Quarterly Narrative

The Office of the Assistant Secretary for Research and Technology (OST) is funding research at the University of Alaska Fairbanks to study “Advanced Imaging of Transportation Infrastructure Using Unmanned Aircraft Systems.” This is cooperative agreement OASRTRS-14-H-UAF, and was executed by UAF on May 7, 2014.

The cost share for this project is from the UAF research partner, Alyeska Pipeline Service Company, which operates the Trans Alaska Pipeline System.

The project team includes at UAF, two of the three major research organizations including the International Arctic Research Center (IARC) and the Geophysical Institute (GI). The third major research unit is the Institute of Northern Engineering (INE), and will likely join the research project to study the issue of frozen debris lobes (FDL), which is described later.

The project principal investigator (PI) is Dr. Keith Cunningham. Dr. Cunningham is part of the Scenarios Network for Alaska & Arctic Planning (SNAP), which is a sub-entity of IARC. Dr. Cunningham’s research focus is unmanned aircraft systems (UAS) to collect a variety of remote sensing data. He has a strong interest in how remote sensing data create information that can be used in executive decision making and for policy-making. Dr. Cunningham is also very active in the creation of intellectual property and commercialization of technology at UAF.

The project kickoff meeting was July 7. Attending the kickoff meeting were approximately 25 individuals from Alyeska, UAF, Alaska DOT, and Caesar Singh from OST. All members of the Technical Advisory Committee (TAC) attended, as well as the four project sub-contractors.

Technical Advisory Committee (TAC)

The TAC is providing guidance related to broad industry needs, specific operational needs for Alyeska, and input to the broader decision support systems this project envisions. The TAC will also review and comment on the Quarterly Reports.

<table>
<thead>
<tr>
<th>Name</th>
<th>Role</th>
<th>Company</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gary Shane</td>
<td>UAS for pipeline integrity monitoring</td>
<td>TCQ Consulting</td>
</tr>
<tr>
<td>Cheryl Seiwald</td>
<td>Inspection of new construction</td>
<td>CR Inspection</td>
</tr>
<tr>
<td>Frank Wuttig</td>
<td>Geotechnical Engineering</td>
<td>Alyeska</td>
</tr>
<tr>
<td>Ben Wasson</td>
<td>Regulatory Engineering</td>
<td>Alyeska</td>
</tr>
<tr>
<td>Jacques Cloutier</td>
<td>Survey &amp; GIS</td>
<td>Alyeska</td>
</tr>
</tbody>
</table>

Biographies for the TAC members are:
Gary Shane retired from British Petroleum after 32 years as manager of their Pipeline Management Office. Over the past eight years, Gary has researched how UAS can be utilized to perform integrity monitoring of pipeline corridors. Now he is the lead consultant of TCQ Consulting, and continues to pilot manned aircraft on regular integrity inspection flights.

Cheryl Seiwald owns CR Inspection, the oldest pipeline inspection firm in the United States. Their inspectors operate worldwide, providing third-party inspection of new construction and certifying inspection records for the Pipeline and Hazardous Materials Safety Administration.

Frank Wuttig is a geotechnical engineer with Alyeska and provides expertise related to unstable soils and slopes, thawing permafrost, and engineering solutions to mitigate geotechnical risks.

Ben Wasson manages regulatory engineering with Alyeska, ensuring compliance with a variety of engineering and environmental issues. His previous position at Alyeska oversaw surveying, mapping, and GIS operations.

Jacques Cloutier recently joined Alyeska and provides technical oversight of surveying operations. Prior to Alyeska, he worked in the remote sensing field, primarily in lidar data collection and processing, in Alaska.

The four project subcontractors are:

<table>
<thead>
<tr>
<th>Consultant</th>
<th>Role</th>
<th>Lead Investigator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atkinson Aeronautics</td>
<td>FAA &amp; project management</td>
<td>Dave Vandivort</td>
</tr>
<tr>
<td>Northern Embedded</td>
<td>Systems integration &amp; data telemetry</td>
<td>Corey Upton</td>
</tr>
<tr>
<td>CR Inspection</td>
<td>Expertise in construction inspection</td>
<td>Cheryl Seiwald</td>
</tr>
<tr>
<td>TCQ Consulting</td>
<td>Expertise in right-of-way monitoring</td>
<td>Gary Shane</td>
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</table>

The first task for Atkinson is securing the permissions from the Federal Aviation Administration to operate the unmanned aircraft systems (UAS) with a Certificate of Authority (COA). The COA is specific to the planned flight area, aircraft, and safety plan, which is described in detail later in this report.

Northern Embedded is performing systems engineering related to streaming video, video telemetry, and UAS operations.

CR Inspection and TCQ are initially assisting with design of the survey questionnaire, building the survey mailing list, and analysis of the survey results. CR Inspection will provide expert advice on the business of pipeline construction.
inspection. TCQ will provide expert advice on the business of pipeline integrity monitoring.

Executive Summary

The following, high-level, executive summary was circulated among the TAC members and consultants to provide a clear mission statement.

The University of Alaska Fairbanks has been conducting research into unmanned aircraft systems (UAS) since 2000, with more missions and mission diversity than any other university. With the creation of the Alaska Center for Unmanned Aircraft Systems Integration, UAF was poised to lead the effort for UAS research in Alaska as well as leading the winning proposal to become one of the six Federal Aviation Administration (FAA) test sites for UAS research. This project with the US Department of Transportation (DOT) and with Alyeska as a partner will provide global attention to our research on how UAS can be safely and efficiently integrated into pipeline business and engineering operations.

Project goals are to develop two items:

- First is a Decision Support System (DSS) that integrates UAS for a variety of pipeline management and engineering operations.
- Second is a set of best practices and operational examples on the safe integration of UAS for pipeline operators.

These two project outcomes can be considered the project deliverables by the US Department of Transportation.

Because of the nature of the cost share with Alyeska, we ultimately decided to focus on three areas of research. We call these the research scenarios:

Scenario 1 is right of way monitoring. The goal is to work with to test the use of real-time video and high-resolution imaging with UAS. The video will be fed in real time to secure web browsers, anywhere, on a variety of devices. The idea can be that Alyeska security officer in Fairbanks can be monitoring the video along with an engineer in Anchorage, from a PC, tablet, or even a smart phone. The engineer can ask the pilot flying the UAS to capture a high resolution image of some engineering issue and the security officer can ask the pilot to loiter at a location while an encroachment or threat is evaluated. Year one will be with a hexacopter, short range, line-of-site piloting. Year two will be a longer endurance mission, likely a fixed wing aircraft. The longer range mission will require more complex air space management, safety planning, and authorizations from the FAA, which is the reason for doing this in year two.

Scenario 2 will be pipeline inspection, primarily for the generation of as-built survey data, using a photo modeling technology called structure from motion. Ben Wasson and Jacques Cloutier are familiar with this concept and we want to explore the survey accuracy of the 3D photo models and how they compare to traditional as-built surveys. Year one will be a hexacopter with optical imagery and year two could be a different aircraft with a different camera, including infrared.

Scenario 3 is aligned with the function of the thermosiphons and keeping the soils stable. Unstable soils due to thaw are a growing concern and a more efficient method of inspecting thermosiphons is our goal with UAS. Optimal time of year for the first flights will likely be when temperatures are about zero degrees Fahrenheit. Existing inspection methods have been developed by Alyeska which we will attempt to replicate on a UAS. Year two may use another aircraft and camera.

All three research areas should then provide Alyeska executive management with an understanding of UAS technology, the capabilities, and value proposition.

Pump Station # 7

This pump station was selected because of its proximity to Fairbanks, the nature of its operations, and logistics. The FAA permissions to operate the aircraft at the pump station have been submitted and we
are now on the flight safety approvals. We hope to have all FAA permissions in place for first UAS flights in September. We are planning on the second year of FAA permissions to be for beyond-line-of-site missions, with flights of approximately 10 miles, to test airspace management systems, video and data telemetry from the UAS, and other mission performance issues.

FAA Coordination

The FAA regulates the National Airspace System (NAS) and manages the permission for UAS operations. The permission is called a Certificate of Authorization (COA) which waives certain flight regulations.

Two COA will be utilized on the project. The first one is for flight operations beginning late this summer (August-September) utilizing direct and visual line-of-sight by the pilot and observers. The second COA will be for beyond-line-of-sight operations with flights to commence in the spring of 2015.

The first COA operational summary specifies the aircraft (UAF Ptarmigan hexacopter), the geographic location (70 nautical miles north and south of Pump Station 07), and the altitude above the pipeline structure (200 feet). The second COA will specify a fixed-wing aircraft with a longer range, with an operational altitude of 400 feet.

During flight operations, the UAS pilot will be monitoring air traffic control operations (ATC) at the Fairbanks International Airport and maintain communications with ATC via cellular and/or satellite telephone.

The first COA has passed FAA Administrative Review, Air Traffic Control Review, and Safety Review. It is now in the final Regional Review process.

FAA Redefinitions of Note

On July 11 the PI asked for a written clarification regarding the operation of tethered UAS. The regulations at that time generally stated that tethered aircraft do not require a Certificate of Authority (COA)

The regulation to be clarified was 8900.227, which was set to automatically expire on July 30, 2014. Unbeknownst to the PI was that 8900.227 had already been replaced by FAA regulation 8900.1, Volume 16, which took effect a month earlier, in June 2014.

The effect is that now any powered aircraft, even with a tether, requires a COA to operate with the approval of the FAA.
Outreach & Communications

Outreach has included a local radio station interview and an initial press release reviewed and approved by Alyeska public relations.

The link for the radio podcast is:  http://www.970kfbx.com/media/podcast-whats-up-at-uaf-UAFUpdate/uaf-unmanned-aircraft-71614-25035392/

The press release is below:

UAF researcher initiates pipeline research using unmanned aircraft

University of Alaska Fairbanks (UAF) researcher Keith Cunningham’s vision is to make pipeline operations safer and more cost effective through the use of unmanned aircraft systems (UAS).

Recently funded by the US Department of Transportation, Cunningham’s $1.3 million research project will seek to transform his idea into a reality that will help the pipeline industry achieve greater safety and efficiencies.

“The benefit of using UAS is multi-fold,” said Cunningham, a researcher at UAF’s International Arctic Research Center. UAS can replace manned aircraft when and where flying and data gathering are ‘dull, dirty and dangerous’ work. “We’ve already demonstrated that UAS makes sense when we don’t want to disturb animals—for example in an earlier UAF project, we used it to count sea lions resting on a beach.”

The new project will test whether unmanned aircraft systems are applicable for a monitoring task that is critical to the energy industry and to the state and national economy. US law requires flying all pipeline rights-of-way 26 times per year to perform certain risk assessments. In deploying UAS to augment manned helicopter flights, Cunningham will examine how the technology affects the overall cost of pipeline operations. The idea has sparked interest within the Alyeska Pipeline Service Company, which has agreed to participate in Cunningham’s project.

“We will also test the possibility of using low-flying UAS to help with the inspection of new pipelines,” Cunningham said. “In this case, the UAS would be used to collect survey data prior to covering a newly constructed pipeline with earth.”

Another research focus includes the use of infrared cameras for the close-up inspection of pipeline thermosiphons. Thermosiphons are devices that help prevent the thawing of permafrost that can lead to unstable soils and slopes in critical places like river crossings. The result may contribute to safer pipeline operations by reducing the cost of such inspections and easing the process.

An important goal of the research is to assist in the development of best practices for using UAS in pipeline operations and provide the US Federal Aviation Administration and the Pipeline & Hazardous Materials Safety Administration with useful guidelines as they set future UAS operational regulations.

Cunningham also contemplates that the results of his research will bring increased international attention to UAF, Fairbanks and Alaska. “I hope that pipeline operators around the world will be attracted to this work as they too seek to reduce costs and increase operational safety in the pipeline industry. This type of major research can have a multiplier effect—opening the door to additional research funding for UAF, as well as supporting economic development in the city of Fairbanks and the state of Alaska.”

ADDITIONAL CONTACTS: Keith Cunningham, 907-474-6958, kw cunningham@alaska.edu.

Conferences planning in this quarter has included a dedicated transportation planning and engineering track for the Alaska UAS Interest Group conference. This conference has been in planning for several months and will occur September 14-18, in Anchorage (www.uasalaska.org). At this conference, there will be a dedicated UAS track for transportation applications in Alaska such as bridge inspection, permafrost, avalanche management, rural airports, and pipeline operations.

We have also started the development of the storyboard for our first outreach video, which will be part of a series of videos describing the projects components and research results.
The project website will go live the last week of August, 2014. The temporary website is available at http://cerberus.snap.uaf.edu/projects (username: snap / password: awesome)

Literature Review

A review of the pipeline industry’s application of UAS technology is underway. There is significant literature related to UAS operations in foreign countries with more relaxed aviation regulations.

A very useful link (http://trid.trb.org/) for the literature review is hosted by the Transportation Research Board (TRB) and it combines records from the TRB’s Transportation Research Information Services (TRIS) Database and the OECD’s Joint Transport Research Centre’s International Transport Research Documentation (ITRD) Database.

The bibliography of the literature review will be made available on the project website.

Pipeline Operator Survey

The industry survey is in development, with assistance from TCQ, CR Inspection, and the Pipeline Research Council International (PRCI). The survey is broken into three sections, one dealing with UAS for pipeline right-of-way surveillance, the second being facilities inspection with UAS, and the third being geotechnical engineering with UAS derived mapping products.

Mailing lists to send the emails inviting survey participation are also in development, again with the three supporting team members.

The anonymized and aggregated survey results will be made available on the project website and in the second quarterly status report.
Project Management Summary

The project management and deliverable tracking system has been created. The screen shots below summarize the events underway for 2014.
Supplemental Research

Frozen Debris Lobes (FDL) Proposal

The agreement between OST and UAF is currently being evaluated to support a special geotechnical investigation of the frozen debris lobes encroaching the Dalton Highway and the Alyeska Pipeline. FDL are a mass of gravel, soil, and ice that flows downhill. There are about a half dozen FDL impinging the right-of-way that contains the haul road to Prudhoe Bay as well as the pipeline.

The majority of the research monies will be spent on geotechnical surveys and sensors (in-situ arrays), but a portion will be reserved to operate UAS to calculate the volume of the moving FDL and possibly its flow velocity.

Commercialization Proposal

OST also requested a proposal to augment the commercialization of the UAS research. The proposal was specific to the UAS ground control station being utilized on this project and if the proposal is accepted by OST, additional customer needs analysis will be conducted and support to continue the commercial development of the ground control station will accelerated.
Alyeska Coordination

Coordination with Alyeska is important in several areas and several levels over the two-year span of this project. In general, coordination includes:

- Management Interactions,
- Outreach/Messaging,
- GIS/Survey Data Sharing,
- Information Technology & Cyber Security, and
- Safety and Security Issues.

Management Interactions are designed to communicate project activities to the various levels of management at Alyeska to ensure that appropriate project details are being shared to foster a positive project understanding and shareholder awareness. Alyeska is owned by three large oil companies including British Petroleum Pipelines, ConocoPhillips, and ExxonMobil, all having an interest in this project.

Outreach/Messaging has included a local radio station interview and an initial press release reviewed and approved by Alyeska public relations. Outreach will continue with educational videos, the website, and a variety of reports.

GIS & Survey Data sharing has been initiated. Alyeska utilizes a consultant to manage survey crews and the resulting survey and mapping/GIS data. We have reached out to the consultant to acquire information on the metadata such as coordinate systems, survey datum(s), and delivery schedules for various data. Data will be forthcoming in August, prior to the UAS flight operations planned for September and October. This data represents the bulk of the 1:1 project cost share and is valued by Alyeska at $693,718, thus we have a slight overmatch.

Information Technology & Cyber Security evaluation was conducted in July to determine if the existing fiber optic backbone used by Alyeska for equipment monitoring (supervisory control & data acquisition) and emergency operations could be used to carry the high-definition (HD) streaming video from the UAS to the Alyeska Emergency Operations Centers (EOC) located in Fairbanks and Anchorage. It was determined there is sufficient bandwidth to deliver color HD video in real-time with no reduction in the video frame rate.

Also the streaming video can be securely shared with select viewers via web browsers, thus live streaming to OST offices in Washington, DC as well as pipeline owners in Houston and elsewhere are now planned. A test of the streaming video will be conducted at Alyeska’s Fairbanks office in mid-August, with a dress-rehearsal test at Pump Station #07 in late August, prior to UAS flights in September and October.
Safety and Security discussions with Alyeska reflect not only the importance of worker safety, but also risk mitigation in the event of some unforeseen emergency. All UAF faculty and staff working on this project will participate in a half-day safety workshop with Alyeska related to personal and worksite safety.

We are also developing a UAS flight-safety plan for Alyeska to define and understand any risks associated with the UAS. This has included an impact risk assessment of the UAS to be operated. The kinetic energy from a UAS crash into the pipeline was calculated to be 3,274 Joules, which was derived from a mass of 11 kilogram in flight configuration with the most mass (batteries and largest camera), with an accelerating free fall from 30 meters. This impact would likely have no impact on the exterior galvanized steel cladding around the insulation of the pipeline within.

Historic research into the collision of a manned aircraft with the pipeline also supports the assessment that there is little if any risk to the pipeline. A fatal Cessna collision on October 19, 1980 caused no pipeline damage. See the summary report below from the National Transportation Safety Board (NTSB):

<table>
<thead>
<tr>
<th>FILE</th>
<th>DATE</th>
<th>LOCATION</th>
<th>AIRCRAFT DATA</th>
<th>INJURIES</th>
<th>FLIGHT REPORTS</th>
<th>PILOT DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-2227 80/10/19 DEADHORSE,AK</td>
<td>CESSNA U200F</td>
<td>CR- 1 0 0 COMMERCIAL</td>
<td>COMMERCIAL, FL.INSR., TIME - 2105</td>
<td>NS9199</td>
<td>F/O 1 0 0 AIR TAXI-PASS</td>
<td>LT - 0 0 0</td>
</tr>
<tr>
<td>NAME OF AIRPORT - DEADHORSE</td>
<td>DEPARTURE POINT</td>
<td>INTENDED DESTINATION</td>
<td>LAST ENROUTE STOP</td>
<td>NUIQSIT, AK</td>
<td>TYPE OF ACCIDENT</td>
<td>FLIGHT TYPE</td>
</tr>
<tr>
<td>PROBABLE CAUSE(S)</td>
<td>TYPE OF WEATHER CONDITION</td>
<td>INCIDENTS - MISJUDGED DISTANCE AND ALTITUDE</td>
<td>WEATHER - LOW CEILING</td>
<td>WEATHER - LOW CEILING</td>
<td>WEATHER - NIMBLY</td>
<td>WEATHER - NIMBLY</td>
</tr>
<tr>
<td>PILOT IN COMMAND - CONTINUED VFR FLIGHT INTO ADVERSE WEATHER</td>
<td>WEATHER - NIMBLY</td>
<td>SKY CONDITION</td>
<td>CEILING AT ACCIDENT SITE</td>
<td>OBSERVATION</td>
<td>VISIBILITY AT ACCIDENT SITE</td>
<td></td>
</tr>
<tr>
<td>OBSTRUCTIONS TO VISION AT ACCIDENT SITE</td>
<td>WIND DIRECTION - DEGREES</td>
<td>WIND VELOCITY - knots</td>
<td>SPECIAL VFR</td>
<td>FIRE AFTER IMPACT</td>
<td></td>
<td></td>
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<tr>
<td>BRIEFED BY FLIGHT SERVICE II</td>
<td>SPECIAL VFR</td>
<td>TYPE OF FLIGHT PLAN</td>
<td></td>
<td></td>
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</tbody>
</table>

See the summary report below from the National Transportation Safety Board (NTSB):
Alyeska Safety Plan for Pump Station 07

The following detailed safety plan was submitted to Alyeska for the 2014 & 2015 flight operations.

Person in Charge: Keith Cunningham – 907-474-6958
Safety Officer: David Vandivort – 252-675-3798
Qualified Pilots: Mike Cook, Corey Upton
Project PI: Keith Cunningham – 907-474-6958

Proposed Dates & Objectives:
September – October, 2014 (first round of scenario testing with line-of-sight flights)
March – April, 2015 (thermosiphon scenarios at zero degrees Fahrenheit)
May – June, 2015 (second round of scenario testing with beyond-line-of-sight flights)

Equipment Being Used:
UAF Hexacopter, aka Ptarmigan
  - Mass in flight configuration: 11 kg
  - Dimensions: 1m x 1m x 0.5m
  - Max. forward speed: 10 m/s
  - Max. flight time: 18 min
  - Payload: GoPro camera on gimbal with a Light Bridge streaming video link
  - 2.4 GHz radio control
  - This aircraft is equipped with a GPS navigation system. Should the link between the aircraft and the ground controller be lost, the aircraft will immediately fly back to and land at the takeoff point.

Safety Equipment Used:
  • Safety vests
  • Hard hats
  • Steel toe boots
  • Li-Po safety bags
  • Vented ammunition cases

Collection Plan:
Multiple flights to over the site will be performed. This would include flights directly above the site with the camera pointed at nadir as well as from the side with the camera pointed at an oblique angle to the ground. Takeoffs and landing will occur near the slopes being investigated. The flight paths are to be linear lengths of 100m, at a speed <3 m/s, at an altitude of 25-50 m. All collects will be conducted while the hexacopter is in GPS mode as well as autonomous robotic flights will be made. While in GPS mode the hexacopter will hold its position when no inputs are made on the controller and it will return and land at it starting position if connection to the controller is lost.

Fire Hazards:
The local Forest Service fire warning status will be checked prior to any flight operations. Lithium Polymer batteries will be stored in vented, metal, latching ammunition cases until installation prior to flight. A general purpose fire extinguisher will be on hand in event that a malfunction sets fire to any surrounding brush. The safety officer will make a final assessment of the fire risk in the field and will determine if it is too great for safe operations.

Conditions Precluding Flights:
  • Other aircraft in the vicinity
  • Winds in excess of 30 knots
  • Obstacles in the flight path – power lines, structures, equipment, etc.
  • Traffic on driveway
  • Persons under the flight path
Flight Risk Analysis:
UAF Operations and Engineering personnel, in conjunction with Alyeska, conducted a Preliminary Hazard Analysis of the operation.

Assumptions made in the Flight Risk Analysis include:
1. The UAS flight control and flight termination systems will function correctly.
2. Manned aircraft will not operate below 500 ft AGL in the vicinity of the operational area.
3. Unauthorized personnel and vehicles will not be allowed within the confines of the operational area.

The following hazards were identified in descending order of magnitude:
1. Loss of navigation control.
2. UAS PIC loses visual contact with UAV.
3. Loss of voice communications between PIC and ATC.
4. Loss of voice communications between PIC and Observer(s).

The Preliminary Hazard Analysis Worksheet and Risk Matrix diagram are included on the following pages.
<table>
<thead>
<tr>
<th>Hazard #</th>
<th>Hazard Description</th>
<th>Causes</th>
<th>System State</th>
<th>Existing Control or Requirement</th>
<th>Possible Effect</th>
<th>Severity/Rationale</th>
<th>Likelihood/Rationale</th>
<th>Current/Initial Risk</th>
<th>Recommended Safety Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Loss of navigation control.</td>
<td>Pilot error, UAV system error, ground control station error, interference from external source.</td>
<td>UAV and GCS systems prefight checked for proper operation, geo-fence established, VMC, daytime, operating within visual line of sight</td>
<td>1. A hard geo-fence feature exists within the control tablet. Upon reaching the geo-fence, the UAS will stop all movement and an error indicator will alert the PIC. If the UAS attempts to proceed past the geo-fence it will experience a total power loss and fall straight to the surface. 2. The navigation and geo-fence parameters are flown first by simulation to ensure programming is accurate. Tripots will be verified by one or two fully qualified Scout UAS experienced operators. 3. The PIC will immediately implement a flight termination shutdown of the UAS. 4. ATC will be immediately notified of the situation. 5. Personnel inside the operating area will wear Personal Protective Equipment (PPE) such as helmets/hard hats and eye protection.</td>
<td>1. Inadvertent flight into the path of non-participating aircraft resulting in mid-air collision. 2. Inadvertent flight into structure, vehicle or person outside of the operating area. 3. Loss of UAV.</td>
<td>E Extremely improbable due to operating altitude, location of operating area, absence of non-participating aircraft in the area, mitigating strategies and system capabilities.</td>
<td>1E</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>UAS PIC loses visual contact with UAV.</td>
<td>Atmospheric conditions or excessive distance between UAV and pilot</td>
<td>VMC, daytime, operating within visual line of sight</td>
<td>1. UAS will be operated in VMC conditions within .5 nm of the PIC at all times. 2. A trained observer will monitor the UAV in addition to the PIC. 3. The UAV will be commanded to hold position until visual contact is reestablished. 4. ATC will be immediately notified of lost-sight condition.</td>
<td>1. Loss of UAV 2. Increased potential for collision on ground or mid-air</td>
<td>3 Major due to increased potential for collision on ground or mid-air.</td>
<td>D Extremely Remotely due to mitigating strategies and system capabilities.</td>
<td>3D</td>
<td>NA</td>
</tr>
<tr>
<td>Hazard #</td>
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<tr>
<td>3</td>
<td>Lost comms between PIC and ATC.</td>
<td>Communications equipment failure, insufficient battery power, radio interference from external source.</td>
<td>Frequencies checked for clarity, communications equipment checked for operators, VMC, daytime, operating within visual line of sight.</td>
<td>1. An ICOM A-6 VHF hand-held radio which has been tested from the flight area and found to be highly effective. 2. The PIC will have a cell phone by which he/she will be able to reach ATC personnel. This number will have been pre-coordinated with the FAI ATC supervisor. 3. A hard-line telephone will be extended to the PIC location in the event either of the first two means of communications fail. This number too will have been pre-coordinated with the FAI ATC supervisor.</td>
<td>Loss of ability to notify ATC of potentially hazardous situations as they occur.</td>
<td>4 Minor due to systems and procedures that will ground the aircraft in the event of lost comms between PIC and ATC.</td>
<td>0 Extremely Remote due to redundancy of comms methods.</td>
<td>4D</td>
<td>NA</td>
</tr>
<tr>
<td>4</td>
<td>Lost comms between PIC and observers.</td>
<td>Communications equipment failure, insufficient battery power, radio interference from external source.</td>
<td>Spectrum analysis performed on frequencies to ensure clarity, PIC and Observers have functioning cell phones, communications equipment checked for operators, VMC, daytime, operating within visual line of sight.</td>
<td>1. Tested and fully charged UHF hand-held radios will be available during all flights 2. Observer will always be located within 25 ft of the PIC during flights, thus radio communications shouldn't be necessary. 3. Should circumstances arise whereupon the observer is required to be located more than 25 ft from the PIC, the UHF radio will be utilized. 4. Should UHF communications fail to provide the necessary levels of safety, all flight activity will cease.</td>
<td>1. Pilot and/or observer lose sight of the UAV and are unable to notify the other. 2. A potentially hazardous situation is not communicated.</td>
<td>4 Minor due to systems and procedures that will ground the aircraft in the event of lost comms between PIC and observer.</td>
<td>0 Extremely Remote due to redundancy of comms methods.</td>
<td>4D</td>
<td>NA</td>
</tr>
</tbody>
</table>
Treatment of Risks/Mitigation of Hazards:

1. Loss of navigation control.
   a. A hard geo-fence feature exists within the programming syntax of the control tablet. This feature allows the PIC to set a specific operating area as well as the functions that will occur should the UAS attempt to "wander" outside the fence. For this mission, the UAS is programmed to enable one of two functions:
      i. If the UAS attempts to navigate outside the geo-fence: upon reaching the geo-fence, the UAS will stop all movement in a three-dimensional plane and proceed no further. An error indicator will alert the PIC that the geo-fence has been reached.
      ii. Should the UAS attempt to proceed past the geo-fence vertically, horizontally or in altitude, the UAS will experience a total power loss and fall straight to the surface.
   b. The input parameters are flown first by simulation on the control tablet. This feature ensures that the operator can see where their programming projects their UAS to be at any given moment during flight.
   c. To ensure programming is accurate, all programming inputs for flights over this area will be verified by one other fully qualified Scout UAS experienced operator.

2. UAS PIC loses visual contact with UAV.
   a. Visual Observers will assist the PIC in reacquiring visual contact with the UAV.
   b. The UAV will be commanded to hover in-place until the PIC reacquires visual contact.
   c. ATC will be immediately notified of the lost-sight situation and again once the UAV is reacquired by the PIC.

3. Loss of voice communications between PIC and ATC.
   a. Three means of communications will be available to the PIC for the purpose of communicating with ATC:
      i. An iCOM A-6 VHF hand-held radio which has been tested from the flight area and found to be highly effective.
ii. The PIC will have a cell phone by which he/she will be able to reach ATC personnel. This number will have been pre-coordinated with the FAI ATC supervisor.

iii. A hard-line telephone will be extended to the PIC location in the event either of the first two means of communications fail. This number too will have been pre-coordinated with the FAI ATC supervisor.

b. Should all three means of communications fail to provide the necessary levels of safety, all flight activity will cease.

4. Loss of voice communications between PIC and Observer(s).

a. Tested and fully charged UHF hand-held radios will be available during all flights.

b. A single observer will be employed during this test. This observer will always be located within 25 ft of the PIC during flights, thus radio communications shouldn’t be necessary.

c. Should circumstances arise whereupon the observer is required to be located more than 25 ft from the PIC, the UHF radio will be utilized.

d. Should UHF communications fail to provide the necessary levels of safety, all flight activity will cease.

Conclusion:
Based on the current information, this site, Pump Station 07, is deemed safe to fly. Prior to any flights, the safety officer will make a final assessment of site to determine any conditions that would preclude the flight. Bystanders will be briefed on the proposed plan and the proper action in an emergency. A safe viewing zone will be identified for bystanders. The safety officer will inform the pilot when it is safe to begin flight. During collection flights, the safety officer will act as an observer to alert the pilot to any approaching aircraft. Should another aircraft enter the vicinity, the collection flight will be immediately terminated and the aircraft landed at the nearest safe location.