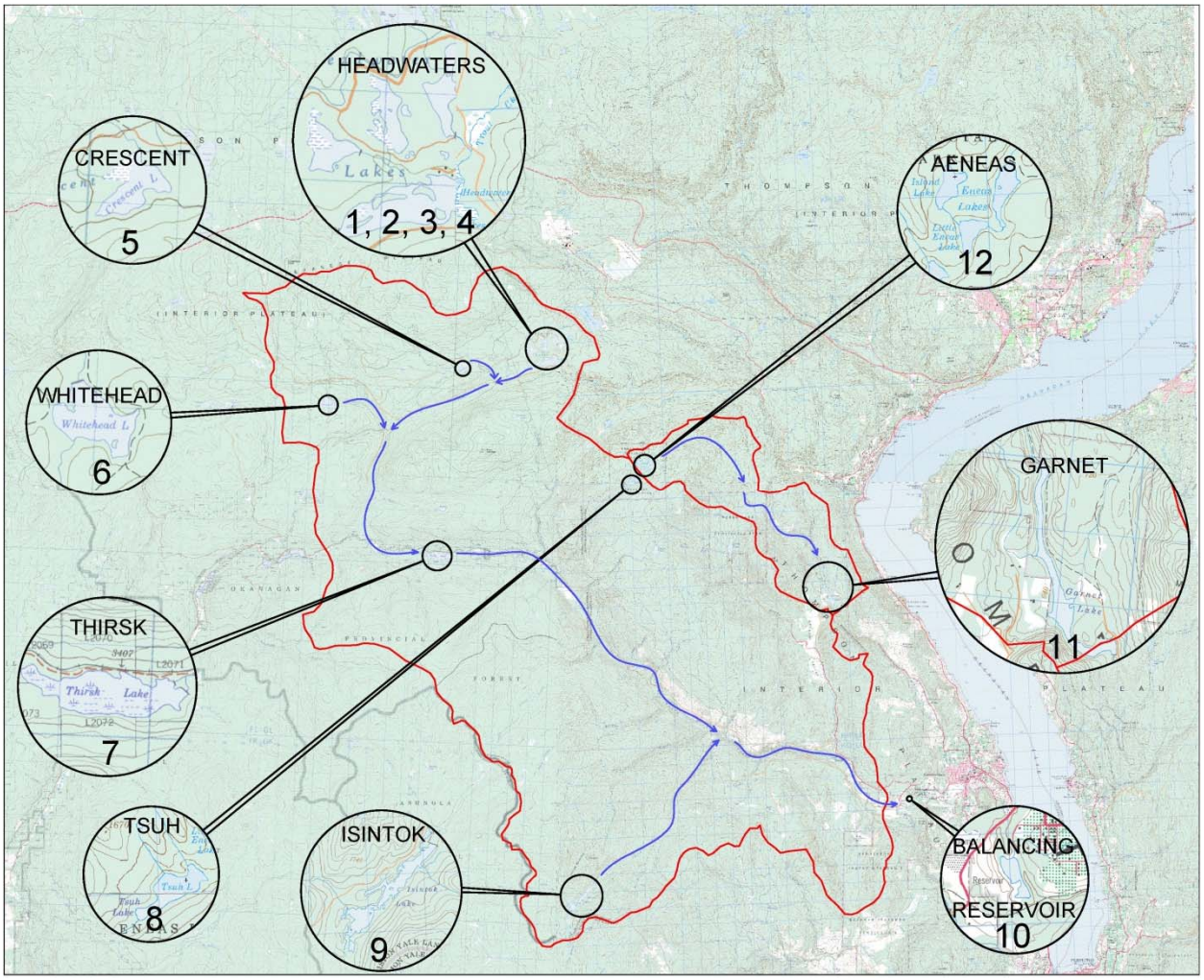
DISTRICT OF SUMMERLAND



DISTRICT OF SUMMERLAND DAMS

OPERATION, MAINTENANCE AND SURVEILLANCE MANUAL

November 2012

TABLE OF CONTENTS

1.0 - INTRODUCTION

1.1 GENERAL

The purpose of this Operation and Maintenance Manual is to provide a central reference document to be used by personnel responsible for operation, maintenance, and surveillance of the water storage facilities owned by The Corporation of the District of Summerland. This manual contains basic background information on the design of the various structures and it provides the basic guidelines, procedures and instructions for the operation, maintenance and inspection of the works.

While the process for dealing with most operation and maintenance issues is described in this manual, unusual or unforeseen occurrences which are not specifically identified may arise. When in doubt about a particular operation or procedure, the responsible operator must utilize common sense and good judgment and when necessary, consult the person to whom they report.

This Manual is prepared for use of operating personnel and their immediate supervisors who are assigned the direct responsibility for the operation, maintenance and surveillance of the facilities. The manual is also designed for emergency operation of the dam system by a knowledgeable water professional in the absence of the regular operators.

The District Staff responsible for the Operation, Maintenance and Surveillance of dams is encouraged to regularly familiarize themselves and their staff with the most current Dam Safety Regulations.

In addition to this introductory section, there are five other sections to this manual. The sections are as follows:

- 1.0 - Introduction
- 2.0 – General Information
- 3.0 – Facility Operation
- 4.0 – Inspection and Maintenance
- 5.0 – Emergency Response
- 6.0 – Dam Specific Information

This manual is designed for the water supply system operated by The Corporation of the District of Summerland covers the following dams:

TROUT CREEK WATERSHED

- Headwaters Reservoir No. 1 Dam
- Headwaters Reservoir No. 2 Dam
- Headwaters Reservoir No. 3 Dam
- Headwaters Reservoir No. 4 Dam
- Crescent (Paul) Reservoir Dam
- Whitehead Reservoir Dam
- Thirsk Reservoir Dam
- Tsuh (Deer) Reservoir Dam
- Isintok (Canyon) Reservoir Dam
- Summerland Balancing Reservoir (Trout Creek Source)

AENEAS WATERSHED

- Garnett Reservoir Dam
- Aeneas Reservoir Dam

1.2 USER'S GUIDE

Each user should read and become thoroughly familiar with the contents of this manual. The Table of Contents provides a concise reference to the various subjects covered in each section. Tables and Figures pertaining to a particular section are numbered with a prefix which is the same as the section number. They are located at the end of the relevant section; Tables first, followed by Figures.

1.3 REVISIONS

The Director of Engineering and Public Works for the District of Summerland is responsible for the issue of all revisions or addenda to registered holders of this manual. The individual holder is responsible for placing the insertions in the manual and recording receipt of same on Table provided at the end of this section. Revisions will always be made by correcting a page or drawing and re-issuing it in complete form so that the "old" or incorrect copy can be removed from the manual and destroyed.

1.4 SYSTEM OF UNITS

The design of the facilities and the reference drawings are in metric units and this system of measurement has been retained and used throughout the manual, unless noted otherwise. Some dam staff gauges are still in Imperial units and those associated recordings may be displayed and recorded in those units until staff gauges are changed out and converted to metric.

All water storage volumes and flow is presented in megalitres.

1.5 REFERENCE DOCUMENTS AND REPORTS

"Clearing, Excavating and constructing Two Concrete Dams on Trout Creek Near Thirsk (K.V.R.) (Bylaw 502) – Specifications, Plans, Forms of Tender and Contract", R.A. Barton, C.E., July 1940.

"Report on Rehabilitation of Irrigation System, Part 2 – Storage Dams", Ingledow Kidd & Associates Limited, March 1965.

"Review of the District's Water supply from the Headwaters, Crescent Lake and Whitehead", T. Ingledow & Associates Limited, December 1967.

"Thirsk Dam – Study of Structural Stability and of Required Rehabilitation Work", Gepac Consultants Ltd., December 1972.

"Trout Creek Water Supply for District of Summerland", Province of British Columbia, Department of Lands, Forests and Water Resources, Water Investigations Branch (D.E. Reksten, P. Eng.), March 1973.

"Engineering Study – Rehabilitation of Irrigation and Water Supply Systems – The Corporation of the District of Summerland", Province of British Columbia, Department of Lands, Forests and Water Resources, Water Investigations Branch (N.J. Morrison, P. Eng.), April 1973.

"Design and Construction of Garnett Lake Dam", H. Fellhauer, P. Eng., December 1976.

"Trout Creek Water Supply Study". Province of British Columbia, Ministry of Environment, Water Management Branch (E. Weiss), November 1981.

"Water Supply Analysis for Trout Creek and the District of Summerland", Province of British Columbia, Ministry of Environment, Water Management Branch (D.B. Letvak, P. Eng.) August 1989.

"2004 Climate Change Scenarios" Water Management Consultants;

"2004 Trout Creek Water Use Plan" Water Management Consultants;

"2008 Water Master Plan" District of Summerland, Agua Consulting Inc.

"2011 Watershed Master Plan" District of Summerland, Agua Consulting Inc.

1.6 REGISTERED MANUAL HOLDERS

The following table lists the registered manual holders.

Table 1.1 – Registered Manual Holders

Name and Address	Set No.
Kris Johnson, Director of Works and Utilities District of Summerland, Works and Utilities Box 159, 9215 Cedar Avenue Summerland, BC V0H 1Z0 Phone: (250) 494-0431 kjohnson@summerland.ca	1
Devon van der Meulen, Manager of Utilities District of Summerland, Water Division Box 159, 16700 Prairie Valley Road Summerland, BC V0H 1Z0 Phone: (250) 494-0431 dvandermeulen@summerland.ca	2 (WTP) 3 (Field Copy)
Bob Hrasko, P.Eng Agua Consulting Inc. 3660 Anderson Road Kelowna, BC V1X 7V8 Phone: (250) 212-3266 rhrasko@shaw.ca	4
DAMS UNDER 9 METRES IN HEIGHT Mike Noseworthy, P.Geo, Eng.L. Senior Regional Dam Safety Officer, Water Stewardship Ministry of Forests, Lands and Natural Resource Operations 102 Industrial Place Penticton BC V2A 7C8 Phone: (250) 490-2291 Mike.Noseworthy@gov.bc.ca	5
DAMS OVER 9 METRES IN HEIGHT Robert McLean, Senior Dam Safety Officer Dam Safety Section, Water Management Branch Ministry of Forests, Lands and Natural Resource Operations PO Box 9340 Stn Prov Govt Victoria, BC V8W 9M1 Phone: (250) 952-6805 Robert.McLean@gov.bc.ca	6
Glenn Noble, Emergency Program Coordinator District of Summerland, Fire Department Box 159, 10115 Jubilee Road West Summerland, BC V0H 1Z0 Phone: (250) 404-4092 Res: (250) 494-0745 Email: gnoble@summerland.ca **DISPATCH 24 HOURS (250) 490-2305**	7
Dale Kronebusch, Emergency Program Coordinator Regional District of Okanagan Similkameen 101 Martin Street Penticton, BC V2A 5J9 Phone: (250) 492-0237 Cell: **(250) 809-2541 - 24 HOURS** Email: dkronebusch@rdos.bc.ca	8

Last Updated January 25, 2017

1.7 Record of Revisions

Table 1.2 - Record of Revisions

Description of Revision	Rev. No.	Date
Issued Initial Document	0	Nov. 8, 2012
Updated: 1.6 Registered Manual Holders, pg. 10 1.7 Record of Revision, pg. 11 Table 5.1 Dam Operations Personnel Contact Information, pg. 34 Table 5.3 Dam Alert Emergency Contact List, pg. 36 Table 5.4 Dam Breach Emergency Contact List, pg. 37 Table 5.7 Transportation Contact Information, pg. 40	1	Jan. 14, 2015
Updated: 1.6 Registered Manual Holders, pg. 10 1.7 Record of Revision, pg. 11 Table 5.1 Dam Operations Personnel Contact Information, pg. 34 Table 5.3 Dam Alert Emergency Contact List, pg. 36 Table 5.6 Media Contact Information, pg. 39 Table 5.7 Transportation Contact Information, pg. 40	2	Feb. 17/16
Updated: 1.6 Registered Manual Holders, pg. 10 1.7 Record of Revision, pgs. 11 and 12 Table 5.2 Summerland and Regional District Office Contact Information, pg. 34 Table 5.3 Dam Alert Emergency Contact List, pg. 36 Table 5.4 Dam Breach Emergency Contact List, pg. 37 Table 5.5 Other Resource Contact Information, pg. 38 Table 5.6 Media Contact Information, pg. 39 Table 5.7 Transportation Contact Information, pg. 40 Table A1.4 – Headwaters No. 1 – Record of Annual Inspections, pg. 53 Table A2.3 Headwaters No. 2 – Record of Annual Inspections, pg. 62 Table A3.3 – Headwaters No. 3 Dam – Record of Annual Dam Inspections, pg. 71 Table A4.2 – Headwaters No. 4 – Record of Annual Inspections, pg. 79 Table A5.4 – Crescent Reservoir – Record of Annual Inspections, pg. 89 Table A6.3 – Whitehead Dam – Record of Annual Inspections, pg. 98 Table A7.8 – Thirsk Dam – Record of Annual Inspections, pg. 113 Table A8.3 – Tsuh (Deer) Dam – Record of Annual Inspections, pg. 122 Table A9.4 – Isintok (Canyon) Dam – Record of Annual Inspections, pg. 132 Table A10.2 – Summerland (Trout Creek) – Record of Annual Inspections, pg. 138	3	Jan. 25/17

Table A11.3 – Garnett Dam – Record of Annual Inspections, pg. 147 Table A12.4 – Aeneas Reservoir Dam – Record of Annual Inspections, pg. 156		

2.0 – GENERAL INFORMATION

2.1 INTRODUCTION

The District has both concrete and earth embankment dams. Thirsk Dam is a concrete arch structure with a concrete gravity ogee crest spillway located in a saddle on the right side of the reservoir, remote from the dam. All other dams are earthfill embankments with gated low level outlet works and side channel spillways.

The Summerland water system is supplied from two separate watersheds; Trout Creek Watershed and Aeneas Creek Watershed. The various structures in the watersheds are as follows:

Trout Creek Watershed

- Headwaters Reservoir No. 1 Dam
- Headwaters Reservoir No. 2 Dam
- Headwaters Reservoir No. 3 Dam
- Headwaters Reservoir No. 4 Dam
- Crescent (Paul) Reservoir Dam
- Whitehead Reservoir Dam
- Thirsk Reservoir Dam
- Tsuh (Deer) Reservoir Dam
- Isintok (Canyon) Reservoir Dam
- Summerland Balancing Reservoir (Trout Creek)

Aeneas Creek Watershed

- Garnett Reservoir Dam
- Aeneas Reservoir Dam

2.2 DAM LOCATION MAPS

Figures showing the location of all the dams can be found at the end of Appendix A.

2.3 WATER LICENSES

A summary of the water licenses for both the Trout Creek Watershed and the Aeneas Creek watershed is included in Appendix B.

2.4 GENERAL ACCESS

The District of Summerland is located on the west bank of Okanagan Lake along Highway 97. The community is some 45 kilometres south of Kelowna and 15 kilometres north of Penticton. Airport facilities for scheduled and charter aircraft are available in Penticton and Kelowna.

Maps showing the watershed areas, the location of the dams, and the location of the roads have been provided in Appendix A. Although road access is available to all of the dams, inclement weather conditions necessitate the use of a 4-wheel drive vehicle to some locations. A snowmobile is required to access most locations during winter conditions. For all seasons, a chainsaw is useful to clear fallen trees. Many of the roads in the Trout Creek watershed and in the headwaters of Aeneas Creek are active logging areas. Due care and attention is required when using these roads.

Thirsk Dam and the other dams in the headwaters of Trout Creek watershed can be reached by travelling west through Summerland on Prairie Valley Road which then becomes the Princeton-Summerland Road and primary route to Faulder. An alternative route to the Headwaters Lakes area and the upper Trout Creek watershed is available from Peachland, via the Brenda Mine Road. Access to the Trout Creek headwaters area from Highway 97C (Coquihalla Connector) is from the Sunset Main Road interchange, following the Sunset Main Forestry Road south to the Peachland Main Forestry Road, then proceeding west along Peachland Main to reach Headwaters, Crescent and Whitehead Dams. The road from Princeton to Osprey Lake also provides access from the west to the Trout Creek watershed.

Access directions to each specific Dam site can be found in their individual Specification Sheets in Appendix A.

2.5 COMMUNICATIONS

There are no communications facilities at any of the dams except Thirsk Dam. A satellite phone is functional and is located in the Thirsk turbine building (Global Star Network).

The Corporation has a VHF radio system with mobile units that can communicate with the base station from some locations in the Trout Creek and Aeneas Creek watersheds.

Cellular phone service areas or “hot spots” are to be identified in the ERP Communication Information when identified.

2.6 ELECTRICAL POWER

There is no electric power supply to most of the dams. Garnett Dam has power as does the Summerland Balancing Reservoir. There is a generator in the Thirsk Turbine building to run instrumentation. For the majority of dams, any electric power needs require use of a portable generator set.

2.7 FACILITIES PURPOSE

The water storage dams are used to regulate the flow on various streams. This is accomplished annually by collection of snowmelt in the spring for release during the summer and early fall to meet the domestic and irrigation water demands in the service area of the District. There is recreational use of the watershed and some of the reservoirs.

2.8 OPERATING ORGANIZATION

The Corporation of the District of Summerland holds the water licenses and is responsible for the operations and maintenance of the dams, spillways and outlet works. The Director of Engineering and Public Works has overall responsibility for the day-to-day activities regarding system operation and maintenance.

2.9 OPERATING LOG BOOK

The Director of Engineering and Public Works is responsible for ensuring that the Operating Log Book for the water storage dams is maintained. The following information should be recorded:

- Dam Name
- Date and Time of observation
- Reservoir water level
- Rate of water outflow from Reservoir (includes spillway and outlet flow)
- Gate Position
- Inspection of dam and spillway noting debris and surface conditions

Spare forms for inspections are included in Appendix C.

2.10 WATERSHED PROTECTION

Appropriate signs are installed to advise the public that they are entering a watershed used for domestic water supply purposes. In addition, these signs encourage the reporting of hazardous spills or other water contamination.

2.11 INSPECTION

There is no full time operator attendance at any of the sites. The requirements for periodic inspection of the facilities are outlined in Section 4.0. Particular attention is required during spring runoff and/or heavy rainfall events which may result in spillway discharges that could cause erosion in the channels downstream of the structures.

2.12 RESTRICTED AREAS

Some of the restricted areas include the walkway on the crest of the Thirsk arch dam, the Summerland Balancing Reservoir, and Garnett Dam. These areas are secured by locked chain-link fences. The fencing and appropriate signage should be kept in good repair. Signage advising of the danger inherent in swimming near the low level outlet intakes is posted at the access point to Garnett Dam.

2.13 ROAD INDEX AND WATERSHED MAPS

Maps showing the layout and access throughout the District of Summerland's watershed can be found at the start of Appendix A. Facility specific maps and figures are also included in Appendix A.

END OF SECTION 2.0

3.0 – FACILITY OPERATION

3.1 GENERAL

This section covers general facility operations and descriptions. The District of Summerland operates 14 dams, 12 for the Trout Creek system and 2 in the Eneas Creek system. Specific dam information has been included in Appendix A.

3.2 RESERVOIR STORAGE AND RUNOFF

The Trout Creek System has nine upper watershed storage reservoirs and one balancing reservoir with a total live storage capacity of 12,668 ML. The 251 ML of storage within Tsuh (Deer) Reservoir is not included in the storage volume summaries or in the District's Water Use Plan.

Table 3.1 - Runoff and Live Storage Volumes

Dam Facility Name	Storage Volume (ML)	Mean Runoff (ML)	1:100 Drought Year Runoff (ML)
Headwaters Res. No.1 - No.4	4,472	4,640	1,480
* Crescent	765	2,300	800
Whitehead	1,216	980	400
Thirsk	6,490	27,520	6,790
Tsuh(Deer)	308	486	173
Isintok(Canyon)	1,384	2,460	820
**Summerland Balancing Res.	0	83,370	22,360
*** Garnett	2,360	5,690	2,180
*** Aeneas	148	0	0
TOTAL – Trout Creek system	14,635		
*TOTAL – Eneas Creek system	2,508		

* Surplus runoff collected in Crescent Reservoir can be diverted to the Headwaters Res-Lakes
** Balancing storage
*** Separate watershed from Trout Creek

Last Updated October 2012

There are two reservoirs on Aeneas Creek having a total live storage of 2,508 ML. Storage tables for the Garnett and Aeneas Lakes Reservoirs are provided in Appendix A.11 and Appendix A.12 respectively. The live storage volumes and the annual runoff available to each reservoir are shown in the following table. The dry year runoff is provided

The District of Summerland holds water licenses issued by the Province that allows Summerland to collect, store and divert water for uses of irrigation and waterworks (domestic) purposes. The storage licenses are listed in Appendix B.

3.3 RESERVOIR FILLING PROCEDURES

All reservoirs can be filled during an average water year. During an extreme 1:100 return period dry year, only Crescent and Thirsk are expected to fill to full pool water level. Water supply system operation and withdraw of water from storage to meet demand should be based on the following rules:

- Fill the reservoirs during the freshet to the maximum extent possible and use the spring runoff flows from the uncontrolled part of the watershed to meet water demands during the early part of the irrigation season.
- First, withdraw water from those reservoirs where there is higher probability for filling in a dry year (i.e. Thirsk and Crescent).
- Next, withdraw water from the following reservoirs, only to the extent that storage depletion at the end of the irrigation season is no greater than the dry year inflow volume (indicated in parenthesis).
  - Whitehead (432 ML)
  - Headwaters No. 1 (432 ML)
  - Tsuh (173 ML)
  - Isintok (1,098 ML)
- Next withdraw from the reservoirs in order of the inflow/storage ratio, as follows:
  - Isintok
  - Headwaters No. 1
  - Headwaters No. 2
  - Headwaters No. 3
  - Headwaters No. 4
  - Tsuh
  - Whitehead
- The ability to fill the various reservoirs in the Trout Creek system is shown in the following table.

Table 3.2 - Trout Creek Reservoir Inflow - Summary

Facility Name	Storage Volume (ML)	Average Year		Dry Year	
		Inflow (ML)	Inflow/Volume (%)	Inflow (ML)	Inflow/Volume (%)
Headwaters 1 – 4	4,472	4,640	104	1,480	33
Crescent	765	2,300	301	800	104
Whitehead	1,216	980	81	400	33
Thirsk	6,490	27,520	424	6,790	105
Tsuh	308	486	158	173	56
Isintok	1,384	2,460	177	820	59
Aeneas	148				
Garnett	2,360	5,690	241	2,180	92
Totals (Trout)	**14,635**				
Totals (Garnett)					

- Last Updated March 2012

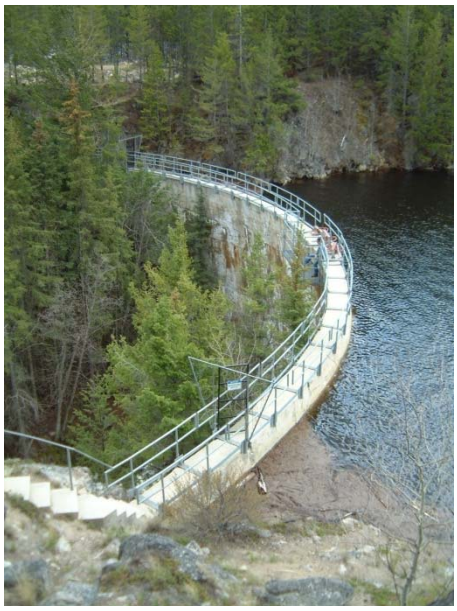
The Water Management Consultants' *Water Use Plan – Technical Background Document on Hydrology, Water Usage and Reservoir Operations* was used as the basis for defining reservoir capacity, operations and operating rules. The operating rules for the mouth of Trout Creek were as follows:

- Make-up water from the reservoirs is generally released to meet water supply demand, losses and fisheries requirements; and
- Demands are adjusted accordingly considering the time of year and volume of water remaining in storage.

The overriding concept in setting the reservoir drawdown procedure is that the reservoir storage volume that can most reliably be filled be first utilized. Once that volume of water is used, the next most reliable source water is utilized. This process continues and adjustments are made considering storage remaining, water demands, time of year and drought stage condition.

The operating rules for release from the reservoirs were in the following order:

1. Withdraw water from storage in Thirsk to the specified level above the intake. Begin releasing makeup water from other reservoirs when 80% of the Thirsk storage capacity has been depleted;
2. Withdraw water available from Crescent Reservoir first. In the model, this water was routed through Headwaters Reservoirs. Until the Headwaters Reservoirs were filled, Crescent was held at the specified level above the intake;
3. Withdraw the top 432 ML of water from Whitehead Reservoir and hold at that level until the next drawdown of this reservoir or the next time when the demand is not required;
4. Withdraw 2,339 ML of water from Headwaters and hold at that level until the next drawdown or when the demand is not required;
5. Drawdown Isintok Reservoir to the specified level above the intake and pass any additional inflow until the demand is not required;



6. Draw down the remainder of Headwaters Reservoirs to the specified level above the intake and pass any additional inflow until the demand is not required;
7. Draw down the remainder of Whitehead Reservoir to the specified level above the intake and pass any additional inflow until the demand is not required.

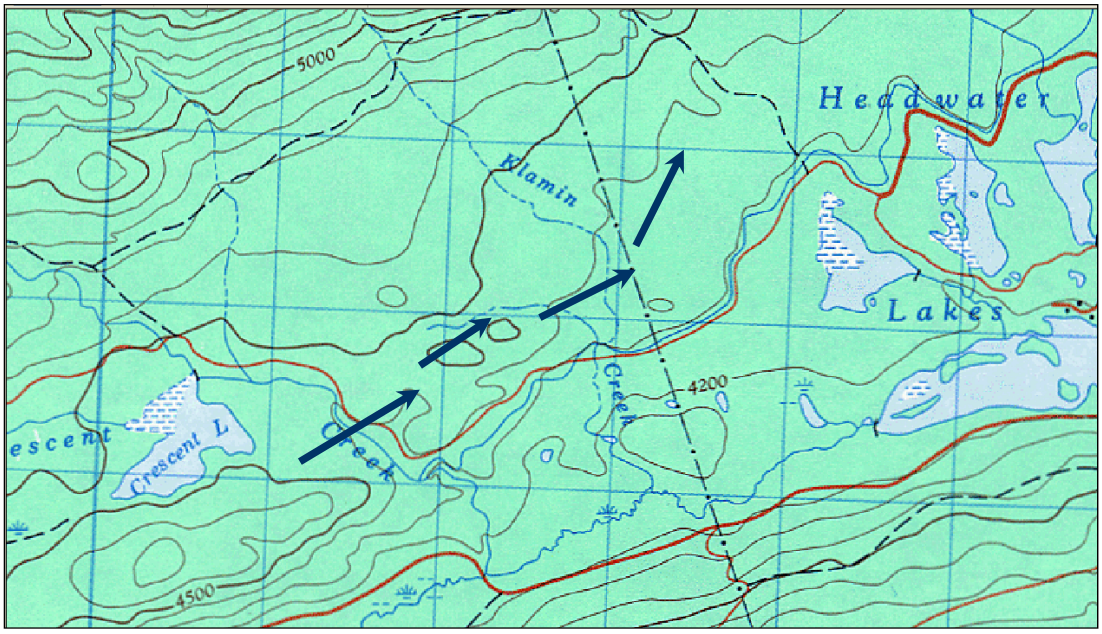
It is noted that in the Water Use Plan (WUP), all reservoirs are allowed to be drawn down to a minimum level of 1.8m above the bottom outlet pipe of the reservoir. The reservoirs are not drawn down lower so as not to draw off sediment from the bottom of the reservoirs.

3.4 HEADWATERS RESERVOIR-LAKES OPERATIONS

Operations of the Headwaters Reservoir-Lakes is described below. As illustrated in Figure 3.1, water fills Crescent Reservoir and is then diverted to the Crescent Diversion ditch (blue arrows) that runs along the access road (red line) to the Headwaters Reservoirs. This diversion ditch also collects water from the lands immediately upstream of the road. Water from the diversion ditch flows into either Headwaters Reservoirs No. 2 or No. 4. Both reservoirs have gates at the inlet to allow water into the reservoir.

Headwaters Reservoirs 2, 3 & 4 all have outlet gates that release to Headwaters 1. The release from Headwaters 1 is directly into Trout Creek.

Figure 3.1 - Headwaters Reservoir-Lakes Operations



Headwaters No. 4 fills and then overflows into Headwaters No. 3 which then subsequently fills. Crescent Reservoir is one of the most reliable water reservoirs for the District.

3.5 FLOOD FLOWS

Hazard classification of the dams was reviewed with Ministry Dam Safety staff and is listed within Table 3.3. In 2010, the spillways for each dam were reviewed. Based on the hazard classification for each dam and the appropriate flood return period, the inflow design flood (IDF) was compared to the spillways. The following table summarizes the findings of this review.

Thirsk Reservoir spillway was designed and reviewed as part of the recent Dam safety improvements made at Thirsk Reservoir.

Table 3.3 - Reservoir Hazard Classifications & Spillway Capacity Review

RESERVOIR NAME	HAZARD CLASS	IDF RETURN PERIOD*	WEIR TYPE	EST. SPILLWAY CAPACITY (cms)	IDF FLOW (cms)*	COMMENTS
HEADWATERS #1	VERY HIGH	1:200	Rectangular	32.2	17.8	Satisfactory
HEADWATERS #2	SIGNIFICANT	1:200	Trapezoid	15.8	12.5	Satisfactory
HEADWATERS #3	SIGNIFICANT	1:200	Trapezoid	15.8	12.5	Satisfactory
HEADWATERS #4	SIGNIFICANT	1:200	Trapezoid	15.8	12.5	Satisfactory
CRESCENT RESERV.	SIGNIFICANT	1:200	Rectangular	24.5	14.5	Satisfactory
WHITEHEAD RESER.	SIGNIFICANT	1:200	Trapezoid	21.5	13.5	Satisfactory
THIRSK LAKE	HIGH	1:1000				Requires Further Review
TSUH (DEER) LAKE	SIGNIFICANT	1:200	Trapezoid	10.9	6.1	Satisfactory
ISINTOK RESERV.	HIGH	1:200	Rectangular	41.0	40.9	Requires Further Review
SUMMERLAND (TROUT CRK) BALANCING RESERVOIR	HIGH	1:200	None	n/a	n/a	n/a
GARNETT RESERVOIR	VERY HIGH	1:1000	Cipolletti	70.0	164.0	Requires Further Review
AENEAS LAKES RESERVOIR	SIGNIFICANT	1:200	Rectangular	11.2	7.7	Satisfactory
*IDF (Inflow Design Flood) flow values are based on the 2010 Associated Engineering Dam Safety Review Report						

Last Updated March 2012

3.6 DROUGHT (LOW FLOW) CONDITIONS

In November 2004, Water Management Consultants completed the "Trout Creek Water Use Plan-Climate Change Scenarios". This report was written to address drought condition scenarios in the Trout Creek Watershed and to develop a balance between competing interests for water use from the creek.

The staged releases of stored water has proven to be effective as an accepted water management tool designed to maintain acceptable minimum flows in Trout Creek during a drought.

The Summerland Water Operator is expected to follow the WUP work procedure for the Trout Creek Slide Gate to accommodate low flow conditions in Trout Creek. The following section details this procedure.

Work Procedure for the Trout Creek Slide Gate

The following operating information for the Trout Creek Slide Gate has been included for the purpose of maintaining and controlling the water level of the Summerland Balancing Reservoir.

Background Information

Under an Operational Agreement with the Ministry of Environment, the District of Summerland is required to maintain minimum water flows downstream of the water system intake gates on Trout Creek. This release of water is to support fish habitat in the lower reaches of Trout Creek. It is imperative that the District maintains the minimum required release at all times.

The minimum release varies throughout the year and is estimated by using a multiplication factor of the measured natural flow in Camp Creek. A Water Survey of Canada automated streamflow recorder is installed on Camp Creek, which is an unregulated creek (no storage or diversions) in the Trout Creek watershed. It varies with Summerland's stage of Water Restriction (from the Water Storage Trigger Graph) and the time of year. See Table 3.4 in this section.

Operations Under Various Water Restriction Stages

If more water is required in the Summerland Reservoir, the following procedure should be followed when operating the Trout Creek Slide Gate.

- Log onto the website (daily) for Environment Canada Realtime Hydrometric Data at http://www.wateroffice.ec.gc.ca/graph/graph_e.html
- Select "Camp Creek at mouth near Thirsk, Station No. 08NM134"
  You will be required to agree to the disclaimer and to select a Province (BC). Change Parametre Type from Primary Level to Primary Discharge
  For the current date, multiply the discharge in m^3/sec by 70 to calculate the flow in acre-ft./day. Ignore short-term spikes and/or short term rain events on the real-time graph and utilize the previous days' data if required;
- Based on the month of the year and the current water restriction stage, multiply multiplier value (in the table below) by the acre ft (AF)./day determined in the previous step. The product is the volume of water that must pass the Trout Creek Intake daily, at a constant rate.

Table 3.4 – Camp Creek Multipliers for Estimating Trout Creek Downstream Flows

Month	WATER RESTRICTION STAGES				
Stage	1	2	3	4	5
June	10	8	6	4	0
July	10	10	9	4	0
August	10	10	10	4	0
September	10	10	10	4	0
October	10	10	10	4	0

Last Updated March 2012

- A calculation is carried out using Camp Creek flows to estimate the natural flow in Trout Creek. The calculated Camp Creek flow rate is compared to flow values obtained by metreing the Trout Creek and the flow rate to the reservoir supply flume. The difference of the two flow rates is the volume that bypasses the intake and is released for fish flow. This volume is compared to the Fish Flow (FQ) gauge (located at the intake, downstream of the spillway) and recorded on the "Fish Flow Status in Trout Creek" sheet for future comparisons;
- Record fish flow gauge readings on the FISH FLOW STATUS IN TROUT CREEK sheet daily, as a record of release.
- It may be necessary to release more water from Thirsk or Isintok Dam before more water is diverted to the Summerland Reservoir.
- If the determined water releases beyond the Trout Creek Slide Gate are much greater than the required FQ, the releases can be reduced by throttling the gates at either Thirsk or Isintok Dam.

3.7 DAMS AND STRUCTURES OPERATION

Operation of the dams and appurtenant hydraulic structures (spillway and low level outlet) involves the following:

- Facility Inspection and Surveillance
- Low Level Outlet Operation
- Reservoir Release Records

LOW LEVEL OUTLET OPERATION

With the exception of Garnett Dam, the release of water from all dams is controlled by the low level outlet when reservoir levels are below the crest of the spillway. Note: At Garnett Dam, the distribution main is connected directly to the low level outlet and water is released from the reservoir to meet water demand.

Low level outlets consist of conduits through the dam with steel slide gates operated by screw stem hoists at the upstream end. The reservoir gate can be opened by rotation of the hand wheel located on the crest of the dams. The mechanism should be securely locked to prevent unauthorized operation.

The gate opening can be measured by turning the hand wheel until the water starts to flow in the outlet pipe and measuring the distance from the end of the stem to the hub of the wheel to establish the "zero" position. Further incremental openings of the gate should be referenced to this zero position.

For gates equipped with non-rising stems, the gate position can be measured in terms of the number of complete revolutions of the hand wheel, however this is a gate specific.

Rating curves should be developed for each low level outlet to show the relationship between gate opening, reservoir level and low level outlet discharge. This can be done using a flow metre in the outlet channel to determine discharge with various gate openings and several different reservoir levels.

OPERATIONS RESTRICTIONS

There are operating restrictions or precautions that apply to the following dams:

SPILLWAY RESTRICTIONS AT ALL EARTHFILL DAMS

Should the reservoirs at any of the earthfill dams approach spillway level during freezing conditions, the reservoir should be allowed to fill and overflow in the spillway. Operations of the gates during freezing conditions may result in the gate being frozen open. If the reservoir is full and spilling through the winter season, is should be checked for ice build-up. Flowing water is less likely to freeze than standing water.

CRESCENT DAM

Crescent Reservoir fills early and easily each spring. Care must be taken when managing the discharge from Crescent Dam, particularly during spring runoff, to avoid damage to the diversion structure and intake to the Brenda diversion ditch. The reservoir should be drained to the Headwaters Lakes each fall. During years with high winter runoff, additional releases from the reservoir may be required. The objective is to use this reservoir to supplement other reservoirs and store as much of the spring runoff as possible.

HEADWATERS NO. 1 DAM

High spillway discharges have caused problems with channel erosion at this structure and weekly surveillance is required during times of high spring runoff. In addition, there were some upstream slope failure problems during reservoir drawdown in 1970. Drawdown rates should not exceed the following limits:

Table 3.5 - Headwaters No.1 Dam - Maximum Reservoir Drawdown Rates

Reservoir Elevation (ft)	Depth (ft)	Gauge (ft)	Rate (ft / day)
4202.5 to 4192.5	0-10	16.3-6.3	0.3
4192.5 to 4186.2	10-16.3	6.3-0.0	0.1

Last Updated October 2012

THIRSK DAM

The reservoir level behind Thirsk Dam should be reduced to Elevation 1017.7 metres or lower (11.0 m below the spillway crest) during the winter to avoid excessive ice pressures on the concrete

structure. Water must be channeled through the outlet pipe containing the Flotis Valve to reduce the potential for freezing of the exposed pipe.

ISINTOK DAM

In the past, high spillway discharges have caused channel erosion problems at Isintok Dam. Weekly surveillance is required during times of high spring runoff.

GARNETT DAM

The release rate of water from the dam must be set so to minimize the potential for downstream flooding. The release flows to Aeneas Creek are limited as the creek flows through the developed part of Summerland. The Ministry of Environment is to provide the minimum flow rate to downstream spawning and rearing areas in Aeneas Creek. Consult with the Fish and Wildlife Branch of the B.C. Ministry of Environment.

MINIMUM RESERVOIR DRAWDOWN LEVELS

For all dams, the minimum level of drawdown should be to a level at least 1.0 metre above the low level gate. This will allow the water and ice to protect the outlet gate and concrete structure from the freeze-thaw actions of ice in this harsh environment.

In the fall of the year the reservoirs should be partially drawn down in order to reduce the possibility of ice buildup in the spillways during winter operation and to provide storage for the attenuation of runoff flows during the spring freshet.

The suggested end-of-season maximum reservoir levels are shown in the following table.

Table 3.6 - End-of-Season Target Reservoir Levels

Dam Name	Reservoir Elevation (m)	Gauge (m)	Volume (ML)
HeadwatersNo.1	1279.1	3.1	1465.4
HeadwatersNo.2	1292.2	3.1	416.9
HeadwatersNo.3	1286.1	2.6	346.6
HeadwatersNo.4	1290.6	4.4	281.2
Whitehead	1438.7	2.9	900.5
Crescent	1353.1	1.6	246.7
Thirsk	1017.7	In progress	429.0
Tsuh	22.4	1.5	185
Isintok	1643.3	4.8	493.4
Garnett	630.9	8.2	1,665.2
Aeneas	26.8	1.4	92.5

Last Updated March 2012

END OF SECTION 3.0

4.0 INSPECTION AND MAINTENANCE

4.1 FACILITY INSPECTION AND SURVEILLANCE

Regular inspection and surveillance of the facilities are required to ensure that safe conditions are maintained. The frequency of routine inspections is based on the dam regulation classifications and operator knowledge. Annual documented inspections are required on all dams.

4.2 DAM SAFETY REGULATIONS FOR INSPECTIONS

An inspection program is required to ensure that the project facilities are in a condition to function safely in the manner intended by the design. All structures should be inspected with the following objectives in mind:

- To verify the physical safety of the structures and facilities.
- To disclose conditions which may cause service disruption or dam failure
- To determine the adequacy of structures and facilities in serving the purpose for which they were designed and are being used.
- To note the extent of deterioration as a basis for planning maintenance and repair.

Dam inspection type and frequency is largely based on the Hazard classification of the dam. Schedule 1 and Schedule 2 in the BC Dam Safety Regulations provide guidance for determining the classification and frequency of safety activities for each dam. A detailed summary of the specific inspections required for each dam is provided in the dam sections in Appendix A.

4.3 PROVINCIAL DAM HAZARD CLASSIFICATION RATINGS

The following table summarizes the dam hazard classification ratings for the Summerland dams.

Table 4.1 – Provincial Dam Hazard Ratings

Facility Name	Hazard Rating	Administering Office
Headwaters No. 1	Very High	Victoria
Headwaters No. 2	Significant	Victoria
Headwaters No. 3	Significant	Victoria
Headwaters No. 4	Significant	Victoria
Crescent	Significant	Penticton
Whitehead	Significant	Penticton
Thirsk Control	High	Victoria
Thirsk Saddle	High	Victoria
Thirsk Spillway	High	Victoria
Tsuh (Deer)	Significant	Penticton
Isintok	High	Victoria
Aeneas	Significant	Penticton
Garnett	Very High*	Victoria
*Hazard Ratings that may be subject to change		

4.4 ROUTINE INSPECTIONS

Routine inspections are part of the duties and responsibilities of the District of Summerland operating staff and are to be one of their regular functions. In many instances it is difficult to separate inspection functions from those which are part of day-to-day operating procedures. For purposes of this manual the term "*Routine Inspection*" refers to those activities required to determine that the project facilities have remained unchanged from their as-built state, or, if changes have occurred, determine what remedial action is required.

During *Routine Inspections*, emphasis is to be placed on the word: "change". For example, a sudden increase in the flow rate from drains or the appearance of wet areas on the downstream face of the dam are significant and must be reported so that the cause can be investigated and assessment made as to the need for remedial action. Also, sudden decrease in flow rate in the drains can also be indicative of a potential problem such as the drains becoming blocked off with fines. On the other hand, a change in flow rate may be a "normal" occurrence associated with a change in reservoir level, ground water levels, or groundwater flow, resulting from a wetter cycle of weather.

Routine Inspections will be carried out by on-site operating staff on a regular basis throughout the life of the facility to provide for an early identification of any problems requiring remedial action.

The Routine Dam Site Surveillance Schedule will follow the guidelines provided in Section 4.2 with the noted exceptions:

- Aeneas and Tsuh Dams (classification Significant) – Schedule 2 in the "British Columbia Dam Safety Regulation" specifies monthly visits, but due to limited accessibility in the winter at this high elevation, and the small volume of water retained, site surveillance occurs only 3 times annually between the months of May/June to October.
- Headwaters #1 Dam - (classification Very High)– Schedule 2 specifies weekly. This frequency will be followed during May through November but due to limited accessibility in the winter, the frequency from approximately December thru April is monthly.
- Crescent Dam (classification Significant -Schedule 2 in the "British Columbia Dam Safety Regulation" specifies monthly visits, but due to limited accessibility in the winter, the frequency from approximately December thru April is monthly.
- Whitehead Dam (classification Significant) Schedule 2 in the "British Columbia Dam Safety Regulation" specifies monthly visits, but due to limited accessibility in the winter, the frequency from approximately December thru April is monthly..
- Isintok Dam – (classification High) Schedule 2 specifies weekly. This frequency will be followed from approximately May through November but due to access restrictions during the winter the frequency will be reduced to monthly. Winter time storage level is typically well below full pool storage.

The "Routine Dam Inspection Report" form is available for printing via the link provided for each dam in Appendix A of this report.

4.5 FORMAL INSPECTIONS

The items to be covered in this type of inspection are essentially the same as for the *Routine Inspection*. The distinction between the two types of inspections resides in the fact that the *Formal Inspection* is to be carried out by a registered professional engineer who is not part of the operating personnel. The objective of the *Formal Inspection* is to carry out a detailed review of the condition of all project facilities. This information will also be used to plan the future maintenance program.

A *Formal Inspection* is to be performed by a registered professional engineer experienced in the design of the various project components to verify that the structures are functioning in the intended manner.

The "Formal Dam Inspection Report" form is available in Appendix C of this report.

4.6 MAINTENANCE

A well-developed maintenance program can save money through efficient and effective expenditures and through preventative maintenance. The best constructed facilities will eventually fail if maintenance is neglected. Keeping maintenance activities current maximizes the lifespan and effectiveness of expenditures. The objectives of the maintenance program are:

- Keep facilities in top operating condition at all times through proper maintenance.
- Obtain the longest life and greatest use of the facilities by providing adequate maintenance and replacements in a timely fashion.
- Achieve the foregoing at the lowest possible cost.
- Maintain care and security of all infrastructure and facilities to protect the integrity and safety of the water system infrastructure.

Since all structures and facilities are subject to some sort of deterioration, on-going monitoring is necessary to identify and correct potentially unsafe or unsatisfactory conditions as they develop.

Seepage from the abutments or below the dam, cracks in the concrete, erosion on the embankment side slopes, settlement of a structure, etc. can lead to major failure. Problems such as these are serious and the cause of the trouble generally has to be determined from investigations carried out by a qualified professional or technical personnel before remedial maintenance work can be defined. There are, however, many other problems of a less serious nature that may develop with the various structures. In this regard, the term maintenance refers to those preventative or corrective measures which are to be carried out on an on-going basis as minor problems arise; thereby ensuring the safe and efficient operation of the project facilities.

EARTHFILL DAMS

Routine maintenance of earthfill dams involves necessary repairs to embankment slopes and the roadways, periodic cleaning of abutment drains and control of vegetation.

UPSTREAM SLOPE PROTECTION

Wave action during severe wind storms or ice action during the winter may cause movement of the upstream slope material or dislocation of riprap. Rapid drawdown of a reservoir can cause sloughing and/or shallow slope failures. The required remedial action consists of placing additional embankment material or riprap on any areas of the slope where there has been obvious movement of the original material.

DOWNSTREAM SLOPE EROSION

Heavy rainfall and runoff from the crest may cause erosion channels to form on the downstream slope of the dam. Once an erosion channel starts to form, it can lead to a concentration of runoff in these particular areas and the erosion problem is aggravated. There is also the possibility of an erosion channel developing in the areas where the downstream slope of the dam intersects the abutment side slope. Any erosion channels should be promptly backfilled with granular material. Should the erosion channels continue to form at the same locations, consideration should be given to constructing a safe alternative overland drainage path.

ABUTMENT DRAINS

Perforated CSP pipes have been installed at the downstream toe of some of the dams. The presence of fine soil particles in the seepage water can be detected by examining the color and the turbidity of the seepage water. A decrease in the amount of seepage water coming from the pipe, with the same reservoir level, could signify that the drain has been plugged with fines. When it is suspected that fines may have accumulated in the pipe, the drains should be flushed or replaced altogether.

ROADWAY (DAM CREST)

Settlements in excess of 0.15 metres at the crest of the dam should be corrected by adding sufficient granular material to re-establish the design elevations.

VEGETATION

Vegetation, except for grasses, should not be allowed to establish on the dam or abutment slopes. The principal problem with trees or shrubs lies in the fact that their root systems can create paths for percolation of water from the reservoir. The use of herbicides in control of vegetation must take proper account of their toxicity and the fact that the reservoirs are a recreation area and the streams are a source of drinking water and aquatic habitat. Even though certain chemicals may be safe at the suggested rates of application, care must be taken to avoid spilling or dumping such substances into the water bodies in concentrated form.

BURROWING ANIMALS

Burrowing animals such as gophers may create seepage paths from the reservoir through the dam. These holes may be burrowed at a time when the reservoir is below full supply level and become submerged when the reservoir level increases, thereby creating a point where water can flow through the dyke. The methods generally employed to eliminate burrowing animals is trapping, poisoning or shooting the creatures.

CONCRETE DAMS OR STRUCTURES

Maintenance requirements for concrete structures are limited to the patching of severely spalled sections and replacement of badly deteriorated concrete. The cause of any differential settlement should be investigated and structure replacement may be warranted if the structure performance is adversely affected.

Debris booms in front of spillways should be maintained in good repair. Floating debris should be removed from the upstream face of the dams and from the debris booms and spillway areas.

Thirsk Dam has a concrete gravity ogee spillway founded on bedrock. All other dams have spillways that consist of channels in earth with a concrete sill control section at the entrance to the channel. Most of these spillways are on the abutment and adjacent to the dam. It is important to ensure that the spillway entrance and channel do not become blocked and that significant erosion does not occur, especially during the spring runoff period and after severe rainstorms.

EQUIPMENT

Lubricants should be applied to the gate stem screws on an annual basis. All metalwork and equipment that is exposed to a harsh environment should be wire brushed and then coated with a coat of rust resistant paint. The trash racks should be cleaned of debris each time the reservoir is drained. Periodic painting is required.

SECURITY FENCING

A fencing program has been initiated in the district to provide more protection and security for the water system. This program is subject to available budgets and the history of damage at the individual sites. Examples of existing security fencing include Garnett Dam area and Thirsk Dam area. These fences should be checked during routine inspections.

SIGNAGE

A number of signs are maintained at various watershed locations and at all dam sites. The signs provide the public with contact information of the Dam Owner, an awareness of possible dangers, and reasons for the protection of their drinking water systems. They also provide the public with DOS contact information in the event they need to report a concern.

DAM INSPECTION FREQUENCY

Table 4.2 summarizes the dam hazard classification and inspection frequency for Routine and Formal Dam Inspections.

Table 4.2 – Dam Inspection Frequency

Facility Name	Hazard Rating	Administering Office	Routine Inspections	Formal Inspections
Headwaters No. 1	Very High	Victoria	1 X WEEK	ANNUAL
Headwaters No. 2	Significant	Victoria	MONTHLY	BI-ANNUAL
Headwaters No. 3	Significant	Victoria	MONTHLY	BI-ANNUAL
Headwaters No. 4	Significant	Victoria	MONTHLY	BI-ANNUAL
Crescent	Significant	Penticton	MONTHLY	BI-ANNUAL
Whitehead	Significant	Penticton	MONTHLY	BI-ANNUAL
Thirsk Control	High	Victoria	1 X WEEK	ANNUAL
Thirsk Saddle	High	Victoria	1 X WEEK	ANNUAL
Thirsk Spillway	High	Victoria	1 X WEEKLY	ANNUAL
Tsuh (Deer)	Significant	Penticton	MONTHLY	BI-ANNUAL
Isintok	High	Victoria	1 X WEEK	ANNUAL
Aeneas	Significant	Penticton	MONTHLY	BI-ANNUAL
Garnett	Very High*	Victoria	1 X WEEK	ANNUAL

Notes:

1. Hazard ratings may be subject to change by the Provincial Government
2. Access to upper watershed reservoirs is limited in the winter (Nov.-May) and frequency may be reduced if reservoirs are at low levels.

5.0 – EMERGENCY RESPONSE PROCEDURES

5.1 INTRODUCTION

This Emergency Response Plan has been assembled to provide information and guidance for responding quickly and rationally to a dam emergency. This section satisfies the emergency preparedness requirements for dams of consequence levels varying from SIGNIFICANT to VERY HIGH.

5.2 PURPOSE

The purpose of this plan is to first prevent loss of life, then to minimize damage and/or loss of property that may result from flooding due to an incident at a District of Summerland owned dam.

5.3 GENERAL INFORMATION

Summerland is located on the west side of Okanagan Lake on Highway 97; about 15 kilometres north of Penticton and 45 kilometres south of Kelowna.

The Trout Creek watershed encompasses approximately 775 km^2. Within this boundary there are 11 significant storage dams owned by the District of Summerland, they are:

- Headwaters Dam #1 (Very High consequence)
- Headwaters Dams #2, #3 and #4 (Significant consequence)
- Crescent Reservoir Dam (Low consequence)
- Whitehead Reservoir Dam (Low consequence)
- Thirsk Reservoir Dams, Main Dam, Spillway Dam and Saddle Dam (High consequence)
- Tsuh (Deer) Reservoir Dam (Significant consequence)
- Isintok (Canyon) Reservoir Dam (High consequence)
- Summerland Reservoir (not rated)

The Aeneas Creek watershed has a catchment area of 91 km2 above Garnett Reservoir with two significant water storage infrastructure components.

- Garnett Dam (Very High consequence)
- Aeneas Reservoir-Lakes Dam (Significant consequence)

Other privately owned dams are located at various locations within the watershed. These include dams at Pitin, Chapman, Darke, and Munro Lakes.

A network of gravel roads throughout the watershed provides access to most reservoirs from more than one direction. Snow machines are required to access most of the locations during the winter months.

5.4 DAM EMERGENCY CONDITIONS AND ACTIONS

The dam emergency conditions and actions are set out in order of increasing level of emergency. The steps are set out as "*No Dam Incident*", "*Dam Incident*", "*Dam Alert*" and "*Dam Breach*". Actions and appropriate contact persons are provided in this section.

The following list contains names and phone numbers of District and support personnel who are responsible for dam operations. All dam operations fall under the responsibility of the Director of Engineering and Public Works who would initiate this Emergency Preparedness Plan.

For lesser events such as a "*No Dam Incident*" or "*Dam Incident*", it may not be necessary to contact the Director of Engineering and Public Works. In these lesser events, contacting of the persons on the list, in order, until someone is reached is recommended. Messages are to be left at each unsuccessful contact. Table 5.1 provides a contact list order for ""*No Dam Incident*" and "*Dam Incident*" events.

Table 5.1 - Dam Operations Personnel Contact Information

Name and Title	Business	Residence	Cell
On Call Water Division Operator	250 809-7041		
Devon van der Meulen Manager of Utilities	250-404-4075	250-494-7703	250-462-0493
Shawn Hughes Water Distribution Chief Operator	250-494-9747	250-494-7896	250-809-9818
Maarten Stam Manager of Works	250-404-4082		250-809-7737
Kris Johnson Director of Works and Utilities	250-404-4096		250-809-9925

Table 5.2 provides contact information for the Summerland municipal offices.

Table 5.2 - Summerland and Regional District Office Contact Information

SUMMERLAND OFFICES	PHONE	FAX
Works and Utilities Department	250-494-0431	250-494-3399
After Hours Answering Service	250-493-0005	n/a
Water Division (Dam Operators)	250-494-9747	250-494-1526
Electrical Utility Division	250-494-0431	250-494-3399
Municipal Hall	250-494-6451	250-494-1415
Wastewater Division	250-494-0619	250-494-0620
Fire Department / Emergency Response	911	

Reviewed: January 25, 2017

For emergency conditions that may arise, the response is categorized into one of four responses. Consult the appropriate condition and action list for the present dam situation. The conditions are set out so that if the situation escalates, the District can step up the response to the next level of dam safety notification and action.

NO DAM INCIDENT

No Dam Incident – is any report that has been received, and confirmed NOT to impact the safety of the dam. The event should be recorded under normal surveillance and documented within this OMS manual. Qualified personnel should conduct a thorough inspection of the dam site and record findings.

DAM INCIDENT

Dam Incident - Abnormal conditions or performance is noted at the dam that are NOT expected to lead to an immediate breach of the dam. For a *Dam Incident*, there is expected to be time to deal with issue. If time is not available or the situation may not remain stable, the *Dam Incident* condition may be elevated to the next higher level, *Dam Alert*. This is a decision may be senior District of Summerland operations staff.

The person initiating the plan, will notify the persons listed in Table 5.1 in order as presented on the list. Documentation of the surveillance should be recorded in this manual.

Additional actions are required for Garnett, Thirsk, Isintok and Headwaters No.1 dams. The actions and other information have been included in their appropriate parts within Appendix A (Headwaters No.1 – **Appendix A.1**, *Thirsk* ***Appendix A.8,*** *Isintok –* **Appendix A.9**, *and Garnett –* **Appendix A.11**.

DAM ALERT

Dam Alert - abnormal conditions or performance at the dam, expected to lead to a breach of the dam without immediate intervention. If the condition has been raised from the previous conditions, in addition to the notification of persons in Table 5.1, the District of Summerland senior staff is to contact the persons in Table 5.3 as they deem appropriate.

Table 5.3 - *Dam Alert* Emergency Contact List

Name and Title	Business	Residence	Cell
Emergency Management BC (EMBC)	1-800-663-3456		
Robert McLean, Senior Dam Safety Engineer, Victoria **Dams over 9 metres in height**	250-952-6805		
Scott Morgan, Head, Dam Safety Section, Victoria **Dams over 9 metres in height**	250-387-3265		
Mike Noseworthy, Senior Regional Dam Safety Officer, Penticton **Dams under 9 metres in height**	250-490-2291		
Darren Bennett, Alternate Dam Safety Officer **Dams under 9 metres in height**	250-371-6329		
Glenn Noble, District of Summerland Emergency Program Coordinator	250-404-4092	250-494-0745	Dispatch 250-490-2305
Rob Robinson and George Pugh Asst. Emergency Program Coordinators District of Summerland	250-404-4089	Rob 250-492-1105 George 250-490-6640	Dispatch 250-490-2305
Dale Kronebusch, RDOS Emergency Program Coordinator	250-492-0237		250-809-2541
Peter Fearon, Kerr Wood Leidal Engineering Consultant, Earth Fill Dam	778-477-4755	250-764-5042	250-718-5042
Dwayne Meredith, Kerr Wood Leidal Engineering Consultant, Earth Fill Dam	250-503-0841		250-550-6762
Rod MacLean, Associated Engineering Engineering Consultant, Thirsk Dam	250-763-3638		250-470-8133
Bob Hrasko, Engineering Consultant Agua Consulting Inc.	250-212-3266	250-765-2442	250-212-3266
Linda Tynan, Chief Administrative Officer District of Summerland, communications with Elected Officials	250-404-4043		250-486-6011

Last Updated January 25, 2017

Additional actions are required for Garnett, Thirsk, Isintok and Headwaters No. 1. The actions and other information have been included in their appropriate parts under Section 6.0 (Garnett – Section 6.5.4***, Headwaters No. 1 –*** Section 6.7.4***, Isintok –*** Section 6.11.4***, and Thirsk –*** Section 6.13.4***).***

DAM BREACH

A *Dam Breach* condition is where a dam breach is imminent or the dam is in the process of breaching. The Director of Engineering or the person initiating the plan will ensure that the persons in Tabls 5.1 and 5.3 are notified. In addition, they will notify the persons in Table 5.4.

Table 5.4 - *Dam Breach* Emergency Contact List

Name and Title	Business	Residence	Cell
Emergency Management BC (EMBC)	1-800-663-3456		
Peter Prendergast EMBC Regional Manager, Kamloops	250-371-5245 250-371-5240	Personal Office Main Office	
Ministry of Transportation and Infrastructure, Penticton	250-490-8200		
Summerland RCMP	250-494-7416 911		
Judi Ekkert Interior Health Authority	250-469-7070, Ext. 12274		250-808-3444
Media outlets as per Table 5.6			

Last Updated January 25, 2017

Additional actions are required for Garnett, Thirsk, Isintok and Headwaters No.1. The actions and other information have been included in their appropriate parts under Section 6.0 (Garnett – Appendix A, A11***, Headwaters No.1 –*** Appendix A1.3***, Isintok –*** Appendix A A.11.4***, and Thirsk –*** Section 6.13.4***).***

5.5 RESOURCE CONTACTS

Resource contact persons and agencies are provided in this section.

Table 5.5 – Other Resource Contact Information

NAME	CONTACT	PHONE	CELL	EQUIPMENT
Nesters	Genessa Wyllie	250-494-8338	250-809-5822	Bottled Water
Bartlett Tree Service	Thor Klaussen	250-494-0707	250-490-6868	Bucket Truck
Clay Resources	Kevin Clay		250-486-7725	Dump Trucks/Skid Steer/Excavators/Backhoes/Compaction Equipment
Minty Bulldozing	Mervin Minty	250-494-3486	250-490-7939	Rubber Tire Backhoe/ Tandem Dump Truck
Dicks Septic Service	Dallas Bradner	250-494-6916	250-486-4298	Vacuum Septic Trucks
D. Knight Trucking	Dave Knight	250-494-1628	250-490-7652	Tandem Dump Truck/ Loader
Inglis Enterprises	Gil Inglis	250-494-8100	250-809-8208	Track Excavator/ Bobcat Loader
Summerland Excavation Services	Brian Taylor		250-490-7096	Track Excavator/ Dump Truck
SOS Security		250-492-0911 (24hr hotline)		Manpower to man Barricades/security
Summerland Rental Centre	Dallas Bradner	250-494-6916	250-486-4298	Generators/Bobcat Loader/Excavator/ Heaters Pumps/ Barricades/Portable Toilets
R&G Smith Contracting	Greg Smith	250-494-1302	250-486-3437 250-486-3427	Tandem Dump Truck/ Excavators/Skid Steer/other equip available
Highmark Excavating	Rick Givens		250-212-4204	Excavators/Grader/ Skid Steer/Dump Truck & Pup/Packer/ 2000 gallon Water Truck
Golder Hydrogeology	Jacqui Foley	250-860-8424	250-717-6907 250-494-4140	Hydrogeology support
Piteau	Remi Allard	778-484-1777	250-212-7511	Hydrogeology support

Last Updated January 25, 2017

Table 5.6 - Media Contact Information

NAME	PHONE	FAX
Summerland		
Summerland Review	250-494-5406	250-494-5453
EZ Rock	250-494-0333	
Penticton		
Penticton Herald	250-492-4002	250-492-2403
Sun FM/EZ Rock	250-492-2800	250-493-0370
New Country 100.7	250-493-6767	1-250-469-9963
Shaw Cable Okanagan	250-492-5940/2	1-250-979-6550
Penticton Western News	250-492-0444	250-492-9843
Kelowna		
Daily Courier	250-762-4445	250-762-3866
Capital News	250-763-3212	250-862-5275
Global Okanagan	250-762-4535	250-868-0662
Bell Media - Sun FM/EZ Rock/AM1150	250-868-8600	250-860-8856
Q103.1 Radio	250-762-3331	250-762-2141

Last Updated January 25, 2017

Table 5.7 - Transportation Contact Information

PERSONNEL	PHONE	BUSINESS	CELL
Facilities			
School District No. 67 Buses: Phil Kline Maint. Supervisor: Ray Schmidt		250-494-9587	H: 250-494-0249 C: 250-490-6759
Summerland Taxi		250-494-6651	
PDCRS (Handi-Dart)	250-492-5814		C: 250-462-3340
Repairs Facilities			
District of Summerland, Works Division Maarten Stam	250-494-0431	250-494-0431	250-809-7737
District of Summerland After Hours Emergency		250-493-0005	
Automotive Repair Centres			
Adrian's Automotive	250-494-0031		
Big O Tires	250-494-7471		
Tirecraft Auto Service Centre	250-404-8688		

Last Updated January 25, 2017

Appendix A – Dam Specific Information

A 0.0 GENERAL

This section is made up of 12 parts. Each part contains specific information and documentation for each of the 12 dam/reservoir facilities. The following list summarizes the layout of each part:

- Photos and Figures
- History and Technical Data
- Storage Tables and Spillway Data
- Emergency Plan – Additional Actions List
- Specification Sheet
- Inspection Schedule, Archived Records and Forms

The following Table summarizes the District of Summerland's reservoirs and dams in this section.

Table A 0.1 - Summary of Dam General Info

Facility Name	Drainage Area (km^2)	Watershed Mean Elevation (m)	FSL Elevation (m)	Reservoir Volume (ML)
HeadwatersNo.1	36.0	1408	1280.9	2613
HeadwatersNo.2	n/a	1293.6	738.0	
HeadwatersNo.3	n/a	1287.4	618.0	
HeadwatersNo.4	n/a	1292.0	505.0	
Crescent (Paul)	15.5	1,670.0	1355.3	765
Whitehead	5.4	1474.0	1439.6	125
Thirsk	245.8	1463.0	1028.7	6293
Tsuh(Deer)	2.3	1625.0	1569.7	310
Isintok(Canyon)	16.3	1780.0	1645.6	1373
Summerland Reservoir				
Aeneas	3.1	1612.0	1569.7	152
Garnett	56.7	999.7	632.7	2339
Summerland Reservoir	n/a	680.0	595.1	69 (live)
Note: Includes 10.6km2 drainage area intercepted by the diversion ditch from Crescent Creek.				

Last Updated October 2012

A 0.1 DAM LOCATION ACCESS MAPS

The figure on the following page illustrates the location of all 12 dams throughout the Aeneas and Trout Creek Watersheds.

A.1 HEADWATERS RESERVOIR-LAKES - GENERAL INFORMATION

There are four dams on the Headwaters Reservoirs, referred to as Headwaters No. 1, through to Headwaters No. 4. The natural drainage area to the Headwaters Reservoir-Lakes system is 25.4 km^2. Inflow to the Headwaters Reservoir-Lakes is augmented by the Crescent Creek diversion ditch which delivers inflow surplus required to fill the reservoir behind Crescent Lake dam (drainage area 15.5 Km^2) and intercepts runoff from an intervening catchment of 10.6 Km^2. This diversion flow can be directed to Headwaters No. 2 or Headwaters No. 4 reservoirs and then into Headwaters No. 1 reservoir. Once Crescent Reservoir, Headwaters Reservoir-Lakes and Thirsk Reservoir are at full pool level, surplus runoff in the diversion ditch is to be routed to the neighbouring watershed to Peachland Lake, as required under an existing water license. Conditional water licence No. 32947 held by Brenda Mines Ltd. provides for the diversion of up to 4,157 mega-litres (ML) per annum and licence No. 32948 allows for storage of an additional 752 ML at Crescent Lake. The Crescent Lake diversion operates from a point on Crescent Creek approximately 1402.1 metres downstream from the dam. The maximum capacity of the diversion ditch is approximately 1.42 m^3/sec and the length of the ditch from Crescent Creek to Headwaters No. 4 Lake is about 3,560 metres.

As the name implies, the Headwaters Lakes are located in the headwaters of Trout Creek. Considering the watershed area intercepted by the diversion ditch, the total area draining into the Headwaters Lakes is 36.0 Km^2. This area has a mean level of Dl. 1408.2 Km. The low level outlets from Headwaters No. 2, Headwaters No. 3 and Headwaters No. 4 discharge into tributary streams that enter Headwaters No. 1 reservoir. The spillway from Headwaters No. 4 discharges into the Headwaters No. 3 reservoir. The spillways for Headwaters No. 3 and Headwaters No. 2 discharge to the reservoir for Headwaters No. 1.

Figure A1.1 – Headwaters Reservoirs

A.1 HEADWATERS NO. 1 DAM

A1.1 HEADWATERS NO. 1 DAM - SPECIFICATION SHEET

General: This dam is located in the upper area of the Trout Creek watershed. The dam holds back water from Headwaters Nos. 2, 3 and 4 reservoirs and overflow diverted from Crescent Reservoir.

Provincial Dam No.	D220006
Water License Point Code	_____
Dam Type	Earth Fill
Dam Function	Main & Spillway
In-Service Date	1961
Dam Height	6.7 m
Crest Elevation (m)	1,282.4 m
High Water Level (m)	1,280.9 m
Freeboard (m)	1.5 m
Crest Length (m)	244 m
Dam Coordinates	
DMS	49-48-30.35 N 120-01-10.62 W
UTM	714,431 E 5,521,603 N
Storage Volume (ML)	2,613 ML
Other Comments	_____

_____

Subcatchment Area**:**	4,890 ha
Reservoir Surface Area:	69.7 ha
Reservoir Elevation:	1,282 m
Mean Subcatchment Elev.:	1,585 m
Ave. Reservoir Depth:	3.75 m

Applicable Water Storage Licenses

C-029847	925 ML
*C-034399	1,233 ML
*C-016414	3,699 ML (shared)

* shared license with HW 2,3 and 4

General Comments**:** A dam that had existed earlier was reconstructed in 1961 with the aid of the Province. This dam is the release point from the four Headwaters Reservoirs. The subcatchment area includes all areas upstream to all four Headwaters Reservoirs.

A1.2 HEADWATERS NO.1 PHOTOS AND FIGURES

Figure A1.2 - Headwaters Reservoir-Lake No.1 Location

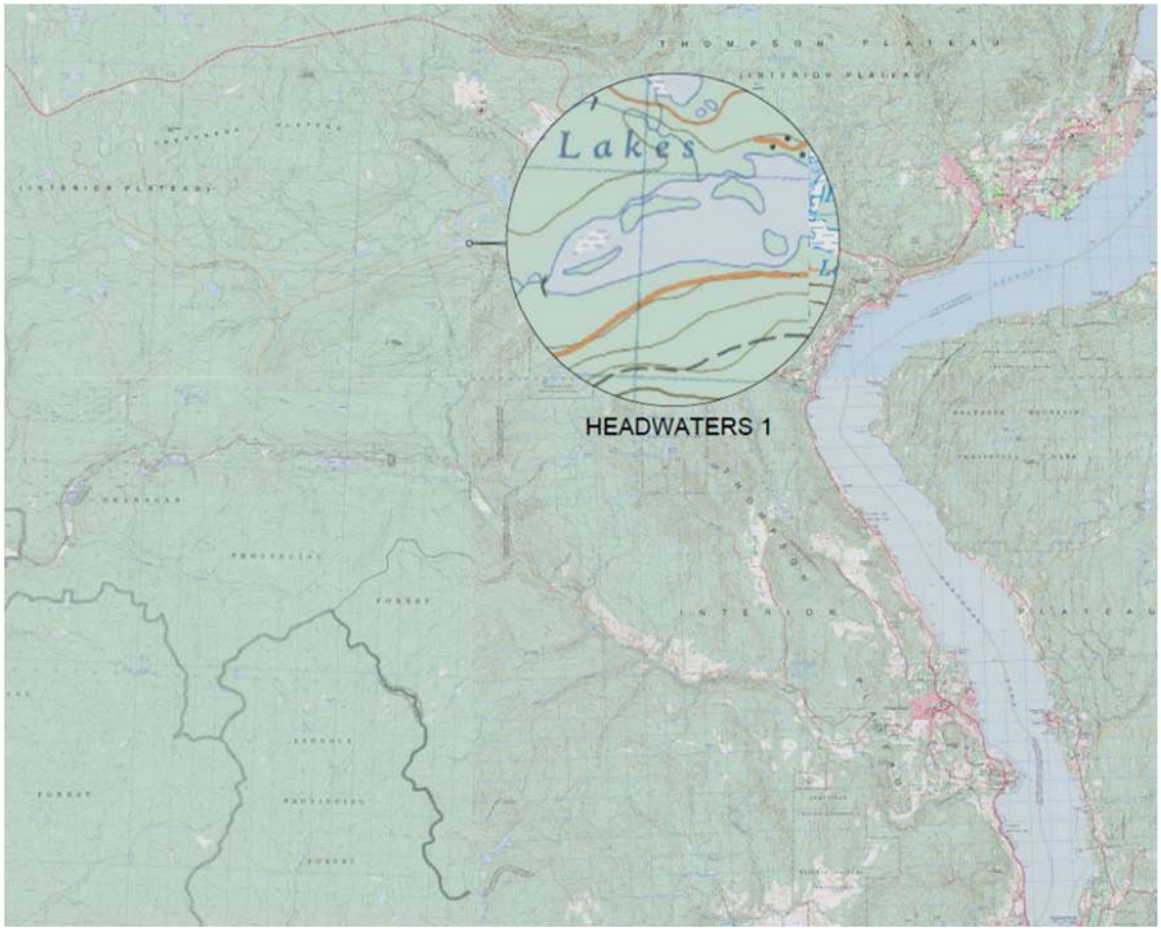


Figure A1.3 - Headwaters No.1 Reservoir - Aerial Photo

Figure A1.4 - Headwaters No.1 Reservoir Spillway

Figure A1.5– Headwaters No. 1 Reservoir - Gate Control

Figure A1.6 –Headwaters No.1 Dam

A1.3 HEADWATERS DAM NO.1 - HISTORY AND TECHNICAL DATA

Headwaters No. 1 Dam was rehabilitated and raised to its present level in 1961. Repairs to the upstream slope were undertaken in 1970 and riprap erosion protection was added to the spillway channel in 1972.

The dam consists of a homogeneous earthfill embankment with a maximum height of 6.7 metres. The crest level is at El. 1,282.4 metres. The crest width is 4.6 metres and the dam has a crest length of approximately 243.8 metres. The upstream slope is 4.0H:1.0V and the downstream slope is 3.5H:1.0V down to El. 1280.7 metres and 4.0H:1.0V for the lower portion of the embankment. There is a pervious sand and gravel toe drain in the vicinity of the outlet.

The low level outlet consists of a 750mm diameter concrete pipe approximately 45.7 metres long on a 0.50 % grade. Flow control is provided by an Armco slide gate with the gate stem mounted on a reinforced concrete beam cast on the upstream slope of the dam. Drawdown from El. 1276.9 metres to El. 1276.0 metres is accomplished by raising a separate vertical lift gate on the intake structure. The outlet pipe discharges into a concrete stilling basin with riprap protection for the downstream channel. A short section of 200mm perforated pipe is located under the outlet pipe in the pervious toe drain.

The spillway is located on the left abutment of the dam. It consists of a 9.1 metre wide concrete control section with 1.0 metre high vertical walls. The sill is at El. 1,280.9 metre. The downstream spillway channel is lined with riprap for a distance of 30.5m from the weir.

A1.4 HEADWATERS NO.1 STORAGE AND SPILLWAY DATA

Table A1.1 - Headwaters No.1 Dam Reservoir Data

Reservoir Elevation (m)	Flooded Area (ha)	Storage Volume (ML)	Comments
1272.8	0.5	634	Dead Storage
1276.0	37.3	0	Vertical Gate Sill
1276.5	41.8	217	
1276.9	44.9	375	Inclined Gate Sill
1277.1	46.7	487	
1277.7	48.9	778	
1278.3	51.4	1083	
1278.9	55.2	1409	
1279.7	59.7	1847	
1280.8	65.9	2515	
1280.9	66.6 (est.)	2613	Spillway Crest
1283.2	77.5	4265	

Last Updated March 2012

Table A1.2 - Headwaters No.1 Dam Spillway Discharge

Reservoir Level(m)	Discharge (cms)	Comments
1280.9	0.0	Spillway Sill
1281.1	2.8	
1281.2	2.4	
1281.4	4.4	
1281.5	6.8	
1281.7	9.5	
1282.0	15.7	
1282.4	26	Dam Crest

Last Updated March 2012

Table A1.3 - Headwaters No.2 Dam Reservoir Data

Reservoir Elevation (m)	Flooded Area (ha)	Storage Volume (ML)	Comments
1288.1	1.2	37	Dead Storage
1288.7	12.0		
1289.0	17.2(est.)		Gate Sill
1289.3	21.4	29	
1289.9	25.2	81	
1290.5	32.4	150	
1291.1	38.1	239	
1291.7	44.2	340	
1292.4	50.6	459	
1293.6	59.9	733	
1293.6	60.2(est.)	738	Spillway Crest
1295.4	72.7	1216	

Last Updated March 2012

A1.5 HEADWATERS NO. 1 EMERGENCY PLAN - ADDITIONAL ACTION LIST

NOTE: The following actions are to be used as a guide. Because every event is unique, some actions may need to be altered or added. Any significant alterations to this guide should be made by qualified personnel only.

ACCESS

Turn west off Hwy 97 in Peachland, onto Princeton Ave. Follow Princeton Ave. to the Peachland F.S.R. which will take you to kilometre 22 before turning left towards the Headwaters #1 camp area. Take the immediate right turn and follow past lake #2 and #3. At lake #4 head across dam and follow road about 600 metres to the dam site. An alternate route off the Connector is the Sunset Exit heading south to the Headwaters Lakes. Neither of these routes will be effected by a Headwaters #1 dam breech.

See the watershed area map in Appendix A.

COMMUNICATIONS

Neither cell phone communication nor the District's radio (frequency 169.14) communication system works from the dam site. The closest reliable communication site is on the Peachland F.S.R. at around kilometre 6. Throughout most of the year the radio phone at the Headwaters Fishing Camp office may be accessible.

POSSIBLE FLOOD AREAS

A *Flood Inundation Area Study* has not been done. The areas listed are those which may be impacted by flood water in the event of a dam breach (work in progress).

DOWNSTREAM NOTICATION LIST

The following is a list of residents who will be the first or greatest impacted by floodwater.

The Mazama Ranch home is the only one in this flood area. It is located just east of where Trout Creek crosses the Princeton-Summerland Hwy. at the top end of Thirsk Lake.

ACTION LIST FOR: DAM INCIDENT

- Conduct complete inspection of site.
- Monitor dam site frequently enough to confirm dam condition is not deteriorating.
- Arrange meeting with local Dam Safety personnel and appropriate Engineering Consultant for repair advice.
- With advice from a Professional Design Engineer, undertake any remedial work that may reduce the possibility, or extent, of uncontrolled flow releases.

ACTION LIST FOR: DAM ALERT

- If additional staff members are available, delegate specific tasks as needed to complete the following actions. Record who is assigned and have them record what they accomplish.
- Arrange a meeting with Dam Safety personnel and Engineering Consultants for advice/supervision on correcting the problem or minimizing damage.
- Close Headwaters #2, 3, 4 and Crescent Diversion. These actions will reduce the inflow into Headwaters #1.
- Close Whitehead and Crescent Lakes to reduce inflow into Thirsk.
- If safe to do so and the operation of the outlet works will not have a negative effect on the integrity of the dam, begin to lower the reservoir water level.
- Monitor downstream releases to minimize water damage and diffuse potential problems.
- Continuously monitor dam site until all flood danger has passed, further damage is unlikely to occur and has been deemed safe by a qualified engineer.
- With advice from a Professional Design Engineer, undertake any structural work that may reduce the possibility, or extent, of uncontrolled flow releases.)

ACTION LIST FOR: DAM BREACH

- If additional staff members are available, delegate specific tasks as needed to complete the following actions. Record who is assigned and have them record what they have accomplished.
- Notify logging companies and Highways contractor who could possibly be in the area
- Close Headwaters #2,3,4 and Crescent Diversion. Also close gates #2 and #4 if the Municipality of Peachland can take the excess. These actions will help reduce the inflow into Headwaters #1.
- Close Whitehead and Crescent Lakes to reduce inflow into Thirsk.
- Water released from the Headwaters Lake #1 flows into Thirsk Lake. If Headwaters Dam #1 were to fail, a risk to Thirsk Dam could arise. All Outlet control gates at Thirsk Dam should be opened and downstream residents need to be notified.
- Arrange a meeting with Dam Safety personnel and Engineering Consultants for advice/supervision on minimizing damage.
- Contact helicopter service for possible surveillance and rescue.
- Continuously monitor dam site until all flood danger has passed, further damage is unlikely to occur and has been deemed safe by a qualified engineer.
- With advice from a Professional Design Engineer, undertake any structural work that may reduce the possibility, or extent, of uncontrolled flow releases.

A1.6 HEADWATERS NO.1 – INSPECTION SCHEDULE, ARCHIVED RECORDS AND FORMS

A copy of this dam's inspection schedule can be found in Table 4.2 on Page 32.

The annual inspections, routine inspections, and other documentation regarding this dam can be accessed through the following links:

- Archived Routine Dam Inspection Reports
- Archived Annual Dam Inspection Reports
- Other Archived Documentation (Engineering, Measurement, Testing, etc)

Printable forms can be easily accessed by the following links:

- Routine Dam Inspection Form
- Annual Dam Inspection Form

Table A1.4 –Headwaters No.1 – Record of Annual Inspections

Dam Name Headwaters No. 1	Summerland Inspector or Consultant's Name	Date	Formal Inspection or DSR (Dam Safety Review)	Document Filed
Headwaters No. 1	Agua Consulting (Bob Hrasko)	2009-07	Formal	Y
Headwaters No. 1	Associated Engineering (R. MacLean / G. Imada)	2010-04	DSR	Y
Headwaters No. 1	District of Summerland (Shawn Hughes)	2011-2016	Formal	Y

Dam Name Headwaters No. 1	Summerland Inspector or Consultant's Name	Date	Formal Inspection or DSR (Dam Safety Review)	Document Filed

A.2 HEADWATERS NO. 2 DAM

A2.1 HEADWATERS NO. 2 DAM - SPECIFICATION SHEET

General: This dam is the easternmost dam of the three dams above Headwaters No. 1 dam

Provincial Dam No.	D220007
Water License Point Code	_____
Dam Type	Earth Fill
Dam Function	Main
In-Service Date	1966
Dam Height	6.1 m
Crest Elevation (m)	1,295.5 m
High Water Level (m)	1,293.6 m
Freeboard (m)	1.9 m
Crest Length (m)	130 m
Dam Coordinates	
DMS	49-49-05.59 N 120-00-05.48 W
UTM	715,685 E 5,522,732 N
Storage Volume (ML)	738 ML

Other Comments _____

_____

Subcatchment Area (all 4 HW):	4,890 ha
Reservoir Surface Area:	21.0 ha
Reservoir Elevation:	1,293 m
Mean Subcatchment Elev.:	1,585 m
Ave. Reservoir Depth:	3.51 m

Water Storage Licenses

*C-030787	308 ML
**C-034399	1,233 ML
**C-016414	3,699 ML (shared)

* shared license with HW 3 and 4
**shared with HW 1, 3 and 4

General Comments: A dam that had existed earlier was reconstructed in 1966 with the aid of the Province. This dam releases water to Headwaters No. 1 Reservoir.

A2.2 HEADWATERS NO. 2 RESERVOIR - PHOTOS AND FIGURES

Figure A2.1 - Headwaters No.2 Reservoir-Lake Location

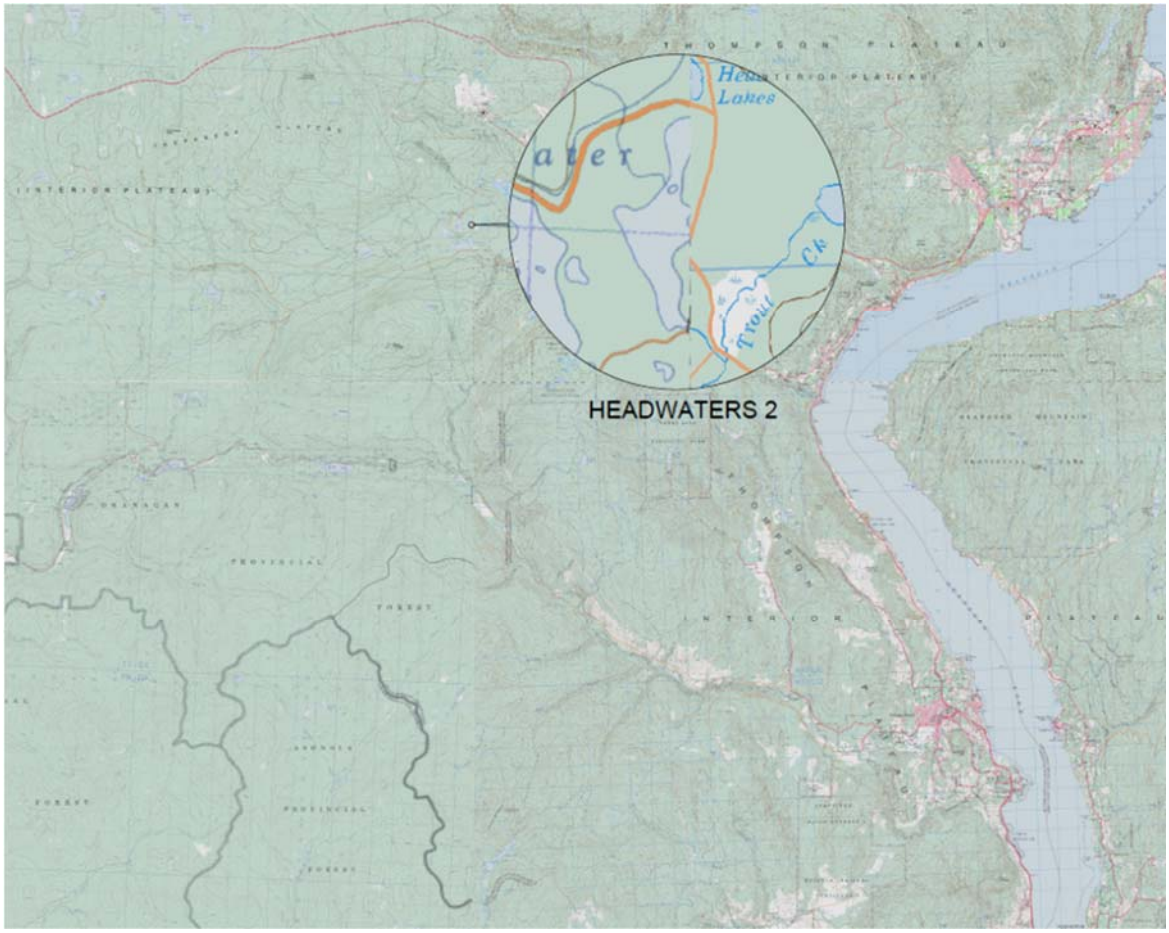


Figure A2.2 - Headwaters No.2 Reservoir-Lake - Aerial Photo

Figure A2.3 - Headwaters No. 2 Dam - Spillway

Figure A2.4 – Headwaters No. 2 Dam - Gate Control

Figure A2.5 –Headwaters No. 2 Dam

A2.3 HEADWATERS NO. 2 HISTORY AND TECHNICAL DATA

Headwaters No. 2 dam was rehabilitated and raised to its present height in 1966. The dam consists of a homogeneous earthfill embankment with a maximum height of 6.1 metres. The crest width is 3.0 metres and the length is approximately 129.5 metres. The crest is at El. 1295.5 metres. The downstream section of the dam has a pervious toe filter with 150 millimetre diameter perforated pipe with drains leading to a single pipe under the downstream end of the outlet that drains into the stilling basin. The upstream slope of the dam is 4.0H:a.0V and the downstream slope is 2.0H:1.0V.

The low level outlet consists of a 600 millimetre concrete pipe, 36.6 metres in length. Flow control is provided by a slide gate with the gate stem mounted on a reinforced concrete beam cast on the upstream slope of the dam. The gate sill is at El. 1289.0 metres. At the downstream end, the outlet pipe discharges into a concrete stilling basin with riprap protection in the downstream channel.

The spillway channel is located on the left abutment of the dam. It consists of a 4.9 metre wide concrete sill structure with the invert at El. 1293.6 metres and concrete side walls inclined at 1.5H:1.0V extending up to El.1294.6 metres. The spillway channel has a slope of about 1.0 percent and discharges back to Trout Creek and then into the reservoir behind Headwaters Dam No. 1.

A2.4 HEADWATERS NO. 2 STORAGE AND SPILLWAY DATA

Table A2.1 - Headwaters No. 2 Reservoir Stage - Storage Data

Reservoir Elevation (m)	*Spillway Discharge (cms)*	*Comments*
1293.6	*0*	*Spillway Sill*
1293.9		
1294.0	*1.8*	
1294.2	*7.4*	
1294.3	*11.3*	
1294.5	*15.9*	
1294.6	*20.1*	*Top of Sidewalls*

Table A2.2 – Headwaters No. 2 Dam Spillway Discharge

Reservoir Elevation (m)	Spillway Discharge (m3/s)	Comments
1293.6	0.0	Spillway Sill
1293.9	1.8	
1294.0	4.2	
1294.2	7.4	
1294.3	11.3	
1294.5	15.9	
1294.6	20.1	Top of Sidewalls

Last Updated March 2012

A2.5 HEADWATERS NO. 2 EMERGENCY PLAN – ADDITIONAL ACTION LIST

There are no additional actions required for this dam.

A2.6 Headwaters No. 2– Inspection Schedule, Archived Records and Forms

A copy of this dam's inspection schedule can be found in Table 4.2 on Page 32.

The annual inspections, routine inspections, and other documentation regarding this dam can be accessed through the following links:

- Archived Routine Dam Inspection Reports
- Archived Annual Dam Inspection Reports
- Other Archived Documentation (Engineering, Measurement, Testing, etc.)

Printable forms can be easily accessed by the following links:

- Routine Dam Inspection Form
- Annual Dam Inspection Form

Table A2.3 –Headwaters No. 2 Dam - Record of Annual Inspections

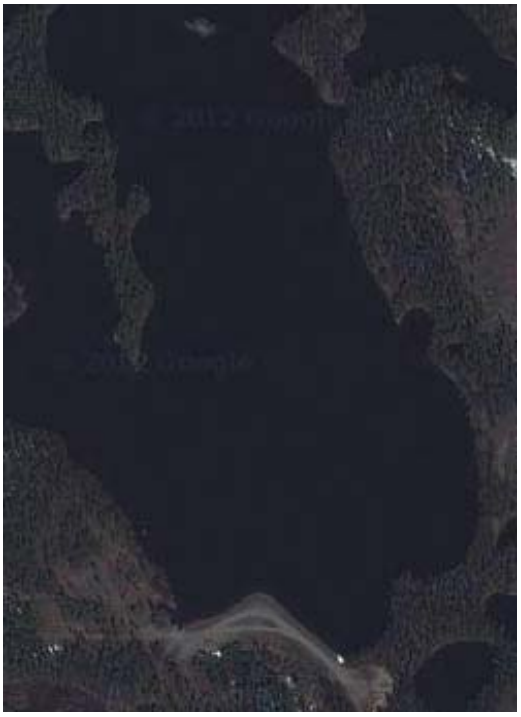
Dam Name Headwaters No. 2	Summerland Inspector or Consultant's Name	Date	Formal Inspection or DSR (Dam Safety Review)	Document Filed
Headwaters No. 2	Agua Consulting (Bob Hrasko)	2009-07	Formal	Y
Headwaters No. 2	Associated Engineering (R. MacLean / G. Imada)	2010-04	DSR	Y
Headwaters No. 2	District of Summerland (Shawn Hughes)	2011-2016	Formal	Y

Insert additional record sheets as needed.

A3 HEADWATERS NO. 3 DAM

A3.1 HEADWATERS NO. 3 DAM - SPECIFICATION SHEET

General: This dam is the middle dam of the three dams above Headwaters No. 1 dam



Provincial Dam No.	D220008	
Water License Point Code	_____	
Dam Type	Earth Fill	
Dam Function	Main	
In-Service Date	1966	
Dam Height	5.5 m	
Crest Elevation (m)	1,288.8 m	
High Water Level (m)	1,287.2 m	
Freeboard (m)	1.6 m	
Crest Length (m)	130 m	
Dam Coordinates		
DMS	49-49-59.24 N	120-00-40.00 W
UTM	715,004 E	5,522,509 N
Storage Volume (ML)		617 ML

Other Comments _____

_____

Subcatchment Area (all 4 HW):	4,890 ha
Reservoir Surface Area:	21.0 ha
Reservoir Elevation:	1,287 m
Mean Subcatchment Elev.:	1,585 m
Ave. Reservoir Depth:	2.93 m

Water Storage Licenses

*C-030787	308 ML
**C-034399	1,233 ML
**C-016414	3,699 ML (shared)

* shared license with HW 2 and 4
**shared with HW 1, 2 and 4

General Comments: A dam that had existed earlier was reconstructed in 1966 with the aid of the Province. This dam releases water to Headwaters No. 1 Reservoir.

A3.2 HEADWATERS NO. 3 DAM - PHOTOS AND FIGURES

Figure A3.1- Headwaters No. 3 Reservoir-Lake - Location

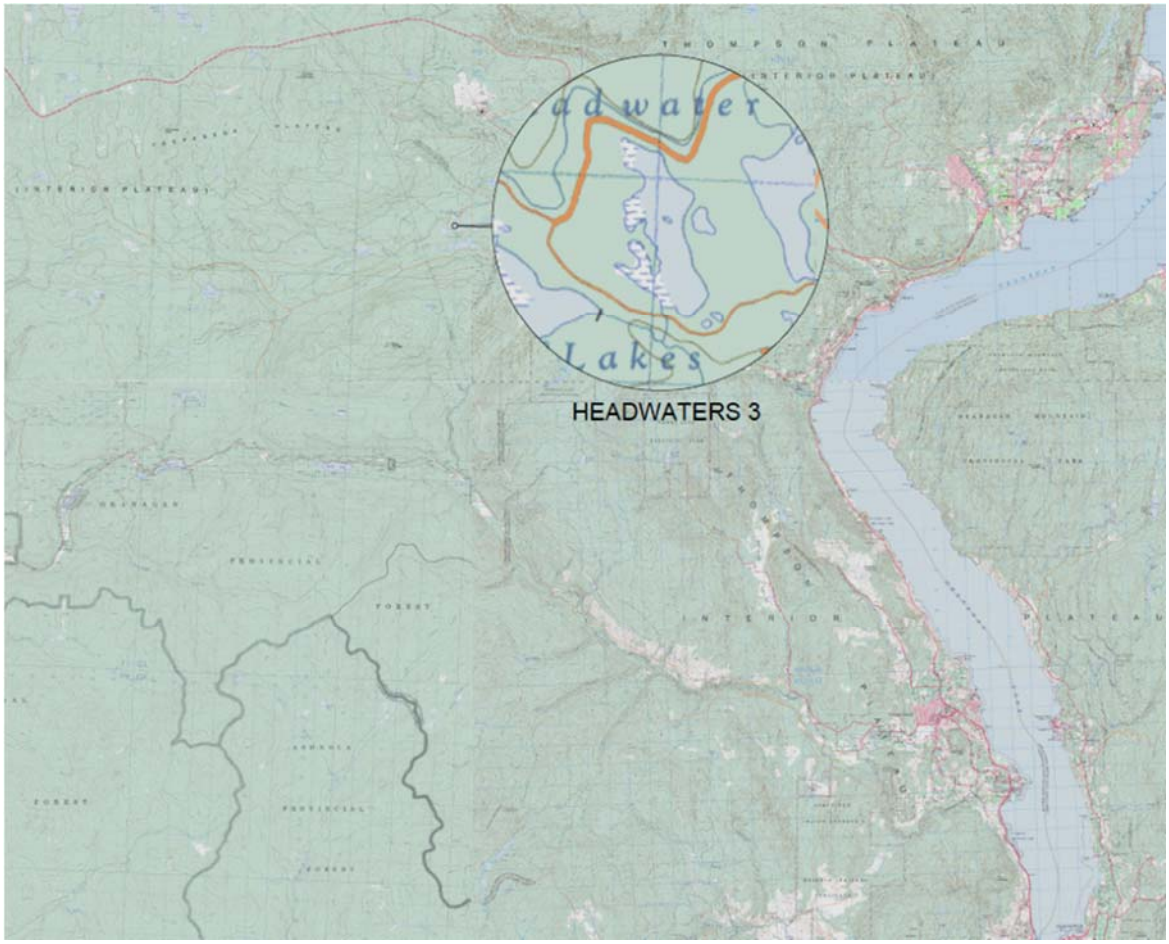


Figure A3.2 - Headwaters No. 3 Reservoir-Lake - Aerial Photo

Figure A3.3 - Headwaters No. 3 Dam - Spillway

Figure A3.4 – Headwaters No. 3 Dam - Gate Control

Figure A3.5 – Headwaters No. 3 Dam

A3.3 HEADWATERS NO. 3 DAM - HISTORY AND TECHNICAL DATA

Headwaters No. 3 dam was rehabilitated in 1966. The dam consists of a homogeneous earthfill embankment with a maximum height of 5.5 metres. The crest is at EL. 1288.8 metres. The crest width is 3.0 metres and the length is approximately 129.5 metres. The downstream section of the dam has a toe filter berm at EL. 1286.6 metres with a 150 millimetre diameter perforated pipe drain leading to a single pipe under the downstream end of the outlet pipe that leads into the stilling basin. The upstream slope is 4.0H:1.0V and the downstream slope is 3.0H:1.0V down to the 3.0 metres wide berm at EI.1286.65m and 2.0H:1.0V for the remainder of the slope.

The low level consists of about 30.5 metres of 610mm D-shaped concrete conduit with a cross-sectional area of about 0.33m^2 and the short extensions on the upstream and downstream ends constructed as part of the rehabilitation program. The total length of the conduit is approximately 41.1 metres. Flow control is provided by a slide gate with the gate stem mounted on a reinforced concrete beam cast on the upstream face of the dam. The outlet pipe terminates in a concrete stilling basin with downstream riprap channel protection.

The spillway channel is located on the right abutment and discharges into the reservoir behind Headwaters Dam No. 1. The spillway consists of a 3.1 metre wide concrete sill with a crest at EL. 1287.2 metres and vertical side walls to EL. 1288.1 metres. The spillway channel has a slope of about 1.0 percent.

A3.4 HEADWATERS NO. 3 RESERVOIR STORAGE AND SPILLWAY DATA

Table A3.3 – Headwaters No.3 Dam Reservoir Data

Reservoir Elevation (m)	Flooded Area (ha)	Storage Volume (ML)	Comments
1279.6	0.2	111	Dead Storage
1283.2	5.6		
1283.5	7.6(est.)	0	Gate Sill
1283.8	10.0	58	
1284.4	12.0	131	
1285.0	14.6	218	
1285.6	16.2	317	
1286.2	17.7	424	
1286.9	19.9	546	
1287.4	22.9	618	Spillway Crest
1289.3	29.5	1101	

Last Updated March 2012

Table A3.4 - Headwaters No. 3 Dam Spillway Discharge

Reservoir Elevation (m)	Spillway Discharge (m3/s)	Comments
1287.4	0	Spillway Sill
1287.6	0.4	
1287.8	0.9	
1287.9	1.6	
1288.1	2.8	Top of Sidewalls

Last Updated March 2012

A3.5 HEADWATERS NO. 3 EMERGENCY PLAN – ADDITIONAL ACTION LIST

There are no additional actions required for this dam.

A3.6 HEADWATERS NO. 3 DAM – INSPECTION SCHEDULE, ARCHIVED RECORDS AND FORMS

A copy of this dam's inspection schedule can be found in Table 4.2 on Page 32.

The annual inspections, routine inspections, and other documentation regarding this dam can be accessed through the following links:

- Archived Routine Dam Inspection Reports
- Archived Annual Dam Inspection Reports
- Other Archived Documentation (Engineering, Measurement, Testing, etc.)

Printable forms can be easily accessed by the following links:

- Routine Dam Inspection Form
- Annual Dam Inspection Form

Table A3.3 –Headwaters No.3 Dam– Record of Annual Dam Inspections

Dam Name Headwaters No. 3	Summerland Inspector or Consultant's Name	Date	Formal Inspection or DSR (Dam Safety Review)	Document Filed
Headwaters No. 3	Agua Consulting (Bob Hrasko)	2009-07	Formal	Y
Headwaters No. 3	Associated Engineering (R. MacLean / G. Imada)	2010-04	DSR	Y
Headwaters No. 3	District of Summerland (Shawn Hughes)	2011-2016	Formal	Y

Dam Name Headwaters No. 3	Summerland Inspector or Consultant's Name	Date	Formal Inspection or DSR (Dam Safety Review)	Document Filed

A4 HEADWATERS NO. 4 DAM

A4.1 HEADWATERS NO. 4 DAM - SPECIFICATION SHEET

General: This dam is the west dam of the three dams above Headwaters No. 1 dam

Provincial Dam No.	D220003
Water License Point Code	_____
Dam Type	Earth Fill
Dam Function	Main
In-Service Date	1965
Dam Height	8.8 m
Crest Elevation (m)	1,295.2 m
High Water Level (m)	1,292.0 m
Freeboard (m)	3.2 m
Crest Length (m)	55 m

Dam Coordinates

DMS	49-48-59.77 N	120-00-57.07 W
UTM	714,659 E	5,522,505 N

Storage Volume (ML) 504 ML

Other Comments _____

_____

Subcatchment Area (all 4 HW):	4,890 ha
Reservoir Surface Area:	15.9 ha
Reservoir Elevation:	1,292 m
Mean Subcatchment Elev.:	1,585 m
Ave. Reservoir Depth:	3.17 m

Water Storage Licenses

*C-030787	308 ML
**C-034399	1,233 ML
**C-016414	3,699 ML (shared)

* shared license with HW 2 and 3
**shared with HW 1, 2 and 3

General Comments**:** A dam that had existed earlier was reconstructed in 1965 with the aid of the Province. This dam releases water to Headwaters No. 1 Reservoir.

A4.2 HEADWATERS NO. 4 PHOTOS AND FIGURES

Figure A4.1 - Headwaters No. 4 Reservoir-Lakes Location

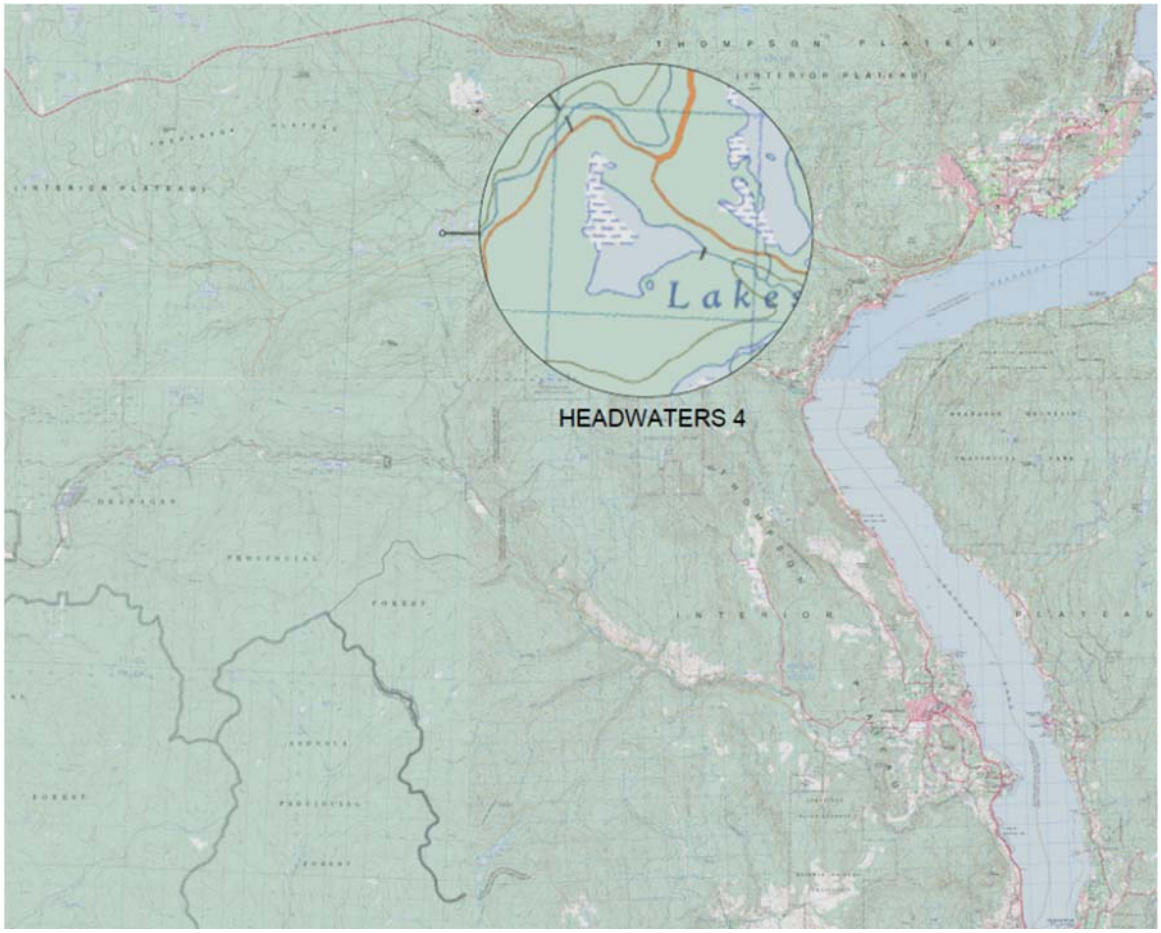


Figure A4.2 - Headwaters No. 4 Aerial Photo

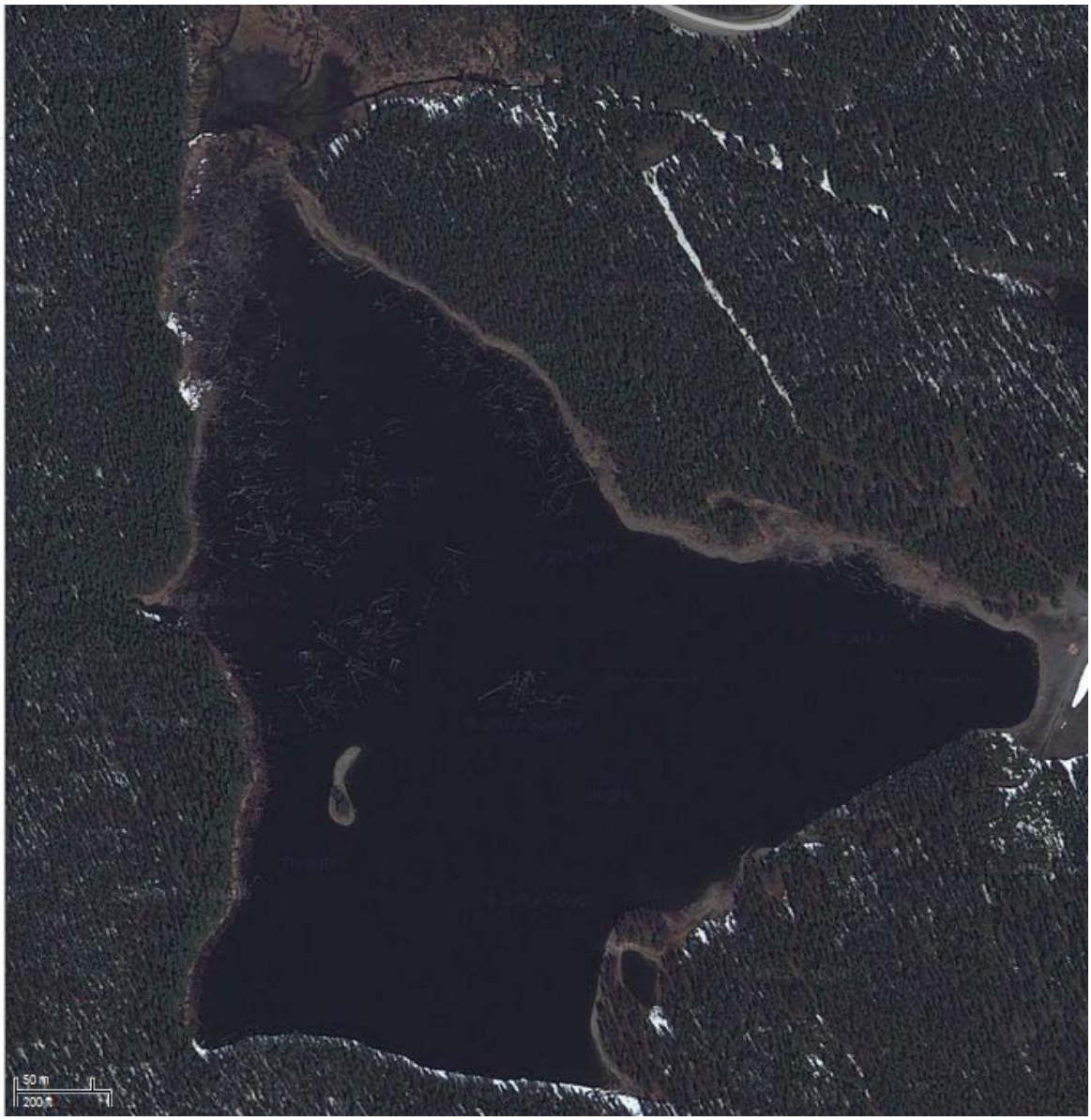


Figure A4.3 - Headwaters No. 4 Dam - Spillway

Figure A4.4 – Headwaters No. 4 Dam - Gate Control

A4.3 HEADWATERS NO. 4 HISTORY AND TECHNICAL DATA

This dam was rehabilitated and raised to its present height in 1965. The dam consists of a homogeneous earth fill embankment with a maximum height of 8.8 metres. The crest width is 3.0 metres and the length is approximately 54.9 metres. The crest is at EL.1295.2 metres. The upstream slope is 3.5H:1.0V. The downstream slope is 3.0H:1.0V down to EL. 1293.0 metres. At this point there is a 3.0 metre wide berm and pervious fill on a slope of 4.0H:1.0V for the remainder of the section. The toe filter has 150 mm diameter perforated drain pipes leading to a single collector that discharges into the stilling basin under the outlet pipe.

The low level outlet consists of a 600 millimetre diameter concrete pipe, some 77.7 metres in length. Flow control is provided by a slide gate with the stem mounted on a reinforced concrete beam cast on the upstream face of the dam. The gate sill is at EL. 1286.3 metres. At the downstream end, the outlet pipe discharges into a concrete stilling basin with riprap protection in the downstream channel.

The spillway is located in the northwest corner of the reservoir, some 610 metres from the dam. No details are available for the spillway. The channel discharges to the reservoir behind Headwater Dam No. 3.

A4.4 HEADWATERS NO. 4 STORAGE AND SPILLWAY DATA

Table A4.1 - Headwaters No.4 Dam Reservoir Data

Reservoir Elevation (m)	Flooded Area (ha)	Storage Volume (ML)	Comments
1286.3	0.0	0	Gate Sill
1286.9	2.1	6	
1287.5	4.2	26	
1288.1	5.7	56	
1288.7	7.3	95	
1289.3	8.6	144	
1289.9	10.2	201	
1290.5	12.6	271	
1291.1	15	356	
1291.7	16.6	453	
1292.0	17.6(est.)	504	Spillway Crest
1292.4	18.4	559	
1293.0	19.7	675	
1295.4	26.7	1241	

Last Updated March 2012

A4.5 HEADWATERS NO. 4 EMERGENCY PLAN - ADDITIONAL ACTION LIST

There are no additional actions required for this dam.

A4.6 HEADWATERS NO.4 – INSPECTION SCHEDULE, ARCHIVED RECORDS AND FORMS

A copy of this dam's inspection schedule can be found in Table 4.2 on Page 32.

The annual inspections, routine inspections, and other documentation regarding this dam can be accessed through the following links:

- Archived Routine Dam Inspection Reports
- Archived Annual Dam Inspection Reports
- Other Archived Documentation (Engineering, Measurement, Testing, etc.)

Printable forms can be easily accessed by the following links:

- Routine Dam Inspection Form
- Annual Dam Inspection Form

Table A4.2 –Headwaters No.4– Record of Annual Inspections

Dam Name Headwaters No. 4	Summerland Inspector or Consultant's Name	Date	Formal Inspection or DSR (Dam Safety Review)	Document Filed
Headwaters No. 4	Agua Consulting (Bob Hrasko)	2009-07	Formal	Y
Headwaters No. 4	Associated Engineering (R. MacLean / G. Imada)	2010-04	DSR	Y
Headwaters No. 4	District of Summerland (Shawn Hughes)	2011-2016	Formal	Y

Dam Name Headwaters No. 4	Summerland Inspector or Consultant's Name	Date	Formal Inspection or DSR (Dam Safety Review)	Document Filed

A.5 CRESCENT RESERVOIR DAM

A5.1 CRESCENT RESERVOIR DAM - SPECIFICATION SHEET

General: This dam is located above and to the west of the Headwaters Reservoirs

Provincial Dam No.	D220124	
Water License Point Code	PD 54800	
Dam Type	Earth Fill	
Dam Function	Main	
In-Service Date	1976	
Dam Height	5.5 m	
Crest Elevation (m)	1,356.7 m	
High Water Level (m)	1,355.3 m	
Freeboard (m)	1.4 m	
Crest Length (m)	146 m	
Dam Coordinates		
DMS	49-48-35.93 N	120-04-25.12 W
UTM	710,543 E	5,521,606 N
Storage Volume (ML)	765 ML	

Other Comments _____

_____

Subcatchment Area (all 4 HW):	1,539 ha
Reservoir Surface Area:	29.6 ha
Reservoir Elevation:	1,355 m
Mean Subcatchment Elev.:	1,661 m
Ave. Reservoir Depth:	2.58 m

Water Storage Licenses

C-030398	314 ML
C-016414	617 ML

General Comments**:** The dam was constructed in 1976. It drains directly into Trout Creek or can be diverted via ditch to supplement filling of Headwaters Reservoirs.

A5.2 CRESCENT RESERVOIR - PHOTOS AND FIGURES

Figure A5.1 - Crescent (Paul) Lake Location

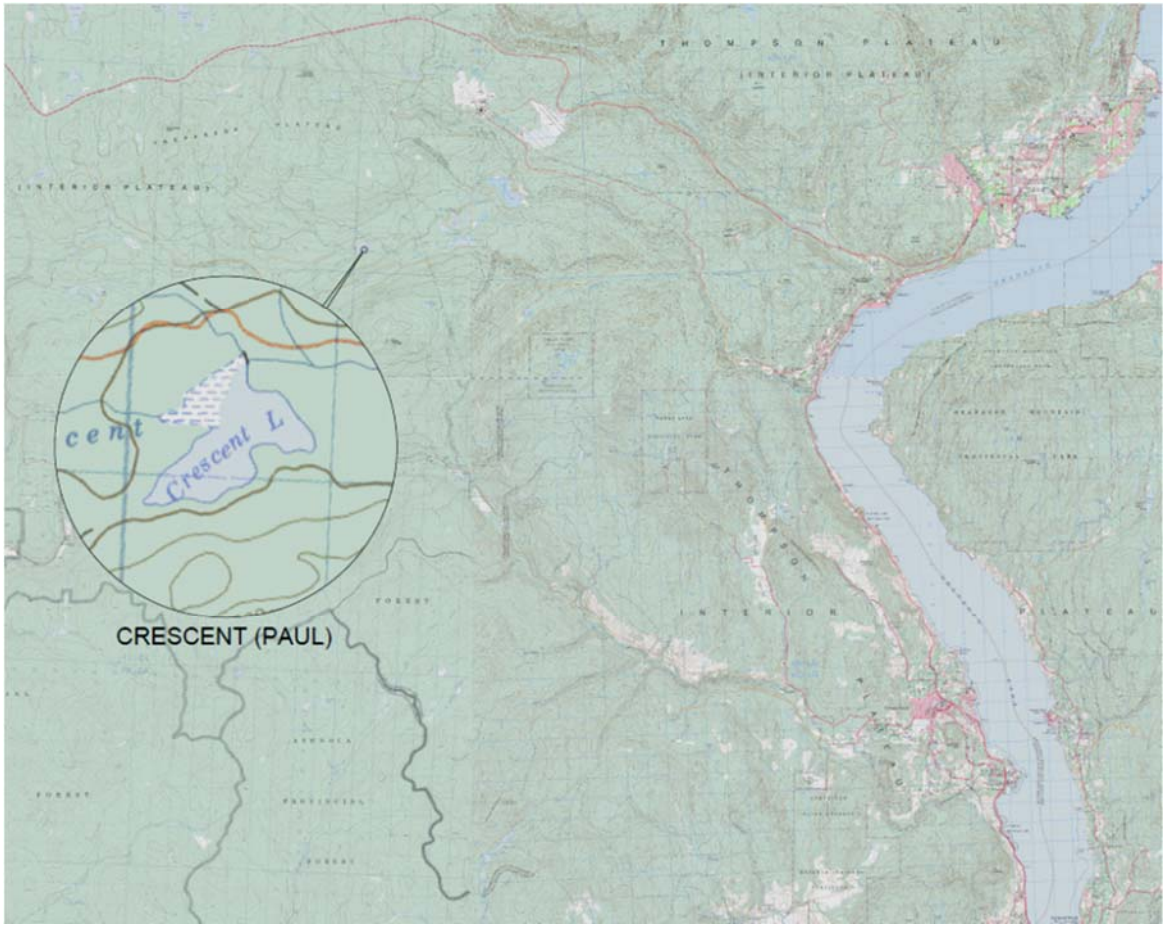


Figure A5.2 - Crescent (Paul) Reservoir Aerial Photo

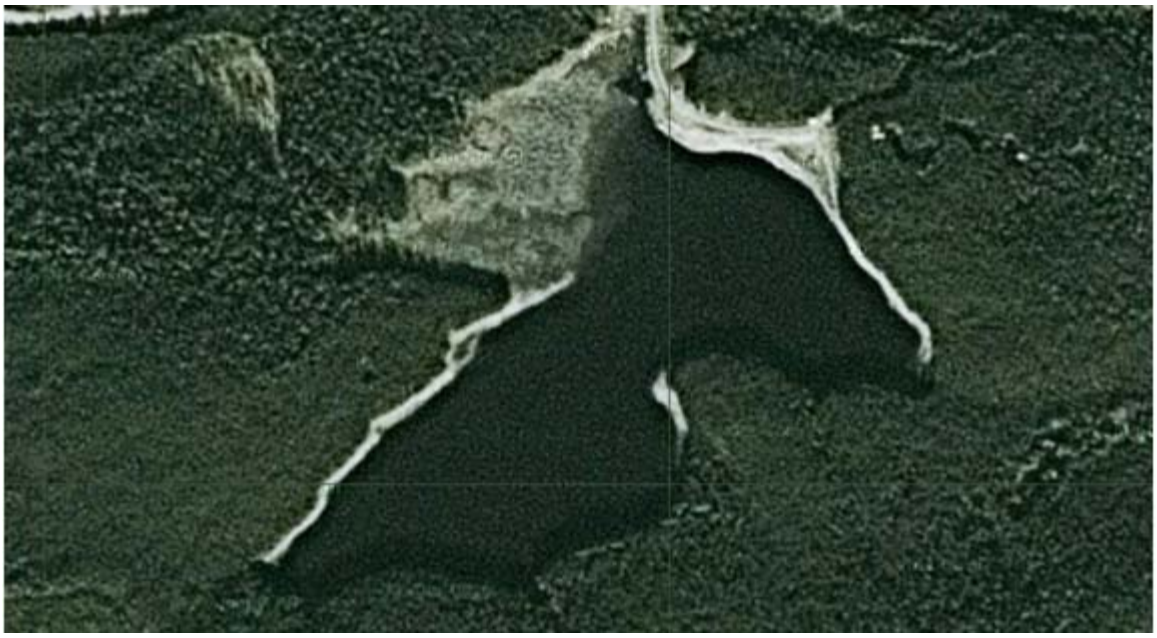


Figure A5.3 - Crescent (Paul) Reservoir Spillway

Figure A5.4 – Crescent (Paul) Reservoir Gate Control

A5.3 CRESCENT (PAUL) DAM - HISTORY AND TECHNICAL DATA

Crescent Lake Dam is located on Crescent Creek which joins Trout Creek at a point approximately 2.5 kilometres downstream from Headwaters No. 1 Dam. The catchment upstream of the dam has an area of 15.5 km^2 and the mean level of the watershed is at El. 1670 metres.

The facilities were rehabilitated in 1976. At that time, remedial work included flattening of the embankment slopes, construction of a freeboard dyke between the right abutment of the dam and the spillway structure, abandonment of the original outlet works by plugging the pipe with sand-cement grout, construction of a new low level outlet and construction of new concrete training walls for the spillway control structure.

The dam is a homogenous embankment with a pervious toe filter. It has a maximum height of 5.5 metres. The upstream slope is 3.0H:1.0V and the downstream slope is 2.5H:1.0V except for the filter portion where the slope varies from 3.0H:1.0V to 3.5H:1.9V. The crest width is 3.7 metres and the length is about 146.3 metres. The crest is at El. 1356.7 metres and the full supply level of the reservoir is at El. 1355.3 metres. The freeboard dyke is a homogenous embankment with an upstream slope of 3.0H:1.0V and a downstream slope of 2.0H:1.0V. The crest width is 3.0 metres and the length of the dyke is 198.1 metres on the left side of the spillway and 109.7 metres on the right side.

The low level outlet works consist of a 600mm diameter Class III reinforced concrete pipe bedded in concrete. The pipe is 36.6 metres long and has a slope of about 1.1 percent. There is a concrete stilling basin and riprap at the outlet. The inlet consists of a concrete box with fish screens and trash racks on three sides. The fish screen panels, each 2.1 by 0.9 metres, consist of stainless steel wire cloth, eight stands per inch. The trash rack has 19 millimetre clear openings between the bars. Flow control is provided by an inclined Armco gate with the gate stem mounted on a concrete beam cast on the upstream face of the dam. The invert of the gate opening is at El. 1351.6 metres.

The spillway is located some 198 metres from the right abutment of the main embankment dam. It consists of a concrete crest control weir with vertical concrete abutment walls. The control weir is 8.5 metres wide and the crest is at El. 1355.3 metres.

A5.4 CRESCENT (PAUL) RESERVOIR STORAGE AND SPILLWAY DATA

Table A5.1 - Crescent (Paul) Reservoir Data

Reservoir Elevation (m)	Flooded Area (ha)	Storage Volume (ML)	Remarks
1349.6	0.7	120	Dead Storage
1351.5	11.5		
1351.5	12.0 (est.)	0	Gate Sill
1352.1	15.4	73	
1352.7	17.3	173	
1353.3	19.3	285	
1353.9	22	471	
1354.5	25.3	554	
1355.1	28.3	717	
1355.3	29.0 (est.)	770	Spillway Crest
1355.8	30.7	897	
1356.4	34.4	1095	

Last Updated October 2012

Table A5.2 - Crescent (Paul) Reservoir Stage-Storage Table

	Storage in ML									
Feet	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	0.0	3.7	8.0	11.1	14.8	18.5	23.4	27.1	30.8	35.8
1	39.5	44.4	51.9	53.0	56.7	61.7	66.6	70.3	75.2	80.1
2	85.1	90.0	94.9	98.6	103.6	108.5	113.4	118.4	123.3	129.5
3	134.4	139.3	144.2	149.2	154.1	159.1	165.2	170.2	175.1	181.2
4	186.2	191.1	197.3	202.2	207.1	213.3	218.2	224.4	229.3	235.5
5	240.4	246.6	252.7	257.7	263.9	270.0	275.0	281.1	287.3	293.5
6	299.6	304.6	310.7	316.9	323.0	329.2	335.4	341.5	347.7	355.1
7	361.3	367.4	373.6	379.8	387.2	393.3	399.5	406.9	413.1	420.5
8	426.6	434.0	440.2	447.6	455.0	461.1	468.5	475.9	483.3	490.7
9	498.1	505.5	512.9	520.3	527.7	535.1	542.5	549.9	557.3	565.9
10	573.3	580.7	589.3	596.8	605.4	612.8	621.4	628.8	637.5	644.9
11	653.5	662.1	670.7	678.2	686.8	695.4	704.0	712.7	721.3	729.9
12	738.6	747.2	755.8	764.5						
SPILLWAY @ 12.35 ft and 769.33ML										

Last Updated October 2012

Table A5.3 - Crescent Lake Dam Spillway Discharge

Reservoir Elevation (m)	Spillway Discharge (cms)	Comments
1355.3	0	Spillway Sill
1355.4	0.6	
1355.8	4.2	
1356.1	9.5	
1356.4	15.9	
1356.7	23.5	
1356.8	27.6	Crest of Dam

Last Updated October, 2012

A5.5 CRESCENT (PAUL) LAKE EMERGENCY PLAN - ADDITIONAL ACTION LIST

There are no additional actions required for this dam.

A5.6 CRESCENT LAKE – INSPECTION SCHEDULE, ARCHIVED RECORDS AND FORMS

A copy of this dam's inspection schedule can be found in Table 4.2 on Page 32.

The annual inspections, routine inspections, and other documentation regarding this dam can be accessed through the following links:

- Archived Routine Dam Inspection Reports
- Archived Annual Dam Inspection Reports
- Other Archived Documentation (Engineering, Measurement, Testing, etc.)

Printable forms can be easily accessed by the following links:

- Routine Dam Inspection Form
- Annual Dam Inspection Form

Table A5.4 –Crescent Reservoir – Record of Annual Inspections

Dam Name Crescent Dam	Summerland Inspector or Consultant's Name	Date	Formal Inspection or DSR (Dam Safety Review)	Document Filed
Crescent Dam	Agua Consulting (Bob Hrasko)	2009-07	Formal	Y
Crescent Dam	Associated Engineering (R. MacLean / G. Imada)	2010-04	DSR	Y
Crescent Dam	District of Summerland (Shawn Hughes)	2011-2016	Formal	Y

Dam Name Crescent Dam	Summerland Inspector or Consultant's Name	Date	Formal Inspection or DSR (Dam Safety Review)	Document Filed

A.6 WHITEHEAD DAM

A6.1 WHITEHEAD RESERVOIR DAM - SPECIFICATION SHEET

General: This dam is located on the west arm of Trout Creek and is the highest of the Summerland dams.

Provincial Dam No.	D220203	
Water License Point Code	PD 56951	
Dam Type	Earth Fill	
Dam Function	Main	
In-Service Date	1968	
Dam Height	4.9 m	
Crest Elevation (m)	1,440.6 m	
High Water Level (m)	1,439.3 m	
Freeboard (m)	1.3 m	
Crest Length (m)	168 m	
Dam Coordinates		
DMS	49-47-34.92 N	120-11-03.35 W
UTM	702,654 E	5,519,425 N
Storage Volume (ML)	1,216 ML	

Other Comments _____

_____

Subcatchment Area (all 4 HW):	671 ha
Reservoir Surface Area:	48.6 ha
Reservoir Elevation:	1,439 m
Mean Subcatchment Elev.:	1,472 m
Ave. Reservoir Depth:	2.50 m

Water Storage Licenses

C-016414	432 ML
C-030786	274 ML
C-034400	429 ML

General Comments**:** The dam was constructed in 1968. It drains directly into Trout Creek

A6.2 WHITEHEAD DAM PHOTOS AND FIGURES

Figure A6.1 - Whitehead Reservoir Location

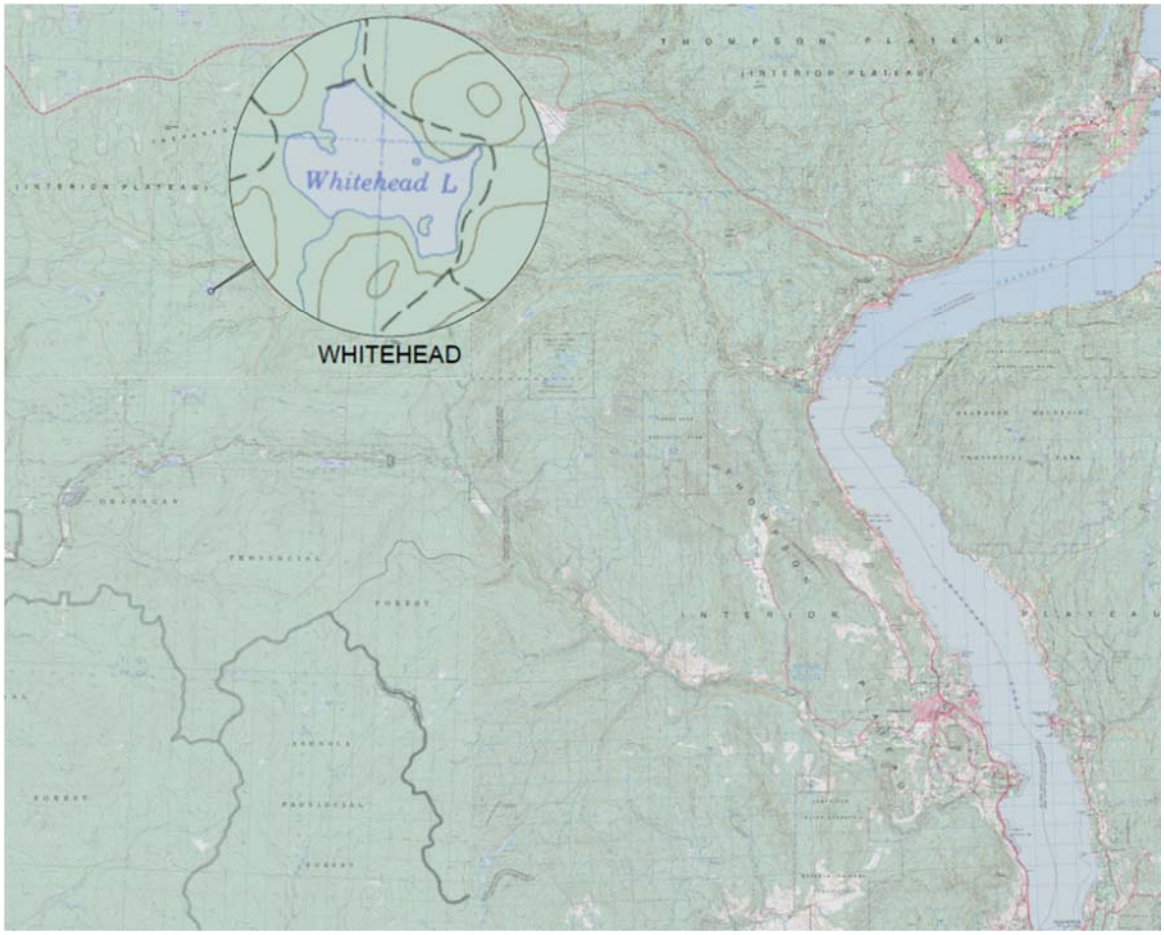


Figure A6.2 - Whitehead Reservoir Aerial Photo

Figure A6.3 - Whitehead Reservoir Spillway

Figure A6.4 – Whitehead Lake Gate Control

Figure A6.5 – Whitehead Lake Dam

A6.3 WHITEHEAD DAM GENERAL

Whitehead Reservoir Dam is located in the headwaters of North Trout Creek. The drainage area to the dam is 5.4 km^2 and the mean level of the watershed is at EL.1473.7 metres. The full supply level of the reservoir is at EL. 1439.6 metres.

The dam, spillway and low level outlet were rehabilitated in 1968. The dam is a homogeneous earthfill embankment with a maximum height of 4.9 metres. The crest, at EL. 1440.6 metres is 3.7 metres wide and some 167.6 metres in length. The upstream slope is 3.0H:1.0V. The downstream slope is 2.0H:1.0V. While the drawings only show a short section of the 150 millimetres diameter perforated drain pipe under the low level outlet conduit, there are pipes in each of the stilling basin wing walls that are presumed to drain the toe filters.

The low level outlet consists of a 450 millimetres diameter concrete pipe, some 29.0 metres long. Flow control is by a slide gate with the stem mounted on a reinforced concrete beam cast on the upstream slope of the dam. The gate sill is at EL. 1435.8 metres. At the downstream end, the outlet discharges into a concrete stilling basin with riprap channel protection.

The spillway channel is located on the right abutment of the dam. It consists of a 5.8 metre wide sill structure with a crest at EL. 1439.6 metres and concrete side walls inclined at 1.5H:1.0V extending up to EL. 1440.4 metres.

A6.4 WHITEHEAD RESERVOIR STORAGE AND SPILLWAY DATA

Table 0-1 - Whitehead Lake Dam Reservoir Data

Reservoir Elevation (m)	Flooded Area (ha)	Storage Volume (ML)	Comments
1428.4	0.0	523	Dead Storage
1435.6	20.1		
1436.0	24.1	0	Gate Sill
1436.1	25.475		
1436.4	26.8	155	
1436.7	28.4	239	
1437.0	29.9	328	
1437.3	31.2	422	
1437.6	32.7	519	
1437.9	34.3	622	
1438.2	35.6	728	
1438.5	36.6	838	
1438.8	37.6	951	
1439.1	38.6	1067	
1439.4	39.6	1187	
1439.6	40.1	1248	Spillway Crest
1441.7	53.7	2240	

Last Updated March 2012

Table A6.2 - Whitehead Reservoir Dam Spillway Discharge

Reservoir Elevation (m)	Spillway Discharge (m3/s)	Comments
1439.6	0	Spillway Crest
1439.8	0.6	
1439.9	1.7	
1440.1	3.1	
1440.2	4.8	
1440.4	6.8	Top of Sidewalls

Last Updated March 2012

A 6.5 WHITEHEAD LAKE EMERGENCY PLAN - ADDITIONAL ACTION LIST

There are no additional actions required for this dam.

A6.6 WHITEHEAD DAM - INSPECTION SCHEDULE, ARCHIVED RECORDS AND FORMS

A copy of this dam's inspection schedule can be found in Table 4.2 on Page 32.

The annual inspections, routine inspections, and other documentation regarding this dam can be accessed through the following links:

- Archived Routine Dam Inspection Reports
- Archived Annual Dam Inspection Reports
- Other Archived Documentation (Engineering, Measurement, Testing, etc.)

Printable forms can be easily accessed by the following links:

- Routine Dam Inspection Form
- Annual Dam Inspection Form

Table A6.3 – Whitehead Dam – Record of Annual Inspections

Dam Name Whitehead Dam	Summerland Inspector or Consultant's Name	Date	Formal Inspection or DSR (Dam Safety Review)	Document Filed
Whitehead Dam	Agua Consulting (Bob Hrasko)	2009-07	Formal	Y
Whitehead Dam	Associated Engineering (R. MacLean / G. Imada)	2010-04	DSR	Y
Whitehead Dam	District of Summerland (Shawn Hughes)	2011-2016	Formal	Y

A.7 THIRSK DAM

A7.1 THIRSK RESERVOIR DAM (MAIN DAM) - SPECIFICATION SHEET

General: This dam is located on the mainstem of Trout Creek. The entire upstream watershed is managed through controlled releases from this dam.

Provincial Dam No.	D220004-01
Water License Point Code	PD 54524
Dam Type	Concrete Arch
Dam Function	Main
In-Service Date	1941 (raised in 2008)
Dam Height	5.5 m
Crest Elevation (m)	1,030.60 m
High Water Level (m)	1,028.70 m
Freeboard (m)	1.90 m
Crest Length (m)	48 m

Dam Coordinates

DMS	49-42-46.21 N	120-11-03.35 W
UTM	710,145 E	5,510,784 N

Storage Volume (ML) 6,490 ML

Other Comments _____

_____

Subcatchment Area:	19544 ha
Reservoir Surface Area:	57.8 ha
Reservoir Elevation:	1028 m
Mean Subcatchment Elev.:	1,335 m
Ave. Reservoir Depth:	11.23 m

Water Storage Licenses

C-014568	2,466 ML
C-106027	3,243 ML

General Comments: The dam was originally constructed in 1941 and was reconstructed and raised in 2008.

A7.2 THIRSK RESERVOIR DAM (SPILLWAY DAM) - SPECIFICATION SHEET

General: The spillway dam is located immediately to the south of the main Thirsk arch-concrete dam.

Provincial Dam No.	D220004-02	
Water License Point Code	PD 54524	
Dam Type	Concrete Gravity	
Dam Function	Spillway	
In-Service Date	(completely reconstructed in 2008)	
Dam Height	13.5 m	
Crest Elevation (m)	1,028.70 m	
High Water Level (m)	1,028.70 m	
Freeboard (m)	0.00 m	
Crest Length (m)	127 m	
Dam Coordinates		
DMS	49-42-43.80 N	120-04-58.18 W
UTM	710,296 E	5,510,714 N
Storage Volume (ML)	6,490 ML	

Other Comments _____

_____

Subcatchment Area**:**	19544 ha
Reservoir Surface Area:	57.8 ha
Reservoir Elevation:	1028 m
Mean Subcatchment Elev.:	1,335 m
Ave. Reservoir Depth:	11.23 m

Water Storage Licenses

C-014568	2,466 ML
C-106027	3,243 ML

General Comments**:** The spillway dam was originally constructed in 1941 and was reconstructed and raised in 2008.

A7.3 THIRSK RESERVOIR DAM (SADDLE DAM) - SPECIFICATION SHEET

General: The saddle dam is located immediately to the northwest of the main Thirsk arch-concrete dam.

Provincial Dam No.	D220004-03
Water License Point Code	PD 54524
Dam Type	Earth fill
Dam Function	saddle
In-Service Date	2008
Dam Height	8.0 m
Crest Elevation (m)	1,031.50 m
High Water Level (m)	1,028.70 m
Freeboard (m)	2.80 m
Crest Length (m)	135 m

Dam Coordinates

DMS	49-42-47.77 N	120-05-08.31 W
UTM	710,092 E	5,510,828 N

Storage Volume (ML) 6,490 ML

Other Comments _____

_____

Subcatchment Area**:**	19544 ha
Reservoir Surface Area:	57.8 ha
Reservoir Elevation:	1028 m
Mean Subcatchment Elev.:	1,335 m
Ave. Reservoir Depth:	11.23 m

Water Storage Licenses

C-014568	2,466 ML
C-106027	3,243 ML

General Comments**:** The saddle dam was constructed in 2008 as a result of the raising of Thirsk Reservoir.

A7.4 THIRSK DAM PHOTOS AND FIGURES

Figure A7.1 - Thirsk Reservoir Location

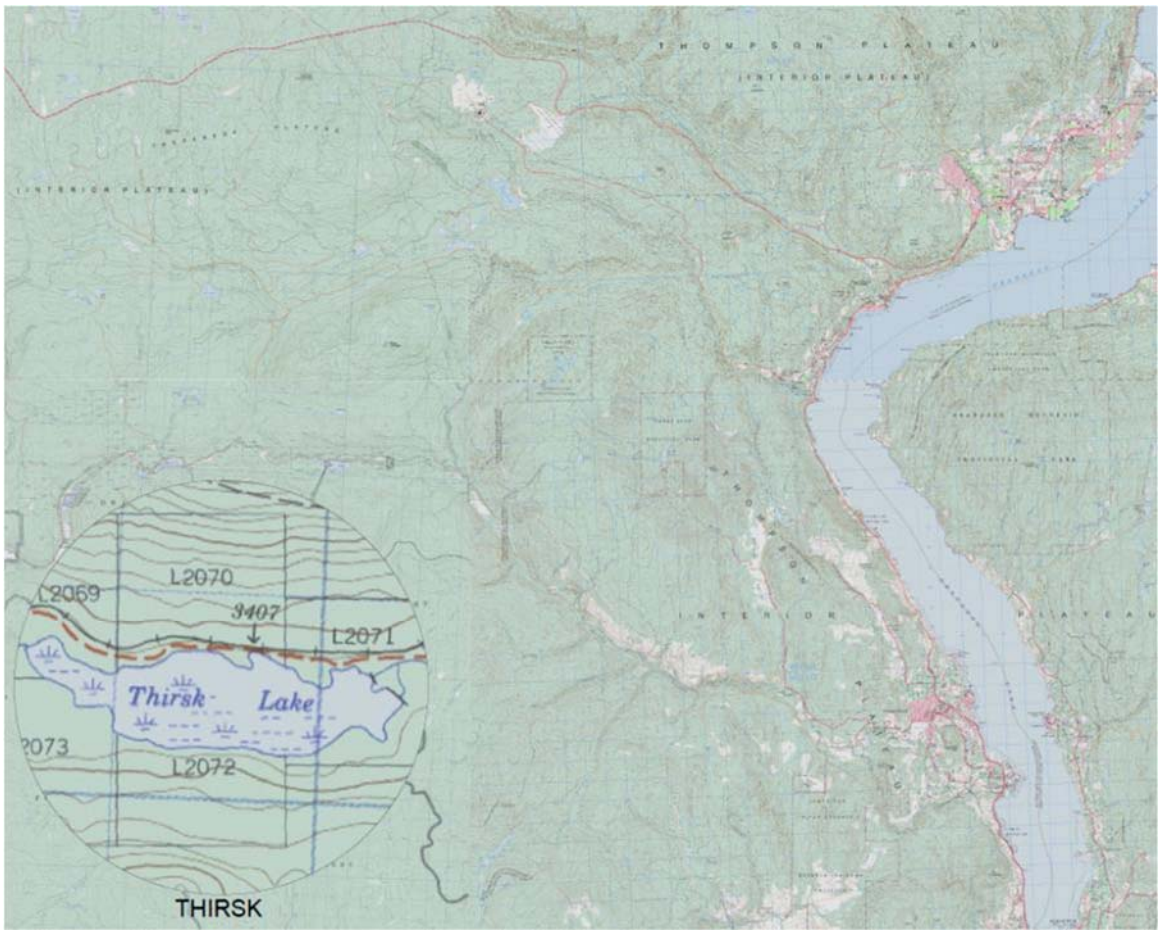


Figure A7.2 - Thirsk Reservoir Aerial Photo

Figure A7.3 - Thirsk Dam Spillway (flowing)

Figure A7.4 – Thirsk Reservoir Gate Control

Figure A7.5 – Thirsk Dam and Spillway

A7.5 THIRSK DAM - HISTORY AND TECHNICAL DATA

Thirsk Dam is located on Trout Creek. Situated some 35 km northwest of Summerland, the dam and reservoir are on the south side of the Summerland-Faulder-Osprey Lake Road. Releases from Headwater No. 1, No. 2, No. 3 and No. 4, Whitehead and Crescent Dams pass through the Thirsk Reservoir. The drainage area to the dam is 245.8 km^2 and the mean level of the watershed is at EL. 1463m. The full supply level of the reservoir is at EL. 1028.7.

The reservoir is an impoundment of Trout Creek contained by three water retaining structures.

1. Reinforced Concrete Arch Dam

2. Reinforced Concrete Gravity Spillway

3. Earth Saddle Dam

REINFORCED CONCRETE ARCH DAM

The original reinforced concrete arch dam was completed in 1941. In 2008 a 5.3 metre dam raise was completed with a top of dam elevation of 1030.60 m. The dam is a variable radius cylindrical arch structure.

The components of the dam raise are:

1. A continuous reinforced concrete plinth located behind the concrete/rock interface. The plinth is anchored to the rock foundation by a system of multi-directional rock anchors.

2. A reinforced concrete thickening of the existing dam. The thickening varies in thickness from a minimum of 300 mm to approximately 1200 mm and is located on the downstream face of the dam. The variability in thickness is non-uniform and results from the irregular geometry of the original dam and removal of weathered concrete from the original dam face during construction.

3. A reinforced concrete dam raise extending 5.3 metres above the top of the original dam.

4. Reinforced concrete thrust blocks (at both ends of the dam raise) that are anchored to bedrock with a combination of multi-directional rock anchors. The raised dam is approximately 27 metres high at its deepest section in the Trout Creek Channel. The radius of the centre of the dam at the top is 22.5 metres and its length is approximately 43 metres. The north and south thrust blocks are 9 and 10 metres long, respectively.

REINFORCED CONCRETE GRAVITY SPILLWAY

The 1941 spillway was completely demolished and removed. The replacement spillway structure is approximately 190 metres long. The spillway is 13.5 metres high at it deepest section. Founded on bedrock, the spillway contains over 6000 cubic metres of reinforced concrete and is secured by rock anchors along its upstream face. Inside the spillway there is an inspection chamber accessed from the downstream side of the spillway. The spillway itself is an ogee weir at elevation 1028.70 m which is 127 metres long.

EARTH SADDLE DAM

The earth saddle dam is located to the northwest of the arch dam. The saddle dam is approximately 8 metres high at its deepest section and approximately 135 metres long. The top of the saddle dam is at elevation 1031.50 m. The saddle dam core is constructed of selected local material. The upstream face of the saddle dam is waterproofed with a buried low density polyethylene membrane closed to bedrock at the base of the dam with a sand, gravel, bentonite mixture and a clay filled membrane. The upstream face of the saddle dam is protected with rock rip-rap underlain by a geotextile.

SITE ACCESS

Site access is from the Princeton – Summerland road which is maintained by the provincial government.

The access road to the arch dam is approximately 1 km long and includes a single-lane bridge across Trout Creek. The bridge spans 11.4 metres across Trout Creek, upstream of the spillway channel. The bridge components include precast concrete deck slabs, footings, and cap beam/ballast walls with short steel pipe columns between the footings and the cap beams. The access road and bridge are maintained by the District of Summerland. Vehicular access across the bridge is blocked by concrete lock-blocks and locked security gate.

TURBINE AND CONTROLS BUILDING

The turbine and controls building is located approximately 20 metres downstream of the arch dam. The precast concrete building measures 3.5 m by 4 m and has a single steel-clad door on the east wall, and no windows. The building houses the power generating turbine and the electrical instrumentation and control systems that provide remote monitoring and outlet flow control by operators located at the Summerland water treatment plant.

FLOW CONTROL

Water (for fish sustenance and community water supply) flows from Thirsk Reservoir into Trout Creek. Water for community consumption is diverted out of the creek and into the community water system approximately 30 km downstream of Thirsk Dam.

Each spring, the reservoir is filled and then overflows as higher elevation snow melts. The overflow or spill period typically begins in May and will come to an end in June or early July as snowpack is depleted. At times, other than the spill period, outflow from the reservoir is controlled by valves on the three low level outlets through the arch dam.

All three outlets are equipped with manually controlled slide gates located on the upstream face of the dam. Each slide gate is manually operated by a handwheel located at the top of the dam. The centre low level outlet is extended behind the dam approximately 25 m. The 600 mm diameter ductile iron pipe extension is equipped with a motorized multi-orifice flow control valve. The multi-orifice flow control valve (flotis valve) is a specialty valve designed for variable flow control applications. This valve will not experience the premature wear and damage that shut-off valves (such as butterfly or gate valves) are susceptible to when continuously subjected to partial opening.

Generally, base flow through the outlet should be routed through the north and south dam outlets with the motorized valve being used to add flow during periods of higher water demand. The base flow is the minimum flow for any particular period or season. Base flow adjustments would be made

during regular maintenance/inspection visits, while additional flow through the motorized valve would be adjusted to suit varying water demands on an as-required basis.

The motorized flow control valve can be operated remotely from the Water Treatment Plant. The operator interface will display the current reservoir level and the current valve opening ratio on an on-demand basis. The valve opening can be modified by the operator through the interface.

STORAGE TABLE

The storage table for Thirsk Reservoir follows. The table is based on the table contained in the 1991 Operation and Maintenance Manual for Water Storage Dams supplemented by survey of the reservoir topography between elevation 1024.4 m and 1028.7 m.

LOG BOOM

Accumulation of debris behind the log boom should be removed. The boom is equipped with a load limited breakaway shackle on the north anchor block. Debris that escapes the log boom or comes from downstream of the log boom will often hang up on top of the spillway from where it should be removed.

ELECTRICAL, INSTRUMENTATION AND CONTROL SYSTEMS

The electrical, instrumentation, and control systems are housed in the precast concrete building located behind the arch dam, with the exception of the antenna which is located on the south thrust block. Electrical System Power is generated by Energy Systems and Design Ltd.'s stream engine turbine. The turbine is supplied by water from the reservoir that is piped into the building to the turbine. Water that has passed through the turbine returns to Trout Creek. The speed of rotation of the turbine varies according to the water level in the reservoir. At low water levels the turbine will rotate at slower speed and will produce less power. At higher reservoir levels the turbine will rotate at higher speed and produce more power. At speeds above 3,000 rpm, the turbine is susceptible to damage. The water is directed to the turbine through four nozzles. When rotation speeds approach 3,000 rpm the speed of flow to the turbine must be reduced by: (a) closing valves to flow to two of the four nozzles or (b) replacing the nozzles with nozzles of smaller orifice size.

During the winter months, if the reservoir level is low and the outside temperatures are low, the turbine may not be able to produce enough power to heat the building and run the instrument and control systems. Isolated depletion of the batteries can be corrected by an external charge applied by a portable generator. However, in the event of repeated battery depletion, the building should be winterized and the power generation system taken out of service until warmer temperatures or higher reservoir levels prevail. Winterization of the building involves dewatering of all piping downstream of the gate valve on the building feed pipe at the junction of the 600 mm diameter dam outlet pipe and the 150 mm diameter building feed pipe. This is done by closing the 150 mm exterior gate valve and separating the interior piping and removing the butterfly valve so that a small diameter pump suction hose can be fed into the exterior piping. All interior piping, including the pressure transmitter piping must be drained.

Apart from flow control and possible winterization as described above, the power generation system operates automatically. The turbine charges the batteries and the batteries power the equipment in the building. In the event that excess power is produced, it is directed automatically to the 300 W water heaters located upstream of the butterfly valve.

INSTRUMENTATION SYSTEM

The instrumentation system monitors water level in the reservoir, via a pressure transmitter, valve open status, critical low temperature in the turbine building, intruder switch and fault detectors in the battery pack. Upon operator request, a status check of the monitoring systems is transmitted via satellite from Thirsk to the operator's computer station located in the Water Treatment Plant. The satellite antenna is located on the south dam thrust block. It is hard-wired to the control panel in the turbine building.

CONTROL SYSTEM

The PLC based control system is located in a control panel in the turbine panel. The control panel can be used to locally operate the exterior flow control valve to vary the outflow from the centre outlet through the arch dam. To operate the valve locally, the selector switch on the control panel must be set to "HAND" and the valve setting is modified using the "OPEN VALVE" and "CLOSE VALVE" buttons. Once the selector switch is returned to "AUTO", the valve will revert to the setting last selected by the operator at the water treatment plant. Remote control of the motorized outlet valve is performed through the operator interface screen at the water treatment plant. Buttons on the screen allow the operator to open and close the valve to the desired setting and acknowledge any alarms from the instrumentation system. The operator can observe the current reservoir water level and outlet valve setting and also a trend chart indicating reservoir levels and valve settings. The trend period is adjustable up to 400 days and is initially set at 90 days.

SPILLWAY

The 1941 spillway was completely demolished and removed. The replacement spillway structure is approximately 190 metres long. The spillway is 13.5 metres high at it deepest section. Founded on bedrock, the spillway contains over 6000 cubic metres of reinforced concrete and is secured by rock anchors along its upstream face. Inside the spillway there is an inspection chamber accessed from the downstream side of the spillway through a watertight marine door.

A study by GEPAC Consultants Ltd. In 1972 concluded that the concrete gravity spillway section of the dam is not stable under winter ice loading conditions unless the maximum level of the reservoir was not higher than 2.4 metres below the former spillway crest or EL. 1024.4m during the winter. It was concluded that the arch is stable under all design loading conditions.

There are three gated low level outlets in the arch dam. The gate stems are mounted on the upstream face of the dam and the handwheels are at crest level. The middle outlet is a 600mm diameter cast iron pipe and the other two outlets are 600mm square formed openings in the concrete. The inverts of all openings are at EL. 1010.8m. The opening gates are armoured with 3 aluminum fabricated trash racks. The south gate trash rack is fitted with a 600mm diameter HDPE bypass pipe extending upstream to allow for minimum flows during cleaning and maintenance of the gate area.

A7.6 THIRSK LAKE STORAGE AND SPILLWAY DATA

Table A7.1 - Thirsk Dam Reservoir Data

Water Level	Stored Volume	Water Level	Stored Volume	Water Level	Stored Volume	Water Level	Stored Volume
1010.8	0	1015.3	101	1019.8	989	1024.3	3142
1010.9	0	1015.4	111	1019.9	1023	1024.4	3197
1011.0	0	1015.5	120	1020.0	1055	1024.5	3261
1011.1	0	1015.6	127	1020.1	1100	1024.6	3326
1011.2	0	1015.7	137	1020.2	1134	1024.7	3392
1011.3	0	1015.8	149	1020.3	1168	1024.8	3458
1011.4	0	1015.9	159	1020.4	1215	1024.9	3524
1011.5	0	1016.0	169	1020.5	1251	1025.0	3590
1011.6	1	1016.1	183	1020.6	1287	1025.1	3657
1011.7	1	1016.2	194	1020.7	1324	1025.2	3724
1011.8	1	1016.3	206	1020.8	1373	1025.3	3791
1011.9	1	1016.4	217	1020.9	1410	1025.4	3859
1012.0	1	1016.5	234	1021.0	1448	1025.5	3927
1012.1	2	1016.6	247	1021.1	1499	1025.6	3995
1012.2	2	1016.7	260	1021.2	1537	1025.7	4063
1012.3	2	1016.8	274	1021.3	1576	1025.8	4132
1012.4	4	1016.9	292	1021.4	1617	1025.9	4201
1012.5	4	1017.0	306	1021.5	1670	1026.0	4270
1012.6	5	1017.1	321	1021.6	1712	1026.1	4340
1012.7	6	1017.2	342	1021.7	1754	1026.2	4410
1012.8	7	1017.3	356	1021.8	1810	1026.3	4480
1012.9	9	1017.4	373	1021.9	1853	1026.4	4551
1013.0	9	1017.5	390	1022.0	1896	1026.5	4622
1013.1	10	1017.6	412	1022.1	1940	1026.6	4693
1013.2	11	1017.7	429	1022.2	1999	1026.7	4765
1013.3	14	1017.8	447	1022.3	2044	1026.8	4837
1013.4	15	1017.9	470	1022.4	2090	1026.9	4909
1013.5	16	1018.0	488	1022.5	2135	1027.0	4982
1013.6	19	1018.1	508	1022.6	2197	1027.1	5055
1013.7	20	1018.2	528	1022.7	2244	1027.2	5128
1013.8	22	1018.3	555	1022.8	2291	1027.3	5202
1013.9	25	1018.4	576	1022.9	2355	1027.4	5276
1014.0	28	1018.5	598	1023.0	2404	1027.5	5350
1014.1	32	1018.6	628	1023.1	2452	1027.6	5425
1014.2	36	1018.7	653	1023.2	2502	1027.7	5500
1014.3	39	1018.8	676	1023.3	2567	1027.8	5576
1014.4	46	1018.9	702	1023.4	2617	1027.9	5652
1014.5	49	1019.0	736	1023.5	2668	1028.0	5730
1014.6	54	1019.1	762	1023.6	2736	1028.1	5809
1014.7	62	1019.2	789	1023.7	2786	1028.2	5889
1014.8	67	1019.3	818	1023.8	2838	1028.3	5969
1014.9	73	1019.4	856	1023.9	2891	1028.4	6049
1015.0	78	1019.5	886	1024.0	2962	1028.5	6130
1015.1	86	1019.6	916	1024.1	3015	1028.6	6211
1015.2	94	1019.7	957	1024.2	3069	1028.7	6293

This table is based on the table contained in the 1990 Operation and Maintenance Manual for Water Storage Dams supplemented by survey of the reservoir topography between elevation 1024.4m and 1028.7m

Last Updated March 2012

A7.7 THIRSK DAM EMERGENCY PLAN - ADDITIONAL ACTION LIST

NOTE: The following actions are to be used as a guide. Because every event is unique, some actions may need to be altered or added. Any significant alterations to this guide should be made by qualified personnel only.

See Section 5 of this document for equipment contractors, contacts and phone numbers not listed in this section.

ACCESS

From Hwy 97 in Summerland turn west onto Prairie Valley Rd. and follow signs to Faulder. From Faulder follow the Summerland-Princeton Road approximately 35 kms to the dam site. (If a dam failure has occurred, this route would most likely be impassable.) In the event of a dam failure alternate access can be gained from turning west off Hwy 97 in Peachland, onto Princeton Ave. Follow Princeton Ave. to the Peachland F.S.R. which will take you to kilometre 21 before turning left onto the Trout Main F.S.R. Follow the Trout Main until it ends at the Summerland-Princeton Road turn left to the dam site. Another route would be to come from the west end of the old Princeton Hwy. past Chain, Link and Osprey Lakes.

If dam failure has occurred or is soon to happen, use an alternate route only.

See the watershed area map in Appendix A.

ADDITIONAL DAM & SPILLWAY INFORMATION

Thirsk Dam is a concrete arch dam that has a maximum crest height of 21.3 metres above bedrock and a crest length of 47.5 metres, its elevation is 1025.3 metres. There are three 24" outlet control gates operated by hand wheels on the crest. Approximately 150 metres to the southeast is a free overflow concrete spillway with a crest height of 7.9 metres above bedrock and 67 metres in length. It is approximately 1.6 metres lower than the dam crest.

COMMUNICATIONS

Neither cell phone communication nor the District's radio communication system works from the dam site. The nearest location for radio (frequency 169.14) and cell phone communication outside of the Summerland area is at kilometre 8.5 on the Summerland-Princeton Road. Communication by both methods is weak at times.

ACTION LIST FOR: **DAM INCIDENT**

- ☐ Conduct complete inspection of site.
- ☐ Monitor dam site frequently enough to confirm conditions are not getting worse.
- ☐ Arrange meeting with local Dam Safety personnel and Engineering Consultants for repair advice.
- ☐ Close all upper dams to reduce inflow into Thirsk. (Whitehead, Crescent, Headwaters #1,2,3 and 4).
- ☐ With advice from a Professional Design Engineer, undertake any structural work that may reduce the possibility, or extent, of uncontrolled flow releases.

ACTION LIST FOR: **DAM ALERT**

- If additional staff members are available, delegate specific tasks as needed to complete the following actions. Record who is assigned and have them record what they have accomplished.
- Arrange a meeting with Dam Safety personnel and Engineering Consultants for advice/supervision on correcting the problem or minimizing damage.
- Close all upper dams to reduce inflow into Thirsk. (Whitehead, Crescent, Headwaters #1,2,3 and 4).
- If safe to do so and the operation of the outlet works will not have a negative effect on the integrity of the dam, begin to lower the reservoir water level.
- Monitor downstream releases to minimize water damage and diffuse potential problems.
- Continuously monitor dam site until all flood danger has passed, further damage is unlikely to occur and has been deemed safe by a qualified engineer.
- With advice from a Professional Design Engineer, undertake any structural work that may reduce the possibility, or extent, of uncontrolled flow releases.

ACTION LIST FOR: **DAM BREACH**

- If additional staff members are available, delegate specific tasks as needed to complete the following actions. Record who is assigned and have them record what they have accomplished.
- Begin calling notification list for properties along Trout Creek from Summerland to Thirsk, and advise them of situation. Also notify logging companies and Highways contractor that could possibly be in the area.
- Close all upper dams to reduce inflow into Thirsk. (Whitehead, Crescent, Headwaters #1,2,3 and 4). Use diversion ditch to route additional water to Peachland Lake if possible during freshest, when dams are spilling.
- Close the Trout Creek intake. See Water Quality Emergency Response Plan for loss of water, page 11.
- Arrange a meeting with Dam Safety personnel and Engineering Consultants for advice/supervision on minimizing damage.
- Contact helicopter service for possible surveillance and rescue.
- Continuously monitor dam site until all flood danger has passed, further damage is unlikely to occur and has been deemed safe by a qualified engineer.
- With advice from a Professional Design Engineer, undertake any structural work that may reduce the possibility, or extent, of uncontrolled flow releases.

POSSIBLE FLOOD AREAS

A flood area study has not been done. The areas listed are those which, in the opinion of the writer, may be impacted by floodwater in the event of a dam breech.

- All low lying areas between Thirsk and Okanagan Lake.
- The Summerland-Princeton Road at numerous locations, east of Thirsk.
- The Trout Creek Ranch property.
- All homes located in close proximity to Trout Creek in Faulder and heading east towards Summerland.
- The Summerland water intake on Trout Creek.
- The George's property on the Indian Reserve.
- The McNulty F.S.R. bridge at kilometre 0.
- Homes in the Trout Creek area of Summerland.

See the Watershed Area Map at the end of the Plan. The areas shaded in blue and green signify the approximate flood zone area.

DOWNSTREAM NOTIFICATION LIST

The following is a list of properties that will be the first impacted by floodwater and are not located in the Municipal boundary. Summerland will be covered under the Municipal Emergency Response Plan.

(Work in progress)

A7.8 THIRSK DAM – INSPECTION SCHEDULE, ARCHIVED RECORDS AND FORMS

A copy of this dam's inspection schedule can be found in Table 4.2 on Page 32.

The annual inspections, routine inspections, and other documentation regarding this dam can be accessed through the following links:

- Archived Routine Dam Inspection Reports
- Archived Annual Dam Inspection Reports
- Other Archived Documentation (Engineering, Measurement, Testing, etc)

Printable forms can be easily accessed by the following links:

- Routine Dam Inspection Form
- Annual Dam Inspection Form

Table A7.2 – Thirsk Dam – Record of Annual Inspections

Dam Name Thirsk Dam	Summerland Inspector or Consultant's Name	Date	Formal Inspection or DSR (Dam Safety Review)	Document Filed
Thirsk (all three)	Agua Consulting (Bob Hrasko)	2009-07	Formal	Y
Ministry of Environment	Ministry of Environment (Inspection Compliance for 2010 received)	2010	Formal	Y
Thirsk (all three)	District of Summerland (Shawn Hughes)	2011-2016	Formal	Y

Dam Name Thirsk Dam	Summerland Inspector or Consultant's Name	Date	Formal Inspection or DSR (Dam Safety Review)	Document Filed

A8 - TSUH (DEER) DAM

A8.1 TSUH RESERVOIR DAM - SPECIFICATION SHEET

General: This dam is located north of Trout Creek on the Deer Creek tributary to Trout Creek. It is very close to Aeneas Reservoir-Lakes.

Provincial Dam No.	D220197	
Water License Point Code	PD 54503	
Dam Type	Earth Fill	
Dam Function	Main	
In-Service Date	1976	
Dam Height	3.7 m	
Crest Elevation (m)	24.38 m (local datum)	
High Water Level (m)	23.20 m (local datum)	
Freeboard (m)	1.18 m	
Crest Length (m)	43 m	
Dam Coordinates		
DMS	49-45-19.64 N	119-57-32.44 W
UTM	287,755 E	5,514,713 N
Storage Volume (ML)	308 ML	

Other Comments _____

_____

Subcatchment Area (all 4 HW):	222 ha
Reservoir Surface Area:	15.8 ha
Reservoir Elevation:	1,569 m
Mean Subcatchment Elev.:	1,624 m
Ave. Reservoir Depth:	1.95 m

Water Storage Licenses

C-016414	370 ML

General Comments**:** The dam was rehabilitated in 1976. It drains directly into Trout Creek. The site is difficult to access year-round.

A8.2 TSUH (DEER) DAM PHOTOS AND FIGURES

Figure A8.1 - Tsuh (Deer) Reservoir Location

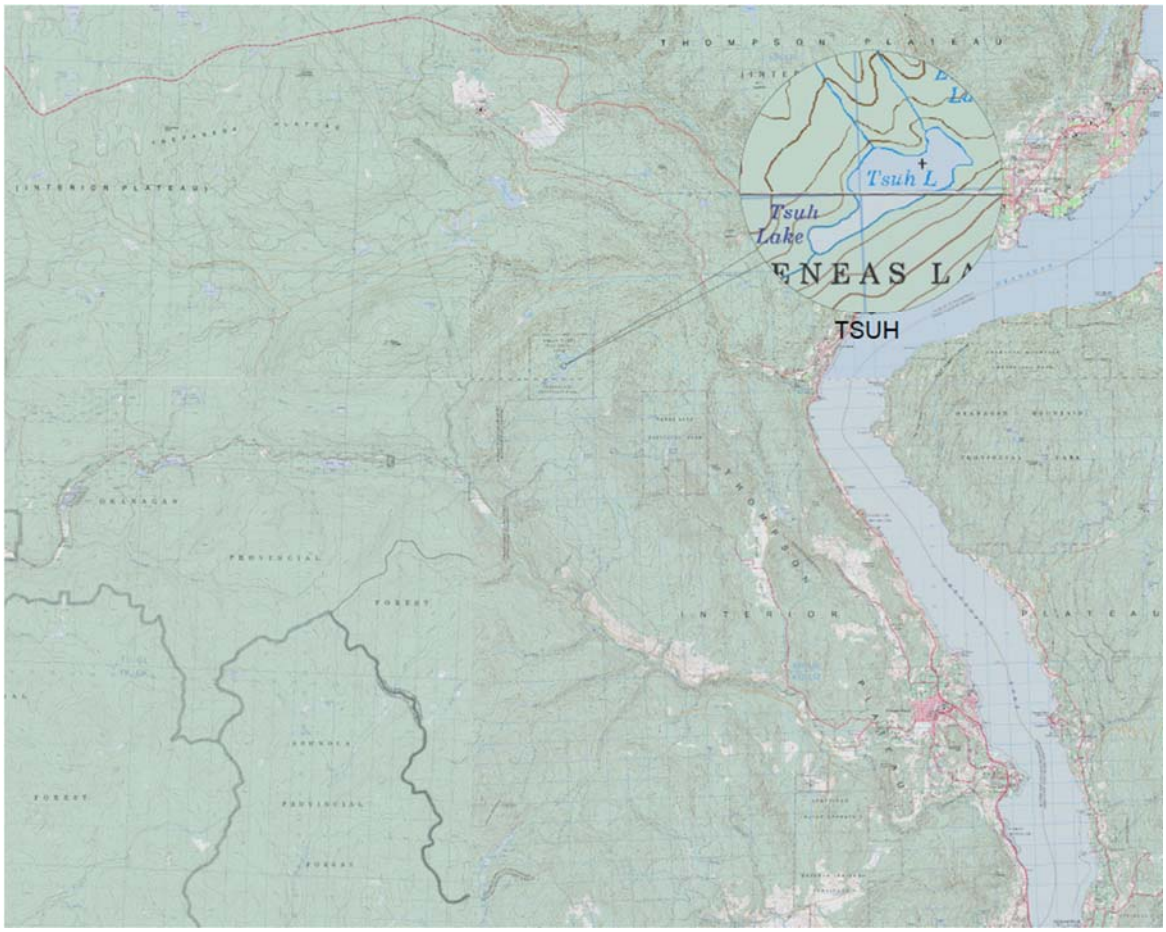


Figure A8.2 - Tsuh (Deer) Reservoir Aerial Photo

Figure A8.3 - Tsuh (Deer) Reservoir Spillway

Figure A8.4 – Tsuh (Deer) Reservoir Gate Control

Photo to be inserted when available

Figure A8.5 – Tsuh (Deer) Lake Dam

Photo to be inserted when available

A8.3 TSUH (DEER) RESERVOIR AND DAM - HISTORY AND TECHNICAL DATA

Tsuh (Deer) Lake is located in the headwaters of Tsuh Creek, close to the divide between the Trout Creek and Aeneas Creek watersheds. The drainage area to the dam is 2.43km^2 and the mean level of the watershed is at El. 1624.6 metres. The full supply level of the reservoir is at El. 1569.7 metres, approximately. All other levels refer to an arbitrary local datum.

The dam and spillway were rehabilitated in 1976. The existing embankment dam was removed and replaced. Seepage collars, a new intake and an extension to the downstream end of the low level outlet were added. A new spillway channel was also constructed.

The dam is a homogeneous embankment with a downstream toe filter in the area of maximum dam section at the outlet. The dam has a maximum height of 3.7 metres. The upstream slope is 3.oH:1.0V and the downstream slope is 2.5H:1.0V, although the downstream side has been over-built in some locations. The crest width is 3.7 metres and the crest length is about 42.7 metres. The crest level is at El. 24.38 metres (local datum).

The spillway is located on the right abutment. It consists of an excavated channel with an invert width of 3.7 metres and a slope of 0.4 percent (S = 0.005). The channel side slopes are 1.5H:1.0V. The control sections consist of a concrete slab in the channel bottom and sloping concrete slabs on the channel side slopes. The control section crest is at El. 23.2 metres.

The outlet works consist of a 53.3 cm diameter concrete pipe, some 21.3 metres in length, on a 1.0 percent slope. Flow control is provided by a fabricated steel gate with the gate stem mounted on a concrete beam cast on the upstream face of the dam. At the downstream end of the outlet works there is a reinforced concrete stilling basin and riprap protection in the outlet channel. The intake has a coarse trash rack screen of 3.2 millimetres galvanized 2.54 cm x 2.54 cm mesh and a stainless No. 8 mesh, 0.89 millimetres diameter wire fish screen. The gate sill is at El. 20.9 metres.

A8.4 TSUH (DEER) LAKE STORAGE AND SPILLWAY DATA

Table A8.1 - Tsuh (Deer) Dam Reservoir Data

Reservoir Elevation (m)	Flooded Area (ha)	Storage Volume (ML)	Comments
5.3	0.0	572	Dead Storage
20.7	9.2		
20.9	10.0(est.)	0	Gate Sill
21.3	12.2	48	
23.2	16.3	310	Spillway Crest
24.4	18.7	524	
27.4	22.7	1152	
30.5	30.7	1966	

Last Updated March 2012

Table A8.2 - Tsuh (Deer) Dam Spillway Discharge

Reservoir Elevation (m)	Spillway Discharge (m3/s)	Comments
23.2	0.0	Spillway Crest
23.3	0.4	
23.5	1.4	
23.6	2.5	
23.8	4.8	
23.9	7.1	
24.1	9.9	
24.2	13.0	
24.4	16.7	Crest of Dam

Last Updated March 2012

A8.5 TSUH (DEER) LAKE EMERGENCY PLAN - ADDITIONAL ACTION LIST

There are no additional actions required for this dam.

A8.6 TSUH (DEER) DAM – INSPECTION SCHEDULE, ARCHIVED RECORDS AND FORMS

A copy of this dam's inspection schedule can be found in Table 4.2 on Page 32.

The annual inspections, routine inspections, and other documentation regarding this dam can be accessed through the following links:

- Archived Routine Dam Inspection Reports
- Archived Annual Dam Inspection Reports
- Other Archived Documentation (Engineering, Measurement, Testing, etc.)

Printable forms can be easily accessed by the following links:

- Routine Dam Inspection Form
- Annual Dam Inspection Form

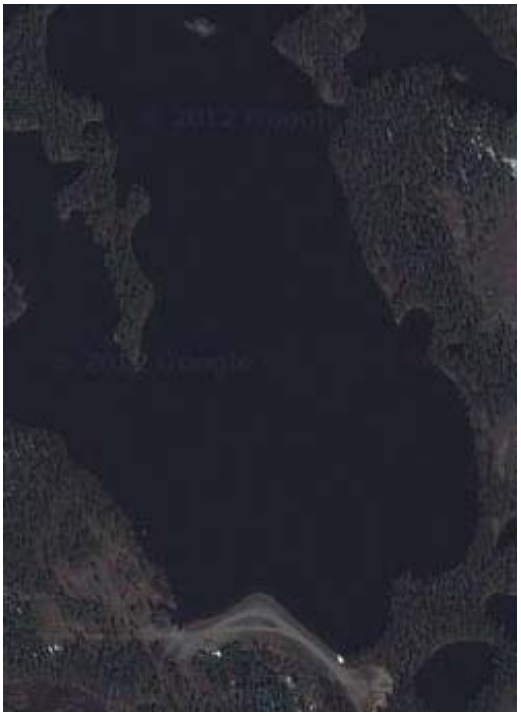
Table A8.3 – Tsuh (Deer) Dam – Record of Annual Inspections

Dam Name Tsuh Dam	Summerland Inspector or Consultant's Name	Date	Formal Inspection or DSR (Dam Safety Review)	Document Filed
Tsuh	Associated Eng. R.MacLean / Golder – Gerald Imada	2010-06	Formal	Y
Tsuh	District of Summerland Shawn Hughes	2011-2016	Formal	Y

A.9 ISINTOK DAM

A9.1 ISINTOK DAM - SPECIFICATION SHEET

General: This dam is located on Isintok Creek southwest of Summerland.



Provincial Dam No.	D220000	
Water License Point Code	PD 54500	
Dam Type	Earth Fill	
Dam Function	Main	
In-Service Date	1960	
Dam Height	10.0 m	
Crest Elevation (m)	1,647.7 m	
High Water Level (m)	1,645.6 m	
Freeboard (m)	2.1 m	
Crest Length (m)	137 m	
Dam Coordinates		
DMS	49-32-49.11 N	119-58-12.19 W
UTM	285,177 E	5,492,498 N
Storage Volume (ML)	1,384 ML	

Other Comments _____

_____

Subcatchment Area (all 4 HW):	1,631 ha
Reservoir Surface Area:	38.7 ha
Reservoir Elevation:	1,647 m
Mean Subcatchment Elev.:	1,780 m
Ave. Reservoir Depth:	3.58 m

Water Storage Licenses

C-016414	1665 ML

General Comments**:** The dam was constructed in 1960. Although it is at a high elevation, it is the closest to Summerland's water intake gates on Trout Creek.

A9.2 ISINTOK RESERVOIR PHOTOS AND FIGURES

Figure A9.1 - Isintok (Canyon) Reservoir Location

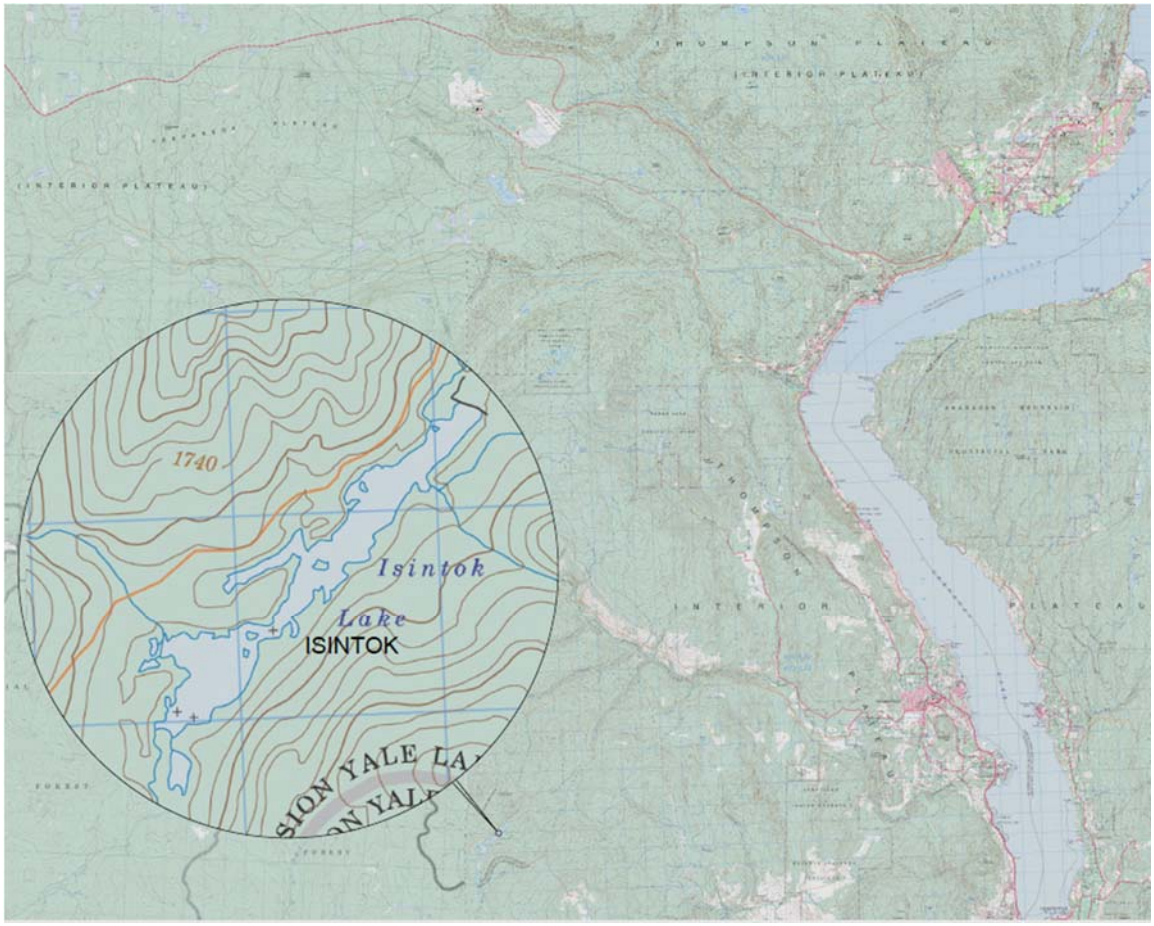


Figure A9.2 - Isintok (Canyon) Reservoir Aerial Photo

Figure A9.3 - Isintok (Canyon) Dam Spillway (lower right)

Figure A9.4 – Isintok (Canyon) Dam Gate Control

Figure A9.5 – Isintok (Canyon) Dam (crest)

A9.3 ISINTOK (CANYON) LAKE HISTORY AND TECHNICAL DATA

Isintok Lake Dam is located in the headwaters of Isintok Creek which discharges into Trout Creek at a point downstream of Thirsk Dam. The drainage area to the dam is 16.3km^2 and the mean level of the watershed is at El 1780.0 metres. The full supply level of the reservoir is at El. 1645.6 metres. The reservoir live storage is 44.7 hectares and the flooded area at full supply level is 1373 ml.

The dam was rehabilitated in 1959-60. Work at that time included flattening the downstream slope of the dam, the installation of a new intake gate, the extension of the low level outlet pipe and the construction of a new spillway weir. In 1972 a perforated drain pipe was installed on the downstream slope of the dam to control seepage during times of high reservoir level. At this time repairs were also made to the spillway channel and a second concrete control weir was added at a location some 45.7 metres downstream of the original structure.

The dam is a homogeneous earthfill embankment with a maximum height of 10 metres. The 6 metre wide crest at El. 1647.7 metres has a length of approximately 137 metres. The upstream slope is 3.0H:1.0V and the downstream slope is 6.0H:1.0V. Seepage drain pipes are provided under the downstream portion of the low level outlet pipe and for toe drains on the left and right abutments. There is also a 150 millimetre perforated drain pipe on the central part of the downstream slope of the dam that drains through a 150 millimetre non-perforated pipe to the outlet structure.

The spillway is 9.1 m wide and located on the left side of the reservoir, some 183 metres west of the left abutment of the dam. The spillway consists of two concrete control structures with a 46 metre long channel on a 0.8 percent slope between the two structures. The upstream structure has a width of 3.7 metres and the vertical side walls are 1.2 metres high. The downstream structure has a crest width of 4.6 metres and vertical side walls that are .76 metres high.

The low level outlet consists of a D-shaped concrete conduit with a cross-section area of about 0.30m^2. The downstream extension is a .76 metre diameter concrete pipe. The total conduit length is about 96 metres and it is on a slope of about 1.0 percent. Flow control is provided by an Armco slide gate with the gate stem mounted on a reinforced concrete beam cast on the upstream slope of the dam. The invert of the low level outlet pipe on the upstream side of the dam is at about El. 1637.7 metres, however, the drawings show an intake structure configuration that would limit the maximum drawdown level in the reservoir to El. 1638.5 metres. At the downstream end the pipe discharge enters a concrete stilling basin with riprap channel protection at the downstream end. Some 67 metres downstream of the stilling basin there is a 3.7 metre wide sharp crested weir founded on bedrock. The weir crest is at El. 1636.2 metres. The stage-discharge relationship for this weir is shown in the following table.

A9.4 ISINTOK (CANYON) RESERVOIR STORAGE AND SPILLWAY DATA

Table A9.1- Isintok Reservoir Stage-Storage Data

Reservoir Elevation (m)	Flooded Area (ha)	Storage Volume (ML)	Comments
1636.0	0.0	107	Dead Storage
1638.5	0.6	0	Gate Sill
1639.1	1.8	7	
1639.7	2.9	22	
1640.3	6.1	49	
1641.0	9.1	96	
1641.6	12.0	160	
1642.2	14.6	241	
1642.6	23.2	312	
1642.8	24.5	349	
1643.4	30.0	516	
1644.0	35.8	717	
1644.6	39.1	945	
1645.2	42.5	1193	
1645.6	44.7	1372	Spillway Crest
1647.7	55.7	2390	
1650.7	70.0	4305	

Last Updated March 2012

Table A9.2 - Isintok Lake Dam Spillway Discharge

Reservoir Elevation (m)	Spillway Discharge (m3/s)	Comments
1645.6	0.0	Spillway Crest
1645.8	0.4	
1645.9	1.0	
1646.1	1.8	
1646.2	2.8	
1646.4	3.8	
1646.5	5.1	
1647.7	16.7	Crest of Dam

Last Updated March 2012

Table A9.3 - Isintok Outlet Channel Weir Discharge

Reservoir Elevation (m)	Depth (m)	Spillway Discharge (m3/s)
1636.1	0	0
1636.2	0.06	0.1
1636.3	0.15	0.4
1636.5	0.3	1.2
1636.6	0.45	2.3

A9.5 ISINTOK DAM EMERGENCY PLAN - ADDITIONAL ACTION LIST

NOTE: The following actions are to be used as a guide. Because every event is unique, some actions may need to be altered or added. Any significant alterations to this guide should be made by qualified personnel only.

See the Section 5 for equipment contractors, contacts and phone numbers not listed in this section.

ACCESS

From Hwy 97 in Summerland turn west onto Prairie Valley Rd. and follow signs to the KVR Train Station. Continue over Trout Creek and follow the McNulty F.S.R. approximately 23 kilometres to the dam site. If a dam failure has occurred, this route may be impassable at kilometre 18, where Isintok Creek passes under a bridge.

Alternate access may be gained off the Summerland-Princeton Road, west of Osprey Lake. If dam failure has occurred or is soon to happen, use an alternate route only. See the Watershed Area Map in Appendix A.

ACTION LIST FOR: **DAM INCIDENT**

- Conduct complete survey inspection of site.
- Monitor dam site frequently enough to confirm conditions are not getting worse.
- Arrange meeting with local Dam Safety personnel and Engineering Consultants for repair advice.
- With advice from a Professional Design Engineer, undertake any structural work that may reduce the possibility, or extent, of uncontrolled flow releases.

ACTION LIST FOR: **DAM ALERT**

- If additional staff members are available, delegate specific tasks as needed to complete the following actions. Record who is assigned and have them record what they have accomplished.
- Arrange a meeting with Dam Safety personnel and Engineering Consultants for advice/supervision on correcting the problem or minimizing damage.
- If safe to do so and the operation of the outlet works will not have a negative effect on the integrity of the dam, begin to lower the reservoir water level.
- Monitor downstream releases to minimize water damage and diffuse potential problems.
- Continuously monitor dam site until all flood danger has passed, further damage is unlikely to occur and has been deemed safe by a qualified engineer.
- With advice from a Professional Design Engineer, undertake any structural work that may reduce the possibility, or extent, of uncontrolled flow releases.

ACTION LIST FOR: **DAM BREACH**

- If additional staff members are available, delegate specific tasks as needed to complete the following actions. Record who is assigned and have them record what they have accomplished.
- Begin calling the notification list for properties along Trout Creek from Summerland to Faulder and advise them of the situation.
- Notify logging companies that could be in the area.
- Arrange a meeting with Dam Safety personnel and Engineering Consultants for advice/supervision on minimizing damage.
- Partially close Thirsk dam to minimize Trout Creek flows.
- Close the Trout Creek intake. See Water Quality Emergency Response Plan for loss of water, page 11.
- Contact helicopter service for possible surveillance and rescue.
- Continuously monitor dam site until all flood danger has passed, further damage is unlikely to occur and has been deemed safe by a qualified engineer.
- With advice from a Professional Design Engineer, undertake any structural work that may reduce the possibility, or extent, of uncontrolled flow releases.

COMMUNICATIONS

Cell phone communication at the dam site is marginal at best and non-existent on route. The District's radio (frequency 169.14) communication system works from the dam site only.

POSSIBLE FLOOD AREAS

A flood area study has not been done. The areas listed are those which may be impacted by flood water in the event of a dam breach.

- All low lying areas between Isintok and Okanagan Lake.
- All homes located in close proximity to Trout Creek in Faulder and heading east towards Summerland.
- The Summerland water intake on Trout Creek.
- The George's property on the Indian Reserve.
- The McNulty F.S.R. bridge at kilometre 0.
- Homes in Trout Creek, Summerland.

DOWNSTREAM NOTIFICATION LIST

The following is a list of residents who will be the first or greatest impacted by floodwater and are not located in the municipal boundary of Summerland. Summerland will be covered under the Municipal Emergency Response Plan. (Work in progress)

A9.6 ISINTOK (CANYON) DAM – INSPECTION SCHEDULE, ARCHIVED RECORDS AND FORMS

A copy of this dam's inspection schedule can be found in Table 4.2 on Page 32.

The annual inspections, routine inspections, and other documentation regarding this dam can be accessed through the following links:

- Archived Routine Dam Inspection Reports
- Archived Annual Dam Inspection Reports
- Other Archived Documentation (Engineering, Measurement, Testing, etc.)

Printable forms can be easily accessed by the following links:

- Routine Dam Inspection Form
- Annual Dam Inspection Form

Table A9.4 – Isintok (Canyon) Dam – Record of Annual Inspections

Dam Name Isintok Dam	Summerland Inspector or Consultant's Name	Date	Formal Inspection or DSR (Dam Safety Review)	Document Filed
Isintok Dam	Agua Consulting (Bob Hrasko)	2009-07	Formal	Y
Isintok Dam	District of Summerland Shawn Hughes	2011-2016	Routine	Y

A.10 SUMMERLAND BALANCING RESERVOIR

A10.1 SUMMERLAND RESERVOIR DAM - SPECIFICATION SHEET

General: Although the water retaining berms holding back the water from this reservoir are not considered or rated as a dam by the province, the site is directly above Prairie Valley in Summerland and seepage monitoring is necessary.

Provincial Dam No.	Not applicable	
Water License Point Code	n/a	
Dam Type	Earth Fill, natural berm	
Dam Function	Balancing reservoir	
In-Service Date	1977	
Dam Height	n/a	
Crest Elevation (m)	n/a	
High Water Level (m)	n/a	
Freeboard (m)	1.5 m (est.)	
Crest Length (m)		
Dam Coordinates		
DMS	49-35-27.99 N	119-43-30.97 W
UTM	303,048 E	5,496,734 N
Storage Volume (ML)	69 ML	

Other Comments _____

_____

Subcatchment Area (all 4 HW):	68209 ha
Reservoir Surface Area:	6.9 ha
Reservoir Elevation:	595.1 m
Mean Subcatchment Elev.:	n/a m
Ave. Reservoir Depth:	1.00 m

Water Storage Licenses

General Comments**:** The reservoir was constructed in 1977 under the ARDA program. It is for daily balancing of the flows from Trout Creek.

A10.2 SUMMERLAND (TROUT CREEK) BALANCING RESERVOIR PHOTOS

Figure A10.1 - Summerland (Trout Creek) Balancing Reservoir Location

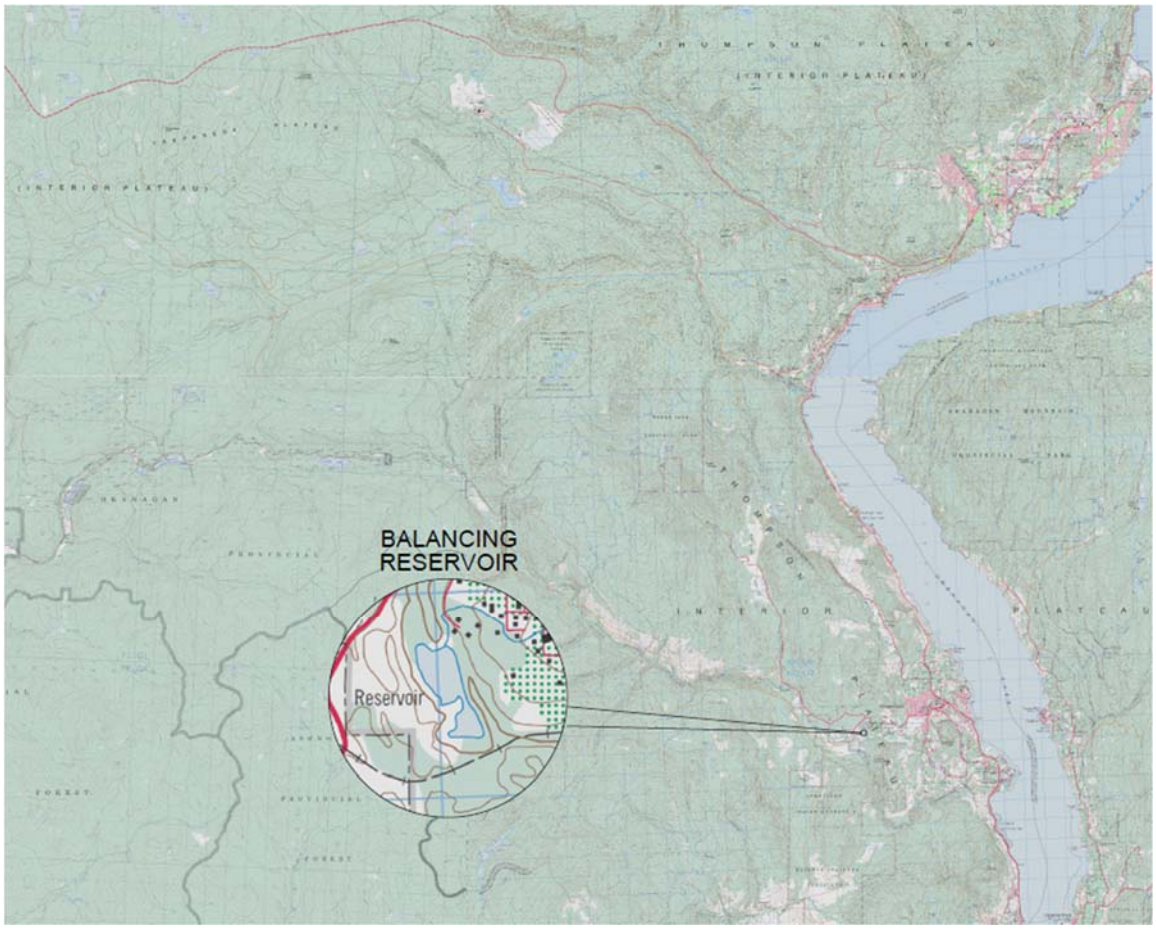
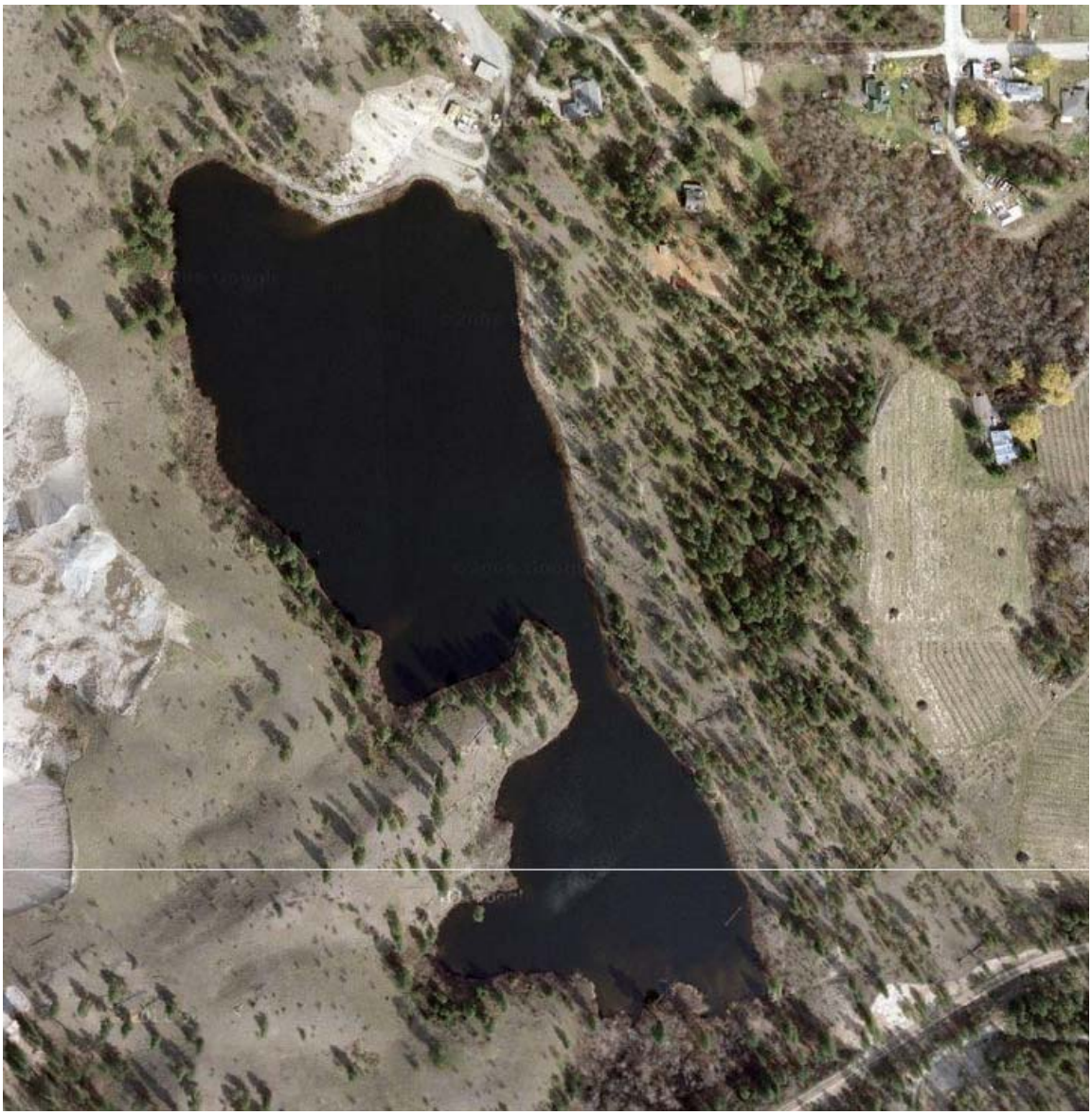


Figure A10.2 - Summerland (Trout Creek) Balancing Reservoir Aerial Photo



A10.3 SUMMERLAND BALANCING RESERVOIR - HISTORY AND TECHNICAL DATA

The Summerland Balancing Reservoir is located adjacent to and at the south end of Aileen Avenue which runs in a southerly direction from the west end of Prairie Valley Road. It lies in a natural depression between Bathville Road and the KVR right of way.

The Reservoir is fed by gravity from Trout Creek in a concrete flume and a winter pipeline which conveys water from an intake structure on Trout Creek a distance of approximately 1,500 m to the south end of the Reservoir. The overall catchment area of the Reservoir is approximately 68,000 ha and it occupies an area of 6.9 ha at full pool. It contains 69 ML of live storage which is used to balance differences in flows in Trout Creek from Summerland's overall water demand.

The Reservoir level is managed to maintain 'hydraulic mounding' to prevent leachate beneath the nearby landfill from entering the water supply. The principle is that if the water level in the Reservoir is maintained at or above a prescribed level, there will be sufficient hydraulic pressure within the Reservoir to prevent potential leachate flow towards the water supply. To do this, the water level is kept above 595.1 m. This results in a usable Reservoir depth of less than 1 metre.

The level in the Reservoir is maintained by controlling flow into to the concrete flume and winter pipeline. This is done with an intake slide gate system which is checked on a daily basis as a minimum and more frequently as required. The intake system and flume are totally surrounded by chain link fencing and are locked. A SCADA system allows for constant remote monitoring and recording of the Reservoir level. It is also checked in person by staff on a daily basis. There is a Water Technician on duty or on call 24 hours per day, 7 days per week. There is also an alarm system which notifies Water System personnel of irregular conditions.

The Reservoir is directly connected at its northeast corner to the District of Summerland Water Distribution System. Water enters the piping system by passing through a coarse screen structure located in the Reservoir itself. It then flows through a dual chambered screening works which houses large 25-mesh stainless steel screens. From this point, the water is metered and the portion which is used for irrigation in the Prairie Valley area is chlorinated. The remainder continues to the Water Treatment Plant (WTP) where it undergoes full treatment. The wet well of the WTP is also monitored by SCADA and is alarmed. The reservoir and screening works were built during the 1977 A.R.D.A project.

The Balancing Reservoir has no spillway structure. Measurements have shown that groundwater losses within the Reservoir are estimated to be between 3.6 and 4.5 ML/day.

A10.4 SUMMERLAND (TROUT CREEK) BALANCING RESERVOIR STORAGE AND SPILLWAY

Table A10.1 - Summerland (Trout Creek) Balancing Reservoir Storage Table

	Storage in ML									
m	**0**	**0.1**	**0.2**	**0.3**	**0.4**	**0.5**	**0.6**	**0.7**	**0.8**	**0.9**
0	0.0	5.0	10.4	15.7	21.2	26.7	32.3	37.9	43.6	49.4
1	55.2	61.1	67.0	73.0	79.1	85.2	91.4	97.6	103.9	110.2
2	116.6	123.1	129.7	136.2	142.9	149.6	156.4	163.2	170.1	177.1
3	184.1	191.1	198.3	205.5	212.7	220.0	227.4	234.8	242.3	249.9
4	257.5	265.2	272.9	280.7	288.5	296.4	304.4	312.4	320.5	328.7
5	336.9	345.2	353.5	361.9	370.3	378.8	387.4	396.0	404.7	413.5
6	422.3	431.1	440.1	449.0	458.1	467.2	476.4	485.6	494.9	504.2
7	513.6	523.1	532.6	542.2						

Last Updated March 2012

A10.5 SUMMERLAND BALANCING RESERVOIR
INSPECTION SCHEDULE, ARCHIVED RECORDS AND FORMS

A copy of this dam's inspection schedule can be found in Table 4.2 on Page 32.

The annual inspections, routine inspections, and other documentation regarding this dam can be accessed through the following links:

- Archived Routine Dam Inspection Reports
- Archived Annual Dam Inspection Reports
- Other Archived Documentation (Engineering, Measurement, Testing, etc.)

Printable forms can be easily accessed by the following links:

- Routine Dam Inspection Form
- Annual Dam Inspection Form

Table A10.2 – Summerland (Trout Creek) – Record of Annual Inspections

Dam Name Summerland Balancing Res.	Summerland Inspector or Consultant's Name	Date	Formal Inspection or DSR (Dam Safety Review)	Document Filed
Summerland Balancing Reservoir	Associated Engineering R.MacLean, Golder Associates – G. Imada	2010-07	Formal (equivalent)	Y
Summerland Balancing Reservoir	District of Summerland Shawn Hughes	2011-2016	Formal	Y

A.11 GARNETT DAM

A11.1 GARNETT RESERVOIR DAM - SPECIFICATION SHEET

General: This dam is located 12 km northwest of Summerland up Garnett valley

Provincial Dam No.	D220001-00	
Water License Point Code	PD 54596	
Dam Type	Earth Fill	
Dam Function	Main	
In-Service Date	1975	
Dam Height	14 m (est.)	
Crest Elevation (m)	634.6 m	
High Water Level (m)	632.7 m	
Freeboard (m)	1.90 m	
Crest Length (m)	85 m	
Dam Coordinates		
DMS	49-41-07.43 N	119-46-29.63 W
UTM	299,855 E	5,507,350 N
Storage Volume (ML)	2,360 ML	

Other Comments _____

_____

Subcatchment Area (all 4 HW):	9,100 ha
Reservoir Surface Area:	38.3 ha
Reservoir Elevation:	634 m
Mean Subcatchment Elev.:	1,200 m
Ave. Reservoir Depth:	6.16 m

Water Storage Licenses

C-016416	2,466 ML

General Comments**:** The dam was reconstructed in 1975 immediately downstream of the first dam site on Aeneas Creek.

A11.2 GARNETT DAM PHOTOS AND FIGURES

Figure A11.1 - Garnett Reservoir Location

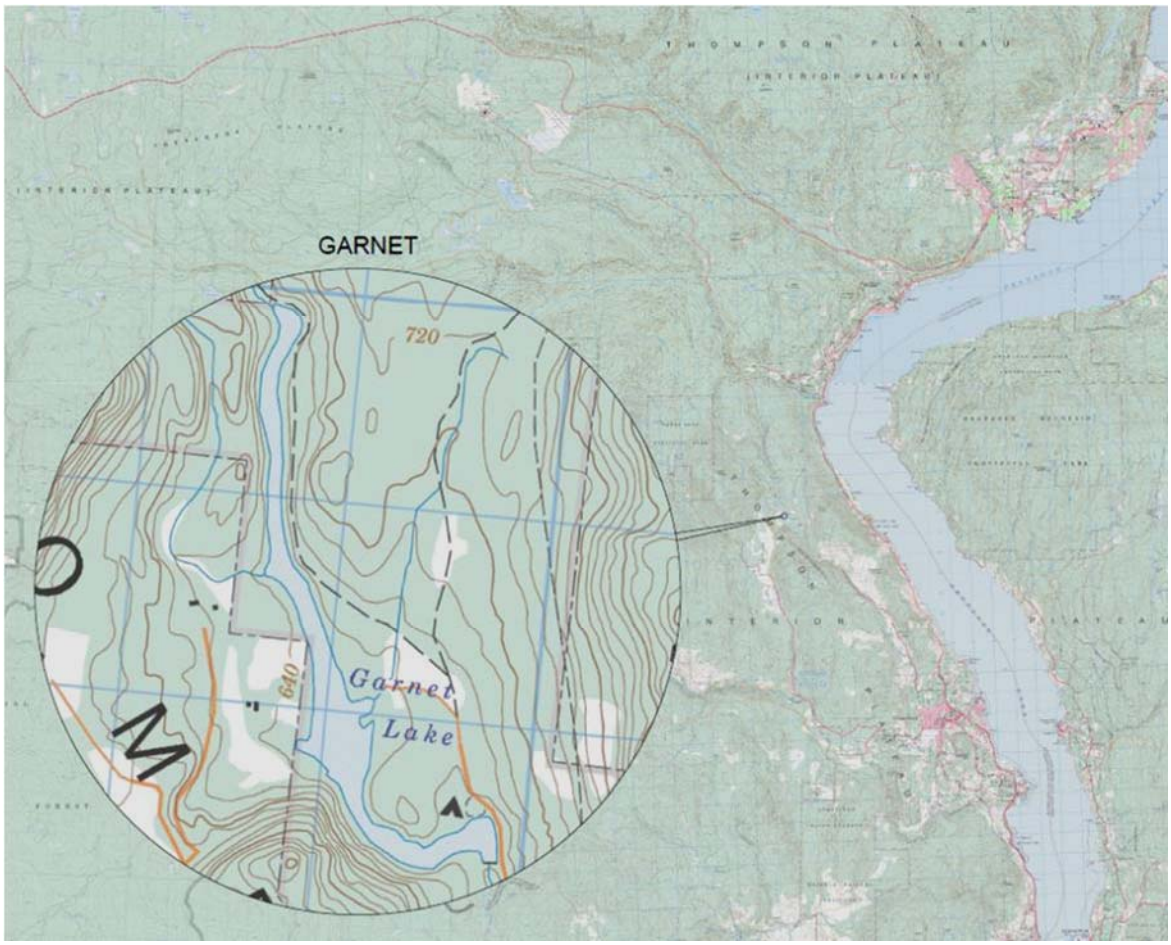
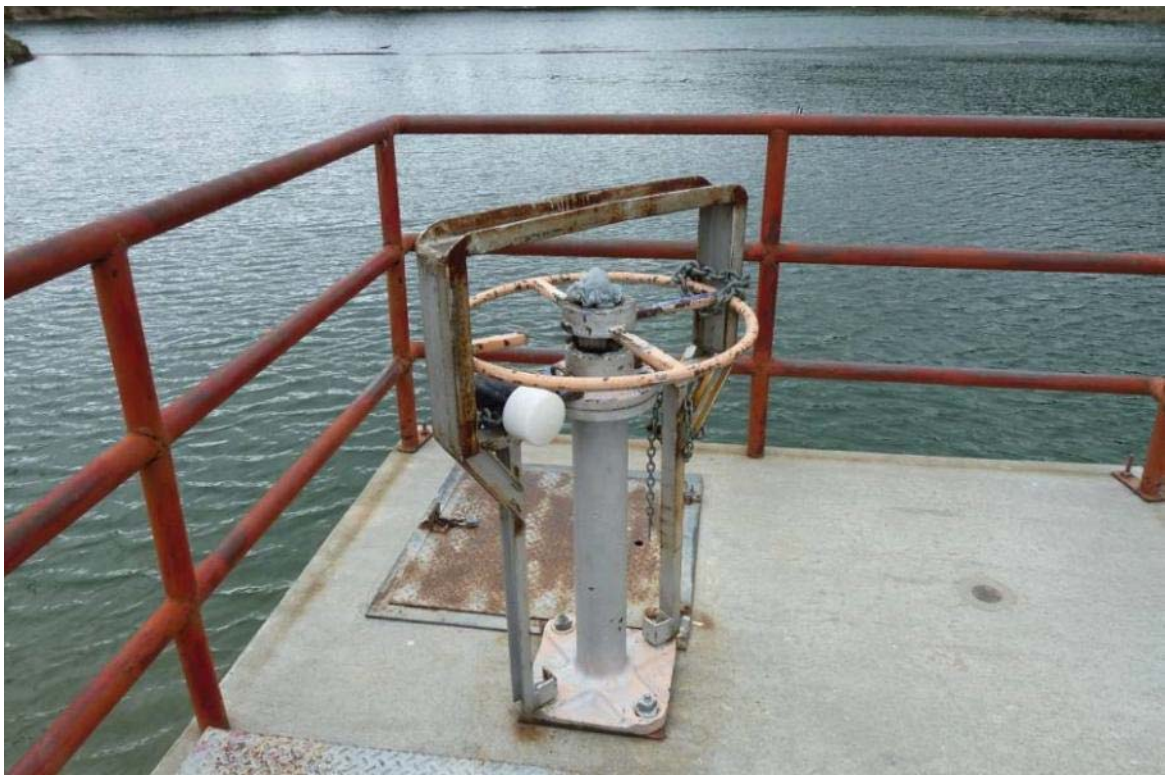


Figure A11.2 - Garnett Reservoir Aerial Photo

Figure A11.3 - Garnett Dam Spillway

Figure A11.4 – Garnett Dam Gate Control



A11.3 GARNETT DAM HISTORY AND TECHNICAL DATA

Garnett Lake Dam, located on Aeneas Creek, lies some 12 km northwest of Summerland. There is a chlorine injection facility at the dam and water enters the distribution system form a pressure pipeline connected to the dam outlet works.

The Meadow Valley Irrigation District has the right to divert up to 616 ML of water from Lapsley Creek in the Aeneas headwaters to Darke Creek. This diversion can only be used once the reservoir at Garnett Dam has received 1850 ML of water during the freshet or if there is no doubt that the reservoir will fill during the freshet.

The drainage area to the dam is 56.7 km^2 and the mean level of the watershed is at El. 999.7 metres. The full supply level of the reservoir is at El. 632.7 metres.

A new dam, spillway and low level outlet works were constructed at a site some 91 metres downstream of the old facilities in 1975.

The crest of the dam at El. 634.6 metres has a width of 1.7 metres and a length of approximately 85 metres. The dam is a homogeneous embankment of well graded silty sand and gravel obtained from a borrow pit located immediately upstream of the old dam. To improve stability under rapid drawdown of the reservoir, the upstream section of the dam contains blanket drain layers at El. 625.4 metres, El. 627.9 metres, and El. 630.3 metres. The downstream section of the dam has a filter blanket at the foundation contact and a pervious toe with beams at El. 623.3 metres and El. 628.5 metres. The downstream toe section is protected from erosion by a layer of rock fill obtained from talus slopes downstream of the dam. The upstream slope for the dam is 2.5H:1.0V and the downstream section has an overall average slope of about 12.7H:1.0V which is made up 2.0H:1.0V embankment sections and beams. Design notes indicate the factors of safety are 2.0 for the downstream slope and 1.5 for the upstream slope under rapid drawdown conditions. An impervious upstream blanket and a foundation cutoff trench in the area of the old streambed limit the amount of seepage form the reservoir. Seepage can be measured from two 150 millimetre diameter perforated drain pipes in the filter blanket.

The spillway is located on the left abutment. The spillway crest is at El. 632.7 metres and it consists of a concrete lined channel for the first 50 metres and a riprap lined channel for the remaining 107 metres where the spillway discharges in Aeneas Creek downstream of the dam. The concrete crest control section has a width of 12 metres and the concrete side walls at 1.5H:1.0V extend up to El. 635 metres. The probable maximum flood has been estimated as 53 m^3/s.

A11.4 GARNETT DAM STORAGE AND SPILLWAY DATA

Table A11.1 - Garnett Lake Reservoir Data

Reservoir Elevation (m)	Flooded Area (ha)	Storage Volume (ML)	Comments
613.7	0.0	-422	Dead Storage
622.4	7.9		
622.8	8.6 (est.)	0	Gate Sill
623.3	8.8	23	
623.6	9.2	52	
624.8	12.1	184	
626.1	17.1	364	
627.3	22.5	609	
628.5	26.8	912	
629.6	31.0	1270	
630.9	36.2	1688	
632.7	39.4 (est.)	2339	Spillway Crest
634.0	41.7	2876	
637.0	46.3	4222	
640.1	51.8	5689	

Last Updated March 2012

Table A11.2 - Garnett Lake Dam Spillway Discharge

Reservoir Elevation (m)	Spillway Discharge (cms)	Comments
632.7	0.0	Spillway Crest
633.1	4.0	
633.4	11.3	
633.7	21.2	
634.0	33.4	
634.3	47.9	
634.6	64.3	Crest of Dam

A11.5 GARNETT DAM EMERGENCY PLAN - ADDITIONAL ACTION LIST

NOTE: The following actions are to be used as a guide. Because every event is unique, some actions may need to be altered or added. Any significant alterations to this guide should be made by qualified personnel only.

ADDITIONAL DAM & SPILLWAY INFORMATION

Garnett Valley Dam is composed of well-graded sand and gravel with a crest width of 3.7m and a length of approximately 85m. There is one 600mm low level outlet gate controlled by a wheel on a concrete tower off the upstream slope of the dam. The spillway entrance is a concrete lined channel located on the left abutment.

ACCESS

Follow Jones Flat Rd. west from Hwy 97 for approximately 1.4 kilometres, then travel north on Garnett Valley Rd. for 10.6 kilometres to the dam. If Garnett Valley Rd. is passable only to Wildhorse Rd., the gas line road will provide a route to the dam. In the event of a total road washout, alternate access may be gained off Hwy 97 through an unlocked gated fence located 2 kilometres south of Deep Creek near Peachland. Re-grading of the dirt road up the mountain may be necessary to make vehicular passage to the trail network heading south to Garnett Lake.

If dam failure has occurred or is soon to happen, use an alternate route only. See the watershed area maps in Appendix A.

ACTION LIST FOR: **DAM INCIDENT**

- Conduct complete inspection of site.
- Monitor dam site frequently enough to confirm conditions are not getting worse.
- Arrange meeting with Dam Safety personnel and Engineering Consultants for repair advice.
- With advice from a Professional Design Engineer, undertake any structural work that may reduce the possibility, or extent, of uncontrolled flow releases.

ACTION LIST FOR: **DAM ALERT**

- If additional staff members are available, delegate specific tasks as needed to complete the following actions. Record who is assigned and have them record what they have accomplished.
- Arrange a meeting with Dam Safety personnel and Engineering Consultants for advice/supervision on correcting the problem or minimizing damage.
- Contact Allan Wiens (Home – 250 494 1139), (cell - 809 6770) or Pat Woods (Home 250 – 494 1997 or Cell 250-488-0278) to ensure the Dark Lake diversion is not contributing to Garnett Lake inflow.

- If safe to do so and the operation of the outlet works will not have a negative effect on the integrity of the dam, begin to lower the reservoir water level.
- Monitor downstream releases to minimize water damage and diffuse potential problems.
- Continuously monitor the dam site until all flood danger has passed, further damage is unlikely to occur and has been deemed safe by a qualified engineer.
- With advice from a Professional Design Engineer, undertake any structural work that may reduce the possibility, or extent, of uncontrolled flow releases.

ACTION LIST FOR: **DAM BREACH**

- If additional staff members are available, delegate specific tasks as needed to complete the following actions. Record who is assigned and have them record what they have accomplished.
- Begin calling the Garnet Valley downstream notification list to advise residents to immediately evacuate to high ground. The evacuation or notification of other Summerland residents will be handled through the Municipal Emergency Plan. Use radio and television contacts to help get the message out quickly.
- Arrange a meeting with Dam Safety personnel and Engineering Consultants for advice/supervision on minimizing damage.
- Contact Allan Wiens (Home – 250 494 1139), (cell - 809 6770 or 809 6771) or Pat Woods (Home 250 – 494 1997) to ensure the Dark Lake diversion is not contributing to Garnet Lake inflow.
- Contact helicopter service for possible surveillance and rescue.
- Contact BRENTAG @ (604 685 5036) for possible spill cleanup. (chlorine)
- Continuously monitor dam site until all flood danger has passed, further damage is unlikely to occur and has been deemed safe by a qualified engineer.
- With advice from a Professional Design Engineer, undertake any structural work that may reduce the possibility, or extent, of uncontrolled flow releases.

COMMUNICATIONS

The Corporation of Summerland has portable handheld and truck radios which can communicate to the Works Yard base (frequency 169.14) and one another from most locations in Garnett Valley. Cell phone communication is also possible at the dam site.

POSSIBLE FLOOD AREAS

(Work in Progress)

DOWNSTREAM NOTIFICATION LIST (will be updated with information within the Garnett Inundation Study)

Attach a list of properties impacted by breach on separate sheet here. (Work in progress)

A11.6 GARNETT DAM – INSPECTION SCHEDULE, ARCHIVED RECORDS AND FORMS

A copy of this dam's inspection schedule can be found in Table 4.2 on Page 32.

The annual inspections, routine inspections, and other documentation regarding this dam can be accessed through the following links:

- Archived Routine Dam Inspection Reports
- Archived Annual Dam Inspection Reports
- Other Archived Documentation (Engineering, Measurement, Testing, etc.)

Printable forms can be easily accessed by the following links:

- Routine Dam Inspection Form
- Annual Dam Inspection Form

Table A11.3 –Garnett Dam – Record of Annual Inspections

Dam Name Garnett Dam	Summerland Inspector or Consultant's Name	Date	Formal Inspection or DSR (Dam Safety Review)	Document Filed
Garnett Dam	Agua Consulting (Bob Hrasko)	2009-07	Formal	Y
Garnett Dam	Associated Eng. R.MacLean, Golder Associates G.Imada	2010-06	Formal	Y
Garnett Dam	District of Summerland Shawn Hughes	2011-2016	Formal	Y

Dam Name Garnett Dam	Summerland Inspector or Consultant's Name	Date	Formal Inspection or DSR (Dam Safety Review)	Document Filed

A.12 AENEAS RESERVOIR DAM

A12.1 AENEAS RESERVOIR DAM - SPECIFICATION SHEET

General: This dam is located on the northernmost lower lake of the Aeneas Lakes chain.

Provincial Dam No.	D220140-00	
Water License Point Code	PD 54585	
Dam Type	Earth Fill	
Dam Function	Main	
In-Service Date	1975 (rehabilitation)	
Dam Height	3.7 m	
Crest Elevation (m)	1,356.7 m	
High Water Level (m)	1,355.4 m	
Freeboard (m)	1.3 m	
Crest Length (m)	61 m	
Dam Coordinates		
DMS	49-45-46.55 N	119-55-33.69 W
UTM	289,286 E	5,516,383 N
Storage Volume (ML)	148 ML	

Other Comments _____

_____

Subcatchment Area (all 4 HW):	3,108 ha
Reservoir Surface Area:	22.4 ha
Reservoir Elevation:	1,569 m
Mean Subcatchment Elev.:	1,612 m
Ave. Reservoir Depth:	4.0 m

Water Storage Licenses

C-056869	444 ML

General Comments**:** The dam was rehabilitated in 1975. It drains directly into Aeneas Creek which feeds Garnett Reservoir.

A12.2 AENEAS DAM PHOTOS AND FIGURES

Figure A12.1 - Aeneas Dam Location

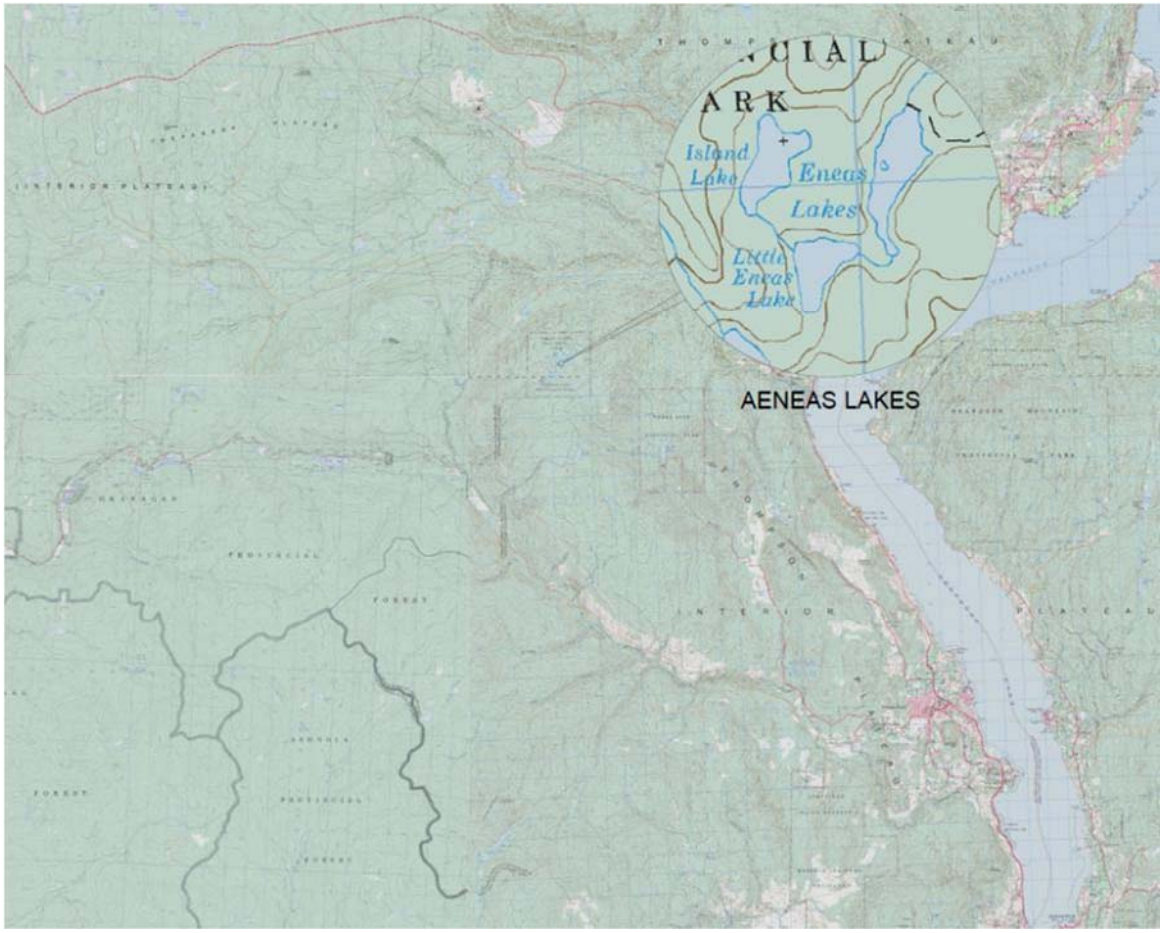


Figure A12.2 - Aeneas Lakes Aerial Photo

Figure A12.3 - Aeneas Lakes Spillway

Figure A12.4 – Aeneas Lakes Gate Control

Photo not yet available

12.3 AENEAS LAKES HISTORY AND TECHNICAL DATA

Aeneas Lake Dam is located in the headwaters of Finlay Creek, a tributary to Aeneas Creek, close to the divide between the Trout Creek and the Aeneas Creek watersheds. The drainage area to the dam is 2.59km^2 and the mean level of the watershed is at El. 1612.4 metres. Island Lake and Little Aeneas Lake are located upstream of the reservoir, but do not contribute any live storage. The full supply level of the reservoir is at El. 1569.7 metres, approximately. All other levels refer to an arbitrary local datum.

The dam was rehabilitated in 1975. Work consisted of increasing the height and flattening the side slope on the embankment dam, installation of a new low level outlet and construction of a new spillway channel.

The earthfill dam is a homogeneous embankment with a pervious filter blanket under the downstream portion of the new embankment. The dam has a maximum height of 3.7 metres and the crest is at El. 28.7 metres. The upstream slope is 3.0H:1.0V and the downstream slope is 2.5H:1.0V. The crest width is 3.7 metres and the crest length is approximately 61 metres.

The spillway on the left abutment consists of an excavated channel with an invert width of 4.6 metres and a slope of about 4 percent. The control section consists of a concrete slab with the invert at El. 27.43 metres, with vertical concrete side walls rising to El. 28.65 metres. There is some bedrock exposure in the approach channel upstream of the control weir.

The outlet works consist of a 450 millimetre diameter ductile iron pipe on a slope of 0.5 percent. The pipe has reinforced concrete bedding and seepage cutoff collars. Some bedrock excavation and clay till backfill was required to provide a uniform soil foundation for the pipe. The outlet pipe is 22.9 metres in length and terminates in a concrete outlet structure with riprap protection in the downstream channel. There is no toe drain pipes associated with the outlet structure. Flow control is provided by a fabricated steel slide gate with the gate stem mounted on a reinforced concrete beam cast on the upstream face of the dam. The intake has a coarse trash rack screen of 3.17 millimetres galvanized 2.54mm x 2.54mm mesh and a stainless steel No. 8 mesh, 0.89 millimetres diameter wire fish screen. The gate sill is at El. 25.39 metres.

12.4 AENEAS LAKES STORAGE AND SPILLWAY DATA

Table A12.1 - Big Aeneas Stage-Storage Table

	Storage in ML									
Feet	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	0.0	1.7	3.5	5.2	7.0	8.8	10.6	12.4	14.2	16.1
1	17.9	19.8	21.7	23.6	25.6	27.5	29.5	31.5	33.5	35.5
2	37.5	39.6	41.6	43.7	45.8	47.9	50.1	52.2	54.4	56.6
3	58.8	61.0	63.2	65.5	67.7	70.0	72.3	74.6	76.9	79.3
4	81.6	84.0	86.4	88.8	91.2	93.7	96.1	98.6	101.1	103.6
5	106.1	108.7	111.2	113.8	116.4	119.1	121.7	124.4	127.0	129.7
6	132.5	135.2	138.0	140.7	143.5	146.3	149.2	152.0		
SPILLWAY @ 6.70 ft and 152.0 ML										

Last Updated March 2012

TableA12.2- Aeneas Lake Reservoir Data

Reservoir Elevation (m)	Flooded Area (ha)	Storage Volume (ML)	Comments
17.1	0	-143	Dead Storage
25	4.9		
25.4	5.6	0	Gate Sill
25.6	6	19	
26.2	7.1	59	
26.8	8.1	107	
27.4	9.4	152	Spillway Crest
30.5	34.8	947	
33.5	47.1	2164	

Last Updated March 2012

Table A12.3 - Aeneas Lake Dam Spillway Discharge

Reservoir Elevation (m)	Spillway Discharge (cms)	Comments
27.4	0	Spillway Crest
27.6	0.4	
27.7	1.1	
27.9	2.1	
28	3.4	
28.2	4.7	
28.3	6.2	
28.5	7.8	
28.7	9.5	Crest of Dam

Last Updated March 2012

12.5 AENEAS LAKES EMERGENCY PLAN – ADDITIONAL ACTION LIST

There are no additional actions required for this dam.

12.6 AENEAS RESERVOIR DAM – INSPECTION SCHEDULE, ARCHIVED RECORDS AND FORMS

A copy of this dam's inspection schedule can be found in Table 4.2 on Page 32.

The annual inspections, routine inspections, and other documentation regarding this dam can be accessed through the following links:

- Archived Routine Dam Inspection Reports
- Archived Annual Dam Inspection Reports
- Other Archived Documentation (Engineering, Measurement, Testing, etc.)

Printable forms can be easily accessed by the following links:

- Routine Dam Inspection Form
- Annual Dam Inspection Form

Table A12.4 – Aeneas Reservoir Dam – Record of Annual Inspections

Dam Name Aneas Dam	Summerland Inspector or Consultant's Name	Date	Formal Inspection or DSR (Dam Safety Review)	Document Filed
Aeneas Dam	Associated Engineering (R. MacLean / G. Imada)	2010-06	DSR	Y
Aeneas Dam	District of Summerland (Shawn Hughes / Rodney Yurick)	2011-2016	Formal	Y

APPENDIX B – SUMMARY OF WATER LICENCES

Table 3.1 District of Summerland – Existing Water Licences Summary

Lic. No	Stream Name	Purpose	Quantity	Units	Storage	WWLA	Irrig.	Status	Priority	Issued
C014568	Trout Creek (Thirsk Reservoir)	Storage	2630	AF	3243			Current	19400626	0
C014569	Trout Creek	Waterworks Local Auth	91250000	GY		414		Current	19400626	0
C016412	Trout Creek	Irrigation Local Auth	3170	AF			3909	Current	18881218	0
C016413	Trout Creek	Irrigation Local Auth	6000	AF			7398	Current	19030711	0
C016414	Isintok Creek	Storage (1665 ML)	5500	AF				Current	19260326	0
"	Tsuh Creek	Storage (370 ML)	5500	AF				Current	19260326	0
"	Crescent Creek	Storage (617 ML)	5500	AF				Current	19260326	0
"	ZZ Creek (7819) (Whitehead)	Storage (432 ML)	5500	AF				Current	19260326	0
"	ZZ Creek (7824) (Headwaters)	Storage (3699 ML)	5500	AF				Current	19260326	0
"	ZZ Creek (7788)	Storage	5500	AF				Current	19260326	0
"	Trout Creek	Storage	5500	AF	6782			Current	19260326	0
C016415	Eneas Creek	Irrigation Local Auth	3000	AF			3699	Current	18890801	0
"	Eneas Creek	Irrigation Local Auth	3000	AF				Current	18890801	0
"	Latimer Creek	Irrigation Local Auth	3000	AF				Current	18890801	0
"	Eneas Creek	Irrigation Local Auth	3000	AF				Current	18890801	0
"	Eneas Creek	Irrigation Local Auth	3000	AF				Current	18890801	0
C016416	Eneas Creek (Garnet)	Storage	2000	AF	2466			Current	19130429	0
"	Finlay Creek (Garnet)	Storage	2000	AF				Current	19130429	0
C029847	Trout Creek (Headwaters 1)	Storage	750	AF	925			Current	19610518	0
C030786	ZZ Creek (7788) (Whitehead)	Storage	222	AF	274			Current	19650628	0
C030787	ZZ Creek (7819)	Storage	250	AF	308			Current	19650628	0
"	ZZ Creek (7824)	Storage	250	AF				Current	19650628	0
"	Trout Creek	Storage	250	AF				Current	19650628	0
C032615	Okanagan Lake	Waterworks Local Auth	584000000	GY		2651		Current	19670606	0
C034398	Crescent Creek	Storage	255	AF	314			Current	19670606	0
C034399	Crescent Creek (Headwaters)	Storage	1000	AF	1233			Current	19670606	0
C034400	ZZ Creek (7788) (Whitehead)	Storage	348	AF	429			Current	19670717	0
C056161	Eneas Creek	Irrigation Local Auth	25	AF			31	Current	19480318	0
C056869	Eneas Creek	Storage	360	AF	444			Current	19800624	0
C060898	Trout Creek	Irrigation Local Auth	1500	AF			1850	Current	19730803	0
"	Trout Creek	Waterworks Local Auth	213000130	GY		967		Current	19730803	0
C066455	Trout Creek	Irrigation Local Auth	2500	AF			3083	Current	19880602	0
C066491	Trout Creek	Irrigation Local Auth	75	AF			92	Current	19410526	0
C106027	Thirsk Lake	Storage	2000	AF	2466			Current	19930122	20000317
C106243	Prairie Creek	Land Improve	0	TF				Current	19930217	19941102
C106464	Eneas Creek	Land Improve	0	TF				Current	19940421	19941027
C118910	Okanagan Lake	Waterworks Local Auth	760000000	GY		3450		Current	20031022	20040212
F066492	Trout Creek	Irrigation Local Auth	697	AF			859	Current	18881218	0
"	Trout Creek	Waterworks Local Auth	1825000	GY		8		Current	18881218	0
F066493	Trout Creek	Irrigation Local Auth	5	AF			6	Current	18901220	0
Okanagan Lake Licenses						6,102				
Trout Creek Licenses					15,974	1,390	17,197			
Garnet Valley Licenses					2,910	0	3,730			
TOTAL WATER LICENSING IN ML / YEAR					18,883	7,491	20,926			
Total number of Licences and/or Applications found is 25										

APPENDIX C – FORMS AND TEMPLATE DOCUMENTS

THIS PAGE IS INTENTIONALLY LEFT BLANK