Diamond Lake Culvert Replacement

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PEND OREILLE PUBLIC WORKS DEPT.

June 26, 2019

Parametrix
ENGINEERING . PLANNING . ENVIRONMENTAL SCIENCES

INTRODUCTION

- Describe the background for the study
- Provide relevant facts about Diamond Lake
- Hydrology and hydraulics in the area
- Show how the lake outlet works
- Culvert replacement
- Question and answer

STUDY BACKGROUND

- Parametrix was selected by the County to perform the study to:
  - Evaluate hydraulic conditions on Diamond Lake
  - Design a replacement culvert

INITIAL STUDY ACTIVITIES

- Visited the area
- Looked through County records
- Installed stage staff gauges
- Surveyed the site
- Prepared a geotechnical study for culvert design

DIAMOND LAKE

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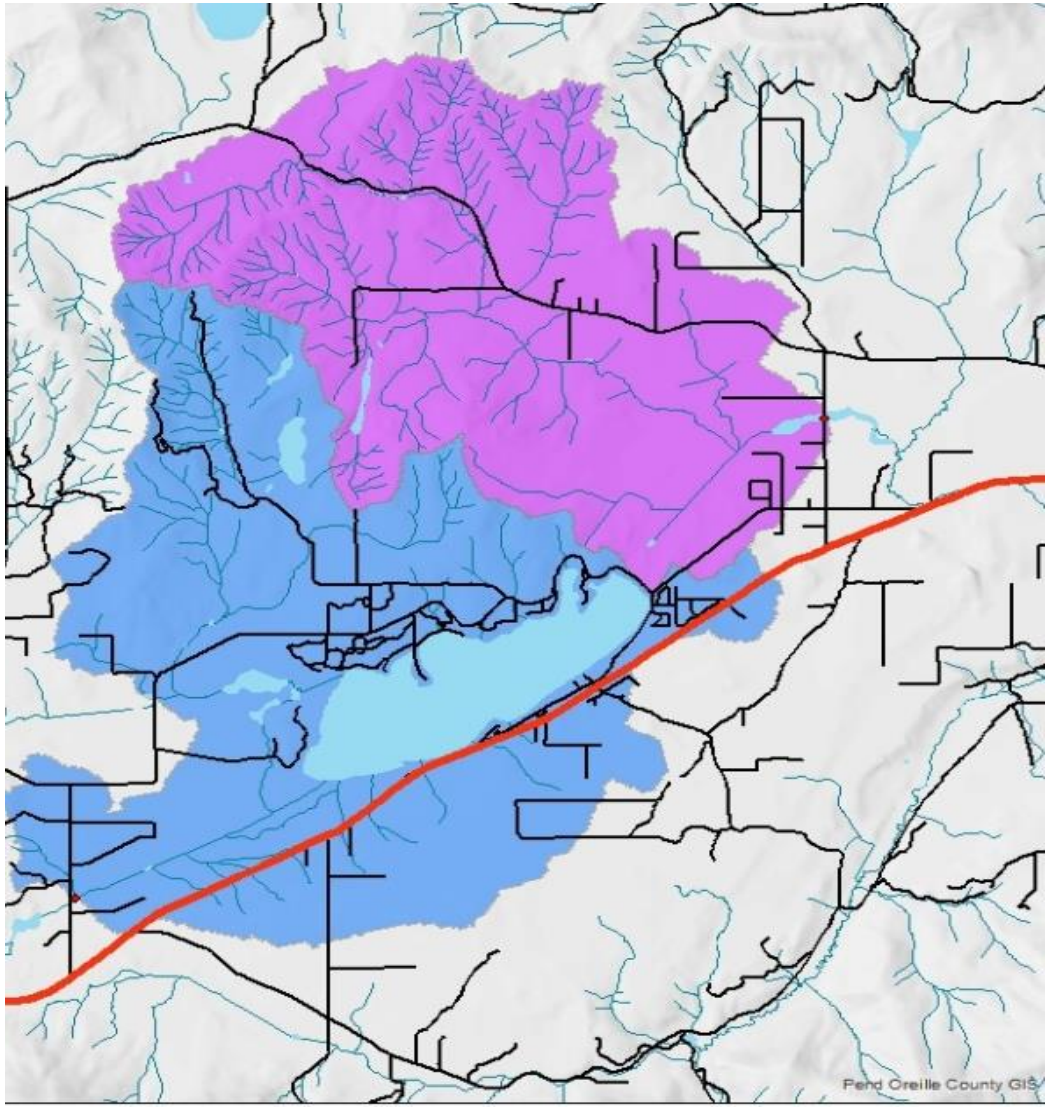
DIAMOND LAKE DRAINAGE BASIN AREA



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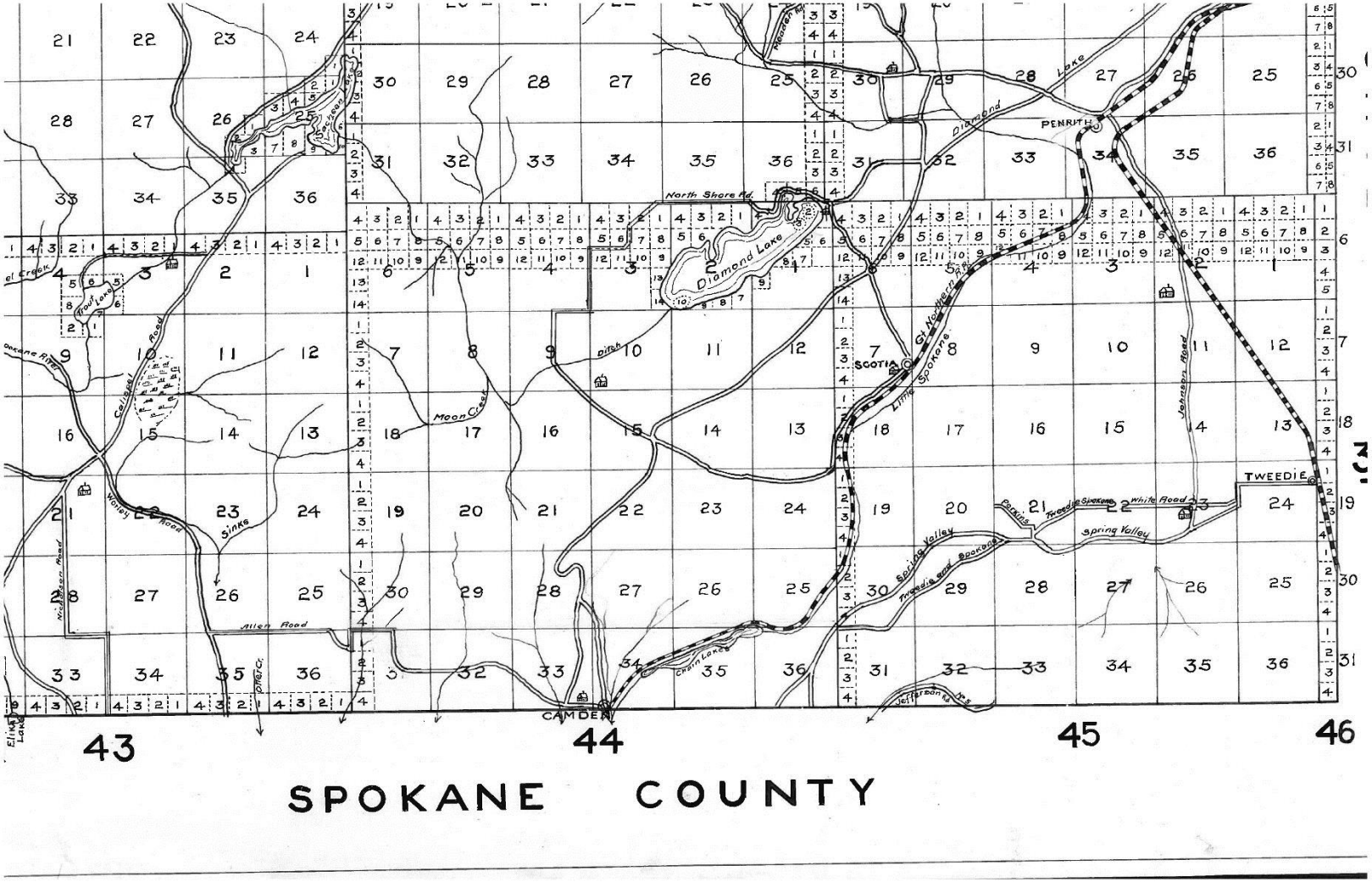
DIAMOND LAKE SURVEY 1914



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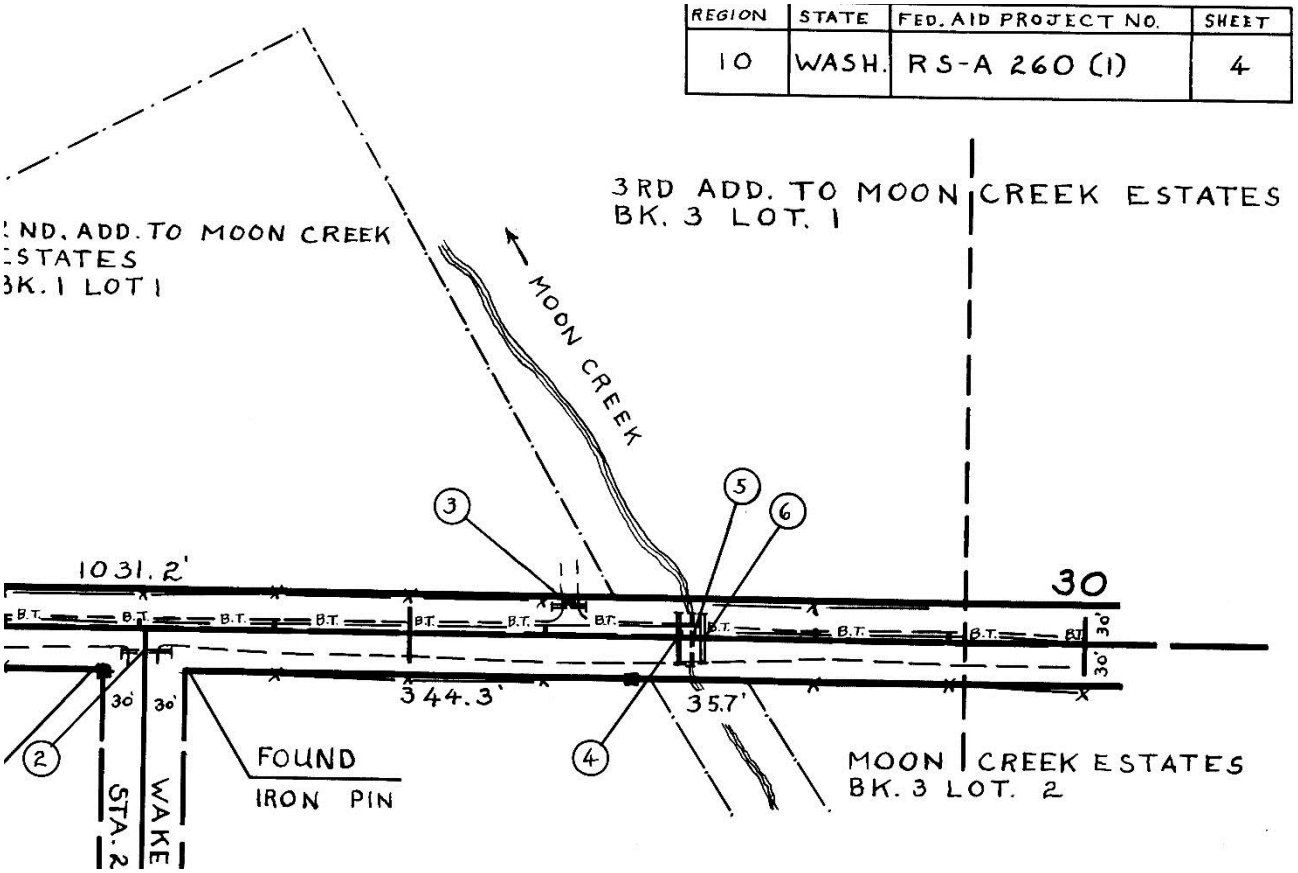
NORTH SHORE ROAD DESIGN - 1977



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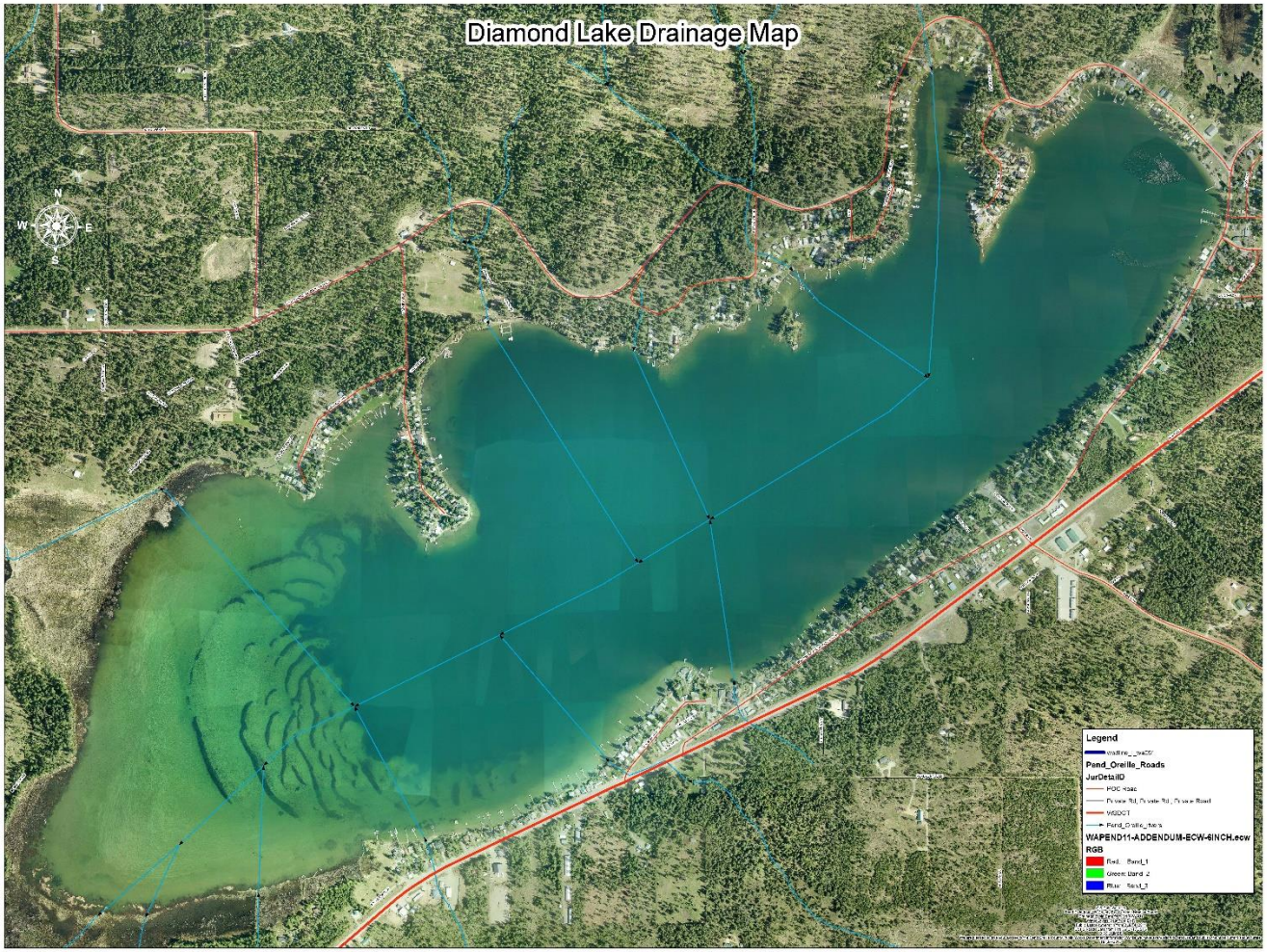
DIAMOND LAKE SURFACE AREA

- About 800 acres



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CLIMATE - PRECIPITATION

- At Newport – 1909 to 2019

	Annual Average Precipitation (in)	Average Annual Snowfall (in)	Average Maximum Snow on Ground (in)(rank)
1909 - 2018	25.5	58.9	33.3
2016-2017	33.5	52.6	40.0 (30)
2017-2018	24.4	61.7	31.0 (41)

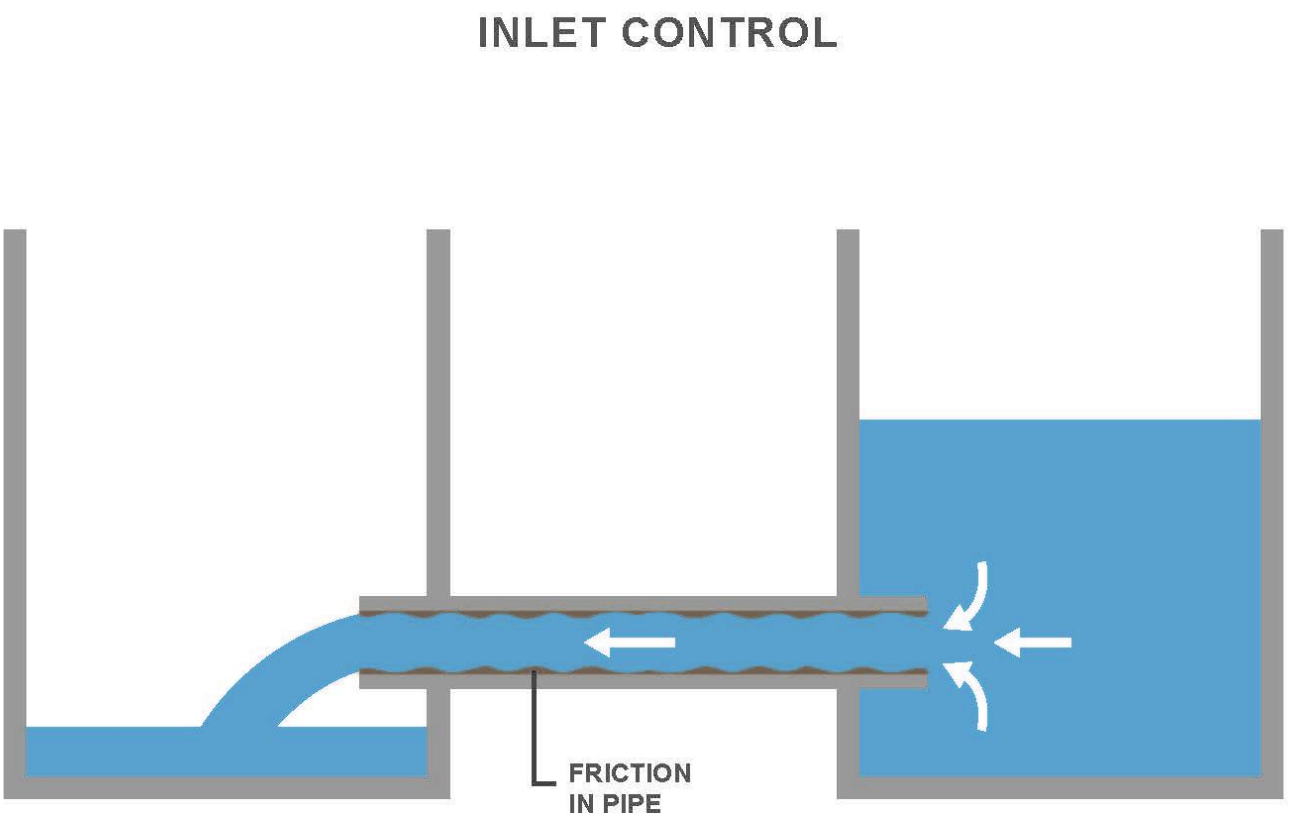
HYDRAULICS – HOW CULVERTS WORK

- Gravity provides the energy to move water
- Friction and turbulence uses up the energy

- Gravity is expressed as “head” or “headwater depth”, which is the difference in water levels on opposite ends of the culvert or the available water energy to make water flow

“water flows downhill”

HYDRAULICS – HOW CULVERTS WORK



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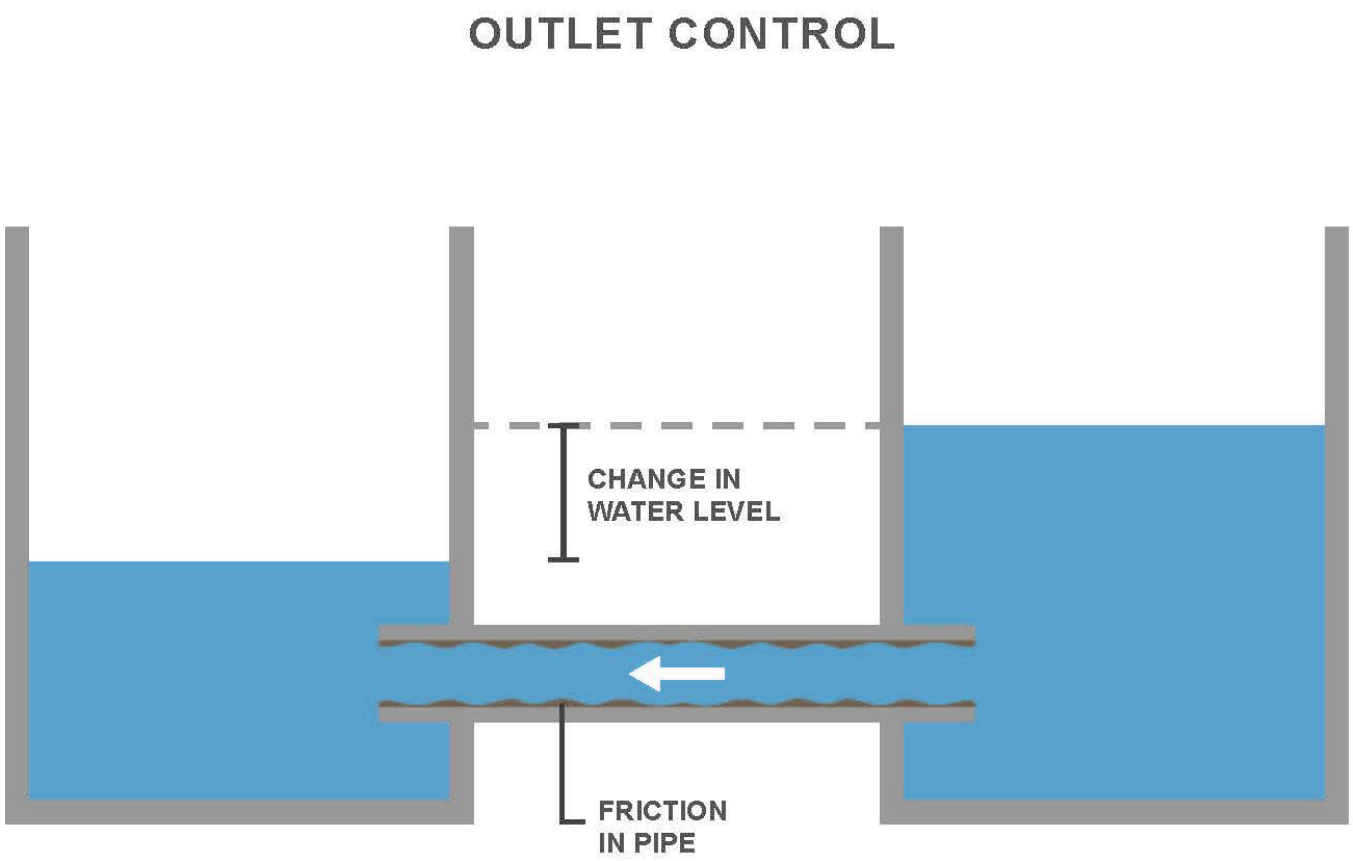
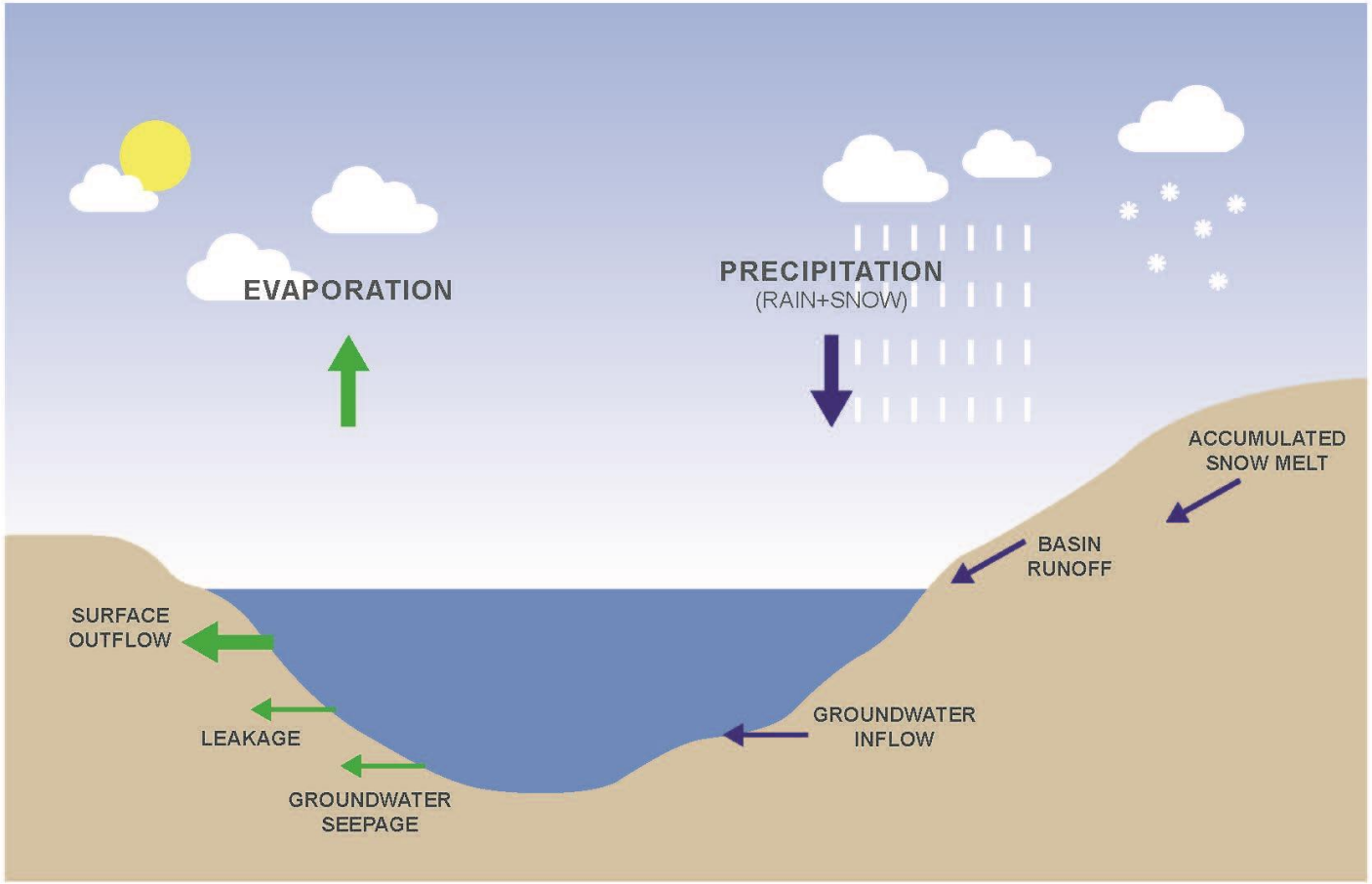
HYDRAULICS – HOW CULVERTS WORK



THE HYDROLOGIC CYCLE

- Water in = water out



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HIGH STAGES ON DIAMOND LAKE

- Inputs
  - Annual snowmelt
  - Spring precipitation
  - Shallow groundwater
- Outputs
  - Evaporation
  - Shallow groundwater and “leakage”
  - Surface water outflow via the Northshore culvert

HIGH STAGES ON DIAMOND LAKE

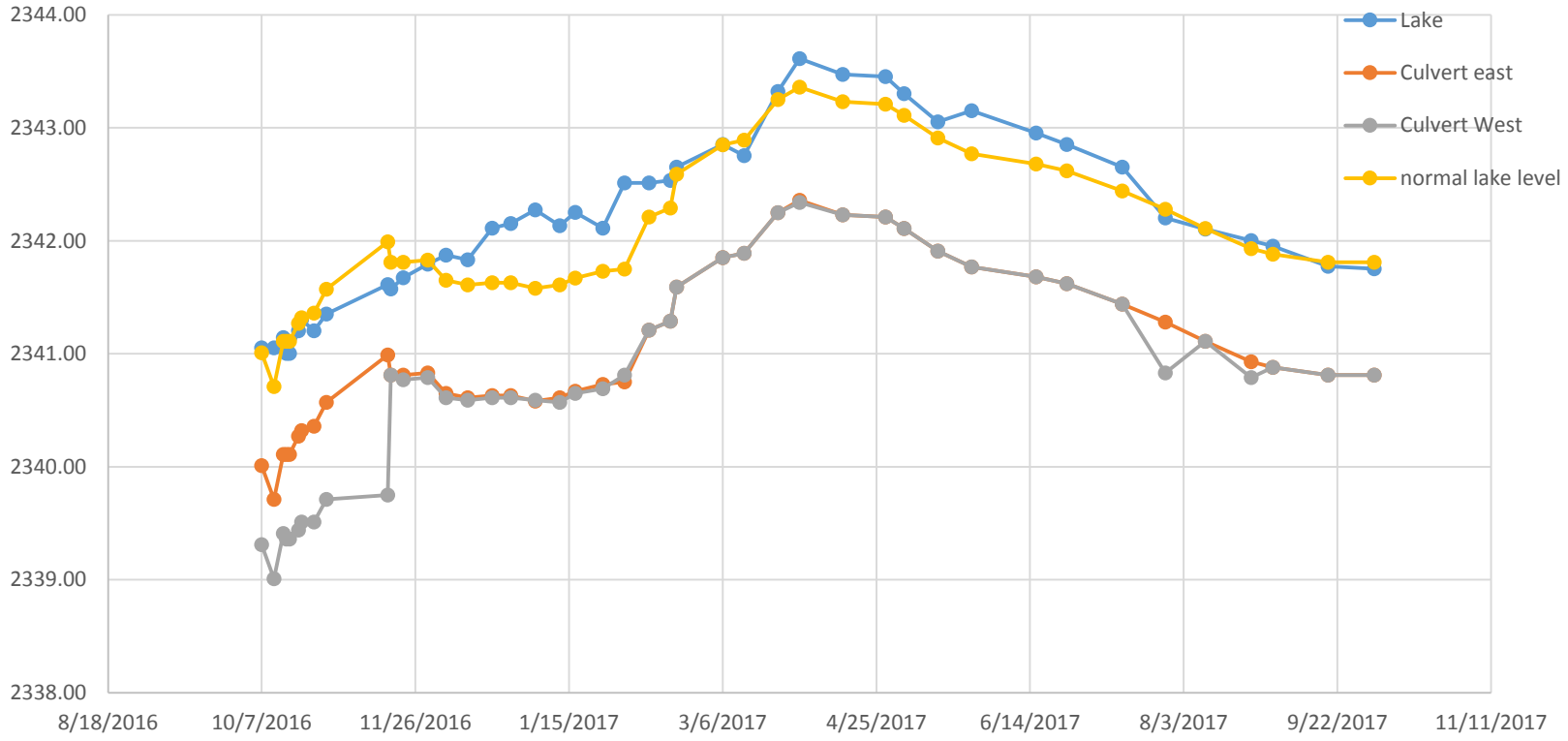
- When inputs exceed outputs, the excess is stored in the lake and levels rise

- Higher levels probably slow groundwater input, increases leakage, and increases surface discharge via the culvert

STAGE MONITORING

- Staff gauges were installed late winter 2017:
  - Downstream of the culvert
  - Upstream of the culvert
  - In the lake at the park

MONITORING RESULTS – SPRING 2017



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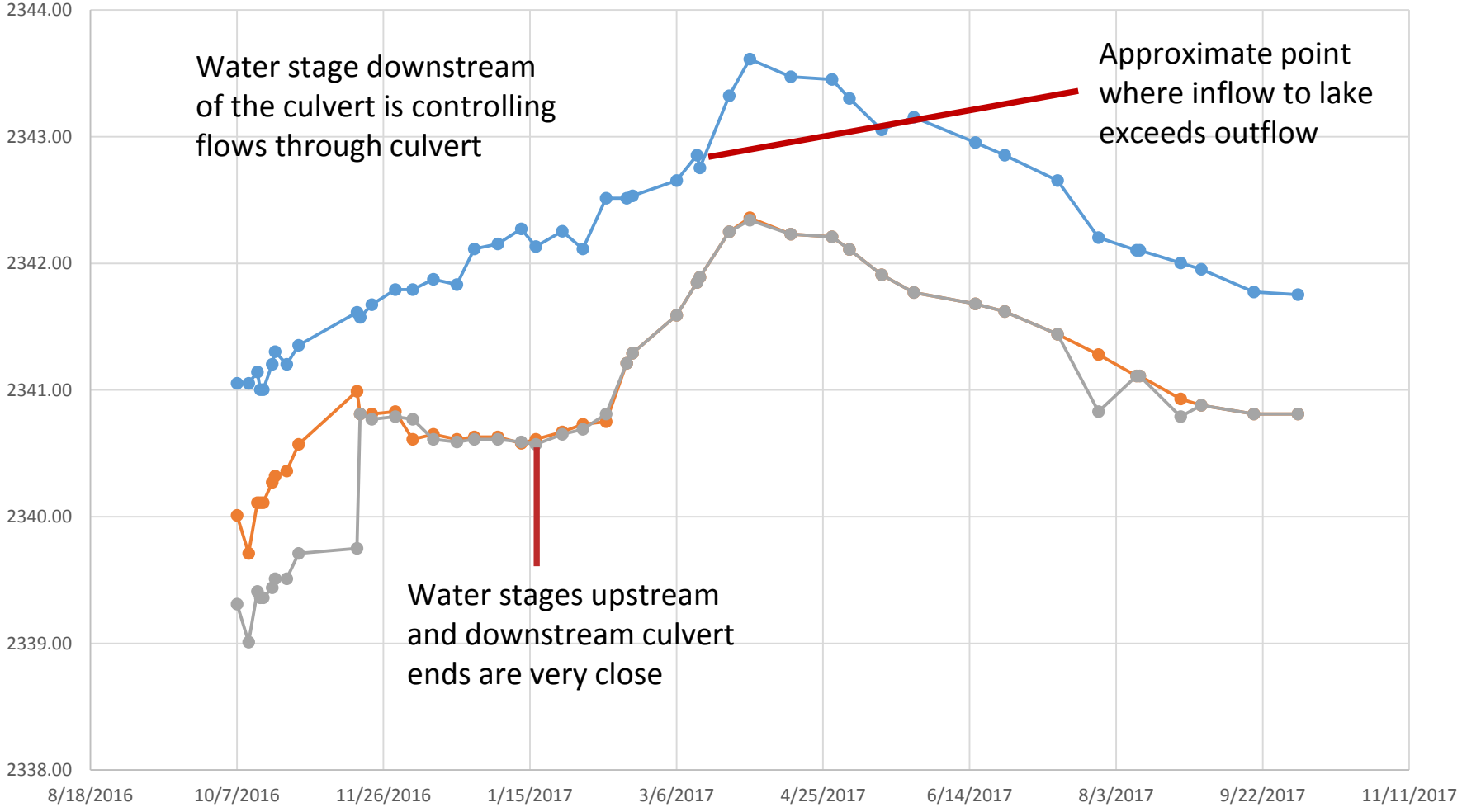
OBSERVATIONS ON STAGE DATA



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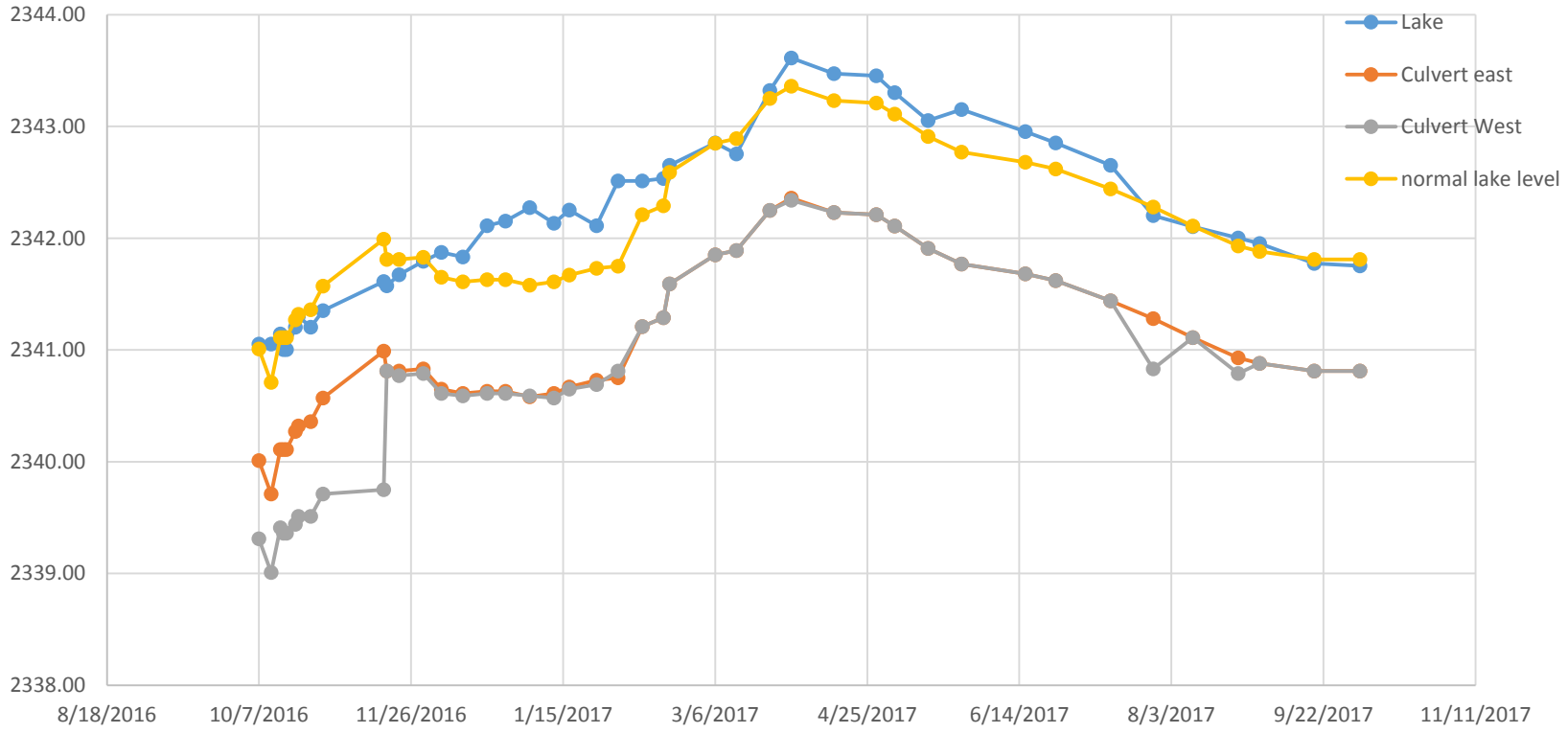
WATER LEVEL BETWEEN LAKE AND CULVERT



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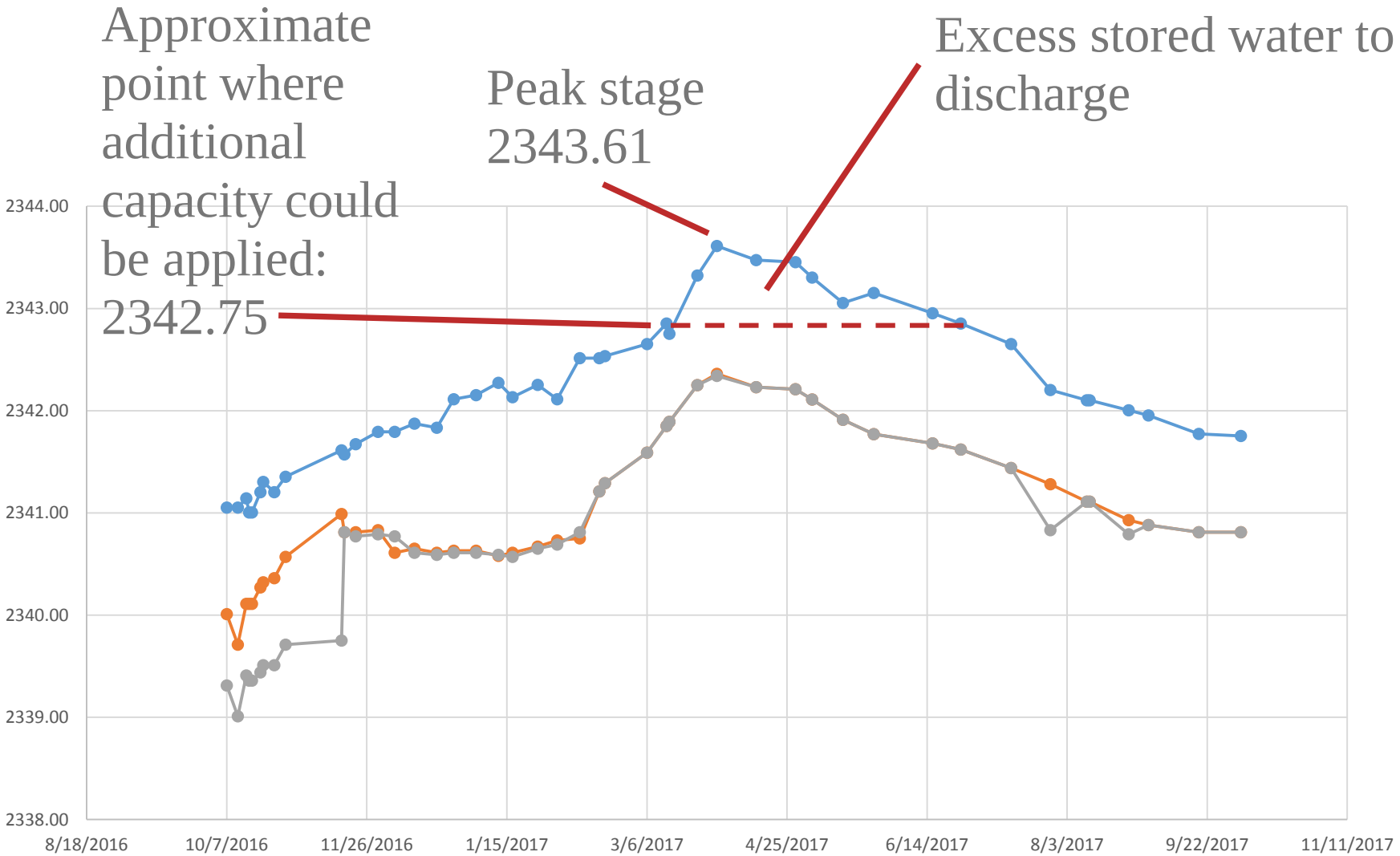
ADDING FLOW CAPACITY TO REDUCE LAKE STORAGE



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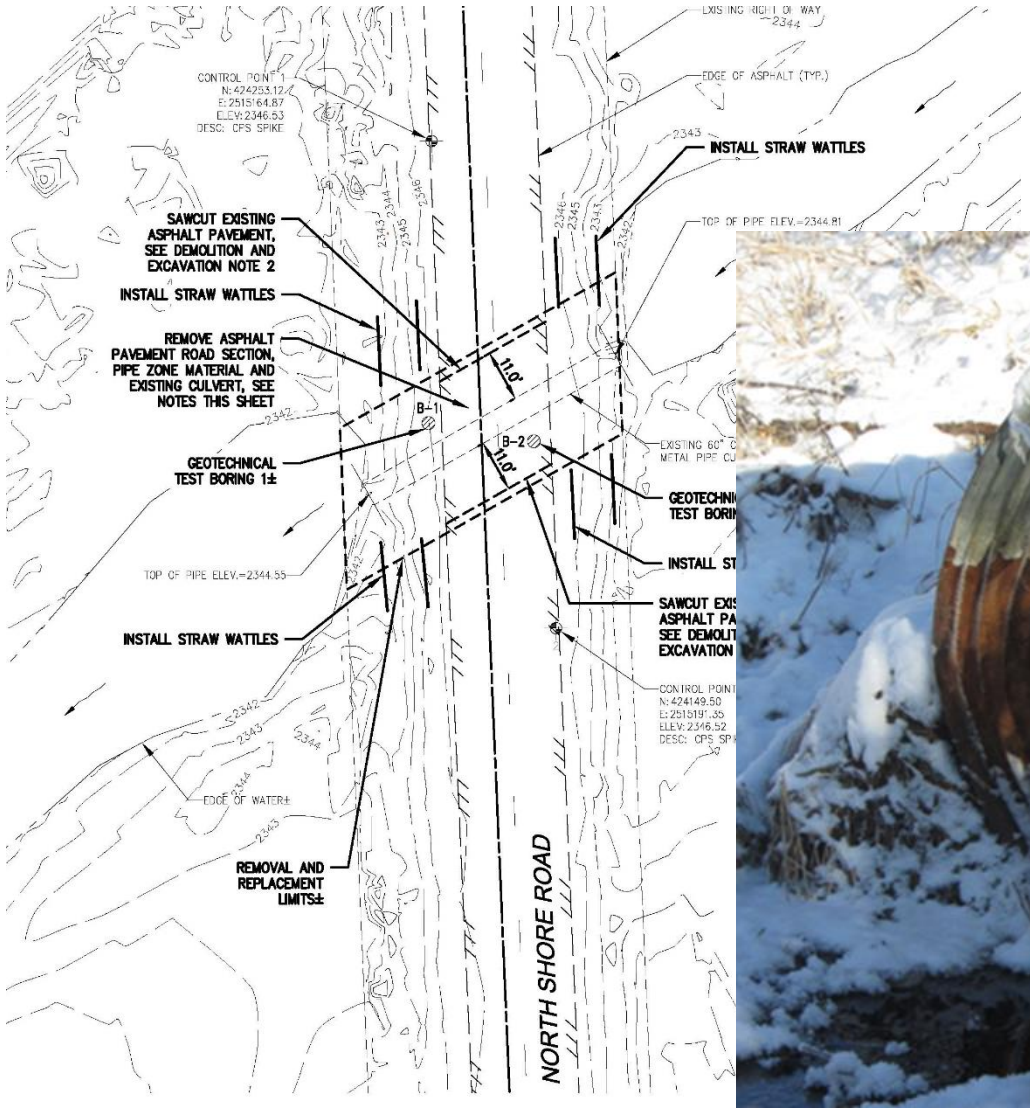
EXISTING CULVERT



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CULVERT RATING CURVE

- What is a rating curve?

"The amount of water flowing through a structure at a given stage, culvert configuration, and downstream water level"

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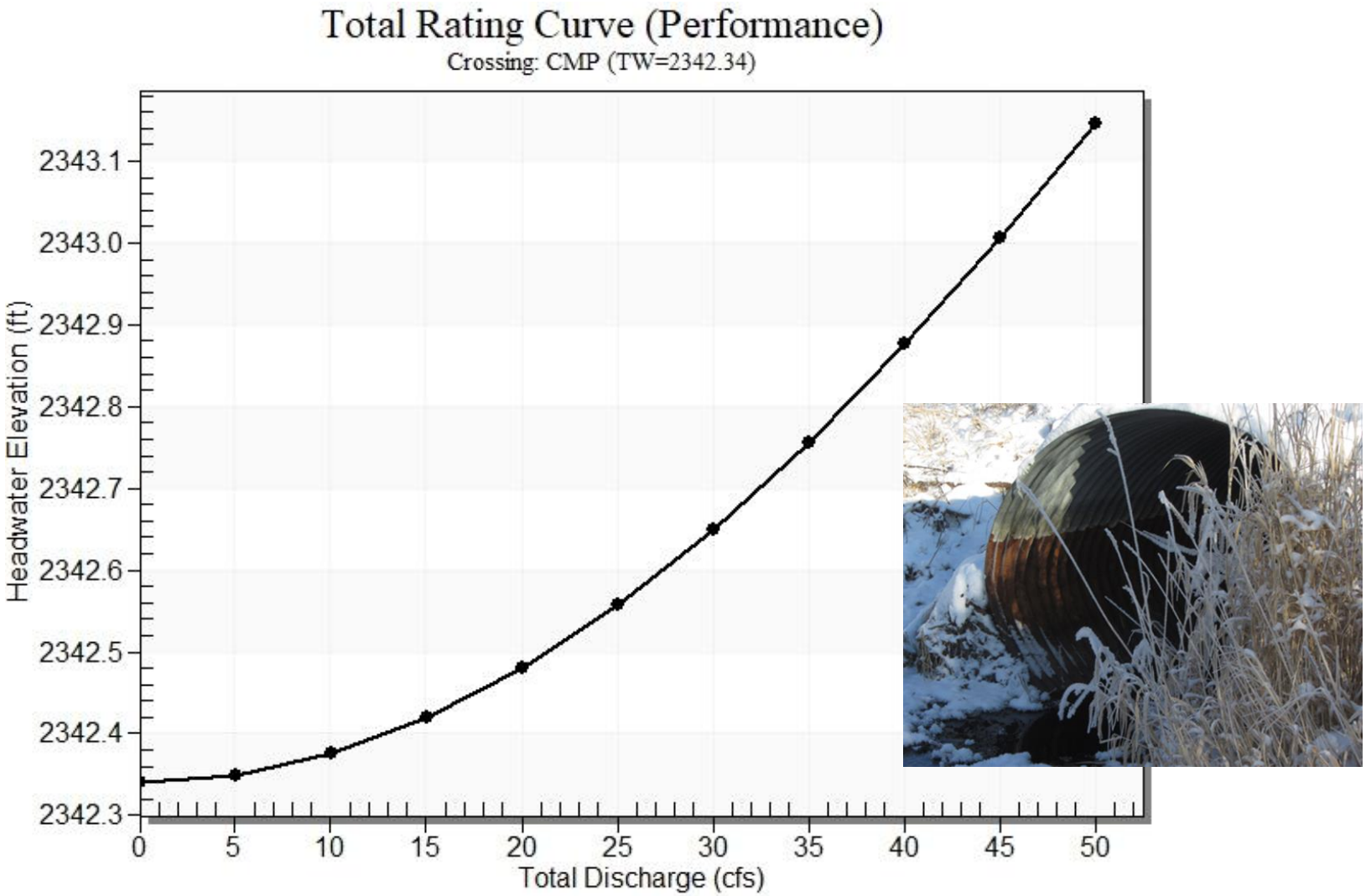
CULVERT RATING CURVE



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CULVERT RATING TABLE

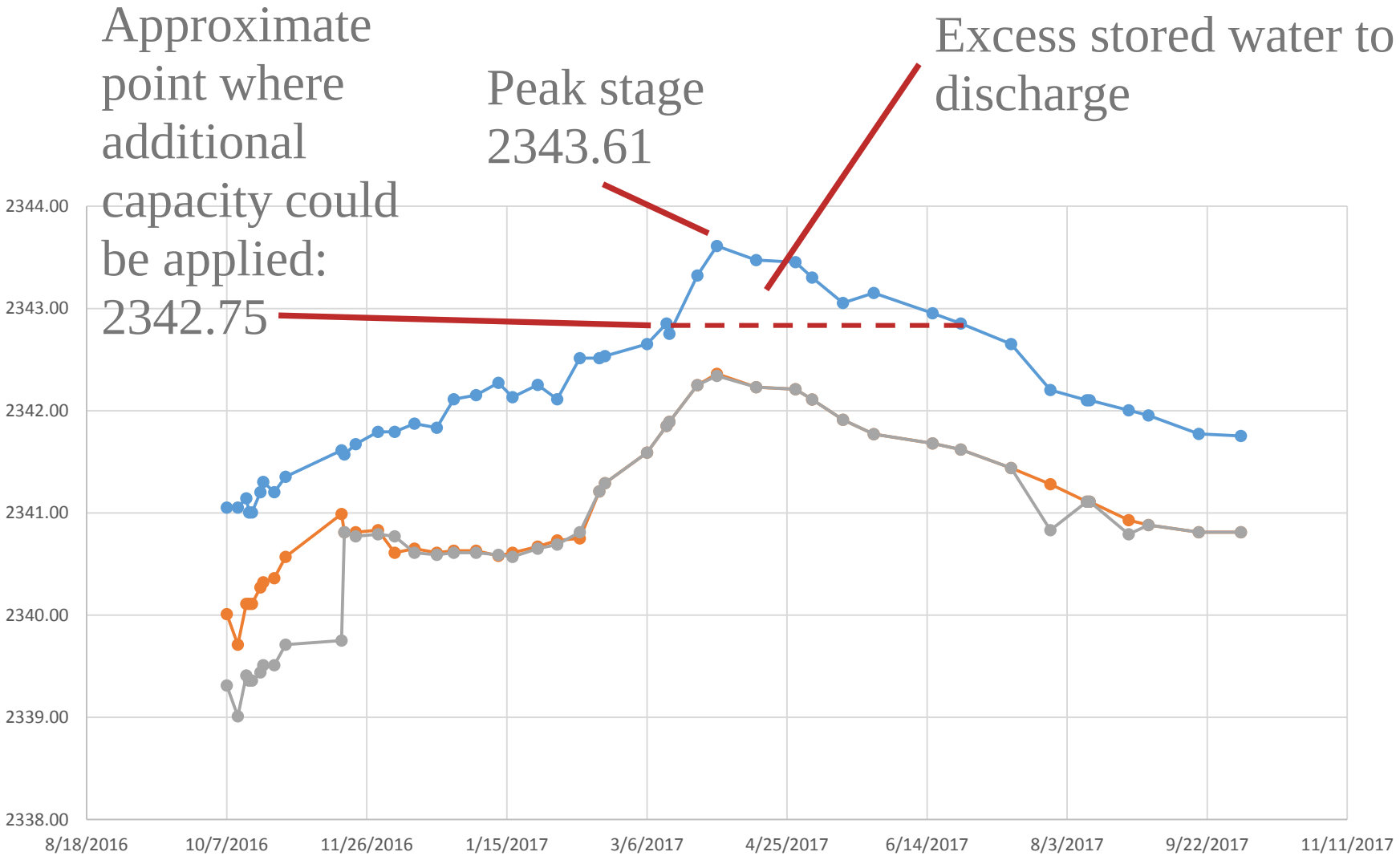
HY-8 Analysis Results

Crossing Summary Table

Culvert Crossing: CMP (TW=2342.34)

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
2342.34	0.00	0.00	0.00	1
2342.37	8.00	8.00	0.00	1
2342.46	16.00	16.00	0.00	1
2342.59	24.00	24.00	0.00	1
2342.77	32.00	32.00	0.00	1
2342.98	40.00	40.00	0.00	1
2342.73	48.00	48.00	0.00	1
2343.00	56.00	56.00	0.00	1
2343.13	60.00	60.00	0.00	1
2343.84	72.00	72.00	0.00	1
2344.11	80.00	80.00	0.00	1
2347.00	160.71	160.71	0.00	Overtopping

ADDING FLOW CAPACITY TO REDUCE LAKE STORAGE



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ADDITIONAL DISCHARGE CAPACITY NEEDED

Date	Stage	variance from 2342.75	volume of water in lake (ac-ft) above 2342.75
13-Mar	2342.75	0.00	0
14-Mar	2342.80	0.05	40
15-Mar	2342.85	0.10	80
16-Mar	2342.90	0.15	120
17-Mar	2342.95	0.20	160
18-Mar	2343.01	0.26	208
19-Mar	2343.06	0.31	248
20-Mar	2343.11	0.36	288
21-Mar	2343.16	0.41	328
22-Mar	2343.21	0.46	368
23-Mar	2343.26	0.51	408
24-Mar	2343.32	0.57	456

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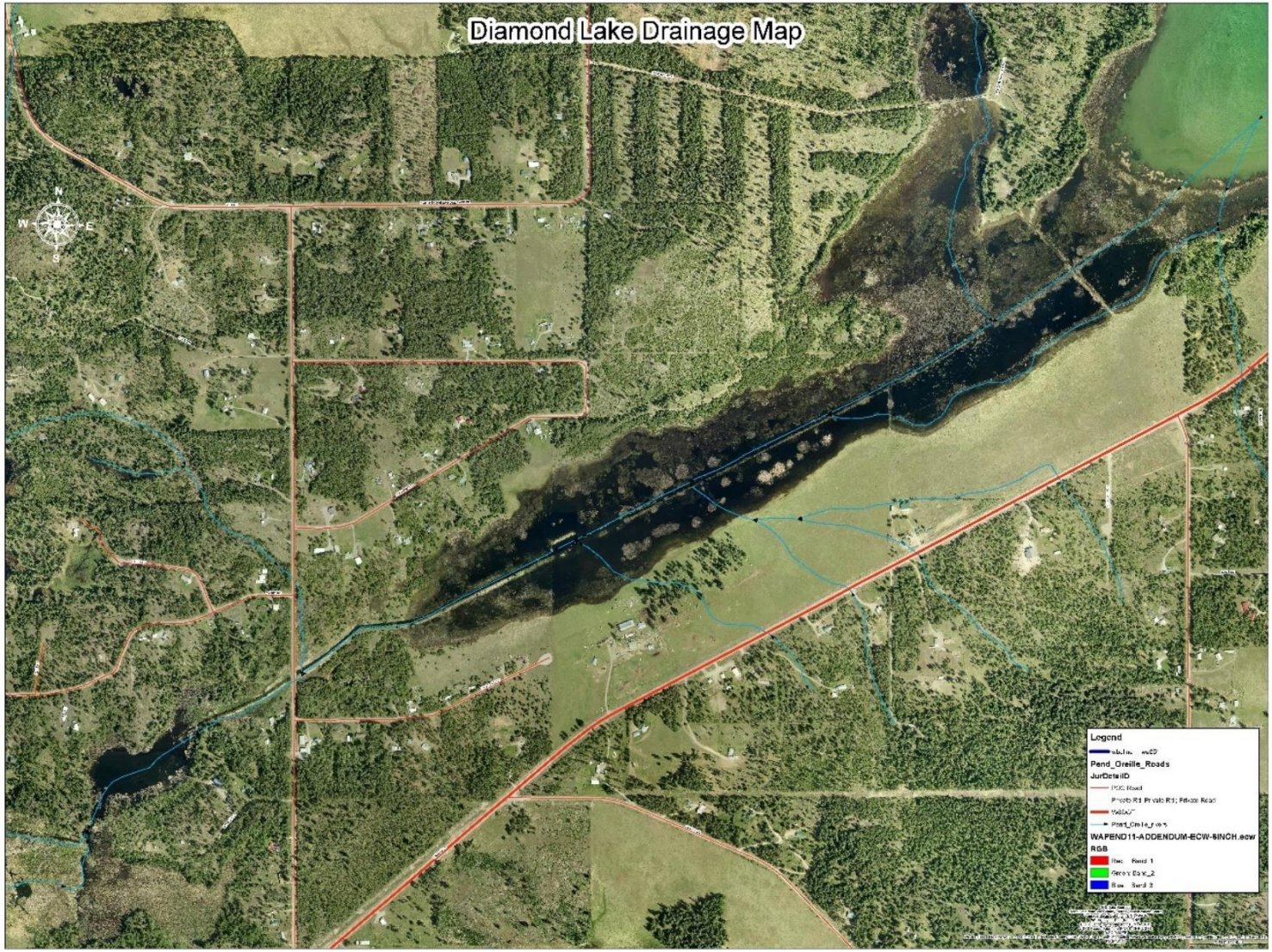
ADDITIONAL DISCHARGE CAPACITY NEEDED

- 40 acre-feet of water = 20 cfs of discharge/day
- Maximum headwater depth = 0.05 feet
- Average headwater depth = 0.025 feet
- Flow rate through 60” culvert at 0.025 feet is about 9 cfs
- Number of additional culverts to address excess input: 20/9 = 2.2

ADDITIONAL DISCHARGE CAPACITY NEEDED

- However….
- Can we get the water to the culverts?
- About 8,700 feet from lake's edge to culvert – about 0.01% slope

WATER FLOW FROM THE LAKE TO THE CULVERT



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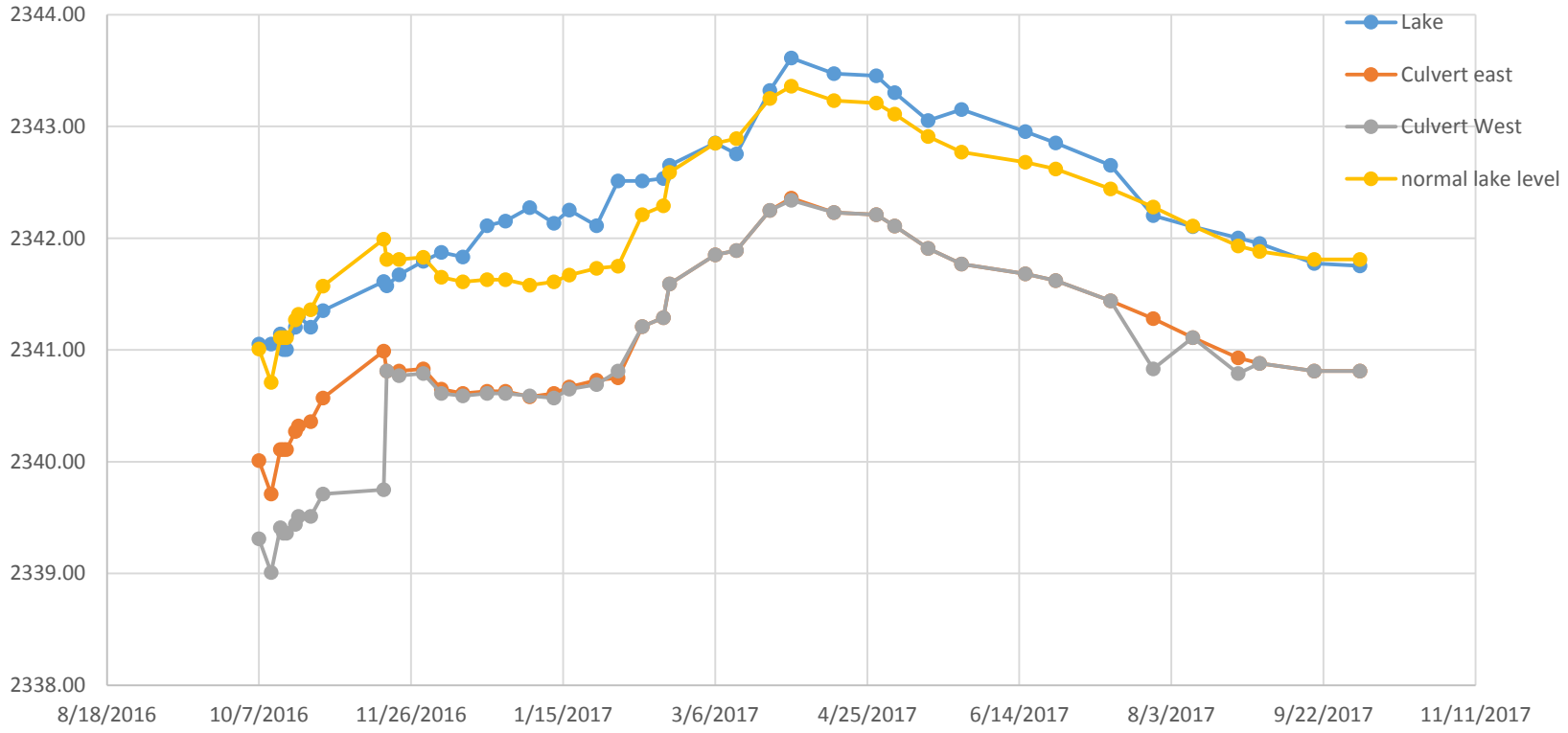
WATER LEVEL BETWEEN LAKE AND CULVERT



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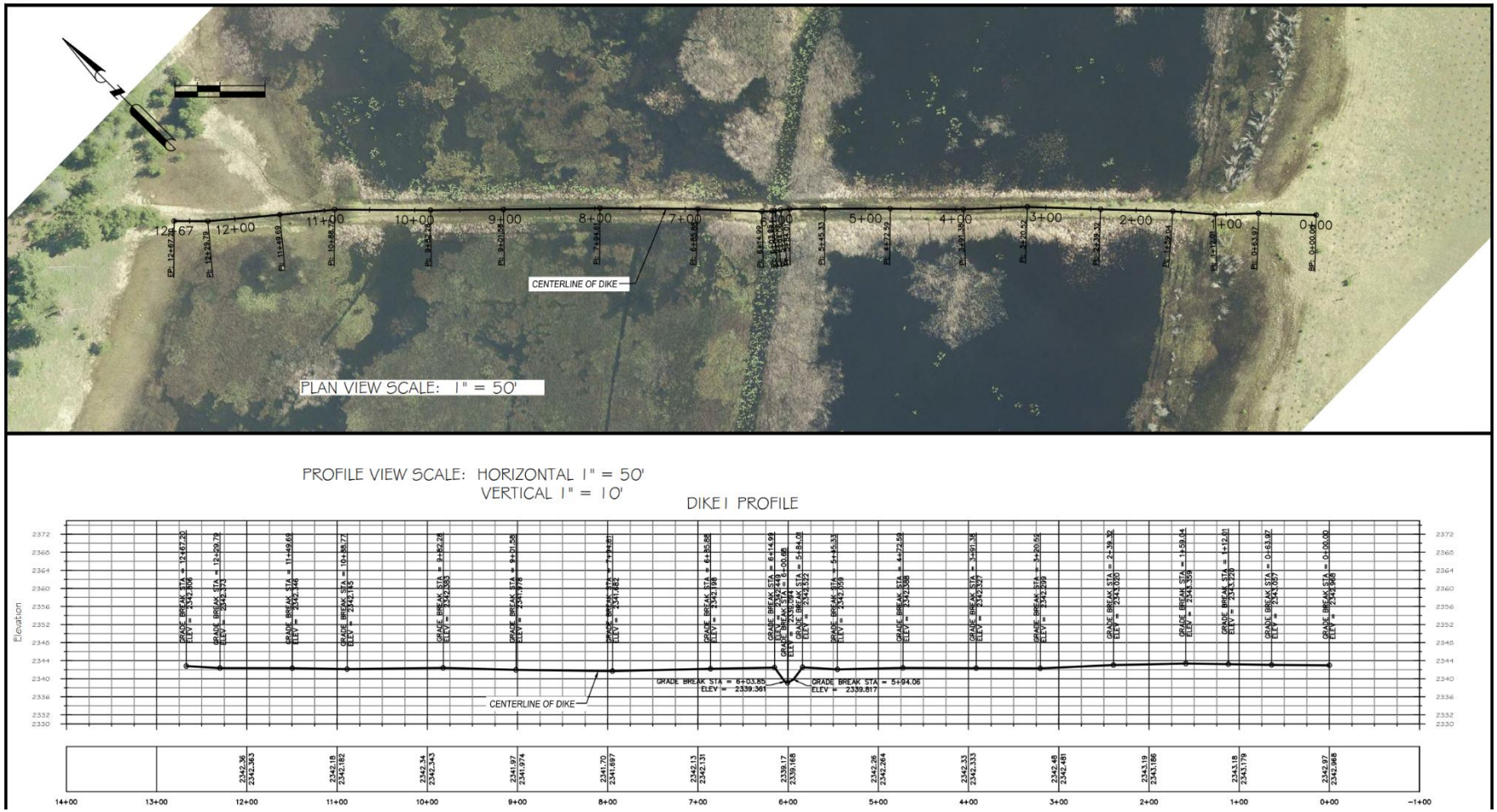
THE “BERM”



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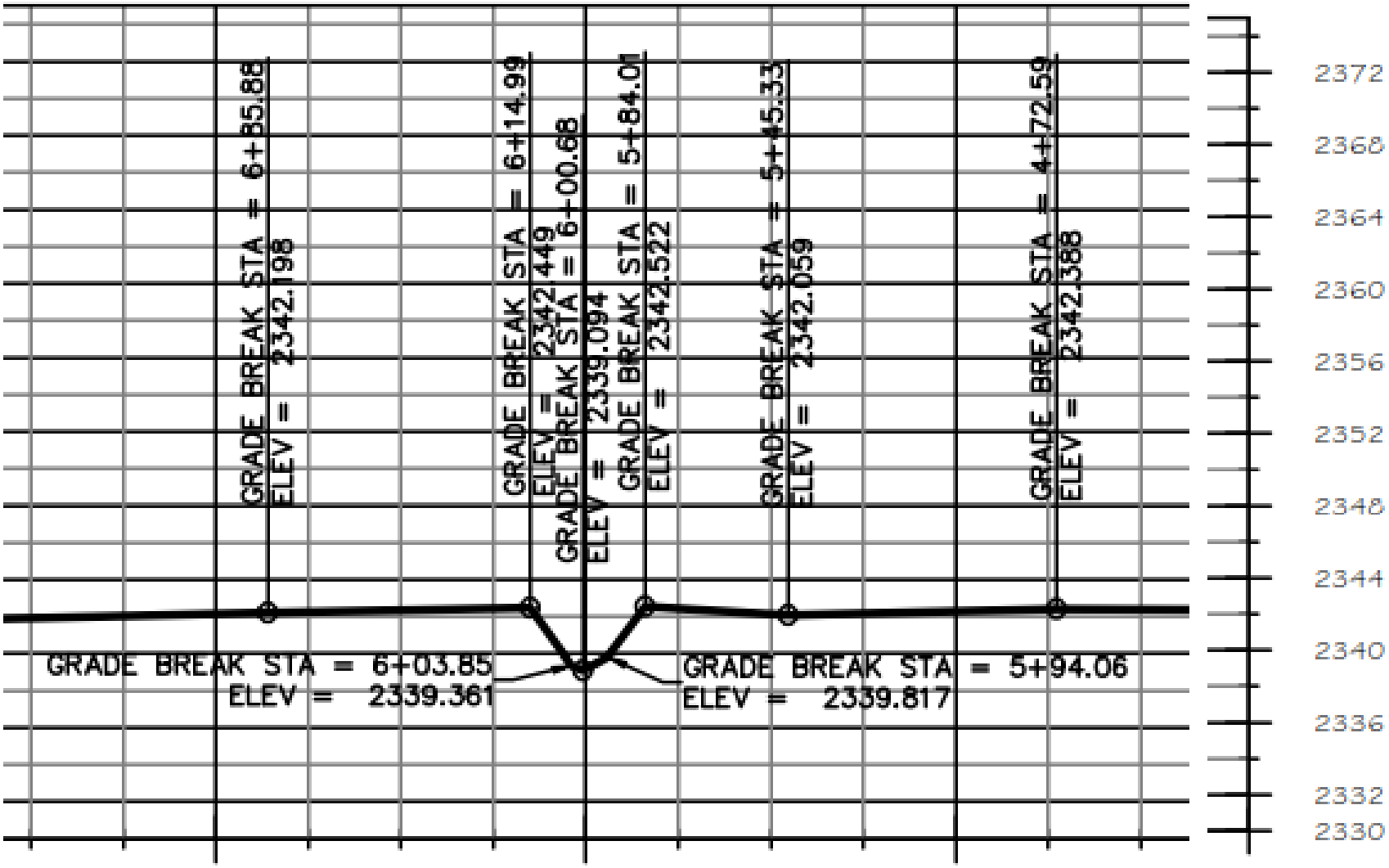
THE BERM OPENING



THE BERM OPENING

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CULVERT CHANGES AND FLOODING - INFLUENCES

- Primary control of flows through culvert is downstream water levels
- The berm will have more influence if the culvert is larger or lower
- There are strong limitations to significant (more than inches) spring lake level reductions – not enough water level to move water through culvert

OTHER APPROACHES

- Large-scale downstream improvements – very difficult and costly
- Pumping – very costly and limited ability to improve conditions
- Floodproofing affected properties
- Improve conveyance between lake and culvert – only small changes possible

PROPOSED CULVERT DESIGN

- Current pipe failing

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PROPOSED CULVERT DESIGN

- Design considerations
  - Equivalent capacity
  - Same flow line
  - Durable material
  - Safe length
  - Constructible alignment

PROPOSED CULVERT DESIGN

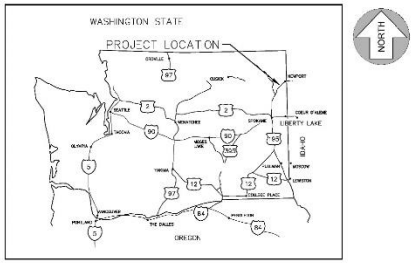
CONSTRUCTION PLANS FOR:

DIAMOND LAKE NORTH SHORE ROAD CULVERT REPLACEMENT

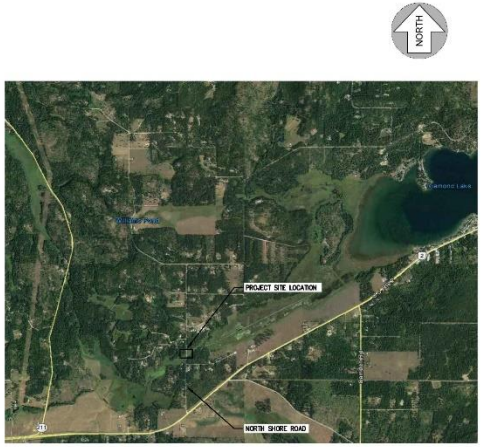
PEND OREILLE COUNTY, WA
SECTION 9, TOWNSHIP 30N, RANGE 44E

SCHEDULE OF DRAWINGS

SHEET NO.	DESCRIPTION
C1	COVER SHEET
C2	REMOVAL AND REPLACEMENT PLAN
C3	REPLACEMENT PLAN ALTERNATE 1
C4	CIVIL DETAILS



VICINITY MAP



LOCATION MAP

SITE AERIAL

90% SUBMITTAL

No.	Date	By	Ckd.	Appr.	Revisions

Drawn BWR Date 06/2019
Designed APS 06/2019
Checked – –/–

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PEND OREILLE COUNTY PUBLIC WORKS
625 W 4TH STREET
NEWPORT, WA 99156
509-447-4513

VERTICAL DATUM: NAVD88
CADD FILE NAME: 553-7752 COVER.dwg

SCALE
HORIZ. N/A
VERT. N/A

DIAMOND LAKE - NORTH SHORE ROAD CULVERT REPLACEMENT
COVER SHEET

CIVIL
SHEET
C1

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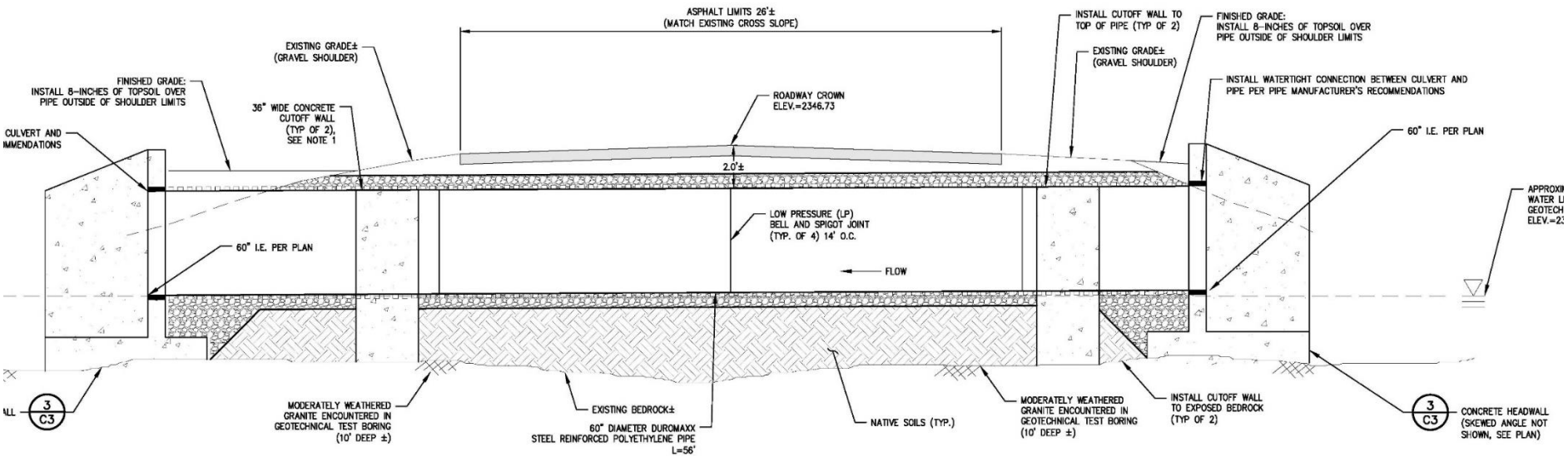
PROPOSED CULVERT DESIGN



CULVERT NOTES:

1. CUTOFF WALLS SHALL BE CONSTRUCTED WITH COMMERCIAL CONCRETE (CLASS 3000) PER 2018 WSDOT STD SPEC 6-02.3(2)B.
2. CUTOFF WALL SHALL BE 36" MINIMUM WIDTH. EXTEND 72" MINIMUM BEYOND CULVERT SECTION (EACH SIDE).

1 CULVERT PROFILE

SCALE: 1"=3'

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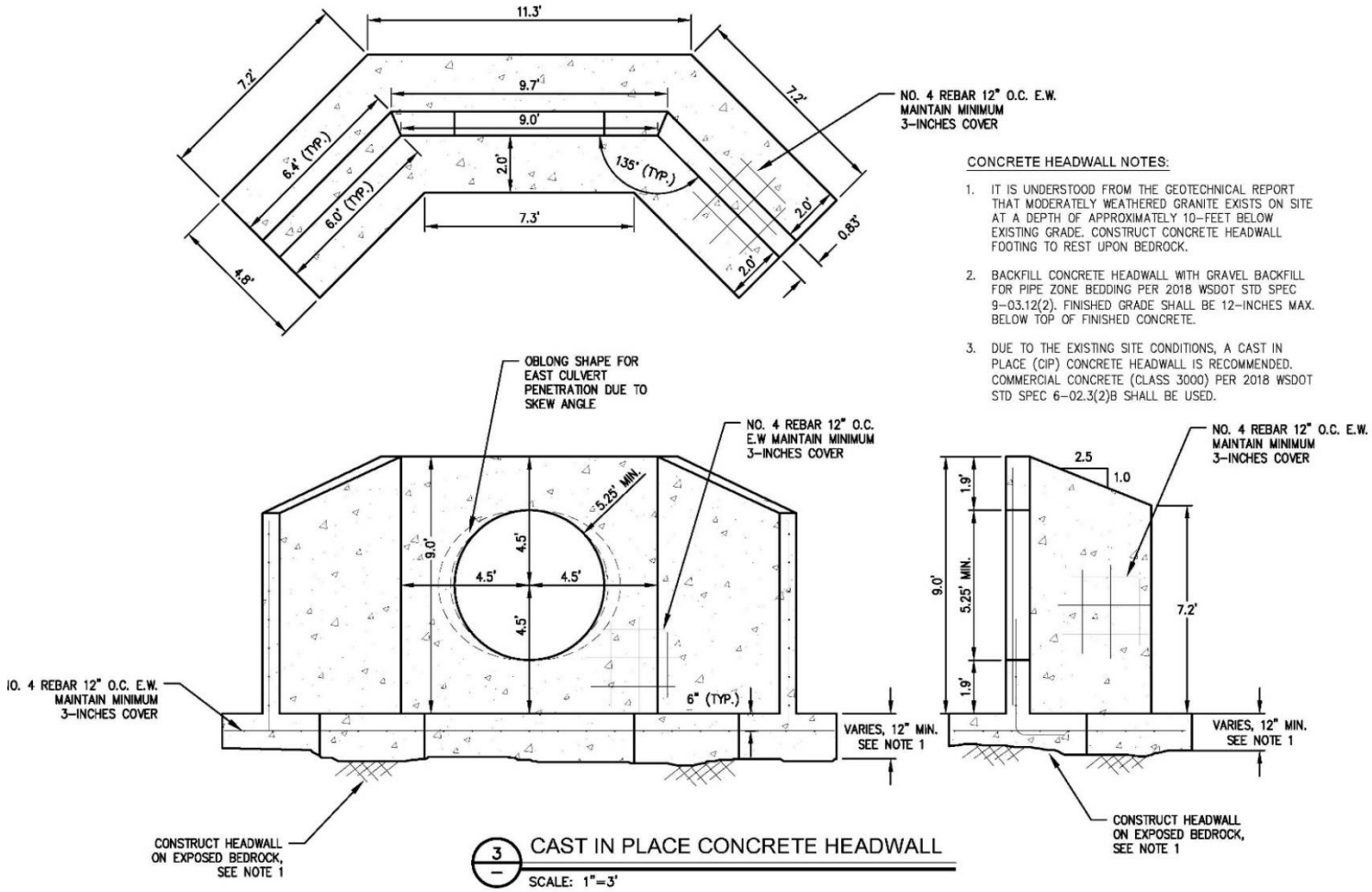
PROPOSED CULVERT DESIGN



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CULVERT CHANGES AND FLOODING - RISKS

- Risks of a larger culvert opening
  - Downstream impacts
- Risks of lower opening
  - Lower stages in summer
  - Little or no difference to spring flooding

OTHER IMPORTANT ISSUES

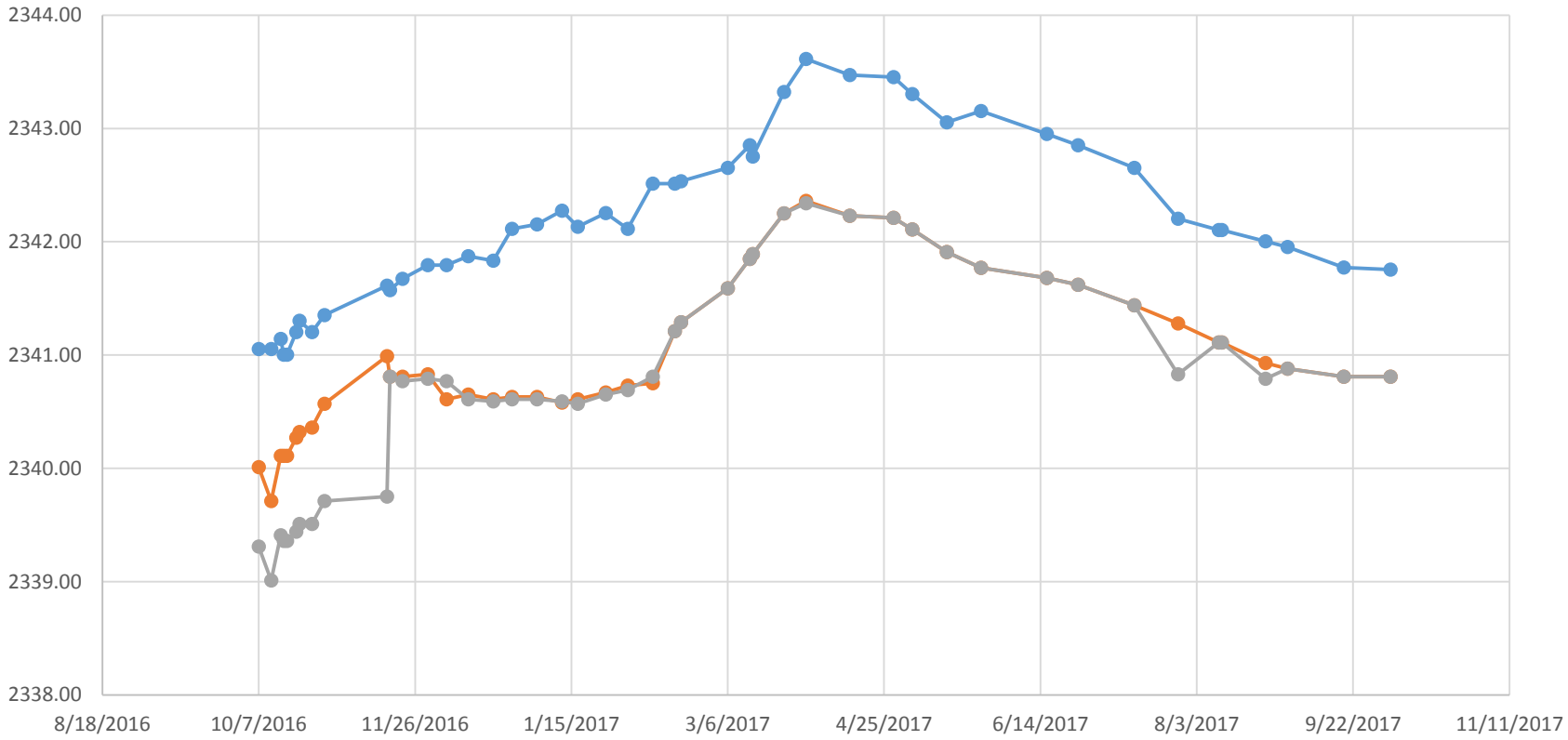
- Increased flows may have downstream impacts
- Increased flows will require more culvert capacity because of higher tailwater

NEXT STEPS

- Culvert design complete in about 30 days
- Construction this summer

QUESTIONS?

MONITORING RESULTS – SPRING 2017



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