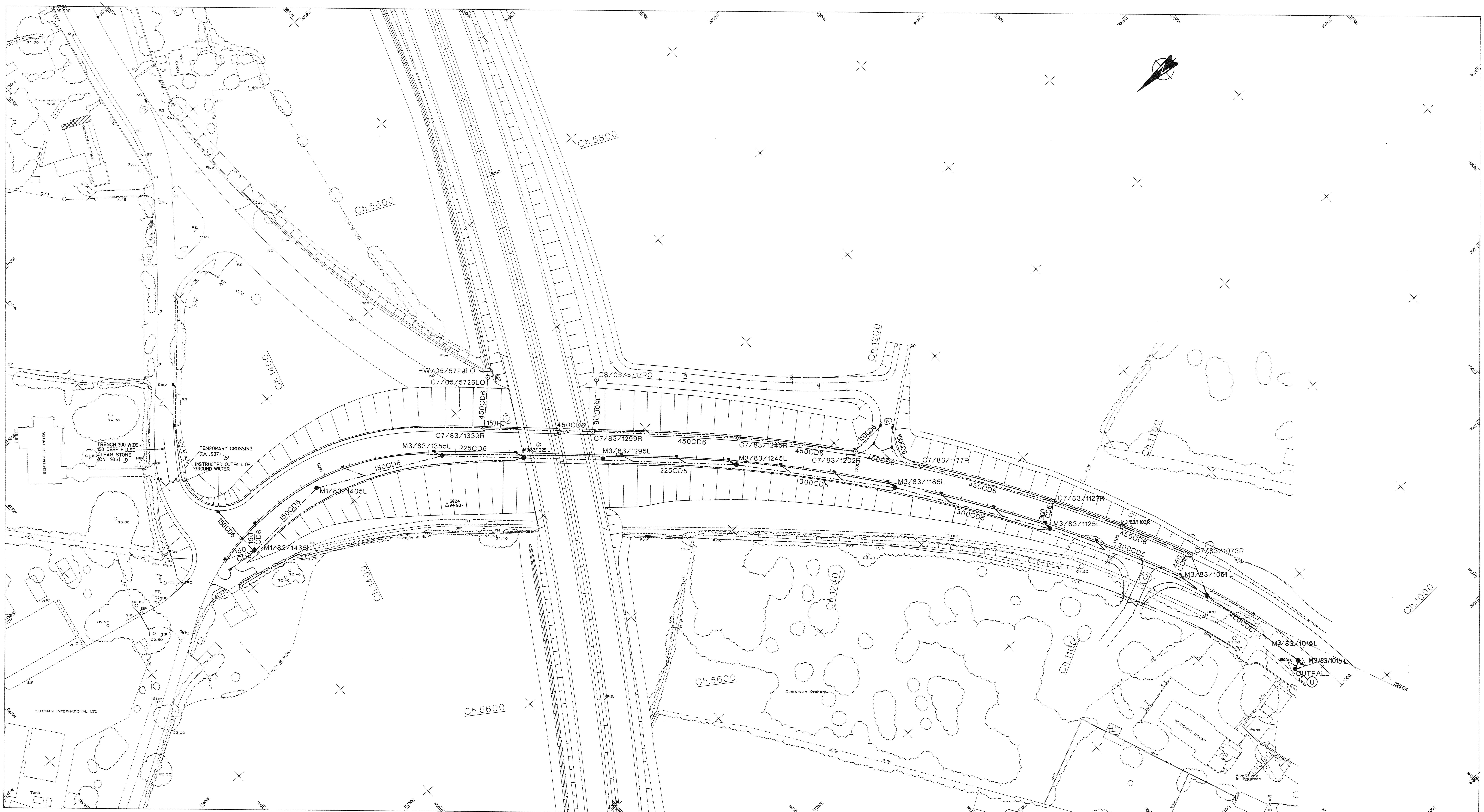
# A417 BROCKWORTH BYPASS

# DRAINAGE DETAILS CHAINAGE 6410m TO 6450m AND DOG LANE

ORIGINAL DRG. SIZE 841 x 1189 (A0)

| DRAWN | DATE | DOC SHEET No. |
|---|---|---|
| N.T.C | 5/93 | 9/1/32 |
| CHECKED | DATE | DRAWING No. |
| A.E. | 6.93 | C 9107/05/12Z |
| APPROVED | DATE | |
| M.C.L. | 5.93 | |

AMDG 22

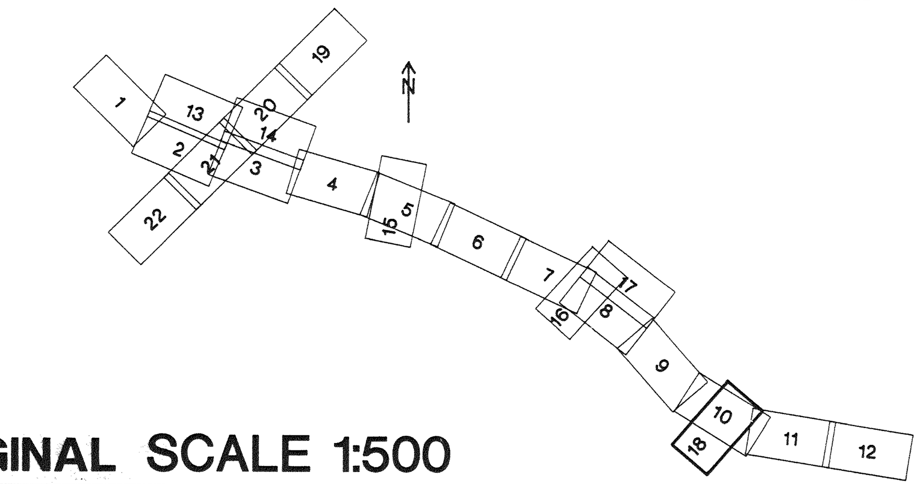



| KEY LINETYPE | TYPICAL IDENTIFIER | DESCRIPTION | DRAWING No. | APPENDIX No. |
|---|---|---|---|---|
| | 525CD6 | Carrier Drain | H.C.D. F1 | A5/1/1 & A5/1/3 |
| | 600FC11 | Filter Carrier | H.C.D. F2 | A5/1/2 & A5/1/3 |
| | N/A | Fin or Narrow Filter Drain | H.C.D. B8 (Type16),9107/05/114 | A5/4/1 |
| | SL150 | Starter Layer Drain | 9107/06/102,103 | A5/1/6 |
| | N/A | Slope Drain Collector | 9107/05/113 | A5/4/2 |
| | FG150 | Fan Gravel Cut-off Drain | 9107/05/109 | A5/1/7 |
| | N/A | Combined Drainage & Kerb System | N/A | A5/5 |
| | SW1200 | Surface Water Channel including Fin or Narrow Filter Drain | H.C.D. B2,B3,B6,B7, B11,B12,B14 | A5/3 & A5/4/1 |
| | N/A | Channel Block B including Fin or Narrow Filter Drain | H.C.D. B4 | A5/3 & A5/4/1 |
| | N/A | Culvert | (See Appendix A1/10) | A1/10 |

| SYMBOL | TYPICAL IDENTIFIER | DESCRIPTION | DRAWING No. | APPENDIX No. |
|---|---|---|---|---|
| ○ | MX/22/93L | Existing Manhole | N/A | A5/1/4 |
| ● | M3/05/5040L | Manhole | H.C.D. F3,F4,F5,F6 | A5/1/4 |
| ⊙ | C8/05/5155RO | Catchpit | H.C.D. F12,9107/05/115 | A5/1/4 |
| ▭ | G4E | Gully and Apron for Surface Water Channels | 9107/05/101,102,103,104, 105,106,117,118,119,120,121,122 | A5/1/5 |
| ▪ | N/A | Gully Type G1 | H.C.D. F13 | A5/1/5 |
| ⊠ | N/A | Gully Type G2 | 9107/05/100 | A5/1/5 |
| ) | HW/05/5044LO | Headwall or Outfall | 9107/05/110,111,112,123 | A5/1/4 |
| | SW1200 SW1300 | Surface Water Channel Transition | 9107/05/107 | A5/3 |
| \ | N/A | Drainage Grip | 9107/05/108 | N/A |
| ........ | MAINLINE BILL INTERCHANGE BILL | Measurement Boundary | N/A | N/A |

Notes

1. For details of drainage to structures see relevant bridgeworks miscellaneous drawing.
2. This drawing is to be used in conjunction with the relevant Appendices and Drawings referred to in the Key.
3. For location of Slope Drains see Drawing numbers 9107/06/1 to 10 inclusive and details shown on 9107/06/106.



**ORIGINAL SCALE 1:500**

THE DEPARTMENT OF TRANSPORT
SOUTH WEST CONSTRUCTION PROGRAMME DIVISION

FRANK GRAHAM CONSULTING ENGINEERS

| No. | AMENDMENT DETAILS | CHECKED | APPR'VD | DATE |
|---|---|---|---|---|
| Z | AS BUILT checked by M C Jones | | MCJ | OCT 97. |
| D | SIR 727. CONNECT EXISTING GULLY AND NEW GULLY TO THE 150FCD (AS IN SIR 713). BENTHAM LANE. ADMENDMENT TO FIELD ACCESS ON BENTHAM LANE. SIR 713 ADD 150mm FILTER CARRIER DRAIN TO C7/83/1339R. ALSO 2x GULLIES | | MCJ | |
| C | SIR544 C7/83/1100R ADDED. 450CD6 CONNECTIONS AMENDED TO FIT. SIR582 GULLIES & NARROW FILTER DRAIN AMENDED Ch 1042-1074 M083. | | | FEB 96 |
| B | SIR255 GULLY NEAR HOLLY BRAE ADDED. SIR 292 & 296 M3/83/1015L ADDED. 2x MH MOVED NEAR OUTFALL (U). SIS 188 M3/83/1325L ADDED. SIR470 300x150 TRENCH, TEMPORARY CROSSING & 150ø PORUS PIPE ADDED BENTHAM CHURCH. | MCJ | | OCT. 95 |
| A | S.I.R134 SL150 INTO C7/05/5726LO : S.I.R 229 MH/83/1031L MOVED AWAY FROM OUTFALL (U) | MCJ | MCJ | FEB. 95 |

A417 BROCKWORTH BYPASS

DRAINAGE DETAILS
SIDE ROADS - BENTHAM LANE

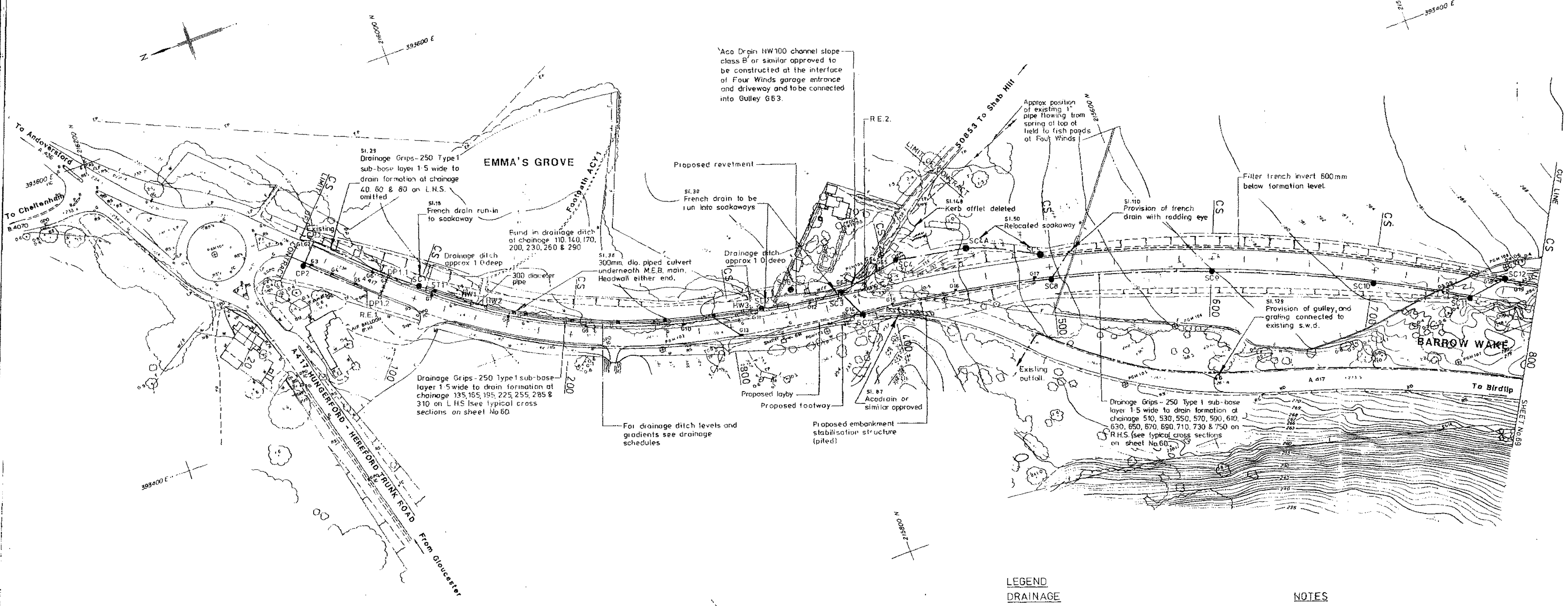
| ORIGINAL DRG. SIZE 841 x 1189 (A0) | DRAWN MG | DATE 5/93 | DOC SHEET No. 9/1/38 |
|---|---|---|---|
| | CHECKED A.E. | DATE 5.93 | DRAWING No. C 9107/05/18Z |
| | APPROVED M.G.L. | DATE 5.93 | |

AMDO 22

DR209

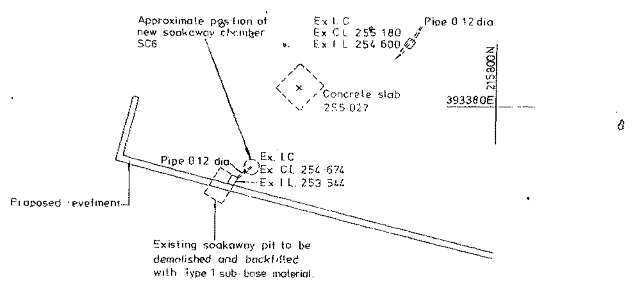
TR55/479/582

AS BUILT



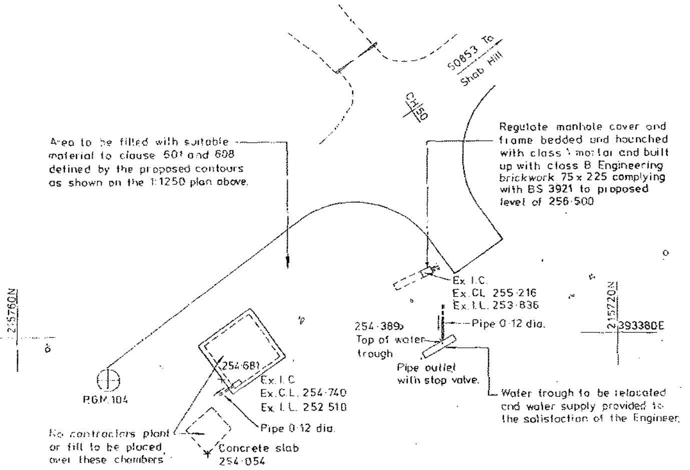

KEY

I.C. Inspection chamber
C.L. Cover level
I.L. Invert level




SURVEY OF EXISTING FOUL SEWER DRAINAGE ARRANGEMENT AT FOUR WINDS

Scale 1:200




SURVEY OF EXISTING WATER CHAMBERS AND TROUGH

Scale 1:200

LEGEND

DRAINAGE

| | |
|---|---|
| | Drainage ditch. |
| | Bund in drainage ditch. |
| | Carrier drain. |
| | Culvert |
| | French drain |
| | Filter trench. |
| | Existing surface water drain. |
| !! | Drainage grip. |
| I.C. | Existing inspection chamber/catchpit. |
| G. | Existing gulley. |
| K.O. | Existing kerb offlet. |
| C.P.1. | Catchpit |
| S.C.1. | Soakaway chamber. |
| G.1. | Gulley. |
| K.O.1. | Kerb offlet. |
| H.W.1 | Headwall. |
| S.T.1 | Silt trap. |
| R.E.1. | Rodding eye. |

DUCTING

| | |
|---|---|
| | 2-Way 100 diameter ducting |
| | 1-Way 50 diameter ducting |
| D.P.1.1. | Drawpit. |

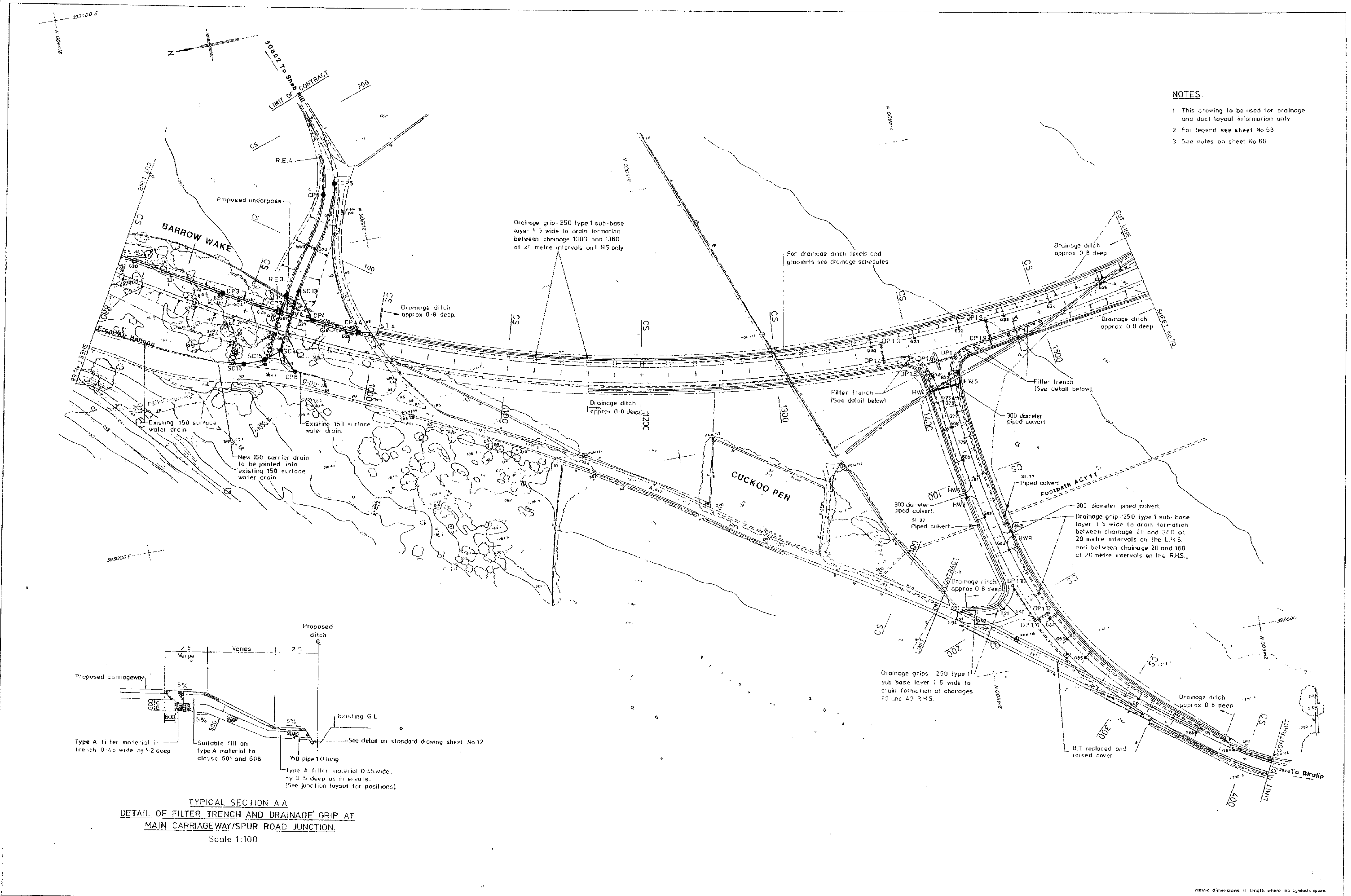
NOTES

1. This drawing to be used for drainage and duct layout information only.
2. For removal of existing drainage see sheet Nos.15, 16, 17 & 18.
3. Drainage drawings are to be read in conjunction with the following information:-
   (i) Typical cross sections
   (ii) Standard drawings.
   (iii) Drainage schedules.
   (iv) Duct schedules.
4. Invert levels of drainage pipes, ditches, catchpits etc. are included in the drainage schedules.

Metric dimensions of length where no symbols given. Whole numbers : mm Decimalised expressions : m.

| | | | | |
|---|---|---|---|---|
| DEPARTMENT OF TRANSPORT,<br>SOUTH WEST REGION,<br>DIRECTOR (TRANSPORT),<br>W.E. GALLAGHER, BSc(Eng)., C.Eng., M.I.C.E. | AGENT AUTHORITY.<br>GLOUCESTERSHIRE COUNTY COUNCIL,<br>COUNTY SURVEYOR,<br>R. ATKINSON, C.Eng., M.I.C.E. | A417 HUNGERFORD - HEREFORD TRUNK ROAD<br>BIRDLIP BYPASS<br>DRAINAGE AND DUCT LAYOUT. | DRAWN M.E<br>TRACED M.D.<br>CHECKED G.R.B.<br>DATE June'89 REV AMENDMENT DATE BY | SCALE 1/1250<br>DRG. No. TR55/479/582<br>SHEET No. 68 AS BUILT |

DR 209

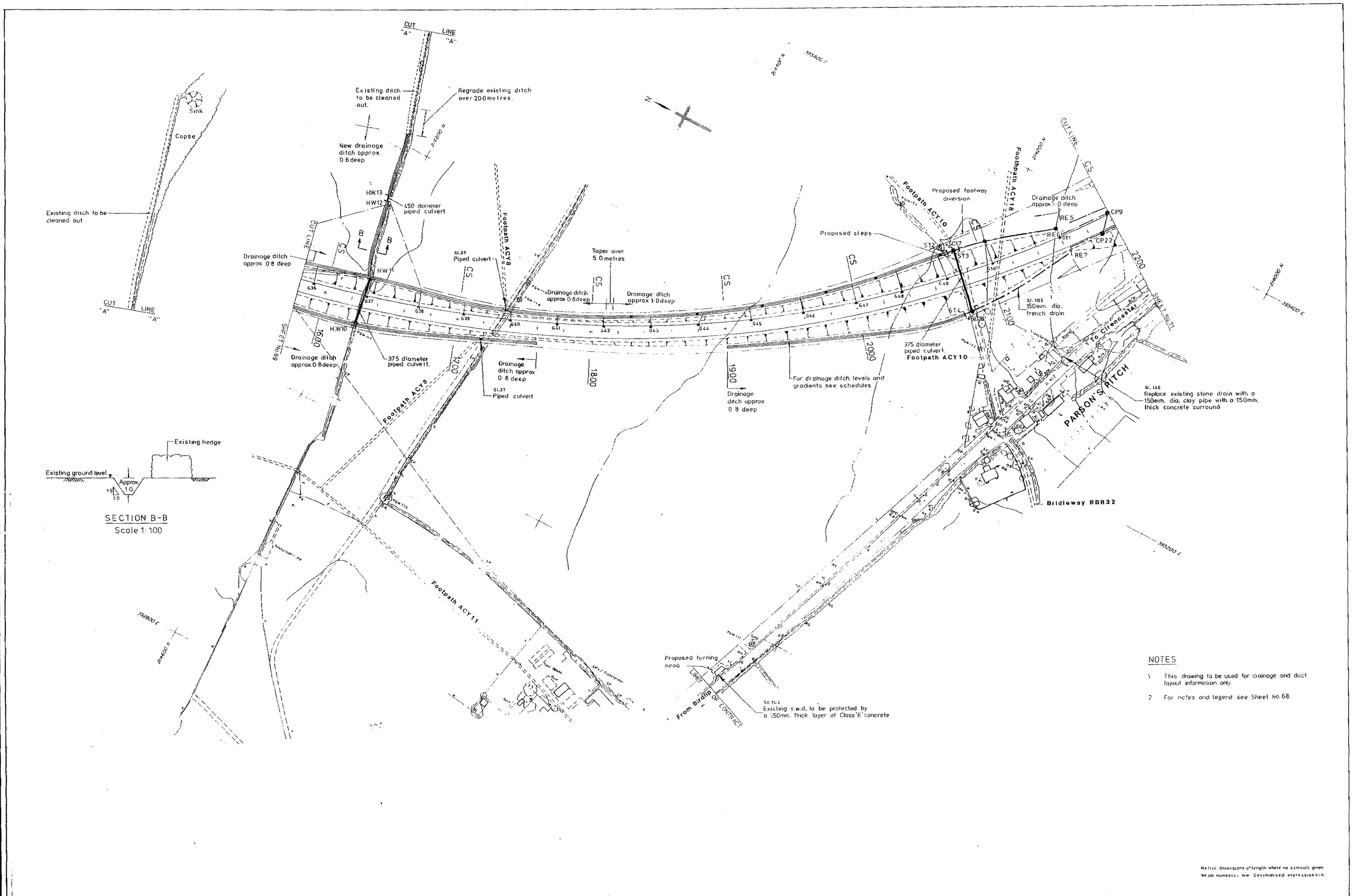



AS BUILT

TR55/480/583

| | | |
|---|---|---|
| DEPARTMENT OF TRANSPORT,<br>SOUTH WEST REGION,<br>DIRECTOR (TRANSPORT),<br>W.E. GALLAGHER, BSc(Eng)., C.Eng., M.I.C.E. | AGENT AUTHORITY.<br>GLOUCESTERSHIRE COUNTY COUNCIL,<br>COUNTY SURVEYOR,<br>R. ATKINSON, C.Eng., M.I.C.E. | A417 HUNGERFORD - HEREFORD TRUNK ROAD<br>BIRDLIP BYPASS<br>DRAINAGE AND DUCT LAYOUT. |

| | | | | | | |
|---|---|---|---|---|---|---|
| DRAWN | HE | | | | | SCALE 1/1250 |
| TRACED | MD | | | | | DRG. No. TR55/480/583 |
| CHECKED | GRB | | | | | |
| DATE | June'89 | REV | AMENDMENT | DATE | BY | SHEET No. 69 AS BUILT |




| | | | | |
|---|---|---|---|---|
| DEPARTMENT OF TRANSPORT,<br>SOUTH WEST REGION,<br>DIRECTOR (TRANSPORT),<br>W.E. GALLAGHER, BSc(Eng)., C.Eng., M.I.C.E. | AGENT AUTHORITY.<br>GLOUCESTERSHIRE COUNTY COUNCIL,<br>COUNTY SURVEYOR,<br>R. ATKINSON, C.Eng., M.I.C.E. | A417 HUNGERFORD - HEREFORD TRUNK ROAD<br>BIRDLIP BYPASS<br>DRAINAGE AND DUCT LAYOUT. | DRAWN M.E.<br>TRACED E.C.<br>CHECKED GRB.<br>DATE June 89 REV AMENDMENT DATE BY | SCALE 1/1250<br>DRG. No. TR55/481/584<br>SHEET No. 70 AS BUILT |

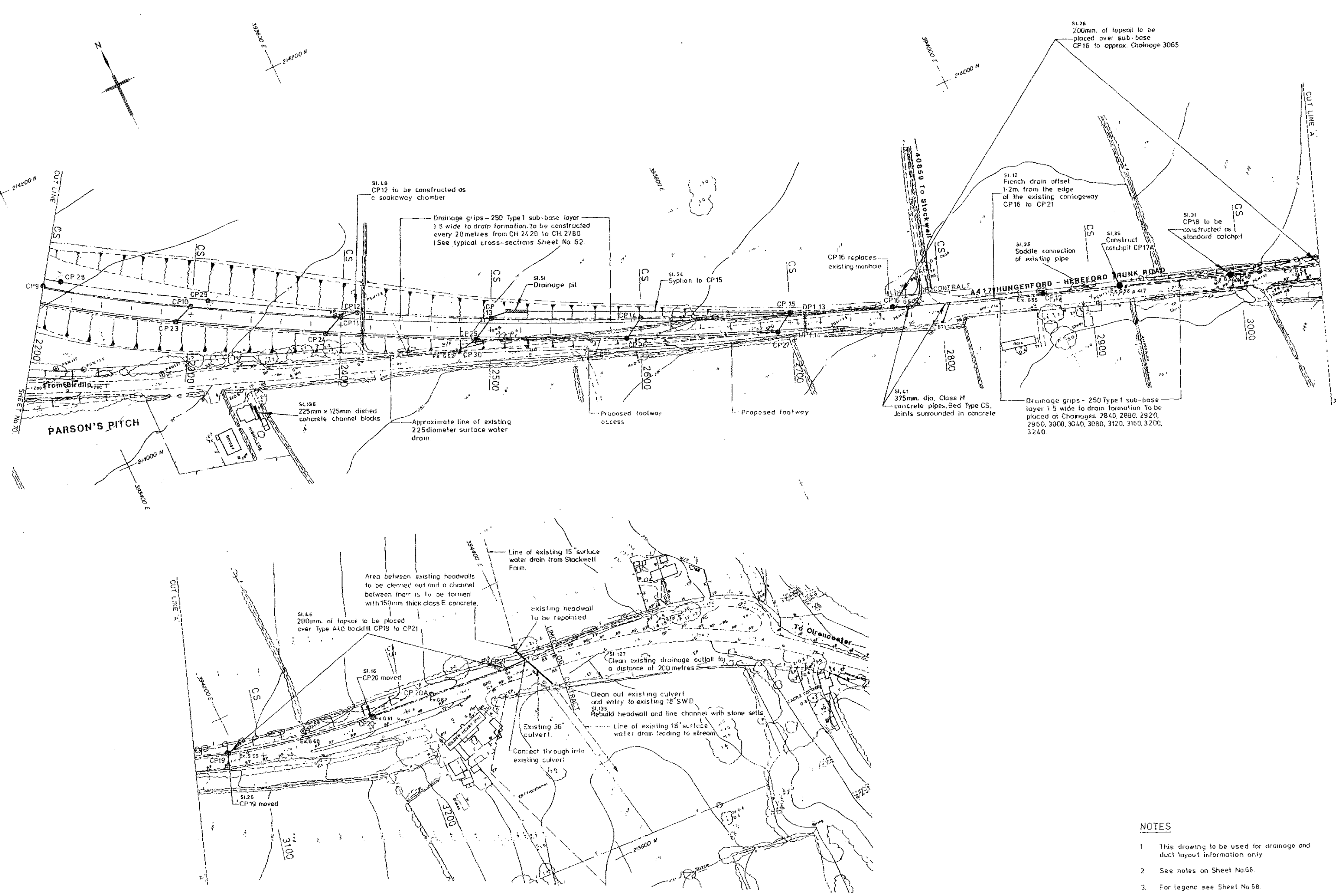
DR 209

TR 55 / 481 / 584

DR209

TR 55/482/585

AS BUILT




## NOTES

1. This drawing to be used for drainage and duct layout information only.
2. See notes on Sheet No.68.
3. For legend see Sheet No.68.
4. At Catchpit Nos. CP17, 18, 19, 20, 20A and Ex. CP21 a 100mm diameter pipe is to be built through the wall of the inlet side of the catchpit only at trench bottom level.

Metric dimensions of length where no symbols given. Whole numbers = mm Decimalised expressions = m.

| | | | |
|---|---|---|---|
| DEPARTMENT OF TRANSPORT,<br>SOUTH WEST REGION,<br>DIRECTOR (TRANSPORT),<br>W.E. GALLAGHER, BSc(Eng)., C.Eng., M.I.C.E. | AGENT AUTHORITY.<br>GLOUCESTERSHIRE COUNTY COUNCIL,<br>COUNTY SURVEYOR,<br>R. ATKINSON, C.Eng., M.I.C.E. | A417 HUNGERFORD - HEREFORD TRUNK ROAD<br>BIRDLIP BYPASS<br>DRAINAGE AND DUCT LAYOUT. | DRAWN M.E.<br>TRACED E.C.<br>CHECKED G.R.B.<br>DATE June'88 |

| REV | AMENDMENT | DATE | BY |
|---|---|---|---|

SCALE 1/1250

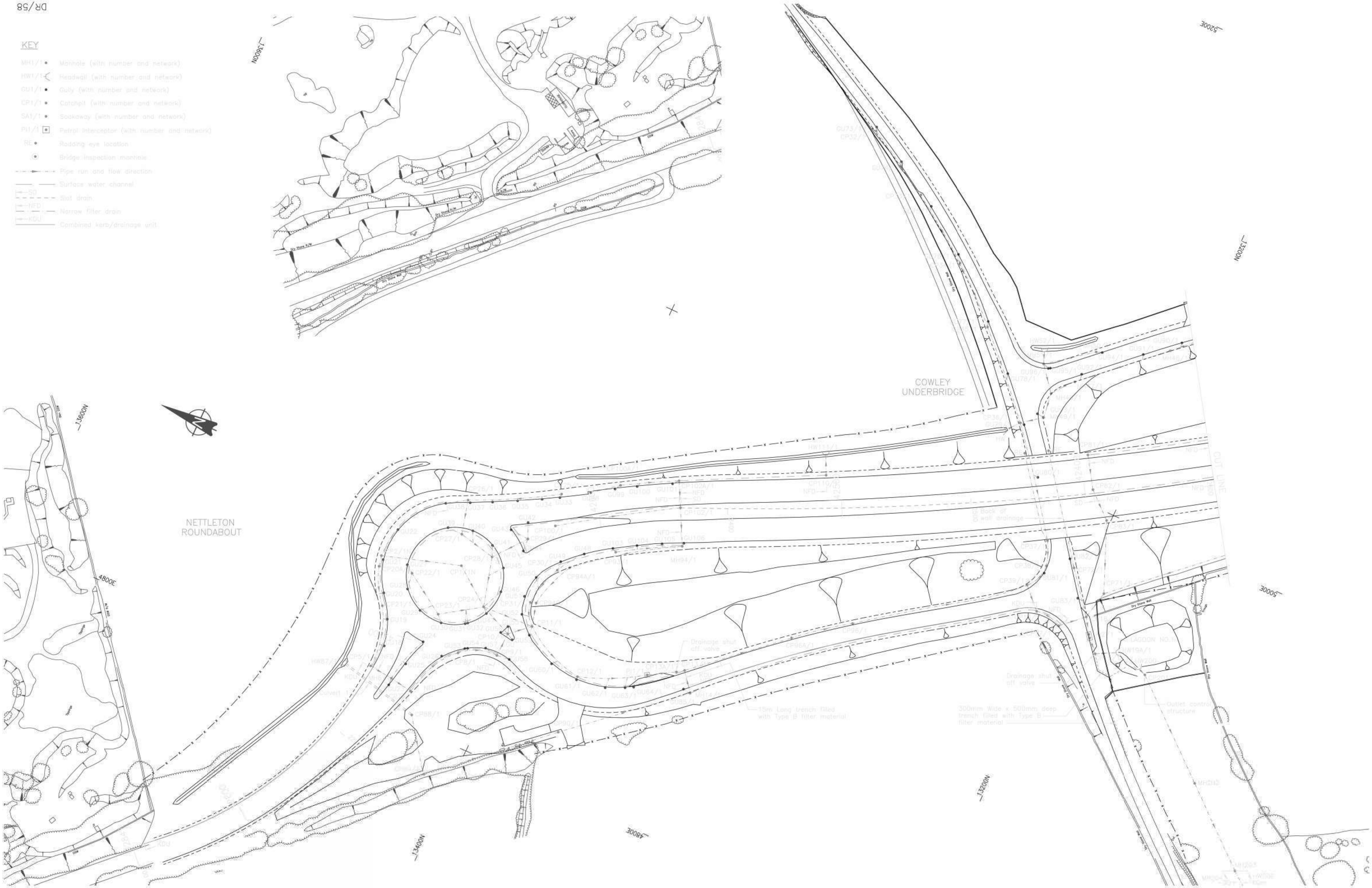
DRG. No. TR55/482/585

SHEET No. 71 AS BUILT

DR/58

KEY

MH1/1 • Manhole (with number and network)
HW1/1 Headwall (with number and network)
GU1/1 • Gully (with number and network)
CP1/1 • Catchpit (with number and network)
SA1/1 • Soakaway (with number and network)
PI1/1 Petrol Interceptor (with number and network)
RE • Rodding eye location
Bridge inspection manhole
Pipe run and flow direction
Surface water channel
SD Slot drain
NFD Narrow filter drain
KDU Combined kerb/drainage unit




NOSNI SCHEME
DRAINAGE
RMG CH2100 – CH2600
RMS CH42850 – CH42350

P.N. MAR 98

A2 – 1:1000
A0 – 1:500

RMSAB58

TR0094

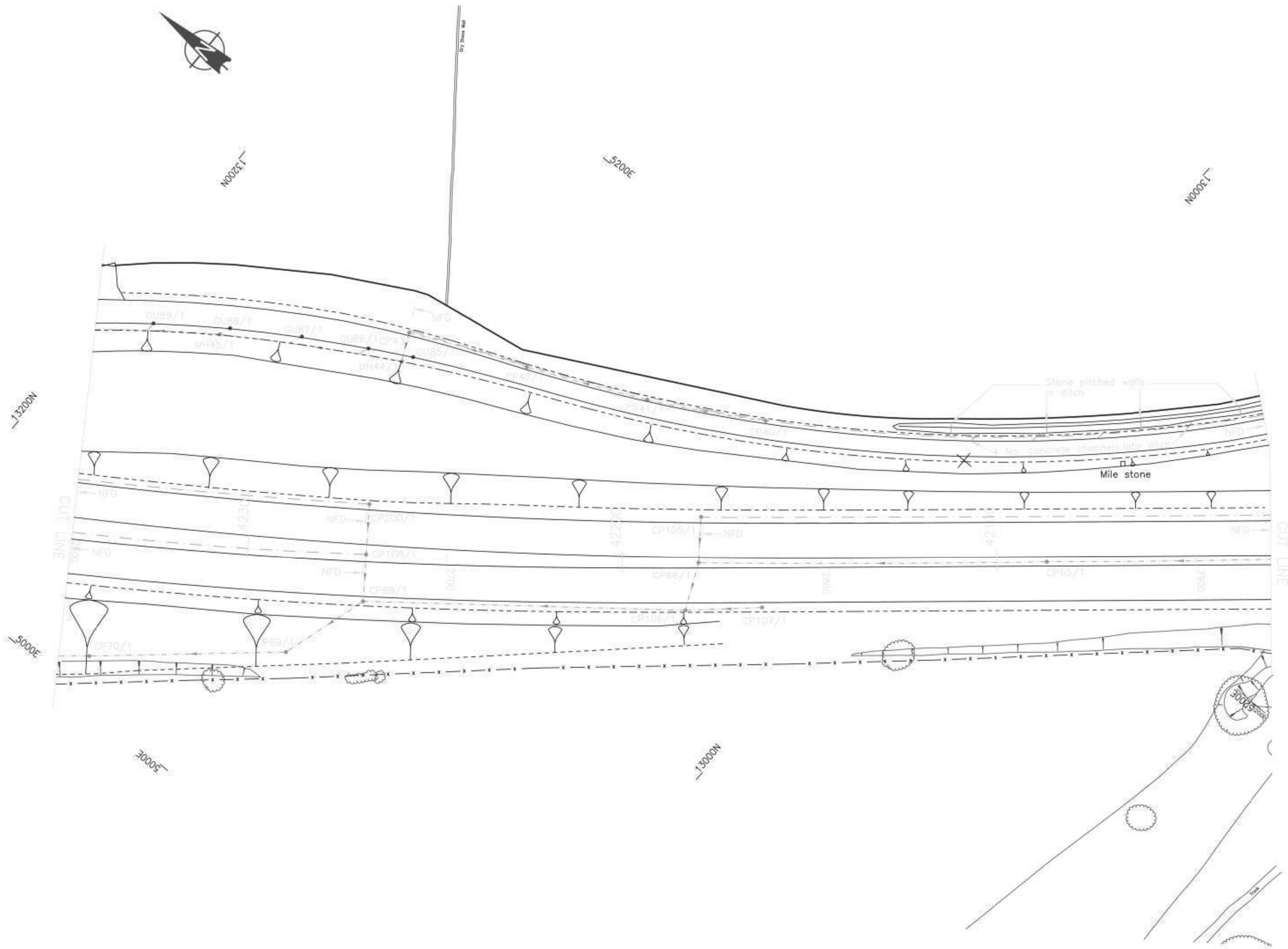
A2 DR/58 D

Xref \\Fs25\sys\DATA\RMGASB\GENERAL\Frmab.dwg

DR/57

KEY

MH1/1 • Manhole (with number and network)
HW1/1 Headwall (with number and network)
GU1/1 • Gully (with number and network)
CP1/1 • Catchpit (with number and network)
SA1/1 • Soakaway (with number and network)
PI1/1 Petrol interceptor (with number and network)
RE • Rodding eye location
Bridge inspection manhole
Pipe run and flow direction
Surface water channel
SD Slot drain
NFD Narrow filter drain
KDU Combined kerb/drainage unit




NOSNI SCHEME
DRAINAGE
RMG CH2600 - CH2920
RMS CH42350 - CH42050

P.N. MAR 98

A2 - 1:1000
A0 - 1:500

RMSAB57

TR0094

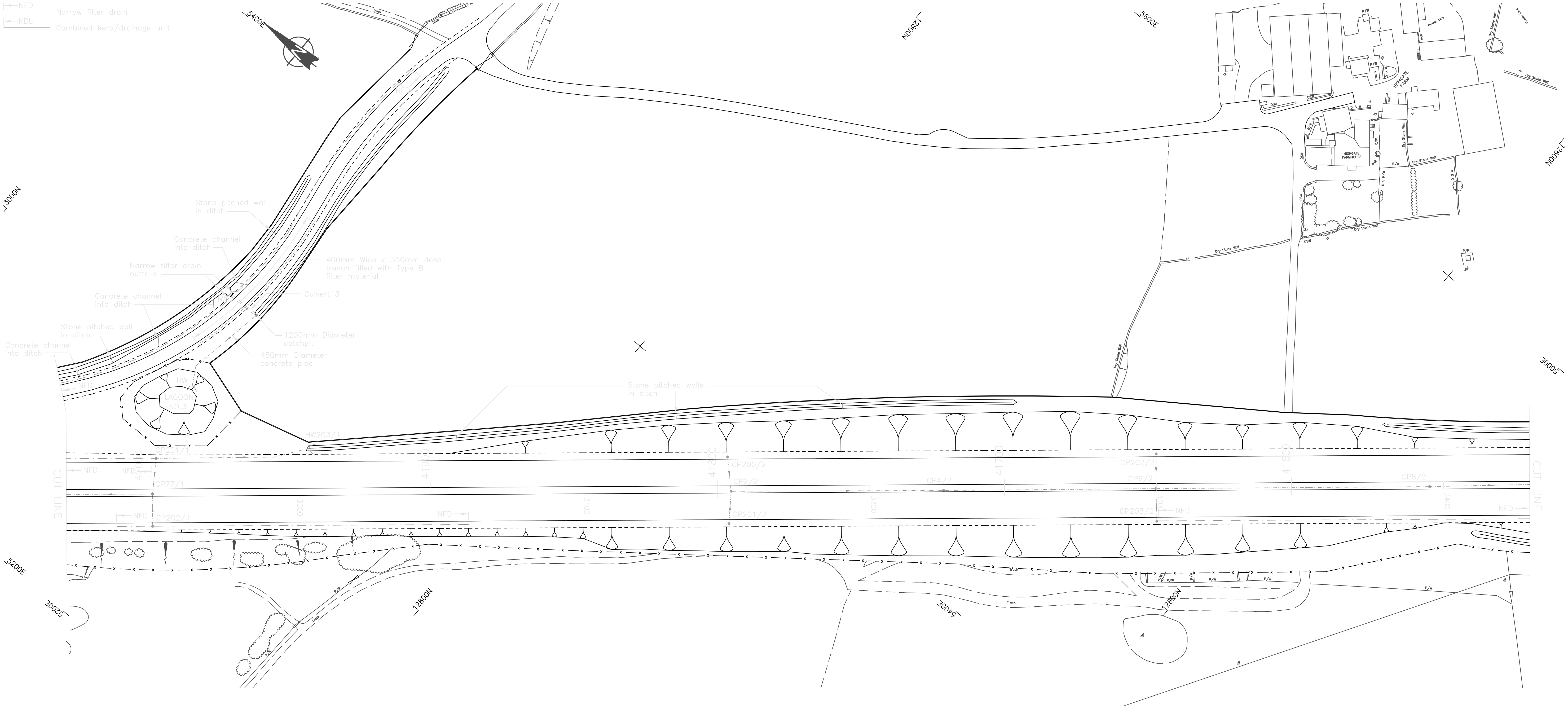
A2 DR/57 D

Xref \\Fs25\sys\DATA\RMGASB\GENERAL\Frmab.dwg

DR/56

## KEY

MH1/1 • Manhole (with number and network)
HW1/1 Headwall (with number and network)
GU1/1 • Gully (with number and network)
CP1/1 • Catchpit (with number and network)
SA1/1 • Soakaway (with number and network)
PI1/1 Petrol interceptor (with number and network)
RE • Rodding eye location
Bridge inspection manhole
Pipe run and flow direction
Surface water channel
SD Slot drain
NFD Narrow filter drain
KDU Combined kerb/drainage unit




NOSNI SCHEME
DRAINAGE
RMG CH2920 – CH3430
RMS CH42050 – CH41550

P.N. MAR 98

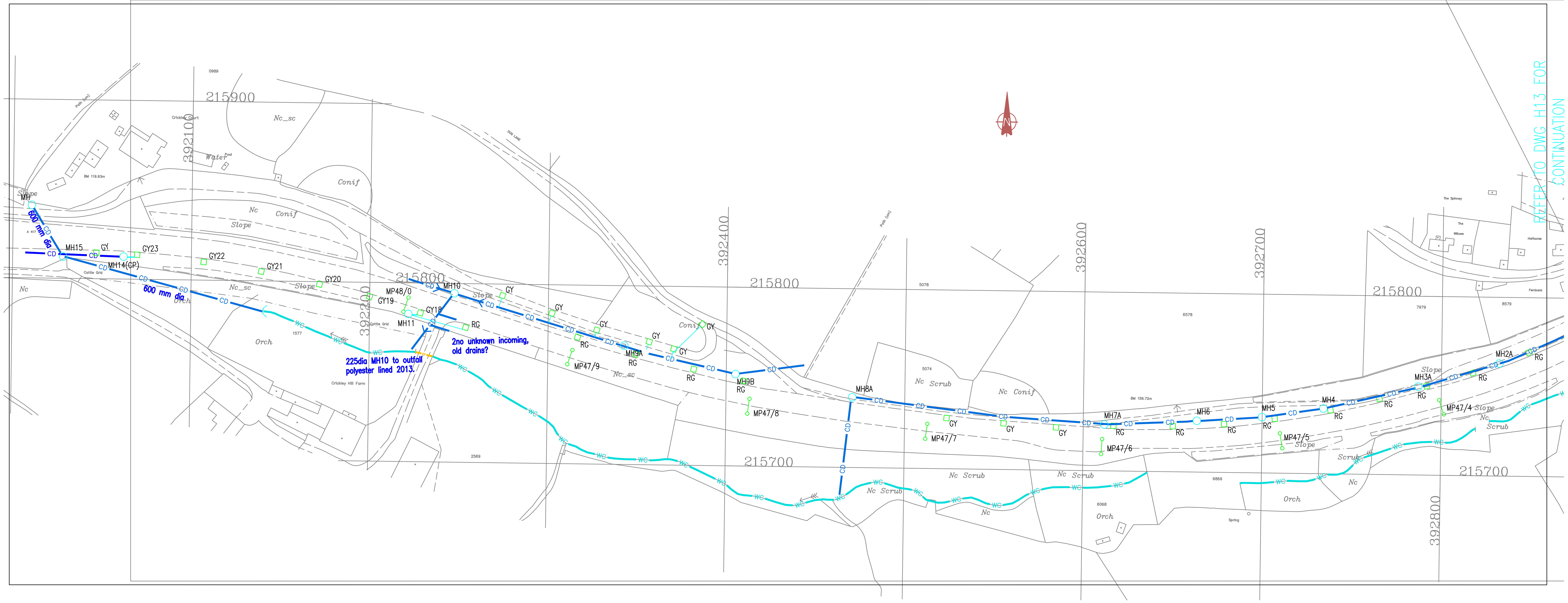
A2 – 1:1000
A0 – 1:500

RMSAB56

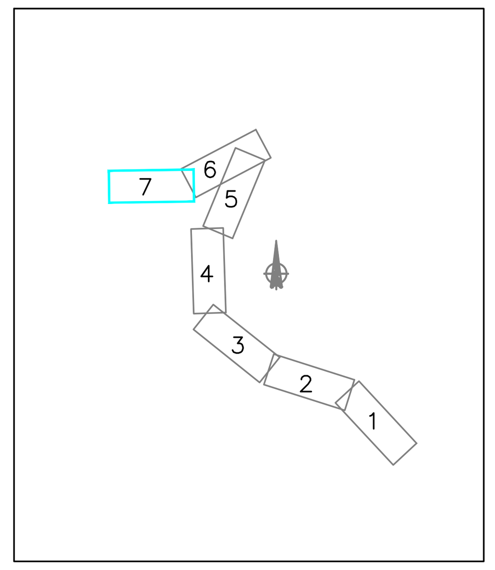
TR0094

A2 DR/56 D

Xref \\Fs25\sys\DATA\RMGASB\GENERAL\Frmab.dwg






LEGEND

| | |
|---|---|
| GY | GULLY |
| RG | GULLY |
| MH | MANHOLE |
| CP | CATCH PIT |
| SC | SOAKAWAY |
| RE | RODDING EYE |
| G | GRIP |
| PG | PIPED GRIP |
| | MARKER POST |
| OIL INTERCEPTOR TYPE 1 | OIL INTERCEPTOR |
| CD | CARRIER DRAIN |
| DI | DITCH |
| FD | FILTER DRAIN |
| FT | FILTER TRENCH |
| TW | THAMES WATER CARRIER |
| CV | CULVERT |
| WC | WATER COURSE |
| KB | COMBINED KERB / DRAINAGE BLOCK |

| Ref | Revision | By | Date |
|---|---|---|---|

RMS (Gloucester) Ltd.

A419/A417

SWINDON TO GLOUCESTER

Client

THE HIGHWAYS AGENCY

Contract

A419 / A417

Title

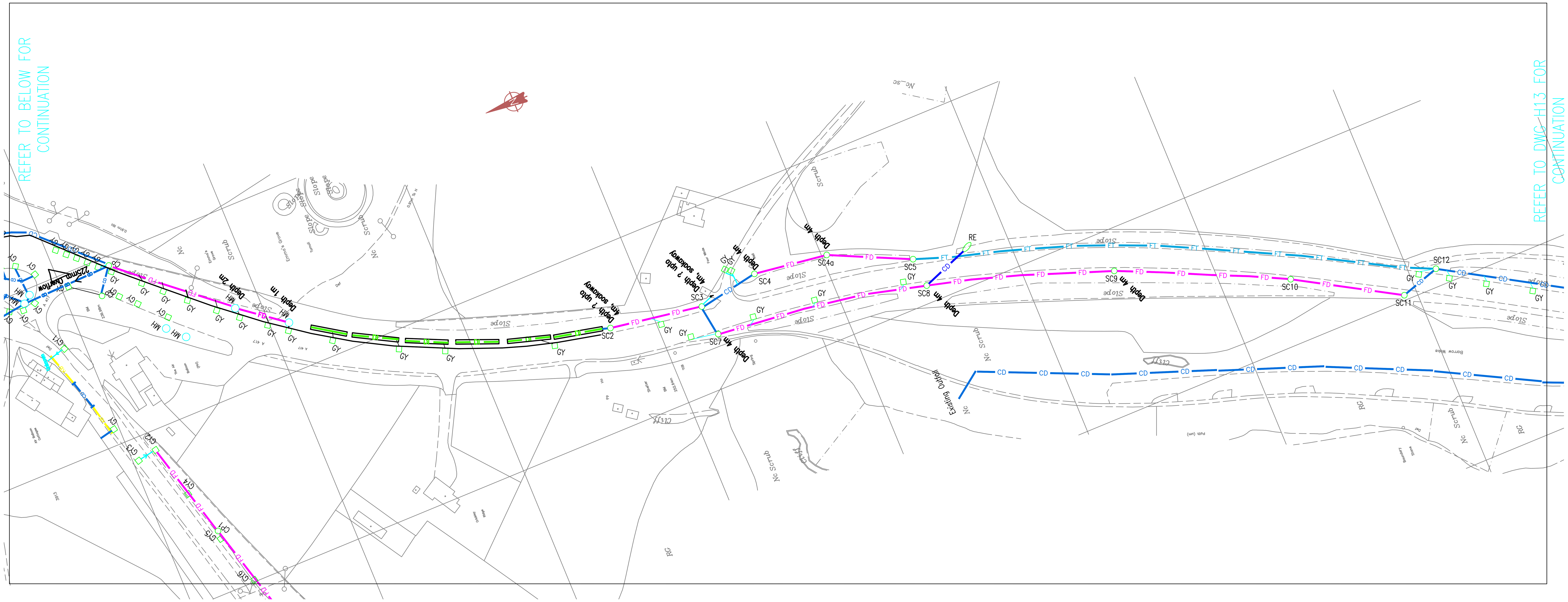
AS BUILT HIGHWAY DRAINAGE

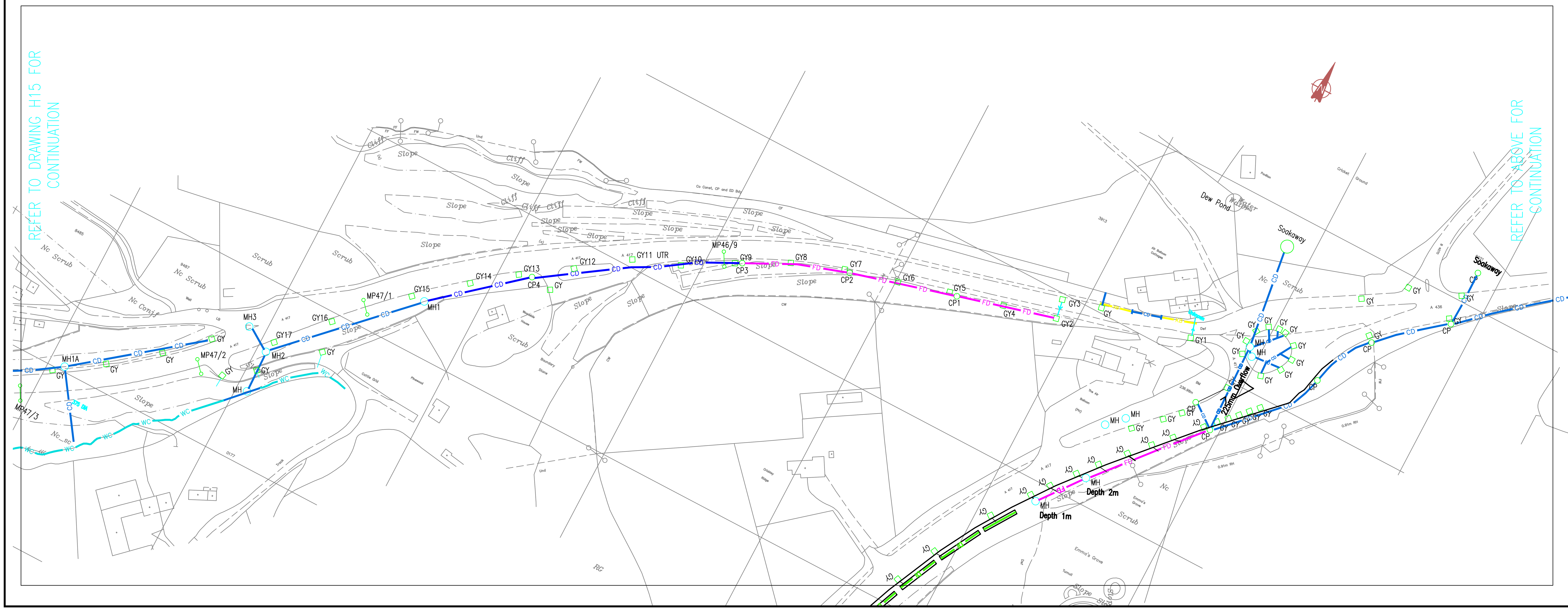
SHEET 4 OF 4

SCALE 1:1250

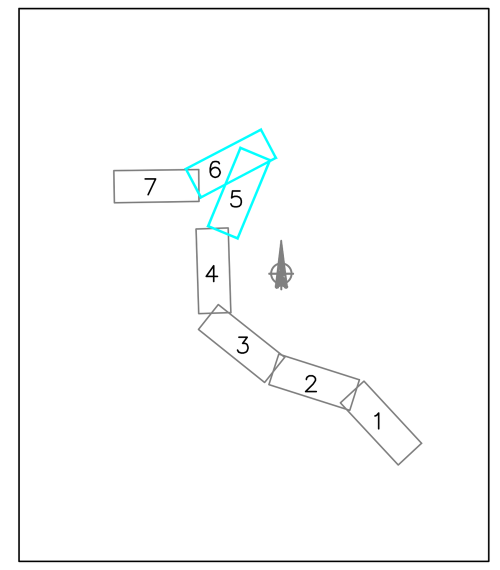
| | | |
|---|---|---|
| Prepared By. | Drawn. WJB | Date. 11/02 |
| Approved By. | | Date. |

Drawing No. 19194/ OM1 / H15






LEGEND

| | |
|---|---|
| GY | GULLY |
| RG | GULLY |
| MH | MANHOLE |
| CP | CATCH PIT |
| SC | SOAKAWAY |
| RE | RODDING EYE |
| G | GRIP |
| PG | PIPED GRIP |
| | MARKER POST |
| OIL INTERCEPTOR TYPE 1 | OIL INTERCEPTOR |
| CD | CARRIER DRAIN |
| DI | DITCH |
| FD | FILTER DRAIN |
| FT | FILTER TRENCH |
| TW | THAMES WATER CARRIER |
| CV | CULVERT |
| WC | WATER COURSE |
| KB | COMBINED KERB / DRAINAGE BLOCK |

| Ref | Revision | By | Date |
|---|---|---|---|
| | | | |

RMS (Gloucester) Ltd.

A419/A417

SWINDON TO GLOUCESTER

Client

THE HIGHWAYS AGENCY

Contract

A419 / A417

Title

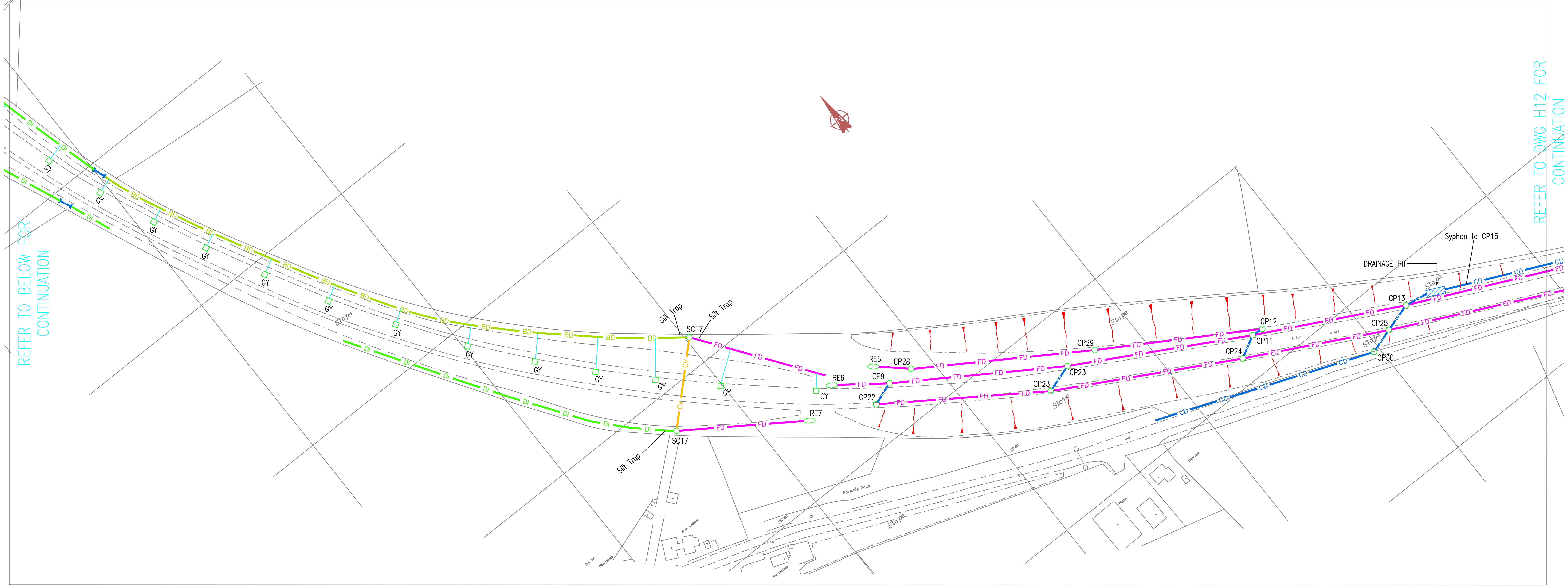
AS BUILT HIGHWAY DRAINAGE

SHEET 3 OF 4

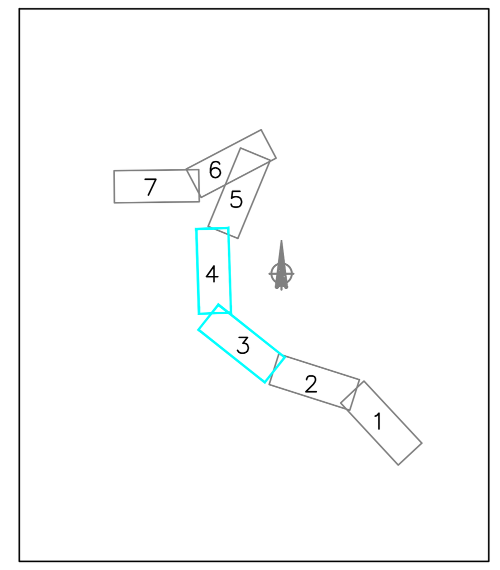
SCALE 1:1250

| | | |
|---|---|---|
| Prepared By. | Drawn. WJB | Date. 11/02 |
| Approved By. | | Date. |

Drawing No. 19194/ OM1 / H14








LEGEND

| | |
|---|---|
| GY | GULLY |
| RG | GULLY |
| MH | MANHOLE |
| CP | CATCH PIT |
| SC | SOAKAWAY |
| RE | RODDING EYE |
| G | GRIP |
| PG | PIPED GRIP |
| | MARKER POST |
| OIL INTERCEPTOR TYPE 1 | OIL INTERCEPTOR |
| CD | CARRIER DRAIN |
| DI | DITCH |
| FD | FILTER DRAIN |
| FT | FILTER TRENCH |
| TW | THAMES WATER CARRIER |
| CV | CULVERT |
| WC | WATER COURSE |
| KB | COMBINED KERB / DRAINAGE BLOCK |

| Ref | Revision | By | Date |
|---|---|---|---|

RMS (Gloucester) Ltd.

A419/A417

SWINDON TO GLOUCESTER

Client

THE HIGHWAYS AGENCY

Contract

A419 / A417

Title

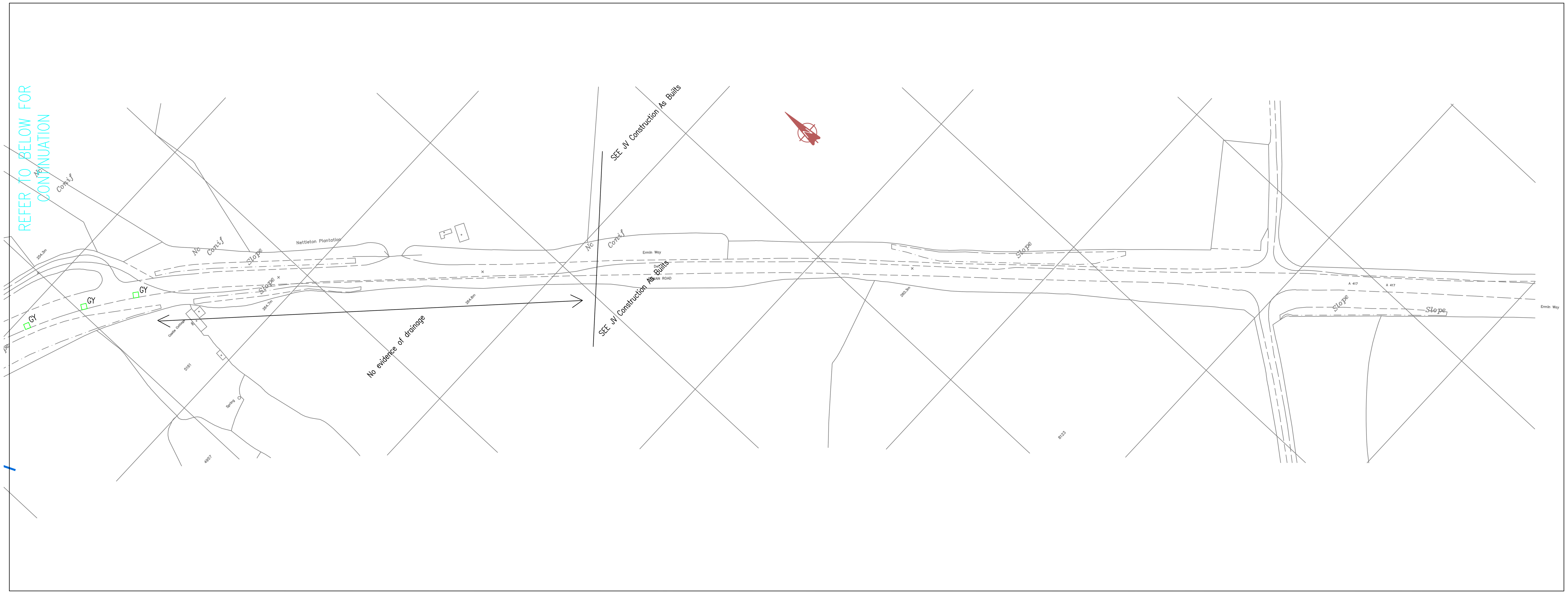
AS BUILT HIGHWAY DRAINAGE

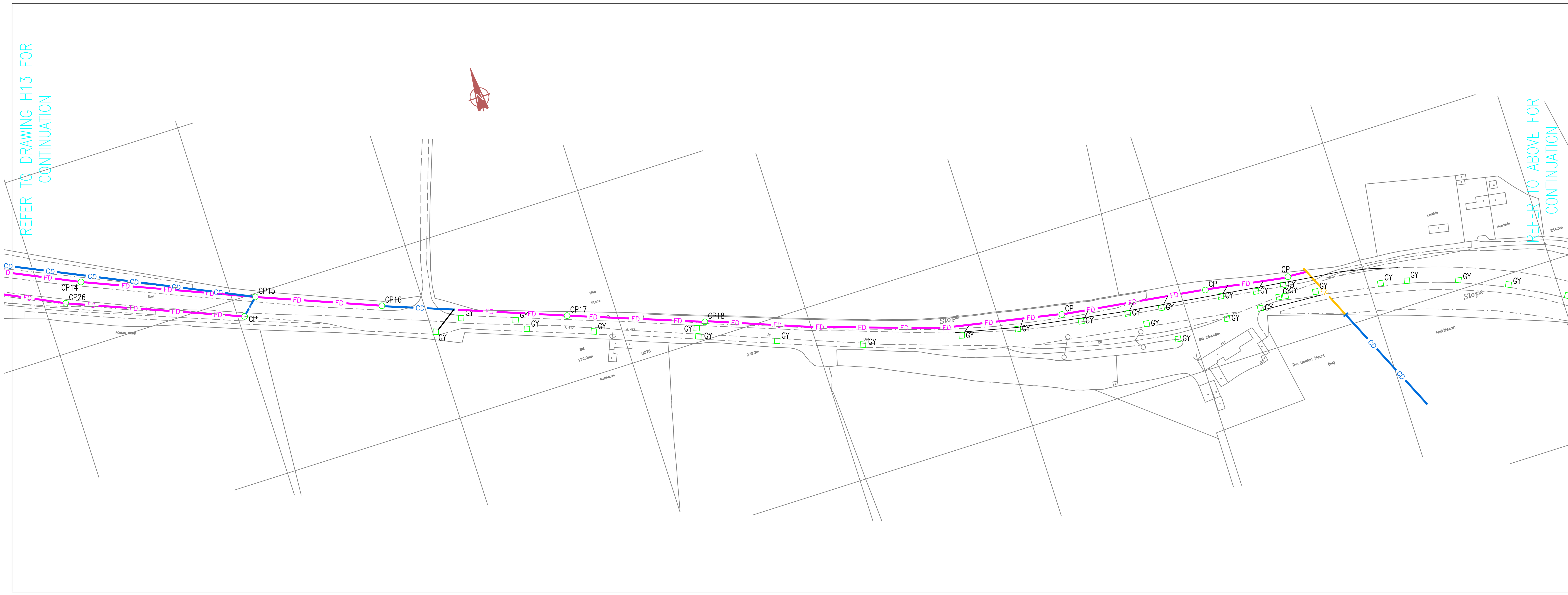
SHEET 2 OF 4

SCALE 1:1250

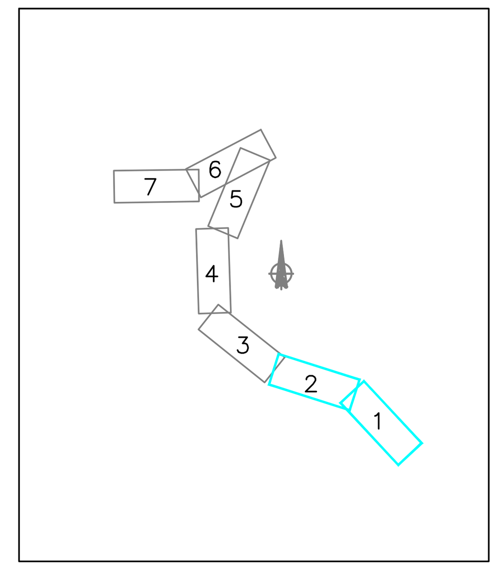
| | | | |
|---|---|---|---|
| Prepared By. | Drawn. WJB | Date. | 11/02 |
| Approved By. | | Date. | |

Drawing No. 19194/ OM1 / H13






LEGEND

| | |
|---|---|
| GY | GULLY |
| RG | GULLY |
| MH | MANHOLE |
| CP | CATCH PIT |
| SC | SOAKAWAY |
| RE | RODDING EYE |
| G | GRIP |
| PG | PIPED GRIP |
| | MARKER POST |
| OIL INTERCEPTOR TYPE 1 | OIL INTERCEPTOR |
| CD | CARRIER DRAIN |
| DI | DITCH |
| FD | FILTER DRAIN |
| FT | FILTER TRENCH |
| TW | THAMES WATER CARRIER |
| CV | CULVERT |
| WC | WATER COURSE |
| KB | COMBINED KERB / DRAINAGE BLOCK |

| Ref | Revision | By | Date |
|---|---|---|---|

RMS (Gloucester) Ltd.

A419/A417

SWINDON TO GLOUCESTER

Client

THE HIGHWAYS AGENCY

Contract

A419 / A417

Title

AS BUILT HIGHWAY DRAINAGE

SHEET 1 OF 4

SCALE 1:1250

Prepared By. | Drawn. WJB | Date. 11/02

Approved By. | Date.

Drawing No. 19194/ OM1 / H12

# Annex B Existing Highway Drainage

# ANNEX B: EXISTING HIGHWAY DRAINAGE - CATCHMENTS

REFER TO ES FIGURE 13.18 EXISTING HIGHWAY DRAINAGE - PLAN (DOCUMENT REFERENCE 6.4)

| Catchment | Road Name | Highway Authority | Impermeable Area (m2) | Impermeable Area (Ha) | Type of Outfall | Pollution Controls | Attenuation Measures | Details of Outfall | Watercourse / catchment |
|---|---|---|---|---|---|---|---|---|---|
| E1-West | A417 | HE | *15,158* | 1.516 | Watercourse | Catchpits, gullies | None identified | Piped outfall to ditch at Old Coach Road<br>**Highway drainage intercepts land drainage on North side of A417 (Bentham)** | Norman's Brook Tributary (Stream at Crickley Hill) |
| E1-East | A417 | HE | *10,192* | 1.019 | Watercourse | Catchpits, gullies | None identified | A417 drainage connects to E1-West network via 450mm diam. pipe on North side of Witcombe Court Underbridge | Norman's Brook Tributary (Stream at Crickley Hill) |
| E2 | A417 | HE | 12,825 | 1.283 | Watercourse | Gullies, (catchpits?) | None identified | West: Piped connection to culverted watercourse (Crickley Hill Stream)<br>East: Piped outfalls to Crickley Hill Stream (3-4 no) .<br>**Highway drainage intercepts land drainage on North side of A417 (Crickley Hill)** | Norman's Brook Tributary (Stream at Crickley Hill) |
| E3 | A417 | HE | 5,826 | 0.583 | Watercourse | Gullies, (catchpits?) | None identified | Piped outfall to Crickley Hill Stream in vicinity of Grove Farm.<br>**Highway drainage intercepts land drainage on North side of A417 (Crickley Hill)** | Norman's Brook Tributary (Stream at Crickley Hill) |
| E4-A Nth | A417 | HE | 5,485 | 0.549 | Soakaways | Catchpits, gullies, filter drains | (Soakaways) | Soakaways.<br>E4-A (Nth) section: 2 soakaways. Overflow route is to E4-B<br>**Highway drainage intercepts land drainage on East side of A417 Birdlip Hill (Emmas Grove)** | River Churn (via Ullenwood, Coberley) |
| E4-A Sth | A417 | HE | 6,752 | 0.675 | Soakaways | Catchpits, gullies, filter drains | (Soakaways) | E4-A (Sth) section served by a network of 10 soakaways at embankment near Four Winds farm.<br>Primary overflow route west to watercourse at Four Winds (connects to Crickley Hill Stream via Grove Farm), but possible overflow route north to E4-A (Nth) | Norman's Brook Tributary (Stream at Crickley Hill) |
| E4-B | A417/A436 Air Balloon Roundabout | HE | 2,814 | 0.281 | Soakaways | Catchpits, gullies, filter drains | (Soakaways) | Overflow/outfall to Soakaway at Ullenwood CC.<br>(No connection to E3) | N/A |
| E5-A417 | A417 | HE | 3,001 | 0.300 | Soakaways with overflow to E5-BW | Catchpits, gullies, filter drains | (Soakaways) | Overflow connections to E5-BW (Barrow Wake) | N/A |
| E5-BW | Barrow Wake | GCC | 7,760 | 0.776 | Watercourse | Gullies | (Soakaways) | Outfall/overflow to watercourse at Four Winds (connects to Crickley Hill Stream via Grove Farm) | Norman's Brook Tributary (Stream at Crickley Hill) |
| E6 | A417 | HE | 11,433 | 1.143 | Soakaways | Catchpits, gullies, filter drains, ditches | Ditches and soakaway pond | Ditch connects to pond/soakaway in copse. Exceedence overflow route is to Coldwell Bottom | N/A |
| E7 | A417 | HE | 4,020 | 0.402 | Soakaway to overflow to dry valley | Catchpits, gullies, filter drains, ditches | Ditches and soakaway overflowing to dry valley | No positive connection to watercourse. Likely exceedence overflow route is to dry valley to west (Parsons Pitch) | N/A |
| E8-West | A417 | HE | 3,500 | 0.350 | Soakaway, with overflow to E8-West | Catchpits, gullies, filter drains | (50% Soakaways) | Section north of Stockwell Lane is partially served by soakaways. (approx 50%). 375mm diam overflow connection to E8-East | River Frome |
| E8-East | A417 | HE | 10,769 | 1.077 | Watercourse | Gullies, (catchpits?), filter drains | None identified | Piped connections to culvert at Nettleton Bottom | River Frome |
| E9-Nth (HE) | A417 | HE | *11,077* | 1.108 | Watercourse | Catchpits (mainline), Gullies(roundabout), Lagoon, Petrol Interceptor, shut off valve | Lagoon | Combined A417, local roads and land drainage network outfalls via (HE) PI & lagoon<br>**Highway drainage intercepts land drainage on East side of A417** | River Frome |
| E9 (GCC) | Cowley Junction (local roads) | GCC | *6,612* | 0.661 | Watercourse | Catchpits, Gullies, Lagoon | Lagoon | Combined A417, local roads and land drainage network outfalls via (HE) PI & lagoon.<br>**Highway drainage intercepts land drainage on East side of A417** | River Frome |
| E9-Sth (HE) | A417 | HE | *11,288* | 1.129 | Watercourse | Catchpits (mainline), Lagoon, Petrol Interceptor, shut off valve | Lagoon | Combined A417, local roads and land drainage network outfalls via (HE) PI & lagoon | River Frome |

| | | | |
|---|---|---|---|
| **TOTAL (A417)*** | **87,695** | **8.769** | |
| **TOTAL (GCC)** | **14,372** | **1.437** | |
| | *soakaway* | 3.801 | *43%* |
| *A417 only, Cowley UB to Witcombe Court UB) | *watercourse* | 4.968 | *57%* |

| | |
|---|---|
| Paved areas (E2, E3) may be taken in to account for A417 ML storage calculations (stream at Crickley Hill) | 1.865 |
| Paved areas (E9-Nth) may be taken in to account for A417 ML storage calculations (River Frome) | 1.108 |
| Paved areas -' like for like' area may be applied in A417 Missing Link calculations | 1.019 |

# Annex C Scheme Highway Drainage

# ANNEX C: SCHEME HIGHWAY DRAINAGE - CATCHMENTS

REFER TO ES FIGURE 13.19 SCHEME HIGHWAY DRAINAGE - PLAN (DOCUMENT REFERENCE 6.4)

| | | | Proposed Area (m2) | | | | | | | | | Storage Requirement (m3) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Catchment ID | Road/Catchment | Adopting Highway Authority | Paved | Earth-works (inc basins) | Total Area | PIMP (%) | Catchment Cutting/ Embankment | Comments | Attenuation/Storage | Receiving watercourse | Qbar (l/s) | Attenuation Storage | Long Term Storage | Storage Volume (ICoP) |
| 1 | **A417 (west of Witcombe Court UB)** | **HE** | 14,005 | 11,457 | 25,462 | 55 | At grade | Area west of Witcombe Court UB - receives the attenuated discharge from Catchment 2.<br>Existing outfall, Old Coach Road.<br>**Outfall also intercepts 8.8ha (88,000m2) rural catchment on north side of A417** | n/a. Existing | Crickley Hill Stream<br>(Tributary of Norman's Brook) | - | - | - | - |
| 2 | **A417 (Witcombe Court UB to Grove Farm)** | **HE** | 53,825 | 12,499 | 66,325 | 81 | Embankment & Cutting | Connection to existing catchment E1-West/P1<br>Basin sized to attenuate Q100+40%cc event. Flow limit based on Existing Catchment E1-East (1.2ha).<br>Lower bound limit the greater of 5l/s or 2l/s/ha | Basin No 2 | Existing Highway Network E1, Old Coach Road, Crickley Hill Stream<br>(Tributary of Norman's Brook) | 4.22 (N/A) | 7951 | 1760 | 9711 |
| 3W | **A417 (Grove Farm to Air Balloon)** | **HE** | 19,683 | 7,664 | 27,347 | 72 | Cutting | Basin next to Grove Farm with access via underpass | Basin No 3c | Crickley Hill Stream<br>(Tributary of Norman's Brook) | 9.6 | 2505 | 676 | 3181 |
| 3E | **A417 (Air Balloon to Shab Hill)** | **HE** | 37701 | 20,051 | 57,752 | 65 | Cutting | Basin south west of new Ullenwood junction roundabout. Outfall/overflow under roundabout to dry valley near Leckhampton Hill and basin 5 | Basin No 3a | Dry Valley (National Star College, Town End Coberley, River Churn) | 20.3 | 4906 | 1191 | 6097 |
| 6 | **A417 (Shab Hill Nth, inc nb slip road)** | **HE** | 20,858 | 11,727 | 32,585 | 64 | Embankment | Basin inside slip lane loop on west side. Connection to culvert under junction. | Basin No 6 | Dry Valley /Ditch (Coldwell Bottom, River Churn) | 11.8 | 2944 | 748 | 3692 |
| 8 | **A417 (Shab Hill Sth, inc sb slip road)** | **HE** | 8,800 | 2,665 | 11,465 | 77 | Embankment | Basin inside slip lane loop on east side. Connection to culvert under junction | Basin No 8 | Dry Valley /Ditch (Coldwell Bottom, River Churn) | 4.0 | 941 | 142 | 1191 |
| 9 | **A417 (Shab Hill to Cowley Lane OB)** | **HE** | 18,935 | 20,144 | 39,078 | 48 | Cutting | Connection to ditch. Overflow flood culvert through landscape bund. | Basin No 9 | Dry Valley /Ditch (Coldwell Bottom, River Churn) | 13.8 | 2962 | 583 | 3545 |
| 10 | **A417 (Cowley Lane OB to Stockwell Acc OB)** | **HE** | 25,167 | 32,559 | 57,727 | 44 | Cutting | Ditch or pipe to Nettleton Bottom (culvert under existing A417). Overflow flood culvert through landscape bund. | Basin No 10 | Dry Valley (Nettleton Bottom, River Froome) | 20.3 | 4217 | 762 | 4979 |
| 11 | **A417 Mainline (Stockwell Acc OB to Cowley Junction)** | **HE** | 29,947 | 35,894 | 65,841 | 45 | Cutting | See GCC catchments 13a & 13b<br>New outfall to re-use route/upgrade existing outfall south of Brimpsfield Lane | Basin group 11 | River Froome | 23.1 | 4874 | 911 | 5785 |
| 13b | **Cowley junction (east - slip lane)** | **HE** | 3,894 | 312 | 4,206 | 93 | Cutting | Slip lane connects to existing highway drainage at junction. Road area equivalent to existing<br>Re-use existing outfall & lagoon (Inc PI). Adjacent WCHR/access would be GCC maintained | Existing lagoon | River Froome | - | - | - | - |
| 12 | **A417 (sth of Cowley Junction)** | **HE** | 27,539 | 37,457 | 64,996 | 42 | Embankment | Catchment south of Cowley UB is unaltered. Total area equal to or less than existing. Re-use existing outfall & lagoon (Inc PI). Area would include some local GCC roads (4472m2) | Existing lagoon | River Froome | - | - | - | - |
| | **TOTAL (HE)**<br>(exc 1 & 12) | **m2** | **218,810** | **143,515** | **362,325** | **m2** | | | | | | | | |
| | | **Ha** | **21.88** | **14.35** | **36.23** | **Ha** | | | | | | | | |

| | | | Proposed Area (m2) | | | | | | | | | Storage Requirement (m3) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Catchment ID | Road/Catchment | Adopting Highway Authority | Paved | Earth-works (inc basins) | Total Area | PIMP (%) | Catchment Cutting/ Embankment | Comments | Attenuation/Storage | Receiving watercourse | Qbar (l/s) | Attenuation Storage | Long Term Storage | Storage Volume (ICoP) |
| 4b | **WCHR route (Dog Lane to Cold Slad Lane)** | **N/A** | 3,622 | 5,055 | 8,677 | 42 | At grade (existing) | Repurposed lane 1 of existing A417. Consider equivalent paved area<br>Proximity to A417. Source control/linear attenuation within road corridor. Connection to Crickley Hill Stream under A417 near bat underpass and to existing culvert at Dog Lane (Crickley Hil Stream). Run-off from hill side intercepted separately from road drainage where practical. | Linear attenuation /source control | Crickley Hill Stream<br>(Tributary of Norman's Brook) | 3.1 | 508 | 79 | 587 |
| 4a | **Cold Slad Lane** | **GCC** | 4,263 | 2,451 | 6,714 | 63 | At grade (existing) | Repurposed lane 1 of existing A417. Consider equivalent paved area<br>Proximity to A417. Source control/linear attenuation within road corridor. Connection to Grove Farm culvert (Crickley Hill Stream) via Grove Farm underpass. Run-off from hill side intercepted separately from road drainage where practical. | Linear attenuation /source control | Crickley Hill Stream<br>(Tributary of Norman's Brook) | 2.4 | 442 | 103 | 545 |
| 5 | **A436 (north) & New AB Roundabout** | **GCC** | 22,224 | 14,793 | 37,017 | 60 | Cutting/ at grade | Infiltration opportunities at roundabout & basins<br>Basin north east of Ullenwood junction with overflow towards golf course/dry valley between Leckhampton Road and A436. | Basin group 5 | Dry Valley (National Star College, Town End Coberley, River Churn) | 13.0 | 3076 | 748 | 3824 |
| 7c | **Access Road (Cuckoopen Farm Nth)**<br>**Unclassified road to be adopted by GCC** | **GCC** | 1,728 | 300 | 2,029 | 85 | Cutting/ Embankment | Access road is unclassified highway. Storage in ditches and swales in verges | Swales/source control | Dry Valley /Ditch (Ullenwood, National Star College, River Churn) | 0.7 | 86 | 0 | 86 |
| 7b | **A436 (south), B4071 east, Shab Hill rdbts**<br>**PMAs/unclassified roads, inc Cuckopen Farm (Sth)** | **GCC** | 21,253 | 21,732 | 42,985 | 49 | Cutting/ Embankment | Accesses on B4071 are unclassified highways. Basin inside sthbd slip loop. Connection to flood culvert under junction | Basin No 7b | Dry Valley /Ditch (Coldwell Bottom, River Churn) | 15.1 | 3245 | 634 | 3879 |
| 7a | **B4071 west (Barrow Wake)** | **GCC** | 7,515 | 6,036 | 13,552 | 55 | At grade | Tank/soakaway under Barrow Wake Car Park. May be substituted with geocellular tank. Existing soakaways may be utilised and/or upgraded. Condition & efficacy of existing drainage uncertain. Existing car park & highway currently drains informally to adjacent GWT land with overflow to Grove Farm (Crickley Hill Stream) | Tank/soakaway | Crickley Hill Stream (Tributary of Norman's Brook) via Grove Farm | 4.8 | 980 | 152 | 1132 |
| 14 | **B4071 (existing)** | **GCC** | 6,144 | 227 | 6,372 | 96 | Cutting/ Embankment | Re-use and adapt existing highway drainage systems. Possibly drains informally to adjacent land and/or infiltrates to ground. | Swales/existing | Crickley Hill Stream (Tributary of Norman's Brook) via existing (informal) outfalls to surrounding fields (est). | - | - | - | - |
| 13a | **Cowley Junction (west)** | **GCC** | 4,805 | 437 | 5,242 | 92 | At grade | Slip lanes and rdbt connect to HE catchment 12. GCC road/rdbt area equivalent area to existing<br>Re-use existing outfall & lagoon (Inc PI). | Existing lagoon | River Froome | - | - | - | - |
| | **TOTAL (GCC)**<br>(exc 4b & 14) | **m2** | **24,922** | **45,749** | **107,538** | **m2** | | | | | | | | |
| | | **Ha** | **2.49** | **4.57** | **10.75** | **Ha** | | | | | | | | |

**NOTES**

**1** Parameters used:
Qbar rural (Ethwks Cv=0.40, R=0.3, M5-60=20, SAAR=872, SPR=0.37)

Qbar (l/s/ha): 3.52 l/s/ha

**2** Minimum flow thresholds: 5l/s and 2l/s/ha