The following information includes the Lake Bernard Dam Operating Manual which has been extracted from the Magnetawan River Dam Operating Manual as reference material for public engagement during winter 2024.

Magnetawan River Dam Operation Manual

Section 5.0 - BE

Lake Bernard Dam

5.LAKE BERNARD DAM

1. LOCATION

- 91 km from Bracebridge MNR office to Bernard Lake dam via Hwy 11 north to Burk's Falls;
- turn right on South Bernard Lake Road 8 km north of Burk's Falls;
- turn left on High Rock Road 3.7 km from Hwy 11, immediately past the CNR railway crossing;
- dam is 2.5 km north on High Rock Road;
- dam is a combined bridge and dam;
- next dam upstream - none
- next dam downstream - Magnetawan Dams

Geographic Twp.	Lot	Con.	Area Municipality	Regional /County Municipality
Strong	13	5	Township of Strong	District of Parry Sound

UTM Zone	UTM East	UTM North	Latitude			Longitude		
			Deg.	Min.	Sec.	Deg.	Min.	Sec.
17	623150	5063700	45°	43'	05" N	79°	25'	05" W

2. ACCESS

- by Township Road year round.

3. WATER LEVEL, FLOW AND PRECIPITATION MONITORING

3.1 Water Level

Lake gauge - none

Dam gauge - metric staff gauge on dam

Tailwater gauge - metric staff gauge approximately 5 metres downstream of dam

- weekly water level readings year-round at dam and tailwater gauge;
- readings are recorded by operator and by MNR Bracebridge Water Control office on daily log sheet and on monthly log sheet.

WATER LEVEL, FLOW AND PRECIPITATION MONITORING (cont'd.)

3.2 Flow

Upstream - tributary creeks - Bernard Creek

Downstream - flows into Stirling Creek for approximately 17 km to the Magnetawan River, 4.3 km west of Burk's Falls

3.3 Rain and Snowfall

See General section of manual for rain gauge and snow course locations.

4. OPERATING PROCEDURE

Operator : Water Control
Bracebridge Area Office
Parry Sound District Office, MNR

Purpose of Dam : recreation

Operating Difficulty : medium

4.1 General Operating Procedure

- dam requires medium frequency of operation;
- rule curve is guide for regulating lake levels; see Fig.4 and Table 1;
- the lake is held at a fairly constant level during the four summer months from mid-June to mid-September within a 0.2 metre normal operating range;
- there is a one month fall draw-down period of 0.2 metres ending October 15th to the winter holding level;
- a late winter draw-down of 0.15 metres to provide flood storage capacity for the spring run-off occurs from mid-February to mid-March;
- normally logs are removed from the dam in the fall which is left with no logs in winter unless it is dry in which case some logs are left in until February;
- valve is kept 1/3 open when logs in dam to provide a minimum flow downstream;
- for discharge calculations with various number of logs in 1 gate, use Fig.5 or Table 2;
  valve discharge is in Fig. 6 and Table 3 (Imperial Fig. 9 & 10 , Table 5 & 6);
- when all logs are out of dam, use Fig. 7 or Table 4 for discharge calculation ;
- logs are gradually replaced well after the peak of the spring run-off has passed to hold the lake at summer level;
- in summer a weekly check is made on the dam; operation is not usually required unless above average rainfall occurs;
- co-ordination of log changes in dam with Magnetawan Dams is usually not required due to the relatively small flows from the dam;
- Lake Bernard is slow to react to log changes at dam due to its large size with a small drainage area; when all logs are removed there is a high tailwater level and usually almost no water level drop through dam when more than 1 log out; this restricts outflow and time for lake to lower;
- storage tables are not used to calculate outflow – not required due to small storage in lake; Table 7 (Imperial Table 8) is a short storage table if needed;
- water travel time from Lake Bernard Dam to Magnetawan Dam is 6 hours approximately.

General Operating Procedures (cont'd.)

4.1.1 Summer Levels

- maintain water levels in normal summer operating range for recreation on lake;
- try to operate below 395.5 metres to provide dry beach area on beaches on north end of lake;
- 3 logs in each gate normally;

- operate the dam using the valve in summer - valve about 1/3 open to maintain flow downstream in Stirling Creek for fish and water quality.

4.1.2 Fall Draw-Down

- all logs normally removed from dam in 2 operations about 2 weeks apart between September 7th and October 15th to prepare the dam for winter; draw-down is 0.2 m;
- remove 1 or 2 logs each gate and open valve after Labour day;
- in a wet fall remove all logs from dam by October 15th
- in a dry fall and lake is below rule curve leave 3 logs in two end gates and 2 logs in centre gates and valve 1/3 open until February if not sufficient fall rains to raise lake by freeze-up. Remove logs in winter draw-down – see below:

  Note: If 1 or 2 logs left in gate they must be pinned to prevent floating because of high tailwater at this dam.

4.1.3 Winter Draw-Down

- normally drop lake 0.15 m between February 15th and March 15th;
- remove logs left in dam starting February 15 and finishing by early March.

4.1.4 Spring Run-off

- no operation during spring flood since all logs are out;
- replace logs and open valve 1/3 after the peak lake level has receded to yellow line – top of conservation zone level – el.329.55 m, usually in mid-May since lake is slow to drain after high levels;
- watch levels and rainfall closely as lake is difficult to fill if a below normal run-off and lake is left too long and too much water is let out.

4.1.5 Flood Periods

- operation in summer flood periods is required;
- flood storage capacity for downstream flood control is large in spring.

General Operating Procedures (cont'd.)

4.2 Stop-log Operation Sequence

Logs Out

Fall Draw-down

- remove logs gradually starting and finishing by October 15th in wet fall for the winter; opening 1 or 2 gates fully each trip;
- in normal or dry fall, take 1 log across top of gates 2, 3 or 4; Gate 1 passes least flow.

Logs In

Spring

- place 3 logs in all gates when lake back down to regulated water level.

4.3 Flow Change - Stop-log Movements

- flow change can be obtained from gate discharge Table 2 or Fig.5 for 0,1,2 or 3 stop-logs in gate (Imperial Table 5 or Fig.9);
- submerged flow occurs at all flows when 0 or 1 log in gates and levels and at medium to high flows when 2 logs in;
- the tailwater rating curve in Fig. 8 (Imperial Fig.12) for this dam is preliminary and was used in developing the discharge rating tables; more observed data is required for better accuracy.

4.4 Operating Constraints

a) Upstream

Flooding

- lake is slow to drop following high lake levels due to natural downstream channel restrictions;
- prolonged high lake levels after heavy rainfall or high spring run-off cause flooded beaches and some shoreline erosion.

Channel Restrictions

- approach channel to dam is shallow but does not cause a restriction – no noticeable draw-down between lake and gauge at dam.

b) Dam

- 2 man crew normally required to operate dam.

General Operating Procedures (cont'd.)

c) Downstream

- natural restrictions in outflow channel from dam cause backup of water into gates at medium and high flows (high tailwater levels); when all logs are removed from dam; outflow is controlled by creek channel and not by dam in this case;
- must maintain valve 1/3 open in dry periods for base flow in creek for water quality and fish.

CONTACTS

Subject	Name	Telephone No.	Fax No
Bernard Lake Dam operation	Water Control Bracebridge MNR	(705) 645-8747	(705) 645-8372

DAM CHARACTERISTICS

Dam			LAKE BERNARD			
Date of Last Reconstruction			1959 - concrete			
Date of Previous Construction			1939			
- Datum			G.S.C. water level gauge datum			
Number of Sluices			4			
Gate No.			1	2	3	4 .
- Sill Elevation		- m	328.56	328.56	328.56	328.56
		- ft.	1078.0	1078.0	1078.0	1078.0
- gates are numbered left to right looking upstream						
Maximum No. of Stop-Logs/Sluice			3			
Sluice Width		- m	3.66	3.66	3.66	3.66
		- ft.	12	12	12	12
Stop-log Maximum Crest Elev.		- m	329.48	329.48	329.35	329.48
		- ft.	1080.72	1080.72	1080.5	1080.72
Stop-log size - top - 3rd log		- inches	12	12	10	12
- 2nd & bottom log		- inches	10	10	10	10
		- m	0.81	0.81	0.76	0.81
		- ft.	2.67	2.67	2.5	2.67
- all logs 10 inches wide						
Operating Deck Elevation		- m	330.85			
		- ft.	1085.47			
Spillwall Crest - Elevation		- m	Nil			
- Length straight		- m				
		- ft				

Valve Size	- round outlet - diameter	- m	0.81	2.67 ft.
	square valve			
	- invert elevation	- m	328.74	
		- ft	1078.55	
	- obvert elevation	- m	329.56	
		- ft.	1081.22	

Head of water held by dam above lowest gate sill:

- at summer regulated level	- m	1.18	= 3.87 ft.
- at start of flood damage level	- m	1.43	= 4.7 ft.

Tailwater depth at dam - normal	- m	0.79	= 2.6 ft.
- spring	- m	1.13	= 3.7 ft.

Datum Conversion: GSC datum - m = (construction datum - ft. + 1.0) 0.3048

LAKE DATA

Regulating Dam	BERNARD LAKE DAM
Lake(s) Controlled	BERNARD LAKE
Regulation Agreement	none
Fall Draw-down	0.25 m = 0.82 ft. - Sep.15 to Dec.31 0.2 m - Sep.15 to Oct.15 0 05 m - Oct.15 to Dec.31
Spring draw-down	0.15 m = 0.49 ft. - Feb.15 to Mar.15
Winter (Lake Trout) Draw-down Rule	None
Total Lake Surface Area	2150 ha = 5312 acres 21.5 sq.km. = 8.3 sq. mi.
Lake Storage Volume - spring - from normal Mar.15 minimum level to top of normal summer operating range in May	968 ha-m = 7837 ac-ft 112 cms- days = 3951 cfs- days
- storage range	0.45 m = 1.48 ft.
Lake Stage-Storage Table	Yes
Summer Normal Operating Range	0.2 m = 0.66 ft. from Jun.1 to Sep.15
Summer Regulated Water Level (RWL) - rule curve level	329.45 m = 1080.87 ft.
Drainage Area to Lake Area Ratio	4.88 : 1
Water Level Gauges: Dam - headwater gauge	

- on north wingwall beside gate 1
- gauge range
- top of gauge reads 330.0 m

- tailwater gauge
  - in creek approx. 10 m downstream of dam
  - gauge range m
  - installed

Drainage Area - Local - upstream of lake 83.4 km^2 = 32.2 mi^2
- Total - to Bernard Lake dam 105 km^2 = 40.5 mi^2

BENCH MARKS

NO.	DATE	INITIALS	REVISIONS

REMARKS:

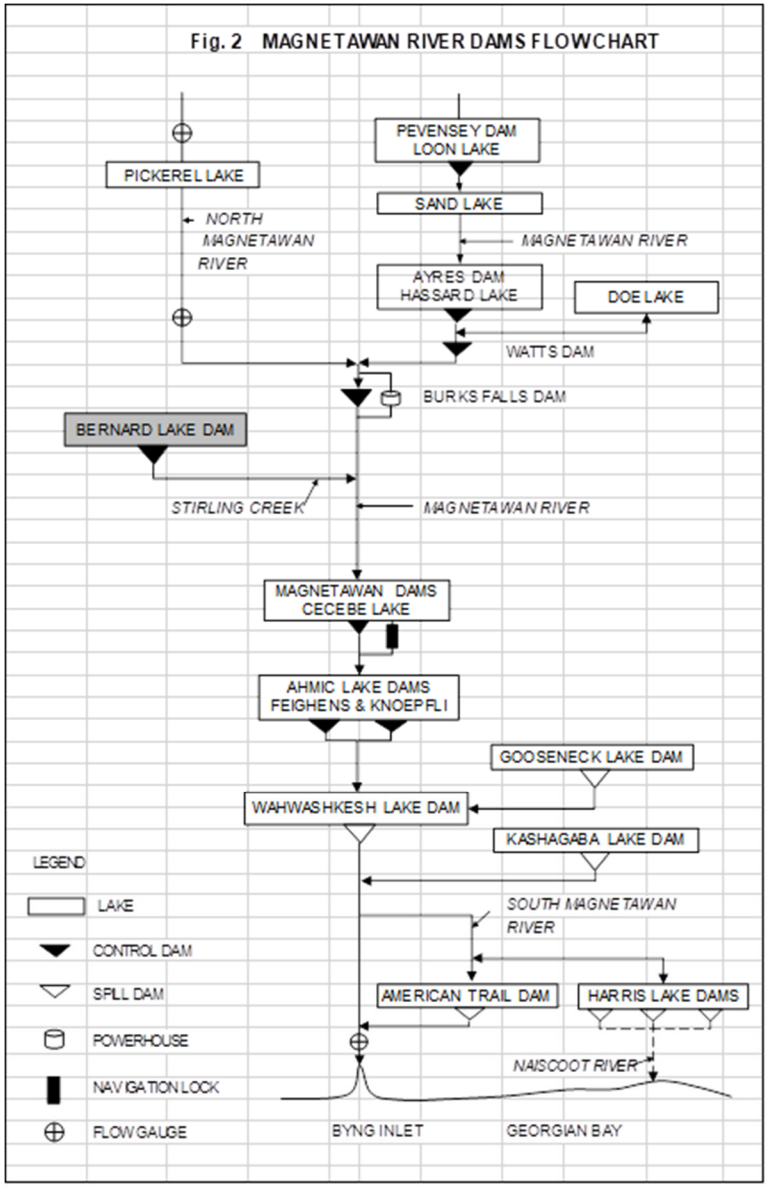


Fig. 2 MAGNETAWAN RIVER DAMS FLOWCHART
PICKEREL LAKE
NORTH MAGNETAWAN RIVER
PEVENSEY DAM
LOON LAKE
SAND LAKE
MAGNETAWAN RIVER
AYRES DAM
HASSARD LAKE
DOE LAKE
WATTS DAM
BURKS FALLS DAM
BERNARD LAKE DAM
STIRLING CREEK
MAGNETAWAN RIVER
MAGNETAWAN DAMS
CECEBE LAKE
AHMIC LAKE DAMS
FEIGHENS & KNOEPFLI
GOOSENECK LAKE DAM
WAHWASHKESH LAKE DAM
KASHAGABA LAKE DAM
SOUTH MAGNETAWAN RIVER
AMERICAN TRAIL DAM
HARRIS LAKE DAMS
NAISCOOT RIVER
BYNG INLET
GEORGIAN BAY
LEGEND
LAKE
CONTROL DAM
SPILL DAM
POWERHOUSE
NAVIGATION LOCK
FLOW GAUGE

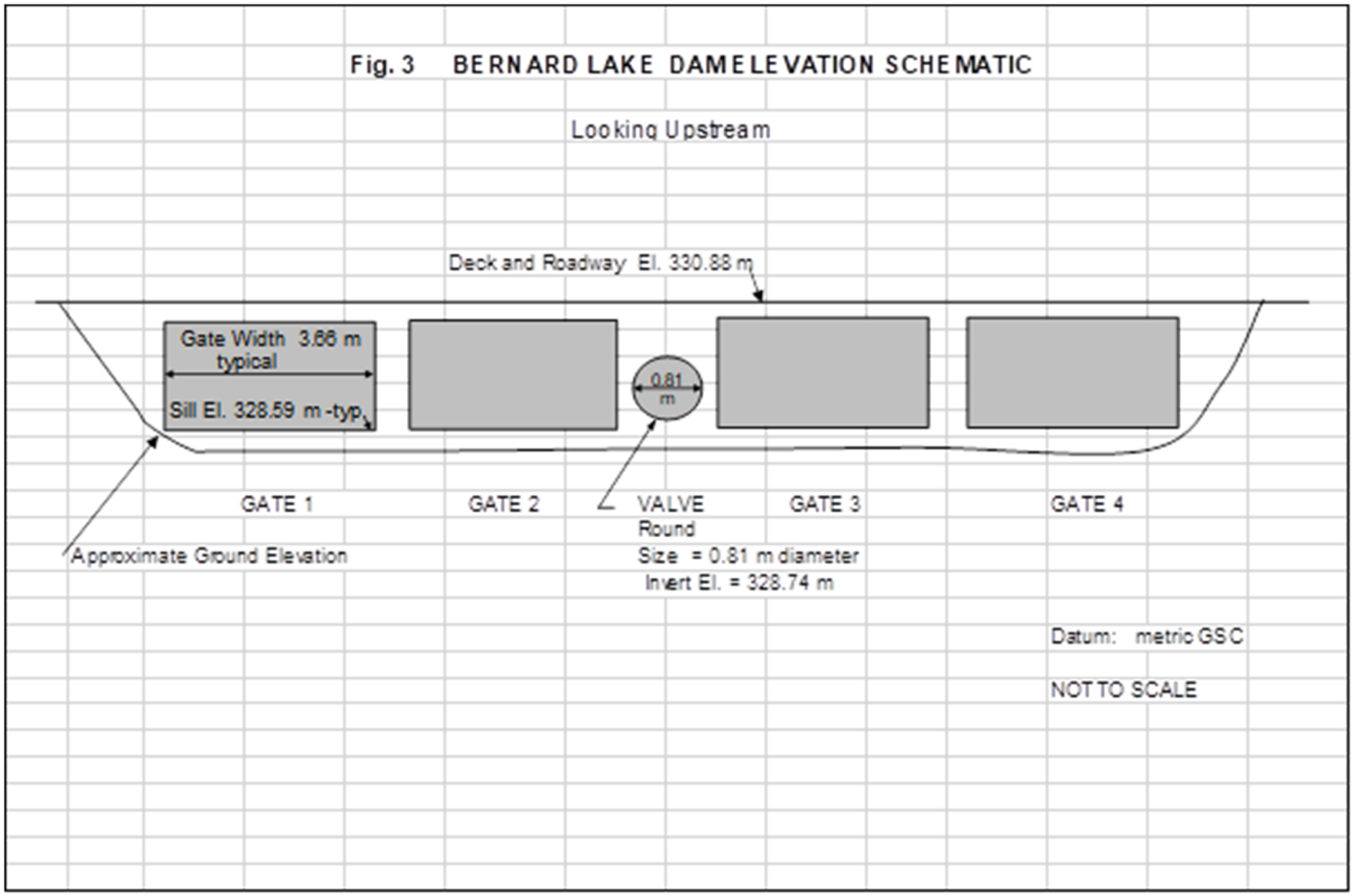
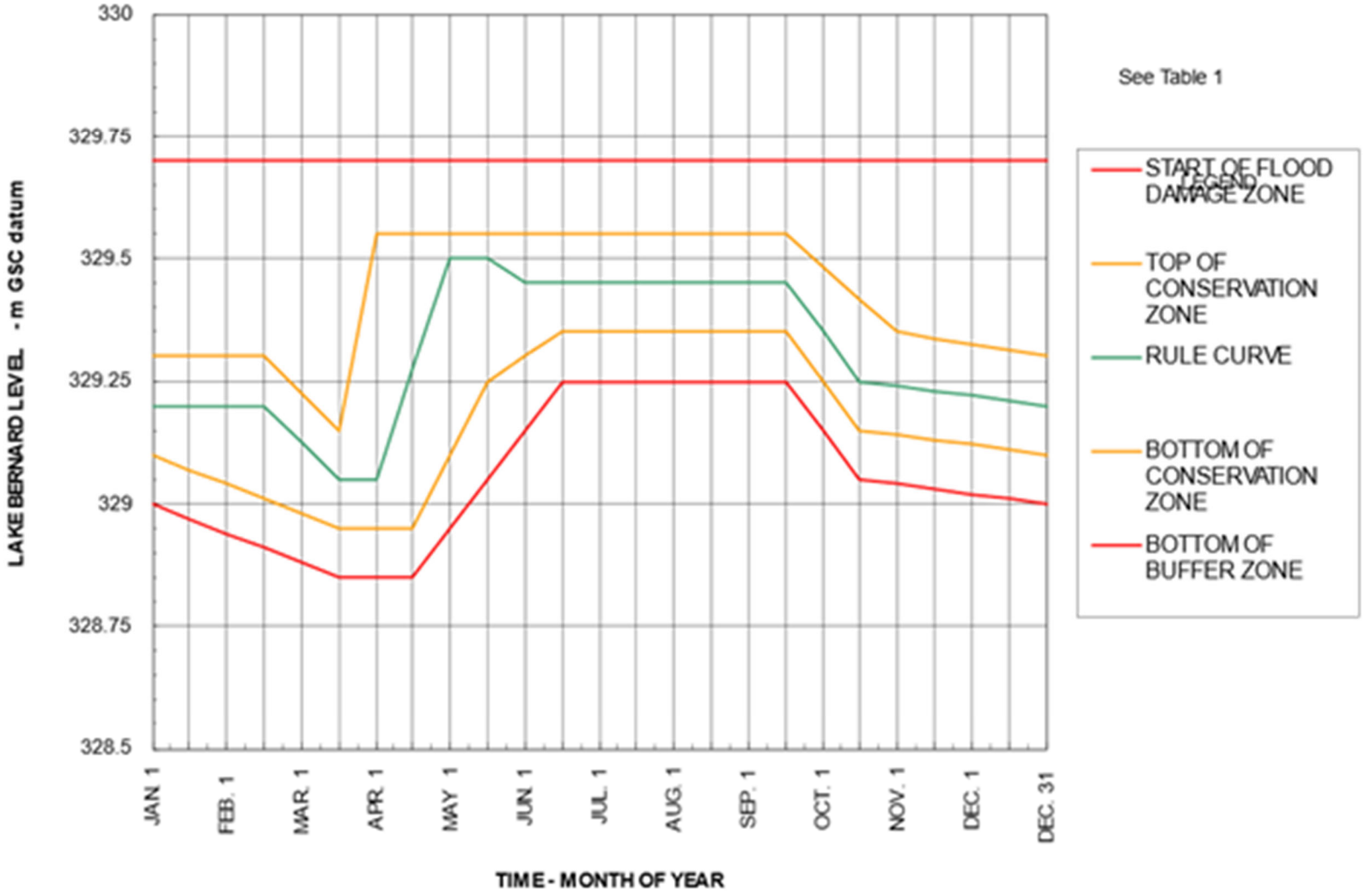


Fig. 3 BERNARD LAKE DAM ELEVATION SCHEMATIC
Looking Upstream
Deck and Roadway El. 330.88 m
Gate Width 3.66 m typical
Sill El. 328.59 m -typ.
0.81 m
GATE 1
GATE 2
VALVE
GATE 3
GATE 4
Round
Size = 0.81 m diameter
Invert El. = 328.74 m
Approximate Ground Elevation
Datum: metric GSC
NOT TO SCALE

Fig. 4 LAKE BERNARD ANNUAL OPERATING WATER LEVELS Metric



AKE BERNARD ANNUAL OPERATING LEVELS

etric GSC datum See Fig. 4 Plot:

TOP OF CONSERVATION ZONE	RULE CURVE	BOTTOM OF CONSERVATION ZONE	BOTTOM OF BUFFER ZONE	DATE	DATE	START OF FLOOD DAMAGE ZONE	TOP OF CONSERVATION ZONE	RULE CURVE	BOTTOM OF CONSERVATIO ZONE	BOTTOM OF BUFFER ZONE
upper yellow line metres	green line metres	lower yellow line metres	lower red line metres			upper red line metres	upper yellow line metres	green line metres	lower yellow line metres	lower red line metres
329.30	329.20	329.10	329.00	JAN 1	JAN. 1	329.70	329.30	329.20	329.10	329.00
329.30	329.20	329.07	328.97	JAN 15	JAN. 15	329.70	329.30	329.20	329.07	328.97
329.30	329.20	329.04	328.94	FEB 1	FEB. 1	329.70	329.30	329.20	329.04	328.94
329.30	329.20	329.01	328.91	FEB 15	FEB. 15	329.70	329.30	329.20	329.01	328.91
329.23	329.15	328.98	328.88	MAR 1	MAR. 1	329.70	329.23	329.13	328.98	328.88
329.15	329.05	328.95	328.85	MAR 15	MAR. 15	329.70	329.15	329.05	328.95	328.85
329.55	329.05	328.95	328.85	APR 1	APR. 1	329.70	329.55	329.05	328.95	328.85
329.55	329.28	328.95	328.85	APR 15	APR. 15	329.70	329.55	329.28	328.95	328.85
329.55	329.50	329.10	328.95	MAY 1	MAY 1	329.70	329.55	329.50	329.10	328.95
329.55	329.50	329.25	329.05	MAY 15	MAY 15	329.70	329.55	329.50	329.25	329.05
329.55	329.45	225.28	329.15	JUN 1	JUN. 1	329.70	329.55	329.45	329.30	329.15
329.55	329.45	329.35	329.25	JUN 15	JUN. 15	329.70	329.55	329.45	329.35	329.25
329.55	329.45	329.35	329.25	JUL 1	JUL. 1	329.70	329.55	329.45	329.35	329.25
329.55	329.45	329.35	329.25	JUL 15	JUL. 15	329.70	329.55	329.45	329.35	329.25
329.55	329.45	329.35	329.25	AUG 1	AUG. 1	329.70	329.55	329.45	329.35	329.25
329.55	329.45	329.35	329.25	AUG 15	AUG. 15	329.70	329.55	329.45	329.35	329.25
329.55	329.45	329.35	329.25	SEP 1	SEP. 1	329.70	329.55	329.45	329.35	329.25
329.55	329.45	329.35	329.25	SEP 15	SEP. 15	329.70	329.55	329.45	329.35	329.25
329.48	329.35	329.25	329.15	OCT 1	OCT. 1	329.70	329.48	329.35	329.25	329.15
329.42	329.25	329.15	329.05	OCT 15	OCT. 15	329.70	329.42	329.25	329.15	329.05
329.35	329.24	329.14	329.04	NOV 1	NOV. 1	329.70	329.35	329.24	329.14	329.04
329.34	329.23	329.10	329.03	NOV 15	NOV. 15	329.70	329.34	329.23	329.13	329.03
329.33	329.22	329.07	329.02	DEC 1	DEC. 1	329.70	329.33	329.22	329.12	329.02
329.31	329.21	329.03	329.01	DEC 15	DEC.15	329.70	329.31	329.21	329.11	329.01
329.30	329.20	329.10	329.00	DEC 31	DEC. 31	329.70	329.30	329.20	329.10	329.00

ıph of operating curves for daily elevations.

Fig. 5 BERNARD LAKE DAM DISCHARGE CAPACITY for 1 GATE
Metric

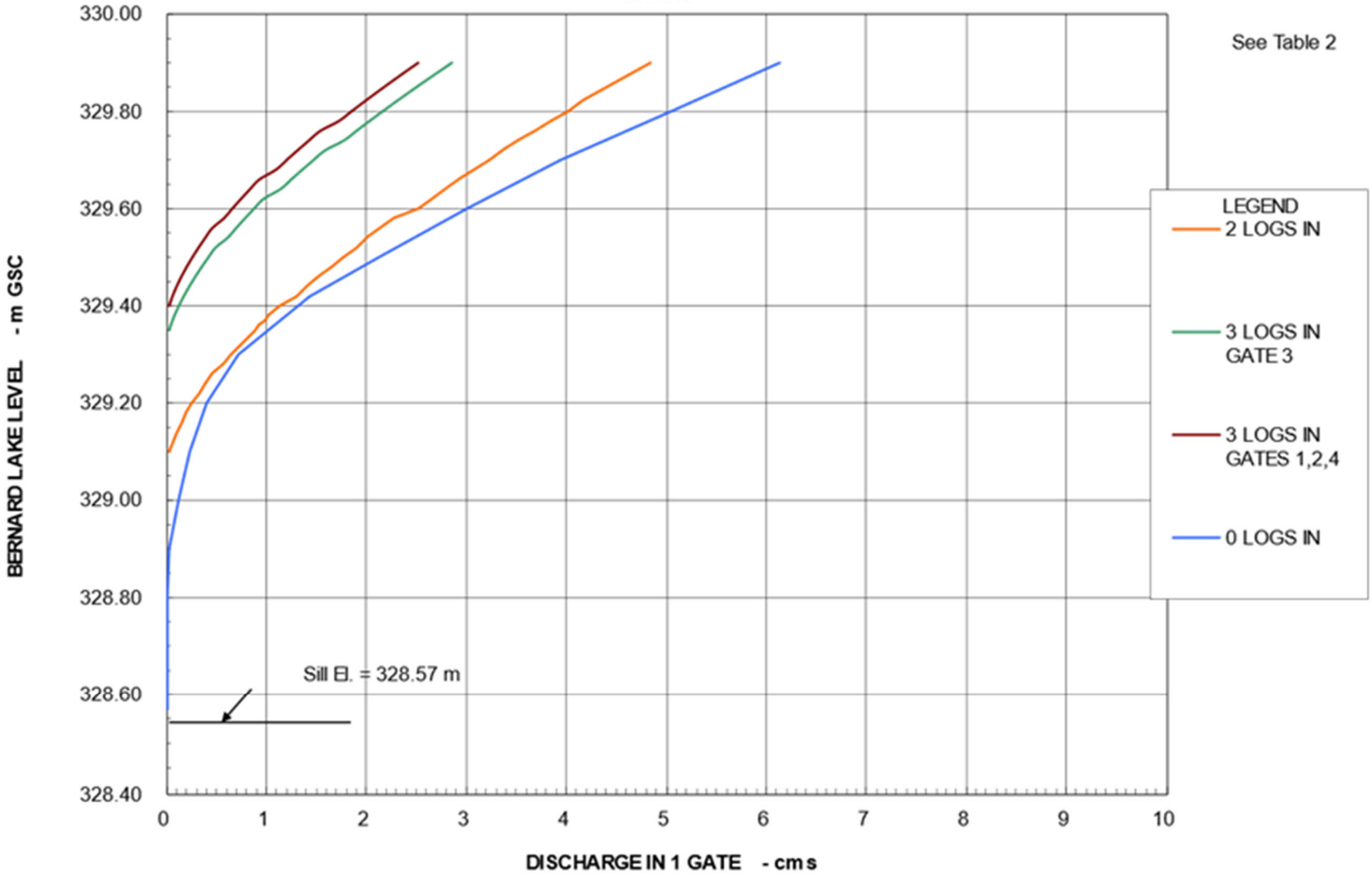


Table 2 BERNARD LAKE DAM DISCHARGE CAPACITY fo							Sheet 1 of 2		
VARIOUS NUMBERS OF LOGS IN 1 - 3.66 m WIDE GATE									
			Metric						
		GATES 1,2,4	- bottom 2 logs 0.25 m deep				See Fig. 5		
			- top log 0.3 m deep - gates 1, 2 & 4						
		GATE 3	- 3 logs 0.25 m deep						
HEADWATER	3 LOGS IN	3 LOGS IN	2 LOGS	1 LOG	0 LOGS	HEAD			HEADWATER
ELEV.	GATES 1,2,4	GATE 3	IN	IN	IN	0 logs in			ELEV.
m	cms	cms	cms	cms	cms	m			m
328.57					0.00	0.00	Sill Elevation		**328.57**
328.60					0.00	0.03			328.60
328.62					0.00	0.05			328.62
328.64					0.00	0.07			328.64
328.66					0.00	0.09			328.66
328.68					0.00	0.11			328.68
328.70					0.00	0.13			328.70
328.72					0.003	0.15			328.72
328.74					0.005	0.17			328.74
328.76					0.007	0.19			328.76
328.78					0.008	0.21			328.78
328.80					0.010	0.23			328.80
328.82					0.002	0.25	1 - 0.25 m deep log in		**328.82**
328.84					0.020	0.27			328.84
328.86					0.023	0.29			328.86
328.88					0.027	0.31			328.88
328.90					0.030	0.33			328.90
328.92					0.050	0.35			328.92
328.94					0.07	0.37			328.94
328.96					0.09	0.39			328.96
328.98					0.11	0.41			328.98
329.00					0.13	0.43			329.00
329.02					0.18	0.45			329.02
329.04					0.20	0.47			329.04
329.06					0.22	0.49			329.06
329.07			0.0		0.23	0.50	2 - 0.25 m deep logs in		**329.07**
329.08			0.01		0.24	0.51			329.08
329.10			0.03		0.25	0.53			329.10
329.12			0.06		0.25	0.55			329.12
329.14			0.10		0.30	0.57			329.14
329.16			0.15		0.35	0.59			329.16
329.18			0.20		0.38	0.61			329.18
329.20			0.26		0.40	0.63			329.20
329.22			0.32		0.45	0.65			329.22
329.24			0.39		0.50	0.67			329.24
329.26			0.46		0.60	0.69			329.26
329.28			0.57		0.65	0.71			329.28
329.30			0.64		0.70	0.73			329.30

Table 2 BERNARD LAKE DAM DISCHARGE CAPACITY for VARIOUS NUMBERS OF LOGS IN 1 - 3.66 m WIDE GATE Sheet 2 of 2

Metric

GATES 1,2,4 - bottom 2 logs 0.25 m deep - top log 0.3 m deep - gates 1, 2 & 4

GATE 3 - 3 logs 0.25 m deep

See Fig. 5

HEADWATER ELEV. m	3 LOGS IN GATES 1,2,4 cms	3 LOGS IN GATE 3 cms	2 LOGS IN cms	1 LOG IN cms	0 LOGS IN cms	HEAD 0 logs in m		HEADWATER ELEV. m
329.32		0.0	0.74		0.80	0.75	3 logs in Gate 3	**329.32**
329.34		0.02	0.83		1.00	0.77	- top log 0.25 m deep	329.34
329.35		0.03	0.88		1.05	0.78		329.35
329.36		0.04	0.93		1.10	0.79		329.36
329.37	0.0	0.06	0.98		1.20	0.80	3 logs in Gates 1, 2, 4	**329.37**
329.38	0.01	0.08	1.02		1.25	0.81	- top log 0.3 m deep	329.38
329.40	0.03	0.13	1.12		1.35	0.83		329.40
329.42	0.06	0.18	1.31		1.44	0.85		329.42
329.44	0.10	0.23	1.42		1.60	0.87		329.44
329.46	0.15	0.29	1.54		1.80	0.89		329.46
329.48	0.20	0.36	1.65		2.00	0.91		329.48
329.50	0.26	0.42	1.77		2.13	0.93		329.50
329.52	0.32	0.50	1.90		2.3	0.95		329.52
329.54	0.39	0.62	2.02		2.4	0.97		329.54
329.56	0.46	0.70	2.15		2.6	0.99		329.56
329.58	0.57	0.79	2.28		2.8	1.01		329.58
329.60	0.66	0.88	2.51		3.0	1.03		329.60
329.62	0.74	0.98	2.65		3.2	1.05		329.62
329.64	0.83	1.15	2.79		3.3	1.07		329.64
329.66	0.93	1.25	2.94		3.5	1.09		329.66
329.68	1.09	1.36	3.08		3.75	1.11		329.68
329.70	1.20	1.48	3.23		3.95	1.13		329.70
329.72	1.31	1.59	3.39		4.20	1.15		329.72
329.74	1.42	1.78	3.54		4.40	1.17		329.74
329.76	1.54	1.91	3.69		4.60	1.19		329.76
329.78	1.72	2.04	3.85		4.80	1.21		329.78
329.80	1.84	2.17	4.01		5.05	1.23		329.80
329.82	1.97	2.30	4.17		5.30	1.25		329.82
329.84	2.10	2.44	4.34		5.50	1.27		329.84
329.86	2.24	2.58	4.50		5.70	1.29		329.86
329.88	2.37	2.72	4.67		5.90	1.31		329.88
329.90	2.51	2.86	4.83		6.13	1.33		329.90

Fig. 6 BERNARD LAKE DAM VALVE DISCHARGE CAPACITY
Metric

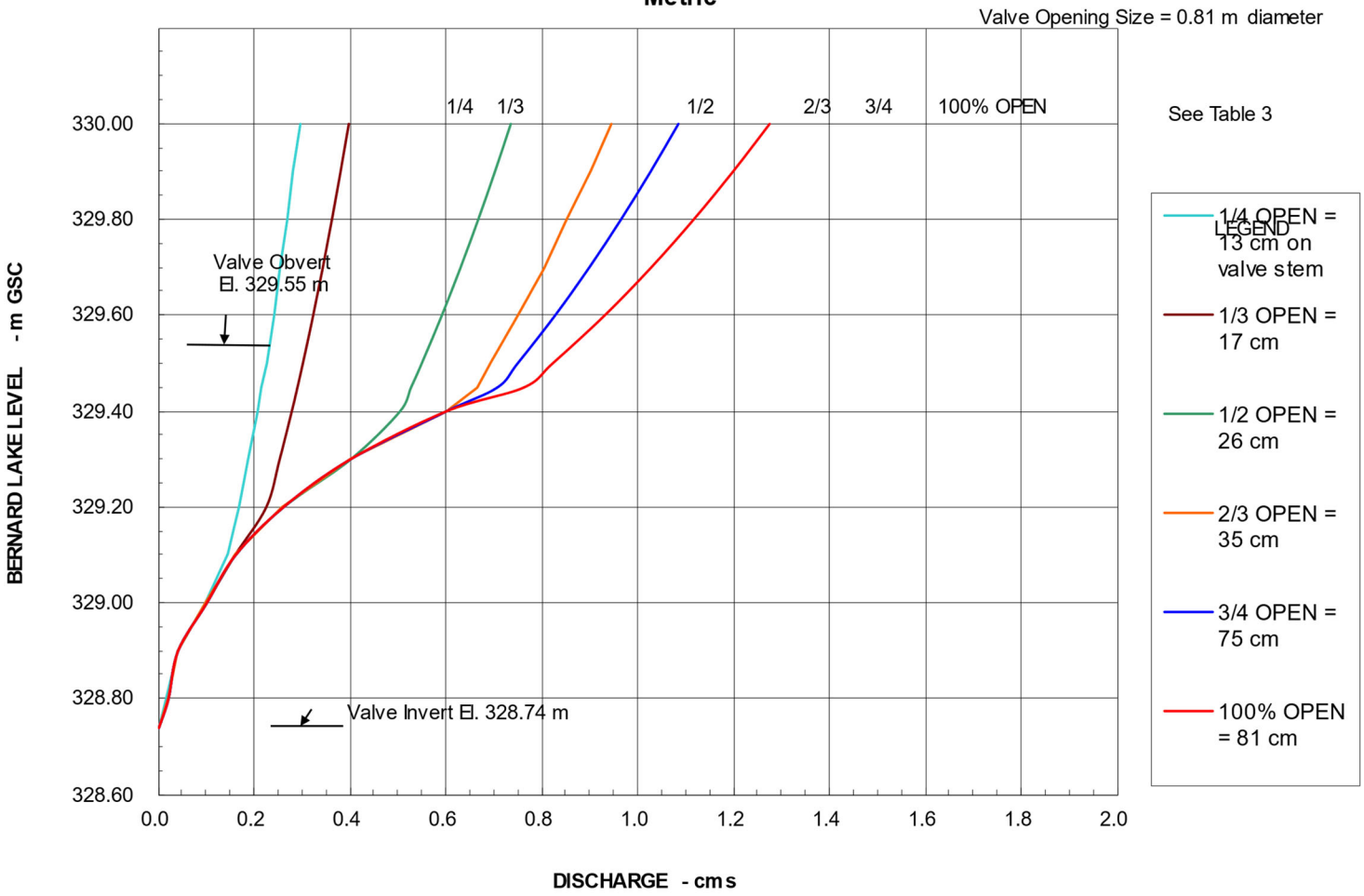


Table 3 BERNARD LAKE DAM VALVE DISCHARGE CAPACITY

Metric

See Fig. 6

Valve Size = 0.81 m dia. = 2.66 ft. dia.
Valve Invert El. = 328.74 m = 1078.55 ft
Area = 0.52 sq. m = 5.57 sq. ft.

BERNARD LAKE LEVEL	DISCHARGE VALVE % OPEN						HEAD ON VALVE CENTRE	LAKE LEVEL
	25% = 1/4	33% = 1/3	50% = 1/2	66% = 2/3	75% = 3/4	100%		
	h = 0.13 m	0.17 m	0.26 m	0.35 m	0.61 m	0.81 m		
m	cms	cms	cms	cms	cms	cms	100% -ft.	m
328.57								**328.57**
328.60								328.60
328.74	0.00	0.00	0.00	0.00	0.00	0.00	328.7	**328.74**
328.80	0.02	0.02	0.02	0.02	0.02	0.02	328.8	328.80
328.90	0.04	0.04	0.04	0.04	0.04	0.04	328.9	328.90
329.00	0.10	0.10	0.10	0.10	0.10	0.10	329.0	329.00
329.10	0.16	0.16	0.16	0.16	0.16	0.16	329.1	329.10
329.20	0.26	0.26	0.26	0.26	0.26	0.26	329.2	329.20
329.30	0.19	0.25	0.40	0.40	0.40	0.40	329.3	329.30
329.40	0.21	0.28	0.50	0.60	0.60	0.60	329.4	329.40
329.45	0.22	0.29	0.53	0.66	0.71	0.76	329.5	329.45
329.50	0.23	0.30	0.55	0.69	0.75	0.82	329.5	329.50
329.60	0.24	0.32	0.59	0.75	0.83	0.93	329.6	329.60
329.70	0.26	0.34	0.63	0.80	0.90	1.03	329.7	329.70
329.80	0.27	0.36	0.67	0.85	0.97	1.12	329.8	329.80
329.90	0.28	0.38	0.70	0.90	1.03	1.20	329.9	329.90
330.00	0.30	0.40	0.73	0.95	1.09	1.28	330.0	330.00
Invert El. - m	328.74	328.74	328.74	328.74	328.74	328.74		
Opening Top El. - m	328.87	328.91	329.00	329.09	329.35	329.55		
Height of opening - m	0.13	0.17	0.26	0.35	0.61	0.81		
Centre of opening - m	328.81	328.83	328.87	328.92	329.05	329.15		
Area - sq. m	0.10	0.14	0.26	0.34	0.42	0.52		
Sector angle - degrees	120	136	180	209	240	0.00		
Sector area - m^2	0.17	0.20	0.26	0.30	0.35	0.00		
Triangle area - m^2	0.07	0.06	0.00	0.04	0.07	0.00		
Opening area - m^2	0.10	0.14	0.26	0.34	0.42	0.52		

h = height of opening of valve

For levels below top of opening, flows calculated from Manning equation;
For levels above top of opening, flows calculated from orifice formula Q = C* A*(2*32.2*H)^0.5
where C=0.6

Fig. 7 BERNARD LAKE DAM MAXIMUM DISCHARGE CAPACITY
Metric

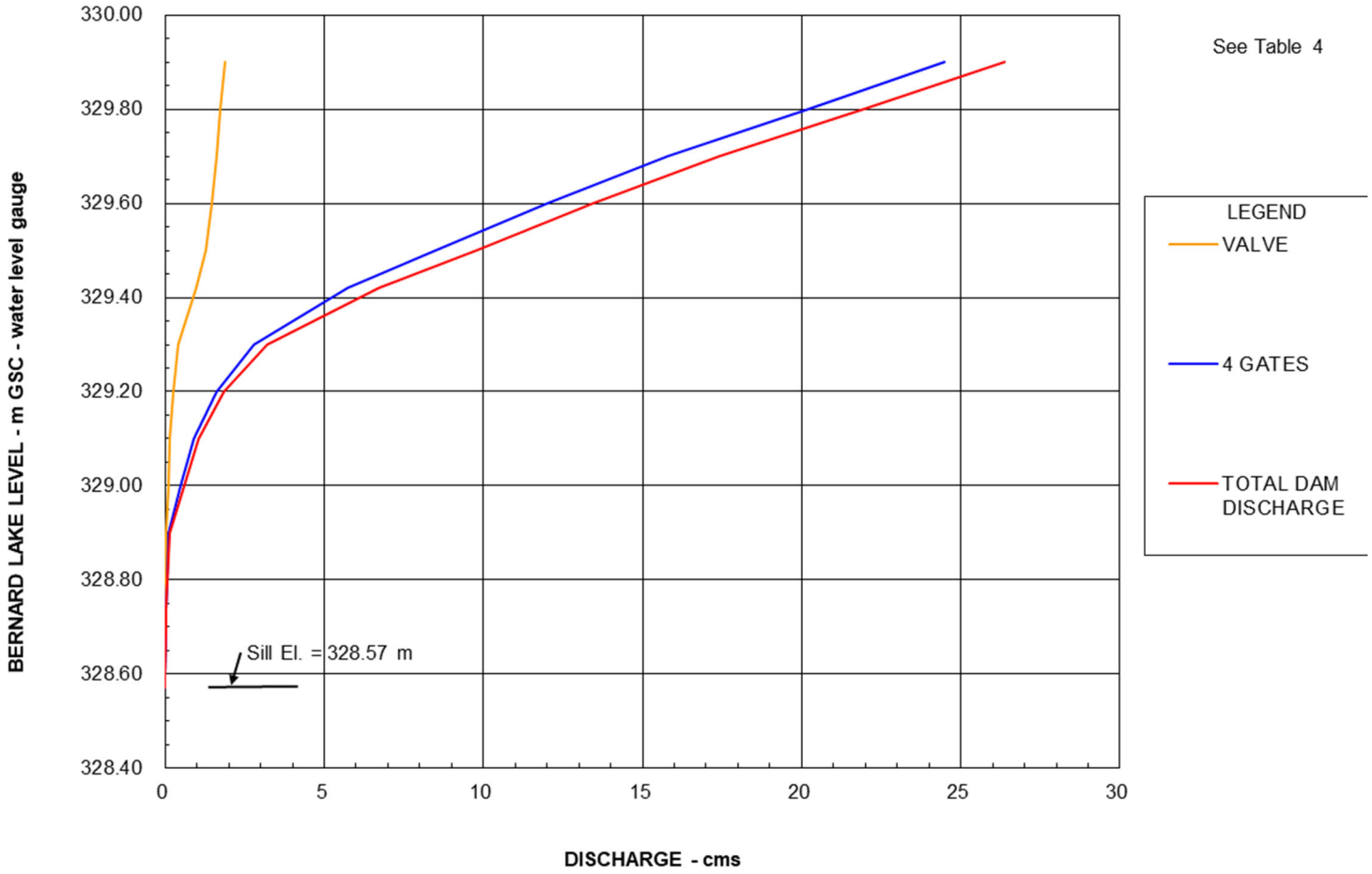


Table 4 BERNARD DAM MAXIMUM DISCHARGE CAPACITY

Metric See Fig. 7

LAKE EL.	DISCHARGE IN 4 GATES 0 Logs In	VALVE DISCHARGE 100% Open	TOTAL DISCHARGE	HEAD
metres	cms	cms	cms	metres
328.57	0.00		0.00	0.00
328.60	0.01		0.01	0.03
328.70	0.02		0.02	0.13
328.74	0.04	0.00	0.04	0.17
328.80	0.05	0.02	0.07	0.23
328.90	0.10	0.04	0.14	0.33
329.00	0.50	0.10	0.60	0.43
329.10	0.90	0.16	1.06	0.53
329.20	1.60	0.26	1.86	0.63
329.30	2.80	0.40	3.20	0.73
329.42	5.75	0.98	6.73	0.85
329.50	8.50	1.28	9.78	0.93
329.60	12.0	1.45	13.45	1.03
329.70	15.8	1.60	17.40	1.13
329.80	20.20	1.74	21.94	1.23
329.90	24.5	1.87	26.37	1.33

Table derived from Manning equation and orifice formula

Imperial

LAKE EL.	DISCHARGE IN 4 GATES	VALVE DISCHARGE 100% Open	TOTAL DISCHARGE	HEAD
feet	cfs	cfs	cfs	feet
1078.00	0		0.0	0.00
1078.55	1.0	0	1.0	0.55
1079.00	3.0	1.5	4.5	1.00
1079.50	10.0	4.0	14.0	1.50
1080.00	40.0	8.0	48.0	2.00
1080.25	78.0	19.5	97.5	2.25
1080.36	98.8	12.5	111	2.36
1080.50	125	13.0	138	2.50
1080.77	203	20.2	223	2.77
1081.00	280	25.0	305	3.00
1081.20	360	33.0	393	3.20
1081.50	480	36.2	516	3.50
1081.70	560	38.0	598	3.70
1082.00	690	40.9	731	4.00
1082.50	900	45.1	945	4.50

Table derived from Manning equation and orifice formula

Fig. 8 BERNARD LAKE DAM TAILWATER DISCHARGE CAPACITY CURVE
Metric Preliminary

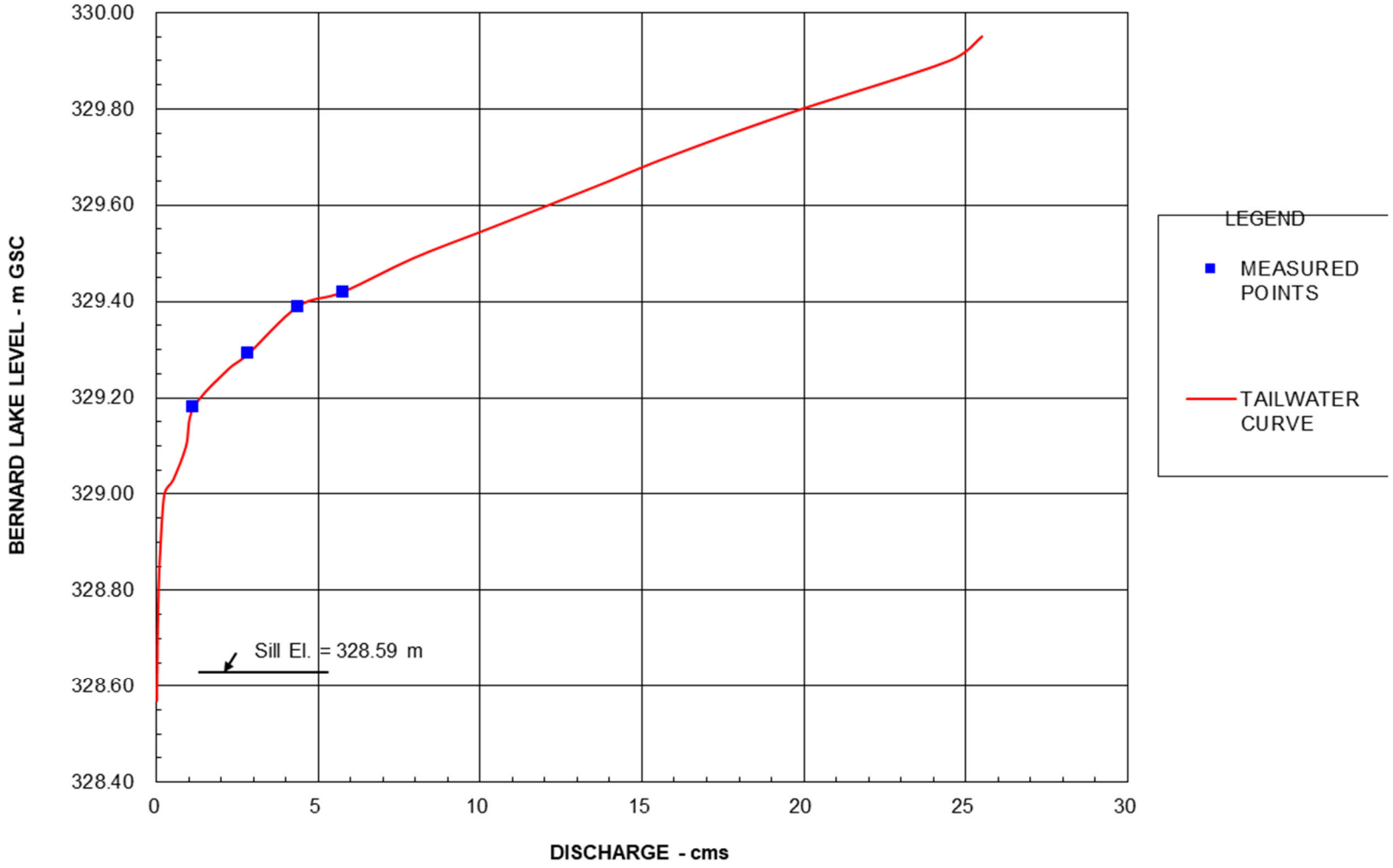


Fig. 9 BERNARD LAKE DAM DISCHARGE CURVES FOR VARIOUS NUMBERS OF STOP-LOGS IN 1 GATE - Imperial

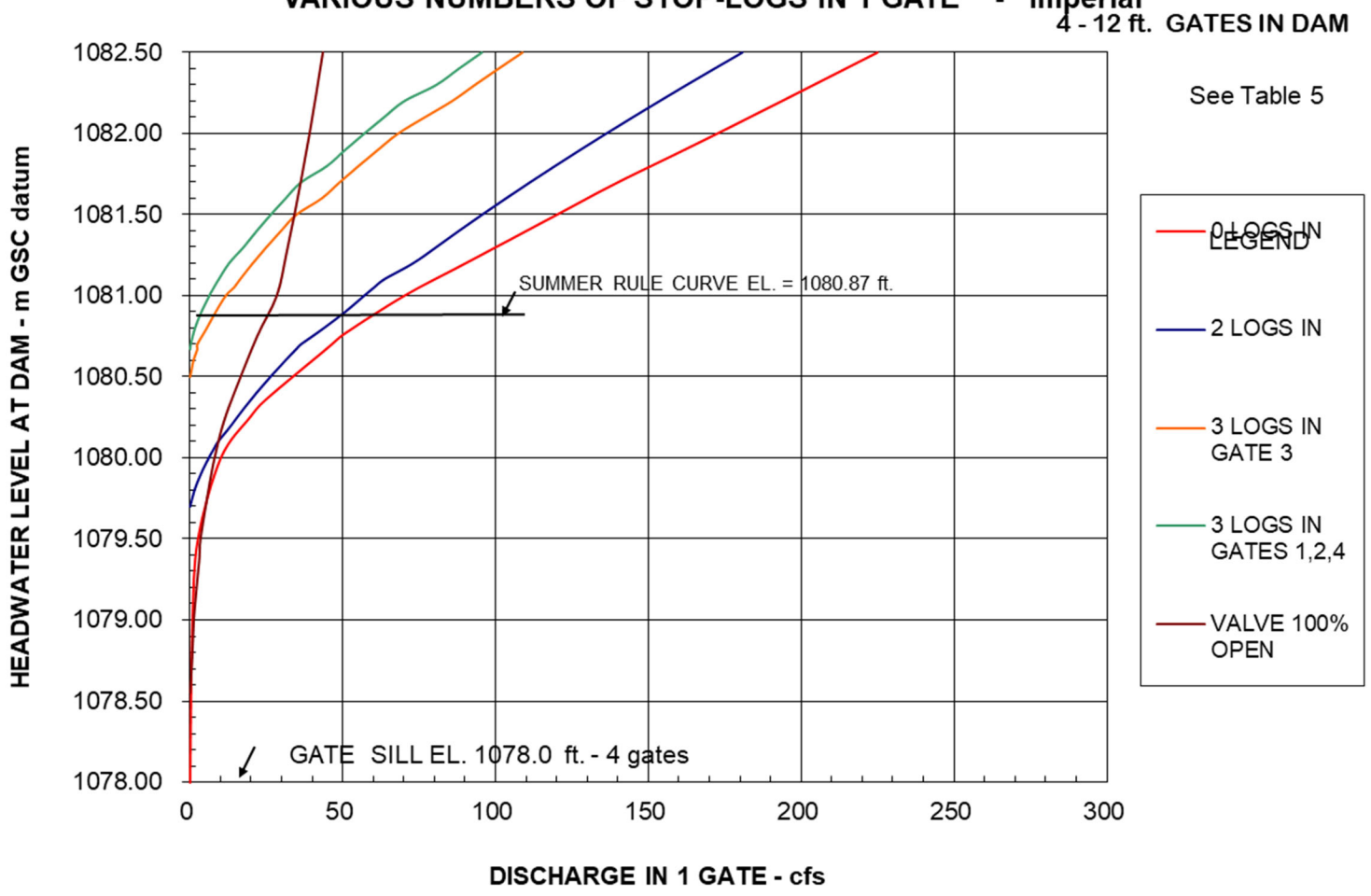


Table 5 BERNARD LAKE DAM DISCHARGE for VARIOUS NUMBERS OF LOGS IN 1-12 FT. WIDE GATE

Imperial See Fig. 9

GATES 1,2,4 - bottom 2 logs 10 inches deep; - top log 12 inches deep

GATE 3 - all 3 logs 10 inches deep = 0.83 ft.

BERNARD LAKE EL. feet	3 LOGS IN GATES 1,2,4 cfs	3 LOGS IN GATE 3 cfs	2 LOGS IN cfs	1 LOG IN cfs	0 LOGS IN cfs	HEAD 0 logs in feet		HEADWATER ELEV. feet
1078.00				dam not	0.00	0.00	Sill Elevation	**1078.00**
1078.10				operated	0.05	0.10		1078.10
1078.20				with 1 log in	0.10	0.20	0 LOGS IN -	1078.20
1078.30					0.15	0.30	submerged	1078.30
1078.40					0.20	0.40	flow - same as	1078.40
1078.50					0.25	0.50	tailwater rating	1078.50
1078.60					0.30	0.60	curve.	1078.60
1078.70					0.40	0.70		1078.70
1078.80					0.50	0.80		1078.80
1078.83					0.60	0.83	1 - 10 in. log in	**1078.83**
1078.90					0.70	0.90		1078.90
1079.00					0.75	1.00		1079.00
1079.05					0.85	1.05		1079.05
1079.10					0.90	1.10		1079.10
1079.20					1.0	1.20		1079.20
1079.30					1.5	1.30		1079.30
1079.40					2.0	1.40		1079.40
1079.50					2.5	1.50		1079.50
1079.60					4.0	1.60		1079.60
1079.66					4.6	1.66		1079.66
1079.67			0.0		4.6	1.67	2 - 10 inch logs in	**1079.67**
1079.70			0.2		5.0	1.70		1079.70
1079.80			1.6		6.0	1.80		1079.80
1079.90			3.7		8.0	1.90		1079.90
1080.00			6.3		10	2.00		1080.00
1080.05			7.7		12	2.05		1080.05
1080.10			9.3		13	2.10		1080.10
1080.20			13.5		18	2.20		1080.20
1080.30			17.5		21	2.30		1080.30
1080.40			21.8		28	2.40		1080.40
1080.50		0	26.4		34	2.50	3 logs in Gate 3	**1080.50**
1080.60		1.0	31.3		40	2.60	- top log 10 in. deep	1080.60
1080.67	0	2.3	34.8		48	2.67		**1080.67**
1080.70	1.6	2.3	34.8		52	2.67	3 logs in Gates 1, 2, 4	1080.70
1080.80	3.7	5.4	43.8		54	2.80	- top log 12 in. deep	1080.80
1080.90	6.3	8.4	50.8		60	2.90		1080.90
1081.00	7.7	11.7	57.1		70	3.00		1081.00
1081.05	9.3	14.3	60.2		75	3.05		1081.05
1081.10	13.5	16.3	63.5		80	3.10		1081.10
1081.20	17.5	20.5	73.0		90	3.20		1081.20
1081.30	21.8	25.0	80.7		100	3.30		1081.30
1081.40	26.4	29.8	88.0		110	3.40		1081.40
1081.50	31.3	34.8	95.6		120	3.50		1081.50
1081.60	39.1	43.1	103		130	3.60		1081.60
1081.70	44.8	49.0	111		140	3.70		1081.70
1081.80	50.8	55.2	119		150	3.80		1081.80
1081.90	57.1	61.5	128		160	3.90		1081.90
1082.00	63.5	68.1	136		173	4.00		1082.00
1082.10	70.2	76.8	145		183	4.10		1082.10
1082.20	80.7	85.8	154		195	4.20		1082.20
1082.30	88.0	93.3	162		204	4.30		1082.30
1082.40	95.6	101	172		214	4.40		1082.40
1082.50		109	181		225	4.50		1082.50

Fig. 10 BERNARD LAKE DAM VALVE DISCHARGE CAPACITY

Imperial

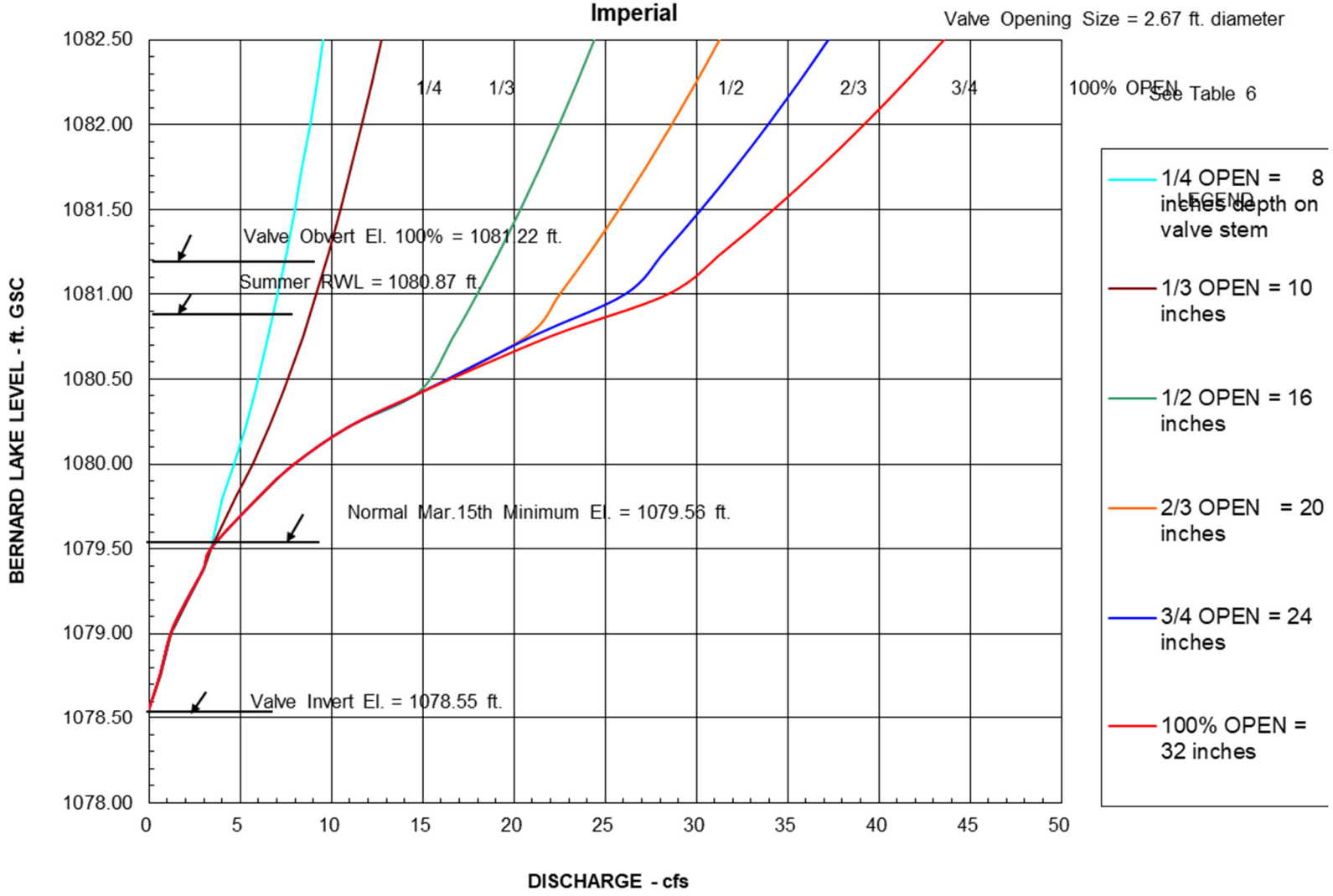


Table 6 BERNARD LAKE DAM VALVE DISCHARGE CAPACITY

Imperial

Valve Opening Size: 2.67 ft. dia. - square valve — See Fig. 10

Valve Invert El.: 1078.55 ft.

Valve Opening Area 5.57 sq.ft.

BERNARD	VALVE % OPEN						HEAD ON
LAKE	25% = 1/4	31% = <1/3	50% = 1/2	63% = <2/3	75% = 3/4	100%	VALVE
LEVEL	h = 8 inches	0 in. =0.83 ft	16 in. =1.33 ft.	20 in. =1.67 ft.	24 in. = 2 ft.	32 in. = 2.67 ft	CENTRE
feet	cfs	cfs	cfs	cfs	cfs	cfs	100% -ft.
1078.00							
1078.25							
1078.55	0.0	0.0	0.0	0.0	0.0	0.0	1079.8
1078.75	0.6	0.6	0.6	0.6	0.6	0.6	
1079.00	1.5	1.5	1.5	1.5	1.5	1.5	
1079.18	2.4	2.4	2.4	2.4	2.4	2.4	
1079.38	3.4	3.4	3.4	3.4	3.4	3.4	
1079.50	3.8	4.0	4.0	4.0	4.0	4.0	
1079.80	4.0	4.7	6.0	6.0	6.0	6.0	
1080.00	4.7	5.7	8.0	8.0	8.0	8.0	1080.0
1080.22	5.3	6.6	11.0	11.0	11.0	11.0	1080.2
1080.43	5.8	7.4	14.8	14.0	14.0	14.0	1080.4
1080.75	6.5	8.4	16.7	20.7	24.0	25.0	1080.8
1081.00	7.0	9.2	18.0	22.5	26.1	28.5	1081.0
1081.25	7.5	9.9	19.2	24.2	28.3	31.5	1081.3
1081.50	8.0	10.5	20.4	25.8	30.3	34.2	1081.5
1081.75	8.4	11.1	21.5	27.2	32.1	36.8	1081.8
1082.00	8.8	11.7	22.5	28.6	33.9	39.2	1082.0
1082.25	9.2	12.2	23.5	30.0	35.6	41.4	1082.3
1082.50	9.6	12.7	24.4	31.3	37.2	43.6	1082.5

Invert El. - ft.	1078.55	1078.55	1078.55	1078.55	1078.55	1078.55
Opening Top El. - ft.	1079.22	1079.38	1079.88	1080.22	1080.550	1081.22
Height of opening h - f	0.67	0.83	1.33	1.67	2	2.67
Area - sq. ft.	1.10	1.49	2.80	3.68	4.50	5.60
Centre of opening - ft.	1079.22	1079.375	1079.22	1079.39	1079.55	1079.89
Sector angle - degree	120	136	180	209	240	0.00
Sector area - ft^2	1.87	2.11	2.80	3.25	3.73	0.00
Triangle area - ft^2	0.77	0.62	0.00	0.43	0.77	0.00
Opening area - ft^2	1.10	1.49	2.80	3.68	4.50	5.60

h = height of opening

For levels below top of opening, flows calculated from Manning equation;

For levels above top of opening, flows calculated from orifice formula Q = C* A*(2*32.2*H)^0.5 where C=0.6

Fig. 11 BERNARD LAKE DAM MAXIMUM DISCHARGE CAPACITY
Imperial

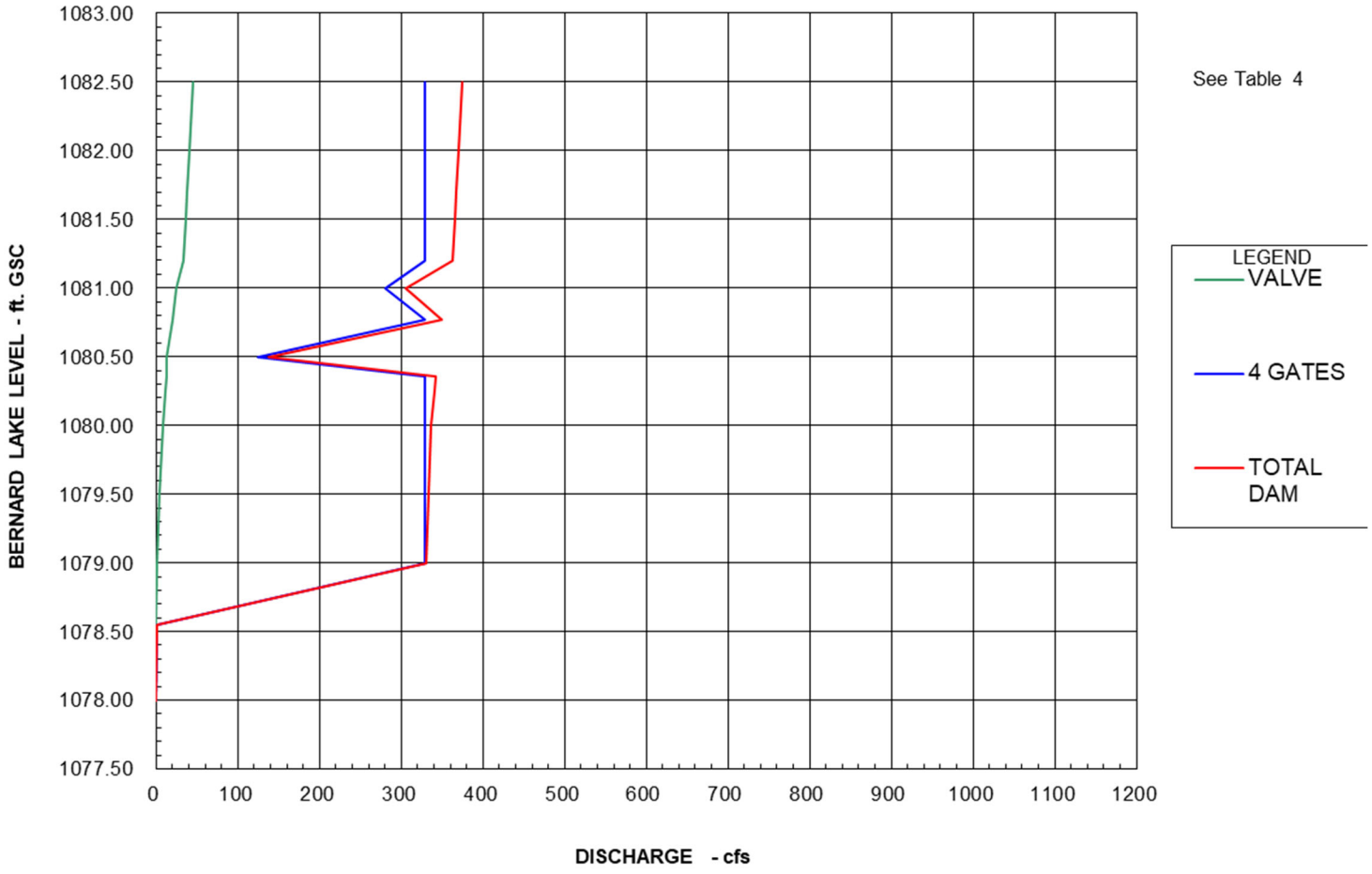


Fig. 12 BERNARD LAKE DAM TAILWATER DISCHARGE CAPACITY

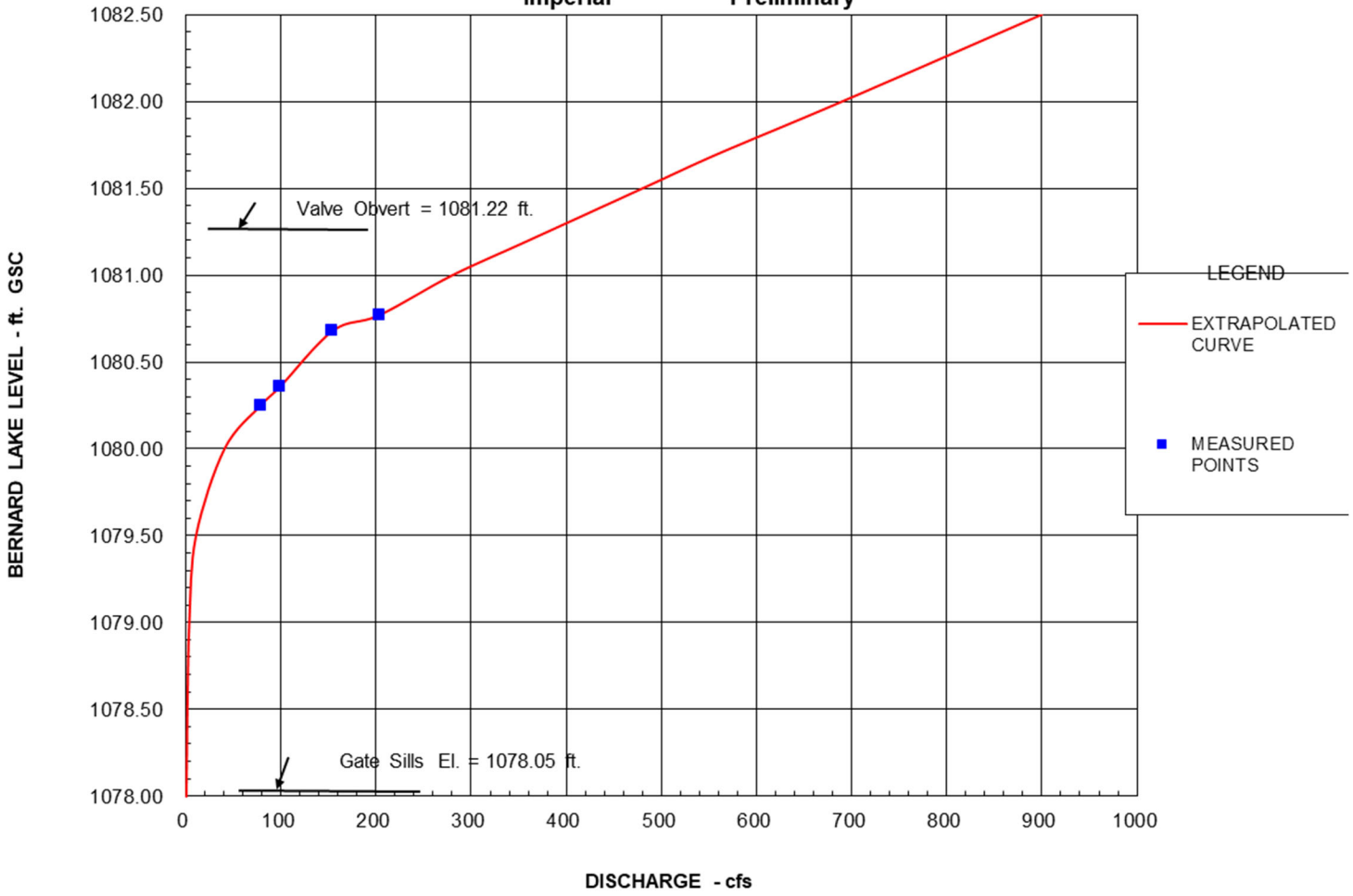


Fig. 13 LAKE BERNARD STORAGE CURVE
Metric

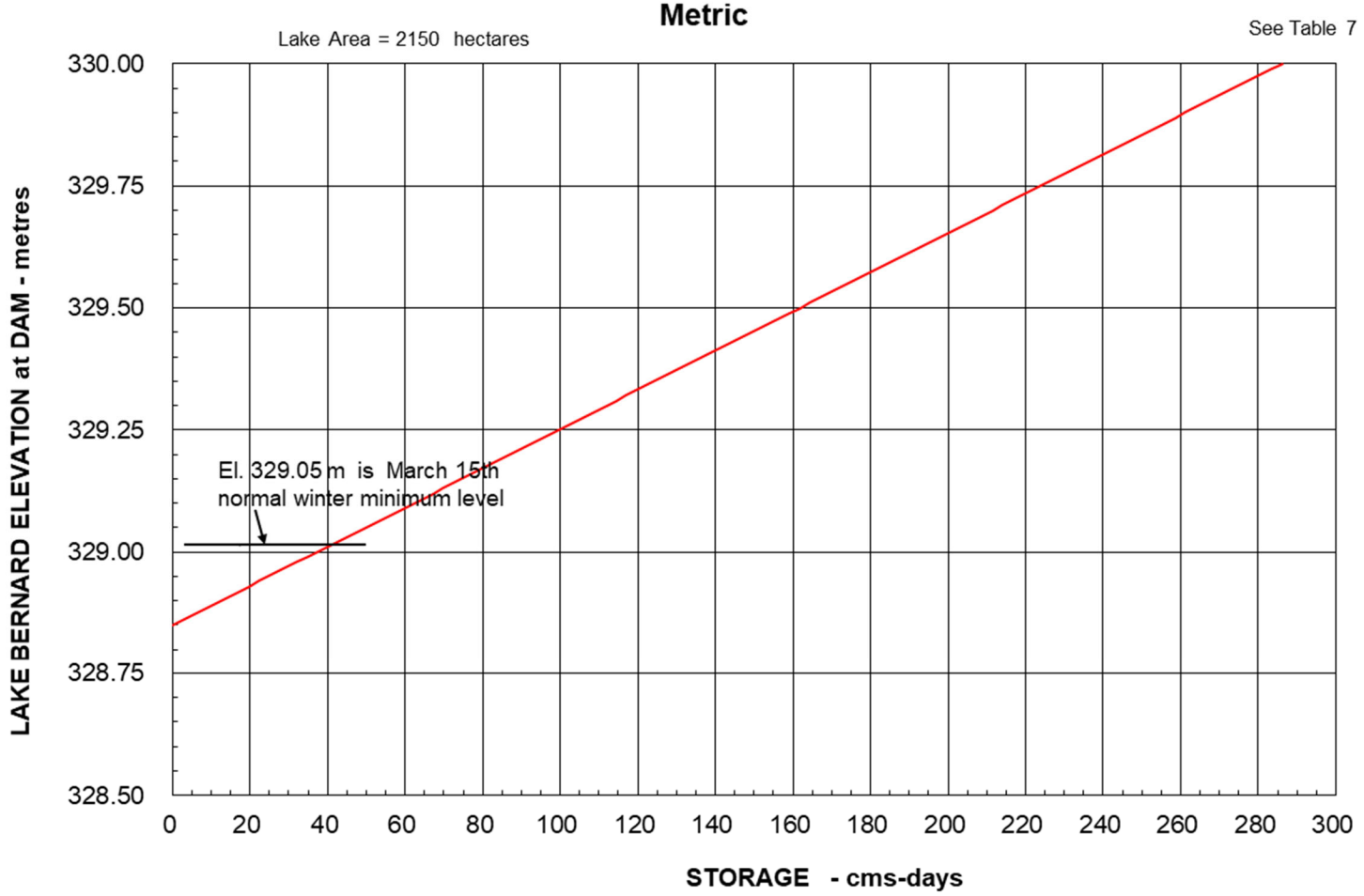


Table 7 LAKE BERNARD STAGE - STORAGE TABLE

Metric

Lake Area = 21.5 sq.km. = 8.3 sq.mi. See Fig. 13

= 2150 hectares = 5312 acres

Normal Storage Range = 329.05 to 329.5 m ha-m x 0.1157 = cms-days

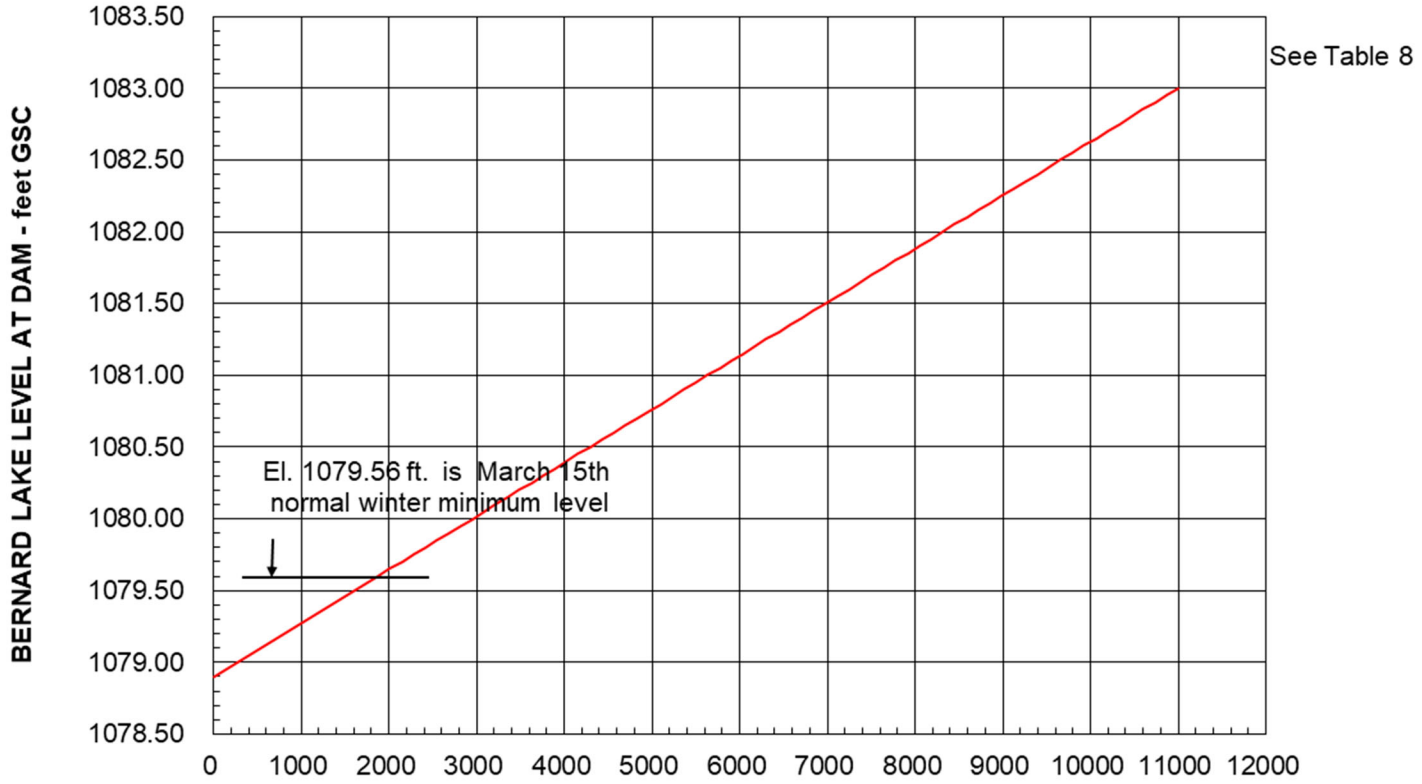
LAKE ELEV metres	STORAGE cms-days	LAKE ELEV. metres	STORAGE cms-days	LAKE ELEV. metres	STORAGE cms-days
328.85	0.00	329.30	111.9	329.75	223.9
328.86	2.49	329.31	114.4	329.76	226.4
328.87	4.98	329.32	116.9	329.77	228.9
328.88	7.46	329.33	119.4	329.78	231.3
328.89	9.95	329.34	121.9	329.79	233.8
328.90	12.44	329.35	124.4	329.80	236.3
328.91	14.93	329.36	126.9	329.81	238.8
328.92	17.41	329.37	129.4	329.82	241.3
328.93	19.90	329.38	131.8	329.83	243.8
328.94	22.39	329.39	134.3	329.84	246.3
328.95	24.88	329.40	136.8	329.85	248.8
328.96	27.36	329.41	139.3	329.86	251.2
328.97	29.85	329.42	141.8	329.87	253.7
328.98	32.34	329.43	144.3	329.88	256.2
328.99	34.83	329.44	146.8	329.89	258.7
329.00	37.31	329.45	149.3	329.90	261.2
329.01	39.80	329.46	151.7	329.91	263.7
329.02	42.29	329.47	154.2	329.92	266.2
329.03	44.78	329.48	156.7	329.93	268.7
329.04	47.26	329.49	159.2	329.94	271.1
329.05	49.75	329.50	161.7	329.95	273.6
329.06	52.24	329.51	164.2	329.96	276.1
329.07	54.73	329.52	166.7	329.97	278.6
329.08	57.21	329.53	169.2	329.98	281.1
329.09	59.70	329.54	171.6	329.99	283.6
329.10	62.19	329.55	174.1	330.00	286.1
329.11	64.68	329.56	176.6		
329.12	67.16	329.57	179.1		
329.13	69.65	329.58	181.6		
329.14	72.14	329.59	184.1		
329.15	74.63	329.60	186.6		
329.16	77.11	329.61	189.1		
329.17	79.60	329.62	191.5		
329.18	82.09	329.63	194.0		
329.19	84.58	329.64	196.5		
329.20	87.06	329.65	199.0		
329.21	89.55	329.66	201.5		
329.22	92.04	329.67	204.0		
329.23	94.53	329.68	206.5		
329.24	97.01	329.69	209.0		
329.25	99.50	329.70	211.4		
329.26	101.99	329.71	213.9		
329.27	104.48	329.72	216.4		
329.28	106.96	329.73	218.9		
329.29	109.45	329.74	221.4		

EL. 329.05 m = March 15th rule curve (normal) minimum

Fig. 14 LAKE BERNARD STORAGE CURVE

Imperial

Lake Area = 5312 acres



See Table 8

Enter start and finish lake level in chart for storage period being considered and subtract

Table 8 LAKE BERNARD STAGE - STORAGE TABLE

Imperial

See Fig. 14

Lake Area: 5312 acres River: Magnetawan Units: cfs-days

LAKE EL. feet	STORAGE cfs-days	LAKE EL. (cont'd.) feet	STORAGE (cont'd.) cfs-days	LAKE EL. (cont'd.) feet	STORAGE (cont'd.) cfs-days	LAKE EL. (cont'd.) feet	STORAGE (cont'd.) cfs-days	LAKE EL. (cont'd.) feet	STORAGE (cont'd.) cfs-days
1078.90	0	1079.80	2415	1080.70	4829	1081.60	7244	1082.50	9658
1078.92	54	1079.82	2468	1080.72	4883	1081.62	7297	1082.52	9712
1078.94	107	1079.84	2522	1080.74	4936	1081.64	7351	1082.54	9765
1078.96	161	1079.86	2576	1080.76	4990	1081.66	7405	1082.56	9819
1078.98	215	1079.88	2629	1080.78	5044	1081.68	7458	1082.58	9873
1079.00	268	1079.90	2683	1080.80	5097	1081.70	7512	1082.60	9926
1079.02	322	1079.92	2736	1080.82	5151	1081.72	7566	1082.62	9980
1079.04	376	1079.94	2790	1080.84	5205	1081.74	7619	1082.64	10034
1079.06	429	1079.96	2844	1080.86	5258	1081.76	7673	1082.66	10087
1079.08	483	1079.98	2897	1080.88	5312	1081.78	7727	1082.68	10141
1079.10	537	1080.00	2951	1080.90	5366	1081.80	7780	1082.70	10195
1079.12	590	1080.02	3005	1080.92	5419	1081.82	7834	1082.72	10248
1079.14	644	1080.04	3058	1080.94	5473	1081.84	7888	1082.74	10302
1079.16	698	1080.06	3112	1080.96	5527	1081.86	7941	1082.76	10356
1079.18	751	1080.08	3166	1080.98	5580	1081.88	7995	1082.78	10409
1079.20	805	1080.10	3219	1081.00	5634	1081.90	8048	1082.80	10463
1079.22	859	1080.12	3273	1081.02	5688	1081.92	8102	1082.82	10517
1079.24	912	1080.14	3327	1081.04	5741	1081.94	8156	1082.84	10570
1079.26	966	1080.16	3380	1081.06	5795	1081.96	8209	1082.86	10624
1079.28	1019	1080.18	3434	1081.08	5849	1081.98	8263	1082.88	10678
1079.30	1073	1080.20	3488	1081.10	5902	1082.00	8317	1082.90	10731
1079.32	1127	1080.22	3541	1081.12	5956	1082.02	8370	1082.92	10785
1079.34	1180	1080.24	3595	1081.14	6010	1082.04	8424	1082.94	10839
1079.36	1234	1080.26	3649	1081.16	6063	1082.06	8478	1082.96	10892
1079.38	1288	1080.28	3702	1081.18	6117	1082.08	8531	1082.98	10946
1079.40	1341	1080.30	3756	1081.20	6171	1082.10	8585	1083.00	11000
1079.42	1395	1080.32	3810	1081.22	6224	1082.12	8639	1083.02	11053
1079.44	1449	1080.34	3863	1081.24	6278	1082.14	8692	1083.04	11107
1079.46	1502	1080.36	3917	1081.26	6331	1082.16	8746	1083.06	11161
1079.48	1556	1080.38	3971	1081.28	6385	1082.18	8800	1083.08	11214
1079.50	1610	1080.40	4024	1081.30	6439	1082.20	8853	1083.10	11268
1079.52	1663	1080.42	4078	1081.32	6492	1082.22	8907	1083.12	11322
1079.54	1717	1080.44	4132	1081.34	6546	1082.24	8961	1083.14	11375
1079.56	1771	1080.46	4185	1081.36	6600	1082.26	9014	1083.16	11429
1079.58	1824	1080.48	4239	1081.38	6653	1082.28	9068	1083.18	11483
1079.60	1878	1080.50	4293	1081.40	6707	1082.30	9122	1083.20	11536
1079.62	1932	1080.52	4346	1081.42	6761	1082.32	9175	1083.22	11590
1079.64	1985	1080.54	4400	1081.44	6814	1082.34	9229	1083.24	11643
1079.66	2039	1080.56	4453	1081.46	6868	1082.36	9283	1083.26	11697
1079.68	2093	1080.58	4507	1081.48	6922	1082.38	9336	1083.28	11751
1079.70	2146	1080.60	4561	1081.50	6975	1082.40	9390	1083.30	11804
1079.72	2200	1080.62	4614	1081.52	7029	1082.42	9444	1083.32	11858
1079.74	2254	1080.64	4668	1081.54	7083	1082.44	9497	1083.34	11912
1079.76	2307	1080.66	4722	1081.56	7136	1082.46	9551	1083.36	11965
1079.78	2361	1080.68	4775	1081.58	7190	1082.48	9605	1083.38	12019

Fig. BERNARD LAKE DAM VALVE LOW FLOW for OPEN CHANNEL FLOW IN VALVE OUTLET PIPE

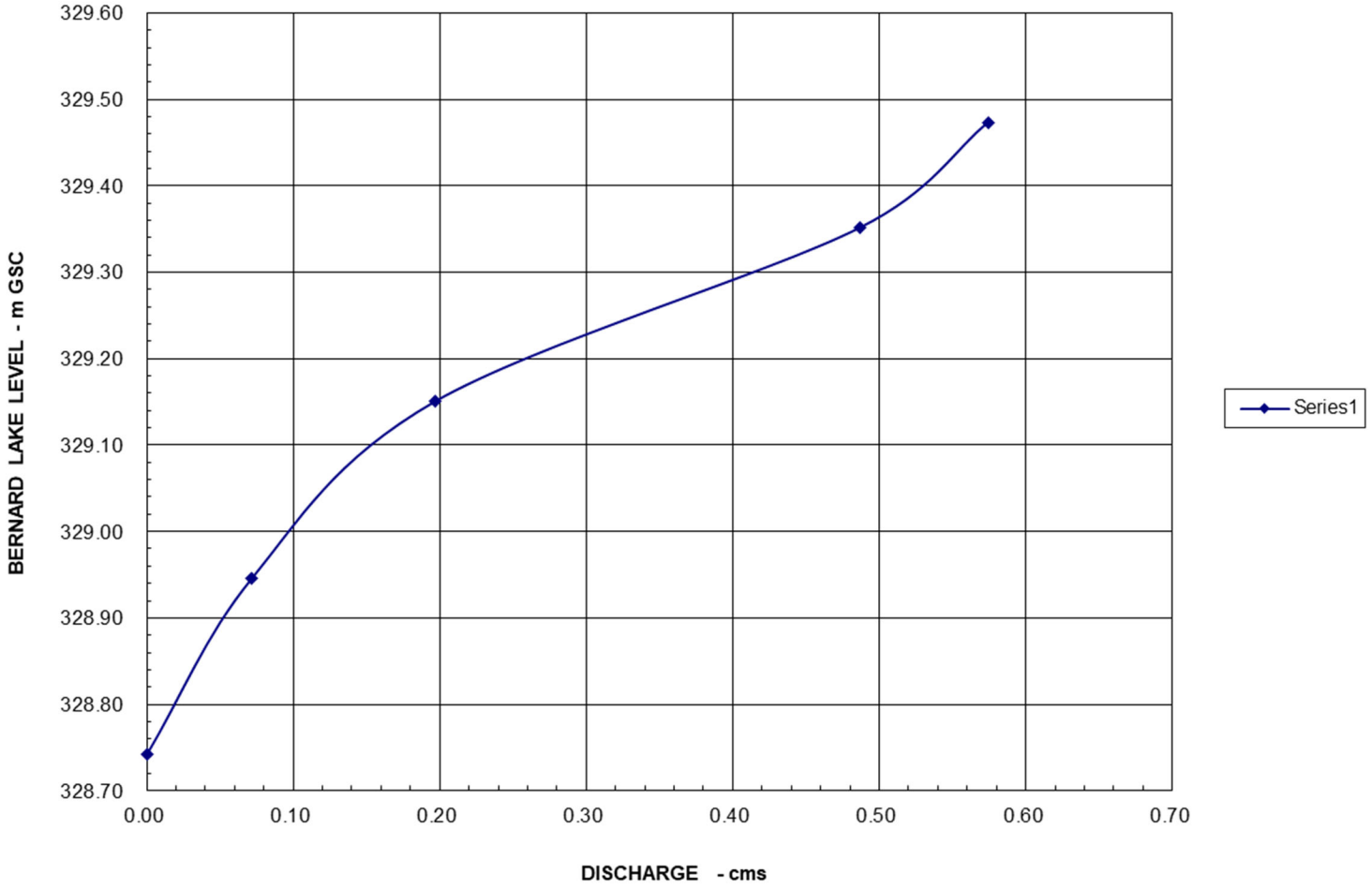
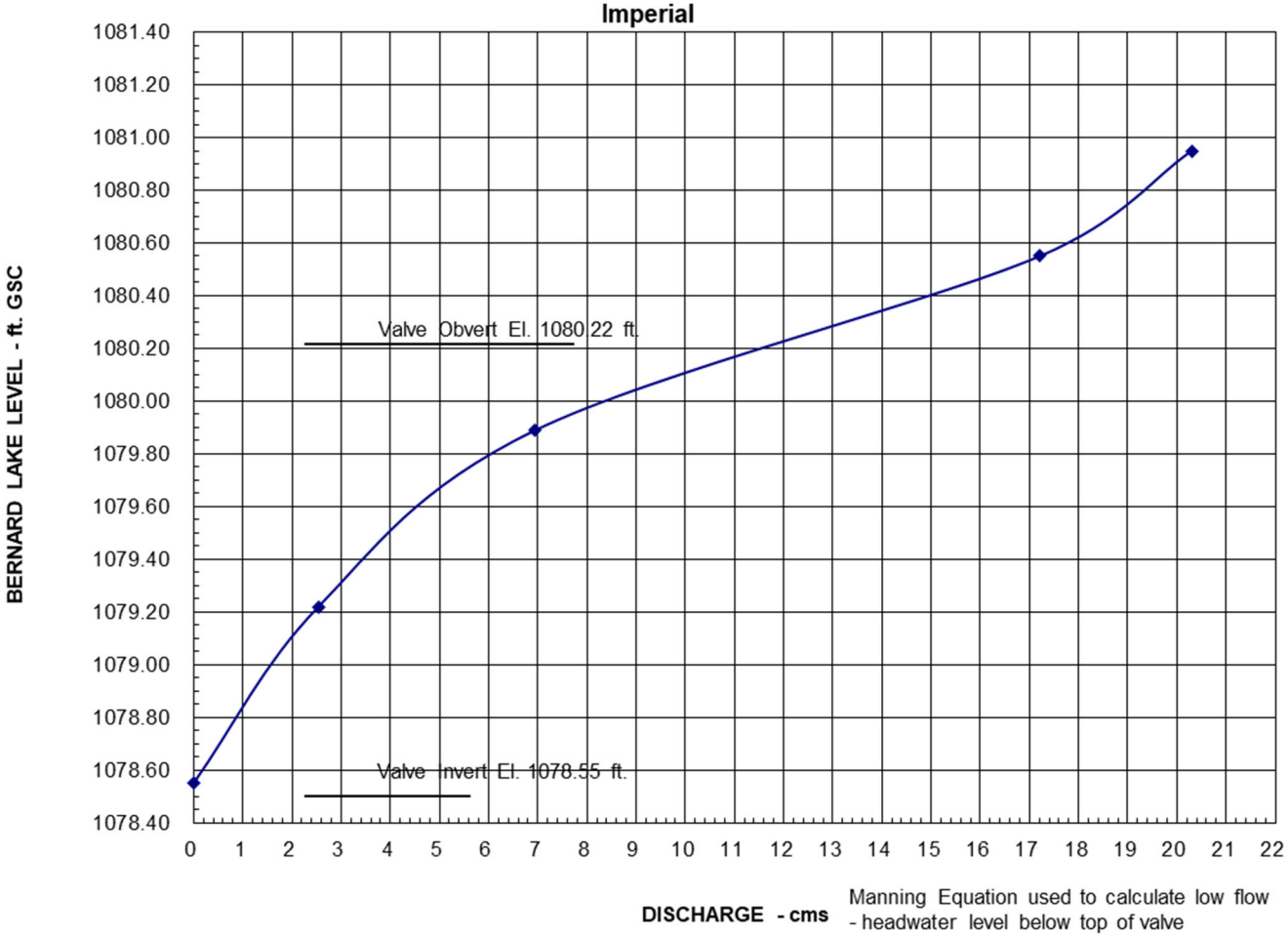


Fig. BERNARD LAKE DAM VALVE LOW FLOWS FOR OPEN CHANNEL FLOW IN VALVE OUTLET PIPE
Imperial



Manning Equation used to calculate low flow - headwater level below top of valve