Leigh Flood Storage Area Officer Procedures

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1 INTRODUCTION

1.1 PREFACE

The Environment Agency is a Category 1 Responder under the Civil Contingencies Act (2004). In order to comply with our Incident Management obligations under the act, we operate a series of duty officer roles on a 24 hours a day, 7 days a week rota.

The Kent and South London Area of the Environment Agency South East Region operate the Leigh Flood Storage Area (FSA); located on the River Medway upstream of Tonbridge. The principals of operation of the Leigh FSA are stated in the Medway Rivers Relief Act (1976).

1.2 SCOPE OF THE DOCUMENT

This document contains the Leigh FSA operational procedures for the Leigh Flood Storage Area Operator (LFSAO) to follow when operating the asset.

1.3 DOCUMENTS TO SUPPORT THE FLOOD LFSAO PROCEDURES

There are a number of other procedures and plans that may be used to support the LFSAO in Kent and South London. The list below is not exhaustive, but shows the key documents that you should be aware of, and which may help you when responding to a flood incident.

The following are operational procedures for other duty officers who have a role in managing flooding incidents:

- Flood Warning Duty Officer (FWDO) Procedures
- Assistant Flood Warning Duty Officer (AFWDO) Procedures
- Area Base Controller (ABC) Procedures
- Flood Incident Duty Officer (FIDO) Procedures
- Assistant Flood Incident Duty Officer (AFIDO) Procedures
- Monitoring and Forecasting Duty Officer (MFDO) Procedures

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6 LEIGH FLOOD STORAGE AREA BACKGROUND AND DESIGN

6.1 SCHEME CONTEXT

Following the 1968 floods, which devastated Tonbridge, the Leigh Flood Storage Area (FSA), then known as the Leigh Barrier was built in 1982 to reduce the risk of flooding from the River Medway to properties and businesses in Tonbridge and Hildenborough. The FSA is an online flood storage reservoir with a capacity of 5.56 million cubic metres and is regulated under the Reservoirs Act 1975. The main clay embankment is 1.3km long and outflows can be managed by the control structure, which consists of three radial gates. The impounding (or storage) area is 278 hectares and stretches from Leigh upstream to the village of Penshurst.

The storage area is operated to store the peak flows during a flood and together with the Tonbridge town floodwalls provides protection from flooding to Tonbridge. Downstream of Big Bridge (TQ 59059 46477) on the right bank, there are private flood walls and an Environment Agency flood wall down to Town Lock.

Dependent upon location, the standard of protection provided to Tonbridge and Hildenborough is between a 1 in 50 year event (2% Annual Exceedance Probability) to better than a 1 in 100 year event (1% Annual Exceedance Probability). 965 homes and 300 businesses benefit from these defences. This variance in the standard of protection provided is mostly due to variance in ground levels.

Communities downstream of Tonbridge will benefit from the operation of Leigh FSA due to a reduction in peak flows on the River Medway. This benefit decreases proportionately the further you go downstream as other factors, such as flows from other tributaries and the shape of the flood plain, become more influential in determining local flood risk.

The principals of operation of the Leigh FSA stated in the Medway Rivers Relief Act 1976 are:

- The structure is to be operated to reduce flood risk from the River Medway to Tonbridge and Hildenborough only.
- Water to be stored in the reservoir shall not exceed the maximum legal reservoir level (currently 28.05m AOD).
- A minimum impounding flow of 35m^3/s.
- The outflow must not exceed the maximum rate of flow which will occur naturally in the river upstream of the control structure, i.e. the peak outflow must not be higher than it would be without the scheme in place.
- The level in the Powdermill Stream must not go below 23.95m AOD.

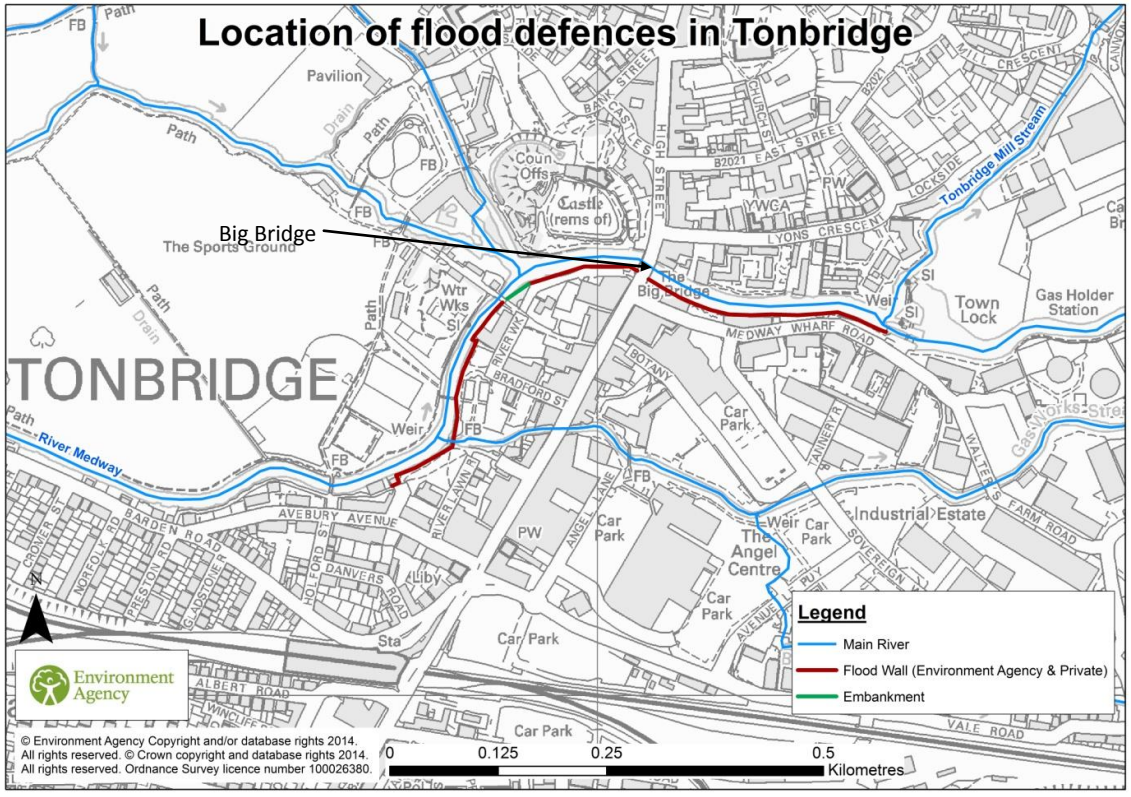

Figure 6.1 Flood defences map for Tonbridge

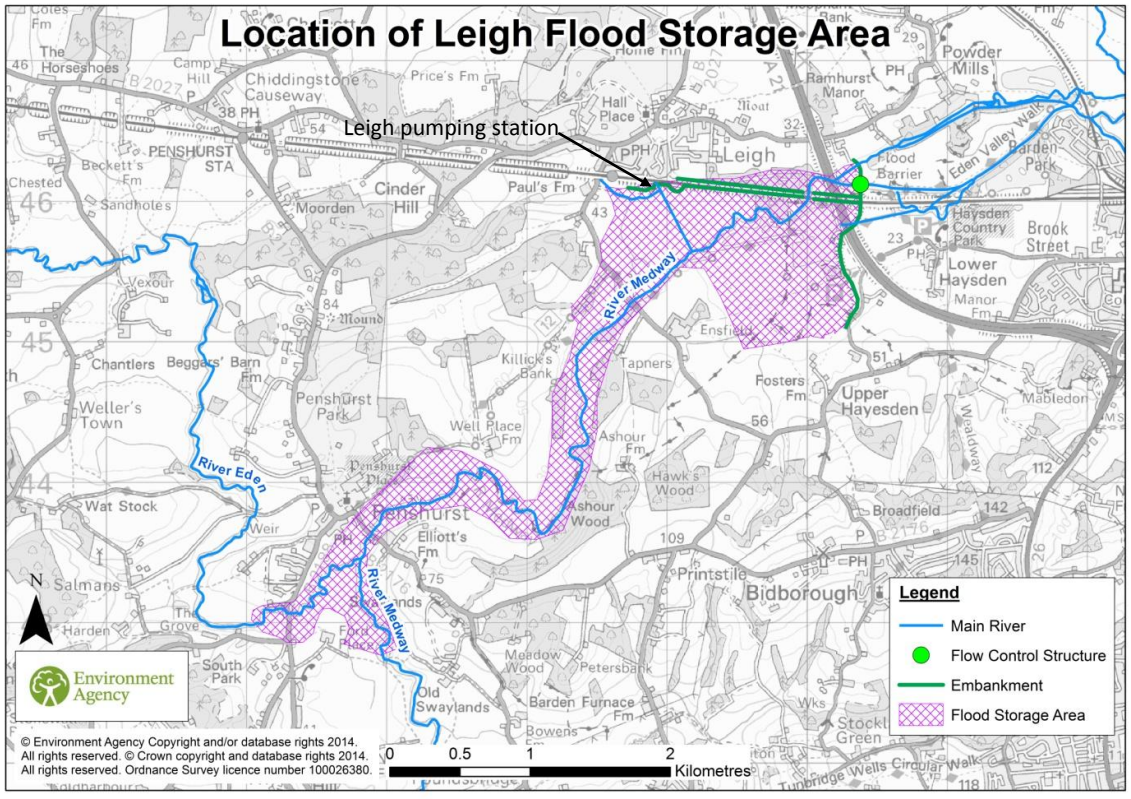

Figure 6.2 Location of the Leigh FSA

Figure 6.3 below illustrates the operation principles of flood storage reservoirs such as Leigh FSA and how it is operated to capture the peak flows in the storage area, leading to a reduction in the peak flows going downstream.

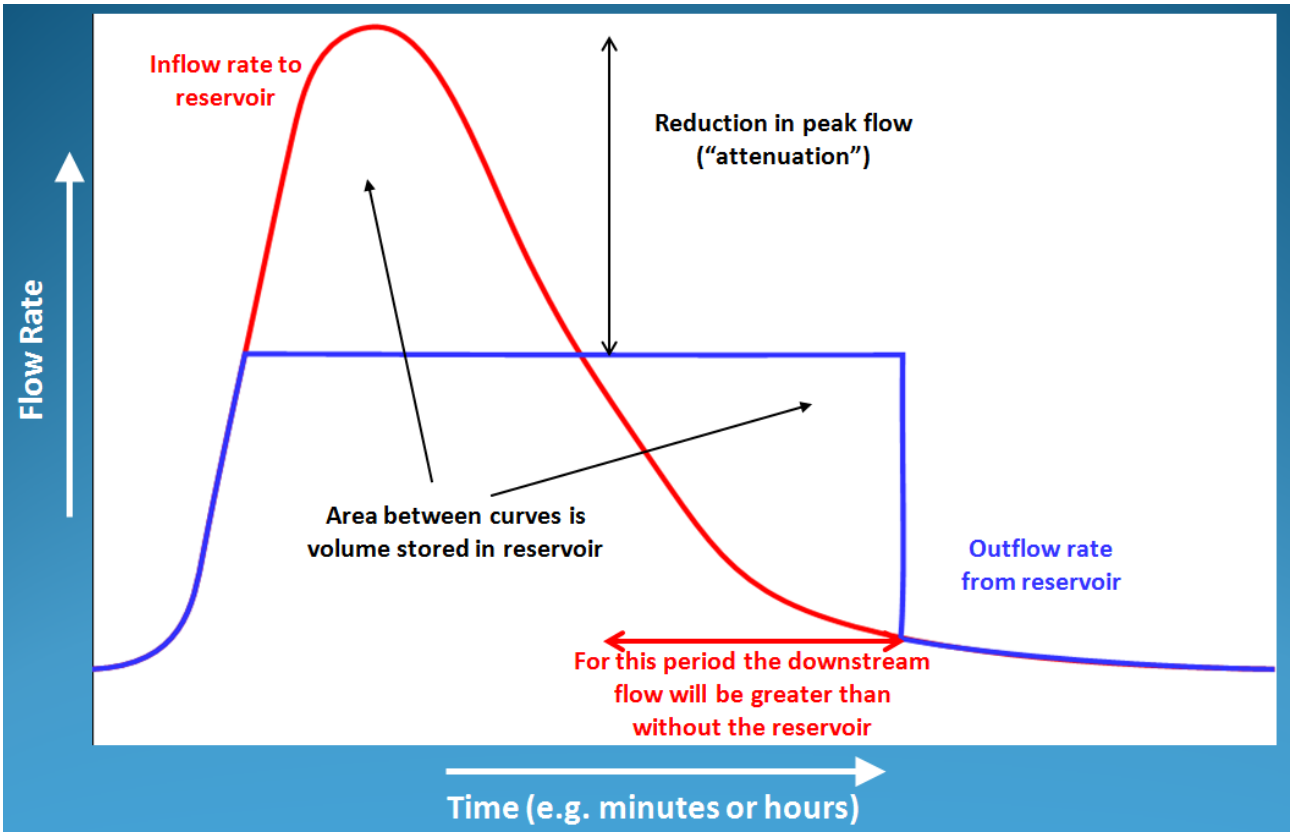

Figure 6.3 The principles of operation of an online flood storage reservoir

(Source: A. Pepper)

6.2 CONTROL STRUCTURE AND RADIAL GATES

- Stilling basin – St Anthony Fall's type
- Downstream channel is revetted to prevent scour to the river banks
- Radial gates: Centre gate: 9.1m wide, 7.0m radius and depth of 4.5m

  South and North gates: 6.6m wide, 7.0m radius and depth of 5.5m

6.3 EMBANKMENTS

- Main embankment 1.3km long, 5.7m high at maximum height, 4.5m wide and side slopes of 1:3
- Clay core supported by gravel shoulders, material derived from borrow pits in the area between Straight Mile and the River Medway.
- Gravel shoulders with relatively low permeability
- Railway embankment 2.8km long, 3.5m high, constructed to ensure stability of the existing bank during drawdown.

6.4 LEIGH PUMPING STATION

Leigh Pumping Station takes surface water from Leigh Village and pumps it over the embankments and into the storage area (grid reference: TQ 54906 46113). Flow from the village is directed into a bypass channel then through a 11m archimedean screw (capacity 1.43m^3/s), which pumps the water over the 3.1m high embankment. There is a gravity discharge culvert that passes through the embankment. There is also a Southern Water pumping station adjacent to ours, with emergency pumps installed to handle storm overflow discharges.

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7 THE ROLE OF THE LEIGH FLOOD STORAGE AREA OPERATOR (LFSAO) ON DUTY

7.1 RESPONSIBILITIES OF THE LFSAO ON STANDBY

The responsibilities of the duty LFSAO are:

- To evaluate conditions which could result in the need to monitor and/or operate Leigh FSA. Using the data available, the LFSAO on duty is responsible for assessing if and when the structure is likely to require continuous/regular monitoring or operating. When defined triggers are expected to be met the LFSAO should make contact with the ABC and ask for a rota to be drawn together.
- To identify and escalate issues with the operability of the structure which may impede operation, following the relevant contingency procedure.

The LFSAO is also required to support the Medway and North Kent Asset Performance Team (APT) with planned maintenance activities and operate the structure when required. This may include lowering of the pen and undertaking manual gate movements.

All LFSAOs will attend operator meetings and participate in post incident reviews to identify areas for continuous improvement.

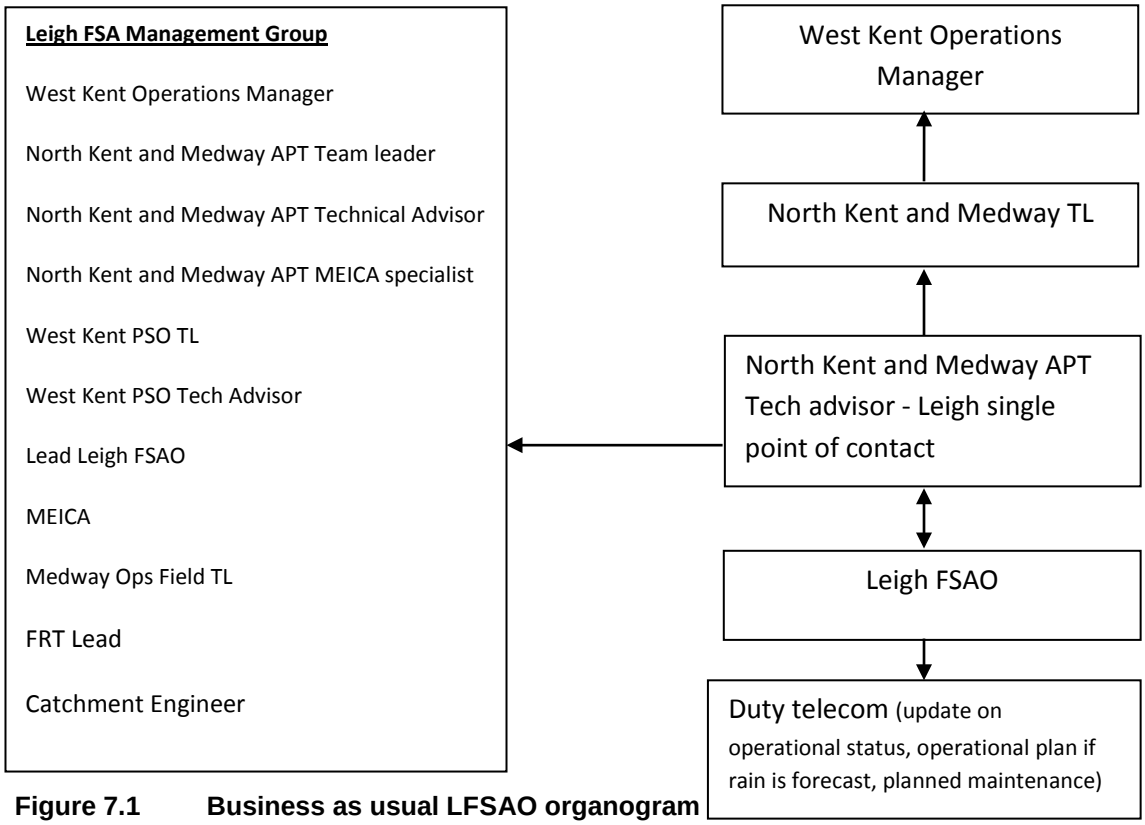


Figure 7.1 Business as usual LFSAO organogram

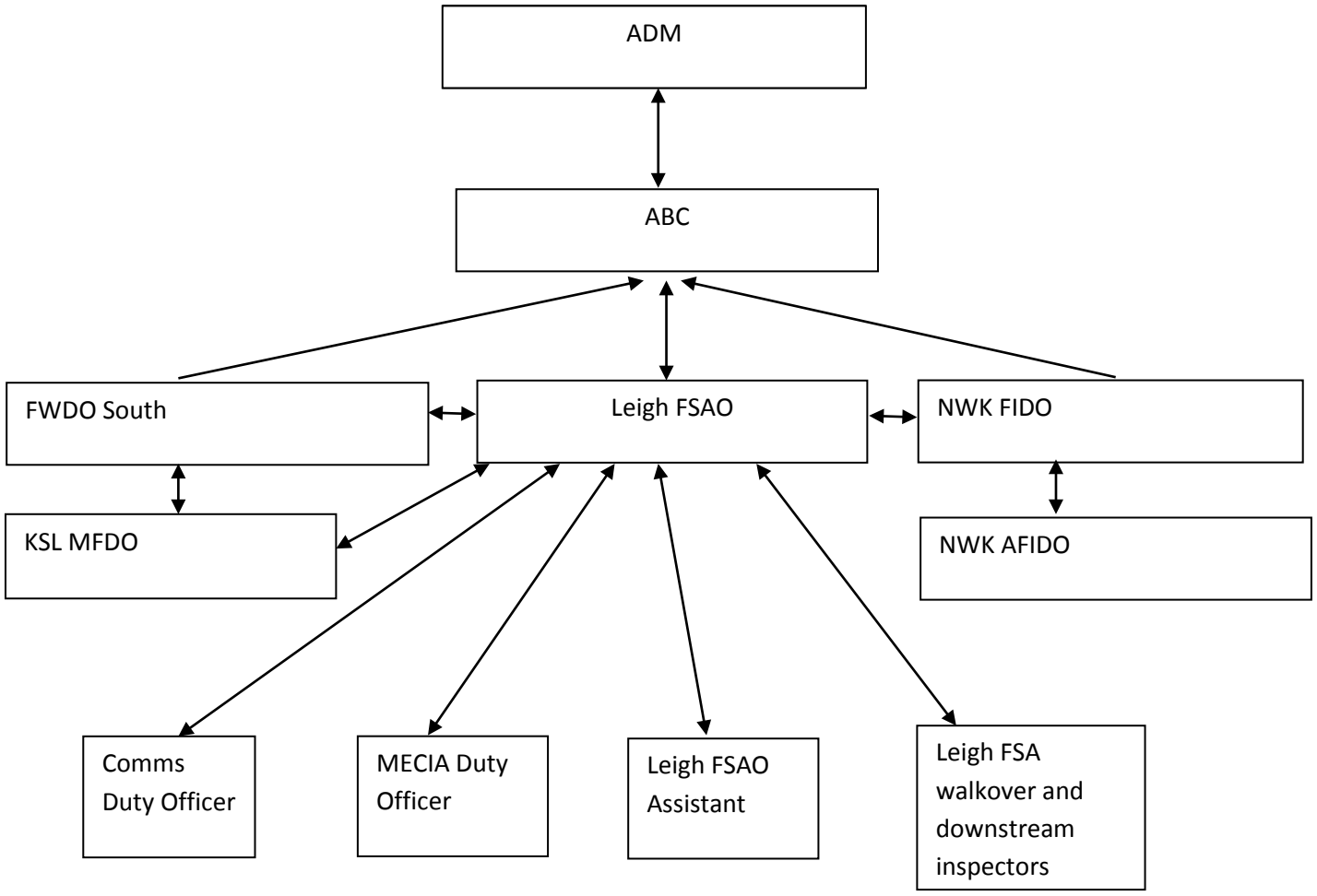


Figure 7.2 Internal Incident LFSAO organogram

7.2 LFSAO WEEKLY DUTY CHECKS

It is the responsibility of the outgoing duty officer to update the incoming duty officer of antecedent catchment conditions and current operational status of the structure. Refer to the Leigh handover prompt sheet (see Appendix B).

7.2.1 ESTABLISHING CURRENT CATCHMENT CONDITIONS

At the beginning of your week on duty make yourself aware of the current forecast, rainfall totals over the previous week and the soil moisture deficit (SMD) for the catchment.

Do this before the weekly duty telecom. Think ahead about what the forecast could mean in terms of monitoring/operation and advise on any developing management plan and any specific considerations of impacts that this may have within the catchment
.

1 - Log in to SETEL and establish current catchment conditions at the following gauges (flow and levels of Upper Medway and River Eden).

Medway gauges:

- Summerford Bridge
- Colliers Land Bridge

Eden Gauges:

- Edenbridge
- Vexour

2 - Review the SMD value for the catchment. The latest SMD data measured in mm can be found on NFFS, click on MORECS and read the data for square 173.

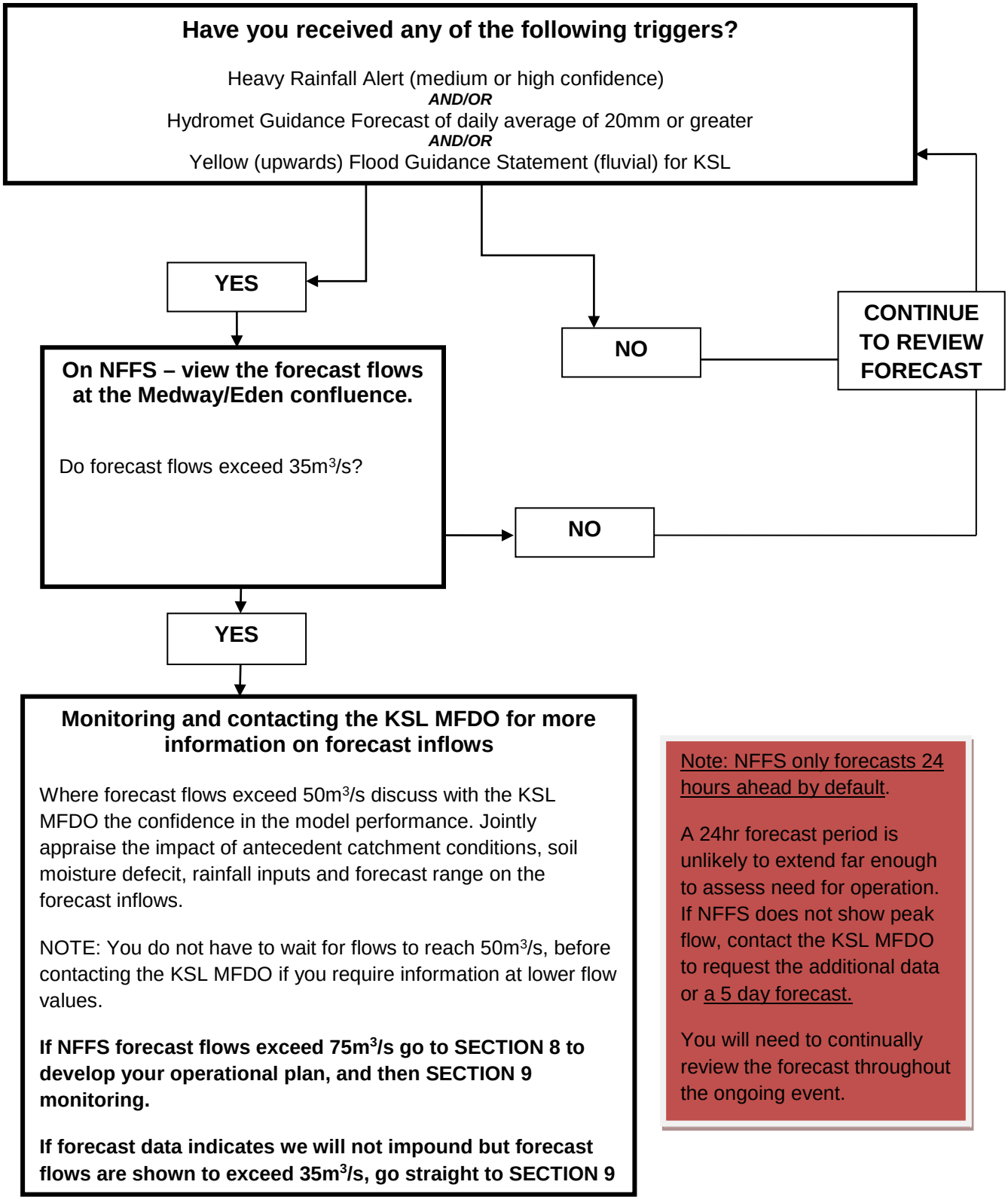
Throughout your duty week pay careful attention to forecasts and continuously review your planning assumptions and feedback changes to the wider incident response duty officer team.

7.2.2 REVIEW TEMPORARY WORKS NOTICES

At the start of the duty week ensure you are aware of any temporary works notices [redacted] so that these can be considered during operational planning or in discussing forecast flows with other duty roles. Also consult with the Incident Management Report which can be found on the Incident Management Toolbox.

7.2.3 TRIGGERS FOR OPERATIONAL PLANNING AND MONITORING

Use the flow chart below to determine when to develop an operational plan and/or start monitoring.



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8 LEIGH FLOOD STORAGE AREA FORECASTING AND OPERATIONAL PLANNING

USE THIS SECTION WHEN FORECAST DATA SUGGESTS THAT IMPOUNDING WILL OCCUR AND YOU NEED TO DEVELOP AN OPERATIONAL PLAN. IF YOU ARE NOT GOING TO IMPOUND GO STRAIGHT TO SECTION 9.

8.1 INTRODUCTION

The LFSAO is responsible for developing the optimum operating plan to maximise the flood storage area (FSA) capacity and reduction in downstream flood risk. The Leigh FSA is designed to allow control over a variable outflow to enable operators to maximise storage volume in the reduction of downstream flood impact.

These procedures are based on two modes of operation for the FSA; these are described as 'Fixed Flow' and 'Variable Flow' and are defined below:

- **Fixed Flow** – An *effective* operating plan is developed based on a 'fixed' outflow from the FSA of 75m^3/s. For the majority of flood events this will provide a safe and effective operation of the FSA and flood risk reduction downstream. This mode of operation is not appropriate for all flood events.

- **Variable Flow** – An *optimum* operating plan is developed based on the operator defining an initial outflow and modifying outflow for the duration of the flood event. This aims to maximize use of FSA volume and provide the greatest flood risk reduction based on forecast and real time data.

The Reservoir Balance Spreadsheet (RBS) provides a decision making support tool allowing the operator to investigate a range of 'variable flow' options in order to tailor operation to the specific event characteristics. Supporting information and guidance is given in these procedures to help the operator with the decision making process.

There are three fundamental reasons to move to 'variable' flow operation:

- To conserve reservoir capacity (outflow is set at greater than 'fixed' flow)

- To reduce flood risk downstream (outflow is set at less than 'fixed' flow)

- The Supervising Engineer has advised that the reservoir must be drawn down for safety reasons.

During the early stages of an event if it is unclear whether the operator should switch from a fixed outflow regime to a variable outflow regime, the operator is advised to keep to the fixed outflow regime, whilst continuing to monitor and evaluate the real time data.

Likewise if the real time data and evidence available suggests that the LFSAO should operate using a variable flow operating regime from the start of an event, this can also be considered.

Forecast inflows from the National Flood Forecasting Service (NFFS) model at the **Medway/Eden confluence** are input into the Reservoir Balance Sheet to develop a strategic operational plan for managing flows through Leigh FSA. This is prepared prior to an event when forecast flows are shown to exceed 75m^3/s.

You will need to update and review this plan as the event progresses using updated model runs, gauge data and information on catchment conditions.

8.2 DEVELOPING AN OPERATIONAL MANAGEMENT PLAN (WHEN FORECAST FLOWS EXCEED 75M^3/S)

1 – Request a copy of the forecast inflows at the Medway/Eden confluence

Request a csv file of inflows for the event from the KSL MFDO. Make sure to ask for flows at the Medway/Eden confluence. Consider an appropriate timeframe that you require the data for (24 hours – 5 days). Speak to the KSL MFDO about their confidence in the model performance.

You may want to plan using most likely and worse case rainfall scenario, which will require separate model runs. The KSL MFDO will advise you the most likely rainfall scenario and discuss current confidence with the performance of the Medway model.

A 5 day model run may be required to allow you to plan for entire events. However it should be noted that model confidence between days 3-5 will be low, as confidence in the rainfall forecast feeding into the model increases the closer that we are to an event.

2 - Open the Reservoir Balance Sheet tool from your desktop and paste in the inflow data to the 'forecast fixed outflow mode' tab

Go to the **'forecast fixed outflow mode'** tab. Paste the forecast flows into the inflow column.

Edit the date and time as appropriate with your first data entry and input the reservoir level at the corresponding date and time. NOTE to find the reservoir level quickly go to the SETEL Leigh FSA overview page, left click on 'Upstream WL' and select 'Display Historic List'.

Figure 8.1 SETEL historic list function

3 – Review reservoir levels under the 'fixed flow' operating regime

Click on the 'forecast fixed chart' tab**.** Review the reservoir levels and capacity filled in the reservoir. Select 'reservoir level' from the chart options. If the reservoir level is forecast to be below 28.05mAOD (represented as a red line showing 100% capacity reached), then you will be able to manage the event by keeping the outflow fixed to $75m^3/s$.

4 – Switching to 'variable flow' operating mode

If the reservoir level is forecast to go above 28.05m AOD then you will need to switch to 'variable flow' operating mode, as keeping to an outflow of $75m^3/s$ would cause the storage area to become full and exceed the legal maximum impounding level (28.05m AOD). This mode allows the LFSAO to identify a variable flow operating plan, maximizing the use of the storage area and providing the greatest flood risk benefit.

5 – Prepare the 'variable flow' operating plan

To prepare the variable flow operating plan click on the **'forecast variable'** tab. Use the variation outflow column to identify the optimum outflow that ensures that the reservoir level does not exceed 28.05m AOD. Go to the '**forecast variable chart'** tab review charts for reservoir level, rate of rise and inflow/outflow.

Remember: we use the forecasting point of the Medway/Eden confluence on the NFFS

model, located upstream of Leigh FSA. This will mean that travel time to Leigh FSA will need to be accounted for.

Further information on how to use the RBS can be found in Appendix J.

6 - Prepare an event data folder for the event

[redacted]

Make a copy of the 'YYMMDD new event template' folder and save it in the relevant year folder renaming the folder with the appropriate date. Save a copy of the RBS in the 'RBS> Forecast' sub folder.

7- Prepare your operational plan

Use the template found in the 'operational plan' sub folder to prepare your operational plan. Rename this template with the appropriate date and save.

Once complete email the operational plan to the ABC, FWDO South, NKFIDO, ADM, other LFSAOs and the LFSAO inbox.

8.3 NFFS UPDATES AND FLOOD WARNING CONSIDERATIONS

In addition when operating in 'variable flow' mode:

1 - Email a copy of the completed RBS with the **forecast variable flow outflows** to the **KSL MFDO** to input into the Medway forecasting model. This will ensure that the model will provide a more accurate NFFS forecast for flows downstream of Tonbridge. If you update your operational plan throughout the event, you must send the new forecast outflows to the KSL MFDO.

2- Discuss the **likely outflows** with the FWDO South in relation to the following downstream flood warning triggers for the River Medway. For your information these are:

East Peckham – 80m^3/s outflow from Leigh

Tonbridge and Hildenborough – 100-120m^3/s outflow from Leigh

Laddingford and Paddock Wood – 140-150m^3/s outflow from Leigh

Tonbridge severe flood warning – 140-150m^3/s outflow from Leigh

This is just an initial discussion at this stage and the FWDO South will require updates throughout the ongoing event once impounding starts and the operational plan is

updated based on real time data, downstream conditions and updated NFFS forecast model runs.

8.4 CONSIDERATIONS DURING MULTIPLE EVENTS

During multiple events the Leigh FSAO should consider downstream conditions when developing the operational plan. The flood plain capacity of the sports fields in Tonbridge and impact of debris and silt that may have been washed downstream means that flood impacts may be observed at lower outflows. Therefore the LFSAO may need to consider if it is appropriate to impound at flows of less than 75m^3/s during some events.

Note: the sports fields in Tonbridge act as floodplain storage and can store 1-2milion m^3 of flood water.

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9 LEIGH FLOOD STORAGE AREA MONITORING

USE THIS SECTION WHEN FORECAST FLOWS FROM THE MEDWAY MODEL ARE SHOWN TO EXCEED 35m^3/s.

Real time data from rain and river gauges in the Upper Medway catchment are used to monitor the developing flood and forecast inflows to Leigh FSA in plus 7 hours. You will also need to record the upstream reservoir level and calculate the outflows at Leigh.

- **Flows** at Colliers Land Bridge and Vexour indicate the size of the potential flood and the likely inflows into the Leigh FSA.
- **Outflow** from Leigh will tell you when to operate in either manual or automatic, when you need to impound and allow the potential downstream impacts of flows to be evaluated.

9.1 MONITORING RAINFALL DATA IN THE UPPER CATCHMENT

Throughout an event monitoring of rainfall totals in the upper catchment should be undertaken frequently and totals recorded in the log book, over the most relevant time frame.

The key upstream rain gauges are:

- **Upper Medway**: Weir wood, Redgate Mill, Cowden and Saints Hill.
- **Upper Eden**: Godstone, Edenvale, Pains Hill, Kent Hatch and Edenbridge.

Real time catchment rainfall data can be found on Leigh SETEL by clicking on **rainfall** from the home page.

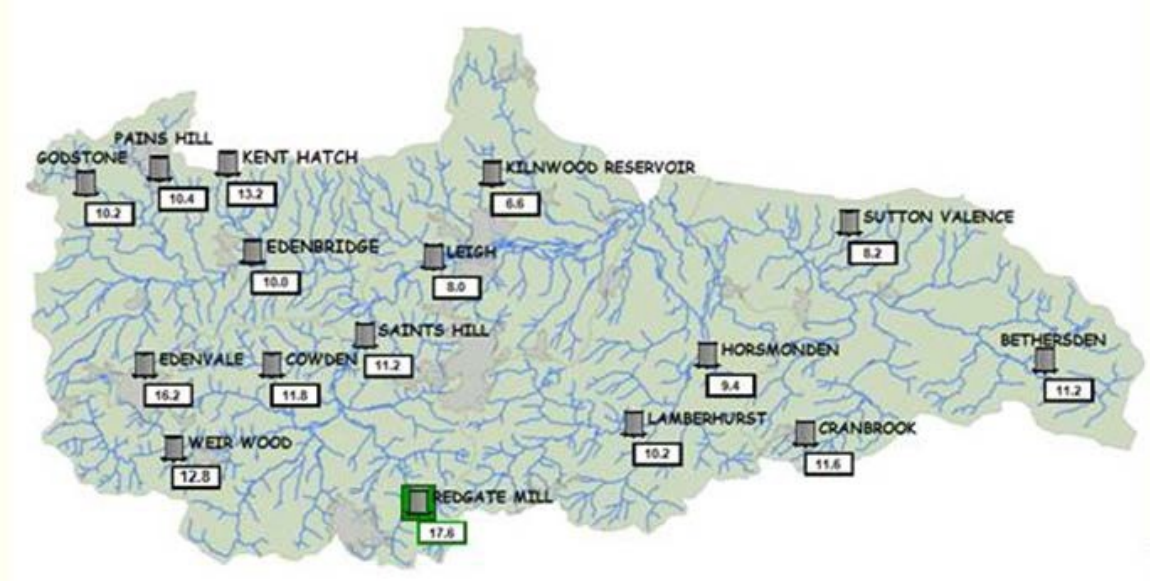


Figure 9.1 Key rain gauges in the Upper Medway catchment

Rain gauges in Sussex such as Balcombe can also be used to provide an indication of actual rainfall versus forecast, when the prevailing weather pattern is coming from the south west. The KSL MFDO will also be reviewing forecast compared to actual rainfall totals.

Table 9.1 below provides a means of assessing the size of the developing flood using recorded rainfall totals. During saturated catchment conditions **only** (when the Soil Moisture Deficit is 0mm) use the table below to assess the size of potential peak flows, using upstream rain gauge data. When using this table it is important to think about storm duration and multiple events. During unsaturated conditions the peak flows shown in the table below will be over estimated.

Table 9.1 Initial assessment of the size of the developing flood (m^3/s)

	Rainfall (mm)										
Storm duration (hrs)	10	20	30	40	50	60	70	80	90	100	>100
6 - 24	40-48	70-85	100-120	130-160	165-210	200-255	240-300				
24-48	30-40	50-70	75-100	95-130	120-165	150-200	175-220				
48-72	25-30	40-50	60-75	75-95	95-120	115-150	140-160	160-200	180-230	200-265	>265

Note: Small flood: inflow < 80 m^3/s
Medium flood: inflow 80 - 160 m^3/s
Large flood: inflow > 160 m^3/s
The calculation is based on FEH techniques

9.2 MONITORING UPSTREAM FLOWS AND COMPLETING THE MONITORING LOG

Following rainfall in the upper catchment the first upstream gauges that provide an indication of upstream river levels starting to rise are Summerford Bridge on the Upper Medway and Edenbridge on the Upper Eden. When you receive the following river level alarms start to increase your awareness of what is happening in the catchment (for example how much rain has fallen, review river levels upstream):

- Summerford Bridge Act Con ops (40.5m AOD) or Act Ops (40.7 m AOD)

  AND/OR

- Edenbridge Act Con ops (39 m AOD) or Act Ops (40.1m AOD)

Just upstream of Penshurst beyond the River Medway and River Eden confluence there are two level/flow gauges; Colliers Land Bridge on the River Medway and Vexour on the River Eden.

When you receive one or more of the following river level alarms:

- Colliers Land Bridge Act Con Ops AND/OR Vexour Act Con Ops, (31m AOD)

The LFSAO will make an assessment on forecast and actual inflows and outflows to help determine if and when continuous Leigh FSA monitoring should commence, as well as how long monitoring might be required for. If river levels are peaking at around the Act Con Ops level and you are not likely to see flows above 35m^3/s, then full monitoring is not required.

If flows are likely to exceed 35m^3/s, monitoring should be undertaken and entries should be made every 30 minutes once the outflow exceeds 30 m^3/s. If monitoring will exceed 8 hours, contact the ABC to organise a rota.

1 – Prepare an event data folder

If you have not already done so under Section 3 prepare an event data folder for the event. Go to: [redacted]

Make a copy of the ‘YYMMDD new event template’ folder and save it in the relevant year folder renaming the folder with the appropriate date.

2 – Open the monitoring log template

Open the monitoring log template in the ‘monitoring’ sub folder and save it with appropriate title YYMMDD.

[redacted]

Table 9.2 Monitoring log template

3 – Use Leigh SETEL to obtain the relevant monitoring data

[redacted]

Figure 9.2 Accessing the Leigh SETEL Overview Page

Figure 9.3 Obtaining monitoring data from the Leigh FSA Overview page

If you have issues with SETEL at any point phone the Supra H&T duty officer on:

Flows can also be read directly from the multiple site mimics on Leigh SETEL. These can be found by selecting Flood Storage Area Live on the screen shown in Figure 2 below. On the Home Display Screen (below) you can view a multiple site mimic by selecting a box displaying the site name (shown by the red arrow).

Figure 9.4 Obtaining flows for Colliers Land Bridge and Vexour from the multiple site mimic

Flows for Collier Land Bridge and Vexour can be read from under the hydrograph (shown by red arrows on Figure 9.4 above). Make a note of the flows at Colliers Land Bridge and Vexour and use the table in Table 9.3 below to predict the estimated inflow to the FSA in approximately +7 hours.

Predicted Flow (m^3/s)	Flow at Collier's Land (m^3/s)																																		
	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60	62	64	66	68	70
4	10	12	13	14	15	16	17	18	20	21	22	23	24	25	26	28	29	30	31	32	33	34	36	37	38	39	40	41	42	43	45	46	47	48
6	12	13	15	16	17	18	19	20	21	23	24	25	26	27	28	29	31	32	33	34	35	36	37	38	40	41	42	43	44	45	46	48	49	50
8	14	15	16	18	19	20	21	22	23	24	26	27	28	29	30	31	32	33	35	36	37	38	39	40	41	43	44	45	46	47	48	49	51	52
10	16	17	18	19	21	22	23	24	25	26	27	28	30	31	32	33	34	35	36	38	39	40	41	42	43	44	46	47	48	49	50	51	52	53
12	18	19	20	21	22	23	25	26	27	28	29	30	31	33	34	35	36	37	38	39	41	42	43	44	45	46	47	48	50	51	52	53	54	55
14	20	21	22	23	24	25	26	28	29	30	31	32	33	34	36	37	38	39	40	41	42	43	45	46	47	48	49	50	51	53	54	55	56	57
16	21	23	24	25	26	27	28	29	31	32	33	34	35	36	37	38	40	41	42	43	44	45	46	48	49	50	51	52	53	54	56	57	58	59
18	23	24	26	27	28	29	30	31	32	33	35	36	37	38	39	40	41	43	44	45	46	47	48	49	51	52	53	54	55	56	57	58	60	61
20	25	26	27	28	30	31	32	33	34	35	36	38	39	40	41	42	43	44	46	47	48	49	50	51	52	53	55	56	57	58	59	60	61	63
22	27	28	29	30	31	33	34	35	36	37	38	39	41	42	43	44	45	46	47	48	50	51	52	53	54	55	56	58	59	60	61	62	63	64
24	29	30	31	32	33	34	36	37	38	39	40	41	42	43	45	46	47	48	49	50	51	53	54	55	56	57	58	59	61	62	63	64	65	66
26	31	32	33	34	35	36	37	38	40	41	42	43	44	45	46	48	49	50	51	52	53	54	56	57	58	59	60	61	62	63	65	66	67	68
28	32	33	35	36	37	38	39	40	41	43	44	45	46	47	48	49	51	52	53	54	55	56	57	58	60	61	62	63	64	65	66	68	69	70
30	34	35	36	38	39	40	41	42	43	44	46	47	48	49	50	51	52	53	55	56	57	58	59	60	61	63	64	65	66	67	68	69	71	72
32	36	37	38	39	41	42	43	44	45	46	47	48	50	51	52	53	54	55	56	58	59	60	61	62	63	64	66	67	68	69	70	71	72	73
34	38	39	40	41	42	43	45	46	47	48	49	50	51	53	54	55	56	57	58	59	61	62	63	64	65	66	67	68	70	71	72	73	74	75
36	40	41	42	43	44	45	46	48	49	50	51	52	53	54	56	57	58	59	60	61	62	63	65	66	67	68	69	70	71	73	74	75	76	77
38	41	43	44	45	46	47	48	49	51	52	53	54	56	56	57	58	60	61	62	63	64	65	66	68	69	70	71	72	73	74	76	77	78	79
40	43	44	46	47	48	49	50	51	52	53	55	56	57	58	59	60	61	63	64	65	66	67	68	69	71	72	73	74	75	76	77	79	80	81
42	45	46	47	48	50	51	52	53	54	55	56	58	59	60	61	62	63	64	66	67	68	69	70	71	72	74	75	76	77	78	79	80	81	83
44	47	48	49	50	51	53	54	55	56	57	58	59	61	62	63	64	65	66	67	68	70	71	72	73	74	75	76	78	79	80	81	82	83	84
46	49	50	51	52	53	54	56	57	58	59	60	61	62	63	65	66	67	68	69	70	71	73	74	75	76	77	78	79	81	82	83	84	85	86
48	51	52	53	54	56	56	57	58	60	61	62	63	64	65	66	68	69	70	71	72	73	74	76	77	78	79	80	81	82	84	85	86	87	88
50	52	53	55	56	57	58	59	60	61	63	64	65	66	67	68	69	71	72	73	74	75	76	77	79	80	81	82	83	84	85	86	88	89	90
52	54	55	56	58	59	60	61	62	63	64	66	67	68	69	70	71	72	74	75	76	77	78	79	80	81	83	84	85	86	87	88	89	91	92
54	56	57	58	59	61	62	63	64	65	66	67	68	70	71	72	73	74	75	76	78	79	80	81	82	83	84	86	87	88	89	90	91	92	94
56	58	59	60	61	62	63	65	66	67	68	69	70	71	73	74	75	76	77	78	79	81	82	83	84	85	86	87	89	90	91	92	93	94	95
58	60	61	62	63	64	65	66	68	69	70	71	72	73	74	76	77	78	79	80	81	82	84	85	86	87	88	89	90	91	93	94	95	96	97
60	61	63	64	65	66	67	68	69	71	72	73	74	75	76	77	79	80	81	82	83	84	85	86	88	89	90	91	92	93	94	96	97	98	99
62	63	64	66	67	68	69	70	71	72	74	75	76	77	78	79	80	81	83	84	85	86	87	88	89	91	92	93	94	95	96	97	99	100	101
64	65	66	67	68	70	71	72	73	74	75	76	78	79	80	81	82	83	84	86	87	88	89	90	91	92	94	95	96	97	98	99	100	101	103
66	67	68	69	70	71	73	74	75	76	77	78	79	81	82	83	84	85	86	87	89	90	91	92	93	94	95	96	98	99	100	101	102	103	104
68	69	70	71	72	73	74	76	77	78	79	80	81	82	84	85	86	87	88	89	90	91	93	94	95	96	97	98	99	101	102	103	104	105	106
70	71	72	73	74	75	76	77	79	80	81	82	83	84	85	86	88	89	90	91	92	93	94	96	97	98	99	100	101	102	104	105	106	107	108

Flow at vexour (m^3/s)

Table 9.3 Plus 7 hour look up chart (Revision C, January 2013)

A larger version of this table can also be found in Appendix C of these procedures and in the Leigh Structure Control Room as an A3 laminated sheet.

During a large flood this table may be exceeded. However flows for Colliers and Vexour should still be recorded from SETEL in the monitoring log table. The +7 hour flow column should be left blank.

4 – Calculating the Leigh FSA outflow (m^3/s)

Should the current Leigh FSA outflow become unavailable on SETEL follow the steps below to calculate the outflow using the Gate Opening Calculator (GOC).

1. Open the Gate Opening Calculator (GOC) tool from your desktop (Figure 9.5) and input the Reservoir Level, D/S level and gate openings to establish the actual outflow at the structure.

Figure 9.5 The GOC Tool

2. Record the results in the table in Table 9.2.

3. If your GOC is unavailable at any time, refer the gate opening and outflow chart in appendix O.

A LFSAO operational tools guide can be found in Appendix J.

The gauging station at Lucifier bridge records the flows on the River Medway, Powdermill Stream and from the Haysden Culvert up to 50m^3/s. This can be used as an indication of the flow through the structure up to 50m^3/s. **However actual outflow should always be recorded from Leigh SETEL.**

5 –Recording NFFS forecast flows

Use the most recent NFFS forecast to record the NFFS forecast flow at the current time. Remember to check if a new forecast report has been issued by reloading the NFFS page.

9.3 MONITORING CONDITIONS AT ENSFIELD ROAD

When assessing or monitoring the inflows upstream of the Leigh Flood Storage Area it is important to consider the impact to Ensfield Road and where possible pre-determine the requirement to deploy the Medway Operations Field Team to inspect and/or close the road due to flooding.

Ensfield Road is at risk of starting to flood under two circumstances:

- During Leigh Flood storage area impounding when the upstream level is between 24.6m AOD and 24.8m AOD.

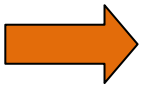
- During fluvial flooding (i.e. overwhelming flow) when the combined flows figures at Colliers Land and Vexour are between [redacted] In this circumstance there is a 6-7 hour lead time before these critical flows reach Ensfield Road.

The following table helps to identify the conditions under which Ensfield Road is at risk of flooding. It should be used by LFSAOs to pre-identify the need for the Medway Operations Field Teams to visually inspect and/or close Ensfield Road.

Table 9.4 Monitoring Ensfield Road conditions

The procedure for closing Ensfield Road can be found in Appendix F.

9.4 TRIGGERS FOR OPERATIONAL ACTIVITY AT THE LEIGH CONTROL ROOM

Actual outflow Trigger	Action	Associated Comments
20m³/s	Notify the Medway Navigation Duty Officer [redacted] that 20m³/s is being discharged at the Leigh Flood Storage Area.	The Medway Navigation Duty Officers put warning signs on the locks to notify users of fast flows.
35-40 m³/s	At 35 m³/s the following SETEL alarm will trigger for information: ACT CON OPS Leigh FSA outflow has reached 35m³/s Contact the FWDO South to discuss the need to issue a **Flood Alert** for The Middle River Medway (Penshurst to East Peckham). If a Flood Alert is issued make contact with [redacted] as they are as risk of flooding. They have demountable barriers (cill level = 22.26 mAOD crest level = 23.45 mAOD) which must be erected before outflow from Leigh reaches 50m³/s.	FWDO South [redacted] [redacted] Out of hours call [redacted] and after the message press **0**. This will divert your call to their out of hours facility. Tell the operator that a Flood Alert has been issued; they will pass the message onto the appropriate individual.
	**Assess current and forecast conditions to establish whether monitoring can be carried out remotely or from the Leigh Control Room. If flows are going to exceed 50m³/s then monitoring should take place from the Leigh Control Room. Speak to the ABC to inform them when monitoring commences from the Leigh Control Room.** [redacted]	

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	[redacted]	
50m³/s	**If outflow reaches 50m³/s and is forecast to increase, attend the Control Room and ensure an operator rota is set up.** **If outflows are likely to exceed 80m³/s, ensure two operators are on duty per shift for the rising limb. This is to ensure two operators are available to undertake the necessary calculations and review the operational plan during the early stages of the event.** [redacted] **IMPOUNDING BEGINS AT 24.7m AOD** Ensure gate movements are made to avoid impounding early. When the upstream reservoir level is <24.7m AOD the River Medway is flowing within its banks and the storage area is empty. [redacted]	

Leigh Flood Storage Area Operational Procedures

	Consider issuing a **Preliminary Impounding Warning** based on catchment conditions and discussion with the NWK FIDO, FWDO South and KSL MFDO. The instructions for issuing can be found in Appendix F. This can include information based on forecast rainfall at this stage and can be issued before 50m^3/s outflow if you have high confidence that you will be impounding . **Contact H&T** to deploy the arc boat to undertake spot gaugings at Lucifer Bridge gauging station and downstream of Leigh for outflows above 50m^3/s.	NWK FIDO [redacted] FWDO South [redacted] KSL MFDO [redacted]
→	**50 m^3/s FLOOD ALERT IN FORCE**	
→	When the u/s level reaches **24.5m AOD** speak to the NWK FIDO to get the Medway Operations Field Team to check the condition of [redacted] as this can start to flood before impounding. (See part 4.3 and Appendix F for more detail). Try to arrange this during daylight hours. The code for the padlock on the Ensfield Road gates to provide to the Fire Brigade [redacted] If the observations from the Operations Field Team are that Ensfield Road needs to be closed activate the **Radio Closure Announcement** using the procedure in Appendix F.	NWK FIDO [redacted]
55m^3/s +	Contact the KSL MFDO and request that the Medway Flood Forecasting Model is run again as per the instructions in section 3. [redacted]	KSL MFDO [redacted]

Leigh Flood Storage Area Operational Procedures

65m³/s +	Liaise with the NWK FIDO to arrange for the Medway Operations Field Team to visit Tonbridge, East Peckham and Yalding. **Liaise with the FWDO South on the potential for issuing Flood Warnings.** The lowest trigger level is for East Peckham where the flood warning for the River Medway is issued at an outflow of 80m³/s from Leigh (see section 5 for more detail).	NK FIDO [redacted] FWDO South [redacted]
70m³/s	At 70 m³/s the following SETEL alarm will trigger for information: ACT CON OPS Leigh FSA outflow has reached 70m³/s. Issue the **Impounding Warning** and consider impounding, dependent upon catchment conditions and forecast information. Discuss with NK FIDO, FWDO South, KSL MFDO and ABC. The instructions for issuing can be found in Appendix G. During large events the flow may increase rapidly from 70-75m³/s. If you are confident you will impound you can issue this warning before 70m³/s. If possible try to issue this warning during daylight hours to make it useful for the upstream landowners.	NK FIDO [redacted] FWDO South [redacted] KSL MFDO [redacted] ABC [redacted]
→	**Following the decision to impound:** • Inform ABC and request that the HELP report or Sitrep is updated • Inform the NWK FIDO, Area Duty Manager (ADM), FWDO South. • During office hours notify [redacted] Engineer) and Peter Howe (Medway & North Kent APT). Notify the Supervising Engineer [redacted]	

[redacted]

Figure 9.6 How to switch a gate to manual control. For each gate select 'enable control' followed by 'gate to man' and then click 'yes' to the command prompt.

9.5 POST EVENT - WHEN TO CEASE MONITORING (NON IMPOUNDING EVENT)

NOTE: When considering ceasing to monitor at Leigh FSA the rainfall forecast must be taken into account. Check also that the peaks have both passed through at Colliers Land and Vexour.

Once monitoring has ceased the upstream water level will need to be monitored to ensure that it does not go above the indicator for impounding

Non Impounding Event - Following a non-impounding event, once flows at Colliers and Vexour have peaked you can reduce the monitoring frequency until the peak flows have passed through Leigh.

The structure should be taken out of Manual and returned to Automatic when the upstream level is between and .

9.6 POST EVENT – AFTER CEASING MONITORING

After the weather event has passed and formal/continuous monitoring has ceased it is the responsibility of the closing LFSAO to carry out the following tasks:

1. Ensure all data recorded is saved in the following location: at [redacted] in the relevant folder.
2. Push the LFSAO BT One Number back to their mobile number.
3. **REMEMBER:** It is important throughout this procedure to discuss likely scenarios as well as forecast and model confidence with the KSL MFDO. The FWDO South should also be involved in these discussions.

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10 LEIGH FLOOD STORAGE AREA IMPOUNDING PROCEDURE

REMEMBER: It is important throughout this procedure to discuss likely scenarios as well as forecast and model confidence with the KSL MFDO. The FWDO South should also be involved in these discussions. The ABC and ADM must be kept informed throughout.

The following steps must be followed to commence impounding.

10.1 CLOSING THE POWDERMILL PENSTOCK

[redacted]

[redacted]

[redacted]

Figure 10.1

[redacted]

[redacted]

Figure 10.2

4. The Powder Mill screen will open (Figure 10.3)

Figure 10.3

Figure 10.4

[redacted]

[redacted]

Figure 10.5

Figure 10.6

[redacted]

10.2 CLOSING THE CENTRE GATE

[redacted]

Figure 10.7

[redacted]

Figure 10.8

[redacted]

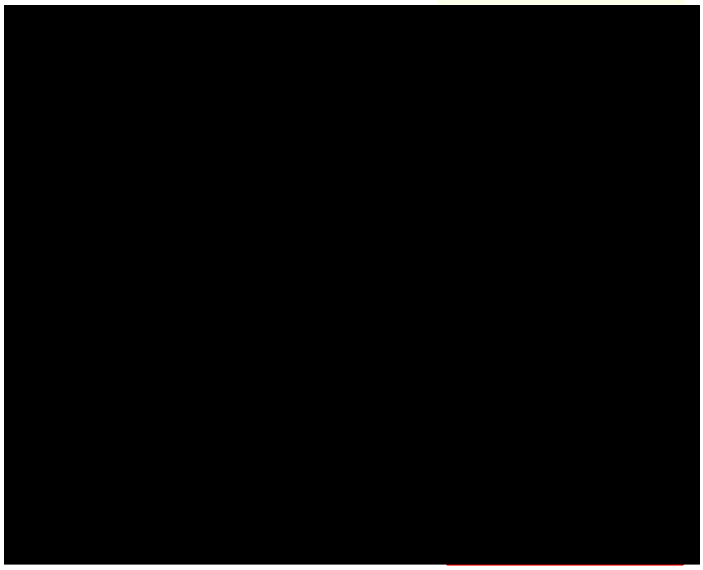

Figure 10.9

[redacted]

2. [redacted]

Figure 10.10

[redacted]

10.3 MANAGING THE OUTFLOW

[redacted]

Use the RBS to work out the target flow. This should be 75m³/s (+/-5 m³/s) if you are operating under the fixed flow operating regime.

[redacted]

Figure 10.11

[redacted]

Figure 10.12

2. Move the North and South gates to the required positions. This can be done using the steps set out in 10.2 of these procedures by enabling the required gate.

3. Go to the Leigh Flood Storage Area Overview page on SETEL to find the latest Leigh FSA outflow in m^3/s (see Section 9 Figures 9.2 and 9.3 for print screens). Input this value into the 'Manual Outflow' column in the RBS (Figure 10.11).

   This will enable you to confirm if the actual outflow is within +/- 5 m^3/s of the outflow set in the RBS ($75m^3/s$ if following the 'fixed flow' operating regime). If the actual outflow is significantly outside of these limits, an additional gate movement may be required to bring the actual outflow back in line with the default.

4. **Every 15 minutes** record the Upstream Reservoir Level in the RBS and the actual Outflow in Manual Outflow column. If a reading is not completed on time use the 'historic list' function on the Leigh FSA Overview page to ensure the correct value is entered. Monitor the calculated inflow and rate of reservoir rise. If the RBS becomes unavailable at any time reservoir rate of rise can be calculated using the equation found in Appendix O.

   Reservoir rate of rise can be used as an indicator to identify the scale of the flood and identify inflows into the reservoir as shown in table 10.1 overpage.

[redacted]

Table 10.1 Net reservoir inflow as a function of the reservoir level and rate of rise

[redacted]

Table 1 - Leigh FSA Monitoring														
Operator(s):														
						Gate Opening (m)							*Optional*	
Date	Time	Flow at Colliers (m^3/s)	Flow at Vexour (m^3/s)	Predicted Inflow using table	+ 7 Hours	N	C	S	Leigh Upstream Level (m AOD)	Leigh FSA GOC Outflow (m^3/s)	Leigh Downstream Level (m AOD)	Lucifer Bridge Flow (m^3/s)	*Forecast Outflow (m3/s)*	*Time of NFFS Forecast*
01/01/2015	00:00	0.00	0.00	0	07:00	0.000	0.000	0.000	24.100	0	24.000	24.0	0	01/01/2015 @ 00:00
	00:30				07:30									

Figure 10.13

[redacted]

10.4 OBSERVATIONS DOWNSTREAM OF LEIGH FSA

[redacted]

[redacted]

Table 10.2 Downstream flood impact thresholds

Actual Outflow	Locations that need to be observed for flood impacts
50m^3/s	**Tonbridge sports fields** start to flood. These fields act as floodplain storage and can store 1-2milion m^3 of flood water. Once full they do not easily drain and so in subsequent events the downstream conditions may change at lower outflows.
65m^3/s	**Tonbridge sports field, Blossom Bank (Cannon Lane) site not properties,** Tonbridge tributaries including **Hildenbrook and Hawden Stream.**
80m^3/s	*River Medway flood warning threshold for East Peckham.* All sites listed above plus **East Peckham** and **Yalding**
100-120m^3/s	*Flood warning threshold for Tonbridge and Hildenborough* All sites listed above plus **Tonbridge town centre** and **Hildenborough**
140-150 cumecs	*River Medway flood warning threshold for Paddock Wood and Laddingford and severe flood warning threshold for Tonbridge* All sites listed above and **Paddock Wood** (south of railway) and **Laddingford.**

10.5 OPERATIONAL REVIEW TRIGGER LEVELS

Whilst impounding the LFSAO should undertake a review of the operational plan at each of the reservoir level triggers identified below.

Table 10.3 Operational Review Trigger Levels

Upstream Level Trigger	Reservoir Capacity	LFSAO Action
26.00m AOD	25% capacity used	Review conditions to see if the outflow of 75m³/s can be maintained for the entire event.
26.75m AOD	50% capacity used	Assess the scale of forecast flood to see if the outflow can be kept below 75 - 80m³/s to avoid flooding problems at East Peckham. If likely to reach 27.7m AOD discuss issuing the flood warning for the River Medway (Penshurst to Leigh FSA) with the South FWDO.
27.25m AOD	67% capacity used	Review likelihood of reservoir filling based on all available information. If so revisit operating plan.
27.7m AOD	85% capacity used	Review the operating plan. Contact the Supervising Engineer to let them know that the storage area is at 85% capacity. ***Consider***: • Can the outflow be maintained at 75 - 80m³/s to avoid flooding the lower parts of Tonbridge (e.g. if the forecast shows that the inflow has already peaked) or will outflow need to be increased to reduce the risk of overtopping? • Check with the FWDO South that the flood warning for the River Medway (Penshurst to Leigh FSA) has been issued.
28.05m AOD	100% capacity used	**THIS IS OUR LEGAL MAXIMUM IMPOUNDING LEVEL - DO NOT ALLOW THE RESERVOIR LEVEL TO INCREASE** **Ensure that the outflow matches the inflow so that no further rise in reservoir level occurs.**
29.15m AOD	**Overtopping occurs**	**DO NOT ALLOW THE RESERVOIR TO OVERTOP** **If this cannot be avoided make sure the Supervising Engineer has contacted the Inspecting Engineer.**

REMEMBER: At each trigger level identified above the following process must be followed.

1 – Speak to the KSL MFDO and request that the Medway Flood Forecasting Model is run. Request a csv file of predicted inflows for the event. Make sure to ask for flows at the Medway/Eden confluence. Consider an appropriate timeframe that you require the data for (24 hours – 5 days). Speak to the KSL MFDO about their confidence in the model performance.

2 – Run the RBS as per steps 2-4 in Section 8.2 of the Forecasting and Operational Planning Procedure.

3 – Review the conditions in Tonbridge, East Peckham and Yalding. Speak to the NK FIDO/downstream inspectors for an update on the Tonbridge town streams.

4 – Carry out a formal review of the operational plan, in particular whether to continue with the current operational plan. If you are following a fixed outflow operational plan you should consider if a variable operating plan could maximize flood risk management benefits. Before moving from a fixed outflow operating plan to a varied outflow operating plan the LFSAO must consult with the duty ABC, NWK FIDO, South FWDO and MFDO.

10.6 INSPECTIONS DURING IMPOUNDING

A visual inspection of the LFSA embankments and structure must be carried out twice a day during daylight hours. The inspections are initiated by the LFSAO and must be carried out by a competent person – a list of competent people can be found in Appendix M. The LFSAO should contact the ABC to facilitate a rota for people to undertake the visual walkover inspections.

An inspection guide, checklist, risk assessments and a sign out/in sheet can also be found in the event data template or in Appendix M. Prepared copies of the printed inspection pack to give to the inspectors which includes the checklist can be found on the cupboard in the Leigh FSA control room.

Any observations made during impounding inspections must be reported to the Supervising Engineer and ABC.

Ask the inspectors to manually record the upstream reservoir level on the gauge board located on the pier of the centre gate.

10.7 LEIGH PUMPING STATION

Leigh pumping station ensures that surface water from Leigh village is collected and pumped over the Leigh embankments and into the storage area. The pumps operate whilst impounding is underway. It has the following SETEL alarms: site power fail, pump 1 and 2 overload. There is also an act con ops alarm for the water level (set to the ground level at the base of the embankments) and act ops alarms for the just below the top of the embankment. Whilst impounding check that the pumps are operational on SETEL for looking up Leigh PS using the search icon and reviewing the water levels.

10.8 CALCULATING RESERVOIR CAPACITY

To identify how full the reservoir is as a percentage enter the current reservoir level and outflow into the Gate Opening Calculator (GOC). The percentage full will then appear as per the red box below.

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