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Governor Bill Walker
STATE OF ALASKA

June 19, 2017

The Honorable E. Scott Pruitt
Administrator
Environmental Protection Agency
USEPA Headquarters
Ariel Rios Building
1200 Pennsylvania Ave. NW
Washington, D.C 20460

Mr. Douglas W. Lamont
Senior Official Performing
the Duties of the Assistant
Secretary of the Army (Civil Works)
Department of the Army
104 Army Pentagon
Washington, D.C. 20310-0104

RE: Proposed Revision of the “Waters of the United States” Definition

Dear Mr. Pruitt and Mr. Lamont:

Thank you for reaching out to the State of Alaska (State) to solicit input on a revised “waters of the United States” (WOTUS) definition as the federal agencies undertake the work directed by the February 28, 2017 Presidential Executive Order. As evidenced by the State’s past comments and our participation in litigation challenging the agencies’ 2015 regulations expanding the WOTUS definition, the assertion of federal control represented by this rule has long been a matter of concern for Alaska.

We appreciate the steps taken to reevaluate the 2015 rule and, in particular, the focus given to Justice Scalia’s opinion in *Rapanos v. United States*, 547 U.S. 715 (2006), in that effort. Justice Scalia appropriately recognized Congress’s clear intent in the Clean Water Act (CWA) to “recognize, preserve, and protect the primary responsibilities and rights of states” in land and water management. 33 U.S.C. § 1251(b). A more restrained interpretation of federal jurisdiction under the CWA – as advanced by Justice Scalia – is consistent with that Congressional intent.

The absence of federal permitting requirements will not leave waters unprotected. The Alaska Constitution and a strong public trust doctrine govern the management of water resources in our state. The Alaska Legislature has already provided State agencies with statutory authority to protect water resources and to ensure all uses are in the public interest.

We also appreciate your emphasis on “cooperative federalism” in this rulemaking process. Alaska has unique characteristics such as permafrost that make our active participation critical to developing a sensible and workable definition of waters of the United States. The State of Alaska has often found itself in an adversarial position with the federal government in the past, fighting to preserve our ability to manage and develop our own lands and resources. We are hopeful that this marks the

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beginning of a more productive and collaborative relationship that takes into account Alaska's complex and unique environment.

We appreciate your effort in reaching out to states at this early stage and look forward to working with you as this rulemaking process advances. I have enclosed more detailed comments prepared by my State of Alaska agencies for your consideration.

Sincerely,



Bill Walker,
Governor

Enclosure

cc: The Honorable Lisa Murkowski, United States Senate
The Honorable Dan Sullivan, United States Senate
The Honorable Don Young, United States House of Representatives
The Honorable Sam Cotten, Commissioner, Alaska Department of Fish and Game
The Honorable Larry Hartig, Commissioner, Alaska Department of Environmental Conservation
The Honorable Marc Luiken, Commissioner, Alaska Department of Transportation and Public Facilities
The Honorable Andrew T. Mack, Commissioner, Alaska Department of Natural Resources
Gib Owen, Office of the Assistant Secretary of the Army (Civil Works), Department of the Army
Donna Downing, Office of Water, Environmental Protection Agency
Andrew Hanson, Federalism Contact, Environmental Protection Agency

State of Alaska Comments on Proposed Revision of Federal Regulations Defining “Waters of the United States” under the Clean Water Act

June 19, 2017

The State of Alaska (State) provides these comments in response to the Presidential Executive Order on “Restoring the Rule of Law, Federalism, and Economic Growth by Reviewing the ‘Waters of the United States’ Rule” and the related invitation from EPA and Corps to Governor Walker. The State understands a guiding principle in this process is a cooperative federalism approach; accordingly, the State of Alaska, independently, and as a member of the Association of Clean Water Administrators and the Western States Water Council, advocates that any effort to clarify or define Clean Water Act (CWA) jurisdiction give as much weight as possible to State needs, priorities, and concerns.¹

The State also understands that the Environmental Protection Agency (EPA) and U.S. Army Corps of Engineers (Corps) are interested in Alaska’s view of a definition that will be appropriate and effective for enforcement of the CWA in Alaska. This information is to be considered in the development of a new federal definition of “waters of the United States” (WOTUS). The President has directed that the agencies consider a new definition that is consistent with Justice Scalia’s opinion in *Rapanos v. United States (Rapanos)*.² It is further understood that EPA and the Corps are interested in understanding how Alaska might respond to a reduced scope of federal jurisdiction under the CWA.³

1. Generally, the State supports an interpretation of “waters of the United States” that is consistent with Justice Scalia’s opinion in *Rapanos*.

Justice Scalia defined “waters of the United States” under the Clean Water Act to include (1) traditional “navigable waters” and (2) other relatively permanent bodies of water that are connected to traditional navigable waters. Relatively permanent bodies of water are those that form geographic features “described in ordinary parlance as ‘streams, oceans, rivers, and lakes.’” By contrast, “channels through which water flows intermittently or ephemerally or channels that periodically provide drainage for rainfall are not relatively permanent bodies of water.”

He clarified that wetlands are not “waters of the United States” in their own right. But a wetland may be regulated as part of a “water of the United States” if it is adjacent to a “water of the United States.” To be considered adjacent, the wetland must have a “continuous surface connection” to the jurisdictional water body such that it is difficult to determine where the “water” ends and the “wetland” begins.⁴ Hydrological connections and ecological relationships are not enough to render a wetland “adjacent” – a continuous surface connection is required.⁵

In concept, the State supports an interpretation of “waters of the United States” that is consistent with this definition. Perhaps the most significant advantage of this language is its clarity, particularly

¹ See Western States Water Council Resolution #369, July 18, 2014.

² 547 U.S. 715 (2006).

³ Letter to Governor Walker from EPA Administrator Scott Pruitt and Senior Official Performing the duties of the Assistant Secretary of the Army (Civil Works) Douglas W. Lamont (May 8, 2017).

⁴ *Rapanos*, 547 U.S. at 739.

⁵ *Id.* at 742.

with respect to wetlands. We also appreciate that Justice Scalia appropriately noted that the phrase “waters of the United States” is itself a definition of a statutory term – “navigable waters.” Ultimately, any definition of “waters of the United States” must be reasonable when measured against that foundation. Justice Scalia also recognized the express Congressional intent to preserve “the primary responsibilities and rights of the States” to manage and protect land and water resources – “a quintessential state and local power.”⁶ As the State has more time to explore potential suitable approaches and evaluate what other states are proposing, we will be active in the consultation process with the Administrator.

As the plurality opinion is generally understood to reflect a substantially narrower jurisdictional reach than the “significant nexus” test, including as applied in the 2015 rule, we hope that the concerns the State has raised in the past are ultimately resolved in this rulemaking.⁷ Our concerns regarding the agencies’ approach in the 2015 rule remain. In particular, as outlined in our prior comments, the breadth of regional differences across the country weighs strongly against a one-size-fits-all approach. Recognizing and supporting a primary role for states in protecting and managing water resources could resolve many of the challenges presented by the diversity of circumstances across the country.⁸ For the same reason, rulemaking efforts on a regional, rather than national, level may lead to better and more constitutionally defensible final rules.⁹

2. Justice Scalia’s WOTUS definition applied to Alaska waters.

As discussed in Section 4 below, Alaska has unique water resources and far more expansive area potentially affected by the WOTUS definition than any other state. As such, any revision to the WOTUS definition is critically important to the State. Because of Alaska’s unique conditions and circumstances, many of the waters discussed below should be categorically exempt from the waters of the U.S. definition or, at a minimum, the final rule should allow for clear demarcations of jurisdictional waters.

A. Rivers and Streams in Arctic Alaska

Because of long winters (October to June) in Arctic Alaska, rivers and streams are not continuously flowing and instead have a distinct seasonal nature. As landscape features, the rivers and streams are permanent fixtures. But many of them do not flow during the winter months. Their peak flow is in June during the winter ice “breakup” and the melt of winter

⁶ See *id.* at 737-738 (citing 33 U.S.C. 1251(b); *FERC v. Mississippi*, 456 U.S. 742 (1982); *Hess v. Port Authority Trans-Hudson Corporation*, 513 U.S. 30(1994). Later in the *Rapanos* opinion Justice Scalia returns to this point again, stating: “...as we have discussed earlier, clear water is not the only purpose of the statute. So is the preservation of primary state responsibility for ordinary land-use decisions.” 547 U.S. at 755-756.

⁷ See e.g. Letter from Director Tom Crafford, Alaska Department of Natural Resources, to Dr. Thomas Armitage, EPA Science Advisory Board Staff Office, Re: State of Alaska’s Comments on EPA’s draft report, *Connectivity of Streams and Wetlands to Downstream Waters: A review and Synthesis of the Scientific Evidence* (Nov. 6, 2013); Letter from Governor Sean Parnell to EPA Administrator Gina McCarthy, Re: State of Alaska’s Comments in Response to the Proposed Rule Defining “Waters of the United States” Under the Clean Water Act (Nov. 14 2014) (2014 State Comments); States of North Dakota, Alaska, Arizona, Arkansas, Colorado, Idaho, Missouri, Montana, Nebraska, Nevada, South Dakota, and Wyoming v. U.S. Environmental Protection Agency, No. 15-3799 (6th Cir.); Letter from 27 Attorneys General to Vice President-Elect Pence, Re: Waters of the United States Rule (Dec. 19, 2016); Letter from Commissioner Larry Hartig, Alaska Department of Environmental Conservation, to U.S. Environmental Protection Agency, Re: Comments on Evaluation of Existing Regulations (May 15, 2017).

⁸ See 2014 State Comments at 10.

⁹ See 2014 State Comments at 20.

snowpack. Only those rivers and streams with continuous flow after the seasonal breakup are “relatively permanent.”

B. Wetlands and Wetland Mosaics in Arctic and Western Alaska

In Arctic and Western Alaska, wetlands (underlain by permafrost) create a mosaic on the landscape. Justice Scalia’s definition does not allow federal jurisdiction to be extended over an entire “wetland mosaic.” While there may be some potential for a subsurface hydrologic connection (which can be difficult to determine), that is not adequate to render wetlands “adjacent” to jurisdictional waters or establish the necessary “continuous surface connection.” Clean Water Act jurisdiction should not be applied in a manner that “jumps over” the uplands/non-wetlands to other wetlands simply because an area is determined to be a “wetland mosaic” with the potential to be hydrologically connected to a navigable water. Only northern latitude wetlands with a clear and consistent surface connection to a navigable water during the open water season should be considered “adjacent to” and therefore within the scope of WOTUS.

C. Geographically Separated Waters

There are several regions of Alaska (Interior and Southcentral) where small ponds or wetlands are geographically isolated from waters of the U.S. Geographically separated small ponds and wetlands have no surface connection, seasonal or otherwise, to a navigable water. The regulations should explicitly exempt these isolated waters from the waters of the U.S. definition.

D. Areas with Permafrost

Approximately 63 percent of Alaska is covered by continuous or discontinuous permafrost. As permafrost is less pervious to water than unfrozen ground, permafrost limits the downward seepage of water and typically makes these environments wetter in lowland areas. This is especially true in continuous permafrost areas (see attachment 1). While these areas may meet the definition of wetlands, absent a continuous surface connection to navigable waters, permafrost should be expressly excluded from the waters of the U.S. definition.

E. Ponds and Lakes

Alaska contains over 3 million lakes larger than five acres, many in remote areas that have not been extensively studied. Under the current rule, jurisdictional determinations require expensive and laborious efforts to identify and map subsurface hydrological connections, often with ambiguous results. A clear and easily determinable definition that limits jurisdiction to lakes with a clear, permanent and continuous surface water connection to a navigable water would significantly reduce the administrative burden and costs of jurisdictional determinations in remote areas of the state.

F. Other non-jurisdictional waters

Any “other waters,” including intermittent, ephemeral, or isolated ponds and wetlands, that have no continuous surface connection to a navigable water or tributary to a navigable water, are not “waters of the U.S.” and should be expressly excluded from the definition.¹⁰

¹⁰ See *Rapanos*, 547 U.S. at 732 & 739.

3. Opportunities and challenges due to Alaska's unique waters and wetlands.

The uniqueness and vastness of water resources in Alaska underscore the critical importance of this rulemaking effort to the State. Alaska fully expects to be a partner with the federal agencies in drafting a new “waters of the U.S.” definition. Below is a sampling of facts and statistics that illustrate the uniqueness and vastness of Alaska's waters.

At more than 403 million acres, the State of Alaska encompasses the largest geographic area of any state in the nation – more than twice the area of the next-largest state. Alaska has more coastline than the entire conterminous United States and over 19,000 water bodies that are known to support resident or anadromous fish.¹¹ When a map of the state is superimposed on the conterminous United States, Alaska's boundaries extend roughly from the east coast to the west coast.

Wetlands and deepwater habitat combined cover over 204 million acres, over 50 percent of Alaska's surface area.¹² By comparison, wetlands and deepwater habitat comprise a little more than 9 percent of the surface area of the conterminous United States.¹³ Setting aside deepwater habitat, the state of Alaska has over 174 million acres of wetlands, comprising approximately 43 percent of the surface area of the state.¹⁴ The rest of the U.S. contains approximately 103 million acres of wetlands, comprising approximately four percent of the surface area.¹⁵ Sixty-three percent of the country's remaining wetlands are in Alaska. Using National Hydrography Dataset¹⁶ information from the Bureau of Land Management (March 2014), Alaska has 884,075 miles of rivers and streams and 21,655 square miles of lakes.

Alaska's water resources are not uniformly distributed across the state. According to the Corps, “[w]etlands occupy 61 percent of Northern and Western Alaska,” and “vast expanses of treeless tundra underlain by permafrost dominate the area.”¹⁷ These permafrost wetlands are a unique feature of the Alaska landscape not found elsewhere in the United States. Interior Alaska is 44 percent wetlands and includes “millions of acres of black spruce... muskeg and floodplain wetlands...”¹⁸ Within Alaska, 32 ecoregions have been identified so that each is a description of the unique areas of land and water containing vegetation communities that share similar ecological dynamics, hydrology and environmental conditions.¹⁹ These ecoregions further distinguish the variety of hydrological characteristics exhibited throughout Alaska.

Adding to the uniqueness and complexity of Alaska's situation is that the majority of the waters in the vast northern, interior, and western regions exist in a frozen state from October through May each year. Only for the short summer season do these waters exhibit some of the traits and provide some of the functions normally attributed to flowing waters and connected wetlands. Southeast

¹¹ Alaska Department of Fish and Game, *Catalog of Waters Important for the Spawning, Rearing or Migration of Anadromous Fishes*, available at: <https://www.adfg.alaska.gov/sf/SARR/AWC/>

¹² Hall, Jonathan V., W.E. Frayer and Bill O. Wilen, *Status of Alaska Wetlands*, 1994, available at <http://www.fws.gov/wetlands/Documents/Status-of-Alaska-Wetlands.pdf>

¹³ *Id.*

¹⁴ *Id.*

¹⁵ *Id.*

¹⁶ This dataset is incomplete, and much additional work will be required to assess the hydrology of Alaska.

¹⁷ U.S. Army Corps of Engineers, Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Alaska Region (Version 2.0), September 2007

¹⁸ *Id.*

¹⁹ Alaska Department of Fish & Game, *Alaska's 32 Ecoregions*, <http://www.adfg.alaska.gov/index.cfm?adfg=ecosystems.ecoregions#prettyPhoto>

Alaska has a more temperate, maritime climate with an average annual precipitation of 100 to 200 inches falling in terrain of mountainous rainforests. The average annual precipitation for the Northern region is 4 to 6 inches with 60 to 70 percent falling as snow; the Western region receives 16 to 25 inches, with 30 to 40 percent falling as snow; and the Interior receives 6 to 13 inches, with 40 to 60 percent falling as snow.²⁰

Permafrost is soil, rock or sediment that is frozen for more than two consecutive years. In areas not overlain by ice, it exists beneath a layer of soil, rock, or sediment, which freezes and thaws annually and is called the “active layer.” The vegetation that lives in this active layer may exhibit the characteristics of wetlands – hydric soils, hydrology, and hydrophytic vegetation. Depending on topography, soil types, and other features, permafrost wetlands are very dynamic systems that are not completely understood. Permafrost zones underlie approximately 80 percent of Alaska, including continuous (32 percent), discontinuous (31 percent), sporadic (8 percent), and isolated (10 percent). The majority of the continuous permafrost lies north of the Arctic Circle, while the discontinuous permafrost lies in Interior and Western Alaska (see attachment 1).

Permafrost wetlands pose a particular challenge. It can be difficult to definitively determine whether there is a continuous connection to downstream waters and wetlands due to, among other reasons, a very short growing season (that may be interrupted with frosts) and hydric soils that generally hover around a “biological zero” temperature. There is often a significant temporal lag in hydrology (freeze/thaw cycle and lack of slope) that is more equivalent to groundwater flow, and in most cases there is little evidence of significant subsurface connection.

**4. A narrowed assertion of federal authority will not leave State waters unprotected;
Alaska’s resource agencies possess the authority and ability to preserve water quality.**

A shift of authority governing pollutant discharges will not result in lower water quality standards. The State does not anticipate that a narrowed interpretation of “waters of the United States” will lead to a substantial change in State pollutant discharge programs. First, pollutant discharges that do not go directly into “waters of the United States” may nevertheless be captured within the scope of §402 through point source regulation if there is a reasonable potential the discharge could exceed a water quality standard in the downstream “waters of the United States.” Second, the State has assumed responsibility for implementing the federal §402 National Pollutant Discharge Elimination System (NPDES) program and regulates other discharges under State law. So, while a narrower WOTUS definition may technically shift permitting authority from federal to State law, as a practical matter, all pollutant discharges will remain regulated, and Alaska’s Department of Environmental Conservation (ADEC) will remain responsible for both federal and State programs. Third, Alaska’s water quality standards are the same for fresh waters and marine waters and groundwater within the state. Further, Alaska’s water quality standards meet all applicable federal requirements. Finally, while we do not have a reason to believe these changes to be substantial, we have identified two potential positive effects of shifting workload from the federal to State programs: (1) reduced paperwork; and (2) flexibility in control technologies required where water quality is not at risk.

While Alaska has not assumed the 404 dredge and fill permit program directly, the State does issue section 401 certifications of the federal 404 permits to ensure that State water quality is maintained

²⁰ Alaska Department of Environmental Conservation, *Alaska Storm Water Guide*, December 2011
<http://dec.alaska.gov/water/wnpspc/stormwater/Guidance.html>

and protected consistent with State standards.²¹ The standards that guide 401 certifications apply equally to all waters in Alaska. Therefore, the same water quality backstop for dredge and fill activity will remain throughout the state, even if the federal agencies adopt a more restrained approach to jurisdictional determinations.

Several other State laws also protect Alaska's water resources. Generally, Article 8 of the Alaska Constitution and a strong public trust doctrine govern the use and management of our natural resources, including water. Guided by those principles, the Alaska Legislature has authorized State agencies to undertake the work necessary to manage and protect State waters in numerous contexts. For example, the Alaska Water Use Act directs the Alaska Department of Natural Resources (ADNR) to ensure any "use of water" is in the public interest.²² That public interest determination includes consideration of effects on public health, fish and game resources, and other persons and generally limits the degradation of water systems.²³ DNR also addresses water contamination through Critical Water Management Areas. Meanwhile, the Alaska Department of Fish and Game (ADF&G) regulates activities that impact catalogued anadromous water bodies. Returning to ADEC, in addition to regulating pollutant discharges as discussed above, our Legislature broadly authorized the State environmental agency to protect the State's waters.²⁴

In summary, as demonstrated by the above sampling, Alaska has statutes and regulations in place to preserve and protect all waters and wetlands within state boundaries.²⁵ If federal jurisdictional authority is narrowed, our State agencies are well positioned to ensure state waters remain protected.

5. The agency's economic analyses should include foreseeable indirect and cumulative effects as well as state and region-specific impacts.

The appropriate scope of any future economic analysis of a revised rule will, of course, depend on the specific rule proposed. However, we ask the agencies to remain mindful of the cost multiplier effects when wetland mitigation requirements are enhanced because other state and federal agencies exercise jurisdiction at or near the boundary of a WOTUS. As an example, the Corps considers the "ecological significance" of a wetland, which heightens the wetland mitigation requirements associated with a 404 dredge and fill permit, based on the value of surrounding resources such as habitat critical for conservation of species listed under the Endangered Species Act (even if the U.S. Fish and Wildlife Service determines the project is not likely to adversely affect the protected species). Any potential impacts to the resources protected by other regulatory agencies are avoided, minimized, or mitigated in coordination with the agency with primary responsibility for the resource. The consideration of these non-WOTUS resources when the EPA and Corps exercise jurisdiction over a WOTUS creates unnecessary financial and logistical burdens that should be considered in the agencies' economic analysis. The economic analysis should also evaluate the risk of costs arising from project delay or exposure to citizen suits – risks that tend to increase when regulations change or lack clarity.²⁶

²¹ DEC issues Certificates of reasonable assurance under 33 U.S.C. 1341 (Clean Water Act, sec. 401), as amended through February 4, 1987; also see 18 AAC 15.180.

²² AS 46.15 and AS 46.16.

²³ AS 46.15.080; *see also* 11 AAC 93.

²⁴ *See* AS 44.46, AS 46.03, 18 AAC.

²⁵ *See, e.g.*, 33 U.S.C. §1341 (CWA Section 401 certification authority); AS 46.03.100 (wastewater discharge permitting authority); 18 AAC 70 (Alaska water quality standards); 18 AAC 72 (wastewater disposal); and 18 AAC 83 (Alaska Pollutant Discharge Elimination System Program).

²⁶ *See* 2014 Comments at 15 to 18.

We also ask that the agencies be mindful of Alaska's broader circumstances when evaluating the economic impacts of a new rule. For a variety of reasons, regulatory programs often affect Alaska differently than the Lower 48. Generally, and in contrast to the conditions that gave rise to the enactment of the CWA, Alaska – the 49th state and America's "Last Frontier" – remains largely undeveloped. Higher transportation and operating costs in remote or undeveloped regions together with short construction seasons due to climate conditions mean that the same regulatory burden may be more likely to render projects uneconomic.

Many CWA provisions were designed to protect and enhance limited or degraded wetlands. Yet, Alaska has no shortage of wetlands. In fact, 174 million acres of wetlands cover 43 percent of the state's surface area. By comparison, wetlands across the rest of the country total about 103 million acres or four percent of the surface area. Through the CWA Section 404 permitting process, the EPA and Corps exert regulatory jurisdiction over vast areas of Alaska compared to other states. This fundamentally different proportion of wetlands suggests a fundamentally different balance of economic burdens and environmental benefits associated with wetland mitigation requirements in Alaska compared to other areas of the country.

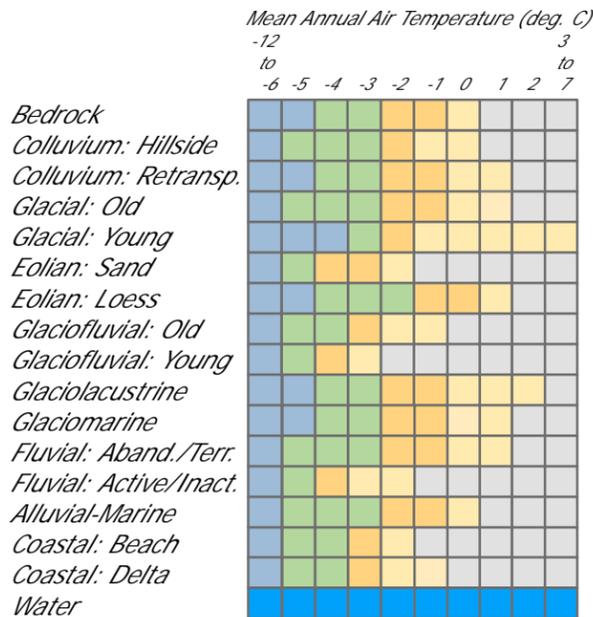
Contributing to the relative burden of wetland mitigation, regions of Alaska consist almost entirely of public land, leaving very little private developable land that can be acquired and set aside to fulfill wetland mitigation requirements. The scarcity of land available for mitigation results in tremendous project cost increases. At the same time, locking up private land in corridors where little private land remains can create substantial hurdles for efforts to establish or develop an economic base in a region.

6. A clear WOTUS standard that is easily applied in practice is most important.

Most importantly, a new WOTUS definition must be clear and concise. A clear and unambiguous test will allow jurisdictional determinations to be made quickly and definitively. The current methodology, using the "significant nexus" test, has proven unnecessarily burdensome and costly. It requires a developer's preliminary WOTUS determination to be confirmed by the Corps through a formal jurisdictional determination. To avoid the considerable time and expense of that formal Corps determination, a developer can "assume" jurisdiction over any area that could possibly be WOTUS. But, to advance the permitting process, the developer must pay mitigation costs for the entire "assumed" WOTUS. Ultimately, projects are bearing the cost and burden of mitigating impacts to lands that are not WOTUS.

The public should not bear the onus and costs of complex technical analyses for jurisdictional determinations or for mitigating impacts to non-WOTUS lands and waters. Any revision to the definition of WOTUS should focus on clarity and practical application. This will reduce permitting time and costs for both regulatory agencies and permit applicants.

Permafrost Extent by Surficial Deposit



Permafrost Characteristics of Alaska

Torre Jorgenson, Kenji Yoshikawa, Mikhail Kanevskiy, and Yuri Shur
 University of Alaska Fairbanks, Institute of Northern Engineering, Fairbanks, Alaska, USA

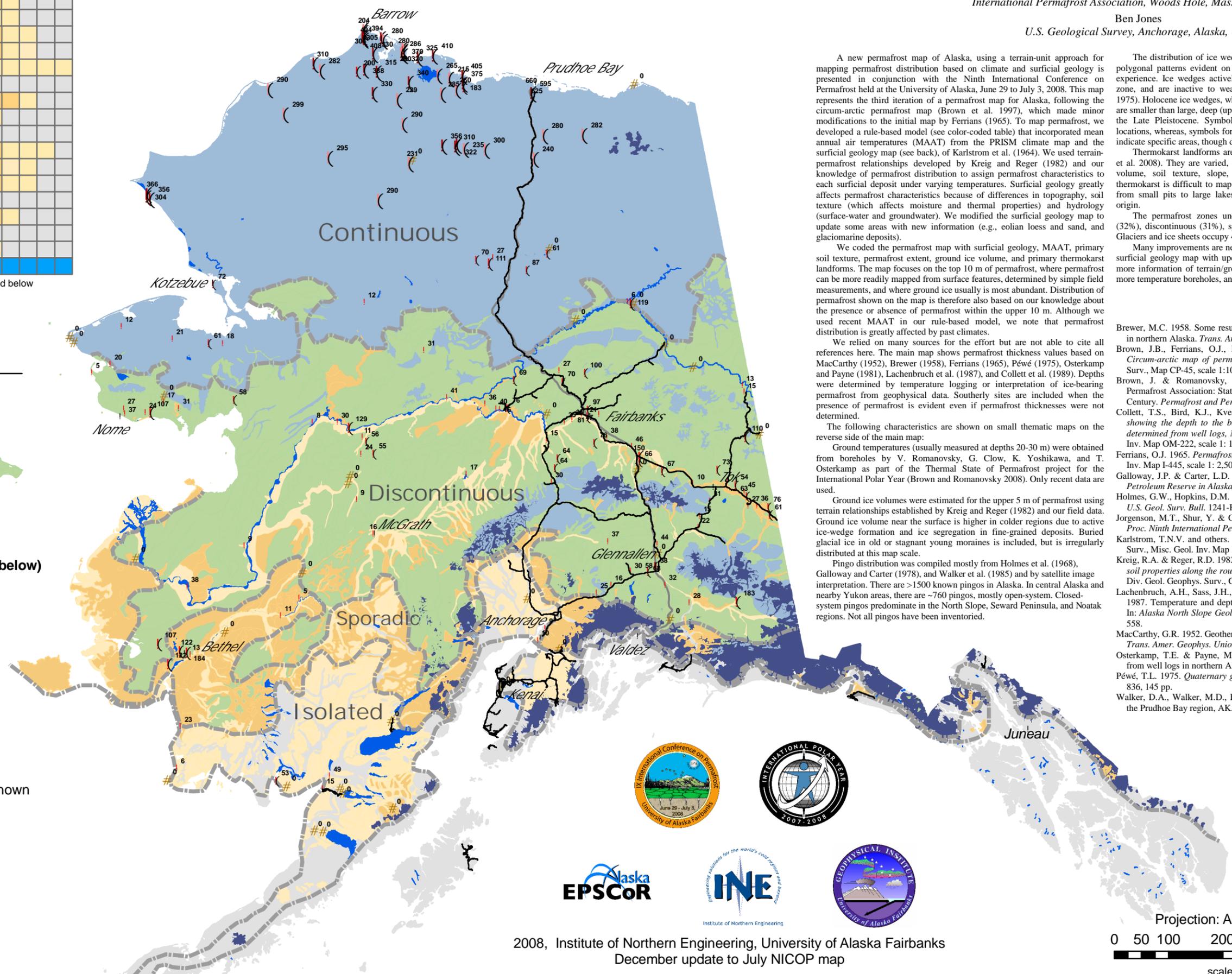
Vladimir Romanovsky, Sergei Marchenko, and Guido Grosse
 University of Alaska Fairbanks, Geophysical Institute, Fairbanks, Alaska, USA

Jerry Brown
 International Permafrost Association, Woods Hole, Massachusetts, USA

Ben Jones
 U.S. Geological Survey, Anchorage, Alaska, USA

Legend

- ### Permafrost Distribution
- Glacier
 - Continuous (>90%)
 - Discontinuous (50-90%)
 - Sporadic (10-50%)
 - Isolated (>0-10%)
 - Absent (0%)
 - Large Waterbodies (unfrozen below)
 - Permafrost_Zones Generalized
- ### Permafrost Depth (m)
- 5 - 50
 - 51 - 100
 - 101 - 200
 - 201 - 300
 - 301 - 500
 - 501 - 600
 - # Permafrost present but depth unknown
- ### Other Features
- Major Roads
 - Trans-Alaska Pipeline



A new permafrost map of Alaska, using a terrain-unit approach for mapping permafrost distribution based on climate and surficial geology is presented in conjunction with the Ninth International Conference on Permafrost held at the University of Alaska, June 29 to July 3, 2008. This map represents the third iteration of a permafrost map for Alaska, following the circum-arctic permafrost map (Brown et al. 1997), which made minor modifications to the initial map by Ferrians (1965). To map permafrost, we developed a rule-based model (see color-coded table) that incorporated mean annual air temperatures (MAAT) from the PRISM climate map and the surficial geology map (see back), of Karlstrom et al. (1964). We used terrain-permafrost relationships developed by Kreig and Reger (1982) and our knowledge of permafrost distribution to assign permafrost characteristics to each surficial deposit under varying temperatures. Surficial geology greatly affects permafrost characteristics because of differences in topography, soil texture (which affects moisture and thermal properties) and hydrology (surface-water and groundwater). We modified the surficial geology map to update some areas with new information (e.g., eolian loess and sand, and glaciomarine deposits).

We coded the permafrost map with surficial geology, MAAT, primary soil texture, permafrost extent, ground ice volume, and primary thermokarst landforms. The map focuses on the top 10 m of permafrost, where permafrost can be more readily mapped from surface features, determined by simple field measurements, and where ground ice usually is most abundant. Distribution of permafrost shown on the map is therefore also based on our knowledge about the presence or absence of permafrost within the upper 10 m. Although we used recent MAAT in our rule-based model, we note that permafrost distribution is greatly affected by past climates.

We relied on many sources for the effort but are not able to cite all references here. The main map shows permafrost thickness values based on MacCarthy (1952), Brewer (1958), Ferrians (1965), Péwé (1975), Osterkamp and Payne (1981), Lachenbruch et al. (1987), and Collett et al. (1989). Depths were determined by temperature logging or interpretation of ice-bearing permafrost from geophysical data. Southerly sites are included when the presence of permafrost is evident even if permafrost thicknesses were not determined.

The following characteristics are shown on small thematic maps on the reverse side of the main map:
 Ground temperatures (usually measured at depths 20-30 m) were obtained from boreholes by V. Romanovsky, G. Clow, K. Yoshikawa, and T. Osterkamp as part of the Thermal State of Permafrost project for the International Polar Year (Brown and Romanovsky 2008). Only recent data are used.

Ground ice volumes were estimated for the upper 5 m of permafrost using terrain relationships established by Kreig and Reger (1982) and our field data. Ground ice volume near the surface is higher in colder regions due to active ice-wedge formation and ice segregation in fine-grained deposits. Buried glacial ice in old or stagnant young moraines is included, but is irregularly distributed at this map scale.

Pingo distribution was compiled mostly from Holmes et al. (1968), Galloway and Carter (1978), and Walker et al. (1985) and by satellite image interpretation. There are >1500 known pingos in Alaska. In central Alaska and nearby Yukon areas, there are ~760 pingos, mostly open-system. Closed-system pingos predominate in the North Slope, Seward Peninsula, and Noatak regions. Not all pingos have been inventoried.

The distribution of ice wedges was determined from the literature, from polygonal patterns evident on remote sensing imagery, and from our field experience. Ice wedges actively form mainly in the continuous permafrost zone, and are inactive to weakly active in the discontinuous zone (Péwé 1975). Holocene ice wedges, which are limited to the top 3-5 m of permafrost, are smaller than large, deep (up to 35 m) syngenetic ice wedges formed during the Late Pleistocene. Symbols for abundant ice wedges denote general locations, whereas, symbols for sparse Holocene and Late Pleistocene wedges indicate specific areas, though distribution remains poorly known.

Thermokarst landforms are abundant in all permafrost zones (Jorgenson et al. 2008). They are varied, due to differences in temperature, ground ice volume, soil texture, slope, and hydrologic conditions. Abundance of thermokarst is difficult to map because of the wide range in size of features from small pits to large lakes, and similar landforms may have different origin.

The permafrost zones underlie 80% of Alaska, including continuous (32%), discontinuous (31%), sporadic (8%), and isolated (10%) permafrost. Glaciers and ice sheets occupy 4% of the area.

Many improvements are needed for a better permafrost map, including: a surficial geology map with updated information and better spatial accuracy; more information of terrain/ground ice/temperature/permafrost relationships; more temperature boreholes; and improved spatial models.

References

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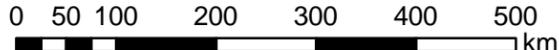






2008, Institute of Northern Engineering, University of Alaska Fairbanks
 December update to July NICOP map

Projection: Albers Alaska, NAD 83



scale 1: 7,200,000