Appraisal Mobilization 5%
Design Contingency 12%
Const Contingency 23% 25%
Field Cost
+ NCC 30%

Prelim
20-30%
25-30%

Cost Estimate Handbook
Unlisted 10%-15%
FAC P09
FAC 09-01(A)
(E) 3

TECHNICAL SERVICE CENTER

Denver, Colorado

Pueblo Dam

Study to Raise the Operating Pool for Southeastern Colorado Water and Storage Needs Assessment Enterprise

Prepared by

John Trojanowski

U.S. Department of the Interior
Bureau of Reclamation

August 31, 1999

Based on this, it is recommended that no spillway crest raise greater than 15 feet (to elevation 4913.7) be considered. This amount of spillway crest raise is estimated to require an angle at the end of the flip of about 6 degrees from the horizontal. This would produce a vertical head component in the jet of approximately 5.5 feet.

Embankment Dam Raise Limits: The proposed 75,000 acre-foot maximum raise will result in a water surface at the current top of dam level in order to pass the design spillway discharge of 110,000 ft^3/s. A parapet was added for freeboard to pass up to 150,000 ft^3/s before overtopping and thus ensure that the downstream levees fail before the dam overtops. Any raise alternative above the 75,000 acre-foot level would result in a design maximum water surface above the current top of dam. Based on experience it is believed that a 6-foot-high parapet may be a reasonable limit before the top of the embankment will need to be raised. However, intentional storage of the reservoir against the parapet wall above the top of dam is not recommended. Therefore, the top of dam would need to be raised to elevation if any storage level above the 75,000 acre-foot raise alternative is to be considered. Raising the embankment would also require raising the concrete dam.

The North Shore Access Road is located in the vicinity of the end of the left (north) embankment. This road is at approximate elevation 4926 (one foot above the current top of dam) at the dam location. Since it will not be possible to extend a parapet across the road, it may be necessary to raise the road.

Based on these estimates for "Practical Limits" to the top of dam, it is concluded that the embankment parapet requirement would control at a top of dam elevation 4929 (75,000 acre-foot raise) if earthfill is not added to the top of dam. Since the "Practical Limit" based on spillway hydraulics is estimated to be elevation 4932, it is reasonable to expect that costs will increase significantly once the 75,000 acre-foot raise is exceeded. These estimates are intended to give a general idea of the "Practical Limits" for planning purposes. However, since these estimates result from making an "educated guess," the limits could be adjusted up or down if more detailed studies are conducted for final design.

Conclusions: The following conclusions have been reached after completion of tasks in the original service agreement with the Enterprise.

1. This report concludes the studies for raise alternatives.

2. There have been two recent flood frequency studies for Pueblo Dam (1997 and 1998). Results from the 1998 study can be used for this conceptual design, but are inadequate for final design. Detailed probabilistic flood studies need to be completed as part of final design activities. This report and intermediate status reports have addressed the range of possible scenarios based on the available hydrologic studies for Pueblo Dam.

3. Without a detailed gate opening sequence, Reclamation could find no significant justification for recommending a gated spillway option based on risk reduction. Additional costs associated with design and maintenance are possible for gated spillway options.

4. Cost estimates based on conceptual designs indicate that the gated spillway option would have a lower cost than the ungated spillway for the lowest raise alternative only (25,000 acre-feet). The ungated spillway would have a lower cost for the highest raise alternative (75,000 acre-feet). The costs are similar for the intermediate raise alternative (60,000 acre-feet).

5. High risks are associated with tension in the upstream face of the concrete dam and overtopping of the embankment dam. Without further dam modification, these risks would exceed the risk guidelines when the results of the 1998 flood frequency studies are used to evaluate hydrologic risk.

6. Based on the various risk analysis studies, dam overtopping is an issue for the 60,000 and 75,000 acre-foot raise alternatives. It is recommended that the dam be modified to safely pass flows that would overtop and fail the downstream levees. A dam raise or parapets are needed to achieve this for the two highest raise alternatives.

7. Median risk values were used in the risk analyses. Risk may increase or decrease as a result of future studies. A CRB would have to agree that these risks are acceptable before any dam modifications are made. However, the study team believes that they have made reasonable assumptions and followed current guidelines while preparing this study.

8. Based on the risk analysis, the spillway section of the dam will require improved foundation stability to meet factors of safety previously recommended by the CRB for the dam modifications. Additional weight provided by RCC placed on the elevation 4763 bench downstream from the spillway section of the dam may provide the most feasible solution.

9. Based on the current top of dam configuration, the spillway stilling basin will not require modification to provide greater erosion protection for the pool raises studied. This issue would have to be evaluated further if higher raise alternatives are proposed in the future, or if the dam is required to pass larger floods without overtopping.

10. The upstream face of the dam experiences tension during normal loading for all of the raise alternatives. Risk analyses indicate that unacceptable risk occurs. Standard concrete dam design guidelines were used to design a corrective action. These guidelines do not allow tension during normal loading (up to the Top of Joint Use Pool). These tensions were apparent during the 3-dimensional linear elastic finite element analyses. More detailed modeling may help reduce the tendon requirement.

Add 20-30% for Design Contg

11. Cost estimates included in this document represent the field costs for the proposed modifications. They include 15 percent for unlisted items and 25 percent for contingencies. These estimates do not include design, project, and construction management costs. The estimates are for the purpose of comparing the relative costs of the alternatives. They are not intended to be used for any other purpose such as budgeting the probable cost for Reclamation to enlarge the conservation storage at Pueblo Dam.

12. Final approval of any raise alternative, including remedial dam modification, will be made by the Regional Director, Area Office Manager, Dam Safety Office.

13. Risk analysis and comparison of the stability guidelines for the left embankment with the calculated factor of safety for the embankment stability at station 77+00 indicates that the existing left embankment's stability under the proposed higher reservoir pool loading conditions is marginal. Given the uncertainty in embankment and foundation porewater pressures under the raised reservoir operating pool and potential flood pools, and the added risk to downstream residents created by the raise alternative, an increase of about 10 percent in the left embankment stability is judged to be an appropriate remedy.

14. The "additional berm" configuration is recommended to improve the stability of the left embankment given the concerns identified under No. 13 above. The stability analysis of this "additional berm" configuration indicated a factor of safety of 1.268 with the reservoir flood pool at the parapet on top of the dam embankment (elevation 4929 for the 75,000 acre-foot raise alternative) compared to the factor of safety of 1.145 for the existing left embankment and berm.

15. Based on the adequacy of the stability analysis results for Station 90+00 shown in the table in Appendix I, and the fact that the top of the existing berm does not need to be elevated at Station 77+00, the "additional berm" configuration does not need to extend beyond the north end of the existing berm at about Station 85+00.

16. The practical limit for a dam raise is approximately the proposed maximum level of 75,000 acre-foot based on not adding additional earthfill to the top of dam.

17. Lack of instrumentation data at higher reservoir levels makes it difficult to predict actual conditions and risk for higher reservoir conditions. Reclamation will continue to build the data base using original and newly installed instrumentation. Conclusions from this report may be adjusted as more data are available.

References:

[1] Service Agreement - Southeastern Colorado Water Conservancy District - Pueblo Dam - Study to Raise the Operating Pool, Bureau of Reclamation, January 21, 1998.

[2] Memorandum of Understanding - MOU No. 98-AG-60-10330, "Pueblo Dam Study to Raise the Operating Pool," January 28, 1998.

[3] Status report for Pueblo Dam Study to Raise the Operating Pool - Part A, Tasks 1, 2, and 3, Bureau of Reclamation, June 22, 1998.

[4] Status report for Pueblo Dam Study to Raise the Operating Pool - Part A, Tasks 4, 5, and 6, Part B, Tasks 9, 10, and 11, Bureau of Reclamation, August 14, 1998.

[5] Status report for Pueblo Dam Study to Raise the Operating Pool - Part A, Bureau of Reclamation, December 9, 1998.

[6] LAN Message From: Kenneth Bullard, To: John Trojanowski, Subject: Pueblo Dam - Return Hydrographs, February 4, 1997.

[7] "Pueblo Dam - Regional Analysis of Duration Frequency Curves with Hydrographs Based on Regional Volume-Frequency Curves - Regional Analysis with Index Flood and L-Moment Methods," Technical Service Center, Bureau of Reclamation, Denver Colorado, April 1998.

[8] "Risk Assessment of Pueblo Dam," Bureau of Reclamation, August 26, 1997.

[9] "Guidelines for Achieving Public Protection in Dam Safety Decision Making," Interim Guidelines to be Revised After 1 Year of Use, Bureau of Reclamation, Denver, CO, April 4, 1997.

[10] Hosking, J. R. M. and Wallis, J. R., Regional Frequency Analysis - An Approach Based on L-Moments, Cambridge University Press, 1997.

[11] "Pueblo Dam - Fryingpan-Arkansas Project - Probable Maximum Flood Study", K. L. Bullard and V. Leverson, USBR, June 1991.

[12] "Report on Enlargement of Pueblo Reservoir for Colorado Springs Utilities," Black & Veatch, Project No. 18210, 1994.

[13] Third Report - Safety Modifications Review - Pueblo Dam, Alfred J. Hendron Jr., Ralph B. Peck, and James R. Obermeyer, April 13, 1998.

[14] Memorandum To: Mr. Steve Arveschoug, From: Bureau of Reclamation, Subject: "Required Design Criteria - Possible Raise of Pueblo Dam - Fryingpan-Arkansas Project, Colorado," January 13, 1998.

[15] Technical Memorandum No. PUE-8110-CAA-98-1, "Corrective Action Alternative Evaluation - Pueblo Dam - Fryingpan-Arkansas Project, Colorado," Bureau of Reclamation, June 1998.

[16] "Draft Report of Findings for Pueblo Dam - Left Embankment Stability," Bureau of Reclamation, May 7, 1999.

U.S. Department of the Interior
Bureau of Reclamation
Technical Service Center

Pueblo Dam - Study to Raise the Operating Pool for Southeastern Colorado Water and Storage Needs Assessment Enterprise

Prepared: John Trojanowski (D-8130) — 8/31/99 Date

Peer Review: John LaBoon (D-8130) — 8/31/99 Date

Appendix J

Construction Cost Estimates

2019 11311
1999 ENR CCI
6100
1.0543

Summary of Construction Costs

Alternative	Spillway Crest	Spillway Foundation Stability *	Drainage	Stability Berm Extension	Tendons	Parapet Wall Along		Total Cost**
						Embankment	Concrete Dam	
U1	$6,700,000	$1,600,000	$1,700,000	$1,550,000	$6,800,000	$0	$0	$18,400,000
U2	$10,000,000	$2,600,000	$1,700,000	$3,100,000	$13,600,000	$1,300,000	$161,000	$32,500,000
U3	$11,500,000	$3,500,000	$1,700,000	$3,100,000	$17,000,000	$2,600,000	$510,000	$39,900,000
G1	$3,800,000	$1,600,000	$1,700,000	$1,550,000	$6,800,000	$0	$0	$15,500,000
G2	$10,000,000	$2,600,000	$1,700,000	$3,100,000	$13,600,000	$1,300,000	$161,000	$32,500,000
G3	$14,000,000	$3,500,000	$1,700,000	$3,100,000	$17,000,000	$2,600,000	$510,000	$42,400,000

Ungated +25K AF
+60K AF
+75K AF
+25K AF
Gated Spillway +60K AF
+75K ML

$28.74M
$60.26M
$78.62M

* The alternative to add RCC weight was used for this estimate due to issues concerning the rock bolt alternative. It was not determined if costs would differ significantly for gated vs. ungated options.

** Estimates in this table represent the field costs for the proposed modifications. They include15 percent for unlisted items and 25 percent for contingencies. These estimates do not include design, project, construction management costs, QA/QC, material testing, etc.

28.74M x 1.3125 * 306 = 37.72M + 11.32 = 49.0M x ENR = 90.93
60.26M x 1.3125 * 306 = 79.09 + 23.73 = 102.82 x CCI = 190.66
78.62M x 1.3125 + 30.96 = 103.19 = 134.15 x CCI = 248.75

Costs x 1.05 Mobilization
15% unlisted included
25% contingencies "
x 1.25 Design Contingencies
x 1.3125
= 30% NCC Costs

work could affect the risk analysis for the dam, which is the basis for the current enlargement concepts.

Environmental and Permitting Issues. Pueblo Reservoir enlargement will involve a major Federal action requiring permitting and intensive review under the guidelines of the National Environmental Policy Act (NEPA) and preparation of an Environmental Impact Statement (EIS). Effects to wetlands, the wildlife inhabiting those wetlands, and bald eagles will be significant issues. Wetland permitting and mitigation likely will be challenging but feasible. A variety of institutional issues will need to be addressed between the USBR, the District, and entities participating in the Project.

Implementation Cost. Cost estimates for raising Pueblo Dam were developed by the USBR. B&V evaluated the costs associated with modifying facilities (railroad, paved roads, waterline, sewer line), recreational amenities (marinas, campgrounds, picnic areas), and environmental mitigation measures associated with Pueblo Dam and Reservoir. Total project cost for enlarging Pueblo Dam and Reservoir is expected to range from $43 to $110 million:

Major Cost Item	Cost in $ Million		
	25,000 af	60,000 af	75,000 af
General Condition	1.4	2.9	4.3
Dam Construction	17.4	31.0	37.9
Facilities modification, recreational amenities, mitigation	9.2	19.2	28.6
Construction Cost	28.0	53.1	70.8
Permitting and NEPA	2.2	4.2	5.7
USBR Legal, Administrative and Engineering Costs	13.2	25.0	33.2
Total Project Cost	$43.4M	$82.3M	$109.7M
Unit Cost ($/af)	$1,730	$1,370	$1,460

Major Cost Item	Cost in $ Million	
	11,950 af	19,600 af
General Conditions	0.7	1.2
Dam Construction	2.8	6.1
Facilities Modification Construction and Mitigation	1.9	2.0
Permitting and NEPA	0.4	0.8
USBR Legal, Administrative and Engineering Costs	2.5	4.4
Total Project Cost	$8.3M	$14.5M
Unit Cost ($/af)	$690	$740

3.3.4 *Enlargement of Non-Project Reservoir (Lake Meredith)*

Five dam raise alternatives were evaluated for Lake Meredith, providing between 15,000 and 75,000 af of additional storage capacity. Any enlargement of Lake Meredith Reservoir by CSU would be subject to the stipulation with Proxy Group in Water Course Cases 84CW62, 84CW63, and 84CW64. Enlargement by the District or another entity would be subject to approval by the Lake Meredith Reservoir Company Board. Dam modification concepts and preliminary cost estimates were developed by URS, Greiner, Woodward-Clyde (URS) in 1998. URS concluded that raising the dam by up to 13 feet (75,000 af of additional capacity) would be technically feasible. Based on the URS work, B&V prepared updated cost estimates for the following reservoir enlargements:

Lake Meredith	Existing Reservoir	Capacity Increase (af)				
		15,000	25,000	40,000	55,000	75,000
Normal Pool Elev. (ft)	4254.2	4256.0	4258.0	4260.0	4262.0	4265.0
Top of Dam Elev. (ft)	4257.0	4261.0	4263.0	4265.0	4267.0	4270.0
Nominal Increase in Normal Pool Elev. (ft)	—	2	4	6	8	11

Table 5.1
Storage Locations and Costs for Participating Entities

LOCATION OF STORAGE [1]					
		New Storage Capacity (Acre-feet)			
Entity	Total Storage	Reoperation Storage	Pueblo	Turquoise	Total
Colorado Springs Utilities	45,000	19,000	16,000	10,000	26,000
Other FVA	22,000	12,500	9,500		9,500
Pueblo	20,000	11,500	5,000	3,500	8,500
St. Charles Mesa	3,600	2,100	1,500		1,500
Florence	2,300	1,300	1,000		1,000
Other Entities West of Pueblo	3,700	2,100		1,600	1,600
Pueblo West	5,500		5,500		5,500
PSCo	5,000		5,000		5,000
Winter Water					
Augmentation Water					
Subtotal	107,100	48,500	43,500	15,100	58,600
District Management Storage	15,000		10,500	4,500	15,000
Total	122,100	48,500	54,000	19,600	73,600

STORAGE COSTS					
			New Storage Cost		
Entity	Cost	Cost of Reoperation	Pueblo	Turquoise	Total
Colorado Springs Utilities	$33,600,000	$3,800,000	$22,400,000	$7,400,000	$29,800,000
Other FVA	$15,800,000	$2,500,000	$13,300,000	$0	$13,300,000
Pueblo [1]	$9,600,000	$0	$7,000,000	$2,600,000	$9,600,000
St. Charles Mesa	$2,500,000	$400,000	$2,100,000	$0	$2,100,000
Florence	$1,700,000	$300,000	$1,400,000	$0	$1,400,000
Other Entities West of Pueblo	$1,600,000	$400,000	$0	$1,200,000	$1,200,000
Pueblo West	$7,700,000	$0	$7,700,000	$0	$7,700,000
PSCo	$7,000,000	$0	$7,000,000	$0	$7,000,000
PSCo	$7,000,000	$0	$7,000,000	$0	$7,000,000
Winter Water	$0	$0	$0	$0	$0
Augmentation Water	$0	$0	$0	$0	$0
Subtotal	$79,500,000	$7,400,000	$60,900,000	$11,200,000	$72,100,000
District Management Storage	$18,000,000	$0	$14,700,000	$3,300,000	$18,000,000
Total	$97,500,000	$7,400,000	$75,600,000	$14,500,000	$90,100,000
Cost per Acre-Foot	$800	$200	$1,400	$740	$1,220

[1] The Board of Water Works of Pueblo has already obtained storage contract similar to a "Re-operations Storage Contract" for up to 15,000 acre-feet. Contract No. 00XX6C0049 was recently executed between The United States and the Board of Water Works. The prorated costs are based on re-operations storage of 37,000 acre-feet.

Aug 9 2018

Hydraulic dredge boat on water
" Vacuum " $4 - $8 / CY
depends on haul distance
$130 - $260 M for 20 yds

$130 M to $260 M

$135 M to 270M

Luke

Generator - weekly test failed Commiss?
- test

Cost of [illegible] [illegible]

Schedule no unit 1
tele call on Bloor - Road?
Meter

Commis.
335

2.8 > 3.1 [illegible]

CP - Thursday Friday 1150 mg Base
80 typical
Cornwall's [illegible]
1150 mg

190% [illegible] 147

8-10

By Scott Lewis with Tim Grogan

A Hundred Years of ENR Cost Indexes

A century of cost leadership through depression and expansion

★ 1913 - 2013 ★

Whenever anything or anyone turns 100, it's a big deal. With a base year of 1913, ENR's cost indexes have joined that category after a century of measuring construction cost fluctuations and reflecting the industry's most important trends. The use of the cost indexes has grown almost as dramatically as the indexes themselves. They captured, for example, the explosion in union wages that caused costs to jump in the 1970s, and they tracked the record drop in steel prices and its effects on overall construction costs in 2004.

Over the years, ENR has labored to ensure the indexes are accurate, objective, transparent and flexible so that they can serve as a benchmark to assess the health of the construction industry's most important sectors. This includes deep-dive analysis that interprets the numbers and tells readers the stories behind them.

These days, they help many municipal officials make the most informed decision they can about their costs of engineering, construction and maintenance work.

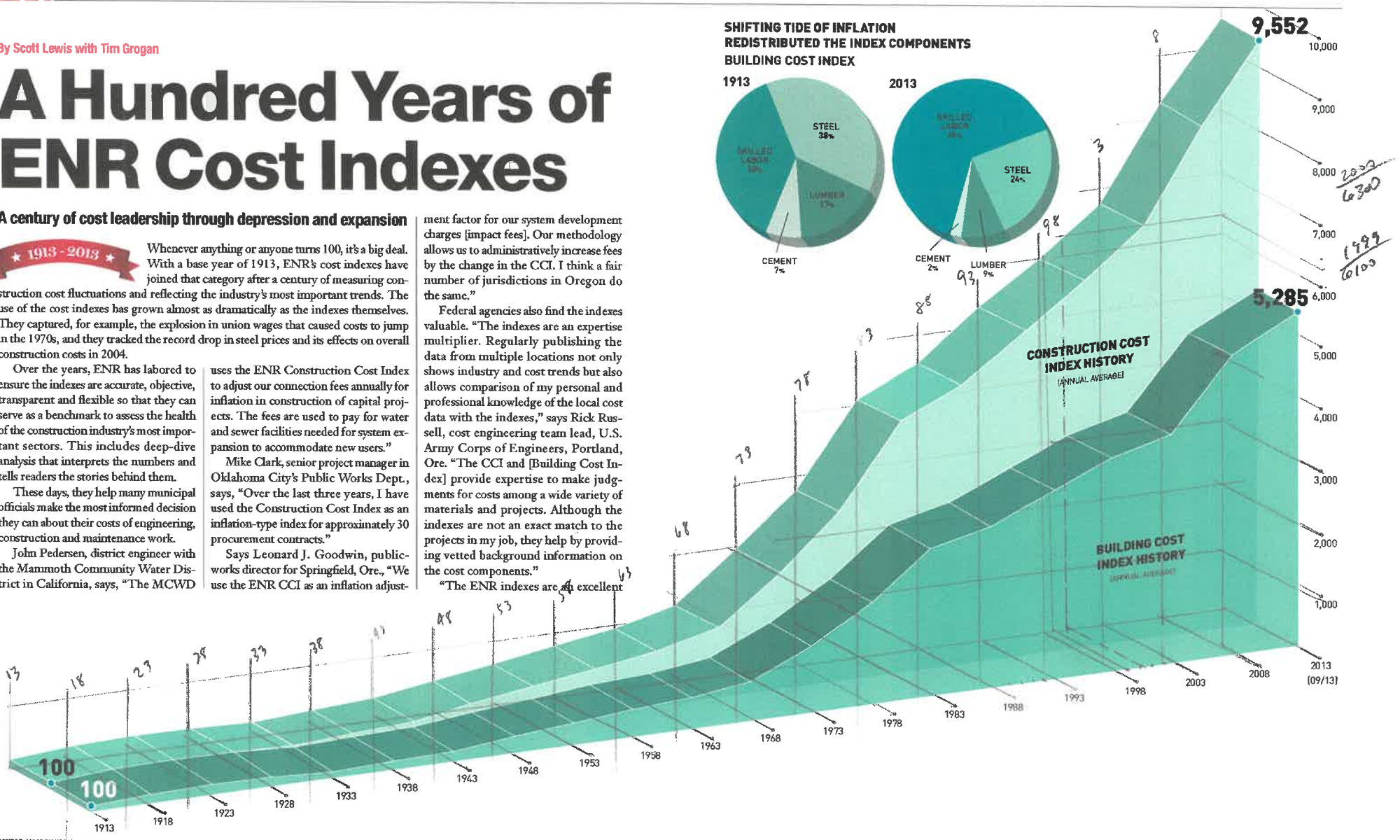
John Pedersen, district engineer with the Mammoth Community Water District in California, says, "The MCWD uses the ENR Construction Cost Index to adjust our connection fees annually for inflation in construction of capital projects. The fees are used to pay for water and sewer facilities needed for system expansion to accommodate new users."

Mike Clark, senior project manager in Oklahoma City's Public Works Dept., says, "Over the last three years, I have used the Construction Cost Index as an inflation-type index for approximately 30 procurement contracts."

Says Leonard J. Goodwin, public-works director for Springfield, Ore., "We use the ENR CCI as an inflation adjustment factor for our system development charges [impact fees]. Our methodology allows us to administratively increase fees by the change in the CCI. I think a fair number of jurisdictions in Oregon do the same."

Federal agencies also find the indexes valuable. "The indexes are an expertise multiplier. Regularly publishing the data from multiple locations not only shows industry and cost trends but also allows comparison of my personal and professional knowledge of the local cost data with the indexes," says Rick Russell, cost engineering team lead, U.S. Army Corps of Engineers, Portland, Ore. "The CCI and [Building Cost Index] provide expertise to make judgments for costs among a wide variety of materials and projects. Although the indexes are not an exact match to the projects in my job, they help by providing vetted background information on the cost components."

"The ENR indexes are an excellent



SOURCE: MCGRAW HILL CONSTRUCTION RESEARCH & ANALYTICS/ENR

Kevin Meador

From: Kugler, Daniel R. <KuglerDR@bv.com>
Sent: Tuesday, September 3, 2019 2:05 PM
To: Kevin Meador
Cc: Creamer, Bruce M.
Subject: RE: ENR index

CCI for April 2016 = 10279
CCI for August 2019 = 11311

Dan

From: Kevin Meador <kevin@secwcd.com>
Sent: Tuesday, September 03, 2019 1:38 PM
To: Kugler, Daniel R. <KuglerDR@bv.com>
Cc: Creamer, Bruce M. <CreamerBM@bv.com>
Subject: ENR index

Hi Dan,
If you still have access to the ENR CCI could you tell me the index on April, 2016 and the most recent value (August, 2019)?
Thanks,
Kevin

Water Conservancy District

KEVIN J. MEADOR, P.E.| Principal Engineer
31717 United Avenue, Pueblo, CO 81001
+ 1 719-948-2400 P | +1 719-948-0036 F | +1 720-252-4205 M
kevin@secwcd.com