Exhibit MSD 63D

Brown AND Caldwell

4700 Lakehurst Court
Suite 100
Columbus, OH 43016

Technical Memorandum

Prepared for: St. Louis MSD

Project Title: Plant Asset Management Services

Project No.: 147884

Technical Memorandum

Subject: Risk Quantification Tool Rulebook

Date: September 11, 2018

To: Chris Pfeuffer

From: Matthew Gregg, Brown and Caldwell
Lorena Croucher, Brown and Caldwell

Prepared by: Lorena Croucher, EIT
Matthew Gregg, P.E.*
*Licensed in the state of Idaho

Reviewed by: Jeff Theerman, P.E.

Section 1: Introduction

The Metropolitan St. Louis Sewer District (MSD) is in the process of implementing an asset management program. This program is intended to enhance the effective and efficient management of MSD resources to minimize overall risk to the utility. As such, a key component of the program implementation is understanding the risks posed by the existing assets. This allows MSD to systematically align project investments with risk reductions.

MSD elected to develop a risk quantification tool to support the overall asset management program. This tool is meant to provide a consistent methodology for assessing risks across various types of projects. The tool was built from utility-specific data and setup to match the intended uses within MSD. The tool was developed through a series of workshops with the Engineering Steering Committee (ESC). These workshops were focused on identifying the risks typically experienced by the utility, developing utility-specific approaches to quantifying these risks, and validating these quantifications through the application of the risks to potential projects.

The ESC envisioned that the use of the tool will be included in the CIRP Prioritization and Scheduling business process workflow described in Table 7-1 of the SAMP. In general, Operations staff will define a project need as part of the Business Case Evaluation (BCE) process. The BCE form will detail the reasons for the project and the risks and benefits which will be provided. When approved by the Director of Operations, the project will be evaluated using the monetized prioritization process. In general, the intent is for all projects to be evaluated with this tool to determine which will move forward for preliminary engineering to develop detailed project scope and cost or budget supplement. Prior to inclusion in the actual CIRP, projects will be re-evaluated using the tool with updated cost and scope. The BCE tool does not provide an absolute ranking for the prioritization of projects; rather, it provides a relative score compared to the other projects being considered.

This technical memorandum (TM) serves both as a documentation of the tool development process as well as a working guide for effectively and consistently using said tool. This guidance is intended to be a living document and updated as MSD implements the tool into the prioritization process and additional insights are gained. Maintenance of the tool and the reference information on a periodic basis (potentially annually) is the responsibility of the Engineering Department Program Planning Division.

Section 2: Risk Quantification Approach

Risks quantifications allow planners, operators, engineers, and management staff to objectively evaluate the consequences associated with a specific event. Risks are quantified as the product of the consequence of an event occurring and the probability that this event occurs. For example, if there is a 50-percent probability of a pump failing and that pump failure would cause $100,000 in costs for MSD, the risk of this pump failing is $50,000. While this is a simple example, being able to consistently express risk across varying types of assets and failure events is a powerful tool for a utility.

The risk tool is configured to represent a risk cost at a snapshot in time; therefore, it is important for the user to consider timing when applying a failure probability. It takes MSD about approximately 3 to 5 years to initiate and complete a project. To be conservative with this planning outlook, it is recommended that MSD consistently consider the assets probability of failure in 5 years. This tool will predominately be used to evaluate asset replacement type projects, and as such, assets at the end of their useful life can be represented with a linear failure curve.

For the purposes of MSD's risk quantification tool, risk quantifications are built from three primary factors. First, monetizing bases were established for common costs associated with risks (e.g., hourly costs for employee time, permit violations, loss of capacity, etc.). These bases were then used to build 'risk blocks', which are the accumulation of these individual risk costs to represent common events experienced by MSD. Finally, these 'risk blocks' were scaled based on the utility's understanding of the severity of the risk posed by the asset or project being considered. The development of each of these components of the risk quantifications are described in the following sections.

2.1 Monetizing Bases

A series of unit costs specific to MSD were developed through a collaboration of utility input and consultant recommendations. These unit costs are the basis of all subsequent risk blocks, discussed further in section 2.2. The unit costs are intended to provide a consistent method for quantifying risk across multiple projects. As such, unit costs should not be adjusted on a project-by-project basis; rather, updates should be made on a programmatic basis (i.e., assessed and updated at a set time interval such as annually or quarterly). Updating on a project-by-project basis opens up the need to potentially revisit previous decisions; therefore, it should be avoided to the greatest extent possible. All emails referenced herein are provided for reference in Attachment A.

The monetizing bases presented in Table 1 are meant to capture the current costs for each metric. It is expected that these costs will change over time as a result of economic factors, changes in operation, and other drivers. Therefore, it is recommended that these bases be revisited periodically by the Engineering Program Planning to verify they are still accurate representations of costs. During the initial use of this tool, it is appropriate to review these costs annually. This programmatic cost update should not trigger the review of projects in delivery or previously approved for consent decree compliance, as previous prioritization decisions would have been made using the best available information at the time.

Table 1. Monetizing Basis Support Summary

Metric	Unit Cost	Unit
Labor Rates:		
Loaded labor rates for internal groups		
Labor cost, admin	$35.99	/hr
Labor cost, trade	$43.92	/hr
Labor cost, professional	$53.03	/hr
Labor cost, management	$81.72	/hr
Labor rates for external groups		
labor cost, consultant	$150.00	/hr
labor cost, contractor	$75.00	/hr
Lost time, public	$28.73	/hr
Lost time, businesses	$2,284	/hr
Violations and Fees:		
Cost of statutory fines for permit violations	$50,000	/day

Table 1. Monetizing Basis Support Summary		
Metric	**Unit Cost**	**Unit**
Emergency contract costs	$50,000	$, placeholder
Cost of consent decree stipulated penalty amounts	$4,000	/day
Cost of statutory fines for air permit violation	$50,000	/day
Local Product Values (Retail):		
Unit cost of electricity	$0.07	/kW-hr
Unit cost of natural gas	$0.49	/Therm
Unit cost for water	$1.77	/100 ccf
Safety and Insurance:		
Health and Safety - Fatality	$9,600,000	/person
Health and Safety - Injury	$28,800	/claim
WBU (water back-up)	$6,220	/claim
Vehicle damage claims	$3,046	/claim
Public Relation Costs:		
PR costs, public notification	$500.04	/notification
PR costs, public meeting	$9,082.88	/public meeting
PR cost, long-term event	$250,000.00	/event
Miscellaneous Items:		
Bypass pumping	$5,000	per 5 MGD/day
Reduction in Available Capacity	$12,307,692.31	/MGD
Moratorium on growth	$133,062.00	/capita
Temporary housing costs	$150	/day per home
Cost of sewer backup	$1,915	/claim

2.2 Risk Blocks

Through the ESC meetings conducted to develop the risk quantification tool, it became apparent that risks are often described in terms of an event, in which many different costs or components could be incorporated

to describe a single risk cost. These events centered around easily identifiable consequences such as building backups or permit violations. Therefore, the ESC recommended that the monetizing bases described in Section 2.1 be combined into common risk events, which are called 'risk blocks.'

This list of risk building blocks is not intended to be exhaustive; rather, the risks included herein are intended to represent the larger risk events that MSD is susceptible to. The goal is to describe the larger risk events that would make up the majority of the risk costs. The identified risk blocks include:

- **NPDES permit violation**. Describes the costs associated with exceeding an NPDES permit limit at an MSD treatment facility. Incorporates costs for permit prescribed fees for violation as well as additional labor and administrative costs for responding to the violation event.
- **Consent decree violation.** Describes the costs associated with violating MSD's consent decree stipulations. Includes costs for penalty amounts as well as additional labor and administrative costs associated with responding to an event.
- **Sanitary sewer overflow (SSO) event.** Describes the costs associated with violating MSD's SSO stipulations. Includes costs for penalty amounts as well as additional labor and administrative costs associated with responding to an event.
- **Air permit violation.** Describes the costs associated with exceeding an air permit limit at an MSD treatment facility. Incorporates costs for permit prescribed fees for violation as well as additional labor and administrative costs for responding to the violation event.
- **Building back-up.** Describes the costs associated with an event where a break in service (likely caused by a blockage or break in a collection system pipe) and consequently wastewater backing up into a user's home or business. The block is comprised of insurance claims costs as well as lost time and additional administrative work to respond to the event.
- **Asset failure event (at treatment facility).** Describes the costs associated with an event where an asset fails at an MSD treatment facility. The risk block includes costs for regulatory violation fees and associated administration tasks, additional labor and maintenance for facility staff, health and safety considerations, as well as costs associated with issuing a public response.
- **Asset failure event (at pump station).** Describes the costs associated with an event where a pump fails at a pump station within the MSD collection system. Costs are included for emergency bypass pumping to maintain service, as well as additional labor and maintenance for facility staff and health and safety considerations. It is assumed that MSD will continue to pump water by extraordinary means, if necessary, which is reflected in the cost.
- **Asset failure event (for a pipe break).** Describes the costs associated with an event where a pipe breaks in the utility collection system. Costs are included for emergency bypass pumping to maintain service, as well as additional labor and maintenance for facility staff, health and safety considerations, building back-up insurance claims, and public lost time.
- **Capacity loss.** Describes a scenario where a proposed project does not sufficiently address system capacity demands. Costs are developed based on the cost of service per million gallons per day (MGD) based on the utility's hook-up fee rate structure. The economic impact due to a moratorium on growth is also incorporated for larger events. This risk block should be considered in plant expansion projects or major pump station projects only; this risk applies only if there is a connection moratorium if a facility is not built. This risk block is not intended to capture short-term capacity loss in the case of asset failure, but rather, to describe

the long-term implications of capital projects that address system-wide hydraulic or treatment capacity limitations. For example, if a secondary clarifier is the limiting unit process at a wastewater treatment facility, then the evaluation of an additional clarifier would leverage this risk block.

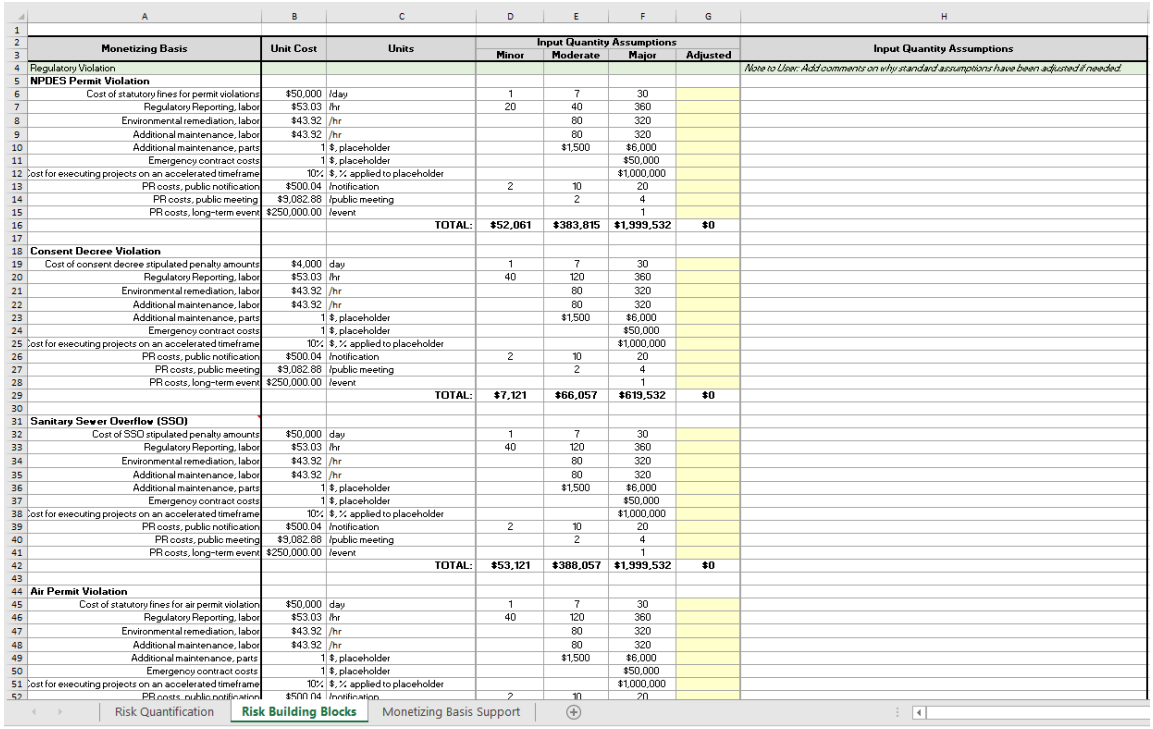
- **Complaint response.** Describes the costs associated with an event that results in an increase of public complaints. Administrative response time, public lost time, and additional maintenance for facility staff are incorporated into the risk block.
- **Efficiency loss (additional costs).** Describes the physical resources (i.e., electricity, natural gas, water, materials/chemicals) as well as the labor resources utilized by MSD. This risk block should be scaled to a scenario to describe any inefficient utilization of resources caused by the implementation of the proposed project.
- **Efficiency gains (reduced costs).** Describes the physical resources (i.e., electricity, natural gas, water, materials/chemicals) as well as the labor resources utilized by MSD. This risk block should be scaled to a scenario to describe any resources saved by the implementation of the proposed project.
- **Project partnership/coordination (benefit).** Describes the potential project savings associated with partnering with outside organizations due to shared administrative, construction, etc. costs.
- **Grants/loans.** Describes the potential project savings associated with pursuing projects that may qualify for grant or attractive loan funding.

In addition to the prescribed risk blocks, an "other" category is included in the "Risk Building Block" tab should any of the defined blocks not apply. The "other" risk block includes a line item for every possible unit cost and can be tailored to the specific evaluation. If the "other" risk block is used, the user should be cautious to not double count the same risk event/costs that might be applied in another risk block.

2.3 Risk Severity

Many of the risk blocks described can occur at various scales depending on a number of asset-specific factors. For instance, a small pipe failing in a subdivision may cause building backups in several homes whereas a major sewer interceptor failure may cause building backups in hundreds or thousands of homes. While the result of each of these failures is the same (i.e. building backups), The scale of the impact can vary greatly. Therefore, different risk scales or severities have been considered and built into the overall tool.

Many of the risk building blocks include a range of input quantity assumptions to describe minor, moderate or major risk events. The assumed input quantities for the monetizing bases for the various risk blocks and severities are included in Attachment B. The selection of risk event scale should occur in the "Risk Quantification" tab of the tool spreadsheet. Again, should one of the prescribed input quantity scale assumptions not accurately describe the given project evaluation, then the user can adjust the inputs. If an adjustment is made, then the user should add a comment to explain why the adjustment was made within the "Input Quantity Assumptions" column (H) under the tab "Risk Building Blocks" of the risk quantification spreadsheet, as shown below.



Monetizing Basis	Unit Cost	Units	Input Quantity Assumptions				Input Quantity Assumptions
			Minor	Moderate	Major	Adjusted	
Regulatory Violation							*Note to User: Add comments on why standard assumptions have been adjusted if needed.*
NPDES Permit Violation							
Cost of statutory fines for permit violations	$50,000	/day	1	7	30		
Regulatory Reporting, labor	$53.03	/hr	20	40	360		
Environmental remediation, labor	$43.92	/hr		80	320		
Additional maintenance, labor	$43.92	/hr		80	320		
Additional maintenance, parts	1	$, placeholder		$1,500	$6,000		
Emergency contract costs	1	$, placeholder			$50,000		
Cost for executing projects on an accelerated timeframe	10%	$,% applied to placeholder			$1,000,000		
PR costs, public notification	$500.04	/notification	2	10	20		
PR costs, public meeting	$3,082.88	/public meeting		2	4		
PR costs, long-term event	$250,000.00	/event			1		
		TOTAL:	**$52,061**	**$383,815**	**$1,999,532**	**$0**	
Consent Decree Violation							
Cost of consent decree stipulated penalty amounts	$4,000	day	1	7	30		
Regulatory Reporting, labor	$53.03	/hr	40	120	360		
Environmental remediation, labor	$43.92	/hr		80	320		
Additional maintenance, labor	$43.92	/hr		80	320		
Additional maintenance, parts	1	$, placeholder		$1,500	$6,000		
Emergency contract costs	1	$, placeholder			$50,000		
Cost for executing projects on an accelerated timeframe	10%	$,% applied to placeholder			$1,000,000		
PR costs, public notification	$500.04	/notification	2	10	20		
PR costs, public meeting	$3,082.88	/public meeting		2	4		
PR costs, long-term event	$250,000.00	/event			1		
		TOTAL:	**$7,121**	**$66,057**	**$619,532**	**$0**	
Sanitary Sewer Overflow (SSO)							
Cost of SSO stipulated penalty amounts	$50,000	day	1	7	30		
Regulatory Reporting, labor	$53.03	/hr	40	120	360		
Environmental remediation, labor	$43.92	/hr		80	320		
Additional maintenance, labor	$43.92	/hr		80	320		
Additional maintenance, parts	1	$, placeholder		$1,500	$6,000		
Emergency contract costs	1	$, placeholder			$50,000		
Cost for executing projects on an accelerated timeframe	10%	$,% applied to placeholder			$1,000,000		
PR costs, public notification	$500.04	/notification	2	10	20		
PR costs, public meeting	$3,082.88	/public meeting		2	4		
PR costs, long-term event	$250,000.00	/event			1		
		TOTAL:	**$53,121**	**$388,057**	**$1,999,532**	**$0**	
Air Permit Violation							
Cost of statutory fines for air permit violation	$50,000	day	1	7	30		
Regulatory Reporting, labor	$53.03	/hr	40	120	360		
Environmental remediation, labor	$43.92	/hr		80	320		
Additional maintenance, labor	$43.92	/hr		80	320		
Additional maintenance, parts	1	$, placeholder		$1,500	$6,000		
Emergency contract costs	1	$, placeholder			$50,000		
Cost for executing projects on an accelerated timeframe	10%	$,% applied to placeholder			$1,000,000		
PR costs, public notification	$500.04	/notification	2	10	20		

Risk Quantification | Risk Building Blocks | Monetizing Basis Support

Section 3: Tool Application

During the final ESC workshop, MSD participants tested a beta version of the risk quantification tool. This section documents the use of and common troubleshooting procedures for the risk quantification tool given the current iteration. This section may be updated as the tool and usage within MSD business processes evolves.

3.1 Functionality

The following section provides a step-by-step guide to using the 'MSD Risk Quantifications" spreadsheet. Users will primarily interact with the 'Risk Quantification' tab, which can be used to determine the risk associated with a specific alternative. The following provides a step-by-step guide to developing risk costs for each project alternative.

Step 1 – Select which risk building blocks and severities are appropriate for the project or project alternative. Note that the spreadsheet is setup for users to input either 'Yes' or 'No' in these cells via the dropdown menu.

	A	B	C	D	E	F
1	RISK QUANTIFICATION - ALTERNATIVE #XX - Alternative Description					
2	Risk Building Block	Consequence	Included?	Likelihood	Adjusted Risk Cost	Likelihood Assumption Notes
4	**NPDES Permit Violation**				**$0**	
5	*Minor*	*$52,061*	*No*		*$0*	
6	*Moderate*	*$383,8*	Yes / No		*$0*	
7	*Major*	*$1,999,532*	*No*		*$0*	
8	*Adjusted*	*$0*	*No*		*$0*	
9	**Consent Decree Violation**				**$0**	
10	*Minor*	*$7,121*	*No*		*$0*	
11	*Moderate*	*$66,057*	*No*			
12	*Major*	*$619,532*	*No*			
13	*Adjusted*	*$0*	*No*			
14	**Sanitary Sewer Overflow (SSO)**					
15	*Minor*	*$53,121*	*No*			
16	*Moderate*	*$388,057*	*No*			
17	*Major*	*$1,999,532*	*No*			
18	*Adjusted*	*$0*	*No*			
19	**Air Permit Violation**				**$0**	
20	*Minor*	*$53,121*	*No*		*$0*	
21	*Moderate*	*$388,057*	*No*		*$0*	
22	*Major*	*$1,999,532*	*No*		*$0*	
23	*Adjusted*	*$0*	*No*		*$0*	
24	**Building Back-up**				**$0**	
25	*Minor*	*$7,234*	*No*		*$0*	
26	*Moderate*	*$407,360*	*No*		*$0*	
27	*Major*	*$1,556,785*	*No*		*$0*	
28	*Adjusted*	*$0*	*No*		*$0*	
29	**Asset Failure (at treatment facility)**				**$0**	
30	*Minor*	*$57,166*	*No*		*$0*	
31	*Moderate*	*$402,154*	*No*		*$0*	

Select which risk building blocks and severities (i.e., minor, moderate, major, or adjusted) are appropriate for the alternative being considered.

If the "adjusted" severity is selected, go to the "Risk Building Block" tab in the workbook and enter quantities in the "Adjusted" column within the desired risk block.

	A	B	C	D	E	F	G	H
2	Monetizing Basis	Unit Cost	Units	Input Quantity Assumptions				Input Quantity Assumptions
3				Minor	Moderate	Major	Adjusted	
4	Regulatory Violation							*Note to User: Add comments on why standard assumptions have been adjusted if needed.*
5	**NPDES Permit Violation**							
6	Cost of statutory fines for permit violations	$50,000	/day	1	7	30		
7	Regulatory Reporting, labor	$53.03	/hr	20	40	360		
8	Environmental remediation, labor	$43.92	/hr		80	320		
9	Additional maintenance, labor	$43.92	/hr		80	320		
10	Additional maintenance, parts	1	$, placeholder		$1,500	$6,000		
11	Emergency contract costs	1	$, placeholder			$50,000		
12	Cost for executing projects on an accelerated timeframe	10%	$,% applied to placeholder			$1,000,000		
13	PR costs, public notification	$500.04	/notification	2	10	20		
14	PR costs, public meeting	$9,082.88	/public meeting		2	4		
15	PR costs, long-term event	$250,000.00	/event			1		
16			**TOTAL:**	**$52,061**	**$383,815**	**$1,999,532**	**$0**	
17								
18	**Consent Decree Violation**							
19	Cost of consent decree stipulated penalty amounts	$4,000	/day	1	7	30		
20	Regulatory Reporting, labor	$53.03	/hr	40	120	360		
21	Environmental remediation, labor	$43.92	/hr		80	320		
22	Additional maintenance, labor	$43.92	/hr		80	320		
23	Additional maintenance, parts	1	$, placeholder		$1,500	$6,000		
24	Emergency contract costs	1	$, placeholder			$50,000		
25	Cost for executing projects on an accelerated timeframe	10%	$,% applied to placeholder			$1,000,000		
26	PR costs, public notification	$500.04	/notification	2	10	20		
27	PR costs, public meeting	$9,082.88	/public meeting		2	4		
28	PR costs, long-term event	$250,000.00	/event			1		
29			**TOTAL:**	**$7,121**	**$66,057**	$619,532		
30								
31	**Sanitary Sewer Overflow (SSO)**							
32	Cost of SSO stipulated penalty amounts	$50,000	/day	1	7	30		
33	Regulatory Reporting, labor	$53.03	/hr	40	120	360		
34	Environmental remediation, labor	$43.92	/hr		80	320		
35	Additional maintenance, labor	$43.92	/hr		80	320		
36	Additional maintenance, parts	1	$, placeholder		$1,500	$6,000		
37	Emergency contract costs	1	$, placeholder			$50,000		
38	Cost for executing projects on an accelerated timeframe	10%	$,% applied to placeholder			$1,000,000		
39	PR costs, public notification	$500.04	/notification	2	10	20		
40	PR costs, public meeting	$9,082.88	/public meeting		2	4		
41	PR costs, long-term event	$250,000.00	/event			1		
42			**TOTAL:**	**$53,121**	**$388,057**	**$1,999,532**	**$0**	
43								
44	**Air Permit Violation**							
45	Cost of statutory fines for air permit violation	$50,000	day	1	7	30		
46	Regulatory Reporting, labor	$53.03	/hr	40	120	360		
47	Environmental remediation, labor	$43.92	/hr		80	320		
48	Additional maintenance, labor	$43.92	/hr		80	320		
49	Additional maintenance, parts	1	$, placeholder		$1,500	$6,000		
50	Emergency contract costs	1	$, placeholder			$50,000		
51	Cost for executing projects on an accelerated timeframe	10%	$,% applied to placeholder			$1,000,000		
52	PR costs, public notification	$500.04	/notification	2	10	20		

Risk Quantification | Risk Building Blocks | Monetizing Basis Support

Adjust input quantities for the desired risk block here, if required.

Step 2 – Enter the appropriate risk likelihood for each of the risk building blocks. The likelihood is based on the probability that the event captured in the risk building block will occur for the alternative under consideration. Once the risk likelihood is entered, the adjusted risk cost for the risk building block will be automatically calculated. Note that Column F ('Likelihood Assumption Notes') can be used to document any comments or assumptions on how the likelihood was developed. In the interest of consistency between evaluations, it is recommended that a library of probability or likelihoods for specific types of events be maintained internally by MSD. This will allow MSD staff to refer to previous evaluations and provide consistency between evaluations.

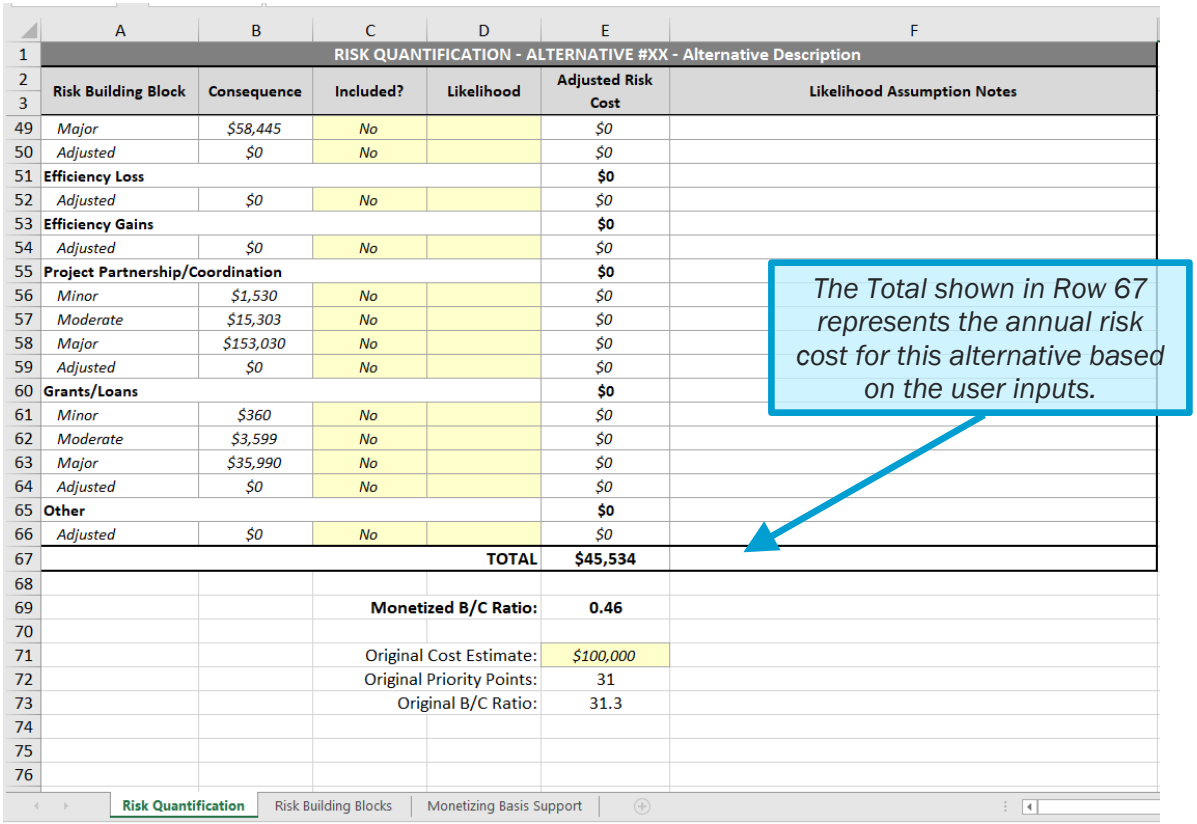
	A	B	C	D	E	F
1	RISK QUANTIFICATION - ALTERNATIVE #XX - Alternative Description					
2	Risk Building Block	Consequence	Included?	Likelihood	Adjusted Risk Cost	Likelihood Assumption Notes
4	**NPDES Permit Violation**				**$5,206**	
5	*Minor*	*$52,061*	*Yes*	*10%*	*$5,206*	
6	*Moderate*	*$383,815*	*No*		*$0*	
7	*Major*	*$1,999,532*	*No*		*$0*	
8	*Adjusted*	*$0*	*No*		*$0*	
9	**Consent Decree Violation**				**$0**	
10	*Minor*	*$7,121*	*No*		*$0*	
11	*Moderate*	*$66,057*	*No*		*$0*	
12	*Major*	*$615,521*	*No*		*$0*	
13	*Adjusted*	*$0*	*No*		*$0*	
14	**Sanitary Sewer Overflow (SSO)**				**$0**	
15	*Minor*	*$53,121*	*No*		*$0*	
16	*Moderate*	*$388,057*	*No*		*$0*	
17	*Major*	*$1,999,532*	*No*		*$0*	
18	*Adjusted*	*$0*	*No*		*$0*	
19	**Air Permit Violation**				**$0**	
20	*Minor*	*$53,121*	*No*		*$0*	
21	*Moderate*	*$388,057*	*No*		*$0*	
22	*Major*	*$1,999,532*	*No*		*$0*	
23	*Adjusted*	*$0*	*No*		*$0*	
24	**Building Back-up**				**$0**	
25	*Minor*	*$7,234*	*No*		*$0*	
26	*Moderate*	*$407,360*	*No*		*$0*	
27	*Major*	*$1,556,785*	*No*		*$0*	
28	*Adjusted*	*$0*	*No*		*$0*	
29	**Asset Failure (at treatment facility)**				**$0**	
30	*Minor*	*$57,166*	*No*		*$0*	
31	*Moderate*	*$402,154*	*No*		*$0*	

Risk Quantification | Risk Building Blocks | Monetizing Basis Support

Enter the likelihood of this risk being experienced for this alternative.

Note any comments or assumptions on how this likelihood was developed.

Step 3 – After applying all the applicable risk building blocks and likelihoods, the total risk cost for the alternative is automatically calculated by the spreadsheet. This value represents the risk cost for this alternative. The user can then enter the project capital cost (in cell E71) to calculate a monetized benefit/cost ratio. If applicable, the user can also input the original priority points ranking and B/C ratio for comparison. This can be used in the capital planning or alternatives evaluation process.



	A	B	C	D	E	F
1	RISK QUANTIFICATION - ALTERNATIVE #XX - Alternative Description					
2 3	**Risk Building Block**	**Consequence**	**Included?**	**Likelihood**	**Adjusted Risk Cost**	**Likelihood Assumption Notes**
49	*Major*	*$58,445*	*No*		*$0*	
50	*Adjusted*	*$0*	*No*		*$0*	
51	**Efficiency Loss**				**$0**	
52	*Adjusted*	*$0*	*No*		*$0*	
53	**Efficiency Gains**				**$0**	
54	*Adjusted*	*$0*	*No*		*$0*	
55	**Project Partnership/Coordination**				**$0**	
56	*Minor*	*$1,530*	*No*		*$0*	
57	*Moderate*	*$15,303*	*No*		*$0*	
58	*Major*	*$153,030*	*No*		*$0*	
59	*Adjusted*	*$0*	*No*		*$0*	
60	**Grants/Loans**				**$0**	
61	*Minor*	*$360*	*No*		*$0*	
62	*Moderate*	*$3,599*	*No*		*$0*	
63	*Major*	*$35,990*	*No*		*$0*	
64	*Adjusted*	*$0*	*No*		*$0*	
65	**Other**				**$0**	
66	*Adjusted*	*$0*	*No*		*$0*	
67				**TOTAL**	**$45,534**	
68						
69			**Monetized B/C Ratio:**		**0.46**	
70						
71			Original Cost Estimate:		*$100,000*	
72			Original Priority Points:		31	
73			Original B/C Ratio:		31.3	
74						
75						
76						

The Total shown in Row 67 represents the annual risk cost for this alternative based on the user inputs.

Risk Quantification | Risk Building Blocks | Monetizing Basis Support

3.2 Troubleshooting: Common Challenges and Solutions

While the risk quantification spreadsheet has been developed with the end-user in mind, there are several common challenges that may be experienced. These are:

- Several of the risk blocks include benefits. These benefits are assigned negative values in the spreadsheet to maintain the convention of costs being positive values. Therefore, the inclusion of a benefit, such as external funding or cost sharing, will reduce the overall risk value for a project. While this is technically correct, it will change the benefit to cost (B/C) ratio (see Section 4.3). Therefore, when benefits are applied to a project, which is uncommon, the B/C ratio should be hand calculated using the equation described in Section 4.3. The risk blocks that include benefits, and thus require extra scrutiny, are as follows:
    - Efficiency Gains
    - External Opportunities
    - Other
- Each of the risk building blocks includes an 'Adjusted' severity level that allows for user input. Users can input the quantities of each type of risk costs in the "Input Quantities Assumptions – Adjusted" (column

G) on the 'Risk Building Blocks' tab. The format for information to be entered should match the "Minor/Moderate/Major" input quantity assumptions (columns D, E, and F) in the same tab. This function should rarely be used and only when the established severity levels cannot accurately represent the risk associated with a proposed project. Using the 'Adjusted' severity level should also increase the scrutiny in the review process to verify that the calculated risk matches the actual risk.

- The 'Monetizing Basis Support' tab includes documentation on the quantification of each risk cost. These values should remain constant until organizational updates on the tool are conducted by MSD. **Note: When an update occurs, all current projects under evaluation that used updated data fields will need to be rescored for prioritization comparison.** It is not necessary to rescore projects that have already been prioritized and are in the execution phase.

In addition, there are several common MSD-specific considerations for the application of the tool, including:

- Efficiency loss vs. efficiency gains: in any given evaluation, efficiency can be looked at as either a risk or a benefit, not both. Consistency within an evaluation is imperative. For consistency between evaluations, it is recommended that the status quo alternative (i.e. do nothing) be looked at as the baseline for assessing efficiency loss/gain. If a proposed project would increase efficiency from the status quo, it would be counted as efficiency gain. Conversely, if a proposed project would decrease efficiency from the status quo, it would be counted as efficiency loss.
- Building back-up vs. asset failure (pipe break): If a pipe break contributes to a building back-up event, the cost associated with insurance claims should be counted in the asset failure risk block only.
- The risk of NPDES permit violations could be double-counted depending on the risk blocks selected. The primary means of accounting for this risk is the 'NPDES Permit Violations' risk block. If this risk block has been selected, the user should verify that other risk blocks do not also capture the consequences of this risk.
- The risk of capacity loss is meant to capture the long-term effects of losing system capacity. This risk should generally not be used for short-term (i.e. less than one month) capacity losses. Rather, it is intended to capture the consequences of system capacity loss that could affect the management and operation of the system and have negative consequences on the overall community.

Section 4: MSD 'Rules' for Risk Quantification Tool

It is important that the risk quantification approach supports the overall capital planning and project prioritization process. Therefore, each utility should have a unique approach used to account for risks in their decision-making process. The risk quantification approach for MSD has noteworthy aspects including the approach to likelihood percentages, the integration of risk costs in the capital planning process, and the acceptable payback periods for various assets. The following sections describe each of these aspects of the MSD risk quantification process. Several other best practices are also noted in this section along with a discussion of how previous events can be used as a reference for the risk quantification.

4.1 Double Counting Costs

The tool includes several instances of risks that captured in multiple risk blocks. For example, the 'Asset Failure (at Treatment Facility)' risk block includes costs for permit violations and public relations. Therefore,

these costs should not be counted separately under the 'NPDES Permit Violation' risk block. As part of the internal review process, the review team should review the detailed risk block information to ensure risks are not double counted.

4.2 Application of Probability Percentages

Time is not incorporated into the current iteration of the risk quantification tool. As such, when a user is considering a proposed project, one should evaluate the probability of risk at the point in time of the analysis or when the project is being consider for implementation. Given the time it takes to initiate and complete a project, it is recommended the user consider the probability of failure five years from the time the evaluation is conducted. The probability of asset failure can be derived from a number of sources including the estimated remaining useful life of the asset, field observations, or experience with past failure events for similar assets. As the asset management program continues to evolve, the likelihood of asset failure may be connected to statistical data on the likelihood of asset failure for MSD specific assets.

4.3 Development of Benefit Cost Ratios

Mitigated project risk costs can then be compared to preliminary capital costs to determine a B/C ratio, which can be compared across a multitude of projects. Once a project's adjusted risk cost has been determined, a benefit to cost ratio can be calculated for the proposed project by dividing the adjusted risk cost by the proposed project capital cost. If benefit costs are included in the evaluation, these should also be factored into the B/C ratio. The equation for calculating the B/C ratio is shown below. Note that because benefits are presented as negative values in the tool for sign convention, they must be subtracted from risk costs. The reason the benefit costs need to be subtracted is as follows: when we think about capital costs, one usually thinks about the value as a positive value, even though the money is technically being spent and would have a negative sign convention associated with it. Similarly, if we keep thinking about costs with this sign convention (where capital and risk costs are presented as a positive value), then the benefit costs would be presented as a negative (i.e., value that the project cost is being reduced by). In this manner, the inclusion of a benefit increases the B/C ratio and thus the viability of the project.

$$Benefit\ to\ Cost\ Ratio = \frac{Risk\ Cost - Benefits}{Capital\ Costs}$$

In this manner, capital projects can be directly compared and projects with a higher benefit to cost ratio (i.e., higher risk mitigated for capital dollars invested) can be prioritized over those with less risk implications. On a project-specific level, the risk cost buy-back period for a given investment can be calculated by taking the inverse of the benefit cost ratio, calculated either by dividing the overall project cost by the adjusted risk cost or by taking 1 divided by the B/C ratio. This value represents the number of years it would take before the capital cost would be justified given the annual mitigated risk cost value. Short of developing a full life-cycle analysis and incorporating time into the project evaluations, the B/C ratio and determining the risk buy-back period allows for the user to incorporate time into the decision-making process.

4.4 Payback by Asset Type

As previously discussed, the risk payback period can be calculated for any given project by taking the inverse of the benefit cost ratio, calculated either by dividing the overall project cost by the adjusted risk cost or by taking 1 divided by the B/C ratio. This value represents the number of years it would take before the capital

cost would be justified given the annual mitigated risk cost value. This risk payback period can then be compared to the anticipated asset service life of the equipment or infrastructure being considered in a project evaluation. If the risk payback period is less than the projected asset service life, then the project should be considered further. Alternatively, if the risk payback period exceeds the projected asset service life, then the project in question may not be viable and should be reevaluated. A list of industry standard service life book values for typical utility assets are included for reference in Table 2 below. The Finance Steering Committee (FSC) has determined that MSD will utilize their historical experience in developing a standard asset service life. This standard will be used for asset depreciation schedules for the District's financials and can be incorporated here for payback determinations when it is developed.

Table 2. Asset Service Life

Asset	Service Life (yrs)
Pressure Pipe - Ductile Iron	60
Pressure Pipe - Cast Iron	60
Pressure Pipe - PVC	60
Pump	30
Submersible Pump	15
Other Mechanical	30
Electrical	30
Reservoirs	60
Structures	60
Chlorination	15

4.5 Reference Events

Past events can and should be used as a comparison for the risk quantifications developed using the risk quantification tool. While the circumstance of past events may vary from the projects under consideration, their overall magnitude can serve as validation for the results generated by the tool. For example, the costs incurred as a result of the last similar pump station failure should be used to validate the risk quantification developed through the use of this tool. This provides a means of validating the risk magnitude so that risks are not over or under-represented. A summary of past events and their consequences are included in Attachment C. This list is meant to be updated periodically to maintain a database of events for comparison.

Attachment A: Monetizing Basis Support Sources and Emails

Table A-1. Monetizing Basis Support Sources	
Metric	**Source**
Labor Rates:	
Loaded labor rates for internal groups	
Labor cost, admin	Updated at 10/17/17 ESC workshop, Direct Labor + Benefits costs for Grade A employees
Labor cost, trade	Updated at 10/17/17 ESC workshop, Direct Labor + Benefits costs for Grade B employees
Labor cost, professional	Updated at 10/17/17 ESC workshop, Direct Labor + Benefits costs for Grade C (below 8) employees
Labor cost, management	Updated at 10/17/17 ESC workshop, Direct Labor + Benefits costs for Grade C (above 8) employees
Labor rates for external groups	
labor cost, consultant	hourly rate assumption
labor cost, contractor	hourly rate assumption
Lost time, public	hourly wage based on median household income ($59,755) for St. Louis County, MO. (US Census Bureau)
Lost time, businesses	Calculated as weighted hourly value from 2012 Economic Census Data
Violations and Fees:	
Cost of statutory fines for permit violations	NPDES Permit
Emergency contract costs	Assumption
Cost of consent decree stipulated penalty amounts	Consent Decree Case: 4:07-cv-01120-CEJ Doc. #: 159 Filed: 04/27/12 Page: 67 of 97 PageID #: 1581
Cost of statutory fines for air permit violation	Email per MSD (via Jeff Theerman) on 10/25/17
Local Product Values (Retail):	
Unit cost of electricity	Current cost of electricity for MSD
Unit cost of natural gas	Current cost of natural gas for MSD
Unit cost for water	Current cost of water for MSD
Safety and Insurance:	
Health and Safety - Fatality	EPA Value of a Statistical Life. https://cms.dot.gov/sites/dot.gov/files/docs/2016%20Revised%20Value%20of%20a%20Statistical%20Life%20Guidance.pdf
Health and Safety - Injury	Assumes EPA statistical value for Minor injury (.003 * Value of a Statistical Life)
WBU (water back-up)	Assumes $1,900 per claim payout plus $4,320 per claim for administrative costs for liability policy ($349,164/year in 2017) and third party risk claims administration ($514,800). Based on assumption of 200 claims per year.
Vehicle damage claims	Email from MSD on 10/11/17

Table A-1. Monetizing Basis Support Sources	
Metric	Source
Public Relation Costs:	
PR costs, public notification	Assume 4 hours of professional labor rate and 8 hours of admin labor
PR costs, public meeting	Assume 24 hours of management time, 80 hours of professional time, and 80 hours of admin time
PR cost, long-term event	Assumed 1,000 hours of management time, 4,000 hours of professional time, and 8,000 of admin time
Miscellaneous Items:	
Bypass pumping	Email from MSD (Bart Hager) on 8/29/17
Reduction in Available Capacity	assumption - 2.5 users per home, 65 gal/day/person residential hook-up fee = $2,000
Moratorium on growth	2012 Economic Census Data - Value of total business transactions ($374B) divided by the population of St. Louis Metro Area (2.81M ppl)
Temporary housing costs	Email from MSD on 10/11/17
Cost of sewer backup	Email from MSD on 10/11/17

Lorena Croucher

From: Cindy Cullen <ckretzer@stlmsd.com>
Sent: Thursday, October 26, 2017 9:24 AM
To: Bart Hager
Subject: RE: Additional Risk Information

Bart,

I found some air violation fee information in the Missouri CSR under 10 CSR 10-6.230. MDNR will assess the severity of the violation and apply penalties using this fine matrix:

Gravity-Based Penalty Assessment Matrix

Potential for Harm	Extent of Deviation		
	Major	Moderate	Minor
Major	$10,000 to $8,750	$8,750 to $7,500	$7,500 to $6,250
Moderate	$6,250 to $5,000	$5,000 to $3,750	$3,750 to $2,500
Minor	$2,500 to $1,250	$1,250 to $500	$0

The total penalty cannot exceed $10,000 per day per violation. However, MDNR can add on additional fines if any violations resulted from economic benefit gained from the violation. MDNR has an economic benefit formula to calculate this amount, and I don't think there is a cap on that number. (I found some correspondence from the EPA, here, stating that MDNR needs to better define it's fine calculation process.) I think MDNR tends to negotiate a settlement if a penalty is warranted.

Additionally, while MDNR is the delegated authority to enforce air regulations in Missouri, I believe the EPA is also authorized to immediately bring suit or to take other action necessary against persons or facilities causing an imminent and substantial endangerment to public health or the environment. The penalty can be up to $37,500 per day and cannot exceed $295,000 unless the EPA and the Department of Justice decide a higher fine is appropriate. I think this only happens in extreme cases.

I'm not sure that I can define the penalty process any further. If Brown & Caldwell needs more information, I can reach out to our environmental lawyer consultant, Ryan Kemper.

Thank you,

Cindy

From: Cindy Cullen
Sent: Tuesday, October 24, 2017 1:52 PM
To: Bart Hager
Subject: RE: Additional Risk Information

Sorry – I didn't get a chance to really look through the permits for fees. I'm wrapping up a couple DEC tasks (it's my last week here), but I can dig in to this later this week or early next week.

From: Bart Hager
Sent: Tuesday, October 24, 2017 1:28 PM
To: Cindy Cullen
Subject: RE: Additional Risk Information

Violation fees don't seem to be addressed in these permits, unless I'm missing something…where would we find those, and what are they?

From: Cindy Cullen
Sent: Tuesday, October 24, 2017 12:23 PM
To: Bart Hager
Subject: RE: Additional Risk Information

Hi Bart,

I attached MSD's three Title V permits. Note that Bissell and Lemay are currently undergoing a permit renewal. The biggest change to these permits is compliance with 40 CFR 60, Subpart MMMM. We have some Stage I vapor recovery permits for some of our fueling areas too (not attached).

Let me know if I can help Matt with finding any more information on violation fees.

Thanks,

Cindy

Cindy Cullen, P.E.
Metropolitan St. Louis Sewer District
Engineering Department - Environmental Compliance
10 East Grand Avenue
St. Louis, MO 63147-2913
(314) 436-8702

From: Bart Hager
Sent: Tuesday, October 24, 2017 9:37 AM
To: Cindy Cullen
Subject: FW: Additional Risk Information

Good Morning! Please see below, a follow up from the meeting last week with Operations…is this something you could help with?

From: Matt Gregg [mailto:mgregg@BrwnCald.com]
Sent: Tuesday, October 24, 2017 9:25 AM
To: Bart Hager
Cc: Jeff Theerman; Lorena Croucher
Subject: RE: Additional Risk Information

Bart – We're looking for information about the stipulated penalties for any air permit violations. It might be easiest if you could just track down the actual permit, which we weren't able to find online, and we can sift through it to find the violation costs. --Matt

Matthew Gregg, P.E.
Brown and Caldwell | Boise, ID
mgregg@brwncald.com
T 208.389.7717 | **C** 208.870.9684
Professional Registration in Specific States

From: Bart Hager [mailto:BXHAGE@stlmsd.com]
Sent: Tuesday, October 24, 2017 6:19 AM
To: Matt Gregg <mgregg@BrwnCald.com>
Cc: Jeff Theerman <JTheerman@BrwnCald.com>; Lorena Croucher <lcroucher@BrwnCald.com>
Subject: RE: Additional Risk Information

What exactly are you looking for on the "Air permit information for any facilities"?

From: Matt Gregg [mailto:mgregg@BrwnCald.com]
Sent: Monday, October 23, 2017 5:45 PM
To: Bart Hager
Cc: Jeff Theerman; Lorena Croucher
Subject: Additional Risk Information

Bart,

We're working to update the risk quantifications coming out of our workshop last week. We had a couple more items that we were hoping you could track down for us:

1. Insurance premium information and third-party administration costs for the insurance payouts noted in the risk (e.g. property damage, vehicle damage, property damage)
2. Air permit information for any facilities.

Thanks! --Matt

Matthew Gregg, P.E.
Brown and Caldwell | Boise, ID
mgregg@brwncald.com
T 208.389.7717 | **C** 208.870.9684
Professional Registration in Specific States

Lorena Croucher

From: Jeff Theerman
Sent: Monday, October 16, 2017 8:45 AM
To: Matt Gregg; Anne Kennedy
Cc: Lorena Croucher
Subject: RE: Asset Management effort - data needed on average claims/costs

Over charged mains are building backups as a result of insufficient capacity during wet weather.

Blocked mains are building backups as a result of a blockage of roots, grease, etc. during either wet or dry weather.

Back flush claims are where water enters the building as a result of sewer hydroflushing, by MSD crews. This doesn't happen a lot and when it is a result of contractor sewer cleaning it is the responsibility of the contractor.

Something we may be missing is that when a building is prone to overcharged conditions MSD will provide and maintain a backflow prevention device in the lateral to avoid future overcharged conditions. We might want to include that cost because when it is applied it results in more cost but not in overcharge claims. I'll ask if they have a number for the backflow prevention approach per home.

Jeff

Jeff Theerman PE
Vice President
Senior Utility Performance Consultant
Brown and Caldwell | St. Louis
JTheerman@brwncald.com
C 314.323.4344

From: Matt Gregg
Sent: Monday, October 16, 2017 9:16 AM
To: Jeff Theerman <JTheerman@BrwnCald.com>; Anne Kennedy <akennedy@BrwnCald.com>
Cc: Lorena Croucher <lcroucher@BrwnCald.com>
Subject: FW: Asset Management effort - data needed on average claims/costs

Jeff and Anne

Can you explain the difference between the following two scenarios? Are these just a difference in the degree of the sewer backup?

- Average Sewer Back Up claim which includes overcharge, blocked main: $1,914.71
- Property Damage Claims: which includes back flush claims is $4,779.89

Thanks! –Matt

Matthew Gregg, P.E.
Brown and Caldwell | Boise, ID
mgregg@brwncald.com
T 208.389.7717 | **C** 208.870.9684
Professional Registration in Specific States

From: Jeff Theerman
Sent: Friday, October 13, 2017 10:19 AM
To: Matt Gregg <mgregg@BrwnCald.com>
Subject: Fwd: Asset Management effort - data needed on average claims/costs

FYI
Sent from my iPhone

Begin forwarded message:

> **From:** Bart Hager <BXHAGE@stlmsd.com>
> **Date:** October 11, 2017 at 12:05:16 PM EDT
> **To:** "Jeff Theerman (JTheerman@BrwnCald.com)" <JTheerman@BrwnCald.com>
> **Cc:** Bruce Litzsinger <BLITZSIN@stlmsd.com>
> **Subject: FW: Asset Management effort - data needed on average claims/costs**
>
> Jeff, following is the rest of the info requested…
>
> ---
>
> **From:** Michael Grace
> **Sent:** Wednesday, October 11, 2017 11:01 AM
> **To:** Bart Hager
> **Cc:** Bruce Litzsinger
> **Subject:** RE: Asset Management effort - data needed on average claims/costs
>
> Bart:
>
> Information that you requested is based upon a fiscal period as opposed to a calendar year.
>
> Average Workers Compensation Claim is $15,487.28
> Average General Liability Claim which is bodily injury claims is : $1,080.44
> Auto Liability Claim $1,598.43
> Auto Physical Damage Claim $1,965.42.
> Total Auto average exposure = $3,045.86
> Average Sewer Back Up claim which includes overcharge, blocked main: $1,914.71
> Property Damage Claims: which includes back flush claims is $4,779.89
> Lodging if and when occurs is approximately up $150 per day as result of a claim that result of system failure such as gate failure.

From: Bart Hager
Sent: Tuesday, October 10, 2017 3:06 PM
To: Michael Grace
Cc: Bruce Litzsinger
Subject: FW: Asset Management effort - data needed on average claims/costs

Mike, see below for Mr. Theerman's input on your questions. If that is adequate, please let us know what numbers we should use.

From: Jeff Theerman [mailto:JTheerman@BrwnCald.com]
Sent: Tuesday, October 10, 2017 2:49 PM
To: Bart Hager
Cc: Bruce Litzsinger; Matt Gregg
Subject: RE: Asset Management effort - data needed on average claims/costs

So for all of these we are trying to use an average number. See my specific guidance below.

Jeff Theerman PE
Vice President
Senior Utility Performance Consultant
Brown and Caldwell | St. Louis
JTheerman@brwncald.com
C 314.323.4344

From: Bart Hager [mailto:BXHAGE@stlmsd.com]
Sent: Tuesday, October 10, 2017 1:17 PM
To: Jeff Theerman <JTheerman@BrwnCald.com>
Cc: Bruce Litzsinger <BLITZSIN@stlmsd.com>
Subject: FW: Asset Management effort - data needed on average claims/costs

Jeff, Mike Grace has some questions, see below…please provide feedback at your convenience.

From: Michael Grace
Sent: Tuesday, October 10, 2017 11:29 AM
To: Bart Hager
Cc: Kurt Bussmann; Bruce Litzsinger
Subject: RE: Asset Management effort - data needed on average claims/costs

Bart:

I would need some additional clarification.

Typical cost of injury for employee: Is this a loss time injury , no loss time injury?
Workers Comp benefits or scheduled benefits, however medical cost will vary depending on severity.
This should be the average cost of injuries. So look at an average year of injuries based on costs. Include both lost time and non-lost time. Total all costs during this average year and divide by the number of injuries (lost time and non-lost time). This should yield a rough average cost of an injury. That will be precise enough for our purpose.

Whereas bodily injury in a general liability setting, (public) will vary based on severity. Same approach. Use an average year based on costs. Divide total cost by number of general liability claims which should yield an average dollars per claim.

Should be able to give you estimate cost on property damage claims resulting from Sewer Back up from overcharge and blocked main.
Overcharge max recovery is $3,000 minus $100 deductible. Overcharge would be range of $2,300 per claim. This is what we want.
Blocked main should be able to obtain estimate. Same method as above.

Temporary housing which we very seldom provide could be as high as $150 a day.
Give us an estimate of the average cost when you provide this.

From: Bart Hager
Sent: Tuesday, October 10, 2017 10:57 AM
To: Michael Grace; Kurt Bussmann
Cc: Bruce Litzsinger
Subject: Asset Management effort - data needed on average claims/costs

As part of the asset management effort with Operations, we are trying to develop a new benefit cost system to prioritize projects.
Certain cost factors are needed for this system. Can you provide the following information, if at all possible by the end of next week?

Requested Risk Cost Information	Notes
Typical cost for injury claim for employee or the public	Risk management group might have some information. Alternatively, we could use an EPA value for this injury
Typical cost of property damage claim	Risk management group should have information on average property damage claim resulting from sewer backup.
Typical cost of vehicle damage claim	Risk management group should have information on average claim for
Cost of providing temporary housing to customer	This cost was identified as a potential result of major sewer backups. Risk management group might have information.

Lorena Croucher

From: Bart Hager <BXHAGE@stlmsd.com>
Sent: Tuesday, August 29, 2017 12:32 PM
To: Matt Gregg; Carole Willis
Cc: Lorena Croucher; Jeff Theerman; Bruce Litzsinger; Bonnie S Hubert
Subject: RE: Risk Quantification Follow-Up
Attachments: MSD Internal Quantifications Info Bart data.xlsx

Bypass pumping costs are in, please see attached updated spreadsheet.

From: Bart Hager
Sent: Monday, August 28, 2017 1:52 PM
To: 'Matt Gregg'; Carole Willis
Cc: Lorena Croucher; Jeff Theerman; Bruce Litzsinger; Bonnie S Hubert
Subject: RE: Risk Quantification Follow-Up

Attached is what I have so far, with separate tabs for each answer created in the spreadsheet. Let me know if you have any questions. Still working on bypass pumping costs.

From: Matt Gregg [mailto:mgregg@BrwnCald.com]
Sent: Monday, August 14, 2017 11:32 AM
To: Carole Willis; Bart Hager
Cc: Lorena Croucher; Jeff Theerman
Subject: Risk Quantification Follow-Up

Bart and Carol,

It was great talking to you last week about the upcoming risk quantification work. We really appreciate your support in tracking down some of this internal information. In the attached table I've tried to capture the information we were hoping to track down, the person responsible, and then any other notes we captured from our discussion. Our target to collect this information is August 28th. Please let me know if you have any questions or are having trouble finding anything. Thanks! –Matt

Matthew Gregg, P.E.
Brown and Caldwell | Boise, ID
mgregg@brwncald.com **T** 208.389.7717 | **C** 208.870.9684
Professional Registration in Specific States

Prorated based off bypass pumping costs for the Coldwater Tank C project:

daily	$1,441/MGD/1000 feet of bypass
weekly	$19,780/MGD/1000 feet of bypass

Cost	Duration	Distance	Flow	
75,000	2.5 days	1400 ft	23 CFS	or 14.87 MGD

1 MGD / day	75000/2.5*14.87*1.4	$1441/MGD/1000 feet of bypass	daily
1 MGD /week		$10090/MGD/1000 feet of bypass	weekly

Attachment B: Risk Blocks and Risk Severities

Monetizing Basis	Unit Cost	Units	Input Quantity Assumptions				Input Quantity Assumptions
			Minor	Moderate	Major	Adjusted	
Regulatory Violation							*Note to User: Add comments on why standard assumptions have been adjusted if needed.*
NPDES Permit Violation							
Cost of statutory fines for permit violations	$50,000	/day	1	7	30		
Regulatory Reporting, labor	$53.03	/hr	20	40	360		
Environmental remediation, labor	$43.92	/hr		80	320		
Additional maintenance, labor	$43.92	/hr		80	320		
Additional maintenance, parts	1	$, placeholder		$1,500	$6,000		
Emergency contract costs	1	$, placeholder			$50,000		
Cost for executing projects on an accelerated timeframe	10%	$, % applied to placeholder			$1,000,000		
PR costs, public notification	$500.04	/notification	2	10	20		
PR costs, public meeting	$9,082.88	/public meeting		2	4		
PR costs, long-term event	$250,000.00	/event			1		
		TOTAL:	**$52,061**	**$383,815**	**$1,999,532**	**$0**	
Consent Decree Violation							
Cost of consent decree stipulated penalty amounts	$4,000	day	1	7	30		
Regulatory Reporting, labor	$53.03	/hr	40	120	360		
Environmental remediation, labor	$43.92	/hr		80	320		
Additional maintenance, labor	$43.92	/hr		80	320		
Additional maintenance, parts	1	$, placeholder		$1,500	$6,000		
Emergency contract costs	1	$, placeholder			$50,000		
Cost for executing projects on an accelerated timeframe	10%	$, % applied to placeholder			$1,000,000		
PR costs, public notification	$500.04	/notification	2	10	20		
PR costs, public meeting	$9,082.88	/public meeting		2	4		
PR costs, long-term event	$250,000.00	/event			1		
		TOTAL:	**$7,121**	**$66,057**	**$619,532**	**$0**	
Sanitary Sewer Overflow (SSO)							
Cost of SSO stipulated penalty amounts	$50,000	day	1	7	30		
Regulatory Reporting, labor	$53.03	/hr	40	120	360		
Environmental remediation, labor	$43.92	/hr		80	320		
Additional maintenance, labor	$43.92	/hr		80	320		
Additional maintenance, parts	1	$, placeholder		$1,500	$6,000		
Emergency contract costs	1	$, placeholder			$50,000		
Cost for executing projects on an accelerated timeframe	10%	$, % applied to placeholder			$1,000,000		
PR costs, public notification	$500.04	/notification	2	10	20		
PR costs, public meeting	$9,082.88	/public meeting		2	4		
PR costs, long-term event	$250,000.00	/event			1		
		TOTAL:	**$53,121**	**$388,057**	**$1,999,532**	**$0**	
Air Permit Violation							
Cost of statutory fines for air permit violation	$50,000	day	1	7	30		
Regulatory Reporting, labor	$53.03	/hr	40	120	360		
Environmental remediation, labor	$43.92	/hr		80	320		
Additional maintenance, labor	$43.92	/hr		80	320		
Additional maintenance, parts	1	$, placeholder		$1,500	$6,000		
Emergency contract costs	1	$, placeholder			$50,000		
Cost for executing projects on an accelerated timeframe	10%	$, % applied to placeholder			$1,000,000		
PR costs, public notification	$500.04	/notification	2	10	20		
PR costs, public meeting	$9,082.88	/public meeting		2	4		
PR costs, long-term event	$250,000.00	/event			1		
		TOTAL:	**$53,121**	**$388,057**	**$1,999,532**	**$0**	
Building Back-up							
WBU (water back-up)	$6,220	/claim	1	50	150		
Lost time, public	$28.73	/hr	20	1000	3000		Moderate assumes 1,000 vehicles per day (residential street) delayed by 15 minutes. Major assumes 31,000 vehicles per day (4 lane road) delayed by 15 minutes
Lost time, businesses	$2,284	/hr		20	200		
Temporary housing costs	$150	day per home			100		
Additional maintenance, labor	$43.92	/hr	10	500	1500		
		TOTAL:	**$7,234**	**$407,360**	**$1,556,785**	**$0**	
Asset Failure (at treatment facility)							
Additional maintenance, labor	$43.92	/hr	40	120	120		
Additional maintenance, parts	1	$, placeholder	$2,000	$10,000	$10,000		
Health and Safety - Injury	$28,800	/claim	0.01	0.1	0.1		
Health and Safety - Fatality	$9,600,000	/person		0.0001	0.0001		
external labor cost, consultant	$150	/hr					
external labor cost, contractor	$75	/hr					
Labor cost, admin	$35.99	/hr					
Labor cost, trade	$43.92	/hr					
Labor cost, professional	$53.03	/hr					
Labor cost, management	$81.72	/hr					
Lost time, public	$28.73	/hr					
Lost time, businesses	$2,284	/hr					
Cost of statutory fines for permit violations	$50,000	/day	1	7	7		
Regulatory Reporting, labor	$53.03	/hr	40	120	120		
Environmental remediation, labor	$43.92	/hr		80	80		
PR costs, public notification	$500.04	/notification	2	10	10		
PR costs, public meeting	$9,082.88	/public meeting		2	2		
Reduction in Available Capacity	$12,307,692.31	/MGD			5		
		TOTAL:	**$57,166**	**$402,154**	**$61,940,615**	**$0**	
Asset Failure (pump station)							
Bypass Pumping	$5,000	per 5 MGD/day					Scale to scenario
Additional maintenance, labor	$43.92	/hr	40	160	1440		
Additional maintenance, parts	1	$, placeholder	$2,000	$1,000	$50,000		
Health and Safety - Injury	$28,800	/claim		0.25	1		
Health and Safety - Fatality	$9,600,000	/person			0.001		
external labor cost, consultant	$150	/hr					
external labor cost, contractor	$75	/hr					
Labor cost, admin	$35.99	/hr					
Labor cost, trade	$43.92	/hr					
Labor cost, professional	$53.03	/hr					
Labor cost, management	$81.72	/hr					
Lost time, public	$28.73	/hr					
Lost time, businesses	$2,284	/hr					
		TOTAL:	**$3,757**	**$15,227**	**$151,645**	**$0**	

Monetizing Basis	Unit Cost	Units	Input Quantity Assumptions				Input Quantity Assumptions
			Minor	Moderate	Major	Adjusted	
Asset Failure (pipe break)							
Bypass Pumping	$5,000	per 5 MGD/day					scale to scenario
Additional maintenance, labor	$43.92	/hr	10		320		
Additional maintenance, parts	1	$, placeholder	$500		$10,000		
Health and Safety - Injury	$28,800	/claim			0.1		
Health and Safety - Fatality	$9,600,000	/person			0.0001		
external labor cost, consultant	$150	/hr					
external labor cost, contractor	$75	/hr					
Labor cost, admin	$35.99	/hr					
Labor cost, trade	$43.92	/hr					
Labor cost, professional	$53.03	/hr					
Labor cost, management	$81.72	/hr					
WBU (water back-up)	$6,220	/claim					
Lost time, public	$28.73	/hr	500		77500		Minor assumes 1,000 vehicles per day (residential street) delayed by 15 minutes for two days. Major assumes 31,000 vehicles per day (4 lane road) delayed by 15 minutes fo 10 days
Lost time, businesses	$2,284	/hr			800		Major assumes 10 businesses impacted for 10 days)
		TOTAL:	**$15,303**		**$4,081,223**	**$0**	
Capacity Loss							
Reduction in Available Capacity	$12,307,692	/MGD	1		5		
Moratorium on growth	$133,062	/capita			100		
		TOTAL:	**$12,307,692**		**$74,844,662**	**$0**	
Complaint Response (Odor)							
Labor cost, calls and response	$35.99	/hr	50		200		
Equipment costs	1	$, placeholder	$500		$5,000		
Lost time, public	$28.73	/hr	5		20		
Lost time, businesses	$2,284	/hr			20		
		TOTAL:	**$2,443**		**$58,445**	**$0**	
Efficiency Loss							
Unit cost of electricity	$0.07	/kW-hr					Scale to scenario
Unit cost of natural gas	$0.49	/Therm					Scale to scenario
Unit cost for water	$1.77	/100 ccf					Scale to scenario
Materials/Chemicals	1	$, placeholder					Scale to scenario
Labor cost, admin	$35.99	/hr					Scale to scenario
Labor cost, trade	$43.92	/hr					Scale to scenario
Labor cost, professional	$53.03	/hr					Scale to scenario
Labor cost, management	$81.72	/hr					Scale to scenario
		TOTAL:				**$0**	
Efficiency Gains							
Unit cost of electricity	$0.07	/kW-hr					Scale to scenario
Unit cost of natural gas	$0.49	/Therm					Scale to scenario
Unit cost for water	$1.77	/100 ccf					Scale to scenario
Materials/Chemicals	1	$, placeholder					Scale to scenario
Labor cost, admin	$35.99	/hr					Scale to scenario
Labor cost, trade	$43.92	/hr					Scale to scenario
Labor cost, professional	$53.03	/hr					Scale to scenario
Labor cost, management	$81.72	/hr					Scale to scenario
		TOTAL:				**$0**	
External Opportunities							
Project Partnership/Coordination							
Project Savings, professional	$53.03	/hr	10	100	1000		
Organization Partnering, saved project costs	10%	$, % applied to placeholder	$10,000	$100,000	$1,000,000		
		TOTAL:	**$1,530**	**$15,303**	**$153,030**	**$0**	
Grants/Loans							
Grant Value	-1	$, placeholder					Scale to scenario. Note that grant funding should be included as a negative number as costs are represented as positive values.
Cost of grant administration, labor	$35.99	/hr	10	100	1000		
		TOTAL:	**$360**	**$3,599**	**$35,990**	**$0**	

Monetizing Basis	Unit Cost	Units	Input Quantity Assumptions				Input Quantity Assumptions
			Minor	Moderate	Major	Adjusted	
Other							*Note to User: This section is meant to capture any other costs that may be associated with the evaluation using the same risk quantification basis as the other sections.*
Labor cost, admin	$35.99	/hr					
Labor cost, trade	$43.92	/hr					
Labor cost, professional	$53.03	/hr					
Labor cost, management	$81.72	/hr					
Environmental remediation, labor	$43.92	/hr					
Additional maintenance, labor	$43.92	/hr					
Regulatory Reporting, labor	$53.03	/hr					
external labor cost, consultant	$150	/hr					
external labor cost, contractor	$75	/hr					
Cost for executing projects on an accelerated timeframe	10%	$, % applied to placeholder					
Lost time, public	$28.73	/hr					
Lost time, businesses	$2,284	/hr					
Cost of statutory fines for permit violations	$50,000	/day					
Emergency contract costs	1	$, placeholder					
Cost of consent decree stipulated penalty amounts	$4,000	day					
Cost of SSO stipulated penalty amounts	$50,000	day					
Cost of statutory fines for air permit violation	$50,000	day					
Unit cost of electricity	$0.07	/kW-hr					
Unit cost of natural gas	$0.49	/Therm					
Unit cost for water	$1.77	/100 ccf					
Health and Safety - Injury	$28,800	/claim					
Health and Safety - Fatality	$9,600,000	/person					
WBU (water back-up)	$6,220	/claim					
Vehicle damage claims	$3,046	/claim					
Bypass pumping	$5,000	per 5 MGD/day					
Reduction in Available Capacity	$12,307,692	/MGD					
Moratorium on growth	$133,062	/capita					
Temporary housing costs	$150	/day per home					
Cost of sewer backup	$1,915	/claim					
Labor cost, calls and response	$35.99	/hr					
PR costs, public notification	$500	/notification					
PR costs, public meeting	$9,083	/public meeting					
PR costs, long-term event	$250,000.00	/event					
Additional maintenance, parts	1	$, placeholder					
Equipment costs	1	$, placeholder					
Materials/chemicals	1	$, placeholder					
Project Savings, professional	$53.03	/hr					
Organization Partnering, saved project costs	10%	$, % applied to placeholder					
Grant Value	1	$, placeholder					
Cost of grant administration, labor	$35.99	/hr					
		TOTAL:				**$0**	

Attachment C: Example Risk Events