MONTGOMERY
& ASSOCIATES
Water Resource Consultants

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REVISED REPORT

Monitoring and Mitigation Plan for Groundwater-dependent Ecosystems and Water Wells

Prepared for:

South32 Hermosa Inc.

1860 E. River Road, Suite 200, Tucson, Arizona

Prepared by:

Montgomery & Associates

1550 E. Prince Road, Tucson, Arizona

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1 INTRODUCTION

Montgomery & Associates (M&A) has prepared this Monitoring and Mitigation Plan at the request of the United States Forest Service (USFS) and on behalf of South32 Hermosa Inc. (South32), for the South32 Hermosa Critical Minerals Exploration and Mine Plan of Operations (Plan of Operations). The Plan of Operations is an expansion of mining on private land to National Forest System (NFS) lands and collectively with the Plan of Operations will be referred to herein as the "Hermosa Project."

The Hermosa Project is located in the Patagonia Mountains in Santa Cruz County within the Coronado National Forest, approximately 5 miles southeast of Patagonia, Arizona. The Hermosa Project requires the extraction of local groundwater to allow safe access to the deposit (South32 Hermosa Inc., 2025). Both Groundwater-dependent Ecosystems (GDEs)—which comprise springs and surface water that are partially or fully dependent on the regional groundwater system—and wells in the mine area may be impacted by groundwater management activities.

This Monitoring and Mitigation Plan has been developed to minimize environmental impacts from the Hermosa Project by repairing, rehabilitating, mitigating, or replacing the affected environment as specified for each GDE or well in the following sections. The plan has been incorporated into the Hermosa Project design and is intended to be implemented under the Selected Alternative (GSI Environmental Inc., 2024). Figure 1 provides a map of the GDEs and wells surrounding the Hermosa Project that will be the subject of long-term monitoring, with Table 1 listing these features by watershed.

The purpose of this document is to provide the following:

- A monitoring plan to track and assess potential impacts to each GDE or well
- A definition of triggers to indicate if mining-related activities have impacted GDEs and wells, and associated actions to be taken by South32
- Proposed measures to repair, rehabilitate, mitigate, or replace each GDE or well shown by monitoring to be sufficiently impacted (based on triggers) by mining-related activities

Efforts to avoid and minimize impacts are integrated into the mine design and the analysis of alternative plans during the early stages of mine planning. For the purpose of this plan, mitigation refers to actions that avoid, minimize, or compensate for adverse impacts caused by a proposed action or selected alternative (NEPA, 2025).

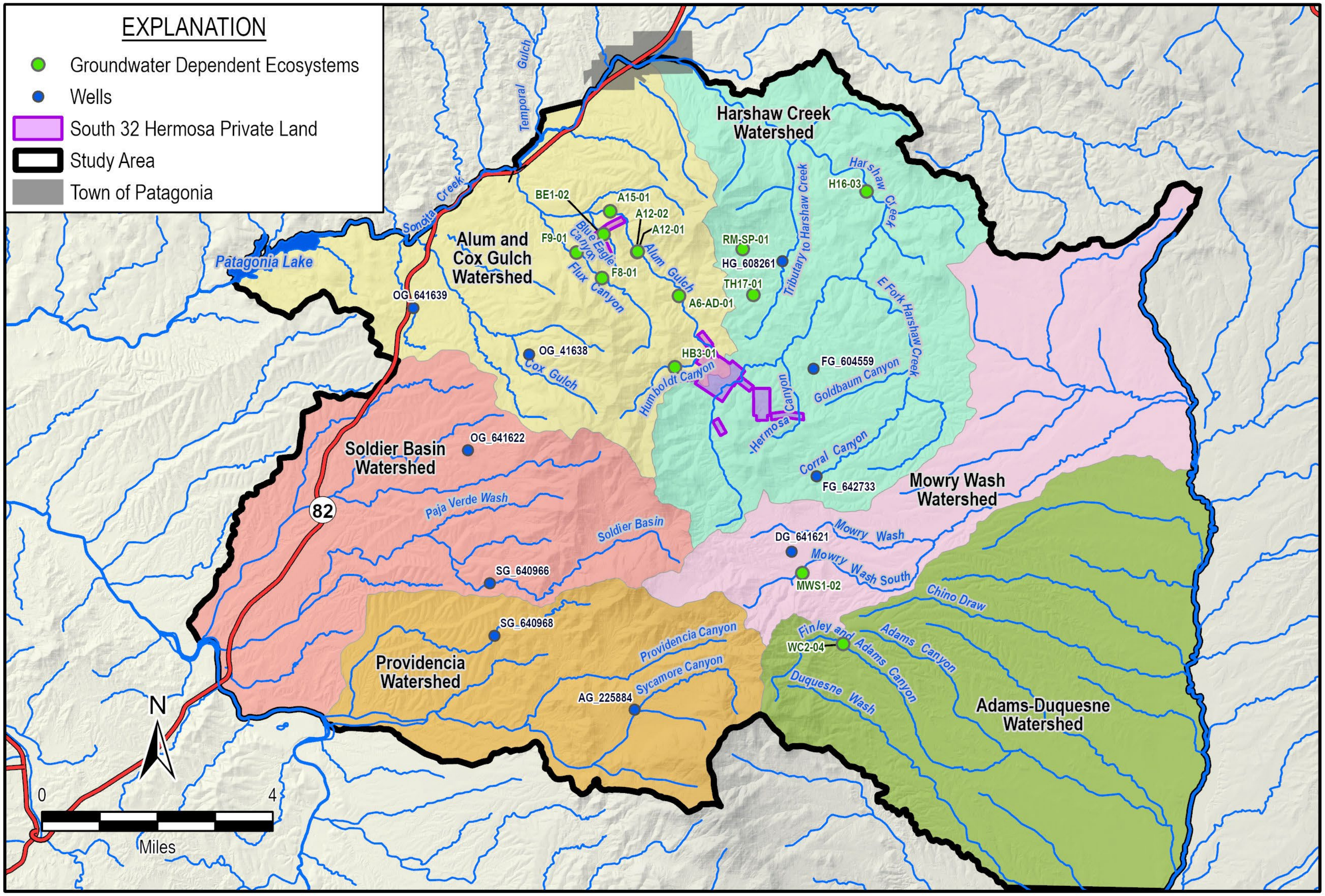

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Figure 1. Map Showing all GDEs and Wells on NFS Land for Long-term Monitoring

Table 1. GDEs and Wells on NFS Land for Long-term Monitoring

WATERSHED	DRAINAGE	SITE TYPE	SITE NAME
Adams-Duquesne	Finley and Adams Canyon	Spring	WC2-04
Alum and Cox Gulch	Alum Gulch	Spring	A6-AD-01
			A12-01
			A12-02
			A15-01
	Blue Eagle Canyon		BE1-02
	Flux Canyon		F8-01
			F9-01
	Humboldt Canyon		HB3-01
		Well	OG_41638
			OG_641639
Harshaw Creek	Harshaw Creek	Spring	H16-03
	Red Mountain drainage		RM-SP-01
	Tributary to Harshaw Creek		TH17-01
		Well	FG_604559
			FG_642733
			HG_608261
Mowry Wash	Mowry Wash South	Spring	MWS1-02
		Well	DG_641621
Providencia		Well	AG_225884
			SG_640968
Soldier Basin		Well	OG_641622
			SG_640966

Note: 19 total seeps/springs were previously identified as connected or potentially connected to regional groundwater; however, two locations (TH11-ST-01 and TH14-01) are not candidates for long-term monitoring given that they will be covered by Plan of Operations facilities. Sonoita Creek (SNTA-01 and SNTA-02) and TNC (TNC-Cienega Spring and SNTA-TNC-01R) sites are also not included in this Monitoring & Mitigation Plan because they are located on private property and not under the jurisdiction of USFS.

Name Prefixes (Provided by South32 personal communication):

DG – Duquesne Grazing Allotment
FG – Farrell Grazing Allotment
HG – Harshaw Grazing Allotment
OG – Oak Bar Grazing Allotment
SG – Santa Cruz Grazing Allotment
AG – Alisos Grazing Allotment
LG – Lewis Grazing Allotment
WC – Washington Camp
A – Alum Gulch
BE – Blue Eagle Canyon
F – Flux Canyon
HB – Humbolt Canyon
H – Harshaw Creek
RM – Red Mountain
TH – Tributary to Harshaw Creek
MWS – Mowry Wash South
SP – Spring
ST – Stock Tank
AD – Adit

2 OVERVIEW OF GROUNDWATER-DEPENDENT ECOSYSTEM HYDROLOGY

There are three general sources of water for springs and surface water: 1) precipitation runoff, 2) local, perched groundwater systems with limited storage capacity, and 3) the regional groundwater system with greater storage capacity (M&A, 2024). Sites included in this plan are springs and surface water that are fully or partially supported by regional groundwater systems. The suite of springs, seeps, and wells herein represent the features to be monitored.

As discussed in the introduction, the GDEs included in this Monitoring and Mitigation Plan were identified through several years of baseline monitoring and field investigations. GDEs were selected using an evidence-based decision process that integrates isotopic, radiocarbon, and hydrologic indicators. Springs and seeps were classified according to three primary criteria: (1) a radiocarbon age greater than 70 years paired with tritium values below detection, indicating connection to the regional groundwater system; (2) 100% measurable flow during all monitoring events, also signifying regional groundwater support; and (3) tritium concentrations below the annually adjusted modern threshold, suggesting a potential regional groundwater connection (M&A, 2024). Sites not meeting these criteria were classified as locally perched, anthropogenically altered, or unevaluable due to discharge influences.

The selection of wells on NFS land was based on field investigation of wells on grazing allotments that were identified as actively being used. Surface water occurs in channels, streams, creeks, rivers, and ephemeral washes and may include both flowing and standing water. Groundwater can enter a surface water feature via several pathways: it can seep up from the base of a channel along a gaining reach, merge with the channel from a spring along the bank, or seep in through fractures or joints in the bedrock. A reduction in either local or regional groundwater levels can impact groundwater connected surface water features; they may dry up completely, have reduced discharge rates, or have higher seasonal variability.

3 MONITORING PLAN

Groundwater management activities are predicted to cause local groundwater levels to decline and may reduce groundwater availability to GDEs and wells connected to regional groundwater. The intent of monitoring is to identify changes within the regional groundwater system and associated changes to GDE and well attributes.

This Monitoring and Mitigation Plan is based on several years of baseline data collection through physical monitoring of springs, surface waters, and wells. All GDEs included in the Plan were identified and characterized through this baseline monitoring. Groundwater modeling was not used to determine monitoring locations; rather, some of the selected monitoring locations are sited beyond the extent of the modeled 10-foot drawdown contour. This ensures comprehensive coverage of potentially impacted areas, regardless of modeling outcomes.

This Monitoring and Mitigation Plan proposes monitoring locations, monitoring data types, mitigation criteria for each GDE and well, and types of mitigation informed by the baseline conditions. Mitigation will be initiated when observed changes at a site (GDE or well) are determined to be associated with South32 groundwater management activities. The location and purpose of monitoring for each GDE and well are shown in Tables 2 and 3, respectively, and all GDEs and wells are shown on Figure 1. The following sections present a generalized description of each element of the Monitoring and Mitigation Plan.

3.1 Monitoring Locations and Types

The monitoring locations prescribed in this plan include GDEs and water supply wells (Table 2 and Table 3). Proposed data collection at each GDE and well site will be used to evaluate temporal changes from baseline conditions and serve as the basis for implementing mitigation actions in coordination with USFS if mining-related impacts are observed. The evaluation uses multi-year trend analysis, baseflow separation (when possible), climate data, and impacts from other well users to reasonably distinguish mining-related effects from natural variability, while acknowledging inherent uncertainty.

With respect to the water supply wells listed in Table 3, this Monitoring and Mitigation Plan aims to protect the use of a well, not its capacity or the well itself. The wells identified in this plan are actively in use primarily for stock water supply.

A modeling study completed by GSI Environmental Inc. (2024) provides an inventory of area wells predicted to experience at least 10 feet of drawdown, along with the estimated timing of those impacts. Wells incorporated into this Plan were identified through a review of grazing allotments and subsequently verified in the field to confirm active use. Only active wells on NFS lands that are expected to incur 10 feet or more of drawdown are included in this Monitoring and Mitigation Plan.

Monitoring is proposed to begin as soon as the record of decision is issued, when access to the wells is granted. South32 will conduct a model update every five years during the life of project, which incorporates data collected from various sources, including flow meters and pressure transducers, to determine the quantity of water being used. Based on the results from the five-year update, the selection of wells for continued monitoring may be modified in consultation with USFS.

Monitoring equipment will be installed when access is granted by the USFS and the authorized well user, if necessary. Well modifications may be required to install the monitoring equipment. South32 will coordinate with the authorized well user and/or USFS before any modifications are made. Detailed methods and materials for the installation of continuous monitoring sensors at GDE locations are provided in Appendix A-1. This appendix describes the specific types of equipment that may be used, installation configurations suitable for various site conditions, and estimated temporary and permanent disturbance footprints associated with each installation.

Proposed monitoring for GDEs will include continuous monitoring for the presence of water (soil saturation or water level), discrete biannual flow rate measurements, and temporal monitoring of phreatophyte area via remote sensing and ground-truthing. For groundwater wells, monitoring will include continuous groundwater level and flow. The required data types for each GDE depend on its characteristics and monitoring feasibility. For example, monitoring the type and area of phreatophytes (defined here as plant species with a wetland indicator status of obligate wetland [OBL] or facultative wetland [FACW]) is required for all GDEs. Monitoring data requirements for each GDE are listed in Table 2.

3.2 Assessment Triggers

This plan specifies criteria for each GDE or well that will require South32 to initiate further assessment to determine, in consultation with USFS, if mitigation is needed (Table 4 and Table 5).

3.2.1 Groundwater-dependent Ecosystems

Statistical Analysis

For each dataset collected, a Mann-Kendall or seasonal Mann-Kendall trend test (Helsel *et al.*, 2020) will be used to determine if there are statistically significant decreases in the measured GDE attribute (calculated flow rate, water level, moisture persistence, and phreatophyte area, etc.). Trend analysis will be conducted three years after installation of monitoring equipment, subsequent to initiation of South32 groundwater management activities, which began in

September 2023. The trend is considered statistically significant if the associated p-value falls below 0.05 (Helsel *et al.*, 2020). If a significant decrease in the measured GDE attribute is identified, an assessment will be triggered to determine the cause. If South32 and USFS teams determine that mitigation is necessary on NFS lands, the implemented mitigation type will be selected based on mutual agreement between Coronado National Forest and South32.

Transducers, Inundation Sensors, and Flow Rate

For each GDE, ponding depth (transducers), moisture persistence (inundation sensors), and flow rate will be measured and, if possible, a baseflow separation analysis will be conducted prior to conducting a trend analysis, to isolate the groundwater-dependent component of flow and remove the influence of climatic features to the extent possible. Baseflow separation will be applied only where flow records are continuous or semi-continuous and hydrograph responses are well-defined.

3.2.2 Groundwater Wells

For each groundwater well dataset collected, a Mann-Kendall or seasonal Mann-Kendall trend test (Helsel *et al.*, 2020) will be used to determine if there are statistically significant decreases in the measured well attribute (water level and flow rate). Trend analysis will be conducted three years after installation of monitoring equipment, subsequent to initiation of South32 groundwater management activities, which began in September 2023. The trend is considered statistically significant if the associated p-value falls below 0.05 (Helsel *et al.*, 2020). If a significant decrease in the measured well attribute is identified, an assessment will be triggered to determine the cause. Water levels in the wells may decrease if the pumping rate in the well increases, there is a reduction in the groundwater recharge rate caused by climatic factors or the well is impacted by South32 groundwater management or pumping from other wells. Pumping rate in wells may decline due to declines in the water level described above or due to changes in well and pump condition. If South32 and USFS determine that mitigation is necessary on NFS lands, the implemented mitigation type will be selected based on mutual agreement between Coronado National Forest and South32.

3.2.3 Trigger Analysis Process

When an assessment is triggered, South32 will implement a structured analysis process developed in coordination with the NFS. This process will include site-specific data review and investigation steps to evaluate observed changes in the context of baseline conditions, hydrologic trends, and climate variability. Analytical methods may include trend analysis, baseflow separation, comparison with climate records, and evaluation of potential effects from other water users. The results will be used to determine whether observed changes are consistent with natural variability or are reasonably attributable to South32 groundwater management activities, guiding decisions on whether mitigation is warranted.

4 MITIGATION PLAN

Mitigation measures are direct actions taken to offset mining-related impacts on a specific GDE or well as part of the Monitoring and Mitigation Plan. Initial mitigation measures for each site are specified in Table 4 for GDEs and Table 5 for wells and may include one or more approaches. Additional baseline monitoring or improved understanding of site conditions may indicate that one mitigation approach is more appropriate than another. A selected mitigation is considered acceptable if it accomplishes the goal of repairing, rehabilitating, mitigating, or replacing the affected GDE or well. Table 4 and 5 identify the mitigation alternatives that may be implemented if required. Appendix A-2 addresses any mitigation-related impacts. If mitigation is necessary for a site, South32 in consultation with USFS will determine which mitigation alternative to pursue from the options listed below. Any deviation from the proposed mitigation alternatives will be coordinated with and approved by the USFS.

As part of ongoing groundwater management, treated water from WTP2 will be discharged to local drainages that include Goldbaum Canyon, Mowry South Wash, and Harshaw Creek. These discharge locations, referred to as *alternative discharge sites*, have been evaluated for their geomorphic condition and capacity to receive treated flow. Mitigation and monitoring actions associated with these sites emphasize the use of Nature-Based Solutions (NBS) to enhance channel stability and resilience; detailed implementation procedures are provided in Appendix B.

4.1 Groundwater-dependent Ecosystems

Mitigation alternatives are intended to mitigate GDE water availability and ecosystem services. For this reason, mitigation alternatives identified include direct interventions using either passive or active measures that aim to mitigate and enhance GDE function.

WTP2 Water Supply

Water Treatment Plant #2 (WTP2) discharge consists primarily of regional groundwater sourced from wells with screens ranging in depth from 700 to 4,600 feet below land surface (bls) that is treated to meet applicable surface water and aquifer water quality standards as part of South32 groundwater management activities. During the Life of Mine (LoM), WTP2 treated water may be brought to a GDE via piping or hauled in by truck as a temporary mitigation. Groundwater recovery is a slow process, and this mitigation option can supply water to groundwater dependent ecosystems affected by mine dewatering for the LoM. Restoration of hydraulic gradients sufficient to reestablish flow to these ecosystems may not occur until long after mine closure.

Installation of a Guzzler

Guzzlers are relatively simple systems for harvesting rainwater for wildlife consumption (Figure 1). Guzzlers use an impermeable apron, typically installed on a slope, to collect rainwater which is then piped to a storage tank. A drinker allows wildlife and/or livestock to access water without trampling or further degrading the spring or water feature. Guzzlers are a highly effective method of providing water to animals but are not a viable mitigation measure for maintaining phreatophytic vegetation at a GDE.

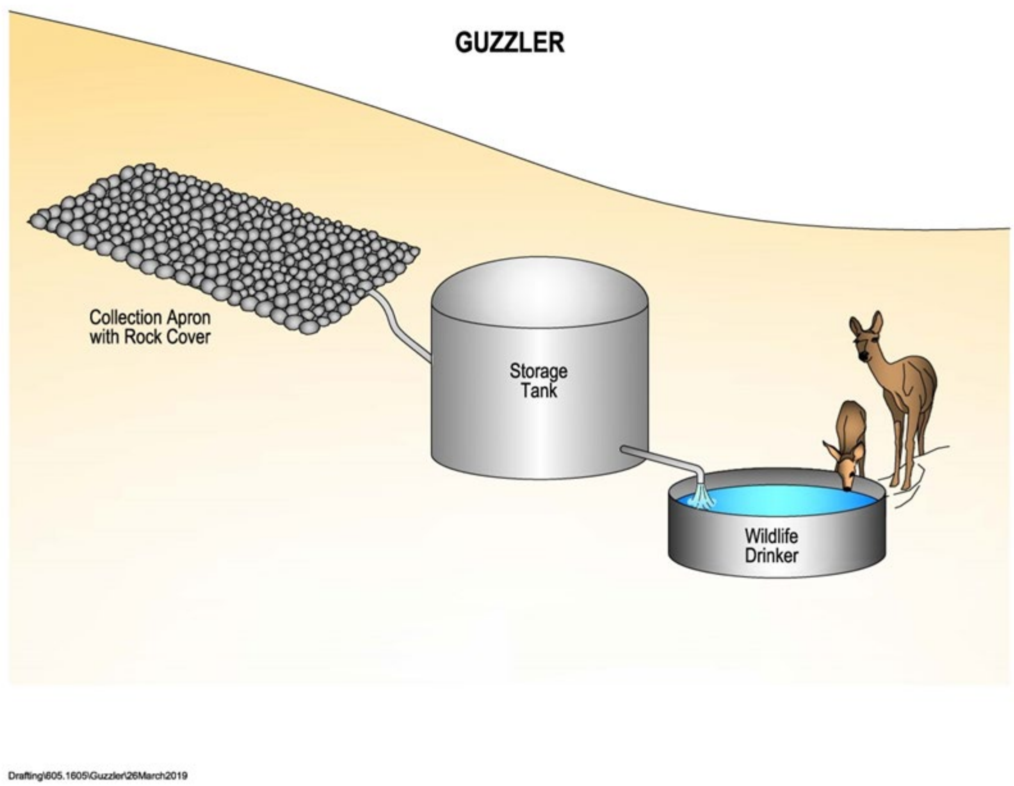

Figure 2. Conceptual Diagram of Guzzler, including Collection Apron, Storage Tank, and Wildlife Drinker

Install Spring Box or Well and Pump to Surface

A spring box can be installed or a well can be drilled or used near a GDE, after which water is pumped to the surface. The use of a spring box or well will supply water to a GDE to maintain the ecosystem.

Rock Detention Structures

Rock Detention Structures (RDS) are relatively low-impact design interventions that dissipate stream energy promoting bank infiltration, sediment retention, and promotes channel and grade stabilization (i.e., making the stream less erosive). RDS are built upgradient to a GDE to slow surface water runoff from precipitation and concentrate water in the area of interest. Additionally, RDS can contribute to the stable growth of riparian vegetation by promoting consistent water availability (DeBano and Heede, 1987; Gurnell, 1998).

Natural structures such as beaver dams, debris jams (woody vegetation or rock), and rock outcrops serve similar functions by enhancing watershed health. Human-constructed RDS can mimic these natural processes and achieve comparable benefits, as demonstrated by low-tech, process-based restoration (LTPBR) techniques (Wheaton *et al.*, 2019). The most commonly used RDS, as outlined by Norman *et al.* (2022), include gabions, cross vane weirs, and trincheras (Figure 3). The most appropriate option for each location will be selected in consultation with USFS.

One-Rock Dams

One-rock dams are a low impact form of rock detention structure consisting of a single layer of rock placed across the channel bed. These structures are intended to slow surface water flow, promote sediment deposition, increase infiltration, and reduce erosive energy without creating a barrier to aquatic or wildlife movement. When installed in series, one-rock dams can support grade stabilization, attenuate runoff from precipitation events, and improve channel conditions that support riparian vegetation and groundwater dependent ecosystem function. Placement and design of one-rock dams will be coordinated with and approved by the USFS.

Seep Relocation

South32 Hermosa has designed seep relocation measures for two GDEs, TH14-01 and TH11-ST-01, which are located within the TSF2 disturbance footprint. This design feature will allow potential groundwater currently seeping at these locations to be conveyed beneath TSF2 and routed to daylight outside of the TSF2 footprint, where flow will be discharged to the natural drainage north of the TSF2 Underdrain Collection Pond (UDCP) (USFS, 2025).

This mitigation measure is specific to TH14-01 and TH11-ST-01 and is intended to maintain surface expression of seep flow outside of the TSF2 footprint. Seep relocation is not proposed as a mitigation measure for other GDEs.

Nature-Based Solutions Integration Framework

In addition to the mitigation measures described above, South32 and the USFS have developed a supplemental framework to guide the monitoring and phased implementation of NBS at treated-water discharge locations, including Goldbaum Canyon, Mowry South Wash, and Harshaw Creek. This framework provides an adaptive, stepwise approach for evaluating geomorphic and hydrologic response to discharge, establishing triggers for stabilization, and applying low-impact, process-based restoration techniques such as cross-vane weirs to provide grade control, J-hooks to direct shear stress away from channel banks, and reshaping of vertical to near vertical stream banks combined with native plant seeding. Detailed methods, monitoring criteria, and adaptive-management procedures are presented in Appendix B.

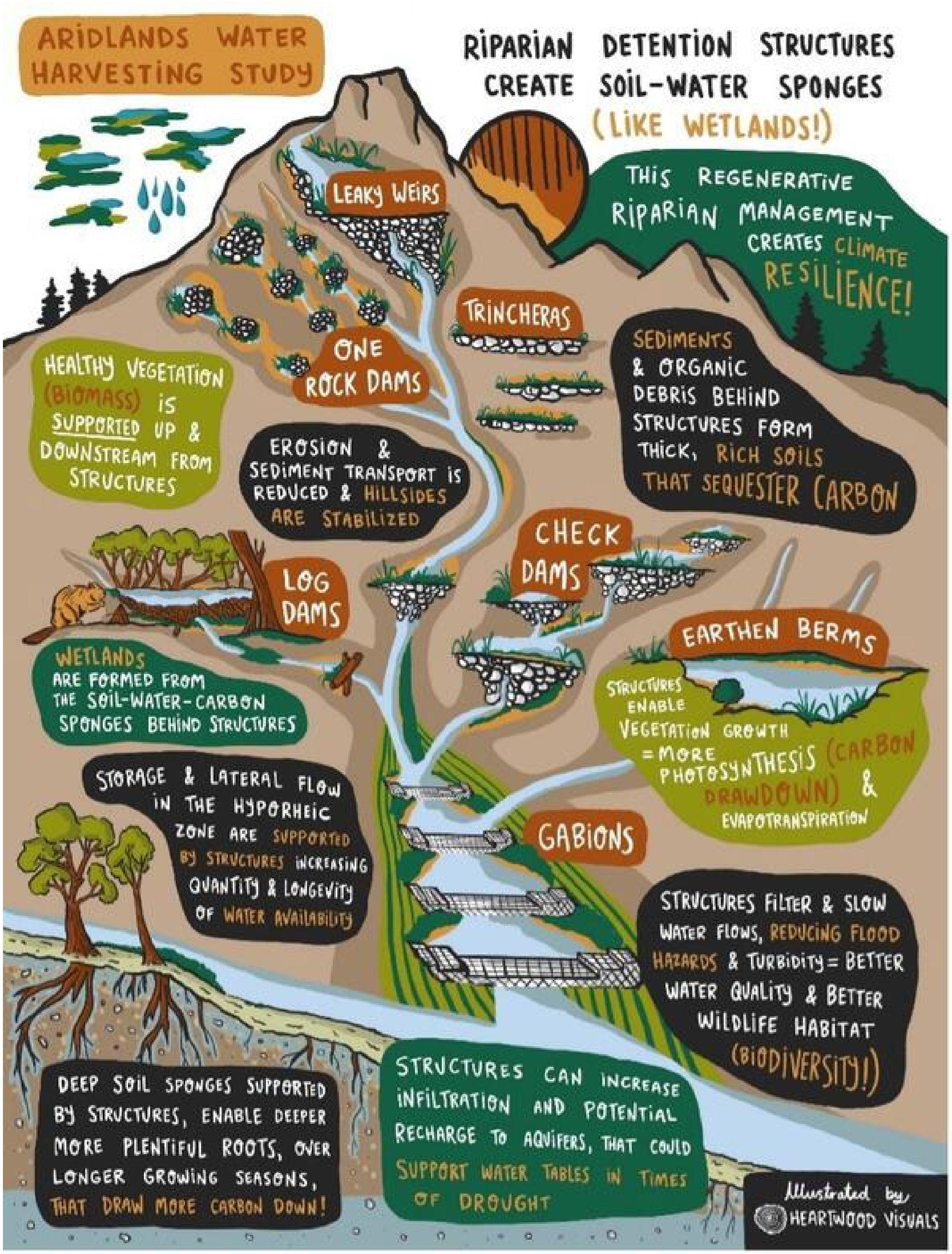

Figure 3. Natural Infrastructure for Dry Lands

Note: Illustration reproduced with permission from Heartwood Visuals

4.2 Groundwater Wells

Mitigation plans specific to groundwater wells are intended to increase water availability similar to the pre-impacted condition. For this reason, mitigation options identified in this plan are focused on protecting continued safe access to water for well users in the region that may be impacted by South32 groundwater management activities. These mitigations are not intended to increase local or regional groundwater levels.

If a mitigation assessment is triggered at a well site, the well will be assessed on an individual basis to determine the best mitigation route to protect continued access to water supplies. Options include the following:

Installation of a Guzzler

Similar to mitigations for GDEs, guzzlers are relatively simple systems for harvesting rainwater for livestock consumption and can be useful in replacing a well if the purpose of water is for wildlife or livestock (Figure 2). A drinker allows wildlife and/or livestock to access water without trampling or further degrading the spring or water feature. Appropriately sized guzzlers are a highly effective method of providing water to animals.

Hauling of Water

Water could be hauled to supplement the loss of water at an impacted well site. Water discharged from WTP2 may be hauled to a property or from municipal service providers. If water is hauled from WTP2, an alternative source may be needed until the groundwater system has sufficiently recovered after mine closure.

Piping of Water

Water could be piped to supplement the loss of water at an impacted well site, dependent on topography and other physical factors. Source water could be from WTP2 or from another water supply well on NFS lands. If water is piped from WTP2, an alternative source may be needed until the groundwater system has sufficiently recovered after mine closure.

Well Modifications or New Well

Modification options may include deepening the well to penetrate a deeper aquifer or more productive portion of the aquifer. Or, if water is present and production is limited or decreased, well rehabilitation or pump replacement is a possibility. If these options are unlikely to augment water supply, a new well may be drilled in place of the old well. All well modifications require careful site-specific planning and engineering. Prior to well drilling or construction, detailed well design plans will be provided to the USFS and well users to communicate and implement an effective approach.

5 REPORTING

To document continued compliance with this proposed Mitigation and Monitoring Plan, monitoring data will be submitted to USFS on an annual basis. Monitoring reports will summarize available data (Table 6) and analysis and climatic information, along with GDE or well triggers and mitigation plans. Reported water levels will be used to update the groundwater flow model every five years. In the event that statistically significant impacts are observed, these will be managed by the proposed mitigation steps, which are not reliant on predictions from the model. Once these annual reports have been reviewed and approved by the USFS, a final draft of each annual monitoring report can be uploaded to the South32 Hermosa website for public use and review.

Table 6. Monitoring Frequency for GDEs and Wells

Monitoring Type	Monitoring Frequency
Groundwater-dependent Ecosystems	
Transducers or Inundation Sensors	Continuous – Quarterly visits to download data unless telemetry is installed
Flow Rate	Semi-annual field visit
Reduction of Phreatophytic Vegetation	Annual - ground-truthing, plot measurement, and remote sensing
Statistical Analysis	Annual analysis of surface water level and flow data
Groundwater Wells	
Water Level Pressure Transducers	Continuous – Quarterly visits to download data unless telemetry is installed
Flow Rate	Annual user provided documentation and continuous monitoring using flow meter
Statistical Analysis	Annual analysis of review groundwater level data

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TABLES

Table 2. Monitoring Plan for Regional Groundwater Dependent Ecosystems, Hermosa Project

Watershed	Drainage	Regional Groundwater Dependent Ecosystem (GDE)	Monitoring Location(s)	Purpose	Measurement Type	Monitoring Frequency	Reporting Frequency	Infrastructure Currently Existing?
Adams-Duquesne	Finley and Adams Canyon (Washington Camp)	WC2-04	Spring	Indication that mining related drawdown may occur	Transducer or inundation sensor	Continuous	Annually	No
				GDE monitoring	Flow	Semi-annually	Annually	N/A
			Vegetation area	GDE monitoring	Area and type of phreatophytes via remote sensing, ground-truthing, and plot measurement	Annually	Annually	N/A
Alum and Cox Gulch	Alum Gulch	A6-AD-01	Adit	Indication that mining related drawdown may occur	Transducer or inundation sensor	Continuous	Annually	No
				GDE monitoring	Flow	Semi-annually	Annually	N/A
			Vegetation area	GDE monitoring	Area and type of phreatophytes via remote sensing, ground-truthing, and plot measurement	Annually	Annually	N/A
		A12-01	Spring	Indication that mining related drawdown may occur	Transducer or inundation sensor	Continuous	Annually	No
				GDE monitoring	Flow	Semi-annually	Annually	N/A
			Vegetation area	GDE monitoring	Area and type of phreatophytes via remote sensing, ground-truthing, and plot measurement	Annually	Annually	N/A
		A12-02	Spring	Indication that mining related drawdown may occur	Transducer or inundation sensor	Continuous	Annually	No
				GDE monitoring	Flow	Semi-annually	Annually	N/A
			Vegetation area	GDE monitoring	Area and type of phreatophytes via remote sensing, ground-truthing, and plot measurement	Annually	Annually	N/A
		A15-01	Spring	Indication that mining related drawdown may occur	Transducer or inundation sensor	Continuous	Annually	No
				GDE monitoring	Flow	Semi-annually	Annually	N/A
			Vegetation area	GDE monitoring	Area and type of phreatophytes via remote sensing, ground-truthing, and plot measurement	Annually	Annually	N/A
	Blue Eagle Canyon	BE1-02	Spring	Indication that mining related drawdown may occur	Transducer or inundation sensor	Continuous	Annually	No
				GDE monitoring	Flow	Semi-annually	Annually	N/A
			Vegetation area	GDE monitoring	Area and type of phreatophytes via remote sensing, ground-truthing, and plot measurement	Annually	Annually	N/A
	Flux Canyon	F8-01	Spring	Indication that mining related drawdown may occur	Transducer or inundation sensor	Continuous	Annually	No
				GDE monitoring	Flow	Semi-annually	Annually	N/A
			Vegetation area	GDE monitoring	Area and type of phreatophytes via remote sensing, ground-truthing, and plot measurement	Annually	Annually	N/A
		F9-01	Spring	Indication that mining related drawdown may occur	Transducer or inundation sensor	Continuous	Annually	No
				GDE monitoring	Flow	Semi-annually	Annually	N/A
			Vegetation area	GDE monitoring	Area and type of phreatophytes via remote sensing, ground-truthing, and plot measurement	Annually	Annually	N/A
	Humboldt Canyon	HB3-01	Spring	Indication that mining related drawdown may occur	Transducer or inundation sensor	Continuous	Annually	No
				GDE monitoring	Flow	Semi-annually	Annually	N/A
			Vegetation area	GDE monitoring	Area and type of phreatophytes via remote sensing, ground-truthing, and plot measurement	Annually	Annually	N/A

Table 2. Monitoring Plan for Regional Groundwater Dependent Ecosystems, Hermosa Project

Watershed	Drainage	Regional Groundwater Dependent Ecosystem (GDE)	Monitoring Location(s)	Purpose	Measurement Type	Monitoring Frequency	Reporting Frequency	Infrastructure Currently Existing?
Harshaw Creek	Harshaw Creek	H16-03[1]	Spring	Indication that mining related drawdown may occur	Transducer or inundation sensor	Continuous	Annually	No
				GDE monitoring	Flow	Semi-annually	Annually	N/A
			Vegetation area	GDE monitoring	Area and type of phreatophytes via remote sensing, ground-truthing, and plot measurement	Annually	Annually	N/A
	Red Mountain	RM-SP-01	Spring	Indication that mining related drawdown may occur	Transducer or inundation sensor	Continuous	Annually	No
				GDE monitoring	Flow	Semi-annually	Annually	N/A
			Vegetation area	GDE monitoring	Area and type of phreatophytes via remote sensing, ground-truthing, and plot measurement	Annually	Annually	N/A
	Tributary to Harshaw Creek	TH17-01	Spring	Indication that mining related drawdown may occur	Transducer or inundation sensor	Continuous	Annually	No
				GDE monitoring	Flow	Semi-annually	Annually	N/A
			Vegetation area	GDE monitoring	Area and type of phreatophytes via remote sensing, ground-truthing, and plot measurement	Annually	Annually	N/A
Mowry Wash	Mowry Wash South	MWS1-02	Spring	Indication that mining related drawdown may occur	Transducer or inundation sensor	Continuous	Annually	No
				GDE monitoring	Flow	Semi-annually	Annually	N/A
			Vegetation area	GDE monitoring	Area and type of phreatophytes via remote sensing, ground-truthing, and plot measurement	Annually	Annually	N/A

Notes:

[1] H16-03 will be wetted during the life of mine due to WTP 2 discharge water consistently contributing to Harshaw Creek, therefore, this site will only be monitored during life of mine, and mitigation will happen if necessary after mine closure.

TH11-ST-01 and TH14-01 are not included in this Monitoring & Mitigation Plan because they are within the footprint of the proposed TSF2. They will be addressed in collaboration with the USFS and Fish & Wildlife.

Sonoita Creek and TNC sites are not included in this Monitoring & Mitigation Plan because they are located on private property and not under the jurisdiction of USFS.

Name Prefixes (Provided by South32 personal communication):

WC – Washington Camp	F – Flux Canyon	SP – Spring	RM – Red Mountain
A – Alum Gulch	HB – Humbolt Canyon	ST – Stock Tank	TH – Tributary to Harshaw Creek
BE – Blue Eagle Canyon	H – Harshaw Creek	AD – Adit	MWS – Mowry Wash South

Table 3. Monitoring Plan for Regional Groundwater Wells, Hermosa Project

Watershed	Groundwater Well ID	Purpose	Measurement Type	Monitoring Frequency	Monitoring Start	Reporting Frequency	Infrastructure Currently Existing?
Alum and Cox Gulch	OG_41638	Indication that mining related drawdown may occur	- Water Level Pressure Transducer - Flow rate	Continuous	As soon as possible	Annually	Yes
	OG_641639	Indication that mining related drawdown may occur	- Water Level Pressure Transducer - Flow rate	Continuous	As soon as possible	Annually	Yes
Harshaw Creek	FG_604559	Indication that mining related drawdown may occur	- Water Level Pressure Transducer - Flow rate	Continuous	As soon as possible	Annually	Yes
	FG_642733	Indication that mining related drawdown may occur	- Water Level Pressure Transducer - Flow rate	Continuous	As soon as possible	Annually	Yes
	HG_608261	Indication that mining related drawdown may occur	- Water Level Pressure Transducer - Flow rate	Continuous	As soon as possible	Annually	Yes
Mowry Wash	DG_641621	Indication that mining related drawdown may occur	- Water Level Pressure Transducer - Flow rate	Continuous	As soon as possible	Annually	Yes
Providencia	AG_225884	Indication that mining related drawdown may occur	- Water Level Pressure Transducer - Flow rate	Continuous	As soon as possible	Annually	Yes
	SG_640968	Indication that mining related drawdown may occur	- Water Level Pressure Transducer - Flow rate	Continuous	As soon as possible	Annually	Yes
Soldier Basin	OG_641622	Indication that mining related drawdown may occur	- Water Level Pressure Transducer - Flow rate	Continuous	As soon as possible	Annually	Yes
	SG_640966	Indication that mining related drawdown may occur	- Water Level Pressure Transducer - Flow rate	Continuous	As soon as possible	Annually	Yes

Name Prefixes (Provided by South32 personal communication):

DG – Duquesne Grazing Allotment
SG – Santa Cruz Grazing Allotment
FG – Farrell Grazing Allotment
AG – Alisos Grazing Allotment
HG – Harshaw Grazing Allotment
LG – Lewis Grazing Allotment
OG – Oak Bar Grazing Allotment

Table 4. Mitigation Plan for Regional Groundwater Dependent Ecosystems, Hermosa Project

Watershed	Drainage	Regional Groundwater Dependent Ecosystem (GDE)	Water Use				Trigger Types
			Human Consumption / Irrigation	Cattle / Wildlife Drinking	Aquatic / Riparian Vertebrates	Vegetation / Ecological	
Adams-Duquesne	Finley and Adams Canyon (Washington Camp)	WC2-04		X		X	- Transducer or inundation sensor - Flow rate - Phreatophytic vegetation - Statistical Significance
Alum and Cox Gulch	Alum Gulch	A6-AD-01		X		X	- Transducer or inundation sensor - Flow rate - Phreatophytic vegetation - Statistical Significance
		A12-01		X		X	- Transducer or inundation sensor - Flow rate - Phreatophytic vegetation - Statistical Significance
		A12-02		X		X	- Transducer or inundation sensor - Flow rate - Phreatophytic vegetation - Statistical Significance
		A15-01		X		X	- Transducer or inundation sensor - Flow rate - Phreatophytic vegetation - Statistical Significance
	Blue Eagle Canyon	BE1-02		X		X	- Transducer or inundation sensor - Flow rate - Phreatophytic vegetation - Statistical Significance
	Flux Canyon	F8-01		X		X	- Transducer or inundation sensor - Flow rate - Phreatophytic vegetation - Statistical Significance
		F9-01		X		X	- Transducer or inundation sensor - Flow rate - Phreatophytic vegetation - Statistical Significance
	Humboldt Canyon	HB3-01		X		X	- Transducer or inundation sensor - Flow rate - Phreatophytic vegetation - Statistical Significance

Table 4. Mitigation Plan for Regional Groundwater Dependent Ecosystems, Hermosa Project

Watershed	Drainage	Regional Groundwater Dependent Ecosystem (GDE)	Water Use				Trigger Types
			Human Consumption / Irrigation	Cattle / Wildlife Drinking	Aquatic / Riparian Vertebrates	Vegetation / Ecological	
Harshaw Creek	Harshaw Creek	H16-03[1]		X	X	X	- Transducer or inundation sensor - Flow rate - Phreatophytic vegetation - Statistical Significance
	Red Mountain	RM-SP-01		X		X	- Transducer or inundation sensor - Flow rate - Phreatophytic vegetation - Statistical Significance
	Tributary to Harshaw Creek	TH17-01		X	X	X	- Transducer or inundation sensor - Flow rate - Phreatophytic vegetation - Statistical Significance
Mowry Wash	Mowry Wash South	MWS1-02		X	X	X	- Transducer or inundation sensor - Flow rate - Phreatophytic vegetation - Statistical Significance

Notes:

[1]H16-03 will be wetted during the life of mine due to WTP 2 discharge water consistently contributing to Harshaw Creek, therefore, this site will only be monitored during life of mine, and mitigation will happen if necessary after mine

TH11-ST-01 and TH14-01 are not included in this Monitoring & Mitigation Plan because they are within the footprint of the proposed TSF2. They will be addressed in collaboration with the USFS and Fish & Wildlife.

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BE – Blue Eagle Canyon	H – Harshaw Creek	AD – Adit	MWS – Mowry Wash South

Table 5. Mitigation Plan for Regional Groundwater Wells, Hermosa Project

Watershed	Groundwater Well ID	Trigger Types	Potential Mitigation Options
Alum and Cox Gulch	OG_41638 OG_641639	- Transducer - Flow rate - Statistical significance	- Installation of a guzzler - Hauling of water - Piping of water
Harshaw Creek	FG_604559 FG_642733 HG_608261	- Transducer - Flow rate - Statistical significance	- Installation of a guzzler - Hauling of water - Piping of water - Well modifications or new well
Mowry Wash	DG_641621	- Transducer - Flow rate - Statistical significance	- Installation of a guzzler - Hauling of water - Piping of water - Well modifications or new well
Providencia	AG_225884 SG_640968	- Transducer - Flow rate	- Installation of a guzzler - Hauling of water
Soldier Basin	OG_641622 SG_640966	- Transducer - Flow rate - Statistical significance	- Installation of a guzzler - Hauling of water - Piping of water - Well modifications or new well

Name Prefixes (Provided by South32 personal communication):

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LG – Lewis Grazing Allotment
OG – Oak Bar Grazing Allotment

Appendix A-1

Continuous Monitoring Equipment Installations

CONTINUOUS MONITORING EQUIPMENT INSTALLATIONS

Instrumentation Installation Description

Continuous monitoring sensors will be installed at 13 GDE locations to record continuous hydrologic and environmental data. These sensors may include pressure transducers, soil-moisture probes, temperature sensors, and conductivity sensors, among others. Installations will be designed to minimize surface disturbance and visual contrast while ensuring durable, secure operation under site-specific conditions.

Monitoring Unit Installation Methods

The specific installation method will be selected based on the hydrologic and geomorphic setting of each GDE to ensure reliable performance and minimal disturbance. Depending on site characteristics, transducers will be installed using one of the following configurations:

1. **Submerged Installation**:
   Monitoring unit will be submerged below the water surface and secured with a small-diameter stainless-steel cable to a stable anchor (e.g., bedrock outcrop or large rock). This configuration prevents movement during variable flow conditions and protects the sensor from debris and sediment.

2. **Installation in Shallow Alluvium**:
   Monitoring unit will be buried within the spring outflow channel. It will be enclosed in a short, perforated PVC sleeve or wrapped in geotextile fabric to prevent clogging. Burial depth will vary by site but may extend up to approximately 3 feet below ground surface to maintain contact with saturated materials.

3. **Affixed to Bedrock (Sonde)**:
   Monitoring unit will be installed within a short section of 1- to 2-inch steel pipe bolted into the bedrock channel. This configuration provides structural protection from sediment accumulation and physical disturbance.

Telemetry Modem and Infrastructure

Each monitoring unit will connect to a telemetry modem via a communication cable routed along the ground surface. The cable will typically extend 50 to 75 feet between the unit and the modem and may be enclosed in protective conduit where necessary (e.g., across exposed rock, open ground, or wildlife pathways). Cable placement will not require trenching or cause ground disturbance.

The telemetry modem will be mounted on a 2-inch-diameter galvanized steel pipe extending approximately 4 to 5 feet above land surface. The pipe will be secured in a reinforced concrete foundation approximately 1.5 feet × 1.5 feet in plan view and embedded approximately 12 inches below grade for stability. Rebar reinforcement will be installed within the concrete base. Where required to provide continuous power to the telemetry system, a small solar panel may be mounted near the post or attached to the same support structure. The foundation will be back-filled and compacted so that the upper surface is flush with or slightly below the surrounding ground level, reducing visibility and tripping hazards.

Estimated Disturbance and Footprint

Component	Description	Approximate Dimensions (ft)	Estimated Temporary Disturbance Area (ft²)	Estimated Permanent Disturbance Area (ft²)	Disturbance Type
Monitoring Unit (submerged / buried / affixed)	Sensor installed in GDE spring pool, alluvium (≤3 ft depth), or bedrock housing	≤1 × 1	<2	<1	Below-grade
Communication cable	Surface-mounted cable with optional conduit protection	50–75 (length)	—	—	No ground disturbance
Telemetry modem, soar panel, and mounting pipe	Steel post with reinforced concrete foundation embedded ~12 in below grade	1.5 × 1.5 foundation	~4.5	2.25	Minor surface disturbance
Total per site	—	—	~4–6 ft² temporary	~2–3 ft² permanent	Localized
Total for 13 GDE sites	—	—	~52–78 ft² temporary (~0.002 acre)	~26–39 ft² permanent (<0.001 acre)	Cumulative disturbance from all installations

Construction Considerations

Installation will be performed by a two-person field crew using hand tools such as shovels, hammer drills, or portable augers. No heavy equipment or vehicle access outside existing routes will be required. Installation at each GDE site is expected to take less than one day. Upon completion, any temporarily disturbed areas will be backfilled and contoured to match surrounding conditions. Permanent infrastructure will have minimal visual presence and negligible environmental impact while enabling continuous groundwater monitoring at each GDE location.

Appendix A-2

Monitoring and Mitigation Related Impacts

MONITORING AND MITIGATION RELATED IMPACTS

Monitoring Impacts

Water Level Pressure Transducers

The installation of a pressure transducer in an existing well to continuously monitor water levels may result in minor surface disturbances at the wellhead due to equipment installation and access modifications. While the well's integrity will be maintained, potential impacts include wellhead modifications that could require vegetation clearing or minor surface disruption. Additionally, maintaining a proper seal around cable passthroughs is essential to prevent any risk of surface water infiltration. To mitigate these impacts, cables will be properly secured, any necessary wellhead modifications should be conducted with minimal disturbance, and any affected surface areas should be restored after installation.

The installation of a pressure transducer or inundation sensor at a GDE to monitor water levels may result in minor surface disturbances from equipment placement, access modifications, and the installation of piping for a telemetry setup. If installation requires drilling into bedrock to affix a permanent housing, potential impacts include localized rock disturbance, minor sediment displacement, and noise during drilling. The addition of piping for telemetry may require further surface disturbance, vegetation clearing, or minor excavation. While the overall integrity of the GDE will be maintained, improper securing of the sensor housing or telemetry infrastructure could lead to equipment displacement, affecting data reliability. To mitigate these impacts, drilling and excavation should be conducted with precision to minimize disturbance, any disturbed rock or sediment should be stabilized, and vegetation should be restored as necessary. The sensor housing and telemetry piping should be buried or securely anchored to ensure long-term stability while avoiding interference with natural GDE flow patterns.

Flow Meters

The installation of a flow meter on well piping to monitor discharge may result in minor surface disturbances from equipment placement, access modifications, and potential adjustments to existing piping infrastructure. If installation requires modifications to the wellhead or associated piping, potential impacts include temporary disruptions to water flow, minor excavation for securing the meter, and possible vegetation disturbance if clearing is necessary for access. While the integrity of the well and piping system will be maintained, improper installation or securing of the flow meter could lead to operational issues, leaks, or inaccurate data collection. To mitigate these impacts, installation should be conducted with minimal disturbance, any disturbed surface areas should be restored, and the flow meter should be securely fastened to ensure long-term stability and functionality without interfering with well operations.

Mitigation Impacts

WTP-2 Water Supply

The installation of a pipeline to convey WTP-2 discharge water at the impacted GDE location has potential for temporary environmental disturbances, including soil compaction, erosion, and vegetation loss from excavation and equipment use. Construction will require erosion control measures and adherence to permitting regulations. During construction, temporary disturbance is expected to extend 10 to 20 feet on either side of the pipeline due to equipment movement and material staging, while permanent disturbance is typically limited to 3 to 6 feet along the pipeline alignment, depending on vegetation regrowth and soil stability. Air quality impacts from dust and emissions, along with potential road damage from hauling materials, must be considered. Proper mitigation measures such as re-vegetation, sediment control, and effective site access planning can help minimize these impacts.

Useful for mitigation at GDE and well locations.

Installation of a Guzzler

The construction of a guzzler for rainwater harvesting will involve site preparation, material transport, and installation, leading to temporary environmental impacts. Soil disturbance from excavation may cause erosion and sediment runoff, while vegetation clearing could disrupt local wildlife habitat and increase the risk of invasive species. Construction activities may generate noise and emissions, potentially displacing wildlife. Compliance with permitting requirements and erosion control measures will be necessary. Additionally, altering surface water flow patterns could impact local hydrology. If the drainage is not conducive for guzzler placement, then installation may disturb approximately 0.1 to 0.25 acres, depending on the design and access requirements. Proper site selection, minimal vegetation removal, and erosion control measures will help mitigate these impacts. In addition, during dry periods, guzzler storage tanks may need to be filled to ensure animals have adequate water requiring water delivery trucks. The water delivery trips will generate additional emissions and dust.

Useful for mitigation at GDE and well locations.

Install Spring Box or Well and Pump to Surface

The drilling of a well or construction of a spring box may result in localized environmental impacts including soil disturbance, vegetation clearing, and potential groundwater alterations. Before any action is taken near GDE sites, historical and cultural attributes will be thoroughly evaluated. Drilling activities may generate noise, dust, and emissions, temporarily displacing wildlife. The use of heavy equipment can compact soil and increase erosion risk, while trenching for pipelines or infrastructure could impact surface hydrology. Water withdrawal from a well may affect groundwater levels and nearby springs, requiring additional monitoring equipment. Compliance with permitting, erosion control, and reclamation requirements is essential. Depending on site access and equipment needs, disturbance could range from 0.15 to 0.25 acre. Proper site selection, sediment control, and habitat restoration efforts will help minimize long-term environmental effects. In addition, spring boxes and wells both rely on the aquifer to bring water to the surface to support GDEs. These GDE mitigations will have the effect of further lowering aquifer water levels.

Useful for mitigation at GDE locations.

Well Modifications or New Well

Well modification, including deepening, rehabilitation, pump lowering, or replacement, will have localized environmental impacts primarily associated with soil disturbance, water table alterations, and temporary construction activities. Drilling or deepening a well may generate noise, dust, and emissions, potentially disturbing nearby wildlife. Heavy equipment use can cause soil compaction and minor vegetation disturbance around the worksite. On USFS land, compliance is essential with permitting, erosion control, and site restoration requirements. The estimated disturbance area is 0.0 to 0.3 acres, depending on equipment access and available storage area. Proper sediment control, careful water management, and minimal land disruption will help mitigate long-term environmental effects.

Useful for mitigation at an existing well location.

Rock Detention Structures (RDS)

RDS mitigation requires careful site-specific planning, understanding of the watershed, and use of hydraulic engineering principles to be effective mitigation systems and to prevent negative impacts to the GDE. Prior to beginning work, detailed work plans will be provided to the USFS to guide proper and effective placement. Hand constructed RDS—such as one-rock dams, trincheras, and Zuni bowls—using local materials are the least impactful RDS mitigation measure to surface resources. Impacts from RDS work will depend on site conditions, such as access road modifications, laydown yards, imported material, and need for heavy machinery. More intrusive RDS measures—such as rock gabion structures, large rock sills, or rock rundowns—result in increased surface disturbances, require imported material, and require the use of heavy equipment. Whenever possible, RDS mitigations will focus on using hand-crew-only mitigations. Heavy equipment (excavators, backhoes, etc.) will only be used if site-specific conditions mandate their use. Any impacts associated with development of RDS would be evaluated and approved by USFS prior to construction.

Useful for mitigation at GDE locations.

Hauling of Water

Water hauling by truck to the impacted spring site will cause temporary environmental disturbances primarily related to road use, emissions, and potential water quality concerns. Frequent truck trips may lead to increased dust generation, noise pollution, and soil compaction along access routes, potentially impacting vegetation and wildlife movement. On unpaved or rugged roads, erosion and sediment runoff could increase, particularly on USFS land, requiring road maintenance and dust suppression measures. Fuel consumption and vehicle emissions will contribute to air quality impacts. Additionally, improper handling or accidental spills during water transfer could introduce contaminants. Disturbances will most likely be confined to existing roads and staging areas and dependent on site access and frequency of deliveries. Implementing dust control, designated access routes, and spill prevention measures will help reduce environmental impacts.

Useful for mitigation at well locations.

Appendix B

Nature-Based Solutions (NBS) Integration Framework for Alternative Discharge Sites

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NATURE-BASED SOLUTIONS (NBS) INTEGRATION FRAMEWORK FOR ALTERNATIVE DISCHARGE SITES

Introduction

The Goldbaum Canyon and Mowry Wash South drainages have experienced downcutting that prevents bankfull flows from accessing their historic flood plains. As a result of this channel incision, sections of stream banks are vertical to near vertical and experiencing lateral erosion. These baseline conditions provide the context for evaluating geomorphic response to discharge and distinguishing natural adjustment from discharge-related effects. Upon discharge of WTP2-treated water, the goal is to prevent additional geomorphic changes that further reduce stream function while promoting conditions for stream bank and bed infiltration of treated water.

To maintain geomorphic stability associated with WTP2-treated water discharge to Goldbaum Canyon and Mowry South Wash and monitoring and mitigating measured effects, this framework will supplement the Monitoring and Mitigation Plan for Groundwater Dependent Ecosystems and Water Wells (MMP).

Implementation follows an adaptive, phased approach in which monitoring data and trend analyses guide decisions regarding the need for mitigation, maintenance, or design refinements. Where stabilization is warranted, Nature-Based Solutions (NBS) will be used to enhance channel resilience through the application of native materials—locally sourced rock and native vegetation—to prevent further channel incision, limit discharge-induced bank erosion, and improve overall channel stability. Some bank grading of vertical or near-vertical slopes may be required to prevent further erosion and to facilitate vegetative establishment.

The monitoring reach in Goldbaum Canyon extends approximately 1.5 miles downstream of the WTP2 outfall to the confluence with the East Fork of Harshaw Creek. The monitoring reach in Mowry South Wash extends approximately 0.5 miles downstream of the outfall to the private property boundary.

Baseline Characterization and Monitoring Criteria

Initially, baseline conditions of the contemplated outfall locations and immediate downstream areas will be documented using drone-based land surveys and photogrammetry and ground-verified surveys to develop high-resolution digital-elevation models (DEM). These datasets will establish initial cross sections, longitudinal profiles, and photo-monitoring locations for subsequent comparison.

Baseline characterization and all subsequent monitoring will apply the following standard criteria:

- **Longitudinal and cross-sectional surveys** – quantify channel geometry, slope, and width-to-depth ratios, and include installation of rebar pins or equivalent fixed markers at representative bank locations to measure small-scale vertical or lateral change and quantify bank erosion or deposition over time.
- **LiDAR-derived DEM analysis** – evaluate vertical and lateral channel change, incision, or deposition trends over time.
- **Substrate characterization (pebble counts, sediment analyses)** – determine bed-material composition and mobility.
- **Permanent benchmarks and photo points** – provide fixed references for repeat measurements.
- **Photo documentation** – completed during each scheduled monitoring event to evaluate channel condition and NBS structure integrity, where applicable.
- **Rosgen Stream Classification evaluation** – A geomorphic system that categorizes streams (Types A–G) based on channel shape, slope, entrenchment, and substrate to describe form, stability, and dominant fluvial processes.
- **Bank Erosion Hazard Index (BEHI) surveys** – A field-based method developed by Rosgen to quantify streambank erosion potential based on factors such as bank height, angle, rooting depth, surface protection, and material composition. Scores are combined to assign a relative erosion risk rating from very low to extreme.

Pasture Management Measures

If U.S. Forest Service (USFS) or grazing permittees observe treated-water discharge or mitigation activities resulting in increased surface water availability that attracts permitted livestock, management measures may be implemented to reduce localized impacts to channel condition or groundwater dependent ecosystem function. Potential measures may include temporary or permanent fencing to limit access to sensitive areas and installation of alternative livestock water systems. Selection and implementation of livestock management measures will be coordinated with and approved by the USFS and implemented consistent with applicable grazing permits.

Phased Implementation Framework

Following baseline data collection, an adaptive, phased implementation framework will be applied that will allow South32 and the USFS to monitor, evaluate, and refine stabilization efforts over time as needed. Each phase builds upon results from the preceding phase, ensuring that actions remain proportional to any observed geomorphic trends and hydrologic response.

The framework begins with monitoring of treated-water discharge in unmodified channels (Phase 1) and, if necessary, progresses through incremental construction of NBS features (Phases 2–4) only where monitoring data demonstrate a clear need for additional stabilization. This measured, stepwise approach promotes efficient resource use, minimizes unnecessary disturbance, and supports iterative design refinement as site conditions evolve.

Monitoring results determined through cross-sectional and longitudinal surveys and LiDAR-based DEM analyses form the basis for determining whether progression between phases is warranted.

If monitoring data show two or more consecutive monitoring events of measurable geomorphic change such as channel widening, bed incision, bank retreat, or sediment loss, indicating a trend toward increased lateral and vertical instability of the stream, the results will be treated as a potential trigger.

When one or more trend indicators are observed:

1. The data are reviewed by appointed geomorphic source expert.
2. The expert provides a written recommendation summarizing findings and potential adaptive measures.
3. South32 and USFS collaboratively determine whether additional stabilization, design refinement, or maintenance actions are necessary.

Triggers therefore do not automatically advance implementation to the next phase; instead, they initiate a structured, collaborative review to ensure that adaptive actions are based on verified, trend-based data, not isolated observations.

Table B-1 summarizes the phased framework, including implementation steps, monitoring criteria, evaluation methods, trigger levels, and adaptive responses.

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Table B-1. Summary of Phased Implementation Framework for Goldbaum Canyon and Mowry South Discharge Locations

Phase	Phase Implementation	Objective	Monitoring Criteria	Monitoring Duration / Frequency	Evaluation Method	Trend / Trigger Indicators	Adaptive Action / Response
Baseline Data collection and Monitoring Setup	• Establish permanent benchmarks and photo points. • Survey longitudinal and cross sections of channels. • Collect baseline LiDAR data for high-resolution DEM generation. • Characterize bed and bank materials and substrate composition. • Install fixed monitoring points and define reference stations.	Establish baseline geomorphic and hydrologic conditions prior to discharge or construction.	• Channel geometry (cross sections, longitudinal profiles). • Substrate characterization (pebble counts, sediment analysis). • Photo documentation and benchmarks. • Baseline LiDAR survey and DEM generation	One full baseline survey prior to discharge initiation	• Baseline Rosgen Stream Classification and BEHI assessment • Statistical summaries of initial morphology and substrate conditions • Baseline LiDAR-derived DEM analysis of channel topography.	N/A	Proceed to **Phase 1** upon WTP2 treated water discharge initiation.
Phase 1 – Monitoring of Discharge to Natural Channel	• Monitor natural channel response to WTP2 treated water discharge	Monitor and document geomorphic response at outfall locations to confluence with E. Fork of Harshaw Creek within natural (unmodified) channels.	• Longitudinal and cross-sectional surveys. • Substrate characterization. • Photo documentation. • Repeat LiDAR surveys to generate DEMs for topographic change detection.	• Biannual monitoring for 2 years after discharge initiation • Annually thereafter	• Comparison to baseline using Rosgen Stream Classification, BEHI assessment, and cross section overlays. • LiDAR-derived DEM differencing to identify degrading geomorphic trends (incision, lateral erosion).	• Two or more consecutive monitoring periods showing measurable changes (channel widening, incision, sediment loss) that support a trend toward an increasing BEHI category and/or decreasing Rosgen classification. • LiDAR DEMs showing consistent bed lowering or lateral expansion.	If one or more trend indicators are observed, the appointed geomorphic source expert reviews data and provides a written recommendation. Response: collaborative evaluation by South32 and USFS to determine whether to advance to **Phase 2 – NBS Pilot Implementation.**
Phase 2 – NBS Pilot Implementation	• Construct Nature-Based Solutions (NBS) features such as cross-vanes and J-hooks (up to seven per phase at Goldbaum, four per phase at Mowry). • Perform bank grading and native seeding where appropriate to stabilize near-channel banks. • Conduct maintenance of existing NBS features and vegetation as needed to preserve function and stability. • Establish post-implementation record of longitudinal and cross-sectional surveys using LiDAR and ground-based monitoring to document geomorphic response and channel evolution.	Implement and evaluate pilot-scale NBS stabilization measures to evaluate performance under discharge conditions.	• Longitudinal and cross-sectional surveys at fixed stations. • Substrate and bedform condition monitoring. • Photo documentation of structures and banks. • Repeat LiDAR surveys to develop DEMs and evaluate topographic change. • Maintain consistent monitoring points from previous phases.	• Biannual for 2 years post-construction, then annually	• Cross section overlays • BEHI and Rosgen trend analysis to evaluate stabilization effectiveness. • Structure condition and stability assessment. • LiDAR-based data review for topographic and geomorphic trend analysis. • Reevaluation of Rosgen Stream Classification following pilot implementation.	• Two or more consecutive monitoring periods showing measurable changes—such as channel widening, bed incision, or sediment coarsening—that support a trend toward increasing BEHI category and/or decreasing Rosgen stream classification. • LiDAR-derived DEMs and cross section overlays showing consistent bed lowering and/or lateral expansion • Observed trends prompt review by the appointed geomorphic source expert to recommend adaptive action.	Geomorphic expert (USFS / South32) reviews results; collaborative decision whether to refine designs or advance to **Phase 3 – Expanded Implementation.**
Phase 3 – Expanded NBS Implementation	*Same Implementation as Phase 2* (see above).	Extend stabilization measures based on pilot outcomes to achieve channel equilibrium.	Same monitoring criteria as Phase 2 plus: – Photo documentation of NBS structures and channel conditions to confirm longitudinal stability	*Same as Phase 2.*	Same as Phase 2 with continued LiDAR-based trend analysis and Rosgen reevaluation.	*Same as Phase 2.*	Geomorphic expert (USFS / South32) conducts collaborative review to determine if design modifications, maintenance, or transition to **Phase 4 – Full Implementation** is warranted.
Phase 4 – Full Integration and Maintenance	*Same Implementation as Phase 2* (see above).	Complete final suite of NBS features and transition to long-term maintenance and adaptive management.	Same monitoring criteria as Phase 3	*Same as Phase 2.*	Same as Phase 2 with continued LiDAR-based trend analysis and Rosgen reevaluation.	*Same as Phase 2.*	Collaborative response between South32 and USFS to implement targeted maintenance (e.g., re-seeding, debris removal, structure repair). Finalize long-term performance summary and establish an ongoing adaptive-monitoring plan.

Harshaw Creek Monitoring and Adaptive Management

Harshaw Creek currently receives treated discharge from WTP2. Given its existing flow regime and infrastructure constraints, implementation actions in this drainage will focus on monitoring, evaluation, and coordination rather than new NBS installations.

Monitoring will focus on fixed-point channel assessments and road-crossing inspections to identify localized instability and recommend practical stabilization or maintenance measures on behalf of South32 to the USFS.

Key program elements include:

- Establishment of permanent point-monitoring locations along Harshaw Creek for repeat cross-sectional and longitudinal surveys.
- Routine evaluation of road-crossing conditions, including survey of culvert inverts, headwalls, and outlet channels to detect scour, blockage, or deposition.
- Documentation of all observations through photo records and concise field forms suitable for integration into annual MMP reporting.

Table B-2 summarizes the monitoring framework and adaptive actions specific to Harshaw Creek.

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Table B-2. Summary of Monitoring Framework for Discharge in Harshaw Creek

Monitoring Element	Objective	Monitoring Criteria	Monitoring Frequency / Duration	Evaluation Method	Trend / Trigger Indicators	Recommendation
Point Monitoring Locations	Establish fixed monitoring points along Harshaw Creek to evaluate geomorphic and hydrologic response to continuous WTP2 discharge.	• Longitudinal and cross-sectional surveys at fixed transects. • Substrate characterization (pebble counts, sediment observations). • Photo documentation at each location to assess stability, sediment deposition, or bank retreat.	• Biannual (spring and fall) for the first 2 years, then annually. • Maintain consistent transects and benchmarks for all surveys.	• Compare channel form, slope, and stability to baseline conditions established from 2025 surveys. • Conduct Rosgen Stream Classification and Bank Erosion Hazard Index (BEHI) evaluations based on collected data. • Assess cross-sectional change and morphological trends over time.	• Two or more consecutive monitoring periods showing measurable geomorphic trends (e.g., channel widening, incision, or bank retreat) that indicate a trend toward increasing BEHI category and/or decreasing Rosgen classification.	• Findings are reviewed by a geomorphic expert jointly agreed upon by South32 and USFS. • Provide recommendations to the USFS regarding potential stabilization or maintenance needs.
Road Crossings	Monitor road crossings along Harshaw Creek and tributaries for degradation or blockage related to sustained discharge and storm events.	• Elevation and condition survey at crossing approaches • Visual assessment of erosion, sediment deposition, or culvert/vent obstruction • Photo documentation during each monitoring event	• Biannual inspections (spring and fall) with periodic checks during scheduled field visits.	• Compare survey and photo records to previous conditions to detect changes in grade, scour, or culvert performance. • Evaluate maintenance needs based on observed degradation or blockage trends.	• Two or more monitoring cycles showing progressive scour, sediment blockage, or culvert degradation indicating reduced hydraulic function.	• Provide recommendations USFS for maintenance or design improvements • Coordinate with USFS for corrective actions (e.g., improved design, culvert replacement, or other)

Reporting and Adaptive Review

The Goldbaum Canyon and Mowry South Wash channels are already degraded as a result of historical land-use disturbance. Consequently, monitoring results and subsequent evaluations will consider this existing condition when determining whether observed trends represent continued natural adjustment or discharge-related effects.

- All monitoring results and implementation activities will be summarized in an annual monitoring report. Each reporting cycle will include a synthesis of:
    - Survey and LiDAR data
    - Cross-sectional and bank-erosion trend analyses (including rebar-pin measurements)
    - BEHI and Rosgen classification trend analysis to evaluate stabilization effectiveness.
    - Documentation of NBS performance, maintenance, or design refinements

Monitoring results will be compared to the established baseline dataset to evaluate changes in channel form, stability, and response to discharge.

If trend indicators or trigger conditions defined in Tables B-1 and B-2 are met, South32, and the USFS will jointly review findings and determine the appropriate adaptive response.

- If mitigation or stabilization is necessary on NFS lands, the type and location of actions will be selected based on mutual agreement between the South32 and USFS. Potential adaptive responses may include:
    - Include installation of additional NBS features
    - Minor re-grading or bank stabilization
    - Other maintenance or design refinements consistent with the objectives of this framework
    - Water systems for wildlife and/or livestock