Cost/Benefit Analysis of the Newark Reservoir

(May 19, 2002, rev. July 4, 2020)

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Objective

The objective of this paper is to update an *in media res* (during the course of a project) cost/benefit analysis (CBA) of the Newark Reservoir originally prepared in May 2002 during project construction four years before the reservoir came on line. Three alternatives are evaluated: (A) no reservoir, preserve land for 112acre city park, (B) no reservoir, 112-acre site developed for 200 homes, and (C) 317 mg reservoir, preserve land for 112-acre city park. The project standing is the City of Newark with 33,600 residents in 2018. The discount rate over a 20-year assumed project life is 3%. The CBA employs the equation: Net Present Value (NPV) = Present Value Benefits (B) minus Present Value Costs (C) or NPV = B - C (Boardman 2001).The alternative with the highest NPV provides the most economic benefits to society.

Project Definition

After the turn of the 21st Century as insurance against drought, the City of Newark, Delaware built a 317 million gallon (mg) reservoir a mile north of downtown. Over a 60-day drought planning period, the reservoir can provide up to 5 million gallons per day (mgd) of supplemental water should stream flows in the White Clay Creek decline below drought flow levels or during high turbidity loads in the creek. Groundbreaking for the reservoir was in May 2002, construction began in June 2002 with project completion and fill up in 2005 and 2006.

The reservoir built on the 112-acre Koelig Farm, the last farm in Newark proper. If the reservoir were not built by the City, the owner was prepared to sell the land to develop 200 homes. The reservoir now includes a city park with hiking, bird watching, and other passive recreation activities. The city fills the reservoir by pumping water through 3,500 linear feet of 18-inch diameter ductile iron pipeline from the White Clay Creek Water Treatment Plant at elev. 70 ft msl to a head house near the reservoir dam at elev. 190 ft msl (Figure 1). The capital cost was \$8 million for land acquisition and \$10 million for construction of the reservoir and pump station as bid by the contractors. Estimated operation/maintenance (O&M) costs are \$1 million annually for pump station electricity, treatment costs, reservoir clean out, and pump upkeep.



Figure 1. Newark Reservoir water supply system

Cost/Benefit Analysis

We evaluate the cost effectiveness of the Newark Reservoir utilizing the cost/benefit analysis:

- 1. Specify alternatives.
- 2. Decide project standing.
- 3. Catalogue impacts, select indicators, and monetize and attach dollar values.
- 4. Compute net present value (NPV) of each alternative.
- 5. Make recommendations based on the NPV of each alternative.

1. Specify Alternatives

Three alternatives are evaluated for the 112-acre Koelig Farm property:

- (A) No reservoir, preserve land for city park.
- (B) No reservoir, land developed for 200 homes
- (C) 317 mg reservoir preserves land for city park.

Alternative A: The farm is sold to the city to preserve as open space for a city park, which has environmental and recreational benefits. The city would not have a new reserve supply of water and during drought would be required to buy water from a private water utility at water rates that exceed \$4.00 per 1000 gallons. Fair market appraisals indicate the land cost of the unimproved 112-acre site for open space park purposes is \$6 million. The park land would be removed from city tax rolls.

Alternative B: The land is sold to a developer who would erect 200 homes as approved then by New Castle County Council. There would be no recreational and environmental benefits. The city would not have a reserve supply of water and during drought would be required to buy water from a private water utility at water rates that exceed \$4.00 per 1000 gallons. Land appraisals from the land condemnation proceedings indicate the land cost of an improved site permitted for homes with water and sewer is \$10 million. The site would be added to the city tax rolls with property taxes of \$3,000 per parcel accruing from 200 new dwellings.

Alternative C: The land was sold to the city in 2001 for the construction of a 317-mg reservoir and surrounding city park. There would be recreational and environmental benefits from the new park with hiking trails, habitat, and birding. The city would have a new reserve supply of water during drought and would not be required to buy water from a private water utility when stream flows in the White Clay Creek decline during drought. Instead the City could sell the water to its customers for water rates at \$3.00 per 1000 gallons. Land appraisals from the condemnation proceedings indicate the land acquisition costs for the reservoir was \$8 million. The reservoir and parkland would be removed from the city tax rolls.

2. Decide project standing.

Next we decide for whom the benefits and costs should be counted. In this case the City funded most of the reservoir and the park. City residents will use the reservoir. Therefore, the project standing is the 33,600 residents and 9,333 properties of the City of Newark in 2018.

3. Catalogue impacts, select indicators, and monetize values to all impacts.

In this step we associate dollar values to the benefits and costs of the alternatives.

Benefits

Water Supply Benefits: Water supply benefits include the willingness to pay by the city voters through referenda to (1) raise property taxes and (2) increase water rates to pay for the reservoir and (3) savings from avoided water purchases.

- (1) In 2001, the voters approved by a 3 to 1 margin to raise property taxes approximately \$30 per home annually to pay for the reservoir or \$280,000 annually for the 9,333 properties in the city.
- (2) Also in 2001, the voters approved by referendum to raise water rates from \$100/yr for 60,000 gallons used annually to \$200/yr, an increase of \$100/yr or \$933,300/yr for 9,333 properties in the city.
- (3) A third water supply benefit is that the city would not have to buy water at rates that exceed \$4.00 per 1000 gallons from a private water utility during drought (Office of the State Water Coordinator 2002). Based on stream gage records, during drought the White Clay Creek can reliably provide sufficient water for the 3 mgd treatment plant 84 percent of the time or 305 days/yr. The other 16 percent or 60 days in a year the city must buy water at from another water utility. Since 2007, the Newark Reservoir released 1,772 mg over 795 days over 13 years back to the White Clay Creek water treatment plant (Table 1 and Figure 2). If the City had to buy the water from an adjacent private water utility at rates varying from \$4.70/1000 gal in 2007 to \$9.04/1000 gal in 2019, the City has saved \$12,461,703 in avoided water purchases or \$958,000/yr. If the reservoir was not built, this cost not paid is accrued on the "cost" side of the ledger.

Date	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total
Release (mg)	82	149	186	110	140	115	143	98	191	180	68	81	229	1772
Water Rate (\$/1000gal)	4.70	5.44	5.44	5.44	5.44	6.28	7.83	7.83	7.83	7.83	8.84	9.04	9.04	
Savings (SUEZ DE \$/1,000 mg)	384,930	810,016	1,011,296	597,312	759,424	719,060	1,115,775	764,278	1,496,794	1,405,659	597,405	728,454	2,071,300	12,461,703
Release days	39	59	76	45	66	50	72	44	89	85	47	39	84	795
% in Use	11%	16%	21%	12%	18%	14%	20%	12%	24%	23%	13%	11%	23%	

 Table 1. Newark Reservoir release rate data (2007-2019)



Figure 2. Newark Reservoir release data (2007-2019)

Environmental Benefits: Accrue economic value from preserving the reservoir land for a park for (1) habitat, (2) open space, (3) recreation (hiking), and (4) health/community cohesion/water pollution/air pollution benefits.

(1) The ecosystem services value of habitat for Alternative A city park, no reservoir with freshwater wetlands, forest, and farm habitat is \$445,266/yr (Table 2). The ecosystem services value of habitat for Alternative B build 200 homes with urban land is \$38,304. The ecosystem services value of habitat for Alternative C reservoir with city park with freshwater wetlands, forest, farm habitat, and 30-ac of open water is \$538,466.

Ecosystem	Habitat Value \$/ac/yr	(A) Park, No Reservoir (ac)	(B) No Reservoir 200 homes (ac)	(C) Reservoir w/City Park (ac)	(A) Park, No Reservoir (\$/ac/yr)	(B) No Reservoir 200 homes (\$/ac/yr)	(C) Reservoir w/City Park (\$/ac/yr)
Freshwater wetlands	13,621	10		10	136,210	0	136,210
Farmland	4,124	50		10	206,200	0	41,240
Forest land	1,978	52		62	102,856	0	122,636
Barren land	0				0	0	0
Urban	342		112		0	38,304	0
Open water	7,946			30	0	0	238,380
Total		112	112	112	445,266	38,304	538,466

Table 2. Ecosystem services habitat value of Newark Reservoir site

- (2) While the reservoir was under construction, the state legislature awarded \$3,400,000 in funds for the acquisition of the 112-acre City Park as open space which counts as an additional open space benefit of \$229,160/yr over 20 years at a discount rate (n) of 3% for a capital recovery factor (A/P) of 0.0674.
- (3) Recreational benefits accrue from the preservation of the property as a city park (Walsh et al. 1992). Trail counts indicate the City has recorded up to 100,000 visitors/yr or 275 visitors/day to Newark Reservoir Park during 2017, 2018, and 2019 (Table 3 and Figure 3). The U.S. Forest Service estimates the willingness to pay for recreation hiking varies from \$5.02 to \$451.00 per day with a mean of \$78.19/day (Rosenberger et al. 2017). Assuming a low range plug in value for hiking of double the low range value of \$10.04/person/day, the recreational hiking value of Newark Reservoir Park is \$503,882. or \$1,007,765 annually for 275 park visitors/day. By comparison the Delaware State Park system charges \$4.00 per vehicle for instate and \$8.00 per vehicle for out of state residents.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ADT	Days	Total
2017								10,368	10,739	9,976	7,583	1,276	444	90	39,942
2018	4,898	9,586	9,285	9,630	8,099	8,052	5,949	6,747	8,746	11,418	9,757	6,998	295	336	99,165
2019	7145			14992	12958	7938	4797	7504	9691	12506	10123	4691	335	276	92,345

Table 3. Recreational trail visits to Newark Reservoir Park.



Figure 3. Newark Reservoir Park trail trends

(4) The Trust for Public Land (2009) found the 444-acre City of Wilmington park and recreation system provides annual economic value and savings to the public from: (1) health benefits from exercise in the parks (\$9,734/ac), (2) c-cohesion benefits from people socializing in the parks (\$2,383/ac), (3) water pollution-mitigation benefits from parks in treating stormwater (\$921/ac), and (4) Air pollution-mitigation value from tree and shrub absorption (\$88/ac). Assuming the data from the City of Wilmington study is appropriate for value (benefits) transfer, the 112-acre Newark Reservoir Park (Figure 4) provides \$1,470,112 in annual economic benefits (Table 4).

Park Benefit (112 ac)	\$/ac	\$
Health benefits from exercise	\$9,734/ac	\$1,090,208
Community-cohesion, people socializing	\$2,383/ac	\$266,896
Water pollution mitigation, treating stormwater	\$921/ac	\$103,152
Air pollution mitigation, tree and shrub absorption	\$88/ac	\$9,856
Total		1,470,112

Table 4. Economic benefits of Newark Reservoir Park

Property Tax: If the reservoir site were developed with 200 homes, property tax revenues would be \$4,000 per property or \$800,000/yr.



Figure 4. Newark Reservoir Park (112 acres)

Costs

Land appraisals during condemnation hearings indicate the acquisition cost of the 109-acre site for Alternative A - no reservoir but park is \$6 million (\$404,000/yr), Alternative B - no reservoir but 200 homes is \$10 million (\$674,000/yr), and for Alternative C - build the reservoir and city park \$8 million (\$539,200) which was actually paid. Annual costs are derived over 20 years at a discount rate (n) of 3% for a capital recovery factor (A/P) of 0.0674.

Construction costs according to engineering contract bids submitted to the City of Newark are \$1 million (\$67,400) for Alternative A new park only and \$10 million (\$674,000) for Alternative C new reservoir and city park.

Maintenance costs of Alternative A new park only are \$50,000/yr. Estimated maintenance cost of a new reservoir pump station, water treatment, pump electricity and sediment removal are for Alternative C or \$1,000,000/yr.

If the reservoir is not built the city must buy water for \$958,000/yr from a private water purveyor for an average of 66 days each year based on records from 2007 through 2019.

If a reservoir is built and new homes are not constructed, then the city loses annual property tax from 200 homes at \$4,000 per property or \$800,000/yr which is a cost for Alternatives A and C but a benefit for Alternative B.

4. Compute Net Present Value (NPV) of each alternative.

Compute the Net Present Value (NPV) of each alternative as NPV = B - C (Table 5).

	(A)	(B)	(C)
	No Reservoir	No Reservoir	317 mg
	Land for City	Land for 200	Reservoir
	Park	Homes	City Park
	(\$/yr)	(\$/yr)	(\$yr)
Benefits			
Water Supply			
WTP for Property Tax			280,000
WTP for Water Rate			933,300
Avoided Water Purchases			958,000
Environmental			
Ecosystems Habitat	445,266	38,304	538,466
Open Space			229,160
Recreational Hiking	1,007,765		1,007,765
Parks	1,470,112		\$1,470,112
Property Tax/Avoided Land Cost	0	800,000	0
Benefits (B)	2,923,143	838,304	5,416,803
Costs			
Land Acquisition	404,000		539,200
Construction	67,400		674,000
Maintenance	50,000	0	1,000,000
Buy Water if No Reservoir	958,000	958,000	0
Loss of Property Tax, 200 homes	800,000	0	800,000
Costs (C)	2,279,400	958,000	3,013,200
Net Present Value (NPV = B-C)	643,743	-119,696	2,403,603

Table 5.	Newark R	Reservoir C	ost/Benefit	Analysis.	Net Present	Value over	20 Years at	t I = 3%
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Alternative	Benefits (B)	Costs (C)	NPV = B-C
	(\$/yr)	(\$/yr)	(\$/yr)
(A) No Reservoir, Land for City Park	2,923,143	2,279,400	643,743
(B) No Reservoir, Land for 200 Homes	838,304	958,000	119,696
(C) 317 mg Reservoir with City Park	5,416,803	3,013,200	2,403,603

5. Make recommendation based on the NPV of each alternative

Public policy makers usually recommend the alternative with the highest net present value since this alternative will cost least over the project lifetime.

Alternative C - Build the reservoir with city park has the highest NPV at \$2,403,603/yr since the water supply, recreational, and environmental benefits out-weigh the cost to build and maintain the reservoir over 20 years. The recreational benefits for this alternative are very significant.

Alternative A - No construction of a reservoir but build a park is the next highest NPV at \$643,743, less than the build a reservoir alternative. The park accrues significant recreational benefits over the years that outweigh the relatively modest construction cost of a park (as compared to the reservoir) and the added cost to buy water from private water utility during drought.

Alternative B - No construction of reservoir and build 200 homes has by far the lowest NPV at -\$119,696 that indicates the project to build homes instead of a much needed reservoir and popular park is not cost effective to the residents of Newark. There are hardly any social benefits to the City except for relatively modest property tax income.

Recommendations

This updated cost/benefit analysis of the Newark Reservoir Park indicates that Alternative C (Build the reservoir) is the most socially beneficial to the standing of Newark from a CBA perspective. This corroborates the decision by Newark City Council to commence construction on this project as per the referenda to raise property taxes and increase water rates that were approved by the voters at 4:1 and 3:1 approval margins, respectively. If for some reason the reservoir was not built, then an advisable alternative was to buy the farm and build a city park only as this Alternative A (Park only) has appreciable environmental and recreational benefits. If desired, CBA sensitivity analyses can be conducted for other City projects and open space acquisitions.

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