ILO-4. Reservoir Operation and Simulation

Learning Objectives:

e. Recommend reservoir operations and release policies when given a time-series of historical inflows, water uses, delivery targets, and economic consequences of deliveries and shortages.

l. Identify potential management options, select appropriate performance criteria, and quantitatively and qualitatively evaluate identified options against stated performance criteria.

n. Present work and findings in a variety of formats required of practicing basin planners and managers, including written reports.

o. Work effectively individually.

How do the annual firm yield, reliability, resiliency, vulnerability, and shortage costs of deliveries to the Bear River Canal Company (BRCC) change if Cache County builds a new reservoir along the Bear River above Cutler? A simplified schematic is shown in Figure 1. Assume:

i. The annual delivery target is 242,000 ac-ft/year,
ii. Monthly evaporation rates are shown in Table 1,
iii. A quadratic relationship for reservoir area vs storage is shown in Figure 2,
iv. Reservoir operators must reserve 15,000 ac-ft of storage as empty in April, May, and June to protect downstream areas from floods,
v. Monthly delivery targets and costs for shortages to BRCC users are listed in Table 2,
vi. Dam operators (inadvisably) use the Standard Linear Operating Procedure (SLOP) to decide releases.

Use the records of Bear River and Little Bear River inflows available in the Lower Bear River Excel file and assume BRCC users have first (most senior) priority water rights in the basin.

Digital versions of all of the above data are available in the Lower Bear River Excel file. In building your spreadsheet model of reservoir operations, make sure to:

a) Produce a yield-reliability plot that compares results with/without the reservoir
b) Suggest a more preferable release policy to reduce shortage costs (e.g., hedging).

Table 1. Monthly Evaporation Rates for the new Bear River Reservoir

Month		Evaporation Rate (ft)
10	October	0.05
11	November	0
12	December	0
1	January	0
2	February	0
3	March	0.02
4	April	0.13
5	May	0.22
6	June	0.36
7	July	0.43
8	August	0.39
9	September	0.2
Total		**1.79**

Table 2. Delivery Targets and Shortage Cost Parameters for New Cache Valley Users

Month		Delivery Target (% of Total)	Shortage Cost Parameter	
			a	b
10	October	12.0%	4.5	1.3
11	November	3.2%	2.5	1.2
12	December	3.2%	2.5	1.2
1	January	3.2%	2.5	1.2
2	February	3.2%	2.5	1.2
3	March	3.2%	2.5	1.2
4	April	12.0%	2.5	1.2
5	May	12.0%	4.5	1.3
6	June	12.0%	4.5	1.3
7	July	12.0%	1.3	1.7
8	August	12.0%	1.3	1.7
9	September	12.0%	1.3	1.7
Total		**100.0%**		

The exponential shortage cost function is $Y_t = a_t \cdot X_t^{b_t}$

where Y_t = shortage cost in month t [\$], X_t = delivery shortage in month t [af], and a_t and b_t are empirical parameters specific to month t.

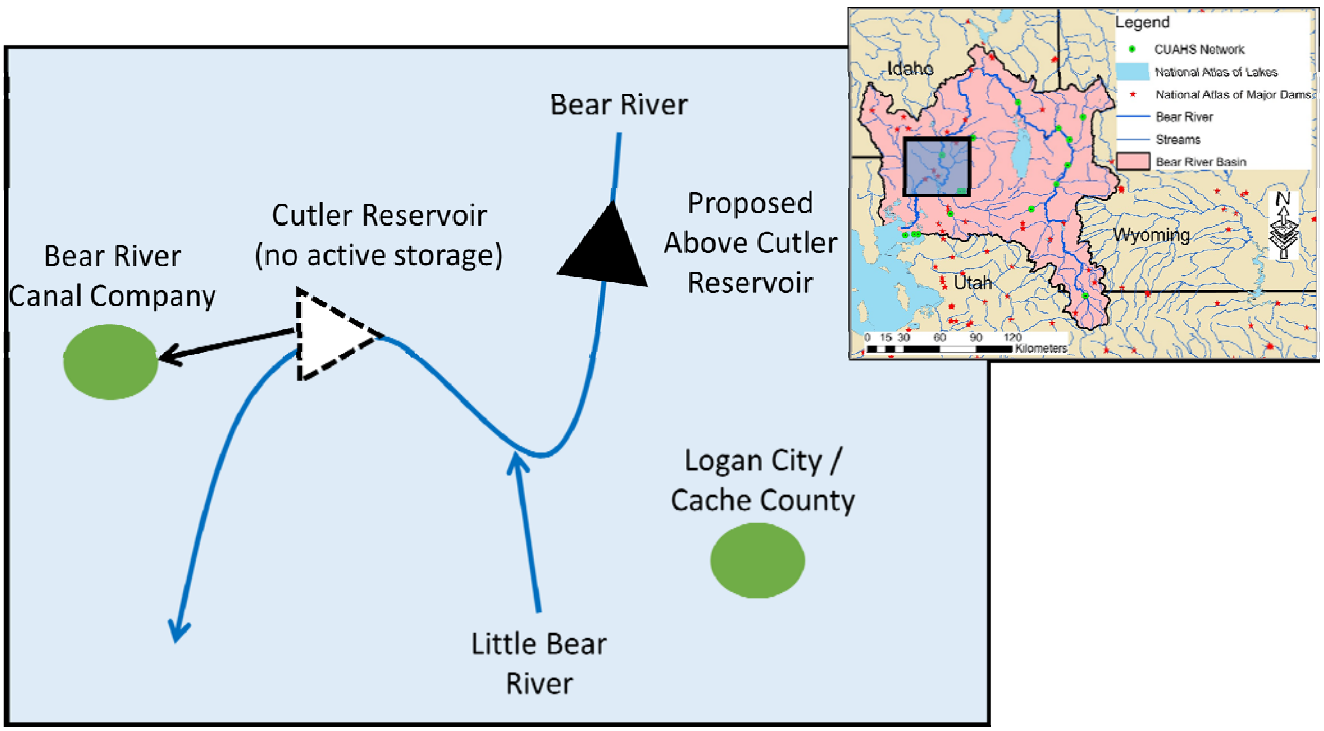

Figure 1. Bear River Schematic with proposed Above Cutler Reservoir

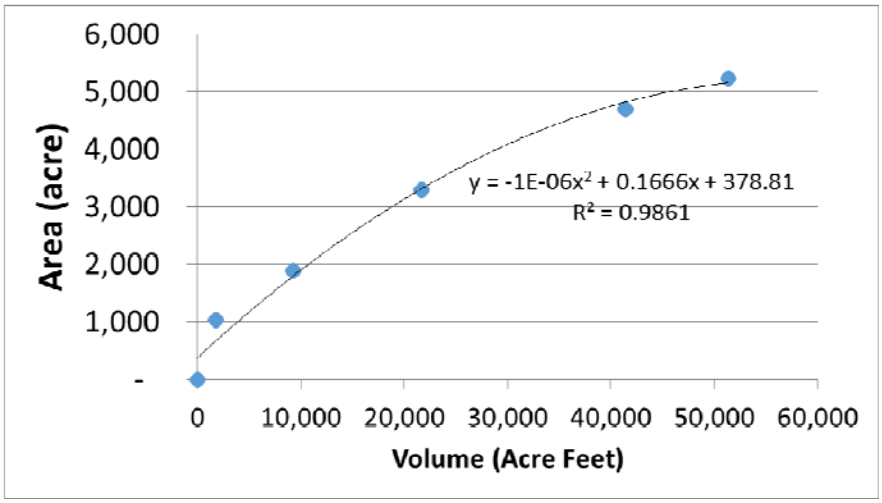

Figure 2. Above Cutler Reservoir Volume-Area Relationship

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Category (Max. Score)	No Evidence	Doesn't Meet Standard	Nearly Meets Standard	Meets Standard	Exceeds Standard	Self-Score	Instructor Score
Title (1)	Absent 0	Evidence of two or less 0	Evidence of three 0	Evidence of four 1	Title – can assess main point from title alone; Name, Instructor's Name, Course, Date, Neatly finished 1		
Introduction (3)	Absent, no evidence 0	There is no clear introduction or main topic. 1	Introduction states the main topic but either: 1. Does not give a full overview, Or: 2. Too detailed, leading to annoying repetition later. 2	The introduction states the main topic and previews the structure of the report. 2	The introduction states the main topic and previews the structure of the report. Good overview of the design and strategy. An effective summary. Gives enough detail to interest the reader. 3		
Organization and structural development of the idea: procedure, results, discussion (10)	Not applicable	Paragraphs fail to develop the main idea. No evidence of structure or organization. 1 – 5	Organization of ideas not fully developed. Paragraphs lack supporting detail sentences. No transitions. Exceeds 1-page limit. 6 - 7	Paragraph development present but not perfected. Each paragraph has sufficient supporting detail sentences. No transitions. 8	Writer demonstrates logic and sequencing of ideas in 1 page through well-developed paragraphs. Each paragraph has thoughtful, supporting detail sentences that develop the main idea. The first sentence of each paragraph is the summary sentence. Transitions enhance structure. 9 - 10		
Engineering Calculations and Design (70)	Design point(s) not addressed. 3 – 42%	The writer has no clue what they are talking about. 45 – 58%	Sketchy: left out required design points. Did not work on this as much as you should have, and it shows. Many important answers are incorrect. 61 – 79%	Discussion lacks adequate detail, but all the necessary points are covered and nearly all answers are correct. 82 – 88%	Provides what was explicitly asked for. The function of each piece is demonstrated to the reader in adequate, but not overwhelming, detail. Answers are correct and reasonable. 91 – 100%	[redacted]	
	a) SLOP – firm yield, reliability, resiliency, vulnerability (30)						
	b) Delivery–reliability plot (10)						
	c) Hedging recommendation and comparison to performance with SLOP and no reservoir (30)						
	d)						

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Category (Max. Score)	No Evidence	Doesn't Meet Standard	Nearly Meets Standard	Meets Standard	Exceeds Standard	Self-Score	Instructor Score
Word Usage and Format (10)	Not applicable	Numerous and distracting errors in punctuation, capitalization, spelling, sentence structure, word usage, significant figures, tables, and figures. Data vomited onto page(s). Unacceptable / unprofessional at the graduate level. 1 – 5	Misspelled words, poor English grammar and word choice. Main body of report is either longer or significantly less than one page. Figures are too small and/or under-labeled, although they are usually of acceptable quality and focus. Tables incoherent or not cohesive. Bad font sizes. Too much or too little data in appendices. Could be improved by being more meticulous. 6 - 7	Almost no errors in punctuation, capitalization, spelling, sentence structure, word usage, significant figures, and presentation of figures, tables, and appendices. Main body of report is one page or less 8	Punctuation, capitalization, spelling, sentence structure, word usage, and significant figures all correct. Main body of report is one page or less. Clear, consistent fonts. Good word processing skills. Figures have adequate contrast. Informative figure and table titles and legends. Figures have appropriate axis tick spacing, labels, units, and legends. Table columns cohesive, labeled, and specify units. Document is stapled. Appendices, if provided, are separated by topic, and each have a title, discussion, and proper formatting and display of information 9 - 10		
Conclusion (4)	Absent 0	Incomplete and/or not focused. 1	The conclusion does not adequately restate the main results. 2	The conclusion restates the main results. 3	The conclusion restates the main results, and is an effective summary. 4		
References (2)	Absent 0	With many errors, off-the-wall sources used. 0	With some errors, appropriate sources were used. 1	With few errors, good sources were used 2	All cited works; text, visual, and data sources are done in the correct format with no errors. Uses innovative sources of information. 2		
TOTAL (100)							