Vera C. Rubin Observatory
Rubin Observatory Operations

Rubin Observatory Risk and Opportunity Management Plan

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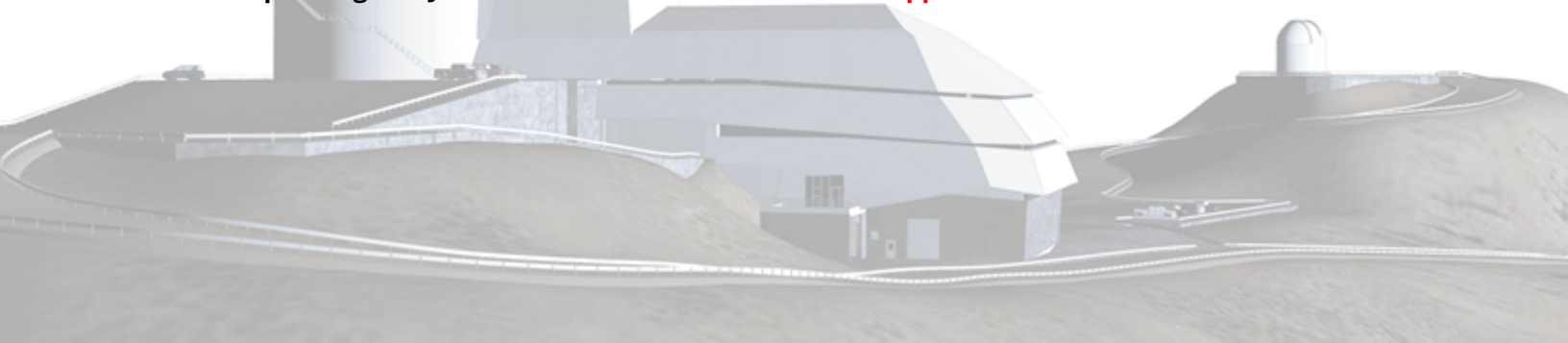

Abstract

The document provides the Rubin Observatory Risk and Opportunity Management Plan.

Change Record

Version	Date	Description	Owner name
1.0	2022-12-12	Unreleased draft.	Matthew Rumore
2.0	2024-03-26	First release preparation.	Matthew Rumore
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Contents

Rubin Observatory Risk and Opportunity Management Plan

1 Introduction and Background

This document describes the Risk & Opportunity Management Plan used to identify, assess, respond to, and manage risks and opportunities associated with the technical, cost, and schedule aspects of the Vera C. Rubin Observatory throughout the This document outlines the Risk & Opportunity Management Plan used to identify, evaluate, respond to, and oversee risks and opportunities related to the technical, cost, and schedule aspects of the Vera C. Rubin Observatory throughout the operation of the Legacy Survey of Space and Time (LSST). The Rubin Observatory Risk & Opportunity Management Plan emphasizes the advantages of managing uncertainty during operations.

The Risk & Opportunity Management Plan is part of a set of Rubin Observatory Operations plans that together establish a comprehensive approach to managing risk and opportunity, known as the decision-making framework under conditions of uncertainty. The Rubin Observatory Safety Policy, RDO-15, primarily addresses the risk of harm to personnel and equipment. Additional elements of risk and safety management are documented in materials from the NSF-related NOIRLab and the Department of Energy-related SLAC National Accelerator Laboratory, where relevant. Furthermore, where applicable, risk, safety, and hazard analysis plans for Rubin Observatory Operations are also adopted from the Rubin Observatory Construction Project.

The key aspects of the Risk & Opportunity Management Plan include:

- A standard methodology for identifying and assessing major risks and opportunities related to Operations Work Breakdown Structure (WBS) elements and operational functions from the Operations Plan.
- A continuous process to review and reassess current risks and opportunities on a quarterly or semi-annual basis, addressing new risks and opportunities as they emerge.
- Common techniques for assigning budget and schedule for the expected response in case of a realized risk.
- An approach and tool to measure and compare remaining major risk exposure across operations against contingency levels.

- A single dynamic and interactive system designed to inform management, support communication across operations, encourage regular team participation, and generate standard reporting and tracking features.

1.1 Risk Management Process Overview

The risk management process is a continuous, proactive approach to keeping risk at an acceptable level through awareness, tracking, and response management. The risk management process is a continuous, proactive approach to maintaining risk at an acceptable level through awareness, monitoring, and response management. The Rubin Observatory Risk Management process is event-focused. It involves identifying potential future events that could have either negative or positive effects on operations.

There are various types of risk related to Rubin Observatory Operations:

- Technical Risk, which includes the risk of not meeting survey performance requirements or deliverables
- Cost Risk, consisting of the risk that the available budget will be insufficient to cover the scope of operations
- Schedule Risk, consisting of the risk that the survey will fail to meet scheduled milestones
- A related type of risk is Programmatic Risk, which arises from events beyond the control of the operations management team and can be a source of risk in any of the other three risk categories.

As the project transitioned from construction to operations, the operations team collaborated with the Rubin Observatory project to identify any risks that might carry over into operations or are more likely to develop into operational risks.

1.2 Risk Management Tools

Rubin Observatory Operations will follow the NOIRLab model, as shown in Figure 1, for managing its risks and opportunities. The Alcea Tracking Solutions (ATS) software tool (Alcea Technologies, 2022) for risk management, adopted by NOIRLab, will be used by Rubin. The user guide for the ATS tool is found in RTN-051.

Additionally, Rubin will use Jira to track response plans as Epics, which can be linked to the ATS tool. Jira has already been integrated with Observatory operations and will help define the related effort and outcomes. Rubin may also choose to add extra tools on top of the Alcea platform to better incorporate risk and opportunity management into the Rubin workflow. Any additional tools Rubin develops for managing risks will be included in this document as they are created.

All risks are reported to the Association of Universities for Research in Astronomy (AURA), SLAC management, and NSF via NOIRLab's quarterly reports.

1.3 Roles and Responsibilities

The Rubin Observatory Risk & Opportunity Board (RROB) serves as the managing group for the Risk & Opportunity Management Plan. The RROB is managed by the System Engineering group. It reviews the risk registry, assesses risks and opportunities, collaborates on risk mitigation strategies, and develops implementation recommendations that are sent to the Director. The RROB includes Associate Directors (ADs), Deputy Directors, and other operations staff. Additionally, the head of safety for NOIRLab is expected to meet with the Council regularly to review risks.

The **Rubin Observatory Operations Director** is responsible for managing and mitigating operational risks. The Director will collaborate with senior managers to review and evaluate current risks quarterly. Additionally, the Director will approve all new risks (or delegate this task to another operations manager as appropriate) in coordination with the RROB.

1.4 Risk & Opportunity Definitions

Risk (also known as **Threat**) — The level of exposure to an event that could potentially harm a program, project, or other activity. It is described by the likelihood that the risk will occur and the severity of the loss or impact from that occurrence. Risk is a fundamental aspect of all activities, whether they are simple and small or large and complex. Risks are classified into four types based on their effect on operations: technical, budget (cost), schedule, and programmatic.

The term *risk* in this document refers to a negative impact, also known as a "threat". The term

FIGURE 1: NOIRLab Risk Management Model.

"risk" with a positive impact is an *opportunity*, as described below.

Issue — A risk that has been realized, e.g., the undesired outcome has materialized.

Technical Risk — The potential that a technical requirement of the system may not be fulfilled during its life cycle. Technical risk occurs if the system might fail to meet performance, operability, producibility, testability, integration, or environmental protection requirements. A possible failure to satisfy any requirement that can be described in technical terms is a source of technical risk (INCOSE, pg. 220).

Budget (Cost) Risk — The possibility that the available budget for operations will be reduced or insufficient to cover operational activities. Cost risk exists if:

- Rubin Observatory must devote more resources than planned to achieve technical requirements
- Rubin Observatory must add resources to support slipped schedules for any reason
- If changes must be made to the scope of operations
- if changes occur in the organization (i.e., Rubin Observatory, Association of Universities for Research in Astronomy [AURA] and/or NOIRLab, SLAC) or the national economy.

Budget risk can be forecasted at the overall operations level or for a specific system component or activity. The combined impact of activity- or element-level cost risks can lead to overall cost risk for Rubin Observatory (see INCOSE, pg. 220).

Schedule Risk — The potential that the Rubin Observatory may fail to meet its scheduled milestones. Schedule risk exists if there is insufficient allowance for delays in survey execution. Schedule risk also occurs when challenges arise in achieving milestones, such as the timely collection of survey data or the prompt release of data. Schedule risk can occur at the overall operations level for milestones such as the deployment of the first data release. The cascading effects of activity or element-level schedule risks can lead to schedule risk for Rubin Observatory overall (see INCOSE, pg. 220).

Programmatic Risk — Produced by events beyond the control of the Rubin Observatory management team. These events are often caused by decisions made by higher-level personnel,

such as reductions in Rubin Observatory priorities, delays in receiving approval to implement changes to the operations plan, funding cuts or delays, organizational shifts, or changes in national objectives. Programmatic risk can be a source of risk across the other three risk categories (INCOSE, pg. 220). AURA maintains an independent risk register for Rubin Observatory Operations.

Risk Management — The art and science of planning, assessing, and handling future events to avoid unfavorable impacts on the Rubin Observatory budget, schedule, or performance to the extent possible. Risk management is a structured, formal, and disciplined process focused on identifying and planning actions to assess and keep risks within acceptable levels. Risk Management is an event-driven approach to managing uncertainty.

Risk and Opportunity Responses — Responses are a strategic process for managing identified risks, where stakeholders determine how to handle each risk, whether as an opportunity or a threat.

Risk and Opportunity Actions — Steps taken to execute a response plan when a threat or opportunity occurs.

The four main response types to risks (threats) are outlined below.

Avoidance — Avoid risk through changes in requirements or redesign (INCOSE, pg. 223).

Mitigation (also known as **Control**) — Requires allocating budget or other resources to lower the likelihood or impact. Mitigations are suggested activities that are not part of the regular operations baseline. Once approved, mitigation activities become part of the baseline and are no longer called mitigations.

Transfer — Transferring responsibility for the risk through an agreement with another party that it is their scope to mitigate and respond to impacts if the risk occurs. Purchasing insurance is an example of risk transfer.

Acceptance — Accept the risk and the consequences if it materializes.

Existential Risk — A risk that is defined as "existential" to NOIRLab.

Opportunity (also known as **Benefit**) — The level of exposure to an event that could benefit a program, project, or other activity. It is defined by a combination of the likelihood that the opportunity will occur and the potential benefit or impact of that event. There are two levels of opportunities: at the macro level, a project itself embodies the pursuit of an opportunity; at the element level, tactical opportunities arise where certain events, if realized, can lead to cost or schedule savings or enhance survey performance.

Opportunity Management — The proactive art and science of planning, assessing, and managing future events to maximize positive impacts on project, cost, schedule, or performance. Opportunity management is a structured, formal, and disciplined activity focused on the necessary steps and planning actions to identify and capitalize on opportunities as much as possible.

The four main response types to opportunities are outlined below.

Exploit — Boost the chances of the opportunity occurring by allocating budget or other resources. The budget spending should be assessed against the probability-weighted risk of the opportunity to ensure that the expected net payoff remains positive.

Share — Sharing the risk among multiple stakeholders (teams/projects/programs).

Enhance — An action taken to improve the likelihood of the opportunity happening.

Ignore (also known as **Acceptance**) — Accept the opportunity as it is presented and hold off on taking any action for now.

Contingency — Rubin Observatory Operations does not have a formal "cash" contingency. Contingency can be achieved by scaling back the scope of activities or deliverables in the operations plan.

Contingency Management — The formal process enables the project to respond with flexibility to unforeseen issues that could affect the project's budget, schedule, and technical performance. This process accounts for activity-based uncertainties and high-impact event-based uncertainties. It essentially serves as the yearly and multiyear planning cycle for operations. Replanning might occur in less than a year for significant events, such as unexpected funding cuts from NSF or DOE. While routine annual planning usually leads to small adjust-

ments in scope and deliverables based on yearly appropriations, Rubin Operations will collaborate with the agencies to develop plans over multiple years.

Event — An incident or item that occurs at specific points in time—whether at a fixed time, over a distributed period, or randomly—during operations. Events are defined by something happening and are independent of activities. When events with negative consequences are combined with their likelihood of occurring, impact on operations, and response approach, they form the basis for entries in the Risk Register.

Activity — A specific task or set of tasks that Rubin Observatory Operations require, use resources, and take time to complete (Project Management, pg. 338).

2 Terminology: Risk & Opportunity Management Process

This section clarifies the terminology used to describe the management of risks and opportunities at Rubin. Risks and opportunities are assigned one of the statuses in the Risk Register and follow the lifecycle outlined in Figure 2.

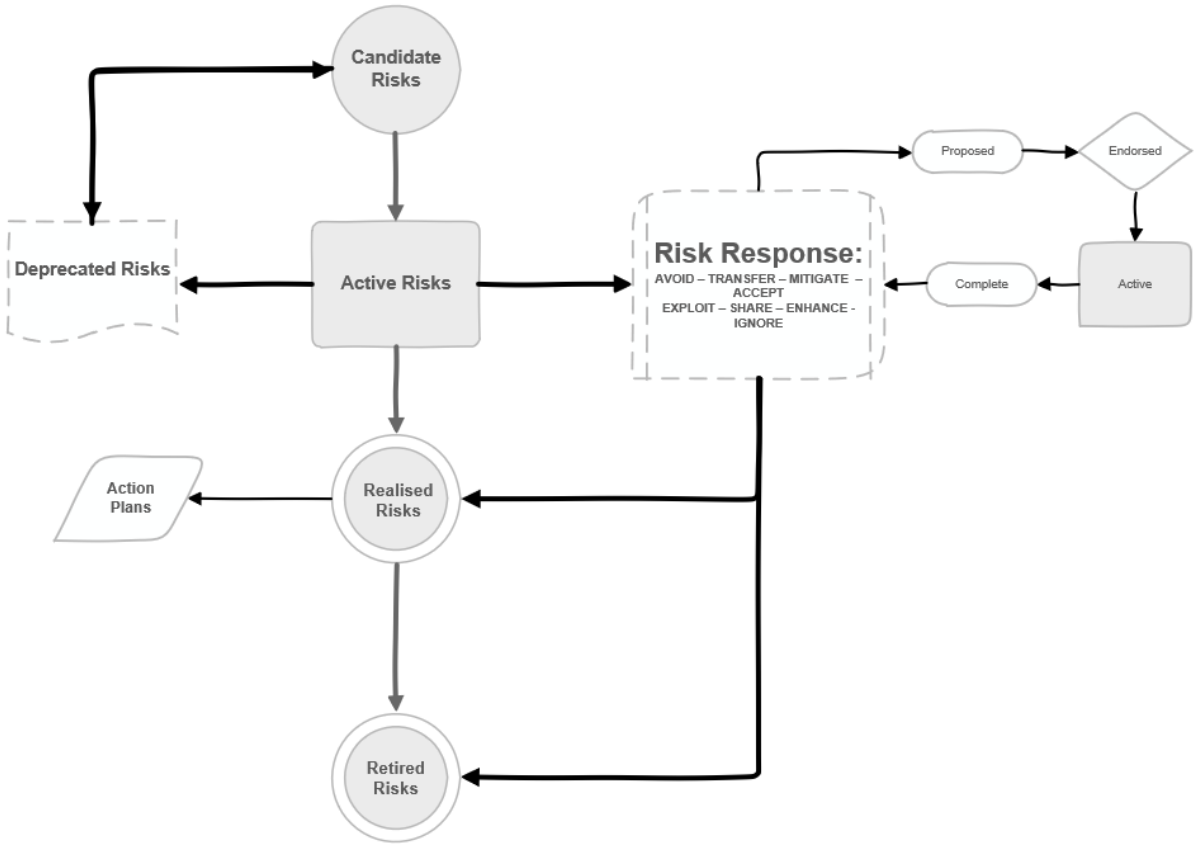
- **Candidate** — Risks and opportunities in a draft stage that are not actively managed by the project.
- **Active** — Risks and opportunities are deemed valid and actively managed by the project.
- **Realized** — Risks and opportunities that have been realized. There are three available models for the trigger.
  - **Specific Trigger Date** — A specific calendar date by which contingency funds must either be obligated to address a risk, the risk can be retired, or an opportunity's beneficial event will occur.
  - **Random Occurrence** — Certain risks or opportunities are possible but unpredictable in timing; for example, critical staff may leave the project, weather delays could occur, or equipment may fail. This kind of event needs an estimate of how often it happens randomly and the cost for each occurrence.
  - **Distributed Occurrence** — Identical risks or opportunities sometimes occur across different periods in the project; for example, software packages are evaluated for

performance annually. This type of event distributes the potential contingency obligation profile over the designated time frame.

- **Retired** — Risks and opportunities that are no longer relevant or actively managed because they have already occurred or the event trigger no longer happens.
- **Deprecated** — Risks and opportunities that were considered invalid and not actively managed.

2.1 Diagram: Risk & Opportunity Management Process

FIGURE 2: Lifecycle of Risks.



2.2 Terminology: Risk Categories

The following categories and subcategories are used to define risks in the Risk Register.

- **Program Science** Category
  - Astronomy and Astrophysics Community — Priorities, needs, and expectations, along with related changes.
  - Science Related — The organization's science, its relevance, and impact.
- **Technical** Category
  - Scope — Related to scope changes of the organization or project objectives.
  - Requirements — Identifying missing or poorly defined requirements.
  - Processes — Unclear or poorly defined technical or operational processes.
  - Technology — Technology readiness level and related aspects.
  - Interfaces — Technical interfaces, infrastructure, and the complexity of the interfaces, and related aspects.
  - Quality — Verification of the requirements and concept of operations to ensure performance. How well does the as-built system compare against the requirements?
- **Management** Category
  - Program/Project Management — Includes all aspects related to projects and programs, such as scheduling, planning, monitoring, and controlling.
  - NOIRLab/AURA Management — AURA, NOIRLab ratings, and other management-related topics for AURA and NOIRLab.
  - Operations Management — Portfolio management, finance, ITOps, safety group, and other operations-related areas.
  - Resourcing — Labor resourcing, shared resource availability, and conflicts among the shared resources.
  - Communication — Internal and external communication within the organization.
  - Health & Safety Environment — Mental health of employees due to the pandemic, safety in observatories, etc.
- **Commercial/Organizational** Category

  - Contractual/Procurement — All contractual and procurement-related events, liabilities, warranties, legal matters, and compliance issues.
  - Partnerships and Joint Ventures — Any risks related to tenants, partners, and in-kind support relationships.
  - Subcontracts and Suppliers — Any risk related to subcontractor and supplier issues (non-contractual), such as a supplier going bankrupt.

- **External** Category
  - Financial — All sources of risks related to funding and cash flow.
  - Legislation and Regulatory — Lease renewals, political matters, sites & facilities, applicable law.
  - Exchange Rates — Exchange rates for currencies, e.g., USD-CLP USD-EUR.
  - Natural Environmental Factors — Risks from weather, earthquakes, tsunamis, and other natural events.
  - Human Environmental Factors — Risks associated with light pollution, satellites, air pollution, and other passive human factors.
  - External Stakeholders — External stakeholders influencing, such as funding agencies, the public, protest groups, hackers, hostile competitors, or other active human factors.

2.3 Terminology: Risk Likelihood and Impact Categories

This subsection includes the following tables that define risk likelihood and risk impact categories:

- Table 1 provides the definitions of risk likelihood categories and their corresponding percentage probabilities.
- Table 2 provides the definition of impact categories based on overall risk.
- Table 3 provides the definition of impact categories based on cost.
- Table 4 provides the definition of impact categories based on the schedule.
- Table 5 provides the definition of impact categories based on L1 milestones.

- Table 6 includes the definition of impact categories based on L2 Table 6 provides the definition of impact categories based on L2 milestones.milestones.
- Table 7 includes the impact category definitions based on L3 milestones.
- Table 8 provides the definition of impact categories based on performance.

Table 1: Risk Likelihood Categories.

Likelihood Category	Percent Chance	Definition
Remote	10-20%	Extremely unlikely to occur.
Unlikely	21-40%	May occur only in exceptional circumstances.
Possible	41-60%	Could occur in certain circumstances.
Likely	61-80%	Probably will occur in many circumstances.
Very Likely	81-90%	Expected to occur in most circumstances.

Table 2: Risk Overall Impact Categories.

Impact Category	Overall Impact
Low	Impact on activities that affect internal (Rubin) aspects.
Moderate	Impact could affect L1 and L2 milestones representing POP expectations.
Significant	Loss of ability or accuracy in evaluating performance to meet milestones.
Damaging/Major	Potential changes in prioritization or delays to key deliverables.
Catastrophic/Extreme	Removing essential or critical aspects to the Rubin program or key deliverables.

Table 3: Risk Cost Impact Categories.

Impact Category	Cost Impact
Low	Minimal Consequences ($100K ≤ Cost Variance)
Moderate	Cost variance is less than or equal to 5% of the total approved FY baseline (≤ $3.5M)
Significant	Cost variance greater than 5% but less than or equal to 10% of the total approved FY baseline (≤ $7M)
Damaging/Major	Cost variance greater than 10% but less than or equal to 15% of the total approved FY baseline (≤ $10.5M)
Catastrophic/Extreme	Cost variance greater than 15% of the total approved FY baseline ([Cost Variance] > $10.5)

Table 4: Risk Schedule Impact Categories.

Impact Category	Schedule Impact
Low	Minimal consequence.
Moderate	Critical path does not slip; total slack of slipped tasks will not impact critical path in less than 10 days.
Significant	Critical path does not slip; total slack of slipped tasks is within 10 days of impacting the critical path.
Damaging/Major	Critical path slips.
Catastrophic/Extreme	Critical path slips and one or more critical milestones or events cannot be met.

Table 5: L1 Schedule Delay

Impact	Performance Impact
Low	N/A
Moderate	N/A
Significant	Any potential L1 Delay ≤ 1 month
Damaging/Major	Any anticipated L1 Delay
Catastrophic/Extreme	L1 ≥ 3 months

Table 6: L2 Schedule Delay

Impact	Performance Impact
Low	1 month ≤ Delay
Moderate	≤ 1 Month
Significant	≤ 2 months
Damaging/Major	≤ 4 months
Catastrophic/Extreme	Delay > 4 months

Table 7: L3 Schedule Delay

Impact	Performance Impact
Low	2 months ≤ Delay
Moderate	≤ 2 Months
Significant	≤ 4 months
Damaging/Major	≤ 6 months
Catastrophic/Extreme	Delay > 6 months

TABLE 8: Risk Performance Impact Categories.

Impact Category	Performance Impact
Low	Minimal consequence to objectives/goals.
Moderate	Minor consequence to objectives/goals.
Significant	Unable to achieve a particular objective/goal, but remaining objective goals represent better than minimum success or outcome.
Damaging/Major	Unable to achieve multiple objectives/goals, but minimum success can still be achieved or claimed.
Catastrophic/Extreme	Unable to achieve objectives/goals such that minimum success cannot be achieved or claimed.

3 Risk & Opportunity Identification and Assessment

This section explains who identifies and evaluates risks and opportunities, as well as how they do so. This is currently written assuming that the Risk Register is implemented in NOIRLab's ATS Risk Tool.

3.1 Create Risk Item

Minimum information required before saving in the Risk Register:

- Project — Rubin Operations.
- Risk Type — "Threat" or "Opportunity".
- Risk Department — Select the Rubin Observatory department that owns the risk and its evaluation.
- Risk Owner — Point of contact for ownership and technical information, responsible for coordinating the response to the risk.
- Risk Category — Select from the list provided by Section 2.2.
- Risk Title — Concise, descriptive title.
- Risk Statement — Description of risk, including at least an IF-THEN statement.
- Status — Automatically set to "Candidate".

Optional fields:

- Risk Sub Category — Select from the list provided by Section 2.2.
- Parent — Select all applicable Parent risk(s).

Risks can be created as ”children” of ”parent” risks. This is suitable for a risk expected to occur in separate, time-ordered phases or as distinct parallel events with their own impact. The parent’s cost and schedule impact is the combined cost and schedule impact of its children (see Section 3.2 for details). For the combined impact to be easy to understand and estimate, child risks must be defined as entirely independent (non-overlapping) and form a complete set. Risk owners should only break down a risk into component children if they can meet these criteria.

3.2 RROB Candidate Risk Review

The Risk Owner assesses risks prior to submitting them for review by the RROB. The Risk Owner is responsible for verifying the assessment in the automatically generated fields of the Risk Register. The RROB reviews the sufficiency and accuracy of the information and confirms the Risk Owner’s ability to manage the risk effectively as an active risk.

Minimum content required before submitting a Candidate Risk for review by the RROB.

- Status Description — Records a list of Rubin teams involved in defining, assessing, or implementing risk and plans.
- Existential Risk — The RROB will confirm or deny whether a risk is existential.
- Cost Impact — Choose from the list shown in Table 3.
- Schedule Impact — Choose from the list provided in Table 4.
- Likelihood — Choose from the options listed in Table 1.
- Residual Likelihood — Choose from the options listed in Table 1.
- Cost and/or Schedule Impact Description — Narrative explaining analysis and impact assessment.

- Fill in Cost and/or Schedule fields under Analyze Risk Quantitative if the impact is significant. — Quantitative analysis and impact assessment.
  - Likely Cost — The estimated post-mitigation cost of managing the risk in the year after it occurs. These short-term cost estimates are used to predict the necessary annual reserve funds.
  - Likely Delay — The estimated duration of delay to the "Impacted Milestone."
  - Impact Milestone — Event related to the realization of a risk. If the "Impacted Milestone" is either "Start of Operations" or "LSST Survey Completion," the "Realized Risk Plan" (a separate item on this list) must include "Extend Survey" because such schedule delays lead to a post-operations situation cost.
- Plan Type and at least one associated Response Plan (i.e., how the risk will be mitigated). — Choose from the plan type list provided in Section 4.1.
- Realized Risk Plan — Description of the event trigger and the plan for addressing the risk once it occurs.

Optional fields:

- Overall Impact — Impact category that can override the automatically generated cost and schedule impact categories. Note that the "Impact Severity" will be set to the most severe of the three impact categories.
- Related Actions

Each risk is initially scored based on its Cost Impact and Schedule Impact. In accordance with the NOIRLab Overall Impact Criteria, Risk Owners will also consider the Likely Cost, Likely Delay, and the milestone's impact to further evaluate the overall risk score. These additional assessment points help Risk Owners better distinguish between prioritization and escalation. As Risk Owners assess their risks, some risk scores may increase from their initial evaluation. Risk Owners should bring these to their Associate Director's attention for potential discussion and elevation during the next RROB meeting. Additionally, if the risk score changes by more than 7 or exceeds 17 before adjustment, the Risk Board will review whether to escalate it to Rubin Operations.

When analyzing a risk that is the parent of N child risks:

- First, analyze each child separately, i.e., estimate the Residual Probability, P_k, Likely Cost, C_k, and Likely Delay, S_k, for the k-th risk, and repeat this for all k in the range $(1 \dots N)$.
- For each child risk, calculate its Cost Exposure: $E_k = C_k \times P_k$.
- The overall Cost Exposure for the parent risk is the total of the Cost Exposures of its children. $E_{\text{total}} = \sum_{k=1}^{N} E_k$.
- The Likely Cost of the parent risk equals the sum of the likely costs of its children. $C_{\text{total}} = \sum_{k=1}^{N} C_k$.
- The Residual Probability of the parent risk is its Cost Exposure divided by its Likely Cost: $P_{\text{total}} = E_{\text{total}}/C_{\text{total}}$. This is the cost-weighted average of the child risks' residual probabilities, and it is the most meaningful way to define probability for parent risks.
- Other quantitative attributes of parent risks can be calculated through straightforward addition (Minimum Cost, Maximum Delay, Schedule Exposure, etc.).
- Pre-response quantities of parent risks, like Impact Scores, can be reverse engineered from their Residual Probabilities.

3.3 Continuous Review and Updates to Active Risks

Risk Owners identify issues or proposed changes to Active Risks for review at a monthly RROB meeting. The goal of the RROB monthly meeting is to review 3-5 risks each month.

All risks will be evaluated twice a year: during the Annual Scrub in May and again in the second half of the year. In the (May) Annual Scrub, Level 3 Team Leaders are invited to review, in the "Scrub Sandbox," the relevant risk areas that impact their team and for which they are expected to assist in response. The changes they suggest are reviewed by the RROB and added to the Risk Register by the Risk Owners during the post-scrub implementation phase (June).

For more significant and evolving risks, managing departments will review risks more frequently as needed. Any risks listed among the Top 15 Risks must be reviewed at least quarterly by the relevant Risk Owner. A few of these risks should be discussed during the monthly meetings to meet the quarterly review cycle. The Risk Review Board will also examine any evolving risks with status changes during the monthly meetings. This applies to any risk regardless of its status.

3.4 Addressing Realized Risks

Triggering a Realized Risk: The Risk Owner reviews all Response Plans and Actions, followed by a review with department management. The Risk Owner proposes changing the status from "Active" to "Realized." A review by the RROB is required if the severity exceeds a threshold set by the RROB Chair. By default, any Realized Risk is reviewed at least once every two months until it can be retired. This review also includes the plans and actions, not just the risks themselves.

Addressing a Realized Risk: The risk owner collaborates with department management to submit a Request Beyond Target (RBT) for additional resources needed to mitigate the risk (see RTN-005 for the RBT process). The RBT is reviewed by RDO, which then works with the department to handle any necessary escalations to NOIRLab, SLAC, funding agencies, or the Resource Forum.

Additional resources for managing risks are drawn from reserve funds. The annual reserve budget is estimated as the total of the cost exposures across all parent risks. Currently, the cost exposure and budget calculations are done outside the Risk Register in a separate tool—the "Rubin View of the NOIRLab Risk Register" Google sheet.

When a risk is in the "Realized" state, the ongoing quantitative analysis should determine the Residual Probability and the associated Likely Cost and Likely Delay relevant to the risk after both mitigation efforts and partial (to-date) mitigation. (Some risks require significant time and multiple resource planning cycles to address.) This ensures that the Cost Exposure related to the risk only includes the funds still likely to be needed, not the total amount required to fully mitigate the risk. This continuous analysis should be reviewed during monthly meetings, at least every other month, until the risk has been managed.

To monitor Risk Mitigation in Jira, Risk Owners should create epics for actions and plans related to identified risks. The Risk Owner must assign each Jira ticket to the Plan Owner, who will be responsible for delegating tasks associated with the Plan. The Plan Owner will also specify the expected effort and impact when addressing risk realization, coordinate with relevant Teams, establish criteria for completion, and estimate potential costs. As actions arise from implementing response plans, Plan Owners will identify Action Owners. Action Owners will oversee coordinating actions with related Teams, addressing actions with risks of Significant impact or higher within their due dates, and creating or maintaining subsequent Jira tickets linked to

the parent Jira Epic.

3.5 Retiring Risks

The Risk Owner reviews the risk before closing it, whether it has been realized or if the risk's event cannot be triggered. The RROB reviews the associated plans and actions before retiring a risk that did not trigger, to ensure there is no impact on other risks. All actions should be completed in the Risk Register (including Jira tickets for follow-up work) before retiring the risk that triggered. Documentation updates should be considered during this review. A conclusion statement is included in the Risk Register to record the reason for retiring or deprecating a risk.

3.6 Risk Assessment

There are six aspects to evaluating the status of each risk and opportunity within a subsystem:

1. Identification: recognizing elements of risk in the department's activities.
2. Establishing a time frame: determining when an event is likely to occur.
3. Assessing probability: estimating the likelihood that an undesirable event could happen.
4. Assessing severity: evaluating how much such an event would affect the project's status if it happens.
5. Developing risk options: creating plans to avoid, accept, mitigate, or transfer.
6. Develop a management response: consider how the project might react if the event occurs.

3.7 Authority of Risks

In some cases, the RDO may delegate authority to the Associate Director to manage risks, plans, actions, and mitigation funding decisions in order to speed up mitigation efforts and improve operational flexibility. The Associate Director may then assign lower priority risks to Team Leads. The Risk Board consents to all delegations of responsibility. For guidelines of appropriate delegations, see the Rubin Observatory Risk Management Tool User Guide:

- AD's have authority if the Risk Score is less than 10 and do not impact L1/L2 milestones
- AD's can delegate authority to Team Leads for risks less than 7 and do not impact L1/L2 milestones
- RDO can delegate authority to AD's when a Risk Score is below 12

3.8 Risk Reporting

The Risk Board will report to NOIRLab monthly. This report will highlight the risks discussed during the monthly meeting, any updated risks in status or impact, any risks whose risk score has changed by more than 7, any risks whose risk score was more than 17 before the change, any risks with impact categories exceeding the threshold of damaging or major, and any risks whose contingency draws on NOIRLab funds. If escalation is needed beyond NOIRLab, the Risk Board will review it with the RDO before engaging the agencies. All escalated risks should be reported within 7 days of management discovery.

4 Terminology: Risk & Opportunity Response Monitoring and Control

This section defines terminology related to managing risks and opportunities.

4.1 Risk & Opportunity Response

The definition of responses is provided in the ATS Risk Software. The following describes the definition of response plans to risks.

- **Avoid** — changing your strategy or plans to avoid the risk. This risk response strategy aims to eliminate the threat by any means necessary. That may involve adjusting your management plan to steer clear of the risk because it could be harmful to the project or program.
- **Transfer** — passing ownership and/or liability to a third party involves transferring or passing on the work, thus shifting the risk to someone else. For example, purchasing fire insurance for an unfinished building.

- **Mitigate** — reducing the probability and/or impact of a risk below an acceptable threshold. Some risks cannot be avoided and require actions to minimize their impact, such as work procedures and equipment designed to enhance workplace safety.
- **Accept** — recognizing residual risks and developing responses to control and monitor them - This risk response strategy involves identifying a risk, documenting all risk management information related to it, and taking no action unless the risk occurs.

The following contains the definition of response plans to opportunities.

- **Exploit** — Taking advantage of a risk to seize the opportunity it creates if the risk materializes.
- **Share** — Sharing the risk among multiple stakeholders (teams/projects/programs)
- **Enhance** — Enhancements are measures used to boost the chances of the opportunity happening.
- **Ignore** — Opportunities that cannot be actively addressed by exploiting, sharing, or improving can be ignored without special measures.

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B Acronyms

Acronym	Description
AD	Associate Director
AURA	Association of Universities for Research in Astronomy
CLP	Chilean Peso
DOE	Department of Energy
FY	Financial Year
L1	Lens 1
L2	Lens 2
L3	Lens 3
LSST	Legacy Survey of Space and Time (formerly Large Synoptic Survey Telescope)
NOIRLab	NSF's National Optical-Infrared Astronomy Research Laboratory; https://noirlab.edu
NSF	National Science Foundation
POP	Project Operating Plan
RBT	Requests Beyond Target

RDO	Rubin Directors Office
RTN	Rubin Technical Note
SLAC	SLAC National Accelerator Laboratory
TBD	To Be Defined (Determined)
USD	United States dollar
WBS	Work Breakdown Structure