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**SOME OVERARCHING COMMENTS**

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- The catalog over-emphasizes sea level rise and underemphasizes thawing permafrost.
- There is redundancy throughout the catalog. I bet we can get this down to 15-20 options with a little bit of work.
- We should think about how nature-based adaptation strategies, like protecting coastal wetlands, might actually be more cost-effective than building more hard infrastructure like sea walls, etc.

	<b>Public Infrastructure Technical Working Group</b>	<b>Immediate Action Working Group</b>
<b>focus</b>	ALL of Alaska	6 imperiled coastal communities
<b>timeline</b>	short, medium, long term (our group can define this, a suggestion is 1-2 years, 3-24 years, greater than 25 years)	12-18 months

**Public versus private infrastructure**

- Barbara: PI TWG is addressing *public* infrastructure. The Economic Activities-Adaptation TWG is addressing private infrastructure.
- Response: There may be more ambiguity here than is evident. The line between public and private infrastructure can be ‘fuzzy.’ Private infrastructure is often regulated and even financed by government. Also, private infrastructure still relies on government for protection against natural disasters, security of supply chains and civil order. Decisions on private infrastructure – building, renovating, expanding – often rely on government policies on taxation, support mechanisms. Also, decisions on public infrastructure rely on predictions of the potential actions by private sectors corporations, service providers, and on economic issues.

I think we need to discuss alignment between the public and private infrastructure groups rather than separation.

Relocating facilities is certainly an option but design and construction of facilities is underway today and will continue into the future. Business as usual in engineering design is not a good approach. Failure to recognize and incorporate changes in environmental parameters such as wind loading, snow loading, precipitation, permafrost temperature, etc. into designs can result in the failure of new infrastructure. Engineering should not be a secondary consideration.

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The following changes are suggested to the planning assumptions for climate change impacts to public infrastructure that I sent you on Sept 29)

Public\_Infrastructure\_Climate\_Change\_Assumptions.doc

In an effort to ensure use of sound science, data from the Arctic Climate Impact Assessment, and other sources were compiled by the National Commission on Energy Policy, at the beginning of the climate change strategy process to define, in 'layman' terms, the impacts from climate change. They developed four clusters of impacts (sectors), one of which focused on public infrastructure.

**RURAL DUMPS AND MUNICIPAL LANDFILL IMPACTS**

Current Impacts – Flooding and erosion from storm surges can inundate landfills, which can wash away their contents and contaminate water and land.

Future Impacts – More contamination as flooding and erosion from storm surges become more frequent. **WATER AND SEWER SYSTEM IMPACTS** Current Impacts – Minimal from thawing permafrost if the foundations of water treatment buildings and water storage tanks are insulated and/or refrigerated using thermopiles or thermal siphons. However, erosion can cause permafrost to thaw and damage these existing structures as well as aboveground and buried water and sewer mains that are along the shorelines in coastal communities. Also, flooding and erosion from storm surges can damage to sewer lagoon by causing berm breaches to discharge untreated sewage. Flooding can cause impact surface water supplies for drinking water and contaminate ground water wells.

Future Impacts – Higher risk of damage to these systems from thawing permafrost, flooding and erosion unless mitigating and preventive measures are taken.

Other?

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Deleted: <#>Landfill damage from erosion and thawing permafrost: Current impacts – there have been landfill problems, failures, and losses associated with shoreline erosion and river erosion (e.g., Newtok). Future projections – greater landfill problems and failures, especially with sea level rise and more intense storms (e.g., U.S. Air Force Long Range Radar Site near Kaktovik at risk); also landfill problems due to thawing permafrost and warmer temperatures. ¶

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WATER SYSTEMS¶  
<#>Above-ground water systems: Current impacts – thawing permafrost, eroding shorelines, and drying of lakes leading to diminished community water sources (e.g., in NE Alaska, of 23 lakes studied, 21 decreased in size); water quality compromised from storm surges, etc. Future projections – increased above-ground water system problems and failures; potential decrease in available non-community based water sources as more lakes, ponds and streams dry and shrink. ¶

<#>Subsurface water systems: Current impacts – low interior snowfall causes deep frost levels that freeze well-based water systems. Future projections – loss and reduction of permafrost to have major impact on subsurface hydrology; loss of some confined aquifers and domestic artesian water wells; inc... [1]

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OPTION NO. ADAPTATION POLICY OPTION	NOTES/COMMENTS
<p><b>Principles to guide state policy development and adoption: a disciplined, comprehensive, purposeful, strategic, and efficient approach.</b></p>	<p>There is redundancy throughout this document. I am biased, but there are too few references to the ISER infrastructure-climate change study that took over two years to complete. Also, there is way too much emphasis on sea-level rise and not enough emphasis on other issues like permafrost thaw and coastal erosion. This catalog could easily be boiled down into about 15-20 options, because there is significant redundancy. This catalog should emphasize planning options and not get into engineering technicalities. Finally, there are plenty of examples where promoting nature-based adaptation strategies (e.g., conserving coastal wetlands) is more cost effective than simply adding more coastal protection in some of these challenging building environments.</p>
<p><b>PUBLIC INFRASTRUCTURE</b> - <i>This sector addresses the physical impacts of climate change on Alaska’s built environment and transportation options.</i></p>	
<p><b>PI-1 Highways, Roads, and Bridges</b></p>	
<p>1.1 Ensure Climate Change is considered as part of upcoming review of ‘Alaska’s State Transportation Plan’</p>	
<p>1.2 Review Department of Transportation’s Future Corridors Initiatives to insure it appropriately addresses climate change</p>	
<p>1.3 Require/Enable Metropolitan Planning Organizations to take climate into account</p>	<p>Anchorage MATS  <a href="http://www.muni.org/transplan/amats.cfm">http://www.muni.org/transplan/amats.cfm</a>                      Fairbanks Metropolitan Area Transportation System (FMATS)  <a href="http://www.dot.state.ak.us/nreg/planning/fmats/index.shtml">http://www.dot.state.ak.us/nreg/planning/fmats/index.shtml</a></p>
<p>1.4 Integrate Transportation and Land Use Planning</p>	
<p>1.5 Explore options for Community Planning Efforts, to address program for SLR (sea level rise) &amp; other climate impacts</p>	
<p>1.6 Establish Climate Change and Public Infrastructure Task Force (focused on adaptation)</p>	
<p>1.7 Review public education funding criteria to address adapting behavior in light of climate risk</p>	
<p>1.8 Re-evaluate evacuation Routes and modify as necessary</p>	
<p>1.9 Evaluate and address damage to highways, roads, and bridges</p>	<p>Building on permafrost in the first place</p>

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from thawing permafrost	changes the temperature profile of the permafrost. This effect needs to be netted out from the temperature effects related to greenhouse gas-induced climate change.
1.10 Evaluate and address damage to highways, roads, and bridges from temperature changes	
1.11 Evaluate and address damage to and loss of roads from coastal and river erosion	
1.12 Evaluate and address buckling and submersion of boardwalks in village communities	
1.13 Evaluate and address damage to highways, roads, and bridges, from glacier melting, flooding, avalanches, and debris flows.	
1.14 Evaluate and develop a management plan for vegetative growth along infrastructure (highways, pipelines, etc.) where vegetation has not previously been (North Slope)	
1.15 Evaluate infrastructure design standards/codes associated with retrofitting activities for existing infrastructure to address lower probability events and to recognize SLR and potential increased severity of storms and storm surges	e.g. some cities are protecting to the 500 year event rather than the 100 year event because of the increased vulnerability. Instead of using these benchmark, incorporate projected sea level rise in the design storm event
1.16 Minimize the installation of paved surfaces as a strategy for flood runoff control	
1.17 Add additional planning scrutiny to future infrastructure investments in undeveloped hazard-affected coastal areas	Redundant
1.18 Strengthen design codes for bridges, roads, and highways, to account for climate impacts	Redundant
1.19 Implement strict maintenance regulations for existing infrastructure in acute sea level rise hazard zones	Redundant
1.20 Develop an inventory of potentially impacted infrastructure and maintain this database relative to emerging projected sea level rise findings	This is an essential first step in scoping relevance/viability of potential adaptation options. ISER-UAA has a public infrastructure database that was created to assess climate risk. See Larsen et al (2008) and Foster and Goldsmith (2008) for more info.
1.21 Evaluate the need for redeveloping structures to raise first floor elevations some distance above base flood elevation considerations	Such action would need to be based on compliance with climate change-proofed comprehensive standards/codes; base flood elevation refers to the 100-yr flood incorporating sea level rise considerations
1.22 Evaluate the vulnerability of existing and future unprotected reaches of shoreline with respect to existing infrastructure. Determine need for and type of shoreline protection appropriate	Determine need for and type of shoreline protection appropriate to these reaches

OPTION NO. ADAPTATION POLICY OPTION	NOTES/COMMENTS
to these reaches.	
1.23 Develop and evaluate a public repurchase program for vulnerable lands and public/private infrastructure	This option would also seek to assess relevance to private sector infrastructure
1.24 Plant trees and other vegetation to reduce flooding and erosion	
1.25 Require that counties act on comprehensive planning requirements	
1.26 Integrate critical area planning requirements with comprehensive planning laws, including emergency planning, emergency evacuation routes, and infrastructure planning requirements	
1.27 Develop and emergency evacuation plan – (evaluate infrastructure for emergency preparedness)	
1.28 Develop a strategy to regularly update floodplain maps	<p>1.28 should be strengthened and enhanced.</p> <p>Detailed elevation mapping is required along with detailed surveys of transportation routes and critical infrastructure (eg 3.1) in coastal areas in order to define evacuation routes and facilities at risk under flooding scenarios of various intensities.</p> <p>Emergency managers must know at what point during a storm event the road to the airport will flood, for example, and thus be cut off.</p> <p>Parcel to this is equally detailed mapping of the offshore environment. Computer models used to predict flooding and wave activity during storms depend on detailed measure of water depths and the form of the underwater environment. This exerts strong control on the flood/wave response during a storm. For many areas of the AK coast our knowledge comes from maps created, in many areas, in the 1960s or earlier. Without detailed offshore maps even the best storm surge model will only ever give results of moderate accuracy. <b>I think a call for a push to improve offshore</b></p>

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	mapping must be stated in the recommendations. This underpins many of the recommendations listed in the Catalog of Options, including all related to event-level emergency planning (eg 4.6).
1.29 Establish a coordinating mechanism to assure that local governments act in concert with the state to reduce future impacts from SLR and associated hazards	
1.30 Synchronize future design with emergency planning and evacuation infrastructure requirements	
1.31 Investigate opportunities and innovations with potential to benefit the economy, public services, and business sectors	
1.32 Create inventory of infrastructure vulnerable to future SLR and associated hazards	Sea-level rise is not an immediate concern. Coastal erosion, flooding, wildfires, and thawing of permafrost are of bigger immediate concern to infrastructure planners.
1.33 Create on-line mapping capability for multiple audiences including local governments	SNAP program at UAF is working on this.
1.34 Create visualization tool for SLR and associated hazards	Redundant
1.35 Establish structures training and vocational support for trades and others involved in implementation of new design standards	
1.36 Integrate climate change and adaptation issues into advanced training in university, community college, and technical training programs	
<b>PI-2 Airports, Landing Strips, and Air Transportation</b>	Permafrost and infrastructure. This is of special importance where non-continuous permafrost occurs and the mean annual temperature is close to the freezing point. Special importance for road and airport construction and maintenance.
2.1 Evaluate and address the impacts on airports and landing strips related to thawing permafrost	
2.2 Develop new standards for developing airport and landing strips in light of climate change impacts	
2.3 Evaluate and address the need to relocate, re-align or repair airstrips due to coastal and river erosion and flooding	
2.4 Develop a comprehensive airstrip maintenance plan to address issues associate with climate impacts (thawing permafrost, ice, heavy precipitation, flooding, vegetative growth, etc...)	
2.5 Evaluate and address dangerous flying conditions, associated with icing, coastal fog, and non-traditional storms	

OPTION NO. ADAPTATION POLICY OPTION	NOTES/COMMENTS
<p><b>PI-3 Buildings</b></p>	<p>Require communities to implement simple set-back ordinances for new construction (4.10 is more or less stating that).</p> <p>Modify the buildings and the built environment to reduce heat generation and energy consumption. Health &amp; Culture TWG raises this as cross-cutting issue.</p>
<p>3.1 Survey existing building damage and loss due to shoreline erosion, less shorefast ice, melting permafrost, storms, realignment of rivers and flooding and identify the need to relocate buildings (e.g. Koyukuk) and plan for future siting</p>	
<p>3.2 Evaluate wild fire risk to buildings due to increased wild fire intensity and frequency and increased threat from diseased/dead trees (e.g. Caribou Hills fire in 2007)</p>	
<p>3.3 Strengthen existing building codes for new infrastructure and incorporate an increase in building inspection effectiveness as part of the strengthened codes as well as setback zones and phased-out or no development in areas vulnerable to sea level rise.</p>	<p>Incorporating projected sea level rise in the design storm event, as the design criteria applicable to vulnerable infrastructure.</p>
<p>3.4 Improve hazard preparedness of residential homes and commercial entities by providing operational assistance or incentives</p>	
<p>3.5 Assess sea level rise hazard insurance for businesses as part of standard operations</p>	
<p>3.6 Assess sea level rise hazard insurance for home owners in inundation hazard zones</p>	
<p>3.7 Develop and use insurance policies to drive and support retreat activities</p>	
<p>3.8 Implement standardized community education materials on hazards that addresses the relationship between climate variability and climate change</p>	
<p>3.9 Conduct a comprehensive vulnerability assessment for all public and private properties</p>	<p>This would include critical facilities such as power stations, hospitals, etc, as well as cultural resources such as museums.</p> <p>Redundant.</p>
<p>3.10 Increase construction protocols/conventions for piers and wharves for wave strength</p>	
<p>3.11 Evaluate the riparian rights/property rights in the context of sea level rise</p>	<p>Current riparian rights are based on the paradigm that sea level is constant. Could include recommendations for resolving issues resulting from consequences of protective measures.</p>
<p>3.12 Relocation of threatened structures - Evaluate presence and</p>	

OPTION NO. ADAPTATION POLICY OPTION	NOTES/COMMENTS
significance of threatened historical structures and develop plans for their relocation and/or protection	
3.13 Guide future development out of areas vulnerable to sea level rise and associated hazards	
3.14 End permitting of new homes in areas vulnerable to sea level rise and associated hazards	
3.15 Buy out unused properties in areas vulnerable to sea level rise and associated hazards	
3.16 Develop retreat strategies for the management of existing structures or conditions that may become submerged hazards to navigation or public health (e.g. effluent outfalls, water intakes, septic fields, rockwalls, docks, and piers)	
3.17 Develop strategies to address situations of changing ingress/egress to structures as support for access roads in areas vulnerable to sea level rise and associated hazards is withdrawn	
3.18 Modification of land use, agricultural , and landscape practices including aquaculture, saline-resistant crops, depending on location and purpose	
3.19 Raise shoreline structures	Redundant
3.20 Establish a mechanism to evaluate and recommend new design standards for structures (and placement of mechanical and electrical equipment) that may be vulnerable to SLR and associated hazards	
3.21 Require all municipalities to have written and operational disaster response plans that are updated at least every 5 years, and that include consideration of likely changes in the frequency and intensity of extreme events due to climate change	
<b>PI-4 Sea Walls and River Shoreline Protection</b>	Increased coastal erosion due to reduced sea ice (longer fetch and more wave action) and increased storminess. Protection of the coast line (sea walls) and relocation should be addressed.
4.1 Re-evaluate current icing and ice control methods due to more ice from longer seasonal transition periods	
4.2 Evaluate the effectiveness of hard structural options such as dikes, levees, floodwalls, saltwater intrusion barriers and install these options based upon effectiveness and feasibility	
4.3 Review construction standards for piers and wharfs for wave strength	
4.4 Increase flood protection, e.g., dams, reservoirs, sea walls	Vague.
4.5 Limit infrastructure investments in hazard-affected coastal areas	
4.6 Develop an early warning system (i.e., enhance hazard preparedness) through incorporation of sea level rise in hurricane and storm-surge evacuation planning.	4.6 - AK doesn't get hurricanes; that word should be removed to reduce confusion about climate change. Storms generate

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	hurricane-strength winds, waves, and storm surges but they are very different in form and lifecycle from hurricanes (or "tropical cyclones" in meteorology circles).
4.7 Develop an inventory of potentially impacted infrastructure and maintain this database relative to emerging projected sea level rise findings	This is an essential first step in scoping relevance/viability of potential adaptation options. <b>Redundant.</b>
4.8 Evaluate the vulnerability of existing and future unprotected reaches of shoreline with respect to existing infrastructure. NOTES: Determine need for and type of shoreline protection appropriate to these reaches.	
4.9 Develop operational protocols that specify disclosure requirements for coastal hazards	Does not include underwater structures that may pose a risk to navigation, among other risks
4.10 Evaluate shoreline erosion buffers for zones subject to flooding in which significant infrastructure is located	<b>Require communities to implement simple set-back ordinances for new construction (4.10 is more or less stating that).</b>
4.11 Develop and implement a tree planting program along vulnerable coastal areas as a flooding control strategy	Various options in the catalog advocate use of vegetation to help mitigate erosion (eg 4.11) - A serious impediment to that is the greatly expanded use of ATVs. These are extremely destructive to vegetation. Alongside any vegetation planting recommendation should be a call for ATV limiting ordinance. For communities that are not eager to comply state funds should be tied to their demonstrated enforcement or adherence. Trees aren't an option for many threatened communities in AK anyways.
4.12 Add additional planning scrutiny to prevent new development from infringing upon sensitive shoreline areas subject to sea level rise hazards	
4.13 Increase erosion and hazard planning focused on all coastlines, especially sheltered coastlines	
4.14 Evaluate structural and non-structural options for beach protection (flood walls, dune restoration and creation, and periodic beach nourishment)	<b>Redundant.</b>
4.15 Develop and/or strengthen a system for the comprehensive surveillance, monitoring, documentation, and dissemination of rates and locations of sea-level rise.	
4.16 Develop a system for the regular monitoring of sea level rise and updating of flood inundation mapping from changes due to	

OPTION NO. ADAPTATION POLICY OPTION	NOTES/COMMENTS
sea level rise	
4.17 Initiate a study that examines the replacement of soft protection options with hard structural options such as dikes, levees, floodwalls, saltwater intrusion barriers (this presupposes a solution)	As a first step, this option calls for a pre-feasibility study to evaluate the pros and cons and potential applications of hard, structural options to large estuaries like the Chesapeake Bay.
4.18 Enhance public education programs aimed at informing the public about sea level rise and coastal hazards	
4.19 Develop a strategy for managing the retreat of (Small and large) ports and associated infrastructure, such as rail and roads	
4.20 Develop a strategy to assure long-term public access to water	
4.21 Evaluate the effectiveness of soft structural options such as dune restoration and creation Wetland restoration, periodic beach nourishment, temporary barriers and other options and implement the best options based upon effectiveness and feasibility 4.22	
4.23 Investigate potential and limitations of eminent domain, vesting, grandfathering, and amortizing strategies to support retreat activities	
4.24 Assess financial impact of property value changes	
4.25 Evaluate existing shoreline protection structures to determine their effectiveness under varying sea level rise and the need for modification/ replacement/ abandonment	Should include a review of available Federal, state, and local shoreline protection programs; provide recommendations on how each could be modified to address future changes in seas level rise with respect to infrastructure and other land assets
PI-5 <a href="#">Electric, Fuel and Natural Gas Systems</a>	
5.1 Develop a mechanism that requires utility companies to relocate existing overhead utility wires underground and require new wires to be placed underground.	This option needs to be reviewed by a utility company representative as it may be risky from a reliability and serviceability perspective (i.e. submerged networks).
5.2 Site industrial systems away from areas vulnerable to changes in sea level rise and associated hazards.	
5.3 Address impacts of sea level rise and coastal and river erosion on buried or above-ground utility and oil pipelines.	
5.4 Address impacts of sea thawing permafrost on existing buried or above-ground pipelines.	
5.5 Develop appropriate standards for the future development of buried and above-ground utility and oil pipelines taking into account sea level rise, coastal and river erosion, and thawing permafrost.	
5.6 Address the impacts of thawing permafrost and erosion on shoreline and river-side fuel delivery, storage, and piping.	

Deleted: Utility and Fuel Infrastructure

OPTION NO. ADAPTATION POLICY OPTION	NOTES/COMMENTS
5.7 Develop new standards for the future development of shoreline and river-side fuel delivery, storage, and pipeline facilities.	Health & Culture TWG raises this as cross-cutting issue.
5.8 <u>Provide incentives for the development of increased efficiency of hydroelectricity facilities. (ability to operate with less water).</u>	<b>Deleted:</b> Engage Utility Siting Board in incorporating SLR and climate risk factors
<b>PI-6</b> <u>Water and Sewer Systems</u>	<b>Deleted:</b> Landfills
6.1 <u>Evaluate if the current failures from thawing permafrost were caused by climate change instead of poor design and construction.</u>	
6.2 <u>Address the current and future flooding and erosion impacts from storm surges on water and sewer facilities for communities most vulnerable along shorelines of rivers and seas.</u>	<b>Deleted:</b> Address the impacts currently occurring in landfills such as failures and losses associated with shoreline erosion and river erosion resulting from sea level rise and more intense storms
6.3 <u>Assess the public health impacts on vulnerable communities from damage to water and sewer facilities caused by climate change (thawing permafrost and flooding and erosion from storm surges).</u>	<b>Deleted:</b> Develop new standards for the future development of landfills that will address impacts associate with climate change such as sea level rise, thawing permafrost, and more intense storms.
6.4 <u>Investigate the contamination impacts from flooding on surface water and well water sources for drinking water and sewage lagoons.</u>	
6.5 <u>Develop new standards for designing water and sewer systems that will address future conditions caused by climate change.</u>	
<b>PI-7</b> <u>Rural Dumps and Municipal Landfills</u>	<b>Deleted:</b> Sewage and Septic Systems
7.1 <u>Address the current and future flooding and erosion impacts to dumps and landfills caused by storm surges for communities most vulnerable along shorelines of rivers and seas.</u>	
7.2 <u>Develop new standards for the future development of landfills that will address impacts associate with climate change such as sea level rise, thawing permafrost, and more intense storms.</u>	<b>Deleted:</b> Provide incentives for the development of septic systems that can better operate under the conditions associate with climate change.
<b>PI-8</b> <u>Municipal Storm Water Systems</u>	<b>Deleted:</b> Develop new standards for sewer and septic systems that address having less snow cover, thawing permafrost, sea level rise, and increased organics
8.1 Evaluate and improve capacity of storm water infrastructure for high intensity rainfall events	
8.2 <u>Revise</u> design standards to address lower probability events (e.g. some cities are protecting to the 500 year event rather than the 100 year event because of the increased vulnerability)	<b>Deleted:</b> Increase water system
8.3 Enhance existing storm water infrastructure capacity in zones subject to increasing high intensity rainfall events	
8.4 Identify public and private systems and facilities at serious risk from sea level rise and initiate a system for siting such facilities away from vulnerable areas.	
8.5 <u>Develop new, or expand current storm water management facilities and systems to address increased precipitation and possible flooding.</u>	<b>Deleted:</b> Identify the causes of drying lakes and diminished community water sources.

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	<b>PI-9 Ocean Transportation</b>	The urgency for marine ice forecasting is High. The Coast Guard has given NOAA a new requirement for 7 day a week sea surface temperature charts and ice forecasts.
	9.1 Evaluate the potential risks from climate impacts to a ferry system (incl. public transportation and emergency planning)	
	9.2 Develop an emergency evacuation plan for the ferry system	
	9.3 Create new standards for floating piers to accommodate both higher water levels and flooding events	Sea ice will impact offshore resource development and marine supply to coastal villages. This is of special importance for the Bering, Chukchi and Southern Beaufort Seas.
	9.4 Evaluate the potential opportunities, risks, and needs associated with new shipping lanes opening up in the Artic Ocean and Bering Sea, associated with less ice.	9.4 etc - Arctic shipping with respect to increased availability of Arctic sea routes - AK should really think about establishing a container port facility linked by rail to the continental interior. Nome or Barrow could work, even Prudhoe Bay because of the existing transportation corridor. Without this, opportunities for AK associated with increased arctic shipping will not be realized. AK will be stuck with the bad aspect, e.g. Selendang Ayu messes to clean up. AK should work with Yukon and BC/Alberta on this. Sea ice will impact offshore resource development and marine supply to coastal villages. This is of special importance for the Bering, Chukchi and Southern Beaufort Seas.
	9.5 Identify navigation problems associated with melting glaciers	
	9.6 Develop new shipping lanes through the Artic Ocean and Bering Sea.	
	9.7 Monitor shipping lanes through the Artic Ocean and Bering Sea for ice melt, glacier melt, and security.	
	9.8 Study the impacts of increased siltation in harbors stemming from glacier melt and flooding events.	
	9.9 Develop measures to minimize the impacts of siltation in	

**Deleted:** 8.6 Develop policies for the conservation of community water sources. . . . .

**Deleted:** 8.7 Develop methodologies to stop or minimize the drying of lakes. . . . .

**Deleted:** 8.8 Provide incentives for the development of well-based water system technologies that avoid freezing due to increased deep frost levels. . . . .

**Deleted:** 8.9 Develop new standards for the development and deployment of new well-based water systems, taking into account deep frost levels. . . . .

**Deleted:** 8.10 Provide incentives for the development of increased efficiency of hydroelectricity facilities. (ability to operate with less water). . . . .

**Deleted:** 8.11 Develop new, or expand current stormwater management facilities and systems to address increased precipitation and possible flooding. . . . .

OPTION NO. ADAPTATION POLICY OPTION	NOTES/COMMENTS
harbors stemming from glacier melt and flooding events.	
9.10 Provide incentives for the development of mechanisms that can minimize the levels of and impacts from siltation in harbors	
<b>PI-10 Rural Non-Road Ground Transportation</b>	Request that NOAA in partnership with ADOT&PF develop the capability for improved, higher temporal and spatial resolution sea and river ice forecasts to enhance safety of winter travel in roadless areas.NS/H&S TWG
10.1 Develop rural infrastructure to supplement lost rural routes due to thinner winter ice, insufficient snow, and ground that does not freeze	
10.2 Provide incentives for the development of new modes of transportation that can travel across the altered rural landscape	
10.3 Identify new rural transportation routes	Redundant.
10.4 Provide rural public transportation across new and existing rural transportation routes to more efficiently move people and freight across the altered rural landscape.	Redundant.
10.5 Develop new regulations for traveling across ice roads, taking into account thinner ice and shorter season length	
10.6 Identify alternate routes to accommodate for the shortened ice road season	Redundant.
10.7 Further develop rural airstrips to accommodate larger planes with greater cargo capacity to compensate for the shortened ice road season	
<b>PI-11 River Transportation</b>	
11.1 Create new standards for floating piers to accommodate both lower water flow and flooding events	
11.2 Further develop river transportation routes to accommodate lower water flow as well as flooding events.	
11.3 Provide incentives for the development of nautical vessels capable of navigating rivers during times of low water flow and flooding events.	
11.4 Provide incentives for the purchase of nautical vessels capable of navigating rivers during times of low water flow and flooding events.	
<b>PI-12 National Defense Infrastructure</b>	
12.1 Address national security concerns associated with new shipping lanes opening up due to less ice in the Arctic Ocean and Bering Sea.	
12.2 Promote the new development of Early-Warning-Radar Sites capable of withstanding thawing permafrost and erosion.	CRREL is working on a project that attempts to look at DOD and climate change risk.

**Sewage and septic system impacts:** Current impacts – some septic systems are freezing because of less snow cover. Future projections – sewage system problems and failures, especially with thawing permafrost and sea level rise (e.g., US Air Force Site near Kaktovik); increased organics adversely affecting treatment processes; ultimately significantly warmer temperatures could result in less damage to septic systems.

## **WATER SYSTEMS**

**Above-ground water systems:** Current impacts – thawing permafrost, eroding shorelines, and drying of lakes leading to diminished community water sources (e.g., in NE Alaska, of 23 lakes studied, 21 decreased in size); water quality compromised from storm surges, etc. *Future projections – increased above-ground water system problems and failures; potential decrease in available non-community based water sources as more lakes, ponds and streams dry and shrink.*

**Subsurface water systems:** Current impacts – low interior snowfall causes deep frost levels that freeze well-based water systems. *Future projections – loss and reduction of permafrost to have major impact on subsurface hydrology; loss of some confined aquifers and domestic artesian water wells; increased risks of contamination.*