3935

seqwater
WATER FOR LIFE

MANUAL

OF

OPERATIONAL PROCEDURES

FOR

FLOOD MITIGATION

AT

WIVENHOE DAM

AND

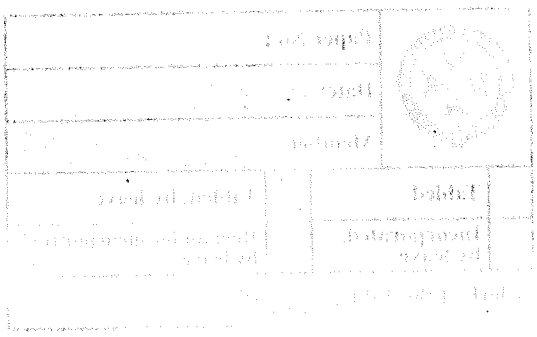
SOMERSET DAM

Revision 7
November 2009

Revision No.	Date	Amendment Details
0	27 October 1968	Original Issue
1	6 October 1992	Complete revision and re-issue
2	13 November 1997	Complete revision and re-issue
3	24 August 1998	Change to page 23
4	6 September 2002	Complete revision and re-issue
5	4 October 2004	Complete revision
6	20 December 2004	Miscellaneous amendments and re-issue
7	November 2009	Complete Revision

Note:

This version is a redacted version that has been amended to remove material that may be of concern in relation to the security of critical infrastructure.



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1 INTRODUCTION

1.1 Preface

Given their potential significant impact on downstream populations, it is imperative that Wivenhoe and Somerset Dams be operated during flood events in accordance with clearly defined procedures to minimise impacts to life and property. This manual outlines these procedures and is an approved Flood Mitigation Manual under Water Supply Act 2008.

The Manual in its current form was developed in 1992 and the basis of this document was a manual written in 1968 covering flood operations at Somerset Dam (Wivenhoe Dam was completed in 1984). Six revisions of the Manual have occurred since 1992 to account for updates to the Flood Alert Network and the Real Time Flood Models, the construction of an Auxiliary Spillway at Wivenhoe Dam in 2005 and to account for institutional and legislative changes.

The primary objectives of the procedures contained in this Manual are essentially the same as those contained in previous Manual versions. These objectives in order of importance are:

- Ensure the structural safety of the dams;
- Provide optimum protection of urbanised areas from inundation;
- Minimise disruption to rural life in the valleys of the Brisbane and Stanley Rivers;
- Retain the storage at Full Supply Level at the conclusion of the Flood Event.
- Minimise impacts to riparian flora and fauna during the drain down phase of the Flood Event.

In meeting these objectives, the dams must be operated to account for the potential effects of closely spaced Flood Events. Accordingly, normal procedures require stored floodwaters to be emptied from the dams within seven days of the flood event peak passing through the dams.

Wivenhoe Dam and Somerset Dam are operated in conjunction so as to maximise the overall flood mitigation capabilities of the two dams. The procedures outlined in this Manual are based on the operation of the dams in tandem.

1.2 Meaning of Terms

In this Manual, save where a contrary definition appears -

"Act" means the *Water Supply (Safety and Reliability) Act 2008*;

"AEP" means annual exceedance probability, the probability of a specified event being exceeded in any year.

"Agency" includes a person, a local government and a department of state government within the meaning of the Acts Interpretation Act 1954;

"AHD" means Australian Height Datum;

"Chairperson" means the Chairperson of Seqwater;

"Chief Executive" means the Director General of the Department of Environment and Resource Management or nominated delegate;

"Controlled Document" means a document subject to managerial control over its contents, distribution and storage. It may have legal and contractual implications;

"Dams" means dams to which this Manual applies, that is Wivenhoe Dam and Somerset Dam;

"Dam Supervisor" means the senior on-site officer at Wivenhoe or Somerset Dam as the case may be;

"Duty Flood Operations Engineer" means the Senior Flood Operations Engineer or Flood Operations Engineer rostered on duty to be in charge of Flood Operations at the dams;

"EL" means elevation in metres Australian Height Datum;

"Flood Event" is a situation where the Duty Flood Operations Engineer expects the water level in either of the Dams to exceed the Full Supply Level;

"Flood Operations Centre" means the Centre used during by Flood Operations Engineers to manage Flood Events;

"Flood Operations Engineer" means a person designated to direct flood operations at the dams in accordance with Section 2.4 of this Manual;

"FSL" or "Full Supply Level" means the level of the water surface when the reservoir is at maximum operating level, excluding periods of flood discharge;

"Gauge" when referred to in (m) means river level referenced to AHD, and when referred to in (m^3/s) means flow rate in cubic metres per second;

"Manual" or "Manual of Operational Procedures for Flood Events at Wivenhoe Dam and Somerset Dam" means the current version of this Manual;

"Power Station" means the Wivenhoe pumped storage hydro-electric power station associated with Wivenhoe Dam and Split-Yard Creek Dam;

"Senior Flood Operations Engineer" means a person designated in accordance with Section 2.3 of this Manual under whose general direction the procedures in this Manual must be carried out;

"Seqwater" means the Queensland Bulk Water Supply Authority trading as Seqwater.

1.3 Purpose of Manual

The purpose of this Manual is to define procedures for the operation of Wivenhoe Dam and Somerset Dam to reduce, so far as practicable, the effects of flooding associated with the dams. This is achieved by the proper control and regulation in time of the flood release infrastructure at the dams, with due regard to the safety of the dam structures.

The procedures in this Manual have been developed on the basis that the community is to be protected to the maximum extent practical against flood hazards recognising the limitations on being able to:

- Obtain accurate forecasts of rainfall during flood events;
- Accurately estimate flood run-off within the dam catchments;
- Identify all potential flood hazards and their likelihood;
- Remove or reduce community vulnerability to flood hazards;
- Effectively respond to flooding;
- Provide resources in a cost effective manner.

1.4 Legal Authority

This manual has been prepared as a Flood Mitigation Manual in accordance with Chapter 4 Part 2 of the Act.

1.5 Application and Effect

The procedures in this Manual apply to the operation of Wivenhoe Dam and Somerset Dam for the purpose of flood mitigation, and operation in accordance with the manual shall give the protection from liability provided by Section 374 of the Act.

1.6 Date of Effect

The procedures in this Manual shall have effect on and from the date on which this version of the Manual is approved by gazette notice.

The Manual shall remain in force for the period of approval as determined by the Chief Executive. This approval may be for a period of up to five years.

Before the approval of the Manual expires, Seqwater must review and if necessary update the Manual and submit a copy to the chief executive for approval.

1.7 Observance of Manual

This Manual contains the operational procedures for Wivenhoe Dam and Somerset Dam for the purposes of flood mitigation and must be used for the operation of the dams during flood events.

1.8 Provision for Variations to Manual

If Seqwater is of the opinion that this Manual should be amended, altered or varied, it must submit for approval as soon as practical, an appropriate request to the Chief Executive, setting out the circumstances and the exact nature of the amendment, alteration or variation sought. The Chief Executive may accept, reject or modify the request prior to approval.

1.9 Distribution of Manual

Seqwater must regard the manual as a Controlled Document and ensure that only controlled manuals are used in the direction of flood mitigation activities. Agencies having copies of controlled hardcopies of the Manual are listed in Appendix A. Seqwater must maintain a Register of Contact Persons for issued controlled hardcopies of the Manual and must ensure that each issued document is updated whenever amendments or changes are approved.

2 DIRECTION OF OPERATIONS

2.1 Statutory Operation

Pursuant to the provisions of the Act, Seqwater is responsible for operating and maintaining the dams in accordance with this Manual in order to retain the protection from liability afforded by the Act. Operators, employees, agents, and contractors working for Seqwater must also comply with this Manual to obtain the protection of the Act.

2.2 Operational Arrangements

For the purposes of operation of the dams during Flood Events, Seqwater must ensure that:

- Sufficient numbers of suitably qualified personnel are available to operate the dams if a Flood Event occurs.
- Sufficient numbers of suitably qualified personnel are available to operate the Flood Operations Centre if a Flood Event occurs
- A Duty Flood Operations Engineer is on call at all times. The Duty Flood Operations Engineer must constantly review weather forecasts and catchment rainfall and must declare a Flood Event if the water level of either Wivenhoe or Somerset Dam is expected to exceed Full Supply Level as a result of prevailing or predicted weather conditions.
- A Senior Flood Operations Engineer is designated to be in the charge of Flood Operations at all times during a Flood Event.
- Release of water at the dams during Flood Events is carried out under the direction of the Duty Flood Operations Engineer.
- All practical attempts are made to liaise with the Chairperson and the Chief Executive if the release of water from the Dams during a Flood Event is likely to endanger life or property.

2.3 Designation and Responsibilities of Senior Flood Operations Engineer

Seqwater must nominate one or more suitably qualified and experienced persons to undertake the role of Senior Flood Operations Engineer. If approved by the Chief Executive, these persons can be authorised in the Schedule of Authorities (see Section 2.6). When rostered on duty during a Flood Event, the responsibilities of the Senior Flood Engineer are as follows:

- Set the overall strategy for management of the Flood Event in accordance with the objectives of this Manual.
- Provide instructions to site staff to make releases of water from the Dams during Flood Events that are in accordance with this Manual.
- Apply reasonable discretion in managing a Flood Event as described in Section 2.8.

Seqwater must ensure that an adequate number of Senior Flood Operations Engineers are available to manage all Flood Events.

2.4 Designation and Responsibilities of Flood Operations Engineer

Seqwater must nominate one or more suitably qualified and experienced persons to undertake the role of Flood Operations Engineer. If approved by the Chief Executive, these persons can be authorised in the Schedule of Authorities (see Section 2.6). When rostered on duty during a Flood Event, the responsibilities of the Flood Engineer are as follows:

- Direct the operation of the dams during a flood event in accordance with the general strategy determined by the Senior Flood Operations Engineer.
- Follow any direction from the Senior Flood Operations Engineer in relation to applying reasonable discretion in managing a Flood Event as described in Section 2.8. Unless otherwise directed, a Flood Operations Engineer is to follow this Manual in managing Flood Events and is not to apply reasonable discretion unless directed by the Senior Flood Operations Engineer or the Chief Executive.
- Provide instructions to site staff to make releases of water from the Dams during Flood Events that are in accordance with this Manual.

Seqwater must ensure that an adequate number of Flood Operations Engineers are available to manage all Flood Events. Seqwater must also ensure that an adequate number of suitably qualified and experienced persons are available to assist the Flood Operations Engineers during all Floods Events.

2.5 Qualifications and Experience of Engineers

Qualifications

All engineers referred to in Sections 2.3 and 2.4 must hold a Certificate of Registration as a Registered Professional Engineer of Queensland and must hold appropriate engineering qualifications to the satisfaction of the Chief Executive.

Experience

All engineers referred to in Sections 2.3 and 2.4 must, to the satisfaction of the Chief Executive, have:

(1) Knowledge of design principles related to the structural, geotechnical and hydraulic design of large dams, and

(2) At least a total of five years of suitable experience and demonstrated expertise in at least two of the following areas:

- Investigation, design or construction of major dams;
- Operation and maintenance of major dams;
- Hydrology with particular reference to flooding, estimation of extreme storms, water management or meteorology;
- Applied hydrology with particular reference to flood forecasting and/or flood forecasting systems.

2.6 Schedule of Authorities

Seqwater must maintain a Schedule of Authorities containing a list of the Senior Flood Operations Engineers and Flood Operations Engineers approved by the Chief Executive to direct flood operations at the dams during floods. A copy of the Schedule of Authority must be provided to the Chief Executive by 30 September of each year.

Seqwater shall nominate suitably qualified and experienced engineers for registration in the Schedule of Authorities as the need arises. Each new nomination must include a validated statement of qualifications and experience as required by the Chief Executive. Seqwater must obtain the approval for all nominations from the Chief Executive prior to their inclusion in the Schedule of Authorities.

If, in the event of unforseen and emergency situations, no Senior Flood Operations Engineer or no Flood Operations Engineer is available from the Schedule of Authorities to manage a Flood Event, Seqwater must temporarily appoint a suitable person or persons and immediately seek ratification from the Chief Executive.

2.7 Training

Seqwater must ensure that operational personnel required for flood operations activities receive adequate training in the various activities involved in flood control operation as required by the Chief Executive.

2.8 Reasonable Discretion

If in the opinion of the Senior Flood Operations Engineer, it is necessary to depart from the procedures set out in this Manual to meet the flood mitigation objectives set out in Section 3, the Senior Flood Operations Engineer is authorised to adopt such other procedures as considered necessary subject to the following:

- Before exercising discretion under this Section of the Manual with respect to flood mitigation operations, the Senior Flood Operations Engineer must make a reasonable attempt to consult with both the Chairperson and Chief Executive.
- The Chief Executive would normally authorise any departures from the Manual. However if the Chief Executive cannot be contacted within a reasonable time, departures from the Manual can be authorised by the Chairperson.
- If both the Chairperson and the Chief Executive cannot be contacted within a reasonable time, the Senior Flood Operations Engineer may proceed with the procedures considered

necessary and report such action at the earliest opportunity to the Chairperson and Chief Executive.

2.9 Report

Seqwater must prepare a report after each Flood Event. The report must contain details of the procedures used, the reasons therefore and other pertinent information. Seqwater must forward the report to the Chief Executive within six weeks of the completion of the Flood Event.

3 FLOOD MITIGATION OBJECTIVES

3.1 General

To meet the purpose of the flood operational procedures in this Manual, the following objectives, listed in descending order of importance, are as follows:

- Ensure the structural safety of the dams;
- Provide optimum protection of urbanised areas from inundation;
- Minimise disruption to rural life in the valleys of the Brisbane and Stanley Rivers;
- Retain the storage at Full Supply Level at the conclusion of the Flood Event.
- Minimise impacts to riparian flora and fauna during the drain down phase of the Flood Event.

In meeting these objectives, the dams must be operated to account for the potential effects of closely spaced Flood Events. Accordingly, normal procedures require stored floodwaters to be emptied from the dams within seven days of the flood event peak passing through the dams.

Additionally, the auxiliary spillway constructed at Wivenhoe Dam in 2005 incorporates fuse plugs. Triggering of a fuse plug will increase floods levels downstream. Where possible, gate operations at both Wivenhoe and Somerset dams should be formulated to prevent operation of the fuse plug. This potential scenario is possible only when the forecast peak water level for Wivenhoe Dam just exceeds the trigger level for the fuse plug and sufficient time is available to alter releases.

3.2 Structural Safety of Dams

The structural safety of the dams must be the first consideration in the operation of the dams for the purpose of flood mitigation.

Wivenhoe Dam

The structural safety of Wivenhoe Dam is of paramount importance. Structural failure of Wivenhoe Dam would have catastrophic consequences. Wivenhoe Dam is predominantly a central core rockfill dam. Such dams are not resistant to overtopping and are susceptible to breaching should such an event occur. Overtopping is considered a major threat to the security of Wivenhoe Dam. Wivenhoe Dam is overtopped by an event with a 1 in 100,000 AEP.

Somerset Dam

The structural safety of Somerset Dam also is of paramount importance. Failure of Somerset Dam could have catastrophic consequences. Whilst Wivenhoe Dam has the capacity to mitigate the flood effects of such a failure in the absence of any other flooding, if the failure were to occur during major flooding, Wivenhoe Dam could be overtopped and destroyed also.

Somerset Dam is a mass concrete dam. Such dams can withstand limited overtopping without damage. Failure of such structures is rare but when they do occur, they occur suddenly without warning, creating very severe and destructive flood waves. Although Somerset Dam is overtopped by an event with a 1 in 5,000 AEP, it is expected that the dam could withstand at least 2.2 metres of overtopping without failure, provided all radial gates are fully open. This equates to an event centred on the Somerset Dam catchment with a 1 in 20,000 AEP.

Extreme Floods and Closely Spaced Large Floods

As indicated in the previous section, techniques for estimating extreme floods show that floods are possible which would overtop both dams. In the case of Wivenhoe Dam such an overtopping would most likely result in the destruction of the dam. Such events however require several days of intense rainfall to produce the necessary runoff.

Historical records show that there is a significant probability of two or more flood producing storms occurring in the Brisbane River system within a short time of each other. Therefore, unless determined otherwise by the Senior Flood Operations Engineer in accordance with Section 2.8, the aim during a Flood Event should be to empty stored floodwaters within seven days after the flood peak has passed through the dams. In a very large flood, this time frame may not be achievable because of downstream flood conditions and it may be necessary to extend the emptying period by several days.

The discharges from the dams should be regulated so as to have little impact on the urban reaches of the Brisbane River, taking into account inflows into the river downstream of the dams. However the seven day drainage requirement may result in submergence of some bridges. Regardless, the level of flooding as a result of emptying stored floodwaters after the peak has passed is to be less than the flood peak unless accelerated release is necessary to reduce the risk of overtopping.

3.3 Inundation of Urban Areas

The prime purpose of incorporating flood mitigation measures into Wivenhoe Dam and Somerset Dam is to reduce flooding in the urban areas of the flood plains below Wivenhoe Dam. The peak flows of floods emanating from the upper catchments of Brisbane and Stanley Rivers can be reduced by controlling flood releases from the dams, while taking into account flooding derived from the lower Brisbane River catchments.

3.4 Disruption to Rural Areas

While the dams are being used for flood mitigation purposes, bridges and areas upstream of the dams may be temporarily inundated. Downstream of the dam, bridges and lower river terraces will be submerged. The operation of the dams should not prolong this inundation unnecessarily.

Disruption to navigation in the Brisbane River can also be taken into account when considering disruption to rural areas downstream of the dam. Generally, this consideration is secondary to considerations associated with reducing bridge inundation.

3.5 Retain the storage at Full Supply Level at the Conclusion of the Flood Event

As the dams are the primary urban water supply for South East Queensland, it is important that all opportunities to fill the dams are taken. There should be no reason why the dams should not be full following a Flood Event.

3.6 Minimising Impacts to Riparian Flora and Fauna

During the drain down phase, consideration is to be given to minimising the impacts on riparian flora and fauna. In particular, strategies aimed at reducing fish deaths in the vicinity of the dam walls are to be instigated, provided such procedures do not adversely impact on other flood mitigation objectives.

Additionally, when determining the time interval between successive gate closures consideration should also be given to reducing potential bank slumping. Rapid draw down of stream levels where banks are saturated should be avoided if this can be managed within the other flood mitigation objectives.

4 FLOOD CLASSIFICATION

For the reference purposes of this Manual, four magnitudes of flooding are classified as follows:

Minor Flooding

Causes inconvenience. Low-lying areas next to watercourses are inundated which may require the removal of stock and equipment. Minor roads may be closed and low-level bridges submerged.

Moderate Flooding

In addition to the impacts experienced during Minor Flooding, the evacuation of some houses may be required. Main traffic routes may be impacted. The area of inundation is substantial in rural areas requiring the removal of stock.

Major Flooding

In addition to the impacts experienced during Moderate Flooding, extensive rural areas and/or urban areas are inundated. Properties and towns are likely to be isolated and major traffic routes likely to be closed. Evacuation of people from flood affected areas may be required. The 1974 flood that impacted on the Ipswich and Brisbane areas is classified as a major flood.

Extreme Flooding

This causes flooding impacts equal to or in excess of levels previously experienced. In addition to the impacts experienced during Major Floods, the general evacuation of people from significant populated areas is likely to be required.

It should be noted that a flood may not cause the same category of flooding along its entire length and the relevant agencies shall have regard to this when flooding is predicted. The classifications of minor, moderate and major flooding are based on the Bureau of Meteorology Standard Flood Classifications for Australia.

The current classifications for key reference gauges in the Brisbane River are given in Appendix B.

5 FLOOD MONITORING AND FORECASTING SYSTEM

5.1 General

A real time flood monitoring and forecasting system has been established in the dam catchments. This system employs radio telemetry to collect, transmit and receive rainfall and stream flow information. The system consists of more than 100 field stations that automatically record rainfall and/or river heights at selected locations in the dam catchments. Some of the field stations are owned by Seqwater with the remainder belonging to other agencies.

The rainfall and river height data is transmitted to Seqwater's Flood Operations Centre in real time. Once received in the Flood Operations Centre, the data is processed using a Real Time Flood Model (RTFM) to estimate likely dam inflows and evaluate a range of possible inflow scenarios based on forecast and potential rainfall in the dam catchments. The RTFM is a suite of hydrologic and hydraulic computer programs that utilise the real time data to assist in the operation of the dams during flood events. Seqwater is responsible for providing and maintaining the RTFM and for ensuring that sufficient data is available to allow proper operation of the RTFM during a Flood Event.

5.2 Operation

The Senior Flood Operations and Flood Operations Engineers use the RTFM for flood monitoring and forecasting during flood events to operate the dams in accordance with this Manual. This is done by optimising releases of water from the dams to minimise the impacts of flooding in accordance with the objectives and procedures contained in this Manual.

Seqwater is responsible for improving the operation of the RTFM over time by using the following processes:

- Implementing improvements based on Flood Event audits and reviews.
- Improving RTFM calibration as further data becomes available.
- Updating software in line with modern day standards.
- Improving the coverage and reliability of the data collection network to optimise data availability during Flood Events.
- Recommendations by Senior Flood Operations Engineers.

A regular process of internal audit and management review must be maintained by Seqwater to achieve these improvements.

Seqwater must also maintain a log of the performance of the data collection network. The log must include all revised field calibrations and changes to the number, type and locations of gauges. Senior Flood Operations and Flood Operations Engineers are to be notified of all significant changes to the Log.

Seqwater must also maintain a log of the performance of the RTFM. Any faults to the computer hardware or software are to be noted and promptly and appropriately attend to.

5.3 Storage of Documentation

The performance of any flood monitoring and forecasting system is reliant on accurate historical data over a long period of time. Seqwater must ensure that all available data and other documentation is appropriately collected and catalogued for future use.

5.4 Key Reference Gauges

Key field station locations have been identified for reference purposes when flood information is exchanged between authorities or given to the public. Should it be deemed desirable to relocate field stations from these locations or vary flood classification levels, agreement must first be obtained between Seqwater, Bureau of Meteorology and the Local Government within whose boundaries the locations are situated.

Gauge boards that can be read manually must be maintained by Seqwater as part of the equipment of each key field station. Where possible and practical during Flood events, Seqwater is to have procedures in place for manual reading of these gauge boards in the event of failure of field stations.

5.5 Reference Gauge Values

Other agencies such as the Bureau of Meteorology, Brisbane City Council and Ipswich City Council have direct access to the information from field stations for flood assessment purposes. The consultation between agencies is a very important part of the assessment and prediction of flood flows and heights.

Seqwater must ensure that information relevant to the calibration of its field stations is shared with these agencies.

6 COMMUNICATIONS

6.1 Communications between Staff

Seqwater is responsible for providing and maintaining equipment to allow adequate channels of communication to exist at all times between the Seqwater Flood Operations Centre and site staff at Wivenhoe and Somerset Dams.

6.2 Dissemination of Information

Agencies other than Seqwater have responsibilities for formal flood predictions, the interpretation of flood information and advice to the public associated with Flood Events. Adequate and timely information is to be supplied to agencies responsible for the operation of facilities affected by flooding and for providing warnings and information to the public. Agency information requirements are generally as shown in the table below.

The Senior Flood Operations and Flood Operations Engineers must supply information to each of these agencies during Flood Events. The contact information for these Agencies and communication procedures is contained in the Emergency Action Plans for the dams and each agency is to receive updated controlled copies of these documents.

Seqwater must liaise and consult with these agencies with a view to ensuring all information relative to the flood event is consistent and used in accordance with agreed responsibilities.

AGENCY INFORMATION REQUIREMENTS

Agency	Activity	Information Required from Flood Operations Centre	Trigger
Bureau of Meteorology	Issue of flood warnings for Brisbane River basin	Actual and projected discharges from Wivenhoe Dam Actual and projected discharges from Somerset Dam	Initial gate operations and thereafter at intervals to suit forecasting requirements
Department of Environment and Resource Management	Review of flood operations and discretionary powers	Actual and predicted lake levels and discharges	
Somerset Regional Council	Flood level information upstream of Somerset Dam and upstream and downstream of Wivenhoe Dam	Actual and predicted lake levels, Somerset Dam and actual and predicted lake levels and discharges, Wivenhoe Dam	Somerset Dam water level predicted to exceed EL 102 m AHD and initial Wivenhoe Dam gate operation
Ipswich City Council	Flood level information for Ipswich City area	Nil (information obtained from BOM)	
Brisbane City Council	Flood level information for Brisbane City area	Nil (information obtained from BOM)	

6.3 Release of Information to the Public

Seqwater is responsible for the issue of information regarding storage conditions and current and proposed releases from the dams to the public and the media.

The Bureau of Meteorology has responsibility for issuing flood warnings.

The Emergency Services Response Authorities, under the Disaster Management Act 2003, have responsibility for the preparation of a local counter disaster plan and the interpretation of flood forecast information for inclusion in their local flood warnings prepared under the flood sub plan of the counter disaster plan.

7 REVIEW

7.1 Introduction

With the passage of time neither the technical assumptions nor the physical conditions on which this Manual is based may remain unchanged. It is also recognised that the relevance of the Manual may change with changing circumstances. It is important therefore, that the Manual contain operational procedures which cause the assumptions and conditions upon which they are based, to be checked and reviewed regularly.

This process must involve all personnel involved in the management of Flood Events, to ensure that changes of personnel do not result in a diminished understanding of the basic principles upon which the operational procedures are based. Variations to the Manual may be made in accordance with provisions in Section 1.8.

7.2 Personnel Training

Seqwater must report to the Chief Executive by 30 September each year on the training and state of preparedness of operations personnel.

7.3 Monitoring and Forecasting System and Communication Networks

Seqwater must provide a report to the Chief Executive by 30 September each year on the state of the Flood Monitoring and Forecasting System and Communication Networks. The report must assess following in terms of hardware, software and personnel:

- Adequacy of the communication and data gathering facilities.
- Reliability of the system over the previous period.
- Reliability of the system under prolonged flood conditions.
- Accuracy of forecasting flood flows and heights.
- The overall state of preparedness of the system.

Seqwater must take any action considered necessary for the proper functioning and improvement of this system.

7.4 Operational Review

After each significant flood event, Seqwater must report to the Chief Executive on the effectiveness of the operational procedures contained in this manual. This report must be submitted within six weeks of any flood event that requires mobilisation of the Flood Operations Centre.

7.5 Five Yearly Review

Prior to the expiry of the approval period, Seqwater must review the Manual pursuant to provisions of the Act. The review is to take into account the continued suitability of the communication network and the flood monitoring and forecasting system, as well as hydrological and hydraulic engineering assessments of the operational procedures.

8 WIVENHOE DAM FLOOD OPERATIONS

8.1 Introduction

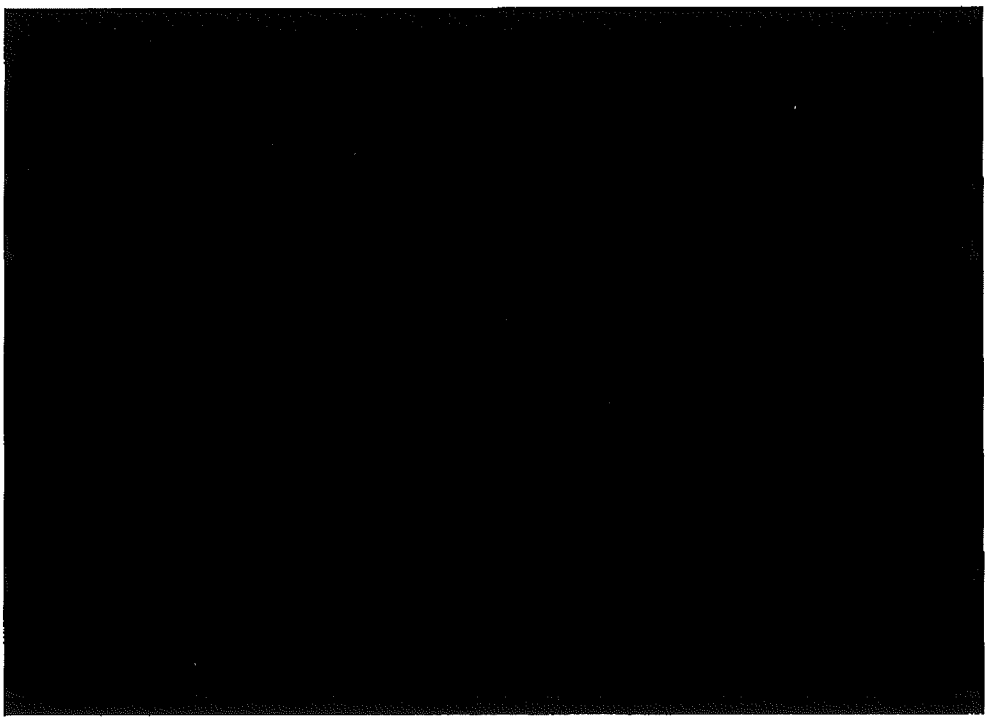
Wivenhoe Dam is capable of being operated in a number of ways to reduce flooding in the Brisbane River downstream of the dam, depending on the origin, magnitude and spatial extent of the flood. Maximum overall flood mitigation effect will be achieved by operating Wivenhoe Dam in conjunction with Somerset Dam.

The reservoir volume above FSL of EL 67.0 is available as temporary flood storage. How much of the available flood storage compartment is utilised, will depend on the initial reservoir level below FSL, the magnitude of the flood being regulated and the procedures adopted.

Splityard Creek Dam is part of the overall Wivenhoe Area Project and it forms the upper pumped storage for hydro power generation. Splityard Creek Dam impounds a volume of 28,700 ML at FSL (EL 166.5). This volume can be emptied into Lake Wivenhoe within 12 hours and this water can affect the level in Wivenhoe Dam by up to 300mm when Wivenhoe Dam is close to FSL. Operation of the power station and release of water from Splityard Creek Dam to Lake Wivenhoe is outside the control of Seqwater, but should be considered when assessing the various trigger levels of Wivenhoe Dam.

8.2 Flood Release Infrastructure

Radial Gates and an Auxiliary Spillway are the primary infrastructure used to release water during flood events at Wivenhoe Dam. The arrangement of the Radial Gates is shown in the diagram below:

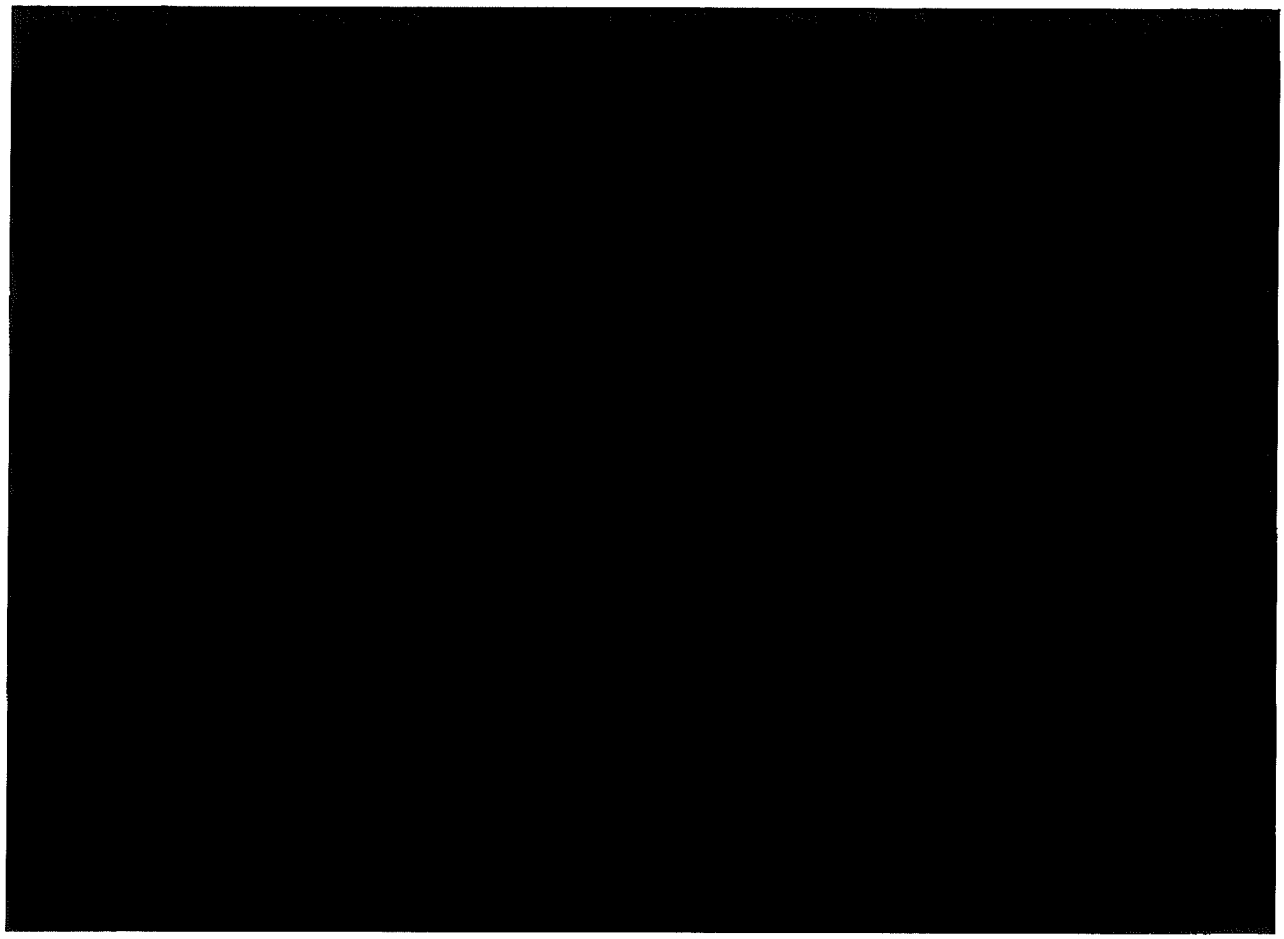


In addition to the five radial gates, the auxiliary spillway was constructed in 2005 as part of an upgrade to improve flood adequacy of this storage. The auxiliary spillway consists of a three bay fuse plug spillway at the right abutment. In association with other works constructed at the dam, this gives the dam crest flood an AEP of approximately 1 in 100,000. Another one bay fuse plug spillway may be constructed at Saddle Dam Two in the future.

Pertinent information about the auxiliary spillway, including the initiation level for the specific bays is given in the following table.

AUXILIARY SPILLWAY - FUSE PLUG DETAILS

The arrangement of the Auxiliary Spillway is shown in the diagram below.



8.3 Initial Flood Control Action

Once a Flood Event is declared, an assessment is to be made of the magnitude of the Flood Event, including:

- A prediction of the maximum storage levels in Wivenhoe and Somerset Dams.
- A prediction of the peak flow rate at the Lowood Gauge excluding Wivenhoe Dam releases.
- A prediction of the peak flow rate at the Moggill Gauge excluding Wivenhoe Dam releases.

The spillway gates are not to be opened for flood control purposes prior to the reservoir level exceeding EL 67.25.

8.4 Flood Operations Strategies

There are four strategies (W1 to W4) used when operating Wivenhoe Dam during a flood event as outlined below. These strategies are based on the Flood Objectives of this manual. As outlined in Section 3, the objectives, listed in descending order of importance, are as follows:

- Ensure the structural safety of the dams;
- Provide optimum protection of urbanised areas from inundation;
- Minimise disruption to rural life in the valleys of the Brisbane and Stanley Rivers;
- Retain the storage at Full Supply Level at the conclusion of the Flood Event.
- Minimise impacts to riparian flora and fauna during the drain down phase of the Flood Event.

Within any strategy, consideration is always given to these objectives in this order, when making decisions on dam releases.

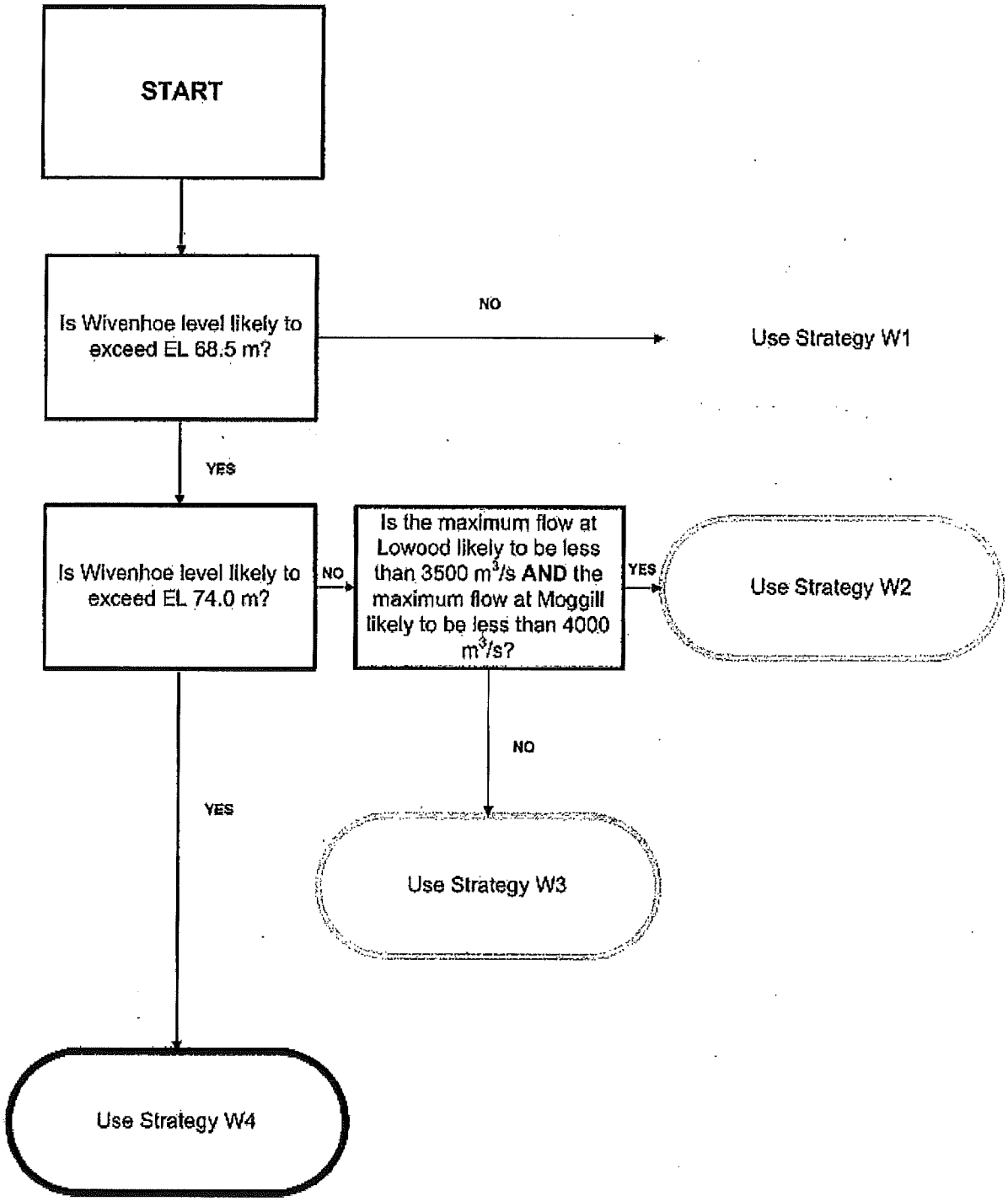
The strategy chosen at any point in time will depend on the actual levels in the dams and the following predictions, which are to be made using the best forecast rainfall and stream flow information available at the time:

- Maximum storage levels in Wivenhoe and Somerset Dams.
- Peak flow rate at the Lowood Gauge (excluding Wivenhoe Dam releases).
- Peak flow rate at the Moggill Gauge (excluding Wivenhoe Dam releases).

Strategies are likely to change during a flood event as forecasts change and rain is received in the catchments. It is not possible to predict the range of strategies that will be used during the course of a flood event at the commencement of the event. Strategies are changed in response to changing rainfall forecasts and stream flow conditions to maximise the flood mitigation benefits of the dams.

When determining dam outflows within all strategies, peak outflow should generally not exceed peak inflow. A flowchart showing how best to select the appropriate strategy to use at any point in time is shown below:

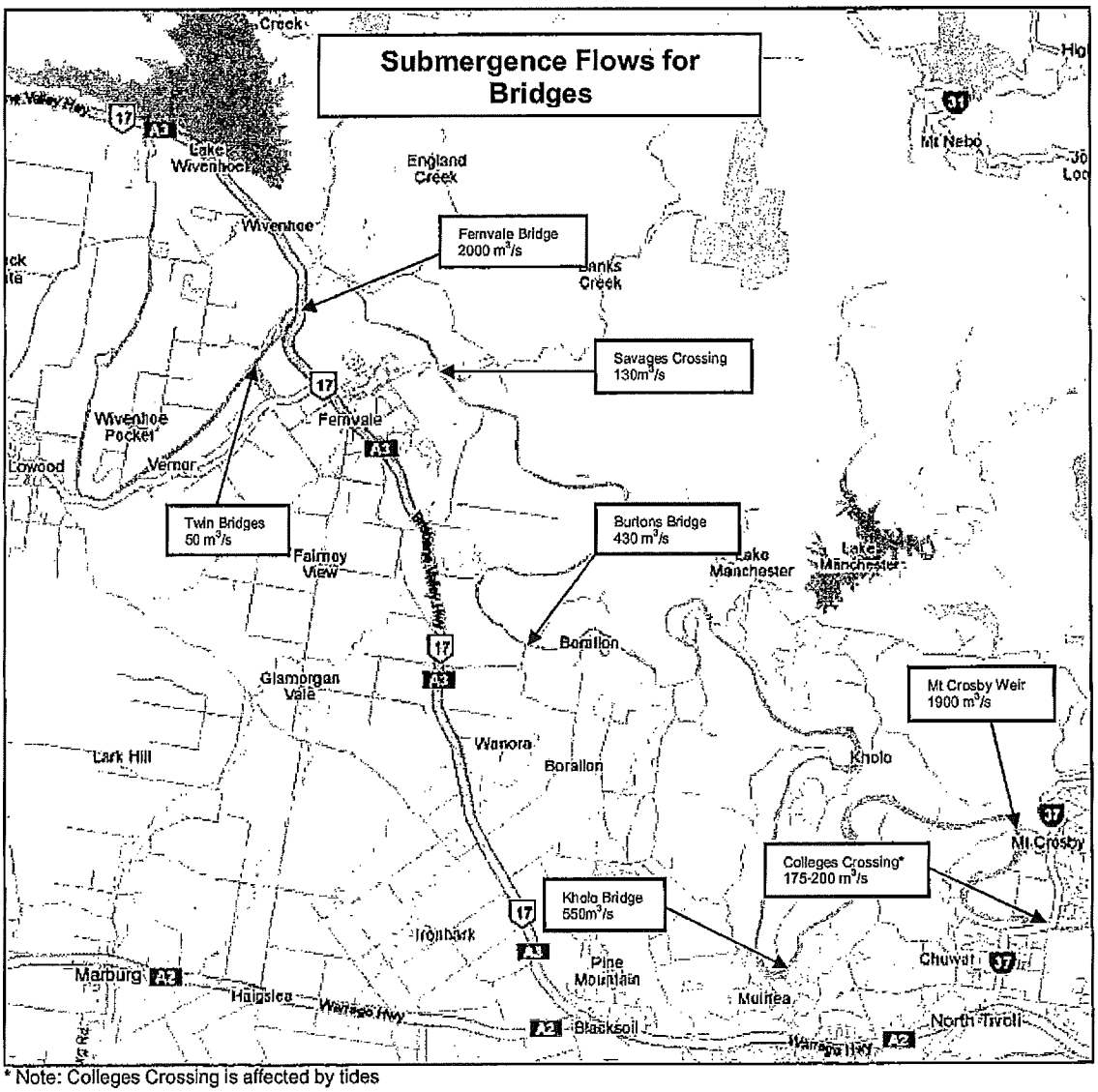
WIVENHOE FLOOD STRATEGY FLOW CHART



Strategy W1 - The Primary Consideration is Minimising Disruption to Downstream Rural Life

Conditions	• **Wivenhoe Storage Level predicted to be less than 68.50 m AHD** • **Maximum release predicted to be less than 1,900 m^3/s** • **The primary consideration is minimising disruption to downstream rural life**

The intent of Strategy W1 is to not to submerge the bridges downstream of the dam prematurely (see Appendix I). The limiting condition for Strategy W1 is the submergence of Mt Crosby Weir Bridge that occurs at approximately 1,900 m^3/s.



* Note: Colleges Crossing is affected by tides

For situations where flood rains are occurring on the catchment upstream of Wivenhoe Dam and only minor rainfall is occurring downstream of the dam, releases are to be regulated to limit, as much as appropriate in the circumstances, downstream flooding.

The following strategies require a great deal of control over releases and knowledge of discharges from Lockyer Creek. In general, the releases from Wivenhoe Dam are controlled such that the combined flow from Lockyer Creek and Wivenhoe Dam is less than the limiting values to delay the submergence of particular bridges. The diagram above shows the location of the impacted bridges and the approximate river flow rate at which they are closed to traffic.

Strategy W1A Twin Bridges, Savages Crossing and Colleges Crossing

Lake Level greater than 67.25 m AHD
[Maximum Release 110 m^3/s]

Firstly, endeavour to maintain Twin Bridges trafficable by limiting the combined flows from Wivenhoe Dam and Lockyer Creek to a maximum of 50 m^3/s.

Once Twin Bridges is closed to traffic, endeavour to maintain Savages Crossing trafficable by limiting the combined flows from Wivenhoe Dam and Lockyer Creek to a maximum of 110 m^3/s.

Once Savages Crossing is closed to traffic, endeavour to maintain College's Crossing trafficable by limiting the combined flows from Wivenhoe Dam and Lockyer Creek to a maximum of 175 m^3/s. Note that College's Crossing can be impacted by tidal influences.

When the flood event subsides, all gates are to be closed when the dam achieves FSL in accordance with Section 8.5.

Strategy W1B College's Crossing and Burtons Bridge

Lake Level greater than 67.50 m AHD
[Maximum Release 380 m^3/s]

No consideration is given to maintaining Twin Bridges or Savages Crossing open.

Endeavour to maintain College's Crossing trafficable by limiting the combined flows from Wivenhoe Dam and Lockyer Creek to a maximum of 175 m^3/s.

Once College's Crossing is closed to traffic, endeavour to maintain Burtons Bridge trafficable by limiting the combined flows from Wivenhoe Dam and Lockyer Creek to a maximum of 430 m^3/s.

Strategy W1C Burtons Bridge and Kholo Bridge

Lake Level greater than 67.75 m AHD
[Maximum Release 500 m^3/s]

No consideration is given to maintaining College's Crossing open.

Endeavour to maintain Burtons Bridge trafficable by limiting the combined flows from Wivenhoe Dam and Lockyer Creek to a maximum of 430 m^3/s.

Once Burtons Bridge is closed to traffic, endeavour to maintain Kholo Bridge trafficable by limiting the combined flows from Wivenhoe Dam and Lockyer Creek to a maximum of 550 m^3/s.

Strategy W1D Kholo Bridge and Mt Crosby Weir Bridge

Lake Level greater than 68.00 m AHD
[Maximum Release 1900 m^3/s]

No consideration is given to maintaining Burtons Bridge open.

Endeavour to maintain Kholo Bridge trafficable by limiting the combined flows from Wivenhoe Dam and Lockyer Creek to a maximum of 550 m^3/s.

Once Kholo Bridge is closed to traffic, endeavour to maintain Mt Crosby Weir Bridge trafficable by limiting the combined flows from Wivenhoe Dam and Lockyer Creek to a maximum of 1900 m^3/s.

Strategy W1E Mt Crosby Weir Bridge and Fernvale Bridge

Lake Level greater than 68.25 m AHD
[Maximum Release 1900 m^3/s]

No consideration is given to maintaining Kholo Bridge open.

Endeavour to maintain Mt Crosby Weir Bridge trafficable by limiting the combined flows from Wivenhoe Dam and Lockyer Creek to a maximum of 1900 m^3/s.

Once Mt Crosby Weir Bridge is closed to traffic, endeavour to maintain Fernvale Bridge trafficable by limiting the combined flows from Wivenhoe Dam and Lockyer Creek to a maximum of 2000 m^3/s.

If the level reaches EL 68.5 m AHD in Wivenhoe Dam, switch to Strategy W2 or W3 as appropriate.

Strategy W2 - Strategy W2 is a Transition Strategy where the primary consideration changes from Minimising Impact to Downstream Rural Life to Protecting Urban Areas from Inundation.

Conditions	• **Wivenhoe Storage Level predicted to be between 68.50 and 74.00 m AHD** • **Maximum Release predicted to be less than 3,500 m^3/s** • **This is a transition strategy in which the primary consideration changes from minimising disruption to downstream rural life to protecting urban areas from inundation** • **Lower level objectives are still considered when making decisions on water releases. Objectives are always considered in order of importance**

The intent of Strategy W2 is limit the flow in the Brisbane River to less than the naturally occurring peaks at Lowood and Moggill, while remaining within the upper limit of non-damaging floods at Lowood (3,500 m^3/s). In these instances, the combined peak river flows should not exceed those shown in the following table:

LOCATION	TARGET MAXIMUM FLOW IN THE BRISBANE RIVER
Lowood	The lesser of: • the natural peak flow at Lowood excluding Wivenhoe Dam releases, and; • 3,500m^3/s.
Moggill	The lesser of: • the natural peak flow at Moggill excluding Wivenhoe Dam releases, and; • 4,000m^3/s.

Strategy W3 – The primary consideration is Protecting Urban Areas from Inundation

Conditions	• **Wivenhoe Storage Level predicted to be between 68.50 and 74.00 m AHD** • **Maximum Release should not exceed 4,000 m^3/s** • **The primary consideration is protecting urban areas from inundation** • **Lower level objectives are still considered when making decisions on water releases. Objectives are always considered in order of importance**

The intent of Strategy W3 is to limit the flow in the Brisbane River at Moggill to less than 4000 m^3/s, noting that 4000 m^3/s at Moggill is the upper limit of non-damaging floods downstream. The combined peak river flow targets for Strategy W3 are shown in the following table. In relation to these targets, it should be noted that depending on natural flows from the Lockyer and Bremer catchments, it may not be possible to limit the flow at Moggill to below 4000 m^3/s. In these instances, the flow at Moggill is to be kept as low as possible.

TIMING	TARGET MAXIMUM FLOW IN THE BRISBANE RIVER
Prior to the naturally occurring peak at Moggill (excluding Wivenhoe Dam releases).	The flow at Moggill is to be minimised.
After the naturally occurring peak at Moggill (excluding Wivenhoe Dam releases).	The flow at Moggill is to be lowered to 4,000m^3/s as soon as possible.

Strategy W4 – The primary consideration is Protecting the Structural Safety of the Dam

Conditions	• **Wivenhoe Storage Level predicted to exceed 74.00m AHD.** • **No limit on Maximum Release rate** • **The primary consideration is protecting the structural safety of the dam** • **Lower level objectives are still considered when making decisions on water releases. Objectives are always considered in order of importance**

The intent of Strategy W4 is to ensure the safety of the dam while limiting downstream impacts as much as possible.

This strategy normally comes into effect when the water level in Wivenhoe Dam reaches 74.0 m AHD. However the Senior Flood Operations Engineer may seek to invoke the discretionary powers of Section 2.8 if earlier commencement is able to prevent triggering of a fuse plug.

Under Strategy W4 the release rate is increased as the safety of the dam becomes the priority. Opening of the gates is to occur generally in accordance with the requirements of Section 8.6, until the storage level of Wivenhoe Dam begins to fall.

There are no restrictions on gate opening increments or gate operating frequency once the storage level exceeds 74.0 AHD, as the safety of the dam is of primary concern at these storage levels. However the impact of rapidly increasing discharge from Wivenhoe Dam on downstream reaches should be considered when determining gate opening sequences.

Strategy W4A – No Fuse Plug Initiation Expected

Lake Level between 74.0 and 75.5 m AHD
[No Maximum Release]

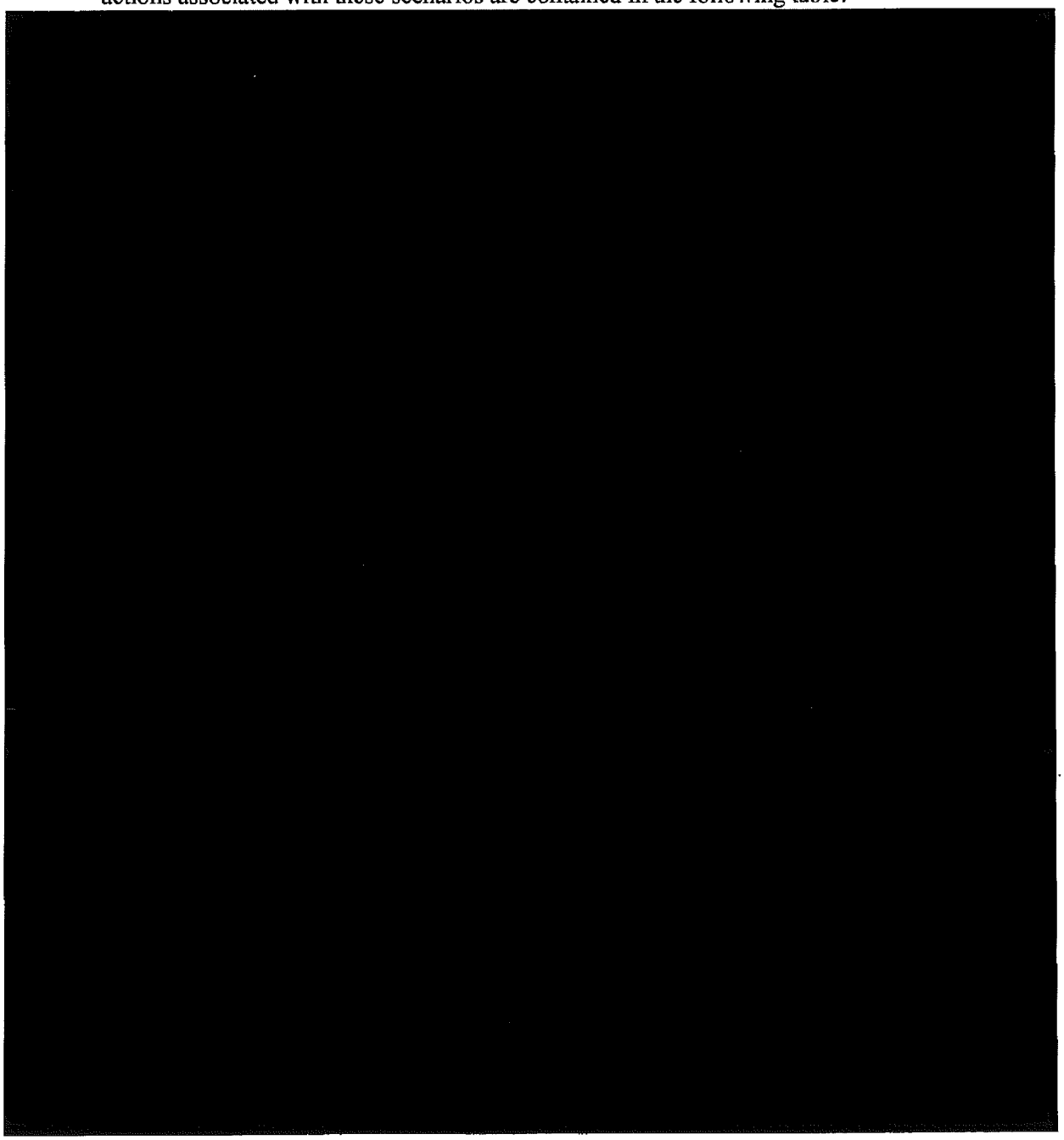
Strategy 4A applies while all indications of the peak flood level in Wivenhoe Dam are that it will be insufficient to trigger operation of the first bay of the fuse plug by reaching 75.5 m AHD.

Gate openings are generally to occur at the minimum intervals and sequences as specified in Section 8.6 until the storage level of Wivenhoe Dam begins to fall. However, to protect the safety of the dam, minimum opening intervals can be reduced and gate opening sequences can be modified.

Strategy W4B – Fuse Plug Initiation Possible

Lake Level greater than 75.5 m AHD
[No Maximum Release]

Strategy W4B applies once indications are the peak flood level in Wivenhoe Dam may exceed EL75.5 and trigger the fuse plug under normal operations. Two scenarios are possible under this strategy. The first scenario is where it may be possible to prevent fuse plug initiation by early opening of the gates. The second scenario is where fuse plug initiation cannot be avoided. The actions associated with these scenarios are contained in the following table:



8.5 Gate Closing Strategies

In general, gate closing commences when the level in Wivenhoe Dam begins to fall and is generally to occur in the reverse order to opening. The final gate closure should occur when the lake level has returned to Full Supply Level. The following requirements must be considered when determining gate closure sequences:

- Where possible, total releases during closure should not produce greater flood levels downstream than occurred during the flood event.
- The maximum discharge from the dam during closure should generally be less than the peak inflow into Wivenhoe Dam experienced during the event. The discharge from Wivenhoe Dam includes discharge from triggered fuse plugs, gates, regulator cone dispersion valve and hydro release.
- If, at the time the lake level in Wivenhoe Dam begins to fall, the combined flow at Lowood is in excess of 3,500 m^3/s then the combined flow at Lowood is to be reduced to 3,500 m^3/s as quickly as practicable.
- The aim should always be to empty stored floodwaters stored above EL 67.0m within seven days after the flood peak has passed through the dams. However, provided a favourable weather outlook is available, this requirement can be relaxed for the volume between EL 67.0m and EL 67.5m, to obtain positive environmental outcomes.
- If the flood storage compartments of Wivenhoe Dam and Somerset Dam can be emptied within seven days, the maximum flow in the Brisbane River at Lowood should not exceed 3,500 m^3/s.
- To minimise the stranding of fish downstream of the dam, final closure sequences should consider Seqwater policies relating to fish protection at the dam.

There may be a need to take into account base flow when determining final gate closure. This may mean that the lake level temporarily falls below Full Supply Level to provide for a full dam at the end of the Flood Event.

8.6 Gate Operation Sequences

Radial Gate Opening Operations

When dam outflows are less than 4,000 m^3/s, rapid opening of the radial gates can cause undesirable rapid rises in downstream river levels. Accordingly, when dam outflows are less than 4,000 m^3/s, the aim in opening radial gates is to operate the gates one at a time at intervals that will minimise adverse impacts on the river system. The table below shows the target minimum interval for gate operations in these circumstances. This target interval can be reduced if the gates are at risk of being overtopped or the safety of the dam is at risk.

TARGET MINIMUM INTERVAL FOR RADIAL GATE OPENING (DOWNSTREAM RIVER FLOWS < 4000 m^3/s)

OPERATION	TIME INTERVAL BETWEEN SUCCESSIVE OPENING OF INDIVIDUAL GATES (mins)
Radial Gate opening of 500 mm	10

When dam outflows exceed 4,000 m^3/s, the impact of rapid gate openings on downstream water levels is reduced due to the already elevated river levels. Under these circumstances, the safety of the dam will generally be of primary concern and therefore there are no minimum gate opening intervals in these circumstances.

Under extreme circumstances, the mechanical capability of the radial gate operating system provides the facility to open each radial gate more than five metres within a one hour period. Accordingly, unless a mechanical breakdown is experienced, physical gate opening capability in unlikely to be a constraint in meeting projected outflow targets.

Radial Gate Closing Operations

When dam outflows are less than 4,000 m^3/s, rapid closure of the radial gates can cause adverse impacts to the river system. Accordingly, when dam outflows are less than 4,000 m^3/s, the aim in closing radial gates is to operate the gates one at a time at an interval that will minimise adverse impacts on the river system as outlined in the table below.

TARGET MINIMUM INTERVAL FOR RADIAL GATE CLOSURE

OPERATION	TIME INTERVAL BETWEEN SUCCESSIVE CLOSING OF INDIVIDUAL GATES (mins)
Radial Gate closure of 500 mm	20

When dam outflows exceed 4,000 m^3/s, the impact of rapid gate closings is reduced due to the already elevated river levels. However, given that the safety of the dam is unlikely to be at risk if decisions are made to close radial gates, the target of operating the gates one at a time in accordance with the time interval shown in the above table remains.

Rapid closure of radial gates is permissible however, when there is a requirement to preserve storage or to reduce downstream flooding. When determining gate closure sequences, consideration should also be given to following the calculated natural recession of the flood in the river to aim to ensure that the recession impacts are not greater than those that would have been experienced had the dam not been constructed.

Protection of the Spillway Walls

The flip bucket spillway is designed to control the discharge from the reservoir and to dissipate the energy of the discharge. The flip throws the discharge clear of the concrete spillway structures and into a plunge pool where the energy is dissipated by turbulence. Under non-symmetric flow conditions or when Gates 1 and 5 are not operating, the discharge jet may impinge on the walls of the plunge pool. As these walls have been excavated into erodible sandstone rock, this impingement may cause non-predictable erosion. Upstream migration of this erosion is to be avoided. This can be achieved by operating Gates 1 and 5 to deflect the discharge away from the walls of the plunge pool.

Therefore in operating the spillway, the principles to be observed in order of priority are:

(i) The discharge jet into the plunge pool is not to impinge on the right or left walls of the plunge pool.

(ii) The flow in the spillway is to be symmetrical.

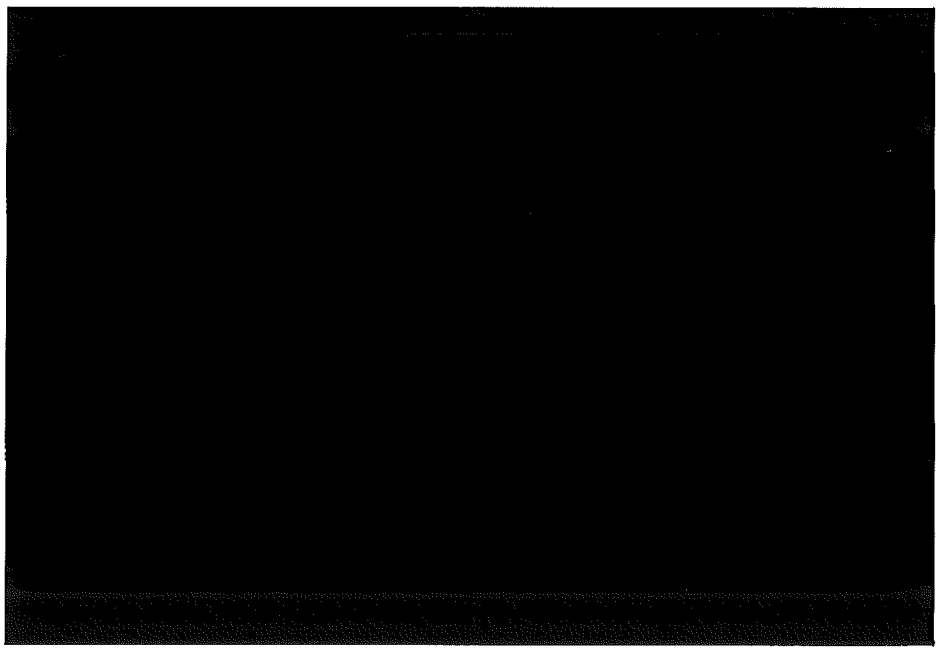
Normal Gate Operation Sequences

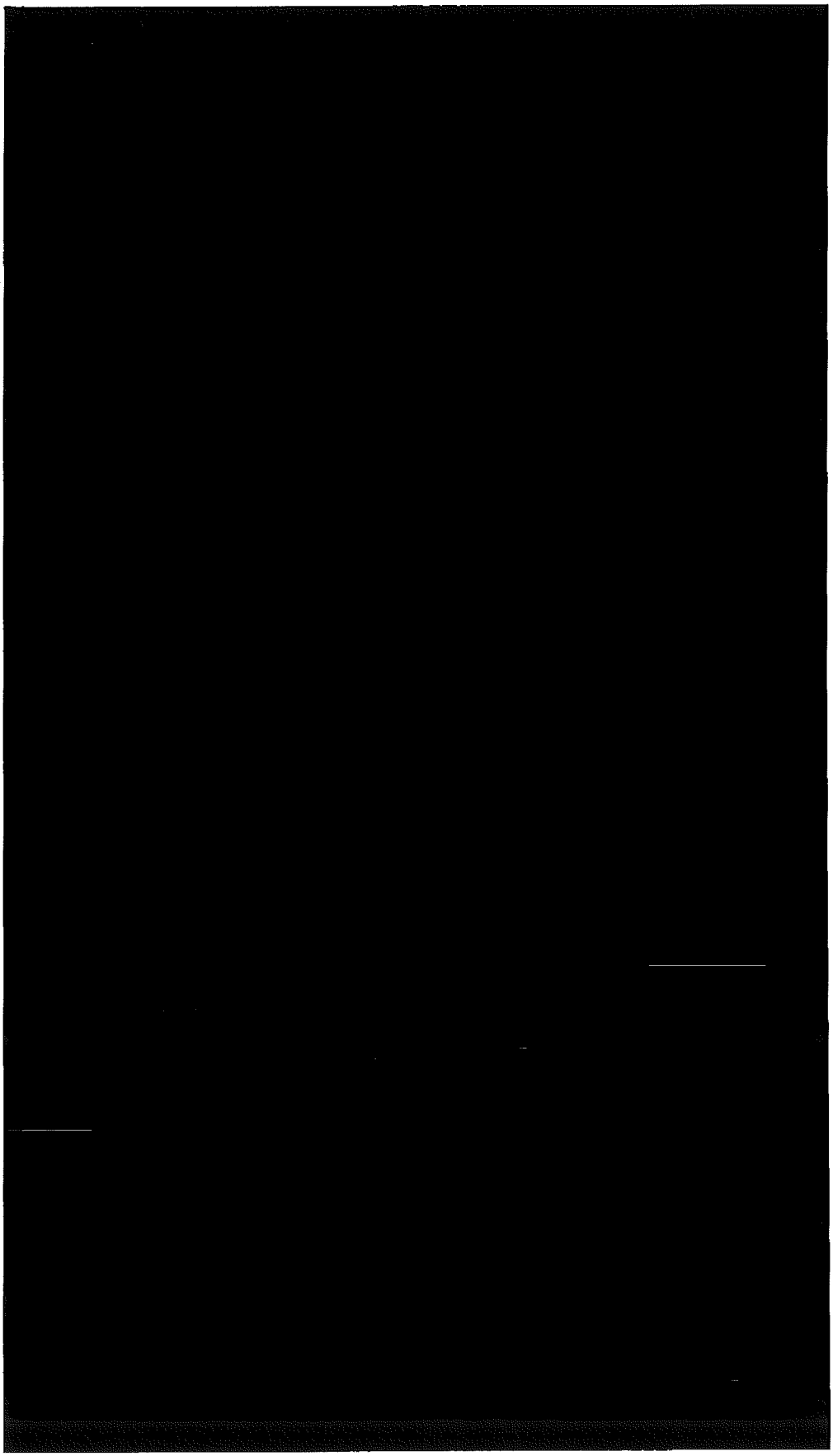
Under normal operation, only one gate is to be opened at any one time and the sequences shown in the table below are to be adopted. Generally gates are operated in the order of 3,2,4,1,5. Variations are allowed at any time to protect the structural safety of the dam.

It should also be noted that:

- Gates are numbered 1 to 5 from the left bank looking downstream
- Flow in spillway to be as symmetrical as possible.

RADIAL GATE OPENING SEQUENCES





During the initial opening or final closure sequences of gate operations it is permissible to replace the discharge through a gate by the immediate opening of a regulator valve (or the reverse operation). This allows for greater control of low flows.

Gate Failure or Malfunction Procedures

Gate operating procedures in the event of equipment failure are contained in Appendix G. If one or more gates are inoperable during the course of the flood event, the gate openings of the remaining gates are to be adjusted to provide the required discharge from the dam. These adjustments should ensure that:

- The impact of the flow on the sidewalls of the plunge pool should be minimised, and
- The flow in the spillway is as symmetrical as practicable.

Radial Gate Turbulence Considerations

Unless in the process of lifting the gates clear of the flow, the bottom edge of the radial gates must always be at least 500 millimetres below the release flow surface. Having the bottom edge of the gates closer to the release flow surface than 500 millimetres may cause unusual turbulence that could adversely impact on the gates. This procedure has never been undertaken in practice and should be observed closely when being undertaken. Variations to the procedure are allowed to protect the structural safety of the dam.

Lowering Radial Gates that have been lifted Clear of the Release Flow

When lowering radial gates that have been lifted clear of the release flow, the bottom edge of the gates must be lowered at least 500 millimetres into the flow. Lowering gates into the release flow less than this amount may cause unusual turbulence that could adversely impact on the gates. This procedure has never been undertaken in practice and should be observed closely

when being undertaken. Variations to the procedure are allowed to protect the structural safety of the dam.

8.7 Modification to Flood Operating Procedures if a Fuse Plug Triggers

Where the operation of a fuse plug spillway bay has been triggered, the flood operation procedures are to be modified such that:

- The discharge from the triggered fuse plug is to be taken into account when determining total flood releases from the dam;
- The gates are to be operated, to the extent possible, so that the same discharge restrictions apply as would have if the fuse plug embankment was intact.

8.8 Modification to Flood Operating Procedures if a subsequent flood event occurs prior to the reconstruction of Triggered Fuse Plugs

Where the operation of any or all of the fuse plug spillway bays has been triggered and a flood event occurs before the fuse plug can be reinstated, the flood operation procedures are to be modified such that:

- The discharge from the triggered fuse plug is to be taken into account when determining total flood releases from the dam;
- The gates are to be operated, to the extent possible, so that the same discharge restrictions apply as would have if the fuse plug embankment was intact.
- Discharge from the Auxiliary Spillway will occur before the Gate Trigger Level of EL 67.25 m AHD. This flow should be taken into account when applying the flood operation strategies relevant to the low level bridge crossings.

9 SOMERSET DAM FLOOD OPERATIONS

9.1 Introduction

Somerset Dam is capable of being operated in a number of ways to regulate Stanley River floods. Somerset Dam and Wivenhoe Dam are to be operated in conjunction to optimise the flood mitigation benefits downstream of Wivenhoe Dam. The arrangement of the Somerset Dam Radial Gates, Sluice Gates and Regulator Valves is shown in the diagram below. At EL 107.45, flood waters commence to flow over the dam crest. To account for this discharge, the dam crest is assumed to operate as a broad crested weir with a spillway width of 135.33 m:

9.2 Initial Flood Control Action

Once a Flood Event is declared, all radial gates are to be fully opened and all sluice gates and regulator valves are to be fully closed. An assessment is to be made of the magnitude of the Flood Event, including a prediction of the maximum storage levels in Wivenhoe and Somerset Dams.

9.3 Flood Operations Strategies

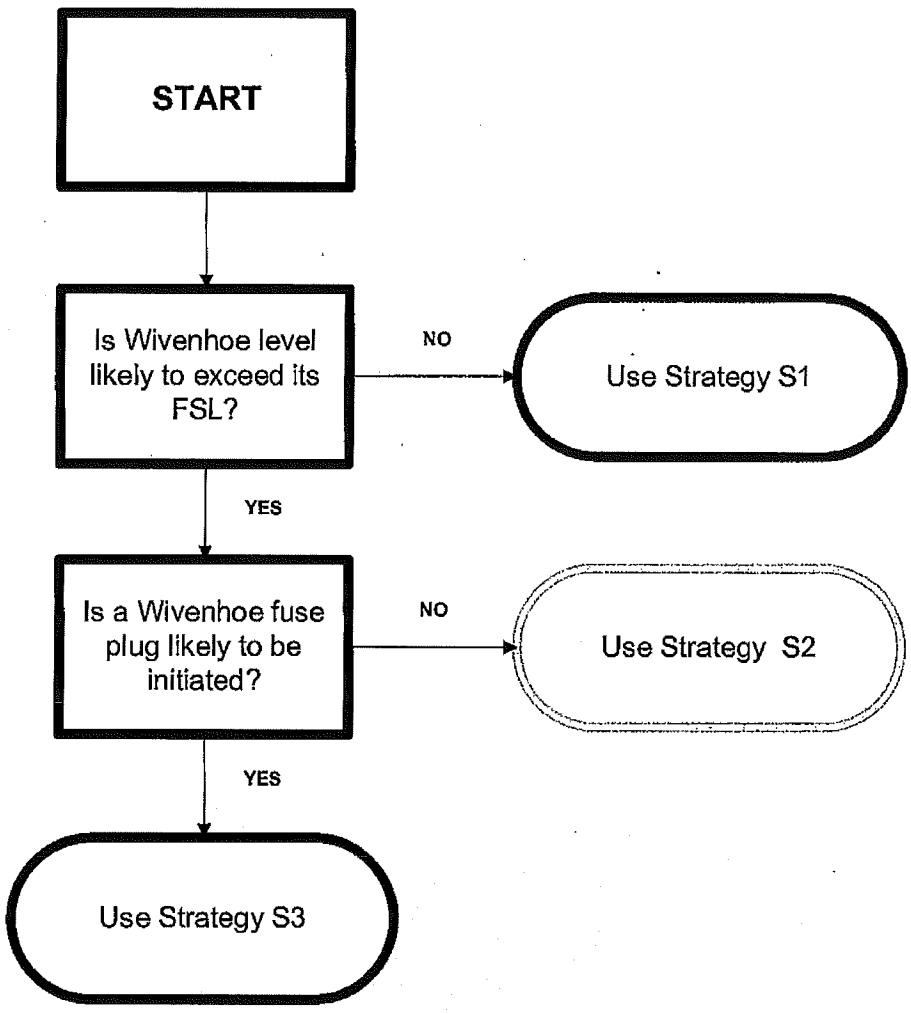
There are three strategies used when operating Somerset Dam during a flood event as outlined below. These strategies are based on the Flood Objectives of this manual. The strategy chosen at any point in time will depend on predictions of the maximum storage levels in Wivenhoe and Somerset Dams which are to be made using the best forecast rainfall and stream flow information available at the time.

Strategies are likely to change during a flood event as forecasts change and rain is received in the catchments. It is not possible to predict the range of strategies that will be used during the course of a flood event at the commencement of the event. Strategies are changed in response to changing rainfall forecasts and stream flow conditions to maximise the flood mitigation benefits of the dams.

When calculating the impacts of flood releases from Somerset Dam, the gate opening sequences outlined in Section 9.5 should be used to determine likely outflow rates from the dam.

A flowchart showing how best to select the appropriate strategy to use at any point in time is shown below:

SOMERSET FLOOD STRATEGY FLOW CHART



The order of operation for opening the sluices under each strategy is LMKNJOIP. Sluices are to be closed in reverse order of opening. Any inoperable sluices are to be dropped from the opening or closing sequences.

Strategy S1 – Minimising Impact on Rural Life Upstream

Conditions	• **Somerset Dam Level expected to exceed EL 99.0 and Wivenhoe Dam not expected to reach EL 67.0 (FSL) during the course of the Flood Event**

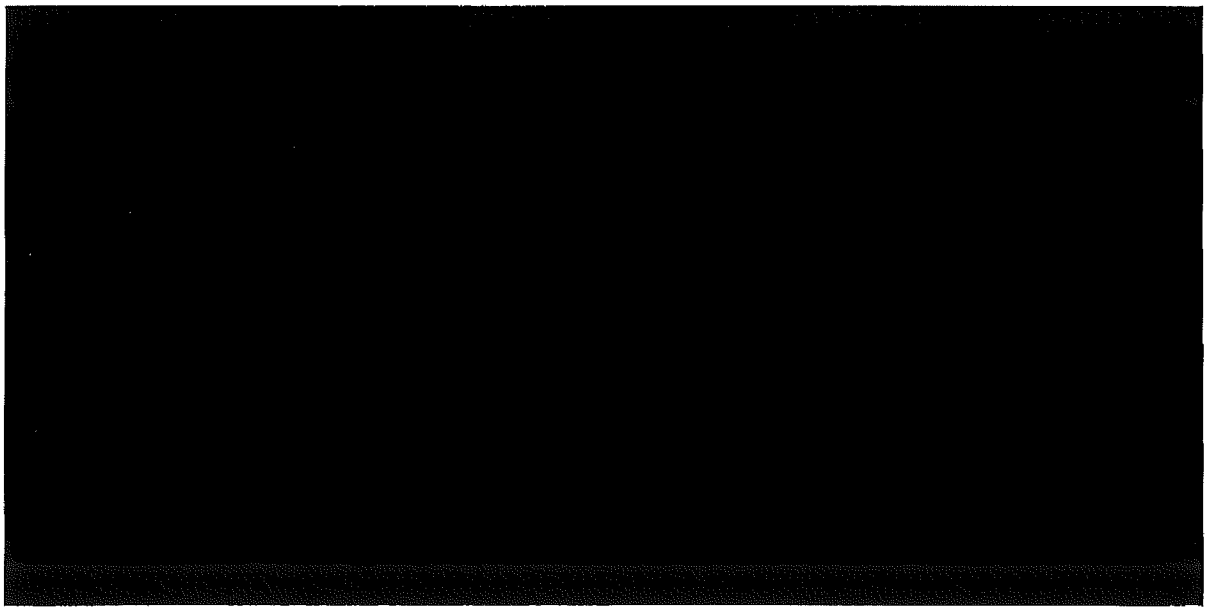
The intent of this strategy is to return the dam to full supply level while minimising the impact on rural life upstream of the dam. Consideration is also given to minimising the downstream environmental impacts from the release.

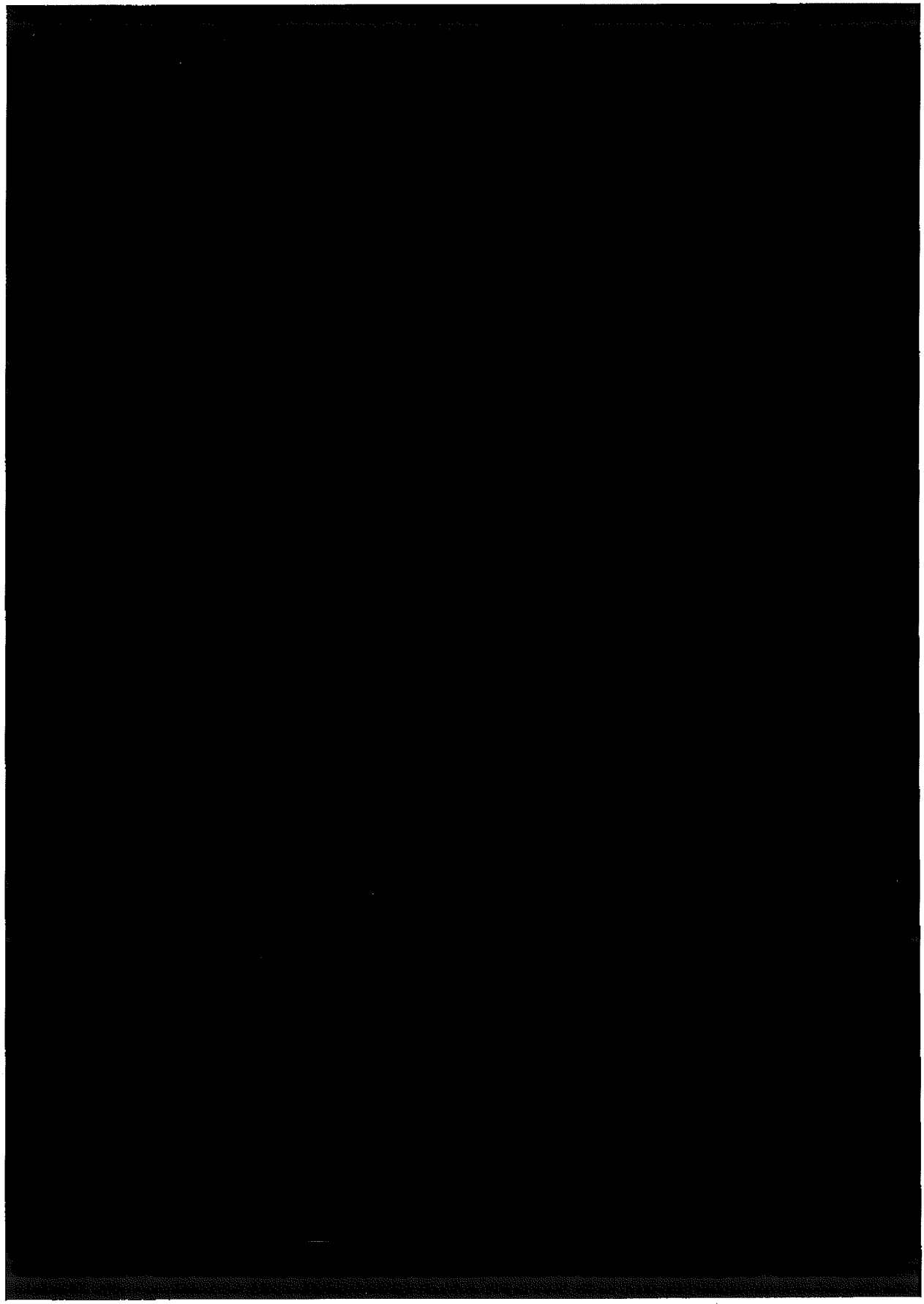
The crest gates at Somerset Dam are raised to enable uncontrolled discharge. The Regulator Valves and Sluice gates are to be used to maintain the level in Somerset dam below EL 102.0 (deck level of Mary Smokes Bridge). The release rate from Somerset dam is not to exceed the peak inflow into the dam.

Strategy S2 – Minimise Impacts below Wivenhoe Dam

Conditions	• **Somerset Dam Level expected to exceed EL 99.0 and Wivenhoe Dam level expected to exceed EL 67.0 (FSL) but not exceed EL 75.5 (fuse plug initiation) during the course of the Flood Event.**

The intent of this strategy is to maximise the benefits of the flood storage capabilities of the dam while protecting the structural safety of both dams. The table below contains the operating conditions and actions for Strategy S2.





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Strategy S3 - Protect the Structural Safety of the Dam

Conditions	• **Somerset Dam Level expected to exceed EL 99.0 and Wivenhoe Dam level expected to exceed EL 75.5 (fuse plug initiation) during the course of the Flood Event.**

The intent of this strategy is to maximise the benefits of the flood storage capabilities of the dam while protecting the structural safety of both dams.

In addition to the operating protocols used in Strategy S2, to prevent fuse plug initiation, consideration can be given to temporary departure from the operating protocols contained in this strategy under the following conditions:

- The safety of Somerset Dam is the primary consideration and cannot be compromised.
- The peak level in Somerset dam cannot exceed EL 109.7.

9.4 Gate Closing Strategies

In general, gate closing commences when the level in Somerset Dam begins to fall and is generally to occur in the reverse order to opening. The final gate closure should occur when the lake level has returned to Full Supply Level. The following requirements must be considered when determining gate closure sequences:

- Unless determined otherwise by the Senior Flood Operations Engineer in accordance with Section 2.8, the aim should be to empty stored floodwaters within seven days after the flood peak has passed through the dams.
- To minimise the stranding of fish downstream of the dam, final closure sequences should consider Seqwater policies relating to fish protection at the dam.

There may be a need to take into account base flow when determining final gate closure. This may mean that the lake level temporarily falls below Full Supply Level to provide for a full dam at the end of the Flood Event.

9.5 Gate Operation Sequences

Intervals between Operations

Releases from Somerset Dam flow directly into Wivenhoe Dam and therefore the downstream river impact considerations associated with radial gate operations at Wivenhoe Dam, do not directly apply to Somerset Dam. However, the following minimum intervals should generally be observed whilst opening and closing regulators, sluices and crest gates at Somerset Dam for flood mitigation purposes. These intervals have been chosen to minimise any adverse impacts caused by lake level rises above the junction of the Stanley and Brisbane Rivers.

MINIMUM INTERVALS FOR NORMAL GATE OPERATIONS

ITEM	OPENING	CLOSING
Regulator Valves	30 mins	60 mins
Sluice Gates (Dam level < EL 100.45)	120 mins	180 mins
Sluice Gates (Dam level > EL 100.45)	60 mins	60 mins
Crest Gates	Gates are normally open	-

Sluice Gate Operations

The order of operation for opening the sluices under each strategy is LMKNJOIP. Sluices are to be closed in reverse order of opening. Any inoperable sluices are to be dropped from the opening or closing sequences.

Regulator Valve Considerations

During the initial opening or final closure sequences of gate operations it is permissible to replace the discharge through a sluice gate by the immediate opening of one or more regulator valves (or the reverse operation). This allows for greater control of low flows and enables a smooth transition on opening and closing sequences.

It must also be noted that the Regulator Valves are not to be operated when the tail water level below Somerset Dam is above the invert of the valves (68.60 m AHD). Operating the valves under these circumstances can damage the valves. This requirement can be ignored if the structural safety of the dam is at risk.

10 EMERGENCY FLOOD OPERATIONS

10.1 Introduction

While every care has been exercised in the design and construction of the dams, there still remains a low risk that the dams may develop an emergency condition either through flood events or other causes. Vigilance is required to recognise emergency flood conditions such as:

- Occurrence of a much larger flood than the discharge capacity of the dam;
- Occurrence of a series of large storms in a short period;
- Failure of one or more gates during a flood.
- Development of a piping failure through the embankment of Wivenhoe Dam;
- Damage to the dams by earthquake;
- Damage to the dams as an act of war or terrorism;

Responses to these conditions are included in Emergency Action Plans for the dams.

10.2 Overtopping of Dams

Whatever the circumstances, every endeavour must be made to prevent overtopping of Wivenhoe Dam by the progressive opening of operative spillway gates. The Auxiliary Spillway constructed at the dam in 2005 gives the dam crest flood an AEP of approximately 1 in 100,000. Another one bay fuse plug spillway may be constructed at Saddle Dam Two in the future, thereby increasing this immunity.

Somerset Dam should not be overtopped by flood water, but if Wivenhoe Dam is threatened by overtopping, the release of water from Somerset Dam is to be reduced at the risk of overtopping Somerset Dam in order to prevent the overtopping of Wivenhoe Dam.

10.3 Communications Failure

If communications are lost between the Flood Operations Centre and either dam, the officers in charge at each dam are to adopt the procedures set out below.

Wivenhoe Dam Emergency Procedure

In the event of communications loss with the Flood Operations Centre, the Dam Supervisor at Wivenhoe Dam is to assume responsibility for flood releases from the Dam. Once it has been established that communications have been lost, the Dam Supervisor at Wivenhoe Dam is to:-

- Take all practicable measures to restore communications and periodically check the lines of communication for any change;

- Follow the procedures set out below to determine the relevant magnitude and duration of releases from Wivenhoe Dam;
- Log all actions in the Event Log;
- Ensure the dam is at full supply level at the end of the event;
- Remain in the general vicinity of the dam while on duty.

The radial gate opening sequence is as set out in Table 10.2. Individual sequence steps are shown against a target storage level. The minimum time intervals between each step in the radial gate opening sequence are shown in Table 10.1. Falling behind or being in front of the target gate openings is permissible when the storage level is less than 74.0 m AHD, but not allowed when the storage level is greater than 74.0 m AHD. When the storage level is below 74.0 m AHD, the operating intervals shown in Table 10.1 must generally be followed and can be ignored only to protect the structural safety of the dam.

Where the operation of a fuse plug spillway bay has been triggered, the relevant table contained in Appendix J is to be substituted for Table 10.2.

TABLE 10.1
MINIMUM INTERVALS BETWEEN OPERATING SEQUENCE STEPS

ITEM	MINIMUM OPENING INTERVAL	MINIMUM CLOSING INTERVAL
Radial Gates (Dam Level < EL 74.0)	10 mins	20 mins
Radial Gates (Dam Level > EL 74.0)	No Minimum	No Minimum

TABLE 10.2
RADIAL GATE OPENING SEQUENCE STEPS AND TARGET GATE OPENINGS AGAINST STORAGE LEVEL

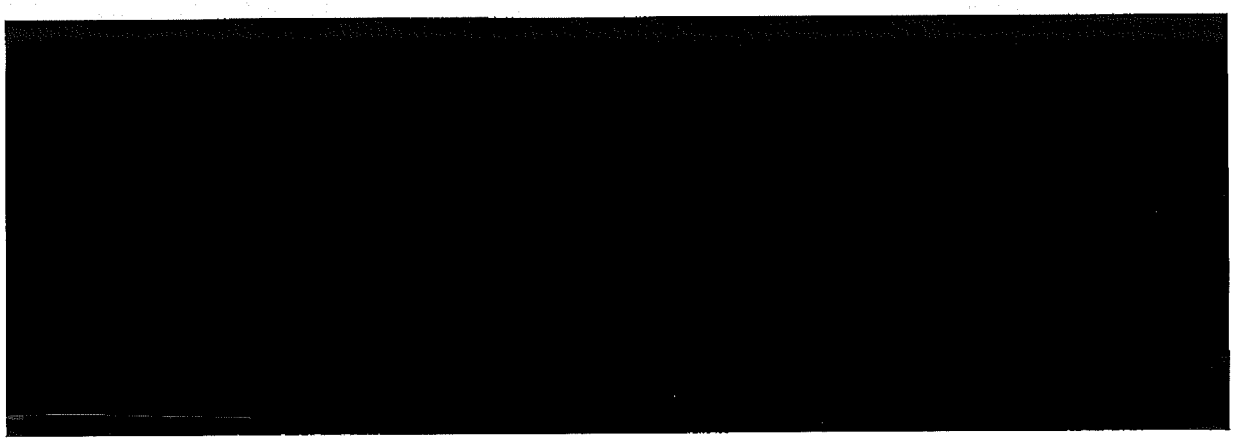


TABLE 10.2 (CONTINUED)

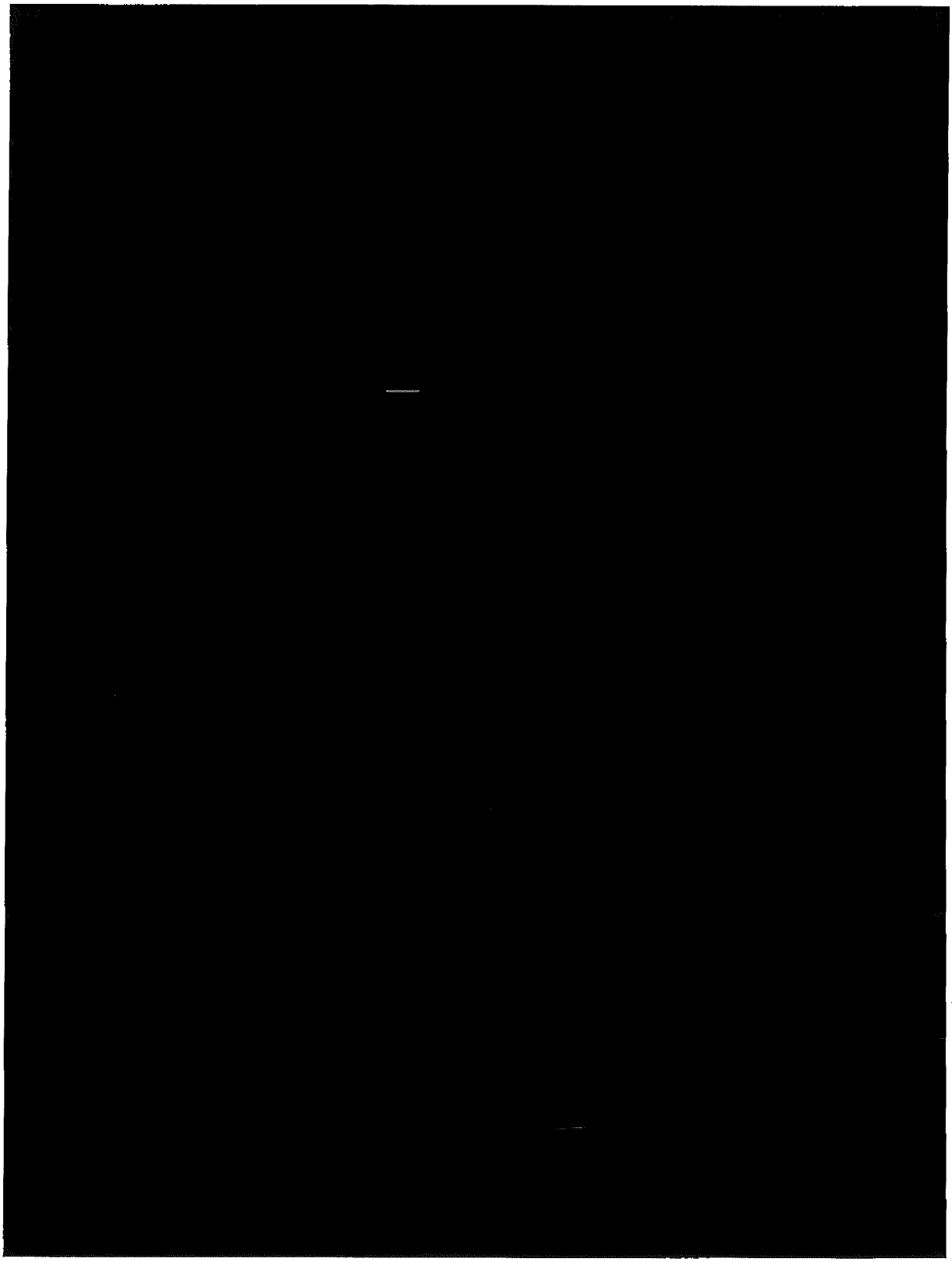
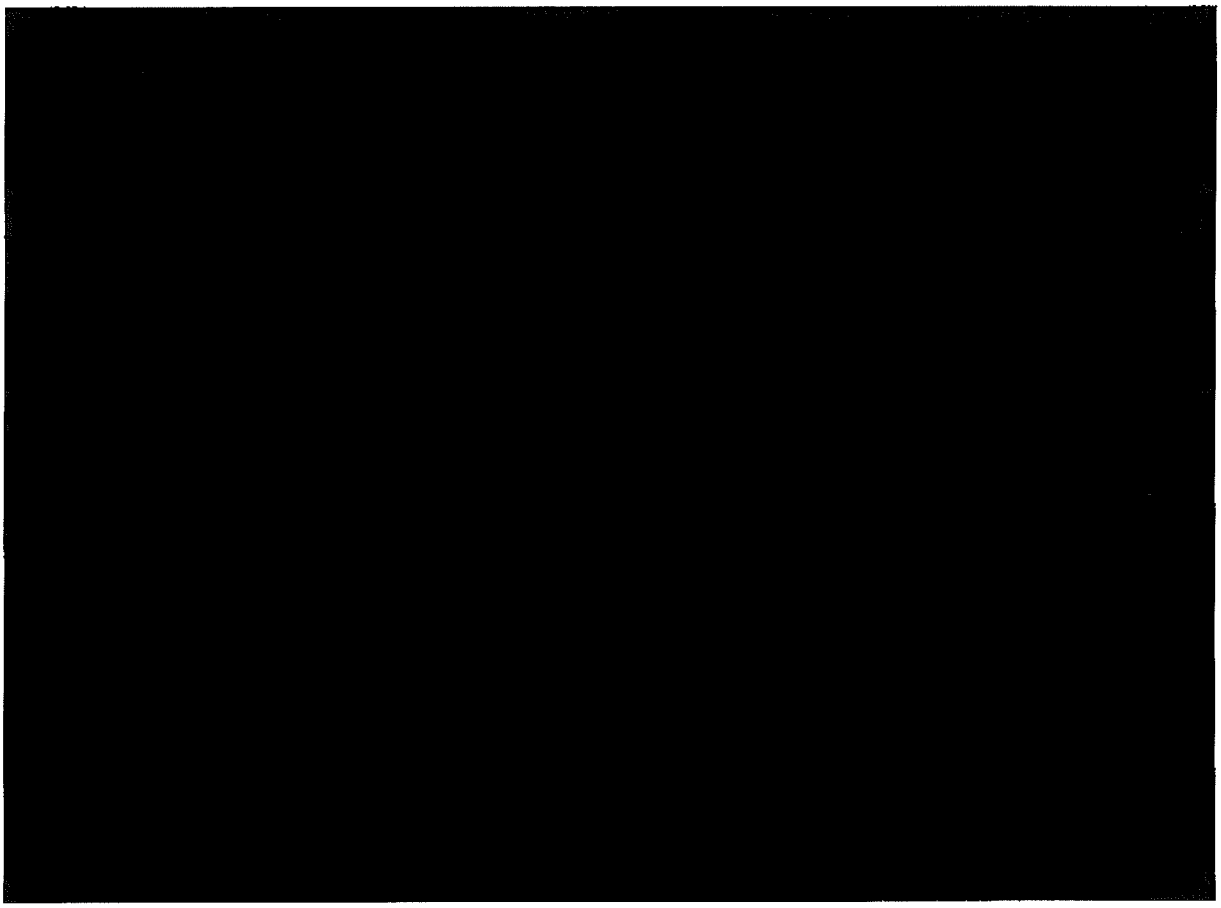


TABLE 10.2 (CONTINUED)



Under extreme circumstances, the mechanical capability of the gate operating system allows the facility to open each radial gate more than five metres within a one hour period. Accordingly, unless a mechanical breakdown is experienced, physical gate opening capability in unlikely to be a constraint in meeting projected gate opening targets. However in a loss of communications scenario, when extreme rises in lake level are being experienced, dam operators will have difficulty in continually matching minimum gate settings to lake level. Accordingly, in these circumstances when the dam level exceeds 74.0 AHD, it is permissible to estimate target dam levels one hour in advance, based on lake level rises in the previous hour and undertake gate operations on this basis.

In the event of one or more radial gates becoming jammed, the remaining gates are to be operated to provide the same total opening for a particular storage level, as shown in the Table 10.2. In these circumstances, gates are generally operated in the order of 3,2,4,1,5, moving through the sequence shown in the table.

In a loss of communication scenario, the bulkhead gate is only to be used to prevent a situation occurring which could endanger the safety of the dam. At the end of the event, the full supply level of the storage is to be achieved.

Somerset Dam Emergency Procedure

In the event of communications loss with the Flood Operations Centre, the Dam Supervisor at Somerset Dam is to assume responsibility for flood releases from the Dam. Once it has been established that communications have been lost, the Dam Supervisor at Somerset Dam is to:

- Take all practicable measures to restore communications and periodically check the lines of communication for any change;
- Undertake the actions set out below to release flood water from Somerset Dam;
- Log all actions in the Event Log;
- Ensure the dam is at full supply level at the end of the event;
- Remain in the general vicinity of the dam while on duty.

The actions to be undertaken to release flood water are:

- If communications with Wivenhoe Dam are lost, the level in Wivenhoe Dam is to be assumed as the level shown on gauge boards located downstream of Somerset Dam.
- The radial gates are to be kept raised to allow uncontrolled discharge.
- The regulators are to be closed if the tail water level exceeds EL 68.60 and are generally kept closed. The only exception to this is if the regulators are used to prevent overtopping of the dam.
- Sluice gates are operated as either fully opened or fully closed. The order of operation for opening the sluice gates is LMKNJOIP. Sluices are to be closed in reverse order of opening. Any inoperable sluices are to be dropped from the opening or closing sequences. The sluice gates are to be operated in accordance with the following procedures:
    - **Case 1** - the level in Somerset Dam is below EL 100.45; or
    - **Case 2** - the level in Somerset Dam is above EL 100.45.

  These procedures are described below.

Case 1 Procedure (Level in Somerset Dam is below EL 100.45)

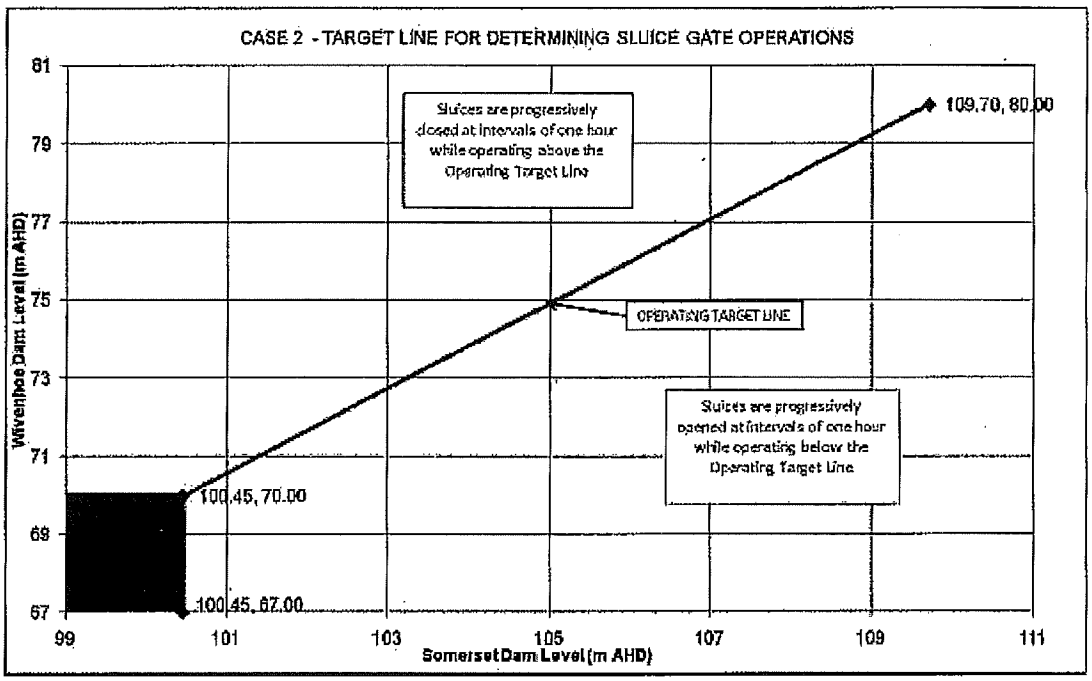
The sluice gates are to be operated in accordance with the following table:

SOMERSET DAM LOSS OF COMMUNICATIONS CASE 1 PROCEDURE	
CONDITIONS AT SOMERSET AND WIVENHOE DAMS	**ACTIONS**
Level in Somerset Dam is below EL 100.45, Level in Wivenhoe Dam is below EL 70.0 and falling.	Sluice gates are to be opened at intervals of not less than 120 minutes, provided the number of open sluice gates does not exceed that shown in the "**SOMERSET DAM - MAXIMUM SLUICE GATE OPENING**" table. Once a sluice gate is opened, no further sluice gate operations are to be undertaken for 120 minutes.
Level in Somerset Dam is below EL 100.45, Level in Wivenhoe Dam is below EL 70.0 and rising.	Sluice gates are to be closed at intervals of not less than 180 minutes. Once a sluice gate is closed, no further sluice gate operations are to be undertaken for 180 minutes.
Level in Somerset Dam is below EL 100.45, Level in Wivenhoe Dam is above EL 70.0.	Sluice gates are to be closed at intervals of not less than 60 minutes. Once a sluice gate is closed, no further sluice gate operations are to be undertaken for 60 minutes.

SOMERSET DAM MAXIMUM SLUICE GATE OPENING	
SOMERSET DAM LEVEL	**MAXIMUM NUMBER OF SLUICE GATES ALLOWED TO BE OPEN**
[redacted]	

Case 2 Procedure (Level in Somerset Dam is above EL 100.45)

The sluices gates are to be operated in accordance with the following graph:

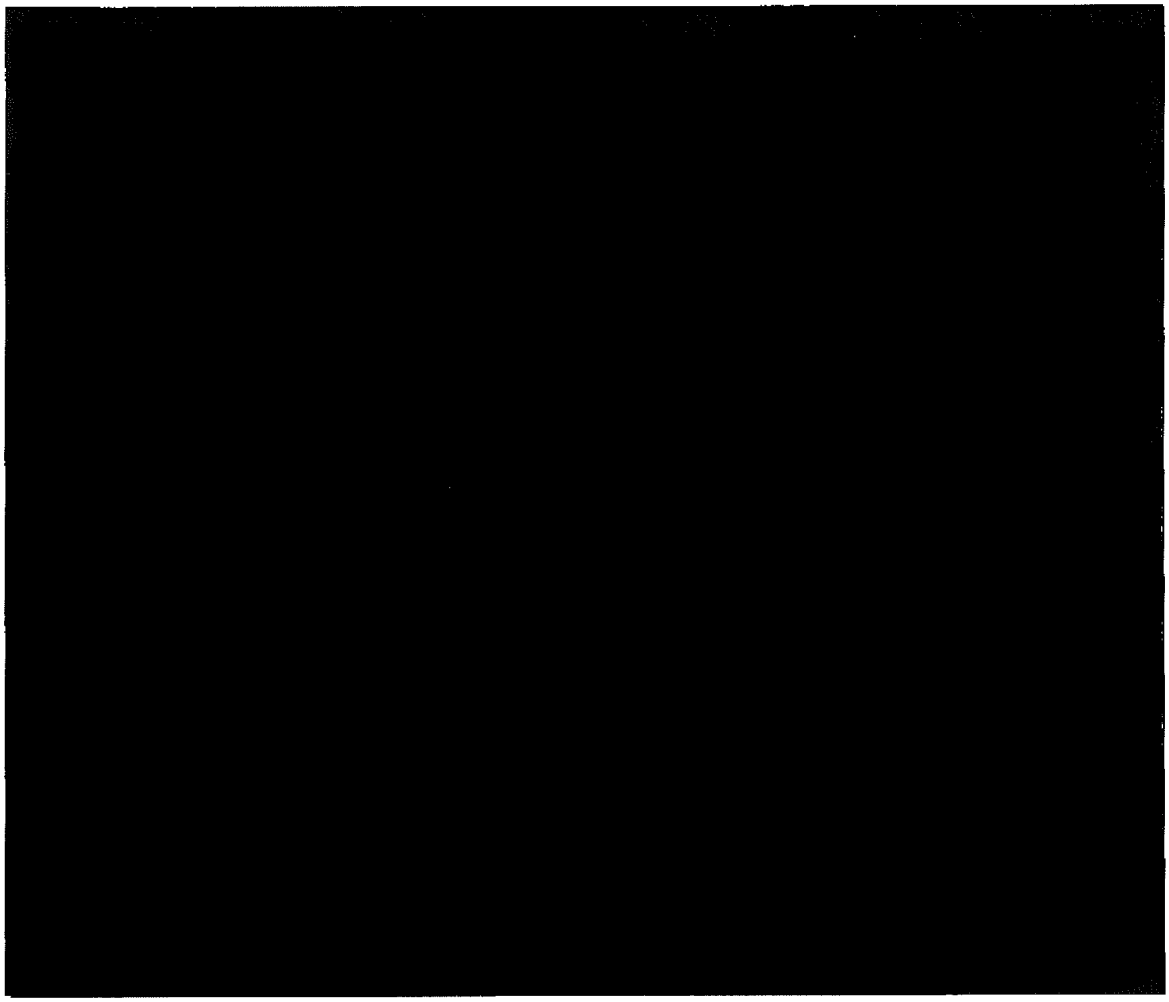


Sluices are progressively closed at one hour intervals if operating above the Operating Target Line and progressively opened at one hour intervals if operating below the Operating Target Line. The aim is always to follow the Operating Target Line as closely as possible.

10.4 Equipment Failure

In the event of equipment failure the action to be taken is indicated in Appendix E for Wivenhoe Dam and Appendix F for Somerset Dam.

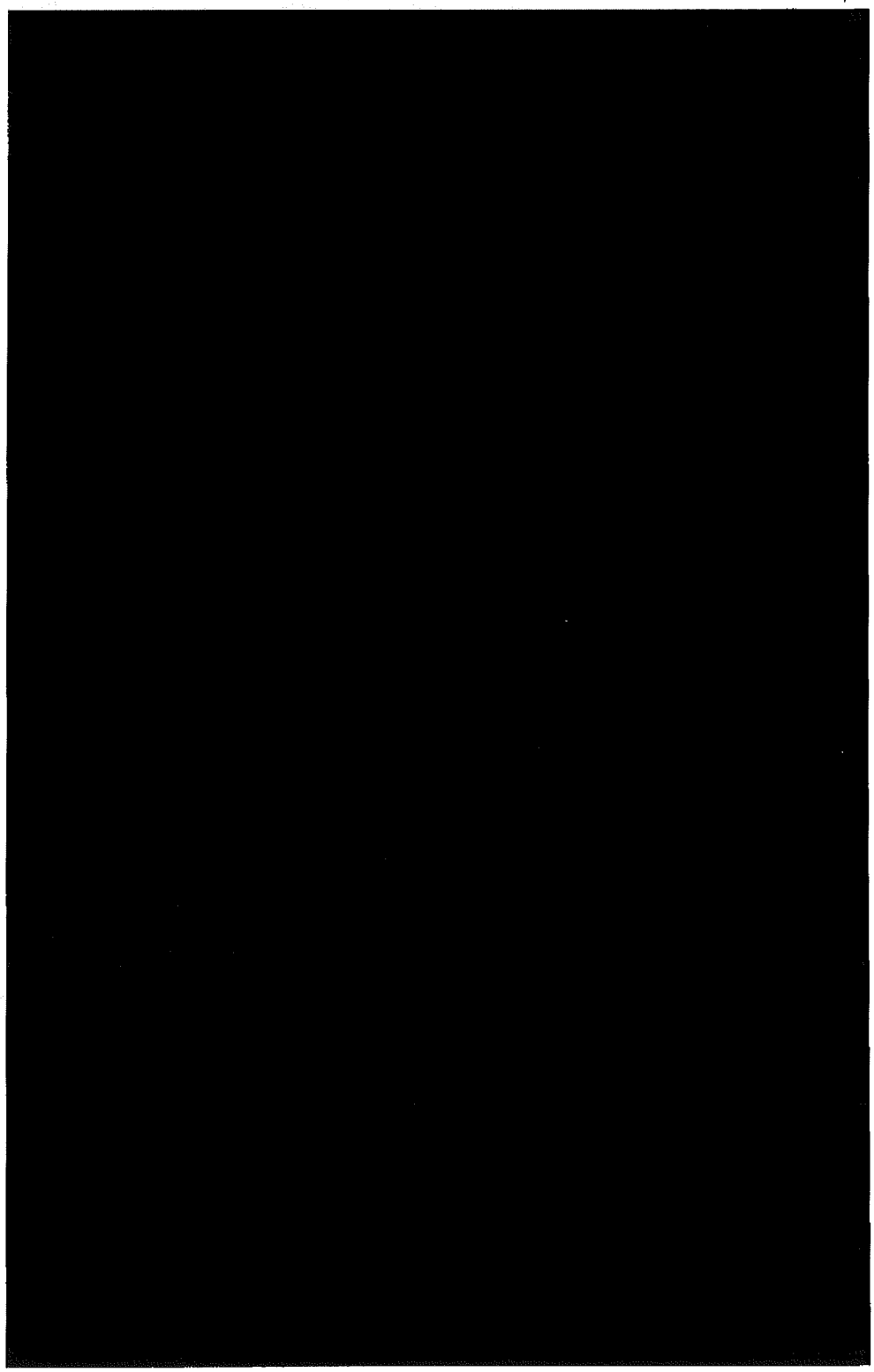
APPENDIX A
AGENCIES HOLDING CONTROLLED COPIES OF THIS MANUAL

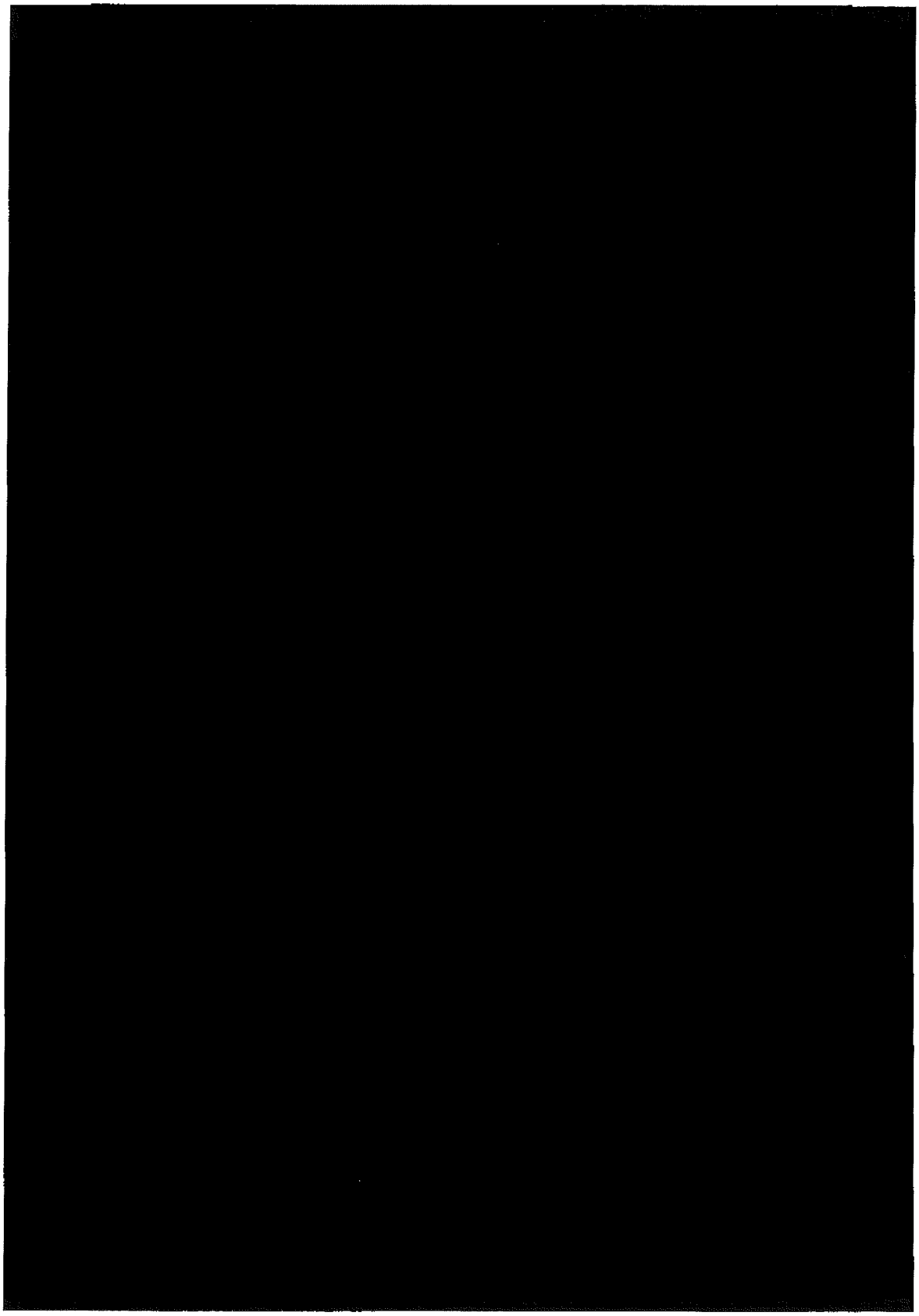


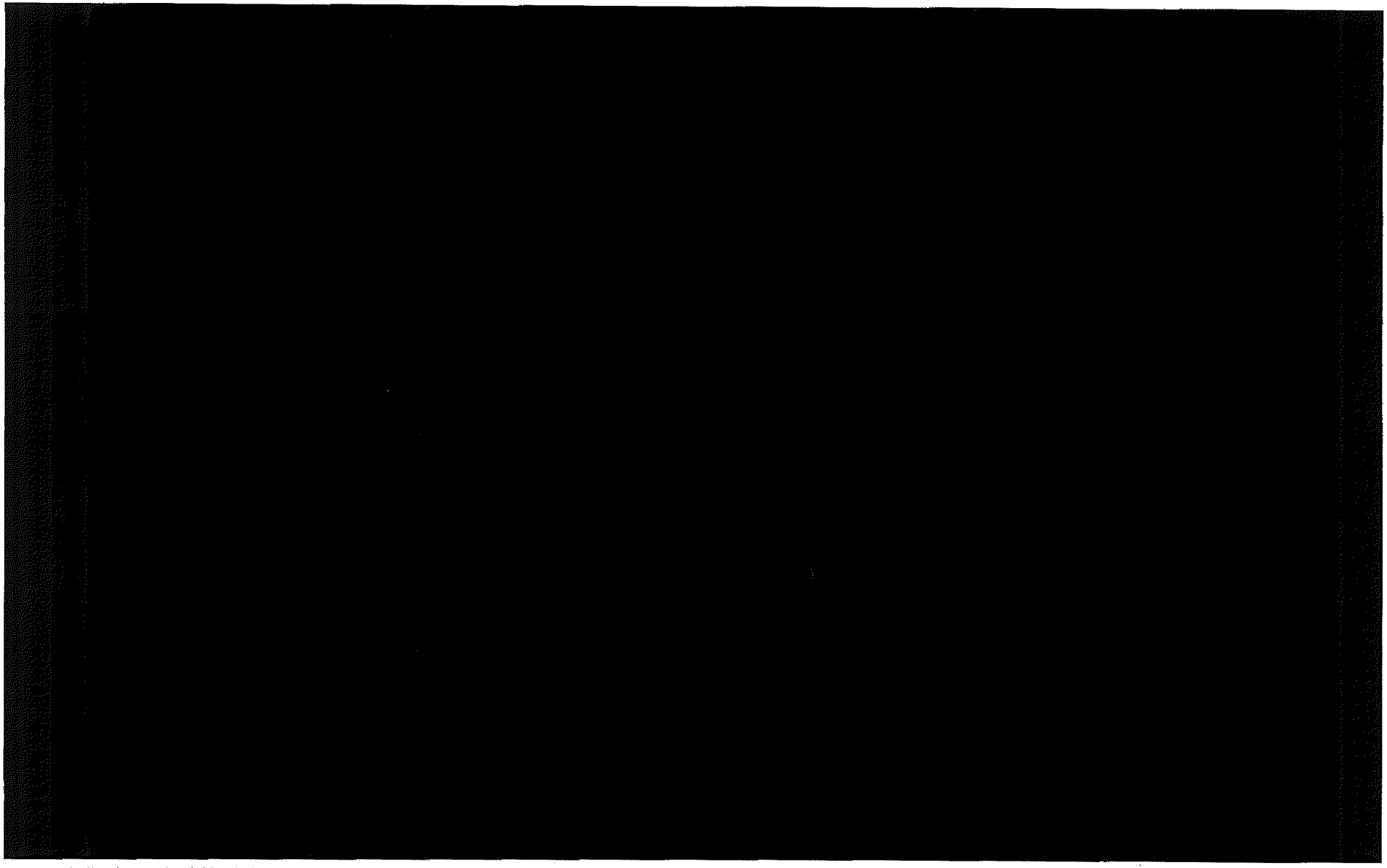
APPENDIX B
KEY REFERENCE GAUGES

Location	Gauge Zero	1974 Gauge Height	Minor Flood		Moderate Flood		Major Flood	
			Gauge Height	Flow	Gauge Height	Flow	Gauge Height	Flow
	m AHD	m	m	m^3/s	m	m^3/s	m	m^3/s
[redacted]								

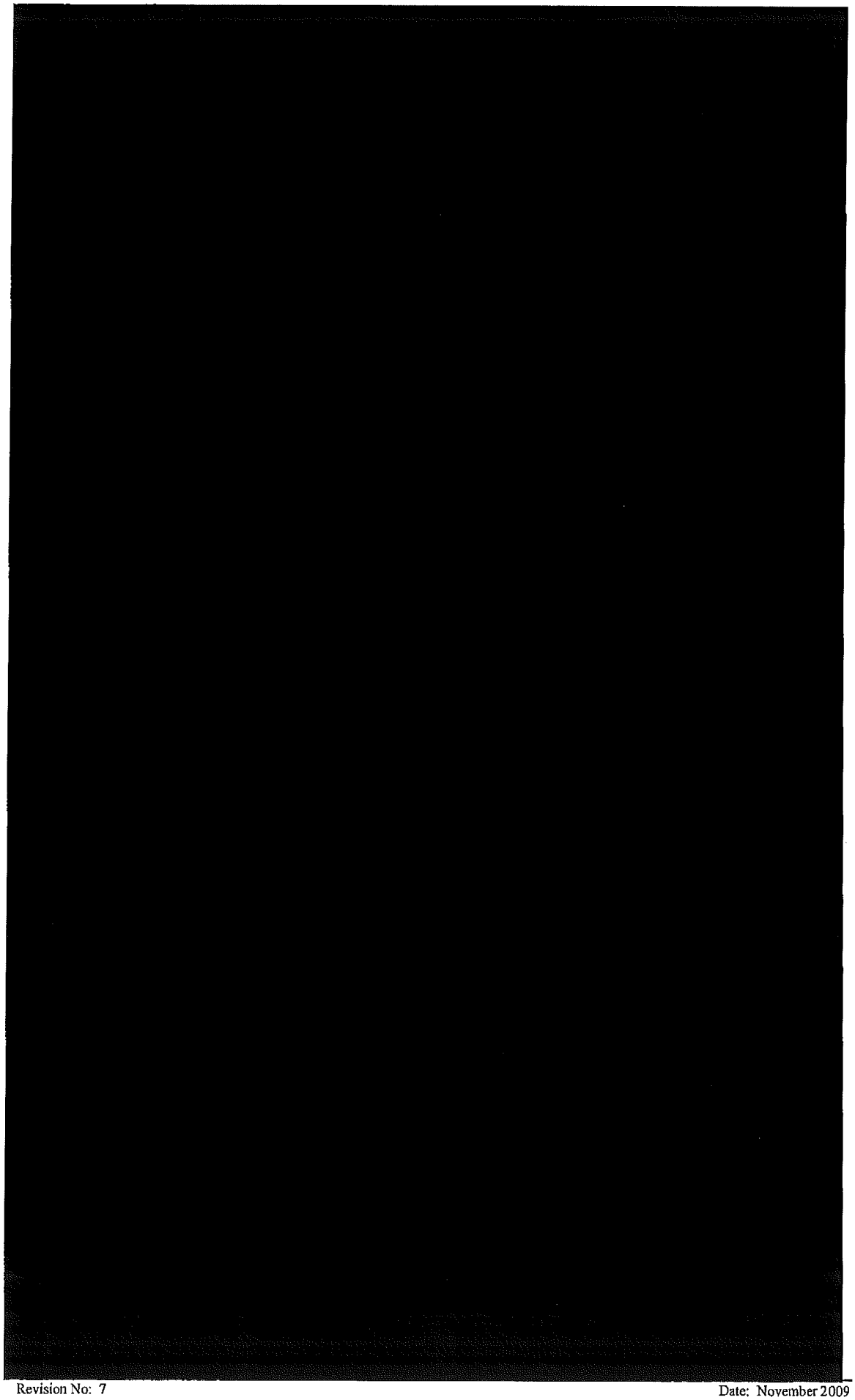
APPENDIX C
WIVENHOE DAM TECHNICAL DATA



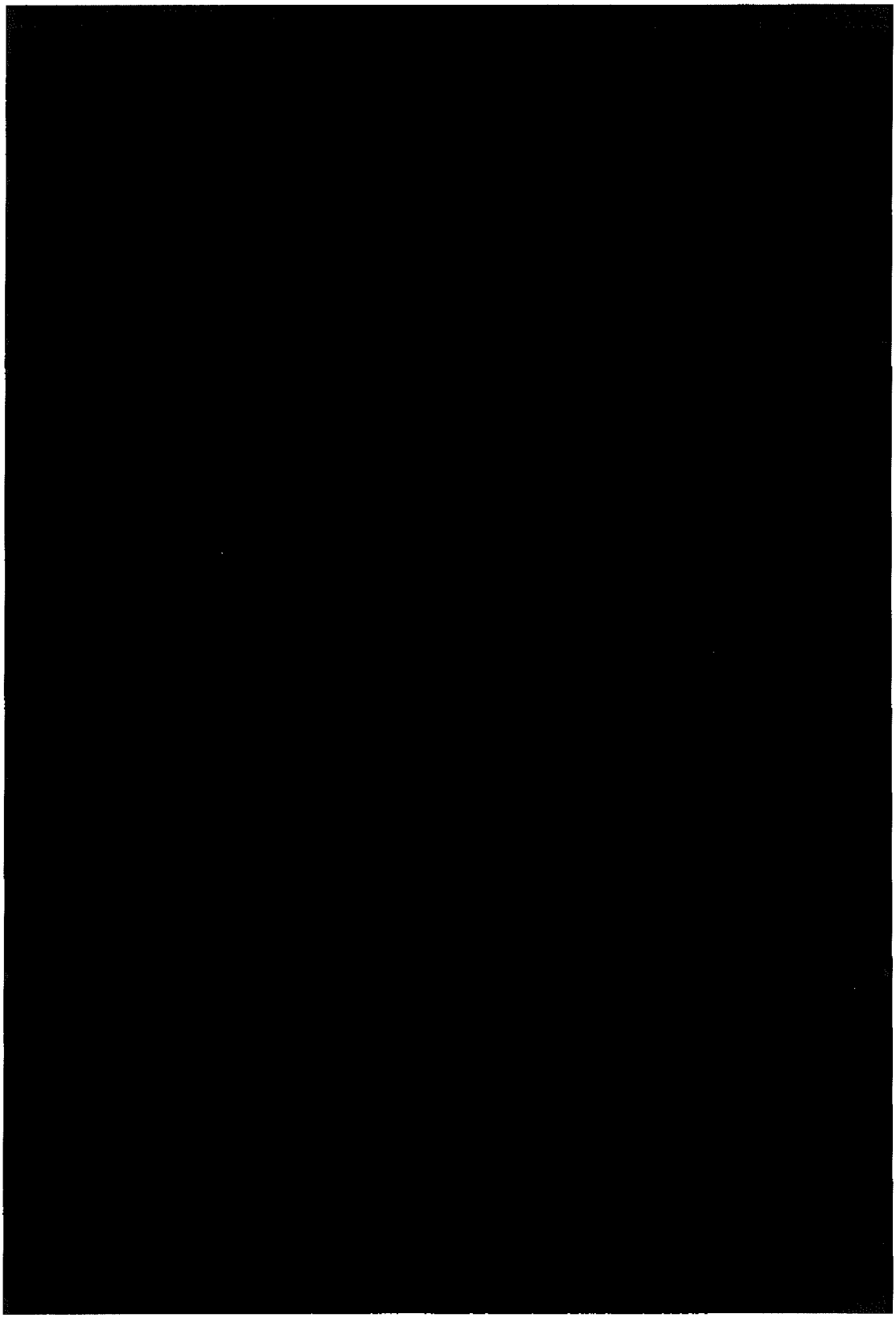




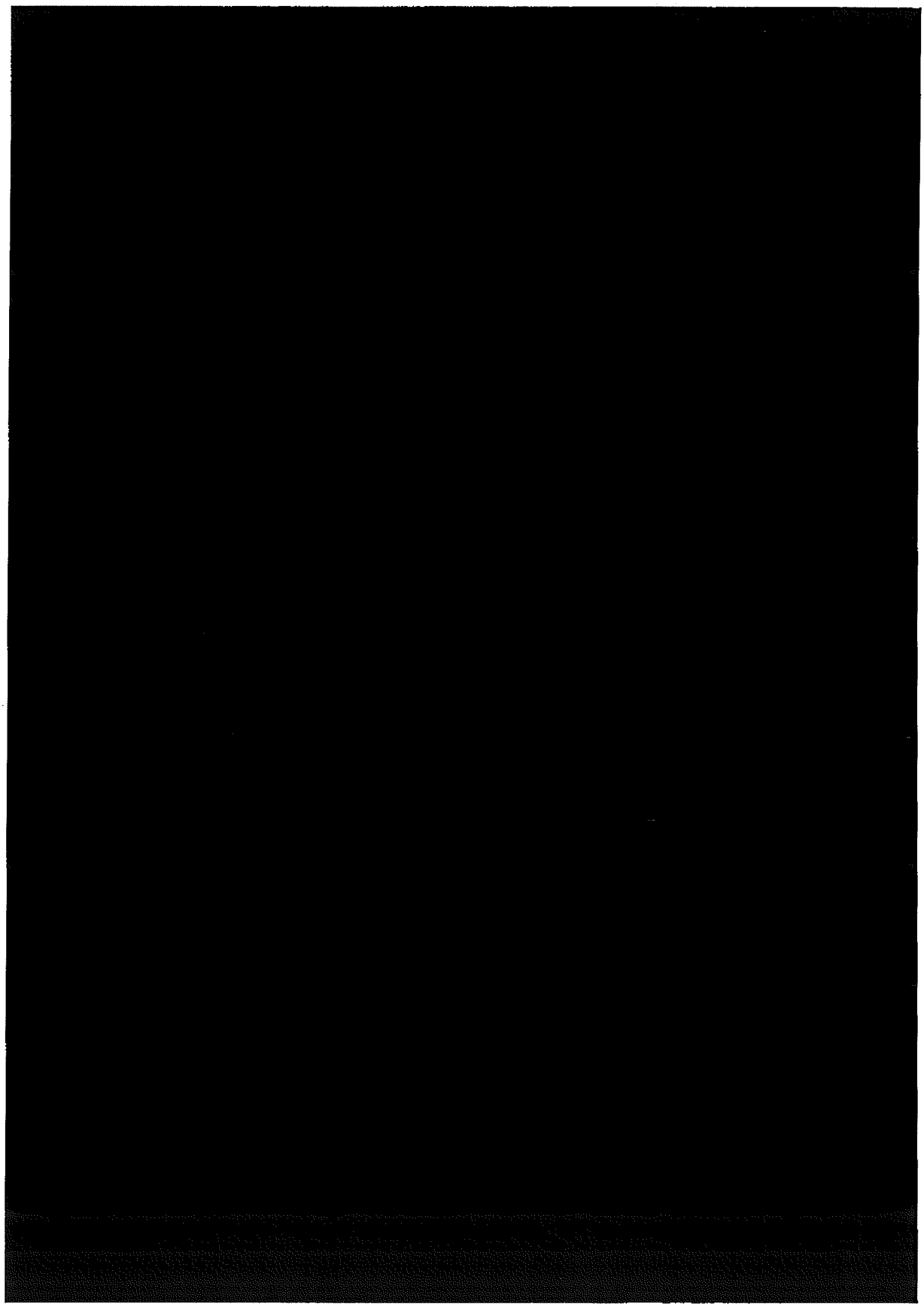
* Flow impacted by bridge deck.

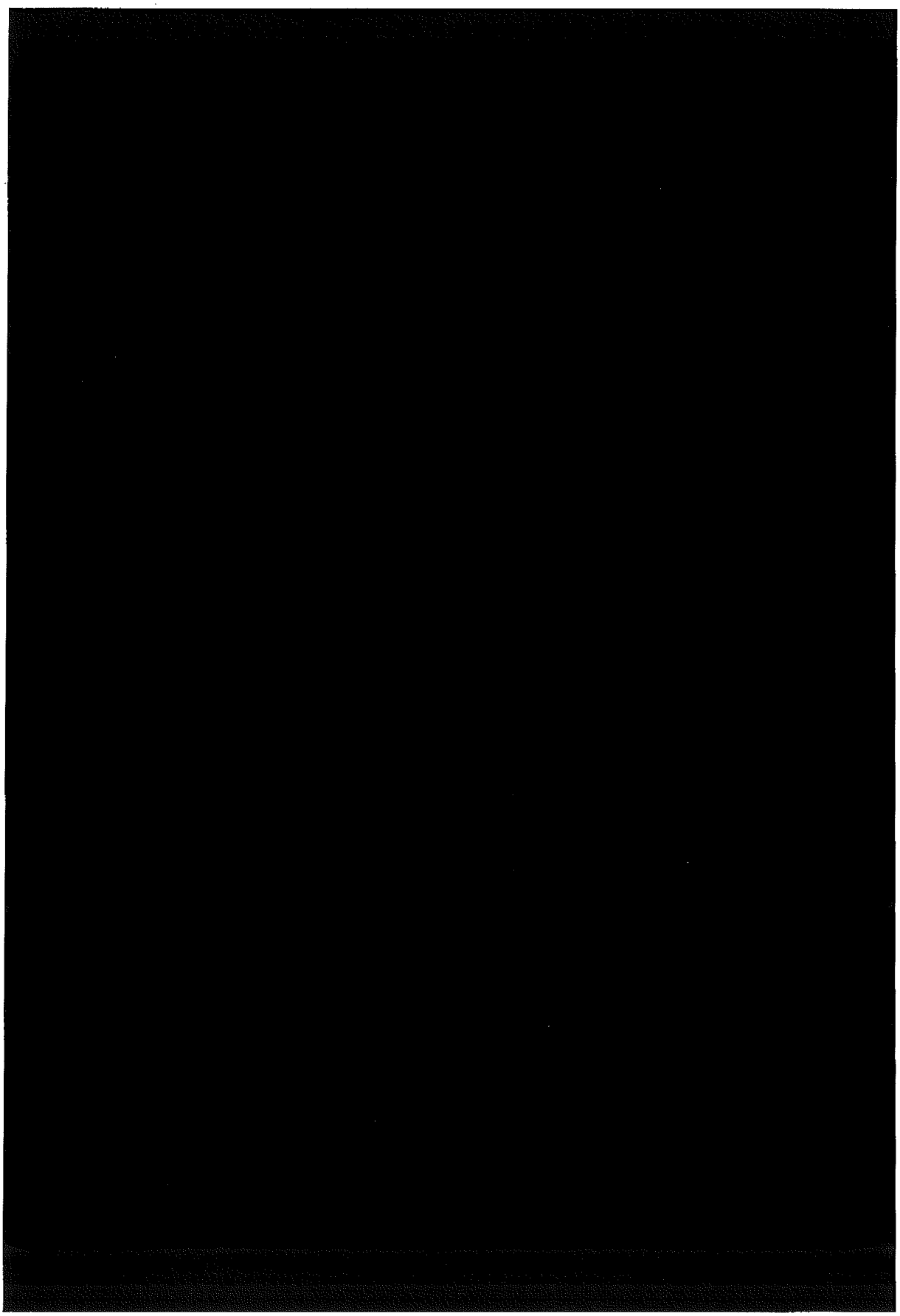


WIVENHOE DAM AUXILIARY SPILLWAY RATING TABLE

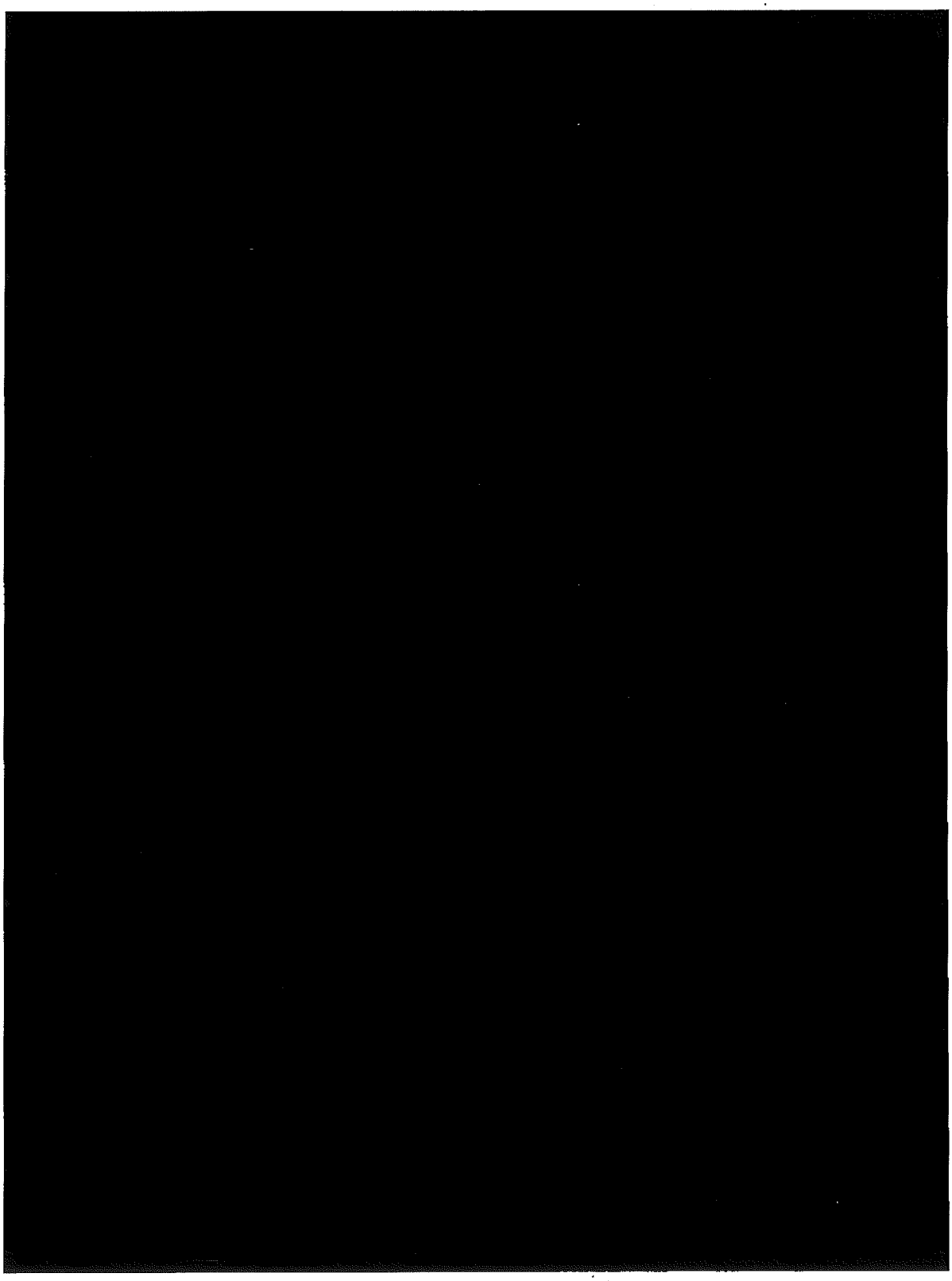


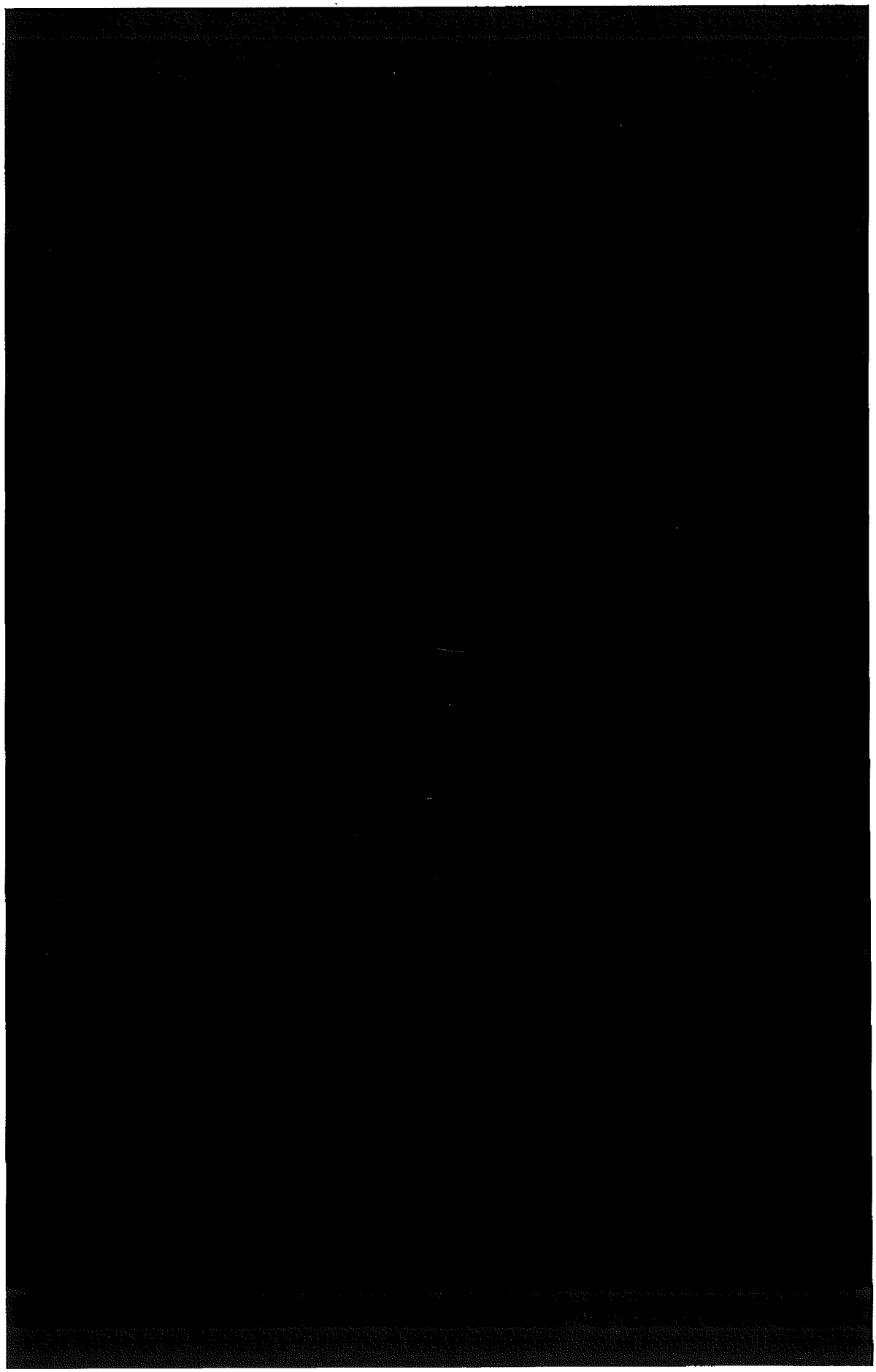
APPENDIX D
SOMERSET DAM TECHNICAL DATA

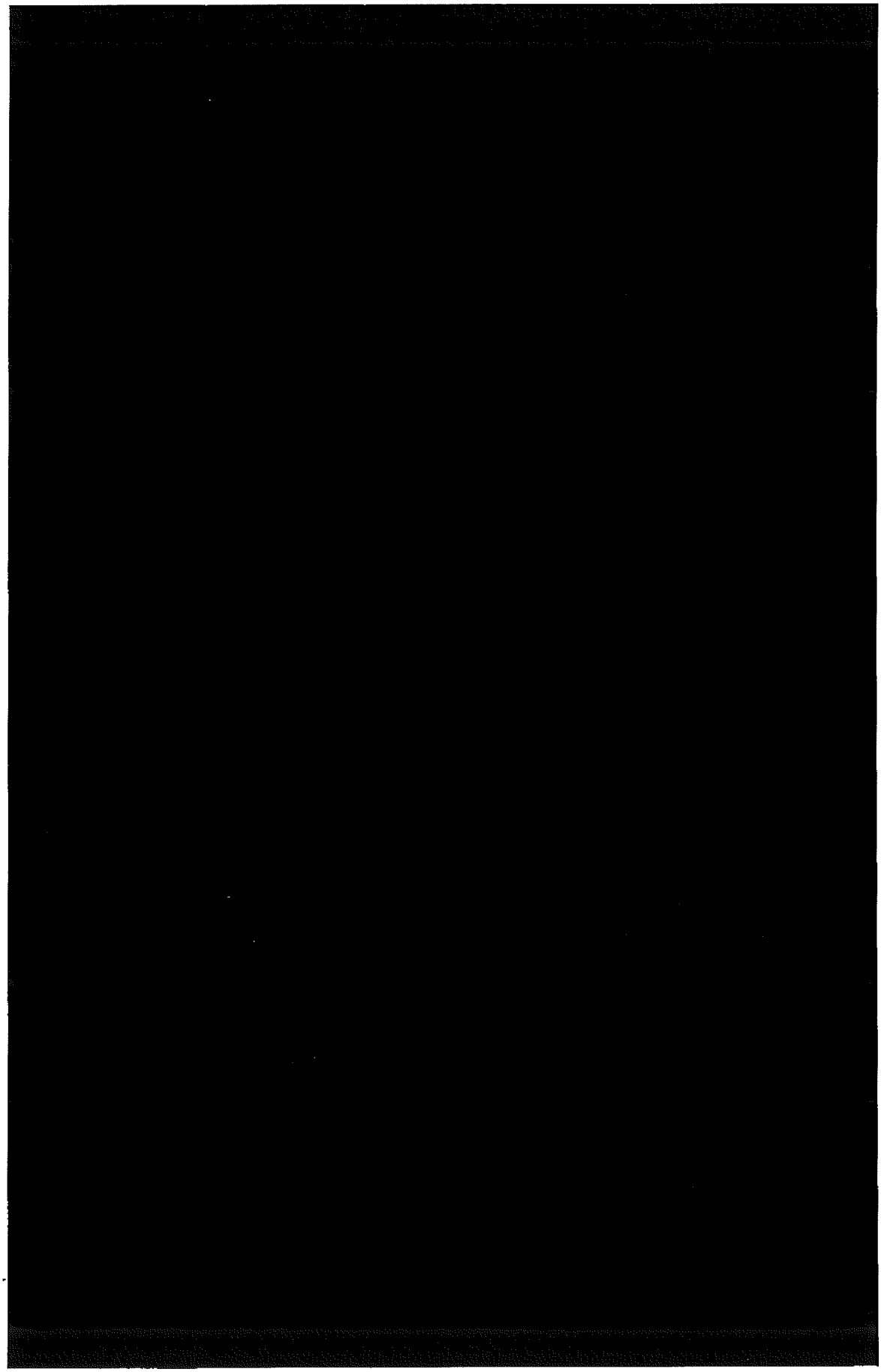


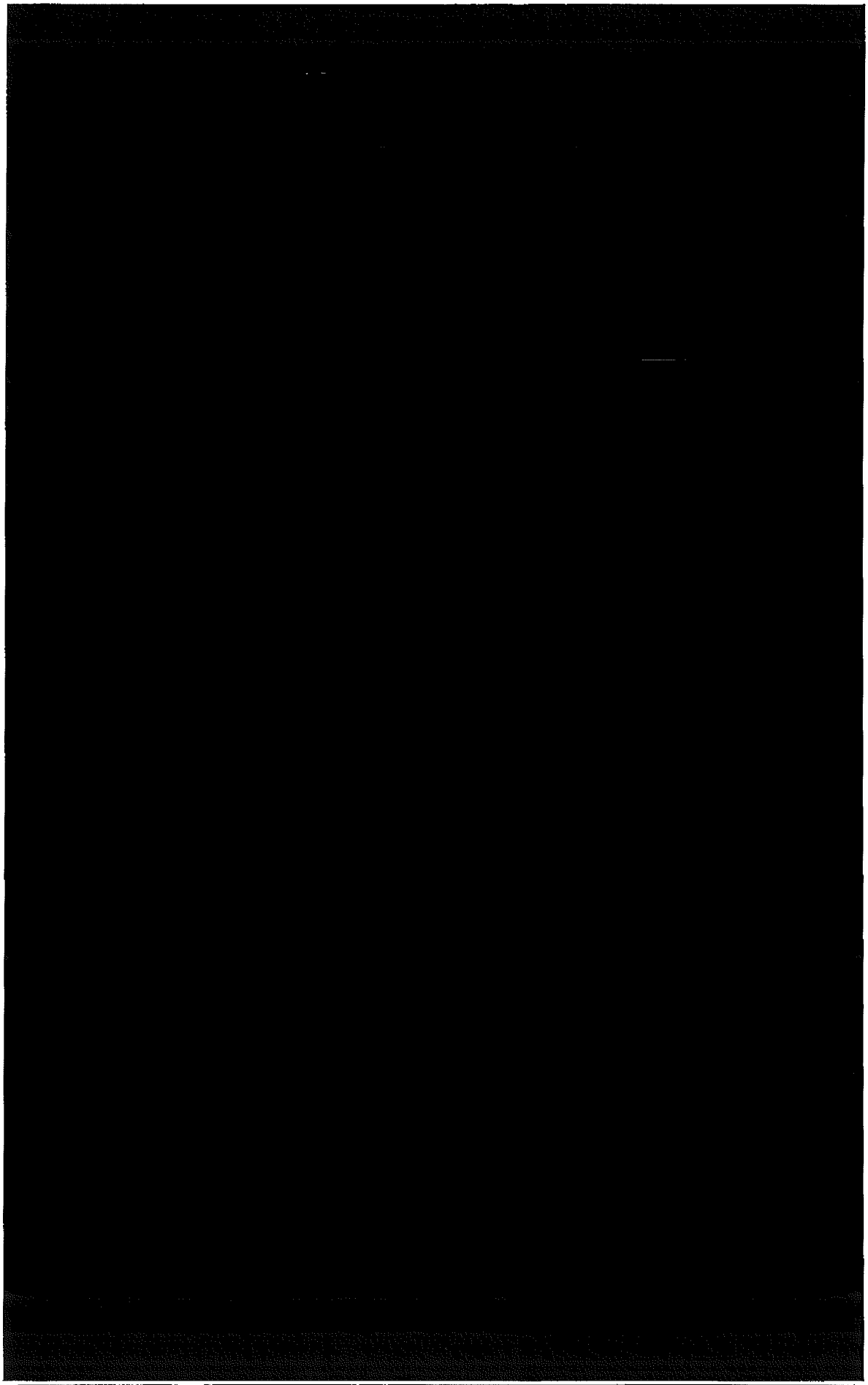


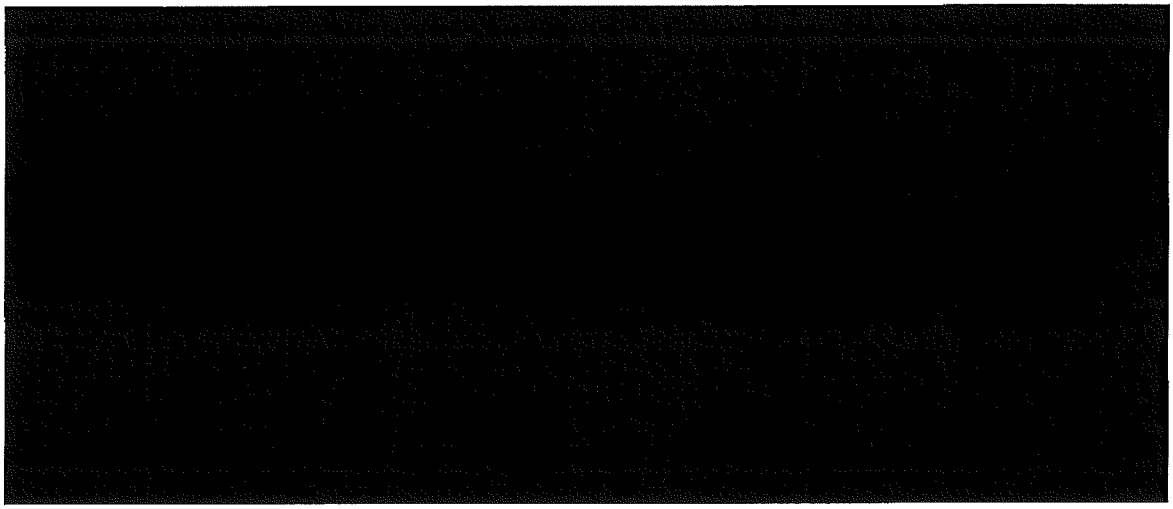
APPENDIX E
WIVENHOE DAM GATE OPERATION CONSIDERATIONS



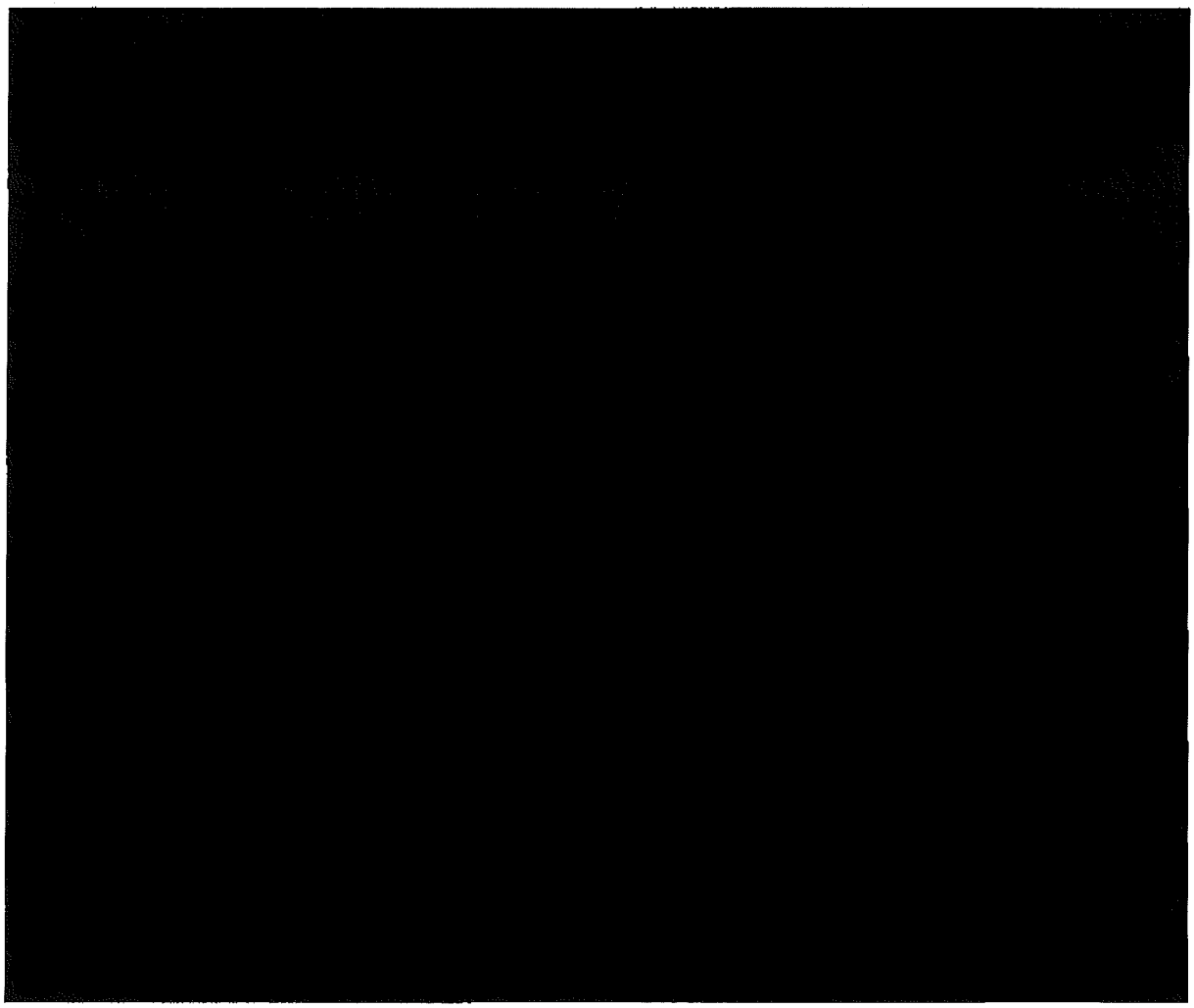




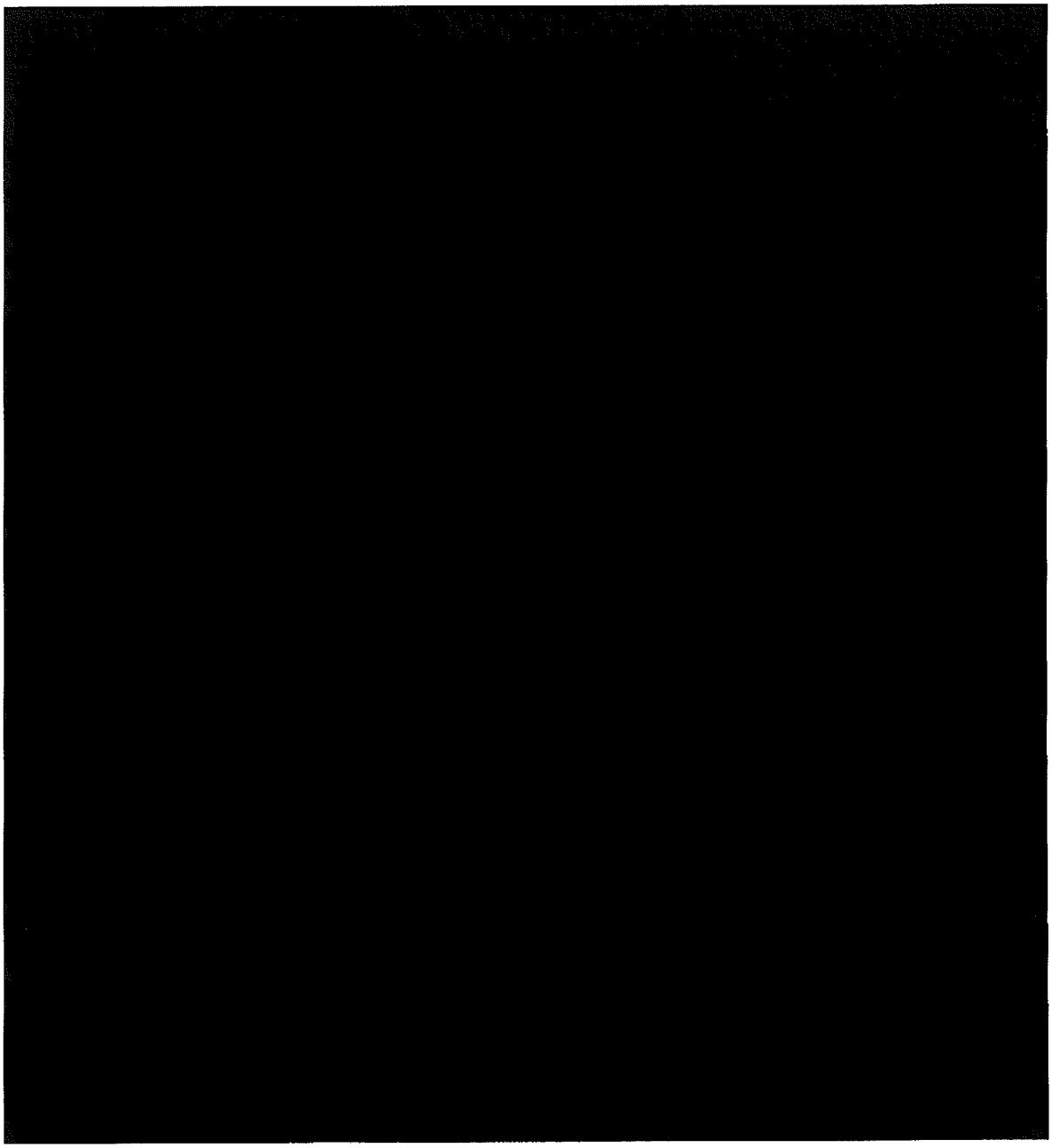




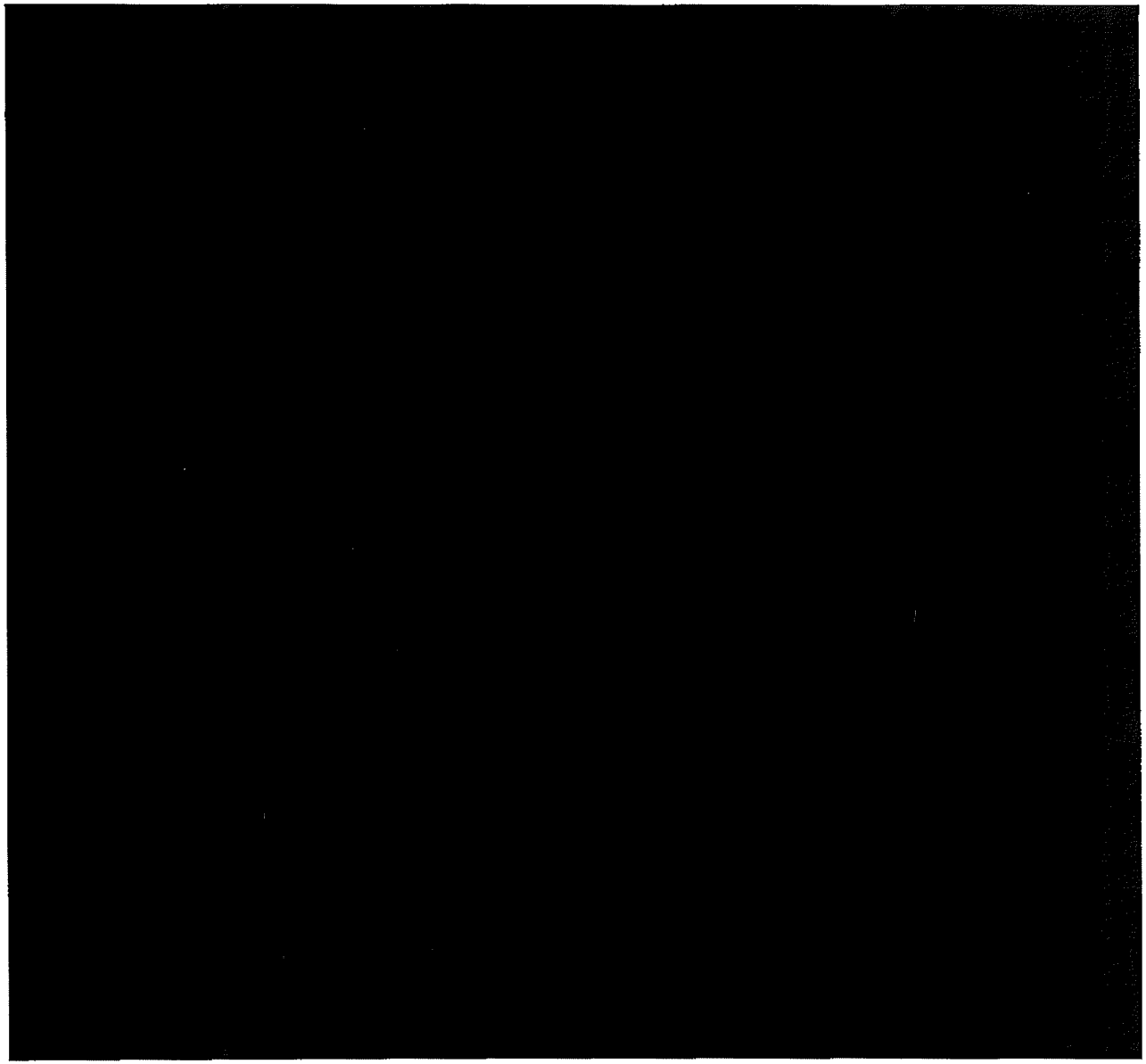
APPENDIX F
SOMERSET DAM AUXILIARY EQUIPMENT

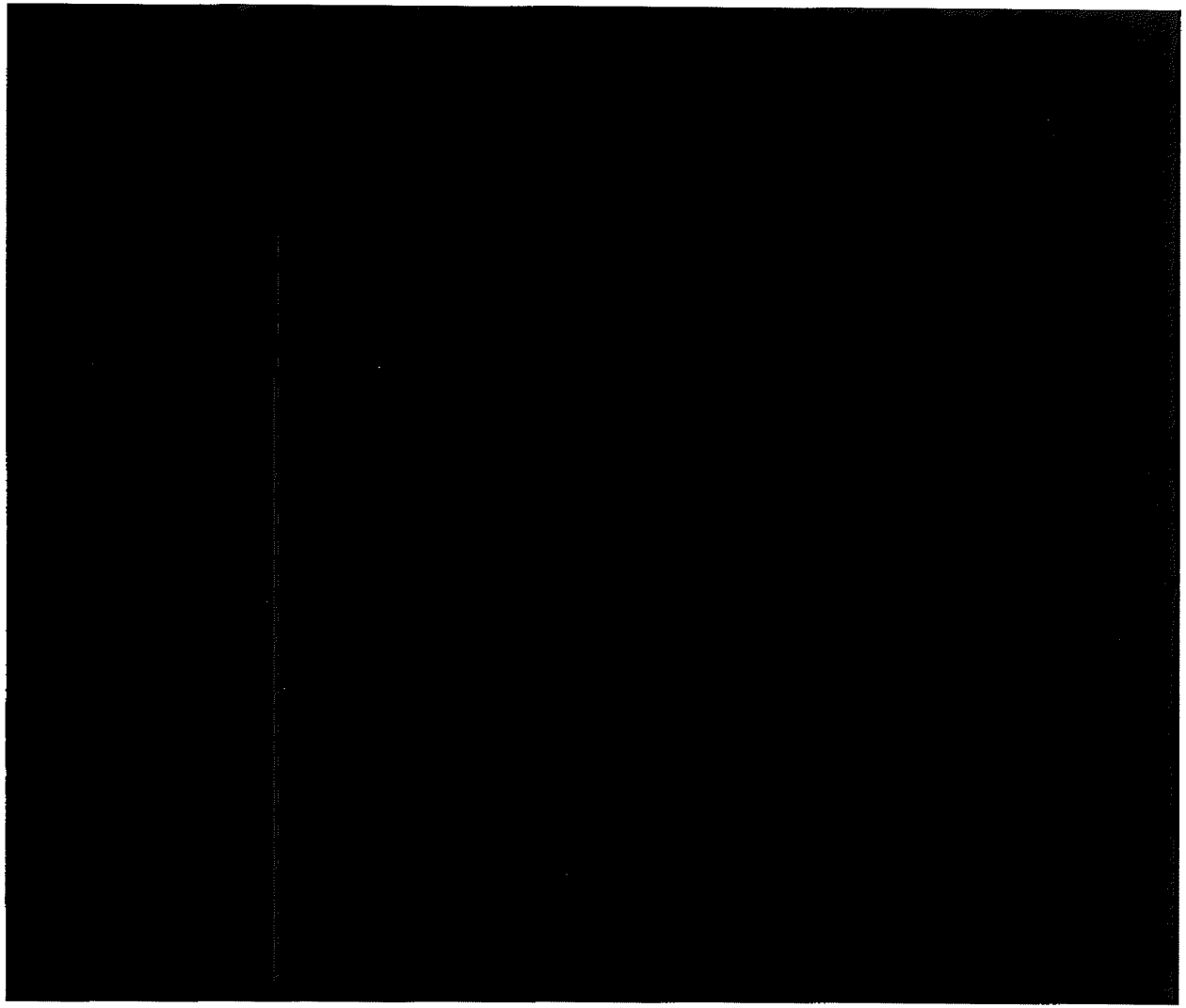


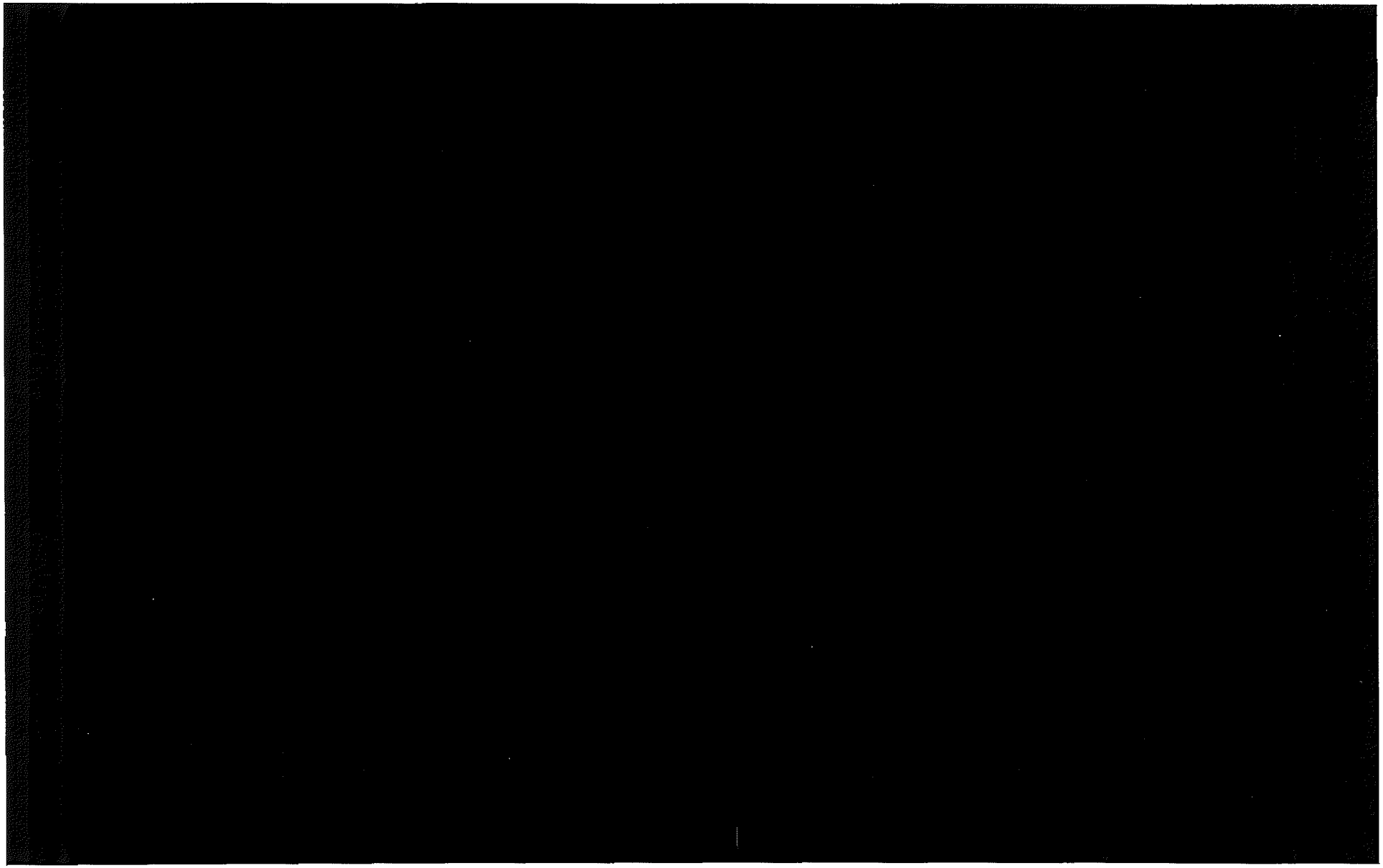
APPENDIX G
HYDROLOGIC INVESTIGATIONS

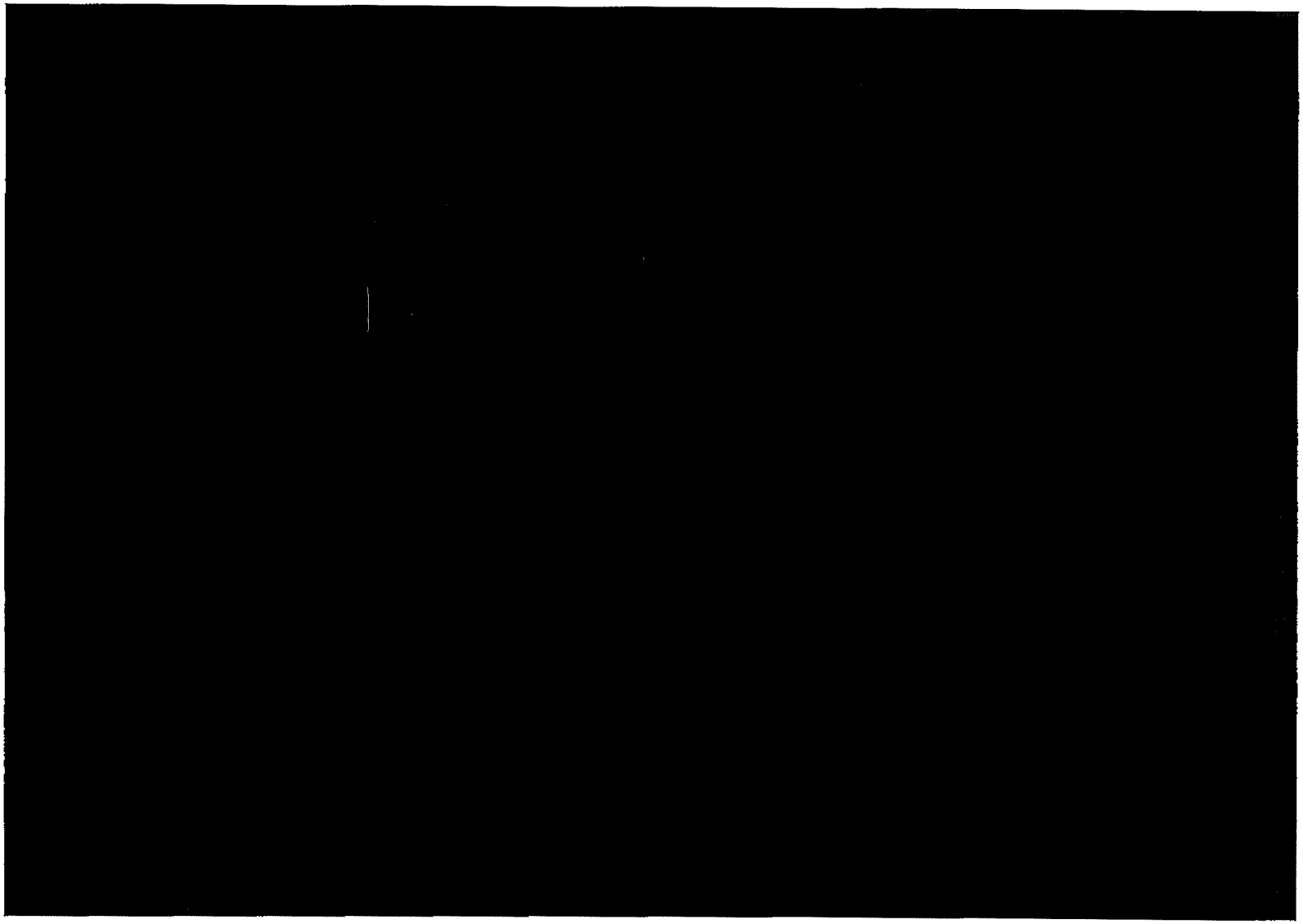


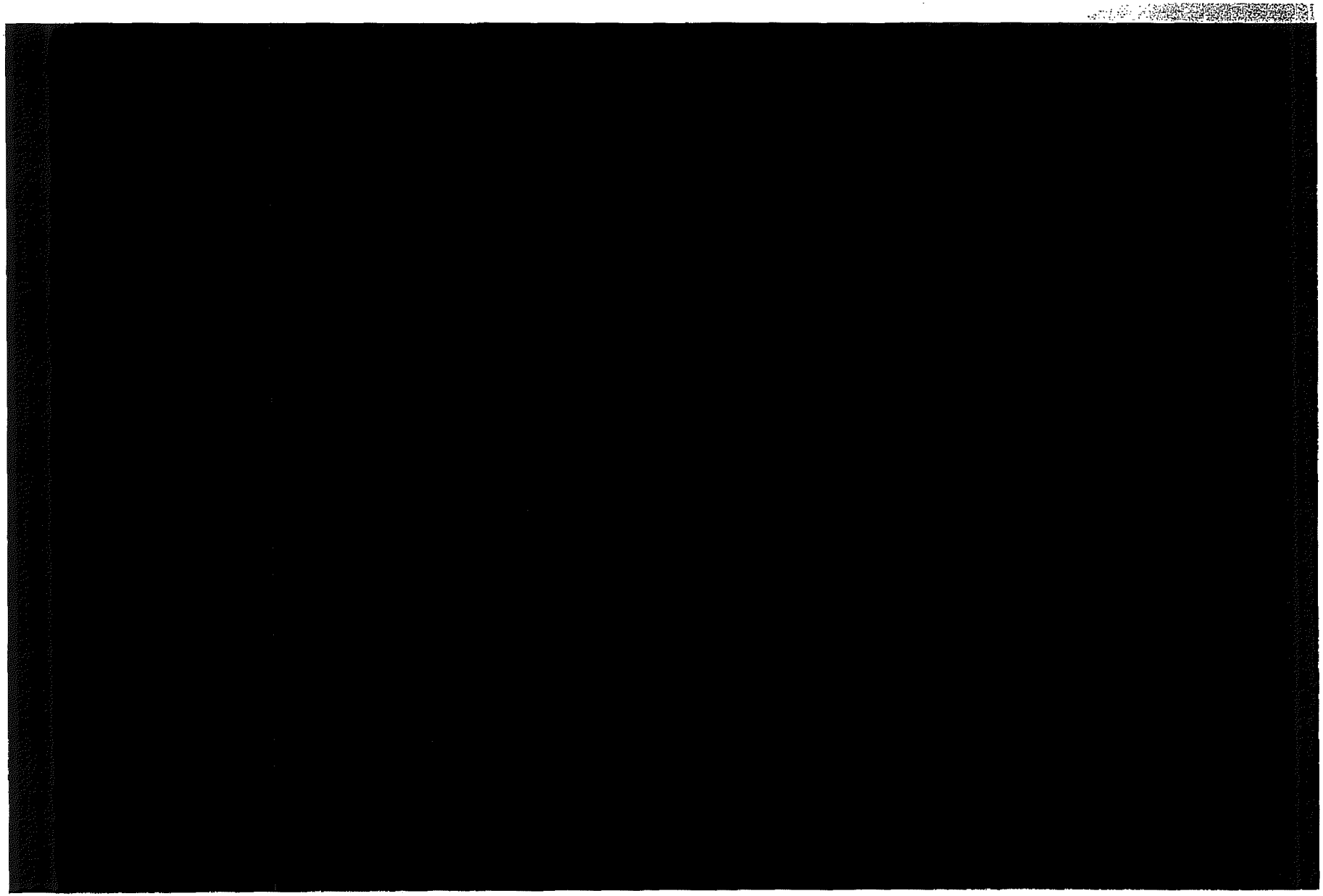
APPENDIX H
WIVENHOE DAM
PLANS, MAPS AND PHOTOGRAPHS



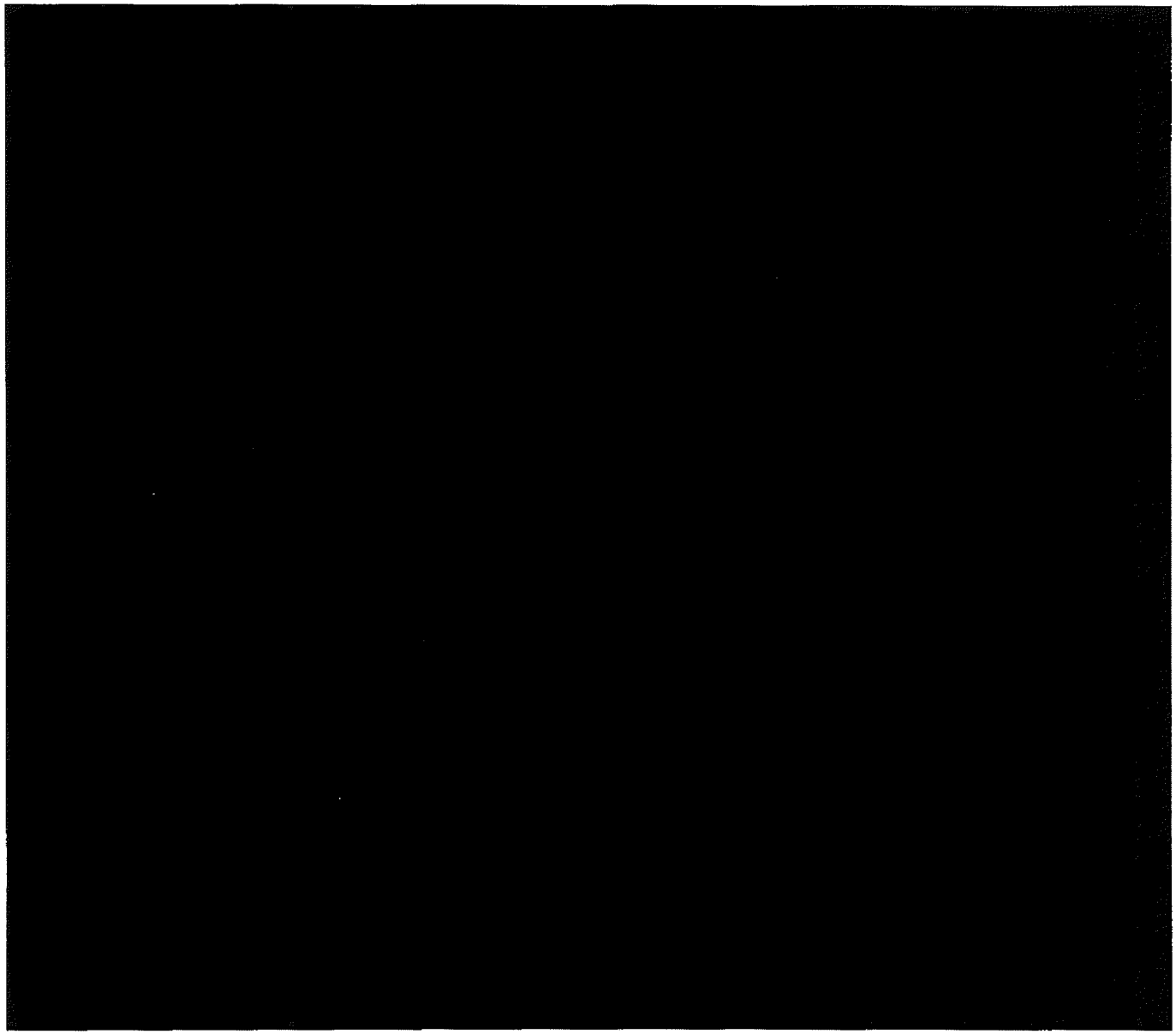


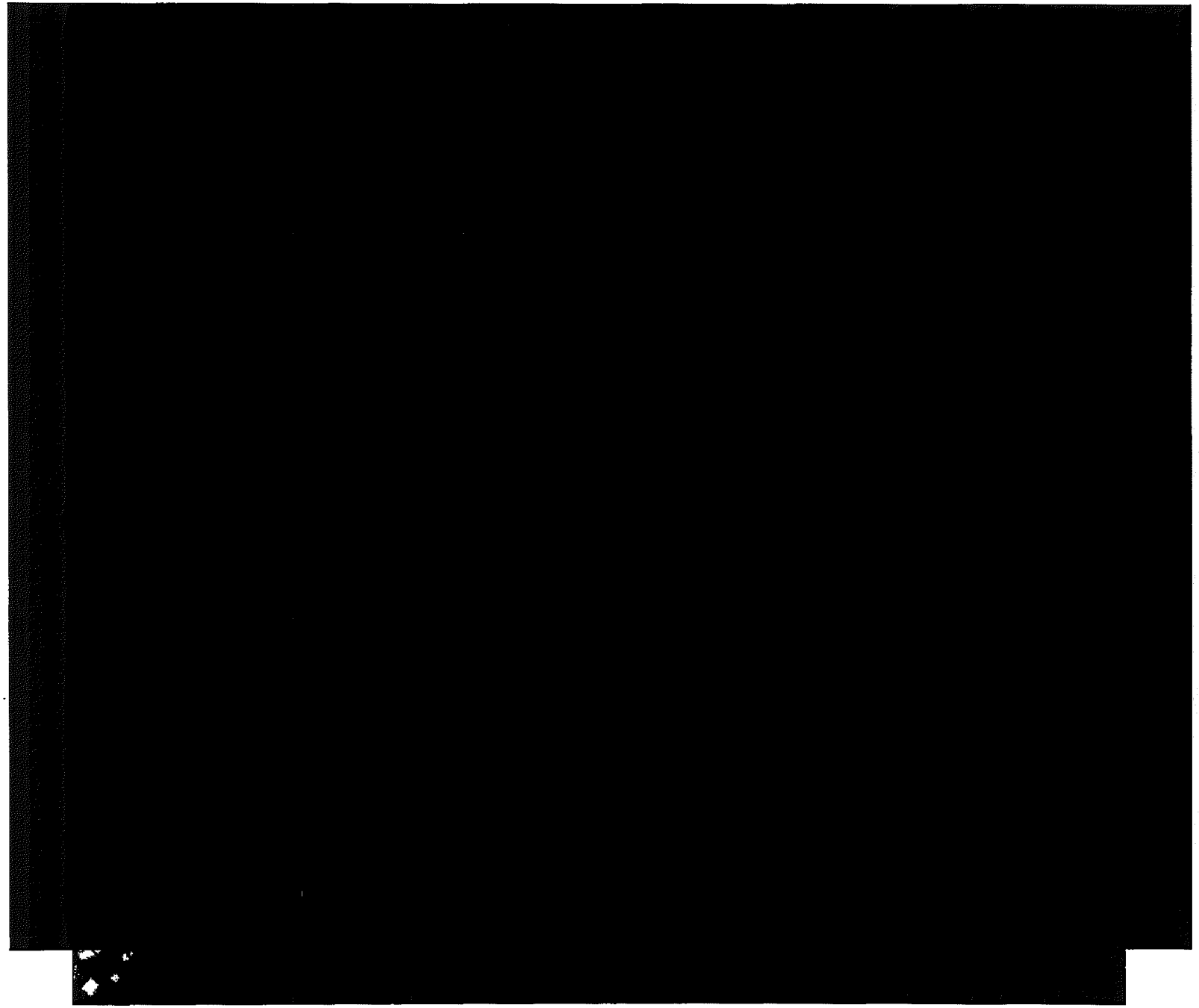


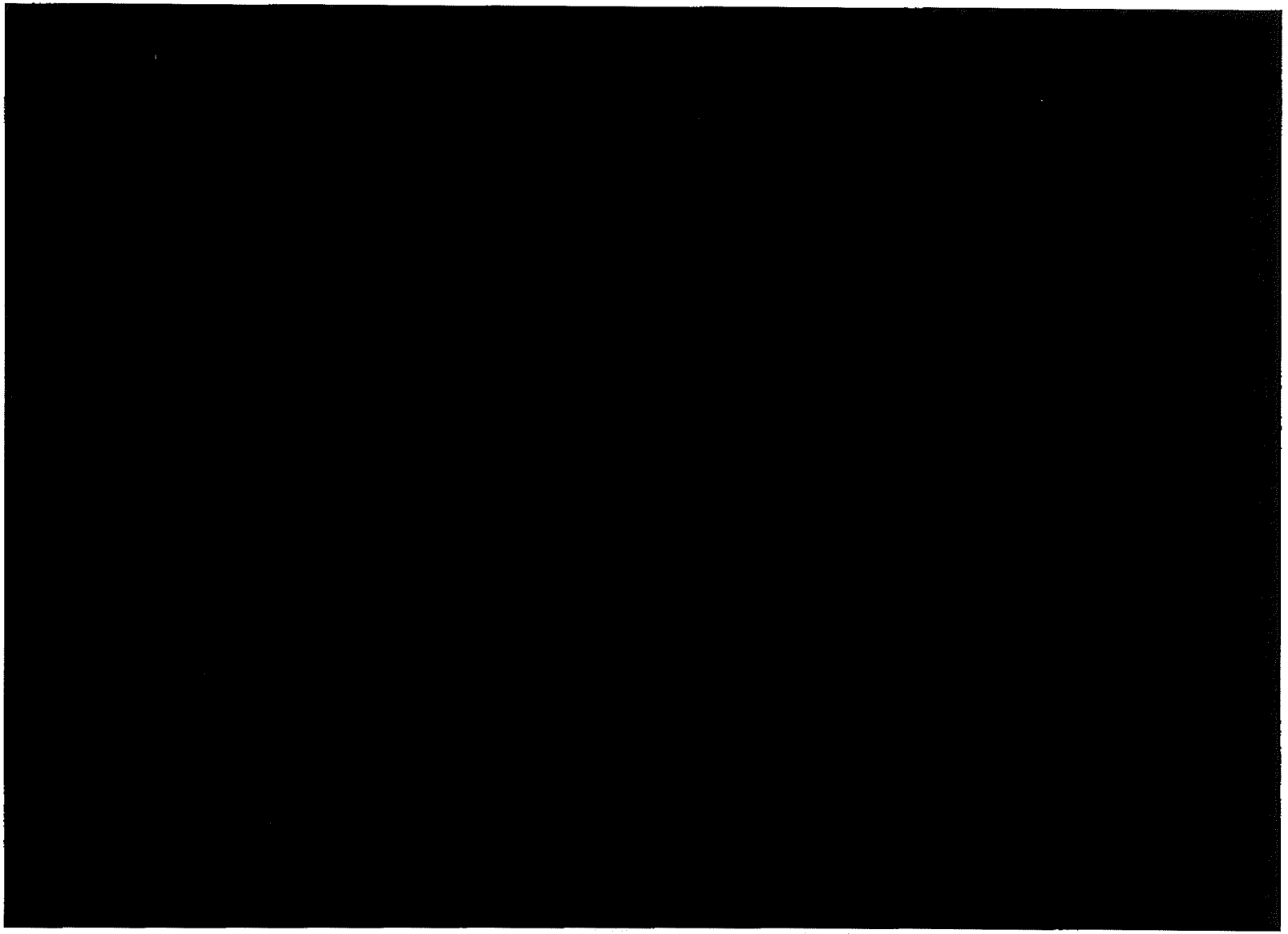


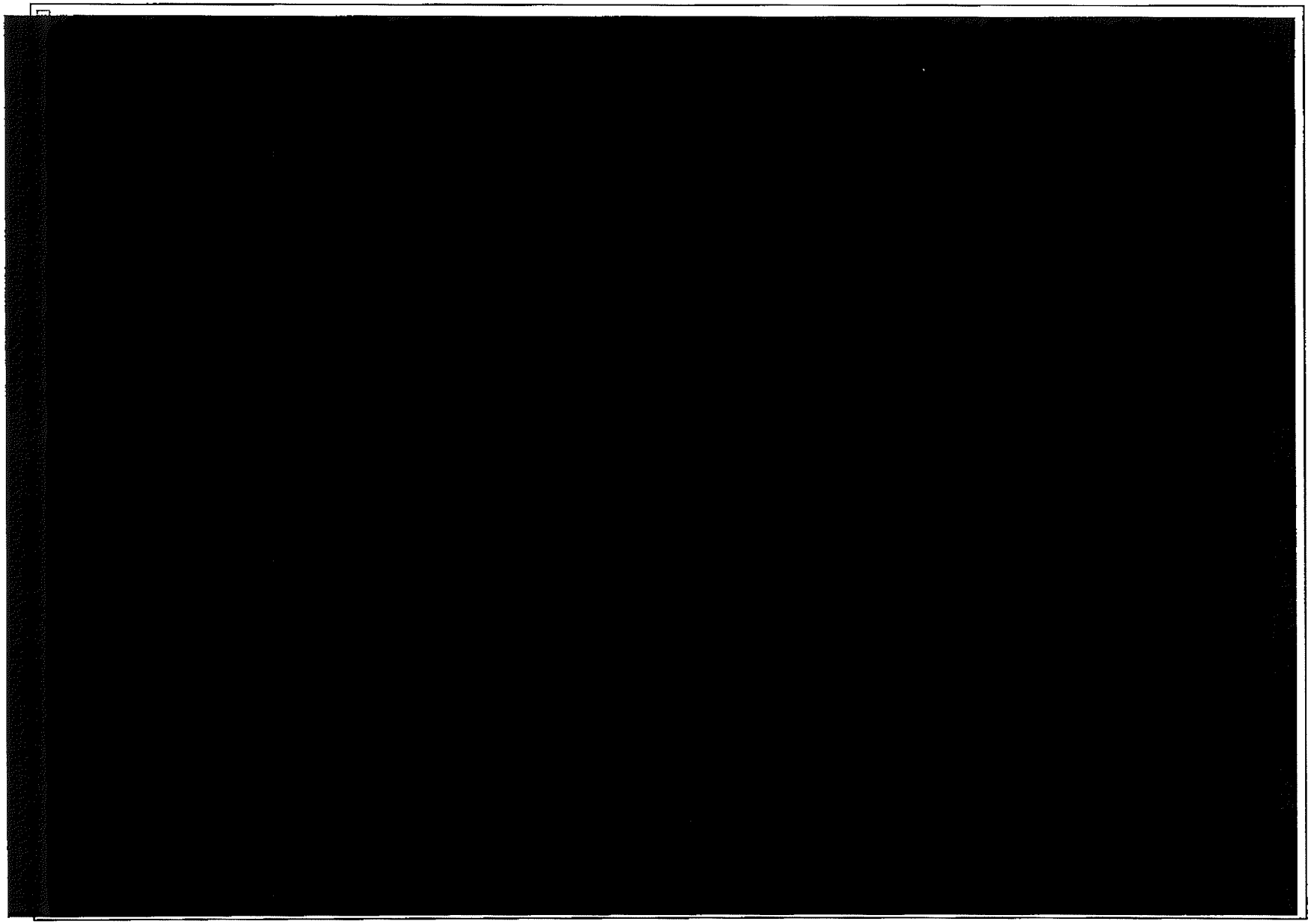


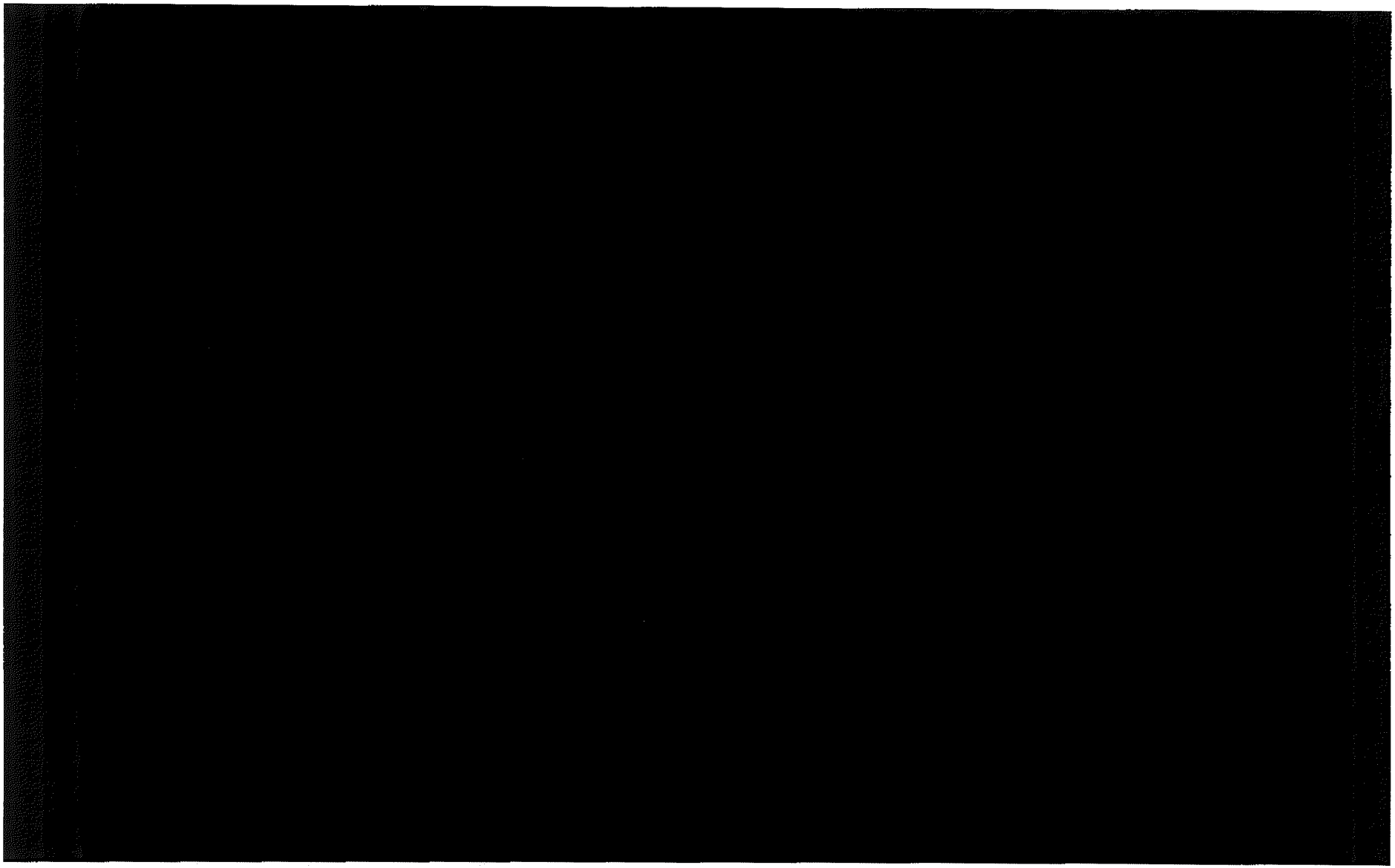
APPENDIX I
SOMERSET DAM
PLANS, MAPS AND PHOTOGRAPHS











APPENDIX J
WIVENHOE DAM – FUSE PLUG BREACH SCENARIOS