U.S. ARMY CORPS OF ENGINEERS
BALTIMORE DISTRICT

DENTS RUN SITE 3888
SECTION 206, ACID MINE DRAINAGE

CONTRACT NO. DACA31-03-D-0009
BENEZETTE TOWNSHIP, ELK COUNTY, PA

OPERATION AND MAINTENANCE PLAN

Prepared for:

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Introduction

The Site 3888 passive treatment system collects acid mine drainage (AMD) from two abandoned underground coal mine discharges identified as Seeps 2A and 2B. The combined flow is piped to an open limestone channel (OLC) for initial alkalinity generation. The OLC discharges to an oxidation/precipitation basin (OPB) that will be converted into a vertical flow wetland (VFW) for final alkalinity generation. The VFW will discharge via an underdrain system and outlet pipe to an unnamed tributary to Dents Run.

The passive system design criteria and performance prediction sections from the Design Engineer's Report are attached with this Operation and Maintenance (O&M) Plan for reference. Individuals and organizations responsible for site O&M should review these materials for an understanding of the functions of the passive technologies utilized and the pre-construction expectations for their performance. The following are the recommended O&M activities for the individual system components. It is recommended that the site be inspected weekly for basic integrity and performance factors. A system component map and inspection checklist is attached with this plan for reference in the field.

General System

All pipes and flow controls should be regularly checked for blockage, and debris should be removed immediately. Specific areas of concern are the Seep 2A & 2B collection system, the OLC, and the outlet water level control on the VFW.

Open Limestone Channel

The operational life of OLCs is unknown. Previous studies have indicated that the limestone lining material will become coated with metal precipitates (aluminum and iron) over time. The existing OLC shows some aluminum removal and a diminishing rate of acidity removal over time, potentially indicating the onset of armoring. The OLC should be regularly inspected to assure that armoring does not inhibit flow. If significant loss of hydraulic capacity occurs, it may be necessary to rework the limestone lining by machinery to break up the deposits, or to replace the limestone entirely.

Vertical Flow Wetland

VFWs rely on the hydraulic capacity of their substrates to permit downward water flow to their underdrains and prevent overtopping of the cell. Dissolved metals present in AMD, particularly aluminum, will trend to precipitate in the compost and limestone beds, reducing hydraulic capacity over time. Routine operation of VFWs involves gradually adjusting the difference between the standing water level in the cell and the discharge level in the outlet water level control to provide increasing driving head as compensation for loses of hydraulic capacity. Eventually, a point is reached where adjustments can no longer compensate for capacity losses, and the substrate must either be maintained or replaced.

In addition to the loss of void space and hydraulic conductivity, VFWs can decline in performance by the consumption of organic carbon in the compost, which is essential for sulfate reduction. Monitoring of both the influent and effluent for each cell should be conducted at least once a quarter to determine if there is a downward trend in alkalinity production in the VFWs and overall system performance. If such a trend is observed that could affect treatment goals, the compost will need to be replaced or supplemented with an acceptable source of organic carbon.

Under average flow conditions, the Site 3888 VFW is designed to maintain approximately 1 foot of standing water on top of the compost substrate. A formula is provided on the inspection checklist for estimating the flow at the VFW outlet water level control based on the height of water above the stop logs, with measurements taken from the top of the inside rim of the control structure. The VFW cell inlet pipe is constructed with the bottom invert at the minimum design water level, leaving 2 feet of freeboard up to the emergency spillway. Water levels will normally back up several inches above the inlet pipe invert during higher flows, but should not overtop the pipe. If a water level is observed at greater than 0.5 feet above the inlet pipe invert, the water level should be adjusted downward by 1 to 2 inches at the water level control; however, the minimum water level should not be allowed to drop more than 2 inches below the pipe invert. Water levels are adjusted by removing and replacing the upper stop logs in the water level control. Stop logs are provided in heights of 5 and 7 inches, combinations of which can be used for incremental adjustments of 1 inch upward or downward. If under any flow condition the inlet pipe becomes completely submerged, a 5 inch stop log should be removed from the water level control for the initial adjustment.

The stop log top elevations should not be adjusted more than 0.5 feet below the inlet pipe invert. If the inlet pipe is persistently overtopped at this adjustment level, the cell substrate is losing significant hydraulic capacity and requires maintenance. Two potential methods of maintenance are flushing or stirring, described as follows:

- Flushing can be accomplished by removing the stop logs from the water level control and allowing the cell to free drain at a rapid rate. The water depth at the inlet pipe invert should be measured prior to flushing. The stop logs should be replaced to their original setting levels immediately after the cell is drained, and it is recommended that the compost substrate not be exposed to the air for more than 4 hours. The cell should be allowed to refill, and the stable water level measured at the inlet pipe invert for indication that the level has dropped compared to pre-flushing conditions. Several drain-and-fill cycles may be needed before improvements are observed. Flushing has not proven to be effective for long-term maintenance of hydraulic capacity in previous VFW systems, but may provide short-term improvements to extend substrate lives before replacement. Costs of flushing are essentially labor, estimated at approximately $2,000 for two site laborers at $30/hr each for four days.

- Stirring or otherwise breaking up precipitate deposits in the compost bed may also increase hydraulic capacity. This approach has been used for VFWs subject to periodic surface drying of the compost by insufficient maintenance of cell water levels, apparently causing a more rapid formation of precipitate lenses or oxidized compost clumps. It is unknown whether similar deposits will form in a permanently inundated VFW as designed for Site 3888. Stirring of the upper compost surface by overhead equipment may be possible, but would likely require a large gradeall or similar machine at considerable expense. Another conceptual approach would be to draw down the VFW and allow the compost to dry sufficiently to permit a small, low ground pressure vehicle to tow a york rake or similar attachment across the compost surface. Fresh compost could be spread and incorporated into the surface at the same time to replace organic carbon losses. The surface would be rutted on completion, but could be leveled using a pressure hose. The effects of dewatering and raking on performance are not documented at this time. Costs of raking could vary considerably depending on the machinery used, but may be on the order of $7,000.

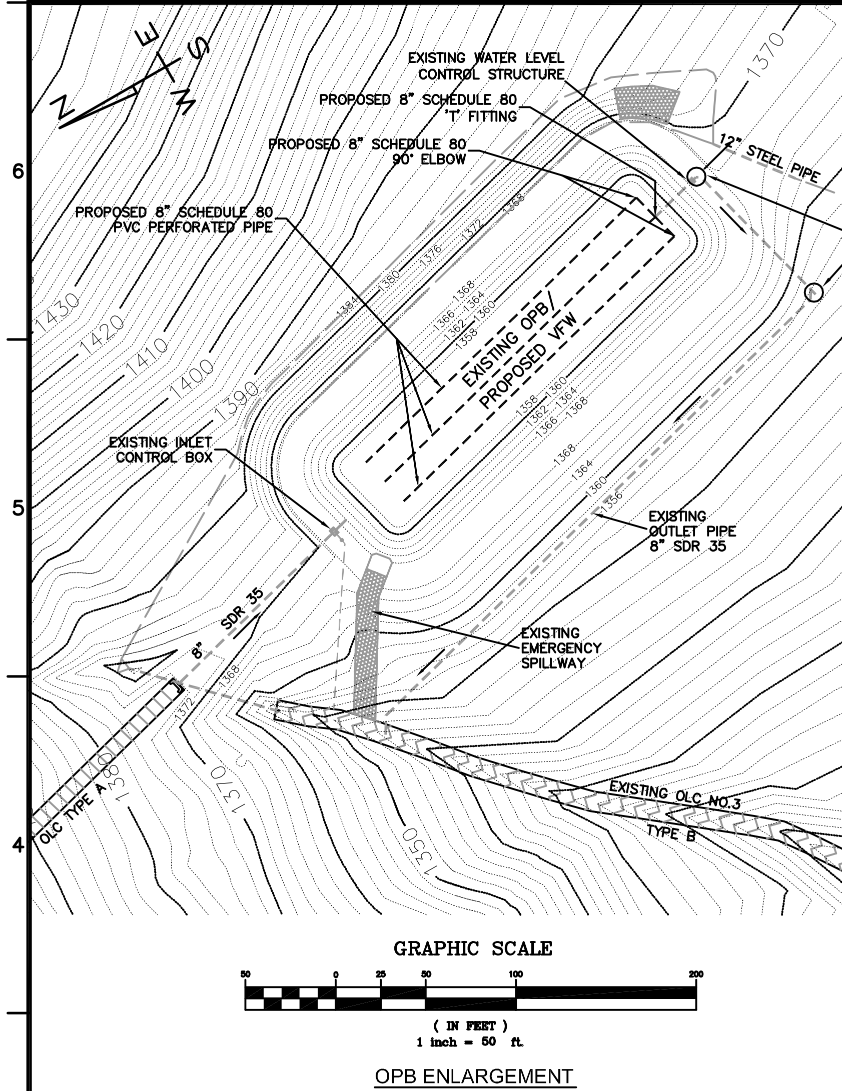
If adequate hydraulic capacity is not restored by flushing or stirring, the compost should be replaced before the freeboard capacity is exceeded. Maintenance or replacement activities should only be conducted during low to average flow conditions (19 gpm maximum). A capped bypass pipe is provided at the VFW inlet to bypass influent around the cell during excavation and replacement of substrates. A temporary energy dissipater and sediment trap should be constructed at the bypass outlet before opening the pipe. Temporary chemical treatment will be required to maintain water quality in the bypass while the VFW is off-line. Soda ash briquettes or pebble quicklime would be suitable for this purpose.

For compost replacement, the cell should be drained and allowed to dry sufficiently for a skid steer or other low ground pressure equipment to operate. Spent compost may be scraped by bucket and loaded into haul trucks for disposal. Care should be taken not to over excavate into the limestone bed if it is to remain in place. The characteristics of spent compost are not sufficiently documented to predict whether this material will be suitable for on-site disposal. It may be possible to spread it on the abandoned mine site between Seeps 2A and 2B, but provision should be made for off-site disposal if needed. On-site loading and hauling within one mile is estimated to cost approximately $14,000. Fresh compost may be spread on the exposed limestone bed using the same methodology as the original bed placement, typically a small bulldozer. The cost of new compost and placement is estimated at approximately $48,000.

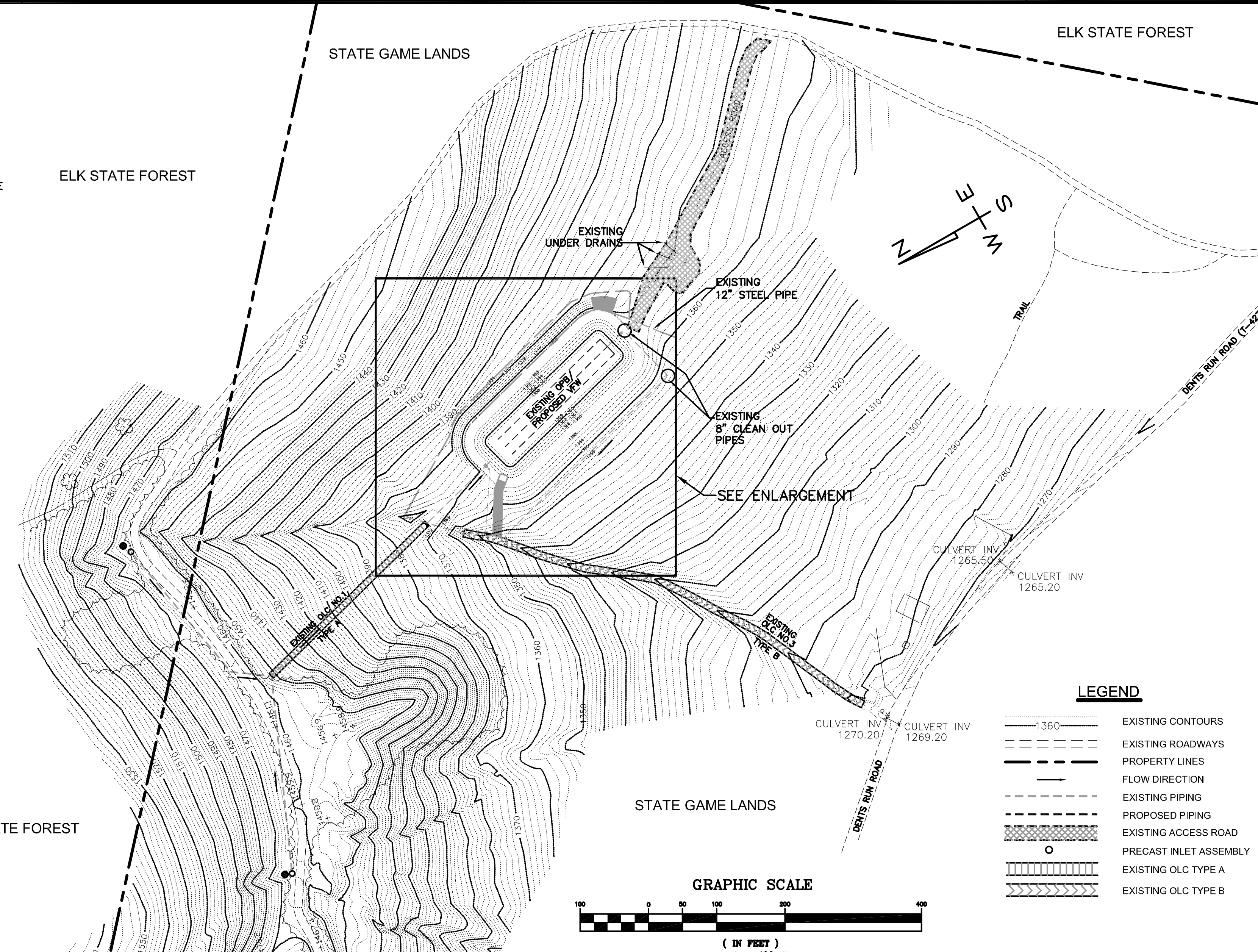
It is not currently known whether limestone substrates in VFWs must be replaced concurrently with the compost substrates. The compost presumably acts to protect the limestone to some degree from clogging and armoring, but the duration of this effect has not been documented for systems designed to the sizing standards of the Site 3888 VFW. It is recommended that limestone replacement be included as a contingency option in any maintenance contract involving compost replacement. Care should be exercised in excavating spent limestone around the underdrain pipes to prevent damage. The characteristics of spent limestone are not sufficiently documented to predict whether this material will be suitable for on-site disposal. It may be possible to spread it on the abandoned mine site between Seeps 2A and 2B, but provision should be made for off-site disposal if needed. On-site limestone loading and hauling within one mile is estimated to cost approximately $20,000. The cost of new limestone and placement is estimated at approximately $54,000.

No standard methodology has been developed for estimating the operational life of VFW substrates before maintenance or replacement is required. From studies of surface flow wetlands, aluminum sludge formation for open water precipitation is estimated at approximately 1 liter for every 10 grams removed, with a rate of about 1 liter per 20 grams of iron removed. This equates to about 3 cubic feet per day of sludge generation in the Site 3888 VFW. Available void space in compost and limestone is approximately 40 percent. Given the volume of these materials to be placed in the VFW (71,469 cubic feet), the hypothetical time required to fill the void spaces is about 26 years. In practice, sludge formation will not occur in all void spaces, so significant loss of hydraulic capacity will likely occur in a lesser timeframe, potentially estimated at about 15 years. Because of the potential differences between wetland sludge and VFW sludge volume factors, the calculated substrate life estimate should be used only for conceptual planning purposes, and actual maintenance should be scheduled based on field observations of remaining hydraulic capacity.

Refer to Figure 1 for an overall map of the Seep 8 design layout. A site inspectors checklist has been included in Appendix A for routine operation and maintenance purposes.



OPB ENLARGEMENT



LEGEND

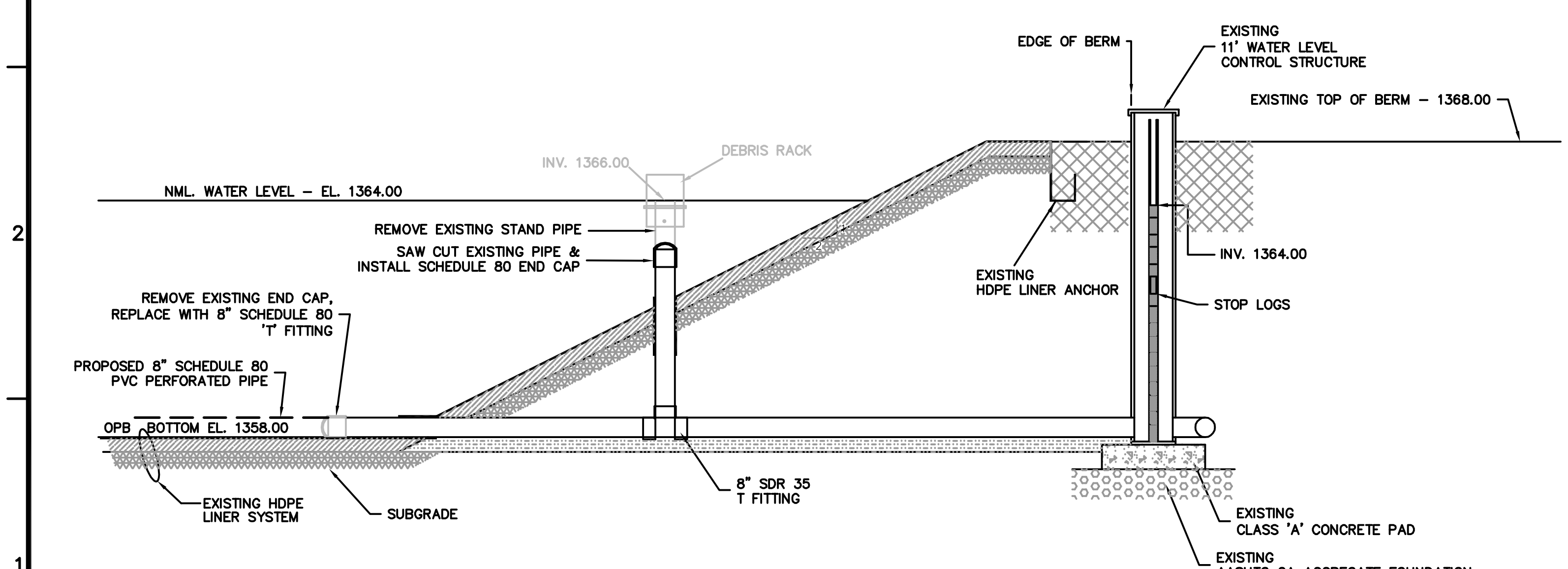
1360	EXISTING CONTOURS
	EXISTING ROADWAYS
	PROPERTY LINES
	FLOW DIRECTION
	EXISTING PIPING
	PROPOSED PIPING
	EXISTING ACCESS ROAD
o	PRECAST INLET ASSEMBLY
	EXISTING OLC TYPE A
	EXISTING OLC TYPE B

GENERAL NOTES:

1. RECORD DRAWING/AS-BUILT DATA PROVIDED BY P & N COAL COMPANY.

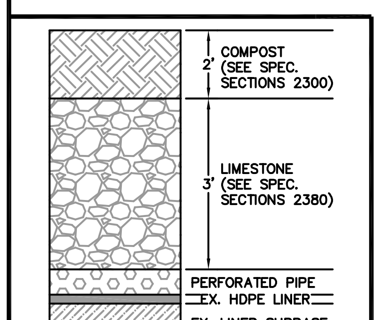
INSTALLATION NOTES:

1. POND TO BE DEWATERED.
2. SAND TO BE REMOVED FROM THE INTERIOR OF POND IN A MANNER THAT DOES NOT DAMAGE THE EXISTING HDPE LINER. DEPTH OF SAND UNKNOWN.
3. SAW CUT AND REMOVE STAND PIPE AND APPURTENANCES, AS SHOWN.
4. INSTALL SCHEDULE 80 PVC PIPE AS SHOWN.
5. ADD LIMESTONE (3' DEPTH) AND MUSHROOM COMPOST (2' DEPTH) TO INTERIOR OF POND.
6. DISPOSE OF ALL WASTE MATERIALS IN A LAWFUL MANNER AT A LANDFILL.



WATER LEVEL CONTROL STRUCTURE OUTLET MODIFICATION DETAIL

NO SCALE



PROPOSED VFW TYPICAL SECTION

NO SCALE

US Army Corps of Engineers Baltimore District

Mark	Description	Date	Appr.	Mark	Description	Date	Appr.

Designed by:		Date: AUGUST, 2006
Dwn by:	Ckd by:	Design file no.
Reviewed by:		Drawing Number:
Submitted by: Chief, Branch		File name: Plot date: Plot scale: AS SHOWN

Rev.

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SITE 3888 DESIGN LAYOUT

FIGURE 1

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APPENDIX A
Operation and Maintenance Checklist

Dents Run Site 3888 Passive Treatment System
SITE INSPECTION CHECKLIST

Inspector(s):____ Date:________________

General System

Inspect and clear blockage from:

- ☐ Seep 2A & 2B Collection System
- ☐ Open Limestone Channel
- ☐ VFW Outlet Water Level Control

Vertical Flow Wetland

Depth to Stop Logs (*A* ft)[a]	________
Depth to Water (*B* ft)[b]	________
Water Depth at Inlet Pipe Invert (*C* ft)[c]	________
Flow Height ($H = A - B$ ft)	________
Flow Rate ($1495[1 - 0.2H]H^{3/2}$ gpm)	________
Design Flow Rates (average/maximum)	19/40 gpm

[a,b]Measure *A* and *B* from the top inside rim of the VFW outlet water level control.

[c]Measure C from the bottom inside rim of the VFW inlet pipe.

If *C* is greater than 0.5 feet, adjust stop logs down 1 to 2 inches; remove one 5 inch stop log if $C > 0.75$ ft.

If *C* remains at greater than 0.75 feet for several days after adjustment, arrange for substrate maintenance.

Notes/Maintenance Performed: ____

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