UNITED UTILITIES
SUSTAINABLE CATCHMENT MANAGEMENT PROGRAMME

WATER QUALITY MONITORING RESULTS
JULY 2012

United Utilities

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CONSULTANT ECOLOGISTS

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SCAMP WATER QUALITY MONITORING

JULY 2012

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This project has been undertaken in accordance with PAA policies and procedures on quality assurance.

Signed

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1. INTRODUCTION

1.1 The hydrological monitoring that had been established as part of SCaMP 1 (2006-2010 inclusive) has been continued throughout 2011 and into 2012. It is due to continue under this phase of SCaMP until the end of 2014. No botanical monitoring was undertaken in 2011, but is due to take place on the key blanket bog sites where hydrological monitoring is conducted later in 2012.

1.2 The hydrological monitoring has comprised:

- water quality monitoring (colour and turbidity) after grip blocking in the Goyt Valley, Peak District and Brennand, Bowland, along with stage discharge measurements;
- water quality monitoring (colour and turbidity) after re-vegetation work on Ashway Gap, Longdendale, Peak District, along with stage discharge measurements; and,
- water table levels in the peat at all three sites (i.e. Ashway Gap, the Goyt and Brennand study catchments).

1.3 The results of these studies are reported in the following sections, adding to the data already presented for the period 2006 (2007 for Brennand) to 2010.

2. GOYT STUDY CATCHMENT

2.1 The River Goyt is a major tributary and significant headwater of the River Mersey. Rising to 525m, the sub-catchment studied within SCaMP consists of around 600ha of predominately blanket bog over deep peats (averaging 1.5m) and around 250ha of dwarf shrub heath. The vegetation is a mix of cotton grasses and dwarf shrubs typical of drier blanket bog habitat, with little *Sphagnum* cover except in the wettest areas. Figure 1 illustrates the Upper Goyt study catchment together with SCaMP monitoring plots and the location of monitoring equipment installations. Photo 1 illustrates a typical view of the Goyt study catchment.

2.2 Grip blocking has been carried out on the Goyt on two areas of catchment. At the same time, sheep stocking levels were reduced and burning for grouse moor management ceased, at least for a period. The objectives for these activities were:

- to raise the water table in the peat, thus establishing wetter and, therefore, better condition blanket bog, thus also increasing the possibility of maintenance and enhancement of carbon sequestration;
- to encourage, through this re-wetting, a more diverse blanket bog vegetation with more characteristic plant species, including a greater cover and diversity of *Sphagna sp*.; and,
- to reduce the production and loss of dissolved organic carbon (DOC), thus contributing to improved water quality for United Utilities' (UU) treatment works, but also reducing carbon loss from the peat store on the moorlands.

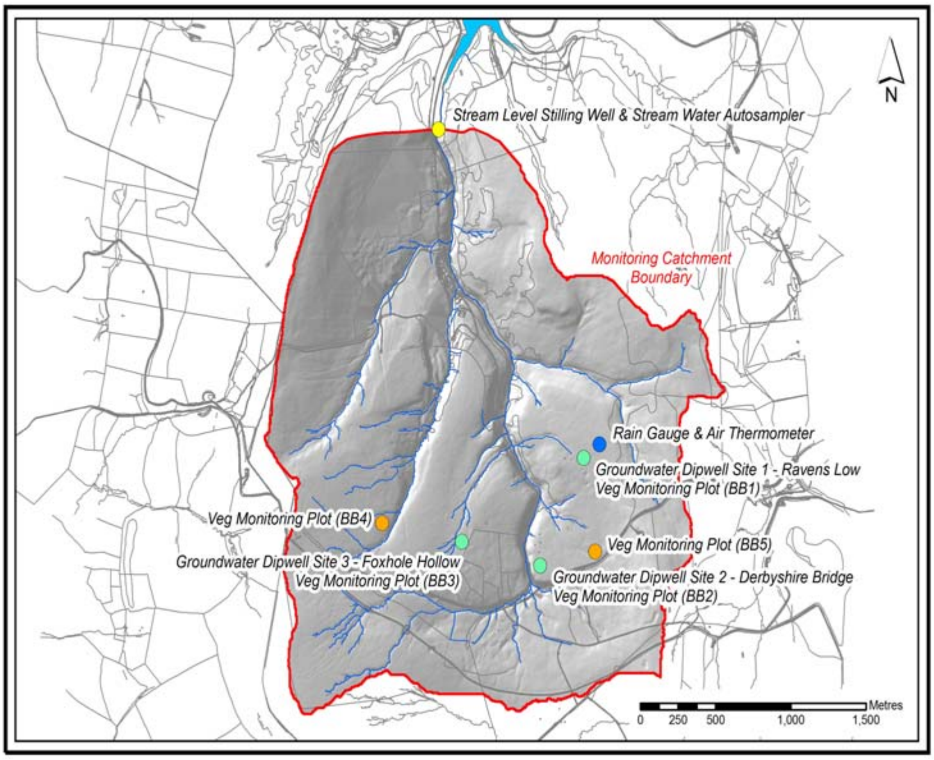

Figure 1 *Location of Monitoring Sites Across the Goyt Estate*

Photo 1 *View Across the Goyt Valley Study Catchment*

Goyt - Raw Streamflow Water Colour

2.3 The time series record for raw streamflow water colour (a surrogate for dissolved organic carbon, or DOC) in the Goyt is illustrated in Figure 2.

2.4 The colour trend observed on the River Goyt continues to improve at a slight, but statistically significant rate, once seasonality has been factored out of the series.

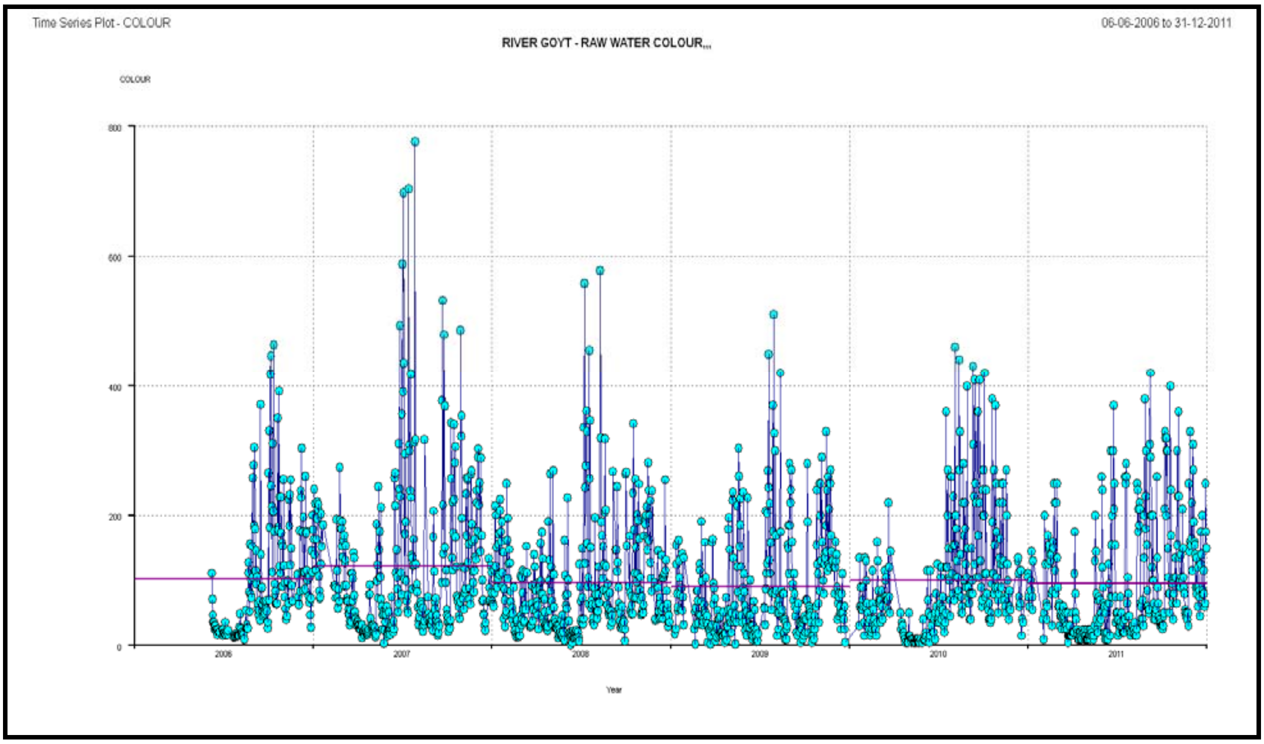

Figure 2 *River Goyt - Raw Streamflow Colour 2006-2012*

2.5 A slight improvement in raw water colour at a mean rate of 0.7% per annum (entire data series taken together, from 2006 to 2011) has been observed and reported previously.

2.6 At present, the median raw water colour in the Goyt streamflow is 68 degrees hazen (mean is 99.54 hazen). Thus, a 0.7% annual reduction in colour equates to a 0.476 hazen drop in median raw water colour per annum. If this trend is projected forward, the annual reduction in median raw water colour ten years from now would be 4.76 hazen, assuming that the trend in water colour continues to decline at the same rate over this period.

2.7 Using the arithmetic mean value, the annual year on year rate of colour production will decrease at 0.69 hazen per annum. Thus, we may expect mean raw water colour to decline by 6.9 hazen by 2022, based on the same assumptions as set out above.

2.8 A comparative statistical test between raw streamflow water colour in the Goyt pre and post SCaMP works is not possible with the Goyt data as the vast majority of grip blocking work had been completed across the catchment by the time SCaMP monitoring had started. Nevertheless, trend tests continue to show declining colour levels at the catchment outlet.

2.9 The key Goyt results demonstrate that real, although slight improvements in water quality have been achieved as a result of grip blocking, stock exclusion and cessation of burning across only a relatively small catchment.

Goyt – Streamflow Turbidity (Suspended Sediment)

2.10 As in previous years, Goyt turbidity levels remain low and constant, a function of the intact nature of the blanket bog in the upper catchment. No trends have been detected and levels remain very low.

3. ASHWAY GAP STUDY CATCHMENT

3.1 The Ashway Gap study catchment (as shown in Figure 3) forms one of the three restoration sites selected for restoration. Much of the blanket bog (some 12.5%) has been heavily gullied, severely eroded and incorporates much bare peat. The extensive bare ground is thought to be related to repeated wildfires, but the loss of *Sphagnum* about 230 years ago across the Peak District is linked to air pollution and a coincident increase in the rate of erosion, both of which would have contributed to increased bare peat exposure.

3.2 On-going heavy grazing and air pollution have prevented effective regeneration of the vegetation in the recent past.

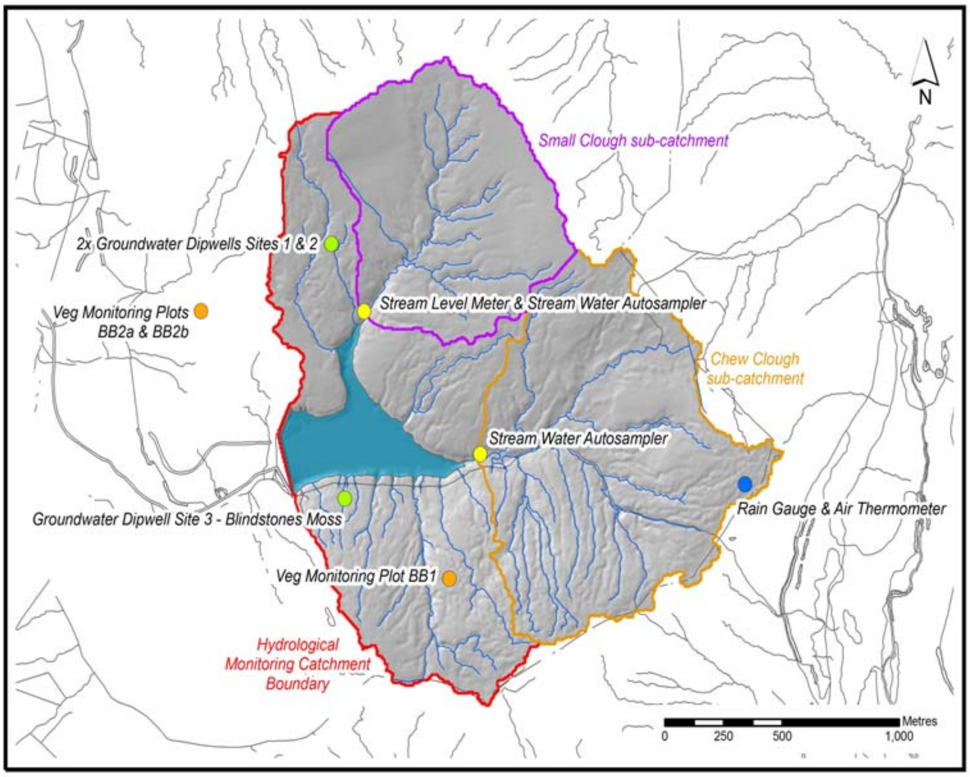

Figure 3 *Location of Monitoring Sites Across Ashway Gap*

3.3 SCaMP has provided the opportunity to restore areas of damaged blanket bog with the dual objectives of improving the water quality in the nearby reservoirs and restoring the habitat as part of the SSSI condition targets.

3.4 The vegetation of the area is poor in species and dominated by hare's-tail and common cotton grasses (*Eriophorum vaginatum* and *E. angustifolium*) with crowberry (*Empetrum nigrum*) and bilberry (*Vaccinium myrtillus*) on the drier peat. Heather (*Calluna vulgaris*) is only locally abundant. *Sphagnum* and other mosses are scarce but currently increasing as a response to reductions in sulphur dioxide.

3.5 The restoration works were implemented within a stock-proof fence (covering 1,675.9ha of blanket bog), in the winters of 2007/8 and 2008/9 and focused on the worst affected areas within the western half of the fenced site. The scale of the measures is significant, reflecting the integrated approach that SCaMP has taken, with lime, seed and fertiliser added to some 93ha and heather brash with lime, seed and fertiliser applied to a further *c*.377ha. Rolls of a geotextile; geojute totalling 12.97ha have been pegged out onto the steeper peat slopes. Figure 3 illustrates the Ashway Gap study catchment together with SCaMP monitoring plots and the location of equipment installations.

3.6 The specifications, which were based on experimental work undertaken within the Moorland Management Project (Anderson, Tallis and Yalden, 1997), were:

- the addition of lime and fertiliser with a grass seed nurse crop mix;
- the addition of cut heather with pods and seeds still attached (brash) to the lime/seed and fertiliser-treated areas;
- securing geojute geotextile to steep, bare gully sides with the addition of lime/seed and fertiliser with or without the brash also added;
- some experimental placing of coir rolls in peat pans to stabilise the peat and reduce peat loss and rill development; and some gully blocking with stone (deeper gullies) or heather bales (shallower areas) in selected sites.

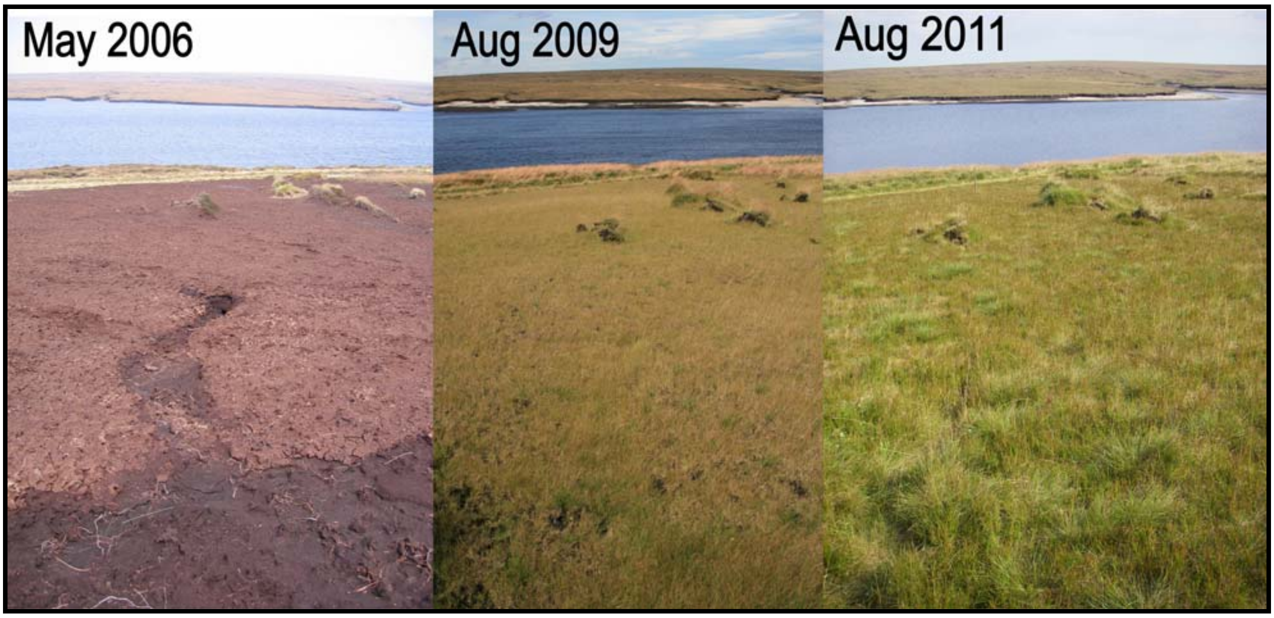

Photo 2 *View Across the Ashway Gap Study Catchment Showing Changes in Vegetation Following SCaMP Management*

Ashway Gap - Streamflow Water Colour

3.7 In order to attempt to isolate out the direct effects of SCaMP management works (re-vegetating much of the extensive areas of bare and eroding peat), a set of trend tests have been completed on the post SCaMP treatment datasets for raw water quality on Ashway Gap.

3.8 Post treatment water quality records have been assessed for streamflow colour on both Chew Clough and Small Clough catchments (see Figure 3 for locations and context).Overall, the raw water colour trends in both Chew and Small Clough have always indicated a slight, statistically significant increase and this pattern has been consistent throughout SCaMP monitoring, until the end of 2010.

3.9 However, the latest statistical results based on the post treatment data series point to a slight reduction in raw water colour production as time series trend tests conducted show raw water colour decreasing on both Chew and Small Clough simultaneously, suggesting that SCaMP works may be having a similar effect on raw water colour production as observed on the Goyt. These results are obviously exciting, as to date it was thought unlikely that colour production would be influenced so directly by re-vegetation and gully blocking work on such a degraded catchment. Furthermore, it was also expected that changes in water colour would take much longer to become apparent, if at all.

3.10 Despite the unexpected results outlined above, the observed trends are slight and datasets are still subject to climatic variations and so results and interpretations should still be treated with caution.

3.11 The time series record for raw streamflow water colour in Chew Clough is illustrated in Figure 4.

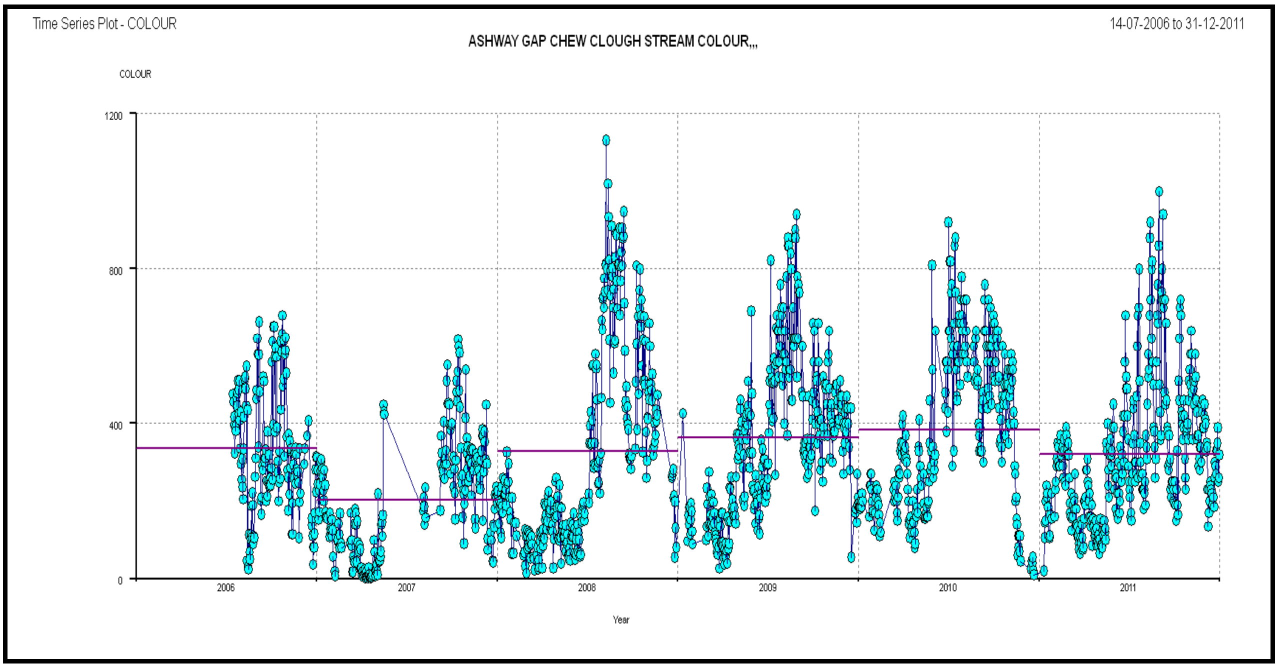

Figure 4 *Chew Clough - Raw Streamflow Colour 2007-2012*

Ashway Gap – Streamflow Turbidity

3.12 Monitoring results have consistently shown that there has been a statistically significant decrease in mean raw water turbidity levels from pre treatment levels to post treatment levels. Again, crucially, both median turbidity levels and standard deviations have also declined, suggesting that the streamflow turbidity levels has also stabilised as well as decreased across both study catchments.

3.13 In Chew Clough, raw streamflow turbidity levels appear to have decreased at an annual rate of -0.136 (nonparametric trend slope coefficient) between 2008 and 2012. This equates to a 13.6% decrease on average per annum. Taking the median daily turbidity level of 13.64 NTU (arithmetic mean 30.11 NTU), this rate of decrease equates to a decreasing trend of approximately 1.85 NTU per annum in the post treatment period.

3.14 On Small Clough, overall trends in raw streamflow turbidity levels are static at the present time (See Figure 5). The background rate probably remains in a decreasing state, but recent presence of algae in the sample results in 2011 and 2012) has lead to false readings. Thus at the present time, it can be assumed that turbidity levels will remain static, or else fall slightly with increasing vegetation cover across the catchment and further gully blocking work.

3.15 Thus, the results of comparative statistical tests indicate that there have been real reductions in turbidity (suspended sediment) levels as a result of SCaMP works across Ashway Gap. Projecting these declining trends forwards, results indicate that, in theory at least, after ten years, raw turbidity levels could have reduced to a theoretical minimum for the catchment, although this is unlikely to be achieved fully until all the bare peat still on the site is restored.

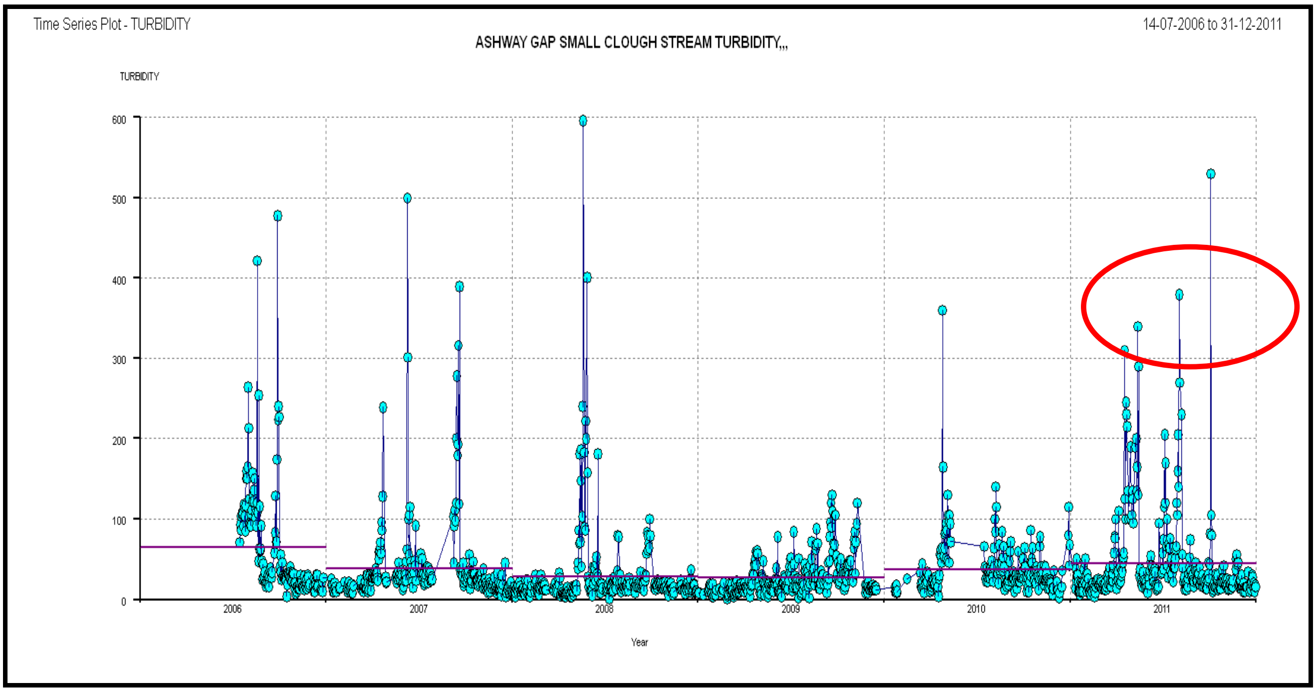

Figure 5 *Ashway Gap Small Clough - Raw Streamflow Turbidity 2008-2011*
(Red ellipse denotes turbidity spikes caused by algal blooms)

3.16 Furthermore, these reductions in suspended sediment delivery have been achieved only by re-vegetating bare peat areas across the catchment. As bare peat covers approximately 20% of the catchment, the observed reductions in suspended sediment are highly significant and demonstrate the effectiveness of blanket bog restoration in reducing suspended sediment loading into streamflow and reservoirs.

3.17 It is important to note that the delivery of turbidity in streamflow is highly event-driven and so the statistics presented here can in some ways be misleading. Periods of elevated suspended sediment delivery during rainfall events may only last for one or two hours on these small, flashy upland catchments. Thus daily sampling may completely miss many such events and so report misleading, under-estimates for turbidity.

4. BRENNAND STUDY CATCHMENT

4.1 The River Brennand lies in the heart of the Forest of Bowland in Lancashire, serving as a tributary to the River Hodder and forming a significant part of the headwaters to the River Ribble. The Brennand catchment, rising to 527m, is some 1,100ha, with its headwaters divided into the two large sub-catchments of Brown Syke (277ha) and Bield Field (166ha). The area is characterised by deeply incised streams arising from blanket bog covered, gently sloping plateaux with peat depths varying from 0.5m to over 2m.

4.2 Brennand Farm includes just over 400ha of blanket bog, almost all of which was identified as in unfavourable recovering condition by Natural England in 2005, and 300ha of upland dwarf shrub heath with some 15% classified as degraded. The study sub-catchments, Brown Syke and Bield Field, were extensively gripped in the 1950s with over 25km of grips representing 15% and 37% of the sub-catchment areas respectively. Bield Field has a proportionately greater area of its catchment surface gripped at the same density as that of Brown Syke. In addition, the upper catchment zone of Brown Syke is highly degraded with substantial areas of exposed peat and bed rock, whereas Bield Field has an intact blanket bog/dwarf shrub heath cover throughout. Brown Syke has also recently been fenced for stock exclusion.

4.3 Figure 6 illustrates the Brennand study catchment together with SCaMP monitoring plots and the location of equipment installations.

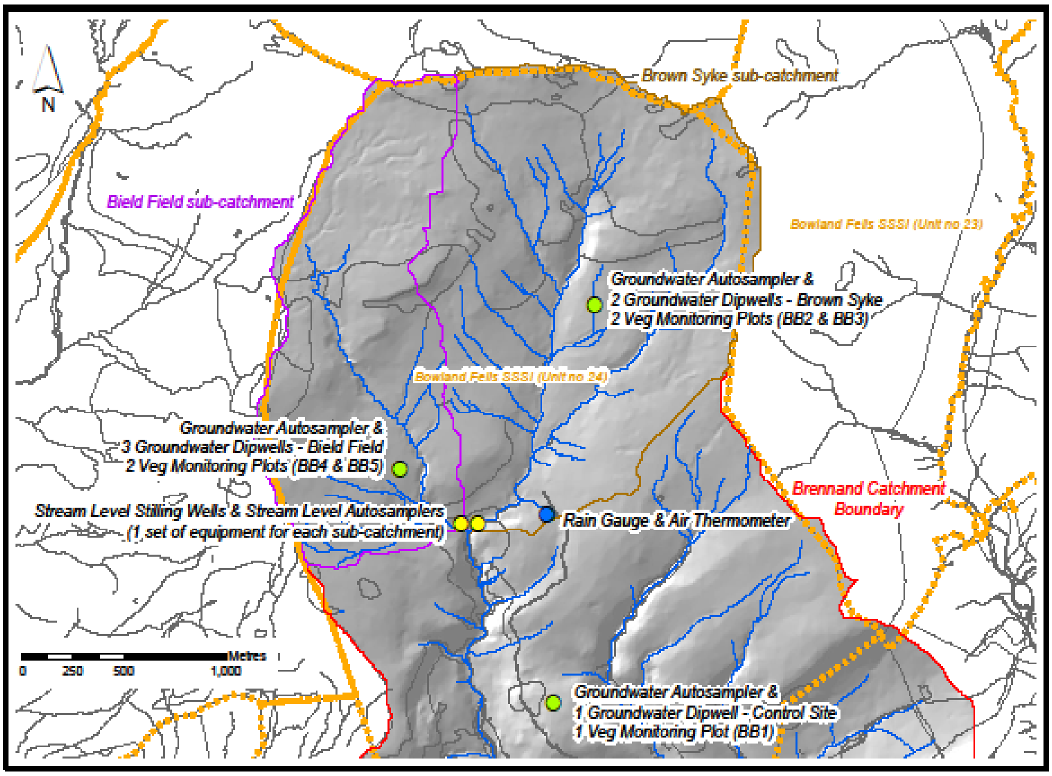

Figure 6 *Location of Monitoring Sites Across the Brennand Catchment*

Photo 3 *Brennand Brown Syke Sub-Catchment Before (May 2007- left) and After (February 2009 - right) Major Grip Blocking Work was Completed*

4.4 Grip blocking has been carried out on Brennand and Whitendale on a large scale. The grip blocking process and its favourable consequences are illustrated in Photos 3, 4 and 5. At the same time, sheep stocking levels were reduced (Brennand) or sheep grazing was re-introduced (Whitendale). The objectives for these activities were:

- to raise the water table in the peat, thus establishing wetter and, therefore, better condition blanket bog, thus also increasing the possibility of maintenance and enhancement of carbon sequestration;
- to encourage, through this re-wetting, a more diverse blanket bog vegetation with more characteristic plant species, including a greater cover and diversity of *Sphagnum*; and,
- to reduce the production and loss of dissolved organic carbon (DOC), thus contributing to improved water quality for UU's treatment works, but also reducing carbon loss from the peat store on the moorlands.

4.5 With an additional year's worth of post treatment monitoring data some key trends are now being observed on the Brennand study catchment after extensive grip blocking and stock reduction. These clearly present cause for cautious optimism, although the trends are not entirely consistent across all sampling sites and instruments.

Photo 4 *A Blocked Grip in the Whitendale Catchment where Vegetation Succession is Beginning to Fill in the Channel. In this Case,* Sphagnum fallax *is Building up in the Old Grip*

5. RAW STREAMFLOW COLOUR

5.1 The latest statistical test results for Bield Field Stream indicate a (post treatment) stationary data series that is neither increasing nor decreasing over time. Although not decreasing, this represents positive news in that it shows how the rate of production and delivery of raw water colour is remaining constant. This result also has to be considered in the context of the Bield Field catchment which was intensively gripped and so displayed high, increasing levels of streamflow colour previous to grip blocking.

5.2 Results from Brown Syke Stream are more positive. The latest trend test results indicate a slight, statistically significant declining trend in colour in the post treatment (grip blocking) monitoring phase. This is supported by a review of summary statistics for the pre and post treatment phases, which show decreasing mean, median and standard deviation (variability in colour delivery) in the post treatment phase compared with the pre treatment phase. This equates to a current rate of decrease of 0.78% per annum.

5.3 Considering the highly degraded nature of the blanket peat across a significant area of the Brown Syke catchment, this result is perhaps the most surprising and positive. The trend is indicated in Figure 7.

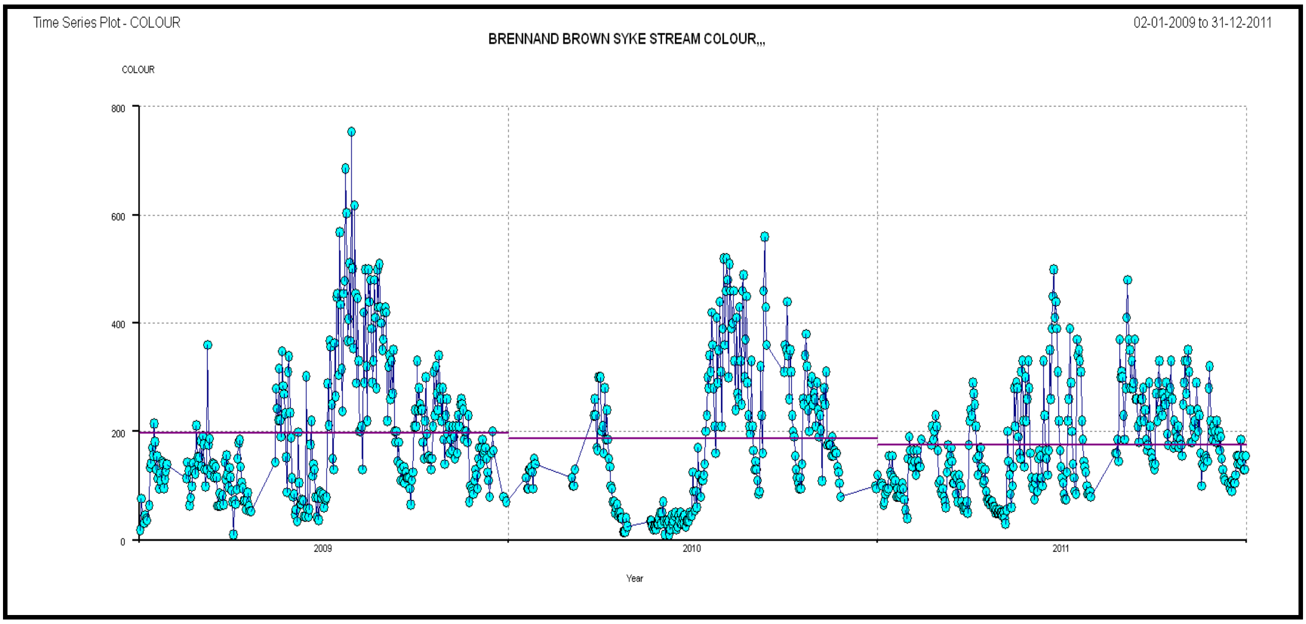

Figure 7 *Brown Syke Stream – Raw Streamflow Colour 2009-2012*

Streamflow Turbidity

5.4 In Bield Field Stream, no statistically significant directional trends in turbidity levels have been observed, although the overall trend appears to hint towards a slight decline in turbidity post grip blocking (see Figure 8). Additional statistical evidence does support this notion as the monthly mean turbidity levels are decreasing with time and, far more importantly, the variability is also decreasing, as also illustrated in Figure 8. Taken together, the results indicate a reduction in throughput of turbidity, suggesting that suspended sediment load is slightly lower and far more stable post grip blocking.

5.5 In Brown Syke Stream, as with Bield Field, no statistically significant directional trends in turbidity levels have been observed and the data series appears to be stationary. Here, however, there is no additional evidence to suggest that the variability in suspended sediment delivery is decreasing. All test results were non significant with no trends and changes in behaviour detected.

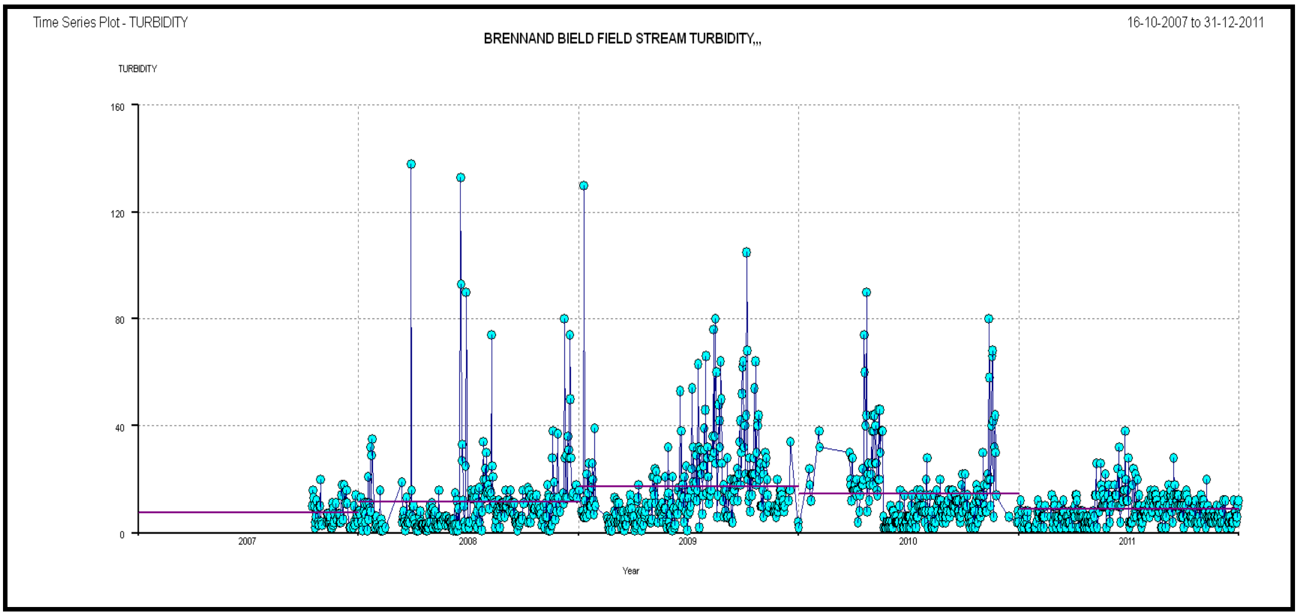

Figure 8 *Bield Field Stream – Raw Streamflow Turbidity 2007-2012*

Using ARIMA Models for Forecasting Colour and Turbidity

5.6 Autoregressive moving average models (ARIMA) were employed in order to try to forward predict trends and rates of change in raw water colour for the Goyt data series and for raw water turbidity for both streams on Ashway Gap.

5.7 Unfortunately, the ARIMA models all predicted a zero rate of change, or stationary in the future data series. This was almost certainly as a result of the very low actual rates of change and the inherent variability in the data series in terms of seasonal variability and random noise. The results of the ARIMA forecasting were therefore rejected. Having said that, no forecast model showed an increasing trend in colour or turbidity.

5.8 In summary, the results of a variety of statistical tests indicate that SCaMP-induced improvements in key water quality parameters are real, although usually slight in effect. This is to be expected. However, long-term there will be significant benefits to the work undertaken for SCaMP and definite improvements in water quality post works and compared to the previous 'do nothing' or deteriorating catchment conditions, pre SCaMP.

6. PEAT WATER TABLE RECOVERY

6.1 SCaMP monitoring results (as reported in the Year 5 (2011) report) also demonstrate that across many study catchments, water table levels are generally rising and stabilising, particularly in zones adjacent to blocked grips. This is leading to real changes in vegetation, particularly the re-establishment of *Sphagnum* species and, over time, the re-establishment of active blanket bog vegetation communities (see Photo 5).

6.2 Having said this, a re-evaluation of the most recent peat water table monitoring datasets, collected up to March 2012 is presented here.

Ashway Gap

6.3 The peat water table dipwell installation on Blindstones Moss, Ashway Gap is still indicating a statistically significant improving (decreasing) trend in peat water table depth over time, in the post treatment period (Figure 9a). Results indicate that background peat water table depth is decreasing, relative to the ground surface (i.e. the water table is gradually rising) in the peat body, albeit slowly and the variability in water table depth is decreasing also, suggesting a slight stabilisation in peat water table regime.

6.4 These results are particularly encouraging for the site at Ashway Gap, given the degraded nature of the peat body. Examination of the monthly mean, median and standard deviation data allows the potential to observe and quantify changes levels and variability further. This is currently being completed.

6.5 In May 2010, a new study was commissioned on the Ashway Gap catchment where stone dams were being used to attempt to block gullies over an extended timeframe. Resources have now been diverted into utilizing technology to provide a more accurate, wider picture of how the SCaMP works influence peat water table levels. Investment was made in an automated array of eight peat water table level meters measuring depth every 50cm from a blocked gully every 15 minutes. This array has now been in for two years and a significant dataset is now accumulating. The aim is for this data to be analysed within the next SCaMP year; a decision was taken not to analyse the data now in order to allow a sufficient time span of records to accumulate.

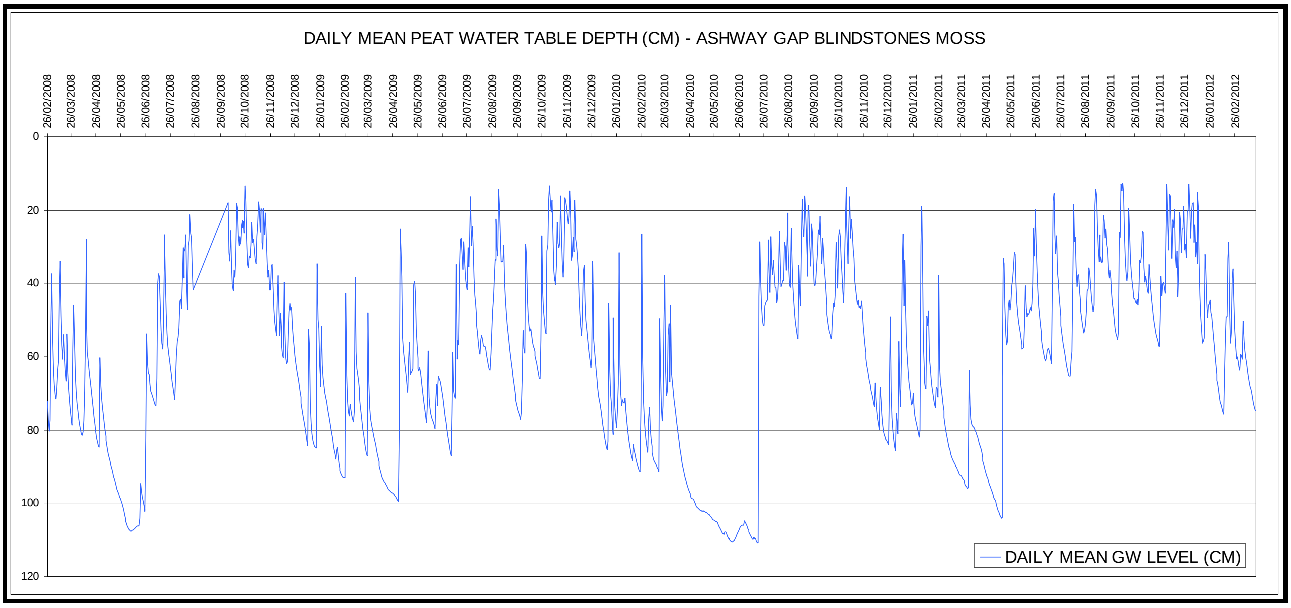

Figure 9a *Mean Daily Peat Water Table Depth - Ashway Gap, Blindstones Moss Dipwell*

Goyt

6.6 Visual examples of SCaMP-related peat water table level response are provided in Figure 9b and 9c. As in previous years, the Goyt 1 Raven's Low water table monitoring dipwell is consistently indicating a weak improving (decreasing) trend in peat water table depth from 2007-2012. At the Goyt 2 Derbyshire Bridge dipwell, a similar trend is observed over the same period. Finally, the trend in improving (decreasing) water table depth is again observed at the Goyt 3 Foxhole Hollow water table dipwell.

6.7 Again, examination of the monthly mean, median and standard deviation data allows the potential to observe and quantify changes levels and variability further. This is currently being completed.

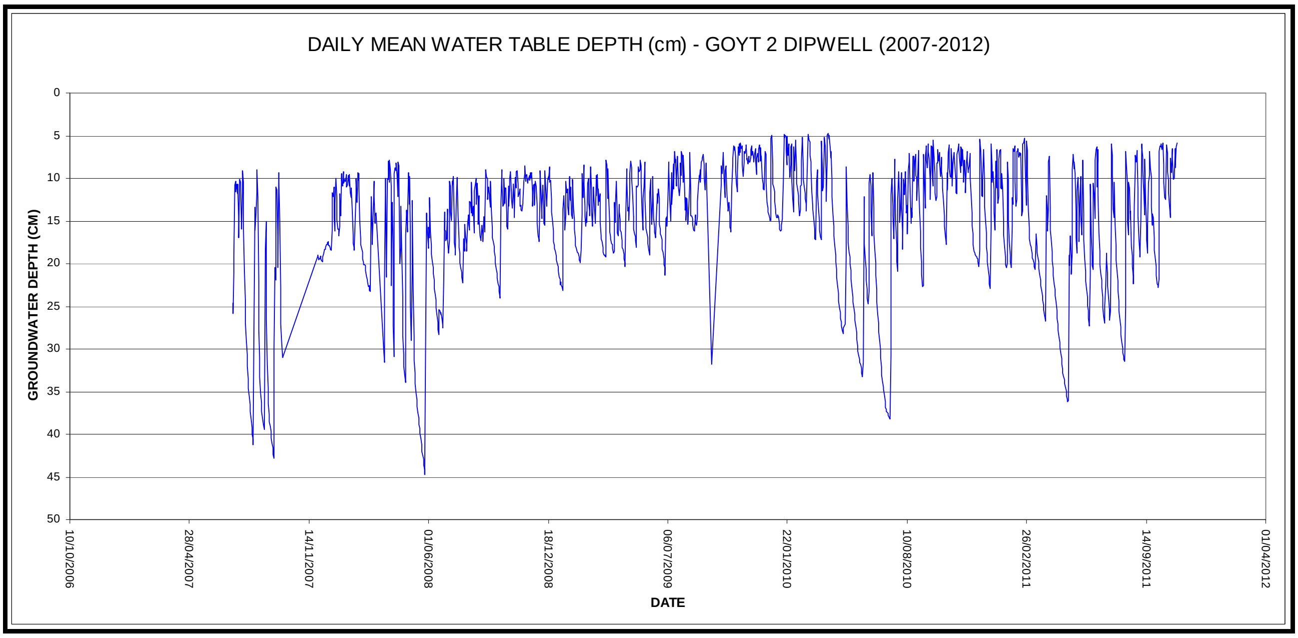

Figure 9b *Mean Daily Peat Water Table Depth – Goyt 2 Dipwell*

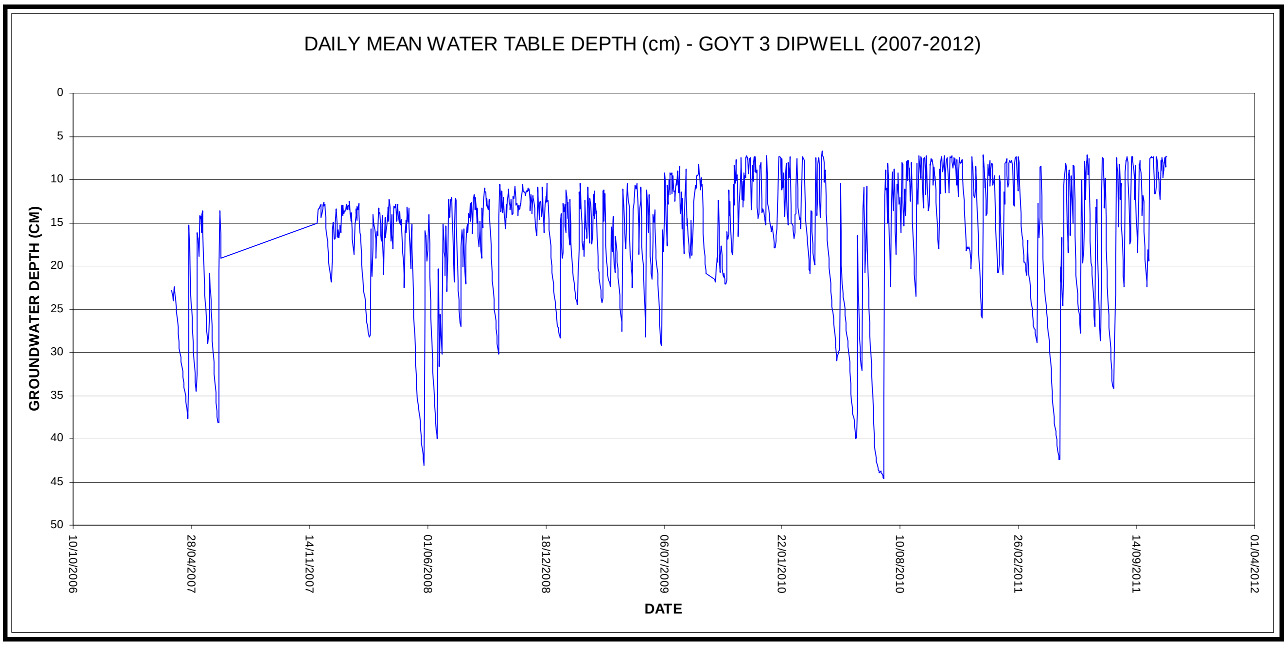

Figure 9c *Mean Daily Peat Water Table Depth – Goyt 3 Dipwell*

Whitendale

6.8 The Whitendale East peat water table dipwell shows a stable groundwater regime with no overall time series directional trend. However, the Whitendale Central water table dipwell shows a very slight, statistically significant improving (decreasing) trend in peat water table depth (increase in level) over the monitoring period 2007-2012.

6.9 Similarly, the Whitendale West water table dipwell shows a similar, though slightly stronger trend to that observed at the Central dipwell, with a slight, improving (decreasing) trend in peat water table depth for the period 2007-2012.

6.10 Taken together, available evidence points to stable or improving groundwater conditions at the monitoring sites.

Brennand

6.11 On the Brennand study catchment, peat water table monitoring dipwells on Brown Syke (the catchment with extensive, degraded sections in its upper reaches) both appear to indicate very slightly declining peat water table levels. At the Brown Syke 1 monitoring dipwell, peat water table depth appears to be increasing very slightly and the Brown Syke 2 dipwell shows an identical, very slight increasing trend also.

6.12 These results are interesting as analyses of the peat water table levels at the Brennand Control dipwell indicates an identical, increasing trend in water table depth over the same monitoring period. Thus, the results show that although trends seem to be indicating a slight drying out of the peat body, this is also the case on the control site and is, therefore, likely not to be a result of any SCaMP-related land management change.

6.13 Across the catchment on Bield Field, the decreasing peat water table levels observed across Brown Syke and the Control site are replicated, with the exception of the Brennand Bield Field 2 dipwell, which is showing a rather marked decrease in water table depth (increase in level) relative to the ground surface. It is not known why this one dipwell is showing a markedly different trend to all others across both sub-catchments, but taken all together, the results suggest a slight drying due to other factors such as climatic conditions or peat pipes rather than any land management-induced changes on the ground.

6.14 The latest Bield Field peat water table monitoring results are conflicting when compared to results from previous years and when compared with water table regimes on the adjacent Whitendale study catchment. This highlights the need to take into account seasonal and longer-term climatic effects when considering the results of statistical tests for trend and change within the SCaMP Monitoring Programme. In addition, there may be other unknown factors serving to complicate patterns and trends further, such as the presence of peat pipes and macro-void structures, which may locally affect peat water table regimes.

6.15 Investigations into the localised effects of grip blocking across gullies and grip cross sections has been undertaken in two distinct ways, manual measurements around grips, and automated monitoring of a gully.

6.16 The study into the influence of grips on peat water table levels using manual techniques was undertaken between 2006 and 2010. This was reported in the 2010 report following the successful grip blocking of the Brennand catchment in Bowland. The results demonstrated a levelling of the peat water table surface within the cross sections of grips where the localized influence of grip drainage was arrested.

Photo 5 *Peat Water Table Recovery Leading to Vegetation Re-colonisation with* Sphagnum *Following Grip Blocking*

Concluding Remarks

6.17 Taken together, the results from the latest batch of trend tests broadly support observations from previous years and across all SCaMP study catchments, where peat water table levels are seen to respond positively in the post SCaMP (grip blocking, grazing removal and gully blocking) period. Measured water table levels have generally been slowly rising in the peat profile and becoming generally less variable, as reflected in the diminishing standard deviations. Achieving this was a direct SCaMP objective and one which appears to be working, though with some degree of success and variation.

7. CAN SCAMP CHANGES BE DETECTED DOWNSTREAM? - EVIDENCE FROM ERRWOOD RESERVOIR, GOYT

7.1 A final set of analyses were undertaken in order to investigate whether the potential water quality benefits from SCaMP-induced land management changes can be detected in raw water colour downstream in the reservoir of the Goyt study catchment. Errwood Reservoir was chosen as a suitable site for study as the treated catchment feeds directly into the reservoir and makes up the majority of the supply into the reservoir. No other monitored SCaMP catchment is suitable for this type of investigation.

7.2 Time series analyses and trend tests were undertaken on the raw water colour data, which has been collected from Errwood Reservoir by UU since 1990, and regularly since 2000. The time series plots are illustrated in Figures 10a, 10b and 10c below, which show the entire data series (Figure 10a), the same data from 2000 onwards, when regular sampling commenced (Figure 10b) and the same data from the post SCaMP land management period only (Figure 10c).

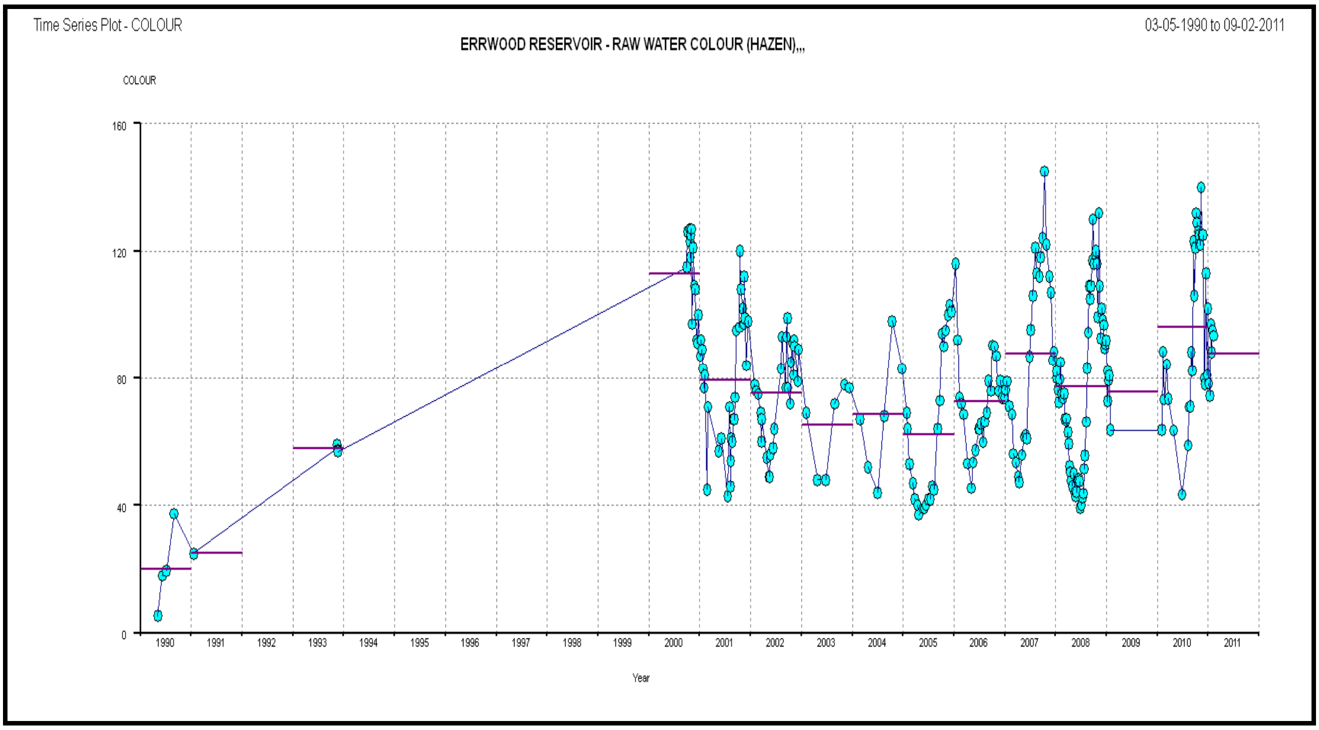

Figure 10a *Raw Water Colour Time Series Plot - Errwood Reservoir, Goyt 1990-2012*

7.3 The trend test results indicate a consistent picture of slight, but statistically significant increasing colour levels in the reservoir. When the data series are considered as a whole, including the small number of spot samples taken in the period 1990 to 2000, there is a slight, statistically significant increasing trend in raw water colour (slope 0.003, $n = 329$, $p < 0.001$).

7.4 This increasing trend is also observed, at the same rate (slope 0.003, $n = 319$, $p > 0.001$) when the data are confined to the period where regular monitoring began, i.e. 2000 onwards (Figure 10b).

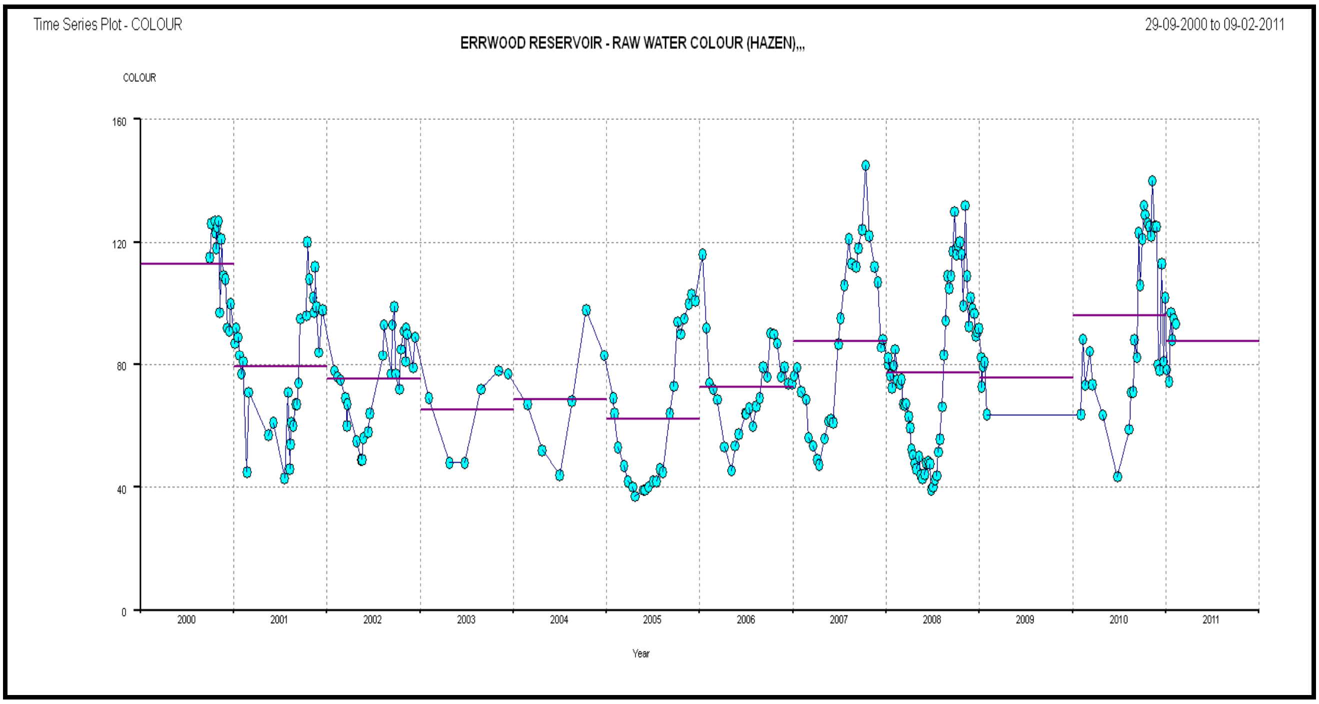

Figure 10b *Raw Water Colour Time Series Plot - Errwood Reservoir, Goyt 2000--2012*

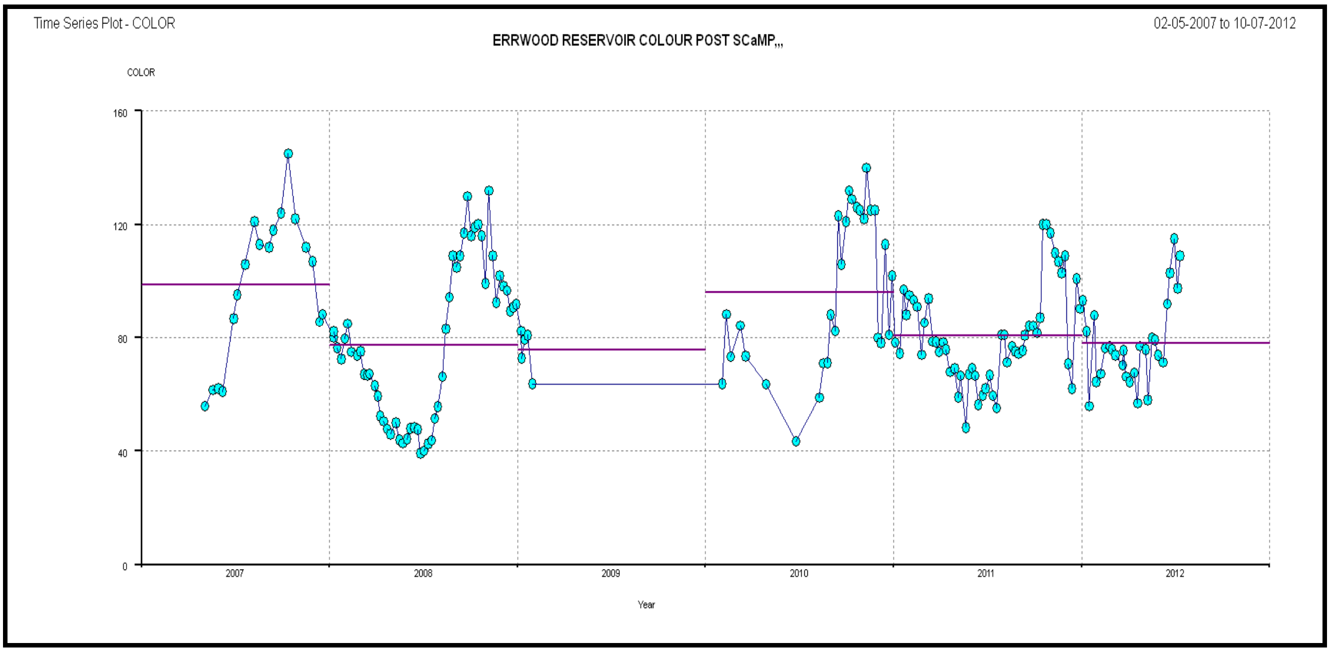

Figure 10c *Raw Water Colour Time Series Plot - Errwood Reservoir, Goyt for the post SCaMP period, 2007-2012*

7.5 However, when the dataset is further confined to the post-SCaMP land management phase, from spring of 2007 until the present, an increasing trend is observed, but at a lower rate of increase (slope 0.001, n = 184). These data are illustrated graphically in Figure 10c. In all cases, the trend test accounts for the strong seasonality in the data. Tentatively, this result can be interpreted that the rate of colour increase in the reservoir is slowing and that this may be direct evidence confirming that SCaMP land management treatment does have a positive effect on water quality in the reservoir.

7.6 Broadly speaking, the results appear to show a changing state of colour flux from one of net increase to net decrease. These results broadly support those found in the Upper Goyt stream running directly off catchment.

8. WATER QUALITY MONITORING – CONCLUSIONS

8.1 In summary, the results of a variety of statistical tests indicate that overall, SCaMP-induced improvements in key water quality parameters are real, although relatively slight in effect. This is to be expected. However, long-term there will be significant benefits to the work undertaken for SCaMP and definite improvements in water quality post works and compared to the previous 'do nothing' or deteriorating catchment conditions, pre SCaMP.

9. REFERENCES

Anderson, P., Tallis, J.H. and Yalden, D.W., 1997. *Restoring Moorland*: *Peak District Moorland Management Project Phase III Report*. Peak Park Joint Planning Board.