Operations and Maintenance Manual

District of Summerland

Thirsk Reservoir Expansion

June 2008

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1 Reference Documents

This 2008 Operation and Maintenance Manual should be read in conjunction with the following companion documents:

1. District of Summerland Operation and Maintenance Manual for Water Storage Dams. October 1990, UMA Engineering Ltd.
2. Trout Creek Water Supply System Water Use Plan. April 2005, Water Management Consultants.
3. Thirsk Reservoir Expansion Record Drawings. February 2008, Associated Engineering.
4. British Columbia Dam Safety Regulations, Water Act, February 2000.
5. British Columbia Dam Safety Guidelines, May 1998.
6. Canadian Dam Association, Dam Safety Guidelines, 2007.

2 System Description

2.1 GENERAL

Thirsk Reservoir is located approximately 35 km from the Summerland town site. 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

2.2 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.

2.3 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 through a watertight marine door.

The spillway itself is an ogee weir at elevation 1028.70 m which is 127 metres long.

2.4 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.

2.5 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. At the time of writing, vehicular access across the bridge is blocked by concrete lock-blocks, to be replaced by a security gate, in the future.

2.6 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.

3 System Operation

3.1 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 snow, which has accumulated higher in the watershed, 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 gate valves located on the upstream face of the dam. Each slide gate valve 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 is a specialty valve designed for variable flow control applications. It 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 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.

3.2 STORAGE TABLE

The storage table for Thirsk Reservoir follows. The 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 1024.4 m and 1028.7 m.

3.3 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.

3.4 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.

3.4.1 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.

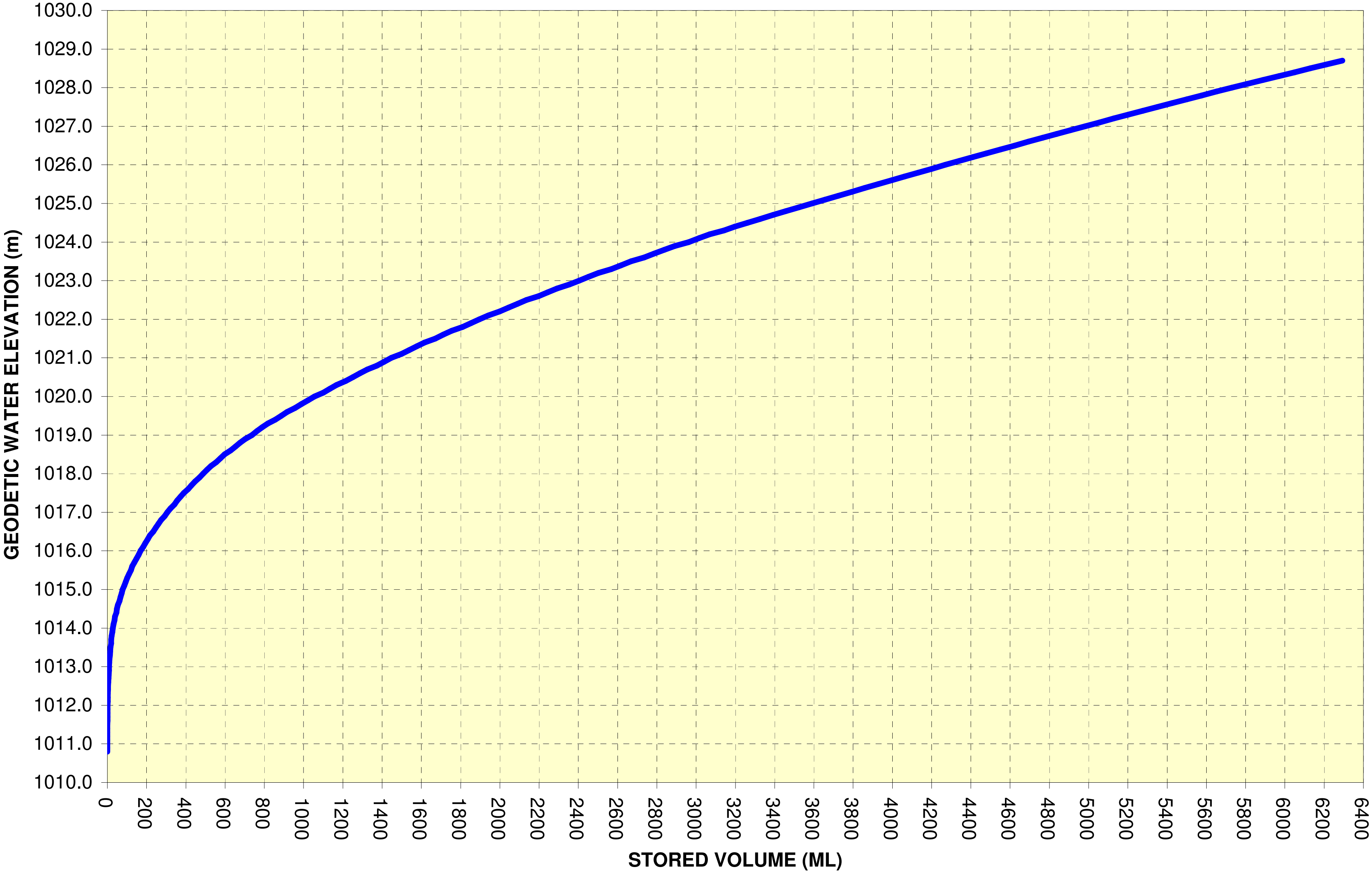
During the winter months, if the reservoir level is low and the outside temperatures are low, the turbine may not be able to produce enough power to heat the building and run the instrument and control systems. Isolated depletion of the batteries can be corrected by an external charge applied by a portable 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 breaking 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.

DISTRICT OF SUMMERLAND
THIRSK RESERVOIR EXPANSION
2008 RESERVOIR STORAGE TABLE

Geodetic Water Level (m)	Stored Volume (ML)	Geodetic Water Level (m)	Stored Volume (ML)	Geodetic Water Level (m)	Stored Volume (ML)	Geodetic Water Level (m)	Stored Volume (ML)
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

DISTRICT OF SUMMERLAND
THIRSK RESERVOIR EXPANSION
2008 RESERVOIR STORAGE



3.4.2 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.

3.4.3 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.

4 System Maintenance

4.1 DAM SAFETY GUIDELINES – CANADIAN DAM ASSOCIATION

Thirsk dam and spillway are classified as High Consequence Dams by the provincial Dam Safety Office. Refer to the British Columbia Government Dam Safety Guidelines for the minimum suggested inspection and maintenance frequency. Note that for a high consequence dam, a Dam Safety Review as defined in the Dam Safety Guidelines is required at seven year intervals. The next Dam Safety Review should take place in 2014.

4.2 SPILLWAY

The spillway is a low maintenance structure. Maintenance tasks will include:

- Visual inspection including inspection inside the internal galley.
- Maintenance of the marine door and the flap gate valve located on the downstream face of the dam.
- Removal of debris from the spillway surfaces.
- Removal of debris from the downstream base of the spillway.
- Removal of floating debris in the forebay to the spillway.
- Reading data from the piezometers. Refer to the Technical Memorandum prepared by Golder Associates found at the end of this section.
- Visual inspection of the drains in the gallery during high reservoir level.
- Lift-off tests on the rock anchors at 7-year intervals.

4.3 ARCH DAM

The arch dam is a low maintenance structure. Maintenance will include:

- Visual inspection of upstream and downstream surfaces and drains.
- Maintenance of upstream trash rack and approach channel.
- Maintenance of slide gate valves on upstream face of dam.
- Maintenance of motorized control valve on centre low level outlet.
- Maintenance of gate valve on branch to turbine building.

4.4 SADDLE DAM

The saddle dam is a low maintenance structure. Maintenance tasks will include:

- Visual inspection of upstream and downstream surfaces.
- Tree and shrub removal.

4.5 TURBINE BUILDING, ELECTRICAL, INSTRUMENTATION, AND CONTROL SYSTEMS

Maintenance tasks will include:

- Visual inspection of inside and outside surfaces.
- Maintenance of positive drainage away from building.
- Door and locks maintenance.
- Maintenance of valves and pipework.
- Maintenance of y-strainer including cleaning and flushing.
- Inspection of batteries.
- Maintenance of stream engine turbine.
- Visual inspection of the rock face above the turbine building. Rock scaling as necessary.

4.6 TROUT CREEK BRIDGE

Trout Creek Bridge is a low maintenance structure. Maintenance tasks will include:

- Visual inspection of substructure and superstructure including curb rails.
- Maintenance of bridge deck.

4.7 LOG BOOM

Maintenance tasks for the log boom will include the following:

- Visual inspection of the anchor blocks and hardware.
- Visual inspection of the boom sticks and replacement of degraded units.
- Removal of accumulated debris that is floating against the boom.

TECHNICAL MEMORANDUM

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TO:	Ed Bird, P. Eng. Associated Engineering	**DATE:**	June 3, 2008
FROM:	Glen Rutherford, P. Eng.	**JOB NO:**	05-1440-204
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RE: GEOTECHNICAL INPUT TO THIRSK DAM OPPERATIONS MANUAL, INSTRUMENTATION SECTION

The following presents information to be included in the operations manual for the Thirsk Dam Spillway. Golder has previously provided recommendations and input for installation of eight vibrating wire piezometers located in section 12 and 14 of the spillway.

The intent of the vibrating wire piezometers was to determine the effectiveness of the grout and drainage curtains and to provide input on hydraulic uplift pressures for the dam's structural reviews.

Initial/baseline readings should be conducted for all the instruments to determine initial/normal operating parameters for piezometric pressure at the instrument locations.

The baseline readings should be taken for the following conditions:

1 Low water level conditions (already completed).

2 Midway through reservoir filling.

3 Immediately prior to spilling.

4 Full spill conditions.

Annual monitoring should be conducted at low water level conditions and full spill water levels (normal operating water level) and at any irregular reservoir conditions such as flood conditions and during rapid drawdown conditions.

The water pressure data should be collected and reviewed by the geotechnical and structural engineers until typical and threshold ranges of values can be presented for inclusion into the operations manual.

It is recommended that Golder review the proposed operations manual for geotechnical considerations.

We trust the foregoing provides the information that you require at this time. Should you have any questions, please contact the sender.

GR/GI

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5 Equipment Manuals and Data

Equipment manuals and data for the following components are found in the following pages:

1. Flotus Valve
2. Global Star Satellite System
3. Energy Systems and Design Stream Engine
4. Xantrex DR Inverter/Charger
5. Xantrex DC Disconnect
6. Xantrex C-Series Controllers
7. Tri-Metric Battery System Monitor
8. RST Instruments Model VW2100 Vibrating Wire Piezometer
9. Discover EVGC6A AGM batteries
10. Crane Butterfly Valves
11. EIM Valve Actuator
12. Mueller Stream Specialty “Y” Strainer