SISTER: An Intermodal Atmospheric Measurement Laboratory for Mobile Measurement

Vendor Name:
Bubbleology Research International

Primary Contact:
Ira Leifer, CEO and Chief Scientist
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To whom it may concern,

I am pleased to submit the following response to 2023CARB_SMMI-RFI001.

All the information in this response is true & accurate to the best of my knowledge.

Sincerely,

Ira Leifer
CEO & Chief Scientist
Bubbleology Research International

Attachment A – Vendor Profile

1. Identify the Company Name, address, city, state, and zip code, telephone.

Bubbleology Research International
1642 Elm Ave., Solvang, CA 93463
(805) 683-3333

2. Identify the name, title, address, phone number, and email address of the primary contact person for this RFI.

Ira Leifer, CEO and Chief Scientist
1642 Elm Ave., Solvang, CA 93463
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3. Provide a brief overview of your company including number of years in business, number of employees, nature of business, and description of clients.

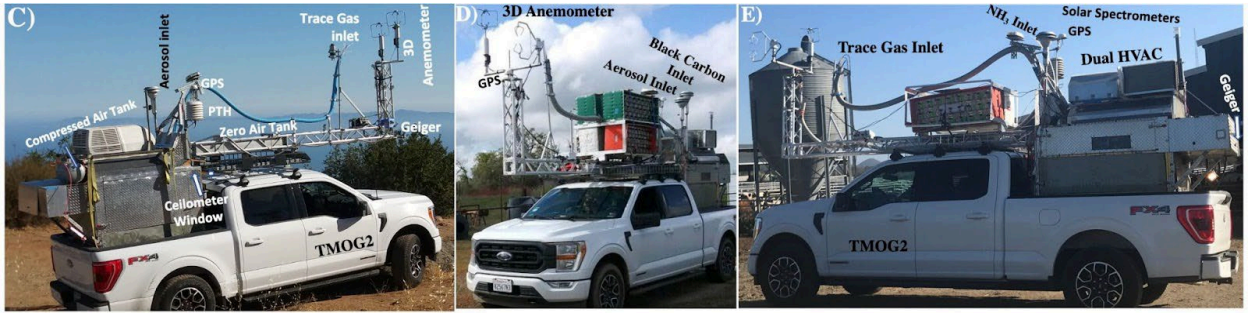
Bubbleology Research International (BRI) is a small flexible company (10 employees) dedicated to environmental consulting, instrumentation development, satellite analysis and validation, and environmental assessment. At BRI, we continuously adapt to change, to meet the demands of our clients. Established in 2003, BRI handles a variety of complex projects; subcontracting multi-institution, international projects for Fortune 500 companies, universities, the United States Navy, NASA, ESA (European Space Agency), and other government agencies.

BRI manages complex projects by staying well equipped with many facilities readily available including an in-house machine shop, 3D printing capabilities, a gas analysis lab, sufficient computing power to meet data processing needs, and administrative staff. We bring a project from conception to peer review/litigation to the finished product in a timely manner.

4. Identify any parent corporation and/or subsidiaries, if applicable.

Solaris Trailers (a relocatable solar trailer solution) is a subsidiary of Bubbleology Research International.

5. Give a brief description of your company's product(s), platform(s), service(s), etc. that may be relevant to this RFI.



BRI performs air quality surveys using SISTER, an air quality laboratory in a 1-ton box. SISTER2 deploys by a pickup truck, boat, or trailer and measures 14 gasses, aerosols, and meteorology at up to highway speed. SISTER2 also features real-time visualization that informs how the BRI team drives SISTER2 – slowing down in areas of interest and redirecting to follow the emissions. BRI analyzes data to derive emissions, fingerprint sources, and validate airborne and satellite remote sensing, as well as to improve atmospheric transport modeling.

BRI also performs analysis of air quality station data including numerical inversion to derive emissions and for satellite data.

6. List and briefly describe the projects and/or activities your company was engaged within the last ten (10) years that are similar to the project identified in the RFI.

BRI began mobile air quality surveys in 2013, using a developing range of platforms, documented in numerous peer reviewed publications (Leifer and Melton, 2021; Leifer et al., 2021; Leifer et al., 2023a; Leifer et al., 2022a; Leifer et al., 2019a; Leifer et al., 2018a; Leifer et al., 2016a; Leifer et al., 2014; Leifer et al., 2022b; Leifer et al., 2018b; Leifer et al., 2019b; Leifer et al., 2016b; Leifer et al., 2023b; Thompson et al., 2015).

Field data collection surveys have been conducted for NASA for satellite and airborne remote sensing validation, for major oil and gas companies (Fortune 500) for leak detection.

For NASA for disaster response (Aliso Canyon leak).

For NSF for emissions from volcanic sources in death valley

For NASA for emissions from abandoned oil and gas wells

For the California Energy Commission to fingerprint emissions from oil and gas wells all over California and to derive emissions;

For NASA to monitor emission of GHG from the Ports of LA/LB and industry.

Additionally, BRI has conducted numerous in-house funded surveys to estimate emissions from a variety of sources including oil & gas, husbandry, landfill, natural seepage onshore and offshore, pipeline leakage, and volcanic, and to assess air quality in disadvantaged and diverse low income communities.

7. Are there any of the requirements described in the *Proposed Environment* section not technologically feasible with your existing service(s), product(s), platform(s)?

SISTER and our in-house data analysis are fully capable of meeting the needs of this RFI.

Attachment B – Vendor Questions

I. General Questions

1. What scale of operation would be required to bid on a future RFP of the concept described here? Are there any minimum requirements necessary at which below you would not be interested in bidding on a proposal of this nature?

Our mobile platform has been in use for several years now and has participated in both small & large air quality projects. There is no minimum requirement required. In the event that the site is prohibitively far from our lab (Goleta, CA), we may require lodging non-local surveys.

2. What types of monitoring objectives have you explored using your company's mobile monitoring approaches?

SISTER monitoring objects have been to evaluate emissions for a very wide range of sources, to validate remote sensing observation, to improve atmospheric transport parameterization in plume inversion models, to fingerprint air masses and pollution far from the source (e.g., Kern River oil field emission in the Mojave), to validate an inversion model based on air quality station data, to understand the role of atmospheric chemistry in pollutant transformation, to understand the role of boundary layer height and dynamics on plume inversion and atmospheric transport, and to understand the exposure form various sources on nearby communities.

3. What are the advantages and limitations of your company's mobile monitoring services?
SISTER is designed for rapid deployment - in about 3 hours and can cover a large survey area rapidly by collecting high quality data at up to the speed limit, including offroad. For example, if we were to perform 10 surveys per month, we might cover up to 8000 linear miles in a month - speed limits depending. Currently, our analysis routines are partially automated and thus can be performed in parallel to field data collection, requiring 1-2 days for a days' survey. However, these routines could be completely automated for repetitive objectives. Our primary limitation is that currently we do not have two SISTER units and can be in only one place at a time, and current staffing levels.

II. Engagement and Coordination

1. Describe your interpretation of what community engagement should look like throughout the process of conducting mobile air monitoring in communities.

Community engagement would include presentations at local schools, and installing small temporary trailer based or roof-based air quality stations to engage students and the public. For example, we are discussing with a principal at Cabrillo High School, West Long Beach with respect to setting up an AQ station on site, and merging its data into survey and satellite data. Not only will this inform the community, but also to engage students in air quality research and hopefully inspire the (underserved community) students to pursue a career in science.

2. What experience do you have with community and public engagement? Is any of this experience directly related to air monitoring activity and data dissemination?
We have done outreach talks, and as noted above are currently discussing setting up an AQ station at Cabrillo High School for one of our proposed studies. We also have done numerous media events on our research and press releases to reach a larger audience with our research. Additionally, we work with stakeholders, for example, we are currently working with Heal The Ocean on issues of well abandonment off Summerland, CA.

3. What is your experience coordinating with community members, CBOs, regulated industry, academia, and governmental agencies when planning monitoring objectives and data analysis and communication?
BRI has extensive experience working with government agencies (state, federal, local); including, for example sub-contacting the Navy, with current projects with NIH, NASA, CDFA, CEC, and more. Most of our projects are partnered with academic institutions as subcontractors following our long history and commitment to collaboration. BRI has done work for major oil

and gas companies including monitoring for gas pipeline leaks and installing meteorology trailers, and basic emissions research. SISTER has been involved in 10+ contracts with many different institutions and partners to great success. BRI maintains a common language website to communicate our results to the public and produces general interest articles on our research.

4. Please provide the number and size ($) of technical projects previously managed for coordination and communication with both community and technical contractors.

I am unsure how to answer this. Cumulative BRI research projects have been $20-30 million.

5. How would you apply your engagement and coordination model on a statewide scale? We would partner with stakeholder organizations, foundations, and nonprofits to engage communities. Currently, we are working with Heal the Ocean on a State Land Commission funded project to understand emission risks associated with planned abandonment of oil wells off Summerland, CA. This model is easily extended across the state.

III. Mobile Monitoring Technologies and Capabilities

1) How many mobile monitoring platforms do you currently own and operate? How long have these platforms been in operation?

We currently operate 1 mobile monitoring platform, and have been using it (and prior incarnations) since 2014. We could construct two additional SISTER platforms in FY 2024 assuming no significant design changes.

a) What areas/sources/locations do you have experience conducting mobile monitoring?

All over the state, from Humboldt to Death Valley to San Joaquin, to Los Angeles, to Imperial Valley (Salton Sea), coastal California, the High Sierras, and many other places in California (as well as outside).

b) Has collected data been used to support community emission reduction, enforcement, or other actions? Please provide examples.

Collected data has been for basic scientific research and has been used by regulatory agencies. For example, a leaking well was detected and shared with CalGem,

Please provide operational information on your company's current mobile monitoring capabilities. This should answer the following questions:

c) What frequency can platforms be deployed?

d) What days/hours are the platforms generally in use?

e) What pollutants can be monitored and with what frequency?

f) What types of instrumentation do you use? Describe all relevant methodologies.

g) What level of coverage or scale of monitoring can be accomplished within a community? (For example, how would you approach characterizing emissions from a source or identifying a leak? How long would that take?)

h) How do you determine that you've adequately characterized a given area?

i) What workflow processes or software do you have for managing mobile monitoring?

SISTER can be deployed upwards of 20 days per month with current staffing, more is feasible if we add staff. For example, pipeline leaks have been reported to SOCalGas, oil well leaks to CalGem, and our findings from the Aliso Canyon Leak were published and widely used. SISTER can operate day or night, as long as staffing capacity is not exceeded (overtime).

In leak detection studies for So Cal Gas, approximately 20 leaks were detected in a day and derived emissions were within 20% of known (blind) values, sources located within five meters. This involved driving every street in a 1 mile square community (Pico Rivera). Data are collected orthogonal to the winds downwind of the leak. After converting to anomaly, a Gaussian plume inversion is applied to the data. The approach is described in the manu SISTER references noted below. SISTER uses real time data written in house in Matlab that integrates all sensors and provides the operators immediate feedback, allowing repetition of important transects. Similarly all our analysis and modeling software are in house developed in Matlab. Additionally, we triage from a distance and then focus in on areas with hot spots. For example, we derived emissions for a dairy from 5 miles downwind at highway speed, and our emissions disagreed by only 10% versus contemporaneous airborne remote sensing data. We have a different approach for abandoned wells where we circle them, and are able to detect methane plumes with peak strength of ~50 ppt, developed under our NASA project.

SISTER gases analyzed are -$d^{13}CH_4$, CH_4, C_2H_6, C_3H_8, CO_2, CO, H_2O, NH_3, O_3, SO_2, NO_X, NO, NO_Y, NO_2, N_2O, H_2S at sub-ppb levels, CO_2, H_2O at sub-ppm. SISTER includes targeted air sample collection in 96 evacuated canisters analyzed for >87+ trace gases at 0.003-0.004 ppbv detection limits. The technology of SISTER, including precursor platforms, is well-described (Leifer and Melton, 2021; Leifer et al., 2021; Leifer et al., 2023a; Leifer et al., 2022a; Leifer et al., 2019a; Leifer et al., 2018a; Leifer et al., 2016a; Leifer et al., 2014; Leifer et al., 2022b; Leifer et al., 2018b; Leifer et al., 2019b; Leifer et al., 2016b; Leifer et al., 2023b; Thompson et al., 2015).

Analyzer Model (-)	Measurement (-)	Rate (Hz)	Typical (Hz)	Specified Precison	SISTER Precision		Manufacturer	Method
Gas Measurements								
Fast Greenhouse Gas Analyzer (911-010)	Carbon Dioxide (CO_2)	1	1	300	300	ppb	Los Gatos Research	Mid-Infrared Absorption
	Methane (CH_4)	1	1	1	0.1	ppb		
	Water Vapor (H_2O)	10	5	100	100	ppm		
G2210-I Methane Isotope analyzer	dC^{13} Methane (CH_4)	1	1	0.05	0.05	ppb	Picarro	Cavity Enhanced Absorption Spectrometry
	Methane (CH_4)	1	1	0.1	0.1	ppb		
	Ethane (C_2H_6)	1	0.017	1	1	ppb		
	Carbon Dioxide (CO_2)	1	1	200	200	ppmv		
	Water Vapor (H_2O)	10	5			ppm		
Mira CH_4,C_2H_6, C_3H_8 Analyzer	Methane (CH_4)	1	1			ppb	Aeris Tech.	Mid-Infrared Absorption
	Ethane (C_2H_6)	1	1		0.050	ppb		
	Propane (C_3H_6)	10	5		0.050	ppb		
	Water Vapor (H_2O)	10	5			ppm		
Mira CO, N_2O Analyzer	Carbon Monoxide (CO)	1	1	0.5	0.5	ppb	Aeris Tech.	Mid-Infrared Absorption
	Nitrous Oxide (N_2O)	1	1	0.5	0.5	ppb		
	Water Vapor (H_2O)	10	5			ppm		
42iTL- Trace Analyzer	Nitric Oxide (NO)	0.1	0.1	25	0.025	ppb	ThermoFisher	Fluorescence
	Nitrogen Dioxide (NO_2)	0.1	0.1	25	0.025	ppb		
42i-Y NOy Analyzer	Nitrogen oxides (NO_Y)	0.1	0.1	0.05	0.05	ppb	ThermoFisher	Fluorescence
49i Ozone Analyzer	Ozone (O_3)	0.1	0.1	1	0.2	ppb		
Ammonia / Hydrogen Sulfide Analyzer	Ammonia (NH_3)	1	0.2	1	0.2	ppb	Los Gatos Research	Cavity Enhanced Absorption Spectrometry
	Hydrogen Sulfide (H_2S)	1	0.2	15	5	ppb		
450c Trace Analyzer	Sulfur Dioxide (SO_2)	0.1	0.1	1	0.05	ppb	ThermoFisher	Fluorescence
	Hydrogen Sulfide (H_2S)	0.02	0.017	1	0.05	ppb		
5020 SO_2 analyzer Trace	Sulfur Dioxide (SO_2)	1	1	0.05	0.05	ppb	ThermoFisher	Fluorescence
Aerosol Measurements								
11-A Aerosol size Spectrometer	0.1-32 μm aerosol size	0.17	0.17		32	channels	Grimm	Optical
31CL Ceilometer	Aerosol optical depth profile	0.02	0.017	10	10 #	m vertical $srad^{-1}$ km^{-1}		Lidar
Scanning Mobility Particle Sizer	10-1094 nm						Grimm	
ObservAir	Black Carbon	0.50	0.25	0.10		$\mu g\ m^{-3}$	DS Tech	Optical Absorbtion
Meteorology Measurements								
Anemometer (CSAT)	Wind speed	50	5	0.25	0.3	$mm\ s^{-1}$	Campbell Scientific	Ultrasonic
	Wind direction	50	5	2	2	°		
Anemometer (81000)	Wind speed	4	4	0.3	0.3	$m\ s^{-1}$	RM Young	Ultrasonic
	Wind direction	4	4	2	10	°		
PTU200 Barometer	Pressure	1	1	0.1	0.1	hPA	RM Young	
	Humidity	1	0.08	1	1	%		
	Temperature	1	1	0.2	0.2	°C		
Spectroscopy Measurements								
Pyranometer SP-110	Radiation, (360-1120 nm)	2	1	5%	5%	$W\ m^{-2}$	Apogee	Thermopile
Pyrgeometer SL-510	Radiation (5-30 μm)	2	1	5%	5%	$W\ m^{-2}$	Apogee	Thermopile
Spectrometer (HR4000)	Radiation (182-1109 nm, 0.3 nm)	1000	100		300	SNR	Ocean Optics	Grating
Spectrometer (HR4000)	Radiation	1000	100		300	SNR	Ocean Optics	Grating
Spectrometer (HR4000)	Radiation 280-1090	1000	100		300	SNR	Ocean Optics	Grating
Spectrometer (Red Wave)	Radiation (.9-1.7 μm, 0.0016 μm)	1000	1		4000	SNR	Stellarnet	Grating
Radiation Measurements								
Geiger Counter (GCA-04W)	Alpha, Beta Radiation	1	1				ImageSc	GM Tube
Geiger Counter (GCA-04W)	Beta Radiation	1	1				ImageSc	GM Tube

Table BRI-1. SISTER scientific capabilities.

2) Describe your usual approach or strategy to mobile monitoring. Include, if possible:
   a) Drive plan and operational logistics
   b) Staffing

c) Power requirements (e.g. battery powered, requires generator, etc.)
d) Consumables
e) Quality control procedures
f) Performance and acceptance criteria (e.g. precision, bias, limit of detection)
g) Data logging and storage
h) Notifications and communication

The approach is described in the cited references. Route planning uses Google maps and earth, consulting existing data, which can be displayed as active navigation aids on a tablet while surveying. Real time data display in the Google Earth environment allows an adaptive survey strategy to change routes and speeds based on real time data. Two technical support staff, one data analyst and two operators are needed to maintain SISTER data collection. System uses a 7.4 kW generator built into the Ford pickup truck. All consumables are included in daily costs which have been submitted to DCMA and are accepted for federal grants. Analyzers are calibrated daily, all sensors and analyzers are logged asynchronously using a tag protocol following GPS. Raw and processed data are converted into Level 0-2 data products after NASA satellite protocols and submitted to ORNL DAAC for archiving, and include all metadata, again following NASA requirements for QC.

4) Please provide an estimated cost to operate all applicable mobile monitoring platforms as a function of time (e.g. 1 week of monitoring) deployed and/or measurements taken.
a) These cost estimates should include all costs associated with mobile monitoring operation. This includes but is not limited to:

Our cost estimate for 1 month deployed (10 surveys per month) is $80,396.

i. Direct costs – instrumentation consumables and repairs, vehicle operation costs, staff cost to operate platforms, recharging requirements.

Direct costs are the cost to operate SISTER ($1060/survey), labor ($2200/survey), and travel ($244/survey). All consumables, calibration gases, and so on are included in the charter rate.

ii. Indirect costs – support staff costs, associated insurance for operation, administrative overhead, any required permits.

Indirect costs include fringe (on Labor):$588/survey, overhead (on labor + fringe): $2,424/survey, and G&A (on labor + fringe+overhead+travel): $897/survey.

iii. Data Management – costs to move data from raw data collected by instrumentation to the final data products requested by CARB.

Data analysis costs are estimated at $640/survey and reporting costs are estimated at $160/survey.

We have also included a fee @5%: $383/survey.

b) How often are invoices and payments typically required?
30 day net. Faster is appreciated, as we are a small company.

4) If an RFP is developed based on the information provided here, how much preparation time is required to deploy the platforms and begin monitoring?

3 hours

a) Do you have recommendations for a minimum timeline to achieve potential monitoring objectives described here?
We are ready to perform surveys in 3 hours.

b) What is the maximum number of platforms that you could deploy by early 2025?
We can deploy SISTER immediately. If there was a business model, we would solicit investor funding and construct two additional units by early 2025.

5) Do you have experience developing Community Air Monitoring Plans (CAMPs) as defined by the CARB Community Air Protection Program Blueprint5 or similar? Please provide examples of community-focused monitoring plans or similar.
No

6) Do you have existing standard operating procedures (SOPs) or quality assurance project plans (QAPPs) for your mobile monitoring approach?
Yes.

Data Collection, Storage, Reporting

1. In what format do you generally provide data to your clients? What is your final data product?

Data management: Quality Assurance/Quality Control. All SISTER data and instrumentation parameters are automatically logged as an asynchronous ASCII file following GPS protocols. SISTER data collection protocols are submitted as metadata to netcdf files to ORNL as three data levels, following NASA data and metadata standards, with review and acceptance by ORNL. Level 0 data are raw with calibrations applied, data quality data points flagged, and corrected for sample delay times. Level 1 data are corrected to a uniform timebase, QC flagged data are de-spiked and gap-filled. Level 2 data are aggregated datasets. The data collection and modeling approaches have been published in *the SISTER References*.

2. Do you have off-the-shelf, or modifiable-off-the-shelf, data management products compatible with mobile monitoring data?

We develop automated, custom data management solutions tailored to clients' specific needs.

3. What is your experience in mobile monitoring data analysis and visualization? Specifically, do you have any experience using ESRI products to manage and visualize data?

We do all our visualization in Matlab and Google Earth. However, it is not difficult to adapt to other platforms, though ESRI is an expensive software package

4. What is your experience in public dissemination of complex information? To what extent have you generated data visualization for the public?

We have written many general audience science articles on our website and have produced graphics to present our studies there as well as in press releases. We also have an educational website on hydrocarbon seeps that is targeted towards a middle/high-school education level.

5. What suggestions do you have for handling large amounts of data from a variety of sources (e.g. multiple mobile monitoring platforms) into cohesive data visualizations?

We regularly do this, please consult out publications where we fuse air quality station data, in situ survey data, satellite data and airborne data - we do work for NASA.

V. Feedback

1) Provide input on the requirements or areas listed in this RFI. Specifically, CARB is looking for:

a) Availability of existing systems that perform all or a portion of the requirements in Section II – C. New systems cannot be built using funds in a potential RFP.

Our mobile monitoring system , SISTER, is able to meet all the needs listed by CARB in this proposal. SISTER can cover 8000 linear miles (excluding highway transit time to destination) in a month of surveying. If new systems were needed, our costs would increase We are not sure what other systems may meet the requirements of this RFP.

b) Questions, suggested modifications, or additions to the proposed environment that would allow or encourage potential bidders. Please include justifications for any suggested changes and concept modifications.

None.

Attachment C – Rough Order of Magnitude Cost Estimate

Rough Order of Magnitude

Estimated range of cost per month of full-time monitoring. *This may be costs associated with conducting monitoring, engagement activities to support monitoring, or both. If this is not applicable, please specify a different time range or more appropriate metric to quantify your capabilities. Please describe what "full-time monitoring" looks like for you and itemize costs with as much specificity as possible.* We evaluated this cost estimate* based on a "full-time monitoring" schedule of 10 surveys a month. This allows time for deployment, calibration, and data analysis. A month of full-time (10 surveys/month) surveying could cover up to 8000 linear miles (excluding highway transit time to destination). SISTER Survey cost: $1060 Labor: $2,200 Travel: $244 Overhead: $2,424 G&A: $897 Fee @ 5%: 383 *Please note that community engagement, etc. is not included in this time estimate	$ 80,396
Estimated range of cost to complete a full year of monitoring. $ 964,752	

Answers and Assumptions Used in Cost Estimate

Please answer, in as much detail as possible, the State's questions (1-4) below.
Also, please provide details pertaining to the assumptions, expectations, and/or performance parameters used as the basis of the cost estimate.

THE STATE's QUESTIONS and VENDOR'S RESPONSE/ANSWERS:

1. What is the timeline for your mobile platform(s) (that is, how many platforms do you have operational right now, and what is your timeline for launching more)? Will your platform(s) depend on additional funding to reach and sustain maximum planned capacity?

SISTER can be deployed in 3-4 hours. It is currently our only operable mobile platform. SISTER relies on external funding and projects to sustain maximum planned capacity, but we also have a lot of partners and projects currently and upcoming. SISTER would not solely rely on funding within this initiative to sustain maximum planned capacity.

2. Approximately how much monitoring can be accomplished in the period of a month? A year?

BRI staff can easily perform 10 surveys in a month, 120 in a year. A month of surveys can cover up to 8000 linear miles of survey area.

3. Are there any requirements that would preclude you from competing should an RFP be released? If yes, what suggested changes would allow you to compete?

No

4. Are any of the goods, products, or services you've identified in your RFI response available on a Federal GSA or State of CA LPA? If yes, please identify the contract type, name, and number.

No

VENDOR'S ASSUMPTIONS:

What assumptions have you made in preparing a response to this RFI?

We have made assumptions based on our previous efforts. SISTER is involved in many projects and we believe these assumptions have led to an accurate ROM Cost Estimate. As always, we cannot predict weather changes that make it impossible to survey, unusual parts malfunction, etc. However, our 10 surveys/month estimate does leave room for general, predictable maintenance.