

# **MAYFIELD SPILLWAY PIERS REMEDICATION**

**NORTHWEST HYDRO OPERATORS FORUM  
TOBY BREWER**





# AGENDA

1. **BACKGROUND OF MAYFIELD SPILLWAY PIERS**
2. **RISK ANALYSIS**
3. **OPTIONS**
4. **SOLUTION**
5. **COST**
6. **TIMELINE**
7. **OTHER DAMS**

# PROJECT LOCATIONS





# COWLITZ PROJECT



## **Mayfield Dam: 1963**

Type: Concrete Arch with Gravity Sections

Height: 250 feet

Width: 875 feet

Reservoir Length: 13 miles

Reservoir Volume: 133,700 ac-ft



## **Mossyrock Dam: 1968**

Type: Concrete Double Curvature Arch with Gravity and Earth Embankment

Height: 606 feet

Width: 1,878 feet

Reservoir Length: 23.5 miles

Reservoir Volume: 1,677,500 ac-ft



# MAYFIELD DAM





# SPILLWAY GATES

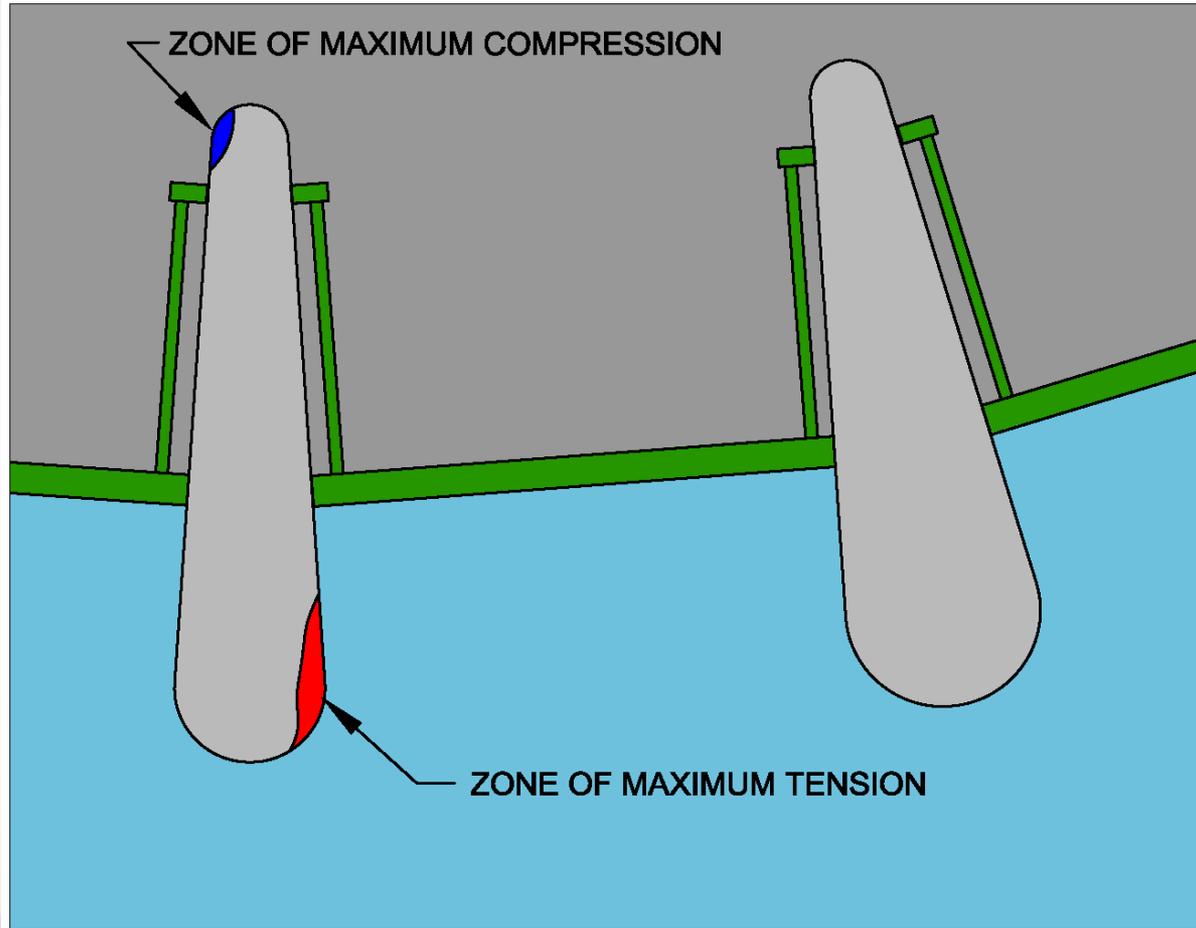




# BACKGROUND

- **2008 PFMA raised the question about “Weak Axis Bending” of spillway piers**
- **Piers are under-reinforced in the weak axis given current loading practices**
- **Westergaard and “Added Mass”**
- **Piers may crack at contact to ogee**
- **Inadequate steel reinforcement once the concrete has cracked**
- **Piers may “Unzip”**

# SPILLWAY PIERS





# RISK ANALYSIS

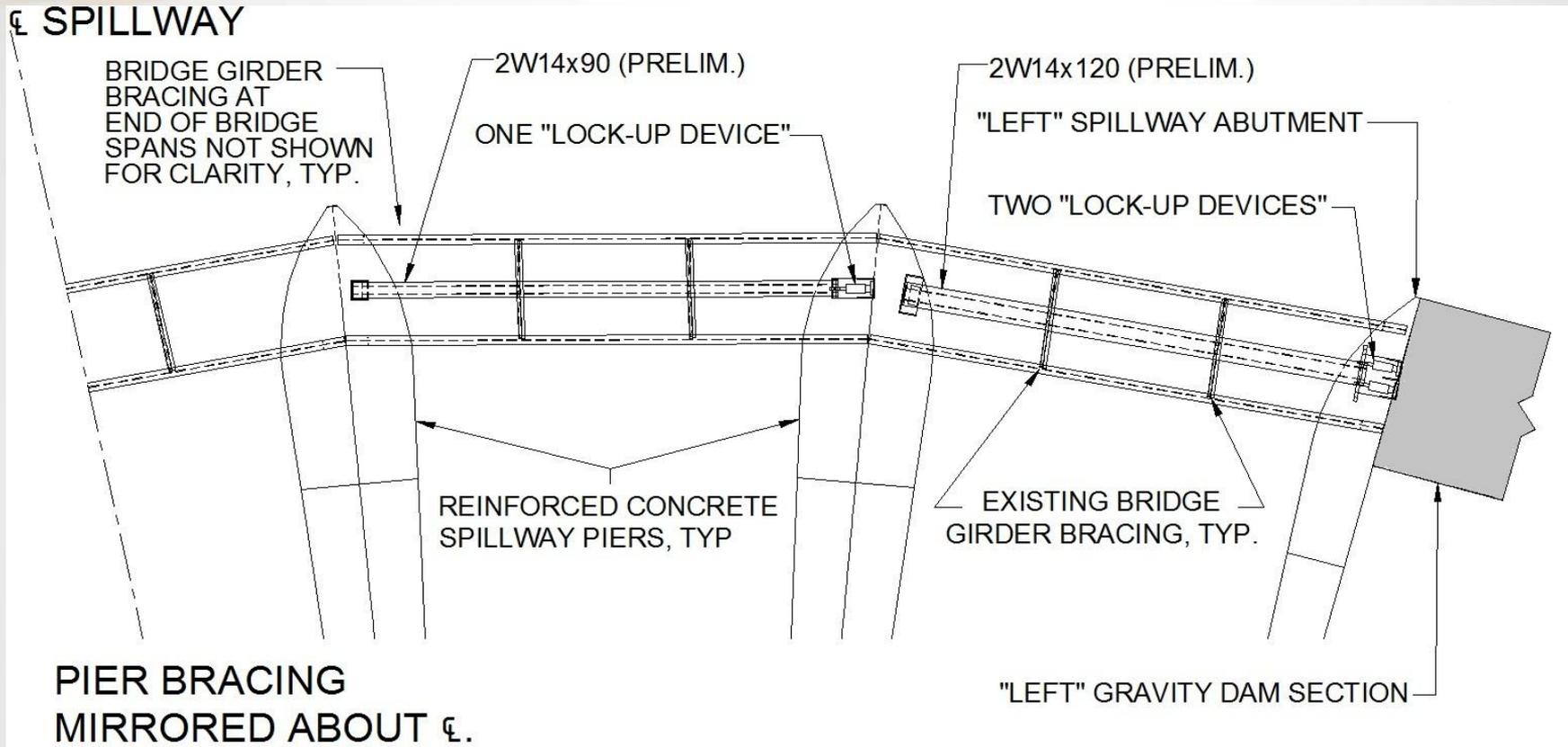
- **What if all Piers failed?**
- **Flood of Record; 68,000 cfs resulting in flooded homes**
- **Spillway Pier failure; 168,000 cfs**
- **Resulting flood would likely inundate;**
  - **Two large fish hatcheries**
  - **City of Toledo**
  - **I-5 Bridges and commercial rail lines**
  - **City of Castle Rock**
  - **Possibly the City of Longview**



# OPTIONS

1. **Do Nothing; Statistically it may never happen**
2. **Install post tension anchors in Piers**
3. **Attach carbon fiber/fiberglass reinforcing mat to the exterior of the piers**
4. **Lock in the existing bridge girders and roadway deck system**
5. **Install additional steel beams with “Lock-up Devices” (Modified Viscous Dampers) to allow thermal expansion of the beams**

# PIER BRACES

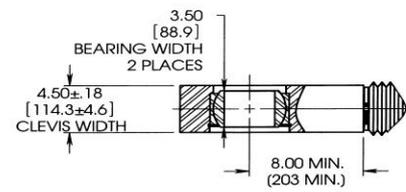


# LOCK-UP DEVICES

**SPECIFICATIONS:**

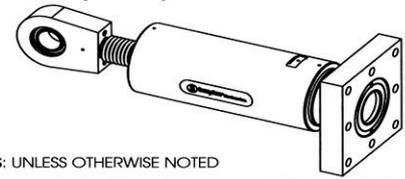
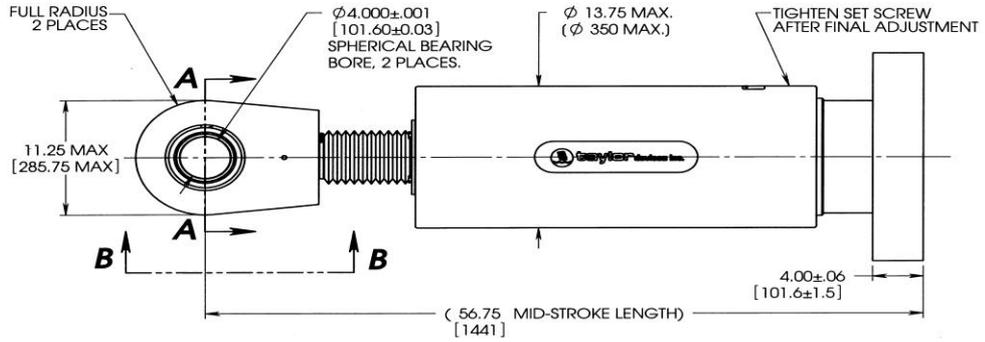
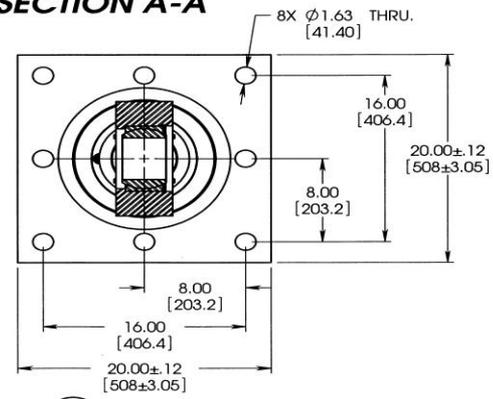
- 1.) UNIT TYPE: DOUBLE ACTING FLUID VISCOUS DAMPER.
- 2.) ALL PARTS THAT SLIDE RELATIVE TO ANY SEALS SHALL BE MADE FROM 17-4PH STAINLESS STEEL.
- 3.) APPROXIMATE WEIGHT OF THE UNIT = 1750 LBS. (794 KG.)
- 4.) UNITS TO BE CONSTRUCTED FROM CORROSION PROTECTED MATERIALS.
- 5.) OPERATING FLUID IS INERT SILICONE, PER U.S. FEDERAL STANDARD VV-D-1078.
- 6.) OPERATING AMBIENT TEMPERATURE RANGE: 32°F TO 120°F (0° TO 49°C) WITH MINIMAL CHANGE IN PERFORMANCE CHARACTERISTICS.
- 7.) DAMPER STROKE +5" (+125 mm) WITH IDENTICAL CHARACTERISTICS IN EITHER DIRECTION OF MOTION.
- 8.) DAMPING FORCE = 715 KIP. (325 MT).
- 9.) NOMINAL OUTPUT FUNCTION:  $F=CV^\alpha$   
C=TBD  $\alpha$ =TBD

| REVISIONS |      |             |      |          |
|-----------|------|-------------|------|----------|
| ZONE      | REV. | DESCRIPTION | DATE | APPROVED |
|           |      |             |      |          |



**SECTION B-B**

**SECTION A-A**



NOTES: UNLESS OTHERWISE NOTED

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES, ANGLES ±2°

|                                      |         |     |        |
|--------------------------------------|---------|-----|--------|
| XX                                   | +0.1    | XXX | ±0.002 |
| XXXX                                 | ±0.0005 | XXV | ±1/16  |
| ALL CORNERS & EDGES TO BE R. 0.1-.02 |         |     |        |
| ✓ MAX. ALL SURFACES                  |         |     |        |

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STOCK SIZE (REF):  
Ø

|           |          |         |
|-----------|----------|---------|
| PREPARED  | K.VARNEY | 05/4/13 |
| CHECKED   |          |         |
| G.A.      |          |         |
| MFG APPR. |          |         |
| ENGINEER  | J.C.M.   | 07/2/16 |
| APPROVED  | J.C.M.   | 07/2/16 |
| MATERIAL: |          |         |

**taylor devices inc.** NORTH TOWNANDA, NY  
PHONE 716-694-0800  
FAX 716-695-6015

**715 KIP (325 MT) FLUID VISCOUS DAMPER**

|      |           |                 |      |
|------|-----------|-----------------|------|
| SIZE | CAGE CODE | DRAWING NO.     | REV. |
| B    | 06742     | 67DP-17180-01-3 |      |

SCALE: 1:8      WEIGHT:      SHEET 1 OF 1





# LOCK-UP DEVICES

- **Requires new steel beams under existing bridge decks**
  - 2 ea W14X90, (two sets)
  - 2 ea W14X120, (two sets)
- **Allows expansion of the beams**
- **Instantly takes seismic load**
  - 600 kips (+/-)
- **Converts piers from Cantilever Loading to Fix/Pin Loading Condition**
- **Will prevent cracking of the pier and thus the failure**



# ESTIMATED COST

| Item                     | Cost      |
|--------------------------|-----------|
| Lock-up Device (6 ea)    | \$180,000 |
| Steel Beams (\$3.00/lb)  | \$145,000 |
| Installation             | \$250,000 |
| Engineering / Inspection | \$75,000  |
| Total                    | \$650,000 |



# TIMELINE

- **Plan approved by the FERC; September 2012**
- **Verify condition of piers during the full height gate tests; Summer 2013**
- **Complete designs and gain final FERC approval; Fall 2013**
- **Advertise, Construct/Install; Summer 2014**



# OTHER TACOMA POWER DAMS WITH SPILLWAY ISSUES



## Wynoochee Dam

- 2 Spillway Gates
- May need to brace one set of piers (Left Gate)



# OTHER TACOMA POWER DAMS WITH SPILLWAY ISSUES



## Mossyrock Dam

- 4 Spillway Gates
- Currently looking at loading criteria; ANSYS LS-DYN model
- Bracing will be much more difficult
- Modifications are likely to both the piers and the spillway gates

**QUESTIONS?**

