ATKINS	CALCULATION CONTROL SHEET
PROJECT: Church Beck PAR	**Job No. 5002531**
PART OF PROJECT: Hydrological Analysis	**Calc. Ref. No. 5002531/95/ca/06**
CALCULATION TITLE: Appendix C.1FEH Calculation Record	**No. Calc. Shts.**
FILE LOCATION: P:GBWAE\Water\ Rivers & Coastal\Projects\5002531 Scarborough\Projects\ 90-100 Work Processes - Church Becks\95 - Hydrology\FEH Calc record - .doc	

CALCULATION SUMMARY

This report provides a record of the calculations and decisions made during design flood estimation using the techniques of the Flood Estimation Handbook (Institute of Hydrology, 1999).

Purpose of Calculations

1. To derive inflows to hydraulic model

2. To derive flow estimates for various return periods

REVISION HISTORY

Revision Ref./ Date Issued	Date	Purpose and description of Amendments	Re-issued to

CHECKING AND REVIEW STATUS

D1	Draft	E Ainsworth	O Drieu	T Ishaq	K Tilford	Jan 2004	SBC
Rev	Purpose	Originated	Checked	Reviewed	Authorised	Date	Client
	Description	WS ATKINS					

1 CONTENTS

1 METHOD STATEMENT

Table 1.1: Overview of study

Item	Comments
Purpose of study	To derive flow estimates for Church Beck and Coldgill Beck
Description of catchment	Jurassic s'st, l'st and shales. Predominantly rural catchment with substantial forest cover. FEH, Flood regime strongly affected by a major drainage diversion, the Sea Cut (27033) which intercepts flood flows from 95% of the catchment. Not used in FEH analyses.
Flood estimates required	5, 10, 25, 50, 75, 100, 200
Approx. time available for study	

Table 1.2: Flow or level data available - None

(at the sites of flood estimates or for nearby donor catchments)

Watercourse	Station	Gauging authority number	NWA number (used in FEH)	Grid reference	Rating?	Period of data in WINFAP-FEH	Period of additional data
Comments on data quality and any checks made							

Table 1.3: Other data available - None

Item	Comments
Flow gaugings (if planned to update rating curve)	
Historic flood data	.
Extra data for other sites in pooling groups (if a major study)	

Table 1.3: Other data available - None

Item	Comments
Flood event data (if planned to use rainfall-runoff method)	
Rainfall event data (if planned to use rainfall-runoff method)	

Table 1.4: Initial choice of approach

Item	Comments
Statistical, rainfall-runoff or hybrid approach?	Hybrid
If statistical, single-site or pooled analysis?	Pooled Analysis
Review and update rating curves?	N/A
Any unusual factors to take into account? (e.g. highly permeable or urban catchment)	No

2 LOCATIONS WHERE FLOOD ESTIMATES REQUIRED

Table 2.1: Summary of subject sites

Site code	Watercourse	Site	Easting	Northing	Catchment area from FEH CD-ROM (km^2)	Any adjustments to catchment descriptors extracted from FEH CD-ROM 1999
01	Church Beck	d/s extent	501050	490100	4.47	URBEXT increased to 2003
02	Church Beck	Upstream of confluence with Coldgill	500850	490450	2.52	URBEXT increased to 2003
03	Coldgill Beck	d/s extent/confluence with Church Beck	500750	490300	1.87	URBEXT increased to 2003
Record how catchment descriptors checked		Catchment area and URBEXT checked with OS Maps in MapInfo. All other catchment descriptors checked for accuracy and reasonability.				

3 RECORD OF DATA USED

Table 3.1 details the catchment descriptors for the catchments representing the 3 summary sites

Table 3.1 – Catchment Descriptors

Catchment Descriptors	All Church Beck	Church Beck	Coldgill Beck
NGR	501050 490100	500850 490450	500750 490300
AREA	4.47	2.52	1.87
FARL	1	1	1
PROPWET	0.32	0.31	0.36
ALTBAR	92	81	110
ASPBAR	115	110	120
ASPVAR	0.45	0.44	0.47
BFIHOST	0.564	0.459	0.707
DPLBAR	2.19	1.78	1.76
DPSBAR	86.5	55.2	130.3
LDP	4.5	4.03	3.03
RMED-1H	10.6	10.6	10.7
RMED-1D	34.4	34.3	34.4
RMED-2D	43.9	43.8	43.9
SAAR	746	729	772
SAAR4170	750	743	761
SPRHOST	25.1	32.9	14.7
URBCONC	0.697	0.705	0.5
URBEXT2003	0.029	0.04	0.006
URBLOC	0.487	0.391	0.396
C	-0.021	-0.021	-0.021
D1	0.365	0.366	0.363
D2	0.401	0.402	0.401
D3	0.237	0.236	0.238
E	0.29	0.29	0.29
F	2.395	2.391	2.402
C(1km)	-0.021	-0.021	-0.021
D1(1km)	0.366	0.366	0.366
D2(1km)	0.396	0.396	0.396
D3(1km)	0.241	0.241	0.241
E(1km)	0.29	0.29	0.29
F(1km)	2.383	2.383	2.383

4 STATISTICAL METHOD

See Appendices C.2, C.3 and C.4 for pooling group details

Table 4.1: Estimate of QMED

Site Code	Method: AM – Annual maxima DT – Catchment descriptors with data transfer	Initial estimate of QMED (m^3/s)	If DT, numbers of donor/analogue sites used (see Table 4.2)	Adjustment ratio derived from average of analogue catchments	Final estimate of QMED (m^3/s)
01	DT	0.915	1, 2, 3, 4,	1.33	1.217
02	DT	0.724	3, 1, 5, 6, 7	1.018	0.740
03	DT	0.201	1, 2, 8	1.296	0.260

Table 4.2: Donor and analogue sites for QMED (for the top sites in the pooling group that are geographically close to the subject site)

No.	Watercourse	Station	NWA number	Method (AM or POT)	QMED from flow data (A)	QMED from catchment descriptors (B)	Adjustment ratio (A/B)
1	Leven	Easby	25019	AM	2.965	3.104	0.955
2	Ancholme	Toft Newton	29009	AM	1.997	2.814	0.710
3	Burbage Brook	Burbage	28070	AM	4.304	3.473	1.239
4	Riccal	Crookhouse Farm	27058	AM	11.028	8.902	1.239
5	Crimple	Burn Bridge	27051	AM	4.032	4.118	0.979
6	Henmore Brook	Ashbourne	28058	POT	16.219	11.647	0.694
7	Hodge Beck	Bransdale Weir	27010	AM	9.419	7.717	1.221
8	Lud	Louth	29003	AM	2.873	2.194	1.309

Table 4.3: Check of QMED using Channel Dimensions

Site Code	Watercourse	Location (eq model chainage)	BCW (Bankfull Channel Width in metres)	QMED from Channel Dimensions	Comment /comparison with estimate above	Final value of QMED used
01	Church Beck	CHU_00020	BCW	2.501	verestimate	1.217
02	Church Beck	CHU_00481	BCW	1.864	Overestimate	0.740
03	Coldgill Beck	COL_00016	BCW	2.134	Overestimate	0.260
See FEH Volume 3 Section 5.2 (page 24)						

Table 4.4: Derivation of pooling groups

Name	Site code for which group initially derived	Target return period (years)	Changes made to default pooling group produced by WINFAP-FEH using the flood peak data now stored on the CD. Note also any sites that were investigated but retained in the group.
All Church	01	100	**Added Sites:** **Removed Sites:** 45801, 54058, 32029 (short record)
Church	02	100	**Added Sites:** 27010, 27058, 25010, 9927044, 31025 **Removed Sites:** 32029, 45801, 54058, 41021 (short record) 41026, 40809 (low FARL) 15809, 12004 (high PROPWET) 68011 (skewness outlier) 20004 (steep growth curve) 52020 (long gap in record)
Coldgill	03	100	**Added Sites:** 41028 **Removed Sites:** 45801, 54059, 54058 (short record)

Table 4.5: Derivation of flood growth curves at each subject site

See Appendices C.5, C.6 and C.7 for Flood Growth Curves

Site code	Method: SS – Single site P – Pooled A – Average of the two H – Incorporating historical data	If P or A, code of pooling group? (see Table 4.3)	Distribution(s) chosen and reason	Parameters of chosen distribution(s)
01	P	01	Generalised Logistic	L-moments
02	P	02	Generalised Logistic	L-moments
03	P	03	Generalised Logistic	L-moments
General Notes:				

Table 4.6 Statistical Method Estimate of Peak Flows

Name	Site code	Flood peak (m^3/s) for the following percentage chance of an event occurring in any one year (with return periods in years in brackets).							
		50% (2)	20% (5)	10% (10)	4% (25)	2% (50)	1.33% (75)	1% (100)	0.5% (200)
All Church	**1**	1.22	1.86	2.34	3.07	3.72	4.15	4.49	5.38
Church	**2**	0.74	1.15	1.47	1.96	2.40	2.70	2.93	3.56
Coldgill	**3**	0.26	0.38	0.46	0.59	0.69	0.76	0.81	0.94

5 RAINFALL-RUNOFF METHOD

Table 5.1: Derivation of parameters for rainfall-runoff model

Methods: FEA : Flood event analysis (see Table 5.3)
LAG : Catchment lag (see Table 5.3)
DT : Catchment descriptors with data transfer from donor catchment
CD : Catchment descriptors alone
BFI : SPR derived from baseflow index calculated from flow data

Site code	Rural (R) or urban (U)	Tp(0): method	Tp(0): value (hours)	SPR: method	SPR: value (%)	BF: method	BF: value (m^3/s)	If DT, numbers of donor sites used (see Table 5.2) and reasons
1	R	CD	2.9	CD	25.1	CD	0.564	
2	R	CD	2.9	CD	32.9	CD	0.459	
3	R	CD	2.3	CD	14.7	CD	0.707	

Table 5.2: Donor sites for rainfall-runoff parameters – N/A

No.	Watercourse	Station	Tp(0) from data (A)	Tp(0) from CDs (B)	Adjustment ratio for Tp(0) (A/B)	SPR from data (C)	SPR from CDs (D)	Adjust-ment ratio for SPR (C/D)
1								
2								
3								
4								
5								

Table 5.3: Availability of river and rainfall event data - None available

Station name	Station number	Flood event date							
Gauging stations									
Event raingauges									

Table 5.4: Inputs to and outputs from rainfall-runoff model – assuming critical storm duration is used.

Site code	Design storm duration (hours)	Storm area (if not individual catchment area)	Flood peak (m^3/s) for the following percentage chance of an event occurring in any one year (with return periods in years in brackets).							
			50% (2)	20% (5)	10% (10)	4% (25)	2% (50)	1.33% (75)	1% (100)	0.5% (200)
1	5.129		1.38	1.95	2.37	3.28	4.06	4.49	4.85	5.83
2	5.126		1.02	1.45	1.77	2.40	2.93	3.23	3.48	4.14
3	4.174		0.38	0.53	0.64	0.93	1.20	1.35	1.48	1.83

Table 5.5: Inputs to and outputs from rainfall-runoff model – assuming a catchment wide storm duration (and storm area) is used.

Site code	Design storm duration (hours)	Storm area (if not individual catchment area)	Flood peak (m^3/s) for the following percentage chance of an event occurring in any one year (with return periods in years in brackets).							
			50% (2)	20% (5)	10% (10)	4% (25)	2% (50)	1.33% (75)	1% (100)	0.5% (200)
1	5.129		1.38	1.95	2.37	3.28	4.057	4.489	4.849	5.833
2	5.129	4.47	1.02	1.45	1.77	2.40	2.93	3.23	3.48	4.15
3	5.129	4.47	0.38	0.53	0.64	0.94	1.21	1.35	1.48	1.82
4										
5										
6										

6 RATIONAL METHOD

As an additional check flows were calculated for each hydrological inflow using the Rational Method

Q = 0.278 C i A

Where Q flow (m^3/s)
C runoff coefficient
i rainfall intensity (mm)
A catchment area (km^2)

Runoff coefficients were derived from the land use/urbext value and also vary with runoff intensity and return period. The rainfall intensity was taken from the design storm depth and duration for a catchment wide storm. Table 6.1 summarises the runoff coefficients used and Table 6.2 summarises the flow estimates

Table 6.1: Rational method runoff coefficients

Site code	AREA (km^2)	urbext2003	100 year Runoff Coefficient C100
All Church	4.47	0.029	0.38
Church	2.25	0.042	0.41
Coldgill	1.87	0.006	0.36

Table 6.2: Rational method flow estimates

Site code	Flood peak (m^3/s) for the following percentage chance of an event occurring in any one year (with return periods in years in brackets).						
	20% (5)	10% (10)	4% (25)	2% (50)	1.33% (75)	1% (100)	0.5% (200)
All Church	2.2	2.8	3.7	4.8	5.3	5.8	6.9
Church	1.3	1.7	2.3	3	3.3	3.6	4.3
Coldgill	1	1.3	1.8	2.3	2.5	2.7	3.3

7 SUMMARY OF RESULTS

Table 7.1: Overview of results

Item	Comments
Final choice of method and reasons	A comparison of the different flow estimates are represented graphically in Appendix C8, C9 and C10. The rainfall runoff flow estimates are considerably higher than the statistical flow estimates for Coldgill Beck and Upper Church Beck but there is a good comparison for All Church Beck. The validity of the FEH statistically derived flow regime is heavily dependant upon how suitably the adopted pooling group represents the catchment of interest. As all catchments within the pooling group are gauged, invariably this means that the majority are generally sizeable river systems. It has been assumed that the response mechanisms of these larger catchments are not strictly representative of the characteristics inherent in the smaller Church Beck catchment. The flows estimated using the rational method are generally much larger than the rainfall runoff method and the statistical method, apart from Upper Church Beck where there is a close similarity between the rational method and rainfall runoff method. The Rational Method is generally used for small uniform urban catchments as a crude first estimate and may therefore not be the most appropriate method to represent the flows in the small rural catchments of Church Beck. For these reasons, the rainfall runoff model flows have been adopted in this instance for design purposes.

Table 7.2: Final flood estimates for each site

See Table 5.5

Name	Site Code	Method Code	Flood peak (m^3/s) for the following percentage chance of an event occurring in any one year (with return periods in years in brackets).						
			50% (2)	20% (5)	10% (10)	4% (25)	2% (50)	1% (100)	0.67% (150)
	1								
	2								
	3								
	4								
	5								
	6								