IDAHO-MARYLAND MINE

WATER TREATMENT PLANT DESIGN REPORT

Prepared for:

RISE GOLD CORP

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LIST OF ACRONYMS AND ABBREVIATIONS

acre-ft.	Acre-Feet
AMSL	Above Mean Sea Level
As	Arsenic
CCR	California Code of Regulations
CEQA	California Environmental Quality Act
cfm	Cubic Feet per Minute
CLS	California Laboratory Services
EBCT	Empty Bed Contact Time
EC	Electrical Conductivity
EMKO	EKMO Environmental Inc.
Fe	Iron
GAC	Granular Activated Carbon
gal/ft^3	Gallon per Cubic Foot
gpm	Gallons per Minute
gpm/ft^2	Gallon per Minute per Square Foot
H_2SO_4	Sulfuric Acid
HRT	Hydraulic Retention Time
IX	Ion Exchange
$KMnO_4$	Potassium Permanganate
Linkan	Linkan Engineering
MCL	Maximum Contaminant Level
MDBM	Mount Diablo Base Meridian
mg/L	Milligrams per Liter
ml	Milliliters
MMF	Mixed Media Filtration
Mn	Manganese
MnO_2	Manganese Dioxide
NaOC1	Sodium Hypochlorite
NaOH	Sodium Hydroxide
NBS	New Brunswick Shaft
NH_3	Ammonia
NPDES	National Pollutant Discharge Elimination System
ORP	Oxidation Reduction Potential
PFD	Process Flow Diagram
pH	Potential of Hydrogen
Pyrolusite	Mined MnO_2
QA/QC	Quality Assurance/Quality Control

Rise	Rise Grass Valley Inc.
SBS	Sodium Bisuslfate
SDS	Safety Data Sheets
TCLP	Toxicity Characteristic Leaching Procedure
TDS	Total Dissolved Solids
TSS	Total Suspended Solids
TTHM	Total Trihalomethanes
ug/L	Micrograms per Liter
uS/cm	Micro Siemens per centimeter (measure of electrical conductance)
WTP	Water Treatment Plant

1.0 INTRODUCTION

This report presents pertinent information for the Idaho-Maryland Mine Project being proposed and implemented by Rise Grass Valley Inc. (Rise). The purpose of this report is to provide a water treatment design sufficient for the purposes of the Use Permit application with Nevada County and the California Environmental Quality Act (CEQA). Detailed design, which may include pilot plant test work, will be required after approval of the Use Permit to support secondary permitting with the California State Water Resources Control Board, Nevada County, and other regulatory agencies.

This report considers the design of the treatment plant at a level sufficient to provide the general specifications and arrangement of equipment and buildings. This scope of work does not include or require detailed design elements on building services, electrical, fire sprinklers, safety equipment, chemical storages, etc. The detailed design will present these elements and be in accordance with appropriate codes and regulations.

The report is presented in the following manner:

- Section 1.0 introduces the report
- Section 2.0 presents a discussion of the project
- Section 3.0 presents the proposed process location
- Section 4.0 presents a process description
- Section 5.0 presents technical specifications
- Section 6.0 presents references

2.0 DISCUSSION

2.1 Background

The New Brunswick Shaft (NBS) of the Idaho-Maryland Mine is located on private property owned by Rise. The shaft is approximately 2.5 miles east of downtown Grass Valley, California, and is accessed off of East Bennett and Brunswick Roads. The NBS is situated in the northeast quadrant of Section 36, T 16 N, R 8 E, and in the northwest quadrant of Section 31, T 16N, R 9 E, Mount Diablo Base Meridian (MDBM).

The Idaho-Maryland Mine complex was a significant gold producer in California, with approximately 2.4 million ounces produced between 1866 and 1955. The mine closed in 1956. The mine property consists of 2,750 acres of deeded mineral rights including 119 acres of contiguous surface ownership centered on the NBS.

Rise is in the planning and preparation phase to restart exploration and active mining activities at the Idaho-Maryland Mine. Linkan Engineering (Linkan) was commissioned by Rise to evaluate water treatment options at the site. This evaluation was structured to facilitate the issuance of a permit for water treatment and discharge at the facility, with Rise considering discharging treated water from the NBS underground workings into the South Fork of Wolf Creek. Currently, the shaft is flooded and will need to be dewatered prior to any exploration or mining activities. After initial dewatering, the shaft will need to be continuously dewatered as mining activities continue. All effluent discharges from the property will need to meet the requirements of the State of California Central Valley Regional Water Quality Control Board National Pollutant Discharge Elimination System (NPDES) No. CAG995002.

As the first step in this evaluation, Linkan performed a scoping study that included water quality analysis, a review of effluent discharge allowances, and the flow rates that would be required. This information is documented by EMKO Environmental Inc. (EMKO) in their March 2020 *Groundwater Hydrology and Water Quality Analysis for the Idaho-Maryland Mine Project* report. The findings served as the basis of design which is presented in Table 2-1.

Table 2-1: Rise Idaho-Maryland Mine Basis of Design

Design Criteria	
The estimated volume of water in the mine	385 million gallons
Steady-state groundwater flow rate into the shaft	850 gallon per minute (gpm)
Maximum dewatering flow rate	2,500 gpm
Effluent receiver	South Fork of Wolf Creek
Discharge Standards	NPDES No. CAG995002

Constituents of concern identified during Linkan's scoping study for the treatment of NBS water have been tabulated in Table 2-2, along with their corresponding concentrations and maximum contaminant level (MCL) standards for discharge as specified by the NPDES No. CAG995002 permit.

Table 2-2: Rise Idaho-Maryland Mine Contaminants of Concern

Constituents of Concern	Reported Concentration milligrams per liter (mg/L)	NPDES No. CAG995002 MCL
Iron (Fe)	1.6	0.3
Manganese (Mn)	0.27	0.05

NOTE 1: The values listed in Table 2-2 represent the highest concentrations noted in the California Laboratory Services (CLS) report, CLS Work Order #: 18B0794 for the samples designated 'NBS'. All elevations sampled in the NBS showed similar concentrations to those listed.

NOTE 2: Fe and Mn are listed as secondary drinking water standards in the California Code of Regulations (CCR) 17 & 22.

The water quality analysis indicated that Fe and Mn concentrations exceed the regulatory discharge requirement and that these elements will, therefore, need to undergo removal treatment.

2.2 Assessment

Linkan evaluated the contaminants of concern and determined from their type and concentrations that oxidation would be beneficial for their removal. Oxidation of aqueous Fe and Mn is an electrochemical process in which each metal reacts with oxygen occurring either naturally or as a chemically bound form. This reaction between the metal and oxygen forms a hydrated species. This occurs in a 2-step mechanism in which there is an anodic dissolution of the aqueous metal, where the metal loses electrons and becomes ionic and soluble in water. This is then followed by a cathodic reduction of oxygen that yields hydroxide ions, by reacting with water and the available electrons lost from the metal. These hydroxide ions then react with the metal ions and form metal hydroxides, which eventually become super-saturated in solution and begin to precipitate out as solid masses. These solid masses can then be removed by settling (sedimentation) and/or filtration, which are relatively simple and cost-effective mechanisms for removal. Oxidation can be induced by introducing oxygen into the water either by aerating the water to increase its dissolved oxygen levels, or by introducing soluble chemicals (i.e., sodium hypochlorite {$NaOC1$} or potassium permanganate {$KMnO_4$}) which contain oxygen in their makeup.

Figure 2-1 presents a picture of the NBS test water after it was exposed to air for a short period of time. Note the solids in the bottom of the container, which had rapidly and naturally precipitated out of solution. This phenomenon is due to the underground shaft water being extremely oxygen-deficient, with recorded ORP levels being negative in value during sampling and then having sufficient oxygen to quickly and without additional oxidants transform ferrous iron to ferric iron once brought to the surface and exposed to ambient air. This noted phenomenon is the basis for aeration being ultimately selected as the primary source of oxidation in the process, which was supported by the extreme water conditions noted and observed. Advantageously, this condition will allow a significant portion of the Fe in the water to precipitate out in the pond, and not be introduced into the subsequent treatment process, thereby reducing the solids loading of the water treatment plant (WTP). This reduction in solids is not only beneficial for process treatment efficiency, but it will also benefit the periodic cleaning cycles which are an integral part of water treatment systems.

Figure 2-1: Photograph of NBS Shaft Water Undergoing Natural Oxidation

It was concluded that treatment through natural, mined manganese dioxide (pyrolusite) media would be preferred over surface coated media such as greensand, uncoated media like sand, mixed media filtration (MMF), or ion exchange (IX). The selection of this media may necessitate a small supplemental dose of chemical oxidant being introduced into the WTP feed water after pond detention in order to maximize the efficiency of Mn removal.

The preferred filtration media, mined pyrolusite, has highly efficient Mn and Fe removal characteristics due to adsorbing the oxidized species Mn(IV) on the external and the porous internal structures of the media, and then catalytically precipitating it as MnO_2, while also converting soluble Fe(II) to insoluble Fe(III) and adsorbing it. The media then also allows for sufficient retention time for the formation of ferric hydroxide ($Fe(OH)_3$ which can adsorb other contaminants such as arsenic and thereby remove them from the water, with the complexed masses of solids being retained within the media bed until backwash events release them and direct them to waste. The high adsorptive surface area and capacity of this media can process water at a faster flow rate than traditional media, which keeps vessel sizes and numbers within reason for high throughput plants such as the Idaho-Maryland Mine, which is anticipated to operate at upwards of 2,500 gpm.

When compared to surface-activated media that utilizes an applied MnO_2 coating, such as greensand, the natural mined media has lower regeneration costs and longer service life projections. This is primarily due to the particles of the mined pyrolusite media having high purity, which allows for regeneration to occur partially through periodic backwash events that cause particle attrition, exposing fresh active surface area. This effect complements oxidation of the feed stream that is the primary mechanism for keeping the media in an efficient state, with chemical oxidation having a higher regenerative capability than aeration. Coated media, such as greensand, are wholly dependent on chemical regenerations, and as the media ages and begins to lose the MnO_2 coating, these regeneration cycles become less effective while still costing the same to perform. Uncoated sand or MMF media can also act as an effective filter for solids removal, but they lack catalytic oxidative properties that make the mined pyrolusite a more robust option.

IX was also evaluated by Linkan as a potential treatment, but the mined pyrolusite is lower in both purchase costs and operational costs, and has a simpler operational strategy, without frequent periodic chemical regeneration or replacement needed. The use of IX resins for the removal of iron and manganese were also determined by Linkan to have limited viability for this application due to the requirement that the contaminants remain in dissolved form and exist at very low levels. As previously described, dissolved oxygen levels of the NBS water are very low when it is first obtained from the shaft, but once the water is exposed to ambient oxygen it reacts rapidly with the Fe and Mn and causes solids formation (Fe precipitation), therefore increasing the potential for plugging and buildup on the resin surface. Fe fouling is a common and sometimes irreversible problem with IX Fe and Mn treatment, and it was noted by Linkan that the potential for this type of fouling is high. This observation excluded IX from process consideration.

Due to the aforementioned considerations and existing water conditions, it is Linkan’s opinion that oxidation followed by mined pyrolusite media treatment will provide Rise with an effective strategy in both terms of cost as well as efficiency for removing the contaminants of concern. The oxidation can result from aeration or by use of chemical additives; therefore, the use of oxidants, specifically potassium permanganate or sodium hypochlorite, will be included in the design as a contingency.

2.3 Testing

Linkan requested NBS water to perform lab-scale tests and verify the effectiveness of the prescribed treatment components which consisted of oxidation of NBS water (via aeration, NaOCl, and $KMnO_4$), filtration through natural, mined pyrolusite media, and through granular activated carbon (GAC). Samples containing one each of the three oxidizing agents assessed were processed independently through each component of the treatment system, for a total of three individual tests.

GAC tests were performed on the oxidized and pyrolusite media treated water to assess additional removal of primary contaminants, as well as the removal of chemical oxidant residuals and disinfection byproducts that arise from the use of chlorine. GAC acts as a very high surface area filter that has an affinity for dissolved Fe and Mn (Fe(II) and Mn(II), respectively), with the adsorption capacity for Fe(II) being somewhat higher due to the ionic radius and electronegativity differences. It is also commonly employed to remove chlorine and is an effective treatment for total trihalomethanes (TTHMs) that are formed from the reaction between chlorine and certain organics that may be present in the water that is undergoing treatment. Since it is an effective adsorbent for both contaminants of concern and chlorine and its potential byproducts, it was included in the testing assessments.

2.3.1 Test Methodology

Lab-scale tests of NBS water using oxidation, pyrolusite, and GAC were performed between 12/19/2018 and 1/3/2019 at Linkan's Elko, NV facility. Samples generated from the tests were collected, properly preserved, and submitted along with a comparative baseline sample to a CA certified laboratory for analysis. The lab-scale tests were structured and conducted as follows:

A 1" diameter test column was constructed and packed with the mined pyrolusite media (brand name, 'MangOx', produced by Noble House Group). The media selected for testing was 20 x 40 mesh (0.0331" x 0.0165", which provides a uniformity coefficient of 2.0), which represents a media size 45 times on average smaller than the diameter of the column. This size differential helps to mitigate, but does not completely eliminate "wall effects". Wall effects serve to short-circuit the liquid in a bench-scale test column and decrease the efficiency of the media by allowing a significant portion of the liquid to come in contact with the material (the column wall) that is not contributing to the treatment. Because the surface of the column wall has no irregularities it provides larger flow channels as opposed to more central sections of the column which contain tortuous pathways and therefore more contact with the media. The use of a 1" diameter column with the media size selected affords a conservative approach in which treatment can be assessed with a slightly less than conventional sizing (typically a sizing ratio of media is 50 times on average smaller than the diameter of the column). It is Linkan's opinion that if treatment can be demonstrated to work with slight short-circuiting, the treatment has robust characteristics in regard to removal of contaminants of concern, and data gathered at the bench-scale can be considered useful for assessment purposes.

Figure 2-2 and Figure 2-3 are presented as schematic drawings of the pyrolusite and GAC bench-scale test apparatuses, respectively. As indicated, the pyrolusite column was constructed with a 4" gravel support layer, 36" pyrolusite media bed, 4" overlying anthracite cap (for filtration of solids), and 16" of freeboard. When the column was loaded with GAC it was constructed with a 4" gravel support layer, 36" GAC bed, and 20" of freeboard. Figure 2-4 is provided for photographic documentation of the actual test apparatus.

Figure 2-2: Bench-Scale Testing Configuration for Pyrolusite

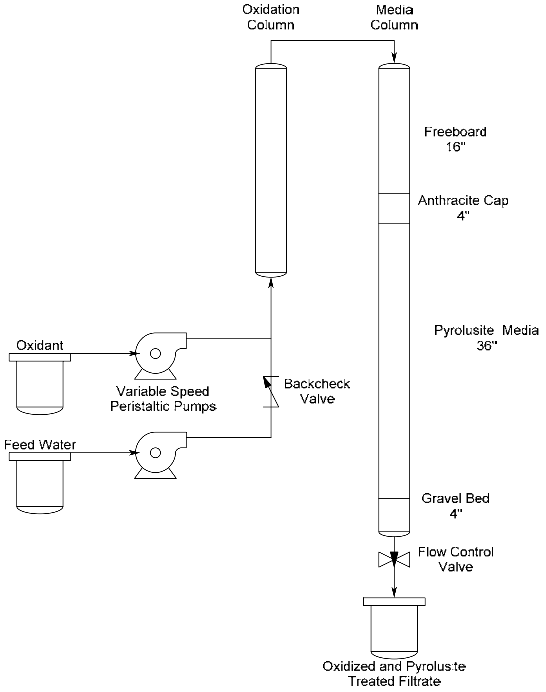

Figure 2-3: Bench-Scale Testing Configuration for GAC Treatment

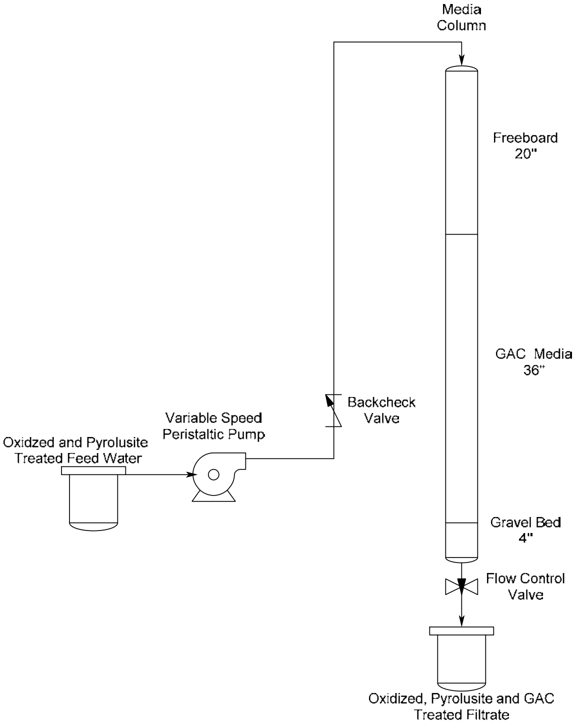

Figure 2-4: **Bench-Scale Column Test Apparatus**

NOTE: The column used to hold the media in the bench-scale tests is the taller column shown on the far right-hand side of the apparatus. The four columns to the left of it were designed to add reaction time after oxidation. The only column that was used for oxidation reaction time was the column immediately preceding the media column.

Based upon the manufacturer's recommended loading rate range of 3 – 8 gallons per minute per square foot (gpm/ft^2), a loading rate of 4.3 gpm/ft^2 was selected for the tests. For a 1" diameter column, this equates to 0.02344 gpm (88.7 milliliters {ml}/minute) which was used for all of the pyrolusite column tests. The flow was provided by a variable drive peristaltic pump with additional control provided by a flow control valve on the discharge side of the column. Periodic flow verifications were performed during testing to ensure the loading rate was consistent. 60 gallons of water were made available for testing, which allowed a maximum possible testing duration of 42.7 hours. However, the water had to be distributed between three oxidant test conditions which allowed for 14.2 hours of testing per oxidant type. This limited the resultant data to primarily being an assessment of contaminants of concern removal efficiency in conditions that included a relatively small number of simulated backwashes (media exchanged every seven hours of runtime in accordance with the manufacturer's recommendation of backwashing at intervals of 600 gallons per cubic foot {gal/ft^3} of media).

Each of the three oxidant types received identical column treatment, in which new and freshly rinsed gravel, mined pyrolusite media, and anthracite was installed into the column that was pre-filled with water to avoid entrapment of air during media loading. Once the column was loaded with the three media types and the flow rate calibrated to the target value, the raw feed water was subjected to oxidation per the aforementioned treatments and conveyed by a pump into the media column. Aeration was performed by subjecting the NBS shaft water to treatment in which fritted airstones were placed in a bucket containing two gallons of the water and having air sparged into the water for a period of 8 hrs. The volume of air per time interval as measured in cubic feet per minute (cfm) was not measured during aeration. $KMnO_4$ was applied to the NBS water in a 0.35 percent by weight solution at a dosage of 1.7 mg/L. NaOCl was dosed using an 8.25 percent by weight solution and was administered at 1.0 mg/L.

Once the column received the oxidized feed water and the water used during the loading process was fully purged from the system, the filtrate was collected for each oxidant type. The cycle of periodic filtrate collection, flow rate verification, and flow rate adjustment (as necessary) was continued until the backwash timer was triggered. Then the media column was unloaded and recharged with new and freshly rinsed media prior to returning to service. Again, the filtrate was not collected post-media reloading until the column had been fully purged of the water used during the reloading process and was in steady-state. The column provided ~6.4 total minutes of empty bed contact time (EBCT), with ~5.25 minutes being in contact with the pyrolusite media. The total EBCT corresponds to approximately 0.15 gallons of volume, and the system was deemed in steady-state when a minimum of 6.5 minutes after each reloading cycle had elapsed, which also provided a minimum of 0.15 gallons of test water to recharge the treatment column. The timing for this restart began when the oxidation reaction column was reconnected to the primary media column and the oxidized water began to flow into the media column. The first 200 ml of sample was discarded after column reloading events, with the subsequent filtrate being retained, preserved, and submitted for certified laboratory analysis.

Additional aliquots of oxidized and pyrolusite treated water were then also passed through a GAC packed column at the manufacturer's specified loading rate of 3 – 5 gpm/ft^2 in order to assess if carbon filtration would provide additional treatment benefit. Due to the loading rate being within the boundaries of the pyrolusite material, the flowrate for this GAC treatment was also performed at 0.02344 gpm (88.7 milliliter {ml}/minute). The GAC material, which was new material for each of the oxidants tested, was coconut shell-based carbon, and it was not regenerated in any way during the tests. Oxidized and pyrolusite treated water was also flowed through the column for approximately 6.5 minutes prior to collection of the filtrate, with the first 200 ml of filtrate also being discarded prior to being retained, preserved, and submitted for certified laboratory analysis.

2.3.2 Test Results

Laboratory testing using a California certified lab indicated that the treatment strategy was effective at removing the contaminants of concern in the samples that are listed as ‘GAC Effluent’, as shown in Table 2-3, with each oxidizing agent yielding regulatory compliant results as final effluent. The values denoted in red font are treated water values that were noted to be above the discharge allowance.

Table 2-3: Certified Laboratory Results and Discharge Allowances

Sample Designation	Test Number	Fe (mg/L)	Mn (mg/L)	TTHMs (mg/L)			
				1	2	3	4
NBS Baseline		1.400	0.240				
Aeration Pre-Column	1	0.170	0.221				
Aeration-MnO2 Effluent		<0.0091	0.022				
Aeration-GAC Effluent		<0.0091	0.012				
KMnO4-MnO2 Effluent	2	<0.0091	0.037				
KMnO4-GAC Effluent		<0.0091	0.012				
NBS Raw Baseline	3			<0.000061	<0.00013	<0.00016	<0.00013
NaOCl-MnO2 Effluent		<0.0091	0.100	0.00036	<0.00013	<0.00016	0.0033
NaOCl-GAC Effluent		<0.0091	0.0093	<0.000061	<0.00013	<0.00016	<0.00013
NPDES No. CAG995002 Allowance		**0.300**	**0.050**	**0.0005**	**0.0005**	**0.0005**	**0.0005**

NOTE: THM #1 = Bromodichloromethane
THM #2 = Dibromochloromethane
THM #3 = Bromoform
THM #4 = Chloroform

Refer to Appendix A for certified laboratory results. Table 2-4 provides a cross-reference of the sample designations used in Table 2-3 and those used for the laboratory submissions. The Fe and Mn result for the sample designated ‘Aeration Pre-Columns’ was obtained during field testing on 12/27/2018, and is therefore not listed in the laboratory results. This sample was oxidized for several days in ambient conditions and its oxidation-reduction potential (ORP) increased 145 mV during this time over the initial aerated values obtained on 12/20/2018. Refer to Appendix B for testing notes.

Table 2-4: Sample Designations Cross-Reference

Sample Designation	Laboratory Report Designation
NBS Baseline	Rise Baseline
Aeration Pre-Columns	Aeration Pre-Columns
Aeration MnO2 Effluent	Aeration Post-MnO2
Aeration GAC Effluent	Aeration Post-GAC
KMnO4-MnO2 Effluent	KMnO4-1.7ppm-MNO2 Effluent
KMnO4-GAC Effluent	KMnO4-1.7ppm-GAC Effluent

Sample Designation	Laboratory Report Designation
NBS Baseline	Rise Raw-NaOCl Test
NaOCl-MnO2 Effluent	NaOCl-1ppm-MnO2 Effluent
NaOCl-GAC Effluent	NaOCl-1ppm-GAC Effluent

Table 2-3 indicates that treatment using aeration followed by filtration through natural, mined pyrolusite will remove the contaminants of concern to compliant levels. Under testing conditions, this process required no chemical additives and did not need GAC polishing to achieve compliance. This process is, however, dependent on the post-aeration ORP of the feed water to reach a minimal value of +200 mV to be effective at transforming soluble Fe and to a lesser extent Mn into their insoluble species. For this reason, to provide a treatment system capable of operating with varying feed water physical properties and to provide a very robust solution, it is Linkan's opinion that it would be advantageous to include chemical oxidation capabilities in the design.

It should also be noted that although the treatment does not require GAC for contaminant removal in the current water quality conditions, it is included in the process design to provide additional robustness in the chance that feed water quality worsens during periods of active mining, and to remove TTHMs if NaOCl is ultimately employed as a chemical oxidant. GAC is an effective barrier for many water pollutants and is relatively inexpensive and capable of being thermally regenerated and reused. It can serve to remove organics such as those found in drilling fluids and other mining-related additives, and although the current water quality does not contain these types of contaminants, it is Linkan's opinion that a removal system for them would be of additional benefit for the Rise design, thereby adding value to including a GAC system.

Bench-scale test results indicate that aeration followed by pyrolusite filtration is effective in removing iron and manganese to meet water quality objectives without the use of NaOCl or $KMnO_4$; however, these elements are included in the design to ensure a robust treatment in all operating conditions, with NaOCl being the Linkan preferred oxidant and $KMnO_4$ being included strictly as a contingency.

3.0 PROPOSED PROCESS LOCATION

3.1 Water Treatment Plant (WTP)

The proposed WTP will be located at the Brunswick Industrial Site near Grass Valley, CA. The site is located 2.5 miles south of the intersection between State Highway 20 and Brunswick Road and on the west side of Brunswick Road. Refer to Appendix C for a site location drawing.

3.1.1 Geographic Coordinates

The WTP will be located at the following coordinates:

Latitude	39°12’35.99” N
Longitude	121º0’57.62” W

Table 3-1: Calculated Location Values

Position Type	Latitude - Longitude
Degrees Lat Long	39.2099972°, -121.0160056°
Degrees Minutes	39°12.59983', -121°00.96033'
Degrees Minutes Seconds	39°12'35.9900", -121°00'57.6200"
UTM	10S 671295mE 4341955mN
UTM Centimeter	10S 671295.52mE 4341955.87mN
MGRS	10SFJ7129541955
Grid North	1.3°
GARS	118LU43
Maidenhead	CM99LF80BJ95
GEOREF	DJPK59031259

Note: Based on degrees latitude longitude to seven decimal places.

The elevation is 2,755 feet above mean sea level (AMSL).

4.0 PROCESS DESCRIPTION

The proposed Idaho-Maryland Mine water treatment process is described in the following section. It should be noted that all of the proposed treatment components have been used successfully on an industrial scale for the contaminants of concern noted at the Rise facility, with none of them being novel or experimental in any way. The American Water Works Association publication *Iron and Manganese Removal Handbook (Second Edition, 2015, Civardi and Tompeck)* lists oxidation and adsorption onto manganese dioxide media (ore or coated) with a filtration component as being conventional approaches to remove Fe and Mn from water. The science behind each proposed component is well understood and has been validated over years of application in facilities worldwide.

The water treatment plant will be designed to operate at flow rates up to 2,500 gpm. It is assumed that the average treatment flow rate will be less than this maximum value once the mine is fully dewatered, and is anticipated to average approximately 850 gpm during active mining operations. The water treatment plant will be designed to run efficiently at either the maximum or lower flow rates expected during the life of the operation. Refer to Appendix C for the proposed Process Flow Diagram (PFD) and proposed plant layout.

The proposed WTP will consist of vessels filled with media in which the water will pass through for treatment. The water that passes through the media vessels will be in an oxidized state, from aeration and, if necessary, a small dose of additive chemical oxidant, with this oxidation being conducive to the treatment strategy. Initially, the water will be treated in vessels that have anthracite material for solids capture atop a pyrolusite bed, which will remove the bulk of the Fe and Mn that enters the vessels. This will then be followed by flowing the water through GAC beds that will remove remaining Fe and Mn, disinfection byproducts from the oxidation, residual cis-1,2 DCE as well as other inorganic and organic compounds. The vessels holding the media will be periodically backwashed, with the pyrolusite backwash stream being directed to a dewatering system that will remove the solids fraction, prior to returning the liquid fraction to the pond. The GAC media will not release an appreciable amount of captured contaminants during the backwashes, with this media only requiring very short backwashes that are primarily intended to decompress the media which can begin to compact during operations, reducing the throughput rate.

Influent to the process will be obtained from the NBS at a dewatering design rate of 850 gpm to 2,500 gpm. The water will be pumped to the existing clay-lined pond where an aeration system will be installed. It is anticipated that the aeration system will consist of a blower housed in a well-insulated and soundproof enclosure on the shore that will supply a high volume of air to submerged, horizontally constructed porous diffusers located within the clay-lined pond. The aeration diffusers will emit a continuous plume of gas-flushing bubbles that will ideally be small in size, significant in numbers, and will have a high overall amount of surface area for efficient mass transfer of oxygen. The aeration of water would occur in the northwest portion of the pond and the treatment plant feed pumps would be placed on the opposite, southeast area of the pond. In this configuration, the turbulence caused by aeration will not interfere with the settling characteristics of suspended solids that migrate toward the plant feed area; in turn, the plant feed will have a lower solids loading than if the aeration and plant feed piping were placed closer together.

Additionally, a mechanical solids separation process, such as centrifugation, or belt or drum filters, will be installed onshore in order to segregate the solids from the pyrolusite media backwash stream that will be returned to the clay-lined pond. In this manner, the pond will remain unaffected by the solids generated by backwash events.

During the aeration process, Fe will be the predominant element precipitated in the pond, with some Mn precipitation (unless a pH of at least 8.3 is reached to improve Mn oxidation by aeration), and will begin to settle to the bottom of the pond (sedimentation). With a working volume of 23 acre-ft (~7,495,000 gallons), the clay-lined pond will have a hydraulic retention time (HRT) of ~50 hours at a 2,500 gpm flow rate and ~147 hours at 850 gpm. These HRTs are lengthy enough to allow both Fe and Mn to oxidize to a significant extent; however, Mn is much slower to undergo its electrochemical transformation and therefore requires lengthier HRTs than iron. Due to the rather rapid transformation and precipitation of Fe, the pond will collect a high percentage of it while the pyrolusite media treatment will be the primary removal method for Mn.

The aeration process will also help liberate any volatile cis-1,2 DCE compounds present in the mine waters. The concentration of cis-1,2-DCE detected in the mine water (4.0 micrograms per liter {ug/L}) is less than the regulatory thresholds, and bench-testing showed that after aeration the cis-1,2, DCE was reduced to less than 0.15 ug/L. This same level was achieved without aeration, but with passage through GAC media, and so the proposed treatment train provides two forms of environmental protection against this organic compound.

The aeration area of the pond can include, as a contingency, pH adjustment using a base additive (sodium hydroxide {NaOH} is assumed due to low solids formation) to increase the alkalinity of the water. Sufficient alkalinity and oxidation will cause a significant percentage of the dissolved Fe and Mn in the water to change their base states. With this change, oxy-hydroxide floc will begin to form in the case of Fe and an oxide species in the case of Mn, and due to this, each will begin to precipitate out of solution. For Fe, the transformation will be from the soluble ferrous (Fe(II)) state to the insoluble ferric (Fe(III)) form, and for Mn, this will be a transformation from the soluble manganous Mn (Mn(II)) state to the insoluble manganic Mn (Mn(IV)) form. If pH adjustment is deemed necessary, it is anticipated that initially, the pond would receive the chemistry at a calculated dose while undergoing circulation via pumps. Once the pond is at the target pH, the circulation pumps would be halted and the chemistry would then be added into the pond feed from the underground workings. The pumps adding this adjustment would be flow paced, and would always introduce the chemistry at the correct dose to keep the pond at the target pH.

While the water is being conveyed to the treatment plant, a small dose of NaOCl (or $KMnO_4$) may be added to enhance the kinetics of the oxidation reactions under all surface conditions such as seasonal variations. This dose of oxidant will also serve to keep the adsorptive media continuously regenerated and in an optimal state for transforming any remaining dissolved Fe(II) to Fe(III), and Mn(II) to Mn(IV). In the presence of these conditions, the Mn(IV) will then be oxidized to MnO_2 and be adsorbed onto the media along with Fe(III). It is also possible to add a chemical oxidant to the backwash stream as opposed to the feed stream in order to keep the pyrolusite media activated.

The insoluble solids that do not settle in the pond's plant feed section will be conveyed to the WTP and filtered out within the anthracite cap section of the pyrolusite treatment vessels (the uppermost section). The anthracite cap consists of finely or coarsely divided coal, which is much lighter than the pyrolusite media underneath. Backwash cycles will fluidize the media and release the captured solids; however, the anthracite cap will retake its place and preferentially settle on top of the column due to its lower density and therefore slower settling characteristics. The anthracite cap will also adsorb some of the soluble Mn(II) onto its surface which will then be followed by subsequent oxidation to MnO_2. The majority of any remaining soluble Fe and Mn in the water that passes into the underlying pyrolusite bed will be oxidized and adsorbed to the media and subsequently released and removed during backwashes.

The design assumption for the pyrolusite treatment vessels is that they will be sized for the maximum flowrate of 2,500 gpm. It is anticipated that the pyrolusite media vessels will be configured as downflow units and sized to accommodate the typical manufacturer's pyrolusite loading rate of 3 – 8 gpm/ft^2. At a loading rate of ~4.5 gpm/ft^2, and assuming vessels with 120" diameters, 44" minimum bed depth (4" anthracite cap, 36" pyrolusite, and 4" gravel bed), and 60" working bed height (which allows for ~27 percent expansion during 5-minute backwash events) seven vessels will be required to process water at 2,500 gpm and a 100 percent service factor. This will afford an EBCT of ~5 minutes, which is sufficient contact time for both Fe and Mn treatment at the treatment pH range and in an oxidizing environment. However, backwashes are anticipated to occur every 6 hours (4 times per day at ~141,400-gallon intervals per vessel, and generating ~252,898 gallons of backwash water per day). To achieve the 100 percent service factor, eight vessels will be necessary, enabling the required seven to be in forward flow mode at all times and allowing one of the vessels at a time to go into a backwash cycle. The backwash cycles will require a minimum of ~23 gpm/ft^2 of backwash water. This high loading rate is due to the significant density of the pyrolusite material (120 lbs/ft^3 and a specific gravity of 3.8), which requires significant pump energy to fluidize it; therefore, backwash pump selection will be an important consideration during the final design phase of the project. However, opposed to manganese coated media such as greensand, which requires lengthy backwash cycles, the pyrolusite only needs short backwashes of approximately 5 minutes, which over time helps offset the cost of the high-performance backwash pumps required.

It is anticipated that piping and valves will be configured to use the treated filtrate from the forward flow vessels to provide backwash water to a unit undergoing its periodic cleaning event. It is further anticipated that system programming will allow only one vessel at a time to undergo a backwash cycle.

In order to help ensure regulatory compliance, the water will then be pumped through GAC vessels which will act as a final treatment polishing step for Fe, Mn, and other contaminants that may still be present in the water such as TTHMs and cis-1,2- DCE. It is anticipated that a commercial grade of activated coconut shell carbon would be an adequate final treatment material since it has a high density of micro-porosity which affords it a high surface area and enabling it to efficiently adsorb volatile organic compounds and other contaminants. It is further anticipated that the GAC contactor vessels will also be configured as downflow units and will be sized to accommodate loading rates of approximately 3 – 5 gpm/ft^2. At a loading rate of ~4.5 gpm/ft^2, and assuming vessels with 120” diameters, 36” GAC bed depth, and 60” working bed height (allowing ~33 percent expansion during 1-minute backwash events) seven vessels will be required to process water at 2,500 gpm and a 97 percent service factor. This will afford an EBCT of ~5 minutes, which is sufficient for adsorption of the contaminants of concern. However, backwashes are anticipated to occur every 6 hours to decompress the GAC and release any surface solids. To achieve the 97 percent service factor and allow on average ~0.75 hrs per day for infrequent carbon exchanges, eight vessels will be necessary, enabling the required seven to be in forward flow mode at all times and allowing one of the contactors at a time to go into a backwash cycle. The backwash decompression cycles will require ~8 gpm/ft^2 of backwash water, but due to their short duration will only require approximately ~17,593 gallons of water per day.

The infrequent carbon exchanges are for regeneration purposes and will only be required when the carbon exhibits signs of contaminant breakthrough. Vendors offer offsite thermal regeneration of carbon and if the regeneration cycles are staggered, very little downtime of the plant will be required to accommodate this routine maintenance. However, there will be some loss of material during regeneration, and on average approximately 5% - 10% of new carbon will need to be procured and added per regeneration event.

It is anticipated that piping and valves can be configured to use the treated GAC filtrate from the forward flow vessels to provide backwash water to a unit undergoing its periodic decompression event. It is further anticipated that system programming will allow only one vessel at a time to undergo a backwash cycle.

Following media filtration, the water may need to be subjected to sodium bisulfite (SBS) addition, or an alternative reducing agent, to neutralize any residual chemical oxidant (if it is used) which could otherwise contribute to downstream aquatic toxicity. Additionally, if pH adjustments are required, a small dose of sulfuric acid (H_2SO_4) will be added to the treated effluent before it is stored in the finished water tank. The water stored in the finished water tank will provide the final effluent and will be released into the South Fork of Wolf Creek or used for other approved purposes.

As described above, periodic backwashes of the pyrolusite and GAC media vessels will release filtered and adsorbed solids. Ideally, effluent water from the treatment vessels will be redirected to a vessel undergoing backwash; however, post-treatment effluent that will be stored in the finished water tank may be used as backwash water. The backwashes will be directed to a mechanical solids removal system. It is anticipated that this system will be comprised of centrifugation equipment, which will dewater the solids prior to conveying the liquid supernatant to the clay-lined pond. Dewatered solids removed from the backwash will be stored in containers and periodically transported to an appropriate facility for disposal. The mass of solids removed during backwashing is small, estimated at ~3 kg per day at the 850 gpm operational rate and ~10 kg per day at the 2,500 gpm dewatering rate.

Along with Fe and Mn treatment, this process will also reduce the concentrations of arsenic (As) and ammonia (NH_3), both of which have been detected in low concentrations in surface water seeps near the Idaho-Maryland Mine. Arsenic will be oxidized from its As(III) state to the As(V) state, and in this state will be adsorbed by the hydrous ferric oxide that forms from the oxidation of Fe in the water when it undergoes its electrochemical transformation in an environment of sufficient alkalinity during the treatment process. The Fe/As complex will then either settle in the pond or be filtered out by the anthracite cap media, which will remove both contaminants. The majority of any remaining dissolved iron and arsenic will then undergo oxidation, complexation, and adsorption to the underlying pyrolusite media. Low concentrations of NH_3 may occur as a result of explosives used during periods of active mining and will be removed by the aeration process. If required, the efficiency of this aeration can be enhanced by increasing the pH. This will generate more of the gaseous form of NH_3 which can be stripped from the water. Therefore, as a contingency component for Fe (and Fe/As), Mn, and ammonia treatment, sodium hydroxide (NaOH) will be included in the permitting efforts for pH adjustments should it become necessary to add alkalinity to the water for Fe (along with Fe/As) and Mn treatment, or to treat NH_3 more efficiently or in higher concentrations than have been previously detected. In regard to ammonia treatment, this may occur as a result of explosives used during periods of active mining.

The EMKO 2020 report states that due to the oxygen deficiency of the NBS water that carbonate minerals associated with the pyritic ore may be susceptible to being oxidized during dewatering activities, and that the conditions present could possibly mobilize sulfate, calcium, and magnesium – thereby increasing the electrical conductivity (EC) and total dissolved solids (TDS) of the water in mine areas where sulfide minerals are present. The percentage of affected mine workings is anticipated to be only a small fraction of the volume of the new workings, and can be partially controlled in those areas by strategic backfilling of stopes with cementation products to provide protective barriers. If source control cannot mitigate the rise in TDS and electrical conductivity, and the aforementioned ions cause an exceedance of regulatory discharge allowances, additional treatment would be required. The EMKO 2020 report listed EC values for the NBS water as approximately 385 µS/cm. The mobilized divalent ions from the carbonate and sulfide minerals would add to that specific conductance, although it would require significant contributions of Ca, Mg, and SO_4 to surpass the NPDES CAG995002 screening level of 900 uS/cm. However, if treatment is deemed necessary for TDS mitigation at some point during mining operations, it is Linkan’s opinion that mobile ion exchange water softeners should be deployed as opposed to building additional permanent infrastructure that may not be needed or only needed for relatively short periods. These mobile units are readily available, and various vendors offer the service of replacing them as necessary as the resin becomes spent and in need of regeneration. Additionally, the resins used for these constituents are common throughout the industry for softening water and do not pose a health or environmental risk. Therefore, the additional treatment would be rather transparent to mining and other water treatment operations, and would be less complex than lime softening or installing and operating membrane filtration systems, both of which are also widely used methods for removing Ca, Mg and SO4, but which also have onsite waste handling and management requirements that makes their use less attractive.

5.0 TECHNICAL SPECIFICATIONS

5.1 Major Equipment

Equipment data sheets for major equipment anticipated for the WTP are presented in Appendix D. Note that equipment specifications are subject to change with any changes to the process or design necessitated by the information presented by Rise or their authorized agents.

5.2 Chemicals

Chemicals considered for the treatment process include NaOH, NaOCl or $KMnO_4$, H_2SO_4, and SBS. In addition to aeration, the process includes, as a contingency, an additional chemical oxidant (either NaOCl or KMnO4). NaOCl is the preferred oxidant due to lower chemical consumption, easier plant operation, handling, and storage considerations, as well as reduced cost. Any TTHMs created from using NaOCl are removed in the GAC process. $KMnO_4$ was also used in the bench-scale tests and is included as a contingency. NaOH is included as a contingency for enhancing Fe and Mn removal via alkalinity addition, as well as NH_3 removal via aeration should it become necessary during mining operations. SBS is included to ensure that the oxidant is neutralized prior to effluent discharge in order to safeguard against aquatic toxicity. H_2SO_4 is included as a contingency in the event that the pH of the effluent water must be adjusted prior to discharge to the South Fork of Wolf Creek. The projected consumption of these chemicals, when used at a flowrate of 850 gpm, is presented in Table 5-1:

Table 5-1: Chemical Type & Estimated Usage at the Idaho-Maryland Mine – 850 GPM Treatment Rate

Chemical	Estimated Usage
12.5% NaOC1	35 gal/day
3% $KMnO_4$	224 gal/day
93% Sulfuric Acid	19 gal/day
50% Sodium Hydroxide	72 gal/day
39% Sodium Bisulfite	2.5 gal/day

It is anticipated that any flocculent used during active mining for underground total suspended solids (TSS) removal will not adversely affect the water treatment process, since contact with contaminants on the surface would also yield settling in the clay-lined pond or filterable solids at the MnO_2 media vessels. However, the oxidant demand could increase due to oxidative destruction of any excess polymer that might be present and additional MnO_2 vessel backwash cycles might become necessary.

Chemical storage areas are identified on the site layout drawing as presented in Appendix C. Safety data sheets (SDS) are attached in Appendix E.

5.3 Containment of Process Fluids and Chemicals

The chemical storage will be in areas with secondary containment. Chemical piping will be routed to minimize exposure to personnel.

5.4 Waste Management

5.4.1 Liquid Waste

No liquid waste is anticipated to be generated using the proposed process.

5.4.2 Solid Waste

The major component of the solid waste generated by the water treatment process will be sedimentation of iron precipitates in the pond from the aeration process, and secondarily from backwashing the pyrolusite and GAC vessels. The backwash discharge will be directed to dewatering equipment and will therefore be removed from the system on a routine basis. This solid waste will then be characterized by toxicity characteristic leaching procedure (TCLP) testing or other means designated by the regulatory agencies, and disposed of in accordance with applicable laws and regulations.

The quantity of Fe, and to a much lesser extent Mn, removed from the mine waters by aeration treatment and stored in the pond is relatively small. Assuming the laboratory reported raw water concentrations for Fe and Mn of 1.6 mg/L and 0.27 mg/L, respectively, which corresponds to 3.06 mg/L as $Fe(OH)_3$ and 0.43 mg/L MnO_2 as oxidized and precipitated species, and additionally assuming that 85% of the Fe will precipitate out of solution in the pond and that 5% of the Mn will likewise remain in the pond as solid MnO_2, approximately 14 tons per year of iron and manganese residues would accumulate in the pond at the maximum flow rate of 2,500 gpm, and approximately 5 tons per year of iron and manganese residues would accumulate at the average flow rate of 850 gpm.

Using the assumptions presented above, 15% of the Fe would be conveyed to the pyrolusite vessels for treatment, while 95% of the Mn would be treated by the pyrolusite media. These solids would then be removed from the media during backwash events and dewatered by centrifugation or other means. This corresponds to ~5 tons / yr. of dewatered and removed solids at a flowrate of 2,500 gpm, and ~1.5 tons / yr. at a flowrate of 850 gpm.

The treatment design intent that allows for the majority of the iron mass to precipitate after aeration in the pond with pyrolusite vessel backwashing providing a minority of the mass of iron which will be removed via dewatering, and for the majority of the manganese residues being removed via the pyrolusite vessel backwashing and dewatering, with comparatively very little MnO_2 forming in the pond, will result in a slow buildup of solids in the pond. However, even though the cumulative accumulations of these elements in the pond are projected to be relatively small, the management and removal of sludge from the pond will nonetheless be required throughout the operational period. This is heavily influenced by the additional TSS load from the mining operation, which will convey silt from the underground workings and deposit this into the clay-lined pond along with the water that contains the dissolved Fe and Mn in need of treatment.

During initial NBS shaft dewatering, the total suspended solids (TSS) in the underground water are expected to be low, and data presented by EMKO from their sampling events shows suspended solids below laboratory detection limits (<5 mg/L) in the water currently flooding the shaft (EMKO 2020, Table 3-6). During active mining, the amount of TSS in the water is expected to increase and will be heavily influenced by the effectiveness of the underground settling sumps. Assuming that water discharged from the mine has suspended solids of 100 mg/L, which are subsequently reduced by settlement in the pond to the 20 mg/L treatment goal (EMKO 2020 Table 4-10), and an average flow rate of 850 gallons per minute, the mine would produce approximately 37 tons per year of silt-born sludge. Therefore, the great majority of sludge in the pond will be comprised of fine rock material (~37 tons per year), well in excess of the iron and manganese residue (~5 tons per year), with a combined total of approximately 42 tons per year.

Remobilization of manganese can potentially result from biological activity which can create anoxic conditions and liberate Mn(II) from the MnO_2 form. However, most solids containing manganese will be removed via dewatering the media backwash stream, thereby greatly negating this effect. Any MnO_2 that is remobilized in the pond as Mn(II) due to this mechanism will eventually enter the pyrolusite treatment vessels and be reconverted to the solid MnO_2 form, and will subsequently be removed during backwash stream dewatering.

Rise plans to remove sludge from the pond approximately every 10 years. The solids removed from the pond will be dewatered and hauled to an appropriate and approved off-site landfill. If conditions warrant, more frequent sludge removal events will be performed. It is assumed that the sludge will need to pass standard paint filter tests per SW-846 Method 9095B, to ensure no free liquid is present in the sludge, and TCLP tests or other tests designated by regulatory authorities prior to transport.

The volume of the pond, assuming operational freeboard, is ~23 acre-feet (EMKO 2020 Section 4.5). Assuming a flow rate of 850 gpm and a sludge density of ~122 lbs/ft^3 (16.4 ft^3/ton), approximately one percent of the operational volume of the pond would be required to impound sludge over a period of 10 years. This correlates to approximately 420 tons of sludge being removed from the pond every 10 years. This sludge mass takes into account the TSS conveyed to the surface from the underground sumps, the estimated sludge generated by Fe and Mn retention in the pond, and the dewatered media vessel backwash stream that will remove solids from the system.

The removal of sludge from the pond can be achieved with slurry pumps and the periodic sludge dewatering activities can be performed using Rise's mining-related process plant equipment, which includes thickeners and filter presses. It is anticipated that the process plant equipment will be temporarily repurposed for sludge removal and dewatering, as necessary. If the process plant cannot accommodate sludge removal activities for any reason, the sludge could also be dewatered using mobile dewatering equipment (belt press, centrifuge, settling tanks, etc.) that is readily available from contractors and service providers who specialize in sludge removal from treatment ponds.

5.5 Operations

The water treatment system will include instrumentation that will provide continuous feedback of stable operations. This will include pH, ORP, conductivity, and turbidity measurements. Values that extend beyond predetermined control limits will initiate the shutdown of the entire system and will prompt operator investigation, correction, and restart. The pH will provide feedback for the chemical doses of acids and bases. The ORP will provide feedback for oxidizing and reducing agent control. Conductivity and turbidity will provide effluent water quality in relation to discharge allowances.

It is anticipated that periodic field tests for Fe and Mn will be performed on the treated effluent on a continuing basis as part of standard operating procedures. Fe testing can also act as an indicator for the effective removal of As, since the As will travel with the Fe as a complex. NH_3 testing can also be performed to monitor the effectiveness of the aeration system.

6.0 REFERENCES

The American Water Works Association (2015). Iron and Manganese Removal Handbook (Second Edition, 2015, Civardi and Tompeck)

EMKO Environmental, Inc. (2020). Groundwater Hydrology and Water Quality Analysis Report for the Idaho-Maryland Mine Project, Nevada County, California. El Dorado Hills, CA.

APPENDIX A

LABORATORY RESULTS

CALIFORNIA LABORATORY SERVICES
Committed. Responsive. Flexible.

January 16, 2019

CLS Work Order #: 19A0196
COC #:

Sam Billin
Linkan Engineering
2720 Ruby Vista Drive
Elko, NV 89801

Project Name: Rise Gold

Enclosed are the results of analyses for samples received by the laboratory on 01/04/19 13:15. Samples were analyzed pursuant to client request utilizing EPA or other ELAP approved methodologies. I certify that the results are in compliance both technically and for completeness.

Analytical results are attached to this letter. Please call if we can provide additional assistance.

Sincerely,

James Liang, Ph.D.
Laboratory Director

CA SWRCB ELAP Accreditation/Registration number 1233

Linkan Engineering	Project: Rise Gold	
2720 Ruby Vista Drive	Project Number: 54.02.03	**CLS Work Order #: 19A0196**
Elko, NV 89801	Project Manager: Sam Billin	COC #:

Metals by EPA 200 Series Methods

Analyte	Result	MDL	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Rise Baseline (19A0196-01) WW Sampled: 12/19/18 15:30 Received: 01/04/19 13:15										
Arsenic	ND	5.0	5.0	µg/L	1	1900121	01/07/19	01/07/19	EPA 200.7	
Iron	**1400**	9.1	100	"	"	"	"	"	"	
Manganese	**240**	0.92	20	"	"	"	"	"	"	
Aeration Post-MnO2 (19A0196-02) WW Sampled: 12/20/18 14:00 Received: 01/04/19 13:15										
Arsenic	ND	5.0	5.0	µg/L	1	1900121	01/07/19	01/07/19	EPA 200.7	
Iron	ND	9.1	100	"	"	"	"	"	"	
Manganese	**22**	0.92	20	"	"	"	"	"	"	
KMnO4-1.7ppm-MnO2 Effluent (19A0196-04) WW Sampled: 12/31/18 11:15 Received: 01/04/19 13:15										
Arsenic	ND	5.0	5.0	µg/L	1	1900121	01/07/19	01/07/19	EPA 200.7	
Iron	ND	9.1	100	"	"	"	"	"	"	
Manganese	**37**	0.92	20	"	"	"	"	"	"	
NaOCl-1ppm-MnO2 Effluent (19A0196-06) WW Sampled: 12/31/18 15:30 Received: 01/04/19 13:15										
Arsenic	ND	5.0	5.0	µg/L	1	1900121	01/07/19	01/07/19	EPA 200.7	
Iron	ND	9.1	100	"	"	"	"	"	"	
Manganese	**100**	0.92	20	"	"	"	"	"	"	
Aeration Post-GAC (19A0196-07) WW Sampled: 01/02/19 14:45 Received: 01/04/19 13:15										
Arsenic	ND	5.0	5.0	µg/L	1	1900121	01/07/19	01/07/19	EPA 200.7	
Iron	ND	9.1	100	"	"	"	"	"	"	
Manganese	**12**	0.92	20	"	"	"	"	"	"	J
NaOCl-1ppm, GAC Effluent (19A0196-08) WW Sampled: 01/02/19 16:45 Received: 01/04/19 13:15										
Arsenic	ND	5.0	5.0	µg/L	1	1900121	01/07/19	01/07/19	EPA 200.7	
Iron	ND	9.1	100	"	"	"	"	"	"	
Manganese	**9.3**	0.92	20	"	"	"	"	"	"	J

Linkan Engineering	Project: Rise Gold	
2720 Ruby Vista Drive	Project Number: 54.02.03	**CLS Work Order #: 19A0196**
Elko, NV 89801	Project Manager: Sam Billin	COC #:

Metals by EPA 200 Series Methods

Analyte	Result	MDL	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
KMnO4-1.7-2, GAC Effluent (19A0196-09) WW Sampled: 01/03/19 11:00 Received: 01/04/19 13:15										
Arsenic	ND	5.0	5.0	µg/L	1	1900121	01/07/19	01/07/19	EPA 200.7	
Iron	ND	9.1	100	"	"	"	"	"	"	
Manganese	**12**	0.92	20	"	"	"	"	"	"	J

Linkan Engineering 2720 Ruby Vista Drive Elko, NV 89801	Project: Rise Gold Project Number: 54.02.03 Project Manager: Sam Billin	**CLS Work Order #: 19A0196** COC #:

Purgeables by EPA Method 624

Analyte	Result	MDL	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Rise Baseline (19A0196-01) WW Sampled: 12/19/18 15:30 Received: 01/04/19 13:15										**HT-1**
cis-1,2-Dichloroethene	**4.0**	0.15	0.50	µg/L	1	1900140	01/07/19	01/08/19	EPA 624	
Surrogate: 1,2-Dichloroethane-d4			*100 %*	*65-135*		"	"	"	"	
Surrogate: 4-Bromofluorobenzene			*115 %*	*73-125*		"	"	"	"	
Surrogate: Toluene-d8			*89 %*	*72-125*		"	"	"	"	
Aeration Post-MnO2 (19A0196-02) WW Sampled: 12/20/18 14:00 Received: 01/04/19 13:15										**HT-1**
cis-1,2-Dichloroethene	ND	0.15	0.50	µg/L	1	1900140	01/07/19	01/08/19	EPA 624	
Surrogate: 1,2-Dichloroethane-d4			*106 %*	*65-135*		"	"	"	"	
Surrogate: 4-Bromofluorobenzene			*113 %*	*73-125*		"	"	"	"	
Surrogate: Toluene-d8			*95 %*	*72-125*		"	"	"	"	
Aeration Pre-Column (19A0196-03) WW Sampled: 12/20/18 09:00 Received: 01/04/19 13:15										**HT-1**
cis-1,2-Dichloroethene	ND	0.15	0.50	µg/L	1	1900140	01/07/19	01/08/19	EPA 624	
Surrogate: 1,2-Dichloroethane-d4			*131 %*	*65-135*		"	"	"	"	
Surrogate: 4-Bromofluorobenzene			*114 %*	*73-125*		"	"	"	"	
Surrogate: Toluene-d8			*94 %*	*72-125*		"	"	"	"	
KMnO4-1.7ppm-MnO2 Effluent (19A0196-04) WW Sampled: 12/31/18 11:15 Received: 01/04/19 13:15										
cis-1,2-Dichloroethene	**3.4**	0.15	0.50	µg/L	1	1900140	01/07/19	01/08/19	EPA 624	
Surrogate: 1,2-Dichloroethane-d4			*102 %*	*65-135*		"	"	"	"	
Surrogate: 4-Bromofluorobenzene			*114 %*	*73-125*		"	"	"	"	
Surrogate: Toluene-d8			*84 %*	*72-125*		"	"	"	"	
Rise Raw-NaOCl Test (19A0196-05) WW Sampled: 12/31/18 13:00 Received: 01/04/19 13:15										
Bromodichloromethane	ND	0.061	0.50	µg/L	1	1900140	01/07/19	01/08/19	EPA 624	
Bromoform	ND	0.16	0.50	"	"	"	"	"	"	
Chloroform	ND	0.13	0.50	"	"	"	"	"	"	
cis-1,2-Dichloroethene	**3.8**	0.15	0.50	"	"	"	"	"	"	

Linkan Engineering	Project: Rise Gold	
2720 Ruby Vista Drive	Project Number: 54.02.03	**CLS Work Order #: 19A0196**
Elko, NV 89801	Project Manager: Sam Billin	COC #:

Purgeables by EPA Method 624

Analyte	Result	MDL	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Rise Raw-NaOCl Test (19A0196-05) WW Sampled: 12/31/18 13:00 Received: 01/04/19 13:15										
Dibromochloromethane	ND	0.13	0.50	µg/L	1	1900140	"	01/08/19	EPA 624	
Surrogate: 1,2-Dichloroethane-d4			*106 %*	*65-135*		"	"	"	"	
Surrogate: 4-Bromofluorobenzene			*112 %*	*73-125*		"	"	"	"	
Surrogate: Toluene-d8			*81 %*	*72-125*		"	"	"	"	
NaOCl-1ppm-MnO2 Effluent (19A0196-06) WW Sampled: 12/31/18 15:30 Received: 01/04/19 13:15										
Bromodichloromethane	**0.36**	0.061	0.50	µg/L	1	1900140	01/07/19	01/08/19	EPA 624	J
Bromoform	ND	0.16	0.50	"	"	"	"	"	"	
Chloroform	**3.3**	0.13	0.50	"	"	"	"	"	"	
cis-1,2-Dichloroethene	**3.4**	0.15	0.50	"	"	"	"	"	"	
Dibromochloromethane	ND	0.13	0.50	"	"	"	"	"	"	
Surrogate: 1,2-Dichloroethane-d4			*106 %*	*65-135*		"	"	"	"	
Surrogate: 4-Bromofluorobenzene			*111 %*	*73-125*		"	"	"	"	
Surrogate: Toluene-d8			*96 %*	*72-125*		"	"	"	"	
Aeration Post-GAC (19A0196-07) WW Sampled: 01/02/19 14:45 Received: 01/04/19 13:15										
cis-1,2-Dichloroethene	ND	0.15	0.50	µg/L	1	1900140	01/07/19	01/08/19	EPA 624	
Surrogate: 1,2-Dichloroethane-d4			*114 %*	*65-135*		"	"	"	"	
Surrogate: 4-Bromofluorobenzene			*110 %*	*73-125*		"	"	"	"	
Surrogate: Toluene-d8			*76 %*	*72-125*		"	"	"	"	
NaOCl-1ppm, GAC Effluent (19A0196-08) WW Sampled: 01/02/19 16:45 Received: 01/04/19 13:15										
Bromodichloromethane	ND	0.061	0.50	µg/L	1	1900140	01/07/19	01/08/19	EPA 624	
Bromoform	ND	0.16	0.50	"	"	"	"	"	"	
Chloroform	ND	0.13	0.50	"	"	"	"	"	"	
cis-1,2-Dichloroethene	ND	0.15	0.50	"	"	"	"	"	"	
Dibromochloromethane	ND	0.13	0.50	"	"	"	"	"	"	
Surrogate: 1,2-Dichloroethane-d4			*113 %*	*65-135*		"	"	"	"	

Linkan Engineering	Project: Rise Gold	
2720 Ruby Vista Drive	Project Number: 54.02.03	**CLS Work Order #: 19A0196**
Elko, NV 89801	Project Manager: Sam Billin	COC #:

Purgeables by EPA Method 624

Analyte	Result	MDL	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
NaOCl-1ppm, GAC Effluent (19A0196-08) WW Sampled: 01/02/19 16:45 Received: 01/04/19 13:15										
Surrogate: 4-Bromofluorobenzene			*110 %*	*73-125*		*1900140*	"	*01/08/19*	*EPA 624*	
Surrogate: Toluene-d8			*72 %*	*72-125*		"	"	"	"	
KMnO4-1.7-2, GAC Effluent (19A0196-09) WW Sampled: 01/03/19 11:00 Received: 01/04/19 13:15										
cis-1,2-Dichloroethene	ND	0.15	0.50	µg/L	1	1900140	01/07/19	01/08/19	EPA 624	
Surrogate: 1,2-Dichloroethane-d4			*117 %*	*65-135*		"	"	"	"	
Surrogate: 4-Bromofluorobenzene			*111 %*	*73-125*		"	"	"	"	
Surrogate: Toluene-d8			*78 %*	*72-125*		"	"	"	"	
Trip Blanks (19A0196-10) Water Sampled: 01/03/19 10:15 Received: 01/04/19 13:15										
Bromodichloromethane	ND	0.061	0.50	µg/L	1	1900140	01/07/19	01/08/19	EPA 624	
Bromoform	ND	0.16	0.50	"	"	"	"	"	"	
Chloroform	ND	0.13	0.50	"	"	"	"	"	"	
cis-1,2-Dichloroethene	ND	0.15	0.50	"	"	"	"	"	"	
Dibromochloromethane	ND	0.13	0.50	"	"	"	"	"	"	
Surrogate: 1,2-Dichloroethane-d4			*104 %*	*65-135*		"	"	"	"	
Surrogate: 4-Bromofluorobenzene			*115 %*	*73-125*		"	"	"	"	
Surrogate: Toluene-d8			*94 %*	*72-125*		"	"	"	"	

Linkan Engineering
2720 Ruby Vista Drive
Elko, NV 89801

Project: Rise Gold
Project Number: 54.02.03
Project Manager: Sam Billin

CLS Work Order #: 19A0196
COC #:

Metals by EPA 200 Series Methods - Quality Control

Analyte	Result	MDL	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch 1900121 - EPA 200 Series											
Blank (1900121-BLK1)					Prepared & Analyzed: 01/07/19						
Arsenic	ND	5.0	5.0	µg/L							
Iron	ND	9.1	100	"							
Manganese	ND	0.92	20	"							
LCS (1900121-BS1)					Prepared & Analyzed: 01/07/19						
Arsenic	1050	5.0	5.0	µg/L	1000		105	85-115			
Iron	917	9.1	100	"	1000		92	85-115			
Manganese	1030	0.92	20	"	1000		103	85-115			
Matrix Spike (1900121-MS1)			**Source: 19A0196-01**		Prepared & Analyzed: 01/07/19						
Arsenic	997	5.0	5.0	µg/L	1000	ND	100	70-130			
Iron	2100	9.1	100	"	1000	1370	72	70-130			
Manganese	1170	0.92	20	"	1000	236	93	70-130			

Purgeables by EPA Method 624 - Quality Control

Batch 1900140 - EPA 5030 Water MS

Blank (1900140-BLK1) Prepared: 01/07/19 Analyzed: 01/08/19

Analyte	Result	MDL	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Benzene	ND	0.057	0.30	µg/L							
Bromodichloromethane	ND	0.061	0.50	"							
Bromoform	ND	0.16	0.50	"							
Bromomethane	ND	0.20	0.50	"							
Carbon tetrachloride	ND	0.092	0.50	"							
Chlorobenzene	ND	0.11	0.30	"							
Chloroethane	ND	0.20	0.50	"							
2-Chloroethylvinyl ether	ND	0.11	2.0	"							
Chloroform	ND	0.13	0.50	"							
Chloromethane	ND	0.29	0.50	"							
Dibromochloromethane	ND	0.13	0.50	"							
1,2-Dichlorobenzene	ND	0.042	0.30	"							
1,3-Dichlorobenzene	ND	0.081	0.30	"							
1,4-Dichlorobenzene	ND	0.061	0.30	"							
Dichlorodifluoromethane (Freon 12)	ND	0.37	0.50	"							
1,1-Dichloroethane	ND	0.12	0.50	"							
1,2-Dichloroethane	ND	0.054	0.50	"							
1,1-Dichloroethene	ND	0.092	0.50	"							
cis-1,2-Dichloroethene	ND	0.15	0.50	"							
trans-1,2-Dichloroethene	ND	0.13	0.50	"							
1,2-Dichloropropane	ND	0.057	0.50	"							
cis-1,3-Dichloropropene	ND	0.097	0.50	"							
trans-1,3-Dichloropropene	ND	0.12	0.50	"							
Ethylbenzene	ND	0.090	0.30	"							
Methylene chloride	ND	0.24	0.50	"							
1,1,2,2-Tetrachloroethane	ND	0.13	0.50	"							
Tetrachloroethene	ND	0.12	0.50	"							
Toluene	ND	0.10	0.30	"							
1,1,1-Trichloroethane	ND	0.18	0.50	"							
1,1,2-Trichloroethane	ND	0.098	0.50	"							
Trichloroethene	ND	0.11	0.50	"							

Linkan Engineering	Project: Rise Gold	
2720 Ruby Vista Drive	Project Number: 54.02.03	**CLS Work Order #: 19A0196**
Elko, NV 89801	Project Manager: Sam Billin	COC #:

Purgeables by EPA Method 624 - Quality Control

Batch 1900140 - EPA 5030 Water MS

Blank (1900140-BLK1) Prepared: 01/07/19 Analyzed: 01/08/19

Analyte	Result	MDL	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Trichlorofluoromethane	ND	0.20	0.50	µg/L							
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113)	ND	0.15	0.50	"							
Vinyl chloride	ND	0.17	0.50	"							
Xylenes (total)	ND	0.35	0.50	"							
Surrogate: 1,2-Dichloroethane-d4	*10.1*			*"*	*10.0*		*101*	*65-135*			
Surrogate: Toluene-d8	*9.27*			*"*	*10.0*		*93*	*72-125*			
Surrogate: 4-Bromofluorobenzene	*11.3*			*"*	*10.0*		*113*	*73-125*			

LCS (1900140-BS1) Prepared & Analyzed: 01/07/19

Analyte	Result	MDL	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Benzene	24.6	0.057	0.30	µg/L	20.0		123	37-151			
Bromodichloromethane	14.9	0.061	0.50	"	20.0		75	35-155			
Bromoform	13.9	0.16	0.50	"	20.0		70	45-169			
Bromomethane	15.0	0.20	0.50	"	20.0		75	10-242			
Carbon tetrachloride	17.2	0.092	0.50	"	20.0		86	70-140			
Chlorobenzene	17.6	0.11	0.30	"	20.0		88	37-160			
Chloroethane	23.9	0.20	0.50	"	20.0		119	14-230			
Chloroform	21.2	0.13	0.50	"	20.0		106	51-138			
Chloromethane	19.7	0.29	0.50	"	20.0		98	10-273			
Dibromochloromethane	17.9	0.13	0.50	"	20.0		90	53-149			
1,2-Dichlorobenzene	23.6	0.042	0.30	"	20.0		118	18-190			
1,3-Dichlorobenzene	22.3	0.081	0.30	"	20.0		111	59-156			
1,4-Dichlorobenzene	21.8	0.061	0.30	"	20.0		109	18-190			
Dichlorodifluoromethane (Freon 12)	18.7	0.37	0.50	"	20.0		93	50-150			
1,1-Dichloroethane	24.8	0.12	0.50	"	20.0		124	59-155			
1,2-Dichloroethane	21.1	0.054	0.50	"	20.0		105	49-155			
1,1-Dichloroethene	16.6	0.092	0.50	"	20.0		83	5-234			
trans-1,2-Dichloroethene	24.4	0.13	0.50	"	20.0		122	54-156			
1,2-Dichloropropane	21.8	0.057	0.50	"	20.0		109	5-210			
cis-1,3-Dichloropropene	12.8	0.097	0.50	"	20.0		64	5-227			
trans-1,3-Dichloropropene	14.5	0.12	0.50	"	20.0		73	17-183			
Ethylbenzene	20.0	0.090	0.30	"	20.0		100	37-162			

Purgeables by EPA Method 624 - Quality Control

Batch 1900140 - EPA 5030 Water MS

LCS (1900140-BS1) Prepared & Analyzed: 01/07/19

Analyte	Result	MDL	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Methylene chloride	26.5	0.24	0.50	µg/L	20.0		132	5-221			
1,1,2,2-Tetrachloroethane	25.2	0.13	0.50	"	20.0		126	46-148			
Tetrachloroethene	16.6	0.12	0.50	"	20.0		83	64-148			
Toluene	19.3	0.10	0.30	"	20.0		97	47-150			
1,1,1-Trichloroethane	18.1	0.18	0.50	"	20.0		91	52-162			
1,1,2-Trichloroethane	18.7	0.098	0.50	"	20.0		94	52-150			
Trichloroethene	22.0	0.11	0.50	"	20.0		110	71-157			
Trichlorofluoromethane	15.6	0.20	0.50	"	20.0		78	47-181			
Vinyl chloride	22.0	0.17	0.50	"	20.0		110	10-251			
Surrogate: 1,2-Dichloroethane-d4	*8.39*			*"*	*10.0*		*84*	*65-135*			
Surrogate: Toluene-d8	*8.20*			*"*	*10.0*		*82*	*72-125*			
Surrogate: 4-Bromofluorobenzene	*10.7*			*"*	*10.0*		*107*	*73-125*			

LCS Dup (1900140-BSD1) Prepared & Analyzed: 01/07/19

Analyte	Result	MDL	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Benzene	24.8	0.057	0.30	µg/L	20.0		124	37-151	0.6	30	
Bromodichloromethane	17.2	0.061	0.50	"	20.0		86	35-155	14	30	
Bromoform	15.9	0.16	0.50	"	20.0		79	45-169	13	30	
Bromomethane	19.2	0.20	0.50	"	20.0		96	10-242	24	30	
Carbon tetrachloride	16.9	0.092	0.50	"	20.0		84	70-140	2	30	
Chlorobenzene	20.4	0.11	0.30	"	20.0		102	37-160	15	30	
Chloroethane	23.6	0.20	0.50	"	20.0		118	14-230	1	30	
Chloroform	20.5	0.13	0.50	"	20.0		103	51-138	3	30	
Chloromethane	18.8	0.29	0.50	"	20.0		94	10-273	5	30	
Dibromochloromethane	17.7	0.13	0.50	"	20.0		89	53-149	1	30	
1,2-Dichlorobenzene	23.0	0.042	0.30	"	20.0		115	18-190	2	30	
1,3-Dichlorobenzene	21.5	0.081	0.30	"	20.0		108	59-156	3	30	
1,4-Dichlorobenzene	21.3	0.061	0.30	"	20.0		106	18-190	3	30	
Dichlorodifluoromethane (Freon 12)	19.1	0.37	0.50	"	20.0		96	50-150	2	30	
1,1-Dichloroethane	18.1	0.12	0.50	"	20.0		91	59-155	31	30	QR-2
1,2-Dichloroethane	20.2	0.054	0.50	"	20.0		101	49-155	4	30	
1,1-Dichloroethene	17.1	0.092	0.50	"	20.0		85	5-234	3	30	

Linkan Engineering	Project: Rise Gold	
2720 Ruby Vista Drive	Project Number: 54.02.03	**CLS Work Order #: 19A0196**
Elko, NV 89801	Project Manager: Sam Billin	COC #:

Purgeables by EPA Method 624 - Quality Control

Analyte	Result	MDL	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch 1900140 - EPA 5030 Water MS											
LCS Dup (1900140-BSD1)					Prepared & Analyzed: 01/07/19						
trans-1,2-Dichloroethene	16.9	0.13	0.50	µg/L	20.0		84	54-156	36	30	QR-2
1,2-Dichloropropane	21.7	0.057	0.50	"	20.0		108	5-210	0.6	30	
cis-1,3-Dichloropropene	16.8	0.097	0.50	"	20.0		84	5-227	27	30	
trans-1,3-Dichloropropene	14.4	0.12	0.50	"	20.0		72	17-183	1	30	
Ethylbenzene	23.0	0.090	0.30	"	20.0		115	37-162	14	30	
Methylene chloride	18.2	0.24	0.50	"	20.0		91	5-221	37	30	QR-2
1,1,2,2-Tetrachloroethane	25.0	0.13	0.50	"	20.0		125	46-148	0.8	30	
Tetrachloroethene	16.5	0.12	0.50	"	20.0		83	64-148	0.4	30	
Toluene	22.4	0.10	0.30	"	20.0		112	47-150	15	30	
1,1,1-Trichloroethane	17.9	0.18	0.50	"	20.0		89	52-162	1	30	
1,1,2-Trichloroethane	18.7	0.098	0.50	"	20.0		93	52-150	0.2	30	
Trichloroethene	22.0	0.11	0.50	"	20.0		110	71-157	0.05	30	
Trichlorofluoromethane	16.5	0.20	0.50	"	20.0		83	47-181	6	30	
Vinyl chloride	20.6	0.17	0.50	"	20.0		103	10-251	6	30	
Surrogate: 1,2-Dichloroethane-d4	*8.83*			*"*	*10.0*		*88*	*65-135*			
Surrogate: Toluene-d8	*10.0*			*"*	*10.0*		*100*	*72-125*			
Surrogate: 4-Bromofluorobenzene	*10.7*			*"*	*10.0*		*107*	*73-125*			

Notes and Definitions

QR-2	The RPD result exceeded the QC control limits; however, both percent recoveries were acceptable. Sample results for the QC batch were accepted based on percent recoveries and completeness of QC data.
J	Detected but below the Reporting Limit; therefore, result is an estimated concentration.
HT-1	The sample was received outside of the EPA recommended holding time.
DET	Analyte DETECTED
ND	Analyte NOT DETECTED at or above the reporting limit (or method detection limit when specified)
NR	Not Reported
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference

This is a “MDL Report”, thus if the report denotes an “ND” for a particular analyte, it should be noted that the analyte was not detected at or above the MDL.

CALIFORNIA LABORATORY SERVICES

CHAIN OF CUSTODY

CLS ID No.: 19A0196

LOG **WEB COC**

REPORT TO:

NAME AND ADDRESS Linkan Engineering
2720 Ruby Vista Dr.
Elko, NV 89801

PROJECT MANAGER Sam Billin PHONE # (775)777-8003

PROJECT NAME Rise Gold

SAMPLED BY Jason Wheeler

JOB DESCRIPTION Testing

SITE LOCATION Idaho - Maryland

CLIENT JOB NUMBER 54.02.03

DESTINATION LABORATORY

☑ CLS (916) 638-7301
3249 FITZGERALD RD.
RANCHO CORDOVA, CA.
95742

☐ OTHER

GEOTHRACKER:
EDF REPORT ☑ YES ☐ NO
GLOBAL ID:

CDPH WRITE ON EDT TRANSMISSION? ☐ YES ☑ NO
STATE SYSTEM NUMBER
IF "YES" PLEASE ENTER THE SOURCE NUMBER(S).

COMPOSITE:

DATE	TIME	SAMPLE IDENTIFICATION	MATRIX	CONTAINER NO.	CONTAINER TYPE	PRESERVATIVES	Cis-1,2-DCE	Fe, Mn	TTHM, HAAS					TURN AROUND TIME 1 DAY	2 DAY	3 DAY	5 DAY	SPECIAL INSTRUCTIONS OR ALT. ID:
12/19/18	15:30	Rise Baseline	waste water	4	Glass, Plastic	1,2	X	X									X	
12/20/18	14:00	Aeration Post-MnO_2	ww	4	"	1,2	X	X									X	
12/20/18	9:00	Aeration Pre-column	"	3	Glass	1	X										X	
12/31/18	11:15	$KMnO_4$-1.7ppm-MnO_2 Effluent		4	Glass, plastic	1,2	X	X									X	
12/31/18	13:00	Rise Raw - NaOCl Test	ww	3	Glass	1	X		X								X	
12/31/18	15:30	NaOCl-1ppm-MnO_2 Effluent	ww	4	Glass, plastic	1,2	X	X	X								X	
1/2/19	14:45	Aeration post-GAC	ww	4	"	1,2	X	X									X	
1/2/19	16:45	NaOCl-1ppm, GAC Effluent	ww	4	"	1,2	X	X	X								X	
1/3/19		$KMnO_4$-1.7-2ppm, GAC Effluent	ww	4	"	1,2	X	X									X	INVOICE TO: nicole.burgess@linkan.biz

P.O. # 1914

QUOTE #

SUSPECTED CONSTITUENTS

PRESERVATIVES: (1) HCL (2) HNO_3 (3) = COLD (4) = NaOH (5) = H_2SO_4 (6) = $Na_2S_2O_3$ (7) =

RELINQUISHED BY (SIGN)	PRINT NAME / COMPANY	DATE / TIME	RECEIVED BY (SIGN)	PRINT NAME / COMPANY
	Scott Barton Linkan	1/3/19 1015		

REC'D AT LAB BY: DATE / TIME: 1/4/19 1315 CONDITIONS / COMMENTS: 0.9

SHIPPED BY: ☐ FED X ☒ UPS ☐ OTHER AIR BILL #

Gold- Project Mgr./Field Sampler/Terms and conditions

Pink: Origin/Terms and Conditions

Yellow- Lab file copy/Terms and Conditions

White-Lab/Terms and conditions

19A0196

Scott Furnas

From:	Mark Smith <marks@californialab.com>
Sent:	Friday, January 04, 2019 6:14 AM
To:	Scott Furnas; shellief@californialab.com
Subject:	Fwd: Lab Samples for Linkan Engineering

These samples should arrive this morning. The HAA will not be able to be run, due to improper preservation (client aware)
Please share this with sample Receiving. They should analyze by 624 low level (TTHM and cis-1,2-DCE) & Fe &Mn only
Thanks

Mark Smith
Operations Manager
CLS Labs
Sent from my iPhone

Begin forwarded message:

> **From:** Scott Barton <scott.barton@linkan.biz>
> **Date:** January 3, 2019 at 11:56:46 AM PST
> **To:** Mark Smith <marks@californialab.com>, Nicole Burgess <nicole.burgess@linkan.biz>
> **Subject: RE: Lab Samples for Linkan Engineering**
>
> Hi Mark –
> The Ni and TTLC was for a different project. We also discussed a second project with TTHM testing and cis -1,2 DCE. My recollection was that TTHM was quantified as a whole and reported as chloroform, bromoform, dibromochloromethane and dibromochloromethane for the same price. So, if you could please review our COC and advise on the cost (we have a budget and so would like to know if we are within it).
>
> Also, in regard to the first set of samples that we sent for Ni and TTLC, with the project name "McLaughlin", can you please provide a status and estimated completion time. Thanks.
>
> Scott Barton
>
> *Process Scientist*
>
> Linkan | Solutions for the World of Water
>
> office: 775.777.8003 x305 fax: 775.777.8004
> direct: 775.299.3587 cell: 775.443.7293
>
> 2720 Ruby Vista Drive • Suite 101
> Elko, Nevada 89801
>
> linkan.biz • scott.barton@linkan.biz
>
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CLS LABS

SAMPLE RECEIVING EXCEPTION REPORTS

CLS Labs Job # 19A0196

Problem discovered by: MATT **Date:** 1/4/19

Nature of problem

1) NO SAMPLE TIME FOR -09.

2) NO REQUESTED ANALYSIS FOR TRIP BLANKS ON COC.

3) SAMPLE -01, -02, -03 - 624 OUT OF HOLD TIME

Client contacted? [✓ Yes] **No** ____ **Spoke With:** SAM BILLIN

By whom: MATT **Date:** 1/4/19 **Time:** 1330 **HRS**

Client instructions:

1) TIME OF SAMPLE FOR -09 IS 11:00

2) CREATE NEW SAMPLE FOR TRIP BLANKS ON WORK ORDER RUN 624 L.L. AT TIME OF RELINQUISH.

Resolution of problem:

1) LOGGED IN AS PER CLIENT INSTRUCTION

2) LOGGED IN AS PER CLIENT INSTRUCTION

3) LOGGED IN REGARDLESS

APPENDIX B

TESTING NOTES

Linkan
ENGINEERING

JOB Idaho-Maryland
SHEET NO. OF
CALCULATED BY DATE 12/20/18
CHECKED BY DATE
SCALE

Baseline -
Fe - 1.13 mg/L
Mn - 0.291 mg/L

Aeration Pre-Filter (MnO_2) 240 mV ORP

Aeration Post-Filter (MnO_2)
Fe - ~~[illegible]~~ mg/L 0.01 mg/L
Mn - 0.03 mg/L (0.032 Dup mg/L)

12/27/18

$KMnO_4$ test

Linkan
ENGINEERING

JOB	Idaho - Maryland		
SHEET NO.		OF	
CALCULATED BY	JW	DATE	12/27/18
CHECKED BY		DATE	
SCALE			

ORP Titration

Raw water

used 5wt% sodium bisulfite

Addition	ORP(mV)	Temp(°C)	Time
Raw	201	13.9	11:05 am
0.060 mL	172	14.0	
0.1 mL	149	14.0	
0.2 mL	138	14.1°C	11:15
1.0 mL	121	14.1°C	
2.0 mL	105	13.5	

used 10wt% sodium bisulfite

Addition	ORP(mV)	Temp(°C)	Time	Conductivity
1.0 mL	91			
1.0 mL	90			
1.0 mL	76	12.8°C	11:25	770µS

Added → SMBS solid

150 mg → 86 mV

1000 mg 79 mV

2,000 mg 80 mV PH=5.4 13.6°C

4,000 mg 80 mV

Add 7.65 mL 2N NaOH → pH=6.42 ORP= 54mV

Added

250mL 50% NaOH pH= 6.56

1,200mL 50% NaOH pH= 7.09 ORP= 34mV

1,000mL 50% NaOH pH= 7.56 ORP= ~~20mV~~ 13mV

cond = 8,308µS @14.2°C

Bench Test Plan **Idaho-Maryland**

Test ID	Date	Solution Strength	Process Dose	1 gpm Process Flow	Chemistry Flow	Run Started	Run Ended	Time Sampled	pH	ORP	Cond.	Fe	Mn	Sampling	Notes
		wt%	ppm	mL/min	mL/min	HH:MM	HH:MM	HH:MM	pH unit	mV	µS	ppm	ppm		
Raw	12/2~~6~~7/2018	10:00am							7.38 @ 11°C	250mV @ 11.2°C	3403.6 µS		0.23	VOA	
KMNO4 - 14ppm - MnO2 Feed	12/2~~6~~7/2018	1.05%	14	~3,785	5.0										
KMNO4 - 14ppm - MnO2 Effluent	12/2~~6~~7/2018	1.05%	14	~3,785	5.0									cis-1,2-DCE, Fe, Mn	
KMNO4 - 12ppm - MnO2 Feed		1.05%	12	~3,785	4.3										
KMNO4 - 12ppm - MnO2 Effluent		1.05%	12	~3,785	4.3									cis-1,2-DCE, Fe, Mn	
KMNO4 - 16ppm - MnO2 Feed		1.05%	16	~3,785	5.8										
KMNO4 - 16ppm - MnO2 Effluent		1.05%	16	~3,785	5.8									cis-1,2-DCE, Fe, Mn	
Raw?															
NaOCl - 3.1ppm - MnO2 Feed		0.24%	3.128	~3,785	5.0										
NaOCl - 3.1ppm - MnO2 Effluent		0.24%	3.128	~3,785	5.0									TTHM, HAA5, cis-1,2-DCE, Fe, Mn	

More Notes:

Bench Test Plan

Decanted w/ a lot of settled iron

Idaho-Maryland

0.0234 gpm

Test ID	**Date**	**Chem Solution Strength**	**Process Dose**	**Process Flow**	**Chemistry Flow**	**Run Started**	**Run Ended**	**Time Sampled**	**pH**	**ORP**	**Cond.**	**Fe**	**Mn**	**Sampling**	**Notes**
		wt%	ppm	mL/min	mL/min	HH:MM	HH:MM	HH:MM	pH unit	mV	µS	ppm	ppm		
Raw	3:35pm 12/27/2018							15:35	7.22	385	382.6	0.17	0.221	cis-1,2-DCE	
KMNO4 - 2.5 ppm - MnO2 Feed	12/27	0.0044%	2.5	~89	5.0			16:03	7.54 @ 16°C	507	372.4 @ 16°C		~~0.04~~	Fe, Mn "Rise Raw-Decanted"	
KMNO4 - 2.5 ppm - MnO2 Effluent	12/27	0.0044%	2.5	~89	5.0	16:02	17:12	16:12	7.47 @ 16.5°C	379mV	372.2 @ 16.5°C	0.02	0.046	cis-1,2-DCE, Fe, Mn	Collected 1gal H_2 Efflue
Raw?															
NaOCl - 2 ppm - MnO2 Feed		0.00355%	2	~89	5.0									TTHM, HAA5, cis-1,2-DCE, Fe, Mn	
NaOCl - 2 ppm - MnO2 Effluent		0.00355%	2	~89	5.0									TTHM, HAA5, cis-1,2-DCE, Fe, Mn	

More Notes:

Bench Test Plan **Idaho-Maryland**

Decanted

0.0234 gpm

Test ID	Date	Chem Solution Strength	Process Dose	Process Flow	Chemistry Flow	Run Started	Run Ended	Time Sampled	pH	ORP	Cond.	Fe	Mn	Sampling	Notes
		wt%	ppm	mL/min	mL/min	HH:MM	HH:MM	HH:MM	pH unit	mV	µS	ppm	ppm		
Raw	12/28/18							09:38	7.23	377 @ 15.9°C	394.3 µS	0.08	0.231	~~cis-1,2-DCE~~	
KMNO4 - 2.5 ppm - MnO2 Feed		0.0044%	2.5	~89	5.0	13:30								Cis-1,2-DCE	Sampled Before column
KMNO4 - 2.5 ppm - MnO2 Effluent		0.0044%	2.5	~89	5.0	13:30 ~~13:30~~ ~~14:00~~		14:00	6.93 @ 20.6°C	211	349.4	0.01	0.058	~~cis-1,2-DCE, Fe, Mn~~	
Raw?															
NaOCl - 2 ppm - MnO2 Feed		0.00355%	2	~89	5.0									TTHM, HAA5, cis-1,2-DCE, Fe, Mn	
NaOCl - 2 ppm - MnO2 Effluent		0.00355%	2	~89	5.0									TTHM, HAA5, cis-1,2-DCE, Fe, Mn	

More Notes:

12/28/18

Replace column media after trying (and failing) to backwash

Rinsed column w/ tap water until Mn value = 0.041ppm

- ~~Did not dose~~
- Dosed KMnO4 at first, but got high level of Mn - ~~13:45~~ 13.45
- Turned dose off and got low Mn - Mn = 0.058ppm
- Ran ~2.5gal of water w/out KMnO4 - Mn = 0.064ppm

16:00 - Accidently let feed water run out & column dried
- started water again and took sample Mn = ~~0.89ppm~~
0.089ppm

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JOB Idaho-Maryland
SHEET NO. 1 OF
CALCULATED BY DATE 12/31/18
CHECKED BY DATE
SCALE

Finish KMnO4 Testing

Raw water - 12/31

Mn= 0.17 ppm

Filter water w/ 2 ppm maintenance dose:

Mn= 0.062 ppm @ 8:50 am

Mn= ~~0.0~~ 0.2 ppm @ 9:15 am

Lowered Mn dose 9:20 am

Dose: ~~(24)~~ (24% on pump)

Mn= 0.018 ppm 10:00 am

Mn= 0.265 ppm 10:40 am

Mn= 0.046 ppm 10:50 am of composite sample

Mn= 0.025 ppm 10:57 am after stopping dose for 10 minutes

10:57 restarted dose @ ~20% pump speed

= 4.53 mL/min

Mn= 0.04 ppm 11:14 am = 1.72 mg/L

ORP= 393 mV @ 16.7°C

pH= 6.82

Cond. = ~~3.78~~ 378.0 μS

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JOB Idaho-Maryland
SHEET NO. 2 OF
CALCULATED BY DATE 12/31/18
CHECKED BY DATE
SCALE

NaOCl Testing

Raw water - 12/31/18

pH = ~~6.~~ 7.08 @ 15.3°C
ORP = 318 mV @ 15.3°C
Cond = 395.0 µS
Fe = ~~0.0~~ 0.5 ppm
Mn = 0.197 ppm

started flowing with
20 ppm (0.00201%)
NaOCl @ 13:00

After NaOCl addition (~1 ppm)

pH = 7.83 @ 17.8°C
ORP = 278 mV
Cond = 401.6 µS

Effluent - NaOCl addition (~1 ppm)

pH = 7.05
ORP = 135 mV @ 18.2°C
Cond = 390.5 @ 18.2°C
Fe = 0.01 ppm
Mn = 0.012 ppm

Effluent - NaOCl add (~1 ppm) - 15:08

Mn = 0.078 ppm

Free Cl_2 = ~~0.06~~ ppm (slight pink color)
0.18 ppm (stabilized after 1 min)

~~Composite sample (15:45) - Mn =~~

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JOB Idaho Maryland
SHEET NO. 3
OF
CALCULATED BY
DATE 12/31/18
CHECKED BY
DATE
SCALE

Composite NaOCl (1ppm) sample (16:45)

pH = 7.21 @ 18.1°C
ORP = 255mV
Cond = 384.4 @ 18.1°C
Fe = 0.01 ppm
Mn = 0.026 ppm

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JOB Idaho-Maryland
SHEET NO. ______ OF ______
CALCULATED BY J. Wheeler DATE 1/2/19
CHECKED BY ______ DATE ______
SCALE ______

GAC Column

- Flush column
- Started 14:08
- Effluent: Mn= 0.027ppm
  Fe = 0.04ppm

Ended 15:30

Water from aeration test.
" Fe - 0.01ppm "
" Mn - 0.03ppm "

---

water from NaOCl test performed on 12/31/18

Start: 15:45 w/ flush using actual water

Fe= 0.01ppm
Mn= 0.026ppm

Effluent: Mn = 0.025ppm
Fe = 0.00ppm
pH = 8.93@20.4°C
ORP = 284mV
Cond = 373.2µS

Feed: pH= 7.65@17.8°C
ORP= 410mV
380.1µS@18.0°C

= user input

Idaho Maryland
Permanganate Pump Sizing

Note that this calculation assume a 1:1 molar ratio between chlorine demand and potassium permanganate demand.

Influent Water contaminant levels (mg/L)	Design	Max	No Ammonia rxn	Min
Fe	1.6	1.7	1.6	1.5
Mn	0.25	0.3	0.25	0.23
H2S	0	0	0	0
NH3	0	0.066	0	0
mg/L Cl needed	2.35	3.128	2.35	2.19

Chlorine Req. Continuous Regeneration

Cl2 Demand

Design	Max	
2.35	3.128	mg/L

KMnO4 molar mass

158.0336 g/mol

Cl2 molar mass

35.45 g/mol

Cl2 Demand

Design	Max	
6.6291E-05	8.82E-05	mol/L

Dilution Calculations

NaOCl	8.25%	
Dilution	0.0002435	
V solution	1	gal
V NaOCl	0.0002435	gal
	0.92	mL
Conc.	0.00201%	20.1 ppm

tried to match 5 ml dose on chem pump

Chemical **NaOCl**

$$\frac{20.1\ \text{mg}}{1\ \text{L}} \times \frac{100\ \%}{8.25\ \%} \times \frac{1\ \text{sg}}{1.08\ \text{sg}} \times \frac{1\ \text{ml}}{1000\ \text{mg}} = 0.23\ \frac{\text{mL}}{\text{L}}$$

0.85 mL/gal

KMnO4	0.0035%	wt%
V solution	1	gal
w solvent	3.7854	kg
	3785.4	g
w solute	0.13	g 100%KMnO4
w solute	0.179	g 75%KMnO4

KMnO4 Demand

Design	Below max	Max	TARGET	
10.47613427	12	2.3	2	mg/L

0.02344	gpm water flow rate
0.0035%	KMnO4 Solution Concentration
1	Specific gravity KMnO4 Solution

KMnO4 Solution Dosing Rate

Below max	Max	Above Max	5.000126938
29.9975915	5.749538	4.999598579	mL/min of 0% KMnO4 Solution
0.02999759	0.00575	0.004999599	L/min of 0% KMnO4 Solution
0.00792539	0.001519	0.001320898	gpm of 0% KMnO4 Solution
0.47552325	0.091142	0.079253874	gph of 0% KMnO4 Solution
11.4125579	2.187407	1.902092986	gpd of 0% KMnO4 Solution

NaOCl Demand

Design	TARGET	Max	Above Max	
2.35	1	3.128	4	mg/L

0.02344	gpm water flow rate
0.0020%	NaOCl Solution Concentration
1	Specific gravity KMnO4 Solution

NaOCl Solution Dosing Rate

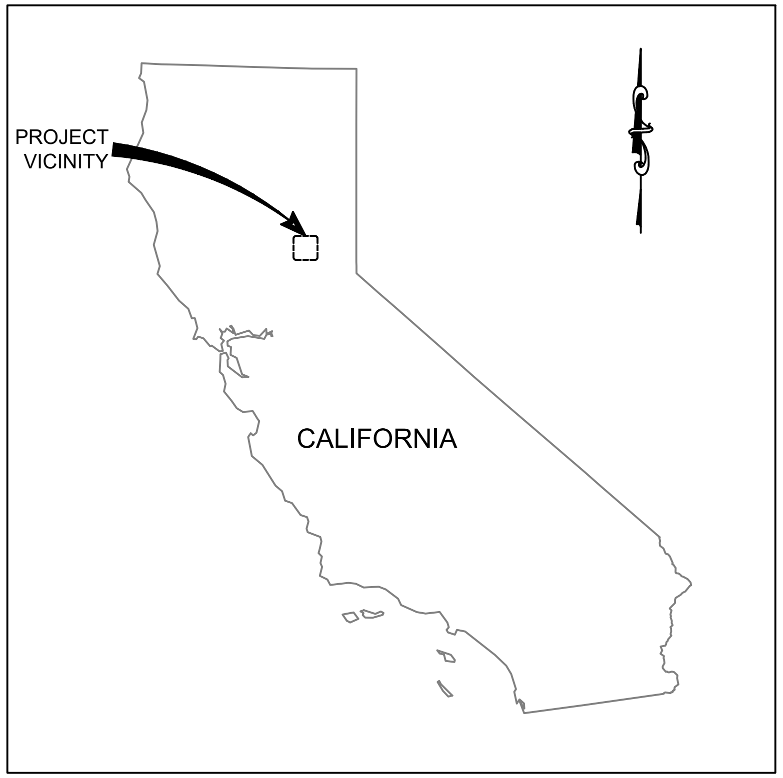
Design	Max	Above Max	
4.415978746	13.8132	17.66391498	mL/min of 0.002% KMnO4 Solution
0.004415979	0.01381	0.017663915	L/min of 0.002% KMnO4 Solution
0.001166705	0.00365	0.00466682	gpm of 0.002% KMnO4 Solution
0.070002305	0.21897	0.28000922	gph of 0.002% KMnO4 Solution
1.680055322	5.25521	6.720221288	gpd of 0.002% KMnO4 Solution

APPENDIX C

DRAWINGS

RISE GRASS VALLEY INC.
NEW BRUNSWICK SHAFT WTP

VICINITY



PREPARED BY:

Linkan ENGINEERING

2720 Ruby Vista Dr. Suite 101
Elko, NV 89801

REVISION: 1

ISSUE DATE: JANUARY 19, 2021

ISSUED FOR: PRELIMINARY DESIGN

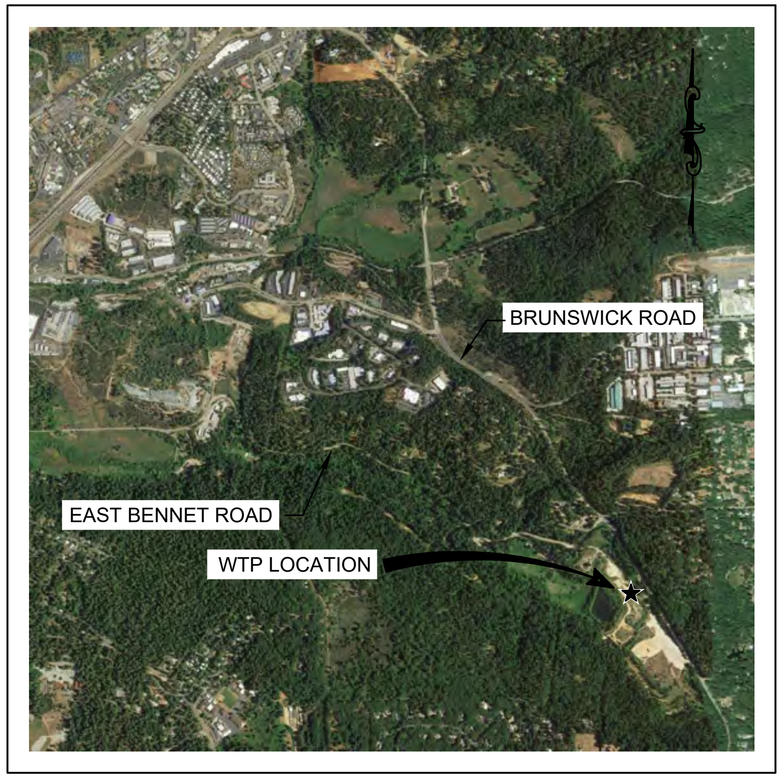
CLIENT INFORMATION: RISE GRASS VALLEY INC.

CLIENT ADDRESS:
333 CROWN POINT CIRCLE
SUITE 215
GRASS VALLEY, CA

PROJECT LOCATION: GRASS VALLEY, CA

PROJECT NUMBER: 54.02

AERIAL

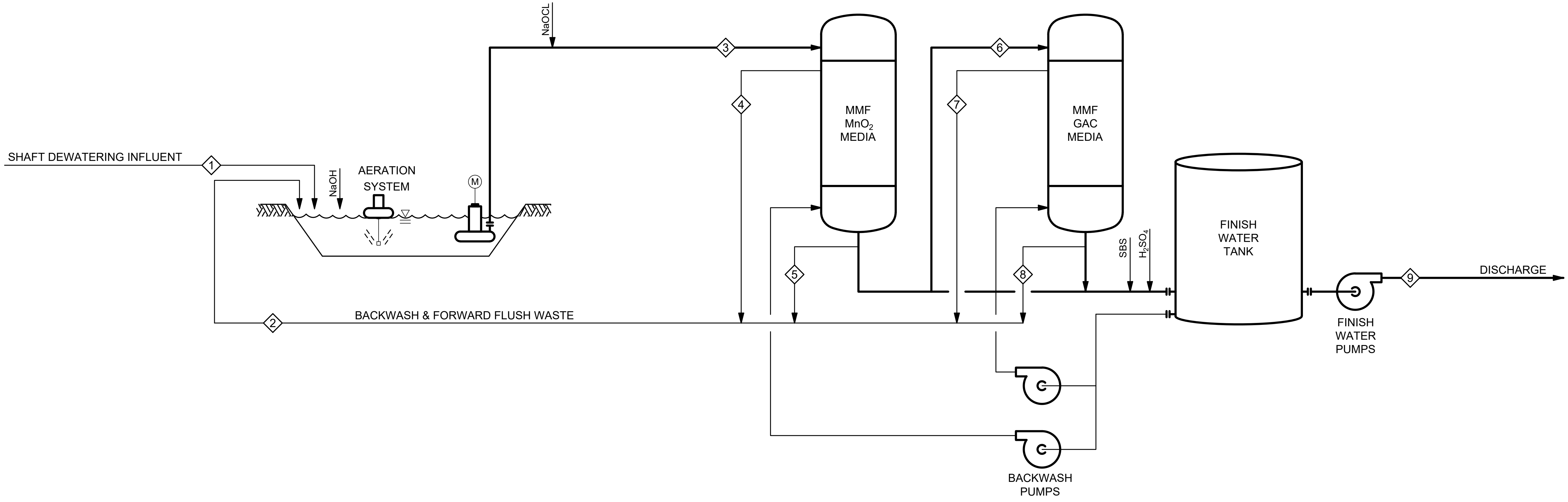


SHEET INDEX

Count	Drawing Number	Description
	General	
1	G-001	Cover Sheet
2	G-100	Process Flow Diagram
	Civil	
3	C-100	Overall Site Plan
4	C-101	Plant Layout Plan

1/20/2021 8:49 AM ---- S:\Projects\54 Rise Gold\54.02 Idaho Maryland Updated Scoping Study\CADD\dwg\G-001 Cover sheet.dwg

1/20/2021 4:45 PM ---- S:\Projects\54 Rise Gold\54.02 Idaho Maryland Updated Scoping Study\CADD\dwg\G-100.dwg



MASS BALANCE

DESIGN (850 GPM DAILY AVG.)									
STREAM TAG	1	2	3	4	5	6	7	8	9
PROCESS PARAMETERS	INFLUENT FROM SHAFT	BACKWASH & FORWARD FLUSH WASTE	MANGANESE DIOXIDE FEED	MANGANESE DIOXIDE BACKWASH	MANGANESE DIOXIDE FORWARD FLUSH	GRANULAR ACTIVATED CARBON FEED	GRANULAR ACTIVATED CARBON BACKWASH	GRANULAR ACTIVATED CARBON FORWARD FLUSH	FINISH WATER
DESIGN FLOW (MAX INSTANTANEOUS), GPM	850	339	958	1,963	339.0	890.9	628	323	850
DESIGN FLOW, GPD	1,224,000	92,100	1,321,536	78,540	13,560	1,229,436	25,133	12,920	1,224,000
TOTAL SUSPENDED SOLIDS, MG/L (%)	3	-	3.2	61	-	0.0	0	-	0.0
TOTAL SUSPENDED SOLIDS, LB/DAY*	32	39.7	35.0	39.7	-	0	0	-	0
SERVICE FACTOR (HR/DAY)	24.0		23.0			23.0			

*Assuming 100% conversion of dissolved iron to precipitated species. Further TSS carried to the surface from underground is not included.

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Elko, NV 89801
775-777-8003

REV.	DATE	REVISION DESCRIPTION
0	12/17/20	ISSUED FOR PRELIMINARY DESIGN
1	01/19/21	ISSUED FOR PRELIMINARY DESIGN

TITLE: PROCESS FLOW DIAGRAM

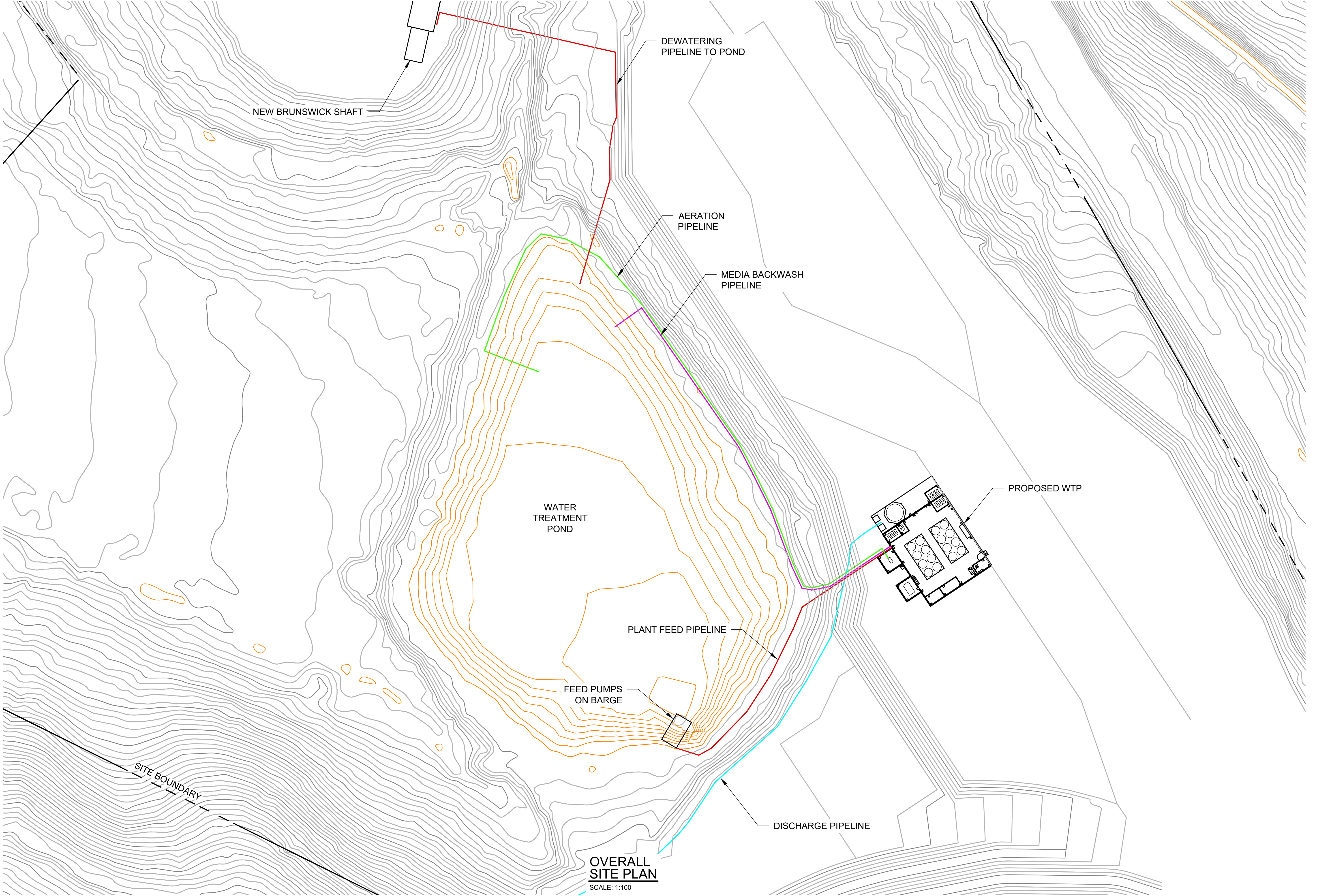
PROJECT: RISE GRASS VALLEY INC.
NEW BRUNSWICK SHAFT WTP

PROJECT NO.
54.02

DATE:
DECEMBER 17, 2020

SCALE:
N/A

SHEET NO.
G-100



OVERALL SITE PLAN
SCALE: 1:100

2720 Ruby Vista Dr. Suite 101
Elko, NV 89801
775-777-8003

REV.	DATE	REVISION DESCRIPTION
0	12/17/20	ISSUED FOR PRELIMINARY DESIGN
1	01/19/21	ISSUED FOR PRELIMINARY DESIGN

TITLE: OVERALL SITE PLAN

PROJECT: RISE GRASS VALLEY INC.
NEW BRUNSWICK SHAFT WTP

PROJECT NO.
54.02

DATE:
DECEMBER 17, 2020

SCALE:
1:100

SHEET NO.
C-100

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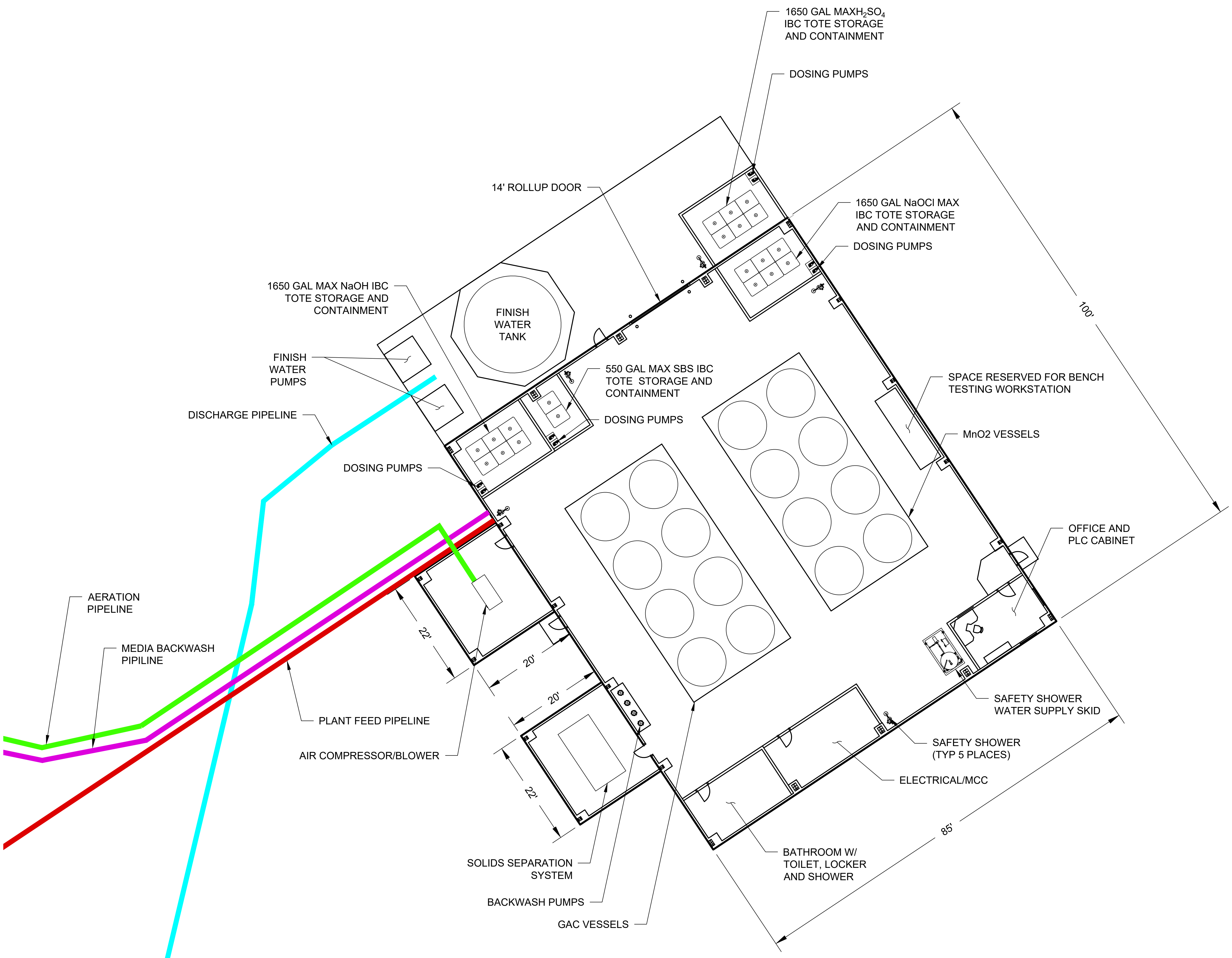

PLANT LAYOUT PLAN

SCALE: 1:20

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E N G I N E E R I N G
2720 Ruby Vista Dr. Suite 101
Elko, NV 89801
775-777-8003

REV.	DATE	REVISION DESCRIPTION
0	12/17/20	ISSUED FOR PRELIMINARY DESIGN
1	01/19/21	ISSUED FOR PRELIMINARY DESIGN

TITLE: PLANT LAYOUT PLAN

PROJECT: RISE GRASS VALLEY INC.
NEW BRUNSWICK SHAFT WTP

PROJECT NO.
54.02

DATE:
DECEMBER 17, 2020

SCALE:
1:20

SHEET NO.
C-101

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1/25/2021 2:06 PM ----

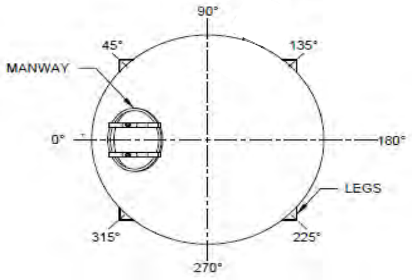
APPENDIX D

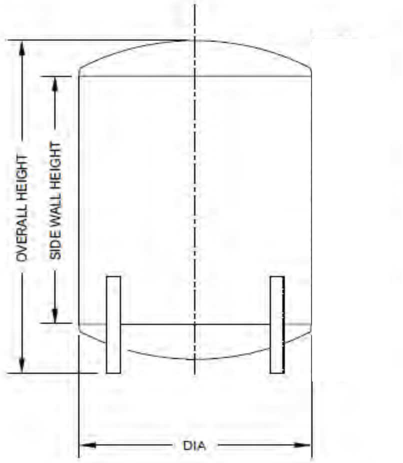
EQUIPMENT DATA SHEETS

PRESSURE VESSEL DATA SHEET		**PROJECT No:**	54.02
DESCRIPTION:	Manganese Dioxide Vessels	**CLIENT:**	Rise Grass Valley Inc.
MANUFACTURER:	-	**LOCATION:**	Grass Valley, CA
MODEL NO:	-	**DATE:**	2019-03-29

TAG	Fitting	Dia.	Degree	Height	Projection	Description
LADDER	N/A	-	-	-	-	LADDER
A	Manuf	Manuf	0°	Top	Manuf	MANWAY
B	Manuf	2" to 3"	Manuf	Manuf	Manuf	INLET
C	Manuf	2" to 3"	Manuf	Manuf	Manuf	OUTLET
D	Manuf	Manuf	-	Manuf	Manuf	DRAIN
E	Window	Manuf	Manuf	Manuf	Manuf	Sight Glass
F						
G						
L						
V						

DIAGRAM





PROCESS		**DESIGN**	
Capacity - Design (gpm):	321	**Mounting:**	Tank Stand
Capacity - Max (gpm):	350	**Overall Height:**	>=6'
Retention Time:	1.7 min	**Diameter:**	10'
Flux Rate (gpm/ft^2):	3.5-5 (4.3)	**Manganes Dioxide Bed Depth:**	36" Min.
Method of withdraw:	Pressure	**Total Bed Depth:**	44" Min.
Loc. of withdraw:	Manuf	**Quantity of Vessels:**	8
Mixing:	No	**Wall Thickness:**	Manuf
Baffles:	No	**Sidewall Height:**	Manuf
ASME (Y/N):	Yes	**Construction Materials:**	Manuf
Code Stamp (psi):	Manuf	**Interior Coating:**	Manuf
Op. Pressure (psi):	Manuf	**Exterior Coating:**	Manuf
INSTRUMENTATION		**Anchorage Requirements:**	Manuf
Sampling:	Inlet and outlet sampling ports	**Lift Lug/Mounting Attach:**	Manuf
		Ladder:	No
Temperature:	No	**Vessel Wt -Empty:**	Manuf
Analytics:	Inlet & Outlet Pressure	**Vessel Wt -Full:**	Manuf
Pressure:	Inlet & Outlet Gauges	**Top/Bottom Head:**	Manuf
		Rating:	ASME

Controls:

Automated valving for backwash and forward flush.

PROCESS DATA:	
Process Fluid:	Water
Pressure Max (psi):	<100
Temperature Max.:	100°F
Specific Gravity:	~1
pH:	5-8
Conductivity:	300-600 µS

DRAWING REFERENCE(S)

P&ID DRAWING NO.

P&ID TAG REFERENCE(S)

Remarks:

Tank lining to protect from feed water. Sampling ports can be on skid piping and are not required on vessels.

HAZARDS:			
Flammable		N/A	X
Corrosive		Other	
Vapor			

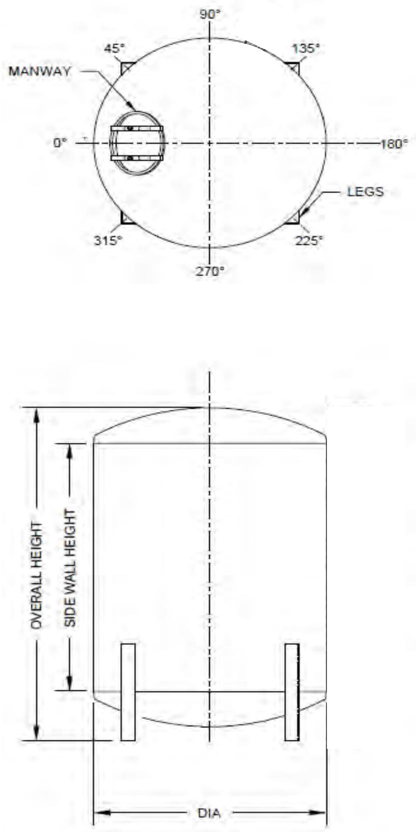
SPECIFICATION REFERENCE(S)

No	DATE	BY	CHK	APP	REVISION
0	2019-03-29	JQG	SJB	SJB	Permit
1					
2					
3					
4					

PRESSURE VESSEL DATA SHEET		**PROJECT No:**	54.02
DESCRIPTION:	Granular Activated Carbon (GAC) Vessels	**CLIENT:**	Rise Grass Valley Inc.
MANUFACTURER:	-	**LOCATION:**	Grass Valley, CA
MODEL NO:	-	**DATE:**	2019-03-29

TAG	Fitting	Dia.	Degree	Height	Projection	Description
LADDER	N/A	-	-	-	-	LADDER
A	Manuf	Manuf	0°	Top	Manuf	MANWAY
B	Manuf	2" to 3"	Manuf	Manuf	Manuf	INLET
C	Manuf	2" to 3"	Manuf	Manuf	Manuf	OUTLET
D	Manuf	Manuf	-	Manuf	Manuf	DRAIN
E	Window	Manuf	Manuf	Manuf	Manuf	Sight Glass
F						
G						
L						
V						

DIAGRAM



PROCESS		DESIGN	
Capacity - Design (gpm):	313	**Mounting:**	Tank Stand
Capacity - Max (gpm):	350	**Overall Height:**	>=6'
Retention Time:	1.7 min	**Diameter:**	10'
Flux Rate (gpm/ft^2):	3.5-5 (4.3)	**GAC Bed Depth:**	40" Min.
Method of withdraw:	Pressure	**Total Bed Depth:**	48" Min.
Loc. of withdraw:	Manuf	**Quantity of Vessels:**	8
Mixing:	No	**Wall Thickness:**	Manuf
Baffles:	No	**Sidewall Height:**	Manuf
ASME (Y/N):	Yes	**Construction Materials:**	Manuf
Code Stamp (psi):	Manuf	**Interior Coating:**	Manuf
Op. Pressure (psi):	Manuf	**Exterior Coating:**	Manuf
INSTRUMENTATION		**Anchorage Requirements:**	Manuf
Sampling:	Inlet and outlet sampling ports	**Lift Lug/Mounting Attach:**	Manuf
		Ladder:	No
Temperature:	No	**Vessel Wt -Empty:**	Manuf
Analytics:	Inlet & Outlet Pressure	**Vessel Wt -Full:**	Manuf
Pressure:	Inlet & Outlet Gauges	**Top/Bottom Head:**	Manuf
Controls:		**Rating:**	ASME

Controls:

Manual valving for backwash and forward flush.

Remarks:

Tank lining to protect from feed water. Sampling ports can be on skid piping and are not required on vessels.

PROCESS DATA:	
Process Fluid:	Water
Pressure Max (psi):	<100
Temperature Max.:	100°F
Specific Gravity:	~1
pH:	5-8
Conductivity:	300-600 µS

DRAWING REFERENCE(S)

P&ID DRAWING NO.

P&ID TAG REFERENCE(S)

HAZARDS:

Flammable		N/A	X
Corrosive		Other	
Vapor			

SPECIFICATION REFERENCE(S)

No	DATE	BY	CHK	APP	REVISION
0	2019-03-29	JQG	SJB	SJB	Permit
1					
2					
3					
4					

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PUMP DATA SHEET		PROJECT NO:	54.02
DESCRIPTION:	Pond Submersible Pumps	**CLIENT:**	Rise Grass Valley Inc.
MANUFACTURER:	TBD	**LOCATION:**	Grass Valley, CA
MODEL NO:	TBD	**DATE:**	2019-03-29

PROCESS DATA				PUMPING REQUIREMENTS	
Maximum Flow:	1500 gpm	**Temperature:**	33 - 80°F	**Viscosity:**	~1 cP
Design Flow:	1340 gpm	**TS (Total Solids)%:**	<0.01%	**Duty (fluid):**	1340 gpm @ 180 ft
Nominal Flow:	1340 gpm	**TSS(Total Suspended Solids):**	~60 ppm	**S.G.:**	~1
Process Fluid:	Settled Water	**pH:**	5-8	**Duty (water):**	1340 gpm @ 180 ft
RPM:	TBD	**Vapor Pressure:**	TBD	**NPSHa:**	TBD

PUMP DESIGN

Nozzles	Size	Fitting	Type:	Centrifugal	Other Features:
Suction:	TBD	150# ANSI	**Subtype:**	Submersible	
Discharge:	TBD	150# ANSI	**NPSHr:**	TBD	
Drain:	Manuf	Manuf	**No Stages.:**	1	
Vent:	-	-	**Impeller dia.:**	TBD	
			Estimated Weight:	TBD	

DRIVE AND SEAL				MATERIAL OF CONSTRUCTION	
Packing or Seal:	TBD	**Coupling Size:**	TBD	**Casing:**	TBD
Motor Shaft Size:	TBD	**Impeller Type:**	TBD	**Casing Coating:**	TBD
Pump Shaft Size:	TBD			**Impeller:**	TBD
RPM:	TBD			**Mechanical Seal:**	TBD
				Pump O-Ring:	TBD

MOTOR				ENVIRONMENT:	
Manufacturer:	TBD	ELECTRICAL		**Location:**	Outdoor/Barge
Baseplate Size:	Manuf	100	HP	**Corrosive Area:**	no
Enclosure:	TEFC	460	V	**Dusty Area:**	yes
Service Factor:	1.15	3	Phase	**Explosive Area:**	no
Full Load Amp:	-	60	Hz	**Elevation (above Sea-Level):**	2755
MOTOR CONTROL		Remote	X	**Temperature Min.:**	15 °F
local	-	VFD	X	**Temperature Max.:**	108 °F

CONTROL METHOD				Drawing No
		Level	X	C-100, C-101
Constant Pressure	-	Flow	X	P&ID Drawing No.
Differential Pressure	-	Other	-	G-100

Remarks

2 Pumps operating in parallel with one additional pump on standby.

P&ID Tag Reference(s)
Pond Submersible Pumps

No	DATE	BY	CHK	APP	REVISION
0	2019-03-29	JQG	SJB	SJB	Permit
1					
2					
3					
4					
5					

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PUMP DATA SHEET		**PROJECT NO:**	54.02
DESCRIPTION:	Manganese Dioxide Backwash Pumps	**CLIENT:**	Rise Grass Valley Inc.
MANUFACTURER:	TBD	**LOCATION:**	Grass Valley, CA
MODEL NO:	TBD	**DATE:**	2019-03-29

PROCESS DATA				**PUMPING REQUIREMENTS**	
Maximum Flow:	2200 gpm	**Temperature:**	33 - 80°F	**Viscosity:**	~1 cP
Design Flow:	1964 gpm	**TS (Total Solids)%:**	<0.00%	**Duty (fluid):**	1964 gpm @ 68 ft
Nominal Flow:	1964 gpm	**TSS(Total Suspended Solids):**	~0 ppm	**S.G.:**	~1
Process Fluid:	Water	**pH:**	5-8	**Duty (water):**	1964 gpm @ 68 ft
RPM:	TBD	**Vapor Pressure:**	TBD	**NPSHa:**	TBD

PUMP DESIGN					
Nozzles	**Size**	**Fitting**	**Type:**	Centrifugal	**Other Features:**
Suction:	TBD	150# ANSI	**Subtype:**	Frame Mounted	
Discharge:	TBD	150# ANSI	**NPSHr:**	TBD	
Drain:	Manuf	Manuf	**No Stages.:**	1	
Vent:	-	-	**Impeller dia.:**	TBD	
			Estimated Weight:	TBD	

DRIVE AND SEAL				**MATERIAL OF CONSTRUCTION**	
Packing or Seal:	TBD	**Coupling Size:**	TBD	**Casing:**	TBD
Motor Shaft Size:	TBD	**Impeller Type:**	TBD	**Casing Coating:**	TBD
Pump Shaft Size:	TBD			**Impeller:**	TBD
RPM:	TBD			**Mechanical Seal:**	TBD
				Pump O-Ring:	TBD

MOTOR				**ENVIRONMENT:**	
Manufacturer:	TBD	**ELECTRICAL**		**Location:**	Outdoor/Barge
Baseplate Size:	Manuf	100	HP	**Corrosive Area:**	no
Enclosure:	TEFC	460	V	**Dusty Area:**	yes
Service Factor:	1.15	3	Phase	**Explosive Area:**	no
Full Load Amp:	-	60	Hz	**Elevation (above Sea-Level):**	2755
MOTOR CONTROL		Remote	X	**Temperature Min.:**	15 °F
local	-	VFD	X	**Temperature Max.:**	108 °F

CONTROL METHOD		Level	X	Drawing No
Constant Pressure	-	Flow	X	C-100, C-101
Differential Pressure	-	Other	-	P&ID Drawing No.
				G-100

Remarks

1 pump operating with one pump on standby.

P&ID Tag Reference(s)

Manganese Dioxide Backwash Pumps

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No	DATE	BY	CHK	APP	REVISION
0	2019-03-29	JQG	SJB	SJB	Permit
1					
2					
3					
4					
5					

PUMP DATA SHEET		**PROJECT NO:**	54.02
DESCRIPTION:	GAC Backwash Pumps	**CLIENT:**	Rise Grass Valley Inc.
MANUFACTURER:	TBD	**LOCATION:**	Grass Valley, CA
MODEL NO:	TBD	**DATE:**	2019-03-29

PROCESS DATA				**PUMPING REQUIREMENTS**	
Maximum Flow:	700 gpm	**Temperature:**	33 - 80°F	**Viscosity:**	~1 cP
Design Flow:	629 gpm	**TS (Total Solids)%:**	<0.00%	**Duty (fluid):**	629 gpm @ 51 ft
Nominal Flow:	629 gpm	**TSS(Total Suspended Solids):**	~0 ppm	**S.G.:**	~1
Process Fluid:	Water	**pH:**	5-8	**Duty (water):**	629 gpm @ 51 ft
RPM:	TBD	**Vapor Pressure:**	TBD	**NPSHa:**	TBD

PUMP DESIGN

Nozzles	**Size**	**Fitting**	**Type:**	Centrifugal	**Other Features:**
Suction:	TBD	150# ANSI	**Subtype:**	Frame Mounted	
Discharge:	TBD	150# ANSI	**NPSHr:**	TBD	
Drain:	Manuf	Manuf	**No Stages.:**	1	
Vent:	-	-	**Impeller dia.:**	TBD	
			Estimated Weight:	TBD	

DRIVE AND SEAL				**MATERIAL OF CONSTRUCTION**	
Packing or Seal:	TBD	**Coupling Size:**	TBD	**Casing:**	TBD
Motor Shaft Size:	TBD	**Impeller Type:**	TBD	**Casing Coating:**	TBD
Pump Shaft Size:	TBD			**Impeller:**	TBD
RPM:	TBD			**Mechanical Seal:**	TBD
				Pump O-Ring:	TBD

MOTOR				**ENVIRONMENT:**	
Manufacturer:	TBD	**ELECTRICAL**		**Location:**	Outdoor/Barge
Baseplate Size:	Manuf	25	HP	**Corrosive Area:**	no
Enclosure:	TEFC	TBD	V	**Dusty Area:**	yes
Service Factor:	1.15	TBD	Phase	**Explosive Area:**	no
Full Load Amp:	-	TBD	Hz	**Elevation (above Sea-Level):**	2755
MOTOR CONTROL		Remote	X	**Temperature Min.:**	15 °F
local	-	VFD	X	**Temperature Max.:**	108 °F

CONTROL METHOD			
		Level	X
Constant Pressure	-	Flow	X
Differential Pressure	-	Other	-

Drawing No
C-100, C-101
P&ID Drawing No.
G-100
P&ID Tag Reference(s)
GAC Backwash Pumps

Remarks

1 pump operating with one pump on standby.

No	DATE	BY	CHK	APP	REVISION
0	2019-03-29	JQG	SJB	SJB	Permit
1					
2					
3					
4					
5					

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AERATION SYSTEM DATA SHEET		PROJECT No:	54.02
DESCRIPTION:	Turbine Aerator	**CLIENT:**	Rise Grass Valley Inc.
MANUFACTURER:	TBD	**LOCATION:**	Grass Valley, CA
MODEL NO:	TBD	**DATE:**	2019-03-29

PROCESS Data

Maximum Flow	1500 gpm	**Temperature:**	33-80°F		
Design Flow	1340 gpm	**TS (Total Solids)%:**	TBD		
Minimum Flow	700 gpm	**TSS(Total Suspended Solids):**	TBD		
Process Fluid:	Shaft Water	**pH:**	5-8		

AERATOR DESIGN

Type	**Turbine Aerator**			
Injection Rate:	76	**ft^3/min**		
	4.7	**lbs O^2/hr**		
Mounting:	Closed cell, UV protected polyethylene pontoons with low water legs.			

DRIVE AND SEAL

Packing or Seal:	Manuf	**Shaft Material**	304 Stainles		
Motor Shaft Size:	1"				
Aerator Shaft Size:	1.5"				

MOTOR				ENVIROMENT:	
Manufacturer:	Baldor	**ELECTRICAL**		**Location**	Outdoor/Barge
Model:	VECP3665T	5	**HP**	**Corrosive Area**	no
Enclosure:	TEFC	240/460	**V**	**Dusty Area**	yes
Service Factor:	TBD	3 or 1	**Phase**	**Explosive Area**	no
Full Load Amp:	13.2/6.6	60	**Hz**	**Temperature Min**	15 °F
Motor Control	☑ Control Box	1750	**RPM**	**Temperature Max**	108 °F
	☐ VFD				

Control Method

☑ Manual

☐ Other

Remarks

Drawing No
C-100
P&ID Drawing No.
G-100
P&ID Tag Reference(s)
Turbine Aerator

No	DATE	BY	CHK	APP	REVISION
0	2019-03-29	JQG	SJB	SJB	Permit
1					
2					
3					
4					
5					

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APPENDIX E

SAFETY DATA SHEETS

Manganese Dioxide

SECTION 1 : Identification of the substance/mixture and of the supplier

Product name :	**Manganese Dioxide**
Manufacturer/Supplier Trade name:	
Manufacturer/Supplier Article number:	**S25420**

Recommended uses of the product and uses restrictions on use:

Manufacturer Details:

AquaPhoenix Scientific
9 Barnhart Drive, Hanover, PA 17331

Supplier Details:

Fisher Science Education
15 Jet View Drive, Rochester, NY 14624

Emergency telephone number:

Fisher Science Education Emergency Telephone No.: 800-535-5053

SECTION 2 : Hazards identification

Classification of the substance or mixture:

Irritant
Acute toxicity (oral, dermal, inhalation), category 4

Acute toxicity - Inhalation - Category 4
Acute toxicity - Oral - Category 4

Signal word :Warning

Hazard statements:
Harmful if swallowed
Harmful if inhaled
Precautionary statements:
If medical advice is needed, have product container or label at hand
Keep out of reach of children
Read label before use
Do not eat, drink or smoke when using this product
Avoid breathing dust/fume/gas/mist/vapours/spray
Wash skin thoroughly after handling
Wash skin thoroughly after handling
Use only outdoors or in a well-ventilated area
IF SWALLOWED: Call a POISON CENTER or doctor/physician if you feel unwell
Rinse mouth
IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing
Call a POISON CENTER or doctor/physician if you feel unwell
Dispose of contents and container to an approved waste disposal plant

Other Non-GHS Classification:

WHMIS

D2B

NFPA/HMIS

NFPA SCALE (0-4)

Health	2
Flammability	0
Physical Hazard	0
Personal Protection	X

HMIS RATINGS (0-4)

SECTION 3 : Composition/information on ingredients

Ingredients:		
CAS 1313-13-9	Manganese oxide	>98 %
		Percentages are by weight

SECTION 4 : First aid measures

Description of first aid measures

After inhalation: Loosen clothing as necessary and position individual in a comfortable position.Move exposed to fresh air. Give artificial respiration if necessary. If breathing is difficult give oxygen.Get medical assistance if cough or other symptoms appear.

After skin contact: Rinse/flush exposed skin gently using soap and water for 15-20 minutes.Seek medical advice if discomfort or irritation persists.

After eye contact: Protect unexposed eye. Rinse/flush exposed eye(s) gently using water for 15-20 minutes. Remove contact lens(es) if able to do so during rinsing. Seek medical attention if irritation persists or if concerned.

After swallowing: Rinse mouth thoroughly. Do not induce vomiting. Have exposed individual drink sips of water. Seek medical attention if irritation, discomfort or vomiting persists.Never give anything by mouth to an unconscious person.

Most important symptoms and effects, both acute and delayed:

Irritation, Nausea,Headache, Shortness of breath.;

Indication of any immediate medical attention and special treatment needed:

If seeking medical attention, provide SDS document to physician.Physician should treat symptomatically.

SECTION 5 : Firefighting measures

Extinguishing media

Suitable extinguishing agents: Use appropriate fire suppression agents for adjacent combustible materials or sources of ignition. Use water, dry chemical, chemical foam, carbon dioxide, or alcohol-resistant foam.

For safety reasons unsuitable extinguishing agents:

Special hazards arising from the substance or mixture:

Combustion products may include carbon oxides or other toxic vapors.Thermal decomposition can lead to release of irritating gases and vapors.

Advice for firefighters:

Protective equipment: Use NIOSH-approved respiratory protection/breathing apparatus.

Additional information (precautions): Move product containers away from fire or keep cool with water spray as a protective measure, where feasible.Avoid inhaling gases, fumes, dust, mist, vapor, and aerosols.Avoid contact with skin, eyes, and clothing.

SECTION 6 : Accidental release measures

Personal precautions, protective equipment and emergency procedures:

Wear protective equipment. Ensure that air-handling systems are operational.Ensure adequate ventilation.

Environmental precautions:

Prevent from reaching drains, sewer or waterway. Collect contaminated soil for characterization per Section 13. Should not be released into environment.

Methods and material for containment and cleaning up:

Keep in suitable closed containers for disposal.Wear protective eyeware, gloves, and clothing. Refer to Section 8.Always obey local regulations.Dust deposits should not be allowed to accumulate on surfaces, as these may form an explosive mixture if they are released into the atmosphere in sufficient concentration. Avoid dispersal of dust in the air (i.e., clearing dust surfaces with compressed air). Collect solids in powder form using vacuum with (HEPA filter). Evacuate personnel to safe areas.

Reference to other sections:

SECTION 7 : Handling and storage

Precautions for safe handling:

Minimize dust generation and accumulation. Follow good hygiene procedures when handling chemical materials. Refer to Section 8.Do not eat, drink, smoke, or use personal products when handling chemical substances. Avoid contact with eyes, skin, and clothing.

Conditions for safe storage, including any incompatibilities:

Store away from incompatible materials.Protect from freezing and physical damage.Keep away from food and beverages.Provide ventilation for containers. Store in cool, dry conditions in well sealed containers. Store with like hazards

SECTION 8 : Exposure controls/personal protection

Control Parameters:	1313-13-9, Magnesium dioxide, ACGIH TLV TWA (inhalable particles) 0.02 mg/m3 1313-13-9, Magnesium dioxide, OSHA PEL TWA (Total Dust) 0.2 mg/m3

Appropriate Engineering controls:	Emergency eye wash fountains and safety showers should be available in the immediate vicinity of use/handling.Provide exhaust ventilation or other engineering controls to keep the airborne concentrations of vapor or dusts (total/respirable) below the applicable workplace exposure limits (Occupational Exposure Limits-OELs) indicated above.It is recommended that all dust control equipment such as local exhaust ventilation and material transport systems involved in handling of this product contain explosion relief vents or an explosion suppression system or an oxygen deficient environment.Ensure that dust-handling systems (such as exhaust ducts, dust collectors, vessels, and processing equipment) are designed in a manner to prevent the escape of dust into the work area (i.e., there is no leakage from the equipment).Use under a fume hood
Respiratory protection:	Not required under normal conditions of use. Where risk assessment shows air-purifying respirators are appropriate use a full-face particle respirator type N100 (US) or type P3 (EN 143) respirator cartridges as a backup to engineering controls.When necessary use NIOSH approved breathing equipment.
Protection of skin:	Select glove material impermeable and resistant to the substance.Select glove material based on rates of diffusion and degradation.Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices.Use proper glove removal technique without touching outer surface. Avoid skin contact with used gloves.Wear protective clothing.
Eye protection:	Wear equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).Safety glasses or goggles are appropriate eye protection.
General hygienic measures:	Perform routine housekeeping.Wash hands before breaks and at the end of work.Avoid contact with skin, eyes, and clothing.Before wearing wash contaminated clothing.

SECTION 9 : Physical and chemical properties

Appearance (physical state,color):	Solid	**Explosion limit lower**: **Explosion limit upper**:	Not determined Not determined
Odor:	Not Determined	**Vapor pressure**:	Not determined
Odor threshold:	Not determined	**Vapor density**:	Not determined
pH-value:	Not Determined	**Relative density**:	5.026 g/cm3
Melting/Freezing point:	535 °C (995 °F)	**Solubilities**:	
Boiling point/Boiling range:	Not determined	**Partition coefficient (n-octanol/water)**:	Not determined
Flash point (closed cup):	Not determined	**Auto/Self-ignition temperature**:	Not determined
Evaporation rate:	Not determined	**Decomposition temperature**:	Not determined
Flammability (solid,gaseous):	Not determined	**Viscosity**:	a. Kinematic:Not determined b. Dynamic: Not determined
Density: Not determined			

SECTION 10 : Stability and reactivity

Reactivity: Nonreactive under normal conditions.
Chemical stability: Stable under normal conditions.
Possible hazardous reactions: None under normal processing
Conditions to avoid: Incompatible Materials.
Incompatible materials: Strong acids.Strong bases.Organic materials.
Hazardous decomposition products:

SECTION 11 : Toxicological information

Acute Toxicity: No additional information.	
Chronic Toxicity: No additional information.	
Corrosion Irritation: No additional information.	
Sensitization:	No additional information.
Single Target Organ (STOT):	No additional information.
Numerical Measures:	No additional information.
Carcinogenicity:	No additional information.
Mutagenicity:	No additional information.
Reproductive Toxicity:	No additional information.

SECTION 12 : Ecological information

Ecotoxicity Persistence and degradability:
Bioaccumulative potential:
Mobility in soil:
Other adverse effects:

SECTION 13 : Disposal considerations

Waste disposal recommendations:

Contact a licensed professional waste disposal service to dispose of this material.Dispose of empty containers as unused product.Product or containers must not be disposed with household garbage.It is the responsibility of the waste generator to properly characterize all waste materials according to applicable regulatory entities (US 40CFR262.11).Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. Chemical waste generators must also consult local, regional, and national hazardous waste regulations. Ensure complete and accurate classification.

SECTION 14 : Transport information

UN-Number

Not Regulated.

UN proper shipping name

Not Regulated.

Transport hazard class(es)

Packing group:Not Regulated
Environmental hazard:
Transport in bulk:
Special precautions for user:

SECTION 15 : Regulatory information

United States (USA)

SARA Section 311/312 (Specific toxic chemical listings):

Acute

SARA Section 313 (Specific toxic chemical listings):

1313-13-9 N450 Manganese Compounds

RCRA (hazardous waste code):

None of the ingredients is listed

TSCA (Toxic Substances Control Act):

All ingredients are listed.

CERCLA (Comprehensive Environmental Response, Compensation, and Liability Act):

None of the ingredients is listed

Proposition 65 (California):

Chemicals known to cause cancer:

None of the ingredients is listed

Chemicals known to cause reproductive toxicity for females:

None of the ingredients is listed

Chemicals known to cause reproductive toxicity for males:

None of the ingredients is listed

Chemicals known to cause developmental toxicity:

None of the ingredients is listed

Canada

Canadian Domestic Substances List (DSL):

All ingredients are listed.

Canadian NPRI Ingredient Disclosure list (limit 0.1%):

None of the ingredients is listed

Canadian NPRI Ingredient Disclosure list (limit 1%):

None of the ingredients is listed

SECTION 16 : Other information

This product has been classified in accordance with hazard criteria of the Controlled Products Regulations and the SDS contains all the information required by the Controlled Products Regulations.Note:. The responsibility to provide a safe workplace remains with the user.The user should consider the health hazards and safety information contained herein as a guide and should take those precautions required in an individual operation to instruct employees and develop work practice procedures for a safe work environment.The information contained herein is, to the best of our knowledge and belief, accurate.However, since the conditions of handling and use are beyond our control, we make no guarantee of results, and assume no liability for damages incurred by the use of this material.It is the responsibility of the user to comply with all applicable laws and regulations applicable to this material.

GHS Full Text Phrases:

Abbreviations and acronyms:
IMDG: International Maritime Code for Dangerous Goods
IATA: International Air Transport Association
GHS: Globally Harmonized System of Classification and Labelling of Chemicals
ACGIH: American Conference of Governmental Industrial Hygienists
CAS: Chemical Abstracts Service (division of the American Chemical Society)
NFPA: National Fire Protection Association (USA)
HMIS: Hazardous Materials Identification System (USA)
WHMIS: Workplace Hazardous Materials Information System (Canada)
DNEL: Derived No-Effect Level (REACH)
PNEC: Predicted No-Effect Concentration (REACH)
CFR: Code of Federal Regulations (USA)
SARA: Superfund Amendments and Reauthorization Act (USA)
RCRA: Resource Conservation and Recovery Act (USA)
TSCA: Toxic Substances Control Act (USA)
NPRI: National Pollutant Release Inventory (Canada)
DOT: US Department of Transportation

Effective date : 10.24.2014
Last updated : 03.19.2015

Potassium Permanganate,

SECTION 1 : Identification of the substance/mixture and of the supplier

Product name : **Potassium Permanganate,**

Manufacturer/Supplier Trade name:

Manufacturer/Supplier Article number: **S25497**

Recommended uses of the product and uses restrictions on use:

Manufacturer Details:

AquaPhoenix Scientific
9 Barnhart Drive, Hanover, PA 17331

Supplier Details:

Fisher Science Education
15 Jet View Drive, Rochester, NY 14624

Emergency telephone number:

Fisher Science Education Emergency Telephone No.: 800-535-5053

SECTION 2 : Hazards identification

Classification of the substance or mixture:

Oxidizing
Oxidizing solids, category 2

Irritant
Acute toxicity (oral, dermal, inhalation), category 4

Environmentally Damaging
Chronic hazards to the aquatic environment, category 1
Acute hazards to the aquatic environment, category 1

Corrosive
Skin corrosion, category 1B
Serious eye damage, category 1

Oxidizing Solids 2
Ac. Oral Tox. 4
Skin Corr. 1B
Eye. Damage 1
Aq. AcTox. 1
Aq. ChrTox. 1

Signal word :Danger

Hazard statements:
May intensify fire; oxidizer
Harmful if swallowed
Causes severe skin burns and eye damage
Causes serious eye damage
Very toxic to aquatic life with long lasting effects

Precautionary statements:
If medical advice is needed, have product container or label at hand
Keep out of reach of children
Read label before use
Keep away from heat/sparks/open flames/hot surfaces. No smoking
Keep/Store away from clothing/combustible materials
Take any precaution to avoid mixing with combustibles
Do not breathe dust/fume/gas/mist/vapours/spray
Wash skin thoroughly after handling
Do not eat, drink or smoke when using this product
Avoid release to the environment
Wear protective gloves/protective clothing/eye protection/face protection
Immediately call a POISON CENTER or doctor/physician
Wash contaminated clothing before reuse
In case of fire: Use agents recommended in section 5 for extinction
Collect spillage
IF SWALLOWED: Call a POISON CENTER or doctor/physician if you feel unwell
Rinse mouth
IF SWALLOWED: Rinse mouth. Do NOT induce vomiting
IF ON SKIN (or hair): Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower
IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing
Immediately call a POISON CENTER or doctor/physician
IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses if present and easy to do. Continue rinsing
Store in a dry place
Dispose of contents and container as instructed in Section 13

Other Non-GHS Classification:

WHMIS

C

D2B

NFPA/HMIS

NFPA SCALE (0-4)

Health	3
Flammability	0
Physical Hazard	2
Personal Protection	X

HMIS RATINGS (0-4)

SECTION 3 : Composition/information on ingredients

Ingredients:

CAS 7722-64-7	Potassium Permanganate	>95 %
Percentages are by weight		

SECTION 4 : First aid measures

Description of first aid measures

After inhalation: Move exposed to fresh air. Give artificial respiration if necessary. If breathing is difficult give oxygen.Loosen clothing and place exposed in a comfortable position.Seek medical assistance if cough or other symptoms appear.

After skin contact: Immediately enter emergency shower rinsing while removing contaminated clothing and shoes.Immediately seek medical attention.Wash hands and exposed skin with soap and plenty of water.

After eye contact: Immediately seek medical attention.Continue rinsing eyes during transport to the hospital.Protect unexposed eye.Flush exposed eye gently using water for 15-20 minutes. Remove contact lenses while rinsing.

After swallowing: Rinse mouth with water.Do not induce vomiting. Never give anything by mouth to an unconscious person.Immediately seek medical attention.

Most important symptoms and effects, both acute and delayed:

Irritation.Shortness of breath.Headache.Nausea.Dizziness.;Central Nervous System impairment.

Indication of any immediate medical attention and special treatment needed:

If seeking medical attention provide SDS document to physician. Physician should treat symptomatically.

SECTION 5 : Firefighting measures

Extinguishing media

Suitable extinguishing agents: Use water, dry chemical, chemical foam, carbon dioxide, or alcohol-resistant foam.

For safety reasons unsuitable extinguishing agents:

Special hazards arising from the substance or mixture:

Contact with other material may cause a fire. Some oxidizers may react explosively with hydrocarbons. Containers may explode when heated.Combustible dust formation is a risk.Thermal decomposition can lead to release of irritating gases and vapors.

Advice for firefighters:

Protective equipment: Wear protective eyeware, gloves, and clothing. Refer to Section 8.

Additional information (precautions): Avoid dust formation.Avoid inhaling gases, fumes, dust, mist, vapor, and aerosols. Avoid contact with skin, eyes, and clothing.

SECTION 6 : Accidental release measures

Personal precautions, protective equipment and emergency procedures:

Ensure adequate ventilation.Ensure that air-handling systems are operational.

Environmental precautions:

Should not be released into environment.Prevent from reaching drains, sewer, or waterway.

Methods and material for containment and cleaning up:

Pick up and arrange disposal without creating dust. Sweep up and shovel.Contain spillage, and then collect with an electrically protected vacuum cleaner or by wet - brushing and place in container for disposal according to local regulations (see section 13).Wear protective eyeware, gloves, and clothing. Refer to Section 8.Always obey local regulations.If necessary use trained response staff or contractor. Evacuate personnel to safe areas. Containerize for disposal. Refer to Section 13.Keep in suitable closed containers for disposal.

Reference to other sections:

SECTION 7 : Handling and storage

Precautions for safe handling:

Wash hands after handling. Avoid contact with skin and eyes. Discard contaminated materials.Avoid contact with skin, eyes, and clothing.Follow good hygiene procedures when handling chemical materials. Refer to Section 8.Follow proper disposal methods. Refer to Section 13.Do not eat, drink, smoke, or use personal products when handling chemical substances.

Conditions for safe storage, including any incompatibilities:

Protect from freezi ng and physical damage.Store in a cool location.Keep away from food and beverages.Protect from freezing and physical damage.Provide ventilation for containers. Keep container tightly sealed. Store away from incompatible materials.

SECTION 8 : Exposure controls/personal protection

Control Parameters:	7722-64-7, Potassium permanganate, C 5.000000 mg/m3 USA. OSHA 7722-64-7, Potassium permanganate, TWA 0.200000 mg/m3 USA. ACGIH 7722-64-7, Potassium permanganate, TWA 1.000000 mg/m3 USA. NIOSH
Appropriate Engineering controls:	Emergency eye wash fountains and safety showers should be available in the immediate vicinity of use or handling. Provide exhaust ventilation or other engineering controls to keep the airborne concentrations of vapor and mists below the applicable workplace exposure limits (Occupational Exposure Limits-OELs) indicated above.
Respiratory protection:	Where risk assessment shows air-purifying respirators are appropriate use a full-face particle respirator type N100 (US) or type P3 (EN 143) respirator cartridges as a backup to engineering controls.When necessary use NIOSH approved breathing equipment. Use only under chemical fume hood.
Protection of skin:	Select glove material impermeable and resistant to the substance.Select glove material based on rates of diffusion and degradation. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices.Use proper glove removal technique without touching outer surface. Avoid skin contact with used gloves.Wear protective clothing.
Eye protection:	Tightly fitting safety goggles and faceshield (8 - inch minimum) are appropriate eye protection.Wear equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).Safety glasses or goggles are appropriate eye protection.
General hygienic measures:	Perform routine housekeeping.Wash hands before breaks and immediately after handling the product.Avoid contact with skin, eyes, and clothing.Before rewearing wash contaminated clothing.

SECTION 9 : Physical and chemical properties

Appearance (physical state,color):	Dark brown solid	**Explosion limit lower**: **Explosion limit upper**:	Not Determined Not Determined

Odor:	Odorless	**Vapor pressure**:	Not Determined
Odor threshold:	Not Determined	**Vapor density**:	Not Determined
pH-value:	7.2 - 9.7 at 20 g/l at 20 °C	**Relative density**:	2.710 g/cm3
Melting/Freezing point:	> 240 °C	**Solubilities**:	Soluble in water: 65.1 g/l at 20 °C
Boiling point/Boiling range:	Not Determined	**Partition coefficient (n-octanol/water)**:	Not Determined
Flash point (closed cup):	Not Determined	**Auto/Self-ignition temperature**:	Not Determined
Evaporation rate:	Not Determined	**Decomposition temperature**:	> 240 °C
Flammability (solid,gaseous):	Not Determined	**Viscosity**:	a. Kinematic:Not Determined b. Dynamic: Not Determined
Density: Not Determined			

SECTION 10 : Stability and reactivity

Reactivity: Oxidizing Solid. Nonreactive under normal conditions.
Chemical stability: Stable under normal conditions.
Possible hazardous reactions: None under normal processing.
Conditions to avoid: Incompatible materials.Moisture , excess heat, and dust formation. Oxalates slowly corrode steel.
Incompatible materials: Strong reducing agents, Powdered metals, Peroxides, Zinc, Copper, Alcohols, Hydrogen fluoride, Acids, Sulfuric acid
Hazardous decomposition products: Potassium oxides, Manganese, or Manganese oxides. Formic acid.

SECTION 11 : Toxicological information

Acute Toxicity:		
Oral:	7722-64-7	LD50 Oral - Rat - 1,090 mg/kg
Chronic Toxicity: No additional information.		
Corrosion Irritation:		
Dermal:	7722-64-7	Skin - Rabbit Result : Corrosive - 4 h
Sensitization:		No additional information.
Single Target Organ (STOT):		No additional information.
Numerical Measures:		No additional information.
Carcinogenicity:		No additional information.
Mutagenicity:		No additional information.
Reproductive Toxicity:		No additional information.

SECTION 12 : Ecological information

Ecotoxicity

7722-64-7: LC50 - Oncorhynchus mykiss (rainbow trout) - 0.3 - 0.6 mg/l - 96.0 h

7722-64-7: EC50 - Daphnia magna (Water flea) - 0.084 mg/l - 48 h

Persistence and degradability:
Bioaccumulative potential: 7722-64-7: Bioaccumulation Lamellibranchia (mussel). 7722-64-7: Bioconcentration factor (BCF) : < 10,000 Remarks : Can accumulate in aquatic organisms
Mobility in soil:
Other adverse effects:

SECTION 13 : Disposal considerations

Waste disposal recommendations:

Burn in a chemical incinerator equipped with an afterburner and scrubber but exert extra care in igniting as this material is highly flammable.Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber.Contact a licensed professional waste disposal service to dispose of this material.Dispose of empty containers as unused product.Product or containers must not be disposed together with household garbage. It is the responsibility of the waste generator to properly characterize all waste materials according to applicable regulatory entities (US 40CFR262.11). Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. Chemical waste generators must also consult local, regional, and national hazardous waste regulations. Ensure complete and accurate classification.

SECTION 14 : Transport information

UN-Number

1490

UN proper shipping name

Potassium permanganate

Transport hazard class(es)

Class:
5.1 Oxidizing substances

Packing group:II
Environmental hazard:
Transport in bulk:
Special precautions for user:

SECTION 15 : Regulatory information

United States (USA)

SARA Section 311/312 (Specific toxic chemical listings):

Reactive, Acute

SARA Section 313 (Specific toxic chemical listings):

7722-64-7 Potassium Permanganate

RCRA (hazardous waste code):

None of the ingredients is listed

TSCA (Toxic Substances Control Act):

All ingredients are listed.

CERCLA (Comprehensive Environmental Response, Compensation, and Liability Act):

7722-64-7 Potassium Permanganate 100 lb

Proposition 65 (California):

Chemicals known to cause cancer:

None of the ingredients is listed

Chemicals known to cause reproductive toxicity for females:

None of the ingredients is listed

Chemicals known to cause reproductive toxicity for males:

None of the ingredients is listed

Chemicals known to cause developmental toxicity:

None of the ingredients is listed

Canada

Canadian Domestic Substances List (DSL):

All ingredients are listed.

Canadian NPRI Ingredient Disclosure list (limit 0.1%):

None of the ingredients is listed

Canadian NPRI Ingredient Disclosure list (limit 1%):

7722-64-7 Potassium Permanganate

SECTION 16 : Other information

This product has been classified in accordance with hazard criteria of the Controlled Products Regulations and the SDS contains all the information required by the Controlled Products Regulations. Note: . The responsibility to provide a safe workplace remains with the user. The user should consider the health hazards and safety information contained herein as a guide and should take those precautions required in an individual operation to instruct employees and develop work practice procedures for a safe work environment.The information contained herein is, to the best of our knowledge and belief, accurate. However, since the conditions of handling and use are beyond our control, we make no guarantee of results, and assume no liability for damages incurred by the use of this material. It is the responsibility of the user to comply with all applicable laws and regulations applicable to this material.

GHS Full Text Phrases:

Abbreviations and acronyms:

Effective date : 03.04.2015
Last updated : 03.19.2015

SAFETY DATA SHEET
COCONUT SHELL ACTIVATED CARBON
DATE OF ISSUE: 02/24/2015

SECTION 1 – PRODUCT AND COMPANY INFORMATION

Product Name:	ACTIVATED CARBON – Coconut Shell Based
Product Use:	According to Manufacturer's recommendation
Company Identification:	CALIFORNIA CARBON CO., INC. 2825 E. GRANT ST. WILMINGTON, CA 90744
Telephone Number:	1-800-663-5830 1-562-436-1962
Fax Number:	1-562-437-1217
Email:	CCarbon2@aol.com

SECTION II – HAZARDS IDENTIFICATION

		Key to Ratings
OSHA Regulatory Status:	Not regulated	4 = Extreme/Severe
HMIS Ratings:	Health – 0	3 = High/Serious
(NFPA)	Flammability – 1	2 = Moderate
	Reactivity – 0	1 = Slight
	Special – n/a	W = Water Reactive
		OX = Oxidizer

Protective Equipment:	Safety glasses with side shield or goggles, gloves, long sleeve shirt or lab coat, long pants recommended.
Health Effects:	See Section IV
Environmental Effects:	See Section XII

Hazard Symbol:

Eye Irritation Category 2B Respiratory Irritation Category 3	Contact may cause eye irritation. Dust may be slightly irritating to eyes and respiratory track. Wet activated carbon removes oxygen from air causing a severe hazard to workers in enclosed or confined space.

Precautionary Statements

Prevention:	Avoid generation of dust during handling. Avoid breathing dust. Wash thoroughly after handling. Use in a well-ventilated area.
Response:	IF INHALED: Remove to fresh air. IF IN EYES: Rinse with water for several minutes. Remove contact lenses if present. Continue rinsing.
Storage:	Store in a well-ventilated place. Keep container tightly closed.
Container Labeling:	Not implemented at this time.

SECTION III – COMPOSITION/INFORMATION ON INGREDIENTS

Chemical Identity (% by weight)	Common Name	CAS No.	Impurities
100%	Activated Carbon	68647-86-9	None

SECTION IV – FIRST AID MEASURES

Routes of Exposure	
Inhalation:	Dust may cause mild irritation to the upper respiratory tract.
Skin:	Dust may cause mild irritation, possible reddening.
Eyes:	Dust may cause mild irritation, possible reddening.
Ingestion:	Dust may cause mild irritation to digestive track resulting in nausea or diarrhea.
Signs/Symptoms of Exposure:	Dust may cause irritation and redness of eyes, irritation of skin and respiratory system. The effects of long-term, low-level exposures to this product have not been determined.
Emergency and First Aid Procedures:	For Eye Contact: Immediately flush with copious amounts of water for at least 15 minutes, lifting both the upper and lower lids occasionally; seek medical attention. For Skin Contact: Wash with soap and water; seek medical attention. For Inhalation: Remove to fresh air and rest as needed; seek medical attention for any breathing difficulty. For Ingestion: Drink plenty of water; seek medical attention.
Medical Conditions Generally Aggravated by Exposure:	People with pre-existing skin conditions or eye problems or impaired respiratory function may be more susceptible to the potential effects of the dust.

SECTION V – FIRE FIGHTING MEASURES

Suitable Extinguishing Media:	Use an extinguishing media suitable for the surrounding fire.
Specific Hazards:	As with most organic solids, fire is possible at elevated temperatures or by contact with an ignition source. Activated carbon is difficult to ignite and tends to burn slowly (smolder) without producing smoke or flame. Carbon monoxide and carbon dioxide gas may be emitted upon combustion of material. Contact with strong oxidizers such as ozone or liquid oxygen may cause rapid combustion.
Protective Equipment and Procedures:	Wear NIOSH approved self-contained breathing apparatus suitable for the surrounding fire.

SECTION VI – ACCIDENTAL RELEASE MEASURES

Personal Precautions:	Wear protective equipment, keep unnecessary personnel away, and ventilate area of spill.
Environmental Precautions:	The material is not soluble, but can cause a particulate emission if discharged to waterways; therefore, dike all entrances to sewers and drains to avoid introducing the material into the waterways.
Containment and Clean-up:	Dike all entrances to sewers and drains. Vacuum or shovel spilled material and place in closed container for disposal. Remove product to appropriate storage area until it can be properly disposed of in accordance with local, state and federal regulations. Avoid dust formation.

SECTION VII – HANDLING AND STORAGE

Precautions for Safe Handling:	Avoid prolonged contact with eyes and skin. Keep away from ignition sources. Use in well ventilated areas. Protect containers from physical damage. Wash hands after handling.
Conditions for Safe Storage:	Store in cool, dry, ventilated area and in closed containers. Keep away from oxidizers, heat or flames. Store away from ignition sources.

SECTION VIII – EXPOSURE CONTROLS/PERSONAL PROTECTION

Exposure Guidelines: Wet activated carbon removes oxygen from air posing a hazard to workers in enclosed or confined space. Before entering such an area, sample the air to assure sufficient oxygen supply. Use work procedures for low oxygen levels, observing all local, state and federal regulations.

Engineering Controls: Exhaust ventilation should be designed to prevent accumulation and recirculation in the workplace and safely remove carbon black from the air.
If risk of overexposure exists, wear an approved respirator.
Provide adequate ventilation in warehouse or closed storage area.

Personal Protective Equipment: Use of NIOSH approved particulate filter is recommended if dust is generated in handling. The usual precautionary measures for handling chemicals should be followed, i.e. gloves, safety glasses with side shields or goggles, long sleeve shirt or lab coat, dust respiration if dusty and/or other protective clothing or equipment as determined appropriate.

General Hygiene: The usual precautionary measures for handling chemicals should be followed: i.e. keep away from food and beverage; remove contaminated clothing immediately; wash hands before breaks or eating; avoid contact with eyes and skin.

SECTION IX – PHYSICAL AND CHEMICAL PROPERTIES

Physical State (Appearance): Black granular, pellet or flake

Color:	Black	Molecular Weight:	N/A
Odor:	None	Odor Threshold:	None
pH Value:	N/A	Vapor Pressure:	0
Melting Point:	N/A	Vapor Density:	Solid
Freezing Point:	N/A	Relative Density:	0.4 to 0.7 g/ml
Initial Boiling Point:	N/A	Partition Coefficient:	N/A
Flashpoint:	N/A	Solubility:	Not Soluble
Evaporation Rate:	N/A	Auto Ignition Temp.:	>220 Deg. C
Flammability:	>220 Deg. C	Decomp. Temp.:	N/A
UEL:	N/A	Viscosity:	N/A
LEL:	N/A		

SECTION X – STABILITY AND REACTIVITY

Chemical Stability: Stable Conditions to avoid: None
Possibility of Hazardous Reaction: Will Not Occur Conditions to avoid: None
Caution: High concentrations of organics in air will cause temperature rise due to heat of adsorption. At very high concentration levels this may result in an exothermic reaction, referred to as a bed fire. High concentrations of Ketones and Aldehydes may cause a bed temperature rise due to adsorption and oxidation.

Materials to Avoid: Alkali metals and strong oxidizers such as ozone, oxygen, permanganate, chlorine.
Hazardous Decomposition Products: Carbon monoxide and carbon dioxide gas may be generated during combustion of this material.

SECTION XI – TOXICOLOGICAL INFORMATION

Acute Toxicity: Not Classified
Inhalation, Ingestion, Eye Irritation, Skin Irritation: See Section IV.
Sensitization: Not determined on the finished product.
Target Organ(s) or System: Eyes, skin and upper respiratory system.
Signs and Symptoms of Exposure: See Sections III and IV
Chronic Effects: Carcinogenicity, Mutagenicity, Reproductive Effects, Developmental Factors: Not determined on the finished product.

SECTION XII – ECOLOGICAL INFORMATION

Ecotoxicity, Persistence/Degradability, Bioaccumulation/Accumulation, Mobility in Environmental Media, Other Adverse Effects: Not determined on the finished product.

SECTION XIII – DISPOSAL CONSIDERATIONS

Vacuum or shovel material into a closed container. Storage and disposal should be in accordance with applicable local, state and federal laws and regulations. Local regulations may be more stringent than state or federal requirements. Activated Carbon is an adsorbent media; hazard classification is generally determined by the adsorbate that the carbon has picked up. Consult with the US EPA Guidelines listed in 40 CFR Part 261.3 for the classifications of hazardous waste prior to disposal.

SECTION XIV – TRANSPORT INFORMATION

Ship in accordance with all local, state, and federal laws and regulations.

UN Number: Not regulated
UN Proper Shipping Name: N/A
Transport Hazard Classes: N/A
Packing Group: N/A
Sea Pollutants: N/A
Special Precautions for user related to transport: N/A

Note: Under the UN classification for activated carbon, all activated carbons have been identified as a class 4.2 product. However this product has been tested according to the United Nations Transport of Dangerous Goods test protocol for a “self-heating substance” and it has been determined that this product does not meet the definition of a self-heating substance, or any other hazard class, and therefore should not be listed as a hazardous material. This information is applicable only for the Activated Carbon product identified in this document.

SECTION XV – REGULATORY INFORMATION

Carbon (7440-44-0): Listed on the United States TSCA Inventory

SECTION XVI – OTHER INFORMATION

The information contained herein is based on data considered accurate in light of current formulation. However, no warranty is expressed or implied regarding the accuracy of this data or the results to be obtained from the use thereof.

SAFETY DATA SHEET

1. Identification

Product identifier	**Sodium hypochlorite solution - sodium hypochlorite 12.5%**
Other means of identification	Not available.
Recommended use	Primarily used as a water treatment chemical as a disinfectant. Also used as a bleaching agent.
Recommended restrictions	None known.

Manufacturer/Importer/Supplier/Distributor information

Company name	Carus Corporation
Address	315 5th Street Peru, Illinois 61354, USA
Telephone	(815) 223-1500
Toll Free	(800) 435-6856
Fax	(815) 224-6816
E-mail	salesmkt@caruscorporation.com
Website	www.caruscorporation.com
Company name	Alexander Chemical Corporation, a Carus Group Inc. Company
Address	7593 S. First Road, Kingsbury Industrial Park, Kingsbury, Indiana 46345, USA
Website	www.alexanderchemical.com
Company name	Sierra Chemical Co, a Carus Group Inc. Company
Address	2302 Larkin Circle Sparks, Nevada 89431, USA
Website	www.sierrachemsales.com
Contact person	Dr. Chithambarathanu Pillai
Telephone	(800) 348-8827 - All other non-emergency inquiries about the product should be directed to the company
Emergency telephone number	For Hazardous Materials [or Dangerous Goods] Incidents ONLY (spill, leak, fire, exposure or accident), call CHEMTREC at CHEMTREC®, USA: 001 (800) 424-9300 CHEMTREC®, Mexico (Toll-Free - must be dialed from within country): 001-800-13-203-9987 CHEMTREC®, Other countries: 001 (703) 527-388

2. Hazard(s) identification

Physical hazards	Corrosive to metals	Category 1
Health Hazards	Skin corrosion/irritation	Category 1
	Serious eye damage/eye irritation	Category 1
Environmental hazards	Hazardous to the aquatic environment, acute hazard	Category 2
OSHA defined hazards	Not classified.	

Label elements

Signal word	Danger
Hazard statement	May be corrosive to metals. Causes severe skin burns and eye damage. Toxic to aquatic life.

Precautionary statement

Prevention	Keep only in original container. Do not breathe mist or vapor. Wash thoroughly after handling. Avoid release to the environment. Wear protective gloves/protective clothing/eye protection/face protection.

Response	If swallowed: Rinse mouth. Do NOT induce vomiting. If on skin (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower. If inhaled: Remove person to fresh air and keep comfortable for breathing. If in eyes: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Immediately call a poison center/doctor. Wash contaminated clothing before reuse. Absorb spillage to prevent material damage.
Storage	Store locked up. Store in corrosive resistant container with a resistant inner liner.
Disposal	Dispose of contents/container in accordance with local/regional/national/international regulations.
Hazard(s) not otherwise classified (HNOC)	None known.

3. Composition/information on ingredients

Mixtures

Chemical name	CAS number	%
Sodium chloride	7647-14-5	5-20
Sodium hypochlorite	7681-52-9	5-20
Sodium hydroxide	1310-73-2	1-5

Composition comments	All concentrations are in percent by weight unless ingredient is a gas. Gas concentrations are in percent by volume.

4. First-aid measures

Inhalation	Move to fresh air. Call a physician if symptoms develop or persist.
Skin contact	Take off immediately all contaminated clothing. Rinse skin with water/shower. Call a physician or poison control center immediately. Chemical burns must be treated by a physician. Wash contaminated clothing before reuse.
Eye contact	Immediately flush eyes with plenty of water for at least 15 minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Call a physician or poison control center immediately.
Ingestion	Call a physician or poison control center immediately. Rinse mouth. Do not induce vomiting. If vomiting occurs, keep head low so that stomach content doesn't get into the lungs.
Most important symptoms/effects, acute and delayed	Burning pain and severe corrosive skin damage. Causes serious eye damage. Symptoms may include stinging, tearing, redness, swelling, and blurred vision. Permanent eye damage including blindness could result.
Indication of immediate medical attention and special treatment needed	Provide general supportive measures and treat symptomatically. Chemical burns: Flush with water immediately. While flushing, remove clothes which do not adhere to affected area. Call an ambulance. Continue flushing during transport to hospital. Keep victim under observation. Symptoms may be delayed.
General information	Ensure that medical personnel are aware of the material(s) involved, and take precautions to protect themselves.

5. Fire-fighting measures

Suitable extinguishing media	Water fog. Foam. Dry chemical powder. Carbon dioxide (CO_2).
Unsuitable extinguishing media	Do not use water jet as an extinguisher, as this will spread the fire.
Specific hazards arising from the chemical	During fire, gases hazardous to health may be formed.
Special protective equipment and precautions for firefighters	Self-contained breathing apparatus and full protective clothing must be worn in case of fire.
Fire fighting equipment/instructions	Move containers from fire area if you can do so without risk.
Specific methods	Use standard firefighting procedures and consider the hazards of other involved materials.

6. Accidental release measures

Personal precautions, protective equipment and emergency procedures	Keep unnecessary personnel away. Keep people away from and upwind of spill/leak. Keep out of low areas. Wear appropriate protective equipment and clothing during clean-up. Do not breathe mist or vapor. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Ensure adequate ventilation. Local authorities should be advised if significant spillages cannot be contained. For personal protection, see section 8 of the SDS.

Methods and materials for containment and cleaning up	This product is miscible in water. Large Spills: Stop the flow of material, if this is without risk. Use water spray to reduce vapors or divert vapor cloud drift. Dike the spilled material, where this is possible. Absorb spillage to prevent material damage. Use a non-combustible material like vermiculite, sand or earth to soak up the product and place into a container for later disposal. Prevent entry into waterways, sewer, basements or confined areas. Following product recovery, flush area with water. Small Spills: Wipe up with absorbent material (e.g. cloth, fleece). Clean surface thoroughly to remove residual contamination. Never return spills to original containers for re-use. For waste disposal, see section 13 of the SDS.
Environmental precautions	Avoid release to the environment. Inform appropriate managerial or supervisory personnel of all environmental releases. Prevent further leakage or spillage if safe to do so. Avoid discharge into drains, water courses or onto the ground.

7. Handling and storage

Precautions for safe handling	Do not breathe mist or vapor. Do not get in eyes, on skin, or on clothing. Provide adequate ventilation. Wear appropriate personal protective equipment. Avoid release to the environment. Observe good industrial hygiene practices.
Conditions for safe storage, including any incompatibilities	Store locked up. Store in corrosive resistant container with a resistant inner liner. Keep only in the original container. Store away from incompatible materials (see Section 10 of the SDS).

8. Exposure controls/personal protection

Occupational exposure limits

US. OSHA Table Z-1 Limits for Air Contaminants (29 CFR 1910.1000)

Components	Type	Value
Sodium hydroxide (CAS 1310-73-2)	PEL	2 mg/m3

US. ACGIH Threshold Limit Values

Components	Type	Value
Sodium hydroxide (CAS 1310-73-2)	Ceiling	2 mg/m3

US. NIOSH: Pocket Guide to Chemical Hazards

Components	Type	Value
Sodium hydroxide (CAS 1310-73-2)	Ceiling	2 mg/m3

US. Workplace Environmental Exposure Level (WEEL) Guides

Components	Type	Value
Sodium hypochlorite (CAS 7681-52-9)	STEL	2 mg/m3

Biological limit values	No biological exposure limits noted for the ingredient(s).
Appropriate engineering controls	Good general ventilation (typically 10 air changes per hour) should be used. Ventilation rates should be matched to conditions. If applicable, use process enclosures, local exhaust ventilation, or other engineering controls to maintain airborne levels below recommended exposure limits. If exposure limits have not been established, maintain airborne levels to an acceptable level. Eye wash facilities and emergency shower must be available when handling this product.

Individual protection measures, such as personal protective equipment

Eye/face protection	Wear safety glasses with side shields (or goggles) and a face shield.
Skin protection	
Hand protection	Wear appropriate chemical resistant gloves. Be aware that the liquid may penetrate the gloves. Frequent change is advisable. Nitrile or neoprene gloves are recommended.
Other	Wear appropriate chemical resistant clothing.
Respiratory protection	In case of insufficient ventilation, wear suitable respiratory equipment.
Thermal hazards	Wear appropriate thermal protective clothing, when necessary.
General hygiene considerations	Always observe good personal hygiene measures, such as washing after handling the material and before eating, drinking, and/or smoking. Routinely wash work clothing and protective equipment to remove contaminants.

9. Physical and chemical properties

Appearance	
Physical state	Liquid.
Form	Greenish yellow liquid.
Color	Light greenish yellow.
Odor	Chlorine.
Odor threshold	Not available.
pH	11.5 ±0.3
Melting point/freezing point	-150 °F (-101.11 °C)
Initial boiling point and boiling range	> 212 °F (> 100 °C)
Flash point	Not available.
Evaporation rate	Not available.
Flammability (solid, gas)	Not available.
Upper/lower flammability or explosive limits	
Flammability limit - lower (%)	Not available.
Flammability limit - upper (%)	Not available.
Explosive limit - lower (%)	Not available.
Explosive limit - upper (%)	Not available.
Vapor pressure	Not available.
Vapor density	Not available.
Relative density	1.09 -1.21
Solubility(ies)	
Solubility (water)	Completely soluble in water.
Partition coefficient (n-octanol/water)	Not available.
Auto-ignition temperature	Not available.
Decomposition temperature	Not available.
Viscosity	Not available.

10. Stability and reactivity

Reactivity	May be corrosive to metals.
Chemical stability	Material is stable under normal conditions.
Possibility of hazardous reactions	No dangerous reaction known under conditions of normal use.
Conditions to avoid	Contact with incompatible materials.
Incompatible materials	Acids. Metals. Strong oxidizing agents.
Hazardous decomposition products	No hazardous decomposition products are known. Contact with acids liberates toxic gas.

11. Toxicological information

Information on likely routes of exposure	
Inhalation	May cause irritation to the respiratory system. Prolonged inhalation may be harmful.
Skin contact	Causes severe skin burns.
Eye contact	Causes serious eye damage.
Ingestion	Causes digestive tract burns.
Symptoms related to the physical, chemical and toxicological characteristics	Burning pain and severe corrosive skin damage. Causes serious eye damage. Symptoms may include stinging, tearing, redness, swelling, and blurred vision. Permanent eye damage including blindness could result.

Information on toxicological effects

Acute toxicity

Components	Species	Test Results
Sodium chloride (CAS 7647-14-5)		
Acute		
Dermal		
LD50	Rabbit	> 10000 mg/kg
Inhalation		
LC50	Rat	> 42 mg/l, 1 Hours
Oral		
LD50	Rat	3550 mg/kg
Sodium hydroxide (CAS 1310-73-2)		
Acute		
Dermal		
LC50	Rabbit	1350 mg/kg, (Calculated)
Oral		
LDLo	Rabbit	500 mg/kg, (Calculated)
Sodium hypochlorite (CAS 7681-52-9)		
Acute		
Dermal		
LD50	Rabbit	> 20000 mg/kg
Inhalation		
LC50	Rat	> 10.5 mg/l, 1 Hours
Oral		
LD50	Rat	8.91 g/kg

Skin corrosion/irritation	Causes severe skin burns and eye damage.
Serious eye damage/eye irritation	Causes serious eye damage.
Respiratory or skin sensitization	
Respiratory sensitization	Not classified.
Skin sensitization	This product is not expected to cause skin sensitization.
Germ cell mutagenicity	No data available to indicate product or any components present at greater than 0.1% are mutagenic or genotoxic.
Carcinogenicity	This product is not considered to be a carcinogen by IARC, ACGIH, NTP, or OSHA.

IARC Monographs. Overall Evaluation of Carcinogenicity

Sodium hypochlorite (CAS 7681-52-9)	3 Not classifiable as to carcinogenicity to humans.

OSHA Specifically Regulated Substances (29 CFR 1910.1001-1050)

Not listed.

Reproductive toxicity	This product is not expected to cause reproductive or developmental effects.
Specific target organ toxicity - single exposure	Not classified.
Specific target organ toxicity - repeated exposure	Not classified.
Aspiration hazard	Not classified.
Chronic effects	Prolonged inhalation may be harmful.

12. Ecological information

Ecotoxicity

Components		Species	Test Results
Sodium chloride (CAS 7647-14-5)			
Aquatic			
Crustacea	LC50	Daphnia magna	874 mg/l, 48 hours

Components		Species	Test Results
Fish	LC50	Rainbow trout,donaldson trout (Oncorhynchus mykiss)	4747 - 7824 mg/l, 96 hours
Sodium hydroxide (CAS 1310-73-2)			
Aquatic			
Crustacea	EC50	Water flea (Ceriodaphnia dubia)	34.59 - 47.13 mg/l, 48 hours
Fish	LC50	Western mosquitofish (Gambusia affinis)	125 mg/l, 96 hours

Persistence and degradability	No data is available on the degradability of this product.
Bioaccumulative potential	No data available.
Mobility in soil	No data available.
Other adverse effects	No other adverse environmental effects (e.g. ozone depletion, photochemical ozone creation potential, endocrine disruption, global warming potential) are expected from this component.

13. Disposal considerations

Disposal instructions	Collect and reclaim or dispose in sealed containers at licensed waste disposal site. Do not allow this material to drain into sewers/water supplies. Do not contaminate ponds, waterways or ditches with chemical or used container. Dispose of contents/container in accordance with local/regional/national/international regulations.
Local disposal regulations	Dispose in accordance with all applicable regulations.
Hazardous waste code	D002: Waste Corrosive material [pH <=2 or =>12.5, or corrosive to steel] The waste code should be assigned in discussion between the user, the producer and the waste disposal company.
Waste from residues / unused products	Dispose of in accordance with local regulations.
Contaminated packaging	Empty containers should be taken to an approved waste handling site for recycling or disposal. Since emptied containers may retain product residue, follow label warnings even after container is emptied.

14. Transport information

DOT	
UN number	UN1791
UN proper shipping name	Hypochlorite solutions
Transport hazard class(es)	
Class	8
Subsidiary risk	-
Label(s)	8
Packing group	II
Environmental hazards	
Marine pollutant	Yes
Special precautions for user	Read safety instructions, SDS and emergency procedures before handling.
Special provisions	A7, B2, B15, IB2, IP5, N34, T7, TP2, TP24
Packaging exceptions	154
Packaging non bulk	202
Packaging bulk	242
IATA	
UN number	UN1791
UN proper shipping name	Hypochlorite solution
Transport hazard class(es)	
Class	8
Subsidiary risk	-
Packing group	II
Environmental hazards	Yes
ERG Code	8L
Special precautions for user	Read safety instructions, SDS and emergency procedures before handling.
IMDG	
UN number	UN1791

UN proper shipping name	HYPOCHLORITE SOLUTION
Transport hazard class(es)	
Class	8
Subsidiary risk	-
Label(s)	8
Packing group	II
Environmental hazards	
Marine pollutant	Yes
EmS	F-A, S-B
Special precautions for user	Read safety instructions, SDS and emergency procedures before handling.
Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code	This product is a liquid and when transported in bulk is covered under MARPOL 73/78 Annex II. This product is listed in the IBC Code. Ship type: 2 Pollution category: Y

15. Regulatory information

US federal regulations This product is a "Hazardous Chemical" as defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200.
All components are on the U.S. EPA TSCA Inventory List.

TSCA Section 12(b) Export Notification (40 CFR 707, Subpt. D)

Not regulated.

OSHA Specifically Regulated Substances (29 CFR 1910.1001-1050)

Not listed.

CERCLA Hazardous Substance List (40 CFR 302.4)

Sodium hydroxide (CAS 1310-73-2)	LISTED
Sodium hypochlorite (CAS 7681-52-9)	LISTED

Superfund Amendments and Reauthorization Act of 1986 (SARA)

Hazard categories Immediate Hazard - Yes
Delayed Hazard - Yes
Fire Hazard - No
Pressure Hazard - No
Reactivity Hazard - No

SARA 302 Extremely hazardous substance

Not listed.

SARA 311/312 Hazardous chemical Yes

SARA 313 (TRI reporting)

Not regulated.

Other federal regulations

Clean Air Act (CAA) Section 112 Hazardous Air Pollutants (HAPs) List

Not regulated.

Clean Air Act (CAA) Section 112(r) Accidental Release Prevention (40 CFR 68.130)

Not regulated.

Safe Drinking Water Act (SDWA) Not regulated.

US state regulations This chemical is a pesticide product registered by the Environmental Protection Agency and is subject to certain labeling requirements under federal pesticide law. These requirements differ from the classification criteria and hazard information required for safety data sheets, and for workplace labels of non-pesticide chemicals. Following is the hazard information as required on the pesticide label:

DANGER
Keep out of reach of children. Hazardous to Humans and domestic animals.
Corrosive, causes severe skin and eye irritation or chemical burns to broken skin.
Causes eye damage.
This pesticide is toxic to fish and aquatic organisms.
Strong oxidizing agent.

US. Massachusetts RTK - Substance List

Sodium hydroxide (CAS 1310-73-2)
Sodium hypochlorite (CAS 7681-52-9)

US. New Jersey Worker and Community Right-to-Know Act

Sodium hydroxide (CAS 1310-73-2)
Sodium hypochlorite (CAS 7681-52-9)

US. Pennsylvania Worker and Community Right-to-Know Law

Sodium hydroxide (CAS 1310-73-2)
Sodium hypochlorite (CAS 7681-52-9)

US. Rhode Island RTK

Sodium hydroxide (CAS 1310-73-2)
Sodium hypochlorite (CAS 7681-52-9)

US. California Proposition 65

California Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65): This material is not known to contain any chemicals currently listed as carcinogens or reproductive toxins.

International Inventories

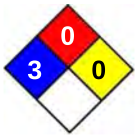
Country(s) or region	Inventory name	On inventory (yes/no)*
United States & Puerto Rico	Toxic Substances Control Act (TSCA) Inventory	Yes

*A "Yes" indicates this product complies with the inventory requirements administered by the governing country(s).
A "No" indicates that one or more components of the product are not listed or exempt from listing on the inventory administered by the governing country(s).

16. Other information, including date of preparation or last revision

Issue date	03-November-2014
Revision date	-
Version #	01

NFPA ratings



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SAFETY DATA SHEET

1. Identification

Product identifier	**Sulfuric acid 93%**
Other means of identification	Not available.
Recommended use	Sulfuric acid is an acid used in chemical industries, water treatment, fertilizer, pulp and paper applications.
Recommended restrictions	None known.

Manufacturer/Importer/Supplier/Distributor information

Company name	Carus Corporation
Address	315 5th Street Peru, Illinois 61354, USA
Telephone	(815) 223-1500
Toll Free	(800) 435-6856
Fax	(815) 224-6816
E-mail	salesmkt@caruscorporation.com
Website	www.caruscorporation.com
Company name	Alexander Chemical Corporation, a Carus Group Inc. Company
Address	7593 S. First Road, Kingsbury Industrial Park, Kingsbury, Indiana 46345, USA
Website	www.alexanderchemical.com
Company name	Sierra Chemical Co, a Carus Group Inc. Company
Address	2302 Larkin Circle Sparks, Nevada 89431, USA
Website	www.sierrachemsales.com
Contact person	Dr. Chithambarathanu Pillai
Telephone	(800) 348-8827 - All other non-emergency inquiries about the product should be directed to the company
Emergency telephone number	For Hazardous Materials [or Dangerous Goods] Incidents ONLY (spill, leak, fire, exposure or accident), call CHEMTREC at CHEMTREC®, USA: 001 (800) 424-9300 CHEMTREC®, Mexico (Toll-Free - must be dialed from within country): 001-800-13-203-9987 CHEMTREC®, Other countries: 001 (703) 527-388

2. Hazard(s) identification

Physical hazards	Corrosive to metals	Category 1
Health Hazards	Skin corrosion/irritation	Category 1A
	Serious eye damage/eye irritation	Category 1
OSHA defined hazards	Not classified.	

Label elements

Signal word	Danger
Hazard statement	May be corrosive to metals. Causes severe skin burns and eye damage.
Precautionary statement	
Prevention	Do not breathe mist or vapor. Wear protective gloves/protective clothing/eye protection/face protection. Wash thoroughly after handling. Keep only in original container.

Response	If swallowed: Rinse mouth. Do NOT induce vomiting. If on skin (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower. Wash contaminated clothing before reuse. If inhaled: Remove person to fresh air and keep comfortable for breathing. If in eyes: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Immediately call a poison center/doctor. Absorb spillage to prevent material damage.
Storage	Store locked up. Store in corrosive resistant container with a resistant inner liner.
Disposal	Dispose of contents/container in accordance with local/regional/national/international regulations.
Hazard(s) not otherwise classified (HNOC)	None known.

3. Composition/information on ingredients

Substances

Chemical name	Common name and synonyms	CAS number	%
Sulfuric acid		7664-93-9	93

Composition comments	All concentrations are in percent by weight unless ingredient is a gas. Gas concentrations are in percent by volume.

4. First-aid measures

Inhalation	Move injured person into fresh air and keep person calm under observation. Get medical attention if symptoms occur.
Skin contact	Immediately flush with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Get medical attention immediately. Chemical burns must be treated by a physician.
Eye contact	Immediately flush eyes with plenty of water for at least 15 minutes. Remove contact lenses, if present and easy to do. Hold eyelids apart. Continue rinsing. Get medical attention immediately.
Ingestion	Rinse mouth thoroughly with water and give large amounts of milk or water to people not unconscious. Do not induce vomiting. If vomiting occurs, the head should be kept low so that stomach vomit doesn't enter the lungs. Obtain medical attention and take along these instructions.
Most important symptoms/effects, acute and delayed	Corrosive. Prolonged contact causes serious eye and tissue damage. May cause burns in mucous membranes, throat, esophagus and stomach. Contact can cause corrosive burns, corneal damage, and blindness. Causes permanent skin damage (scarring). Causes respiratory tract burns. May cause lung edema.
Indication of immediate medical attention and special treatment needed	In case of shortness of breath, give oxygen. Keep victim warm. Keep victim under observation. Symptoms may be delayed.
General information	In the case of accident or if you feel unwell, seek medical advice immediately (show the label where possible). If the heart has stopped, trained personnel should begin cardiopulmonary resuscitation immediately. In case of shortness of breath, give oxygen. Ensure that medical personnel are aware of the material(s) involved, and take precautions to protect themselves. Wash contaminated clothing before reuse. Chemical burns: Flush with water immediately. While flushing, remove clothes which do not adhere to affected area. Call an ambulance. Continue flushing during transport to hospital.

5. Fire-fighting measures

Suitable extinguishing media	Use fire-extinguishing media appropriate for surrounding materials.
Unsuitable extinguishing media	Do not use water jet as an extinguisher, as this will spread the fire.
Specific hazards arising from the chemical	Fire may produce irritating, corrosive and/or toxic gases.
Special protective equipment and precautions for firefighters	Firefighters should wear full protective clothing including self contained breathing apparatus. Structural firefighters protective clothing will only provide limited protection.
Fire fighting equipment/instructions	Use standard firefighting procedures and consider the hazards of other involved materials. Use water spray to cool unopened containers. Cool containers with flooding quantities of water until well after fire is out. Prevent runoff from fire control or dilution from entering streams, sewers, or drinking water supply.
Specific methods	Use water spray to cool unopened containers.
General fire hazards	The product is non-combustible. Contact with certain metals liberates flammable gas. Contact with moisture or water may generate sufficient heat to ignite nearby combustible materials.

6. Accidental release measures

Personal precautions, protective equipment and emergency procedures	Keep unnecessary personnel away. Local authorities should be advised if significant spillages cannot be contained. Stay upwind. Keep out of low areas. Ensure adequate ventilation. Avoid contact with eyes, skin, and clothing. Avoid breathing mist or vapor. Use personal protection recommended in Section 8 of the SDS.
Methods and materials for containment and cleaning up	Should not be released into the environment. Large Spills: Dike far ahead of liquid spill for later disposal. Use a non-combustible material like vermiculite, sand or earth to soak up the product and place into a container for later disposal. Small Spills: Absorb spill with vermiculite or other inert material. Clean contaminated surface thoroughly. After removal flush contaminated area thoroughly with water. Never return spills in original containers for re-use.
Environmental precautions	Prevent further leakage or spillage if safe to do so. Do not contaminate water.

7. Handling and storage

Precautions for safe handling	Handle and open container with care. Use only with adequate ventilation. Avoid contact with skin, eyes and clothing. Avoid breathing mist or vapor. Wash thoroughly after handling. Observe good industrial hygiene practices.
Conditions for safe storage, including any incompatibilities	Keep in a well-ventilated place. Keep containers tightly closed in a dry, cool and well-ventilated place. Keep this material away from food, drink and animal feed. Use care in handling/storage. Transfer and storage systems should be compatible and corrosion resistant.

8. Exposure controls/personal protection

Occupational exposure limits

US. OSHA Table Z-1 Limits for Air Contaminants (29 CFR 1910.1000)

Components	Type	Value
Sulfuric acid (CAS 7664-93-9)	PEL	1 mg/m3

US. ACGIH Threshold Limit Values

Material	Type	Value
Sulfuric acid (25%-95%) (CAS Mixture)	Ceiling	2 mg/m3

Components	Type	Value	Form
Sulfuric acid (CAS 7664-93-9)	TWA	0.2 mg/m3	Thoracic fraction.

US. NIOSH: Pocket Guide to Chemical Hazards

Material	Type	Value
Sulfuric acid (25%-95%) (CAS Mixture)	TWA	2 mg/m3

Components	Type	Value
Sulfuric acid (CAS 7664-93-9)	TWA	1 mg/m3

Biological limit values	No biological exposure limits noted for the ingredient(s).
Appropriate engineering controls	Provide adequate ventilation. Observe Occupational Exposure Limits and minimize the risk of inhalation of vapors. Eye wash facilities and emergency shower must be available when handling this product.

Individual protection measures, such as personal protective equipment

Eye/face protection	Wear approved safety glasses or goggles.
Skin protection	
Hand protection	Wear protective gloves. Be aware that the liquid may penetrate the gloves. Frequent change is advisable. Suitable gloves can be recommended by the glove supplier.
Other	Wear appropriate chemical resistant clothing. Protective shoes or boots. Structural firefighters protective clothing provides limited protection in fire situations ONLY; it is not effective in spill situations. Wear chemical protective equipment that is specifically recommended by the Personal Protective Equipment manufacturer.

Respiratory protection	If engineering controls do not maintain airborne concentrations below recommended exposure limits (where applicable) or to an acceptable level (in countries where exposure limits have not been established), an approved respirator must be worn. Use a NIOSH/MSHA approved air purifying respirator as needed to control exposure. Consult with respirator manufacturer to determine respirator selection, use, and limitations. Use positive pressure, air-supplied respirator for uncontrolled releases or when air purifying respirator limitations may be exceeded. Follow respirator protection program requirements (OSHA 1910.134 and ANSI Z88.2) for all respirator use.
Thermal hazards	Wear appropriate thermal protective clothing, when necessary.
General hygiene considerations	When using, do not eat, drink or smoke. Wash hands before breaks and immediately after handling the product. Remove and isolate contaminated clothing and shoes. Handle in accordance with good industrial hygiene and safety practice. Launder contaminated clothing before reuse.

9. Physical and chemical properties

Appearance	Colorless solution.
Physical state	Liquid.
Form	Liquid.
Color	Colorless.
Odor	Odorless.
Odor threshold	Not available.
pH	Not available.
Melting point/freezing point	-21 - -10 °F (-29.44 - -23.33 °C)
Initial boiling point and boiling range	392 - 536 °F (200 - 280 °C)
Flash point	Not applicable.
Evaporation rate	Not applicable.
Flammability (solid, gas)	Not available.
Upper/lower flammability or explosive limits	
Flammability limit - lower (%)	Not applicable.
Flammability limit - upper (%)	Not applicable.
Vapor pressure	0 - 0.3 mm Hg at 100 °F / 38 °C
Vapor density	Not applicable.
Relative density	1.84 ± 0.03
Relative density temperature	77 °F (25 °C)
Solubility(ies)	
Solubility (water)	Completely soluble in water.
Partition coefficient (n-octanol/water)	No data available.
Auto-ignition temperature	Not available.
Decomposition temperature	Not available.
Viscosity	Not applicable.
Other information	
VOC (Weight %)	Not applicable.

10. Stability and reactivity

Reactivity	The product is non-reactive under normal conditions of use, storage and transport.
Chemical stability	Stable at normal conditions.
Possibility of hazardous reactions	Hazardous polymerization does not occur.
Conditions to avoid	Water, moisture.
Incompatible materials	Strong oxidizing agents. Reducing agents. Bases. Metals.
Hazardous decomposition products	Sulfur oxides.

11. Toxicological information

Information on likely routes of exposure

Inhalation	Causes severe respiratory tract irritation. High concentrations: May cause lung damage.
Skin contact	Causes severe skin burns.
Eye contact	Causes severe eye burns.
Ingestion	Causes digestive tract burns.
Symptoms related to the physical, chemical and toxicological characteristics	Corrosive. Prolonged contact causes serious eye and tissue damage. May cause burns in mucous membranes, throat, esophagus and stomach. Contact can cause corrosive burns, corneal damage, and blindness. Causes permanent skin damage (scarring). Causes respiratory tract burns. May cause lung edema.

Information on toxicological effects

Acute toxicity	Strongly corrosive.

Components	Species	Test Results
Sulfuric acid (CAS 7664-93-9)		
Acute		
Oral		
LD50	Rat	2140 mg/kg

Skin corrosion/irritation	Causes severe skin burns.
Serious eye damage/eye irritation	Causes severe eye damage.
Respiratory or skin sensitization	
Respiratory sensitization	No data available.
Skin sensitization	No data available.
Germ cell mutagenicity	No data available.
Carcinogenicity	Exposure to strong inorganic acid mists containing sulfuric acid has been classified as carcinogenic to humans.

OSHA Specifically Regulated Substances (29 CFR 1910.1001-1050)

Not listed.

Reproductive toxicity	Not expected to be a reproductive hazard.
Specific target organ toxicity - single exposure	No data available.
Specific target organ toxicity - repeated exposure	No data available.
Aspiration hazard	Not classified.
Chronic effects	May cause lung damage. Sulfuric acid fumes: Prolonged, repeated exposure to acid fumes/mists may cause chronic bronchitis, irritation of skin, mucous membranes and gastrointestinal tract and erosion of the teeth.

12. Ecological information

Ecotoxicity	The product is not classified as environmentally hazardous. However, this does not exclude the possibility that large or frequent spills can have a harmful or damaging effect on the environment.
Persistence and degradability	No data available.
Bioaccumulative potential	No data available.
Mobility in soil	The product is water soluble and may spread in water systems.
Other adverse effects	The product may affect the acidity (pH-factor) in water with risk of harmful effects to aquatic organisms.

13. Disposal considerations

Disposal instructions	Collect and reclaim or dispose in sealed containers at licensed waste disposal site. Do not allow this material to drain into sewers/water supplies. Dispose of contents/container in accordance with local/regional/national/international regulations. Dispose in accordance with all applicable regulations.
Hazardous waste code	D002: Waste Corrosive material [pH <=2 or =>12.5, or corrosive to steel] Waste codes should be assigned by the user based on the application for which the product was used.

Waste from residues / unused products	Dispose of in accordance with local regulations.
Contaminated packaging	Dispose of in accordance with local regulations. Since emptied containers may retain product residue, follow label warnings even after container is emptied.

14. Transport information

DOT

UN number	UN1830
UN proper shipping name	Sulfuric acid
Transport hazard class(es)	
Class	8
Subsidiary risk	-
Label(s)	8
Packing group	II
Special precautions for user	Read safety instructions, SDS and emergency procedures before handling.
Special provisions	A3, A7, B3, B83, B84, IB2, N34, T8, TP2, TP12
Packaging exceptions	154
Packaging non bulk	202
Packaging bulk	242

DOT BULK

BULK

UN number	UN1830
UN proper shipping name	Sulfuric acid
Transport hazard class(es)	
Class	8
Label(s)	8
Packing group	II
Special precautions for user	Read safety instructions, SDS and emergency procedures before handling.
Special provisions	A3, A7, B3, B83, B84, IB2, N34, T8, TP2, TP12
Packaging exceptions	154
Packaging non bulk	202
Packaging bulk	242

IATA

UN number	UN1830
UN proper shipping name	Sulphuric acid
Transport hazard class(es)	
Class	8
Subsidiary risk	-
Label(s) Packing	8
group Environmental	II
hazards ERG Code	No
	8L
Special precautions for user	Read safety instructions, SDS and emergency procedures before handling.

IMDG

UN number	UN1830
UN proper shipping name	SULPHURIC ACID
Transport hazard class(es)	
Class	8
Subsidiary risk	-
Label(s) Packing	8
group Environmental hazards	II
Marine pollutant	No
EmS	F-A, S-B
Special precautions for user	Read safety instructions, SDS and emergency procedures before handling.
Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code	This product is a liquid and when transported in bulk is covered under MARPOL 73/78 Annex II. This product is listed in the IBC Code. Ship type: 3 Pollution category: Y

15. Regulatory information

US federal regulations This product is a "Hazardous Chemical" as defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200.

TSCA Section 12(b) Export Notification (40 CFR 707, Subpt. D)

Not regulated.

OSHA Specifically Regulated Substances (29 CFR 1910.1001-1050)

Not listed.

CERCLA Hazardous Substance List (40 CFR 302.4)

Sulfuric acid (CAS 7664-93-9)	LISTED

Superfund Amendments and Reauthorization Act of 1986 (SARA)

Hazard categories

Immediate Hazard - Yes
Delayed Hazard - No
Fire Hazard - No
Pressure Hazard - No
Reactivity Hazard - No

SARA 302 Extremely hazardous substance

Chemical name	CAS number	Reportable quantity	Threshold planning quantity	Threshold planning quantity, lower value	Threshold planning quantity, upper value
Sulfuric acid	7664-93-9	1000	1000 lbs		

SARA 311/312 Hazardous chemical Yes

SARA 313 (TRI reporting)

Chemical name	CAS number	% by wt.
Sulfuric acid	7664-93-9	25-95

Other federal regulations

Clean Air Act (CAA) Section 112 Hazardous Air Pollutants (HAPs) List

Not regulated.

Clean Air Act (CAA) Section 112(r) Accidental Release Prevention (40 CFR 68.130)

Sulfuric acid (CAS 7664-93-9)

Clean Water Act (CWA) Section 112(r) (40 CFR 68.130) Hazardous substance

Safe Drinking Water Act (SDWA) Not regulated.

Drug Enforcement Administration (DEA). List 2, Essential Chemicals (21 CFR 1310.02(b) and 1310.04(f)(2) and Chemical Code Number

Sulfuric acid (CAS 7664-93-9)	6552

Drug Enforcement Administration (DEA). List 1 & 2 Exempt Chemical Mixtures (21 CFR 1310.12(c))

Sulfuric acid (CAS 7664-93-9)	20 %WV

DEA Exempt Chemical Mixtures Code Number

Sulfuric acid (CAS 7664-93-9)	6552

Food and Drug Administration (FDA)

Total food additive
Direct food additive
GRAS food additive

US state regulations WARNING: This product contains a chemical known to the State of California to cause cancer and birth defects or other reproductive harm.

US. Massachusetts RTK - Substance List

Sulfuric acid (CAS 7664-93-9)

US. New Jersey Worker and Community Right-to-Know Act

Sulfuric acid (CAS 7664-93-9)

US. Pennsylvania Worker and Community Right-to-Know Law

Sulfuric acid (CAS 7664-93-9)

US. Rhode Island RTK

Sulfuric acid (CAS 7664-93-9)

US. California Proposition 65

US - California Proposition 65 - Carcinogens & Reproductive Toxicity (CRT): Listed substance

Sulfuric acid (CAS 7664-93-9)

International Inventories

Country(s) or region	Inventory name	On inventory (yes/no)*
United States & Puerto Rico	Toxic Substances Control Act (TSCA) Inventory	Yes

*A "Yes" indicates this product complies with the inventory requirements administered by the governing country(s).
A "No" indicates that one or more components of the product are not listed or exempt from listing on the inventory administered by the governing country(s).

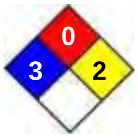
16. Other information, including date of preparation or last revision

Issue date 31-October-2014

Revision date -

Version # 01

NFPA ratings



References

Registry of Toxic Effects of Chemical Substances (RTECS)
GESTIS Substance Database
US. IARC Monographs on Occupational Exposures to Chemical Agents

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