REPORT TO CONGRESS

IMPROVING NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION COMMUNICATION OF HAZARDOUS WEATHER AND WATER EVENTS

Developed pursuant to: Section 406 of the Weather Research and Forecasting Innovation Act of 2017 (Public Law 115-25)

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SECTION 406 OF THE WEATHER RESEARCH AND FORECASTING INNOVATION ACT OF 2017 (PUBLIC LAW 115-25) INCLUDED THE FOLLOWING LANGUAGE

SEC. 406.—IMPROVING NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION COMMUNICATION OF HAZARDOUS WEATHER AND WATER EVENTS.

(a) PURPOSE OF SYSTEM.—For purposes of the assessment required by subsection (b)(1)(A), the purpose of National Oceanic and Atmospheric Administration system for issuing watches and warnings regarding hazardous weather and water events shall be risk communication to the general public that informs action to prevent loss of life and property.

(b) ASSESSMENT OF SYSTEM.—

(1) IN GENERAL.—Not later than 2 years after the date of the enactment of this Act, the Under Secretary shall—

(A) assess the National Oceanic and Atmospheric Administration system for issuing watches and warnings regarding hazardous weather and water events; and

(B) submit to Congress a report on the findings of the Under Secretary with respect to the assessment conducted under subparagraph (A).

THIS REPORT RESPONDS TO THE COMMITTEES' REQUEST.

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I. Executive Summary

Congress has directed the National Oceanic and Atmospheric Administration (NOAA) to assess its system for issuing watches and warnings regarding hazardous weather and water events, as well as submit a report on the findings of that assessment. This report summarizes activities that NOAA has undertaken to assess the current hazard messaging system. The NOAA National Weather Service (NWS) has led an ongoing evaluation and improvement of its primary hazard messaging system since 2014. This system is called the *Watch, Warning, and Advisory* (WWA) system designed to convey expected hazard certainty and severity.

NWS forecasters use the WWA system to alert the public and its partners to the wide variety of weather- and water-based hazards that impact the Nation. These hazards include (but are not limited to) winter weather, tropical storms, fire weather, severe thunderstorms, tornadoes, flooding, and excessive heat/cold.

The WWA evaluation and improvement activities have been conducted under the umbrella of the NWS Hazard Simplification (Haz Simp) Project. As a key component of this project, NWS has engaged social, behavioral, and economic science expertise throughout each phase. Infusion of this expertise continues to advance project goals. NOAA has received a number of recommendations for WWA system improvement and is implementing and evaluating them, as appropriate. These main recommendations are:

- Simplify and shorten the text within the WWA messages.
- Reduce the number of individual messages or "products" that undergird the WWA system to reduce user confusion.
- Evaluate alternatives to the WWA system itself, including consideration of a hierarchical color and/or language approach.

This report documents the social science research that has led to the generation of these recommendations, outlines initial changes to the WWA system that have already been made as a result, and describes options for future change. All of these initial and proposed changes have been (and will continue to be) based on extensive collaboration across the *Weather, Water, and Climate Enterprise*.

The goal is an improved hazard messaging system to protect life and property, support the national economy, and enhance Impact-based Decision Support Services (IDSS) for NWS' core partners. In turn, this improved system will support NOAA's goal to build a "Weather Ready Nation."

This report is prepared in response to the direction provided by the Weather Research and Forecasting Innovation Act of 2017 (Public Law 115-25), which requires a report on improvements to NOAA's communications of hazardous weather and water events.

PLEASE NOTE: *This report covers the period April 2017-August 2019*.

II. Overview – What is the Watch, Warning and Advisory System, How is it Used, and What are the Issues?

The NWS mission statement is: *"The National Weather Service (NWS) provides weather, water, and climate data, forecasts and warnings for the protection of life and property and enhancement of the national economy."*

The WWA system was established to communicate expected levels of hazard certainty and severity, per the definitions shown in Figure 1. The system is used by forecasters at each of NWS' 122 Weather Forecast Offices (WFO) and some of its National Centers.[1] NWS and its partners disseminate messages using the system through a variety of means. A "Watch" is issued if a significant hazard *has the potential* to impact a given area but its occurrence and/or timing is not yet certain. A "Warning" is issued for *imminent or occurring* hazards that threaten life and/or property. An "Advisory" is also issued for imminent or occurring hazards that are less serious than a "Warning," but still could pose a hazard if caution is not exercised.

The WWA system has been in place in various forms since the 1950s; however, NWS has received feedback that the system can cause some confusion. Reasons for the confusion vary, but include: 1) both terms "Watch" and "Warning" begin with the letters "WA"; 2) the term "Advisory" does not have any specific connection to forecast certainty or expected severity; and 3) the three terms are often (and mistakenly) interpreted to be hierarchical with respect to each other.

Compounding the confusion is that, associated with the WWA terms, there is a suite of over 100 messaging "products" that have evolved over the years to specify certainty and severity for very specific hazards. Examples of these products include "Winter Storm Watch," "Coastal Flood Advisory," and "Excessive Heat Warning." Figure 2 depicts the original suite of NWS products, as of July 2017, arranged for visual convenience in a "Periodic Table of WWA" format (https://www.weather.gov/hazardsimplification/wwaperiodictable for the high-resolution version).

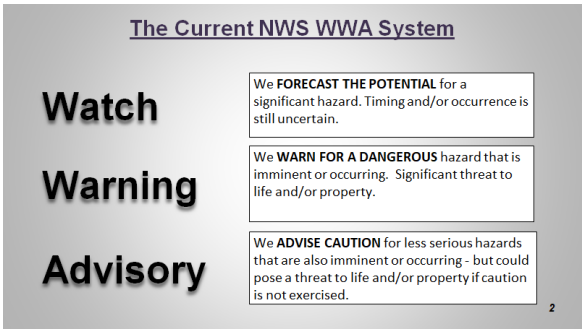

Figure 1: WWA System Definitions

[1] NOAA/NWS National Centers that issue messages using the WWA system include the National Hurricane Center, the Storm Prediction Center, and the National and Pacific Tsunami Warnings Centers. The Space Weather Prediction Center also issues alerts, but uses a different system.

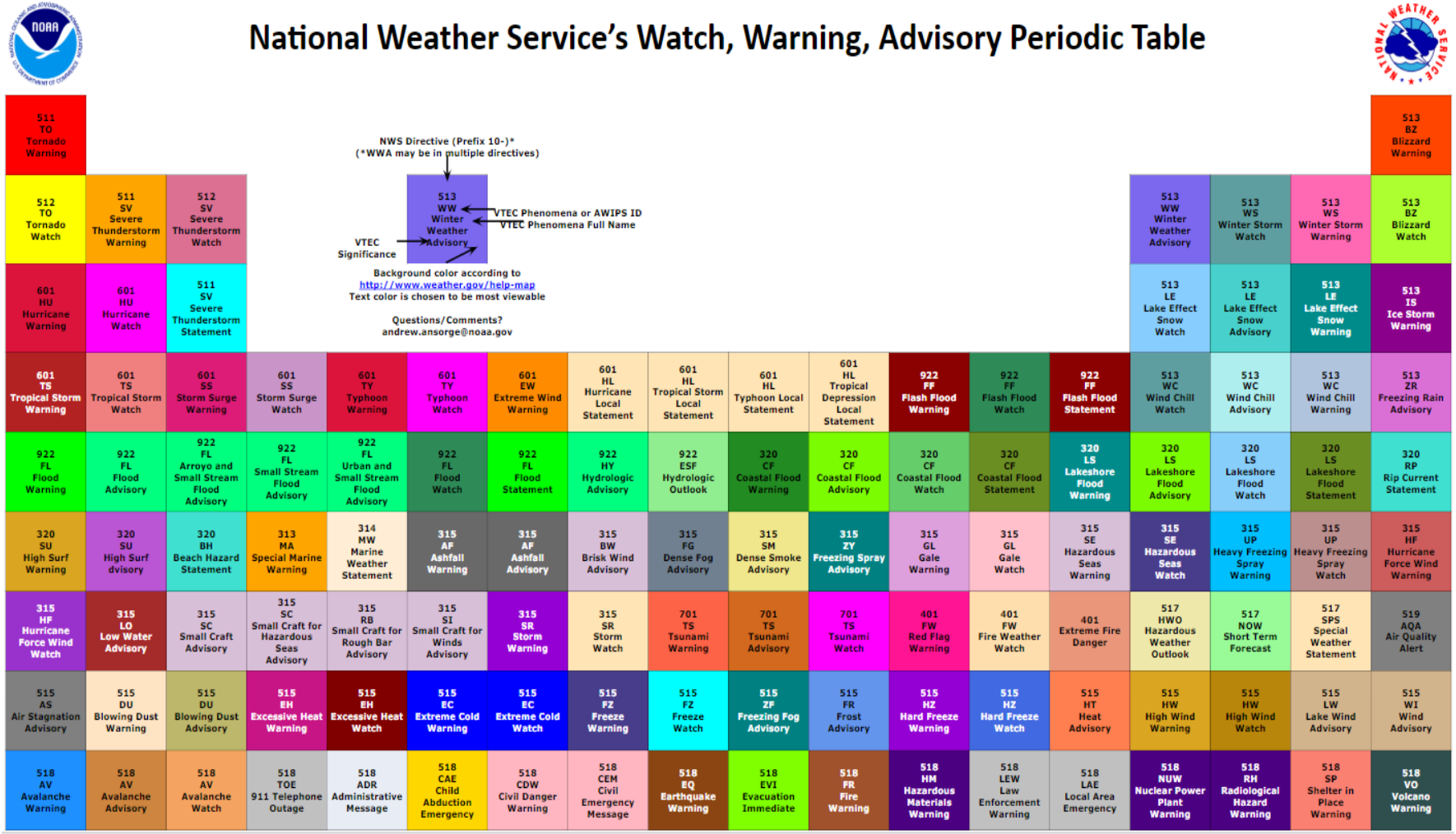

Figure 2: Depiction of NWS WWA Product Suite

Any confusion among the WWA terms and their associated products introduces mission risk. This is because hazard preparedness, assessment of risk, and inclination to take action based on the hazard messages NWS disseminates are critical for the protection of lives and property. These messages must be clearly (and intuitively) understood. Correct interpretation of NWS messages is essential for people to take appropriate action.

Based on the feedback NWS has received regarding WWA confusion among the public and even its partners, NWS initiated the Haz Simp Project. As a core project component, NWS engaged experts in the social, behavioral, and economic sciences (social science) to conduct a formal assessment of the WWA system and how people use the information from the system. Specific social science elements include exploring users' level of confusion with the WWA terms, recommendations for improving the current system, and identification of alternatives for a possible WWA system replacement.

III. Assessment

Including the wide variety of stakeholders that comprise the *Weather, Water and Climate Enterprise* was critical to assessing the WWA system. These stakeholders include NWS core partners, such as emergency managers, industry, broadcast media, as well as other Federal and state agencies (such as state departments of transportation). The National Academy of Sciences[2] encouraged NOAA, specifically the NWS, to fully integrate the social sciences and also encouraged "…investing wisely in research that addresses specific knowledge gaps… [including in] message design, delivery, interpretation and use." NWS applied this guidance designing surveys for the general public.

A. Social Science Engagements

A variety of engagement approaches were used to assess the consistency of the feedback received and to ensure wide participation across user sectors. These engagements are outlined below.

Phase 1: Multidisciplinary Focus Groups

Working with focus groups provided the initial groundwork for understanding the strengths and limitations of the present system. These focus groups, which were conducted between May and July 2014, included NWS forecasters, emergency managers, members of the media involved in weather information dissemination, and randomly selected members of the public. The findings of these engagements are documented in a report [3] from Eastern Research Group (ERG), Inc.

ERG traveled to four locations and held five focus groups at each location, for a total of 20 focus groups. The objectives of this activity were to: 1) gather initial feedback from a

[2] Integrating Social and Behavioral Sciences Within the Weather Enterprise, NAS 2017 Recommendation to Focus on Critical Knowledge Gaps

[3] https://www.weather.gov/media/hazardsimplification/Haz-Simp-Final%20-Focus-Group%20Report-Phase%20I-TO%20NOAA.pdf (Contract #EAJ33C-09-CQ-0034 Task Order #40).

variety of users on the current understanding of the WWA system; and 2) collect ideas for current system improvement and ideas for a possible future system. The main recommendation from the focus group interactions was to develop prototypes for testing with key stakeholder groups that included the current WWA (to serve as a control), a three-tier hierarchical system, and a four-tier system (that included an extreme event category). These prototypes featured a variety of options, such as threat levels, meteorological hazards, location, probability, calls to action (symbols, phrases, words), societal impacts (e.g., road closings, building damage, power outages), and timing of hazard onset.

Phase 2: Stakeholder Workshop and Testbed Activity

Stakeholder Workshop: This collaborative workshop, held in October 2015, engaged the *Weather, Water, and Climate Enterprise* to envision how the current WWA language might be revised to promote simplicity and clarity. This pivotal point in the project brought together a cross-section of NWS personnel with members of key partner groups and social scientists. The workshop resulted in initial prototypes coalescing around a three- or four-tiered hierarchical system. The results are documented in the workshop report.[4]

Testbed Activity: Following the workshop, in May-June 2016, three prototypes were tested as part of the 2016 Hazardous Weather Testbed (HWT) at NOAA's National Severe Storms Laboratory (NSSL) in Norman, Oklahoma. The testbed environment provided an opportunity to integrate the workshop prototypes and messaging into the NSSL's *Forecasting a Continuum of Environmental Threats* project, the goal of which is to create and display probabilistic hazard information through graphical threat grids.

During the three-week testbed, NWS forecasters, broadcast meteorologists, and emergency managers simulated an integrated warning team to test Hazard Simplification prototypes in the context of both past-event and real-time case studies of severe weather. Forecasters conducted these tests in a realistic operational environment, which included issuing and updating forecasts. Emergency managers logged actions they would take in response to the simulated forecasts, such as sending emails and sounding sirens. Broadcast meteorologists generated mock news segments that were shared with the other participants.

The study report[5] revealed that, because NWS forecasters were so accustomed to the current WWA system, they had some difficulty with the messaging of the alert-level language phrases and with mapping these phrases to meteorological criteria. From the partner perspective, the study revealed that emergency managers and broadcast meteorologists used different NWS information in different ways, but both groups relied more on graphical information than text.

[4] https://www.weather.gov/media/hazardsimplification/Final-Haz-%20Simp%20Workshop%20Summary-TO%20NOAA-2-26-16.pdf
[5] https://www.weather.gov/media/hazardsimplification/Final_HazSimp%20Testbed%20Report.pdf

The testbed environment offered an opportunity for NWS to gather new data in a unique way. Rather than asking participants what they thought about the current WWA system or what their ideas were for a future system, the testbed provided important insight into science, technology, human behavior, and organizational adaptability.

Phase 3: Institutionalization Survey and Partner "Case Study" Survey

Institutionalization Survey: This survey, conducted during September and October 2016, sought to examine the degree to which the WWA terms are embedded in laws, policies, contracts, procedures, and systems. This phase supported gathering feedback from organizations that use hazardous weather warning information. In particular, it enabled these organizations to provide feedback on the degree to which the terms "Watch," "Warning," and "Advisory" are embedded or "institutionalized" in their decision making, laws, policies, operating procedures, bylaws, and/or other activities or practice.

The survey included over 4,500 constituents in 32 different public sectors, including school systems, departments of transportation, utilities, and insurance companies. A number of key results were identified. First, the term "Warning" is most institutionalized among the three terms. Next, most organizations (>80 percent) surveyed responded that they could adjust to a new system if provided at least a year of advance notice. Overall, while the WWA terms are embedded in some policy, organizations expressed their ability to make necessary adjustments given sufficient notice.

While the results[6] of this survey were not generalizable, they did support continued exploration of alternatives to the WWA system terminology.

Partner "Case Study" Survey: In an effort to better understand how the NWS and its stakeholders perceive and use the current system, a survey was distributed during the summer of 2015 to NWS staff and partners. The survey was designed to address the following questions:

- What are the strengths and weaknesses of the current WWA system from a hazard messaging standpoint?
- How do perceived weaknesses relate to potential solutions?
- Do stakeholders want to change the current WWA language? How much change is desired?

Over 700 responses were collected as a result of this survey. Results[7] indicated there was a spectrum of agreement on the level of change required. For instance, emergency managers preferred the least amount of change, whereas forecasters and broadcast media were more open to larger scale adjustments. The greatest *strengths* of the current system were: 1) "Warning" is well recognized and effective; 2) WWA terms carry authority and

[6] https://www.weather.gov/media/hazardsimplification/Final%20Institutionalization%20Report_TO%20NOAA_2_2_17.pdf

[7] https://www.weather.gov/media/hazardsimplification/Final%20Report%20of%20the%20Case%20Studies_TO%20NOAA_9_2_a16.pdf

are able to initiate action; and 3) WWA terms and subsequent IDSS are powerful tools for planning and preparation. On the other hand, *weaknesses* of the current system include: 1) too many WWA product headlines and confusing product text; 2) rigid criteria and verification that can limit forecaster flexibility; and 3) anecdotal evidence of public and partner confusion over the meaning behind "Watch," "Warning," and "Advisory" terms.

Phase 4: Generalizable Public Surveys

These surveys were conducted in February-March 2018. This was the first time a series of surveys were deployed to collect *generalizable* public feedback on two key questions. In this context, the term "generalizable" implies that the results can be applied to all demographics and populations within the United States and, therefore, can be applied to support national decisions. The two questions targeted to be answered via the survey were:

- How well does the public understand the meaning of the WWA terms?
- Does there exist a new term or combination of terms that better promotes understanding and intended monitoring, preparation, and action as compared to WWA?

These questions were answered through a set of 10 public surveys that were conducted in February and March 2018, covering six distinct weather hazards. The surveys tested four prototypes for each hazard and each of the prototypes tested alternative language to the current WWA system. An "emergency" level was also tested for all hazards.

The hazards tested included: winter weather (for both mild and cold climates); thunderstorms; tornadoes; and land- and coastal-based flooding. There were nearly 9,500 responses collected from the public across a broad geography where these hazards are most prevalent.

In addition, a National Science Foundation Graduate Research Intern Program intern deployed three additional surveys that collected 1,079 responses for high winds and excessive heat (for both mild and cold climates).

The prototypes tested are shown in Figure 3 below. Note that, in each prototype, "X" represents each of the hazards tested (e.g., flood, thunderstorm, tornado, winter storm).

Level	Current System	Prototype 1	Prototype 2	Prototype 3	Prototype 4
Watch level	X Watch	X Outlook	X Notice	Possible X Event	Possible X Conditions
Advisory level	X Advisory	X Warning	X Alert	Moderate X Warning	Level Orange X Warning
Warning level	X Warning	X Warning	X Warning	Severe X Warning	Level Red X Warning
Emergency level	X Emergency	X Warning	X Emergency	Extreme X Warning	Level Purple X Warning

Figure 3: Four Prototypes Tested via the Generalizable Survey

Collectively, the surveys determined that a combination of prototypes 2 and 4 performed better in terms of hazard monitoring, preparation, and action as compared to the WWA system – and at a statistically significant level. Details on these findings are described in Section III.B below.

Based on these findings[8] (Generalizable surveys; Additional Surveys), NWS developed an engagement plan with its partners in the *Weather, Water, and Climate Enterprise* to work toward developing a single, candidate prototype that can be tested to assess operational feasibility.

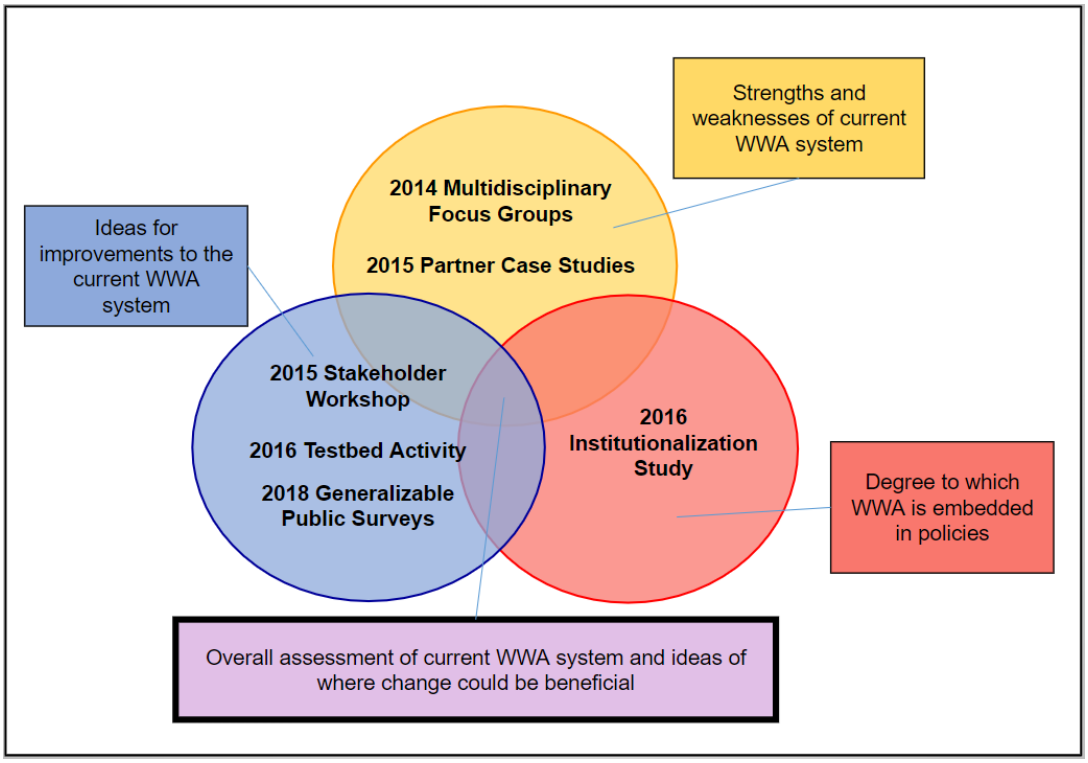

Figure 4: Summary of Social Science Engagements

B. Cross-cutting Themes Across Social Science Engagements

The collective social science effort described in the previous section has led to a holistic assessment of the current WWA system and impetus for change. Each research activity represented a logical and natural progression built upon the results of the previous effort. The diagram in Figure 4 summarizes the connection between each activity and the overarching goals. Through this process, several important and consistent themes emerged, spanning across engagement methods and stakeholders:

Approach change with caution: Participants have continued to stress the importance of cautious and well-informed change. Due to the institutionalized and far-reaching nature

[8] https://www.weather.gov/media/hazardsimplification/Final%20Report%20-%20HazSimp_WindsHeat.pdf

of the WWA system, it is important to fully understand the implications and ramifications of any change, large or small, before moving forward with change.

Refine the current system, but retain its strengths: There was a spectrum of opinions expressed by stakeholders on the level of change needed. The spectrum ranged from opinions supporting an entirely new system to others that no change is needed at all. However, a majority of the participants agreed that at least some refinement of the current system was needed.

Adopt both a short-term and long-term strategy: Discussion of shorter term change coalesced around two main objectives: 1) reducing the number of products; and 2) simplifying product text. At the same time, participants urged NWS to ensure that strengths of the current system be retained (such as the well-understood and institutionalized "Warning" term). Meanwhile, there was support to examine possible longer-term changes while these shorter-term changes are tested and implemented.

Large-scale change to the system should consider a variety of approaches: Examination of the current system was seen as an opportunity to explore unique and creative approaches to conveying weather and risk information. While there was little consensus over what a new system should look like, there was agreement that a variety of approaches should be explored equally. These included using color and/or language to express hierarchy, tiers of "Warning," symbols to express the hazards, and entirely new language to replace "Watch," "Warning," and/or "Advisory."

Explore large-scale change of the system through prototype testing: There was consensus from participants that any major rebuild of the WWA system must be fully tested and vetted with the public and the broader *Weather, Water and Climate Enterprise*. Participants stressed that NWS must understand how a new system would operationally function not only from a technical standpoint, but also from a social perspective.

IV. Integrating Social Science Findings into Hazard Messaging Improvements

As described in the previous section, there were a number of recurring themes that emerged from Haz Simp project social science engagements that have taken place since 2014. These themes fell into two categories: 1) recommended short-term improvements that could be applied to the current WWA system ("Repair"); and 2) potential longer-term improvements that could result in a "Revamp" of the WWA system.

NWS has already dedicated considerable attention to the recommendations for WWA "Repair" offered by social science. In fact, some initial changes have already been made and plans are now being developed to implement additional short-term improvements over the next 2 years. These changes are detailed in Section IV.A, below.

Meanwhile, NWS continues to conduct engagement activities based on the results of the Generalizable Survey to assess whether the proposed major changes to the WWA system are warranted. These ongoing activities are described in Section IV.B, below.

Before any major changes to the WWA system could be implemented, it is necessary to take full account of the variety of challenges that would need to be overcome. Such challenges include accounting for the level of WWA institutionalization, changes that may be required to international treaties, alignment with other Federal agencies across multi-disciplinary systems (e.g., Wireless Emergency Alerts), NWS forecaster training, internal policy restructuring, and the broad need for public and partner outreach and education.

A. Ongoing Short-Term Improvements to the WWA System (WWA "Repair")

Recurring comments from the focus groups, surveys, and 2015 Workshop provided key recommendations that are already being implemented within NWS operations. The most important of these is to reduce the number of WWA products ("Consolidation"), as well as shorten and simplify the message text within these products ("Reformatting").

These changes are being planned and implemented in a nationally consistent manner across a variety of hazards. As a matter of policy, NWS ensures that comments are collected from partners and the public and are fully analyzed before any changes are made to operational information (products and/or services).

"Reformatting" Within WWA Products

The project also examined WWA message formats used across its 122 WFOs and found that a wide variety of messaging techniques are used. While recognizing that some variety in messaging is required to account for local needs, social science supported the implementation of common messaging systems that could be applied across a variety of NWS hazards.

NWS is reusing two such systems: 1) a "What," When," and, "Where" (or "3W") messaging approach for long-duration hazards such as winter storms and heat events; and 2) an Impact-Based Warning ("IBW") approach for short-duration hazards such as tornadoes and flash floods, featuring "Hazard," "Source," and "Impact" bullets. Social science research indicates that these concise, shortened, consistent messaging approaches enable NWS partners and the public to quickly assess key elements of the hazard to support their decision-making.

Social science also indicated that emergency managers are very well briefed by WFOs on expected hazards in advance of significant events, so they are less concerned with the WWA products headlines and more interested in the "What" of the message. An example of a reformatted *Winter Storm Watch* is provided in Figure 4, below.

Note that the phrase "Heavy snow possible" is used within the "What" section of the message. All NWS "3W" messages now contain the word "possible" in association with any "Watch," and "expected," "occurring," or other language conveying imminence in "Advisories" and "Warnings." We expect this change alone will support improved understanding of the intended messages within the reformatted WWAs.

* **WHAT**...Heavy snow possible.

* **WHERE**...Bradford County

* **WHEN**...From this evening through late Friday night.

* **ADDITIONAL DETAILS**...Plan on difficult travel conditions

Figure 5: Example of a Reformatted Winter Storm Watch

"Consolidation" of WWA Products

The first WWA consolidation and reformatting effort, implemented in October 2017, was applied to NWS' winter product messaging suite. The changes, depicted in Figure 5, reduced the number of winter precipitation products to one *Winter Storm Watch* and one *Winter Weather Advisory*.

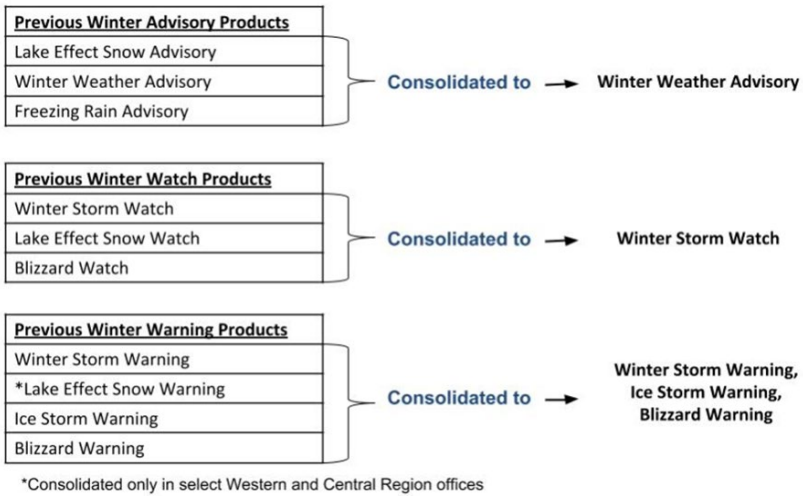

Figure 6: Consolidation of NWS Winter WWA Product Suite (October 2017)

In addition, given that the *Lake Effect Snow Advisory Watches and Warnings* were consolidated into *Winter Storm Watch* and *Winter Weather Advisory*, respectively, WFOs near the western Great Lakes tested consolidation of *Lake Effect Snow Warning* into *Winter Storm Warning*. Given the positive reaction to this change, WFOs near the Eastern Great Lakes followed suit during the winter of 2018-19.

Additional surveys for similar consolidation and reformatting have also been conducted for products within the Marine, Wind, Heat, Cold, Visibility and Flood WWA product suites, and additional, similar "3W" reformatting and consolidation efforts are planned in association with the deployment of new NWS warning software planned for 2020-21.

B. Options for Longer-Term Change to the WWA System

The results from the sets of generalizable surveys were both important and actionable. First, the results confirmed that the WWA terms are poorly understood across many hazards. Since the surveys employed a representative sample, the level of understanding demonstrated within this study can be extrapolated to the broader U.S. population.

Respondents to the survey were asked to indicate their knowledge of the WWA system across a variety of hazards by answering multiple choice questions with three available answer choices. The questions either provided the definition of each specific WWA term and asked them to match it to the term, or vice-versa.

Given the nature of the questions asked and the number of choices available, a random guess would have yielded a 33.3-percent understanding rate. The results, as provided in Figure 6, below, indicate the user understanding is poor across many hazards. Note, in particular, the poor results most-closely associated with the Advisory terms. These results are consistent with recurring feedback from our social science engagements that "Advisory" is the least understood of the three WWA terms.

	Correct Understanding of Current Terms			
Hazard	**Watch**	**Advisory**	**Warning**	**Emergency**
Winter	69.8%	16.0%	43.5%	*N/A*
Thunderstorm	43.5%	24.3%	56.8%	*N/A*
Tornado	67.3%	*N/A*	70.6%	28.9%
Coastal Flooding	41.6%	44.4%	55.6%	*N/A*
Flash Flooding	50%	*N/A*	64.5%	62.2%
Areal Flooding	44.4%	42.6%	43.6%	*N/A*

Figure 7: Level of WWA Term Understanding Across Various Hazards

Second, the surveys indicated there exists a prototype alternative which performs better than WWA in terms of public preparedness, risk assessment and action response. This result was noted at a statistically significant level.

The specific prototype identified for further study in the report was selected based on rigorous statistical analysis, which processed survey respondent reaction to each of four prototypes as alternatives to WWA. These prototypes, which were devised based on feedback from the totality of the social science work, were depicted in Figure 3 earlier (Section II.A, Phase IV) and are provided here again for convenience.

Level	Current System	Prototype 1	Prototype 2	Prototype 3	Prototype 4
Watch level	X Watch	X Outlook	X Notice	Possible X Event	Possible X Conditions
Advisory level	X Advisory	X Warning	X Alert	Moderate X Warning	Level Orange X Warning
Warning level	X Warning	X Warning	X Warning	Severe X Warning	Level Red X Warning
Emergency level	X Emergency	X Warning	X Emergency	Extreme X Warning	Level Purple X Warning

Repeat of Figure 3: Generalizable Survey Prototypes Tested as WWA Alternatives

Distinct surveys were created for 10 different hazards, including winter weather (for both mild and cold climates), thunderstorms, tornadoes, coastal flooding, areal flooding, flash flooding, wind, and excessive heat (for both mild and cold climates). Surveys for each hazard were administered in geographically relevant sectors of the country, as appropriate.

Each of prototypes shown above tested specific elements of importance to an effective hazard messaging system. For example, Prototype 1 tested the importance of changes to the headlines, as changes in expected severity were conveyed only in the "What" section of the message text. Prototype 2 tested alternatives to the "Watch" and "Advisory" terms. Prototypes 3 and 4 tested hierarchical severity language and color terms respectively. A variety of terms were tested as an alternative to the "Watch" term among the prototypes.

To evaluate the prototypes, respondents were asked to consider a realistic scenario for the given hazard as it evolved through hypothetical stages of development. This evolution included a "Watch-level" event becoming "Advisory-level," then upgrading to a "Warning" before ending. Each respondent was provided two prototypes, with some seeing the control WWA system as one of the prototypes.

The overall result of the survey analysis across the hazards tested is that certain elements of Prototype 2 and Prototype 4 performed the best at a statistically significant level. As shown in Figure 7, below, the term "Notice" was preferred to "Watch," the hierarchical color words "Level Orange Warning" and "Level Red Warning" resulted in a more pronounced change in action than "Advisory" and "Warning," and the term "Emergency" tested best for the most urgent events. As a result, a combined prototype, using the most successful elements of Prototypes 2 and 4, was recommended for further testing.

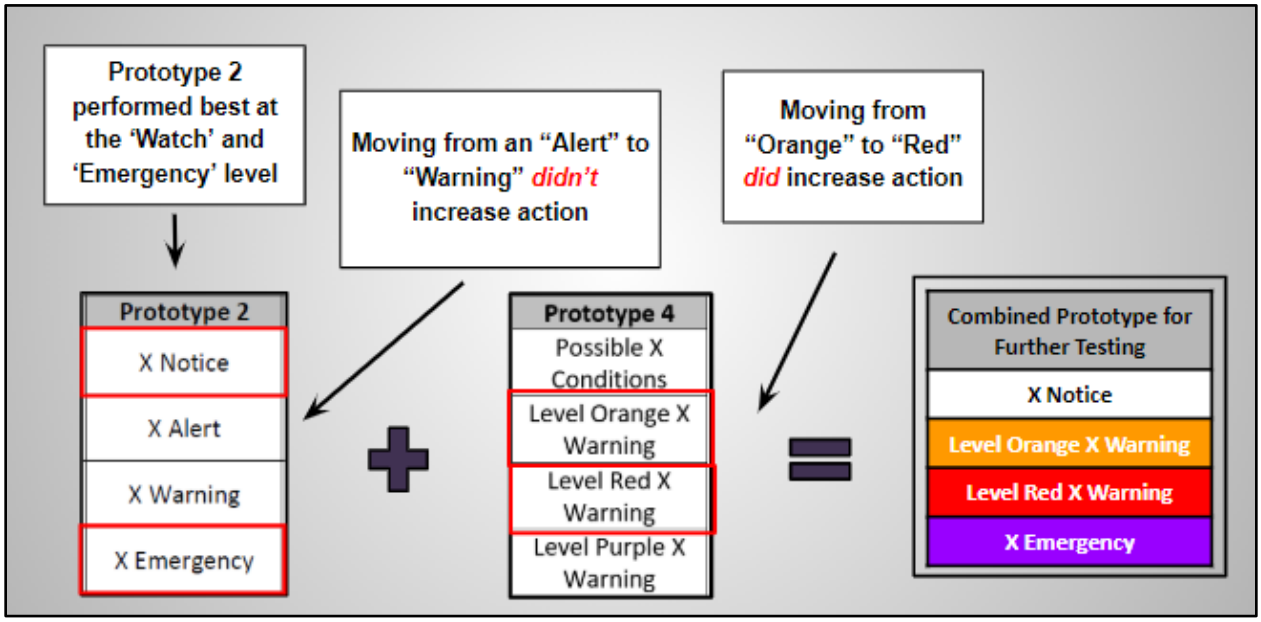

Figure 8: Preferred Prototype from Generalizable Survey

While the survey results are compelling, the only way to assess whether this system can be of improved utility to the public and NWS partners is to conduct additional, broad-scale engagement across hazards.

V. Recently Completed and Planned Activities in Response to Congressional Direction

A series of activities are underway to further assess the overall desire for, and feasibility of, a major change to the WWA system. Recently completed and planned activities are detailed below.

A. Stakeholder Engagements (November 2018 – April 2019)

A series of focus groups were designed to enable live feedback on the recommended prototype alternative to WWA. Participants of these focus groups included NWS forecasters, local broadcasters, emergency managers, and other key stakeholders such as departments of transportation, school system officials, and utility representatives. Separate focus groups were held for each of these stakeholder communities.

The goal of these engagements was to test user reaction to a set of realistic scenarios depicting the use of the recommended prototype and assess whether reaction merits further exploration. A secondary goal was to refine the prototype to enable further exploration at a multidisciplinary workshop to be held this year to further evaluate the prototype (see Section IV, below).

Focus groups were held at the following locations: Louisville, Kentucky; Miami, Florida; Anchorage, Alaska; Sterling, Virginia; Wakefield, Virginia; and Norman,

Oklahoma. In addition, webinars and remote engagements were held for broadcasters, Weather Enterprise partners, and Spanish-speaking communities. A graphic depicting the full level of user engagement is provided in Figure 8:

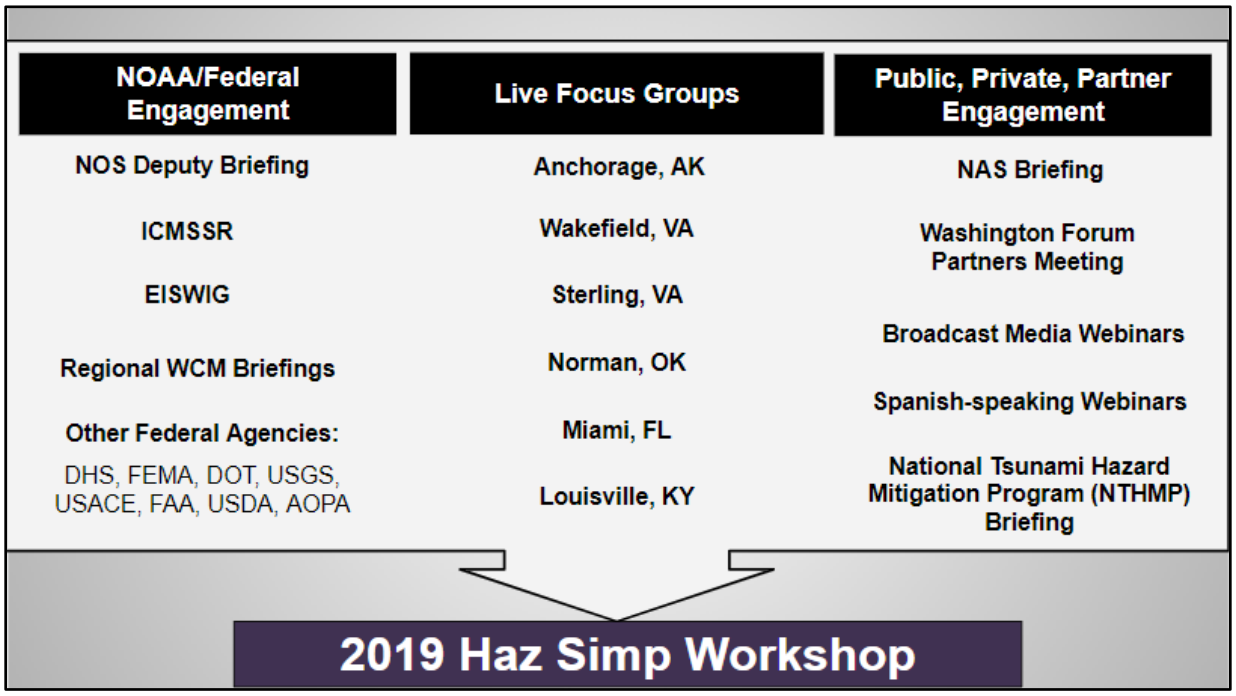

Figure 9: Recent User Engagements (Fall 2018 – June 2019)

B. Stakeholder "Revamp" Workshop (Fall 2019)

The results of the engagements described above is driving the content of a stakeholder workshop planned for the fall of 2019. By this time, we expect to define a final version of the prototype ready for in-depth examination. Attendees of the workshop will be asked to examine actual, past complex weather scenarios across a variety of hazards and to translate communication of these hazards from WWA to the final version of the prototype. This approach was very effective in the initial workshop conducted in 2015.

Attendees will also be asked to examine the impact of the proposed change on a number of key areas of concern. These areas will include any impacts on dissemination protocols (such as NOAA Weather Radio and Wireless Emergency Alerts), NWS-internal policy that governs issuance of hazardous messaging, NWS software that forecasters use to issue these messages, forecaster training, and user outreach. The results of this workshop will drive the next steps of the project, which include integrated, live testing among key users groups such as emergency managers and broadcasters, as well as testing using actual operational warning software used by NWS forecasters.

C. Integrated User and Non-Operational Testing

The output from the 2019 workshop will provide important information regarding the details underlying the proposed prototype that will require in-depth, follow-on testing. The project is being coordinated with HWT in Norman, Oklahoma, and the NWS Operations Proving Ground (OPG) in Kansas City, Missouri, to discuss post-workshop activities.

HWT supports creation of scenarios using the final prototype that can be tested in a simulated real-time environment. This environment simulates creation of actual hazardous messaging products by forecasters, with emergency managers and broadcast media providing response and feedback. The first HWT experiment (Section II.A, Phase II) successfully refined and tested alternative language before large-scale testing with the general public was conducted. This future activity will enable testers to assess strengths and weaknesses of the finalized prototype in a simulated operational setting and provide feedback to the project regarding any adjustments that should be made to optimize it.

Meanwhile, OPG enables forecasters to create actual products using NWS' new warning software (Hazard Services) that will be deployed across NWS starting in 2019. This new software, which is being deployed independent of the Hazard Simplification efforts, will enable all products to be issued on the same platform and enable more forecaster flexibility in specifying warning areas. Any changes made to the current WWA system will need to function within this new environment.

Based on the pending implementation of Hazard Services, it is imperative the prototype is fully tested for any technical concerns. As with HWT, this process will enable testers and forecasters to assess whether the software will enable full and effective use of the prototype as designed. This testing environment will enable NWS to submit any needed requirements for changes to this new warning software in order to fully enable use of the prototype as intended.

D. Project Timeline Summary

Figures 9 and 10 provide an overview the project timeline from the time of this report through 2023 to cover the "Repair" and "Revamp" efforts, respectively.

Figure 9 provides a range of dates for each component of the "Consolidation" and "Reformatting" effort for each of the hazards that will be treated. A range of dates is provided to account for the time it takes to implement the new software required to enable to changes nationwide.

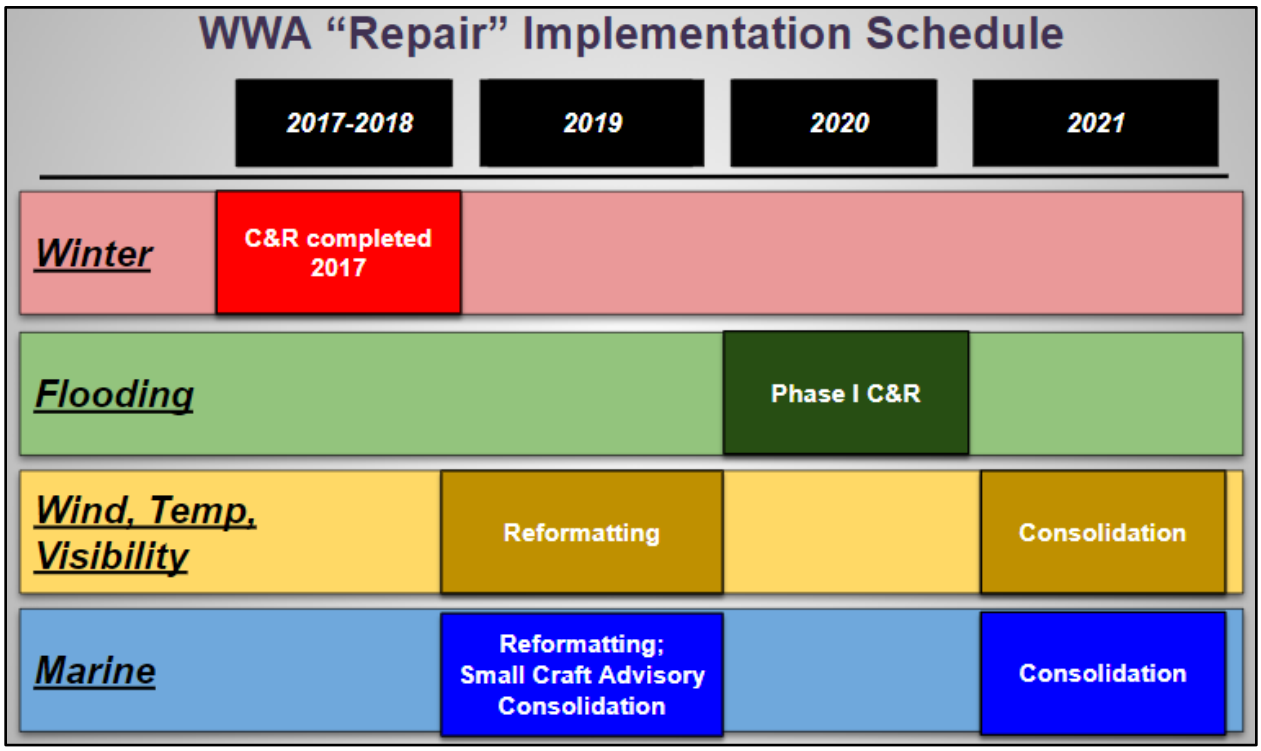

Figure 10: Summary of Planned WWA "Repair" Activities through 2021

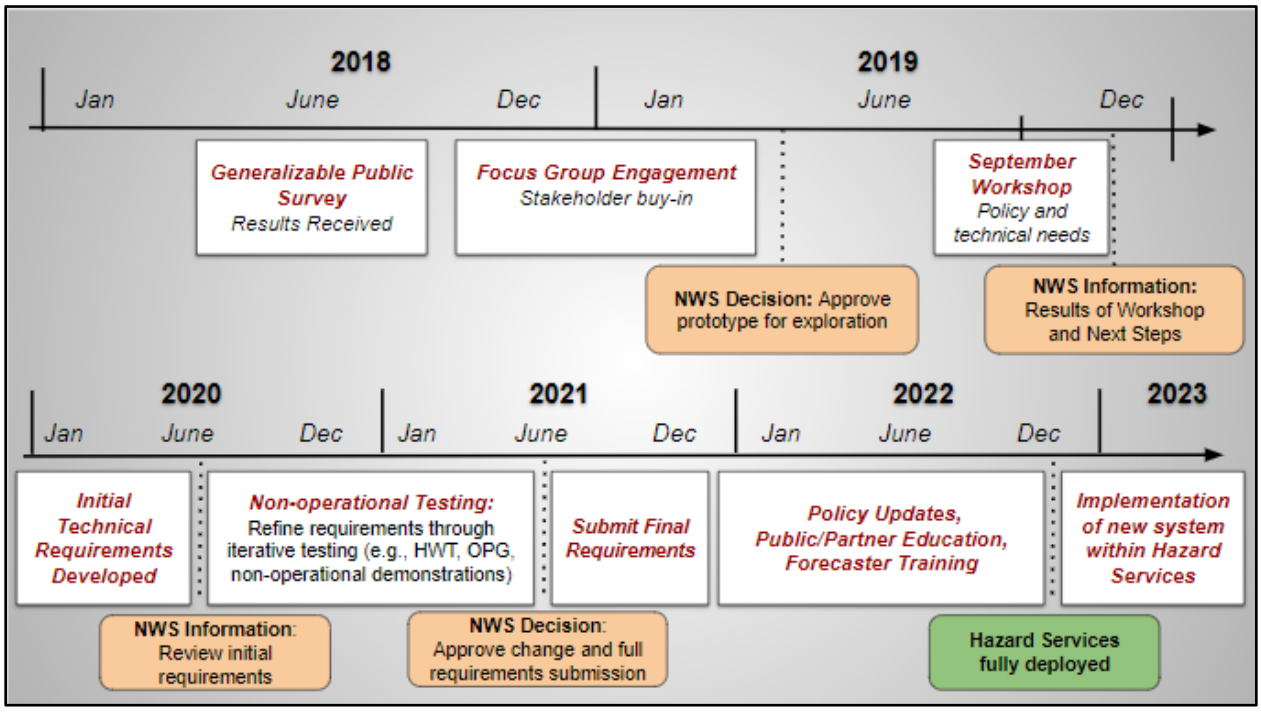

Figure 11: Summary of Planned WWA "Revamp" Activities through 2023

Figure 10 depicts all of the social science engagements, past and future, as part of the WWA improvement project. The figure details integrated user and operational testing, the required development of detailed technical requirements, policy changes, user outreach, and forecaster training that will be required to implement a new system.

Timelines shown in both Figures 9 and 10 are subject to adjustment based on the exact nature of any "Revamp," as well as other unanticipated delays, such as those related to needed software development.

V. Summary

The NWS WWA system has alerted the public and NWS partners of expected weather and water hazards for many decades. However, there is now considerable evidence that many find the system confusing, and any confusion during high-impact weather and water events places protection of life and property at risk.

NWS initiated the Haz Simp Project to assess options for improving the WWA system and to evaluate the potential benefits of any change, being mindful of the cost and effort to implement a new system. Analysis of social science results conducted since 2014 indicate that a simplification of the WWA system via product consolidation and reformatting is widely supported. Accordingly, the project has already implemented these changes for winter products, and additional consolidation and reformatting is planned across the product suite over the next 3 years.

In addition, the project has charted a course to evaluate a possible larger change to the WWA system. User feedback will drive finalization of the proposed prototype as an alternative to WWA. A stakeholder workshop in fall 2019 will facilitate a full evaluation of issues related to policy, software, dissemination, training, and outreach that would need to be addressed before any change could be made. Rigorous non-operational testing of the prototype will be required before any final decision is made regarding change. Finally, it is imperative that NOAA fully ascertain whether the benefit realized by making any major changes to the WWA system is ultimately worth the effort and cost to do so. The goal of any changes made to the WWA system is to enhance protection of life and property in line with NWS' mission.