Operating Manual for Landfill Gas Collection and Control System for the Sudbury Road Landfill - City of Walla Walla, Washington

City of Walla Walla

City Office: 55 Moore Street, Walla Walla, Washington 99362-0216

Sudbury Road Landfill: 414 Landfill Road, Walla Walla, Washington 99362

Prepared by CB&I Environment and Infrastructure

10725 SW Barbur Blvd, Suite 380
Portland, Oregon 97219

Report/Project No. 155296.10021110
Revision 0 April 2017

Operation and Maintenance Manual for the City of Walla Walla Landfill Gas Collection and Control System for the Sudbury Road Landfill, Walla Walla, OR

The material and data in this report were prepared under the supervision and direction of the undersigned.

____

Erik C. Korsmo
Project Manager
CB&I Environment and Infrastructure

____

Darrell H. Thompson
Client Program Manager
CB&I Environment and Infrastructure

TABLE OF CONTENTS

1.0 INTRODUCTION 1

1.1 PURPOSE OF THE GCCS 2
1.2 REGULATORY REQUIREMENTS 2
1.3 PERMIT REQUIREMENTS 2
1.4 RESPONSIBILITIES AND IMPORTANT CONTACT INFORMATION 3

2.0 LANDFILL GAS (LFG) BASICS 3

2.1 LFG GENERATION 4
2.2 LFG GENERATION VARIABLES 4
2.3 PHYSICAL AND CHEMICAL CHARACTERISTICS 4
2.4 LFG COLLECTION SYSTEM DESCRIPTION 5
2.4.1 AREA 1 5
2.4.2 AREA 2 5
2.4.3 AREA 5 5
2.4.4 AREA 6 6
2.4.5 LFG PIPING NETWORK 9
2.4.6 WELLHEAD MONITORING ASSEMBLIES 9
2.5 OPERATION, MONITORING AND TUNING 10
2.6 WELLFIELD MONITORING, BALANCING, AND TUNING 11
2.7 BLOWER/FLARE STATION MONITORING 14
2.8 GAS PROBE MONITORING 17
2.9 LIQUID LEVEL MEASUREMENT 18
2.10 DATA MANAGEMENT 18
2.10.1 ELECTRONIC DATA 18
2.10.2 WRITTEN LOG BOOK DATA 18
2.10.3 REPORTING PROCEDURES 19
2.10.4 INTERNAL MONTHLY WELLFIELD REPORTS 19
2.11 SURFACE EMISSIONS MONITORING (SEM) PROCEDURES – 19

3.0 LANDFILL FLARE STATION SPECIFICATIONS AND PRIMARY EQUIPMENT 21

3.1 BLOWER FLARE SKID AND FLARE 22
3.1.1 CONDENSATE KNOCK-OUT POT 22
3.1.2 PNEUMATIC FLARE INLET VALVE 22
3.1.3 LFG BLOWERS 23
3.1.4 FLAME ARRESTOR 23
3.1.5 ENCLOSED FLARE 23
3.1.6 FLARE CONTROLS 24
3.1.7 PILOT BURNER CONTROL 24
3.1.8 ULTRAVIOLET LIGHT FLAME DETECTOR 26
3.1.9 HIGH INLET GAS TEMPERATURE THERMOCOUPLE 26
3.1.10 STACK THERMOCOUPLES 26
3.1.11 SYSTEM SHUT-DOWN ON POWER FAILURE 27
3.1.12 LFG FLOW METER 27
3.1.13 DIGITAL LFG CHART RECORDER DATA 28
3.1.14 GAS ANALYZER AND OXYGEN SENSOR) 29

3.1.15 Heat Trace Tape 30
3.2 LFG Flare System Equipment and Parts 30
3.2.1 Equipment 30
3.2.2 Spare Parts 30

4.0 CONDENSATE COLLECTION AND DISPOSAL 31

4.1 Wellfield and GCCS Condensate Collection 31
4.2 Knock-Out Pot 32
4.3 Flame Arrestor Drain 32

5.0 LFG FLARE SYSTEM OPERATING PROCEDURES 35

5.1 Flare Station Startup Sequence 35
5.2 Pre-startup System Operational Check List 37
5.3 Start-up Procedure – Automatic Start 37
5.4 Automatic Re-start 38
5.5 START-UP AND OPERATION AFTER FAILURE SHUTDOWN 39
5.6 Flare Station Emergencies 39
5.6.1 Shutdown Event 39

6.0 ROUTINE CONDENSATE COLLECTION SYSTEM OPERATING PROCEDURES 41

6.1 Routine Condensate Sump System Operation 41

7.0 MAINTENANCE 43

7.1 Purpose 43
7.2 LFG Collection System 43
7.3 General Inspection 43
7.4 Routine Preventive Maintenance for the Wellfield 44
7.5 Maintenance Records 44
7.6 Flare Station 45
7.6.1 Flare Station Knock-out Pot (KOP) 45
7.6.2 Pneumatic Flare Inlet Valve 45
7.6.3 Flare Station Blower 45
7.6.4 Flame Arrestor 46
7.6.5 Propane Pilot Fuel Ignition System 46
7.6.6 Flame Detection System 46
7.6.7 Landfill Gas Analyzer 46
7.6.7.1 Factory Calibration and Service 47
7.6.7.2 Field Calibration Check 47
7.6.7.3 Field Maintenance 48
7.6.8 Flare Instrumentation 49

8.0 TROUBLESHOOTING 51

8.1 LFG Collection System 51
8.2 Flare Station 51
8.3 LFG Transmission Pipeline 51
8.4 Condensate Collection and Treatment System 51
8.5 Landfill Gas Analyzer 51

9.0 REFERENCES 59

APPENDIX A.1 - GCCS EQUIPMENT OPERATION MANUALS

APPENDIX A.2 - MONITORING REQUIREMENTS

APPENDIX A.3 - MONITORING AND TROUBLESHOOTING PROCEDURES

APPENDIX A.4 - INSPECTION FORMS

APPENDIX A.5 - KEY COMPONENTS

TABLES

Table 2-1 LFG Extraction Well Construction Details

Table 3-1 Specification for Flare Unit

Table 8-1 through 8-5 Troubleshooting Checklists

ACRONYMS AND ABBREVIATIONS

BMP	Best Management Practices
CFR	Code of Federal Regulations
Decree	Consent Decree 15-2-00536-8
DOE	Department of Ecology
GCCS	gas collection and control system
HDPE	high-density polyethylene
Landfill	Sudbury Road Landfill
LandGEM	Landfill Gas Emissions Model (Version 3.02)
LCRS	leachate collection and removal system
LFG	landfill gas
MSW	municipal solid waste
NSPS	New Source Performance Standards
O&M	Operations and Maintenance
PLC	programmable logic controller
PVC	polyvinyl chloride
scfm	standard cubic feet per minute
SEM	surface emissions monitoring
UV	ultraviolet
w.c.	water column (unit of air pressure measured in inches)

1.0 INTRODUCTION

The following Operating and Maintenance Manual (Manual) details the operation and maintenance (O&M) requirements for the landfill gas control and collection system for the Sudbury Road Landfill (Landfill), located at 414 Landfill Road, Walla Walla, Washington 99362

This Manual serves as the primary reference document to be used by Landfill personnel and those parties responsible or contracted for performing Gas Collection and Control System (GCCS) O&M services for the Landfill.

- This Manual describes the procedures and minimum requirements for:
- Monitoring, inspection and maintenance of the GCCS and components;
- Monitoring, inspection and maintenance of LFG control devices;
- Data management and reporting related to the O&M of the GCCS.

This manual should be read before and consulted during O&M of the GCCS. A glossary of landfill gas (LFG) and GCCS related terms is provided on the previous page. Before operating or maintaining any equipment, this manual, record drawings, specifications, and the equipment vendors' operating and maintenance instructions should be thoroughly consulted. No work of any kind should be attempted without having read the information contained in these documents. Hands-on training is required before operating or maintaining any GCCS equipment.

This GCCS O&M Manual is supplemented by the John Zink, Inc. Landfill Gas Utility Flare System - O&M Manual for a 4' Diameter, 40' High Enclosed ZTOF® Biogas Flare System **Appendix A.1 – GCCS Equipment Operation Manuals** (provided electronically under separate cover). This Manual should be consulted by Landfill personnel or contractors performing O&M on the GCCS for compliance with the Approval Order Number 10AQ-E355. Following the procedures in the Manual does not alone constitute compliance with the Approval Order.

If any discrepancies are found between the documents, the manufacturers' recommendations or instructions shall be followed and modification shall be incorporated into this Manual.

It should be noted that some of the information contained in the Manual references New Source Performance Standards (NSPS) requirements, for which at this time the Sudbury Road Landfill is not required to comply but these references are included for future needs.

This Manual is intended to be a living document and changes will be made based on site specific conditions or changes in equipment, permit conditions, or applicable regulations. This Manual should be reviewed routinely and updated to incorporate any changes in equipment or permit conditions requiring a change in procedures.

1.1 Purpose of the GCCS

The primary purpose of the GCCS at the Landfill is to protect the environment and public health from the hazards of LFG and LFG condensate, in accordance Washington Administrative Code (WAC) 173-351-200(4), WAC 173-351-500(2)(a)(iv), WAC 173-340, and WAC 173-460 and to comply with the State of Washington Department of Ecology (DOE) Approval Order No. 10AQ-E355 dated May 28, 2010.

It should be noted that the current design capacity of the landfill, which is projected to reach capacity in 2024, is below the 2.5 million megagrams threshold which requires landfills to comply to the NSPS for Municipal Solid Waste (MSW) landfills (40 Code of Federal Regulations (CFR) Subpart CC) or the National Emissions Standards for Hazardous Air Pollutants (NESHAP) for MSW landfill (40 CFR Subpart AAAA).

1.2 Regulatory Requirements

The Sudbury Road Landfill (Facility Site #4446540, Cleanup Site #2485) is conducting a cleanup action pursuant to the requirements of the Model Toxics Control Act (MTCA) regulations (Chapter 173-340 WAC) and Consent Decree 15-2-00536-8 (Decree) filed with the Walla Walla Superior Court on August 19, 2015. The cleanup action, as specified in the final Cleanup Action Plan (CAP) prepared by the Washington State Department of Ecology (Ecology) obligates the City to operate the GCCS to reduce LFG contaminant impact on groundwater until site specific cleanup levels in groundwater are achieved.

Additionally, the current regulations governing the operation of landfills and LFG systems require the following:

- Control of subsurface LFG migration off-site or to groundwater;
- Control of LFG accumulation in facilities and structures;
- Control of landfill surface LFG emissions and leaks;
- Control of LFG collection and conveyance system leaks; and
- Efficient treatment of the collected LFG.

1.3 Permit Requirements

<u>Air Permits</u>

The following documents, detail the site specific GCCS requirements for the Landfill:

- State of Washington Department of Ecology (DOE) Approval Order No. 10AQ-E355 dated May 28, 2010.
- Sudbury Road Landfill Gas Destruction Project Monitoring Plan Dated June 8, 2012 and Climate Action Reserve ID: CAR844 (Not a Permit)

The permit compliance requirements for GCCS are summarized in **Appendix A.2 - Compliance Matrix.**

1.4 Responsibilities and Important Contact Information

The following summarizes general responsibilities and facility contact information. This is subject to approval and revisions as appropriate.

The O&M Contractor below has responsibility for the following:

- Operation, monitoring, and maintenance of the LFG collection system;
- Operation, monitoring, and maintenance of the LFG Flare;
- Operation, monitoring, and maintenance of the LFG condensate collection and disposal system; and
- Regulatory compliance with the Decree
- Regulatory compliance with the Approval Order;

The contact persons at the Landfill for each of the GCCS component and operation are:

GCCS Operations Manager:
CB&I Environment and Infrastructure

Erik C. Korsmo
Project Manager
10725 SW Barbur Blvd, Suite 380
Portland, Oregon 97219
(503) 939-3688
Email: erik.korsmo@cbi.com

CB&I Environmental and Infrastructure
Darrell H. Thompson
Western Regional Manager
18100 Von Karman, Suite 405
Irvine, CA 92612
(760) 977-8106
Email: darrell.h.thompson@cbi.com

Flare Equipment Provider:
John Zink Hamworthy
2500 Wilcrest Drive, Suite 401
Houston, TX, 77042
(800) 755-4252

Landfill HHW Technician:
Jay Yonkers
City of Walla Walla:
Sudbury Road Landfill
414 Landfill Road
Walla Walla, Washington 99362
(509) 527-4591
Email: jyonkers@wallawallawa.gov

Solid Waste Supervisor:
David Jensen
City of Walla Walla:
Sudbury Road Landfill
414 Landfill Road
Walla Walla, Washington 99362
(509) 527-4591
Email: djensen@wallawallawa.gov

Utility Manager:
Frank Nicholson, P.E.
City of Walla Walla
55 Moore Street
Walla Walla Washington 99362
(509) 524-4510
Email: fnicholson@wallawallawa.gov

2.0 Landfill Gas (LFG) Basics

The following Sections provide a basic understanding of LFG, how it is generated, and its physical and chemical characteristics.

2.1 LFG Generation

LFG is generated when refuse decomposes in anaerobic (without oxygen) conditions. During anaerobic decomposition, complex organic wastes are broken down into simple molecules, such as methane and carbon dioxide, by microorganisms. Only wastes containing readily decomposable organic material (such as food wastes, yard wastes, paper, wood wastes, etc.) can supply the medium, or substrate, for the microorganisms. Inorganic materials (such as metal, rock, and glass) cannot be biodegraded.

In early stages of degradation, prior to full oxygen depletion and the cooling of the high temperatures generating aerobic (with oxygen) degradation, refuse is degraded and hydrogen and carbon dioxide are generated. When oxygen is depleted and the temperature within the landfill decreases, the microorganisms that generate the hydrogen and carbon dioxide yield to those that generate methane and carbon dioxide.

2.2 LFG Generation Variables

Many variables strongly influence the generation of LFG, the most significant being control of air intrusion into the landfill, refuse moisture content, and temperature. Air intrusion is controlled by sealing high permeability pathways through which air enters the refuse mass. Air intrusion can be reduced using engineered controls and an effective landfill cover. Moisture content may vary widely throughout the interior of a landfill, ranging from an average of 25 percent to completely saturated zones of 40 to 50 percent water by weight. High moisture content and temperatures up to 130 degrees Fahrenheit (^oF) typically encourage increased LFG generation. Other important variables include refuse placement methods, degree of compaction, refuse composition, internal and external temperatures.

2.3 Physical and Chemical Characteristics

Methane and carbon dioxide, the principal components of undiluted LFG, are present in approximately equal portions. If carbon dioxide migrates off site, it may affect groundwater quality and surface vegetation, but impacts to human health and safety are generally considered minimal. Methane, like carbon dioxide, is non-toxic to humans, unless either displace normal quantities of oxygen in air. Both carbon dioxide and methane are classified as simple asphyxiates as they can displace oxygen in a confined space. However, methane is also a combustible gas when present between 5 and 15 percent by volume in air.

In addition to methane and carbon dioxide, LFG contains numerous trace gaseous constituents including hydrogen sulfide, and volatile organic compounds depending on refuse composition. Some constituents may be toxic and may constitute health hazards, even in trace amounts.

The hydrogen sulfide component of landfill gas is heavier than air, flammable gas with a characteristic rotten egg smell. Receptors can detect this odor even when the hydrogen sulfide gas is present at very low levels. Hydrogen sulfide may account for up to 1 percent by volume of landfill gas. The formation of hydrogen sulfide within the landfill depends on certain conditions including moisture content, temperature, pH, and sulfate source.

Extracted LFG is usually fully saturated with moisture (i.e., the relative humidity within the gas collection pipe is 100 percent). Typically, LFG temperatures inside a landfill can range from ambient air to 130ºF, or higher, depending on refuse depth and the type and rate of biological activity. Following its extraction from the landfill, the LFG cools within the piping network and the saturated moisture condenses on the inner walls of the LFG collection pipes, forming a liquid known as LFG condensate.

LFG condensate is a two-phase mixture composed primarily (greater than 95 percent) of water, with the balance being a hydrocarbon phase. Trace amounts of particulate and soluble compounds can also be present. LFG condensate is usually distinguishable from landfill leachate in composition and appearance. Condensate is fairly clear and usually has few dissolved inorganics. Leachate usually has significant concentrations of dissolved inorganics and is often brown or black in color. Both liquids, however, contain concentrations of volatile organic compounds and should be considered potentially toxic, when handling.

2.4 LFG Collection System Description

This section describes the LFG collection system Areas 1, 2, 5 and 6 of the Landfill. The purpose of the collection system for each Area is to control LFG emissions, migration, and odors and comply with the conditions set forth by the Approval Order and Decree. The LFG collection system currently consists of:

2.4.1 Area 1

- Two (2) Vertical LFG extraction wells (2016 installation);
- 1.5-inch diameter vertical wellhead monitoring assemblies;
- Approximately 300 feet of 4-inch diameter HDPE SDR-17 LFG lateral piping connected to the 8-inch diameter header pipe west of the flare area;
- a single isolation valve; and
- a single flow meter.

2.4.2 Area 2

- One (1) Vertical LFG extraction well (2016 installation);
- A 1.5-inch diameter vertical wellhead monitoring assembly;
- Approximately 1,350 feet of 4-inch diameter HDPE SDR-17 lateral piping connecting wells to the header piping. The lateral piping extends from the Area 5 isolation valve located on the west side of Area 6 LFG;
- Various isolation valves; and
- One (1) condensate sump (CS-5) connected to approximately 200’ of 4-inch diameter HDPE SDR-17 gravity drain piping to the header piping at EW-19.

2.4.3 Area 5

- Seven (7) Vertical LFG extraction wells (2016 installation);
- 1.5-inch diameter vertical wellhead monitoring assemblies;
- Approximately 1,700 feet of 4-inch diameter HDPE SDR-17 LFG lateral piping connecting wells to 1,150 feet of 8-inch diameter HDPE SDR-17 LFG header piping extending from the Area 5 isolation valve located on the west side of Area 6;
- Various isolation valves;
- One (1) condensate sump (CS-4) connected to approximately 170’ of 4-inch diameter HDPE SDR-17 gravity drain piping to the header piping near EW-18; and
- One flow meter (totalizer for Area 2 and 5) located at the Area 5 isolation valve.

2.4.4 Area 6

- Eleven (11) Vertical LFG extraction wells (2010 installation);
- Two (2) 1-inch diameter vertical wellhead assemblies and nine (9) 2-inch diameter horizontal wellhead monitoring assemblies;
- Approximately 2,200 feet of 4-inch diameter HDPE SDR-17 LFG lateral piping connecting wells to approximately 2,200 feet of 8-inch diameter HDPE SDR-17 LFG header piping;
- Various isolation valves; and
- Three (3) condensate sumps (CS-1, CS-2 and CS-3).

Example of Horizontal LFG Extraction Wellhead

The table below details the as-built configuration of vertical extraction wells in Areas, 1, 2, 5 and 6. This table should be updated following any additions, decommissioning, or well raising events. This table should also be referenced for well sounding events.

Table 2-1
LFG Extraction Well Construction Details

Area 1			
WELL ID	Solid Pipe Length [(a)] (feet)	Perforated Pipe Length (feet)	Total Completion Depth (feet)
EW-20	36.5	13.0	50.0
EW-21	32.0	10.0	42.0
Area 2			
WELL ID	Solid Pipe Length [(a)] (feet)	Perforated Pipe Length (feet)	Total Completion Depth (Feet)
EW-19	18.8	7.0	27.0
Area 5			
WELL ID	Solid Pipe Length [(a)] (feet)	Perforated Pipe Length (feet)	Total Completion Depth (Feet)
EW-12	24.0	13.0	38.0
EW-13	40.0	17.0	58.0
EW-14	31.0	13.0	45.0
EW-15	40.0	17.0	58.0
EW-16	27.0	11.0	39.0
EW-17	335.0	19.0	55.0
EW-18	24.0	6	31.0
Area 6 [(C)]			
WELL ID	Solid Pipe Length [(d)] (feet)	Perforated Pipe Length (feet)	Total Completion Depth (Feet)
EW-01	25	15	40
EW-02	25	45	70

EW-03	25	60	85
EW-04	25	35	60
EW-05	25	53	78
EW-06	25	34	59
EW-07	15	10	25
EW-08	25	45	70
EW-09	15	10	25
EW-10	25	46	71
EW-11	25	45	70

(a) Does not include four-foot riser stick up, i.e. solid above ground surface, EW-12 through EW-19 are from approximate final grade and EW-20 and EW-21 are from final grade.

(b) Include three-foot riser stick up, i.e. solid above ground surface

(c) Completion depths as recorded in the Sudbury Road Landfill Area 6 Closure Construction Quality Assurance (CQA) Certification Report. Rep. Kennewick, Washington: JUB Engineering, March 2011. Report.

(d) Area 6 - overall solid pipe length consists of the following from top down: no stick-up, 3-inch diameter solid SCH80 PVC from 0-7 feet bgs, a transitional slip joint at 7 feet bgs, 4-inch diameter solid SCH80 PVC from 7-20 (EW-7 and EW-9 are 7-10) feet bgs and 4-inch diameter solid HDPE SDR-17 from 20-25 (EW-7 and EW-9 are 10-15) feet bgs.

The vertical LFG wells were installed approximately 300 feet apart. Refer to Figure 2 in the O&M Plan for well locations and see *Construction Quality Assurance Certification Report, April 2017* for more detail.

Areas 1, 2 and 5

The LFG extraction wells consist of a lower (perforated) and upper (solid) casing. The following describes the construction from the top down (ground surface to the bottom of boring):

The LFG extraction well casing from the top down is fabricated from a solid 3-inch diameter schedule 80 (SCH80) polyvinyl chloride (PVC) section that transitions to a solid 4-inch diameter SCH80 PVC at a slip joint. The solid 4-inch diameter SCH80 PVC pipe then transitions to a perforated section of solid 4-inch diameter SCH80 PVC pipe. The bottom of the perforated pipe is finished with a PVC endcap. The lower casing perforation consists of ¼-inch by 2-inch slots, spaced 90-degrees apart around the pipe circumference. Each row of holes is spaced 6 inches center to center along the length of the well casing; see *Construction Quality Assurance Certification Report, April 2017* for more detail.

The perforated section of the well casing is embedded in a clean/round drainage aggregate to a minimum 1-foot above the top of the perforations. A minimum 3-foot thick layer of hydrated bentonite seal was placed above the gravel backfill sealing the perforate section from potential surface infiltration. Structural soil backfill material was then placed around the well casing to a depth of 3-feet from the bottom of the cover soils where the remaining fill to the surface consisted of a bentonite seal was placed to the top of well.

Area 6

Based on the Design Drawings dated 3/10/2010 (JUB) - The LFG extraction wells consist of a lower (perforated) and upper (solid) casing. The following describes the construction from the top down (ground surface to the bottom of boring):

The LFG extraction well casing from the surface down is fabricated from a solid 4-inch diameter schedule 80 (SCH80) polyvinyl chloride (PVC) section that transitions to a solid 4-inch SCH80 PVC at a slip joint. The solid 4-inch diameter SCH80 PVC pipe then transitions to a section of solid 4-inch diameter HDPE (standard dimension ratio (SDR) 17 at a PVC to HDPE transition adapter. The solid 4-inch diameter HDPE SDR-17 transitions to a perforated 4-inch diameter HDPE SDR-17 pipe that terminates with a cemented PVC end cap. The lower casing perforation consists of 1/2-inch diameter holes, spaced 60-degrees apart around the pipe circumference. Each row of holes is spaced 3 inches center to center along the length of the well casing with the next row off set 3-inches from the previous row; see *Sudbury Landfill Area 6 Closure Project Construction Documents, March, 2010, M-501* for more detail.

The perforated section of the well casing is embedded in a filter pack consisting of 1- to 3-inch diameter rounded stone or gravel to a minimum 1-foot above the top of the perforations. A minimum 3 foot thick layer of hydrated bentonite seal was placed above the gravel backfill sealing the perforate section from potential surface infiltration. Structural soil backfill material was then placed around the well casing to a depth of 2-feet from the bottom of the cover soils where the remaining fill to the surface consisted of a bentonite soil mixture seal was placed to the top of well.

2.4.5 LFG Piping Network

Area 1, 2 and 5

Each well casing is fitting with a 1.5- or 2-inch diameter vertical wellhead monitoring assembly. The downstream connection of the wellhead assembly joins to a four (4)-inch diameter HDPE SDR-17 vacuum lateral which conveys LFG to a 8-inch diameter subheader and subsequently to the main 8-inch diameter header pipe.

Area 6

Each well casing is fitting with a 1-inch diameter vertical wellhead or 2-inch diameter horizontal wellhead monitoring assembly. The downstream connection of the wellhead assembly joins to a 4-inch diameter HDPE SDR-17 vacuum lateral which conveys LFG to a 8-inch diameter subheader (Area 6 only) and subsequently to the main 8-inch diameter header pipe.

2.4.6 Wellhead Monitoring Assemblies

Each wellhead monitoring assembly consists of a 1.5 or 2-inch diameter PVC gate valve for LFG vacuum (and flow) control, multiple hose barbs with vinyl caps for LFG composition monitoring, and a flexible hose which connected to a 2-inch diameter PVC or HDPE pipe that connects the assembly to the HDPE lateral. The hose barb enables connection of instruments for LFG composition, temperature, and pressure monitoring. The flexible hose isolates the well and monitoring assembly from forces exerted by the lateral pipe, and allows a limited amount of differential movement to occur.

A vacuum applied to the extraction wellfield from the flare station's blowers induces LFG flow from the vertical wells. The extracted LFG then flows through the wellhead monitoring assembly and into the LFG piping network as described above.

Example of Vertical LFG Extraction Wellhead

2.5 Operation, Monitoring and Tuning

The following section discusses methods and equipment for operating the LFG extraction wells (vertical or horizontal), collecting readings of LFG quality, temperature, flow, and vacuum, and how to adjust the extraction well vacuum setting for proper operations.

Wellfield Monitoring Equipment

It is important for site operations that the data set collected from the field is consistently complete and accurate. The accuracy and dependability of the monitoring equipment are key to providing reliable results on which to perform adjustments for optimal operation of the GCCS. The monitoring equipment must meet the following minimum requirements:

1) Infrared sensor technology for CH_4 and CO_2 measurement;
2) Sensor for O_2 measurement;
3) Temperature probe to measure the temperature of the gas stream;
4) Internal pressure sensors to measure static, available and differential pressures in order to calibrate flow (scfm);
5) Ability to be calibrated in the field;
6) Ability to store measured data and notes;
7) Ability to download stored data into a file.

Two industry standard LFG meters are listed below. Information on the operation of these meters can be provided by the meter manufacturer. Each meter has various features and functions used for monitoring and tuning LFG extraction wells.

- GEM-2000 et. seq. by CES-Landtec
- Elkins Earthworks

2.6 Wellfield Monitoring, Balancing, and Tuning

Example of Handheld LFG Analyzer and Wellhead

Valid wellfield data is critical to maintaining compliance and essential to making accurate tuning decisions. Without accurate data, improper tuning adjustments are a possibility and can lead to non-compliant operational issues, such as odor, landfill gas migration and potentially long-term damage to the gas-producing bacteria population. A complete and accurate data set for each monitoring event is critically important for Sudbury Road Landfill. It will be used to document compliance, track required improvements for the wellfield and assist with budgeting operational requirements. Incomplete data sets, corrupt or missing data are unacceptable

The following section discusses procedures for proper monitoring, balancing, and tuning the wellfield. The goals of balancing and tuning a wellfield are to:

- Control LFG emissions, migration, and odor;
- Comply with federal, state, and local regulations;
- Prevent air intrusion; and
- Prevent damage to methanogens.

The following monitoring, balancing, tuning procedures have been developed to achieve the above requirements and can be found in **Appendix A.2 - Monitoring Requirements**. Additional monitoring and troubleshooting protocols can be found in **Appendix A.3 - Monitoring and Troubleshooting Procedures**.

1. Monitor and tune each well a minimum of once per month unless permit conditions or other site conditions warrant more frequent monitoring and tuning (please refer to **Appendix A.2 - Monitoring Requirements** for monitoring and reporting requirements). The condition of the wellhead assembly and connecting piping should be entered into the monitoring instrumentation at the time of monitoring. Remonitoring is often required and recommended following making adjustments to wellhead vacuum settings not only to comply with permit conditions but to

assess the effects of any adjustments made. ***(Certain steps below are applicable to the GEM-2000, GEM-5000 or similar instrument by CES-Landtec. For other instruments, refer to the manufacturer's O&M manual.)***

a. Read the User's Manual for the instrument being used.
b. Begin with a calibrated LFG meter in accordance with the meter manufacturer's recommendations.
c. Before beginning and monitoring and tuning event, verify that the collection system is operating under vacuum, stable and operating under representative conditions.
d. Collect a composite LFG quality reading from the inlet to the KOP or at the header near the LFG Analyzer, if present, at the flare station.
e. Record the field vacuum being applied by the flare station.
f. Note weather conditions and barometric pressure.

g. Proceed to the wellfield and select the desired well ID number from the selection screen on the analyzer.
h. Check the wellhead for leaks, excessive lean, cracks, loose fittings, hissing sounds, surging sounds, and broken fittings that could cause air leaks and inaccurate readings. Make sure each well is properly labeled.
i. Allow the analyzer to purge the internal components and sample tubing.

j. Connect the status and impact pressure sampling tubes to the appropriate fittings on the wellhead. They are labeled.
    i. Verify that the connection is airtight and does not allow ambient air to infiltrate the sample.
k. Start the instrument sampling pump within the analyzer to sample the landfill gas from the well.
    i. Make sure any liquid in the sampling tubing does not enter the instrument. If necessary disconnect the tubing from the hose barb or turn off the sample pump. Drain all liquid and repeat steps.
l. With the pump on, allow the gas concentrations to stabilize and record the readings on the analyzer. It may be necessary to activate the pump more than once.
m. Proceed to the Measure Flow screen.
n. Zero the pressure transducer if the analyzer reads ≠ 0
o. Record the static and differential pressure readings and continue with the measurements.
p. For the GEM 2000: Adjustments should be made during the initial pressure vs. adjusted pressure screen. This allows for the adjusted flows and pressures to be recorded within the instrument.
q. All wells should be under vacuum. Adjustments should be made so that the vacuum change is limited to 10% of the initial vacuum (when possible).
r. Adjust the vacuum to the well to achieve desired tuning goals such as:
s.
t. Methane: 45% to 54% (can vary on a case by case basis)
u. Oxygen: 0% to 2%
v. Balance Gas: < 10%
w. Vacuum: > 0 inches of water column
x. Temperature: < 131 Degrees Fahrenheit
y. Instantaneous Surface Emissions < 500 ppm methane or per applicable regulations (**not applicable at the time this report was created**)
z. Integrated Surface Emissions < 25 ppm methane or per applicable regulations (**not applicable at the time this report was created**)
aa. Following any adjustments, press return or store readings.
bb. Select all applicable pre-programmed comments. (See User's Manual for more information.)
cc. Disconnect all tubing and the thermometer. Make sure the fittings springs release and there are no air leaks.
dd. Once the monitoring event is started, complete monitoring and tuning in consecutive days. The Sudbury Road Landfill wellfield monitoring can be completed in one day.

2. Troubleshooting and Guidance: Consult **Appendix A.3 - Monitoring and Troubleshooting Procedures** for the following conditions:

    a. If positive pressure or 0 pressure (vacuum) is detected
    b. For increasing methane (>54%) or low methane (<45%)
    c. For increasing oxygen ($\geq$ 2%) at the wellheads
    d. For increasing balance gas (>10%)
    e. For increase carbon dioxide greater than methane concentrations
    f. For increasing temperatures

3. Should the initial readings exceed permit requirements, perform corrective actions on the same day that the monitoring parameter exceeded the permit limit, if possible, but no later than 5 days following the initial reading or per applicable regulations (**not applicable at the time this report was created**)
4. After corrective action is made, obtain a compliant reading within 15 days of the initial reading or per applicable regulations (**not applicable at the time this report was created**)
5. If a compliance reading is not achieved with 15 days of the initial reading, follow the permit conditions and appropriate response action or per applicable regulations (**not applicable at the time this report was created**)
6. Program and complete monitoring and tuning before the 15th of the month or per applicable regulations (**not applicable at the time this report was created**)
7. Perform any additional monitoring and troubleshooting, once required site tuning has been completed.

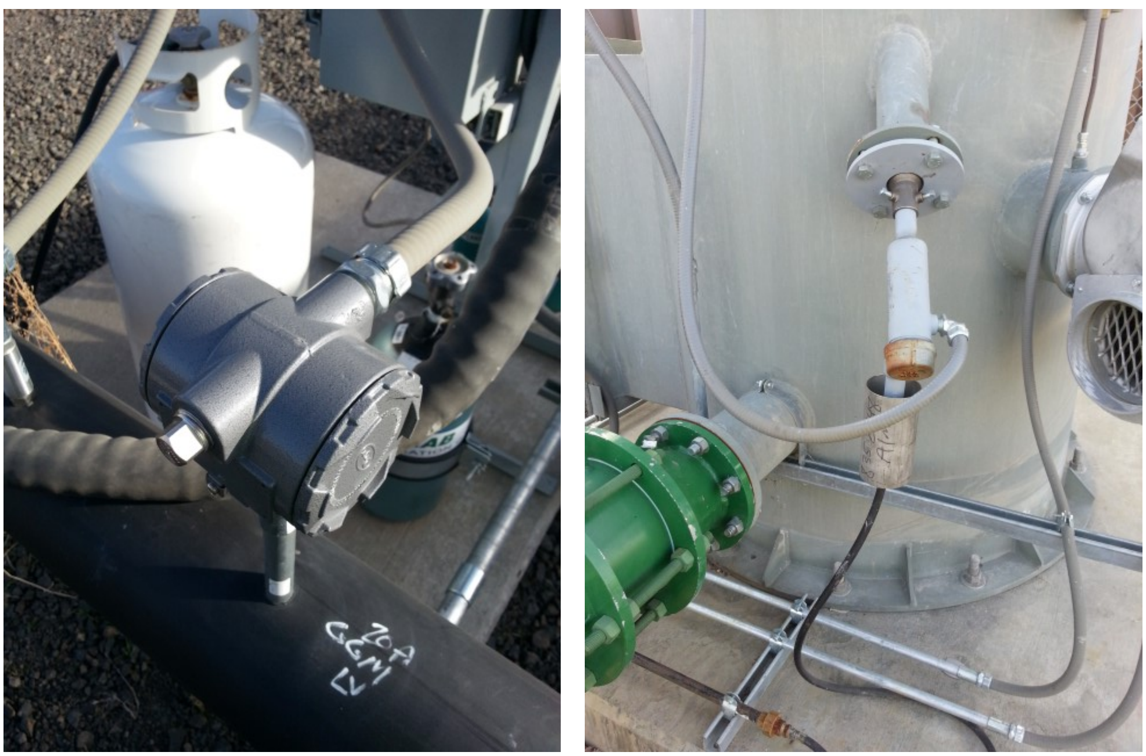
2.7 Blower/Flare Station Monitoring

The following parameters should also be monitored monthly at the flare station. Refer to **Appendix A.4 - Inspection Forms**.

1. Inlet to Knockout Pot (KOP)
    a. Measure vacuum and LFG quality before and after the wellfield monitoring event:
        i. Inlet to the KOP.
        ii. Major header branches if available (**currently sample ports only exist at the wellheads and flare station)**
2. Control Devices
    a. Measure LFG flow before and after the monitoring event at each of the following:
        i. Flare Station
    b. Differential Pressures
        i. KOP
        ii. Across the flame arrestor element
    c. Stack Operating Temperature
        i. 1400 to 1800 Degrees Fahrenheit but should be set at 1500 and remain stable with little to no fluctuation. Shut down occurs at 2000 Degrees Fahrenheit.
3. Sump and Pump
    a. Check operation of the sump pump.
    b. Record cycle counter readings if so equipped monthly.
    c. Check for accumulation of debris in sump or scale on pump.

Sump Control Panel and Sump Vault

4. Pilot and Propane System
    a. Check fullness of each propane cylinder
    b. Check proper pilot sequence and temperatures achieved
    c. Check pilot gas on following purge cycle
    d. Check ignition of pilot gas and “flame proven”
    e. Check blowers on and inlet valve open at set point 200 Deg. F.
    f. Check pilot off at set point 400 Deg. F.



Flowmeter (Left) and Flare Pilot Assembly (Right)

5. In-line LFG Monitoring Device

a. Check methane, oxygen, and carbon dioxide content.

b. Check methane to be relatively same as field tuned compiled quality measured at KOP inlet.

c. Check oxygen content equal to or less then field compiled oxygen content. Oxygen content greater than 2% may indicate an air leak in the piping system or at a wellhead.

d. Check auto-calibration of in-line detection monitor.

6. Blower Devices

a. Check to make sure the blower is maintained in accordance with the manufacturers' recommendations, e.g. proper lubrication, etc.

b. Blowers should be rotated monthly or as determined by the technician to ensure equal usage between blowers and to maintain appropriate lubrication.

c. Periodically inspect foundation and report to the Site Landfill Manager if deficiencies are found. Check for level condition and report conditions as necessary.

d. Check condition of isolation pads and replace as necessary.

e. Make sure lubrication maintenance schedule is established and adhered to.

f. Periodically check all valves in system. A stuck or broken valve can cause severe damage to equipment.

g. Alignment should be checked and corrected annually.

h. Check pipe supports and adjust if necessary.

i. Keep equipment clean. If machine is oil lubricated, be sure to keep oiler bottle clean so oil, or lack of, can be seen. Keep oil breather cleaned to prevent leaks.

j. Follow motor manufacturer's recommendations for motor maintenance.

k. Vibration readings and bearing temperature readings should be taken periodically to monitor the condition of the machine bearings which are the most critical component in your machine. If equipment to do this is not available, consult manufacturer.

LFG Blower and LFG Power Breaker

2.8 Gas Probe Monitoring

Performance LFG monitoring will be conducted at the landfill perimeter during the remedial action. Performance of the LFG control systems will be based on not exceeding the methane lower explosive limit at the Site boundary and diminishing VOC concentrations in the groundwater monitoring wells located at the conditional point of compliance. The LFG operating system will be evaluated and optimized to control the LFG if the methane level is observed consistently above 2% by volume in the gas monitoring probes located at the Site boundary.

Performance monitoring of LFG will occur from system start-up through the duration of the active compliance groundwater monitoring period on a quarterly schedule. The quarterly monitoring events will coincide with the compliance groundwater monitoring program schedule (March, June, September, and December).

During the performance monitoring period, LFG field measurements will be collected from:

- Perimeter gas monitoring probes GW-7S, GW-7D, GW-8, GW-9, GW-10, and GW-12, to monitor for potential gas migration at the Site boundaries; and
- Site gas monitoring probes GW-5, GW-6, and GW-11 to assess the operational effectiveness of the LFG extraction system.

The following parameters will be monitored at each gas probe:

- Methane (CH_4);
- Carbon Dioxide (CO_2); and
- Oxygen (O_2).

During each monitoring event the barometric pressures will be obtained from local atmospheric sources. The barometric pressures will be recorded and it will be noted whether the pressure during the monitoring event was falling, stable, or rising.

Monitoring requirements include:

1. Review barometric pressure trend and conduct the monitoring when the pressure is dropping or stable.
2. Calibrate gas meter
3. Measure probe static pressure before sampling
4. Turn on pump and allow readings to stabilize before storing readings.
5. Record gas qualities
6. Notify GCCS manager if any reading is >2% CH_4 by volume.

2.9 Liquid Level Measurement

LFG extraction can be effected by the presence of liquids within the collection well. Liquid can greatly compromise the effectiveness of the screened interval of a LFG well. Controlling liquid buildup in the LFG wells is required for effective LFG management and Best Management Practices (BMP). Not part of our SOW.

A baseline liquid level measurement shall be undertaken for the site. Additional measurements shall be taken on a regular frequency (quarterly for active areas and semi-annual and annual for closed areas) or in line with the existing monitoring regime. The data shall be collected and plotted to identify any trends to ensure the wellfield is operating at maximum efficiency and that the extraction wells are not watered in. Should it be detected that any wells have liquid levels impacting the perforations of the well casing, the wells should be dewatered to ensure proper performance.

2.10 Data Management

Proper management and reporting of field data is critically important. Manipulation or misrepresentation of field data is a violation of the permit and the Clean Air Act.

2.10.1 Electronic Data

1. Setup/Program the monitoring instruments with the identifications of the wells and or ports to be monitored routinely.
2. Do not alter the raw data file.
3. Download the electronic data and email to GCCS Manager or specified data manager.
4. Retain copies of unaltered data files.
5. All data files are the property of Sudbury Road Landfill.
6. If the data from a monitoring event becomes corrupted, lost, or unusable, immediately re-monitor the affected data point before the end of the monitoring period.

2.10.2 Written Log Book Data

Field conditions that cannot be stored electronically within the monitoring instrument should be noted in a field log book. Field technicians are required to keep a site logbook for recording site conditions which require notation. Site logbooks are the property of the Sudbury Road Landfill and should be relinquished to the site management upon request.

Site conditions which require recording:

- Meteorological conditions
- If any maintenance is performed
- Record any non-tuning efforts for corrective actions
- Calibration results
- Date and unusual conditions
- Erosion areas
- Surface depressions
- Document damage to wellheads and/or surface area discovered during monitoring event or repairs completed.

- Other pertinent information that may be useful at a later date.

2.10.3 Reporting Procedures

See **Appendix A.2 for Reporting Requirements** and **Appendix A.4 - Inspection Forms**

Data and reports generated as part of permit and regulatory requirements are to be submitted to the GCCS Manager and selected consultants for submission to regulatory agencies as required.

2.10.4 Internal Monthly Wellfield Reports

Detailed monthly reports are undertaken by a third party consultant, site reports are to be submitted to inform detailed monthly reports. Monthly site reports should include at a minimum:

1. Summary of the overall condition of the landfill gas collection system including:
    a. Gas flow and quality at control devices (blower, compressor, flares)
    b. General operational issues
2. Service dates and a description of services performed.
3. Monitoring results including adjustments and comments, data shall include:
    a. Gas quality (CH_4, CO_2, O_2 and balance gas).
    b. Gas pressure data.
    c. LFG temperature (ºF)
    d. Flow from the monitoring point in scfm.
    e. Dewatering requirements.
4. Status of corrective actions to meet compliance requirements.
5. Compliance Status and Upcoming Reports.
6. Calibration logs.
7. Details of repairs performed and required.
8. Recommendations
9. Spare Parts Inventory

2.11 Surface Emissions Monitoring (SEM) Procedures –

See Surface Emissions Monitoring Program for City of Walla Walla Sudbury Road Landfill (Not applicable at this time)

Surface (or Performance) emissions monitoring shall be undertaken at Sudbury Road Landfill on a routine quarterly basis to ensure compliance with the requirements of Section 4.3.1 of Method 21 Appendix **A.3**, 40 CFR 60 as well as to evaluate the performance of the LFG control system for the site. **(Not applicable at the time this report was created)**

This page left blank

3.0 LANDFILL FLARE STATION SPECIFICATIONS AND PRIMARY EQUIPMENT

Landfill Gas Flare Station Specifications and Primary Equipment are described in the following section. The enclosed flare station at Sudbury Road Landfill is designed to combust landfill gas in accordance with permit requirements. Table 3-1 lists the general specifications for the flare station.

Table 3-1
Specification for Flare Units

FLARE SPECIFICATIONS	
Reference	John Zink Biogas Flare
Manufacture Date:	12 - 2010
Serial Number #	BF-9109403
Model #	ZTOF 4' x 4'
Style	Enclosed
Diameter and Height (ft)	4' diameter x 40' tall
Maximum Flow (scfm)	350
Minimum Flow (scfm)	150 (2:1 turndown ratio at design operating temperature)

The major components for the John Zink flare station include:

- KOP - One 24-inch. diameter x 60-inch tall condensate knock-out pot with 20 micron carbon steel demister/filter, 8-inch inlet and 8 inch outlet, sight glass, and drain port;
- Three (3) concrete pads; one (1) flare tower pad (6' square), one (1) blower/KOP pad (10' x 20') and one (1) LFG analyzer pad (3' square), which provide support:
- Two (2) New York Blowers Model 2606A pressure blowers each with belt drive, and 7.78 HP, 460 VAC, 3 Ph, 60 Hz, TEFC motor (each blower sized for 380 SCFM @ fan static pressure 50 in. w.g. inlet vacuum and 10 w.c. discharge pressure, 100 deg. F, 600 ft. asl);
- Flame arrestor;
- Flare control and monitoring instrumentation; and
- Heat Trace Tape and Insulation.

The major flare skid components are described below.

3.1 Blower Flare Skid and Flare

A detailed list of equipment and components is provided in **Appendix A.5 – Key Components**. For details and further operational procedures, consult the Zink O&M manual, which is incorporated by reference. The major components are described below, according to sequence in the LFG process flow.

3.1.1 Condensate Knock-out Pot

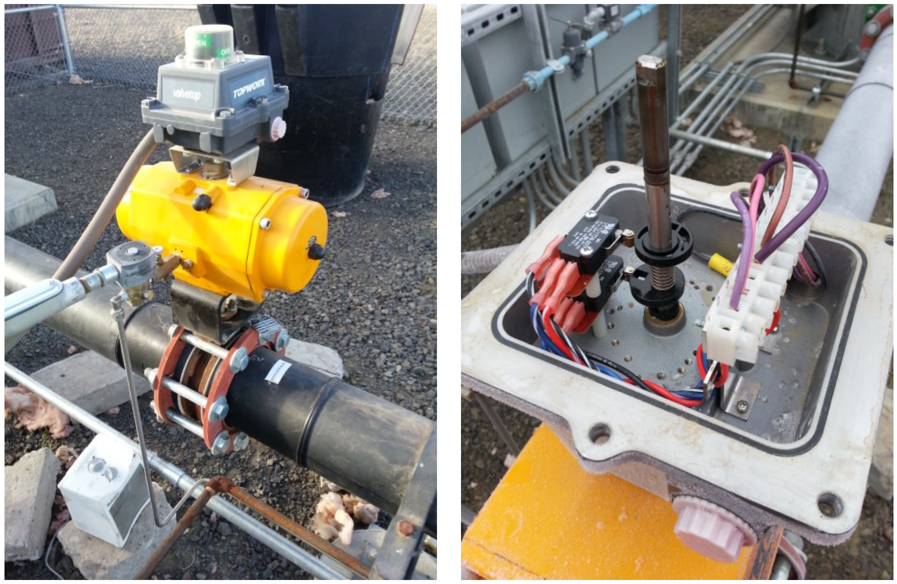
A 24-inch x 60-inch tall condensate knock-out pot with 10-micro carbon steel demister/filter is located at the flare station. The purpose of the condensate knock-out pot (KOP) is to remove excessive moisture and large particles from the LFG flow stream, which might otherwise impact the blower or other sensitive components on the flare skid or in the LFG transmission system. A 2-inch diameter liquid drain is provided at the bottom of the KOP, and is connected to Condensate Sump #1 located North of the flare station. The KOP has an external sight gauge, to allow monitoring of the condensate level in the KOP. The differential pressure across the KOP should not exceed 5 inches of water column. If it does, the KOP demister pad within the KOP may contain debris that needs to be removed. Visually inspection of the KOP demister pad annually is recommended.

3.1.2 Pneumatic Flare Inlet Valve

The purpose of the pneumatic flare inlet valve is to provide fail-safe shutdown of LFG flow to the flare. This valve is controlled by a programmable logic controller (PLC) located at the flare station. The PLC constantly monitors the flare station and if set parameters are exceeded, the PLC will de-energize the flare inlet valve to ensure the safety of the equipment and personnel. Under most conditions, the inlet valve will remain open when the flare skid blower and flare are energized.

The valve actuator consists of a set of pneumatic pistons that opens the LFG butterfly valve when energized/pressurized, and a set of return springs that closes the butterfly valve when the unit is de-energized/de-pressurized. During operation of the flare, the solenoid valve is energized/pressurized and it holds the valve open. When the flare system shuts down or power to the flare skid is disrupted, the solenoid valve is de-energized/depressurized, which allows the springs to close the LFG butterfly valve.

The pressure regulator located between the compressor and the actuated valve should be adjusted to maintain appropriate pressure to the pneumatic valve actuator. The manufacture recommended operating pressure for the pneumatic valve actuator is approximately 100 pounds per square inch, gauge (psig). The pneumatic valve air supply must never exceed the manufacturers recommended operating pressure of 125 psig pressure, as damage to the gauges, valves, and piston could result.



Autovalve (Left) Autovalve Control Relays (Right)

3.1.3 LFG Blowers

The flare skid includes Two (2) New York Blowers Model 2606A pressure blowers each with belt drive that provide 380 standard cubic feet per minute (scfm) each. Although, one blower can support the site, two blowers are provided to avoid shut-down during required maintenance periods. The purpose of the LFG blowers provides the vacuum and pressure required to extract the LFG from the landfill and convey it to the flare. The blower has a maximum capacity of more than 380 cubic feet per minute (scfm) with a total differential pressure of 40 inches water column (in. w.c.), depending on the flow rate. The butterfly valves are provided at the blower inlet and outlet for control of the LFG flow rate.

3.1.4 Flame Arrestor

The purpose of the flame arrestor is to prevent the backward propagation of flame from the flare burner tip into the flare skid piping and blower. This situation could occur through a combination of low LFG flow velocity with high oxygen and low methane concentrations. The flame arrestor contains banks of expanded aluminum, which serve to dissipate the heat required to maintain a continuous flame, preventing further travel of the flame front. The heat absorbing banks can be accessed for periodic cleaning or replacement by removing one of the side cover plates.

The flare arrestor core should be removed annually for steam cleaning or pressure washing. However, more frequent cleaning may be required if the differential pressure across the flame arrestor exceeds a pressure of 2-inches of water column (w.c.).

3.1.5 Enclosed Flare

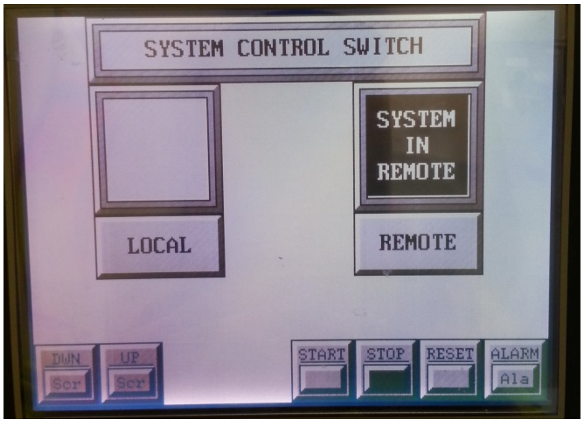
The Zink enclosed flare is designed to burn LFG at an operating temperature to meet local and federal EPA air quality regulations for emissions (40 CFR 60.18).

The flare is a vertical, enclosed flare constructed of ¼-inch carbon steel with stainless steel wind screens, flame retainers, and burner tips. The flare includes the following components:

- Purge blower;
- Automatic Temperature Control;
- Igniter Pilot Assembly;
- Automatic Flare Controller; and
- Spark ignited propane pilot burner.

3.1.6 Flare Controls

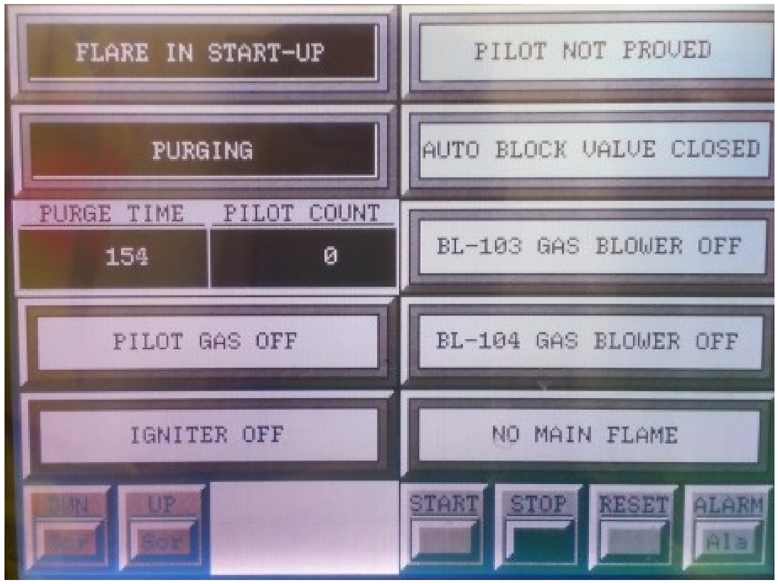
The blower and enclosed flare can be operated in either manual (Local) or automatic mode (Remote). The flare should only be operated in manual mode for short periods, and only when trained personnel are in attendance. In automatic mode, the following controls are activated and provide redundant safeguards and effective combustion of LFG.



Zink Control Panel (Remote vs Local Display Screen)

3.1.7 Pilot Burner Control

The purpose of the pilot burner control is to determine that a sufficient pilot flame is present to ignite a LFG stream. When the flare system is first energized, propane from a storage tank is supplied to a pilot burner where it is ignited by a high voltage sparker assembly. Upon spark ignition at the pilot burner, the pilot flame thermocouple begins transmitting the flame temperature to a recorder/controller. Once the pre-set temperature (typically 200ºF) is reached, the LFG blower is activated and the pneumatic flare inlet valve is opened. The pilot gas flame will remain on until the temperature is increased to 400ºF (typically) is measured by the thermocouple, at which time the pilot flame will turn off. If the pilot flame thermocouple cannot attain 400ºF within a set time interval (commonly around 300 seconds), the blower will automatically shut down and the pneumatic valve will close. A sustained low pilot flame temperature may indicate that the LFG may not have ignited.



Zink Control Panel (Start-up Sequence Display Screen)

View of Flare Tip (View from Inside Flare)

3.1.8 Ultraviolet Light Flame Detector

The purpose of the ultraviolet (UV) flame detector is to monitor for the presence of a flame at the flare burner. The ultraviolet flame detector continuously scans for UV emissions from the flame. If the flame is not detected, then the flame detector will signal the blower controls to automatically shut down operation and close the pneumatic LFG valve.

The UV detector signals are processed by the Coen flame scanner relay control system. The Coen flame scanner uses preprogrammed software and instrumentation to detect when the flare is operating out of normal ranges for programmed parameters.

Coen Flame Scanner Assembly

3.1.9 High Inlet Gas Temperature Thermocouple

A thermocouple is positioned at the base of the flare stack. The purpose of the inlet LFG thermocouple is to detect a flame moving down through the stack. At a pre-set high temperature limit, the LFG inlet temperature probe will shut down the blower/flare Facility, to prevent backward propagation of the flame. The flame arrestor delays flame propagation, until the LFG temperature probe is able to trigger the shutdown of the LFG flow. This combination provides effective redundant protection of the blower/flare skid.

3.1.10 Stack Thermocouples

Thermocouples are used to monitor the stack temperature and the readings are connected to the flare station louvers controls which automatically adjust to maintain the set point operating temperature. The lowest thermocouple is used when the LFG flow rates are low, or near the minimum operating flow rate for the flare to maintain combustion and set point temperature. The middle thermocouple is for mid-range LFG flows. The upper thermocouple is used for high LFG flow rates approaching the maximum recommended operating flow rate for the flare.

3.1.11 System Shut-down on Power Failure

In the event of an electrical power failure, the flare station will shut down. Due to the interruption of LFG flow, the flare will be extinguished. In addition, the pneumatically actuated LFG valve will close. Upon the restoration of electrical power, the ultraviolet flame detector will recognize that the main flame is not ignited and will prevent the automatic restart of the flare. The flare station is programmed to attempt auto-restart upon power restoration.

3.1.12 LFG Flow Meter

There are currently three thermal mass diffusion flow meters installed at the landfill.

Main Flow Meter located at the Flare Station

Secondary Flowmeters located in the Flare Station Maintenance Building and between Area 5 and 6.

The main totalizing thermal mass diffusion flow sensor is installed on the header between the blowers and flame arrestor, to allow LFG flow measurement, indication, totalizing, and recording. The LFG flow through the header at the flare station is measured and the flow data is relayed to the PLC and recorded in the digital LFG chart recorder (Fleetzoom).

The main flow meter output is integrated over time, and both continuous flow rate and periodic total flow is recorded with the digital LFG chart recorder Fleetzoom located in the flare control panel control rack.

The second Flow meter is located in the Flare Maintenance Shed and has an internal totalizer. This flow meter monitors the instantaneous and total LFG flow for of Area 1.

The third flow meter is located between Area 5 and 6 and has an internal totalizer. This flow meter monitors the instantaneous and total LFG flow for of Area 2 and 5.

3.1.13 Digital LFG Chart Recorder Data

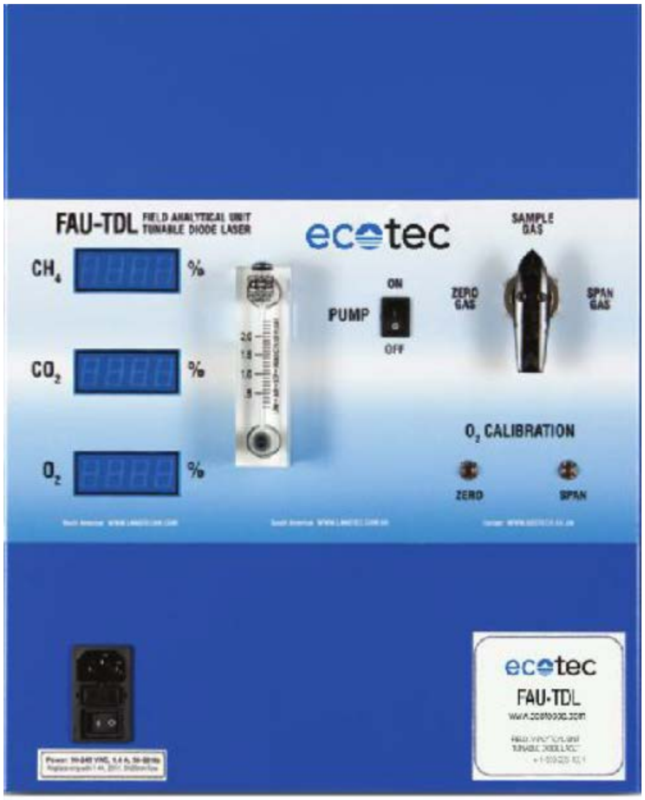
A Fleetzoom FZ400 Cellular Data Acquisition System performs continuous data acquisition and monitoring for the flare and landfill gas analyze providing real-time status. Run times, cycles and values listed below are acquired simultaneously and continuously. Alarms are generated during status changes when signals are detected out of range. The unit uploads samples every 5 minutes and permanently stores them on the monitoring website in real time.

The digital recorder installed at the control panel is used to monitor and record the following parameters:

- Flare Stack Temperature (Degrees F.)
- Inlet Pressure (Field Vacuum in. w.c.)
- Flare Flow (scfm)
- Methane Content (%)
- Carbon Dioxide (%)
- Oxygen (%)

This system requires no maintenance.

3.1.14 Gas Analyzer and Oxygen Sensor)



LFG Analyzer Display Screen and View of Internal Control Panel

The flare station is equipped with an in-line landfill gas analyzer and oxygen sensor. The Field Analytical Unit – Tunable Diode Laser (FAU-TDL) unit analyzes the content of methane and carbon dioxide in the landfill gas stream prior to the flare inlet. The analyzer displays percent (%) methane, % carbon dioxide and % oxygen on the enclosed panel located near the header at the flare station.

The FAU-TDL has been designed to require minimal service and maintenance. One of the advantages of the TDL technology is that it does not require adjustment over time to maintain calibration. Once the instrument is built and factory calibrated the laser channels (CH4 and CO2) should not need any adjustments in the field. However, the Oxygen channel does need to be adjusted periodically to maintain calibration as Oxygen is monitored using galvanic cell technology which will require periodic adjustments and replacement.

As mentioned this unit is self-calibrating and is equipped with a limited supply of calibration gas. The gas supply should be checked on a monthly basis. Further Service and Maintenance is discussed in Section 7. Refer to the FAU-TDL Analyzer manufacturer's O&M manual located in **Appendix A.1 – GCCS Equipment Operation Manuals**.

3.1.15 Heat Trace Tape

The LFG header system at the flare station has been insulated with a self-regulating heat trace tape and corresponding all-weather insulation. The insulation around the valves and other appurtenances in constructed of removable insulation bags. When the system is active the LED lighted sensors will illuminate. The entire system is controlled by the circuit breaker in the flare building electrical panel.

The heat trace tape system required no maintenance. The insulation should be inspected periodically for damage and replaced as necessary.

If the system does not appear to be functioning (not heating) call a certified electrician to have the system inspected and repaired as necessary.

3.2 LFG Flare System Equipment and Parts

3.2.1 Equipment

Appendix A.1 – GCCS Equipment Operations Manuals identifies the key components of the blower and flare system equipment. Manufacturers can be contacted directly should any parts listed in the **Appendix A.5 – Key Components** require replacement. The purpose of these equipment lists is to provide a quick reference to the manufacturer or responsible sales representative. In the case of equipment failure, please refer to the manufacturer's operating and troubleshooting instructions for details. These equipment lists should be used as a supplement to the manufacturer provided operation and maintenance manuals.

3.2.2 Spare Parts

To minimize long-duration system shutdowns and optimize performance, an adequate supply of critical spare parts should be maintained. Each manufacturer's instructional literature typically contains standard recommended spare parts and supplies for various pieces of major equipment. For suggested spare parts inventories for the Zink Specialties flare skid, please refer to specific manufacturer's literature in the Zink - O&M Manual.

4.0 Condensate Collection and Disposal

As described in the previous sections, the extracted LFG is usually warm and has a close to 100 percent saturated moisture content. As the LFG is extracted from the landfill, the gas cools and the saturated moisture condenses on the inner walls of the gas collection pipes, forming a liquid known as LFG condensate. The purpose of the condensate collection system is to collect and remove free liquid from the LFG collection system before it can accumulate and inhibit the GCCS's performance.

The condensate collection system for the GCCS includes the following components:

    - Sump #1 (CS-1) – located on the north side of the main haul road between the flare station and EW-4
    - Sump #2 (CS-2) – located north of EW-9 at the toe of slope and south of the maintenance road
    - Sump #3 (CS-3) – located approximately 150 feet northeast of the flare station towards Area 7. (Currently this Sump is not active)
    - Sump #4 (CS-4) – Located NW of EW-18 and Area 5 at the toe of the slope near the concrete lined stormwater trench structure.
    - Sump #5 (CS-5) – located east of Area 2 near the household hazardous waste recycling building.

- A pumping system for each condensate sump(s);
- A KOP located at the flare station; and
- Onsite leachate storage and evaporation ponds.

4.1 Wellfield and GCCS Condensate Collection

The various sized lateral pipe within the landfill in Areas 1, 2, 5 and 6 collect LFG as well as condensate. All piping inside the perimeter of the landfill gravity drain any collected condensate to the five (5) perimeter sumps. From the various sumps, condensate is conveyed via 1.5-inch or 2-inch force main piping to the LCRS system in Cell 7.

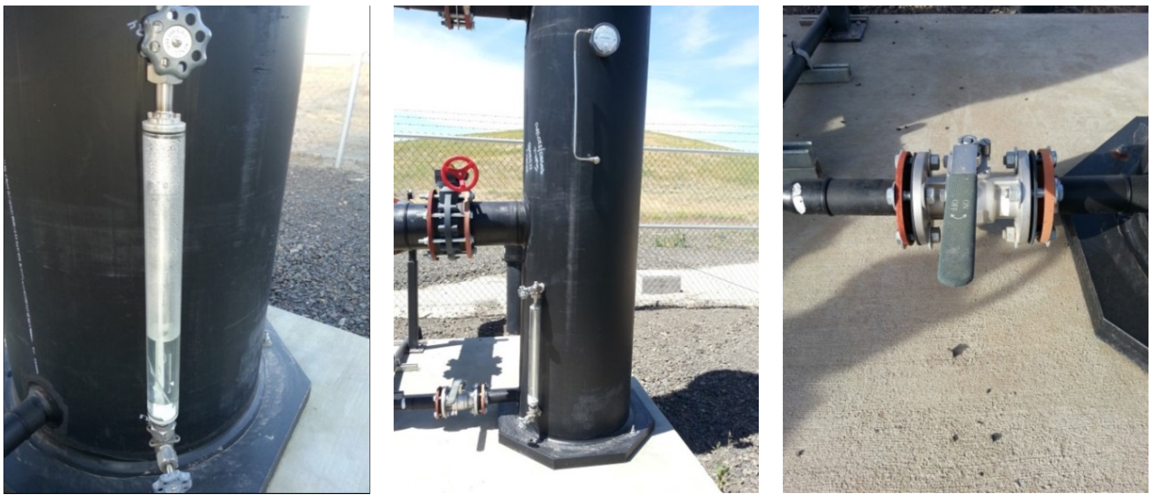
As described above LFG traveling to the flare passes through the KOP, which is designed to remove any remaining condensate prior to entering the flare. Condensate collected at the KOP is gravity drained through a two (2)-inch HDPE pipe to the buried condensate sump #1 (SC-1) located to the north flare station.

The sumps should be inspected periodically for any sediment accumulation or debris. Considerable sediment or debris should be removed from the sump as necessary to prevent damage to the sump pump.

The sumps contain AutoPump 4.0 bottom loading, short pneumatic submersible pumps manufactured by QED. The sump pump is programmed to automatically operate when the level of condensate in the sump reaches 24–inches or more above the bottom of the sump. When the water level in the sump is below 20-Inches, the pump automatically turns off.

The QED pump is designed to be maintenance free but should be inspected routinely for proper operation. The external casing of the pump and the intake screen may need to be cleaned if deposits accumulate or if any debris accumulates in the sump. Clean the pump in accordance with manufacturer recommendations. Should the pump need to be serviced, contact a local QED pump dealer or service provided. A rental pump should be available in the event the original pump must be sent in for service. In the event of an emergency, the sump may be pumped manually using a vacuum truck or approved equivalent.

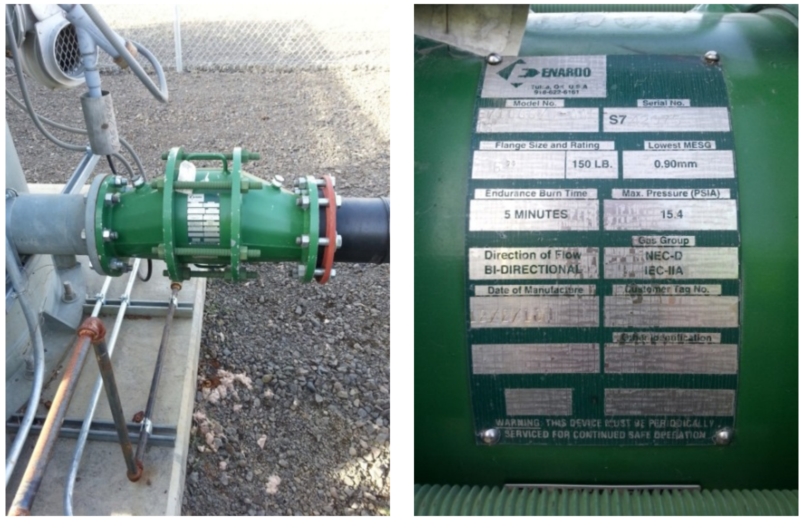
4.2 Knock-Out Pot



Condensate Knock-out Pot Sight Gauge and Drain Valve

The purpose of the KOP is to remove excess and suspended condensate from the LFG before the gas enters the blowers. Condensate that collects in the KOP is drained to the condensate sump #1 (CS-1) via a drain line. The ball valve on the drain should remain open at all times to ensure condensate drains from the KOP to the sump.

4.3 Flame Arrestor Drain



LFG Flame Arrestor

The flame arrestor is equipped with a drain plug at the bottom of the arrestor housing. This drain should be checked periodically for the presence of condensate. Any condensate from the drain may be collected in a container and disposed in the condensate sump.

This page left blank

5.0 LFG Flare System Operating Procedures

Under normal operating conditions, the LFG will be extracted from the landfill and transmitted to the flare via a network of LFG collection pipes. Blowers at the flare will provide a vacuum to the collection system to convey LFG to the flare for combustion.

When operating the landfill flare system, the vacuum required to extract the specified LFG flow from the landfill is adjusted by opening or closing the gate valves at the individual wellheads in the field.

The following operating procedures are provided as guidelines for operation, start-up, and normal shutdown of the LFG flare system. The procedures described below assume that all equipment and controls have been tested and adjusted, and are functioning properly. Prior to operating any equipment the manufacturer's O&M Manuals should be read and understood. If there are any discrepancies between the below processes and the Zink O&M Manual, the Zink O&M Manual shall be the governing document.

5.1 Flare Station Startup Sequence

1. Purge Cycle

   The startup sequence begins with a purge cycle to vent any unwanted gases from the flare stack. The Purge Timer is adjustable and can be set through the operator display. A typical Purge Timer set point of 5 minutes will ensure safe conditions. An air flow switch is used in conjunction with the purge blower to insure proper airflow is obtained. A purge failure fault condition will occur if proper purge air flow is not sensed.

2. Ignition (Pilot) Cycle

   The ignition cycle establishes an initial flame and heat source to generate adequate temperature prior to introducing the flow of landfill gas.

   A pilot gas source, in conjunction with automatic spark ignition, is used to establish the initial flame. Propane is typically used for the pilot gas source.

   The Ignition Timer set point is adjustable (typically 15 to 30 seconds.) A pilot thermocouple is used to monitor the pilot gas flame and is used to determine when to start the gas blowers (Blower-On set point) and open the header valve, allowing the flow of landfill gas. The pilot temperature measurement is also used to determine at what temperature (Pilot-Off set point) to discontinue the use of the pilot gas.

   The Pilot Timer is used to indicate pilot system malfunction or failure and is user adjustable (typically 5 minutes.) If the pilot temperature does not reach the Pilot-Off set point before the Pilot Timer times out, a pilot fault will occur.

3. Combustion of Landfill Gas

   Landfill gas is drawn from the landfill by the blowers and sent into the flare stack for proper destruction using gas blowers.

Once adequate heat in the stack (for proper combustion) has been reached, determined by the measured pilot temperature, the gas blowers are started and the header valve is opened. This event is determined by the Blower-On set point (typically 300 degrees F) which can be adjusted to meet process requirements.

Blower startup and header valve position are monitored to ensure proper equipment operation. A blower auxiliary fault or header valve fault will occur if abnormal operation or positioning is detected.

After the combustion of landfill gas has begun, flame detection and low temperature detection are enabled.

4. Pilot temperature control set points.

   The control system uses two signal outputs which are used to sequence events during start-up. These are:

   a. Blower-On Temperature - Factory set to 300 degrees F. This is the temperature at which the blower will be started and the header valve opened.

   b. Pilot-Off Temperature - Factory set to 400 degrees F. This is the temperature at which the pilot gas solenoid will be closed, shutting off the pilot.

5. Check the Pilot Timer set point.

   The purpose of the Pilot Timer is to specify a set period of time to allow the pilot system to attain the pilot-off temperature. For instance, if the Pilot Timer has been set at five minutes and the pilot-off temperature is set at 400 degrees F, the pilot will have five minutes to heat the thermocouple to 400 degrees F. If the pilot system fails to attain the pilot-off temperature in the time period allotted, due to an exhausted pilot gas supply or other reasons, the entire system will shut down.

6. Check the Ignition Timer set point.

   The purpose of the Ignition Timer is to control the sparking period of the spark plug during start-up. This timer has been set at the factory at fifteen seconds which allows a constant sparking action by the igniter for this period of time. This should be adequate time to purge the pilot gas line of air and ignite the pilot gas. This timer should never need to be altered.

7. Continuous Monitoring

   Once the combustion of landfill gas has begun, certain conditions must be met to ensure proper combustion under safe operating conditions.

   Automatic temperature control is accomplished by manipulating louvers at the base of the flare stack, which introduce cooling air flow. A typical temperature set point may be between 1400 and 1700 degrees F. Maintaining this set point will insure proper combustion within the flare. There are typically at least three thermocouples in the stack. The appropriate thermocouple is automatically selected to be used for control, based on the measured gas flow.

Ultra violet flame detection (UV eye) monitors the presence of a flame in the stack. In the event the flame is extinguished, the pilot ignition system will try to “re-ignite” the flame. Failure to re-ignite will result in a flame fault and the appropriate shutdown actions will occur.

Temperature monitoring for both high and low temperature conditions will insure safe landfill gas combustion. A high temperature limit, typically 2000 degrees F, is measured using the “lowest” thermocouple, closest to the burner deck. This insures the safety of the burner equipment and insulation, resulting in longer equipment life. Monitoring for low temperature conditions insures that proper combustion temperatures are maintained.

The landfill gas flow, typically measured in standard cubic feet per minute (scfm), is also monitored, recorded, and displayed to indicate proper flare operation. High gas flow alarming is also in place to insure the gas flow does not exceed the capacity of the flare stack, which may result in unsafe operating conditions and equipment damage.

5.2 Pre-startup System Operational Check List

Items 1 through 4 below are routine system operational checks

1. Check the condensate drain valve at the base of the knock-out pot (KOP). Inspect the KOP gauge for any liquids present and drain if necessary.
2. Check the condensate discharge valve from the KOP to the condensate sump should be open.
3. Check and verify that all alarms are off and/or have been reset.
4. Check propane tank valve is open, propane line valve is open, and propane tanks are full.

5.3 Start-up Procedure – Automatic Start

Normal flare start-up is abbreviated below. For the detailed start-up procedures, see the Zink - O&M Manual

1. The following lists startup conditions that must be met to permit an automatic startup sequence of the enclosed flare system:
   a. Master switch in the ON position
   b. Absence of any alarm conditions - The red flashing alarm beacon (located on top of the control panel) and the operator display will indicate if there are any alarm or fault conditions present. All fault conditions must be cleared to permit a start sequence.
   c. Inlet valve in the closed position
   d. Pilot temperature below the Blower-On set point

e. Absence of any flame

f. Control Mode switch in the Auto position

2. Verify the manual inlet valves for the desired blower is in the open position.
3. Verify the manual inlet valves for the blower on standby are in the closed position.
4. Drain any condensate from the blower to be used.
5. Verify the primary header and lateral valves are in the open or desired position.
6. Check for the presence of current and recent alarms. Clear all current alarms and verify no alarm conditions exist.
7. Verify power to the control panel and instrumentation.
8. Turn the Master Switch to the ON position.
9. Select desired blower for operation.
10. Turn the operation mode switch in the controller to "Auto" and press the reset button. The controller will then automatically start the system and proceed through the start-up sequence.

5.4 Automatic Re-start

The flare will automatically attempt a re-start under the following fault conditions:

a. Low temperature shutdown

b. Flame failure shutdown

c. Pilot Failure shutdown

d. Power outage / Power Restore

An automatic re-start will occur after the "Down Timer" has elapsed and the temperature has dropped to allow for a safe startup. A re-start consists of the same sequence of events as a typical startup, beginning with the purge cycle. A re-start limit, typically 3, is also used to limit the number of re-starts that can occur before a successful startup has been accomplished. If the number of restart attempts reaches the limit, the system will shut down and operator attention is required.

5.5 START-UP AND OPERATION AFTER FAILURE SHUTDOWN

If the flare system was automatically shut down for an unknown reason, the entire system should be inspected before repeating the start-up procedure to determine the reason for the shutdown.

1. Inspect the flare station equipment and piping for any obvious physical failure (i.e., leaks, pipeline breaks, low pilot fuel).

2. Check the alarm screen for information about the operating status of the flare, of LFG delivery, and user operation Check the Zink O&M Manual for General Alarm screen descriptions. Typical information the alarm screen provides is:

    a. System status;
    b. Faults;
    c. Warnings;
    d. User Logon / Logoff;
    e. Page navigation; and
    f. Setpoint adjustment(s).

3. Inspect the blower housing and shaft for binding or excessive looseness.

4. Investigate the possibility of power interruption, if no other cause is indicated.

To prevent repeated failure alarms, repair any deficient conditions before attempting to restart system. If none of the above appear to have caused the shutdown, please call the manufacturer or CB&I.

5.6 Flare Station Emergencies

IF THERE IS AN IMMEDIATE THREAT TO HUMAN LIFE (E.G., A FIRE IN PROGRESS OR FUMES OVERCOMING WORKERS), MAKE AN ANNOUNCEMENT TO EVACUATE THE AREA AND CALL 911.

The following shall apply for Flare Shutdown Emergencies:

5.6.1 Shutdown Event

If the Flare Station shuts down, the responding technician or designated responder should begin restart procedures as outlined in the Flare Manufacturers Operation Manual.

This page left blank

6.0 Routine Condensate Collection System Operating Procedures

This section summarizes procedures to be used periodically to confirm proper performance of the condensate collection systems.

1. Check for (and release) any condensate accumulation in the blower outlet, flame arrestor, and flare base.
2. Check the condensate drain valve at the base of the KOP. The condensate drain valve should be open. The KOP sight gauge valves should remain closed when the liquid level is not being inspected (to minimize potential for leaks).
3. Check the condensate control panel/gauges in the field and verify that all al condensate sump pumps has the appropriate operating air supply (60 psi).
4. Inspect sump pump to insure it is functioning properly and discharge lines are not obstructed.

6.1 Routine Condensate Sump System Operation

1. Inspect and record condensate sump pump operation. Troubleshoot any deviations from expected operations. Should a pumping failure or clog occur, condensate will accumulate in the sump and header piping eventually blocking the flow of LFG to the flare station which will cause an automatic low-temperature shut down due to a lack of fuel for combustion.
2. Inspect piping for leaks monthly. Discontinue operation to repair any detected leaks. Isolation of piping will be needed to prevent spills from occurring. De-energize any force mains prior to conducting repairs and bleed off any excess air pressure to atmospheric pressures to avoid injury or exposure to gas or liquids.

Potential exposure to LFG should be treated with a high degree of caution and proper safety protocols should be followed. LFG can cause serious health problems sometime resulting in death. A 4-gas meter should be worn at all times. Non-conductive/spark proof tools and equipment should be used at all times.

This page left blank

7.0 Maintenance

7.1 Purpose

The Landfill LFG systems contain piping, equipment, and instrumentation that must be periodically inspected and properly maintained to provide optimum and continuous operation. The purpose of this section is to provide general guidance for inspecting and maintaining the piping system and specific major equipment and instrumentation. This guide provides the procedures for routine work only, and is intended to complement the more detailed procedures provided in the specific equipment manufacturers' O&M instructions.

To maintain warranty protection, in the case of any conflicts, the manufacturers' specific instructions take precedence, and must be consulted and read before any routine or non-routine monitoring or maintenance is performed. In addition to routine maintenance, the manufacturers' instructions contain critical information on installing, operating, adjusting, calibrating, testing, monitoring, and troubleshooting.

7.2 LFG Collection System

Because there are few moving parts, there are only a few maintenance procedures associated with the LFG collection system. Although the collection system is constructed from relatively durable materials, normal wear and tear does occur due to weathering, landfill movement, and temperature stresses.

7.3 General Inspection

After the start-up transition period and once the LFG collection system operation is stabilized, all collection system piping and wells should be inspected monthly. This can be done in conjunction with routine LFG monitoring and extraction balancing procedures, although it is often more efficient when performed separately, to allow for immediate implementation of minor repairs. When performed separately, it is best to schedule the inspection and repairs at least 2 to 3 days before the monitoring and balancing, to allow the LFG collection system to equilibrate to any modifications made.

The following conditions should be inspected for, and scheduled for repair if required:

- Wellheads which have shifted due to landfill or cover movement;
- Well bore backfill which has settled should be backfilled to slightly above grade, and the well bore seal should be adjusted, if required;
- Wells with increasing vacuum requirements, indicating liquid accumulation or other interference with the well casing perforations;
- Abnormal decreases in available pipeline vacuum, indicating a downstream obstruction;
- Pipe alignments which have shifted or pipe supports which have been disturbed;

- Pipe locations with sounds of gurgling or surging water, indicating poor condensate drainage;
- Condensate or LFG pipe leaks; and
- Missing or open labcock valves or access ports.

In conjunction with routine LFG collection system inspection, the following general landfill conditions should also be noted:

- Condition of landfill cover (dead vegetation, holes, burrows, unusual settlement, or erosion); and
- Landfill odors.

7.4 Routine Preventive Maintenance for the Wellfield

The following items should be inspected on a regular basis and can be combined with monthly wellfield readings as the technician traverses the site:

- Transition from wellhead to lateral piping (Any observed stress points and misalignments should be scheduled for correction as soon as possible);
- Wellhead control valves, fittings, and flex hose connections should be replaced when damage is evident;
- Cracks in pipes, fittings, valves, or joints should be repaired immediately; and
- Cracks and depressions that develop on the landfill surface should be filled with soil, compacted, and graded as soon as they appear, to prevent air and water from entering the landfill (refer to O&M Plan, Section 2.4.2 – Landfill Cover Maintenance).
- Inspect the above ground GCCS piping for low points along the laterals and headers.
- Re-grade pipes to drain as required to prevent condensate accumulations.
- Inspect the laterals and headers, especially flexible hoses, for any cracks or leaks.
- Inspect sample ports and covers for weathering, blockage, or leakage. Clean or replace as required.

7.5 Maintenance Records

The LFG control system maintenance records should be comprehensive and clearly organized. A good set of records and the following practices will enhance successful long term operation of the systems and facilitate regulatory compliance:

- Periodic independent evaluation of the systems' overall condition and performance;
- Scheduling maintenance or repair before failures occur;

- Advance budgeting of funds for critical spare parts inventory maintenance and repairs;

- Thorough training of maintenance personnel; and

- Annual review of requirements, documentation, site conditions, and performance with regulatory agencies.

7.6 Flare Station

All flare station equipment, controls, and instrumentation must be maintained in strict compliance with manufacturer's recommendations. The checklist provided in **Appendix A.1 – GCCS Equipment Operations Manuals** provides effective measures to prevent conditions that may cause breaks or other emergency failures. The following are general maintenance activities required to maintain effectiveness of the flare station's major components and do not supersede the procedures out-lined in the Zink – Landfill as Enclosed Flare System O&M Manual. The flare should only be shut down for maintenance or if the flare is not functioning properly.

7.6.1 Flare Station Knock-out Pot (KOP)

Periodically check for liquid accumulation in the KOP using the external sight gauge. Clear any drainage line obstructions, if required.

Periodically monitor pressure drop across the demister pad at maximum LFG flow. Clean or replace demister pad when the pressure drop has increased to twice the normal pressure drop for the clean pad condition. Change or clean if differential pressure across pad exceeds 2 inches water-column.

7.6.2 Pneumatic Flare Inlet Valve

- When starting or stopping the flare system, observe the opening and closing of the flare inlet valve. The valve should open and close slowly and completely in 10 to 15 seconds; and

- Lubricate actuator and valve mechanism, as recommended by manufacturer.

7.6.3 Flare Station Blower

- "Bump" the blower monthly, to prevent motor or bearing freeze-up. With the flare system on "MANUAL", start-up blower, and operate for up to 20 seconds, maximum;

- Rotate the blowers monthly to evenly distribute run hours and wear.

- Inspect the blower during normal operation, listening for unusual noises and feeling for abnormal vibrations. Touch the shaft-bearing housings to detect an overheating bearing, which may indicate high friction and imminent failure;

- Lubricate the bearings once every 2 weeks of normal operation. Use only lubricants recommended by the manufacturer's instructions. **Do not over-lubricate**. Over-lubrication and consequent seal damage is the most frequent cause of bearing failure. Check manufacturer's recommendation for lubrication procedures; and

- If an unusual noise or vibration is detected, consult Zink – Landfill Gas Flare System O&M Manual. The cause of the noise or vibration must be mitigated in accordance with the instructions.

7.6.4 Flame Arrestor

- During normal flare operation, periodically release any accumulated condensate using the valve installed at the bottom of the flame arrestor. Dispose of condensate in accordance with site procedures; and
- During normal flare operation, periodically check the pressure drop across the flare flame arrestor. If the flame arrestor pressure drop exceeds 2 inches of water column at maximum LFG flow, the flame arrestor should be cleaned in accordance with the manufacturer's instructions.

7.6.5 Propane Pilot Fuel Ignition System

- Check for sufficient propane fuel pressure at the tank regulator gauge and the gauge on the pipe;
- Observe the propane tank fuel content or level gauge, or lift and shake the tank to determine the fuel content;
- When the tank pressure has dropped to 10 percent of the reading when full, remove the near-empty tank and install a full tank;
- Refill the empty tank and store it on the rack next to the connected tank; and
- Periodically check piping, solenoid valve, and regulator for leaks propane leaks.

7.6.6 Flame Detection System

- Inspect the condition of the UV flame detector quarterly;
- Inspect the site path of the UV flame detector to make sure clear of debris such as spider webs;
- Clean when necessary in accordance with manufacturer's recommendation
- DO NOT touch the lens with your finger; and
- Replace the UV flame detector, if damaged and not detecting flame.

7.6.7 Landfill Gas Analyzer

As mentioned above, the FAU-TDL family of instruments has been designed to require minimal service and maintenance. One of the advantages of the TDL technology is that it does not require adjustment over time to maintain calibration. Once the instrument is built and factory calibrated, the laser channels (CH4 and CO2) should not require adjustments in the field. The instrument includes an Oxygen channel that will need to be adjusted periodically to maintain calibration. Oxygen is monitored using galvanic cell technology which will require periodic adjustments and replacement.

7.6.7.1 Factory Calibration and Service

The FAU-TDL will not require factory calibration and service however it is recommended that the instrument be checked for proper operation at least annually. If the instrument includes the Oxygen channel option it is recommended that the accuracy of this channel be checked at least quarterly and adjusted as necessary to keep it in calibration. It is expected that the Oxygen cell will need to be replaced every two years. If the internal pump is continually used it may require replacement every two years as well. It is recommended that this service be performed by ECOTEC or ECOTEC approved/trained technician.

7.6.7.2 Field Calibration Check

The FAU-TDL is equipped with input ports and a multi-position valve to facilitate field calibration checks on zero and span gases to periodically check the accuracy of the instrument. During calibration checks the display and output will register the gas concentration flowing through the instrument. In systems under vacuum the gas samples will be taken using the internal pump (ATTN: the system is not in this configuration at this time). However, because the current configuration (pressurized) the internal pump is not needed for the sampling process. Below are the recommended steps for running pressurized calibration gas through the instrument.

- Note the quick connect fittings on the instrument box have one-way valves built in them so it is necessary to have the exhaust connected while calibrating to ensure flow through the instrument.
- Turn the sample pump off
- Connect the calibration gas to the appropriate port (zero or span)
- Ensure that the exhaust port is connected to vent the gas
- Turn the gas selector valve to the same port the gas was connected to in step 2 above
- Open the calibration gas valve and let gas flow through the instrument for a minimum of 60 seconds or until the gas reading has stabilized for 15 to 20 seconds.
- Close the calibration gas valve and disconnect
- Turn the gas selector valve back to sample
- Turn the pump back on.

<u>Calibration Gas Flow and Pressures</u>

During calibration checks the pressure and flow of calibration gas used is important. The gas flow should be between 0.5 and 2.5 liters per minute and the pressure should be between -2 psig and +4 psig. ECOTEC's standard portable calibration gas cylinders and regulators are designed to work seamlessly with the instrument. Other gas cylinders and regulators can be used as long as the pressure and flow meets the above stated specifications. Low flows will not affect the accuracy of the instruments readings but will increase the time required for the instrument to reach an accurate reading. Exhaust gas must be released from the instrument during calibrations.

Manual Field Calibration

If the FAU-TDL is equipped with an Oxygen channel and field calibrations will be necessary as the Oxygen cell ages or when it is replaced. Note: The Methane and Carbon Dioxide channels will not require field or factory calibration adjustments. When performing a field calibration a certified oxygen free gas should be used to check the Oxygen zero. If the instrument is not reading sufficiently close to zero adjust the reading to zero using the "zero" adjustment screw under the "O2 Calibration" heading. Next flow a known concentration of Oxygen through the instrument and adjust the "span" if necessary. When calibrating the Oxygen channel ensure the reading has stabilized before adjusting. Time for the reading to reach stabilization will vary depending on the flow rate however if the reading stays constant for 20 to 30 seconds it is stable.

7.6.7.3 Field Maintenance

The FAU-TDL has been designed to require minimal maintenance. The instrument should have a gas conditioning system that may require minor maintenance including draining condensate and replacing filters. The instrument and gas conditioning system should be checked periodically. If liquids are found in the coalescing filter bowl they should be drained.

Replacing the Filter Element and Membrane Separator Membrane

The following is to be followed when replacing the coalescing filter element:

1. Turn off the FAU-TDL instrument pump
2. Close sample inlet valve
3. Disconnect the liquid drain line
4. Unscrew the filter bowl exposing the filter element and support assembly. Inspect O-ring for any damage. Unscrew element and support from the filter body and remove used element and replace with new element (ECOTEC Part Number 3-FAUCU-0016-E). Reinstall assembly and screw filter bowl back on.
5. Reinstall liquid drain line and tighten securely.
6. Leak check the connections with a suitable test liquid such as SNOOPTM prior to placing unit back in service.

The following procedure is to be followed when replacing membrane separator membrane. Please note: There are two types of membrane housings used. Both hold the membrane between two stainless steel portions. The two parts are held together by either four screws or internal "standard" right hand threads:

1. Turn off the FAU-TDL instrument internal pump.
2. Close sample inlet valve.
3. Disconnect the sample inlet tubing. Then remove the separator from the mounting bracket. Either use a 5/32 hex wrench to remove the four assembly screws or unscrew the separator to separate the two halves of the separator.
4. Remove the membrane O-ring carefully and thoroughly inspect. If O-ring is damaged, obtain a replacement O-ring (ECOTEC Part Number 3-FAUCU-0018-E) and set aside.
5. Install a new membrane (ECOTEC Part Number 3-FAUCU-0017-E) over the membrane support. Next, replace O-ring removed earlier or new replacement O-ring on O-ring groove and center. Then press one side of the O-ring into the groove. Repeat for the opposite side and so on until the O-ring fits snuggly in the groove.
6. Reassemble the separator by aligning the four assembly screws. To prevent damage to the threads from over tightening, first hand tighten the screws and then turn the screws ½ turn with the 5/32 hex wrench.
7. Reinstall the membrane separator to the mounting bracket and reconnect the sample tubing and tighten securely.
8. Leak check the connections prior to placing the unit back into service.

See Trouble Shooting Section for additional information.

7.6.8 Flare Instrumentation

- During normal flare operations; check flare temperature and record periodically;

- Calibrate the flow meter in accordance with manufacturer recommendations or more frequently if required by permit conditions; and

- Periodically inspect control panels and test indicator lights for correct operation. Replace indicator bulbs, if required.

This page left blank

8.0 Troubleshooting

See also **Appendix A.1 – GCCS Equipment Operations Manuals** and **Appendix A.3 – Monitoring and Troubleshooting Procedures**

Troubleshooting is the process by which operational problems can be quickly identified and rectified, reducing the system downtime. Based on experience with similar LFG systems, CB&I has developed generic troubleshooting checklists. These checklists relate symptoms frequently identified in the field to a specific cause. The recommendations in the checklist are intended to enable the operator to identify the possible location and cause of a problem, and resolve simple problems.

The troubleshooting checklist is divided into four sections: LFG collection system, flare station, transmission pipeline, and condensate collection system.

8.1 LFG Collection System

The LFG collection system consists of the LFG extraction wells, LFG lateral and header piping, fittings, and control valves. Table 8-1 presents the most commonly occurring problems and solutions for these problems.

8.2 Flare Station

The flare station encompasses all equipment associated with the flare and its operation. Table 8-2 presents the common symptoms and fixes associated with the flare and its operation.

8.3 LFG Transmission Pipeline

The LFG transmission pipeline consists of the LFG conveyance pipe between LFG wells and the flare station, associated fittings, and control valves. Table 8-3 presents the most commonly occurring problems and solutions for these problems.

8.4 Condensate Collection and Treatment System

The condensate collection and treatment system includes the condensate sump and pump, condensate storage tank (if applicable in future), KOP, and condensate discharge piping. Table 8-4 presents the troubleshooting checklist for the condensate collection system.

8.5 Landfill Gas Analyzer

Table 8-5 presents the troubleshooting checklist for the Landfill Gas Analyzer system.

Table 8-1
LFG Collection and Treatment System Troubleshooting Checklist

Observation	**Possible Symptom and Cause**	**Solution**
Vertical extraction well high oxygen concentration	1. Leaky sample port connection. • Pitot tube fits loose or does not affect a positive seal. • Labcock port is enlarged; threads are damaged. 2. Bad or loose hose connection with meter. • Old and worn out hose. 3. Break in well lateral upstream of sample port. • Test by monitoring the sample port at wellhead. 4. Bad wellhead seal. • Bad/leaky gasket at wellhead or valve. 5. None of the above causes were found. • Overdrawing on the well.	1. Plug, redrill sample port and utilize Teflon tape on threads. 2. Fix hose connection, replace every 12 months or sooner. 3. Repair lateral with coupler or by cutting out broken pipe and refusing a new piece. 4. Replace gasket. 5. Adjust valve setting lower or shutoff.
Low methane concentration (< 48%)	1. Air leak. • See high oxygen concentration troubleshooting. 2. Over drawing on the well. • Check well's historical vacuums.	1. Check for: • Instrument performance and accuracy. • Sample port positive seal. • Inspect piping for breaks. 2. Adjust valve setting lower.
High Nitrogen/Balance gas (>16%)	1. Air leak. • See high oxygen concentration troubleshooting. 2. Over drawing on the well. • Check well's historical vacuums.	1. Check for: • Instrument performance and accuracy. • Sample port positive seal. • Inspect piping for breaks. 2. Adjust valve setting lower.
Fluctuating pressure readings	1. Partial condensate blockage in lateral. • Listen to well lateral for surging of gas or gargling of condensate.	1. If significant, shut off well at valve and drain condensate. 2. Check operation of nearest condensate sump, may need to re-grade header, or inspect condensate sump.

Table 8-1 LFG Collection and Treatment System Troubleshooting Checklist		
	2. Main header pipe partially blocked by condensate. • Listen to well lateral for surging of gas or gargling of condensate.	

Table 8-2 Flare Station(s) Troubleshooting Checklist		
Observation	**Possible Symptom and Cause**	**Solution**
Flare will not start	1. Power failure. • Check controller fuses and power circuit breakers. 2. Does not sense main flame. • UV detector malfunction. 3. Ignition system failure	1. Reset alarms and follow start-up procedure. 2. Clean or replace UV detector. 3. Troubleshoot ignition system
Blower will not start	1. Low LFG flow. 2. Power failure. • Check controller fuses and power circuit breakers. 3. VFD NO VFDot "ON". 4. Alarm sensor malfunction	1. Increase LFG flow 2. Reset alarms and follow start-up procedure. 3. Switch "ON" 4. Switch "ON" 5. Check sensor outputs.
Blower failure light ON	1. Electrical failure. • Electrical power outage. 2. Vibration. • Anchor bolts loose. • Unbalanced impeller. 3. Bearings or drive coupling. • Worn out bearings or coupling. 4. Motor not operational. • No LFG flow due to closed valve or pipe obstruction • Current overload • Bearings worn	1. Reset alarms and follow start-up procedure. 2. Tighten or replace anchor bolts. Repair or replace impeller. 3. Replace blower bearings or coupling. 4. Check and restore LFG flow. Call electrician to troubleshoot motor or supply wiring.
Frost Prevention System	1. Does not heat or light sensors do not illuminate	1. Check circuit breakers 2. Call electrician to repair

Table 8-2 Flare Station(s) Troubleshooting Checklist		
	• No power • Wire short	
Electric fail safe valve	1. Does not open or close. • No power • Disk binding	1. Check power supply 2. Replace butterfly valve
Pilot ignition system failure	1. No ignition. • Low propane. • Spark plug wire short circuit. • Spark plug not functional. • Ignition transformer nonfunctional. • Thermocouple non-functional • UV sensor	1. Refill propane tank. Replace wire. Replace plug. Replace transformer. Replace thermocouple. Replace UV sensor.

Table 8-3 LFG Pipeline Troubleshooting Checklist		
Observation	**Possible Symptom and Cause**	**Solution**
High oxygen concentration	1. Leaky sample port connection. • Pitot tube fits loose or does not affect a positive seal. • Labcock port is enlarged; threads are damaged. 2. Bad or loose hose connection with meter. • Old and worn out hose. 3. Break in pipe upstream of sample port. • Test by monitoring next upstream sample port. 4. Bad flange joint. • Bad/leaky gasket. 5. None of the above causes were found. • Overdrawing on the collection field.	1. Plug, redrill sample port and utilize Teflon tape on threads. 2. Fix hose connection, replace every 12 months or sooner. 3. Repair with patch or new pipe section. 4. Replace gasket. 5. Rebalance collection field wells.

Table 8-3 **LFG Pipeline Troubleshooting Checklist**		
Low methane concentration (< 48%)	1. Air leak. • See high oxygen concentration troubleshooting. 2. Over drawing on the collection field • Check historical vacuums.	1. Check for: • Instrument performance and accuracy. • Sample port positive seal. • Inspect piping for breaks. 2. Adjust blower or valve setting lower.
High Nitrogen/Balance gas (>16%)	1. Air leak. • See high oxygen concentration troubleshooting. 2. Over drawing on the collection field. • Check historical vacuums.	1. Check for: • Instrument performance and accuracy. • Sample port positive seal. • Inspect piping for breaks. 2. Adjust blower or valve setting lower.
Fluctuating pressure readings	1. Partial condensate blockage. • Listen to pipe for surging of gas or gargling of condensate.	Isolate pipeline for 30 minutes, to determine if liquid clears, by gravity flow. (Do NOT shut down the flare if possible). Check operation of nearest condensate sump, may need to re-grade header, change velocity, or clear condensate sump obstruction.

Table 8-4 **Condensate Collection System Troubleshooting Checklist**		
Observation	**Possible Symptom and Cause**	**Solution**
Condensate sump pump not pumping	1. Pump discharge blocked. • Check history of condensate volume. 2. No power to compressor.	1. Clean intake valves. 2. Check power source to compressor system.
No condensate entering condensate storage tank (not applicable at this time)	1. Drain pipe into tank is blocked. 2. Drain pipe into tank is separated.	1. Repair pipe. 2. Repair pipe.

Table 8-5
LFG Analyzer FAU-TDL) System Troubleshooting Checklist

Observation	Possible Symptom and Cause Solution
Unit does not turn on	• No Power - check power to instrument. • Fuses Blown – check fuse in power switch assembly • Contact Factory Service
Gas reading is not correct	• Check reading with known gas, air or calibration gas.
Display is reading about -25% (always).	• 4-20mA Output circuit is open – check output circuit or jumpers at instrument and output connections.
If instrument reads correctly on Calibration gas	• Sample gas may not be flowing through instrument check gas flow. • Gas concentration may not be as expected, check for leaks if CH4 and/or CO2 are lower than expected and/or O2 is higher than expected. • Check manual ball valve 2 (drain valve) ensure that valve is normally closed.
If gas reading on Calibration gas is incorrect	• Check output wiring; instrument provides signal power and should not be connected to 24VDC power. • Contact Factory Service
Instrument always reading same value (nonzero)	• Check output mA. If mA output varies as expected display may be damaged. If mA output does not change output board may be damaged. • Contact Factory Service
No gas flow going through instrument	• The inlet/exhaust is blocked - remove blockage and retry. • The particulate filter or water trap filter is blocked -replace as necessary. • Pump is turned off or multi-position valve is not on "Sample Gas" – turn on pump or adjust valve. • Contact Factory Service.
Display reads over 100% when first started.	• This is normal during the first several seconds of instrument operation. If display doesn't drop below 100% after 30 seconds of operation there may be blockage of laser beam. • Purge instrument with air or calibration gas. • Contact Factory Service.
Temperature Probe output reads 20mA	• Check Temperature probe connection/line the signal is not getting to the instrument.
Liquid blockage or ingress	• Check coalescing filter for blockage or saturation. • Check membrane filter for blockage or damage. • Check manual ball valve 2 (drain valve) ensure that valve is normally closed. • Ensure gas sample line is connected to the top of the gas conveyance pipe. • Ensure the sample line runs vertically for a foot or more.

Table 8-5 LFG Analyzer FAU-TDL) System Troubleshooting Checklist	
	• If instrument is equipped with cold weather option ensure the heater and heat tracing is set correctly. • Contact Factory Service.

9.0 References

Sudbury Road Landfill Area 6 Closure Project, Construction Documents [Drawings]t. Rep. Kennewick, Washington: JUB Engineering, March 2011. Drawings.

Sudbury Road Landfill Area 6 Closure Construction Quality Assurance (CQA) Certification Report. Rep. Kennewick, Washington: JUB Engineering, March 2011. Report.

Sudbury Road Landfill Construction Assurance Certification Report. Spokane, Washington: Schwyn Environmental Services, April, 2017. Drawings.

This page left blank

Appendix A.1 - GCCS Equipment Operation Manuals

O&M Manual (Included on external storage device, DVD or USB Storage Device in binder)

Appendix A.2 – Monitoring Requirements

Appendix A.3 - Monitoring and Troubleshooting Procedures

Monitoring and Troubleshooting Flowchart Protocol

- High or Low Methane Monitoring/ Troubleshooting Procedures for Wellheads
- Flow Monitoring/ Troubleshooting Wellhead Procedures
- High Oxygen Monitoring / Troubleshooting Wellhead Procedures
- High Temperature Monitoring / Troubleshooting Procedures

Appendix A.4 – Inspection Forms

Appendix A.5 - Key Components