SHRP 2 Renewal Project R09

User's Guide for Microsoft Excel Workbook Template for Conducting Simplified Risk Management Planning for Rapid Renewal Projects

SHRP 2
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TRANSPORTATION RESEARCH BOARD
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Contents

1. Introduction

1.1 Purpose and Objectives

- Facilitate simplified risk management planning (in terms of proactive risk reduction, but not contingency or recovery management) for relatively simple rapid renewal projects.
- Optimize key rapid renewal project performance objectives (measures):
    - Minimize project schedule in terms of project construction completion (operations start) date;
    - Minimize project cost in terms of total inflated cost (through construction);
    - Minimize project disruption, in terms of total user impacts (through construction); and
    - Maximize project longevity in terms of combination of schedule, cost, and disruption postconstruction (i.e., considering operations and replacement).
- Optimize by minimizing combined project performance in terms of combination of project schedule (through construction), inflated project cost (through construction), project disruption (through construction), and project longevity (postconstruction).

1.2 Background and Limitations

- Refer to SHRP 2 R09, *Guide for the Process of Managing Risk on Rapid Renewal Projects* (*Guide*) and related training materials— for more discussion and examples.
- Uncertainty (or range) in project performance is not evaluated, only mean values which, by themselves, would not be sufficient to establish budgets or milestones.
- Template was developed by Golder Associates Inc. (Golder) for its own use. This is a Beta version (dated June 30, 2010) and, as such, is still under development and might contain some "bugs." Please contact Golder if bugs are discovered so that they can be fixed in future versions. Golder provides this version solely as a courtesy, but does not warrant that the results are correct and cannot warrant that either the user-specified inputs are appropriate or the results will be interpreted correctly by the user, both of which are outside of Golder's control. In using this template, users acknowledges that they do so at their own risk, and that Golder has no liability for such use.

1.3 General Guidance

- Project performance components are separated (refer to Chapter 2 in the *Guide*):
    - "Activities" (pieces of project) versus "project" (combination of all activities).
    - "Base" (without risk or contingency/float) versus "risk" (complementary to "base," which is intended to be covered by contingency/float), where "risk" includes opportunities (i.e., simply negative risks). "Total" is the combination of "base" and "risk."
    - "Unmitigated" (before additional risk reduction actions) versus "mitigated" (with additional risk reduction actions).
    - "Mean" (probability-weighted average value) versus "uncertainty/range" (likelihoods of various possible values). This template does not include assessment and determination

of full uncertainty/range, only mean values (which by themselves would not be sufficient for establishing budgets and milestones).

- Proactive risk reduction process (refer to Chapter 2 in the *Guide*):
    - Unmitigated (before additional risk reduction actions)
        - Unmitigated "base" assessment and performance analysis
        - Unmitigated "risk" identification and assessments
        - Unmitigated "total" performance analysis
    - Mitigated (with additional risk reduction actions)
        - Mitigation identification (focusing on key risks), implementation and effectiveness assessments, cost-effectiveness evaluation, and subsequent selection
        - Mitigated "total" performance analysis
- Microsoft Excel workbook template developed to document (similar to forms in the *Guide*) and automatically conduct analyses (as described in the *Guide*)
    - Load/save – load/open the template in Excel and then save under a specific project name. Periodically resave the renamed template during use.
    - Template is Microsoft Excel workbook with following linked spreadsheets:
        - Instructions
        - <1."Base" Project Info>
        - <2a.Initial Risks (Brainstorm)>
        - <2b.Risks by Category>
        - <3a.Rating Scales>
        - <3b.Unmitigated Risk Assess>
        - <4a.Unmitigated Risk Results>
        - <4b.Unmitigated Risk Ranking>
        - <4c.Unmitig. Risk Ranking Plots>
        - <5a.Risk Reduction Evaluation>
        - <5b.Risk Reduction Plan>
        - <6a.Mitigated Risk Assess>
        - <6b.Mitigated Risk Results>
        - <6c.Mitigated Risk Ranking>
        - <6d.Mitigated Risk Ranking Plots>
    - Input—required inputs (of which some are drop-down boxes) for each spreadsheet are highlighted (in yellow shading), with other cells protected from being changed. User can reformat specific rows (e.g., autoheight or hide if not unused) or columns (e.g., change width) if needed (for long descriptions and for printing). Note: Must not hide first and last rows of any section, so that hidden rows in between can be unhidden if needed.
    - Output—outputs for each spreadsheet are automatically generated. Template is protected (and most calculations are hidden) to prevent inadvertent changes that could introduce errors in outputs. Print area for each spreadsheet in the workbook is preset, so that user simply needs to "print" worksheet or entire workbook. However, user can

reformat specific rows (e.g., autoheight or hide if not used) or columns (e.g., change width) if needed (for long descriptions).

1.4 Organization

- This User's Guide (in the following chapters) describes the specific input (where needed) and associated output in each spreadsheet for the following basic components of the template (which mirror the proactive risk reduction process described above):

  2. "Base" Project Information and Performance Analysis: <1.Base Project Info>
  3. Unmitigated Risk Identification and Assessment: <2a.Initial Risks (Brainstorm)>, <2b.Risks by Category>, <3a.Rating Scales>, and <3b.Unmitigated Risk Assess>
  4. Unmitigated Risk Analysis: <4a.Unmitigated Risk Results>, <4b.Unmitigated Risk Ranking>, and <4c.Unmitig. Risk Ranking Plots>
  5. Risk Reduction Planning: <5a.Risk Reduction Evaluation> and <5b.Risk Reduction Plan>
  6. Mitigated Risk Analysis: <6a.Mitigated Risk Assess>, <6b.Mitigated Risk Results>, <6c.Mitigated Risk Ranking> and <6d.Mitigated Risk Ranking Plots>

- Instructions are also provided as a separate spreadsheet at the beginning of the workbook (see Figure 1), and these instructions are repeated in each spreadsheet in the workbook. An example of a filled-in template for a specific project is provided in the *Guide*.

Workbook Instructions Golder Associates©

Limitations: This protected MS Excel workbook was developed by Golder Associates Inc. (Golder) for its own use, as a companion to the "Guide for the Process of Managing Risks on Rapid Renewal Projects" and related training materials developed by Golder under NAS/TRB SHRP2 research project R09; these materials include a separate "User's Manual" for this template to which a user is referred. This is a Beta version (dated 30June2010), and as such is still under development and might contain some "bugs" - please contact Golder (broberds@golder.com) if bugs are discovered so that they can be fixed in future versions. Golder provides this version solely as a courtesy, but does not warrant that the results are correct and cannot warrant that either the user-specified inputs are appropriate or the results will be interpreted correctly by the user, both of which are outside of Golder's control. In using this template, a user acknowledges that they do so at their own risk, and that Golder has no liability for such use.

Proceed through worksheets in following order (see cautions about making changes in previous sheets):

<1. "Base" Project Info>	Enter significant (simplified) project cost, schedule, disruption and "value" information per template, and specify whether traditional DBB or DB project delivery - automatically generates a simple cost-loaded schedule with escalation, default extended OH rates (which can be revised), measure of longevity (NPV of O&M and replacement cost and disruption), and "combined" project performance measure (cost, schedule and disruption through construction, and post construction longevity). The risks will subsequently be defined relative to this "base", and might need to be redefined if the "base" changes. Similarly, the risk management (reduction) actions might need to be re-evaluated and the Risk Management (Reduction) Plan changed if the "base" changes.
<2a.Initial Risks (Brainstorm)>	Enter all risks and opportunities identified through brainstorming, and specify which project activity each is most likely to occur during (and very unlikely to occur after), and a more detailed description of each (as needed). At this time, only the nature of the event, and not its severity, are described - severity (expressed in terms of risk factors) will be described in <3b.Unmitigated Risk Assess>.
<2b.Risks by Category>	Risks (and their detailed descriptions) from <2a.Initial Risks> are automatically carried over and listed in appropriate "category" (i.e., the project activity during which the risk is most likely to occur, and after which it is very unlikely to occur). However, add new risks (based on provided check list) and/or edit initial risks (including the detailed description) in this sheet to ensure comprehensive and non-overlapping set. Once a risk is edited in this sheet, the tie to <2a.Initial Risks> is broken. Hence, do not go back to change risks in <2a.Initial Risks>, because they will not necessarily be carried over to this sheet. Can add/edit risks until start <5a.Risk Reduction Evaluation>, however cannot move risks after start <3b.Unmitigated Risk Assess> (because would cause assessments in <3b.Unmitigated Risk Assess> to incorrectly address wrong risk), and editing risks after starting <3b.Unmitigated Risk Assess> might require reassessment of that risk.
<3a.Rating Scales>	If using mean ratings (instead of mean values) in <3b.Unmitigated Risk Assess>, confirm or revise the default rating-scale information for each factor (not needed if using mean values)before doing any assessments in <3b.Unmitigated Risk Assess>. Changes after starting <3b.Unmitigated Risk Assess> might require reassessment of risks.
<3b.Unmitigated Risk Assess>	Risks from <2b.Risks by Category> are automatically carried over, although the detailed description is not - any edits to risk register must be made in <2b. Risks by Category>, which could affect <3b. Unmitigated Risk Assess>. Enter mean rating (per <3a.Rating Scales>)or mean value for each risk factor, assuming no additional risk management. The unmitigated mean severity is determined for each risk automatically. If the set of risks is comprehensive and non-overlapping, approximate mean values for unmitigated collective risk are also determined automatically. Can revise assessments until start <5a.Risk Reduction Evaluation>. Changes to assessments after starting <5a.Risk Reduction Evaluation>, e.g., updates, might require redoing <5a.Risk Reduction Evaluation> and <5b.Risk Reduction Plan>, because the effectiveness might change.
<4a.Unmitigated Risk Results>	The unmitigated collective risks (from <3b. Unmitigated Risk Assess>) are determined automatically and combined with the base factors (from <1.Base Project Info>) to automatically determine approximate mean values of unmitigated total project performance.
<4b.Unmitigated Risk Ranking>	The ranking of the identified risks and opportunities (based on their unmitigated mean severity from <3b.Unmitigated Risk Assess>) is automatically determined.
<4c.Unmitig. Risk Ranking Plots>	The ranking of the identified risks and opportunities (based on their unmitigated mean severity, from <4b.Unmitigated Risk Ranking>) is automatically plotted.
<5a.Risk Reduction Evaluation>	Initially (premitigated/pre-updated) ranked risks and opportunities from <4b.Unmitigated Risk Ranking> must be manually carried over (the current rankings are shown in this sheet); once entered, their properties will be automatically carried over. Enter the candidate actions for each critical risk (both immediate and contractual, first from brainstorming and then from provided check list), and enter the cost-effectiveness factors for each. The cost-effectiveness of each candidate will be automatically determined. Select the most cost-effective action for each risk, with the default being "no action". The assessments can be revised until start <5b.Risk Reduction Plan>; changes after starting <5b.Risk Reduction Plan> might change the ranking of the actions.
<5b.Risk Reduction Plan>	The selected (most cost-effective) set of actions to address the set of risks from <5a.Risk Reduction Evaluation> must be manually carried over (the currently selected actions are shown in this sheet, listed in rank order based on cost-effectiveness); once entered, their properties will be automatically carried over. Add implementation details.
<6a.Mitigated Risk Assess>	The risks and their unmitigated factors are automatically carried over from <3b.Unmitigated Risk Assess>, and combined with the assessed effectiveness of the selected risk reduction actions (from <5b.Risk Reduction Plan>), to automatically determine the mitigated mean severity for each risk. If the set of risks is comprehensive and non-overlapping, approximate mean values for mitigated collective risk are also determined automatically.
<6b.Mitigated Risk Results>	The residual collective risks for the Risk Reduction Plan (from <5b.Risk Reduction Plan>) are determined automatically and combined with the initial base factors (from <1.Base Project Info>), the unmitigated risk factors (from <3b.Unmitigated Risk Assess>), and risk management factors (from <5a.Risk Reduction Evaluation>) to automatically determine approximate mean values of mitigated total project performance.
<6c.Mitigated Risk Ranking>	The ranking of the identified risks and opportunities (based on their mitigated mean severity from <6a.Mitigated Risk Assess>) is automatically determined.
<6d.Mitigated Risk Ranking Plots>	The ranking of the identified risks and opportunities (based on their mitigated mean severity, from <6c.Mitigated Risk Ranking>) is automatically plotted.

Yellow-shaded cells are input cells; all others are protected and/or hidden to prevent inadvertent changes, which could produce misleading results

Comments: Additional information is provided in spreadsheets through embedded comments, denoted by small red triangle in upper right corner of a cell and exposed when mouse moves over that cell.

Printing: Only relevant information is printed for each spreadsheet (print area is pre-set). However, can reformat rows (or columns or even individual cells), e.g., to show wrapped text or hide unused rows. Generally, only need to print latest spreadsheet (relevant info from previous spreadsheets is generally incorporated), but can print entire workbook if desired for complete report.

Figure 1. <Instructions>.

2. "Base" Project Information and Performance Analysis: <1.Base Project Info>

- Refer to Chapter 4 in the *Guide*
- Spreadsheet <1.Base Project Info> (Figure 2)

2.1 Inputs

In spreadsheet <1.Base Project Info> (Figure 2):

- Enter <project name> and select <project delivery method, either Traditional Design/Bid/Build (D/B/B) or Design/Build (D/B), from drop-down box>. Each project delivery method subsequently references a different simplified flowchart, as shown in Figure 2, which is carried throughout the rest of the analysis. Each project is divided into the following activities (regardless of project delivery method, which only affects the sequence of these activities):
    - Planning
    - Scoping
    - Design funding
    - Preliminary design/environmental process
    - Environmental permits
    - ROW/utility/RR funding
    - ROW/utilities/RR
    - Final design
    - Construction funding
    - Procurement
    - Construction
    - Operations
    - Replacement
- Enter project base schedule factors:
    - <mean durations in months or mean milestone dates> for each activity in relevant simplified flowchart (note that funding activities are expressed as milestones, whereas the other activities are expressed as durations)
    - <lags, in months> for specific activities, depending on which flowchart is relevant
        - Traditional D-B-B, which tends to be linear/sequential
            - E – lag (remaining) after finish of ROW Fund to finish of ROW/Utilities/RR
        - Design–Build, which tends to overlap/accelerate
            - A – lag (remaining) from finish of Environmental Permits to B – lag (remaining) to finish of Procurement
            - C – lag (remaining) from finish of Environmental Permits to D – lag (remaining) to finish of ROW/Utilities/RR
            - E – lag (remaining) after finish of ROW Fund to finish of ROW/Utilities/RR
            - F – lag (overlap) from finish of ROW/Utilities/RR to start of

  - G – lag (non-overlap) after start of Final Design to start of Construction and H – lag (remaining) after finish of Final Design to finish of Construction
  - I – lag (remaining) after finish of ROW/Utilities/RR to finish of Construction
  - J – lag (remaining) from finish of ROW/Utilities/RR to K – lag (remaining) to finish of Procurement
- Enter <project base cost factors, in mean uninflated $million> for each activity in relevant simplified flowchart
- Enter <project base disruption factors, in mean million lost hours> for each activity in relevant simplified flowchart
- Enter <inflation rates, in mean average %/year from reference start date through midpoint of relevant activities in relevant simplified flowchart> for following activities (note that operations and replacement are covered separately under longevity trade-offs):
  - Engineering (including planning, scoping, preliminary design/environmental process, environmental permits, final design, and procurement)
  - ROW/Utility/RR
  - Construction
- Enter <extended OH rates, in mean average uninflated dollars per month critical path delay> or accept default values (if default value not overridden) for following phases:
  - Preconstruction (default value = average agency preconstruction "burn rate" = agency baseline preconstruction engineering cost/preconstruction duration)
  - Construction [default value = average agency construction burn rate {= agency baseline construction engineering cost/construction duration) plus compensable contractor OH (= 5% of contractor construction cost/construction duration)]
- Enter "trade-offs" to determine longevity and severity:
  - Enter <disruption value, in terms of mean average current uninflated dollars per lost-hour, to determine user costs>
  - Enter <schedule target, in terms of planned construction completion date> and <schedule value, in terms of current uninflated $million per month change in construction completion date>
  - Enter <net postconstruction discount rate, in terms of %/year, to determine net present value (NPV) of longevity at end of construction> and <longevity value, in terms of year-of-expenditure dollars (YOE$) per NPV$, to determine equivalent inflated cost of longevity> or accept default value of 1.0 (if default value not overridden).

2.2 Outputs

In spreadsheet <1.Base Project Info> (Figure 2):

- The project delivery method (and relevant project flowchart) and the associated base factor assessments (i.e., regarding cost, schedule, disruption, inflation, extended overheads and trade-offs) for the project are documented.

- The base project performance is automatically determined:
    - Project base schedule, in terms of mean early start and end dates and float (in months) for each activity in relevant simplified flowchart, and key project base mean milestone dates (i.e., for advertisement, end of construction, and replacement)
    - Project base cost, in terms of both mean uninflated and inflated millions of dollars, through construction and postconstruction
    - Project base disruption, in terms of mean million lost hours, through construction and postconstruction
    - Project base longevity (i.e., combination via specified trade-offs of mean postconstruction schedule, cost, and disruption), in terms of mean NPV millions of dollars at end of construction
    - Project base combined performance (i.e., combination via specified trade-offs of mean schedule, cost, and disruption through construction, and mean longevity), in terms of mean equivalent inflated millions of dollars.

"Base" Project Info Golder Associates®

Directions : Enter project name, project delivery method (from drop down list), verified "base" project cost/schedule/disruption information (by major project flowchart activity, as shown), and inflation rates/tradeoffs. See separate "User's Manual" for additional discussion of schedule lags.

Yellow-shaded cells are input cells

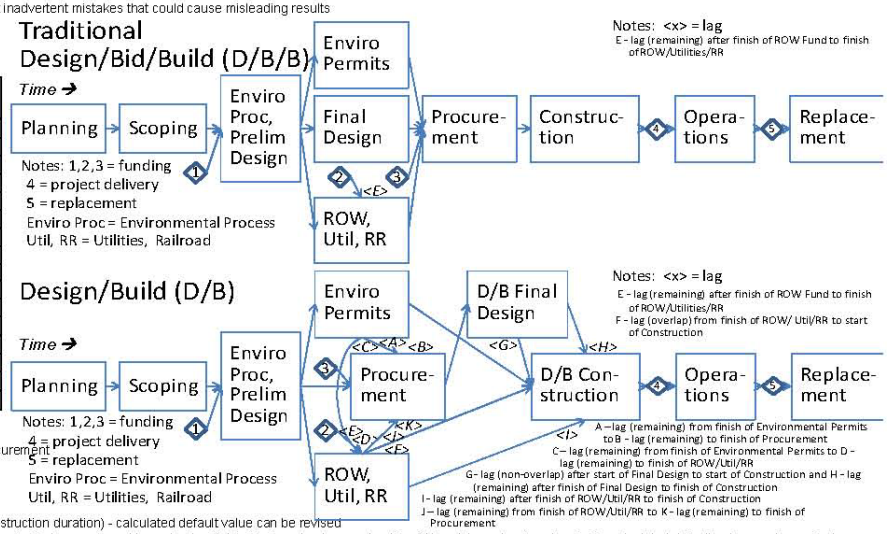
Other cells are protected/hidden and should not be modified (except by someone who has reason and understands the spreadsheet) to prevent inadvertent mistakes that could cause misleading results

<Project Name>

Proj Delivery Method: Traditional D/B/B **Project start date:** for schedule and escalation

Note: "Base" is without contingency (or schedule float)

Activity (master list)	Base Cost (unesc$M)	Base Disruption (M-hrs)	Base Duration (months)	Lag Label	Lag (mos)	Base Early Start Date	Base Early End Date	Float (months)	Base Cost (esc$M)
Planning						1/0/1900	1/0/1900	0.0	$ -
Scoping						1/0/1900	1/0/1900	0.0	$ -
Design Funding								0.0	
Prelim Design/Env Proc						1/0/1900	1/0/1900	0.0	$ -
Environmental Permits						1/0/1900	1/0/1900	0.0	$ -
ROW/Util/RR Funding				E				0.0	
ROW/Util/RR						1/0/1900	1/0/1900	0.0	$ -
Final Design						1/0/1900	1/0/1900	0.0	$ -
Construction Funding								0.0	
Procurement						1/0/1900	1/0/1900	0.0	$ -
Construction						1/0/1900	1/0/1900	0.0	$ -
subtotal	$ -	0.0							$ -
Operations						1/0/1900	1/0/1900	0.0	$ -
Replacement						1/0/1900	1/0/1900	0.0	$ -
subtotal	$ -	0.0	$ -	←longevity (NPV$M)					$ -
Total	$ -	0.0	$ -			1/0/1900	1/0/1900	1/0/1900	$ -
			†combined ($M)			†ad date	†end of CN	†replacement	



Mean Annual Cost Inflation Rate (%/yr)

Engr: incl Planning, Scoping, Prelim Design/Environmental Process, Final Design, Environ Permits & Procurement

ROW/Utility/RR:

Construction: incl Construction, Operations (& Maintenance), and Replacement

Extended OH Rates (unesc $M/month)

Preconstruction $ - Average agency pre-construction "burn rate" (= agency baseline pre-construction engr cost / preconstruction duration) - calculated default value can be revised

Construction $ - Average agency construction "burn rate" (= agency baseline construction engr cost / construction duration) plus compensable contractor OH (= % of contractor construction OH cost / construction duration) - calculated default value can be revised

Values for combining consequences

Disruption Value ($M/M-hr)		to combine disruption with cost (NPV value)
Schedule Target (date)		target date for start of operations
Schedule Value ($M/mo)		to combine schedule (difference from target date) with cost (NPV value)
Net Discount Rate (%/yr)		to determine "longevity" from O&M and replacement cost and disruption
Longevity Value ($M/$M$_{NPV}$)	1.00	to combine "longevity" with cost (NPV value) - default value can be revised

From <Instructions>:

Enter significant (simplified) project cost, schedule, disruption and "value" information per template, and specify whether traditional DBB or DB project delivery - automatically generates a simple cost-loaded schedule with escalation, default extended OH rates (which can be revised), measure of longevity (NPV of O&M and replacement cost and disruption), and "combined" project performance measure (cost, schedule and disruption through construction, and post construction longevity). The risks will subsequently be defined relative to this "base", and might need to be redefined if the "base" changes. Similarly, the risk management (reduction) actions might need to be re-evaluated and the Risk Management (Reduction) Plan changed if the "base" changes.

Figure 2. <1.Base Project Info>.

3. Unmitigated Risk Identification and Assessment: <2a.Initial Risks (Brainstorm)>, <2b.Risks by Category>, <3a.Rating Scales>, and <3b.Unmitigated Risk Assess>

- Refer to Chapters 5 and 6 in the *Guide*
- Spreadsheets <2a.Initial Risks (Brainstorm)> (Figure 3), <2b.Risks by Category> (Figure 4), <3a.Rating Scales> (Figure 5), and <3b.Unmitigated Risk Assess> (Figure 6)

3.1 Inputs

- In <2a.Initial Risks (Brainstorm)> (Figure 3), enter <descriptive title> and <description> for each risk (up to 100, identified through brainstorming, considering current plans without additional risk management) in random order, and then enter their "category" (select <flowchart activity, from drop-down box> during which they are most likely to occur and unlikely to occur after). Unused rows (except the last) can be hidden.
- In <2b.Risks by Category> (Figure 4), edit categorized risks, which have been automatically carried over from <2a.Initial Risks (Brainstorm)>, for example, by comparing with checklist in the *Guide*, to ensure comprehensive and nonoverlapping set in each category (up to maximum number per category, for example, 15 for most categories, 20 for Procurement, 25 for Construction, and 10 for Funding). Can edit <descriptive title> and/or <description>, by either simply typing over or first copying and pasting special (values); however, such editing breaks the link with <2a.Initial Risks (Brainstorm)>. Can also add risks by simply typing <descriptive title> and <description>, overriding the equations that carry them over from <2a.Initial Risks (Brainstorm)>. Similarly, can delete risks by simply deleting <descriptive title> and <description>, although unless replaced there will be a gap in the risk numbering. All changes in <descriptive title> and/or <description> must be made in this sheet; these are carried forward throughout the rest of the workbook (by item number, e.g., PL1).
- In <3b.Unmitigated Risk Assess> (Figure 6), for each risk (which have been automatically carried over from <2b.Risks by Category>), enter risk factor assessments (either <mean values> or <ratings, from drop-down box>, per predefined rating scales in <3a.Rating Scales> (Figure 5), and <affected activity, from drop-down box>) before any additional risk management:
    - Unmitigated probability of that risk event occurring
    - Unmitigated mean cost impact (and affected project activity) if that risk event occurs, in terms of uninflated millions of dollars
    - Unmitigated mean schedule impact (and affected project activity) if that risk event occurs, in terms of months of delay in affected activity (regardless of whether it is on critical path)
    - Unmitigated mean disruption impact (and affected project activity) if that risk event occurs, in terms of million lost hours
- In <3a.Rating Scales> (Figure 5), if rating scales are used in <3b.Unmitigated Risk Assess> (Figure 6), enter <value> in appropriate units for each unique range end point. For cost impact, disruption impact, and severity, default values are tied (as specified percentages) to base costs,

base disruption and base severity (actually combined performance), either from <1.Base Project Info> (Figure 2) or overridden; however, these can be overridden by simply typing in specific values (although this breaks the link to those base values). Common default values are also provided for schedule impacts and probabilities; these default values can also be overridden by simply typing in specific values.

3.2 Outputs

- In <2b.Risks by Category> (Figure 4), the risks (by category) are documented. Unused rows (except first and last in each category) can be hidden.
- In <3b.Unmitigated Risk Assess> (Figure 6):
    - The unmitigated risk factor assessments (in either mean values or ratings, per predefined rating scales in <3a.Rating Scales> (Figure 5) for each identified risk are documented
    - The unmitigated mean change in combined project performance or "severity" (mean values or ratings, per predefined rating scales in <3a.Rating Scales> (Figure 5, in terms of equivalent inflated millions of dollars) is automatically determined for each identified risk (ratings are used if any of the risk factors are expressed as ratings), and the identified risks are ranked on that basis
    - The sums (over all risks) of the mean performance measures (e.g., direct cost) are also determined automatically for each category, as well as over all categories (note that although informative, these sums would not be adequate to establish budgets/milestones/contingencies)
    - Unused rows (except first and last in each category) can be hidden.

Risks and Opportunities - Initial List of Items Golder Associates©

Directions: Through brainstorming, identify risks in any order (short title/description) in Column B, identify which major activity (from pre-selected list) each is most likely to occur during (and very unlikely to occur after) in Column C, and add more detailed description (as desired) in Column D. Can reformat rows (or columns or even individual cells), e.g., to show wrapped text or hide unused rows (bright yellow only) (e.g., for printing).

Yellow-shaded cells are input cells

Other cells are protected/hidden and should not be modified (except by someone who has reason and understands the spreadsheet) to prevent inadvertent mistakes that could cause misleading results.

<Project Name>

Item	Risk or Opportunity	Activity (from list)	Description (possible non-"base" scenarios - causes and consequences)
1			
2			
100			

From <Instructions>:

Enter all risks and opportunities identified through brainstorming, and specify which project activity each is most likely to occur during (and very unlikely to occur after), and a more detailed description of each (as needed). At this time, only the nature of the event, and not its severity, are described - severity (expressed in terms of risk factors) will be described in <3b.Unmitigated Risk Assess>.

Figure 3. <2a.Initial Risks (Brainstorm)> showing only first two and last risk items.

Risks and Opportunities - Items by Categories Golder Associates®

Note: Risks from <2a.Initial Risks> are automatically carried over and listed in the appropriate "category" (i.e., the project activity during which the risk is most likely to occur, and after which it is very unlikely to occur). Need comprehensive and non-overlapping set of risks.
Directions: Add additional risks in first "#NA" in each category if desired and edit risks carried over from <2a.Initial Risks> (over-write equations in "Risk or Opportunity" in Column B and/or "Description" in Column D; "Initial Item" in Column C will show whether this was an initial risk or a new risk). Can reformat rows (or columns or even individual cells), e.g., to show wrapped text or hide unused rows (bright yellow only) (e.g., for printing).

Yellow-shaded cells are input cells

Other cells are protected/hidden and should not be modified (except by someone who has reason and understands the spreadsheet) to prevent inadvertent mistakes that could cause misleading results.

<Project Name>

Risk Register			
Item	Risk or Opportunity (by category) (see checklist for other potential risks)	Initial Item	Description (possible non-"base" scenarios - causes and consequences)
PL	***Planning Risks***		
PL1	#N/A	#N/A	#N/A
PL15	#N/A	#N/A	#N/A
SC	***Scoping Risks***		
SC1	#N/A	#N/A	#N/A
SC15	#N/A	#N/A	#N/A
PD	***Preliminary Design / Environmental Process Risks***		
PD1	#N/A	#N/A	#N/A
PD25	#N/A	#N/A	#N/A
EP	***Environmental Permits Risks***		
EP1	#N/A	#N/A	#N/A
EP15	#N/A	#N/A	#N/A
RU	***ROW/Utility/RR/etc Risks***		
RU1	#N/A	#N/A	#N/A
RU15	#N/A	#N/A	#N/A
FD	***Final Design Risks***		
FD1	#N/A	#N/A	#N/A
FD15	#N/A	#N/A	#N/A
CP	***Procurement Risks***		
CP1	#N/A	#N/A	#N/A
CP20	#N/A	#N/A	#N/A
CN	***Construction Risks***		
CN1	#N/A	#N/A	#N/A
CN25	#N/A	#N/A	#N/A
OM	***Operations Risks***		
OM1	#N/A	#N/A	#N/A
OM15	#N/A	#N/A	#N/A
RP	***Replacement Risks***		
RP1	#N/A	#N/A	#N/A
RP15	#N/A	#N/A	#N/A
FN	***Funding Risks***		
FN1	#N/A	#N/A	#N/A
FN10	#N/A	#N/A	#N/A

From <Instructions>:

Risks (and their detailed descriptions) from <2a.Initial Risks> are automatically carried over and listed in appropriate "category" (i.e., the project activity during which the risk is most likely to occur, and after which it is very unlikely to occur). However, add new risks (based on provided check list) and/or edit initial risks (including the detailed description) in this sheet to ensure comprehensive and non-overlapping set. Once a risk is edited in this sheet, the tie to <2a.Initial Risks> is broken. Hence, do not go back to change risks in <2a.Initial Risks>, because they will not necessarily be carried over to this sheet. Can add/edit risks until start <5a.Risk Reduction Evaluation>, however cannot move risks after start <3b.Unmitigated Risk Assess> (because would cause assessments in <3b.Unmitigated Risk Assess> to incorrectly address wrong risk), and editing risks after starting <3b.Unmitigated Risk Assess> might require reassessment of that risk.

Figure 4. <2b.Risks by Category> showing only first and last risk items in each category.

Rating Scale Definitions for Risks and Opportunities (if Rating Scales are used in "3b.Unmitigated Risk Assess") Golder Associates®

Note: This table is set up for the most commonly-assessed impacts: changes in unescalated direct cost, direct schedule and direct disruption. However, other impacts (e.g., injuries) are possible. Any structural modifications to this table will have impacts on other sheets in this Workbook. Default values are already entered.
Directions: Enter values for each range and associated "base" (if range is expressed as % of base) in the table below if want to change from default values. Can reformat rows (or columns or even individual cells). e.g., to show wrapped text or hide unused rows (e.g., for printing).

Yellow-shaded cells are input cells
Other cells are protected/hidden and should not be modified (except by someone who has reason and understands the spreadsheet) to prevent inadvertent mistakes that could cause misleading results.

<Project Name>

	Impacts if Event Occurs									Probability of Event Occurring (0=impossible to 1=guaranteed)			Severity (equivalent escalated $ million)		
	Cost Change (current unescalated $ million)			Schedule Change (months)			Disruption Change (million person-hours lost)								
Rating	Ranges (absolute or base %)	Low end of range	High end of range	Ranges (absolute or base %)	Low end of range	High end of range	Ranges (absolute or base %)	Low end of range	High end of range	Ranges	Low end of range	High end of range	Ranges (absolute or base %)	Low end of range	High end of range
VH	>25%	0.0	0.0	>12	12	24	>25%	0.0	0.0	0.7 to 1.0 (1:1)	0.7	1.0	>25%	0.0	0.0
H	10 to 25%	0.0	$ -	4 to 12	4	12	10 to 25%	0.0	0.0	0.4 to 0.7 (2:3)	0.4	0.7	10 to 25%	0.0	$ -
M	3 to 10%	0.0	$ -	1 to 4	1	4	3 to 10%	0.0	0.0	0.2 to 0.4 (2:5)	0.2	0.4	3 to 10%	0.0	$ -
L	1 to 3%	0.0	$ -	0.25 to 1	0.25	1	1 to 3%	0.0	0.0	0.05 to 0.2 (1:5)	0.05	0.2	1 to 3%	0.0	$ -
VL	0 to 1%	0.0	$ -	0 to 0.25	0	0.25	0 to 1%	0.0	0.0	0.0 to 0.05 (1:20)	0.0	0.05	0 to 1%	0.0	$ -
-VL	-1 to 0%	0.0	$ -	-0.25 to 0	-0.25	0	-1 to 0%	0.0	0.0				-1 to 0%	0.0	$ -
-L	-3 to -1%	0.0	$ -	-1 to -0.25	-1	-0.25	-3 to -1%	0.0	0.0				-3 to -1%	0.0	$ -
-M	-10 to -3%	0.0	$ -	-4 to -1	-4	-1	-10 to -3%	0.0	0.0				-10 to -3%	0.0	$ -
-H	-25 to -10%	0.0	$ -	-12 to -4	-12	-4	-25 to -10%	0.0	0.0				-25 to -10%	0.0	$ -
-VH	<-25%	0.0	$ -	<-12	-24	-12	<-25%	0.0	0.0				<-25%	0.0	$ -
Base:	*0*			*0*			*0*						*0.0*		

From <Instructions>:

If using mean ratings (instead of mean values) in <3b.Unmitigated Risk Assess>, confirm or revise the default rating-scale information for each factor (not needed if using mean values) before doing any assessments in <3b.Unmitigated Risk Assess>. Changes after starting <3b.Unmitigated Risk Assess> might require reassessment of risks.

Figure 5. <3a.Rating Scales>.

Risks and Opportunities - Unmitigated Expected (Mean) Ratings or Values Golder Associates®

Note: Risks from <2b.Risks by Category> are automatically carried over. Refer to <2b.Risks by Category> for detailed descriptions of risks.

Directions: For each risk, enter either mean ratings (per the rating scales in <3a.Rating Scales>) or the mean value for each risk factor, but not both or "error" will occur (columns C/D, F/G, J/K and N/O), and specify which project activity is affected (columns I, M, and Q); must specify activity if enter impact, or "error" will occur. The resulting "severity" or mean rating or value for each risk (in terms of equivalent escalated cost), and the associated ranking based on that severity, is determined automatically (column R and S, respectively). If the set of risks are comprehensive and non-overlapping, very approximate mean values for collective cost, schedule and disruption risk are determined automatically (as subtotals and totals, in purple-shaded cells); because only mean values are used, any correlations among factors can be ignored. Edit risks and their description in <2b. Risks by Category>. However, can change risk factors in this sheet as new information becomes available - document/date change by inserting/editing comment. Can reformat rows (or columns or even individual cells), e.g., to show wrapped text or hide unused rows (bright yellow only) (e.g., for printing).

Yellow-shaded cells are input cells **Purple-shaded cells are approx project risks (subtotal of risks in category)**

Other cells are protected/hidden and should not be modified (except by someone who has reason and understands the spreadsheet) to prevent inadvertent mistakes that could cause misleading results.

<Project Name>

Unmitigated Risk Register														
		Probability of Occurrence (0 to 1, or rating per rating scale*)		Assessed Impacts (if occur)									Mean Severity (escal $M, or rating per rating scale*)	Risk Ranking (based on mean severity)
				Mean Direct Cost Change (unesc $M, or rating per rating scale*)			Mean Duration Change to Schedule Activity (months, or rating per rating scale*)			Mean Disruption Change (million person-hours lost, or rating per rating scale*)				
Item	Risk or Opportunity (see <2b.Risks by Category> for detailed description)	Value	Rating	Value	Rating	Activity Affected (from list)	Value	Rating	Activity Affected (from list)	Value	Rating	Activity Affected (from list)		
PL	***Planning Risks***			0.00			0.00			0.00			0.00	1
PL1	#N/A												0.00	#N/A
PL15	#N/A												0.00	#N/A
SC	***Scoping Risks***			0.00			0.00			0.00			0.00	1
SC1	#N/A												0.00	#N/A
SC15	#N/A												0.00	#N/A
PD	***Preliminary Design / Environmental Process Risks***			0.00			0.00			0.00			0.00	1
PD1	#N/A												0.00	#N/A
PD25	#N/A												0.00	#N/A
EP	***Environmental Permits Risks***			0.00			0.00			0.00			0.00	1
EP1	#N/A												0.00	#N/A
EP15	#N/A												0.00	#N/A
RU	***ROW/Utility/RR/etc Risks***			0.00			0.00			0.00			0.00	1
RU1	#N/A												0.00	#N/A
RU15	#N/A												0.00	#N/A
FD	***Final Design Risks***			0.00			0.00			0.00			0.00	1
FD1	#N/A												0.00	#N/A
FD15	#N/A												0.00	#N/A
CP	***Procurement Risks***			0.00			0.00			0.00			0.00	1
CP1	#N/A												0.00	#N/A
CP20	#N/A												0.00	#N/A
CN	***Construction Risks***			0.00			0.00			0.00			0.00	1
CN1	#N/A												0.00	#N/A
CN25	#N/A												0.00	#N/A
OM	***Operations Risks***			0.00			0.00			0.00			0.00	1
OM1	#N/A												0.00	#N/A
OM15	#N/A												0.00	#N/A
RP	***Replacement Risks***			0.00			0.00			0.00			0.00	1
RP1	#N/A												0.00	#N/A
RP15	#N/A												0.00	#N/A
FN	***Funding Risks***			0.00			0.00			0.00			0.00	1
FN1	#N/A												0.00	#N/A
FN10	#N/A												0.00	#N/A
	TOTAL (if comprehensive and non-overlapping set of risks)			0.00			0.00			0.00			0.00	

From <Instructions>:

Risks from <2b.Risks by Category> are automatically carried over, although the detailed description is not - any edits to risk register must be made in <2b. Risks by Category>, which could affect <3b. Unmitigated Risk Assess>. Enter mean rating (per <3a.Rating Scales>) or mean value for each risk factor, assuming no additional risk management. The unmitigated mean severity is determined for each risk automatically. If the set of risks is comprehensive and non-overlapping, approximate mean values for unmitigated collective risk are also determined automatically. Can revise assessments until start <5a.Risk Reduction Evaluation>. Changes to assessments after starting <5a.Risk Reduction Evaluation>, e.g., updates, might require redoing <5a.Risk Reduction Evaluation> and <5b.Risk Reduction Plan>, because the effectiveness might change.

Figure 6. <3b.Unmitigated Risk Assess> showing only first and last risk items in each category.

4. Unmitigated Risk Analysis: <4a.Unmitigated Risk Results>, <4b.Unmitigated Risk Ranking>, and <4c.Unmitig. Risk Ranking Plots>

- Refer to Chapters 6 and 7 in the *Guide*
- Spreadsheets <4a.Unmitigated Risk Results> (Figure 7), <4b.Unmitigated Risk Ranking> (Figure 8), and <4c.Unmitig. Risk Ranking Plots> (Figure 9)

No inputs; only the following outputs:

- In <4b.Unmitigated Risk Ranking> (Figure 8), the unmitigated identified risks are automatically presented in rank order (based on mean severity from <3b.Unmitigated Risk Assess> (Figure 6), separately for risks and for opportunities. Unused rows (except the last) can be hidden.
- In <4c.Unmitig. Risk Ranking Plots> (Figure 9), the top 20 unmitigated identified risks are automatically plotted in rank order (based on mean severity from <3b.Unmitigated Risk Assess>; see Figure 6), separately for risks and for opportunities.
- In <4a.Unmitigated Risk Results> (Figure 7), the unmitigated mean project performance is automatically determined (based on the unmitigated risk factor assessments in <3b.Unmitigated Risk Assess> (Figure 6) and on the base factor assessments in <1.Base Project Info> (Figure 2) in similar terms as for the base mean project performance (in <1.Base Project Info>; see Figure 2):
  - Project unmitigated "total" schedule, in terms of mean early start and end dates and float (in months) for each activity in relevant simplified flowchart, and key project unmitigated total mean milestone dates (i.e., for advertisement, end of construction, and replacement)
  - Project unmitigated total cost, in terms of both mean uninflated and inflated millions of dollars, through construction and postconstruction
  - Project unmitigated total disruption, in terms of mean million lost hours, through construction and postconstruction
  - Project unmitigated total longevity (i.e., combination via specified trade-offs of mean postconstruction schedule, cost, and disruption), in terms of mean NPV millions of dollars at end of construction
  - Project unmitigated total combined performance (i.e., combination via specified trade-offs of mean schedule, cost, and disruption through construction, and mean longevity), in terms of mean equivalent inflated millions of dollars

  Note: Mean total project performance is approximate, depending on whether the risk register is comprehensive and nonoverlapping, and should not be used to establish budgets/milestones/contingencies.

Expected Value of Unmitigated Project Performance Golder Associates©

Note: If the set of risks are comprehensive and non-overlapping, very approximate mean values for "unmitigated" (i.e., without additional Risk Management) collective cost, disruption and schedule risk are determined automatically (as subtotals and totals); because only mean values are used, any correlations among factors can be ignored. The mean value generally has about 50-60% chance of not being exceeded (depending on "skewness" of the distribution, e.g., a normal or Gaussian distribution has 50% chance); hence, a higher value should be budgeted to have a higher confidence of not being exceeded. However, additional Risk Management (see <6b.Mitigated Risk Results>) will generally reduce the budget required.

Directions: Can read the approximate mean values for unmitigated project performance. Can reformat rows (or columns or even indiviudal cells), e.g., to show wrapped text or hide unused rows (e.g., for printing).

Yellow-shaded cells are input cells (none on this sheet)

Other cells are protected/hidden and should not be modified (except by someone who has reason and understands the spreadsheet) to prevent inadvertent mistakes that could cause misleading results.

<Project Name>

Proj Delivery Method: Traditional D/B/B **Project start date:** 1/0/1900 for schedule and escalation

	"Base" (without contingency or schedule float)					"Risk" (additional to Base)			"Total" (Base + Risk)						
Activity (master list)	Base Cost (unesc$M)	Base Disruption (M-hrs)	Base Duration (months)	Lag label	Base Lag (mos)	Risk Cost (unesc$M)	Risk Disruption (M-hrs)	Risk Delay (months)	Total Cost (unesc$M)	Total Disruption (M-hrs)	Total Duration (months)	Total Early Start Date	Total Early End Date	Total Float (months)	Total Cost (esc$M)
Planning	$ -	0.0	0.0			0.00	0.0	0.0	0.00	0.0	0.0	1/0/1900	1/0/1900	0.0	$ -
Scoping	$ -	0.0	0.0			0.00	0.0	0.0	0.00	0.0	0.0	1/0/1900	1/0/1900	0.0	$ -
Design Funding								0.0					1/0/1900	0.0	
Prelim Design/Env Proc	$ -	0.0	0.0			0.00	0.0	0.0	0.00	0.0	0.0	1/0/1900	1/0/1900	0.0	$ -
Environmental Permits	$ -	0.0	0.0			0.00	0.0	0.0	0.00	0.0	0.0	1/0/1900	1/0/1900	0.0	$ -
ROW/Util/RR Funding				E	0.0			0.0					1/0/1900	0.0	
ROW/Util/RR	$ -	0.0	0.0			0.00	0.0	0.0	0.00	0.0	0.0	1/0/1900	1/0/1900	0.0	$ -
Final Design	$ -	0.0	0.0			0.00	0.0	0.0	0.00	0.0	0.0	1/0/1900	1/0/1900	0.0	$ -
Construction Funding								0.0					1/0/1900	0.0	
Procurement	$ -	0.0	0.0			0.00	0.0	0.0	0.00	0.0	0.0	1/0/1900	1/0/1900	0.0	$ -
Construction	$ -	0.0	0.0			0.00	0.0	0.0	0.00	0.0	0.0	1/0/1900	1/0/1900	0.0	$ -
subtotal	$ -	0.0				$ -	0.0		$ -	0.0					$ -
Operations	$ -	0.0	0.0			0.00	0.0	0.0	0.00	0.0	0.0	1/0/1900	1/0/1900	0.0	$ -
Replacement	$ -	0.0	0.0			0.00	0.0	0.0	0.00	0.0	0.0	1/0/1900	1/0/1900	0.0	$ -
subtotal	$ -	0.0	$ -	←longevity ($)		$ -	0.0	$ -	0.0	0.0	$ -	←longevity ($)			$ -
Total	$ -	0.0	$ -			0.00	0.0	$ -	0.00	0.0	$ -	1/0/1900	1/0/1900	1/0/1900	$ -
			↑combined ($M)					↑combined ($M)			↑combined (	↑ad date	↑end of CN	↑replacement	

Mean Annual Cost Inflation Rate (%/yr)

Engr	0.0%	incl Planning, Scoping, Prelim Design/Environmental Process, Final Design, Environmental Permits & Procurement
ROW/Utility/RR	0.0%	
Construction	0.0%	incl Construction, Operations (& Maintenance), and Replacement

Extended OH Rates (unesc $M/month)

Preconstruction	0.00	Average agency pre-construction "burn rate" (= agency baseline pre-construction engr cost / preconstruction duration) - calculated default value can be revised
Construction	0.00	Average agency construction "burn rate" (= agency baseline construction engr cost / construction duration) plus compensable contractor OH (= % of contractor construction OH cost / construction duration) - calculated default value can be revised

Values for combining consequences

Disruption Value ($M/M-hr)	0.00	to combine disruption with cost (NPV value)
Schedule Target (date)	1/0/1900	target date for start of operations
Schedule Value ($M/mo)	0.00	to combine schedule (difference from target date) with cost (NPV value)
Net Discount Rate (%/yr)	0.0%	to determine "longevity" from O&M and replacement cost and disruption
Longevity Value ($M/$M$_{NPV}$)	1.00	to combine "longevity" with cost (NPV value) - default value can be revised

From <Instructions>:

The unmitigated collective risks (from <3b. Unmitigated Risk Assess>) are determined automatically and combined with the base factors (from <1.Base Project Info>) to automatically determine approximate mean values of unmitigated total project performance.

Figure 7. <4a.Unmitigated Risk Results>.

Risks and Opportunities Ranked Separately by Unmitigated Mean Severity Rating or Value Golder Associates[6]

Note: Risk assessments from <3b.Unmitigated Risk Assess> are automatically carried over and ranked separately for risks and opportunities by mean severity. Refer to <2b.Risks by Category> for detailed descriptions of each risk, to <3b.Unmitigated Risk Assess> for risk factor assessments, and to <3a.Rating Scales> for definition of severity scale. Total project risk is not the sum of the individual risks because of schedule delay overlaps among multiple risks.
Directions: Read the ranked risks and opportunities (ranked based on their mean severity if considered by itself). Can reformat rows (or columns or even individual cells), e.g., to show wrapped text or hide unused rows (bright yellow only) (e.g., for printing).

Yellow-shaded cells are input cells (none on this sheet)
Other cells are protected/hidden and should not be modified (except by someone who has reason and understands the spreadsheet) to prevent inadvertent mistakes that could cause misleading results.

<Project Name>

Unmitigated Risk Ranking				
Risk Rank	Percentage of Sum of Postive Mean Severities (%)	Item	Risk Title	Mean Severity (Equiv. Inflated $M)
1	#N/A	#N/A	#N/A	#N/A
100	#N/A	#N/A	#N/A	#N/A
total	0.00%			0.00

Unmitigated Opportunity Ranking				
Oppor-tunity Rank	Percentage of Sum of Negative Mean Severities (%)	Item	Opportunity Title	Mean Severity (Equiv. Inflated $M)
1	#N/A	#N/A	#N/A	#N/A
100	#N/A	#N/A	#N/A	#N/A
total	0.00%			0.00

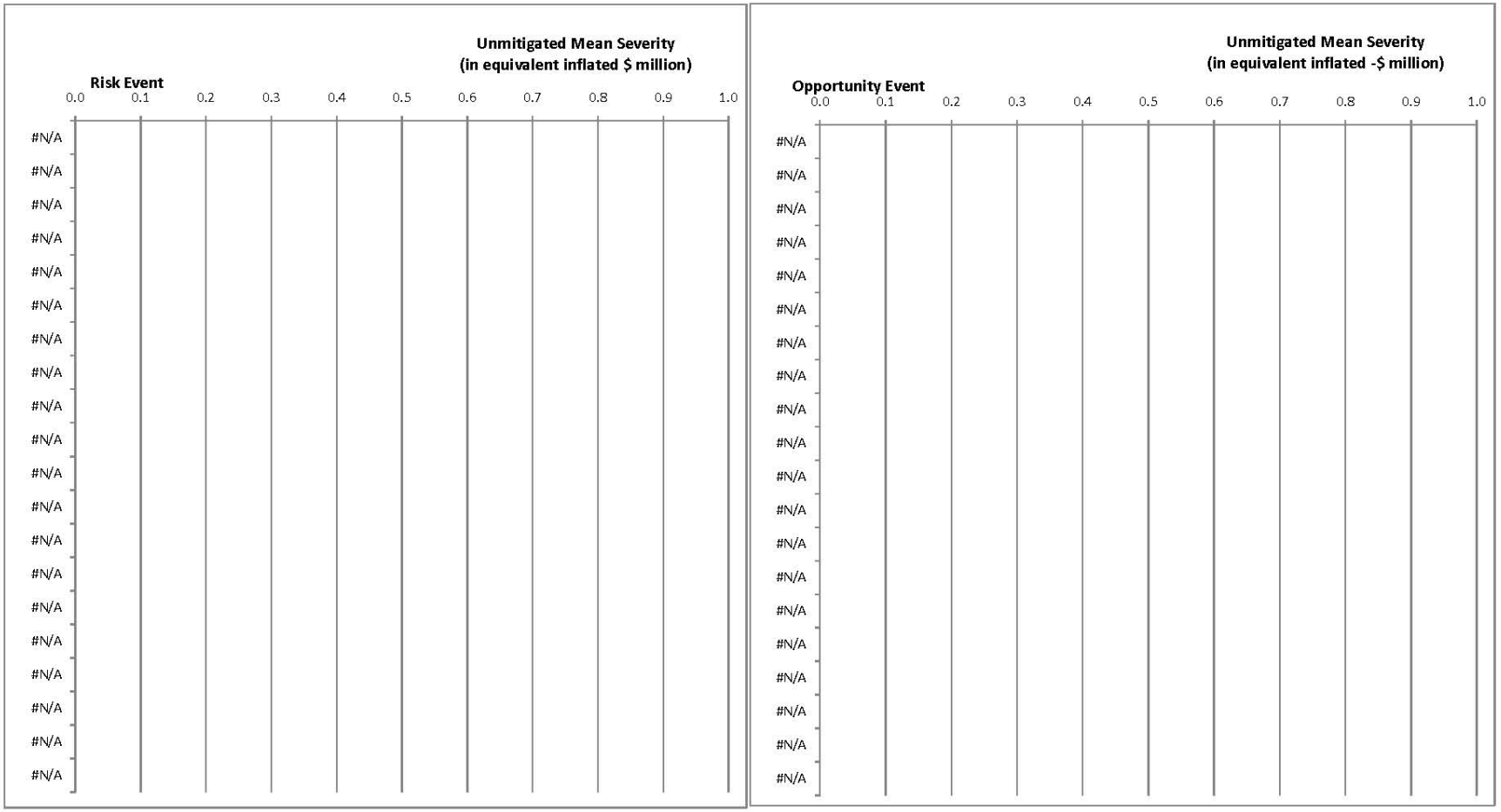
From <Instructions>:
The ranking of the identified risks and opportunities (based on their unmitigated mean severity from <3b.Unmitigated Risk Assess>) is automatically determined.

Figure 8. <4b.Unmitigated Risk Ranking> showing only first and last ranked risk items.

Bar Chart (Tornado Diagram) for Unmitigated Risk Ranking Golder Associates©

Note: Linked to <4b.Unmitigated Risk Ranking>. ***Directions:*** Can manually reformat severity scale and other elements as needed (e.g., data labels)

<Project Name>



From <Instructions>:
The ranking of the identified risks and opportunities (based on their unmitigated mean severity, from <4b.Unmitigated Risk Ranking>) is automatically plotted.

Figure 9. <4c.Unmitig. Risk Ranking Plots>.

5. Risk Reduction Planning: <5a.Risk Reduction Evaluation> and <5b.Risk Reduction Plan>

- Refer to Chapters 8 and 9 in the *Guide*
- Spreadsheets <5a.Risk Reduction Evaluation> (Figure 10) and <5b.Risk Reduction Plan> (Figure 11)

5.1 Inputs

- In <5a.Risk Reduction Evaluation> (Figure 10)
  - Enter <key risk item#>, which have been automatically carried over in rank order from <4b.Unmitigated Risk Ranking> (Figure 8).
  - Enter <potential risk reduction actions> that have been identified for each critical risk, and categorize (select <action category>, that is, avoid, mitigate, transfer, or accept, from drop-down box).
  - Enter risk reduction factor assessments for each listed risk reduction action (except for "no action"):
    - Implementation (note that if an action addresses more than one risk, allocate its implementation impacts to the affected risks)
      - <mean uninflated *cost* to implement, in terms of uninflated millions of dollars> and <affected activity>, from drop-down box
      - <mean *delay* to implement, in terms of months> and <affected activity>, from drop-down box
      - <mean *disruption* to implement, in terms of million lost hours> and <affected activity>, from drop-down box
    - Effectiveness [note that for reference, the unmitigated risk factor assessments for each critical risk have been carried over from <3b.Unmitigated Risk Assess> (Figure 6)]
      - <mean effectiveness, %, in reducing risk (or increasing opportunity, for which negative % is used) *probability* if implemented; note that +100% effectiveness reduces probability of risk to 0, whereas −100% effectiveness increases probability of opportunity to 1, and 0% effectiveness means no change>
      - <mean effectiveness, %, in reducing risk (or increasing opportunity, for which negative % is used) *cost impact* if implemented; note that +100% effectiveness reduces risk impact to 0, whereas −100% effectiveness doubles impact of opportunity, and 0% effectiveness means no change>
      - <mean effectiveness, %, in reducing risk (or increasing opportunity, for which negative % is used) *delay* if implemented; note that +100% effectiveness reduces risk impact to 0, whereas −100% effectiveness doubles impact of opportunity, and 0% effectiveness means no change>

  - <mean effectiveness, %, in reducing risk (or increasing opportunity, for which negative % is used) *disruption impact* if implemented; note: 100% effectiveness reduces risk impact to 0, whereas -100% effectiveness doubles impact of opportunity, and 0% effectiveness means no change>>
- Select (enter <1>) risk reduction actions (based on their cost-effectiveness—see output) (note that if an action that addresses more than one risk is selected, it must be selected for all affected risks)

- In <5b.Risk Reduction Plan> (Figure 11), enter <selected risk reduction action #> (based on information carried over from <5a.Risk Reduction Evaluation> (Figure 10) and then enter implementation plan logistics for that action:
  - <name of person responsible for implementing that action>
  - <schedule/milestone date for completing that action>
  - <comments regarding implementing that action>.

5.2 Outputs

- In <5a.Risk Reduction Evaluation> (Figure 10):
  - The potential risk reduction actions identified for each critical risk are documented (note that an action that affects more than one risk must be entered separately for each affected risk)
  - The risk reduction factor assessments (in mean values) for each identified potential risk reduction action for each critical risk are documented
  - The effectiveness of each identified potential risk reduction action is automatically determined, in terms of mean % effectiveness in reducing each risk (or increasing opportunity) severity
  - The cost-effectiveness of each identified potential risk reduction action is automatically determined, both in terms of mean ratio (i.e., mean change in risk severity over mean change in combined performance for implementation) and mean net (i.e., mean change in risk severity minus mean change in combined performance for implementation, in equivalent inflated millions of dollars) (note that if an action affects more than one risk, the cost-effectiveness of that action is the combination of the cost-effectiveness in addressing each risk)
  - The selection of risk reduction actions (presumably based on their cost-effectiveness) is documented, and the selected actions are automatically ranked on the basis of their cost-effectiveness (i.e., mean net) in addressing each risk separately (note that if an action that addresses more than one risk is selected, it must be selected for all affected risks)
  - Unused rows (except first and last) can be hidden.
- In <5b.Risk Reduction Plan> (Figure 11):

- The selected proactive risk reduction actions are presented (in rank order of their cost-effectiveness) and summarized (in terms of their implementation and effectiveness factor assessments and their resulting cost-effectiveness)
- The implementation plan (i.e., responsibility, schedule/milestone, and comments) for each selected risk reduction action is documented
- Unused rows (except first and last) can be hidden

Identification and Evaluation of Risk Reduction Actions — Golder Associates®

Note: Initially ranked risks from <4b.Risk Rankings> must be manually entered into column N (for convenience, the ranked risks are referenced in column L before any updating). Their unmitigated factor assessments from <3b.Risk Assess> are automatically carried over (to columns A-K) for reference. Refer to <2b.Risks by Category> for detailed descriptions of risks and <3a.Risk Scales> for definition of ratings.

Directions: For each critical risk to be mitigated, manually enter its item number (e.g., "PL1", in column N), and then select possible management options, besides default of Accept (no action), from list (in column P) and enter short title for specific action (in column Q). Enter (in columns R-W) cost, schedule and disruption impacts by activity (from list) if implemented, regardless of their effectiveness in reducing risks. Enter (in columns X-AA) their effectiveness in reducing each risk factor (probability of that risk occuring, cost impact to specific activity if that risk occurs, schedule impact to specific activity if that risk occurs, disruption impact to specific activity if that risk occurs), ranging from 0% (no change, residual factor is same as unmitigated) to 100% (complete mitigation, residual factor is 0). The overall effectiveness in reducing each risk severity (in column AB) is autmaticvally determined as % reduction, and the cost-effectiveness of each action in addressing each risk (in columns AC,AD) is automatically determined in two ways, ratio and net. Select the most cost-effective action for each risk (in column AE); the selected actions are then ranked (in column AF) based on their net cost-effectiveness and the top 20 are carried over to <5b.Risk Management Plan>. {Note: An action that affects more than one risk must be listed/evaluated separately for each of those risks, and its cost-effectivenss determined off-line as the combination of cost-effectiveness for each risk. If such an action is selected, it must be selected for each affected risk.} Can reformat rows (or columns or even individual cells), e.g., to show wrapped text or hide unused rows (bright yellow only) (e.g., for printing).

Yellow-shaded cells are input cells

Other cells are protected/hidden and should not be modified (except by someone who has reason and understands the spreadsheet) to prevent inadvertent mistakes that could cause misleading results.

<Project Name>

Possible Risk Reduction Actions for Each Critical Risk

Current Risk Rank	Risk Item	Mng Item	Manage. Options (from list)	Management Action (see checklist for other possibilities)	Implementation: Cost: Mean (uninfl $M)	Cost: Affected Activity	Schedule: Mean Delay (months)	Schedule: Affected Activity	Disruption: Mean Disruption (M-hrs)	Disruption: Affected Activity	Effectiveness (100% effective to 0% or no effect): Probability (100% eff→0, -100% eff→1)	Impacts if Occurs: Cost	Schedule	Disruption	Residual severity	Cost-effectiveness: Δseverity/ "cost"	Δseverity -"cost"	Selected (1=yes)?	Ranking of selected actions
#N/A		1	Accept	none	0		0		0		0%	0%	0%	0%	#N/A	no cost	#N/A		NA
		2													#N/A	no cost	#N/A		NA
		3													#N/A	no cost	#N/A		NA
#N/A		58	Accept	none	0		0		0		0%	0%	0%	0%	#N/A	no cost	#N/A		NA
		59													#N/A	no cost	#N/A		NA
		60													#N/A	no cost	#N/A		NA

From <Instructions>:

Initially (premitigated/pre-updated) ranked risks and opportunities from <4b.Unmitigated Risk Ranking> must be manually carried over (the current rankings are shown in this sheet); once entered, their properties will be automatically carried over. Enter the candidate actions for each critical risk (both immediate and contractual, first from brainstorming and then from provided check list), and enter the cost-effectiveness factors for each. The cost-effectiveness of each candidate will be automatically determined. Select the most cost-effective action for each risk, with the default being "no action". The assessments can be revised until start <5b.Risk Reduction Plan>; changes after starting <5b.Risk Reduction Plan> might change the ranking of the actions.

Figure 10. <5a.Risk Reduction Evaluation> showing only first and last risk items.

Selected Risk Reduction Actions and Plans — Golder Associates®

Note: Selected Risk Management Actions from <5a.Risk Management Alternatives> must be manually entered in column E; for convenience, the top 20 items are automatically carried over (column B) and ranked in terms of their cost-effectiveness. If a slected action affects multilpe risks, each affected risk is treated as a spearate action, which must be entered (even though it might not be in top 20 items). Automatically refers to <5a.Risk Management Alternatives> for cost-effectiveness factors for each action, and to <3b.Risk Assess> for specific pre-mitigated risk factor assessments. Refer to <2b.Risks by Category> for detailed descriptions of each risk and to <3.1a. Risk Scales> for definitions of ratings.

Directions: Enter the selected management action # as shown in <5a.Risk Management Alternatives> in column E. Then enter the detailed plans for selected Risk Management Actions (columns Y-AA). The revised base cost, disruption and schedule (considering program implementation) and the residual cost, disruption and schedule risk (considering program effectiveness) are automatically determined in <6b. Managed Risk Results>. Can reformat rows (or columns or even indiovidual cells), e.g., to showwrapped text or hide unused rows (bright yellow only) (e.g., for printing).

Yellow shaded cells are input cells

Other cells are protected/hidden and should not be modified (except by someone who has reason and understands the spreadsheet) to prevent inadvertent mistakes that could cause misleading results.

<Project Name>

Rank	Mgt Item	Management Action (see <5a.Risk Reduction Evaluation> for detailed description of action)	Risk Addr	Pre-Mitigation Risk Factors: Probability (0.0 to 1.0)	Cost Impact (unexc $M)	Cost Affected Activity	Schedule Impact (mos)	Schedule Affected Activity	Disruption Impact (M-hr)	Disruption Affected Activity	Risk Reduction Implementation: Cost Impact (unexc $ M)	Cost Affected Activity	Schedule Impact (mos)	Schedule Affected Activity	Disruption Impact (M-hr)	Disruption Affected Activity	Risk Reduct. Effectiveness (+/-100% to 0%): Probability (-100% -0, -100% -1)	Cost Impact	Schedule Impact	Disruption Impact	Responsibility	Schedule or Milestone Check	Comments

From <Instructions>:

The selected (post cost-effective) set of actions to address the set of risks from <5a.Risk Reduction Evaluation> must be manually carried over (the currently selected actions are shown in this sheet, listed in rank order based on cost-effectiveness); once entered, their properties will be automatically carried over. Add implementation details.

Figure 11. <5b.Risk Reduction Plan> showing only first and last selected risk reduction actions.

6. Mitigated Risk Analysis: <6a.Mitigated Risk Assess>, <6b.Mitigated Risk Results>, <6c.Mitigated Risk Ranking> and <6d.Mitigated Risk Ranking Plots>

- Refer to Chapters 6, 7, and 8 in the *Guide*
- Spreadsheets <6a.Mitigated Risk Assess> (Figure 12, <6b.Mitigated Risk Results> (Figure 13), <6c.Mitigated Risk Ranking> (Figure 14) and <6d.Mitigated Risk Ranking Plots> (Figure 15)

No inputs; only following outputs:

- In <6a.Mitigated Risk Assess> (Figure 12), in the same way as in <3b.Unmitigated Risk Assess> (Figure 6):
    - The mitigated risk factor assessments (either in mean values or ratings, per predefined rating scales in <3a.Rating Scales> (Figure 5) are summarized
    - The mitigated mean severity (mean values or ratings, per predefined rating scales in <3a.Rating Scales> (Figure 5), in terms of equivalent inflated millions of dollars) is automatically determined for each risk (ratings are used if any of the risk factors are expressed as ratings), and the risks are ranked on that basis
    - Unused rows (except first and last in each category) can be hidden.
- In <6c.Mitigated Risk Ranking> (Figure 14), in the same way as in <4b.Unmitigated Risk Ranking> (Figure 8), the mitigated risks are automatically presented in rank order (based on mean severity from <6a.Mitigated Risk Assess> (Figure 12), separately for risks and for opportunities; unused rows (except the last) can be hidden
- In <6d.Mitigated Risk Ranking Plots> (Figure 15), in the same way as in <4c.Unmitig. Risk Ranking Plots> (Figure 9), the top 20 mitigated risks are automatically plotted in rank order (based on mean severity from <6a.Mitigated Risk Assess> (Figure 12), separately for risks and for opportunities
- In <6b.Mitigated Risk Results> (Figure 13), the mitigated mean project performance is automatically determined [based on the mitigated risk factor assessments in <6a.Mitigated Risk Assess> - (Figure 12) and on the base factor assessments in <1.Base Project Info>- (Figure 2)] in similar terms as for the base mean project performance [in <1.Base Project Info> - (Figure 2)] and the unmitigated mean project performance [in 4a.Unmitigated Risk Results> (Figure 7)]:
    - Project mitigated total schedule, in terms of mean early start and end dates and float (in months) for each activity in relevant simplified flowchart, and mean key project mitigated total" milestone dates (i.e., for advertisement, end of construction, and replacement)
    - Project mitigated total cost, in terms of both mean uninflated and inflated millions of dollars, through construction and postconstruction
    - Project mitigated total" disruption, in terms of mean million lost hours, through construction and postconstruction

- Project mitigated total longevity (i.e., combination via specified trade-offs of mean postconstruction schedule, cost, and disruption), in terms of mean NPV millions of dollars at end of construction
- Project mitigated total combined performance (i.e., combination via specified trade-offs of mean schedule, cost, and disruption through construction, and mean longevity), in terms of mean equivalent inflated millions of dollars

Note: Same as for <4a. Unmitigated Risk Results>, mean total project performance is approximate, depending on whether the risk register is comprehensive and nonoverlapping, and should not be used to establish budgets/milestones/contingencies.

Risks and Opportunities - Mitigated Expected (Mean) Ratings or Values Golder Associates®

Note: Risks and unmitigated risk factors from <3b.Risk Assess> and risk reduction effectiveness from <5b. Risk Management Plan> are automatically carried over. Refer to <2b.Risks by Category> for detailed descriptions of risks, and to <3a.Rating Scales> for definition of ratings (e.g., H, M, L). The resulting "severity" or mean rating or value for each risk (in terms of equivalent escalated cost), and the associated ranking based on that severity, is determined automatically (column J and K, respectively). If the set of risks are comprehensive and non-overlapping, very approximate mean values for collective cost, schedule and disruption risk are determined automatically (as subtotals and totals, in purple-shaded cells); because only mean values are used, any correlations among factors can be ignored. Risk severity (for prioritization) is relative to base project performance (from <1.Base Project Info>), which currently does not consider changes in base due to implementation (which is generally secondary).
Directions: Can read the mitigated risk factors, and the mitigated risk severity and ranking (in column J and K) for each risk. Can reformat rows (or columns or even individual cells), e.g., to show wrapped text or hide unused rows (bright yellow only) (e.g., for printing).

Yellow-shaded cells are input cells (none on this sheet) **Purple-shaded cells are approx project risks (subtotal of risks in category)**

Other cells are protected/hidden and should not be modified (except by someone who has reason and understands the spreadsheet) to prevent inadvertent mistakes that could cause misleading results.

<Project Name>

Mitigated Risk Register										
			Assessed Mitigated Impacts (if occur)							
		Mitigated Probability of Occurrence (0 to 1, or rating per rating scale*) Assessment	Mean Direct Cost Change (unesc $M, or rating per rating scale*)		Mean Duration Change to Schedule Activity (months, or rating per rating scale*)		Mean Disruption Change (million person-hours lost, or rating per rating scale*)		Mitigated Mean Severity (escal $M, or rating per rating scale*)	Mitigated Risk Ranking (based on mit. mean severity)
Item	Risk or Opportunity		Assess-ment	Activity Affected (from list)	Assess-ment	Activity Affected (from list)	Assess-ment	Activity Affected (from list)		
PL	***Planning Risks***		0.00		0.00		0.00		0.00	1
PL1	#N/A			0		0		0	0.00	#N/A
PL15	#N/A			0		0		0	0.00	#N/A
SC	***Scoping Risks***		0.00		0.00		0.00		0.00	1
SC1	#N/A			0		0		0	0.00	#N/A
SC15	#N/A			0		0		0	0.00	#N/A
PD	***Preliminary Design / Environmental Process Risks***		0.00		0.00		0.00		0.00	1
PD1	#N/A			0		0		0	0.00	#N/A
PD25	#N/A			0		0		0	0.00	#N/A
EP	***Environmental Permits Risks***		0.00		0.00		0.00		0.00	1
EP1	#N/A			0		0		0	0.00	#N/A
EP15	#N/A			0		0		0	0.00	#N/A
RU	***ROW/Utility/RR/etc Risks***		0.00		0.00		0.00		0.00	1
RU1	#N/A			0		0		0	0.00	#N/A
RU15	#N/A			0		0		0	0.00	#N/A
FD	***Final Design Risks***		0.00		0.00		0.00		0.00	1
FD1	#N/A			0		0		0	0.00	#N/A
FD15	#N/A			0		0		0	0.00	#N/A
CP	***Procurement Risks***		0.00		0.00		0.00		0.00	1
CP1	#N/A			0		0		0	0.00	#N/A
CP20	#N/A			0		0		0	0.00	#N/A
CN	***Construction Risks***		0.00		0.00		0.00		0.00	1
CN1	#N/A			0		0		0	0.00	#N/A
CN25	#N/A			0		0		0	0.00	#N/A
OM	***Operations Risks***		0.00		0.00		0.00		0.00	1
OM1	#N/A			0		0		0	0.00	#N/A
OM15	#N/A			0		0		0	0.00	#N/A
RP	***Replacement Risks***		0.00		0.00		0.00		0.00	1
RP1	#N/A			0		0		0	0.00	#N/A
RP15	#N/A			0		0		0	0.00	#N/A
FN	***Funding Risks***		0.00		0.00		0.00		0.00	1
FN1	#N/A			0		0		0	0.00	#N/A
FN10	#N/A			0		0		0	0.00	#N/A
	TOTAL (if comprehensive and non-overlapping set of risks)		0.00		0.00		0.00		0.00	

From <Instructions>:

The risks and their unmitigated factors are automatically carried over from <3b.Unmitigated Risk Assess>, and combined with the assessed effectiveness of the selected risk reduction actions (from <5b.Risk Reduction Plan>), to automatically determine the mitigated mean severity for each risk. If the set of risks is comprehensive and non-overlapping, approximate mean values for mitigated collective risk are also determined automatically.

Figure 12. <6a.Mitigated Risk Assess> showing only first and last risk items in each category.

Expected Value of Mitigated Project Performance

Golder Associates®

Note: If the set of risks are comprehensive and non-overlapping, very approximate mean values for "mitigated" (i.e., with selected additional Risk Management) collective cost, disruption and schedule risk are determined automatically (as subtotals and totals); because only mean values are used, any correlations among factors can be ignored. The mean value generally has about 50-60% chance of not being exceeded (depending on "skewness" of the distribution, e.g., a normal or Gaussian distribution has 50% chance); hence, a higher value should be budgeted to have a higher confidence of not being exceeded.

Directions: Can read the approximate mean values for mitigated project performance. Can reformat rows (or columns or even individual cells), e.g., to show wrapped text or hide unused rows (e.g., for printing).

Yellow-shaded cells are input cells (none on this sheet)

Other cells are protected/hidden and should not be modified (except by someone who has reason and understands the spreadsheet) to prevent inadvertent mistakes that could cause misleading results.

<Project Name>

Proj Delivery Method: Traditional D/B/B **Project start date:** 1/0/1900 for schedule and escalation

	"Base+Impl" (wo contingency or schedule float)					"Residual Risk" (additional to Base)			"Mitigated Total" (Base+Impl + Residual Risk)						
Activity (master list)	Base+Impl Cost (unesc$M)	Base+Impl Disruption (M-hrs)	Base+Impl Duration (months)	Lag Label	Base Lag (mos)	Risk Cost (unesc$M)	Risk Disruption (M-hrs)	Risk Delay (months)	Total Cost (unesc$M)	Total Disruption (M-hrs)	Total Duration (months)	Total Early Start Date	Total Early End Date	Total Float (months)	Total Cost (esc$M)
Planning	$ -	0.0	0.0			0.00	0.0	0.0	0.00	0.0	0.0	1/0/1900	1/0/1900	0.0	$ -
Scoping	$ -	0.0	0.0			0.00	0.0	0.0	0.00	0.0	0.0	1/0/1900	1/0/1900	0.0	$ -
Design Funding			0.0					0.0					1/0/1900	0.0	
Prelim Design/Env Proc	$ -	0.0	0.0			0.00	0.0	0.0	0.00	0.0	0.0	1/0/1900	1/0/1900	0.0	$ -
Environmental Permits	$ -	0.0	0.0			0.00	0.0	0.0	0.00	0.0	0.0	1/0/1900	1/0/1900	0.0	$ -
ROW/Util/RR Funding			0.0	E	0.0			0.0					1/0/1900	0.0	
ROW/Util/RR	$ -	0.0	0.0			0.00	0.0	0.0	0.00	0.0	0.0	1/0/1900	1/0/1900	0.0	$ -
Final Design	$ -	0.0	0.0			0.00	0.0	0.0	0.00	0.0	0.0	1/0/1900	1/0/1900	0.0	$ -
Construction Funding			0.0					0.0					1/0/1900	0.0	
Procurement	$ -	0.0	0.0			0.00	0.0	0.0	0.00	0.0	0.0	1/0/1900	1/0/1900	0.0	$ -
Construction	$ -	0.0	0.0			0.00	0.0	0.0	0.00	0.0	0.0	1/0/1900	1/0/1900	0.0	$ -
subtotal	**$ -**	**0.0**				**$ -**	**0.0**		**$ -**	**0.0**					**$ -**
Operations	$ -	0.0	0.0			0.00	0.0	0.0	0.00	0.0	0.0	1/0/1900	1/0/1900	0.0	$ -
Replacement	$ -	0.0	0.0			0.00	0.0	0.0	0.00	0.0	0.0	1/0/1900	1/0/1900	0.0	$ -
subtotal	**$ -**	**0.0**	**$ -**	**←longevity ($)**		**$ -**	**0.0**	**$ -**	**0.0**	**0.0**	**$ -**	**←longevity ($)**			**$ -**
Total	**$ -**	**0.0**	**$ -**			**0.00**	**0.0**	**$ -**	**0.00**	**0.0**	**$ -**	**1/0/1900**	**1/0/1900**	**1/0/1900**	**$ -**
			↑combined ($M)					↑combined ($M)			↑combined (	↑ad date	↑end of CN	↑replacement	

Mean Annual Cost Inflation Rate (%/yr)

Engr	0.0%	incl Planning, Scoping, Prelim Design/Environmental Process, Final Design, Environmental Permits & Procurement
ROW/Utility/RR	0.0%	
Construction	0.0%	incl Construction, Operations (& Maintenance), and Replacement

Extended OH Rates (unesc $M/month)

Preconstruction	0.00	Average agency pre-construction "burn rate" (= agency baseline pre-construction engr cost / preconstruction duration) - calculated default value can be revised
Construction	0.00	Average agency construction "burn rate" (= agency baseline construction engr cost / construction duration) plus compensable contractor OH (= % of contractor construction OH cost / construction duration) - calculated default value can be revised

Values for combining consequences

Disruption Value ($M/M-hr)	0.00	to combine disruption with cost (NPV value)
Schedule Target (date)	1/0/1900	target date for start of operations
Schedule Value ($M/mo)	0.00	to combine schedule (difference from target date) with cost (NPV value)
Net Discount Rate (%/yr)	0.0%	to determine "longevity" from O&M and replacement cost and disruption
Longevity Value ($M/$M$_{NPV}$)	1.00	to combine "longevity" with cost (NPV value) - default value can be revised

From <Instructions>:

The residual collective risks for the Risk Reduction Plan (from <5b.Risk Reduction Plan>) are determined automatically and combined with the initial base factors (from <1.Base Project Info>), the unmitigated risk factors (from <3b.Unmitigated Risk Assess>), and risk management factors (from <5a.Risk Reduction Evaluation>) to automatically determine approximate mean values of mitigated total project performance.

Figure 13. <6b.Mitigated Risk Results>.

Risks and Opportunities Ranked Separately by Mitigated Mean Severity Rating or Value

Note **:** Mitigated risk assessments from <6a.Mitigated Risk Assess> are automatically carried over and ranked separately for risks and opportunities by mean severity. Refer to <2b.Risks by Category> for detailed descripti
<6a.Mitigated Risk Assess> for unmitigated risk factor assessments and risk management factor assessments, and to <3a.Rating Scales> for definition of severity scale. Total project risk is not the sum of individual risks, b
schedule delays overlap among multiple risks.

Directions: Read the ranked risks and opportunities (ranked based on their mean severity if considered by itself). Can reformat rows (or columns or even individual cells), e.g., to show wrapped text or hide unused rows b(i
only) (e.g., for printing).

Yellow-shaded cells are input cells (none on this sheet)

Other cells are protected/hidden and should not be modified (except by someone who has reason and understands the spreadsheet) to prevent inadvertent mistakes that could cause misleading results.

<Project Name>

Mitigated Risk Ranking				
Risk Rank	Percentage of Total Mean Risk (%)	Item	Risk Title	Mean Severity (Equiv. Inflated $M)
1	#N/A	#N/A	#N/A	#N/A
100	#N/A	#N/A	#N/A	#N/A
total	0.00%			0.00

Mitigated Opportunity Ranking			
Oppor-tunity Rank	Percentage of Total Mean Opportunity (%)	Item	Opportunity Title
1	#N/A	#N/A	#N/A
100	#N/A	#N/A	#N/A
total	0.00%		

From <Instructions>:

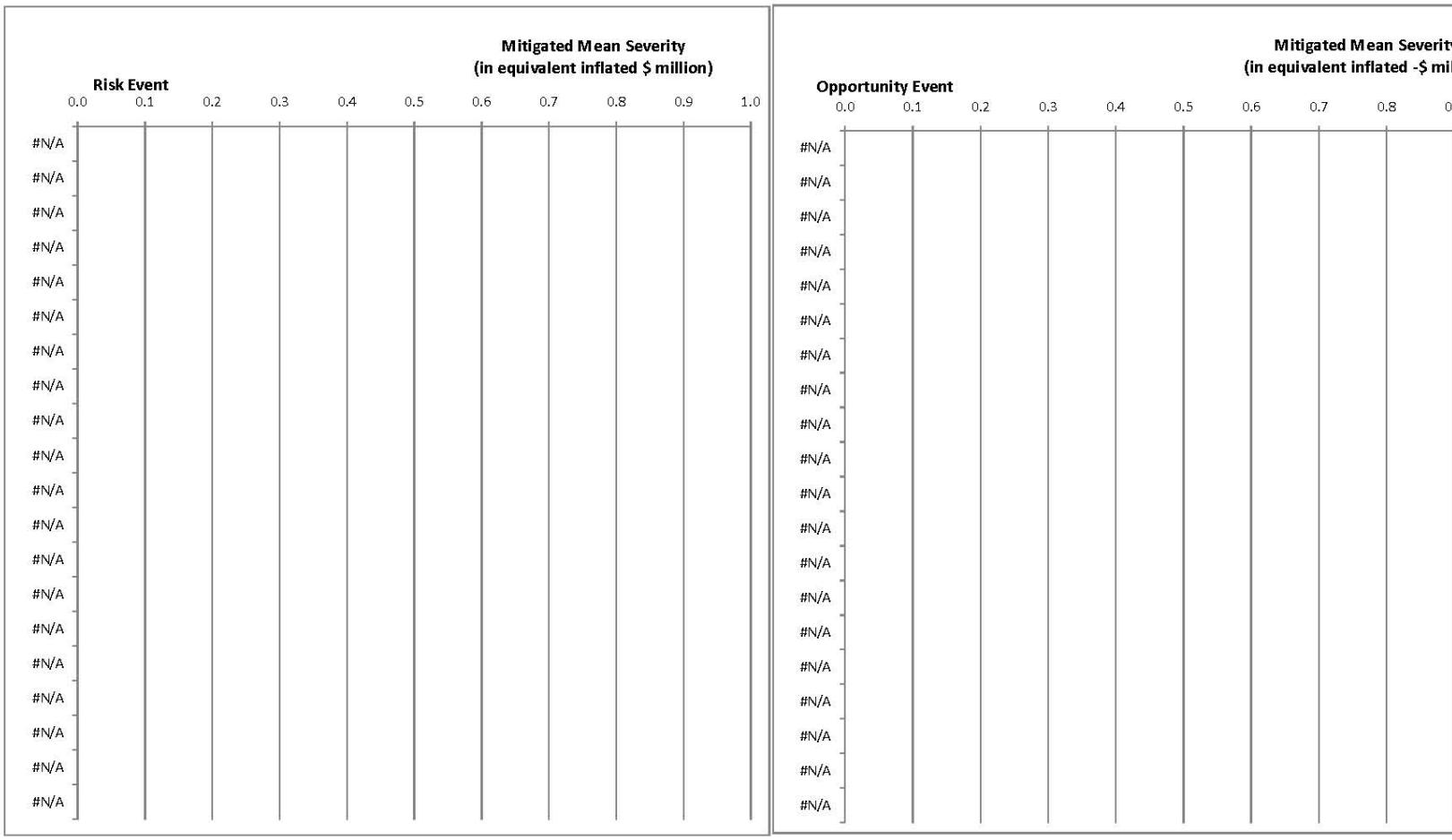
The ranking of the identified risks and opportunities (based on their mitigated mean severity from <6a.Mitigated Risk Assess>) is automatically determined.

Figure 14. <6c.Mitigated Risk Ranking> showing only first and last ranked risk items.

Bar Chart (Tornado Diagram) for Mitigated Risk Ranking Golder Assoc

Notes: Linked to <6c.Mitigated Risk Ranking>. ***Directions:*** Can manually reformat severity scale and other elements as needed (e.g., data labels), e.g., similar to <4c.Unmitigated Risk Ranking Plots>.

<Project Name>



From <Instructions>:
The ranking of the identified risks and opportunities (based on their mitigated mean severity, from <6c.Mitigated Risk Ranking>) is automatically plotted.

Figure 15. <6d.Mitigated Risk Ranking Plots>.