PROJECT REPORT

ROAD WEATHER INFORMATION SYSTEM PHASE II & IIB
FEDERAL #ITS –0106(02) & ITS-9902(1)

November 2004

Project Location: Alaska

FY01 ITS Earmark Total:
RWIS Phase II – $1,875,137 (50/30/20)
RWIS Phase IIb - $697,950 (50/30/20 - Phase II funding extension)

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OVERVIEW

The Alaska Department of Transportation & Public Facilities (ADOT&PF) initiated the first eight environmental sensor stations (ESS) in the Anchorage area, called the Road Weather Information System (RWIS) Phase I. Following Phase I, the need for more ESS statewide increased. The ADOT&PF identified 31 sites, called the RWIS Phase II. The ADOT&PF relocated some sites during the design phase to more desirable locations, some sites were never constructed due to power and communication issues, and newer sites were identified due to priority of maintenance and operations (M&O) personnel. Hence, the ADOT&PF has updated and continues to update the original list of 31 sites.

The need for additional ESS after Phase I grew for various reasons. One, M&O stations statewide have large areas they maintain; sometimes over 100 miles of road in one direction. Having an ESS on their route could help improve daily winter operations. Two, due to budget cuts, some M&O stations were closing and the next closest M&O station would have to extend their area to cover this closure. Rather than having to drive the long routes for road conditions, the M&O stations could simply turn on a computer at their station and access the information. Overall, as the popularity of the RWIS grew from Phase I, this generated more interest from M&O personnel requesting new sites and site relocations.

The ADOT&PF used a site selection plan as a starting point to select Phase II ESS locations (Appendix A). Matrix Management Group (MMG) conducted the plan in August 15, 2001 as a subcontractor to PB Farradyne-project manager. MMG selected sites based on: a reconnaissance of areas suggested by M&O personnel; an analysis of existing weather observation sites; and site analysis to determine the geography that allows for ideal road condition collection.

The Site Selection Plan generated a list of favorable sites. From this list, M&O managers chose the top 31 priority sites based on the funding amount. As Phase II design and installation began, the ADOT&PF delayed or relocated many sites due to higher priority sites, issues with power and communications, and problems with cold weather impeding installation. In addition, new locations have been proposed, but not necessarily finalized. The current RWIS Phase II ESS locations are listed in Table 1. M&O and other agencies such as the National Weather Service and the military have proposed several new sites for 2006 installation, but the ADOT&PF has not finalized those sites and, therefore, are not included in Table 1. Since the ADOT&PF proposes new sites each year, Phase II installation is still ongoing. The original ITS Earmarks, however, have been expended and the ADOT&PF is using new funds from the State Transportation Improvement Program (STIP).

Table 1. RWIS Phase II – ESS locations

1	Parks Highway @ Hawk Lane MP 53.2	Completed
2	Parks Highway @ Talkeetna Road MP 98.7	Completed
3	Parks Highway @ Little Coal Creek MP 163.2	Partially Completed
4	Parks Highway @ East Fork DOT M.S	Proposed – priority level lowered
5	Parks Highway @ Broad Pass Summit, MP 201	Completed
6	Parks Highway @ Nenana Hills MP 328	Proposed- issues with power & comm
7	Seward Highway @ Summit Lake Lodge MP 45.8	Completed
8	Seward Highway @ Russian River Ferry MP 54.8	Completed
9	Seward Highway @ Snow River MP 17.7	Proposed –issues with power & comm
10	Sterling Highway @ Soldotna DOT M.S. MP 98	Completed
11	Sterling Highway @ Ninilchik River Bridge MP 135.9	Completed
12	Richardson Highway @ Tenderfoot MP 292.7	Proposed –install 2005
13	Richardson Highway @ Birch Lake MP 307.2	Completed
14	Richardson Highway @ Badger Interchange MP 358	Completed
15	Richardson Highway @ Trims DOT M.S MP 218.2	Completed
16	Richardson Highway @ Rendezvous Lodge MP 45.6	Proposed – install 2005
17	Richardson Highway @ Valdez MP 19	Completed
18	Richardson Highway @ Thompson Pass MP 26	Completed
19	Edgerton Highway @ Richardson Highway Intersct.	Completed
20	Alaska Highway @ Dot Lake MP 1360.4	Completed
21	Alaska Highway @ Tok Weigh Station MP 1308	Proposed –install 2005
22	North Douglas Highway @ MP 4	Partially Completed
23	Glacier Highway/Egan Drive @ MP 3	Completed
24	Mendenhall Loop Road @ Goat Hill	Completed
25	Glacier Highway @ Cohen Drive MP 22	Completed
26	Klondike Highway @ US/Canadian Border MP 14.9	Partially Completed
27	Haines Highway @ Chilkat River Bridge MP 23.8	Completed
28	Haines Highway @ Klehini MP 36.6	Completed
29	University Avenue, Fairbanks @ Chena River Bridge	Completed
30	Steese Highway @ Cleary Summit MP 20.9	Completed
31	Tok Cutoff @ Mentasta Pass MP 79.2	Completed
32	Glenn Highway @ Gunsight Mountain MP 117	Completed
33	Portage Glacier Road @ Bear Valley	Partially Completed

All of the sites include sensors for surface, sub-surface and/or atmospherics. Some sites include donated equipment such as tipping buckets and barometric pressure gauges from the National Weather Service (NWS) and various sensors from the University of Alaska – Fairbanks (UAF) to further their weather research. The donated UAF equipment, however, has been delayed due to installation delays of UAF specific ESS locations. In addition, all of the ESS that include atmospheric sensors include a fixed-zoom camera or a Pan-tilt-zoom (PTZ). See Table 2 for sensor information.

Table 2. RWIS Phase II – Sensors

Surface	Surface Systems FP 2000 Chemical percent, ice percentage, depth, freeze point
Sub-Surface Temperature Probe	Surface Systems Model #S16UG-D 17" below roadway surface -22 to 176°F
Temperature Data Probe	Measurement Research Corp. Model #TP101 "SHRP" 72" below roadway surface
Wind Speed/Direction	RM Young Model #05103 0-134 MPH Met One Instruments #50.5
Air Temperature/Relative Humidity	Thies Model #032202 10-100% relative humidity -31 to 158°F Ambient Temperature
Fixed-Zoom Camera	Cohu iView– Fixed Zoom Camera Color, low-light
Pan-Tilt-Zoom Camera	Cohu iDome – Pan Tilt Zoom Model #3920 Color, 360° rotation, 64 user-defined preset positions.
Precipitation Sensor	Hawk Eye or Price Yes/No detection, Optical Infra-red
Optical Weather Identifier – precipitation type, intensity and rate	Optical Scientific Inc.
Tipping Bucket Rain Gauge	Texas Electronics #TE525 WS-L8 NovaLynx Corporation Model 260-2500 12" rain gauge
Barometric Pressure	Vaisala-Campbell Scientific #CS105

Similar to Phase I, the ADOT&PF chose Surface Systems, Inc (SSI) to deploy RWIS Phase II. Phase I deployment facilitated RWIS plans, specifications and estimates for additional ESS statewide in Phase II. It also heightened awareness of using RWIS to improve M&O winter operations statewide. Lessons learned from Phase I helped address issues in Phase II. However, this has not been the case entirely. New Phase II issues were addressed concurrently with the design and installation. Phase II generated a whole new set of issues that made managing the project much more involved, such as:

1. In Phase II, the ADOT&PF organized an RWIS team to oversee the design and construction. Whereas, a contractor managed the RWIS Phase I project.
2. Phase II sites consisted of ESS in very remote locations requiring a more complex design in regards to power and communications. This caused a much more complex network of communications to manage and maintain through various types of communication and links, i.e. Freewave Radio, modems, State Wide Area Network, internet, and plain old telephone (POTS). Power resources were more complex due to multiple power companies servicing the sites and unique power sources such as solar and generators being considered. In addition, ADOT&PF sought out other agencies to share in the power and communications for several ESS. These

partnerships generated the need for detailed Memorandum of Agreements that outline the responsibility of each agency.

3. Heightened interest, both internal and external to the ADOT&PF, generated more requests from the RWIS team, such as: access to the raw data, a public web site, equipment donations, sharing of power and communications, metadata, quality controlled data, internal website upgrades, and more.
4. Costs per site tripled due to cost of new equipment, innovative power and communication resources, additions of donated sensors, and ongoing problems and changes with hardware and software.
5. Ongoing maintenance and operations generate a much more complex system to manage and continually monitor and maintain.

Overall, the RWIS Phase II has generated a very positive feedback from both internal and external users of the system. The camera images available on *roadweather.alaska.gov* generates more hits than any other page on the ADOT&PF's web page. M&O have benefited from the improved winter operations efficiency, especially with budget cuts and tight management occurring.

PROJECT TIMELINE

RWIS Site Selection Plan (Matrix Mgmt Group)........................August 2001

Request for Proposal...July 2002

Vendor Selected (Surface Systems, Inc) ....September 2002

Project Begin...September 2002

Project Complete...Ongoing

LESSONS LEARNED

Technical

The majority of technical issues in Phase II were communication, power and ongoing issues related to hardware and software. Phase II included site locations in very remote stretches of highway where power and communications are limited or simply not available. This required innovative communication. Freewave Radio provides a wireless link to a direct line nearby and then into the State WAN where the data is transferred to a central server. This technology has proved very reliable and feasible. Cellular phone was not an option because of the high costs in Phase I.

Installing sites in remote areas also required innovation in power. In a couple ESS locations, the ADOT&PF partnered with other organizations, such as the Federal Aviation Administration (FAA). The FAA invited the ADOT&PF to share power from an FAA facility near the ESS. In another case, the ADOT&PF partnered with a private business using a generator. Both of these required a Memorandum of Agreement (MOA) so that goals and responsibilities of each agency are clear and simple to understand. In areas where no adjacent buildings exist with a power source, the ADOT&PF purchased power modules that use propane generators and solar backup. Three power modules will be operational in 2005. The ADOT&PF anticipates additional power module purchases at sites that have no direct power source.

Many other communication issues arose that were periodic. Some of these issues were caused in the network of data transfer. Phase II consists of a complex network of communication from the ESS RPU to the central server. A break in the network due to equipment or communication failure can cause data not to transfer from the ESS. This requires continuous monitoring of the communication network to make sure data is transferred successfully.

Lessons Learned – Technical:

1. Rely on partnerships to share power and communications in remote areas, if necessary. Partnerships can lead to successful ESS deployment where both parties may benefit. (see Partnerships below)
2. Use innovative communication and power sources, especially for sites in remote areas. Freewave Radio is proving to be a reliable and inexpensive means to link ESS to established, inexpensive communications when POTS or other direct communication sources are not available at the ESS.
3. Pay close attention to the communication network and monitor for inconsistencies or failure in data transfer.

Other technical issues include faulty equipment. For one, accuracy of many of the pavement sensors has been questionable since they were installed. The ADOT&PF detected this issue during Phase I, but made the mistake of pre-purchasing numerous pavement sensors for Phase II. Hence, we were left with the sensors, but still maintained hope that they would produce some reliable data. Moreover, not all the pavement sensors were bad, only some reported false readings. Another other issue with the pavement sensors is that they were susceptible to damage once overlaid with new pavement.

Another equipment issue are camera outages. We elected to purchase pan-tilt-zoom (PTZ) cameras that could collect 16 pre-set images from the RPU. In previous discussions with the Federal Aviation Administration, they were interested in collecting images of the skyline for aviation purposes. The PTZ camera that we purchased was new technology that was not very reliable. Several PTZ cameras failed due to technical problems and had to be replaced. These problems are ongoing with the PTZ and they require periodic monitoring to make sure they are operational.

Other equipment issues relate to integrating donated sensors. The ADOT&PF is open to installing donated equipment. Small issues arise, however, during installation that require unique or additional expenses to make them operational. The NWS donated tipping buckets for several ESS. Many o f these required wind guards that had to be specially fabricated, delaying the installation of several sites. The ADOT&PF also incurred the expense of making the wind guards and installing them.

Lessons Learned – Equipment:

1. Research more robust equipment for the ESS. New technology, such as radar can help alleviate the many problems of in-pavement sensors, including M&O paving projects that cover the pavement sensor. Once the sensor is paved over it must be replaced, costing approximately $5200 per site.
2. Equipment issues arise continuously and must always be monitored for inaccuracies or complete failure. Keeping additional funds in the budget for maintenance & operations of the equipment is essential. In addition, the RWIS team cannot continuously monitor the RWIS data for inaccuracies and failures. Purchasing software warning system that can detect these failures, can save not only embarrassment of having external users notify us of issues, but also increase the chance of early detection.
3. Purchasing the newest technology can be risky. The PTZ cameras produce functional images, but the technology seems to be unreliable. The need for reliable cameras is very high especially since the images are the most highly requested from the users.
4. Work closely with other agencies that are donating sensors to ensure that all the component are ready and complete. Also, ensure that additional expenses caused by the donated sensor are not too costly that they cannot be installed.

Institutional

Internal:

Internal issues in Phase II are mainly managerial related. Phase II generated a whole new set of issues that made managing the project much more involved and complicated. To help alleviate issues that arise, the ADOT&PF created an RWIS team made up of personnel from each region, including the headquarters office. The team meets frequently to discuss installations, ongoing issues and future needs. This is a very positive approach, however, it's not without it's disadvantages. The RWIS team deals with vast amounts of detail needing attention to this project. For one, the ADOT&PF uses Notice to Proceed (NTP) documents to procure additional equipment and services from the Contractor on an as-needed basis. NTP's are a good way to procure additional items as needs arise, however, during Phase II this method is used countless times where tracking all of them becomes critical so as to not exceed budgetary amounts. This method requires continuous attention to the amounts and good accounting.

Phase II also increased the number of invoices being processed. In addition to the monthly invoices from the main RWIS Contractor, numerous invoices were added from phone and power companies to accommodate the statewide ESS sites. Other invoices increased due to contractor services for site inspections and information technology services. Some invoices are sent to more than one source making it difficult to track the funding account. In addition numerous ADOT&PF personnel charge their time and travel to the RWIS budget making it difficult to budget personnel time in the first place. Overall, the RWIS team has to a difficult task of keeping a tight control on the account to ensure that these invoices and personnel expenses do not exceed the budget.

After deploying Phase I, the need for additional ESS statewide and integrating it with other ITS projects became more apparent. As the RWIS becomes more widely accepted by internal staff, they began to make requests on new sites, site relocation, or questions about the ESS equipment and software. Matrix Management evaluated M&O needs before design began, however, the seriousness of M&O's interest did not grow until the ADOT&PF completed Phase I. Most likely, M&O's heightened interest grew once they could see and use the RWIS data. Additionally, it is unknown to what extent M&O personnel are using the data to make winter operation decisions. Since these are built for M&O we assume they are using the data for winter operations. A tighter control over the users and their feedback is necessary to help further steer the direction of the RWIS. An attempt was made to survey the users, but little feedback was given and follow-ups were not completed due to other priority areas the RWIS team addresses continuously.

Similar to Phase I, appointing responsibility on maintaining the sites is a another internal issue. Internal expertise on the sites is minimal. All of the technology involved requires great attention and tremendous training in order to maintain the sites. Even minor maintenance like cleaning the camera lenses or re-positioning the camera is a concern when we don't have M&O trained to perform these procedures. It can be costly to send a Contractor to perform these minor maintenance actions. Currently we have purchased an extended warranty with the Contractor to support and maintain the system, but eventually we will need to be more self-sustaining.

Lessons Learned – Internal:

1. User and on-site training is an essential part of bringing new technology into the ADOT&PF. M&O are expected to use the ESS and eventually maintain the system.
2. Conducting a user needs study with key M&O personnel on ESS location, equipment, usage, etc. is essential during the pre-design phase. However, in this case, the ADOT&PF also needs to conduct follow up surveys after initial deployment. M&O are very aware of their work area and have very specific needs that should be taken into consideration early in the planning stage.
3. A usage survey can help the RWIS team better manage the project. Again, it is unknown to what extent the M&O use the RWIS data and if they are using it at all.
4. A tight control of NTP's, invoices and personnel working on the project can help alleviate budget issues.

External:

Institutional issues external to the ADOT&PF include sharing the data with other agencies, integrating equipment from other agencies, sharing of resources such as power and communications and more. TechNet 2002 was a conference to discuss the sharing of resources between agencies that have remote sensors, such as RWIS. During this conference, other agencies became very interested in accessing the data, donating additional sensors, and in sharing power & communications to help deploy the RWIS. The support from other agencies on our RWIS program was very positive for the ADOT&PF, however, it wasn't without minor institutional issues. For one, the RWIS team was more than open to equipment donations, however, the question arose on maintenance. Who would maintain the equipment? The RWIS team decided to create a Memorandum of Agreement (MOA) outlining the maintenance and operations. Essentially, agencies would donate the equipment to the State and we would maintain it as funding became available. This approach worked the best to alleviate confusion on maintenance and ownership. These same concerns were raised in sharing of power and communications with other agencies or businesses. Again, MOA's were used to alleviate sharing issues.

RWIS data must be easily accessed by any agency requesting the information. This proved to be a fairly easy task by providing an FTP site where the data can be accessed at no cost. The only issue raised is that the data being placed on the FTP site was in vendor-supplied format (raw data) that was not user friendly. The agencies accessing the data need to understand the raw data formats so they can convert it to a user friendly format. This is done by emailing the agencies a document explaining the data formats.

In addition to providing an FTP site, there were issues with providing metadata and updating the public website to keep up with the numerous ESS installations occurring statewide. As RWIS Phase II was deployed, interest from outside agencies grew tremendously. This increases requests from external agencies on data accessibility.

Lessons Learned – External:

1. Take into consideration that road weather data will generate interest from other agencies who will want the data and may donate equipment to improve their weather observations. Other agencies, such as the National Weather Service and the University of Alaska both donated equipment and were interested in free access to the data. Pre-planning early in the design phase will help alleviate integration issues later on.

Financial

The cost of Phase II RWIS is very difficult to compute. For one, each site installation was unique depending on the environment, the closeness of power and communications and equipment needs. The cost of an ESS were dependent on numerous factors:

- trenching requirements
- installing unique communications and power types i.e. installing radio antenna's at high locations using helicopter service, building power modules and housing, etc.
- utility companies extending service to reach the RPU
- installing donated or custom equipment such as tipping buckets
- revisiting sites by the contractor to make changes or updates
- revisiting the sites by utility companies when there's a utility failure
- equipment replacement i.e. pavement sensors
- unique site installation and commissioning
- additional training
- website upgrades

These costs unknown to the RWIS team make it very difficult to estimate the cost and work with a budget. These issues and cost create installation delays and the need to continuously request funding to support the project. The ITS Earmark was not enough to continue these ongoing and additional expenses. More funding is coming from the Statewide

Transportation Improvement Program (STIP) where these costs are competing with other surface transportation projects.

Lessons Learned – Financial

1. When planning an RWIS budget, take into consideration additional expenses to cover ongoing changes and unknown additions, and M&O of the ESS. This can be difficult to do when installing ESS in remote areas where each site installation is unique.

Procurement

The ADOT&PF used a cost plus fixed fee in Phase II, similar to Phase I since it was flexible and successful. The contractor negotiated a fixed fee for each RWIS site and equipment needed (i.e. computers, software, cabling, communications, etc) at the inception of the contract. In addition to the fixed fee, we reimbursed costs for travel expenses and changes in the scope of work. This method proved to be very practical for this project since there were numerous unknown's and additional costs that were indeterminate early in the contract.

The ADOT&PF chose the vendor based on qualifications and cost. The ADOT&PF scored proposals using a 1-5 ranking system for each criteria: understanding of the project and credentials; hardware & installation; software; long term maintenance and operations; communications; technical support and extended warranty; contract cost evaluation. The selection method used for RWIS Phase 1 was a flexible approach in making sure an experienced and economical vendor was chosen.

The ADOT&PF used a sole source contract to hire a electrical engineer to conduct thorough site analysis on the exact placement of the ESS and to identify practicable power and communication resources.

Lessons Learned – Procurement

1. Use procurement methods that are flexible for a project that has both construction and software.
2. Use selection methods that take into consideration both expertise and cost.

Partnerships

RWIS Phase II relied on partnerships to support the ESS installation, in addition to data sharing. With the Dot Lake ESS, the ADOT&PF was able to partner with a local school to share satellite communications. The ADOT&PF partnered with the FAA for power at an ESS located near an FAA facility. The FAA agreed to provide power if they were able to access the data. In particular, the FAA were interested in accessing images of the skyline coming from the PTZ cameras. Many of the ESS sites are in mountain passes used by aviation as well as highway travelers. The ADOT&PF formed a partnership with a lodge to share their power generator. This proved to be very feasible for the ADOT&PF. Numerous partnerships were formed to also share the data at no cost. The NWS signed a Memorandum of Agreement during the design phase in hopes to collect the data and use it to improve local forecasting. These and other partnerships are very beneficial to the ADOT&PF and to the success of the project. More information on partnerships is documented in a paper, "Reliance on partnerships to deploy technology". (Appendix B)

Lessons Learned – Partnerships

- Partnerships are beneficial to the ADOT&PF and to the success of the project when installing remote ESS.
- Memorandum of Agreements help clarify the responsibilities of each agency involved and help maintain ongoing relationships throughout the project lifecycle.
- Developing partnerships early in the project can reduce efforts in securing project support during technology deployment.
- Partnerships can be created through networking conferences and outreach meetings early in the project. i.e. TechNet 2002

ITS STANDARDS

RWIS Phase I equipment is fully compatible with the National Transportation Communications for ITS Protocols/Environmental Sensing Systems (NTCIP/ESS) standards as defined by AASHTO at the time of project completion.
Appendix C contains a table of standards used in RWIS Phase I.

ALASKA ROAD WEATHER INFORMATION SYSTEM

NEW SITE SELECTION
(PHASE II)

August 15, 2001

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August 15, 2001

NEW (RWIS SENSOR) SITE SELECTION PLAN
AKDOT&PF ITS/RWIS PROJECT

PHASE II

(Task R6)

Introduction

The second phase of the Alaska ITS/Road Weather Information System (RWIS) project addresses portions of the Central, Northern and Southeast Regions. The siting analysis has two main objectives. The first is to determine the optimum number and locations for RWIS sensor stations. The second is to determine the desirable equipment for each location to achieve the most efficient use of RWIS hardware technology. The analysis is limited by the time available for it. The intent to have some sensors in place by the winter of 2001-2002 (October 1) requires significant dependence on subjectivity, intuition and compromise. The highly variable nature of climatic effects in the various regions of Alaska creates a demand for increased density of weather observations to support tailoring of forecasts and tailoring of maintenance actions to localized requirements.

Almost 100 prospective sensor sites were identified during the Phase II User Needs identification process, and each was given some evaluation. Some sites were a composite of similar inputs; i.e., several people might have suggested specific places that were different, but within a few blocks of each other—one site was taken to represent all of the related inputs. In other cases, several alternatives with different site characteristics, but responding to the same needs, were separately identified. The sites that were drawn from this process are listed in Appendix IIA. A brief description of the location, likely availability of power and communications, and rationale for inclusion is provided for each site. Because of the close fit between inputs from highway operations personnel and experienced Alaskan meteorologists, and the distinctive microclimates involved, it has been tentatively concluded that most sites should be "fully instrumented." Fully instrumented means they would include a Remote Processing Unit (ESS), pavement sensors (temperature, chemical presence), wind speed and direction sensors, air temperature sensor, humidity sensor, and precipitation sensor, and a video camera. Several locations (and further review could identify others) are near enough to existing atmospheric sensors as to be recommended for pavement sensors only.

Based primarily on operational and meteorological user needs, this prospective list (Appendix IIA) was intuitively and subjectively reduced to an initial "short list" to focus further evaluation through field site visits on the sites most likely to be given serious consideration under the existing Phase II budget. This "Short List of Highest Ranked RWIS Sensor Sites to Serve Phase II Areas" is shown in Appendix IIC. All Short List sites were visited in the field. Following the assimilation of information gained through this process, all sites were evaluated in the manner and ranked with the results shown in Appendix IIB. When Short List sites are further evaluated through preliminary engineering, and considerations of power, communications and right of way are added to the database, the evaluation and ranking will be re-visited. Appendix IIC will also be re-visited, as appropriate, to become the "Short List for Recommended Deployment."

Highway maintenance and operations personnel typically want to have sensors in the locations that are particularly troublesome, and/or furthest from the maintenance station and their first-hand observations, and/or are representative of the microclimates they perceive to exist. Weather analysts and forecasters typically want to generate information from existing data-sparse areas in order to better appraise atmospheric conditions and to make more refined forecasts, especially if snow and ice control decision makers are going to be looking for more specific information. Especially, forecasters would like to see more information "upstream" and at higher elevations. Most observations are now being taken near sea level. There is considerable agreement between both groups on the locales where RWIS sites would ideally be located.

Methodology

Developing the Siting Plan for the "Prototype Phase" has been essentially a six step, somewhat overlapping, process. Each step has provided feedback and informed the other concurrent steps. However, the overlapping process has been mostly necessitated by a schedule requiring a somewhat truncated process with abbreviated documentation and significant subjectivity and intuition. We strive to merge operational and forecaster needs, or in some cases treat them separately with different sites; but fortunately, there is mostly good agreement on the needs.

The six steps have been to:

- Identify needs through interviews among highway operations personnel, meteorologists experienced in the respective regions, and third parties with important perspectives.
- Determine existing weather observations to avoid duplication in siting, and to integrate them with RWIS generated information during deployment.
- Conduct reconnaissance of areas suggested by interviewees, and follow-up for clarification.
- Identify specific sites, in terms of "siting considerations," within the locales suggested.
- Evaluate sites preliminarily against the evaluative criteria arising out of the needs identification process.
- Document the "best" sites, a short list of 25 from which about 16 could hopefully survive the practicality tests of power, communications, and right of way availability. (This list is Appendix IIC, and is an extract from Appendix IIA.)

User Needs – **Maintenance decision-maker** information requirements were appraised. The kinds of weather that triggers their particular actions, the clues they use in discerning weather that is about to or is occurring, their service levels, practices and decision thresholds, and the kinds of weather and pavement condition information they wished they had were noted. Similarly, after explaining the particular activities and decision thresholds of highway operations to meteorologists, the weaknesses in existing data to enable tailored forecasts were identified by them. Finally, the consultant "stirred" experiences from other places with established RWIS and anti-icing programs "into the pot." From these multiple sources, the information that provided a basis for characterizing the RWIS sensor sites included:

- The types of weather and road conditions in the subject regions that require snow and ice control,
- Snow and ice control practices, priorities, areas of responsibility,
- Snow and ice control equipment in use, procedures and schedules,
- Extent and circumstances of anti-icing measures,
- Anti-icing, deicing, abrasives materials in use,
- Sources of local weather information used by decision makers,
- The micro-climates perceived to exist, and particular weather patterns that generate the weather effects that trigger maintenance actions,
- Current practice and possibilities relative to decision thresholds that should be embedded in forecast products,
- Communications used to monitor approaching storms and weather in progress,

- Observed roadway weather “rules of thumb,” or indicators considered as representative and a basis for anticipating the likely impact on trouble spots,
- Impact of roadway elevation changes, terrain shadows, and other effects on snow and ice control practices,
- Functional classification of roads, types and volumes of traffic, relative priority of routes and services.

Particular decision thresholds, practices and service levels are contained in the Task R2 User Needs Interim Report.

User Needs – Meteorological patterns were considered so that RWIS sites would as often as possible also help to detect impending weather patterns. Some of the particular patterns germane to winter highway operations, and for which improved detection would support improved forecast accuracy are as follows:

South Central/Interior:

- Wind speeds and directions relative to a meridian through Valdez provide input for forecasting where the heaviest precipitation will occur, and whether it will be snow or rain.
- “Pineapple Express:” wherein a strong southerly flow of moisture, with lots of variability across the freeze-thaw line causes above normal precipitation at Valdez, and even rain at Thompson Pass, but ironically, below normal precipitation north of the Chugach Mountain Range.
- “Permanent Gulf of Alaska Low:” which, among other things, typically places Valdez-Thompson Pass area in an upper air col, where the main jet stream turns east then south along the Pacific Coast, but a remnant goes north-northwest along the Chugach and causes more frequent snowfalls and colder temperatures. Depending on orientation of the Low, variable precipitation effects occur on the Kenai Peninsula, at times heavy in upslope areas. If this Low moves to the Northeast, against the Alaskan coast, it may induce a “Fort Yukon Low” that generates wind and snowfalls from the east in the Tanana Valley.
- “Colder Low:” A cold surface Low north and west of the usual location of the Gulf of Alaska Low, drawing in cold air from Siberia, creates more snow in Anchorage area and drier colder air for Valdez area. When this Low moves north of the Aleutians, generating southwesterly flow along the north side of the Alaska Range, it also is a classical source of snowfall for the Interior.
- “Interior High:” A big high pressure center over the Alaskan Interior, generates high wind from the North-Northeast for Valdez and south central Alaska, clear sky events, with lot of drifting, ground blizzards, and no melting.
- Moderate to strong front approach or passage from the southeast through southwest is a typical precursor to moderate to strong surface winds, “Chinook winds”, and may result in an inversion near higher mountain ridges,

affecting avalanche conditions, and may be followed by rapid temperature rises and extremely slick road conditions.

Southeast:

- "Arctic Air Mass/Taku Winds:" Arctic air outbreaks of very cold air spills westward through the valleys and over the mountains east of Juneau. This extremely cold and dry air changes the coastal weather from mild and generally wet to clear and very cold with the attendant road icing wherever there was moisture. It may be accompanied by damaging katabatic winds with gusts exceeding 50kts, and in addition to the damaging effects of the winds themselves, is conducive to heavy icing on land surfaces and vessel susperstructures resulting from sea spray.
- "Arctic Air Mass with Marine Overrunning:" consists of westerly relatively warm and moist airflow overrunning the surface arctic air mass (in the previous example). This results in heavy precipitation of up to two feet or more of snow in the Juneau area, then gradually turns to rain.
- Rain followed by snow is the modification of a normal winter rain pattern, when modified by a strong cold front approaching from the northwest. Snow accumulation is typically less than two inches, but the duration of the event is difficult to anticipate.
- Rain followed by snow due to strong arctic outbreak flowing down Lynn Canal from the north. The air mass cools quickly and moisture already present and sustained by additional overrunning from the Gulf turns the precipitation to snowfall. This pattern is infrequent, but timing of its effects is difficult to anticipate due to sparsity of observations.

User Needs – Integration and evaluation was done by keeping these kinds of needs in mind. Interviewees were also asked what kinds of information, from what particular areas, is needed to make better decisions and to achieve more effective practices. And in the case of meteorologists, what data from what particular places would support more localized analysis and tailored forecasts. This process generated the "raw" list of almost 60 locations, containing almost 100 individual "spots", where sensor suites might be placed.

In preparing to evaluate the list, it was recognized that both maintenance managers and meteorologists have essential needs that must be integrated to develop the most responsive RWIS information network. A prime consideration was to develop criteria for selection of sites that would provide the most effective network of timely and accurate weather and pavement information for use by decision makers. The ranking of prospective sites would need to be in terms of their relative value to the basic functions of an RWIS site, which were evident in the stated needs of the potential users. These evaluative criteria would be:

- **DETECTING:** A function of sensors is to detect existing or changing weather, or roadway surface conditions, on a real-time basis. Typical sites emphasizing detection would include known trouble spots, frost and ice formation areas, fog prone areas, and strong wind areas; and some sites would complete a suitable grid for the reliable characterization of significant weather events. A strong subset of DETECT is VERIFY. Maintenance decision makers, in particular, feel a need to "see" whether what the sensors and media broadcasts seem to be reporting is actually occurring and the extent of it. An expected source of cost and time savings from RWIS is to negate the driving out to see what is happening. This is the source of a strong interest in co-locating video cameras with the weather sensor sites. Detection serves both maintenance decision-makers and weather forecasters.

- **FORECASTING:** Sensors are also sited to provide local information to supplement NWS or other weather observations. This information is used to develop site-specific forecasts of weather and road conditions. Since the benefit of using weather information is to make timely decisions through the use of forecasts, acquiring specific local information should be considered a primary reason for siting sensors. Sites selected to support weather forecasting should be meteorologically representative of an area. Maintenance decision makers, ideally in conjunction with a weather forecaster dedicated to their support, make "nowcasts" in accomplishing their work. A "nowcast" is essentially the assumption that is made about what the immediate future weather will be and therefore the basis for the maintenance action undertaken. Thus, forecasting is of interest to both the meteorologists and the maintenance decision makers.

- **MONITORING:** Sensors are also sited to provide a monitoring function, to check the onset, ongoing, and conclusion of weather compared to the predicted conditions in order to make mid-course corrections. Monitoring sites are most useful if selected to provide information "upstream" of the area, i.e. first indications of change where the weather is "coming from." Monitoring sites serve both the operational decision makers and the weather forecasters.

It is worth noting that thermal mapping would be very useful in a siting analysis, but is not an available consideration at the time of this analysis.

Ideally, sites that serve all three aims—detect and verify, forecast, monitor—would be most favorable.

Existing Data Sources - Existing weather observation sites with some proximity and utility to the Road Weather Information System have been identified, and are separately reported in the Existing Data Sources Report (Task R3). This information will help to maximize the RWIS investment by avoiding duplicative sites and provide an opportunity to eventually fuse data from all useful sources into the road weather information system. Existing observations are fairly widespread, but many are cooperative observers not reporting 24 hours per day and there are many areas for which data is sparse. There are no pavement temperature observations being reported and used by maintenance personnel on an operational basis. However, there are 26 temperature data probes operated by the Highway Data Section that do record pavement temperature. Areas of data sparsity are a particular focus of the RWIS.

Reconnaissance – All areas suggested for sites were visited to familiarize with the topographical conditions, and to make an initial survey of sites that might have the necessary attributes for proper operation of weather sensors and representative pavements for surface condition sensors.

Identify Specific Possible Sites – Considerations for the tentative selection of RWIS sites were set down based on the inputs of the User Needs process and established good practice elsewhere. Highway maintenance and operations personnel in each Region and the Consultant identified particular locations that seemed to satisfy those siting considerations. Notes were taken and digital photos documented the most encouraging sites for recurring reference during site evaluation.

Preliminary Evaluation – All sites were subjectively scored in terms of their Detection, Forecasting, and Monitoring value to the identified user-needs, and the siting considerations. User-need considerations relate to the geographic location and kinds of information that will enable decision makers to make better decisions. Site considerations judge whether a specific site will provide valid and representative observations. The rating of user-needs involved a series of judgments on a scale of relative merit. Site consideration was essentially a screening process: yes, no, or maybe. It generally took a "Yes" to move to the "short list."

For a site to be included in the list of prospects it had to pass the "fatal flaw test," and meet either, or ideally both, the meteorology criterion and the decision-maker criterion.

Fatal flaw test: the site must have a favorable aspect, and be free of obstructions to the flow of air, i.e. be representative of ambient atmospheric conditions.
Meteorology criterion: Provides meteorologically important information.
Decision-maker criterion: Provides operationally important information to decision-makers.

The prospective sites listed in Appendix A derived from an initial consideration of these criteria, and were then evaluated through a methodical application of more detailed considerations. The methodology is described in Appendix IIB-1. A spreadsheet displaying the rating process is in Exhibit IIB-2.

"Best Sites" – The sites that scored best are included at Appendix C. In general, the highest scoring sites combined the Detection, Forecasting and Monitoring aims of both the decision-makers and the meteorologists. The Initial Rank Within Region was based on these criteria. Engineering evaluation then added information on the practical considerations of power supply, communications, right of way availability, and constructability. The Final Rating and Recommended Initial Phase deployment list integrate all considerations.

Utilitarian Considerations

The primary reasons for selecting RWIS sites is their utility in meeting the information needs of highway maintenance decision-makers and of meteorologists who provide the tailored weather forecasts that inform their decisions. However, as practical matters, a site must have power to operate, communications infrastructure to transmit the data generated, and right of way in which to be placed. If power is not available, on-site generation (diesel generator, solar, wind, and/or etc.) can be considered. If land line telephone communication is not available, wireless means such as cellular, micro-wave/radio, or satellite communications can be considered. Whether, and which, any of these might be appropriate requires evaluation of both technical and cost considerations. That is the next step in determining the specific implementation plan. Each of these considerations is addressed on a preliminary basis in Appendix IIB-2, based on inputs from Haight-McLaughlin Engineers, and whose valuable assistance is hereby acknowledged.

Implementation

The following actions are recommended:

- Install and place into operational use the sites listed in Appendix C for "Recommended Initial Phase deployment."
- Include installation of as many of the prospective sites as possible within FHWA shared-cost construction projects. RWIS sites are eligible for FHWA cost sharing at the same percentage as the construction shared percentage.
- Include both pavement and atmospheric sensors at virtually all locations because once the Environmental Sensor Station (ESS) is established with a Remote Processing Unit (RPU) and pavement sensors, the incremental cost of adding atmospheric sensors is relatively small. However, there are exceptions: where installation of atmospheric sensors would virtually duplicate existing nearby observations, or the site is wind-sheltered and measurements would not be representative, or worse, misleading, sites are recommended for pavement sensors only.

- Specify in implementing requests for proposals that National Transportation Communications for ITS Protocol (NTCIP) for ESS be met.

Documentation

Photos taken at most prospective sites are attached to the electronic version of this report as Appendix III..

APPENDIX IIA: PROSPECTIVE LIST OF PHASE II RWIS SENSOR SITES

CENTRAL REGION

C1. **Seward Highway Railroad Crossings**

A number of people (DOT, AST, NWS) identify the MP 12 to MP 14 area as where the Seward weather begins to transition to weather that is much different and not represented by the Seward weather observation.

a. MP 12 Alaska Railroad Crossing.
or
b. MP 14 Alaska Railroad Crossing.

C2. **Seward Highway, vicinity Snow River**

The weather in this area is affected by complex terrain and the confluence of several valleys. Sites in this area would be representative of an area that differs from both Seward to the south and the area north of Kenai Lake in the Cooper Landing area.

a. Snow River Bridge, MP 17.7. [Photos C2a.1 Snow River Br Berm, C2a.2 Snow River Bridge, C2a.3 Snow River Power] This site is well placed to be useful to avalanche monitoring. There is an avalanche zone on Sheep Mountain, between the bridge and Lakeview to the north. Airflow is somewhat less impeded at north end of bridge. Airflow would be most unobstructed with mounting of ESS on bridge itself at midspan; however, this has drawbacks, so placement of the ESS on the berm or mound at the NW corner of the bridge is suggested. Pavement sensor should be placed just outside of a wheel track of either lane on the bridge deck; and also, along with a sub-surface sensor, just outside of a wheel track of either lane in the approach roadway far enough from the bridge to be representative of the prevailing highway conditions. This location bristles with power, with a high voltage line adjoining the area; but whether the voltage can be dropped down cost effectively may be an issue. [Photos are from the north end of the b ridge looking south: C2a.1 shows the mound at the NW corner of the bridge; C2a.2 shows the Snow River bridge itself; and C2a.3 shows the power supply about .3 mi (?) away on Primrose Road.]

b. Primrose Road intersection, MP 17, [No photo] provides an alternative close to power. There is an apparent drop down in voltage to serve customer(s) on Primrose Road; but a site here would be more wind-sheltered than desired.

C3. **Seward Highway, Lawing, MP 23.4**

This location provides an alternative to C2., as a representative observation above Seward and below Cooper Landing area. Meteorologists would be particularly desirous of obtaining a precipitation rate observation here. Place ESS in SW corner of Seward Highway-Alaska Railroad intersection, in the triangular shaped field. The narrow space between the ARR tracks and the highway in the NE quadrant may provide more proximity to power.

C4. **Sterling Highway, Cooper Landing, vicinity of Skilak Lake Loop Road, MP 58**

A number of people have identified the east end of Skilak Lake Loop Road, MP 58, as a good representative location for the Cooper Landing area weather. This is also the administrative boundary between the Cooper Landing and Soldotna maintenance stations; road and weather observations would provide information from the furthest reaches of their areas without driving there to look. However, the intersection area is very wind sheltered and not a good site from that perspective, and apparent lack of power affects its practicality.

This area is widely regarded (DOT, NWS, AST) to be warmer than surrounding areas. Mountain shade and tempering effects of Kenai Lake are offered as possible explanations. However, there is little existing data to objectively establish the extent to which this is true, and whether and when conditions will be around the freezing point—both troublesome and the range where the opportunity exists to use RWIS to maximum value. Alternatives to the Skilak Lake Loop Road junctions are identified.

a. Quartz Creek Road, MP 45. [Photo C4a. Quartz Creek]. ESS would be placed in SW quadrant of the intersection. This location provides an objective observation in support of the nearby maintenance station, and could presumably access power and communications in the same way as the adjoining Sunrise Inn. The SE quadrant of the intersection is closer to the power availability, but may be subject to flooding and seems less desirable—it would be OK if engineering finds it more suitable. However, this location is also frequently observed directly by M&O personnel. A location closer to the end of their area of responsibility would be better from an operational point of view. [Photo C4a. is looking SB on the west side of the highway from the Quartz Creek Road intersection, at the proposed site.]

b. Kenai National Wildlife Refuge entrance, MP 57.8. [Photos C4b.1 and C4b.2 Ster MP 57.8] The ESS would be placed approximately .2 mi. east of the entrance to the Kenai National Wildlife Refuge parking lot entrance, behind the guardrail on the south side of the highway, near the Kenai River bank. Place it 20’ behind the guardrail, 35’ east of the west end of the guardrail section (about 80’-100’ long). The most desirable feature of this location is that it is near the limit of the maintenance section (Skilak Lake Loop Road, MP 58) and would provide information from the furthest reach from the shops; but there is no apparent source of power. [Photo C4b.1 is looking southward at the site, an Adopt a Stream – Alaska Fly Fishers sign is in the background near the east end of the guardrail section. Photo C4b.2 is looking EB at the site with the guardrail in the foreground and the Kenai River in the background.]

c. Russian River Ferry, MP 54.8 [Photos C4c.1 Russian River Ferry, C4c.2 Russian River Power.] This site provides most of the advantages of C4b. and has apparent availability of power. It is probably a very busy location during summer and fishing seasons, a possible drawback; but if adequately protected, the many eyes may also serve to protect it from vandalism. The suggested location for the ESS is in the space between the highway and the roadway into the parking area. On the assumption that power is most available at this location, this is the preferred location in this locale; however, if the drop in voltage is practical here, it does raise the question as to whether it might be possible also at the MP 57.8 location. [Photo C4c.1 is the possible site, looking westward on the south side of the road, from within the pullout area. Photo C4c.2 is an overly dark view of the power pole and transformer, with a meter box that says 470v, 150’ east of the site.]

C5. **Sterling Highway MP 98, AKDOT/PF Maintenance Shop** [No Photo.]

Pavement sensors and sub-surface sensor only would be placed at this location because it is fully observed by personnel working there and there is a weather observation at the airport. The existing weather observation is believed by meteorologists to be representative of a wide area, and pavement and sub-soil temperatures are likely to be also. There is a nearby existing pavement/subsurface temperature probe at Soldotna, but it is providing seemingly misleading pavement surface temperature readings (3/10-12/01: pavement surface @ 83°-93°F when bottom of pavement @ 31°-35°F and air temperatures in the 32°-42°F range). The western Kenai Peninsula, the Nikiski-Kenai-Soldotna-Sterling-Kasilof area, is of quite a uniform elevation and climate or aspect to the sun. Place a pavement sensor and sub-surface combination just outside of a wheel track at the nearest location to power.

C6. **Sterling Highway, Ninilchik**

Experienced personnel describe a lot of variation in icing tendencies, and presumably in pavement temperatures or wind exposures in this area from roughly Clam Gulch to above Homer. For example, the stretch north of the Ninilchik River bridge (MP 114.5 to MP 135), Happy Valley (MP 146 to MP 148), Stariski Creek area (MP 151 to MP 152, and Anchor River area, MP 160 to MP 167) are said to freeze before other areas. The Ninilchik – Anchor Point area is known for heavy precipitation, but meteorologists have little data from this area upon which to develop forecasting skill. Presumably, sensors cannot be placed at all such distinctive areas in the near term, so the challenge is to find the place(s) from which experienced interpolations can begin to be made from actual measurements.

a. Ninilchik River bridge and approach, MP 135.5. [Photos C6a.1 Ninilchik SW Cor Site; C6a.2 Ninilchik SW Cor Area; C6a.3 Ninilchik Power.] This location provides a representative area between Homer and Soldotna and an opportunity to monitor a significant bridge deck. The preferred location for the ESS would seem to be the SW corner of the bridge crossing. Southwest of the bridge and at the intersection with Mission Avenue, 15 feet behind the guardrail on the west side of the highway, and 30 feet south of the guardrail across the north end of the flat area. Place pavement and sub-surface sensor just outside of the outside wheel track in the SB lane 100 feet south of Mission Ave.; and just outside of the outside wheel track in the SB lane of the bridge deck. [Photo C6a.1 is a close up view of the area behind the guardrail on west side of highway at SW corner of bridge; C6a.2 shows the flat area in which placement of the ESS is proposed dead center of the photo, and C6a.3shows the power/telephone infrastructure 300 feet southwest across Mission Ave.]

Ninilchik river bridge alternate. [Photo C6a. Alt. Ninilchik Br NE Cor.] ESS would be placed on the mound at the outside of the curve on the SB approach to the bridge in the NE quadrant of the crossing. Pavement sensors would be placed about 500' south in the bridge deck, and along with a sub-surface sensor adjacent to the ESS on the approach. This spot has the least obstructed airflow at this location, but it is probably the furthest from local power availability. [Photo C6a. Alt. Is looking SB from the Ninilchik River Scenic Overlook in the NE quadrant of the bridge.]

b. Deep Creek bridge and approach, MP 136.7 [Photo C6b. Deep Creek Br.] ESS would be placed about 35' east of the back of guardrail in the NE quadrant of the bridge crossing of Deep Creek.. Pavement sensors would be placed in the bridge deck, and along with a sub-surface sensor, in the north approach. Power and telephone appears to be available at a residence on the west side of the road; but too much shielding by trees and diversion of airflow by the house and small hill argues against use of that location. Photo C6b. shows Deep Creek Bridge from the Deep Creek North Scenic Overlook at the NE corner of the bridge, looking SB.]

C7. **Sterling Highway, Anchor Point**

a. MP 156.5 – Transition between maintenance areas of responsibility and furthest distance from shops, for monitoring. Weather representative of the Ninilchik – Anchor Point area.

b. MP 161 – Anchor River bridge

This is reasonably close to the boundary between two maintenance areas (MP 156.5), so it would provide information at the furthest reach from the shop for two crews, is fairly representative of the whole area from above Homer to Ninilchik, and provides an opportunity to monitor a bridge deck as well. It is believed icing observations in the MP 160 to MP 167 area would also be representative of conditions on the North Anchor River Road and Old Sterling Highway.

c. MP 154 – There is an existing pavement/subsurface temperature probe (ANC). In sample data, for March 9-11, 2001, the pavement surface temperature was missing.

C8. **Homer**

There is an existing weather observation site at the Homer airport (although some regard the sensors to be poorly sited) and reportedly, weather observations are reported from the boat harbor on the Spit. Corroboration is needed. There is an existing pavement/subsurface temperature probe (HOM) on the Homer Spit. Thus, some weather information is available at Homer, i.e. sea level, so most interest in data scarcity is focused on the higher elevations. Two long gravel roads maintained by AKDOT are representative of the very different conditions throughout the ridges above Homer and the higher elevations beyond such as North Anchor River Road. As gravel roads, pavement sensors would not be installed. The addition of a weather observation site in this area would be highly desirable in the eyes of meteorologists. Highway maintenance personnel would find wind speed and direction, and precipitation sensors, including amount, to be particularly useful. Observations here would also be indicative of the worst weather impacts, which are either moving from the NE or the SW along the bay. Traffic volumes, however, are light; although there is significant residential development that seems to be increasing. The Homer airport manager believes observations on these ridges would be useful to Homer flight operations as well.

a. Diamond Ridge Rd., near NOAA Weather Radio transmitter (WXJ24, 162.40mhz), 2.3 Miles from Sterling Highway. [Photo C8a. Diamond Ridge] Sensors placed on the existing tower would provide observations at about 1300' MSL, virtually on the ridge top, at a very representative location of Diamond Ridge Road, and likely the North Fork Loop Road and Olson Mountain Road as well. [Photo C8a. is looking northwestward on the west side of Diamond Ridge Road at the tower and NOAA weather radio transmitter.] As a gravel road, pavement sensors would not be installed.

Or

b. Olson Mountain Road, at highest elevations near the end. It is believed this would be representative of predominant conditions at that elevation.

C9. Seward Highway, Summit Lake

Offsets absence of weather observations between Portage and Kenai-Soldotna, and lack of observations at higher elevations. Provides "upstream weather observation for Anchorage area, i.e. detection and monitoring of weather approaching from the Gulf of Alaska. Provides representative high elevation and "upstream" location for pavement conditions for Silvertip Maintenance station. In the past, this was an established NWS observation station with a trained human observer. Re-establishment of observations has a potential for re-establishing and extending an existing climatological record. Highway maintenance personnel regard the Summit Lake area to be indicative of weather conditions all the way from the Hope Highway Junction (Silvertip) to the Sterling Highway Wye.

a. NO. Quartz Creek, MP 42.2 dropped from further consideration. This is a culvert, not a bridge. Although this location is near the southern margin of an avalanche zone, the site is surrounded by trees, and seems marginal. There is a cabin with an antenna in the NE quadrant of the small stream crossing, but no sign of power supply.

b. Colorado Creek, MP 46. [Photos C9b.1 Colorado Ck Shoulder, C9b.2 Colorado Creek Site] ESS would be placed on the west side of highway approaching Summit Lake Lodge southbound, approximately35 feet north of the end of the guardrail north of Colorado Creek and 15 feet from the edge of pavement. Further south presents possible conflict with snow machine trail, and trees get closer to the road. This is a culvert, not a bridge deck, so one pavement sensor, sub-surface sensor combination is suggested for just outside the outside wheel track in the SB lane (nearest to ESS). Power and telephone service to Summit Lake Lodge cross the road an estimated 1000 feet south of this site. [Photo C9b.1 is looking south from the parking lot northwest of Colorado Creek, with the site being approximately where the hole is in the snow; Photo C9b.2 is looking at the site from the roadway, Colorado Creek crosses under the highway at the left edge of the photo.]

c. Summit Lake Lodge. [Photo C9c. Summit Lake Lodge] The ESS would be on the east side of the Seward Highway, just south of the Summit Lake Lodge entrance, at about MP 45.8. Placement of the ESS about 75 feet south of the avalanche highway closure gate, and about 15 feet behind the guardrail, is suggested. Small deciduous trees should be removed and controlled within about 50 feet of the site. This will both ensure unrestricted airflow and improve visibility of the lake for travelers. A pavement sensor, sub-surface sensor combination should be placed just outside the outside wheel track in the NB lane (nearest to ESS). Power and telephone appear to be available at the Lodge. [Photo C9.c is looking south from the Lodge south entrance; the avalanche gate is in the foreground.]

C10. **Seward Highway @ Hope Junction**

This location offsets the absence of weather observations between Portage and Kenai-Soldotna, and the lack of observations at higher elevations. It provides a representative pavement condition location for the Silvertip Maintenance area, and provides bridge deck pavement condition information for a major bridge. A Met Set would be placed on the knoll between roads, and the ESS in the NE corner of the intersection, or on Met Set Mast, whichever is most cost effective, considering pavement sensor distribution. Pavement sensors would be placed in the NB lane of Seward Highway, 400' south of the intersection, and in the WB lane of Hope Highway, and one on the centerline of the Canyon Creek Bridge. Terrain may affect representativeness of wind observations.

C11. **Seward Highway, Turnagain Pass, West Side Visitors Parking Lot**

Turnagain Pass shows up on just about everybody's list of primary concerns, highway personnel, state troopers and meteorologists alike. But lack of suitable power seems to be a major drawback. Sensors at this location would offset the absence of weather observations between Portage and Kenai-Soldotna, and lack of observations at higher elevations. It would provide "upstream" weather observation for the Anchorage area, i.e. weather approaching from the Gulf of Alaska. It would provide weather detection and monitoring for a high-use recreation area, and proximity to an active avalanche zone. One installation possibility would be to co-locate an ESS with the restroom building, perhaps within or adjoining in an enclosure, or on the emergency telephone pole. Perhaps Met sensors could share the emergency telephone pole and solar panel, or use an adjoining pad with fence enclosure. Pavement sensors would be placed in both the NB and SB divided roadways. Pavement condition observation would reduce the need to make the long drive from Silvertip to determine conditions in a critical area. This site serves a much-visited section of the NHS.

C12. **Glenn Highway, Kings River Crossing, MP 66.5**

The Chickaloon area is probably representative of the Matanuska River Valley area and power and right of way are likely available. Observations here would provide information between Palmer and the Eureka area. This location was suggested in response to the circulated questionnaire, but seldom arose in other user needs inquiries. However, an interest was expressed in having wind observations from the vicinity of Jonesville Mine Road (Glenn Highway MP 60.9) where it is said a typical weather observation might be "blowing rocks."

C13. **Glenn Highway, "Gunsight," MP 117** [Photos C13 Gunsight MP 117, C13 Gunsight Power Pole] This area serves the furthest reaches of two maintenance areas in both the Central and Northern Regions, and is believed to be representative of the Eureka-Gunsight-Sheep Mountain area, perhaps sensing air flows from multiple glacial valleys and the south slopes of the Talkeetna Mountains toward the Matanuska Valley, but still above the narrowing topography of the Matanuska River Valley to the west. A weather observation is currently available at Eureka Summit, but it does not include a precipitation gauge and is believed to not be representative for fog occurring in the Tahneta Pass area (MP 122) and westward. There is also an existing pavement/subsurface temperature probe (EUR) at Eureka (MP 128). Highway maintenance personnel access the Eureka observation, and have developed some "rules of thumb." For example, if there is a trace of snow at Nelchina, they conclude it will be much heavier at Eureka, but they still feel the need to go look. So this general area is still identified by meteorologists and highway personnel alike as one in which more weather observations are needed. Pavement conditions are poor throughout the area, but are somewhat better in this MP 117 area. [Photo C13 Gunsight MP 117 provides a view of the MP 117 area looking WB from Camp Creek at MP 117.2, and C13 Gunsight Power Pole is the power supply near which the ESS can be placed.]

a. The south side of the Highway offers a somewhat better, i.e. more open and unobstructed site. However, it is on the wrong side for power. [Photo C13a. Gunsight Southside is looking EB at a site on the south side of the road at MP 117.]

b. The north side is preferred in order to be more accessible to the very available power. Sites either near a (Copper Valley) power pole, or half way between two power poles in the line, are recommended for placement of the ESS. A pavement sensor, sub-surface sensor combination should be placed outside the outside wheel lane in the WB lane adjoining the ESS. [Photos C13b. Gunsight North Side 1, and …North Side 2 provide two views of the site.] As an adjunct to this site, it is suggested a precipitation sensor be acquired and provided to the NWS for the Eureka site.

C14./N9. **Tazlina Profiler (Glenn Highway MP 156**)

Place weather and pavement sensors at a spot that is essentially co-located with the NWS upper air profiler at Tazlina. This location provides a rare opportunity to integrate surface weather observations with upper air observations of great value to weather forecasters. However, existing weather observations at Glennallen and Eureka, and the case for a location further west (C13) probably assign a lower priority from a purely highway maintenance point of view.

C15. **Parks Highway, Vicinity of Big Lake Turnoff**

This is said to be about where the weather starts to change when proceeding northbound from Wasilla.

a. Intersection with Hawk Lane, MP 53.2 [Photos C15a.1 Big Lake Turn SB; C15a.2 Big Lake Turn North Look.] On the west side of the Parks Highway place ESS about 115 feet south of south side of Hawk Lane, and 33 feet from Parks Highway edge of pavement. Existing highway lighting will provide light for video camera without the competing light sources and other visual clutter at the Big Lake Road intersection itself. If the camera is pointed northward, three light pole spacings and the curve .3 mile north can be used to gauge visibility. Place pavement sensor, sub-surface sensor combination just outside the outside wheel track in the SB (morning commute) lane; and a pavement sensor just outside the outside wheel track in the NB lane 500 feet north of this site. [Photo C15a.1 is looking SB on the west side of the highway from the last (most northerly) lighting pole, at the proposed site in a somewhat drier clump of grass. Photo C15a.2 is looking NB from the same spot, with lighting poles 3 and 4 at the right and the curve in the distance. Hawk Lane turns left.]

b. Across the highway from C15a., just north of the Houston Jr.-Sr. High School highway sign. Except for placement of the ESS, all features would be the same as for C15a. This spot is probably somewhat superior to C15a., but access to power would seem to require crossing under the highway. [Photo C15b. Big Lake Turn NB is on the east side of the highway, looking NB, with the site in the foreground.]

C16 **Parks Highway, Chulitna River Bridge, MP 133±**

Reportedly, the prevailing wind in winter along the Parks Highway south of the Alaska Range is from the north, and is strongest north of about MP 105, where the highway crosses the Big Susitna River. Storm systems either come (1) northerly up the Susitna River from Knik Arm and Cook Inlet, or (2) from the east, around the Talkeetna Mountains from Prince William Sound. RWIS sensor sites strategically placed along the Parks Highway will provide better detection and monitoring of systems than now available.

There is an existing pavement/subsurface temperature probe (CHU) at MP 117, a useful pavement temperature location, but not particularly advantageous for a weather sensor site. The threat of icing associated with freezing rain is a particular impact at the curve leading to the Chulitna River bridge from the south at MP 132.8.

C17. **Parks Highway, Byers Creek**

As noted in C16, above, the prevailing wind in winter along the Parks Highway south of the Alaska Range is reportedly from the north, and is strongest north of about MP 105 where the highway crosses the Big Susitna River. Storm systems either come (1) northerly up the Susitna River from Knik Arm and Cook Inlet, or (2) from the east, around the Talkeetna Mountains from Prince William Sound. RWIS sensor sites strategically placed along the Parks Highway will provide better detection and monitoring of systems than now available. The Byers Creek area may be a prime location for this, where highway personnel perceive a recurring wind band to occur around Byers Lake, MP 143, even if not windy below there. The wind is actually beneficial for melting ice on the road, and this area is representative of the northern end of the Central Region's portion of the Parks Highway.

a. Byers Creek General Store, MP 143.9. [Photo C17a. Byers Creek] The primary objective here is to obtain an observation in this representative area, with a bridge deck, at a distance removed from the Chulitna Maintenance Station. However, to do so would probably require mounting the sensors/mast on the side of the bridge deck itself—not good; or to delete the wind observations if moved off the bridge to get reasonably open air flow. There seems to be power/communications at the General Store, in the NW quadrant of the bridge crossing, but may be generated on site. (Telephone number at the store is: (907) 345-2021.) [Photo C17a. is looking SB at the bridge from the General Store entrance driveway.]

b. Alaska Veterans Memorial Turnoff, MP 147.2 [Photos C17b.1 AK Vet Mem SB; and C17b.2 AK Vet Mem Ent] Place the ESS across the highway to the west from the entrance to the Memorial parking lot/loop road (south entrance), and a pavement sensor, sub-surface sensor combination just outside the outside wheel track in the SB lane adjoining the ESS. This site is superior to C17a. due to more open air flow, and is equally representative (except for the loss of a bridge deck observation). However, the only power source is seasonal—originating from a diesel generator near the Ranger's Residence Memorial Day through Labor Day, and only daytime. Cellular service is available. [Photo C17b.1 is looking NB on the west side of the highway; and C17b.2 is looking into the Memorial south entrance from the proposed site.]

[Note: Photo ARR Parks Power Supply shows the windmill and solar panel power generating configuration used by the Alaska Railroad in the area.]

C18. **Parks Highway, Chulitna River Lodge, MP 156**

This location would be very helpful to the Chulitna Maintenance station, because it is at the furthest reach of their area of responsibility, and whether it is snowing, or has ice on the road when it is bare road at the shop basically cannot now be determined other than driving up to look at it. However, power and communication availability is unlikely. The adjoining private property owner reportedly uses a radiophone and generates power for his own use, and could be a source for an RWIS site. [Note: the following info is provided for Haight-McLoughlin should it be desirable to pursue this site further. Martin Bee, AKDOT foreman at Chulitna Shop, (907) 733-2246, martin_bee@dot.state.ak.us, can probably provide phone numbers for Rinehart Grenz, MP 156 resident; and Dave Porter, Park Ranger with contacts in the area.]

N17. **George Parks Highway, vicinity of Broad Pass** is proposed as an **Alternate.**
(See N17)

NORTHERN REGION

N1. **Valdez, Richardson Highway, MP 12.2** [Photos N1 Valdez-1; N1 Valdez-2]

This locale is representative of area at the base of the climb to Thompson Pass. This site represents the area from about MP 9 to MP 13 which locals believe is distinctive from airport observations because of southerly flow down the Browns Creek valley, heating caused by downslope north winds over mountains on the north side, and air somewhat compressed exiting Keystone Canyon (at about MP 13). It is frequently observed to be raining in this area when it is snowing in Valdez.

There is a series of microclimates NB from Valdez: the Valdez area, represented by observations from the airport and NWS office; the stretch from around MP 9 to MP 13 where it is warmer; Keystone Canyon, approximately MP 13 to MP 16; the more open area of MP 16 to MP 19; and the Thompson Pass area itself.

a. Place the ESS on a mound on west side of Highway (approximately 20’ from edge of pavement to toe of slope of the mound, and 47’ to backside toe of slope), and a pavement sensor, sub-surface sensor combination just outside of the outside SB wheel track. Power distribution is directly abutting on the west side. [Photo N1 Valdez-1 is looking SB on the west side of the road at the proposed site; and N1 Valdez-2 is looking directly at the mound.]

b. Alternate 1:The ESS could be placed on the same (west) side of the Highway, directly opposite the MP 12 sign, about 25 feet from the edge of pavement. This would be about 20’ below grade, suggesting a 40-foot mast might be better than the 30-foot standard. Several stakes in this area suggest there may be something underground in the space; in which case, move the ESS to the side of the fill at 15’-20’ from the edge of pavement. Power distribution is still directly abutting on the west side. [Photo N1 Valdez-Alt is looking southward at the site from the west shoulder of the Highway.]

c. Alternate 2:The ESS could be placed on the east side of the Highway at about MP 11.6, but would require crossing the road with power and communications supply.

N2. **Thompson Pass, Elev. 2,678ft., Richardson Highway, MP 26**
[Photos N2a. TP Site (seven different perspectives), and N2a. T Pass Power]

This location is priority number 1 on practically everybody’s list. It is a difficult location operationally. Knowing what is happening there without driving to it to look, is high on M&O personnel list of desires. It is meteorologically significant with a transition from marine environment to interior air mass, avalanche impacts, no consistent weather and pavement information available—even to provide verification of forecasts based on what forecasters believe is happening. For example, a forecasting rule of thumb is that wind speeds east of a meridian through Valdez will be four to five times the 10 millibar difference between Cordova and Glennallen (e.g. Cordova barometric pressure minus Glennallen barometric pressure = 10mb times 4 = forecast of 40mph winds). Another rule of thumb is that west of that meridian is where the heaviest precipitation will occur. This gross rule is the best available because of lack of more definitive observation stations. (Weather observations at the Thompson Pass Maintenance Station include only wind speed/direction and air temperature, and are not recorded; and being in essentially a "hole" in the terrain, are not representative of the larger area.) Observations from Thompson Pass, and ideally Marshall Pass, will help to refine the rules of thumb, verification of forecast assumptions, and thereby forecast support of decisions for weather-impacted activities.

a. The initial siting recommendation would be to place weather sensors on a windswept outcropping that stands about 100' above the highway (based on altimeter reading) on north side of highway right at the pass, with power/communications to be supplied from the nearby AKDOT Highway Maintenance Station. Ideally, to get both north (NE) and south (SW) aspects, pavement sensors would be placed just outside of the outside wheel track in the NB lane 500' south of the Pass and in the SB lane 500' north of the Pass. A sub-surface sensor would be added to both. [Photos N2a. Thompson Pass-1, and –2 are views of the outcrop, looking west from just east of the Pass taken about one month apart; N2a. TP Site Closeup is looking directly at the spot, standing on it; N2a. TP Site Looking E(SB), …Looking W(NB), …Looking N, and …Looking S are panoramas from the site. The N view also looks at a snow fence, across the roadway out of site below in the cut. In the S view, the highway can be seen below in the distance, approaching Keystone Canyon. N2 T Pass Power displays the installation for obtaining power from the power line at the AKDOT Highway Maintenance Station.]

b. An alternate site is on the east side of the Highway, a short distance north of the Pass, behind the Thompson Pass sign. [Photo N2b. T Pass Alt. is looking from the SB lane across the road at the Thompson Pass sign.]

N3. **Thompson Pass Ridge Tops and Snow Depth Monitoring/Avalanche Support**

Not only would it be desirable to have observations of conditions at Thompson Pass, highway level, telemetered to M&O decision makers, but also conditions affecting avalanche conditions are even more unreachable and unavailable. Observations that include snow depth, precipitation type and rate in the 5,000' to 6,000' MSL area, especially on the south side of ridges (north side of highway), would greatly assist avalanche forecasting and thereby improve highway safety. Snow level on ridges, i.e. the tops of slides, will be 2-3 times the depth at highway level, so a crude interpolation could also be made from avalanche snow depth sensors to project the depth at highway level.

The following sites would provide invaluable observations in support of avalanche forecasting and control in the heavy snow region of Thompson Pass, and thereby enable increased safety for both highway and recreational users, and facilitate greater predictability and efficiency for both highway maintainers and highway users. However, the unit costs of installation—especially for ridge top locations--will likely be higher than for roadside RWIS sites. The means of accomplishment and cost impacts assimilated into prioritization require further development.

a. Hogback "Snow Slide Gulch", approximately MP 15.6-15.9. Atmospheric sensors and snow depth gauge would be placed at a high point on the ridge (DeLorme Alaska Gazetteer, p. 86) to, especially, monitor a maritime air mass regime and the top of Hogback avalanche chutes. [Photo N3a. Hogback Ridge Slides is looking westward (north?) at Hogback Ridge from the Lowe River Bridge at approximately MP 16.5.]

b. "School Bus Slide," approximately MP 28-29. Atmospheric sensors and snow depth gauge would be placed just north of Odessey peak in a slight col. This location is impacted by southeast air flow as it comes over the ridge and loads up the top of chutes, just north of the AKDOT Thompson Pass maintenance facility on the east side of the Highway. [Photo N3b. School Bus Slides is looking eastward at Odessey (peak at center right) with the col site at the center between "peaks (bump at left is actually just a nose on the ridge) from the Highway directly below.]

c. Tsaina "MP 37-38 Slide Path." Atmospheric sensors and snow depth gauge would be placed at the ridge top where chutes are loaded. [Photo N3c. MP37-38 Slide is looking westward at the ridge top from a pullout on the east side of the Highway, at the south end of the Tsaina River Bridge at about MP 37.4 where a road closure gate is located.]

d. Tiekel "56 Mile Slide," in the vicinity of Tiekel, MP 56. Atmospheric sensors and snow depth gauge would be placed at the ridge top where chutes are loaded. [Several photos attempt to identify the site. N3d.1 Tiekel Slide is looking westward across the Highway from the south entrance roadway to Tiekel river Lodge, MP 56, with the right (north) shoulder of Mt Tiekel and the source of the avalanches presumed to be visible through the trees. N3d.2 Mt Tiekel(1) is looking NW across the Highway at about MP 57.7 at what might be Mt. Tiekel; and N3d.2 Mt Tiekel(2) is looking SE (SB along Highway) at what might be Mt. Tiekel from the same spot.]

e. "Pump 12 Slide." Atmospheric sensors and snow depth gauge would be placed at the ridge top where chutes are loaded. [Photo N3e. Pump 12 Slides is looking SW at the chute from the NB lane, just north of Pump 12 at approximately MP 65.2.]

f. Worthington Glacier, MP 28.5. Snow depth gauge **only** would be placed in a protected undisturbed area in the vicinity of the State Recreation Site. (Snow-free, and in-use conditions are needed to identify the actual secure location.) This location is believed to be representative of the Thompson Pass area from the point of view of snow accumulation and intensity of snowfall. The RWIS site suggested at N2 is too windswept to provide valid snowfall measurements. An emergency phone at this location does not have a solar panel, and at least a radio transmitter is apparent at the nearby heli-skiing operation—suggesting power is available? [Photo N3f. Worthington Snow Depth is looking across the snow covered recreation site at Worthington Glacier from the State Recreation Site entrance on the west side of the Highway.]

g. Ptarmigan Flats. Snow depth gauge **only** would be placed in a protected undisturbed area of the Ptarmigan Flats. (Snow-free conditions are needed to identify the actual secure location.) Snow depth and inferred snowfall intensity observations from this location would be a useful indicator of sow depth and intensity in the Tsaina River area below the Pass environment. There are still avalanche chutes (c., d., e.) below that. [Photo N3g. Ptarmigan Snow Depth is looking SW across the Highway from the vicinity of Tsaina Lodge at the Ptarmigan Flats area.]

Means of accomplishment, and cost impacts assimilated into prioritization requires further development.

N4. **Richardson Highway, Ernestine**

a. Stuart Creek Bridge, MP 45.6.

[Photos N4a. Stuart Creek-1, N4a. Stuart Creek-2, N4a. Stuart Ck-3 Br, and N4a. Stuart Ck Pwr.] This location would provide observation both at a maintenance area boundary, the furthest point from Ernestine and Thompson Pass stations, and at a location representative of the area approaching Thompson Pass from the north. Mountains limit sunlight hitting the road. The Highway turns to a mostly north-south bearing at this location where N-S winds are prevailing. Field personnel indicate warming and drying "Chinook winds" occur with strong south winds, but that they only occur once or twice during a typical winter. . Weather is often much different than at Ernestine. For example, a "rule of thumb" is that if the Tazlina Area/Ernestine Maintenance Station are snowing with air temperature near freezing, it is likely raining near Stuart Creek, and possibly onto a frozen pavement. An RWIS site would provide information without having to go look, and therefore could reduce time and effort spent on patrols.

This is also a useful location for snow depth measurement in support of avalanche operations in the Thompson Pass area. Avalanche road closure activities occur here. Four streams coming together in this vicinity, enlarging the Tiekel River, are believed to contribute to making this a sometimes heavy snowfall area.

The ESS would be placed in the area in the NE quadrant of the intersection of the Richardson Highway with a short pull-out road to the east .1 mile north of the Stuart Creek bridge. This seems to be the most open in the area. Saplings should be cleared to preserve open air flow. A protected area should also be established here for installation of a snow depth measurement sensor. [Photo N4a.-1 is looking at the proposed area (behind plowed snow) from the east side of the highway looking NB; and N4a.-2 is looking back northwestward at the site from the pullout road, approximately 120 feet from the edge of the Highway pavement. N4a.-3 is looking N past the Stuart Creek bridge from the east side of the highway south of the bridge.]

Power and communications may be available through cooperative arrangements with the heli-skiing operation across the highway, where it is likely self-generated. Otherwise, wire line telephone is 10 miles away. A power line crosses the Highway less than .5 mile from the site at about MP 46.2; however, power distribution from this source seems unlikely. [Photo N4a. Stuart Ck Pwr shows power line crossing Highway.]

b. Ernestine Maintenance Station, MP 62. .

Informal observation during February and April of 2001 found less accumulated snow in the Ernestine-Gakona area than north or south of that area, suggesting a distinctive microclimate. However, there were signs of significant sanding on the grade between MP 59 and MP 56; and this is an area where coastal and interior weather collide with sometimes unusual effects. The lack of weather observations limits the availability of factual information. Most employees of the Ernestine Station come to work from the north and have no information on conditions there until they get there, and then, none south of there to MP 45. A RWIS site would provide monitoring on holidays and days off. A recurrently observed condition is when it is snowing at Ernestine Station with air temperature near freezing, it may be raining south of there onto frozen pavement.

The ESS would be placed near the power pole/transformer at the SE corner of the Station, approximately MP 61.8. [Photo N4b. Ernestine Sta is looking across the Richardson Highway NB at the Ernestine Maintenance Station with the power pole at the center of the picture. The ESS could be placed to the right of it, with one pavement sensor, sub-surface sensor combination outside of the outside wheel track in the SB lane adjoining it.]

N5. **Richardson Highway, Vicinity of Edgerton Highway Junction**

The area in the vicinity of Willow Mountain is said to have locally heavy snow, and a “front” or frequent transition in weather patterns in the vicinity of MP 92. Contrasting with the reports of locally heavy snow, but supporting the reputation of a distinctive climatic area, during observations in February and April, 2001, there did seem to be a sharp demarcation around MP 86 with increasing icing on the pavement south of there, and little significant snow or ice north of there. Two alternate locations offer potential for monitoring this area.

a. MP 86.4, in long north-facing grade with propensity to icing.

Pavement sensors would be especially useful on this grade near Willow Lake, and perhaps representative also of the grade near Squirrel Creek state campground at about MP 79.7, but also atmospheric sensors would monitor weather in the larger Tonsina area.

Or

b. MP 91.1, Junction with Edgerton Highway.

This location at the highway junction is closer to the reputed typical “front” at about MP 92, and is at the north approach to the local effects around Willow Mountain.

N6. **Richardson Highway, at Sourdough, MP 148.**

Pavement sensors placed both on the Gulkana River Bridge and an approach would provide potentially contrasting insights, and the sensor in the bridge deck would provide an observation at a location that would avoid the settling commonplace in the roadbeds in this area. This location is the boundary between the Tazlina and Paxson maintenance areas, therefore sensor reports would reduce the need to drive to see what is happening at the furthest reach for both stations. However, the NWS Automated Surface Observing Station (ASOS) at Gulkana provides a reasonably representative weather observation for this area. Initially assigned a high priority by some field personnel, some conceded it a lower priority because of relatively low traffic volume and more distinctive local weather, further from existing weather observations, at some other candidate sites.

N7. **Richardson Highway, Paxson to Delta Junction**

In response to the question, "What specific examples of data scarcity make weather forecasting difficult in Alaska?", this area is among the first mentioned by meteorologists. Meteorological data from this area would be very important to support forecasts and warnings, especially to identify the high winds that cause blowing and drifting snow. Confounding the scarcity problem is that there is now a weather observation reported from Paxson, but the sensor suite is reportedly not well sited. Observations are needed from this area to detect changing weather patterns. The nearest reliable observation is the ASOS at Gulkana.

Relatively warm rain on snowfields results in lots of flooding problems in this area. For example, 12 creeks in the 40-mile stretch from Michael Creek north to Delta Junction are all susceptible—one year, seven out of thirteen bridges were washed out. One Mile Creek Bridge at MP 228.4 is said to be impacted by flash flooding every year.

The Isabel Pass area was number three priority in the Northern Region response to the Possible RWIS Site Questionnaire circulated by the Department. Isabel Pass is a problem area during both winter and summer. There is heavy drifting and poor visibility during heavy snowfall. There are visibility and vehicle handling problems due to winds coming off the river flood plain, blowing dust and debris across the roadway during summer. Summit Lake is more of the same with even heavier drifting, and reduced visibility due to mist and fog coming off the lake. The Summit Lake area, with a level cleared roadway at MP 194.85, is a suggested representative location, but R/W is likely a problem. Both the Isabel Pass and Summit Lake areas have heavy drifting and whiteout problems during heavy snowfall and wind storms. Winds from three directions at the "Glory Hole" at about MP 210 are distinctive.

Activity in the Trims Creek area makes siting of sensors in that area more practical.

a. Isabel Pass area, MP 197.6 to MP 210

This area is identified as having a very high priority by questionnaire responses in the Northern Region. Highway personnel specifically suggested MP 201.34. However, naming this particular location was probably influenced by the existence of a FY '01 construction project there. Icing and fog are common for this area at different times of the year. It has been noted that at this location a video camera pointed at Isabel Glacier would provide a gauge of visibility, which would be useful to both maintenance personnel and recreational users. From just south of Phelen Creek (MP 201.5) to Fielding Lake (MP 200.4), observation especially of precipitation intensity and wind would be very useful and would be indicative of conditions at the Trims Creek Station as well. Power supply in this area, however, is unlikely. Right of way may be available. Reportedly, there is a good cellular signal, and fibre optic is a future prospect.

b. Trims Creek Maintenance station, MP 218.2.

[Photo N7c.1 Trims Sta-Site; N7c.2 Trims Sta-Bldg] This location is one of many that would be useful for monitoring the area between Paxson and Delta Junction. It is representative of the 40-mile area between Donnelly Dome and McCallum Creek. On the assumption siting in this area is controlled by power, presumably available only at the Trims Maintenance Station, or Aleyeska Pump 10 (MP 219.2), this is the default location. However, for personnel assigned to this station, but not living in the immediate area, or for the times when this station is not manned, observations from this site will be especially useful. Two options at this site are to place the ESS on the west side of the highway about 15 feet south of the maintenance station access road, or add atmospheric sensors to the existing tower on the shop building. Pavement sensor and sub-surface sensor combination would be adjoining the ESS, or directly in front of the shop if the existing tower is used. [Photo N7c.1 is looking SB on the west side of the highway from the station access road; and N7c.2 shows the existing tower on the building.]

Trims area alternates: Each of the following alternates are probably preferable to the Maintenance Station location, but apparent lack of power leaves b. above, the preferred location.

c. Alternate 1:

East side of the highway, on a slight (drier) knoll just south of a small area of melt overflow at approximately MP 217.6.

d. Alternate 2:

Trims Creek, MP 218.8. SW quadrant of the stream crossing would be favored. [Photo N7c.3 Trims Creek is looking SB on the west side of the highway from a small pullout in the NW quadrant , at the mound across the stream. Break in the snow is the stream.]

e. Alternate 3:

Michael Creek, MP 219.8. Site would be just about 15 feet to the right of the SB Michael Creek sign. [Photo N7c.4 is looking SB at the SB Michael Creek sign.]

N8. **Edgerton Highway**

The upper Copper River Valley, especially the Chitina River Valley, is a separate or distinctive climatic area. It is lightly traveled and there are few reports of weather conditions. Most of the employees maintaining the Edgerton Highway live at the northern end, closer to the Richardson Highway, so they don't "see" what is happening along the Edgerton. The NWS issues forecasts for the area, but with no observations, they have little verification or feedback on which to base improved understanding of the local climate. There are existing pavement/subsurface temperature probes at MP 7 (EDI) and MP 29 (EDG).

a. Lower Tonsina area, MP 19.4
   The most severe weather along the Edgerton Highway is regarded to occur in this area. There is probably a lack of power here.
b. Chitina, MP 33.
   This is the location of the maintenance station serving the Edgerton Highway, so observations from this location would be highly useful to personnel, to anticipate conditions there and beyond to the south. This station is often not manned, providing even less contact with weather that may be occurring. One reason for manning the station is just to be able to observe conditions; RWIS observations telemetered to personnel would help to avoid this cost.

N9./C14 alternate **Glenn Highway at Tazlina** , MP 156. See C14.

Site in conjunction with NWS upper air profiler at Tazlina.

N10. **Alaska Highway at Dot Lake**

Obtaining meteorological data from this area is important to support forecasts and warnings. It would fill in a region where there is no data, between Delta Junction to the west and Northway to the east.

a. At MP 1360.4, a cleared area between two homes. [Photo N10a. Dot Lake] Location is very representative and addresses a desire for observations from this area expressed by both AKDOT M&O personnel and NWS personnel. The nearest weather observations are at Delta Junction and Northway, and there is an existing pavement/subsurface temperature probe (TOK) at Tok, Alaska Highway MP F-206. So there is a data void. Both the clearing on adjoining private property that is not wind sheltered, and apparent available power and communications, provide a spot not found elsewhere in the vicinity. Place the ESS on the north side of the highway approximately .2 mi. east of Miller Ave., mid-way in the cleared area, 15 to 20 feet from the edge of pavement. Place one pavement sensor, sub-surface combination outside of the outside wheel track in the WB lane adjoining the ESS. There is a transformer on the power pole approximately 60 feet east of the ESS site. [Photo N10a. is looking WB at the site on the south side of the highway.]

b. Chief Creek Bridge, MP 1358.7. This was initially thought to be the preferred location, but it is not a significant bridge and the location is too wind-sheltered to provide a dependable observation. [Photo N10b. Chief Creek Br. is looking EB at Chief Creek bridge in a pullout on the south side of the highway.]

N11**. Tok Cutoff**

For observations of current weather along this route, decision-makers now depend on reports from employees coming to work. "Rules of thumb" have developed; for example, if the Slana Maintenance Station is getting a trace of snow, it is concluded that a heavier snowfall is probably occurring at Mentasta Pass. Wind and drifting are a particular problem. An RWIS site could reduce road patrols to check on conditions. Weather forecasters would regard observations from the Mentasta area as also indicative of precipitation, and supportive for forecasting precipitation amounts, in the Copper River drainage. This would be a very important site for obtaining meteorological data to support forecasts and warnings, especially to identify high winds that cause blowing and drifting snow.

a. Mentasta Pass, MP G79.2 [Photos N11a.1 Mentasta Site Closeup; N11a.2 Mentasta Pass Site] Place the ESS on the west side of the highway at a site 100 feet north of an old 4" by 4" postThis will put the instruments at about the same elevation as the pavement at the summit. Place a pavement sensor, sub-surface sensor combination just outside of the outside wheel track in the SB lane adjoining the ESS, and another pavement sensor just outside the outside wheel track in the SB lane about .5 mi north of the ESS to get the opposite or north facing aspect. This location provides observations representative of the higher elevations of the Tok Cutoff and from about the furthest reach from the maintenance station. Power supply for this site is not now available; however, there have been several informal reports that power is to be brought through the pass within the next couple of years, or even as early as Fall, 2001. Copper Valley Telephone is reportedly available within the R/W. [Photo N11a.1 is a close up of the proposed site and N11a.2 is looking NB at the site on the west side of the highway.]

b. Alternate 1:

Mentasta Lodge, MP 78.1 [Photo N11a.Alt 1 Mentasta Lodge] The ESS would be placed directly in front, with one adjoining pavement and sub-surface sensor combination adjoining. This location near Mentasta Pass would be useful as an alternate motivated by the possibility of acquiring power from the private owner of the Lodge until commercial power is available. [Photo N11a.Alt 1 is looking south along the Richardson Highway from north of Mentasta Lodge, with the Lodge and suggested site at the center of the photo on the east (left) side of the road.]

c. Alternate 2:

Little Tok River bridge, MP G98.1. [Photos N11a.Alt. 2-Br; N11a.Alt 2-SW Cor] Although 20 mi. away from the preferred location at Mentasta Pass, this location does provide a useful observation, adds the opportunity to monitor a bridge deck and is closer to existing commercial power. The ESS would be placed at the SW quadrant of the bridge crossing, with pavement and sub-surface sensor combination just outside of the outside wheel track 500 feet south of the ESS in the SB lane; and another pavement sensor just outside of the outside wheel track in the SB lane of the bridge deck. [Photo N11a.Alt.2-Br is looking southward from the north end of the bridge on the west side, with the site at the far (top/south) end also on the west side; and N11a.2-SW Cor is looking back (north) at the site from the pullout at the SW corner of the bridge.]

d. Alternate 3:

Rest area, MP G99.3 [Photos N11a.Alt 3 Site; and N11a.Alt 3 Pwr.] To be even closer to the power line, the ESS can be placed between the highway and the rest area parking lot on the west side of the highway at this location. One pavement sensor and sub-surface sensor combination would be placed just outside of the outside wheel track in the SB lane, adjoining the ESS. [Photo N11a.Alt 3 is looking SB on the west side at the ESS site between pavements; and N11a.Alt 3 Pwr shows the power pole (#858) directly across the highway from the ESS site.]

e. Alternate 4:

Slana, MP 76, bridge over Slana Slough; or MP 59.8, junction with Nabesna Road. These would provide observations near the AKDOT/PF Slana maintenance station.

N12. **Richardson Highway, Tanana River bridge, MP 275.4 (Rika's Roadhouse)**

Site adjoins major Aleyeska Pipeline river crossing on a suspension bridge. The site seems to bristle with power and communications. Although weather sensors have not been observed, it seems plausible that Aleyska would have them there; if so, this may provide an opportunity to install pavement sensors only.

N13. **Richardson Highway, Birch Lake, MP 307.2**

[Photos N13.1 Birch Lake-Locale, N13.2 Birch Lake-Site, N13.3 Birch Lake-Power]

Representative of a seemingly distinctive weather- and wind-prone area, generally from MP300 to MP 314. The distinctive windiness in this area is confirmed by AST experience, and experienced AKDOT personnel, including those assigned in other areas. It adjoins a maintenance station where personnel are not resident in the immediate area. It would provide the great benefit of telemetered information on current conditions. Other nearby sections that require attention, such as frequent grades like "Woodchopper" around MP 310, do not lend themselves to RWIS sites and can be inferred from a Birch Lake observation by experienced personnel. This location would also be somewhat important for meteorological data to support forecasts and warnings.

The proposed site is 100 feet north of the station access road north edge of pavement in the NW corner of the school bus turnaround, and 33 feet east of the highway edge of pavement. This provides a good, open location and should not conflict with the school bus turnaround. Connection to power would probably be handier on the south side of the access roadway, but the site would be closer to trees than preferred. Power and transformer are available about 200 feet from of the proposed site, on the south side of the station access road. [Photo N13.1 is looking NB on the east side of the Richardson Highway, across the maintenance station access road; Photo N13.2 is a closer view of the site in the NW corner of the school bus turnaround; Photo N13.3 shows the meter on the power pole.]

One drawback is that this shop has not always been manned and now has only FAX for receiving data.

N14. **Richardson Highway, Badger Interchange, MP 358±**

Current construction project creates opportunity where, pavement sensors on both an elevated structure and at grade will be especially valuable and representative of much of the area. Siting suggestions have been provided directly to the project design engineers, and include: place the ESS at either end of the Richardson Highway crossing of Badger Road, whichever is the lowest cost by virtue of proximity to other power supply infrastructure, with the sensor mast outside the clear zone to a height of 10m above the roadway. At the same end as the ESS, place a pavement sensor just inside of the outside wheel track of the WB through (curb) lane of the bridge deck; and also, a pavement sensor just outside of the outside wheel track of the EB passing lane. Also, place a pavement sensor, sub-surface combination just outside of the outside wheel track of the WB passing lane on the at-grade approach; plus just outside of a wheel track of either lane (probably SB) on the Badger Road lower roadway.

N15. **University Avenue, Fairbanks, Chena River Bridge**

Weather observations at the international airport, Fort Wainwright, Eielson AFB and various cooperative observers provide a reasonably good picture of the Fairbanks atmosphere, but this location will be invaluable for **pavement sensors**, both in the bridge deck and in approach roadways. Add pavement, and sub-surface sensor combination during FY 2004 construction project.

N16. **George Parks Highway at Rex, MP 275.8**

The large thru-arch bridge at this location, where there are numerous accidents each season and where an additional bridge is to be constructed, provides a very good location to obtain comparative observations both on a bridge deck and approach roadways. The NWS human observation at Healy, although only part-time (8-12 hours per day), is believed to be representative of the Nenana River canyon area to the south of Rex. Although Rex would be seem to be in a similar climatic regime to the Nenana ASOS observation, maintenance personnel observe the weather to be frequently different. It is located too far from the responsible maintenance station for personnel to know what is happening there. Power is thought to be available within a mile where people are living.

N17.Alternate to C18. **George Parks Highway, vicinity of Broad Pass**

This is a very important area for meteorologists and they would regard a full RWIS site to be "invaluable" for identifying high winds that cause blowing and drifting snow, which can lead to travel difficulties. Also, the nearest weather observations come from the Denali Park site that does not fully represent winds along the highway, and part-time (8-12 hours per day) observations at Healy, where lack of continuity is a drawback. There are existing pavement/subsurface temperature probes at MP 206 (CAN) and MP 211 (CA2).

a. Broad Pass, MP 201 [No photo.]   This highly exposed area with extremes in weather conditions is one where the responsible crew is said to spend half of its time. Temperature and wind create -80°F chill factors that are dangerous for maintenance crews and any stranded travelers. Blowing and drifting snow are key parameters. Reliable weather observation for the area between Broad Pass and the East Fork (Chulitna River) AKDOT/PF maintenance station is highly desired. Pavement temperature observations in additional locations to the existing pavement/subsurface temperature probe (EST) adjoining the East Fork Maintenance Station at MP 185 would be desirable. Road conditions in April 2001 showed very interesting variations in ice bonded to the pavement in this area. Observations at Broad Pass would reverse the recurring situation of the highway crew responding to a call from AST after an accident, in this area that is virtually uninhabited during the winter, and allow for treatment of the roadway before accidents happen.

   Broad Pass is a traditional NWS observation location. Re-establishing a weather observation at this location will extend the climatology of Broad Pass and supplement it with pavement sensors. It is proposed to place ESS on the west side of the highway directly on a line from the highway to the existing tower with the red light, and half way between the edge of pavement and an existing yellow wand marking (telephone cable?).   A pavement and sub-surface sensor combination should be placed outside of the outside wheel track in the SB lane adjoining the ESS.   Power is available, produced on site by an FAA generator; and telephone is available from an underground telephone cable pedestal.

b. Hurricane Gulch, MP 174. On bridge over Hurricane Gulch, and approaches. [Photo N17b. Hurricane Gulch]   Good representative location in an important area at a long reach from the responsible maintenance stations; and an opportunity to monitor a major bridge. Interestingly, when visited, the air temperature was 27°F and the bridge deck was clear, bare and wet. Some nearby road sections had patches of compact snow and ice. However, nearby open sites with unrestricted air flow are limited; and a source of power is not apparent. The ESS would be best placed on a small hill in the SW corner of the bridge crossing location. Pavement sensors would be placed both on the bridge, and a pavement sensor, sub-surface sensor combination in the SB roadway adjoining the ESS. [Photo N17b. is looking across the highway at the proposed site, at the south end of the bridge. The bridge is out of the picture to the right.]

c. RR crossings with windmill-solar power generation at MP 194, and MP 203.2, may provide alternative sites, using the cleared area in the vicinity of the power generation for the ESS site.

N18. **George Parks Highway at McKinley Village, MP 237±**

This location is mentioned by AKDOT/PF, AST, and NWS personnel alike as a place where they would like to see an available weather observation. Reasons include the high level of visitors during the summer, virtual absence of any people during the winter, its location at the south end of the Nenana River canyon, representativeness of weather in the Alaska Range, and availability of power and communications.

N19. **Chena Hot Springs Road, MP 22.1**

This road is maintained by AKDOT/PF from Fairbanks, but they find the weather often differs from Fairbanks; for example, they observe 6" snow accumulation along this road when there is only 1" accumulation in Fairbanks. This is a popular recreational route during all seasons. This particular location is at the end of power and telephone.

N20. **George Parks Highway, vicinity of MP 321-330**

[Photos N20 Mile 320, N20 Mile 321, N20 Mile 322, N20 Mile 323, N20 Mile 324, N20 Mile 331, portray the area.]

This is an area of recurring steep grades and big curves with signs of heavy sanding to combat iciness. It is 30(±) miles from the maintenance station; observations without driving to get a first hand look would be very useful. Observations, especially of snow depth, would supply needed calibration information for the NWS weather radar at Pedro Dome. [Photo N20. Mile 338 is looking west at the highway area of interest in the distance.]

a. "Skinny Dick's", MP 327.8. [No Photo.] This is the only location in this area that has power year-round at Skinny Dick's Lodge, and cellular service is available. However, it is not the best location meteorologically, due to being in a valley and wind-sheltered.

b. "Swede's Place, MP 329.3. [Photos N20b. MP 329 To the east, N20b. MP 329 to the west] This location is along a ridge, with grades and curves to the east and west, and a better location than N20a. There is a possibility of power supply. A location here that is not wind sheltered, and has the possibility of placing pavement sensors on both sides of a hill to get differing aspects will be ideal. However, power once generated on–site is apparently no longer being generated and is therefore not available. Communications support is also not available. [Photo N20b. MP 329 To the west, is looking west from the south side of the road, with a good site meteorologically and operationally in the foreground.]

c. "Dean's Cabin, MP 330. [No Photo.] This is a good location meteorologically and operationally, but power is not available and there is only a weak cellular signal. Lack of a flat area for locating the ESS would probably require a fill to be provided to place a site.

<u>Southeast Region</u>

S1. **North Douglas Highway, MP 6.1**, near turn to Fish Creek Road to Eaglecrest Ski Area. [No photo.] West side of road. Height of small adjacent trees would need to be controlled.

Although only about 2 miles from airport observation site, airport observations are believed not to be representative of this area in the lee of Douglas Island (Mt. Meek and Mt. Ben Stewart).

S2. **Fish Creek Road at the Fish Creek Bridge**, about 1.8 miles from North Douglas Highway intersection. [Photo S2 Fish Creek Br.] At roughly 450'msl, this location is believed to differ from the airport observation both by being closer to the lee effects of the Douglas Island mountains and 450' higher. This location seems representative of the middle two-thirds of the route to Eaglecrest, and provides an opportunity to place pavement sensors in a bridge deck as well as in the pavement. [Photo S2. Fish Creek Br is looking south at Fish Creek Bridge from east side of Fish Creek Road.]

S3. **Juneau-Douglas Bridge** deck and approach roadways, pavement temperature and condition and sub-surface sensors only. [No Photo.] Weather conditions are probably representatively observed for this location by the instruments at the Douglas Boat Harbor (Mayflower Island), Federal Building and the airport; however, this is a critical location for pavement temperature and chemical presence observations. Available lighting makes this a good location for adding a video camera to an existing pole. A computer/modem -housed by the City and Bureau of Juneau (CBJ) in their adjacent Maintenance facility could make this a relatively inexpensive site. Place pavement sensor in inbound lane of bridge deck; and another along with sub-surface sensor in SB lane of Egan Drive.

S4. **Thane Road**, vicinity of avalanche chutes. Incorporation of observations from the top of the Mt. Roberts Tram are likely to be more useful than these at the bottom of chutes from an avalanche control perspective.

a. Vehicular pullout at approx. MP 1-1.5. [Photo S4a. Thane Aval Zone] Within the avalanche zone, but seemingly not within a chute. Almost directly across from Douglas Boat Harbor observation, perhaps 1 mile away. [Photo S4a. Thane Aval Zone is looking north from pullout.]
b. Sheep Creek bridge. [Photo S4b. Thane Sheep Ck.] About 2.5 miles from Douglas Boat Harbor sensors, allows pavement sensors in bridge deck and provides slightly further south observations than existing sites, south side of avalanche zone. [Photo S4b. Thane Sheep Ck is looking north at bridge from west side of road.]

S5. **Glacier Highway/Egan Drive, MP 3,** adjacent to AKDOT HQ, pavement temperature and condition and sub-surface sensors only. [Photos S5(1) Eagan Exp NB, S5(2) Eagan Exp SB] Weather conditions are probably representatively observed for this location by the instruments at the Federal Building and the airport. A computer/modem housed by DOT in their adjacent HQ building could make this a relatively inexpensive site. Use of wireless pavement sensors transmitting from the lanes with tall retaining walls (approx. .5 mi. south), and installation of video camera using highway lighting to advantage, would expand information generated and provide opportunity to analyze differences in pavement temperature behavior. Place pavement sensor and sub-surface sensor in outside SB lane, and pavement sensor in inside (closest to HQ) NB lane. Place video camera in a place pointed SB toward lighted area along retaining wall section. [Photo S5(1) Eagan Exp NB is looking NB from above east side of highway at the "Channel Marina," across from the east end of Channel Drive. Photo S5(2) Eagan Exp SB is looking SB from above the east side of the highway at the end of the roadway above Eagan Drive.]

S6**. Mendenhall Loop Road.** [No photo.] Most locations are wind sheltered and have weather not significantly different than the Juneau NWS Forecast Office or airport observations, but there are significant differences and trouble prone roadway icing locations. Pavement temperature and condition observations would be very useful to operations.

a. Adjacent to Floyd Dryden Middle School. Place pavement temperature and condition sensor and sub-surface sensor at most cost-effective location on Mendenhall Loop Road in the vicinity of the school.
b. Bottom of Goat Hill. Place pavement temperature and condition sensor and sub-surface sensor outside of a wheel track in the SB lane adjoining an RPU placed near the end of the guardrail, just north of Joann Way. Place an additional pavement temperature/condition and sub-surface sensor in the NB lane at the top of the hill adjoining the end of the guardrail near Goat Hill Road, to gain a different aspect than at the bottom of the hill and coverage of an accident-prone location. Incorporating this installation into the Goat Hill Hazard Elimination Project on Mendenhall Loop may be a way to accomplish it.

S7. **Veterans Memorial Highway (Glacier Highway)** where conditions north of Juneau are frequently different than in the urbanized area.

a. Cohen Drive, approx. MP 21. [Photo S7a. Cohen Drive.] Site is marginal for wind observations, but other meteorological parameters may be representative. The advantage of this location is that it is considered representative of the highway conditions in the area north of Auke Bay that are important to decision-makers; namely, pavement condition, air temperature, precipitation type and rate, and a video image would be very useful. It is also near the highest highway elevation on the Veterans Memorial Highway. This site may seem redundant with the existing nearby observation on Lena Loop, however that observation consists of only a once per day reading of maximum and minimum air temperature. The ESS, including mast and pavement sensors, would be placed north of Cohen Drive, on the east side of the highway. Power and landline telephone are available. [Photo S7a. Cohen Drive is looking north on the east side of the road at the site just north of MP 21 marker in foreground of photo.]

b. Approx. MP 23.5, pullout just north of and overlooking the Shrine of St. Terese. [Photos S7b.(1) Shrine Overlook (April), S7b.(2) Shrine Overlook SB (Aug), S7b.(3) Shrine Overlook NB (Aug)] This is a more open-air flow site than a. and c., but may be too far north for the transition from Juneau weather conditions believed to exist around MP 21. From an airflow point of view, mast should be placed near center of the open space on the west side of the highway south of the pullout. Power line across the road, and home below, suggest availability of power and telephone service. [Photo S7b.(1) Shrine Overlook is from the west side of the highway looking south, from the north end of the overlook of the Shrine of St. Terese,. Photo S7b.(2)… is taken from the parking area, looking south at the proposed site in the area west of the highway. Photo S7b.(3)…is taken across from the proposed site, looking north toward the pullout parking area from the east side of the road.]

c. Eagle Beach, approx. MP29.5, second pullout north of Eagle River. [Photo S7c. MP29 Eagle River] Trees south end of the pullout and forested bluff across the road to the east may restrict air flow somewhat. Power supply is not readily apparent. [Photo S7c. MP 29 Eagle River is from south end of pullout, looking NB.]

d. Benjamin Island Overlook, MP 33.5. [Photos S7d.(1) Ben Is Overlook-scene; S7d.(2) Ben Is Overlook-site.] This would be an excellent location for early detection of weather approaching from the north, and offers one of the few open airflow locations for a good site, meteorologically. The particular suggested site is on the west side of the curve below the pavement grade, perhaps using a 40' tower to get the wind sensors about 30' above the roadway. Pavement sensors should be placed about 500' both north and south of the ESS to get the differing aspects on each side of the curve. However, the location is near the northern limit of winter maintenance, has low traffic volume, and is not as valuable operationally as S7a, above. [Photo S7d.(1) Ben Is Overlook-scene is taken from east side of highway, looking south toward the site on the west side of road near bend at far end of picture; Photo S7d.(2) is taken from the west shoulder of the road looking south at the site.]

S8. Klondike Highway - Midway

a. Pullout at NB beginning of avalanche zone, MP 9.1. [Photos S8a.1 Klondike MP 9.1 SB; S8a.2 Klondike MP9.1 NB] At outside of curve, after approximately half the elevation difference between Skagway airport observations and White Pass, at an elevation of about 1450' MSL. This is a reasonably unsheltered location, and at the beginning of the avalanche zone, so the site is ideal in many ways. The opportunity exists to place pavement sensors on two sides of the bluff and to obtain both north- and south-facing aspects. Adequately sited, this will provide observations, now completely lacking, of strong north or south winds and precipitation, and support improved forecasting. Importantly, it will also provide actual information for verification of forecasts that meteorologists do not have, and information for

M&O personnel who must drive to the area just to see what is happening. Power is said to be available, but is not visually apparent. Attaching the mast base to the steeply sloping rock ballast constituting the roadbed will be a challenge. [Photo S8a.1 Klondike MP9.1 SB is looking southward at the site, which is where the guardrail protrudes into the pullout; and Photo S8a.2 Klondike MP 9.1 NB is looking northward at the same spot.]

Place mast and atmospheric sensors in the space behind the guardrail at midpoint of the pullout; and place pavement sensor and sub-surface sensor both at 600' north and 600' south of the ESS.

b. East side (outside) of NB roadway at US Customs station provides an alternate if placing S8a. is too difficult, and provides a lighted location for a video camera. [No photo.]

S9. **Klondike Highway - Border**

a. Border, MP 14.9. [Photos S9a(1) Klondike Bor SB; S9a(2) Klondike Bor-Site; S9a(3) Klondike Bor-Look SB; S9a(4) Klondike Bor from Can.] This location is the international border and terminus of AKDOT operations, and the approximate northern boundary of Klondike Highway avalanche zones dealt with by AKDOT. It lies about a half mile beyond the White Pass summit and about on the continental divide at elevation 3,290 feet. AKDOT maintains a generator at this location to operate warning lights during the winter. B.C. MOTH may install an RWIS site in the vicinity of Fraser in the future, but there are no plans for doing so in the near future. This high elevation location is within the most extreme conditions faced in AKDOT Klondike Highway operations, and would provide a very valuable continuous weather observation for the NWS from an area where there are none, and from which they get no verification feedback on forecasts issued. An additional attribute of a site at this elevation is that it approximates the elevation and conditions in the loading area at the tops of avalanche chutes. [Photo S9a(1) Klondike Bor SB is looking south toward the site, behind the small building and sign, from the west side of the highway north of the site. Photo S9a(2)… is looking directly at the site on the west side of the highway. Photo S9a(3)… is looking SB along Klondike Highway from the site. Photo S9a(4)… is looking SB along Klondike Highway from the west side of the road from the Canadian side, north of the site, with the site on the right (west) side of the "crest" of the picture.]

b. AKDOT Maintenance Station, MP 12. [Photos S9b(1), S9b(2) Klondike Border MP 12.] Adjacent to the Maintenance Station, at elevation about 2,540 feet, and at the bottom of a "runaway truck escape ramp" this location would provide observations at the location from which operations on the upper Klondike Highway are conducted. [Photo S9b(1) Klondike Border MP 12 is looking south at Klondike Highway from the top of the Upper Truck Escape Ramp (Elev. 2590'); S9b(2)… is looking north at the Maintenance Station site from the truck ramp.]

S10A. **Haines Highway - Chilkat, MP 19-24**, perhaps representative of the area between Haines airport observations and the border, but also at the confluence of Chilkat, Klehini, and Tsirku River drainages which contribute to local convergence effects and anomalous snowfall when cold air drains out of the interior.

a. Pullout MP19.5. Use small space between paved trail and riverbank. [Photo S10a. Haines MP19.5, looking NB on west side of road.]
b. Pullout MP 19.6. Use small space between paved trail and rip rapped riverbank. [Photo S10b. Haines MP19.6, looking NB on west side of road.]
c. Pullout MP 20.1 Use small protruding section into riverbank (at risk of losing bank control); remove saplings to enhance both the view and air flow. [Photo S10c. Haines MP20.1 , looking NB on west side of road.]
d. Council Grounds Trailhead and Kiosk parking lot, MP 20.6 (20.2?). Major viewpoint parking, but provides space and improved airflow the other pullouts do not have. Placement

in the space between the roadway and parking, and just south of drainage/culvert can be accomplished at 15' from edge of pavement on both sides and 18' north of the entrance roadway edge of pavement. [Photo S10d.1 MP20.6 Co Grnds Tr Parking is looking NB at entrance to the pullout; and Photo S10d.2 Site is a close up of the site from the entrance roadway.]

e. Turn to Klukwon, MP 21.5. [Photo S10e. Klukwon, is looking NB at the infield between Haines Highway and Klukwon road where ESS could be placed.]

f. Chilkat River bridge, MP 23.8. [Photos S10f.1 Chilkat Bridge; S10f.2 Chilkat Power Supply; S10f.3 Chilkat Br Scene; S10f.4 Chilkat Br-aerial.] The southeast corner of the Chilkat River Bridge has more restricted air flow than would be preferred, but better than other sites in this desirable stretch for RWIS installation It does have the attribute of being able to monitor both a bridge deck and roadway at grade. Also, power and telephone appear to be highly available at this location. Place ESS in the clear space at southeast corner of bridge, and place pavement sensor in EB lane of bridge deck, and pavement sensor and sub-surface sensor in roadway, say 100' from ESS. [Photo S10f.1 Chilkat Bridge looks at site at SE corner of bridge (bridge runs east-west); Photo S10f.2 is the power supply box at the NE corner of the bridge, and as observed approximately every one mile along the Haines highway to this point; Photo S10f.3… is looking east from mid-span of the bridge at the site at top right, SE corner; and S10f.4… is an aerial view of the east end of Chilkat River Bridge and site on the right (south) side of the approach.]

S10B. **Haines Highway – Klehini, MP 34-40**, a new section of highway on a mostly changed alignment from the former location. The roadway is now hard against the current channel of the Klehini River, exposed to considerable fetch across the braided and open river valley. Weather and pavement observations would provide information to highway operations personnel for a section with which they have no experience, and would support accumulation of objective data on whether the prevailing north-south winds (channeled east-west in the Klehini Valley) will be advantageous or impacting to snow & ice control. The location would be useful to weather forecasters, but perhaps not as representative as a location further east impacted by all three river valleys. Power and communications are available in the original alignment, but would likely be about one mile away from the most favorable sites. The preferred site will likely be determined by ESS foundation considerations; the south side of the road would be preferred if practical.

a. MP 35. [Photos S10B.a.(1) MP 35 EB, S10B.a.(2) Site 1, S10B.a.(3) Site 2, S10B.a.(4) NB, S10B.a.(5) Site aerial.] The ESS could be placed on a nose of the roadbed jutting into the River on the south side of the road at about MP 35 or on the north side in an area apparently used for staging during the recent construction. A pavement sensor and sub-surface sensor would be placed outside the wheel track in the adjoining lane. [Photo S10B.a.(1)… is looking east from the south side of the road at site 1, on the left (north) side, and at site 2 on the right (south) side of road. S10B.a.(2)… is site 1 on north side of road. S10B.a.(3)… is site 2 on south side of the road. S10B.a(4) is a general scene looking NB at the new highway section next to the Klehini River from the proposed sites at MP 35. S10B.a.(5)… is an aerial view looking northward at the MP 35 sites.]

b. MP 36.5. [Photo S10B.b. MP 36.5 EB] An approach similar to MP 35, above, would be used at the westerly end of the new straight stretch of highway adjoining the Klehini River. Attributes are similar to those of MP 35. However, MP 35 is closer to the confluence of three rivers, thought to be meteorologically significant; MP 36.5 would be more representative of the area closer to the border. [Photo S10B.b. MP 36.5 EB is looking east from about MP 36.7 at the site jutting out from the south side of the road.]

S11. **Mitkoff Highway, Banana Point/Blind Slough, MP 20±**, provides observations opposite end of Island from airport observations, distance from maintenance shop, representative of future ferry terminal (MP 36), and advantageous placement in prevailing southwest flow of marine air and outflow from the Stikine River valley. Beyond current pavement, mobile pavement temperature sensor could be provided to maintenance foreman and in-situ pavement sensors added when paved. [No photo]

S12. **Zimovia Highway, MP 11**, south of Chicagof Peak and where local weather is locally regarded to be significantly different than Wrangell airport area, where the AWOS is believed to be not well sited even for Wrangell representative weather. [No photo]

S13. **Big Salt Lake Road, MP 18, Klawock** on an elevation rise where roadway icing is most likely to occur on Prince of Wales Island. [No photo]

S14. **Stephens Passage**, for example, Pt. Styleman at entrance to Port Snettisham, or Harbor Island at entrance to Tracy Arm, Pt. Hugh at south end of Glass Peninsula, or possibly to obtain power, at Snettisham. From a meteorological point of view, and the NWS's ability to provide accurate reports of current weather and more tailored forecasts with improved timing, the observation void in this area is the single biggest impediment in the present capabilities. Observations of all weather parameters, including air pressure, in this region would be the most important for improved weather support to transportation maintenance and operations. The drawbacks, of course, are no road operations in the immediate area and the difficulty of providing power and communications to such locations.

APPENDIX IIB-1: Selection Criteria for RWIS Sites (Phase II)

The following are criteria used in selecting prospective RWIS sites to benefit operations and forecasts in support of operations. The sites were initially identified during interviews and document review of the user needs identification process (Task R2). Most sites are intended to be representative of a larger area or a transition zone between microclimates.

Overall Criterion ("fatal flaw" test):
Does the site have an informative aspect (orientation to the sun), free of obstructions by trees, cuts, embankments, and buildings?   YES?   NO?   MAYBE?

Meteorology Criterion: The location provides meteorologically important information to:

a) Meteorologists in order to develop accurate and timely forecasts of weather conditions, pavement temperature, and road conditions;

b) Meteorologists on the actual type, intensity, and progress of a storm in order to evaluate and update forecasts, as required;

c) Decision-makers on the actual weather and road condition in order to evaluate forecast information in conjunction with their meteorologist.

Decision-maker Criterion: The location provides operationally important information to decision-makers by detecting:

a) Actual road condition (dry, wet, frozen, etc.); in order to evaluate interactively with the forecasters actual storm characteristics and timing compared to forecasts, and therefore, any need for action;

b) Actual weather conditions (especially precipitation or no precipitation, type and intensity of precipitation, wind direction and speed, visibility, and amount of precipitation) in order to determine the appropriate maintenance action or the appropriateness of current maintenance operations;

c) Pavement temperature in order to determine the mix of, or need for, deicing materials;

d) Pavement temperature in order to determine the timing of the application of deicing materials, including anti-icing strategies;

e) The existence and amount of deicing chemicals on the surface, or the temperature at which liquid on the surface will freeze, in order to determine if applications of deicing materials are required.

Rating of Sites

Sites that met the Selection Criteria were methodically rated against evaluative criteria to narrow the list to those that would be recommended. The evaluation process was largely subjective and intuitive but used consistent **considerations** applied to the same **mindsets** from two **perspectives**.

There are three **mindsets** or purposes served in the placement of sensors:

FORECASTING: Sensors are sited to provide local information to supplement NWS and other weather observations to develop site-specific *forecasts* of weather and road conditions. Since the benefit of using weather information is to make timely decision through the use of forecasts, acquiring specific local information should be considered a primary reason for siting sensors. Sites selected primarily in support of weather forecasting should be meteorologically representative of an area.

Embedded in this consideration is the concept of *NOWCASTING*, which is the process whereby a decision-maker, ideally in consultation with a weather forecaster, uses all available information (weather forecasts, advisories, warnings, RWIS road and weather observations, road reports, and other sources of weather and road condition information) to make near-term decisions about the conditions that will prevail. These are the assumptions that underlie the actions to be taken.

DETECTING: Sensors are sited to *detect* existing or changing weather or roadway surface conditions on a real-time basis. Typical sites would include known trouble spots, fog and frost source areas, bridge decks, elevated roadways, as well as sufficient sites to provide a suitable grid for the reliable reporting of snow accumulation or other precipitation events. Sites providing information far from the maintenance station, and reducing the need to go look, score high for *detection.*

MONITORING: Sensors are also sited to provide a *monitoring* function to check the onset or existence of predicted conditions. Ideal monitoring sites provide information "upstream" of an area. For example, if weather usually comes from the southeast, sensors are placed to the southeast for monitoring; or where temperature inversions are common, sensors would be placed at several elevations.

In the case of a RWIS, there are two important **perspectives**. There is the perspective of the *meteorologists* who analyze current and expected weather conditions to provide forecasts tailored specifically to the operationally significant weather thresholds of certain decision-makers. Their focus is on the atmosphere and what its effects are likely to be—where and when. Also, there is the perspective of the *decision-makers*, who are responsible for maintaining safety and efficiency in the transportation system. Their focus is on the procedures that will maintain intended service levels, and therefore, on the current and predicted weather. The weather effects expected to prevail significantly drive the equipment, materials and personnel assignments selected.
Each prospective site was methodically evaluated in terms of the following **considerations** with the foregoing mindsets and perspectives in mind. The ratings are summarized in the matrix at Appendix IIB-2. Inasmuch as each rating was subjectively and intuitively applied by a single individual, as necessitated by the Phase II schedule, certainly the value assigned could arguably be somewhat high or low. However, with so many determinations across the matrix, it is believed the composite scores, the totals, should be fairly representative of relative merit for the Phase II, Central, Northern and Southeast Regions.

Considerations methodically applied were as follows:

Road Perspective:

10 points – Roadway is a high weather impact area where road data is of the highest importance in providing the capability to forecast the onset, duration, and monitoring of road conditions. And multiple maintenance & operations interviewees suggested the approximate location, and the rater favors it.

7-9 points – Roadway is a dangerous ice formation area where road data is very important to providing the capability to forecast the onset, duration, and monitoring of road conditions. And one maintainer suggested the approximate location and the rater favors it; or it is particularly representative for pavement temperature.

4-6 points – Roadway is important, but road data is primarily needed for detecting changes in road conditions in an area; also, the site may only require monitoring of road conditions under certain weather patterns. Also, either the rater favors it or a "third party" suggested it.

0-3 points* – Roadway is of lesser importance in terms of overall snow and ice control, but still would benefit from monitoring of road conditions for a specific area; or sensors are too costly for the expected benefits in forecast capability.
Also, interviewees were indifferent to the location, or their views are unknown.

Meteorology Perspective:

Special considerations:
1. Representative of a forecast problem area.
2. "Upstream" weather location.

Important due to:
3. Elevation.
4. Geographic location.
5. Relation to highway grade.
6. Greater than 3 miles from another observation. (arbitrary)
7. Supports forecaster need for forecast studies.

10 points – Weather data at this location is of the highest importance to forecasting the onset, duration, timing, and for monitoring of severe winter storm events. Existing area weather reporting sites are not representative of this location. All special considerations (above) apply. And multiple meteorologists suggest the approximate location, and the rater favors it.

7-9 points – Weather data at this location is important to forecasting the onset, duration, timing and for monitoring of severe storm events; but topography or proximity of other reporting sites make this site less than a top priority. At least five of the special considerations apply. And one meteorologist suggests the approximate location, and the rater favors it.

4-6 points – Weather data at this location is essential to provide snow pack and icing forecasting capability. At least three of the special considerations apply. And either the rater favors it, or maintenance personnel implied weather information from this location would be used in NOWCASTING.

0-3* points – Weather data at this location would provide added information for enhancing snow and ice control decisions but is not essential for the capability to forecast onset, duration, timing, or monitoring of severe winter storms. Or placement of weather sensors is too costly for the expected benefits in forecast capability. And meteorologists were indifferent to this location, or their views are unknown.

*Actually, sites that would have fallen into this range never made it to the list to be evaluated.

Engineering Considerations:

Availability of power, communications, and right of way was determined through an initial engineering evaluation, and taken more specifically into account for the "Final Ranking." In general, only sites in the Preliminary Short List were evaluated; no entry indicates unevaluated or unavailable information. In a few cases, information obtained as a by-product of the primary evaluation is also entered.

Rating Process Results:

In the Rating Process Results (Appendix IIB-2), pavement-sensor only sites are separated out. In some cases, they were initially conceived as full-complement sites, but during the rating process were converted to pavement-sensor only. After compiling the ratings, the totals that were high enough to be in the Recommended Initial Phase deployment are identified both in the last column of Appendix IIB-2 and in Appendix C.

APPENDIX IIB-2: RATING PROCESS RESULTS

Prospective List of Suggested RWIS Sites (Cross References to Appendix A "Working List")

SITE NUMBER	SELECTION CRITERIA: Meteorological Siting Requirements — "Fatal Flaw Test" Yes, No, Maybe[4]	Detecting: Road Perspective	Detecting: Metorology Perspective	Forecasting: Road Perspective	Forecasting: Metorology Perspective	Monitoring: Road Perspective	Monitoring: Metorology Perspective	Site Attributes total points	Initial Rank within Region	Power Yes, No, Maybe	Communications/Type L=Land-line C=Cellular R=Radio	Right-of-Way Yes, No, Undetermined (UND)	Final Ranking	Recommended Initial Phase
C1a	M	5	4	6	6	7	8	36	17					
C1b	M	5	4	6	6	7	8	36					17	
C2a	Y	7	8	7	9	7	9	47	7	M	L,C	UND	7	X
C2b	Y	7	8	7	8	7	8	45						
C3	Y	5	8	5	7	6	8	39	15				15	
C4a	Y	4	8	5	9	4	8	38						
C4b	Y	6	8	8	9	7	8	46	6					
C4c	Y	7	8	8	9	8	8	48		Y	L,C	UND	6	X
C5[1]	Y	6	6	8	8	10	9	47	8	Y	L,C	UND	8	X
C6a(1)	Y	8	8	9	8	8	8	49		Y	L,C	UND	4	X
C6a(2)	Y	8	8	9	9	8	9	51	4	Y	L,C			
C6b	Y	8	8	8	7	8	7	46						
C7a	M	8	6	7	5	8	6	40	16				16	
C7b	M	8	6	7	5	7	6	39						
C8a[2]	Y	5	8	6	9	6	8	42	12				12	
C8b[2]	M	3	8	4	9	6	9	39						
C9a[5]	N	4	9	5	8	4	8	38						
C9b	Y	8	9	7	9	8	9	50	2					
C9c	Y	8	9	7	10	9	10	51		Y	L,C	UND	2	X
C10[5]	M	7	6	8	8	8	8	45	11				11	

APPENDIX IIB-2: RATING PROCESS RESULTS, CONT.

Prospective List of Suggested RWIS Sites (Cross References to Appendix A "Working List")

	SELECTION CRITERIA Meteorological Siting Requirements	Detecting		Forecasting		Monitoring								
	"Fatal Flaw Test" Yes, No, Maybe[4]	Road Perspective	Metorology Perspective	Road Perspective	Metorology Perspective	Road Perspective	Metorology Perspective	**Site Attributes total points**	**Initial Rank within Region**	**Power** Yes, No, Maybe	**Communications/Type** L=Land-line C=Cellular R=Radio	**Right-of-Way** Yes, No, Undetermined (UND)	**Final Ranking**	**Recommended Initial Phase**
SITE NUMBER														
C11	Y	7	7	7	8	8	8	45	10	N	?		10	
C12	M	5	6	6	6	5	6	34	18				18	
C13a	Y	8	9	9	9	8	8	49	5					
C13b	Y	8	9	9	9	8	8	49		Y 30'	C	Y	5	X
C14/N9[7]	M	4	6	6	10	5	10	41	13				13	
C15a	Y	10	5	9	5	10	5	44	9	Y 115'	L,C	Y	9	X
C15b	Y	10	5	9	5	10	5	44		Y	L,C			
C16[5]	M	8	6	7	7	8	7	43	14				14	
C17a[5]	N(?)	8	6	7	7	8	7	44	3					
C17b	Y	8	8	9	9	8	9	51		N*	C	Y	3	X
C18	M	9	9	8	8	9	8	52						
C18/N17a[6]	Y	10	10	10	10	10	10	60	1	Y .25mi	L	UND	1	X
C18/N17b	Y-	10	9	9	9	9	9	56						
C18/N17c	Y	9	8	10	10	8	8	52						
N1a	Y	8	9	8	8	8	8	48	7	Y 75'	L	Y	7	X
N1b	Y	8	9	8	8	8	8	48						
N1c	Y	8	9	8	8	8	8	48						
N2a	Y	10	10	10	10	10	10	60	1	Y, 1.1mi	L	Y	1	X
N2b	Y	10	9	9	9	9	9	55						

APPENDIX IIB-2: RATING PROCESS RESULTS, CONT.

Prospective List of Suggested RWIS Sites (Cross References to Appendix A "Working List")

	SELECTION CRITERIA: Meteorological Siting Requirements	Detecting		Forecasting		Monitoring								
SITE NUMBER	"Fatal Flaw Test" Yes, No, Maybe[4]	Road Perspective	Metorology Perspective	Road Perspective	Metorology Perspective	Road Perspective	Metorology Perspective	Site Attributes total points	Initial Rank within Region	Power Yes, No, Maybe	Communications/Type L=Land-line C=Cellular R=Radio	Right-of-Way Yes, No, Undetermined (UND)	Final Ranking	Recommended Initial Phase
N3a[2]	Y	10	7	8	8	10	9	53	4				4	
N3b[2]	Y	10	7	8	8	10	9	53					4	
N3c[2]	Y	9	7	8	8	9	9	50						
N3d[2]	Y	9	7	8	8	9	9	50						
N3e[2]	Y	9	7	8	8	9	9	50						
N3f[3]	Y	7	7	8	8	7	9	44						
N3g[3]	Y	7	7	8	8	7	9	44						
N4a[8]	Y	9	7	8	7	8	8	47	9	N	No	Y	9	
N4b[8]	Y	7	7	7	7	7	8	43		Y	Y	UND		X
N5a	M	5	5	6	7	6	6	35	18					
N5b	M	7	5	7	7	6	6	38					18	
N6	M	7	5	7	6	6	6	37	20				20	
N7a	M	10	10	8	10	9	10	57	3					
N7b	Y	8	9	9	10	7	9	52		Y 300'	R	Y	3	X
N7c	Y	8	9	9	10	7	9	52	3					
N7d	Y	9	9	8	10	8	9	53						
N7e	Y	9	9	8	10	8	9	53						
N8a	M	7	6	6	8	7	8	42	12					
N8b	M	8	7	6	9	8	8	46					12	
N9[7]		----------------------See C14------------------------											14	

APPENDIX IIB-2: RATING PROCESS RESULTS, CONT.

Prospective List of Suggested RWIS Sites (Cross References to Appendix A "Working List")

	SELECTION CRITERIA													
	Meteorological Siting Requirements	Detecting		Forecasting		Monitoring								
	"Fatal Flaw Test" Yes, No, Maybe[4]	Road Perspective	Metorology Perspective	Road Perspective	Metorology Perspective	Road Perspective	Metorology Perspective	Site Attributes total points	Initial Rank within Region	Power Yes, No, Maybe	Communications/Type L=Land-line C=Cellular R=Radio	Right-of-Way Yes, No, Undetermined (UND)	Final Ranking	Recommended Initial Phase
SITE NUMBER														
N10a	Y	8	7	8	8	8	8	47	8	Y 60'	L	UND	8	X
N10b	N	4	7	6	6	4	6	33						
N11a	Y	9	8	9	9	8	9	52	5	N	L	UND	5	X
N11b	Y	9	8	9	9	8	9	52		Y	L			
N11c	Y	7	8	7	8	8	8	46		N	L			
N11d	Y	7	8	7	8	7	7	44		N	L			
N11e	M	6	8	6	7	6	7	40						
N12	Y	6	5	6	6	7	7	37	19				19	
N13	Y	9	6	9	7	9	7	47	10	Y 200'	L,C	UND	10	X
N14	Y	8	5	7	5	8	6	39	15	Y	L,C	UND	15	X
N15[1]	Y	9	4	8	4	9	5	39	16	Y	L,C	UND	16	X
N16	Y	9	7	8	7	8	7	46	11				11	
N17[6]		-------------------------See C18-------------------------											2	
N18	M	7	8	7	8	7	7	44	13				13	
N19	M	7	6	6	7	7	5	39	17				17	
N20a[9]	M	9	7	9	5	8	7	45	6	Y	C	UND	6	X
N20b[9]	Y	9	8	9	6	8	8	48		N	No			
N20c[9]	Y	9	8	9	7	8	8	49		N	No			
S1	Y	6	7	6	7	5	5	37	13				14	

APPENDIX IIB-2: RATING PROCESS RESULTS, CONT.

Prospective List of Suggested RWIS Sites (Cross References to Appendix A "Working List")

	SELECTION CRITERIA													
	Meteorological Siting Requirements	**Detecting**		**Forecasting**		**Monitoring**								
	"Fatal Flaw Test" Yes, No, Maybe[4]	Road Perspective	Metorology Perspective	Road Perspective	Metorology Perspective	Road Perspective	Metorology Perspective	**Site Attributes total points**	**Initial Rank within Region**	**Power** Yes, No, Maybe	**Communications/Type** L=Land-line C=Cellular R=Radio	**Right-of-Way** Yes, No, Undetermined (UND)	**Final Ranking**	**Recommended Initial Phase**
SITE NUMBER														
S2	Y	7	8	6	8	6	7	42	8				8	
S3[1]	Y	8	6	8	8	7	7	44	5	Y	L,C	UND	5	X
S4a	Y	6	5	7	5	6	5	34	12					
S4b	Y	7	5	8	5	7	6	38					13	
S5[1]	Y	8	5	8	8	8	5	42	6	Y	L,C	UND	6	X
S6a	M	9	5	6	8	7	5	40	7					
S6b	M	9	5	7	8	8	5	42		Y	L,C	UND	7	X
S7a[5]	M	8	6	9	7	9	6	45	3	Y	L	UND	4	X
S7b	Y	8	6	6	6	7	7	40						
S7c	M	7	6	7	7	9	6	42						
S7d	Y	7	6	9	7	8	6	43						
S8a	Y	8	6	6	7	7	6	40	1	N	R		11	
S8b	Y	7	4	4	4	6	4	29		Y	L			
S9a	Y	7	8	8	9	7	9	48	4	Y	R			
S9b	Y	9	9	10	9	9	9	55		Y	R	UND	1	X
S10Aa	M	7	9	7	9	7	9	48	2					
S10Ab	M	7	9	7	9	7	9	48						
S10Ac	M	7	9	7	9	6	9	47						
S10Ad	Y	8	8	8	9	8	10	51						

APPENDIX IIB-2: RATING PROCESS RESULTS, CONT.

Prospective List of Suggested RWIS Sites (Cross References to Appendix A "Working List")

	SELECTION CRITERIA													
	Meteorological Siting Requirements	**Detecting**		**Forecasting**		**Monitoring**								
	"Fatal Flaw Test" Yes, No, Maybe[4]	Road Perspective	Metorology Perspective	Road Perspective	Metorology Perspective	Road Perspective	Metorology Perspective	**Site Attributes total points**	**Initial Rank within Region**	**Power** Yes, No, Maybe	**Communications/Type** L=Land-line C=Cellular R=Radio	**Right-of-Way** Yes, No, Undetermined (UND)	**Final Ranking**	**Recommended Initial Phase**
SITE NUMBER														
S2	Y	7	8	6	8	6	7	42	2				8	
S10Af	Y	9	8	9	8	9	8	51				UND	2	X
S10Ba	Y	7	9	7	9	7	9	48		Y 1mi	L	UND	3	X
S10Bb	Y	7	9	7	9	7	9	48		N	No			
S11	M	6	8	7	8	6	7	42	9				9	
S12	M	8	6	6	6	8	6	40	11				12	
S13	M	7	5	5	5	7	5	34	14				15	
S14[2]	M	4	8	4	10	5	10	41	10				10	

FOOTNOTES

Sites include both Met Sensors and pavement temperature/condition and subsurface sensors, plus video camera, unless otherwise noted.

[1] Pavement/Subsurface only, plus video camera, unless otherwise noted.
[2] Atmospheric only, may include snow depth

[3] Snow depth gauge only
[4] Includes sites not specifically defined or field-visited

[5] Some concern regarding possible wind observation anomalies due to terrain effects. Could eliminate wind sensor; or install, test and evaluate, move to another location if unrepresentative.

[6] Northern Region N17 is ranked 2, see C18 (Central Rank 1).

[7] Northern Region N9 is ranked 14, see C14 (Central Rank 13).

[8] Stuart Creek N4a is preferred, but Ernestine N4b is selected because of lack of power and communications at Stuart Creek.

[9] Although n20c is preferred, implementation consideration may mandate 20a, in which case wind sensors will likely be deleted.

APPENDIX IIC: Recommended Initial Phase/Highest Ranked RWIS Sensor Sites to Serve Phase II Areas of Central, Northern and Southeastern Regions

The following list of Phase II RWIS sites is recommended for initial implementation. During the engineering process and preparation of plans, specs and estimates, it may become advisable to drop some sites from further consideration at this time; and some may be replaced by other sites from the Appendix IIA Prospective List.

Numbering is cross-referenced to the Appendix IIA Prospective List of Phase II RWIS Sensor Sites.

No prioritization is implied at this time. Cost estimates based on engineering analysis will provide a final basis for comparative site evaluation. Sites printed in **bold** and **underlined** are recommended as of this date and until engineering considerations argue against them. In a few cases where power and communications support is expected to be problematical, an alternate is provided.

CENTRAL REGION

C2. Seward Highway, vicinity Snow River

a. **Snow River Bridge, MP 17.7**. [Photos C2a.1 Snow River Br Berm, C2a.2 Snow River Bridge, C2a.3 Snow River Power] This site is well placed to be useful to avalanche monitoring. There is an avalanche zone on Sheep Mountain, between the bridge and Lakeview to the north. Airflow is somewhat less impeded at north end of bridge. Airflow would be most unobstructed with mounting of ESS on bridge itself at midspan; however, this has drawbacks, so placement of the ESS on the berm or mound at the NW corner of the bridge is suggested. Pavement sensor should be placed just outside of a wheel track of either lane on the bridge deck; and also, along with a sub-surface sensor, just outside of a wheel track of either lane in the approach roadway far enough from the bridge to be representative of the prevailing highway conditions. This location bristles with power, with a high voltage line adjoining the area; but whether the voltage can be dropped down cost effectively may be an issue. [Photos are from the north end of the b ridge looking south: C2a.1 shows the mound at the NW corner of the bridge; C2a.2 shows the Snow River bridge itself; and C2a.3 shows the power supply about .3 mi (?) away on Primrose Road.]

C4. Sterling Highway, Cooper Landing

c. **Russian River Ferry, MP 54.8** [Photos C4c.1 Russian River Ferry, C4c.2 Russian River Power.] This site provides most of the advantages of C4b. and has apparent availability of power. It is probably a very busy location during summer and fishing seasons, a possible drawback; but if adequately protected, the many eyes may also serve to protect it from vandalism. The suggested location for the ESS is in the space between the highway and the roadway into the parking area. On the assumption that power is most available at this location, this is the preferred location in this locale; however, if the drop in voltage is practical here, it does raise the question as to whether it might be possible also at the MP 57.8 location. [Photo C4c.1 is the possible site, looking westward on the south side of the road, from within the pullout area. Photo C4c.2 is an overly dark view of the power pole and transformer, with a meter box that says 470v, 150' east of the site.]

C5. Sterling Highway MP 98, AKDOT/PF Maintenance Shop [No Photo.]

Pavement sensors and sub-surface sensor only would be placed at this location because it is fully observed by personnel working there and there is a weather observation at the airport. The existing weather observation is believed by meteorologists to be representative of a wide area, and pavement and sub-soil temperatures are likely to be also. There is a nearby existing pavement/subsurface temperature probe at Soldotna, but it is providing seemingly misleading pavement surface temperature readings (3/10-12/01: pavement surface @ 83°-93°F when bottom of pavement @ 31°-35°F and air temperatures in the 32°-42°F range). The western Kenai Peninsula, the Nikiski-Kenai-Soldotna-Sterling-Kasilof area, is of quite a uniform elevation and climate or aspect to the sun. Place a pavement sensor and sub-surface combination just outside of a wheel track at the nearest location to power.

C6. Sterling Highway, Ninilchik, MP 135.9

a. Ninilchik River bridge and approach [Photos C6a.1 Ninilchik SW Cor Site; C6a.2 Ninilchik SW Cor Area; C6a.3 Ninilchik Power.] This location provides a representative area between Homer and Soldotna and an opportunity to monitor a significant bridge deck. The preferred location for the ESS would seem to be the SW corner of the bridge crossing. Southwest of the bridge and at the intersection with Mission Avenue, 15 feet behind the guardrail on the west side of the highway, and 30 feet south of the guardrail across the north end of the flat area. Place pavement and sub-surface sensor just outside of the outside wheel track in the SB lane 100 feet south of Mission Ave.; and just outside of the outside wheel track in the SB lane of the bridge deck. [Photo C6a.1 is a close up view of the area behind the guardrail on west side of highway at SW corner of bridge; C6a.2 shows the flat area in which placement of the ESS is proposed dead center of the photo, and C6a.3shows the power/telephone infrastructure 300 feet southwest across Mission Ave.]

Ninilchik River bridge alternate. [Photo C6a. Alt. Ninilchik Br NE Cor.] ESS would be placed on the mound at the outside of the curve on the SB approach to the bridge in the NE quadrant of the crossing. Pavement sensors would be placed about 500' south in the bridge deck, and along with a sub-surface sensor adjacent to the ESS on the approach. This spot has the least obstructed airflow at this location, but it is probably the furthest from local power availability. [Photo C6a. Alt. Is looking SB from the Ninilchik River Scenic Overlook in the NE quadrant of the bridge.]

C9. Seward Highway, Summit Lake

Offsets absence of weather observations between Portage and Kenai-soldotna, and lack of observations at higher elevations. Provides "upstream weather observation for Anchorage area, i.e. detection and monitoring of weather approaching from the Gulf of Alaska. Provides representative high elevation and "upstream" location for pavement conditions for Silvertip Maintenance station.

c. Summit Lake Lodge. [Photo C9c. Summit Lake Lodge] The ESS would be on the east side of the Seward Highway, just south of the Summit Lake Lodge entrance, at about MP 45.8. Placement of the ESS about 75 feet south of the avalanche highway closure gate, and about 15 feet behind the guardrail, is suggested. Small deciduous trees should be removed and controlled within about 50 feet of the site. This will both ensure unrestricted airflow and improve visibility of the lake for travelers. A pavement sensor, sub-surface sensor combination should be placed just outside the outside wheel track in the NB lane (nearest to ESS). Power and telephone appear to be available at the Lodge. [Photo C9.c is looking south from the Lodge south entrance; the avalanche gate is in the foreground.]

C13. Glenn Highway, "Gunsight," MP 117 [Photos C13 Gunsight MP 117, C13 Gunsight Power Pole] This area serves the furthest reaches of two maintenance areas in both the Central and Northern Regions, and is believed to be representative of the Eureka-Gunsight-Sheep Mountain area, while perhaps sensing air flows from multiple glacial valleys and the south slopes of the Talkeetna Mountains toward the Matanuska Valley, but still above the narrowing topography of the Matanuska to the west. A weather observation is currently available at Eureka Summit, but it does not include a precipitation gauge and is believed to not be representative for fog. There is also an existing pavement/subsurface temperature probe (EUR) at Eureka (MP 128). Although highway maintenance personnel access the Eureka observation, this general area is still identified by meteorologists and highway personnel alike as one in which more weather observations are needed. Pavement conditions are poor throughout the area, but are somewhat better in this MP 117 area. [Photo C13 Gunsight MP 117 provides a view of the MP 117 area looking WB from Camp Creek at MP 117.2, and C13 Gunsight Power Pole is the power supply near which the ESS can be placed.]

b. The north side is preferred in order to be more accessible to the very available power. Sites either near a (Copper Valley) power pole, or half way between two power poles in the line, are recommended for placement of the ESS. A pavement sensor, sub-surface sensor combination should be placed outside the outside wheel lane in the WB lane adjoining the ESS. [Photos C13b. Gunsight North Side 1, and …North Side 2 provide two views of the site.] As an adjunct to this site, is suggested a precipitation sensor be acquired and provided to the NWS for the Eureka site.

C15. Parks Highway, Vicinity of Big Lake Turnoff

b. **Intersection with Hawk Lane, MP 53.2** [Photos C15a.1 Big Lake Turn SB; C15a.2 Big Lake Turn North Look.] On the west side of the Parks Highway place ESS about 115 feet south of south side of Hawk Lane, and 33 feet from Parks Highway edge of pavement. Existing highway lighting will provide light for video camera without the competing light sources and other visual clutter at the Big Lake Road intersection itself. If the camera is pointed northward, three light pole spacings and the curve .3 mile north can be used to gauge visibility. Place pavement sensor, sub-surface sensor combination just outside the outside wheel track in the SB (morning commute) lane; and a pavement sensor just outside the outside wheel track in the NB lane 500 feet north of this site. [Photo C15a.1 is looking SB on the west side of the highway from the last (most northerly) lighting pole, at the proposed site in a somewhat drier clump of grass. Photo C15a.2 is looking NB from the same spot, with lighting poles 3 and 4 at the right and the curve in the distance. Hawk Lane turns left.]

b. Alternate: Across the highway from C15a., just north of the Houston Jr.-Sr. High School highway sign. Except for placement of the ESS, all features would be the same as for C15a. This spot is probably somewhat superior to C15a., but access to power would seem to require crossing under the highway. [Photo C15b. Big Lake Turn NB is on the east side of the highway, looking NB, with the site in the foreground.]

C17. Parks Highway, Byers Creek

As noted in C16, above, the prevailing wind in winter along the Parks Highway south of the Alaska Range is reportedly from the north, and is strongest north of about MP 105 where the highway crosses the Big Susitna River. Storm systems either come (1) northerly up the Susitna River from Knik Arm and Cook Inlet, or (2) from the east, around the Talkeetna Mountains from Prince William Sound. RWIS sensor sites strategically placed along the Parks Highway will provide better detection and monitoring of systems than now available. The Byers Creek area may be a prime location for this, where highway personnel perceive a recurring wind band to occur around Byers Lake, MP 143, even if not windy below there. The wind is actually beneficial for melting ice on the road, and this area is representative of the northern end of the Central Region’s portion of the Parks Highway.

a. Byers Creek General Store, MP 143.9. [Photo C17a. Byers Creek] The primary objective here is to obtain an observation in this representative area, with a bridge deck, at a distance removed from the Chulitna Maintenance Station. However, to do so would probably require mounting the sensors/mast on the side of the bridge deck itself—not good; or to delete the wind observations if moved off the bridge to get reasonably open air flow. There seems to be power/communications at the General Store, in the NW quadrant of the bridge crossing, but may be generated on site. (Telephone number at the store is: (907) 345-2021.) [Photo C17a. is looking SB at the bridge from the General Store entrance driveway.]

c. **Alaska Veterans Memorial Turnoff, MP 147.2** [Photos C17b.1 AK Vet Mem SB; and C17b.2 AK Vet Mem Ent] Place the ESS across the highway to the west from the entrance to the Memorial parking lot/loop road (south entrance), and a pavement sensor, sub-surface sensor combination just outside the outside wheel track in the SB lane adjoining the ESS. This site is superior to C17a. due to more open air flow, and is equally representative (except for the loss of a bridge deck observation). However, the only power source is seasonal—originating from a diesel generator near the Ranger's Residence Memorial Day through Labor Day, and only daytime. Cellular service is available. [Photo C17b.1 is looking NB on the west side of the highway; and C17b.2 is looking into the Memorial south entrance from the proposed site.]

[Note: Photo ARR Parks Power Supply shows the windmill and solar panel power generating configuration used by the Alaska Railroad in the area.]

N17. Alternate to C18. George Parks Highway, vicinity of Broad Pass

See N17a.

Northern Region

N1. Valdez, Richardson Highway, MP 12.2, [Photos N1 Valdez-1; N1 Valdez-2]

This locale is representative of area at the base of the climb to Thompson Pass. This site represents the area from about MP 9 to MP 13 which locals believe is distinctive from airport observations because of southerly flow down the Browns Creek valley, heating caused by downslope north winds over mountains on the north side, and air somewhat compressed exiting Keystone Canyon (at about MP 13). It is frequently observed to be raining in this area when it is snowing in Valdez.

There is a series of microclimates NB from Valdez: the Valdez area, represented by observations from the airport and NWS office; the stretch from around MP 9 to MP 13 where it is warmer; Keystone Canyon, approximately MP 13 to MP 16; the more open area of MP 16 to MP 19; and the Thompson Pass area itself.

a. Place the ESS on a mound on west side of Highway (approximately 20' from edge of pavement to toe of slope of the mound, and 47' to backside toe of slope), and a pavement sensor, sub-surface sensor combination just outside of the outside SB wheel track. Power distribution is directly abutting on the west side. [Photo N1 Valdez-1 is looking SB on the west side of the road at the proposed site; and N1 Valdez-2 is looking directly at the mound.]

N2. Thompson Pass, Richardson Highway, MP 26 [Photos N2a. TP Site (seven different perspectives), and N2a. T Pass Power]

This location is priority number 1 on practically everybody's list. Difficult location operationally, meteorologically significant transition from marine environment to interior air mass, avalanche impacts, no consistent weather and pavement information available—even to provide verification of forecasts based on what forecasters believe is happening.

a. The initial siting recommendation is to place weather sensors on a windswept outcropping that stands about 100' above the highway (based on altimeter reading) on north side of highway right at the pass, with power/communications to be supplied from the nearby AKDOT Highway Maintenance Station. Ideally, to get both north (NE) and south (SW) aspects, pavement sensors would be placed just outside of the outside wheel track in the NB lane 500' south of the Pass and in the SB lane 500' north of the Pass. A sub-surface sensor would be added to both. [Photos N2a. Thompson Pass-1, and –2 are views of the outcrop, looking west from just east of the Pass taken about one month apart; N2a. TP Site Closeup is looking directly at the spot, standing on it; N2a. TP Site Looking E(SB), …Looking W(NB), …Looking N, and …Looking S are panoramas from the site. The N view also looks at a snow fence, across the roadway out of site below in the cut. In the S view, the highway can be seen below in the distance, approaching Keystone Canyon. N2 T Pass Power displays the installation for obtaining power from the power line at the AKDOT Highway Maintenance Station.]

b. An alternate site is on the east side of the Highway, a short distance north of the Pass, behind the Thompson Pass sign. [Photo N2b. T Pass Alt. is looking from the SB lane across the road at the Thompson Pass sign.]

(for further consideration)

N3. Thompson Pass Ridge Tops and Snow Depth Monitoring/Avalanche Support

The sites shown at Exhibit 1 would provide invaluable observations in support of avalanche forecasting and control in the heavy snow region of Thompson Pass, and thereby enable increased safety for both highway and recreational users, and facilitate greater predictability and efficiency for both highway maintainers and highway users. However, the unit costs of installation—especially for ridge top locations--will likely be higher than for roadside RWIS sites. The means of accomplishment and cost impacts assimilated into prioritization require further development.

a. Hogback "Snow Slide Gulch", approximately MP 15.6-15.9. Atmospheric sensors and snow depth gauge would be placed at a high point on the ridge (DeLorme Alaska Gazetteer, p. 86) to, especially, monitor a maritime air mass regime and the top of Hogback avalanche chutes. [Photo N3a. Hogback Ridge Slides is looking westward (north?) at Hogback Ridge from the Lowe River Bridge at approximately MP 16.5.]

b. "School Bus Slide," approximately MP 28-29. Atmospheric sensors and snow depth gauge would be placed just north of Odessey peak in a slight col. This location is impacted by southeast air flow as it comes over the ridge and loads up the top of chutes, just north of the AKDOT Thompson Pass maintenance facility on the east side of the Highway. [Photo N3b. School Bus Slides is looking eastward at Odessey (peak at center right) with the col site at the center between "peaks (bump at left is actually just a nose on the ridge) from the Highway directly below.]

c. Tsaina "MP 37-38 Slide Path." Atmospheric sensors and snow depth gauge would be placed at the ridge top where chutes are loaded. [Photo N3c. MP37-38 Slide is looking westward at the ridge top from a pullout on the east side of the Highway, at the south end of the Tsaina River Bridge at about MP 37.4 where a road closure gate is located.]

d. Tiekel "56 Mile Slide," in the vicinity of Tiekel, MP 56. Atmospheric sensors and snow depth gauge would be placed at the ridge top where chutes are loaded. [Several photos attempt to identify the site. N3d.1 Tiekel Slide is looking westward across the Highway from the south entrance roadway to Tiekel river Lodge, MP 56, with the right (north) shoulder of Mt Tiekel and the source of the avalanches presumed to be visible through the trees. N3d.2 Mt Tiekel(1) is looking NW across the Highway at about MP 57.7 at what might be Mt. Tiekel; and N3d.2 Mt Tiekel(2) is looking SE (SB along Highway) at what might be Mt. Tiekel from the same spot.]

e. "Pump 12 Slide." Atmospheric sensors and snow depth gauge would be placed at the ridge top where chutes are loaded. [Photo N3e. Pump 12 Slides is looking SW at the chute from the NB lane, just north of Pump 12 at approximately MP 65.2.]

f. Worthington Glacier, MP 28.5. Snow depth gauge **only** would be placed in a protected undisturbed area in the vicinity of the State Recreation Site. (Snow-free, and in-use conditions are needed to identify the actual secure location.) This location is believed to be representative of the Thompson Pass area from the point of view of snow accumulation and intensity of snowfall. The RWIS site suggested at N2 is too windswept to provide valid snowfall measurements. An emergency phone at this location does not have a solar panel, and at least a radio transmitter is apparent at the nearby heli-skiing operation—suggesting power is available? [Photo N3f. Worthington Snow Depth is looking across the snow covered recreation site at Worthington Glacier from the State Recreation Site entrance on the west side of the Highway.]

g. Ptarmigan Flats. Snow depth gauge **only** would be placed in a protected undisturbed area of the Ptarmigan Flats. (Snow-free conditions are needed to identify the actual secure location.) Snow depth and inferred snowfall intensity observations from this location would be a useful indicator of sow depth and intensity in the Tsaina River area below the Pass environment. There are still avalanche chutes (c., d., e.) below that. [Photo N3g. Ptarmigan Snow Depth is looking SW across the Highway from the vicinity of Tsaina Lodge at the Ptarmigan Flats area.]

<u>N4. Richardson Highway, Ernestine</u>

a. Stuart Creek Bridge, MP 45.6. [Photos N4a. Stuart Creek-1, N4a. Stuart Creek-2, N4a. Stuart Ck-3 Br, and N4a. Stuart Ck Pwr.] This location provides observation both at a significant distance from the maintenance station and at a location representative of the area approaching Thompson Pass from the north. Weather is often much different than at Ernestine; a RWIS site could reduce time and effort spent on patrols. Mountains limit sunlight hitting the road. The Highway turns to a mostly north-south bearing at this location where N-S winds are prevailing. . Field personnel indicate warming and drying "Chinook winds" occur with strong south winds, but that they only occur once or twice during a typical winter.

This is also a useful location for snow depth measurement in support of avalanche operations in the Thompson Pass area. Avalanche road closure activities occur here. Four streams coming together in this vicinity, enlarging the Tiekel River, are believed to contribute to making this a sometimes heavy snowfall area.

Place the ESS in the area in the NE quadrant of the intersection of the Richardson Highway with a short pull-out road to the east .1 mile north of the Stuart Creek bridge. This seems to be the most open in the area. Saplings should be cleared to preserve open-air flow. A protected area should be established here for installation of a snow depth measurement sensor also. [Photo N4a.-1 is looking at the proposed area (behind plowed snow) from the east side of the highway looking NB; and N4a.-2 is looking back northwestward at the site from the pullout road, approximately 120 feet from the edge of the Highway pavement. N4a.-3 is looking N past the Stuart Creek bridge from the east side of the highway south of the bridge.]

Power and communications may be available through cooperative arrangements with the heli-skiing operation across the highway, where it is likely self-generated. Otherwise, wire line telephone is 10 miles away. A power line crosses the Highway less than .5 mile from the site at about MP 46.2; however, power distribution from this source seems unlikely. [Photo N4a. Stuart Ck Pwr shows power line crossing Highway.]

b. **Ernestine Maintenance Station, MP 62.**.

Informal observation during February and April of 2001 found less accumulated snow in the Ernestine-Gakona area than north or south of that area, suggesting a distinctive microclimate. However, there were signs of significant sanding on the grade between MP 59 and MP 56; and this is an area where coastal and interior weather collide with sometimes unusual effects. The lack of weather observations limits the availability of factual information. Most employees of the Ernestine Station come to work from the north and have no information on conditions there until they get there, and then, none south of there to MP 45. A RWIS site would provide monitoring on holidays and days off. A recurrently observed condition is when it is snowing at Ernestine Station with air temperature near freezing, it may be raining south of there onto frozen pavement.

The ESS would be placed near the power pole/transformer at the SE corner of the Station, approximately MP 61.8. [Photo N4b. Ernestine Sta is looking across the Richardson Highway NB at the Ernestine Maintenance Station with the power pole at the center of the picture. The ESS could be placed to the right of it, with one pavement sensor, sub-surface sensor combination outside of the outside wheel track in the SB lane adjoining it.]

N7. Richardson Highway, Paxson to Delta Junction

b. Trims Creek Maintenance station, MP 218.2 [Photo N7c.1 Trims Sta-Site; N7c.2 Trims Sta-Bldg] This location is one of many that would be useful for monitoring the area between Paxson and Delta Junction. On the assumption siting in this area is controlled by power, presumably available only at the Trims Maintenance Station, or Aleyeska Pump 10 (MP 219.2), this is the default location. However, for personnel assigned to this station, but not living in the immediate area, or for the times when this station is not manned, observations from this site will be especially useful. Two options at this site are to place the ESS on the west side of the highway about 15 feet south of the maintenance station access road, or add atmospheric sensors to the existing tower on the shop building. Pavement sensor and sub-surface sensor combination would be adjoining the ESS, or directly in front of the shop if the existing tower is used. [Photo N7c.1 is looking SB on the west side of the highway from the station access road; and N7c.2 shows the existing tower on the building.]

Trims area alternates: Each of the following alternates are probably preferable to the Maintenance Station location, but apparent lack of power leaves b. above, the preferred location.

c. Alternate 1:
East side of the highway, on a slight (drier) knoll just south of a small area of melt overflow at approximately MP 217.6.

d. Alternate 2:
Trims Creek, MP 218.8. SW quadrant of the stream crossing would be favored. [Photo N7c.3 Trims Creek is looking SB on the west side of the highway from a small pullout in the NW quadrant , at the mound across the stream. Break in the snow is the stream.]

e. Alternate 3:
Michael Creek, MP 219.8. Site would be just about 15 feet to the right of the SB Michael Creek sign. [Photo N7c.4 is looking SB at the SB Michael Creek sign.]

N10. Alaska Highway at Dot Lake

a. **MP 1360.4, Cleared area between two homes** [Photo N10a. Dot Lake] Location is very representative and addresses a desire for observations from this area expressed by both AKDOT M&O personnel and NWS personnel. The nearest weather observations are at Delta Junction and Northway, and there is an existing pavement/subsurface temperature probe

(TOK) at Tok, Alaska Highway MP F-206. So there is a data void. Both the clearing on adjoining private property that is not wind sheltered, and apparent available power and communications, provide a spot not found elsewhere in the vicinity. Place the ESS on the north side of the highway approximately .2 mi. east of Miller Ave., mid-way in the cleared area, 15 to 20 feet from the edge of pavement. Place one pavement sensor, sub-surface combination outside of the outside wheel track in the WB lane adjoining the ESS. There is a transformer on the power pole approximately 60 feet east of the ESS site. [Photo N10a. is looking WB at the site on the south side of the highway.]

N11. Tok Cutoff

a. Mentasta Pass, MP G79.2 [Photos N11a.1 Mentasta Site Closeup; N11a.2 Mentasta Pass Site] Place the ESS on the west side of the highway at a site 100 feet north of an old 4" by 4" post. This will put the instruments at about the same elevation as the pavement at the summit. Place a pavement sensor, sub-surface sensor combination just outside of the outside wheel track in the SB lane adjoining the ESS, and another pavement sensor just outside the outside wheel track in the SB lane about .5 mi north of the ESS to get the opposite or north facing aspect. This location provides observations representative of the higher elevations of the Tok Cutoff and from about the furthest reach from the maintenance station. Power supply for this site is not now available; however, there have been several informal reports that power is to be brought through the pass within the next couple of years, or even as early as Fall, 2001. Copper Valley Telephone is available within the R/W. [Photo N11a.1 is a close up of the proposed site and N11a.2 is looking NB at the site on the west side of the highway.]

b. Alternate 1:

Mentasta Lodge, MP 78.1 [Photo N11a.Alt 1 Mentasta Lodge] The ESS would be placed directly in front, with one adjoining pavement and sub-surface sensor combination adjoining. This location near Mentasta Pass would be useful as an alternate motivated by the possibility of acquiring power from the private owner of the Lodge until commercial power is available. [Photo N11a.Alt 1 is looking south along the Richardson Highway from north of Mentasta Lodge, with the Lodge and suggested site at the center of the photo on the east (left) side of the road.]

N13. Richardson Highway, Birch Lake, MP 307.2 [Photos N13.1 Birch Lake-Locale, N13.2 Birch Lake-Site, N13.3 Birch Lake-Power]

This location is representative of a seemingly distinctive weather- and wind-prone area, generally from MP300 to MP 314. The distinctive windiness in this area is confirmed by AST experience, and experienced AKDOT personnel, including those assigned in other areas. It adjoins a maintenance station where personnel are not resident in the immediate area. It would provide the great benefit of telemetered information on current conditions. Other nearby sections that require attention, such as frequent grades like "Woodchopper" around MP 310, do not lend themselves to RWIS sites and can be inferred from a Birch Lake observation by experienced personnel. This location would also be somewhat important for meteorological data to support forecasts and warnings.

The proposed site is 100 feet north of the station access road north edge of pavement in the NW corner of the school bus turnaround, and 33 feet east of the highway edge of pavement. This provides a good, open location and should not conflict with the school bus turnaround. Connection to power would probably be handier on the south side of the access roadway, but the site would be closer to trees than preferred. Power and transformer are available about 200 feet from of the proposed site, on the south side of the station access road. [Photo N13.1 is looking NB on the east side of the Richardson Highway, across the maintenance station access road; Photo N13.2 is a closer view of the site in the NW corner of the school bus turnaround; Photo N13.3 shows the meter on the power pole.]

One drawback is that this shop has not always been manned and now has only FAX for receiving data.

N14. Richardson Highway, Badger Interchange, MP 358±

Current construction project creates opportunity where, pavement sensors especially will be highly valuable and representative of much of the area. Siting suggestions have been provided directly to the project design engineers.

N15. University Avenue, Fairbanks, Chena River Bridge

Weather observations at the international airport, Fort Wainwright, Eielson AFB and various cooperative observers provide a reasonably good picture of the Fairbanks atmosphere, but this location will be invaluable for **pavement sensors**, both in the bridge deck and in approach roadways. Add pavement, and sub-surface sensor combination during FY 2004 construction project.

N17.Altenate to C18. George Parks Highway, vicinity of Broad Pass

a. Broad Pass, MP 201 [No photo.] This highly exposed area with extremes in weather conditions is one where the responsible crew is said to spend half of its time. Temperature and wind create -80°F chill factors that are dangerous for maintenance crews and any stranded travelers. Blowing and drifting snow are key parameters. Reliable weather observation for the area between Broad Pass and the East Fork (Chulitna River) AKDOT/PF maintenance station is highly desired. Pavement temperature observations in additional locations to the existing pavement/subsurface temperature probe (EST) adjoining the East Fork Maintenance Station at MP 185 would be desirable. Road conditions in April 2001 showed very interesting variations in ice bonded to the pavement in this area. Observations at Broad Pass would reverse the recurring situation of the highway crew responding to a call from AST after an accident, in this area that is virtually uninhabited during the winter, and allow for treatment of the roadway before accidents happen.

Broad Pass is a traditional NWS observation location. Re-establishing a weather observation at this location will extend the climatology of Broad Pass and supplement it with pavement sensors. It is proposed to place ESS on the west side of the highway directly on a line from the highway to the existing tower with the red light, and half way between the edge of pavement and an existing yellow wand marking (telephone cable?). A pavement and sub-surface sensor combination should be placed outside of the outside wheel track in the SB lane adjoining the ESS. Power is available, produced on site by an FAA generator; and telephone is available from an underground telephone cable pedestal.

N20. George Parks Highway, MP 329.3

[Photos N20 Mile 320, N20 Mile 321, N20 Mile 322, N20 Mile 323, N20 Mile 324, N20 Mile 331, portray the area.]

This is an area of recurring steep grades and big curves with signs of heavy sanding to combat iciness. It is 30(±) miles from the maintenance station; observations without driving to get a first hand look would be very useful. Observations, especially of snow depth, would supply needed calibration information for the NWS weather radar at Pedro Dome. [Photo N20 Mile 338 is looking west at the highway area of interest in the distance.] (Further evaluation is needed to make a recommendation.)

a. "Skinny Dick's", MP 327.8. [No Photo.] This is the only location in this area that has power year-round at Skinny Dick's Lodge, and cellular service is available. However, it is not the best location meteorologically, due to being in a valley and wind-sheltered.

b. "Swede's Place, MP 329.3. [Photo N20b. MP 329 To the east, Photo N20b. MP329 To the west.] This location is along a ridge, with grades and curves to the east and west, and a better location than N20a. There is a possibility of power supply. A location here that is not wind sheltered, and has the possibility of placing pavement sensors on both sides of a hill to get differing aspects will be ideal. However, power once generated on–site is apparently no longer being generated and is therefore not available. Communications support is also not available. [Photo N20b. MP 329 To the west, is looking west from the south side of the road, with a good site meteorologically and operationally in the foreground.]

c. "Dean's Cabin, MP 330. [No Photo.] This is a good location meteorologically and operationally, but power is not available and there is only a weak cellular signal. Lack of a flat area for locating the ESS would probably require a fill to be provided to place a site.

Southeast Region

S3. Juneau-Douglas Bridge deck and approach roadways, pavement temperature and condition and sub-surface sensors only. [No Photo.] Weather conditions are probably representatively observed for this location by the instruments at the Douglas Boat Harbor (Mayflower Island), Federal Building and the airport; however, this is a critical location for pavement temperature and chemical presence observations. Available lighting makes this a good location for adding a video camera to an existing pole. A computer/modem -housed by the City and Bureau of Juneau (CBJ) in their adjacent Maintenance facility could make this a relatively inexpensive site. Place pavement sensor in inbound lane of bridge deck; and another along with sub-surface sensor in SB lane of Egan Drive.

S5. Glacier Highway/Egan Drive, MP 3, adjacent to AKDOT HQ, pavement temperature and condition and sub-surface sensors only. [Photos S5(1) Eagan Exp NB, S5(2) Eagan Exp SB] Weather conditions are probably representatively observed for this location by the instruments at the Federal Building and the airport. A computer/modem housed by DOT in their adjacent HQ building could make this a relatively inexpensive site. Use of wireless pavement sensors transmitting from the lanes with tall retaining walls (approx. .5 mi. south), and installation of video camera using highway lighting to advantage, would expand information generated and provide opportunity to analyze differences in pavement temperature behavior. Place pavement sensor and sub-surface sensor in outside SB lane, and pavement sensor in inside (closest to HQ) NB lane. Place video camera in a place pointed SB toward lighted area along retaining wall section. [Photo S5(1) Eagan Exp NB is looking NB from above east side of highway at the "Channel Marina," across from the east end of Channel Drive. Photo S5(2) Eagan Exp SB is looking SB from above the east side of the highway at the end of the roadway above Eagan Drive.]

S6. Mendenhall Loop Road. Most locations are wind sheltered and have weather not significantly different than the Juneau NWS Forecast Office or airport observations, but there are significant differences and trouble prone roadway icing locations. Pavement temperature and condition observations would be very useful to operations.

b. Bottom of Goat Hill. [No photo] Place pavement temperature and condition sensor and sub-surface sensor outside of a wheel track in the SB lane adjoining an RPU placed near the end of the guardrail, just north of Joann Way. Place an additional pavement temperature/condition and sub-surface sensor in the NB lane at the top of the hill adjoining the end of the guardrail near Goat Hill Road, to gain a different aspect than at the bottom of the hill and coverage of an accident-prone location. Incorporating this installation into the Goat Hill Hazard Elimination Project on Mendenhall Loop may be a way to accomplish it.

S7. Veterans Memorial Highway (Glacier Highway) where conditions north of Juneau are frequently different than in the urbanized area.

a. Cohen Drive, approx. MP 21. [Photo S7a. Cohen Drive.] Site is marginal for wind observations, but other meteorological parameters may be representative. The advantage of this location is that it is considered representative of the highway conditions in the area north of Auke Bay that are important to decision-makers; namely, pavement condition, air temperature, precipitation type and rate, and a video image would be very useful. It is also near the highest highway elevation on the Veterans Memorial Highway. This site may seem redundant with the existing nearby observation on Lena Loop, however that observation consists of only a once per day reading of maximum and minimum air temperature. The ESS, including mast and pavement sensors, would be placed north of Cohen Drive, on the east side of the highway. Power and landline telephone are available. [Photo S7a. Cohen Drive is looking north on the east side of the road at the site just north of MP 21 marker in foreground of photo.]

d. Benjamin Island Overlook, MP 33.5. [Photos S7d.(1) Ben Is Overlook-scene; S7d.(2) Ben Is Overlook-site.] This would be an excellent location for early detection of weather approaching from the north, and offers one of the few open airflow locations for a good site, meteorologically. The particular suggested site is on the west side of the curve below the pavement grade, perhaps using a 40’ tower to get the wind sensors about 30’ above the roadway. Pavement sensors should be placed about 500’ both north and south of the ESS to get the differing aspects on each side of the curve. However, the location is near the northern limit of winter maintenance, has low traffic volume, and is not as valuable operationally as S7a, above. [Photo S7d.(1) Ben Is Overlook-scene is taken from east side of highway, looking south toward the site on the west side of road near bend at far end of picture; Photo S7d.(2) is taken from the west shoulder of the road looking south at the site.]

S9. Klondike Highway - Border

a. Border, MP 14.9. [Photos S9a(1) Klondike Bor SB; S9a(2) Klondike Bor-Site; S9a(3) Klondike Bor-Look SB; S9a(4) Klondike Bor from Can.] This location is the international border and terminus of AKDOT operations, and the approximate northern boundary of Klondike Highway avalanche zones dealt with by AKDOT. It lies about a half mile beyond the White Pass summit and about on the continental divide at elevation 3,290 feet. AKDOT maintains a generator at this location to operate warning lights during the winter. B.C. MOTH may install an RWIS site in the vicinity of Fraser in the future, but there are no plans for doing so in the near future. This high elevation location is within the most extreme conditions faced in AKDOT Klondike Highway operations, and would provide a very valuable continuous weather observation for the NWS from an area where there are none, and from which they get no verification feedback on forecasts issued. An additional attribute of a site at this elevation is that it approximates the elevation and conditions in the loading area at the tops of avalanche chutes. [Photo S9a(1) Klondike Bor SB is looking south toward the site, behind the small building and sign, from the west side of the highway north of the site. Photo S9a(2)… is looking directly at the site on the west side of the highway. Photo S9a(3)… is looking SB along Klondike Highway from the site. Photo S9a(4)… is looking SB along Klondike Highway from the west side of the road from the Canadian side, north of the site, with the site on the right (west) side of the “crest” of the picture.]

b. AKDOT Maintenance Station, MP 12. [Photos S9b(1), S9b(2) Klondike Border MP 12.] Adjacent to the Maintenance Station, at elevation about 2,540 feet, and at the bottom of a "runaway truck escape ramp" this location would provide observations at the location from which operations on the upper Klondike Highway are conducted. [Photo S9b(1) Klondike Border MP 12 is looking south at Klondike Highway from the top of the Upper Truck Escape Ramp (Elev. 2590'); S9b(2)… is looking north at the Maintenance Station site from the truck ramp.]

S10A. Haines Highway - Chilkat, MP 19-24, perhaps representative of the area between Haines airport observations and the border, but also at the confluence of Chilkat, Klehini, and Tsirku River drainages which contribute to local convergence effects and anomalous snowfall when cold air drains out of the interior.

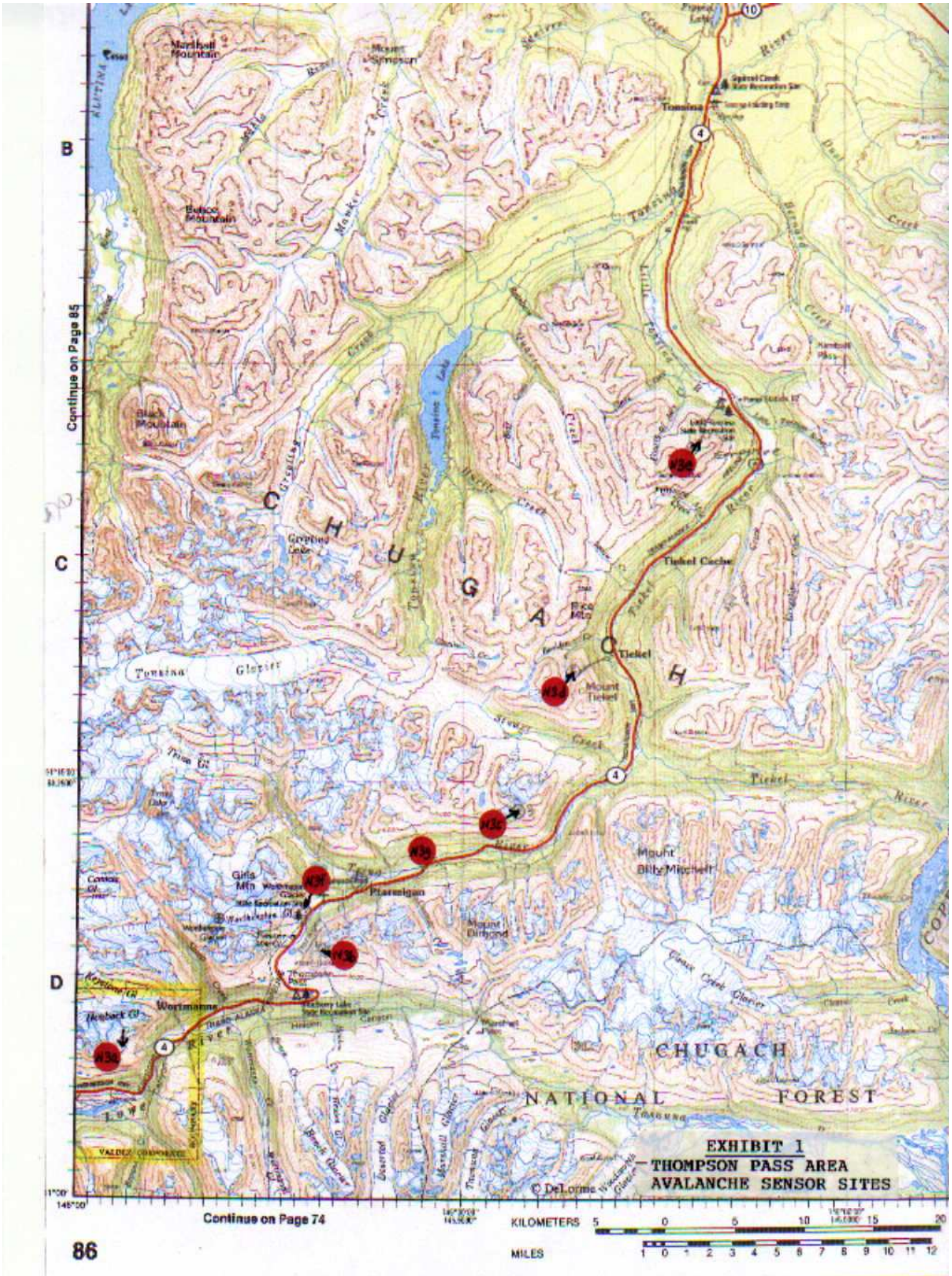
f. Chilkat River bridge, MP 23.8. [Photos S10f.1 Chilkat Bridge; S10f.2 Chilkat Power Supply; S10f.3 Chilkat Br Scene; S10f.4 Chilkat Br-aerial.] The southeast corner of the Chilkat River Bridge has more restricted air flow than would be preferred, but better than other sites in this desirable stretch for RWIS installation It does have the attribute of being able to monitor both a bridge deck and roadway at grade. Also, power and telephone appear to be highly available at this location. Place ESS in the clear space at southeast corner of bridge, and place pavement sensor in EB lane of bridge deck, and pavement sensor and sub-surface sensor in roadway, say 100' from ESS. [Photo S10f.1 Chilkat Bridge looks at site at SE corner of bridge (bridge runs east-west); Photo S10f.2 is the power supply box at the NE corner of the bridge, and as observed approximately every one mile along the Haines highway to this point; Photo S10f.3… is looking east from mid-span of the bridge at the site at top right, SE corner; and S10f.4… is an aerial view of the east end of Chilkat River Bridge and site on the right (south) side of the approach

S10B. **Haines Highway – Klehini, MP 34-40**, a new section of highway on a mostly changed alignment from the former location. The roadway is now hard against the current channel of the Klehini River, exposed to considerable fetch across the braided and open river valley. Weather and pavement observations would provide information to highway operations personnel for a section with which they have no experience, and would support accumulation of objective data on whether the prevailing north-south winds (channeled east-west in the Klehini Valley) will be advantageous or impacting to snow & ice control. The location would be useful to weather forecasters, but perhaps not as representative as a location further east impacted by all three river valleys. Power and communications are available in the original alignment, but would likely be about one mile away from the most favorable sites. The preferred site will likely be determined by ESS foundation considerations; the south side of the road would be preferred if practical.

a. MP 35. [Photos S10B.a.(1) MP 35 EB, S10B.a.(2) Site 1, S10B.a.(3) Site 2, S10B.a.(4) NB, S10B.a.(5) Site aerial.] The ESS could be placed on a nose of the roadbed jutting into the River on the south side of the road at about MP 35 or on the north side in an area apparently used for staging during the recent construction. A pavement sensor and sub-surface sensor would be placed outside the wheel track in the adjoining lane. [Photo S10B.a.(1)… is looking east from the south side of the road at site 1, on the left (north) side, and at site 2 on the right (south) side of road. S10B.a.(2)… is site 1 on north side of road. S10B.a.(3)… is site 2 on south side of the road. S10B.a(4) is a general scene looking NB at the new highway section next to the Klehini River from the proposed sites at MP 35. S10B.a.(5)… is an aerial view looking northward at the MP 35 sites.]

b. MP 36.5. [Photo S10B.b. MP 36.5 EB] An approach similar to MP 35, above, would be used at the westerly end of the new straight stretch of highway adjoining the Klehini River. Attributes are similar to those of MP 35. However, MP 35 is closer to the confluence of three rivers, thought to be meteorologically significant; MP 36.5 would be more representative of the area closer to the border. [Photo S10B.b. MP 36.5 EB is looking east from about MP 36.7 at the site jutting out from the south side of the road.]

(for extraordinary consideration)
S14. **Stephens Passage**, for example, Pt. Styleman at entrance to Port Snettisham, or Harbor Island at entrance to Tracy Arm, Pt. Hugh at south end of Glass Peninsula, or possibly to obtain power, at Snettisham. From a meteorological point of view, and the NWS's ability to provide accurate reports of current weather and more tailored forecasts with improved timing, the observation void in this area is the single biggest impediment in the present capabilities. Observations of all weather parameters, including air pressure, in this region would be the most important for improved weather support to transportation maintenance and operations. The drawbacks, of course, are no road operations in the immediate area and the difficulty of providing power and communications to such locations.



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Alaska Department of Transportation & Public Facilities:
Reliance on Partnerships to Deploy Technology

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Alaska Department of Transportation & Public Facilities: Reliance on Partnerships to Deploy Technology

Jack R. Stickel and Jill Sullivan

ABSTRACT:

The Alaska Department of Transportation & Public Facilities (ADOT&PF) relies on partnerships to support technology deployment. ADOT&PF uses many tools to form and sustain these partnerships. The partnership lifecycle begins with establishing early project support. Networking conferences help generate interest in upcoming projects. Project kickoff meetings help introduce programs and establish stakeholder involvement. Stakeholder support is maintained by hosting frequent teleconferences and meetings. ADOT&PF broadens partnerships by participating in pooled-fund studies, showcasing technology initiatives, and forming interagency working groups. Memorandum of Agreements and Understandings are used to finalize partnerships and clarify agency goals.

Partnerships play key roles in three high profile ADOT&PF technology programs: (1) the Road Weather Information System (RWIS), (2) the Alaska Travel Information System, and (3) the Geographic Information System (GIS). Both public and private RWIS partnerships for sharing weather data, power, and communications have been extremely helpful for successful RWIS deployment. ADOT&PF relies on partnerships both internal and external to the Department to make the Condition Acquisition and Reporting System/511 Travel Information System deployment successful. By partnering with an established consulting company with strong experience in developing GIS deployment strategies, ADOT&PF has been successful in strengthening existing GIS partnerships and creating new ones.

Although ADOT&PF has benefited greatly from partnerships to support technology deployment, there have been challenges along the way. ADOT&PF faced several key partnership issues, including meeting project milestones and working through agency responsibilities. Successful program deployment, however, has provided benefits that are well worth the partnership challenges.

INTRODUCTION

The Alaska Department of Transportation & Public Facilities (ADOT&PF) relies on partnerships to support technology deployment. Because of the state's size, unique geography, and weather, intrastate travel is often difficult and, therefore, travelers frequently rely on marine and air transportation. Alaska comprises over 650,000 square miles (about 20% of the U.S. total) and has a population of approximately 626,000 (about 0.2% of the U.S. total). Consequently, many travel corridors are in rural areas where there are large distances between communities with no communications or power to support facilities. Adverse weather conditions can have a more severe impact on travel than anywhere else in the U.S. Reliance on partnerships to share data and resources is one way ADOT&PF can improve strategies to handle the many transportation challenges in Alaska.

Establishing stakeholder support and maintaining that support throughout a project lifecycle is critical to successful technology deployment. Early stakeholder involvement in the partnership process can reduce later efforts to secure project support, help establish key contacts, define detailed goals, and outline project requirements. Teleconferences and meetings help generate project support, maintain enthusiasm throughout the deployment lifecycle, and ensure stakeholder involvement during the project design and implementation. Pooled-fund studies and professional associations can expand the networking base with partners who have similar concerns and issues. Memorandum of Agreement's (MOA) and Memorandum of Understandings (MOU) finalize the relationship and clarify agency goals. The Memorandum can be used as an outreach tool to show others how partnerships are formed and how both parties benefit.

This paper outlines the partnership lifecycle and reviews three ADOT&PF technology programs in which partnerships play key roles: Road Weather Information Systems (RWIS), Alaska Travel Information System (ATIS), and Geographic Information System (GIS). All three projects involved partnership support throughout the project lifecycle.

PARTNERSHIP LIFECYCLE

Establishing Early Support

TransTech Alaska 2001

In October 2001, ADOT&PF and other co-sponsors hosted the TransTech Alaska conference, also known as the Public Transportation and Intelligent Transportation Systems (ITS) conference. TransTech Alaska showcased potential ITS applications applicable to Alaska. ADOT&PF realized that support from outside the Department would be required to attain successful ITS program development. ADOT&PF planned TransTech Alaska to achieve this initiative. This three day event explored innovative practices for those involved with public transportation and ITS.

The TransTech Alaska conference had over 40 breakout sessions and 80 presenters in public transportation and ITS. Breakout sessions targeted a wide range audience in both private and public sectors to capture statewide ITS interests. Conference attendees included: managers, planners, operators, consultants, manufacturers, resellers, maintenance staff, local officials and agency policy makers, as well as non-profit agencies that provide services to seniors and people with disabilities. ADOT&PF

allocated ample time for networking opportunities during TransTech. Important relationships with key contacts began at this conference and have been an integral part of the successful deployment for the RWIS, GIS, and ATIS projects.

TechNet

TransTech Alaska 2001 fostered interest between agencies that saw the benefits of ITS. The first post-TransTech relationship was with the Federal Aviation Administration (FAA) in integrating remote sensing to improve Alaska aviation and surface transportation safety. This led to the TechNet conference - a technology networking conference. TechNet explored potential partnerships among agencies in the sharing of data, power, and communication at remote sensing sites in three technology areas:

- Alaska Traveler Information Systems (highway, aviation, marine)
- Traffic Monitoring (weigh in motion, traffic counts, real-time video imagery)
- Environmental Monitoring (avalanche, rainfall, bridge scour)

TechNet provided the foundation to develop technology partnerships. Over 20 different agencies presented on ways in which partnerships could help meet agency goals. The conference was a critical step in developing support and cooperation from all levels of government, academia and private agencies interested in technology deployment. TechNet relationships have proved essential to the successful deployment of the ADOT&PF's RWIS and ATIS programs.

Establishing Stakeholder Involvement

Project kickoff meetings are another way to generate interest and capture stakeholder support. Kickoff meetings introduce new programs and generate program support and enthusiasm. Kickoff meetings were held for each of the three projects described in this paper. A well-run kickoff meeting generates a continuous, dynamic partnership with stakeholders and can:

- determine who the stakeholders are (appropriate and missing stakeholders)
- document the project goals and scope in the stakeholder business environment
- establish the agency needs and areas of concern from the stakeholder perspective
- explore the potential cooperative relationships between stakeholders

Maintaining Support

Maintaining stakeholder support throughout the project lifecycle is critical for successful technology deployment. ADOT&PF maintains project support by hosting frequent teleconferences and meetings. It is very important to have open discussions among stakeholders to address the following project milestones:

- User Needs Analysis
- Concept of Operations
- User Requirements Analysis
- Implementation Plans and Project Design
- Site Configuration Management
- Validation and Verification

Stakeholder involvement in addressing these milestones helps to develop a common vision of how the system will work, reduce unwanted project outcomes and delays, and avoid costly reprogramming.

Maintaining support through steering committees also helps generate support. ADOT&PF developed the 511 Steering Committee to channel the short and long term Alaska Travel Information System direction. Most importantly, this steering committee, made up of ADOT&PF system users, helps maintain continuous support throughout the project.

Broadening the Partnerships

Pooled Fund Studies

Pooled fund studies help expand the networking base and offer member states the opportunity for collaborative research and information exchange during technology deployment. ADOT&PF is a member of two Federal Highways Administration (FHWA) sponsored pooled fund studies:

- AURORA - Road Weather Information Systems (RWIS)
- Condition Acquisition & Reporting System/511 (CARS/511)

AURORA is a consortium of public agencies in the United States, Canada and Europe that acts as a catalyst for RWIS research on equipment, standards, deployment approaches, data, and winter weather maintenance programs (http://www.aurora-program.org). AURORA develops a research agenda, solicits proposals to conduct research, and provides "champions" to oversee projects. The AURORA program partnership allows member states to share RWIS best practices and solutions for common data issues and in-the-field equipment problems.

AURORA also provides an extended partnership through other RWIS research efforts. These include:

- COMET - Cooperative Program for Operational Meteorology, Education and Training
- ENTERPRISE – pooled fund to develop, evaluate, and deploy ITS
- NCAR – National Center for Atmospheric Research
- NTCIP - NTCIP ESS (Environmental Sensor Station) Working Group
- SICOP - AASHTO Snow and Ice Cooperative Program
- TRB – Transportation Research Board National Cooperative Highway Research Program (NCHRP research projects)

- ITS Institutes (e.g., University of Minnesota Center for Transportation Studies ITS Institute. DGPS snowplow project developed from this ITS institute)

ADOT&PF joined the CARS/511 pooled fund project in December 2001. The Iowa Department of Transportation is the lead state in a consortium with 9 other states. CARS is an internet map based system used by agencies to enter highway situations such as road closures, driving conditions, maintenance, construction, and major accidents. Once entered into CARS, data is available to the public in two ways: the 5-1-1 Travel Information Number and the ADOT&PF hosted web site http://511.alaska.gov. The CARS/511 system provides a statewide travel information system that helps improve management decisions, incident response, and safety conscious trip planning.

Both the CARS/511 and AURORA pooled fund projects have opened doors to new ways of deploying the Alaska Travel Information System and the Road Weather Information Systems. Membership has helped ADOT&PF to:

- network with other states that have similar issues and concerns
- generate new ideas
- produce quicker problem solving solutions

Professional Associations

ADOT&PF participates in professional association meetings and events to showcase ITS initiatives and explore potential partnerships. One successful partnership that has produced substantial benefits has been with the Prince William Sound Science Center (PWSSC - http://www.pwssc.gen.ak.us/pwssc/pwssc.html). PWSSC is an independent, non-profit research and education organization located in Cordova Alaska. Founded in 1989 following the Exxon Valdez oil spill, the PWSSC focuses on the sustained monitoring and ecological understanding of the Prince William Sound (PWS), the Copper River, and the Gulf of Alaska. PWSSC also manages the Oil Spill Recovery Institute (http://www.pws-osri.org), whose mission is to develop techniques for dealing with oil spills in the Arctic marine environment and study the long-range effects of Arctic oil spills on the environment, economy, and lifestyles in the PWS area.

The Prince William Sound (PWS) is the terminus of Alaska Pipeline and the Richardson Highway, and is home to major recreational, commercial fishing, and transportation activities. The ADOT&PF Alaska Marine Highway System (AMHS) has several ports of call in PWS. Real-time meteorological information is available for only a few locations.

The ADOT&PF, PWSSC, and other agencies hosted the Prince William Sound Meteorological Workshop (PWS Met Workshop, December 2000) to develop a ten-year science plan for the PWS. The science plan objectives are to outline needs for real-time meteorological and oceanographic data, define the observation and forecasting system upgrades to meet these needs, and develop an action plan to meet these upgrades.

The PWS Ten-Year Plan provided significant partnership opportunities between agencies that normally do not conduct business and opened communication lines that were previously closed or not imagined (e.g., the Prince William Sound Regional Citizens Advisory Council - http://www.pwsrcac.org). During the PWS Met Workshop, considerable time was spent in understanding each agency's business needs and data requirements. The workshop was especially helpful in defining the data needs of non-research users. The workshop provided the opportunity to integrate a variety of user group interests, including: maritime and roadway transportation, weather forecasting, commercial fishing, oceanography, and research. The PWS Ten-Year Plan established the PWS Meteorological Network and has expanded the RWIS deployment opportunities.

Interagency Working Groups

Interagency working groups for specific projects and long-term goals are valuable tools for getting results. ADOT&PF's participation in working group has yielded highly effective partnerships.

One example of an interagency working group for a specific projects is where ADOT&PF entered into a cooperative agreement with the City of Whittier, the United States Coast Guard (USCG), and the National Weather Service (NWS) to provide a NOAA (National Oceanographic and Atmospheric Administration) weather radio system for travelers going to Whittier, Alaska. Whittier is accessed via the Anton Anderson Memorial Tunnel, a multi-use (train/highway) vehicle toll road connecting the Seward Highway and Whittier. The opening of this tunnel to highway traffic provided significantly greater access to Whittier and the Prince William Sound recreational activities. Weather information for the Prince William Sound area, particularly marine weather observations and forecasts, is a major factor in deciding whether or not to travel to Whittier. ADOT&PF and the USCG purchased the radio transmitter equipment, the City of Whittier provided the site and electrical power, and the NWS installed and will maintain the equipment. A transmitter on the Seward Highway will alert travelers to the PWS weather before entering the tunnel.

The RWIS Concept of Operations is an example of an interagency working group for a long-term goal. The Concept of Operations describes practical steps for establishing a partnership between the meteorological community and ADOT&PF that will advance their mutual interest in acquiring and using the best possible weather information (*1*). The Concept of Operations anticipates that ADOT&PF will be a catalyst for an interagency working group to develop weather information that improves decision-making effectiveness. The stakeholders who participated in the RWIS kickoff meeting and site selection process, TransTech 2001, and TechNet have provided an excellent long-term interagency forum to address RWIS data needs, deployment strategies, and data applications. ADOT&PF continued this relationship by hosting an inter-agency Weather Workshop in November 2003. This workshop was designed to further expand this cooperation and generate ideas to improve data archiving and dissemination, forecasting, and meso-scale networks.

ITS PROGRAM DEPLOYMENT

ADOT&PF engaged stakeholders in three Intelligent Transportation Systems:

- Road Weather Information Systems
- Alaska Traveler Information Systems
- Geographic Information Systems

Road Weather Information Systems
The Alaska Road Weather Information System includes atmospheric, surface, and sub-surface sensors; temperature data probe thermistors; other agency provided supplemental sensors; and camera imagery. Weather data for travelers and forecasters is extremely limited in Alaska. Most RWIS sites are being located along remote stretches of highway where communications and power are unavailable.

Sharing of weather data, power, and communication is a priority for many of the weather-related agencies. Both public and private partnerships for sharing power and/or communications near the prospective RWIS locations have been extremely beneficial. The TechNet Conference provided a forum to demonstrate the value of a partnership with ADOT&PF for sharing deployment costs and remote sensor data. Key partnerships include:

- National Weather Service
- Federal Aviation Administration
- Educational institutions
- Military bases
- Alaska Snow, Water, and Climate Services
- Oil Spill Recovery Institute
- State and local government
- Private industry and technology companies

National Weather Service (NWS)

ADOT&PF engaged the NWS early in the RWIS user needs analysis for:

- Alternative sources of data
- Specific data needs to improve local forecasts
- Prioritized sensor locations

The NWS Alaska Pacific River Forecast Center is providing tipping bucket precipitation gauges at specific RWIS sites to add to their rainfall network. ADOT&PF will provide the power and communication. NWS also provided on-site recommendations for tipping bucket placement at each RWIS site. One potential opportunity to reduce system cost was to have the NWS technicians maintain the RWIS sites. However, the NWS funding would not support this partnership. Both parties agreed to sign a Memorandum of Agreement (MOA) to formalize the partnership. ADOT&PF designed a simple and flexible MOA that both parties could promptly read and clearly understand (*2*).

Federal Aviation Administration (FAA)

The FAA operates a statewide weather camera network to support Alaska aviation (http://akweathercams.faa.gov/wxcams/map.php). Many of the RWIS sites are in mountain passes used by aviation as well as highway travelers. ADOT&PF and the FAA explored opportunities to integrate the agencies' future camera site deployment. Selected RWIS sites will have pan-tilt-zoom (PTZ), low light cameras capable of 16 different views. ADOT&PF will include aviation views in addition to roadway surface images. RWIS system administrators will be able to select 8 images for polling via a web interface. Excellent coverage for both aviation and ground transportation will be available on the Internet. The FAA will participate in RWIS site commissioning for camera view selection.

FAA will provide power at a co-located RWIS/FAA communication site on the Parks Highway at no charge to the ADOT&PF. The FAA initiated a MOA that included clauses for protection against subsequent damage or costs incurred from the RWIS site (3). This MOA was much more detailed than the ADOT&PF's normal MOA format. The only minor setback in this partnership is that ADOT&PF had a difficult time finding the correct FAA contact person to create the MOA and initiate the site configuration. The contacts made at TechNet were not the same contacts signing the agreement. They did, however, help lead us to the right contact eventually. The MOA completion took several weeks; more time than expected.

Educational Institutions

Educational institutions offer substantial opportunities for data collection networks, communications, weather forecast improvement, data archive, and research. The University of Alaska operates super computers and has several environmental data networks. Local schools often have Internet access that may allow RWIS observations to be transmitted to the RWIS central server. The TechNet Conference provided a forum for developing these partnerships.

The University of Alaska Fairbanks Geophysical Institute (UAF-GI) collects weather data to support UAF-GI's Water and Environmental Research Center (WERC, http://www.uaf.edu/water) and the International Arctic Research Center (http://www.iarc.uaf.edu/). UAF proposed adding additional meteorological sensors and data loggers to RWIS and weigh-in-motion sites. The sensors will be integrated into the RWIS Remote Processing Unit (RPU) polling if possible. ADOT&PF and the UAF established a MOA to add sensors to the temperature data probe (TDP) and RWIS sites (4).

One item critical to this partnership was the agreement on the maintenance & operations of the UAF equipment. UAF decided it was easier to donate the equipment to the ADOT&PF where the Department would own, maintain, and operate the equipment. The MOA included this key line, "ADOT&PF agrees to strive to maintain and repair the RWIS (UAF) instrumentation and data loggers, subject to budgetary limitations that might arise in the future." The additional data will support the UAF-GI forecast requirements and the ADOT&PF winter weather maintenance decision-making. This agreement will work well because both parties receive additional environmental data, the UAF is relieved of its' maintenance responsibilities, and ADOT&PF is relieved from the pressure of having to meet maintenance costs when the budget is short. ADOT&PF will provide the observations on the RWIS and CARS/511 traveler information system web sites (http://www.dot.state.ak.us/iways/roadweather/rwisindex.html and http://511.alaska.gov).

High-speed internet access is one of the better ways to transfer environmental data to the RWIS central server. These opportunities are extremely limited in Alaska. The Alaska Gateway School District, however, near Dot Lake on the Richardson Highway does have a communications system with a high-speed internet connection. The District is allowing ADOT&PF access to their communications system (*5*). ADOT&PF will pay the District for any costs incurred, while ADOT&PF will avoid the much higher long distance telephone charges that they would otherwise incur.

Military Bases

Elmendorf Air Force Base (AFB), similar to the NWS, is interested in the RWIS data for operational weather forecasting. Elmendorf AFB wanted free and open access to data, which ADOT&PF accepted. The Memorandum of Understanding (MOU) between Elmendorf AFBand ADOT&PF is a simple, non-binding understanding that allows Elmendorf AFB to have free access to the RWIS data through a File Transfer Protocol (FTP) web page (*6*). The only minor setback was that Elmendorf AFB had a change of staff and the MOU was not reviewed in a timely manner. The MOU completion took approximately 1 year. The program will be expanded to other military forecast units as the RWIS sites are deployed statewide.

Alaska Snow, Water, and Climate Services

The Alaska Snow, Water, and Climate Services (AMBCS), operated by the U.S. Department of Agriculture's Natural Resources Conservation Service (NCRS), provides snow and precipitation telemetry from SNOTEL sites. ADOT&PF partnered with NCRS on installing an additional SNOTEL site in the Thompson Pass area of the Richardson Highway, an area prone to avalanches (7). NCRS provided the sensors and will maintain the telemetry communications. ADOT&PF provided the radio and will use the data for avalanche control. NCRS will include the SNOTEL data in their web site (http://www.ambcs.org/).

State and Local Government

Small contributions to a data collection program can sometimes yield significant benefits. Two ADOT&PF partnerships demonstrate how cooperative efforts between agencies can impact data collection programs. First, the City and Borough of Juneau (CBJ) agreed to provide power to a Juneau RWIS site (8). In return, CBJ will have access to the RWIS and temperature data probe (TDP) data for their utility monitoring. Second, ADOT&PF provided Fish and Game access to a RWIS tower on the Chilkat River to mount radio antenna (9). Fish and Game will have means to radio fish data quickly from the field. Although ADOT&PF will not gain anything immediately, the goodwill may offer future opportunities.

Private Industry and Technology Companies

Partnerships with the private industry to share power and/or communications can sometimes be the only way to deploy technology. The Alaska TransTech and TechNet conferences helped identify Alaska companies that have experience with remote power and communications. The conferences also provided opportunities to look at many enhancements to the RWIS program. For example, there is potential to use a propane power module for sites where there are no other power options.

Establishing a relationship with an Alaska technology company with experience in communications has been very beneficial. GW Scientific developed the University of Alaska Fairbanks meteorological network and has substantial knowledge of existing local scientific communications networks that potentially could be leveraged. A sister company, Engineering and Environmental Internet Solutions (EEInternet), established the communication links and commissioned sites for the ADOT&PF RWIS Phase 2 sites (*10*). These partnerships also open opportunities to existing cooperative efforts involving local, state, and federal agencies.

The Mentasta Pass Lodge, on the remote Tok Cut-Off Highway, was open to the idea of sharing power from their generator to an RWIS site. ADOT&PF explained the benefits of having an RWIS nearby and how it can affect road maintenance and operations in the area. ADOT&PF and Mentasta Lodge signed an MOA that includes clauses to protect the lodge from any loss, damage or costs incurred as a result of the RWIS (*12*). At the same time, the MOA includes language requesting that the lodge provide "access to the lodge's power distribution panel necessary to connect power to the RWIS site" and that the lodge "will be responsible for maintenance and operations of the power plant on the generator side of the State's disconnect switch." This helps keep the confidence and trust levels between both parties.

ADOT&PF did have some difficulty in determining how the power will be measured and how much to pay the Lodge for sharing the power. ADOT&PF decided to average the yearly power surges, based on RWIS readings from other sites, and pay for the first year of services upfront. ADOT&PF also installed a meter to track the power wattage on a monthly basis. After tracking power usage for the first year, ADOT&PF will revisit the amount owed to the Lodge and compensate for overuse. ADOT&PF will also acknowledge the private industry contribution on the RWIS web site.

Travel Information System

The CARS/511 Alaska Travel Information System relies on partnerships, both internal and external to the Department, to make it a successful one-stop shop of travel information. Key partners include:

- ADOT&PF
- National Weather Service
- Municipality of Anchorage
- Alaska State Troopers
- U.S. Customs and Border Protection

ADOT&PF

The following internal ADOT&PF work centers have an interest in CARS/511:

- Alaska Marine Highway System
- Measurement Standards & Commercial Vehicle Enforcement
- Maintenance & Operations
- Construction
- Right of Way
- Design & Engineering

Although ADOT&PF held numerous kickoff meetings, stakeholder buy-in was not timely. ADOT&PF contacted each of the work centers and asked for their participation. In general, feedback was very positive. However, some work centers were doing their own travel information program such as a separate web page for construction or 800 numbers for users to call for road conditions. Additional overview meetings about the benefits of CARS/511 helped develop buy-in from each work center. Early involvement through the kickoff meeting helped set the stage and generate support even if it was a slow process in gaining full support. In December 2003, a 511 Steering Committee was formed with several of the work centers to help channel the future direction of the Alaska Travel Information System. The committee helps sustain continuous buy-in and support from the work centers.

National Weather Service

The NWS was one of the first partners in the CARS/511 program. ADOT&PF had already established prior contacts and partnerships with NWS; they were immediately open to sharing weather forecasts for the Alaska 511 web page. The NWS attended a training course on the Department's CARS/511 program and data sharing capabilities. CARS/511 now links with the NWS weather forecasts, watches, and warnings.

Municipality of Anchorage

ADOT&PF included the Municipality of Anchorage in the ITS deployment through the Federal Highway Administration's ITS Earmark funding, which provided the Municipality's regional metropolitan ITS architecture and other ITS programs. This early engagement with ITS Earmarks has led to a long term, reliable joint venture with the Municipality.

The Municipality of Anchorage was a major partner during the CARS/511 design phase. CARS/511 requires tremendous coordination among various agencies to enter transportation-related information. Anchorage's CARS/511 participation is critical since Anchorage is the largest Metropolitan Planning Organization in the state, with over 41% of the State's population.

In April 2003, ADOT&PF and the Municipality signed a Memorandum of Understanding to formalize the CARS/511 partnership (12). The Municipality was given direct access to the CARS/511 contractor to develop the Anchorage roads and features component of

CARS/511. This gave the Municipality control over what and how the information gets entered and thereby gave them part ownership in the program. ADOT&PF will coordinate efforts in entering the urban and rural state owned roads. A considerable length of time was involved in getting the formal partnership agreement signed and establishing a Transfer of Responsibilities Agreement (TORA). This delay was mostly due to change in management and the extensive review process within the MOA organization.

Both ADOT&PF and the Municipality of Anchorage benefit by sharing transportation information. More importantly, the public will have access to more travel information. The Municipality's Mayor Wuersh noted "Here's a great example of working together so there are no redundancies. Citizens get better service at less cost where there is cooperation between state and local government."

Alaska State Troopers

The Alaska State Troopers participated in an overview and training course on CARS/511 during the development phase. The overview emphasized that CARS/511 can reduce the amount of 911 non-emergency calls to dispatch and can help advertise where major accidents and urgent reports are occurring to help alleviate traffic problems. A partial partnership has been formed between the Alaska State Troopers and ADOT&PF, but not finalized. Dispatch has agreed to enter situations, but does not have any protocols in place to actually enter them. They have limited staff and other priorities. ADOT&PF is continuing to work with them to come up with a solution.

U.S. Customs and Border Protection

ADOT&PF has invited the U. S. Customs and Border Protection on the Alaska and Canada borders to participate in adding road condition information to the CARS/511 system. The U.S. Customs and Border Protection operate anywhere from 12-24 hours per day, depending on the season. Since their stations are located on remote stretches of Alaska's highways, their road condition information is beneficial to the traveling public. No formal partnerships have been signed, but ADOT&PF anticipates having a MOU or MOA between the two parties in the near future.

Alaska Marine Highways

ADOT&PF's Alaska Marine Highways (AMHS) has been included in the CARS/511 system design since the project kickoff and is a strong supporter of the CARS/511 program. AMHS initial inclusions in the design phase and involvement have kept the AMHS interest and support throughout the project. The AMHS agreed to offer real time ferry arrival and departure information to the CARS/511 system. This is a noteworthy addition to the CARS/511 system, with the public having the biggest benefit of knowing exactly when a ferry will arrive or depart.

Geographic Information System

ADOT&PF is establishing an interface to integrate modern Geographic Information System technology with the Department's legacy mainframe transportation database, the Highway Analysis System. This GIS interface will also improve interoperability with external systems and databases. The targeted upgrades, which can be implemented in three to five years, will:

- unify the processing, management, maintenance, and output of transportation data with road centerline network data in an integrated system.
- improve data access, display, analysis, and output.
- establish the interface as a foundation for a linear reference-based GIS within the Department.

Developing GIS partnerships early in the project life cycle was key to identifying the appropriate stakeholders and capturing their interest and momentum. ADOT&PF held a GIS Forum as part of the TransTech Alaska conference to begin this process. Leading authorities in GIS strategic planning covered key issues that should be addressed as part of the Department's long-range GIS strategy. The forum provided the opportunity for data managers, end users, local governments, and GIS technology vendors to share dialogue.

Once the stakeholders are identified, getting them to the table can sometimes be challenging. Even with well-advertised kickoff meetings, there are some reluctant attendees and others that should attend but do not. There are two strategic ways to overcome reluctant partners. First, understand their business processes. The user needs and user requirements analyses can help define the business rules that apply in each area. Second, develop anticipated project benefits to meet these business needs. Projecting user benefits can open up dialogue and encourage more information exchange during the user needs interviews. ADOT&PF developed GIS demonstrations using existing data collection and "out of the box" software to help the users envision potential benefits.

Partnering with an established company with strong experience in developing GIS deployment strategies was extremely beneficial in strengthening our partnerships. ADOT&PF contracted with Cambridge Systematics, Inc, whose team has experience developing GIS applications for state DOTs for:

- Kickoff meetings
- Comprehensive user interviews
- User needs and requirements analyses
- Upgrade alternatives and implementation strategies
- Implementation plan

Thorough user needs and user requirements analyses helped significantly in establishing partnerships early in the GIS development process. The consultant developed use case diagrams for business activities to show the business flow process and to help all stakeholders understand business practices and how they would benefit from the GIS development. The HAS-GIS Interface Implementation Plan Final Report outlines the implementation strategy for incremental implementation to funding, staffing, and management goals (*13*).

CONCLUSIONS

Due to the vast, remote nature of Alaska, ADOT&PF relies heavily on partnerships to help deploy technology programs throughout the state. Through trial and error, ADOT&PF have found the following tools to be most fruitful:

- Networking conferences to introduce upcoming programs and generate interest
- Kick-off meetings to introduce new programs and generate support and enthusiasm
- Project updates to keep agencies informed of progress
- Steering Committees to maintain support
- Benefit visualization to help demonstrate project vision and milestone successes
- Pooled-funds and participation in professional associations to broaden partnerships
- Simple and flexible Memorandum of Agreements/Understandings to finalize the partnerships and clarify the goals of the participating agency
- Interagency working groups to establish long-term stakeholder buy-in

Although ADOT&PF has benefited greatly from partnerships to support technology deployment, there have been challenges along the way, including:

- Identifying the right agency contact to develop partnerships
- Securing funding for technology operations and maintenance
- Defining each agency's partnership responsibilities
- Establishing stakeholder participation and commitment
- Establishing equitable cost for private industry contributions
- Creating trust in new systems and data
- Removing concerns on agency liability for communications and maintenance

Successful program development, however, has provided benefits that are well worth the partnership challenges.

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[11] Memorandum of Agreement Between Mentasta Lodge and The Alaska Department of Transportation and Public Facilities, October 2003.

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[13] Cambridge Systematics, Inc, *"HAS-GIS Implementation Plan Final Report"*, Alaska Department of Transportation and Public Facilities, December 2003

NTCIP-ESS Implementation

ADOT&PF is presently compliant for NTCIP ESS, having been tested by an independent testing agency funded by the Virginia DOT and FHWA.

ADOT&PF's NTCIP ESS implementation is compliant with the standards specified below. ADOT&PF's compliance has been tested by an independent testing agency funded by the Virginia DOT. Surface Systems, Inc. (ADOT&PF RWIS Contractor) was also an active participant in the standards testing conducted by Battelle Corporation and the Minnesota DOT. In addition, SSI recently contracted with Trevilon Corp. to perform an independent conformance test of the SSI NTCIP ESS implementation. The Trevilon test results are available upon request.

- *NTCIP Document 1204 NTCIP Object Definitions for Environment Sensor Stations (ESS) Version 98.01.12, Status: Approved by 3 SDOs and amended*
- *NTCIP Document 1201 NTCIP Global Object Definitions, Status: Approved by 3 SDOs and amended*
- *NTCIP Document 1101 NTCIP Simple Transportation Management Framework (STMF) Level 1. Status: Approved by 3 SDOs and amended.*
- *NTCIP Document 2202 NTCIP TP-Internet (TCP/IP and UDP/IP), Status: Recommended Standard.*
- *NTCIP Document 2103 NTCIP Point to Point Protocol (PPP), Status: Recommended Standard.*
- *NTCIP Document 2104 NTCIP Ethernet, Status: Recommended Standard.*

SSI is also currently compliant with the following NTCIP Standards of Compliance:

- NTCIP 1201: 1997
  SSI complies with all mandatory conformance groups and several optional conformance groups.
- NTCIP 1204: 1998
  SSI complies with all mandatory conformance groups and several optional conformance groups.
- NTCIP 1101: 1997
  SSI complies with STMF Level 1

SSI is compliant with the following NTCIP Application Levels, for Required NTCIP Functions:

- Application Level: SSI complies with STMF Level 1
- Transport Level:
    - SSI complies with NTCIP Document 2201 TP-Null when the subnet level profile is PMPP.
    - SSI complies with NTCIP Document 2202 NTCIP TP-Internet (UDP/IP) transport profile when the subnet level profile is PPP, SLIP, or Ethernet.

- Subnet Level
- SSI complies with the NTCIP Document 2103 NTCIP, Point to Point Protocol except PPP authentication. It supports data rates of 1200, 2400, 4800, 9600, 19200, 38400, 57600, and 115200 bits per second.
- SSI complies with the NTCIP Document 2101 SP-PMPP/RS232 standard. It supports data rates of 1200, 2400, 4800, 9600, and 19200 bits per second.
- SSI complies with the NTCIP Document 2104, NTCIP Ethernet.
- SSI supports SLIP for RS-232 router interface connections.

- *NTCIP Document 2202 NTCIP TP-Internet (TCP/IP and UDP/IP), Status: Recommended Standard.*
- *NTCIP Document 2103 NTCIP Point-to-Point Protocol, Status: Recommended Standard.*
- *NTCIP Document 2104 NTCIP Ethernet, Status: Recommended Standard.*
  Information Level
- The NTCIP-ESS RPU supports all mandatory objects of all mandatory conformance groups as defined in 1201 and 1204

Optional NTCIP Function Supported:

- Global Configuration Conformance Group
- Global Time Management Conformance Group
- Global PMPP (when PMPP is the sub network profile)
- ESS Configuration
- ESS Location
- Pressure
- Wind Data
- Basic and Enhanced Temperature Data – SSI currently supports 1 Air Temp sensor
- Basic Precipitation Data
- Standard Precipitation Data
- Enhanced Precipitation Data
- Solar Radiation
- Visibility Data – SSI does not presently support the full range of the visibility situation object.
- Standard and Enhanced Pavement Sensor Data
- The NTCIP-ESS RPU supports up to 16 surface sensors (8 wired and 8 wireless)
- Standard and Enhanced Sub-Surface Sensor Data
- The NTCIP-ESS RPU supports up to 16 sub surface sensors (8 wired and 8 wireless)
- MIB files - SSI will supply the following MIB files:
- Standard Device MIB files and Manufacturer specific MIB files as necessary.