STATE OF COLORADO

Eschberger - DNR, Amy <amy.eschberger@state.co.us>

TR application 8, for Cross Gold Mine (m1977-410)

rmittasch@nedmining.com <rmittasch@nedmining.com> Tue, Aug 25, 2020 at 3:36 PM
To: "Eschberger - DNR, Amy" <amy.eschberger@state.co.us>

Dear Ms. Eschberger:

The purpose of this TR is to provide a detailed plan for the rehab and replacement of the liners of Ponds 3A, 3B and 3C at the Caribou Mine,

as well as additional improvements to the Caribou water treatment system.
Please feel free to contact our Team or myself if there are any questions regarding this matter.

Yours truly,

Richard Mittasch

Calais Resources Colorado, Inc.

Grand Island Resources, LLC

VP of operations

(516) 582-0833

Rmittasch@nedmining.com

TR8 8-25-2020.pdf
5416K

COLORADO DIVISION OF RECLAMATION, MINING AND SAFETY
1313 Sherman Street, Room 215, Denver, Colorado 80203 ph(303) 866-3567

REQUEST FOR TECHNICAL REVISION (TR) COVER SHEET

File No.: M- 1977-410 Site Name: Cross Gold Mine

County Boulder TR# TR-8 *(DRMS Use only)*

Permittee: Calais Resources Colorado, Inc. - Grand Island Resources, LLC

Operator (If Other than Permittee): Nederland Mining Consultants,Inc.

Permittee Representative: Richard Mittasch

Please provide a brief description of the proposed revision:

The purpose of this TR is to provide a detailed plan for the rehab and replacement of the liners of Ponds 3A, 3B and 3C at the Caribou Mine as well as additional improvements to the Caribou water treatment system.

As defined by the Minerals Rules, a Technical Revision (TR) is: "a change in the permit or application which does not have more than a minor effect upon the approved or proposed Reclamation or Environmental Protection Plan." The Division is charged with determining if the revision as submitted meets this definition. If the Division determines that the proposed revision is beyond the scope of a TR, the Division may require the submittal of a permit amendment to make the required or desired changes to the permit.

The request for a TR is not considered "filed for review" until the appropriate fee is received by the Division (as listed below by permit type). Please submit the appropriate fee with your request to expedite the review process. After the TR is submitted with the appropriate fee, the Division will determine if it is approvable within 30 days. If the Division requires additional information to approve a TR, you will be notified of specific deficiencies that will need to be addressed. If at the end of the 30 day review period there are still outstanding deficiencies, the Division must deny the TR unless the permittee requests additional time, in writing, to provide the required information.

There is no pre-defined format for the submittal of a TR; however, it is up to the permittee to provide sufficient information to the Division to approve the TR request, including updated mining and reclamation plan maps that accurately depict the changes proposed in the requested TR.

Required Fees for Technical Revision by Permit Type - Please mark the correct fee and submit it with your request for a Technical Revision.

Permit Type	**Required TR Fee**	**Submitted** (mark only one)
110c, 111, 112 construction materials, and 112 quarries	$216	☑
112 hard rock (not DMO)	$175	☐
110d, 112d(1, 2 or 3)	$1006	☐

Cross Mine (M1977-410)
Technical Revision No. 8

Submitted by:

Calais Resources Colorado, Inc.

Prepared for:

Colorado Division of Reclamation, Mining and Safety

August 25, 2020

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Attachment 7 – pH, Water Temperature and TDS monitor and display

1. *INTRODUCTION*

This Technical Revision (TR) addresses deficiencies in the Caribou pond water treatment system. Ponds 3A, 3B and 3C have not been used in water treatment for over 34 years and in that time they have deteriorated greatly. Treatment through the ponds is not currently necessary due to the incredibly clean water coming from Caribou (see historical and current lab results). However, when rehab work begins on the Idaho Tunnel (TR5 and TR7), the disturbances created during the excavation and construction will require all 3 ponds to be operational. Water is currently piped directly to Pond #2 where it joins The Cross Mine water before being discharged to Coon Track Creek.

As of the time of this TR, Calais Resources Colorado, Inc. on April 23, 2020 has submitted an 'Application form for Transfer of Mineral Permit and Succession of Operators', to Grand Island Resources, LLC. (GIR) who is currently the owner of all the mining claims at the Cross Mine with Permit No. M-1977-410. Both Grand Island Resources, LLC., and Calais Resources Colorado, Inc are subsidiaries of Calais Resources, Inc.

2. *BACKGROUND AND MINE WATER CHARACTERISTICS*

The Cross Mine site is located approximately 3 miles west of Nederland, Colorado adjacent to the Roosevelt National Forest, at an elevation of 9700 feet above mean sea level (MSL). The general location is parcels of land in Section 9, Township 1 South, Range 73 West of the 6 Principal Meridian, County of Boulder, State of Colorado, as shown on Map 1. This is an existing hard rock mining operation owned by Grand Island Resources Inc. (GIR), although at present, no active mining is being conducted. The entire permit area is on various properties either owned outright by GIR or granted through various lease agreements.

The mine permit M-1977-410 was last revised through Amendment No. 1 (AM-1), approved in 2012. AM-1 increased the permit area from 2 acres to the current 9.35 acres, provided for surface waste rock disposal resulting from construction of the Cross Mine Decline portal, and construction of a new office/dry facility and a new sewer line and leach field.

The mine is currently in exploration and development stage but will ultimately operate throughout the year, producing ore of various metals to include gold, silver, lead and zinc.

As indicated on Map 1, the site is bisected by Coon Track Creek, a tributary of Beaver Creek which flows into Middle Boulder Creek before delivering water to Barker Reservoir. The mine currently manages discharges directly into Coon Track Creek below Pond 2 under Colorado Department of Public Health and Environment (CDPHE) Water Quality Control Division (WQCD) National Pollutant Discharge Elimination System NPDES) Permit CO- 0032751, as shown on Figure 1 – Water System Map.

Discharge from the Cross Mine reports directly to Pond #1 via pipeline (Figure 1). This water requires daily addition of lime (5 – 15 lbs. daily) to meet discharge standards for the NPDES permit maintained through CDPHE. From Pond #1 the water is directed via pipeline to the larger Pond #2, at a rate of approximately 2-54 gpm. Discharge from the Idaho Tunnel does not require treatment to meet the effluent standards for the NPDES permit and is sent directly to Pond #2, at a rate of approximately 30-35 gpm. The combined water in Pond #2 discharges to Coon Track Creek where it is sampled bi-monthly at the discharge point and reported to CDPHE in accordance with the NPDES permit.

In accordance with the mining permit (DRMS file No. M1977-410, approved April 9, 2012), mine water was conveyed from the Idaho Tunnel by means of an 8-in diameter Schedule 40 PVC pipe and discharged into a series of sediment ponds (Figure 1). Historical monitoring indicates a typical flow range of 10 to 2,500 gallons per day during the winter, and peak of 150,000 gallons per day (104 gpm) during early summer runoff.

During rehabilitation of the remaining portions of the Idaho Tunnel, water discharged from the tunnel will be collected at the portal and routed to the sediment ponds 3A, 3B and 3C per the existing water management system. However, the three ponds require new liners to have affective treatment

3. *PURPOSE*

The purpose of this TR is to provide a detailed plan for the rehab and replacement of the liners of Ponds 3A, 3B and 3C at the Caribou Mine as well as additional improvements to the Caribou water treatment system.

4. *CURRENT CONDITION OF PONDS AND LINERS*

Since the collapse of the Idaho Tunnel in 1986, the Caribou mine has been inactive, rendering the settling ponds previously used for treatment unnecessary. Since that time, they have been neglected and many bushes and shrubs have grown through the liner causing irreparable damage. The liners used on these ponds were not good quality to begin with. They are made of a very thin (25 mil) material that cannot be patched or repaired.


Bushes penetrating liner causing large unrepairable holes.

5. ***REPAIR/REPLACE PLAN***

Ponds 3A and 3B are intact enough and will be left in place to provide future root control. Wherever bushes penetrated the liner, we have cut out the root system and destroyed them as much as possible. We will then patch the hole with a liner repair kit to help prevent future growth.

Pond 3C's liner is much larger and has sustained much more damage and is no longer repairable. It will be removed completely. During the process of removing the liner we will excavate earth to increase the size of pond 3. For the future treatment of Caribou water, especially during the Idaho Tunnel rehab, the additional volume of Pond 3C and the increased residence time will be vital to our treatment success.

GIR has received a quote from Western Environmental Liner for three separate custom cut liners to replace the existing damaged materials. The details of the replacement liners are listed below:

•	Pond 3A	32' x 54'	$725.76
•	Pond 3B	36' x 54'	$816.48
•	Pond 3C	122' x 126'	$6,456.24

The liners to be used are of a high quality and used in applications such as ours throughout the industry. A data sheet with specifications is provided (Attachment 1).

6. *SLUDGE CHARACTERISTICS AND REMOVAL PLAN*

There is a small amount of sludge settled in the bottom of Ponds 3B and 3C that was leftover from treatment 34 years ago. We will remove this sludge, using heavy equipment as well as shovels, squeegees, and any other tool necessary. The material will be stored in "Super Sacks" at our dump site until further direction from DRMS/CDPHE on proper disposal. Multiple samples have been tested through Colorado Analytical for their metals concentration as well as toxicity. Those results are provided for review and recommendation on disposal (Attachment 2). Also provided are the current *Heavy Metal Soil Contamination* guidelines provided by the United States Department of Agriculture (USDA) and National Resources Conservation Service (NRCS) (Attachment 3). Please note that our metals concentration for every item listed is well below the Maximum Concentration in Sludge (measured in mg/kg or ppm).

7. *BENEFITS TO UPGRADING LINERS*

By replacing all three liners instead of repairing them, we ensure that there is no exfiltration of any untreated mine water. The biggest overall benefit to the project is the increased volume and residence time of pond 3C.

Old 3C Pond Dimensions

- 60' x 40' x 5' 90,000 gal

New 3C Pond Dimensions

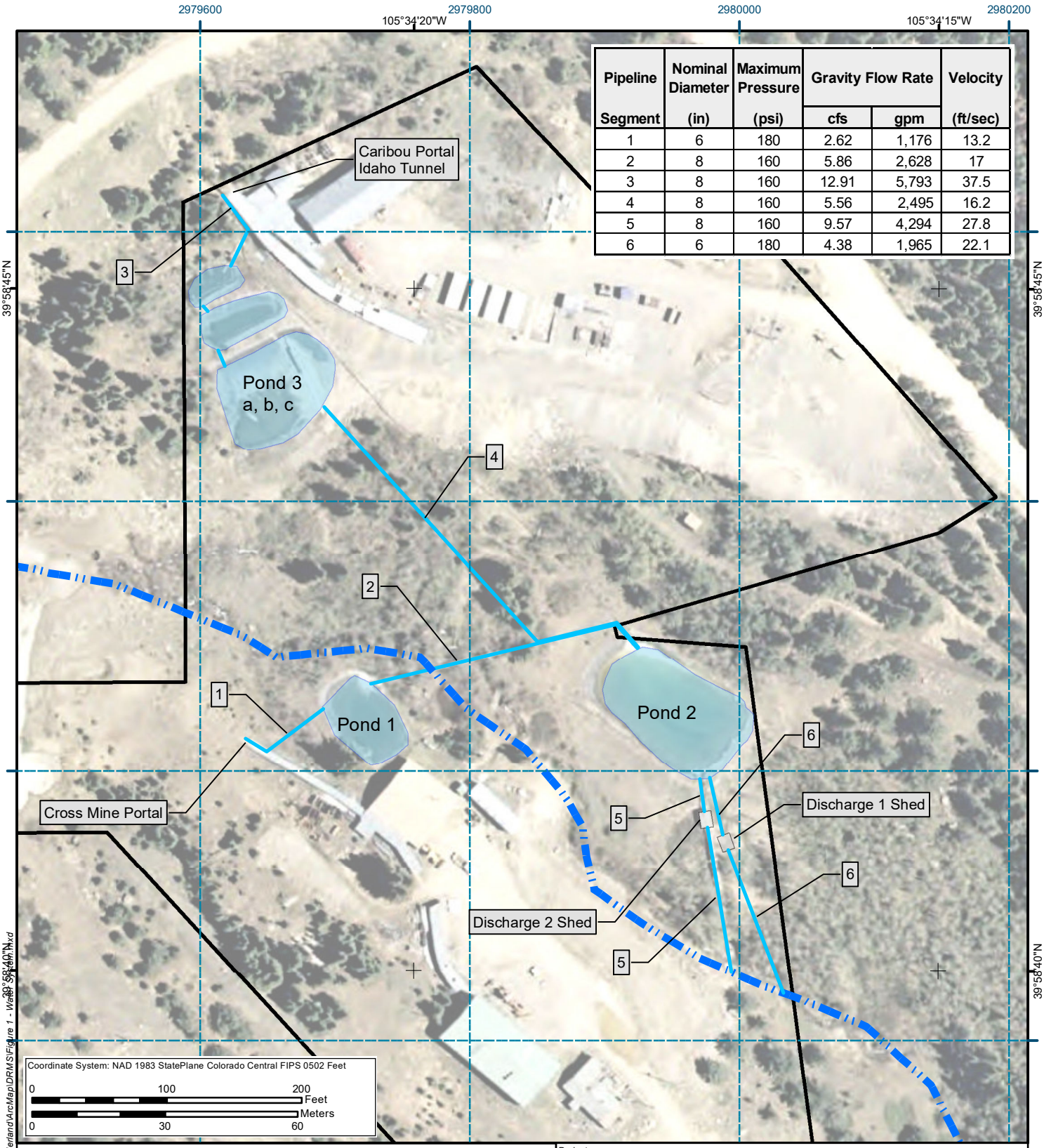
- 104' x 94' x 15' 1,163,250 gal

This increased volume and residence time will greatly increase our ability to filter minerals and metals from the mine water.

8. *LIME FEED AND CONTROL BUILDING*

Addition of a shed that will house the following:

- Bluelab automatic lime feeder for pH adjustment (Attachment 4)
- Flowmeter (Attachment 5)
- Two 8" butterfly valves to direct flows to settling ponds or direct to discharge pond #2 (Attachment 6)
- pH, water temperature and TDS monitor and display (Attachment 7)
- Data logging equipment



Pipeline Segment	Nominal Diameter (in)	Maximum Pressure (psi)	Gravity Flow Rate cfs	Gravity Flow Rate gpm	Velocity (ft/sec)
1	6	180	2.62	1,176	13.2
2	8	160	5.86	2,628	17
3	8	160	12.91	5,793	37.5
4	8	160	5.56	2,495	16.2
5	8	160	9.57	4,294	27.8
6	6	180	4.38	1,965	22.1

Legend

- SWMP Boundary
- Coon Track Creek
- Waterline
- Pond
- Discharge Shed

Project: Cross-Caribou Mine Technical Revision No. 2

Title: **Water Management System**

GRAND ISLAND RESOURCES

Project No. US 0401			File No.	
GIS:	JST	04/13/20	Scale As Shown	Rev 0
Check:	JST	04/13/20	**Figure 1**	
Review:	JST	04/13/20		

Path: C:\Users\jst52\Documents\NMXG\S\Projects\Wedeland\ArcMap\DRMS\Figure 1 - Water System.mxd

Attachment 1

Western AG
Enterprises, Inc.
Western Environmental Liner

Aqua 40 Coextruded
40 Mil Reinforced Polyethylene

DATA SHEET

Heavyweight fabric incorporating a special weave pattern to enhance thickness, flatness, and tear properties. This product is a combination of polyethylene reinforcement and co-extrusion which enhances UV Resistance and improves physical properties. For use in geomembrane applications such as soil remediation, lagoon lining, pond lining, canal lining, landfill covers, tank lining, etc.

FABRIC SPECIFICATIONS

WEAVE	Woven black HDPE scrim
COATING	Top side – 17.5 mil LLDPE/LDPE w/ special blend Bottom side - 5 mil LDPE
COLOR	Black/Black
WEIGHT	20.8 oz/yd^2 (705 g/m^2) +/- 5%
THICKNESS	Nominal 40 mil (1.0 mm) +/- 10% ASTM D1777

GRAB TENSILE	Warp 418lb 1859 N	Weft 385 lb 1712 N	ASTM D7-7004
TOUNGE TEAR	Warp 55 lb 244 N	Weft 55 lb 244 N	ASTM D5884-01
TRAPEZOIDAL TEAR	Warp 80 lb 355 N	Weft 66 lb 293 N	ASTM D4533-04
MULLEN BURST	800 psi 5517 kPa		ASTM D751
HYDROSTATIC RESISTANCE	769 psi 5302 kPa		ASTM D751-00
PERMEABILITY	2.06 x 10^{-12} cm/sec		ASTM D4491-99a
PUNCTURE RESISTANCE INDEX	243 lb 1076 N		ASTM D4833-02
DIMENSIONAL STABILITY	2.86%		ASTM D1204
UV RESISTANCE	> 90% strength & elongation retained after 10,000 light hours		ASTM D7003
LOW TEMPERATURE BRITTLENESS	Pass (@ -60°F) / (@ -51° C		ASTM D2136

These values are typical data and are not intended as limiting specifications.

Attachment 2

Colorado Analytical LABORATORIES, INC.

Analytical Results

TASK NO: 200707016

Report To: Daniel Pollock
Company: Grand Island Resources LLC
PO Box 3395
Nederland CO 80466

Bill To: Daniel Pollock
Company: Grand Island Resources LLC
PO Box 3395
Nederland CO 80466

Task No.: 200707016
Client PO:
Client Project:

Date Received: 7/7/20
Date Reported: 7/17/20
Matrix: Sludge

Customer Sample ID Pond 2 & Pond 3 Sludge
Sample Date/Time: 7/6/20 2:30 PM
Lab Number: 200707016-01

Test	Result	Method	PQL	Date Analyzed	Analyzed By
pH	7.15 units	SM 4500-H-B	0.01	7/7/20	MBN
Total Solids	69.746 %	SM 2540-G	0.001	7/8/20	MBN
Volatile Solids	3.56 %	SM 2540-G	0.01	7/8/20	MBN
Dry Matter Basis					
Ammonia Nitrogen	0.006 %	SM 4500-NH3-C	0.001	7/9/20	MBN
Nitrate Nitrogen	< 0.0001 %	EPA 300.0	0.0001	7/10/20	MAT
Nitrite Nitrogen	< 0.0001 %	EPA 300.0	0.0001	7/10/20	MAT
Organic Nitrogen	0.086 %	Calculation	0.001	7/16/20	SAN
Total Kjeldahl Nitrogen	0.092 %	SM 4500-Norg-B	0.001	7/10/20	MBN
Phosphorus - Total	0.084 %	SM 4500-P C	0.001	7/9/20	PJL
Potassium Total	0.172 %	SW-846 6010	0.001	7/9/20	MBN
Arsenic Total	4.6 mg/kg	SW-846 6020	0.1	7/11/20	IPC
Cadmium Total	1.50 mg/kg	SW-846 6020	0.01	7/11/20	IPC
Chromium Total	8.7 mg/kg	SW-846 6020	0.1	7/11/20	IPC
Copper Total	43.1 mg/kg	SW-846 6020	0.1	7/11/20	IPC
Lead Total	253.8 mg/kg	SW-846 6020	0.1	7/11/20	IPC
Mercury Total	0.46 mg/kg	SW-846 7471	0.02	7/13/20	JTF
Molybdenum Total	1.1 mg/kg	SW-846 6020	0.1	7/11/20	IPC
Nickel Total	6.4 mg/kg	SW-846 6020	0.1	7/11/20	IPC
Selenium Total	0.8 mg/kg	SW-846 6020	0.1	7/11/20	IPC
Zinc Total	361.9 mg/kg	SW-846 6020	0.1	7/11/20	IPC

Abbreviations/ References:

PQL = Practical Quantification Limit
mg/L = Milligrams Per Liter or PPM
ug/L = Micrograms Per Liter or PPB
mpn/100 mls = Most Probable Number Index/ 100 mls
Date Analyzed = Date Test Completed

DATA APPROVED FOR RELEASE BY

[redacted]

Chain of Custody Form

Colorado Analytical Laboratories, Inc.

Commerce City Lab
10411 Heinz Way
Commerce City CO 80640

Lakewood Service Center
12860 W. Cedar Dr, 100A
Lakewood CO 80228

Phone: 303-659-2313

www.coloradolab.com

Report To Information	Bill To Information (If different from report to)	Project Name / Number
Company Name: GRAND ISCANO RESOURCES	Company Name: ____	____
Contact Name: DANIEL POLLOCK	Contact Name: ____	____
Address: P.O. BOX 3395	Address: SAME	Task Number (Lab Use Only)
City: NEDERLAND State: CO Zip: 80466	City State Zip	CAL Task 200707016
Phone: 720.207.5154	Phone:	
Email: DPOLLOCK@NEDMINING.COM	Email:	ARF
Sample Collector: DANIEL POLLOCK		
Sample Collector Phone: 720.207.5154	PO No.:	

Sample Matrix (Select One Only)

Waste Water ☐ Soil ☐ Drinking Water ☐
Ground Water ☐ Sludge ☑
Surface Water ☐

Tests Requested

Date	Time	Sample ID	No. of Containers	Grab or (Check One Only) Composite	503
7/6/20	2:30p	POND 2 & POND 3 SLUDGE	1	☐ ☑	☑
				☐ ☐	☐
				☐ ☐	☐
				☐ ☐	☐
				☐ ☐	☐
				☐ ☐	☐
				☐ ☐	☐
				☐ ☐	☐
				☐ ☐	☐
				☐ ☐	☐
			1	☐ ☐	☐

Instructions:

C/S Info:
Deliver Via: UPS
C/S Charge ☐

Seals Present Yes ☐ No ☒
Temp. 10.8 °C/Ice N
Sample Pres. Yes ☐ No ☒

Relinquished By:	Date/Time:	Received By:	Date/Time:	Relinquished By:	Date/Time:	Received By:	Date/Time:
DUP	7/7/20	[redacted]					

Attachment 3

Heavy Metal Soil Contamination

USDA NRCS

United States Department of Agriculture

Natural Resources Conservation Service

Soil Quality Institute
411 S. Donahue Dr.
Auburn, AL 36832
334-844-4741
X-177
Urban Technical Note No. 3

September, 2000

This is the third note in a series of Soil Quality-Urban technical notes on the effects of land management on soil quality.

Introduction

Soil is a crucial component of rural and urban environments, and in both places land management is the key to soil quality. This series of technical notes examines the urban activities that cause soil degradation, and the management practices that protect the functions urban societies demand from soil. This technical note focuses on heavy metal soil contamination.

Metals in Soil

Mining, manufacturing, and the use of synthetic products (e.g. pesticides, paints, batteries, industrial waste, and land application of industrial or domestic sludge) can result in heavy metal contamination of urban and agricultural soils. Heavy metals also occur naturally, but rarely at toxic levels. Potentially contaminated soils may occur at old landfill sites (particularly those that accepted industrial wastes), old orchards that used insecticides containing arsenic as an active ingredient, fields that had past applications of waste water or municipal sludge, areas in or around mining waste piles and tailings, industrial areas where chemicals may have been dumped on the ground, or in areas downwind from industrial sites.

Excess heavy metal accumulation in soils is toxic to humans and other animals. Exposure to heavy metals is normally chronic (exposure over a longer period of time), due to food chain transfer. Acute (immediate) poisoning from heavy metals is rare through ingestion or dermal contact, but is possible. Chronic problems associated with long-term heavy metal exposures are:

- Lead – mental lapse.
- Cadmium – affects kidney, liver, and GI tract.
- Arsenic – skin poisoning, affects kidneys and central nervous system.

The most common problem causing *cationic* metals (metallic elements whose forms in soil are positively charged cations e.g., Pb^{2+}) are mercury, cadmium, lead, nickel, copper, zinc, chromium, and manganese. The most common anionic compounds (elements whose forms in soil are combined with oxygen and are negatively charged e.g., MoO_4^{2-}) are arsenic, molybdenum, selenium, and boron.

Prevention of Heavy Metal Contamination

Preventing heavy metal pollution is critical because cleaning contaminated soils is extremely expensive and difficult. Applicators of industrial waste or sludge must abide by the regulatory limits set by the U.S. Environmental Protection Agency (EPA) in Table 1.

Table 1. Regulatory limits on heavy metals applied to soils (Adapted from U.S. EPA, 1993).

Heavy metal	Maximum concentration in sludge (mg/kg or ppm)	Annual pollutant loading rates		Cumulative pollutant loading rates	
		(kg/ha/yr)	(lb/A/yr)	(kg/ha)	(lb/A)
Arsenic	75	2	1.8	41	36.6
Cadmium	85	1.9	1.7	39	34.8
Chromium	3000	150	134	3000	2,679
Copper	4300	75	67	1500	1,340
Lead	420	21	14	420	375
Mercury	840	15	13.4	300	268
Molybdenum	57	0.85	0.80	17	15
Nickel	75	0.90	0.80	18	16
Selenium	100	5	4	100	89
Zinc	7500	140	125	2800	2500

Prevention is the best method to protect the environment from contamination by heavy metals. With the above table, a simple equation is used to show the maximum amount of sludge that can be applied. For example, suppose city officials want to apply the maximum amount of sludge (kg/ha) on some agricultural land. The annual pollutant-loading rate for zinc is 140 kg/ha/yr (from Table 1). The lab analysis of the sludge shows a zinc concentration of 7500 mg/kg (mg/kg is the same as parts per million). How much can the applicator apply (tons/A) without exceeding the 140 kg/ha/yr?

Solution:

(1) Convert mg to kg (1,000,000 mg = 1kg) so all units are the same:
7500 mg X (1 kg/1,000,000 mg) = 0.0075 kg

(2) Divide the amount of zinc that can be applied by the concentration of zinc in the sludge:
(140 kg Zn/ha) / (0.0075 kg Zn/kg sludge) =18,667 kg sludge/ha

(3) Convert to lb/A: 18,667 kg/ha X 0.893 = 16,669 lbs/A
Convert lbs to tons: 16,669 lb/A / 2,000 lb/T = 8.3 T sludge per acre

Traditional Remediation of Contaminated Soil

Once metals are introduced and contaminate the environment, they will remain. Metals do not degrade like carbon-based (organic) molecules. The only exceptions are mercury and selenium, which can be transformed and volatilized by microorganisms. However, in general it is very difficult to eliminate metals from the environment.

Traditional treatments for metal contamination in soils are expensive and cost prohibitive when large areas of soil are contaminated. Treatments can be done *in situ* (on-site), or *ex situ* (removed and treated off-site). Both are extremely expensive. Some treatments that are available include:

1. High temperature treatments (produce a vitrified, granular, non-leachable material).
2. Solidifying agents (produce cement-like material).
3. Washing process (leaches out contaminants).

Management of Contaminated Soil

Soil and crop management methods can help prevent uptake of pollutants by plants, leaving them in the soil. The soil becomes the sink, breaking the soil-plant-animal or human cycle through which the toxin exerts its toxic effects (Brady and Weil, 1999).

The following management practices will not remove the heavy metal contaminants, but will help to immobilize them in the soil and reduce the potential for adverse effects from the metals – Note that the kind of metal (cation or anion) must be considered:

1. Increasing the soil pH to 6.5 or higher.

   Cationic metals are more soluble at lower pH levels, so increasing the pH makes them less available to plants and therefore less likely to be incorporated in their tissues and ingested by humans. Raising pH has the opposite effect on anionic elements.

2. Draining wet soils.

   Drainage improves soil aeration and will allow metals to oxidize, making them less soluble. Therefore when aerated, these metals are less available. The opposite is true for chromium, which is more available in oxidized forms. Active organic matter is effective in reducing the availability of chromium.

3. Applying phosphate.

   Heavy phosphate applications reduce the availability of cationic metals, but have the opposite effect on anionic compounds like arsenic. Care should be taken with phosphorus applications because high levels of phosphorus in the soil can result in water pollution.

4. Carefully selecting plants for use on metal-contaminated soils

   Plants translocate larger quantities of metals to their leaves than to their fruits or seeds. The greatest risk of food chain contamination is in leafy vegetables like lettuce or spinach. Another hazard is forage eaten by livestock.

Plants for Environmental Cleanup

Research has demonstrated that plants are effective in cleaning up contaminated soil (Wenzel et al., 1999). Phytoremediation is a general term for using plants to remove, degrade, or contain soil pollutants such as heavy metals, pesticides, solvents, crude oil, polyaromatic hydrocarbons, and landfill leacheates For example, prairie grasses can stimulate breakdown of petroleum products. Wildflowers were recently used to degrade hydrocarbons from an oil spill in Kuwait. Hybrid poplars can remove ammunition compounds such as TNT as well as high nitrates and pesticides (Brady and Weil, 1999).

Plants for Treating Metal Contaminated Soils

Plants have been used to stabilize or remove metals from soil and water. The three mechanisms used are *phytoextraction*, *rhizofiltration*, and *phytostabilization*. This technical note will define rhizofiltration and phytostabilization but will focus on phytoextraction.

Rhizofiltration is the adsorption onto plant roots or absorption into plant roots of contaminants that are in solution surrounding the root zone (rhizosphere). Rhizofiltration is used to decontaminate groundwater. Plants are grown in greenhouses in water instead of soil. Contaminated water from the site is used to acclimate the plants to the environment. The plants are then planted on the site of contaminated ground water where the roots take up the water and contaminants. Once the roots are saturated with the contaminant, the plants are harvested including the roots. In Chernobyl, Ukraine, sunflowers were used in this way to remove radioactive contaminants from groundwater (EPA, 1998).

Phytostabilization is the use of perennial, non-harvested plants to stabilize or immobilize contaminants in the soil and groundwater. Metals are absorbed and accumulated by roots, adsorbed onto roots, or precipitated within the rhizosphere. Metal-tolerant plants can be used to restore vegetation where natural vegetation is lacking, thus reducing the risk of water and wind erosion and leaching. Phytostabilization reduces the mobility of the contaminant and prevents further movement of the contaminant into groundwater or the air and reduces the bioavailability for entry into the food chain.

Phytoextraction

Phytoextraction is the process of growing plants in metal contaminated soil . Plant roots then translocate the metals into aboveground portions of the plant. After plants have grown for some time, they are harvested and incinerated or composted to recycle the metals. Several crop growth cycles may be needed to decrease

contaminant levels to allowable limits. If the plants are incinerated, the ash must be disposed of in a hazardous waste landfill, but the volume of the ash is much smaller than the volume of contaminated soil if dug out and removed for treatment. (See box.)

Example of Disposal

Excavating and landfilling a 10-acre contaminated site to a depth of 1 foot requires handling roughly 20,000 tons of soil. Phytoextraction of the same site would result in the need to handle about 500 tons of biomass, which is about 1/40 of the mass of the contaminated soil. In this example, if we assume the soil was contaminated with a lead concentration of 400 ppm, six to eight crops would be needed, growing four crops per season (Phytotech, 2000).

Phytoextraction is done with plants called hyperaccumulators, which absorb unusually large amounts of metals in comparison to other plants. Hyperaccumulators contain more than 1,000 milligrams per kilogram of cobalt, copper, chromium, lead, or nickel; or 10,000 milligrams per kilogram (1 %) of manganese or zinc in dry matter (Baker and Brooks, 1989). One or more of these plant types are planted at a particular site based on the kinds of metals present and site conditions. Tables 2 and 3 demonstrate the importance of using hyperaccumulators.

Table 2. Percentage decrease in water-extractable zinc and cadmium in three soils after growth of Alpine pennycress (*Thlaspi caerulescens)* (McGrath, 1998).

Site Sampled	Zn	Cd
Farm	28	10
Garden	17	22
Mountain	64	70

Table 3. Removal of zinc in a hypothetical 4.5 T/A (dry matter) crop growing in soil contaminated with 1000 (ppm) zinc with a target of 50 ppm, showing the importance of hyperaccumulation (>10,000 ppm zinc) (McGrath, 1998).

ppm Zn in plant	Lbs. of Zn removed	% of soil total in one crop	years to target
100	0.9	0.04	2470.0
1000	9	0.38	247.0
10,000	90	3.85	24.7
20,000	179	7.69	12.4
30,000	268	11.54	8.2

Phytoextraction is easiest with metals such as nickel, zinc, and copper because these metals are preferred by a majority of the 400 hyperaccumlator plants. Several plants in the genus *Thlaspi* (pennycress) have been known to take up more than 30,000 ppm (3%)of zinc in their tissues. These plants can be used as ore because of the high metal concentration (Brady and Weil, 1999).

Of all the metals, lead is the most common soil contaminant (EPA, 1993). Unfortunately, plants do not accumulate lead under natural conditions. A chelator such as EDTA (ethylenediaminetetraacetic acid) has to be added to the soil as an amendment. The EDTA makes the lead available to the plant. The most common plant used for lead extraction is Indian mustard (*Brassisa juncea*). Phytotech (a private research company) has reported that they have cleaned up lead-contaminated sites in New Jersey to below the industrial standards in 1 to 2 summers using Indian mustard (Wantanabe, 1997).

Plants are available to remove zinc, cadmium, lead, selenium, and nickel from soils at rates that are medium to long-term, but rapid enough to be useful. Many of the plants that hyperaccumulate metals produce low biomass, and need to be bred for much higher biomass production.

Current genetic engineering efforts at USDA in Beltsville, MD, are aimed toward developing pennycress (*Thlaspi*) that is extremely zinc tolerant. These taller-than-normal plants would have more biomass, thereby taking up larger quantities of contaminating metals (Watanabe, 1997).

Traditional cleanup *in situ* may cost between $10.00 and $100.00 per cubic meter ($m^3$), whereas removal of contaminated material (*ex situ*) may cost as high $30.00 to $300/ m^3. In comparison, phytoremediation may only cost $0.05/ m^3 (Watanabe, 1997).

Future Prospects

Phytoremediation has been studied extensively in research and small-scale demonstrations, but in only a few full-scale applications. Phytoremediation is moving into the realm of commercialization (Watanabe, 1997). It is predicted that the phytoremediation market will reach $214 to $370 million by the year 2005 (Environmental Science & Technology, 1998).

Given the current effectiveness, phytoremediation is best suited for cleanup over a wide area in which contaminants are present at low to medium concentrations. Before phytoremediation is fully commercialized, further research is needed to assure that tissues of plants used for phytoremediation do not have adverse environmental effects if eaten by wildlife or used by humans for things such as mulch or firewood (EPA, 1998). Research is also needed to find more efficient bioaccumulators, hyperaccumulators that produce more biomass, and to further monitor current field trials to ensure a thorough understanding. There is the need for a commercialized smelting method to extract the metals from plant biomass so they can be recycled.

Phytoremediation is slower than traditional methods of removing heavy metals from soil but much less costly. Prevention of soil contamination is far less expensive than any kind of remediation and much better for the environment.

References

Baker, A.J.M., and R.R. Brooks. 1989. Terrestrial plants which hyperaccumulate metallic elements – a review of their distribution, ecology, and phytochemistry. Biorecovery 1:81:126.

Brady, N.C., and R.R. Weil. 1999. The nature and properties of soils. 12th ed. Prentice Hall. Upper Saddle River, NJ.

Environmental Science & Technology. 1998. Phytoremediation; forecasting. Environmental Science & Technology. Vol. 32, issue 17, p.399A.

McGrath, S.P. 1998. Phytoextraction for soil remediation. p. 261-287. *In* R. Brooks (ed.) Plants that hyperaccumulate heavy metals their role in phytoremediation, microbiology, archaeology, mineral exploration and phytomining. CAB International, New York, NY.

Phytotech. 2000. Phytoremediation technology. http://clu-in.org/PRODUCTS/SITE/ongoing/demoong/phytotec.htm

U.S. EPA. 1993. Clean Water Act, sec. 503, vol. 58, no. 32. (U.S. Environmental Protection Agency Washington, D.C.).

U.S. EPA. 1998. A citizen's guide to phytoremediation. http://clu-in.org/PRODUCTS/CITGUIDE/Phyto2.htm

Watanabe, M.E. 1997. Phytoremediation on the brink of commercialization. Environmental Science & Technology/News. 31:182-186.

Wenzel, W.W., Adriano, D.C., Salt, D., and Smith, R. 1999. Phytoremediation: A plant-microbe based remediation system. p. 457-508. *In* D.C. Adriano et al. (ed.) Bioremediation of contaminated soils. American Society of Agronomy, Madison, WI.

Attachment 4

Bluelab Product Information Sheet

for Distributors of Bluelab Nutrient Solution Testers and Accessories

4/05/2017

Product Name:	Bluelab pH Controller
Product Code:	CONTPH
UPC Code:	9421024920678
Country of Origin:	New Zealand
Tariff Code:	9027.80
Shipping Quantity:	Sold as singular unit
Packaging Information:	
Packaged Weight:	1.00 kg / 2.205 lb
Packaged Length:	207 mm / 8.150 in
Packaged Width:	107 mm / 4.213 in
Packaged Height:	196 mm / 7.717 in

Sales Description:

NOTE: this copy can be used in brochures, catalogues or online

Automatic dosing of pH levels in nutrient solutions, creating stable environments for plants to thrive

Fine-tunes the reservoir pH levels for you. Confidence - your pH is taken care of.

Automatic measuring and adjusting to pre-set pH levels with optional alarms. Provides consistent control of pH in growing sytems.

Intuitive "on time" and "off time" allows the solution to dose and mix before the controller measures and doses again.

Reassurance with safety lockouts to prevent over delivery of pH.

Probe cable length: 2 meters / 6.5 feet

Features:

- Automatic control of pH level in systems with reservoirs up to 200 gallons / 760 litres
- Dose either pH up or pH down adjusters
- Replaceable double junction pH probe & peristaltic pump
- Plant-safe green backlit LCD with adjustable brightness
- Large, easy to read display
- Easy to navigate menu to adjust settings
- Simple push button pH calibration with on screen instructions
- Flashing high and low alarms with control lockouts
- Water resistant, wall mount design
- Separate Bluelab® Temperature Probe (for pH ATC)

Product Guarantee:

Two year limited guarantee, proof of purchase required. Six months for pH Probe.

Product Image:

Product images available for Screen or Web use:

- Bluelab-pHController-MR-flat-RGB.jpg
- Bluelab-pHController -WEB.jpg
- Bluelab-pHController -Web-sml.jpg

Product images available for PRINT:

Note: these images are high resolution in CMYK.

- Bluelab-GuardianMonitor-MR-flat-CMYK.tif

Technical Specifications:

Control Parameter:	pH – user selectable single direction (up or down)
Control Range:	0.1 – 13.9 pH
Dose Rate:	10ml per minute
Resolution:	0.1 pH
Accuracy at 25C / 77F:	± 0.1 pH
Automatic Temperature Compensation:	Yes, if temperature probe is in same solution as pH probe
Operating Environment:	0 – 50°C / 32 – 122°F
Calibration:	Two or three point, pH 7.0 & pH 4.0 and/or pH 10.0 calibration
Power Source:	International power supply
Certifications:	CE, FCC
Screen Display Languages:	English; Deutsch; Español; Français; Nederlands
User Manual Languages Available:	English

{This Product Information Sheet is NOT intended for distribution to end users.}

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Attachment 5

Transit Time Flow Meters

WALL MOUNT TDS-100F1

APPLICATION GUARANTEE— IF WE RECOMMEND IT AND IT DOES NOT WORK TO YOUR SATISFACTION WE WILL TAKE IT BACK

WARRANTY—We extend our normal 12month warranty conditions to TWO YEARS on TTFM kits

TDS-100F Ultrasonic Flowmeter Manual

ECE*Fast*





Australia
Phone: 1800 811 818
Email: sales@ecefast.com.au
Web: www.ecefast.com.au

New Zealand
Phone: 0800 323 327
Email: sales@ecefast.co.nz
Web: www.ecefast.co.nz

NATA

Certified System

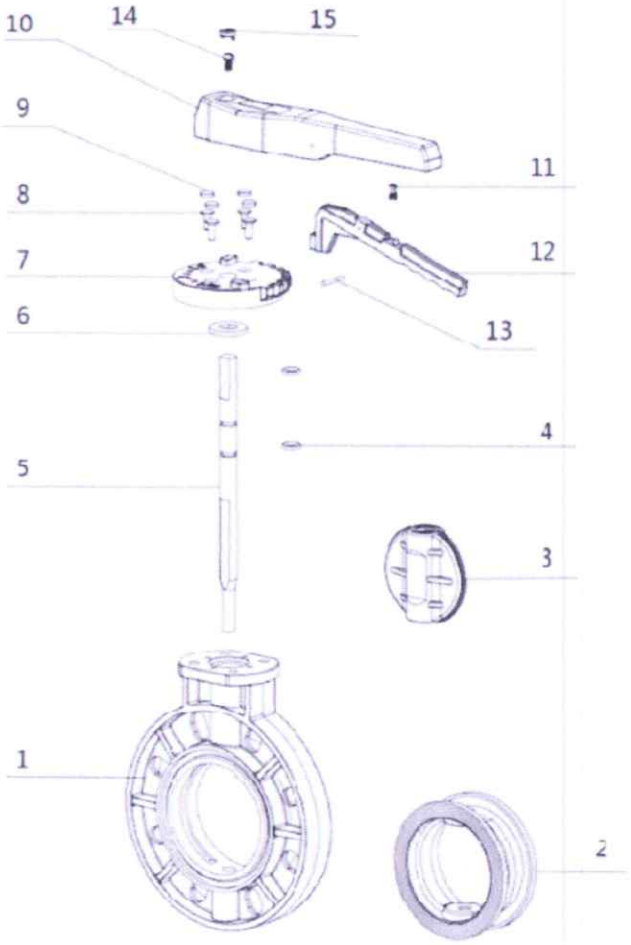
ISO 9001
Quality
Endorsed
Company
Lic. No. 3178

Attachment 6

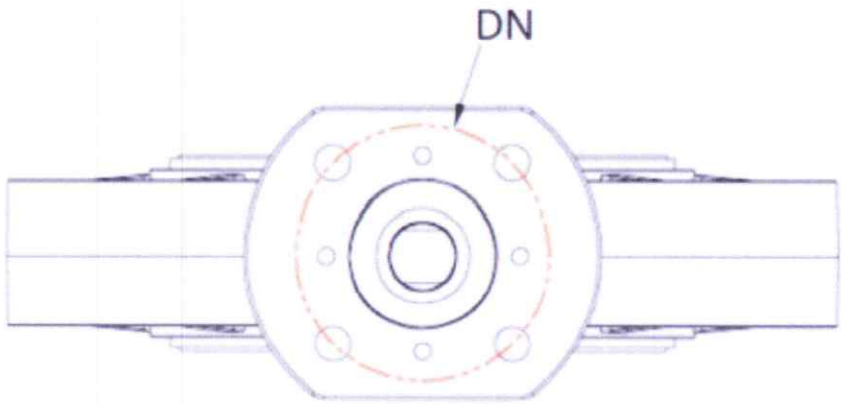
Lever Handle Butterfly Valve

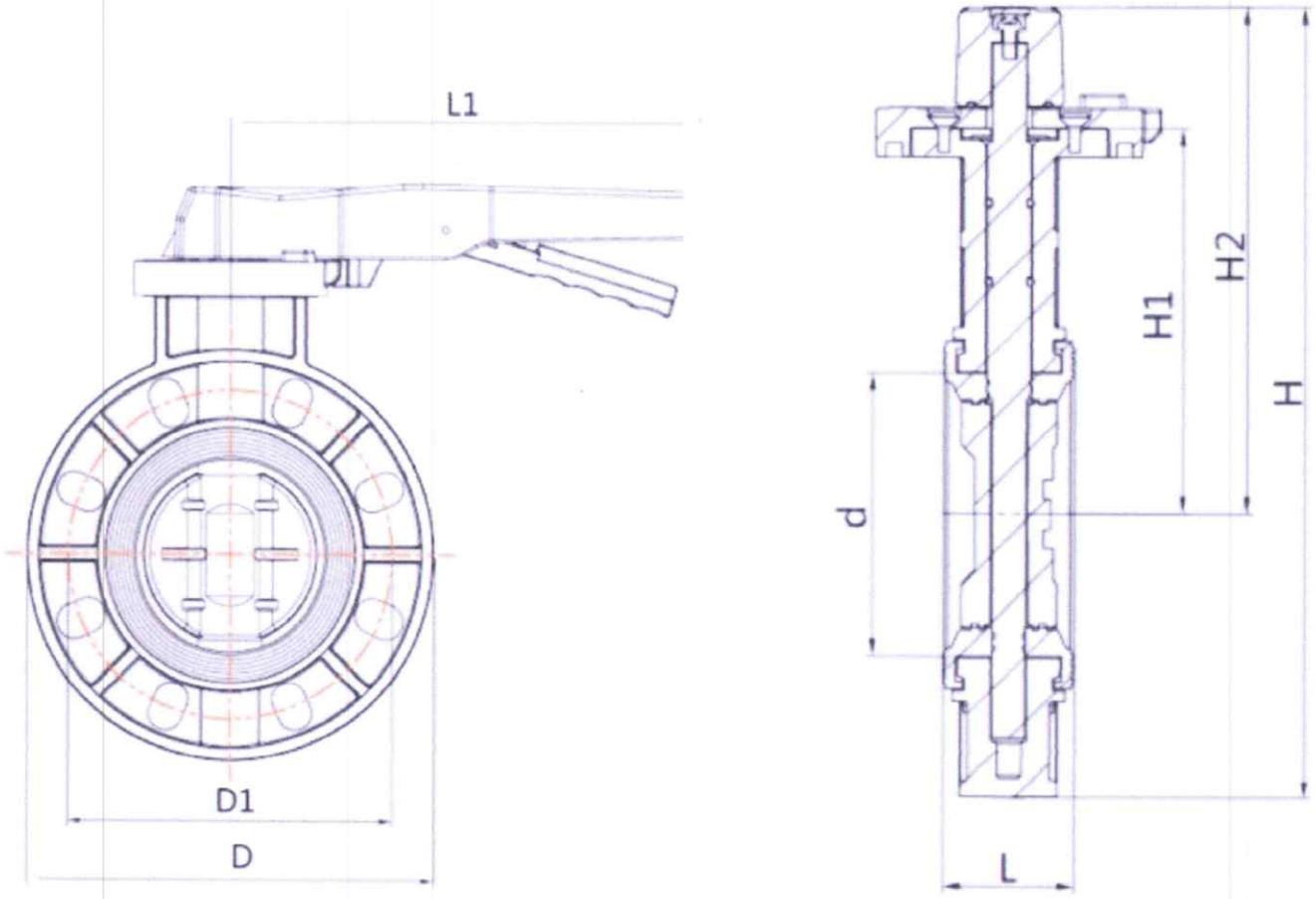
Flui-PRO VALVES

- ✓ Top Quality Industrial Style Valve
- ✓ Durable PVC Body and Disc Construction
- ✓ Locking Lever Handle Design
- ✓ Includes Durable 316 Stainless Steel Shaft
- ✓ Corrosion-Resistant EPDM Seals
- ✓ Flanged Body for Easy Installation
- ✓ Available in 2" – 8" Sizes



Material Table			
No.	Parts	Quantity	Material
01	Body	1	PVC
02	Seat Seal	1	EPDM
03	Disc	1	PVC
04	O-Ring	2	EPDM
05	Shaft	1	316 Stainless Steel
06	Bear	1	PVC
07	Plate	1	PVC
08	Screw	4	Steel
09	Screw Cap	4	PVC
10	Handle	1	PVC
11	Spring	1	Spring Steel
12	Lever	1	PVC
13	Set Pin	1	Steel
14	Bolt	1	Steel
15	Mark Cap	1	PVC





Dimensions in Inches									
Size	D	D1	d	L	DN	L1	H1	H2	H
2"	6.28	4.92	2.45	1-1/8	2.76	8.50	3.92	5.64	8.78
2-1/2"	7.09	5.71	3.10	1-1/8	2.76	8.50	4.39	6.12	9.66
3"	7.72	6.30	3.63	1-3/8	2.76	8.50	5.00	6.73	10.59
4"	9.04	7.09	4.41	1-7/16	2.76	10.40	6.15	8.08	12.60
5"	10.04	8.27	5.43	1-7/8	2.76	10.40	6.85	8.78	13.80
6"	11.08	9.45	6.19	2-1/8	2.76/4.02	12.02	7.48	9.87	15.41
8"	13.49	11.61	8.43	2-5/8	2.76/4.02	11.94	9.01	11.05	18.15

Attachment 7

bluelab® guardian monitor

Technical specifications

Specifications	pH	Conductivity	Temperature
Units:	pH	EC, CF, TDS, ppm 700	°C, °F
Measurement range:	0.0 – 14.0 pH	0 – 5.0 EC, 0 – 50 CF 0 – 2500 TDS (ECx500) 0 – 3500 ppm (ECx700)	0 – 50 °C 32 - 122 °F
Resolution:	0.1 pH	0.1 EC 1 CF 10 TDS 10 ppm	1 °C 1 °F
Accuracy at 25 °C / 77 °F:	±0.1 pH	±0.1 EC ±1 CF ±50 TDS ±70 ppm	±1 °C ±2 °F
Calibration:	Two point pH 7.0, and pH 4.0 or pH 10.0	Not required (factory calibrated)	Not required (factory calibrated)
Automatic Temperature Compensation (ATC):	Yes (if conductivity/ temperature probe is in same solution as pH probe)	Yes	Not applicable
Operating environment:	0 - 50 °C / 32 - 122 °F		
Power source:	Input: 100-240 Vac, 50-60 Hz, 5 VA output: 5VDC 1Amp, 4 interchangeable plug types (USA, Euro, UK, NZ/AUS)		
Other functions:	Greater tolerance to RF/electronic interference provided, silent visual alarm (high and low settings), adjustable display brightness, water resistant, non-volatile memory, over and under range indicators		
Guarantee period:	**Bluelab Guardian Monitor:** 2 years **Bluelab pH Probe:** 6 months		