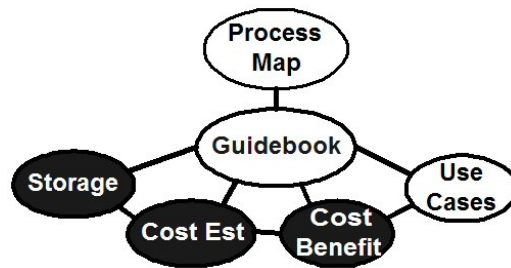


GEOARCHIVING COMPREHENSIVE COST-BENEFIT ANALYSIS GUIDANCE



CONTENTS

1	Toolkit Introduction	2
1.1	Overall Workflow Diagram	2
2	Cost-Benefit Guidance	3
2.1	Overview	3
2.2	CBA Components	4
2.3	Recommended Approach To CBA For Geoarchiving.....	8
3	Estimating Geoarchiving Storage Requirements	10
3.1	Geoarchiving Storage Needs Input	10
3.2	Annual Geoarchiving Storage Needs	12
3.3	Cumulative Geoarchiving Storage Needs	12
4	Estimating Geoarchiving Project Costs.....	15
4.1	Geoarchiving Project Costs Input.....	15
4.2	Geoarchiving PProject Cost Summary.....	17
5	Cost-Benefit Analysis.....	18
5.1	Geoarchiving Benefits.....	18
5.2	Geoarchiving Cost-Benefit Analysis	19

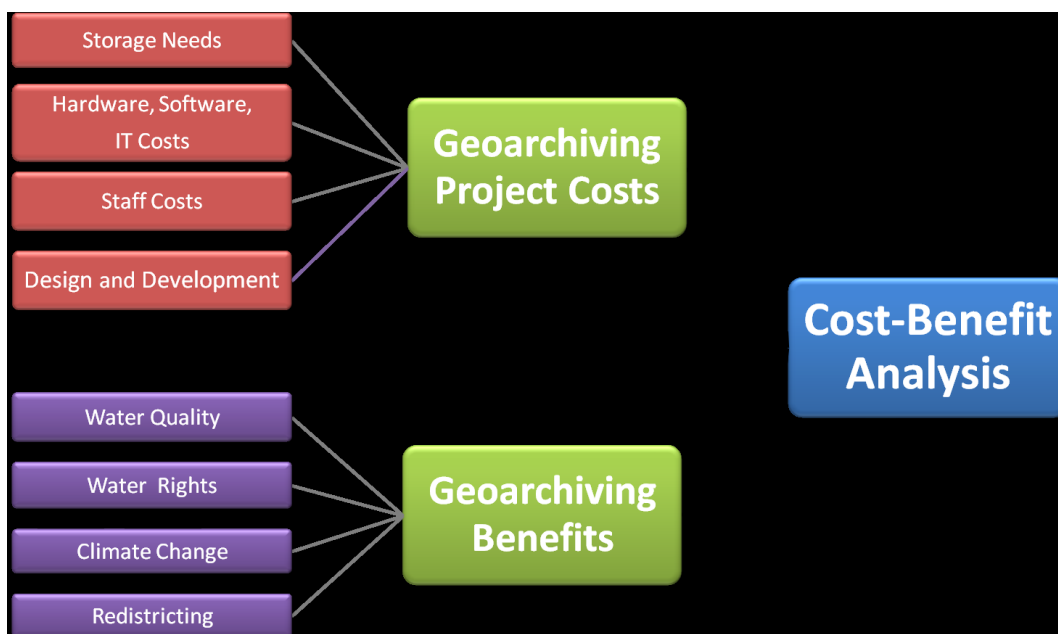
1 TOOLKIT INTRODUCTION

This document serves as guidance for using the Geoarchiving Comprehensive Cost-Benefit Analysis Tool (Geoarchiving Cost-Benefit Analysis Tool.xlsx). This Excel workbook contains several worksheets (tabs) which will allow a user to estimate storage needs and project costs, and then perform a cost-benefit analysis. The workbook is broken down by category to help users apply what pertains to their particular planning process requirements. It contains the following functions, which are explained in this document.

- ★ The following worksheet tabs will allow a user to **Estimate Storage Requirements**
 - Geoarchiving Storage Needs Input
 - Annual Geoarchiving Storage Needs
 - Cumulative Geoarchiving Storage Needs
- ★ The following worksheet tab will allow a user to **Estimate Comprehensive Project Costs**
 - Geoarchiving Project Costs (which uses results of the Storage Needs tabs)
- ★ The following worksheet tabs will then allow a user to **Perform a Cost-Benefit Analysis**
 - Geoarchiving Benefits
 - Geoarchiving Cost-Benefits Analysis (which uses results of the Project Costs tab)

1.1 OVERALL WORKFLOW DIAGRAM

The diagram below provides an overall architecture of the Geoarchiving Comprehensive Cost-Benefit Analysis tools. The items in purple are example use cases for performing the cost-benefit analysis and would be changed in to reflect the use cases chosen by the agency performing the analysis. Benefits could also accrue to the custodians of individual data sets, as well as the business process owners; but care should be taken not to double-count the benefits.



2 COST-BENEFIT GUIDANCE

2.1 OVERVIEW

The toolkit components described in this document for developing Return on Investment (ROI) metrics are for a rigorous Cost Benefit Analysis (CBA). CBA techniques, when properly applied, yield both a net present value dollar amount, and the terms for the ROI equation (benefits minus costs, divided by costs), to derive the ROI ratio for the project being analyzed. The level of effort associated with developing a comprehensive CBA is a significant part of the cost of developing a Business Plan, so it should be budgeted for, accordingly. For flexibility, the tools and guidance are designed so that you can take an incremental approach if you are inadequately funded for a complete CBA. For example, you might just want to estimate storage requirements; or you might want to just estimate costs. However, a partial effort may not be credible with financially-minded decision-makers. Increasingly, it is a requirement in the IT world, for example, to do a complete financial analysis.

The difference between ROI and CBA is briefly explained in the tutorial accompanying the **Strategic and Business Planning Guidelines** (FGDC/NSGIC, c. 2006) entitled “Economic Justification: Measuring Return on Investment (ROI) and Cost Benefit Analysis (CBA)”. A more in-depth explanation is included in the

ROI Workbook (FGDC/GITA/AWWA, c. 2007), entitled “Building a Business Case for Geospatial Information Technology.” Further details on CBA are provided in the federal **OMB Circular A-94** (RE: Executive Order No. 12291, c. 1992), entitled “Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs.” **Note:** These documents are referenced in the Business Plan Guidebook Bibliography with url links. There are also a number of books on the subject of CBA for a full treatment on this subject.

Making the business case for geoarchiving is not easy on financial terms alone. The most evident justification might be meeting the legal requirement for records retention, a fact that should not be overlooked when describing the benefits of the program. However, making the economic argument for why it makes sense on financial terms is not self-evident. Therefore, a good CBA for geoarchiving starts with a qualitative description of why resources need to be devoted to it, with a list of some of the expected benefits.

Intuitively, a coordinated common infrastructure that serves all geoarchiving needs for an enterprise makes more sense than no coordination and unnecessarily redundant systems spread across a multitude of departments. Of course, many departments will not embark on a geoarchiving program on their own, unless they feel it is required to fulfill their mission and legal mandates. And therefore, the notion of any investment whatsoever in infrastructure for geoarchiving might seem unnecessary to department level business-process owners. If they are to support investment at the enterprise level, they need to be convinced it is worthwhile, and that it will not come at the expense of investments that directly support their mission requirements.

2.2 CBA COMPONENTS

The basic components to CBA are listed below, and are explained in subsequent paragraphs:

- ★ Costs
- ★ Benefits
- ★ Time Horizon
- ★ Discount Rate
- ★ Net Present Value
- ★ Sensitivity Analysis
- ★ Return on Investment (ROI) Calculation

COSTS. The costs are fairly straightforward as compared to benefits, and are addressed in the sections below. In brief, costs items are the components that you must spend money on to establish a geoarchiving program, including hardware, software, and personnel. Their dollar value is a function of

observable market prices and documented compensation. The following items are representative of the basic costs needed for CBA on geoarchiving:

- ★ Amount of storage required
- ★ Staff costs (initial and recurring)
- ★ Consulting support (if required)
- ★ Initial Hardware and software costs
- ★ Geoarchiving system design and development costs
- ★ Ongoing maintenance costs for software and hardware
- ★ Ongoing operational costs for personnel
- ★ Technology refreshment & modernization costs
- ★ Ongoing preservation management costs (e.g. migration to more sustainable data file formats)
- ★ Storage expansion costs as the collection grows

BENEFITS. While the dollar value of costs is a function of observable market prices and documented compensation, the same cannot as easily be said of benefits. For example, what is the dollar value of the sample benefits listed below?

- ★ Providing a chain of evidence on historic uses of the land through time
 - Reduction in disputes based on lack of accurate data
 - More favorable outcomes in defending appeals based on disputed data
- ★ Enabling better forecasting of future threats based on reliable historic data
- ★ Supporting independent discovery and analysis of trends, cycles, changes, and other patterns in space and time dimensions

There is no directly observable market valuation for geoarchiving that places a dollar amount on any of the benefits listed above. When there is no obvious value as a function of market prices, there are methods to make an estimate based on “shadow” prices. These methods include looking at observable markets for analogous things that can be measured (market analogies), or asking people for their opinions on what something is worth using various survey methods (contingent valuation). In each case, some level of bias is unavoidable from either the researcher or the informant, or both; and it should be documented as part of the process in qualitative terms.

For geoarchiving, there are not any readily apparent market analogies, so the recommended method is to use survey methods to assess value, based on questionnaires and use cases that yield quantifiable answers from respondents to inform CBA valuation. Examples of potentially quantifiable answers (using hypothetical dollar amounts) include:

- ★ **Cost Savings:** “We currently spend \$100,000 per year searching for data” to defend against lawsuits on which we have inadequate recordkeeping to prove the state’s contentions; with geoarchiving, “we could save \$50K on what we spend” by going to one source for reliable records
- ★ **Cost Avoidance:** Because snapshots were not retained of property parcel boundaries at different times for an area of the state, “\$100,000 was spent to recreate missing records” from multiple disparate sources; we could have avoided this spending if the missing records were retained in a geoarchiving
- ★ **Penalty Fees:** Because histories of hydrography data were retained for a fast developing area of the state, changes to stream channels and the construction of impoundments without permits were discovered that “allowed the state to assess \$100,000 in fines” to help pay for restoration

Procedures for identifying and reaching out to respondents include in-person and telephone interviews, response-by-mail, and on-line response. To make the questionnaire as realistic as possible, and to narrow-down the target population for garnering responses, it is recommended that relevant use cases be selected and developed. ***Separate guidance is provided on the development of use cases and support business-documentation.*** For example, the following are potential use case contexts that could each generate benefits for input to a geoarchiving CBA equation:

- ★ Water Quality
- ★ Water Rights
- ★ Climate Change
- ★ Redistricting

Once dollar values are established for documented benefits based on the uses cases, they should be entered into the accompanying spreadsheet, “Estimating Documented Geoarchiving Program Benefits” on the “Geoarchiving Benefits” tab (section 5.1).

TIME HORIZON. When conducting a CBA, the Geoarchiving Business Planning Committee/Team needs to select a specific time horizon for accruing costs and benefits throughout a slice of the geoarchiving life cycle. The costs of implementing a system tend to be higher on the front-end of a project, whereas the benefits increase over time. Therefore, the longer the time horizon, the more likely it is that sufficient benefits will accrue to offset the system costs. Given the nature of geoarchiving, it is recommended that the time horizon selected for CBA be 10 years or more. This is longer than most IT-related projects, but seems congruent with the notion of preserving data for future value.

DISCOUNT RATE. The details of Net Present Value are explained in the next section, but a key requirement is to select an appropriate discount rate. Since you will be accruing both costs and benefits over the course of time, a factor is needed to discount the future stream of costs and benefits into the present context, to compare with other alternatives competing for investment dollars. This factor is known as the discount rate. When selecting the appropriate discount rate for your CBA, it is important to know if it is the nominal rate, or the real rate. The real discount rate is adjusted for the effects of inflation, and is the recommended rate to use for CBA. The Executive Office of the President, Office of Management and Budget (OMB), publishes recommended discount rates for CBA, annually. The 2011 real discount rate is as follows (linear interpolation can be used for computing rates for in-between years):

3-Year	5-Year	7-Year	10-Year	20-Year	30-Year
0.0	0.4	0.8	1.3	2.1	2.3

Source: "2011 Discount Rates for OMB Circular A-94," Executive Office of the President, 3 February 2011.

NET PRESENT VALUE. The Net Present Value is the difference between the present value of benefits and the present value of costs. The future stream of benefits and costs is discounted in this calculation using the discount rate, which was previously discussed. The following equation and factors would be used:

$$NPV = \sum [(B_t - C_t) / (1 + r)^t]$$

Notation: B = Benefits; C = Costs; r = discount rate; t = time period. The summation \sum in the equation above is from t = 0 (the initial start-up of the program) to t = n (the final year of the program).

The accompanying spreadsheet, "Estimating Documented Geoarchiving Program Benefits" contains functions for calculating Net Present Value on the final tab called "Geoarchiving Cost-Benefit Analysis" (section 5.25.2).

SENSITIVITY ANALYSIS. By changing the time horizon and the discount rate in the NPV equation, different results will occur. Depending on the magnitude of changes to these numbers, the swing in results can be fairly substantial. Also, the benefits can be made greater by doing more use cases and quantifying more value, or they can be factored down by applying probability factors to their likelihood. An important step in CBA is to show the sensitivity in the results to such changes. Overall, a conservative but realistic posture should be taken when performing CBA, and the sensitivity analysis can be helpful in validating the choice of variables.

Note that a budget analyst may be concerned with discount rates and break even periods that can be influenced by outside factors (politics and election cycles. An IT-oriented reviewer may want the cost-benefit to extend at least one and ideally two replacement cycles. An agency head from the preservation or geospatial disciplines may want to see a longer time horizon. Ten years is demonstrated here.

RETURN ON INVESTMENT CALCULATION. The Return on Investment (ROI) for a given financial alternative is a ratio that indicates whether the investment results in more benefits than costs. The ROI result should be greater than zero for a program to be economically attractive. A sub-zero ratio may not automatically “kill” a project, because it may result in a required capability that does not currently exist. Not all government functions are required to have a positive ROI as they are in the business world, given that government is required to provide certain services and protection to the public. The formula for calculating the ROI, using the results of the NPV calculations as inputs, is:

$$\frac{\text{Discounted Benefits} - \text{Discounted Costs}}{\text{Discounted Costs}}$$

2.3 RECOMMENDED APPROACH TO CBA FOR GEOARCHIVING

The following outline assumes a coordinated state-level approach to geoarchiving, but it can be tailored to other approaches. By answering the questions in the outline, the Geoarchiving Business Planning Committee/Team will be giving definition to an executable approach for their particular circumstances; and also, they will be generating input for both the CBA (if undertaken) and the overall Business Plan.

- 1) Describe the geoarchiving program for which funding is being sought
 - a. Why should the state establish a geoarchiving program?
 - b. What are the reasons?
 - c. What is the desired outcome?
- 2) Why is a CBA is being undertaken in this context?
- 3) What are the some examples of geoarchiving programs in other states?
- 4) Do other states have CBA results that they can share on this topic?
- 5) What alternatives were considered?
 - a. Enterprise level approach?
 - b. Do nothing?
 - c. Rely on individual departments?
 - d. Rely on IT or equivalent?
 - e. Incremental approach (focused on a subset of data and time periods)?
 - f. Other?
- 6) Do any alternatives still have standing as possible considerations?

- 7) Who are the project advocates? Why? Biases? Strategic interests?
- 8) Who are the project non-advocates? Why? Biases? Strategic interests?
- 9) Who are the decision-makers? Why? Biases? Strategic interests?
- 10) Who are the key stakeholders with standing and credibility in the enumeration and valuation of benefits? Anybody you absolutely have to talk to?
- 11) Is there a hierarchy of stakeholders? e.g. Are state agencies more important than local government? Than the private sector?
- 12) What are the use cases that will make the estimation of benefits as objective and realistic as possible?
- 13) What are some of the generic benefits of geoarchiving?
- 14) What are some potential ways to quantify them with dollar values? (i.e. valuation methods)
- 15) What are the scaling methods for full valuation of enterprise benefits?
- 16) What variables will you use for calculating Net Present Value (NPV) in your CBA?
 - a. Time period (duration for stream of costs and benefits to be considered)
 - b. Dollar valuations for costs and benefits
 - c. Discount rate (What does the state use? How about OMB rates?)
- 17) What is the result of your CBA?
- 18) Sensitivity analysis (showing effects of changing time period and/or discount rate on the CBA results)
- 19) What is the relevance and/or significance of the program to the state's long-term needs? (i.e. strategic assessment)
- 20) Make recommendations

3 ESTIMATING GEOARCHIVING STORAGE REQUIREMENTS

The first three tabs of the workbook will help to estimate the total amount of storage needed over a 10 year period for geoarchiving. Input includes the amount of data to be archived (both raw and compressed formats), as well as the number of copies needed as part of the archival process.

3.1 GEOARCHIVING STORAGE NEEDS INPUT

The first tab in the Excel spreadsheet is called “Geoarchiving Storage Needs Input”. The image below shows this tab, and each input is labeled with a number (in red). A description of each input is provided below.

Digital Geospatial Data Preservation Data Storage Input

green boxes indicate user input

GeoSpatial ISO Categories (GB)	Current Data (GB)	% to archived each year	Year										Total		
			Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10			
Boundaries	100	100%	100	100	100	100	100	100	100	100	100	100	100	100	1000
Elevation	200	5%	10	10	10	10	10	10	10	10	10	10	10	10	100
Hydrography	10	5%	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	5
Cadastral	20	100%	20	20	20	20	20	20	20	20	20	20	20	20	200
Location	20	25%	5	5	5	5	5	5	5	5	5	5	5	5	50
Transportation	50	50%	25	25	25	25	25	25	25	25	25	25	25	25	250
Other (user defined)	100	25%	25	25	25	25	25	25	25	25	25	25	25	25	250
TOTAL (GB)	500		185.5	185.5	185.5	185.5	185.5	185.5	185.5	185.5	185.5	185.5	185.5	185.5	1855

Imagery (GB)	Uncompressed	Compressed
Existing Imagery to Archive	1000	50
Archive Imagery Planned Year 2	500	25
Archive Imagery Planned Year 3	250	13
Archive Imagery Planned Year 4	500	25
Archive Imagery Planned Year 5	250	13
Archive Imagery Planned Year 6	500	25
Archive Imagery Planned Year 7	250	13
Archive Imagery Planned Year 8	500	25
Archive Imagery Planned Year 9	250	13
Archive Imagery Planned Year 10	500	25
TOTAL (GB)	4500	225

Image Compression factor 4

LiDAR (GB)	LIDAR Raw Point Cloud	LIDAR Compressed
	Existing LiDAR to Archive	1000
Archive LiDAR Planned Year 2	400	200
Archive LiDAR Planned Year 3	200	100
Archive LiDAR Planned Year 4	400	200
Archive LiDAR Planned Year 5	200	100
Archive LiDAR Planned Year 6	400	200
Archive LiDAR Planned Year 7	200	100
Archive LiDAR Planned Year 8	400	200
Archive LiDAR Planned Year 9	200	100
Archive LiDAR Planned Year 10	400	200
TOTAL (GB)	3800	1900

LiDAR compression factor 6

The values in this table are based on inputs 1 and 2. If need be, a user can manually override these values and directly enter totals into this table.

The Compressed values are calculated based on the Uncompressed/Raw values multiplied by the Compression Factor

Input 1. Current Data Storage (ISO Categories)

The first input is amount of data that currently needs to be archived for each of the ISO categories listed. There is a place for "Other" that can be defined by the user for any other type of data not accounted for in the ISO categories. If need be, the "Other" row can be duplicated, and the final total calculations updated to reflect this, allowing a user to add additional data categories.

Input 2. Percent of Data to be Archived Each Year

For each ISO category, the user will estimate the percent of data to be archived each year. In some cases, 100% of the data may be archived each year, while in others it may be less. It will be up to each state to make these determinations for each data type listed.

Based on inputs 1 and 2 above, the ISO category storage estimates for 10 years will be calculated in the table to the right of these inputs for Year 1 through Year 10. If need be, a user can manually override these calculations and directly enter totals into the Year 1 – Year 10 table.

Input 3. Uncompressed Imagery Archive Estimates

The user should input the anticipated amount of uncompressed imagery to be archived for each year.

Input 4. Image Compression Factor

The user should input the compression factor for converting data imagery from its raw/native format (e.g. TIFF) to its compressed format (e.g. .SID). If the image compression is unknown, leave it at 1/20, which is a standard image compression factor

Input 5. LiDAR Raw Point Cloud Archive Estimates

Here, the user should input the anticipated amount of Raw LiDAR data (point cloud) to be archived for each year.

Input 6. LiDAR Compression Factor

Here, the user should input the compression factor for converting the LiDAR point cloud to a compressed format. If the LiDAR compression is unknown, leave it at 1/2, which is a standard LiDAR compression factor.

Note: The LiDAR section of the input tab only relates to the actual LiDAR data itself. Any derivative products created from the LiDAR data should be accounted for in the ISO category data table above.

3.2 ANNUAL GEOARCHIVING STORAGE NEEDS

The “Annual Geoarchiving Storage Needs” tab provides a snapshot of the estimated amount of data to be archived each year, and a bar graph showing the results. This tab answers the question: “How Much Data will we Archive Each Year” showing Uncompressed and Compressed totals.

There are no inputs on this tab. It can be used for getting an estimate of the amount of data that will be archived each year, but for the “Cumulative Geoarchiving Storage Needs” tab (described below) will provide the final totals of storage space required.

3.3 CUMULATIVE GEOARCHIVING STORAGE NEEDS

The “Cumulative Geoarchiving Storage Needs” tab will provide the answers to the following questions: “How much data will we accumulate over five years” and “How much storage of each type is needed?” The answers to these questions feed into the “Geoarchiving Project Costs” worksheet (section 4). The image below shows this tab, and each input (there are only three) is indicated in red. A description of each input is provided below.

Digital Geospatial Data Preservation Cumulative Data Storage Needs

green boxes indicate user input

How much storage of each type is needed?

Storage Type	Number of Copies	Usable % of Storage	Total Storage Needed (TB)
Preservation	1 2	2 75%	27.1
Access	2	75%	10.6
Staging			2.0
TOTAL (TB)			39.7

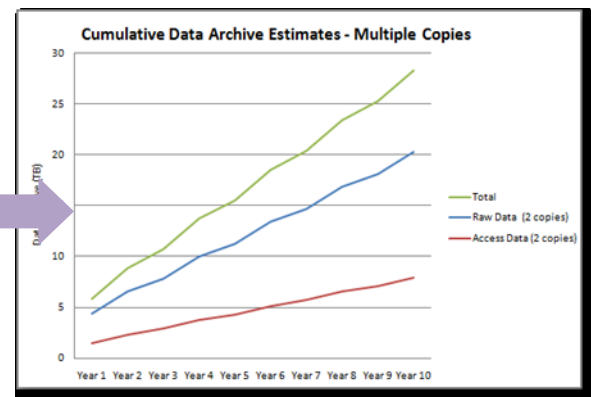
How Much Data will accumulate over ten years?

Multiple Copies (TB)	Raw Data (2 copies)	Access Data (2 copies)	Total
Year 1	4.4	1.5	5.8
Year 2	6.5	2.3	8.8
Year 3	7.8	2.9	10.7
Year 4	10.0	3.7	13.7
Year 5	11.3	4.3	15.6
Year 6	13.4	5.1	18.6
Year 7	14.7	5.7	20.4
Year 8	16.9	6.5	23.4
Year 9	18.1	7.1	25.3
Year 10	20.3	8.0	28.3

Cumulative Single Copy (TB)

Year	Raw Data	Access Data	Total
Year 1	2.2	0.7	2.9
Year 2	3.3	1.1	4.4
Year 3	3.9	1.4	5.4
Year 4	5.0	1.9	6.8
Year 5	5.6	2.2	7.8
Year 6	6.7	2.6	9.3
Year 7	7.3	2.9	10.2
Year 8	8.4	3.3	11.7
Year 9	9.1	3.6	12.6
Year 10	10.2	4.0	14.1

The totals for Preservation and access in this table will automatically feed into the “Geoarchiving Project Costs” worksheet to calculate the cost of the storage infrastructure.



The information in this table is pulled from the first tab, “Geoarchiving Storage Needs Input”, and is used to create the Cumulative table above it, as well as the final totals at the top.

Input 1. Number of Copies

Here the user needs to input the total number of copies of each type (preservation, access, and access derivatives) that will be archived. This will vary depending on the agency. Once this is input, the Cumulative table below will automatically reflect the number of copies needed for each type and calculate the cumulative totals. This information is also displayed in the line graph at the right. Note: Access derivatives can include any number of formats, e.g. GeoPDF, highly compressed MrSID for web access, etc. The GIS staff should be consulted for the current formats. Preservation storage should include at least a Preservation Master and a Preservation Master Security Copy. Access storage will contain the Access Copy, which may be compressed (as in the case of orthoimagery), or not compressed (as in the case of vector datasets), and additionally, may also include one or more access derivatives such as a geospatial PDF, or a formatted version of the geospatial metadata file.

Input 2. Usable Percent of Storage

These inputs take into account the fact that most types of storage cannot be maxed out to 100% full. Depending on the type of storage to be used, the user can input the usable percent. The total needed will then be calculated to the right. These values are automatically input into the “Geoarchiving Project Costs” worksheet (section 4).

Input 3. Size (in TB) needed for Staging

This is a simple user input to account for the storage capacity needed for the “staging” area that is used during the archival data review process and archival processing preparations. This amount gets factored into the total storage needed, but not the Cumulative Data Archive Estimates table and line graph. This value will also be automatically carried over to the “Geoarchiving Project Costs” worksheet to calculate storage costs.

Note: Your storage considerations may need to take into account storage for preliminary quarantine while waiting to perform virus checking in recently submitted data sets and backlog of data sets awaiting processing and transfer to the archival and access storage repositories.

4 ESTIMATING GEOARCHIVING PROJECT COSTS

This fourth tab of the workbook, “Geoarchiving Project Costs”, will estimate comprehensive Geoarchiving Project Costs over a 10 year period. Inputs include storage costs, staff costs, software and hardware costs, replacement and migration costs, and design and development costs. This tab is described in the two sections below.

4.1 GEOARCHIVING PROJECT COSTS INPUT

This worksheet contains several inputs for estimated project costs. The information that is entered gets totaled up in the table at the bottom (described in the next section). A description of each input is provided below.

Digital Geospatial Data Preservation
Comprehensive Project Costs
green boxes indicate user input

Storage Capacity	Cost per TB	Total TB Needed	Cost
Preservation (raw)	1 \$200	27.1	\$5,416
Access (compressed)	\$1,000	10.6	\$10,613
Staging	\$1,000	2.0	\$2,000
		39.7	\$18,029
			Storage costs for 10 years

Staff Costs	Planning	Annual Operational
GIS staff costs	2 \$10,000	\$20,000
Archives staff costs	\$10,000	\$20,000
IT staff costs	\$5,000	\$10,000
Consulting Costs	\$10,000	\$5,000
Total	\$35,000	\$55,000
Annual Salary Increase	3% 3	

Software & Hardware Costs	Initial Purchase	Annual Maintenance & License
Software	4 \$10,000	\$500
Hardware	\$12,000	\$1,000
Other IT Costs	\$2,000	\$1,500
Total	\$24,000	\$3,000

Design and Development Costs	\$25,000 5
Replacement/Migration Costs	\$6,000 Every 4 years 6

Input 1. Cost per TB

The user will input the average cost per TB of storage, depending on the type of storage that is planned for. This will be input for all three types (Preservation, Access, Staging) as most likely the cost per TB will vary for each type. Based on the cost per TB, and the total TB needed (from the “Cumulative Geoarchiving Storage Needs” tab), the total cost of storage is determined. This value is included in the Costs Summary table at the bottom for year 1.

Input 2. Staff Costs

Anticipated staff salary costs need to be input both for the initial planning phase (year 0) as well as the operational years (1 – 10). Staff is broken out into four types: GIS, Archive, IT and Consulting. All four types of staff will be needed throughout the planning and operational phases of the project.

Input 3. Annual Salary Increase

To account for annual salary increase, the user can input a percentage of increase. This will be reflected in the totals table at the bottom of the spreadsheet.

Input 4. Software and Hardware Costs

Here, the user will input anticipated Software and Hardware costs. Please note that there is a separate place to input initial costs (for purchase) and then annual costs (for maintenance and licensing). In the totals table, initial costs are input into year 1, and ongoing costs are input into years 2 – 10. There is also a place for “Other IT Costs” to account for any additional IT overhead as need be. Note that there are also software costs associated with storage.

Input 5. Design and Development Costs

This input will be added to the Planning (year 0) in the costs summary table at the bottom, and is intended to capture all costs associated with design and development of a geoarchiving system. In order for the costs summary to be accurate these costs need to be accounted for within each step of the geoarchiving lifecycle. Items to consider are listed in Section 3 of the Geoarchiving Business Planning Process Map and Checklist. For example:

- ★ Design data transfer implementation
- ★ Design preservation solution
- ★ Design archival metadata scheme
- ★ Design access solution
- ★ Implement tools and software for the functions specified above

Input 6. Technology Refreshment and Modernization Costs

To account for anticipated replacement and modernization costs that may occur within the ten year span, there is a place to input these expected costs. There is also a drop down to choose whether these costs should be accounted for every 3, 4 or 5 years. Depending on the choice made in the drop down, the replacement/migration cost will be applied to the appropriate years in the cost summary table at the bottom.

4.2 GEOARCHIVING PROJECT COST SUMMARY

The table at the bottom of the spreadsheet totals up all inputs provided above for each category and each year to provide a comprehensive look at project costs. If need be, a user could overwrite the calculated totals for an item, and/or add additional rows to this table to account for other costs specific to that state. The totals from this table for each year are automatically carried into the “Geoarchiving Cost-Benefits Analysis” tab (section 5).

Cost Summary	Planning Year 0	Operation Year 1	Operation Year 2	Operation Year 3	Operation Year 4	Operation Year 5	Operation Year 6	Operation Year 7	Operation Year 8	Operation Year 9	Operation Year 10	TOTAL
Data Storage Costs		\$18,029										\$18,029
Staff Costs	\$35,000	\$55,000	\$56,650	\$58,350	\$60,100	\$61,903	\$63,760	\$65,673	\$67,643	\$69,672	\$71,763	\$665,513
Software Costs		\$10,000	\$500	\$500	\$500	\$500	\$500	\$500	\$500	\$500	\$500	\$14,500
Hardware Costs		\$12,000	\$1,000	\$1,000	\$1,000	\$1,000	\$1,000	\$1,000	\$1,000	\$1,000	\$1,000	\$21,000
Other IT Costs		\$2,000	\$1,500	\$1,500	\$1,500	\$1,500	\$1,500	\$1,500	\$1,500	\$1,500	\$1,500	\$15,500
Design and Development Costs	\$25,000											
Replacement/Migration Costs				\$0	\$6,000	\$0	\$0		\$6,000	\$0	\$0	\$12,000
TOTAL	\$60,000	\$97,029	\$59,650	\$61,350	\$69,100	\$64,903	\$66,760	\$68,673	\$76,643	\$72,672	\$74,763	\$746,543

5 COST-BENEFIT ANALYSIS

The final two tabs of the workbook, “Geoarchiving Benefits” and “Geoarchiving Cost-Benefit Analysis”, will provide the framework for performing a cost-benefit analysis over a 10 year period. Inputs include estimated financial benefits of the chosen use cases, and the project costs as determined in the “Geoarchiving Project Costs” tab. These final two tabs are described in the sections below.

5.1 GEOARCHIVING BENEFITS

This worksheet is aimed at capturing the financial benefits of a Geoarchiving program by utilizing specific use cases. Refer to “Guidance Templates for Supporting Business Documentation” (Appendix 10.4) for information on building Use Cases for Geoarchiving. Additionally, section 2 in this document contains detailed information about determining geoarchiving project benefits, as well background information about performing a cost-benefit analysis. Both of these documents should be review prior to beginning this worksheet.

Once the use cases have been determined, the user will input the use cases and their financial benefits in the form of *Cost Savings*, *Cost Avoidance*, and *Penalty Fees* for each use case, for each year. These figures are then totaled up in the summary table at the bottom, and the final totals are used in the final “Cost-Benefits Analysis” tab, which is described in the next section.

Digital Geospatial Data Preservation

Benefits Summary

green boxes indicate user input

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Total
Use Case Example: Water Quality												
Cost Savings		\$10,000	\$10,000	\$10,000	\$10,000	\$10,000	\$10,000	\$10,000	\$10,000	\$10,000	\$10,000	\$100,000
Cost Avoidance			\$50,000		\$50,000		\$50,000		\$50,000		\$50,000	\$250,000
Penalty Fees						\$40,000					\$40,000	\$80,000
	\$0	\$10,000	\$60,000	\$10,000	\$60,000	\$50,000	\$60,000	\$10,000	\$60,000	\$10,000	\$100,000	\$430,000
Use Case Example: Water Rights												
Cost Savings		\$50,000	\$50,000	\$50,000	\$50,000	\$50,000	\$50,000	\$50,000	\$50,000	\$50,000	\$50,000	\$500,000
Cost Avoidance						\$100,000					\$100,000	\$200,000
Penalty Fees											\$100,000	\$100,000
	\$0	\$50,000	\$50,000	\$50,000	\$50,000	\$150,000	\$50,000	\$50,000	\$50,000	\$50,000	\$250,000	\$800,000
Use Case Example: Climate Change												
Cost Savings		\$5,000	\$5,000	\$5,000	\$5,000	\$5,000	\$5,000	\$5,000	\$5,000	\$5,000	\$5,000	\$50,000
Cost Avoidance			\$20,000		\$20,000		\$20,000		\$20,000		\$20,000	\$100,000
Penalty Fees												\$0
	\$0	\$5,000	\$25,000	\$5,000	\$25,000	\$5,000	\$25,000	\$5,000	\$25,000	\$5,000	\$25,000	\$150,000
Use Case Example: Redistricting												
Cost Savings		\$50,000										\$50,000
Cost Avoidance												\$0
Penalty Fees												\$0
	\$0	\$50,000	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$50,000
Benefits Summary	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	TOTAL
Use Case Example: Water Quality	\$0	\$10,000	\$60,000	\$10,000	\$60,000	\$50,000	\$60,000	\$10,000	\$60,000	\$10,000	\$100,000	\$430,000
Use Case Example: Water Rights	\$0	\$50,000	\$50,000	\$50,000	\$50,000	\$150,000	\$50,000	\$50,000	\$50,000	\$50,000	\$250,000	\$800,000
Use Case Example: Climate Change	\$0	\$5,000	\$25,000	\$5,000	\$25,000	\$5,000	\$25,000	\$5,000	\$25,000	\$5,000	\$25,000	\$150,000
Use Case Example: Redistricting	\$0	\$50,000	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$50,000
Other	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
TOTAL	\$0	\$115,000	\$135,000	\$65,000	\$135,000	\$205,000	\$135,000	\$65,000	\$135,000	\$65,000	\$375,000	\$1,430,000

5.2 GEOARCHIVING COST-BENEFIT ANALYSIS

The final worksheet (“Cost-Benefit Analysis”) brings together all information collected and calculated in the previous tabs to compare project costs to project benefits over the 10 year period, and outputs the final “Net Present Value” and “Return on Investment” ratio. Section 2 contains detailed information about performing a cost-benefit analysis, and defines the terms used (e.g. Time Horizon, Discount Rate, Net Present Value, ROI, etc.) and should be reviewed prior to completing this tab.

There is only a single input on this tab for “Discount Rate”, which is used to discount future costs and benefits into the present context. The discount rate can be determined using the following table. In the context of this analysis, which is based on 10 years, the discount rate is 1.3%. Toolkit users should consult the appropriate budget staff in their organizations or the state to ensure that the calculation matches the agency norm.

3-Year	5-Year	7-Year	10-Year	20-Year	30-Year
0.0	0.4	0.8	1.3	2.1	2.3

Source: “2011 Discount Rates for OMB Circular A-94,” Executive Office of the President, 3 February 2011.

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Cost Benefit Analysis

green boxes indicate user input

Discount Rate 1.30%

Cost-Benefit

Analysis	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	TOTAL
Benefits Summary	\$0	\$115,000	\$135,000	\$65,000	\$135,000	\$205,000	\$135,000	\$65,000	\$135,000	\$65,000	\$375,000	\$1,430,000
Cost Summary	\$60,000	\$97,029	\$59,650	\$61,350	\$69,100	\$64,903	\$66,760	\$68,673	\$76,643	\$72,672	\$74,763	\$771,543
Discounted Benefits	\$0	\$113,524	\$131,557	\$62,530	\$128,202	\$192,179	\$124,933	\$59,381	\$121,747	\$57,867	\$329,562	\$1,321,482
Discounted Costs	\$60,000	\$95,784	\$58,129	\$59,018	\$65,621	\$60,844	\$61,782	\$62,736	\$69,119	\$64,697	\$65,704	\$723,433
Net Present Value	(\$60,000)	\$17,740	\$73,428	\$3,512	\$62,582	\$131,335	\$63,151	(\$3,355)	\$52,628	(\$6,830)	\$263,858	\$598,049
Return on Investment (ROI)	0.83	<i>If this result is greater than "0" it is favorable for investment</i>										