NWS Central Region Service Assessment

Enbridge Oil Spill – Marshall, MI (2010)

U.S. DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

National Weather Service, Central Region Headquarters

WFO Grand Rapids, Michigan

WFO White Lake, Michigan

North Central River Forecast Center

Cover Photo – Aug 8, 2010: Workers are cutting out the section of 30 inch pipe that ruptured on the morning of July 26, 2010 spilling nearly one million gallons of crude oil into Talmadge Creek and the Kalamazoo River at Marshall, MI.

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National Weather Service, Central Region Headquarters
Lynn Maximuk, Regional Director

Preface

On July 26, 2010 a 30 inch pipeline, owned by Enbridge Energy Partners LP, ruptured in Marshall, MI spilling one million gallons of crude oil into Talmadge Creek and the Kalamazoo River. The crude oil inundated wet lands and private property along a 30 mile reach of the Kalamazoo River that included the City of Battle Creek. Toxic Benzene fumes emanating from the crude oil resulted in the evacuation of 61 homes and a trailer park with hundreds of persons treated for fume related illnesses at area urgent care centers and hospitals. Damage and cleanup costs are expected to exceed $300 million.

NOAA/National Weather Service was asked to provide Impact-Based Decision Support Services to the State of Michigan's Emergency Operations Center in Lansing, Michigan immediately following a State Disaster Declaration by the Governor of Michigan, Jennifer Granholm on July 28, 2010. The U.S. Environmental Protection Agency assumed the role of Federal On-Scene Coordinator and established an Incident Command Post in Marshall, Michigan to facilitate the containment and clean-up of the spill, and the subsequent environmental restoration of the creek, river, and adjacent wetlands impacted by the oil. National Weather Service began providing Decision Support Services for the Incident Command Post on July 28, 2010 and established on-site support beginning July 30, 2010. NOAA's Office of Response and Restoration also began on-site support beginning July 29, 2010. NWS on-site Impact-Based Decision Support Services continued through November 8, 2010 with remote support continuing as of the writing of this report.

Due to the magnitude and longevity of decision support resources provided to the response and its relevance to NOAA's 2020 strategic goal of a Weather-Ready Nation, a regional service assessment team was commissioned to examine the products and services provided to the State of Michigan's Emergency Operations Center and the U.S. Environmental Protection Agency's Incident Command Post from the beginning of the event in late July through early November 2010. Service assessments provide a valuable contribution to ongoing efforts by the National Weather Service to improve the quality, timeliness, and value of products and services. Findings and recommendations from this assessment will improve techniques, products, services, and information provided to partners and the American Public.

Lynn P. Maximuk
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National Weather Service

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Acronyms

ARL	OAR Air Resources Laboratory
CHPS	Community Hydrologic Prediction System
COO	Chief Operations Officer
CRREL	Cold Regions Research and Engineering Laboratory
CWA	County Warning Area
DARRP	Damage Assessment, Response, and Restoration Program
EM	Emergency Manager
EOC	Emergency Operations Center
ER	Emergency Response
ERD	OR&R Emergency Response Division
ESF	Emergency Support Function
FEMA	Federal Emergency Management Agency
FOSC	Federal On-Scene Coordinator
GLERL	NOAA Great Lakes Environmental Research Lab, Ann Arbor MI
GNOME	General NOAA Operational Modeling Environment
HAZMAT	Hazardous Materials
HSPD	Homeland Security Program Directive
HYSPLIT	Hybrid Single Particle Lagrangian Integrated Trajectory Model
IAP	Incident Action Plan
IC	Incident Commander
ICP	Incident Command Post
ICS	Incident Command Structure
IDSS	Impact-Based Decision Support Services
IMETS	Incident Meteorologists
MIC	Meteorologist in Charge
MIDNRE	Michigan Department of Natural Resources and Environment
MISEOC	Michigan State Emergency Operations Center
MSPEMD	Michigan State Police Emergency Management Division
NCP	National Contingency Plan

NCRFC	North Central River Forecast Center, Minneapolis MN
NDFD	NWS National Digital Forecast Database
NIMS	National Incident Management System
NMFS	NOAA National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOS	NOAA National Ocean Service
NRDA	Natural Resource Damage Assessment
NRF	National Response Framework
NWS	National Weather Service
NWSI	National Weather Service Instruction
NWSRFS	NWS River Forecast System
OGC	Office of General Counsel
OPA	Oil Pollution Act of 1990
OR&R	NOAA Office of Response and Restoration
PRFA	Pollution Removal Funding Agreement
RD	Regional Director
SOO	Science and Operations Officer
SOP	Standard Operating Procedures
SSC	NOAA Scientific Support Coordinator
USACE	US Army Corp of Engineers
USCG	United States Coast Guard
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
VOC	Volatile Organic Compound
WCM	Warning and Coordination Meteorologist
WFO DTX	Weather Forecast Office Detroit/White Lake MI
WFO GRR	Weather Forecast Office Grand Rapids MI

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Executive Summary

The Enbridge Oil Spill was the longest Impact-Based Decision Support Service (IDSS) initiative undertaken by National Weather Service's (NWS) Central Region to date. The initial support effort lasted three months and involved the Grand Rapids and Detroit/Pontiac Weather Forecast Offices, the North Central River Forecast Center, the Central Region Headquarters Regional Operations Center, and 15 National Weather Service Emergency Response (ER) personnel. NWS personnel provided critical meteorological and hydrological forecasts that facilitated the containment and cleanup of the crude oil; and the safety of all responders during excessive heat/cold, severe weather, and flooding hazards. Feedback from the principle responders (US Environmental Protection Agency (USEPA), Michigan State Police Emergency Management Division (MSPEMD), and Enbridge Energy Partners L.P.) has been overwhelmingly positive.

The USEPA led the Federal response under the direction of the National Response Framework (NRF) – Emergency Support Function (ESF) #10: Oil and Hazardous Materials Response Annex. ESF #10 is carried out in accordance with the National Oil and Hazardous Substance Pollution Contingency Plan (NCP), 40 CFR Part 300. Under this plan either the USEPA or US Coast Guard (USCG) act as the Federal On-Scene Coordinator (FOSC) and have authority to direct the clean-up of the spill. The USEPA has authority for inland spills and the USCG has authority for spills that occur in coastal regions or in navigable waterways. Further, the Oil Pollution Act of 1990 holds the polluter responsible for damages and importantly for clean-up costs in a manner consistent with the National Contingency Plan.

NOAA has previously played two critical roles in response to any given oil spill. Under the direction of NCP, NOAA provides a Scientific Support Coordinator (SSC) at the request of the FOSC. The SSC is responsible for obtaining consensus on scientific issues, affecting the response, communicating differing opinions, and resolving conflicting scientific information within the scientific community to the Incident Commander (IC). NOAA SSCs are part of the National Ocean Service Office of Response and Restoration (NOS/OR&R) and are typically collocated with USCG District Offices. Secondly, under the direction of the Oil Pollution Act of 1990 (OPA) and Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA/Superfund), NOAA is one of several trustees responsible for restoring the integrity of natural resources harmed by a spill. As a trustee, NOAA has developed the Damage Assessment Response & Remediation Program (DARRP) to fulfill is responsibilities as directed by CERCLA and OPA. The DARRP program includes resources from NOS/OR&R, National Marine Fisheries Service (NMFS) Office of Habitat Conservation, and the NOAA Office of General Counsel for Natural Resources.

Acting within statutory requirements and the National Incident Management System (NIMS) framework, the USEPA established a Unified Command and Incident Command Post

(ICP) in Marshall, MI, to direct and control the response and clean-up of the spill. Under the Oil Pollution Act of 1980, the polluter is responsible for damages and clean-up costs of an oil spill. USEPA was allocated $27 million from the U.S. Oil Spill Liability Trust Fund to direct clean-up of the spill. Oil companies such as Enbridge Energy L.P. regularly pay royalties into the trust fund to cover U.S. Government response and clean-up costs.

NWS was approved for reimbursement for IDSS services provided in association with the spill response. The USEPA approved a Pollution Removal Funding Agreement (PRFA) with NWS on the first day of NWS on-site support at the Marshall ICP. NWS subsequently tracked expenses incurred for on-site and remote services in support of the spill response and clean-up.

The USEPA Incident Commander met with the NWS Central Region Director on October 19. The IC expressed how impressed he was with the professionalism, dedication, and overall quality of the services provided by the NWS throughout the event. He felt NWS IDSS was critical to the success of their response to the oil spill. He concluded with an expression of gratitude and an expectation that NWS would provide such services to the USEPA for future events.

An identified priority must be to build on the present success moving forward. To meet the next request, the assessment team identified 25 recommendations that focus on the following four critical themes:

Pre-Event Preparation and the Integration of NOAA Resources are Critical to the Success of IDSS during the Initial and Expanding Phases of a Disaster Response

NWS should identify and educate key disaster-response agencies such as USEPA, Federal Emergency Management Agency (FEMA), U.S. Coast Guard (USCG), and State Governments on the decision support capabilities of the NWS. These agencies should be strongly encouraged to formally include NWS support in incident pre-planning, exercises, and Standard Operating/Contingency Plans. Secondly, the NWS should work with OR&R to explicitly outline the role of NWS in spill response efforts within the publication “An FOSC’s Guide to NOAA Scientific Support”. Lastly, a set of NOAA response protocols and exercises should be established with the NOAA Disaster Response Center to organize a collaborated NOAA response to natural and man-made disasters in the Great Lakes, utilizing ICS principles and adhering to a set of national response protocols.

NWS Can Quickly Organize Large-Event IDSS by Codifying the Role of the Regional Operation Centers, Weather Forecast Offices, and River Forecast Centers

The role of the Regional Operations Center (CRH-ROC) is analogous to that of an Emergency Operations Center (EOC) in the NIMS framework. The primary functions of the CRH-ROC as an EOC function should include: the jurisdictional oversight of IDSS services provided by Central Region Offices; the establishment of an NWS Incident Lead; the provision of logistical support for the responding offices; the coordination of response activities with other NOAA/NWS offices; and the submission of regularly scheduled situation reports to senior NOAA/NWS management.

A key EOC function is the establishment of an NWS Incident Lead to quickly establish a coordinated and consistent NWS response posture for a given incident. This was particularly important in the Enbridge Oil Spill where multiple offices became involved in the first 48 hours of the response. Specifically, the NWS Incident Lead acts as a single point of authority to track and coordinate efforts of the response teams; acquire logistical support; and manage information flow. Quite frequently, the NWS Incident Lead will initially reside within the Regional Operations Center (CRH-ROC) while WFOs and RFCs concentrate on establishing the actual IDSS. However, the NWS Incident Lead should be relocated to the primary ICP as soon as is reasonable where on-scene coordination with the event IC can be most effectively accomplished.

A Fast and Effective IDSS Requires Established Deployment Protocols and Training Requirement for NWS Emergency Response Personnel

There are several steps that can be taken to enhance the fidelity of staffing in future events. Initial deployments need to be aggressive and include an NWS Incident Lead and NWS Emergency Response (ER) Personnel assigned to provide on-site and/or remote IDSS. Standard operating procedures should be established to accomplish the following: procedures to staff a remote decision support desk at each WFO/RFC that provides information to deployed NWS staff at the ICP; procedures establishing lengths of deployments and rotation of response personnel; and guidelines for recalling key personnel or providing persons to backup key positions. NWS should also build a set of response deployment and training protocols which establish a cadre of well- qualified ER Personnel to provide IDSS at a significant oil spill or HAZMAT release under the auspices of the National Response Framework – ESF 10.

The Value of NWS IDSS can be Enhanced by Customizing IDSS Toolsets and Information Content/Delivery

NWS ER Personnel demonstrated a sustained and high degree of professionalism throughout all phases of support to both the State of Michigan and the USEPA. This established the NWS as reputable, trustworthy, and highly valuable asset in the view of the incident Unified

Command. This was done by consistently meeting requests for critical weather and water support over the length of the response. The greatest value of NWS service came when customer needs were anticipated and served by highlighting critical weather and water impacts to their operations.

Resources and tools must be sufficient at the ICP to empower NWS ER Personnel with the knowledge to complete the IDSS mission. Information provided to all supporting response functions must be consistent with that provided to the IC in order to ensure a common operating picture to all on-site and remote response personnel. When severe weather approached the ICP on September 21 and WFO GRR issued warnings, the IC called the NWS ER person to request their expert counsel. By ICS design the ER Personnel are not merely a messenger for WFO and RFC products – they are the service, the expert, the authoritative source.

NWS ER Personnel must always have access to the latest forecasts, a variety of observational datasets and access to supporting numerical guidance. Additionally, NWS should provide improved tools for reconciling, customizing, and presenting "what we know and what they need to know" in ways "they can easily interpret and understand". NWS should invest resources into identifying applications (such as smart phones and tablets) that accomplish dynamic visualization from NDFD grids, rapid refresh numerical guidance and other information sources.

Service Assessment Report

Event Overview

On July 26, 2010, a 30 inch pipeline, owned by Enbridge Energy Partners LP, ruptured in Marshall, Michigan, spilling one million gallons of crude oil into Talmadge Creek and the Kalamazoo River. The spill was exacerbated by the fact that the Kalamazoo River was flowing at a high stage due to above normal rainfall over June and July. The Kalamazoo River flows from east to west and empties into Lake Michigan. The crude oil inundated wetlands and private property along a 30 mile reach of the Kalamazoo River from Marshall to Morrow Lake. The affected area included the City of Battle Creek and parts of Calhoun and Kalamazoo counties. The spill area is located in the southern part of the lower peninsula of Michigan and is within the County Warning Area (CWA) of WFO Grand Rapids (**Figure 1**).

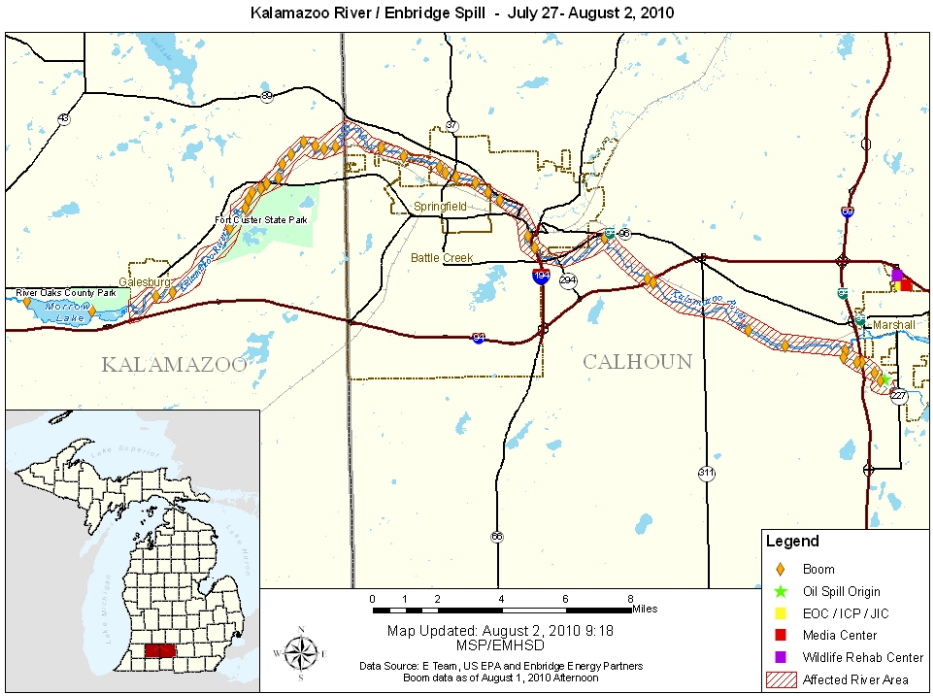

Figure 1 - Spill response area

The ruptured pipeline, segment 6B, is part of the 4,700 mile system of pipelines that has supplied crude oil from western Canada to refineries in the upper Midwest and throughout the Great Lakes over the past 60 years. Line 6B is a segment of the Lakehead System that carries oil from Griffith, Indiana to Sarnia, Ontario. At maximum capacity, Line 6B can transport 283,000 barrels (11.9 million gallons) per day. Prior to the rupture, Line 6B was operating at a reduced capacity due to issues identified during previous routine inspections.

The response phase of the spill for National Weather Service (NWS) began on July 27 after the activation of the Michigan State Emergency Operations Center (MISEOC) and the U.S.

Environmental Protection Agency's (USEPA) establishment of an initial response posture at the Calhoun County Emergency Operations Center (EOC). On July 30, USEPA took the response effort lead and implemented a Unified Command using the National Incident Management System's (NIMS) Incident Command Structure (ICS), and established an Incident Command Post (ICP) in Marshall. The Unified Command included the USEPA (Federal On-Scene Coordinator, or FOSC), Enbridge Energy Partners, Michigan State Police, Michigan Department of Natural Resources and Environment (MIDNRE), and the Emergency Managers from Calhoun and Kalamazoo Counties. There were four principle goals of the ICS response: contain and clean-up the oil; ensure the health and safety of the public; rescue and treat injured wildlife and begin restoration of the affected ecosystem; and provide for the safety of all on-scene responders. The response phase was completed in just over three months ending in the first week of November when the USEPA transitioned from an ICS to an Operations and Maintenance (O&M) command structure.

After engagement of the NWS, both on-site and remote Impact-Based Decision Support Services (IDSS) were provided to the Unified Command at the ICP and to the State of Michigan at the MISEOC. The Enbridge Oil Spill represents the largest HAZMAT incident that NWS Central Region has served.

During the first week of the response (July 26 to August 2), remote IDSS was provided by NCRFC to the National Ocean Service Office of Response and Restoration (NOS/OR&R) per their request. Thereafter, NCRFC support was provided directly to the WFOs as they assumed IDSS activities for the ICP and MISEOC. On July 28, on-site IDSS services were implemented at the MISEOC by WFO GRR and then transferred to WFO DTX on July 30. On July 28, WFO GRR also began remote support to the Calhoun County EOC in Battle Creek, before shifting to on-site IDSS at the USEPA ICP in Marshall on July 30. This date was coincident with establishment of the ICS Structure by USEPA. At the ICP, NWS was assigned to the Situation Unit within the Planning Section of the ICS. The CRH-ROC was activated on July 29; establishing command and control of the overall NWS response, and providing both logistical and administrative support to responding offices.

Over the next three weeks of August, on-site IDSS continued at the Marshall ICP. The MISEOC activation was lowered from "full" to "partial" and consequently, IDSS transitioned from on-site to remote delivery by WFO DTX. The CRH-ROC continued to provide logistical support and jurisdictional authority; but passed command and control of the response to the MIC at WFO GRR.

During September and October, on-site IDSS at the Marshall ICP slowly spun down with the exception of two significant storms on September 21 and October 26. MISEOC remote support was further spun-down and transferred to WFO GRR after September 21. Finally, on-site support at the Marshall ICP transitioned to remote support on November 9. Remote support for the Marshall ICP by WFO GRR and NCRFC continues as of the writing of this report.

Key services provided by NWS were diverse. First was the provision of hydrologic information and forecasts for the Kalamazoo River to help assess contaminant trajectories through the river system and the threat for oil accumulation along the river and in wetlands. Second was weather support for the safety of response and restoration crews. These included forecasts of high-impact threats to work crews such as lightning, heat, severe thunderstorm winds, and heavy rain. Third was the provision of wind rose, wind gram, and plume trajectory forecasts to support evacuation decisions from benzene fumes around the immediate spill site. These forecasts were also of interest to USEPA for the placement of air monitoring equipment around the spill site and affected areas downstream. In their totality, these response efforts provided critical information to Unified Command and key segments within the Incident Command Structure.

Pre-Event Preparation and Initial Response

During the first week of the response, NWS officials found that the work done prior to an event, and the quick integration of resources in the first few days of response, was critical to the value of IDSS during the expanding phase of its disaster response. NWS IDSS provided critical information on how oil in the Kalamazoo River would spread downstream, where and to what degree air quality near the spill might be degraded, and the forecast of weather conditions that could compromise the safety of emergency response personnel. Other segments of NOAA provided scientific advice as part of the Shoreline Clean-Up and Assessment Technique (SCAT) team and the Natural Resource Damage Assessment (NRDA).

Fact: NOAA IDSS to the USEPA Federal On-Scene Coordinator (FOSC), the State of Michigan Emergency Operations Center (MISEOC) and overall Unified Command was multi-faceted.

On-site and remote support was provided, or was available from, the NOAA Scientific Support Coordinator (SSC); the NOAA Damage Assessment, Response, and Restoration Program (DARRP); the NOAA Great Lakes Environmental Research Laboratory; the NOAA National Weather Service; and the NOAA Office of Homeland Security. The DARRP component consists of the National Ocean Service/Office of Response and Restoration (NOS/OR&R), the National Marine Fisheries Service (NMFS) Office of Habitat Conservation, and the Office of General Counsel (OGC) for Natural Resources. The NWS response involved WFOs in Grand Rapids (WFO GRR) and Detroit/White Lake (WFO DTX), MI; the North Central River Forecast Center (NCRFC) in Minneapolis, MN; and the NWS Central Region's Regional Operations Center (CRH-ROC) in Kansas City, MO. In addition to the above offices, a mix of fifteen NWS meteorologists, hydrologists, and Incident Meteorologists (IMETs) provided on-site IDSS at the Marshall ICP. Together, these components of NOAA provide a diverse set of support capabilities ranging from weather forecasts, river level and flow forecasts, legal support, habitat restoration, contaminant assessment and clean-up, to general scientific expertise.

While the NOAA and NWS support provided for the Enbridge Oil Spill was thorough, there are several activities that would significantly improve the sophistication and fidelity of

initial IDSS. First and foremost is effective communication of the need for support. USEPA has a long established relationship with OR&R segments of NOAA, but a much more limited history working with NWS.

Fact: There is no existing protocol for a FOSC to directly contact NWS in the event of an environmental disaster.

Fact: USEPA contacted NWS on July 28 and requested emails of water and weather forecasts twice daily.

Finding: Due to the lack of notification protocols, USEPA did not know it could formally request NWS presence on-site at the Marshall ICP. WFO GRR identified an IDSS gap, and self-deployed to the ICP after this contact to better serve USEPA. Pre-existing relationships between NWS, the State of Michigan Emergency Management Division and Calhoun County Emergency Management enabled NWS to gain admittance to the ICP.

Fact: At the ICP there was not a working knowledge of the decision support capabilities of NWS by any of the agencies present.

Finding: Because USEPA, nor most agencies within Unified Command, did not have an initial working understanding of NWS IDSS capabilities, provisions for utilization of NWS resources were not in their Standard Operating Procedures/Contingency Plans. This yielded a slower evolution of initial interactions with Unified Command.

Recommendation: NWS should identify and educate key disaster-response agencies such as USEPA, Federal Emergency Management Agency (FEMA), U.S. Coast Guard (USCG), and State Governments on the decision support capabilities of the NWS. These agencies should be strongly encouraged to formally include NWS support in incident pre-planning, exercises, and Standard Operating/Contingency Plans.

Recommendation: NWS should work with OR&R to explicitly outline the role of NWS in spill response efforts within the NOAA/OR&R publication "An FOSC's Guide to NOAA Scientific Support".

Notification of the spill from OR&R to the NWS was initially directed toward the NCRFC in the form of an information request on July 27. Communication from USEPA to OR&R/NOAA SSC was not initially clear concerning their response role. Additionally, there is no existing protocol for OR&R/NOAA SSC to formally notify or engage NWS in the event of an environmental disaster. OR&R began on-site support and NRDA at the ICP beginning the evening of July 29, but initially OR&R and NWS on-site personnel were unaware of each other's presence. Due to response requirements in the Gulf of Mexico, the NOAA SSC was unable to respond to Marshall until August 2.

Once the involved NOAA components became aware of the presence and roles of each other on July 30, all were included on daily coordination calls conducted by the CRH-ROC. Even though there is very little mission overlap between the NOAA Line Offices with respect to spill response, these conference calls were highly successful in that they allowed each entity to track each other's activities, provide advice whenever necessary, and to manage the external flow of information from the agency.

Fact: NOAA Line Offices were aware in a rudimentary way of each other's roles and responsibilities with respect to environmental disaster response. However, initial attempts at notification and collaboration were disorganized due to a lack of existing protocols.

Finding: A diverse service portfolio, such as that provided by NOAA, requires a highly organized response structure to maintain an efficient and effective environment of coordination. This includes information sharing, resource sharing, coordinated briefing services, and a consistent, controlled public information flow.

Recommendation: A set of NOAA response protocols and exercises should be established to organize a collaborated NOAA response to natural and man-made disasters in the Great Lakes. This protocol should be championed by the NOAA Great Lakes and Central Regional Collaboration Teams and its structure should utilize ICS principles. The teams should also collaborate with the NOAA Disaster Response Center in developing these protocols such that the Great Lakes adhere to a set of national response protocols.

The initial provision of IDSS to the MISEOC was considerably smoother. As the state liaison office, WFO GRR has focused on improving support of the MISEOC over the past two years. A primary IDSS preparatory exercise was formal participation in annual full-scale radiological releases exercises at three nuclear power plants located in Lower Michigan. Key personnel from WFO DTX were also included in the full scale exercises and thus two Michigan WFOs had developed the necessary relationships, available resources, and deployment protocols to provide robust IDSS to the MISEOC. The result was a quick deployment of WFO GRR personnel to support MISEOC operations and the subsequent seamless handoff of support responsibilities to WFO DTX when WFO GRR personnel were deployed to the ICP.

Fact: WFOs GRR and DTX were well-prepared to provide Impact-Based Decision Support Services for the ICP and MISEOC on short notice.

Best Practice: WFOs GRR and DTX prepared for response to environmental and HAZMAT incidents through pre-event planning activities. These include having pre-established IDSS focal points, basic knowledge and training of NIMS, knowledge of State EOC disaster response protocols, and creation of customized support tools such as pre-loaded IDSS laptop computers, on-station drills, and creation of a web page for quick internal and external briefing during HAZMAT incidents (http://weather.gov/dtx/hazmat).

Once all of the notifications and deployments were complete NWS staff had to quickly learn how to operate from a decision support posture. Considering the urgency of the situation, the learning curve was very steep and the working environment was high-pressure. Some of the challenges of the initial response period included;

1) Determining the immediate needs of their customers (USEPA and MISEOC);
2) Conveying weather and water information to meet those needs;
3) Establishing the important contacts at the MISEOC and Marshall ICP;
4) Determining NWS logistical needs; and
5) Managing the flow of information to and from various sources within the agency.

Fact: Because this was the first time NWS in the Great Lakes region had attempted this type of IDSS, WFO's GRR and DTX were required to spend much of the first 72 hours creating a decision support posture from scratch rather than spinning-up actual IDSS.

Finding: Spinning-up a response posture "on-the-fly" resulted in fragmented decision support services during the critical first 72 hours following NWS engagement.

Recommendation: In order to quickly and effectively spin-up the initial response, NWS needs to develop a "Standard Operating Procedure (SOP)" that can be utilized in single or multiple WFO responses to environmental disasters such as oil spills. Such a SOP should include;

1) Guidance on briefing tools and toolkits;
2) Types of products and services useful to an Incident Command;
3) Plans for logistics and staffing support from a Regional Operations Center; and
4) Guidance on external communications and media coordination.

Role of the Regional Operation Center

The CRH-ROC proved critical in providing support and oversight of IDSS delivery by multiple NWS offices including the NCRFC, WFO GRR, and WFO DTX. The CRH-ROC further facilitated collaboration with OR&R and provided NWS and NOAA senior management consolidated updates on NOAA's overall incident response.

By July 29, the oil spill response had escalated to a multiple office effort. The CRH-ROC was activated and the Chief Operations Officer (COO) was assigned the role of the NWS Incident Lead. The CRH-ROC began to coordinate responses from the various local offices involved in the response to the spill and began to provide both logistical and administrative support. WFO GRR was directed to self-deploy and begin providing on-scene support at the Marshall ICP. WFO DTX was then asked to assume on-site IDSS responsibilities at the MISEOC from WFO GRR.

The CRH-ROC activated per existing instructions in the CRH-ROC Operations Manual. CR personnel filled CRH-ROC roles needed to accomplish support of this IDSS mission as

outlined in the manual. The support roles are critical to establishing early command and control, as well as logistics support, administrative support, and the assignment of personnel to critical roles. The scope of the oil spill, and subsequent IDSS response, was underestimated initially and this led to assigned personnel juggling their ROC responsibilities with their everyday workload.

The lack of experience in an event of this magnitude challenged CRH-ROC personnel in the scope of performing assignments related to logistical requirements and ER Personnel deployments. The role of the CRH-ROC is critical to a response of this magnitude and should be formalized as a critical component of IDSS.

Fact: During the first week of the response, the Regional Director (RD) directed the COO to activate the CRH-ROC and serve as the NWS Incident Lead. As the event evolved, the NWS Incident Lead transitioned to the WFO GRR MIC, while the CRH-ROC continued the remainder of its support and oversight functions.

Fact: The RD provided the operational objectives and constraints regarding the scale, magnitude and longevity of IDSS for this incident. A second function of the RD was the determination to recall or cancel previously scheduled and/or approved leave of personnel critical to the response.

Finding: The CRH-ROC role is analogous to that of an emergency operations center (EOC) function in the NIMS framework. The primary functions of the CRH-ROC included:

1) Assignment of an NWS Incident Lead;
2) Jurisdictional oversight of IDSS services provided by Central Region Offices;
3) Provision of equipment and personnel as requested by the responding offices;
4) Coordination of Central Region's response activities with other NOAA/NWS offices; and
5) Submission of regularly scheduled situation reports to senior NOAA/NWS management.

Finding: The role of the CRH-ROC as an EOC function, and the COO serving as the NWS Incident Lead function, were critical to the success of the support effort - particularly during the formative stages of the NOAA/NWS response. While the staffs at the WFOs, NCRFC, MISEOC, and ICP were concentrating on establishing their IDSS response posture, a single point of authority was established to track and coordinate efforts amongst all NOAA response teams, avoid duplicative efforts, supply and coordinate resources, and manage information flow.

Finding: The role of the COO was analogous to the role of an Emergency Manager. The COO initially served as the incident lead and then continued to be responsible for managing CRH-ROC resources. Following NIMS principles, the COO delegated key responsibilities as needed to meet the demands of the incident response.

Recommendation: Once the initial incident response posture is established, the NWS Incident Lead should be transitioned as soon as is reasonable to the primary Incident Command Post. Being co-located with ICS personnel puts them in the best position to understand and coordinate all resources needed to provide the best weather and water IDSS possible.

Recommendation: An NWS Incident Lead should be designated and deployed during each NWS IDSS mission using the following guidelines:

1) The COO or designee initially serves as the NWS Incident Lead during the first 24 to 48 hours of an event. This role's primary focus is to serve as a single point of authority to track and coordinate efforts amongst response teams, avoid duplicative efforts, coordinate resources, and manage information flow. This person oversees the activation of the CRH-ROC and establishes an organizational chart and contact information for all NWS/NOAA responders.
2) Once incident response is established, the role of agency Incident Lead should be collocated with the primary ICP. Their primary focus is then to ensure the IDSS response is as complete and robust as possible.
3) The CRH-ROC continues analogous to an EOC to provide logistical and administrative support, and manage the overall information flow. They also ensure that the organizational chart and contact information is updated and regularly disseminated to all offices involved in the response.

Recommendation: The CRH-ROC Operations Manual should be reorganized to reflect the operational priorities above and also to provide a simple and flexible set of standard operational procedures that would facilitate accomplishing the goals over a variety of events that range in character from simple and short to those that are complex and long. Support functions documented within the manual should be made more visible to CR Offices and be used in regional tabletop exercises to help all gain familiarity with its application.

Recommendation: NWS should have dedicated personnel to execute the critical function of the Regional Operations Center as a component of the overall NWS IDSS posture.

Another task that the CRH-ROC completed early in the event was the coordination of communication channels between CRH and the responding NOAA offices. The CRH-ROC established daily conference calls, email lists, NWSChat rooms, and combined NOAA situation reports (Sit Reps). Communications up the command chain and laterally amongst responders was critical to the success of a NOAA response to the oil spill.

Best Practice: The CRH-ROC coordinated and issued joint Sit Reps from NWS and OR&R. These joint Sit Reps facilitated a "one-NOAA" approach to response and reporting to NOAA, NOS, and NWS leadership. An example of this Sit Rep can be found in **Appendix A**.

Finding: The use of shared communication tools proved an efficient and effective means of requesting and distributing information. In particular;

a. Daily conference calls with the agency Incident Lead provided an excellent forum for discussing the support effort in a holistic manner and making adjustments "on the fly". Participation in these calls from OR&R/DARRP and occasionally USEPA was especially useful. This was highly successful in that it allowed each entity to track each other's activities, provide advice whenever necessary, and to manage the external flow of information from the agency. Through these calls, NWS first became aware of OR&R's ResponseLink data repository (https://responselink.orr.noaa.gov). This quickly became the primary means of storing and sharing data through the duration of the event.

b. NWSChat (dtx-support and grr-support) proved an effective way of coordinating information and tasks with those actively engaged in the support effort. The negative aspect of NWSChat was that other parts of NOAA did not utilize the tool, despite being given instructions on how to do so.

c. "Kzoo_Ops" mail list was also an effective tool for reaching a large number of people with information. However, this tool was used with less frequency as the incident response progressed. There were complaints about having to constantly monitor email in an operational setting and the large volume of email generated without being directed to those with immediate need to know.

d. NOS/OR&R ResponseLINK proved to be an excellent repository of information from all NOAA parties involved in the response and restoration effort. The ability to push and pull information from the repository was more efficient than email, and provided a one-stop-shop for storage of information for operational and legal documentation purposes.

Recommendation: While conference calls and e-mail lists can be effective collaboration tools, all NOAA entities involved in a disaster response effort should use a shared data repository for internal information (such as ResponseLink) and real-time shared communication tools (such as NWSChat).

Emergency Response Personnel

Over the first several days of the deployment at the ICP, NWS personnel were challenged to meet numerous new service requests, establish instructions for subsequent NWS personnel, provide briefings, monitor current weather, and coordinate resource requests with the CRH-ROC.

Fact: The WFO GRR WCM spent the entire first day at the ICP working with the Planning Section Chief to establish NWS services that included content of three daily stand-up briefings, input into the daily Incident Action Plan (IAP), and weather alert thresholds.

Fact: The initial response team at the ICP was so busy that they were not able to effectively quality control services, such as river forecast information and WFO SPOT forecasts; and did not deliver HYSPLIT (Hybrid Single Particle Lagrangian Integrated Trajectory Model) information that was being produced by WFO DTX.

Finding: More than one NWS person needed to be onsite at the ICP during the first 72 hours. One or two people were needed to actually provide the IDSS support and answer numerous service requests, while the other was needed to establish the IDSS posture, establish instructions or a "playbook" for providing NWS services, and coordinate resource needs and status routinely with the WFO and the CRH-ROC.

Recommendation: The NWS should adopt response spin-up deployment procedures that utilize the following staffing model:

1) Local office dedicates a person on-scene to identify and spin-up required NWS services and to establish the NWS IDSS posture to include an on-scene playbook for use by all NWS ER Personnel, and coordination of support requirements and need for ER Personnel to ROC.
2) One or two additional on-scene ER Personnel to maintain a "weather watch" and provide IDSS. The number depends on the number of support hours required each day.

Both WFO GRR and WFO DTX required additional staffing to support response personnel at ICP and SEOC respectively. In the first few days of the response, WFO DTX reapportioned its baseline staffing to create an "IDSS Desk" to address information and service requests and coordinate overall support activities between the WFO, NCRFC, the CRH-ROC, and the MISEOC. Additionally, the IDSS Desk represented the WFO during CRH-ROC collaboration calls. After the first few days these functions were accomplished within baseline staffing and existing shift duties until the role at the MISEOC diminished.

WFO GRR established additional staffing to provide weather alerts to the ICP between the hours of 8 pm and 6 am when NWS personnel were typically off-duty in Marshall. This support continued through November.

Fact: During the first few days of the response, WFO DTX was able to reapportion baseline staff into a dedicated IDSS Desk that resulted in little impact to routine forecast production and optimized delivery of IDSS at the MISEOC.

Finding: Dedicated staffing of an IDSS Desk is highly beneficial during either the initial NWS deployment phase or the expanding phase of an incident response when information requests, service requests, and the need for coordination of incident information are frequent.

Recommendation: The NWS should develop procedures that ensure the establishment of an IDSS Desk during the initial response and escalation phase of an overall ICS response, to ensure that all information requests, service requests, and coordination of all support activities occur in a complete, consistent, and timely manner.

The effectiveness of IDSS depended on the familiarity of NWS response personnel with:

1) The local geography, hydrology, and climate;
2) Sub grid-scale weather and climate phenomena specific to the response operations area;
3) The size and complexity of the incident itself including the ICS structure and the evolution of current and recent Incident Action Plans; and
4) The professional relationships established with ICS personnel including the command staff and section leaders.

Fact: For the duration of on-site support, only four DTX staff members were deployed to the SEOC. The vast majority of MISEOC staffing was provided by just two DTX staff members. On the first two days, WFO DTX deployed 2 people per shift to the MISEOC to distribute workload and gain situational awareness.

Fact: Four different people covered the ICP in the first four days of the NWS response with eight different people over the first two weeks of the response. The average deployment time of NWS personnel at the ICP was 2 to 3 days during the first month of the response and then increased to 7 days in the latter half of September and October.

Fact: ER Personnel deployments were too short given the four items listed with which these staff had to be familiarized.

Fact: The USEPA Incident Commander advised in a late October meeting with the WFO GRR MIC that ICS deployment should be no shorter than 10 days to ensure continuity of service and maximize on-scene situational awareness.

Finding: The WFO DTX staffing model, which minimized the number of persons providing IDSS at the MISEOC, maintained continuity in service, expertise, and maximized situational awareness. This model also put a “trusted face” to NWS IDSS for all staff at the MISEOC.

Recommendation: The NWS should adopt the following deployment procedures that ensure continuity of service, expertise, and maximize response effectiveness:

1) Developing deployment plans with 10 to 21 day rotational assignments;
2) When more than one person is assigned to the ICP, the rotational periods should be offset in order to maintain continuity of service and situational awareness; and
3) For longer responses - alternate the rotational assignments of ER Personnel in such a way as to minimize the total number of unique NWS personnel deployed to an event.

The oil spill occurred during the middle of the peak leave season for most NWS offices. Initial response efforts by all NWS offices were limited by staffing issues related to leave. This was compounded by lack of experience and standard operating procedures to provide IDSS to the USEPA. While the USEPA incident command staff was pleased with the overall quality and especially the dedication displayed by NWS responders, the response could have been better if key personnel had been recalled or appropriate substitutes identified such as a providing a service hydrologist onsite at the ICP.

Recommendation: Procedures should be developed to ensure adequate backup staffing for responding WFOs and the availability of key support persons at all levels of the incident response. This includes key personnel such as the WCM, MIC, and Service Hydrologist. The following considerations should be addressed in developing the procedures:

1) The availability of suitable substitutes if key personnel are on leave or the position at the time of the incident is vacant;
2) Enacting recall of key personnel in leave status or cancelling leave under the provisions of NWS status as Emergency Employees to ensure availability of response personnel; and
3) The issuance of incident guidance by the Regional Director affirming appropriateness of recalls when the incident response involves multiple offices. Such guidance would ensure consistency and continuity of response by all NWS responders.

Training Requirements

While a mature Emergency Response program exists for Fire Weather with the Incident Meteorologist (IMET) program (NWSI 10-402), nothing nearly as formal exists for supporting oil or other hazardous spills within auspices of the National Contingency Plan (NCP). Due to state requirements and a sustained effort on the part of WFO GRR and WFO DTX to support state, county, and local emergency management, key responders from both WFOs had received training similar to that required of a fire weather IMET. In order to guarantee the quality, consistency, and reliability of the future provision of support to oil spills, NWS should develop and track persons qualified to respond to oil spill and HAZMAT releases as described by the National Contingency Plan or ESF 10 of the National Response Framework.

Fact: The State of Michigan EOC requires completion of NIMS IS-100, IS-200, IS-300, IS-400, IS-700, and IS-800 to be onsite during an EOC activation; and requires documentation of completion be kept on file at the MISEOC. Technically, under the National Response Plan and HSPD-5, the same requirements exist for anyone reporting to an ICP.

Best Practice: Six WFO GRR employees including the WCM and Service Hydrologist, and four WFO DTX employees including the WCM and IDSS Focal Point, have completed NIMs training and were qualified to serve the MISEOC or ICP.

Best Practice: The WCM and Service Hydrologist from WFO GRR and the WCM and IDSS Focal Point from WFO DTX participated in several State of Michigan table-top exercises and

one full scale exercise of a radiological release from the Fermi II Nuclear Power Plant (near Detroit) prior the oil spill.

Finding: WFO GRR and WFO DTX personnel deployed to the MISEOC and ICP were able to confidently identify and prioritize the spin-up of IDSS to support the needs of each respective response center. Familiarity with NIMs and participation in state-wide exercises was critical to their success.

Finding: Three of the ER Personnel deployed to the ICP were certified IMETs. They quickly understood, adapted, identified, and relayed the information that was most critical to the planning and operational needs of the ICP. This was a direct result of their familiarity and training with the command and control structure of the ICS.

Finding: There was a need for both meteorologists and hydrologists to be on-site during the first week of the response. Meteorologists were needed to provide critical weather information including air quality support, severe weather alerts, and to feed daily weather forecasts into both the Planning and Operations sections of the response. Hydrologists were needed to help assess the movement of oil downriver, coordinate information needed from other agencies to rapidly stand-up site specific oil trajectory models, and also to feed daily river forecasts to the Planning and Operations Sections of the response.

Recommendation: NWS should create Emergency Response Personnel "Types" for oil spill and HAZMAT response, similar to the IMET types defined in NWSI 10-402. Designated personnel should include either meteorologists or hydrologists. The suggested classification and certification requirements are as follows:

Type III ER Personnel would be able to remotely support a state emergency operations center or incident command post. Basic training requirements include completion of the following NIMS ICS training components: IS-100, IS-200, IS-700, and IS-800.

Type II ER Personnel would be qualified to provide on-site support at a State Emergency Operations Center or Incident Command Post. In addition to Type III training requirements, they should have completed NIMS IS-300 and IS-400 resident training courses.

Type I ER Personnel would be qualified to act as an NWS Incident Lead at the Incident Command Post. In addition to Type II training requirements, they would have additional training regarding roles and responsibilities of USEPA, USCG, and NOAA in responding to an oil spill or HAZMAT release. They would also have participated in exercises with USEPA and/or USCG in table top and/or full scale exercises or experience providing on-site IDSS at an Incident Command Post.

Recommendation: NWS should set requirements for the number of each ER Personnel Types needed to meet national, regional and local ESF10 support needs and develop formal methods to assure training and availability of ER Personnel at all times.

Impact-Based Decision Support Services

NWS ER Personnel were called upon to provide a diverse suite of IDSS to both the MISEOC and the Marshall ICP. The initial response objectives immediately after the spill required a focus on providing IDSS for NWS river forecasts which provided critical information needed to contain the spread of oil. Alerts for thunderstorms and severe weather were needed to allow sufficient time for up to 2,000 responders working in the open along a 30 mile stretch of the Kalamazoo River to take shelter.

By the end of August, as the oil was contained and levels of toxic fumes were greatly reduced, NWS support emphasis shifted towards forecasting adverse weather and providing weather alerts that principally supported the safety mission and secondarily clean-up tactics.

NWS Emergency Response Personnel at the ICP provided both strategic and tactical weather support directly to Unified Command Staff. NWS personnel interacted regularly with the Situation Unit Lead, the Planning Section Chief/Deputy Chief, and the Safety Officer regarding weather and water forecasts. The WFO GRR MIC or WCM met at least once weekly with the Incident Commander/Deputy Incident Commander to discuss and adjust the overall NWS response/support posture.

At the MISEOC, NWS Emergency Response Personnel were placed at the Office of Services to the Aging desk. In addition to giving situational weather briefings three times per day, ER Personnel helped to establish better communication between NWS assets at the MISEOC, CRH-ROC, ICP, and NCRFC.

Products & Services

Hydrologic Support Services

The USEPA found the hydrologic services provided by NWS to be highly valuable. On the second day of the response, NCRFC began providing a daily river summary, estimates of oil travel times between river forecast points, and river stage forecasts for the Kalamazoo River. Beginning in September, monthly issuances of 90-Day River Stage Probabilities were issued to support long-term clean-up planning. In early, December the WFO GRR Service Hydrologist and MIC provided an ice jam awareness briefing and by mid-January, the NCRFC had developed an ice jam break-up forecast that was provided on a daily basis through late February. Other one-time requests concerning historical crests and probability of exceedence plots were provided as requested.

The initial call for NWS hydrologic support came from OR&R's Emergency Response Division (ERD) to the NCRFC. OR&R had been contacted by USEPA requesting velocity data

and trajectory information for the oil spill. ERD routinely handles such requests from the USCG, but not as routinely for the USEPA. ERD employs the *General NOAA Operational Modeling Environment* (GNOME) to produce oil spill trajectories as requested. In this case, ERD lacked necessary elevation and river velocity data to employ GNOME, which prompted them to seek assistance from the NCRFC.

NCRFC hydrologists were able to use the NWS River Forecast System (NWSRFS) to estimate river velocity information by comparing the NCRFC computed streamflow with velocities observed during recent streamflow measurements taken by the United States Geological Survey (USGS). NCRFC personnel were then able to use the velocity computations to quickly produce rough estimates of travel times between river forecast points. This information was provided to OR&R and subsequently via WFO GRR to the MISEOC and Marshall ICP.

Per request of the USEPA Deputy Planning Section Chief at the Marshall ICP, river travel times, river stage information, 5-day river ensemble forecasts, and river summaries were provided twice per day beginning on August 29. The group of products became collectively known as the river forecast brief (**Appendix C**). They were initially emailed to the ICP from WFO GRR and then provided by on-scene IDSS personnel.

Initially, the river travel times and river stage products were presented three times per day via the daily stand-up briefings at the ICP and at the MISEOC. The provision of travel times was no longer needed by late August, but river stage information continued to be provided at these meetings until on-site services stood down in November. River information continued to be shared via remote briefings given by WFO GRR throughout the winter.

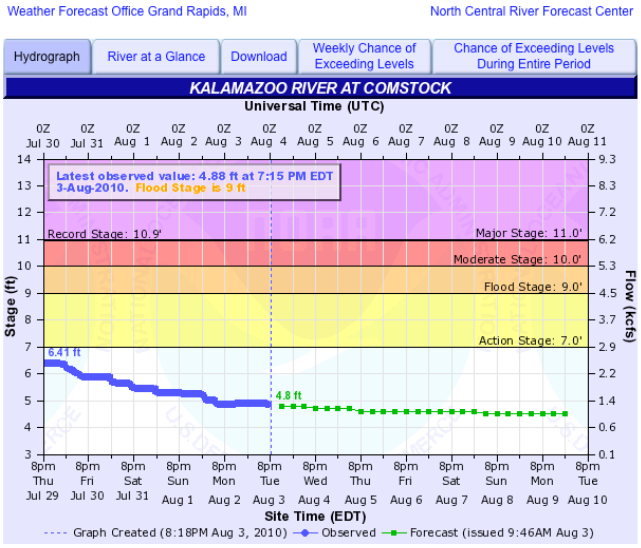

Figure 2 - NCRFC river stage information

Finding: The NCRFC provided exemplary support, particularly during the first few days of the event. The NCRFC staff exceeded the initial call for support from ERD and USEPA requests via WFO GRR. In particular, hydrologists quickly developed and employed techniques to provide river travel time between key points on the Kalamazoo River.

Recommendation: The NCRFC should assess the utility of using the *General NOAA Operational Modeling Environment* (GNOME) to produce oil spill trajectories on smaller non-navigable waterways.

Recommendation: The ability to produce trajectory forecasts for oil or other hazardous substance releases should be addressed in the development of the Community Hydrologic Prediction System (CHPS) now in development to replace the NWSRFS model.

Initially, USEPA had planned to stand down operations during the winter freeze-up period but subsequently determined that they would be able to remove oil from otherwise difficult wetland locations once freeze-up occurred. In early December the WFO GRR MIC, acting on the new plans, requested a meeting with Incident Command to discuss ice-jam related river issues and safety concerns. The WFO GRR MIC and Service Hydrologist gave the briefing on December 6. Based on concerns raised at that meeting, personnel from the U.S. Army Corp of Engineers' Cold Regions Research & Engineering Laboratory (USACE/CRREL) were invited to work with the WFO GRR Service Hydrologist to assess specific ice-jam threats along a 30 mile stretch of the Kalamazoo River from Marshall to the Morrow Lake Dam. Additionally, the NCRFC began development work on break-up ice-jam guidance to further help identify significant safety and operational impacts to clean-up operations. The NCRFC break-up ice-jam guidance began in early January and continued until the river became ice-free in late February.

Fact: The Incident Commander found the December Ice Jam Briefing and subsequent ice break-up forecasts of high tactical and strategic importance.

Best Practice: NWS ER Personnel need to maintain a working knowledge of operational plans and should proactively bring forward weather and water risks to response operations as needed.

Weather Support Services

Weather support services were critical – providing for the safety of all responders at all times. In a strategic sense, weather was a key component of the planning process in terms of vetting various operational approaches to oil containment and clean-up operations. Tactically, short-fused weather alerts ensured the safety of all responders over a period of minutes to hours.

Stand-up briefings were provided at both the MISEOC and the ICP several times daily. At the ICP, weather briefings were incorporated into the ICS Planning Cycle "Planning P" and were provided at the Operations Section, Command & General Staff, and the Planning Meetings. Additionally, weather briefings were also given at a semi-daily Cooperating/Assisting Agency Meeting. Each meeting was approximately one-hour long with the NWS component lasting two to three minutes on average.

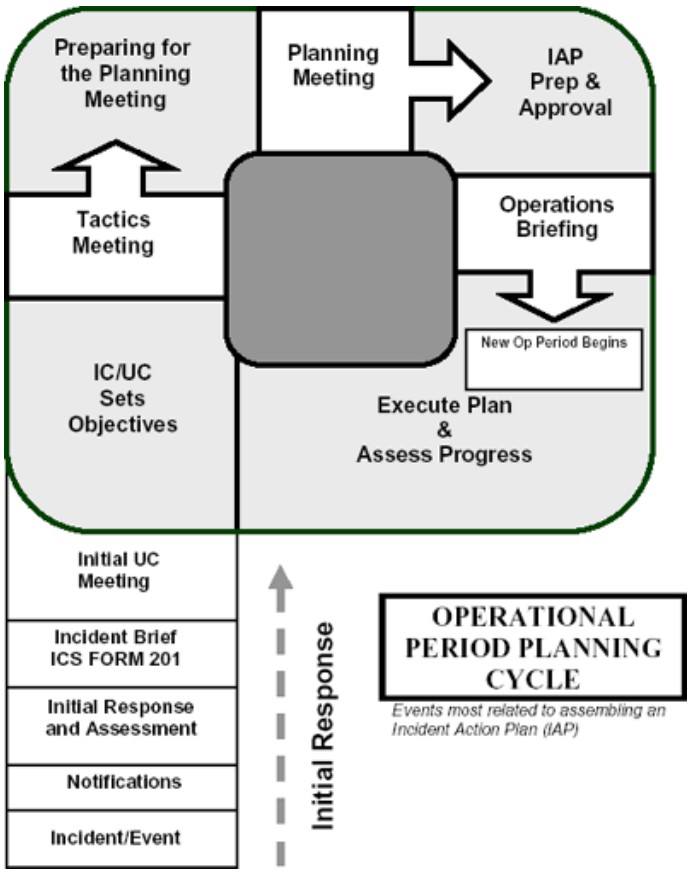

Figure 3 - The "Planning P"

The NWS briefing (**Appendix E**) initially used five slides including: Impacts to Operations, Day 1 forecast, Day 2 forecast, river travel times, and 5-day river stage forecast for Battle Creek. The impact slide contained bullets pertaining to thunderstorm chances, heat indices, expected rainfall amounts and intensity, and river level changes. The Day 1 & 2 Forecasts were graphical cartoon forecasts from NWS Point and Click "Quick Forecasts" with 3-hourly resolution data. This format was directly requested by USEPA rather than the more detailed Point-and-Click Meteograms.

Beginning in early September and following the suspension of the river travel times slide, HPC's 5-day Quantitative Precipitation Forecast graphic was added to the slide deck but the title was changed to "NWS 5-Day Precipitation Potential". Forecasts graphics for days 3 and 4, and eventually an extended graphic for days 5 through 7, were added as the ICS operational period expanded from one day to two days in September to seven days by mid October. An Aviation Impacts slide was added in late September, and the Break-Up Ice Jam slide was added in January. One time seasonal weather or hydrologic outlooks were also added to briefings as requested.

As noted above, the ICS operational period was initially one day but was extended eventually to one week as the response stabilized and gradually transitioned towards a more

routine clean-up operation. As this occurred the ICS meetings also became less numerous and spread out over the operational period. By early October, only the Command & General Staff Meeting was held on a daily basis.

The content of the briefing was tightly controlled by the Planning Section Chief – it needed to be concise, consistent, and relevant to response operations at all times. NWS personnel were instructed by the Planning or Deputy Planning Section Chiefs to adhere to briefing protocols and present relevant, non-technical information focused on impacts.

Best Practice: The Operational Impact slide set the tone of the weather & water brief. It provided the most pertinent information "headlines" to Incident Command in a concise and consistent manner and helped NWS personnel focus their message.

Best Practice: Weather and water requirements of the response will evolve with time. The NWS Lead should review SitReps and IAPs regularly and meet with the Planning Section Chief at least weekly to maintain calibration of both emphasis and content of NWS briefing slides.

At the request of the ICP Safety Officer, NWS was requested to issue weather alerts to response personnel working along the 30 mile stretch of Talmadge Creek and the Kalamazoo River. The response area was broken into five geographical divisions (A through E) and the weather alerts were to be as division specific as reasonable. Initially, weather alerts were issued for severe weather, lightning, Flash Flood, and heat indices. Later, alert thresholds were set for strong winds and wind chills.

Severe weather and lightning alerts were issued when either moved within 30 miles of the response area. Heat index alerts were issued initially at a threshold of 90F but that threshold was subsequently lowered to 80F. Many response personnel were wearing substantial HAZMAT clothing/gear and required increasingly frequent and prolonged work breaks as heat indices rose above 80F. One serious heat-related injury occurred just prior to the establishment of NWS weather alerts – none occurred thereafter. Wind alerts were issued when either sustained surface winds exceeded 25 mph or gusts exceeded 35 mph. Strong winds affected both boating operations on the river and aviation related surveillance flights of the impacted area.

Once issued, alerts were updated on a regular basis until an all-clear was issued. Severe weather and lightning alerts were updated every 15 minutes with the other alerts updated hourly. The alerts were handled by on-site NWS ER Personnel during the day, and remotely by WFO GRR forecast staff during the overnight hours.

Initially, phone and phone trees were being used to communicate the weather alerts. NWS personnel were given a list of cell phone numbers to reach key operational people in the field in the event of an alert, but that list quickly became unmanageable. The WFO GRR MIC met with the Safety Officer and Incident Commander to request that NWS and key personnel in the field be issued hand held 800 MHz radios to facilitate dissemination of weather alerts and

related safety information. The idea was implemented along with a daily radio check by the Communication Unit of the ICS Logistics Section to ensure all radios were working properly.

Best Practice: The NWS Lead should meet with Safety and Incident Command as soon as reasonable to establish weather alerts and communication protocols. Follow-up meetings should also be established to update the protocols as needed.

Through early September, WFO GRR issued SPOT forecasts (**Appendix B**) twice daily for Marshall. Additionally, graphical Wind Rose and Wind Gram products (**Appendix D**) were produced by WFO DTX using NOAA's Air Resource Laboratory's (ARL) version of HYSPLIT and sent along with the SPOT forecast to NWS personnel at the ICP. These forecasts were principally used by the Air Monitoring and the Public Health Groups within the Environmental Unit/Planning Section of the ICP. The wind information within these products was highly beneficial, and was used to place air monitoring canisters in the vicinity of Marshall. Once placed, the canisters recorded 24 hour concentrations levels of volatile organic compounds (VOCs), mainly benzene, from the spill area. Once the bulk of the oil had been removed from the source area and Talmadge Creek, the SPOT and HYSPLIT products were no longer needed.

During the first week of the response, initial clean-up operations at the source and Talmadge Creek inadvertently caused a spike in the release of VOCs and the subsequent voluntary evacuation of 61 homes and a trailer park. Numerous persons were treated for exposure symptoms at area hospitals and urgent care centers and released. Based on a request from the ICP, WFO DTX began producing HYSPLIT plume dispersion and trajectory forecasts to support air quality monitoring and evacuation decisions in the Marshall area. Forecasts were routed to NWS ER Personnel at the ICP via the Kzoo_Ops email alias and posted on NOAA Response Link.

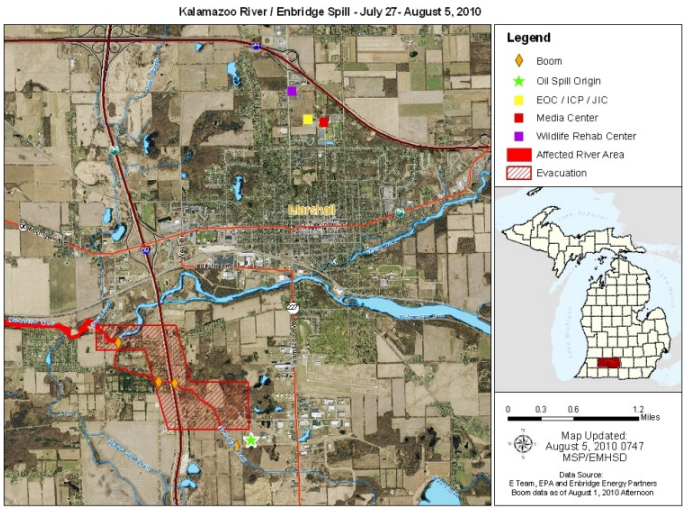

Figure 4 - Evacuation zone

Fact: WFO DTX chose to produce HYSPLIT plume dispersion and trajectory forecasts using the OAR/Air Resources Laboratory (ARL) interactive website rather than contacting the NCEP Senior Duty Meteorologist. DTX staff had previously been trained to request plume model dispersion and trajectory forecasts using both methods, but the ARL method was quicker and functioned in a more "on-demand" manner.

The use of HYSPLIT plume dispersion and trajectory model forecasts were problematic and perhaps inappropriate for this type of incident. The scale of the model output exceeded the local evacuation area and the model is not designed for predicting benzene fume concentrations from a continuous release. As a result, there was great concern at WFO DTX over the likelihood of misleading plume predictions being forwarded to USEPA. It was emphasized to NWS ICP staff that these forecasts were generally to be used as a proxy for plume direction forecasts and not as literal prediction of benzene or other VOC concentrations. There were discussions of switching to Aloha/Cameo models to depict plume concentrations, but this option was rejected due to its lack of predictive capabilities.

Fact: As indicated by the ICP Public Health and Air Monitoring Groups, HYSPLIT Wind Rose and Wind Gram diagrams provided a more appropriate forecast tool for making evacuation decisions and placing air monitoring equipment than the HYSPLIT plume and trajectory forecasts. As a result, the plume forecasts were discontinued and replaced by the HYSPLIT Wind Gram and Wind Rose forecasts on August 4.

Finding: NWS ER Personnel at the ICP were not able to keep track of what NWS products were being sent to ICP personnel and whether the information was being used or found to be useful. This was in part due to the number of different NWS ER Personnel supporting the ICP in the first few days of the response and in the challenges faced with establishing an NWS support posture and simultaneously delivering IDSS.

Finding: The issuance of the SPOT forecast was awkward principally because the product and the associated AWIPS Graphical Forecast Editor (GFE) formatter that creates the product are both configured solely to support fire weather. There is little flexibility in the format and parameters contained within the product. It also lacked the flexibility to provide specific forecast information beyond 36 hours. As a result, NWS ER Personnel both at WFO GRR and at the ICP spent critical time performing workarounds to provide a 72 hour SPOT forecast as well as editing the product to make it ICP friendly.

Recommendation: A more robust GFE SPOT formatter is needed for application to oil spills and the release of hazardous materials. The new formatter should offer a variety of weather and water parameters that can be included in the product as needed. There must also be flexibility in the number of forecast periods to include for a given product issuance.

There were many one-time requests or consults that were routinely addressed by on-site NWS ER Personnel. The kinds of questions received evolved with time reflecting two characteristics of the NWS role in the response. During the first two weeks when many ICP personnel were still learning the nature of NWS expertise, and the ICP responders themselves were “casting large nets” in order to quickly solve many tactical issues, many of the queries were only indirectly related to water or weather. In these cases NWS ER Personnel were quickly able

to redirect them as necessary to the appropriate source such as the USGS, the USACE, or NOAA OR&R Response Personnel.

By early September as the response stabilized and the expertise of NWS ER Personnel became better understood, the nature of the consults became more focused. There were many questions regarding aviation weather, the initiation time of expected convection, or the range of hours when heat indices thresholds would be exceeded. There were also one-time requests for two week, thirty day, and seasonal weather and water outlooks. Such requests were referred to the WFO for completion and then relayed to the requester via NWS ER Personnel at the ICP.

Finding: MISEOC and USEPA both acknowledged that a large part of the value of NWS on-site service was the availability of on-demand consults. The ability to have a question quickly and thoroughly addressed in the context of the requester's needs was paramount to NWS success in supporting the oil spill response.

Finding: The ability of NWS ER Personnel to anticipate and provide weather and water impacts in the context of the responder's objectives depends primarily on their ability to maintain a high degree of situational awareness.

The decision to demobilize from the MISEOC and the ICP was somewhat challenging given the lack of NWS experience supporting such situations. In both cases, NWS consistently underestimated the desire of the ICP Incident Commander for on-site NWS support. This was likely due to an increasing value of NWS services as the response unfolded. The response itself was becoming steadily more stable and routine and thus NWS anticipated either an outright end to the support or more likely a transition to remote IDSS. However, over the same time period the USEPA was gaining trust and respect for on-site NWS IDSS. Additionally, a guiding principle of ICS is that direct response support assets are located at the ICP at all times. The net result was a desire on the USEPA IC's part to keep NWS expertise close at hand for more than two months longer than NWS anticipated.

Another factor in determining the length of support is the cost of the IDSS itself. Unlike the case of the Red River Flood of 2009 in which NWS IDSS costs were absorbed using otherwise discretionary NWS Central Region funds, the cost of the IDSS incurred with the Enbridge Oil Spill will be reimbursed through processes established through a Pollution Removal Funding Agreement (PRFA) approved by the USEPA.

Finding: The NWS should not over-correlate workload with value of service. There was a natural tendency to relate the value of services with the number of briefings, SPOT forecasts, and river forecasts that were being produced each day. As the workload decreased, there was a sense that value was decreasing proportionately, but this was not the opinion of the USEPA Incident Commander and the MISEOC Commander. They both expressed a need for the NWS presence; citing how important NWS ER Personnel insights were in helping them anticipate and optimize

their planning and tactics in terms of evolving response objectives together with changing weather and water impacts.

Recommendation: NWS should work with Lead Agencies such as USEPA and USCG to develop demobilization guidelines for transitioning NWS IDSS from on-site to remote support. Once engaged in support, the NWS Incident Lead under the direction of the NWS Regional Director should facilitate agreement on demobilization milestones with the FOSC/IC.

IDSS Toolkit & Supporting Resources

IT Equipment

Laptop computers were the primary Information Technology (IT) tool that was heavily used and required at the Marshall ICP to maintain weather and water situational awareness; receive support products from WFO GRR, WFO DTX, and the NCRFC; and send products to response personnel at both the ICP and MISEOC. Initially, the WFO GRR WCM laptop and the WFO GRR laptops were used on-site, but these were subsequently replaced when the CRH ROC sent two IDSS configured laptops to WFO GRR for use at the ICP.

While the WFO laptops generally worked well, there were several reoccurring problems. On a couple of occasions, WFO GRR personnel were not able to log onto the WFO GRR Outreach laptop at the ICP because either a cached copy of their profile was not present or their current password had not been synced with Safeboot. In either case, they were not able to log into their laptop after traveling 90 miles to the ICP.

The laptops provided by CRH-ROC were better because they did not have Safeboot and employed a group user account. They did, however, occasionally lock-up and frequently had problems maintaining connectivity with the USEPA-provided wireless network.

At the MISEOC, WFO DTX brought a pre-configured IDSS laptop that also employed a group user account and required a broadband wireless or aircard for Internet connectivity. However, the character of the MISEOC as a bunker limited the effectiveness of the broadband wireless connection. The MISEOC desk also contained a workstation; but Java was not enabled and it also suffered from using an older version of Microsoft Office.

Fact: The CRH-ROC IDSS laptops did not arrive until 4 days after the NWS ER Personnel had deployed to the ICP, but were heavily used once on-site.

Finding: IDSS laptops should use an IDSS group account and should not employ Safeboot per IMET laptop policies. IDSS group accounts should also have sufficient “administrator privileges” to allow for mapping, loading, and configuration of network drives, new software, and network drivers with the intention of integration with IT resources at the ICP.

Best Practice: Broadband network coverage by the major carriers is not homogenous. Each IDSS laptop should include aircards that work with common wireless protocols.

Recommendation: NWS protocols should be developed that provide guidelines for the configuration of IDSS laptops with group IDSS accounts. The protocols should include procedures for:

1) Deployment of the laptop from a WFO or CRH-ROC
2) Integration of ICP provided software and network resources
3) Demobilization of the laptop from a support site

Cell phones were routinely used to talk with WFO GRR or the NCRFC when a simple chat message would not suffice. ICP personnel would also call NWS ER Personnel both during their duty and off-duty hours for weather information. Web-enabled smart-phones were employed by some ER Personnel, and these devices allowed for mobile monitoring of radar and other weather information during Planning and Command & General Staff Meetings. Smart-phones enabled NWS personnel to maintain a high degree of situational awareness when they were away from their laptop.

Although not used during the event, tablet devices would likely have been a very useful IDSS tool. Tablets are small enough to be very mobile and large enough to use as a visual aid when giving unscheduled briefings.

Recommendation: NWS ER Personnel supporting the ICP should be issued a web-enabled smart-phone, for the duration of their deployment. The smart-phone should contain commercially available weather and water apps to allow for mobile situational awareness. In addition, development of a mobile IDSS web page should be considered.

IDSS Applications & Web Services

NWS ER Personnel are the single authoritative source when providing IDSS at the ICP. They must at all times have access to the latest forecast database as well as a wide array of observational and numerical guidance products in order to provide on-demand weather and water consults. Perhaps more importantly, NWS ER Personnel must also be able to recognize the need and take the initiative to provide critical impact information to ICP personnel with regards to developing ICP specific hazards. The CRH-ROC laptops were preloaded with FXnet and GR2Analyst to serve these purposes. NWS ER Personnel also used numerous sources of weather available via the Web.

FXnet is a Java-based AWIPS-like program that can run on any PC or laptop. It is an example of a thin client, meaning that it must first retrieve data from a remote server before displaying a product to the user. FXnet is used frequently by IMETs when they are on-scene at a wildfire.

GR2Analyst is an example of commercial off the shelf software that served the dual purposes of providing NWS ER Personnel access to a wide array of radar and observational data sets, but also has the ability to present information in a clear and easily understandable way that

make it suitable as a briefing tool. GR2Analyst is principally used to display and interpret a full complement of WSR88D data excepting rainfall products. Its GIS capabilities make it easy to integrate maps of the response area into its display of radar data. It also has the capability of displaying surface observations, location of spotters, and most importantly – lightning data.

Recommendation: CRH should provide an outward-facing, password protected server, with a source of data for IDSS resources such as GR2Analyst.

Recommendation: Future NWS use of IDSS support applications should use the example of GR2Analyst's interrogation and presentation attributes as guiding principles of IDSS application functionality and suitability.

IDSS Delivery

Most NWS products were shipped via email to various email aliases. This method of dissemination is cumbersome as recipients constantly changed. Many times a product would initially be sent to just one or two people, but additional recipients would often be added leading to an email address management workload for NWS ER Personnel.

While the "grr_support" NWSChat chatroom worked well for internal NWS coordination, an outward facing chatroom was not used to communicate with ICP personnel. While on-site, this was not a substantial issue because most requests for products and services were made in person. However, once NWS transitioned to a remote support posture, new product requests would often be sent to the last person who sent a product (i.e., a duty forecaster) and not to the NWS Lead. This resulted in a delays and confusion handling remote ICP requests. A chatroom capability with the ICP would have been beneficial, especially once a remote support posture had been established. This would have ensured that requests were either immediately answered or referred to the MIC, Service Hydrologists, etc as necessary.

Finding: Email was a difficult means for disseminating products to various ICP constituents. While it did, by virtue of the recipient, provide a means of tracking who was using the product, the users often changed. Keeping the list of email addresses straight was not always an easy process.

Finding: A web portal would be a preferable way to distribute NWS products at an ICP. The portal would contain all NWS products and the actual web page could be organized on a per event basis based on ICP requirements.

Finding: A well designed web portal would also likely facilitate the transition from on-site to remote support services as appropriate. The portal should be designed as a dashboard to provide relevant ICP products and should have a chatroom interface as part of the dashboard.

Recommendation: NWS should establish procedures and IT capabilities to disseminate IDSS products to the ICP via a web portal.

IDSS Support Instructions

A comprehensive set of ICP support instructions were used to support NWS ER Personnel at the ICP. The instructions provided a product and service table which included delivery times and days, detailed product/service content and preparation instructions, contact information of each key NWS/NOAA contact, and a variety of "need to know or best practice" notes that were passed on to each subsequent NWS ER person.

The instructions were established as a set of notes to be passed to the next NWS person on the first day of the response. The instructions quickly grew from one page to about 20 pages over the first couple of weeks of the response. At the beginning of the second week, the WFO GRR MIC reorganized the document and then maintained a standardized structure of the document throughout the remainder of on-site support.

A sister ICP support instruction document was developed for providing remote off-hour support for WFO GRR. Again this document proved crucial for ensuring products were prepared in a consistent manner and delivered on-time. The WFO ICP support instruction evolved to become the remote ICP support instructions once on-site ICP support ended in early November.

Finding: The NWS ICP instructions were an absolute necessity for providing a clear set of support instructions for all NWS ER Personnel. The instructions also helped ensure consistency of service between all NWS ER Personnel.

Finding: The instructions were highly praised by responding personnel in being helpful for both spin-up and execution of their IDSS role.

Recommendation: The NWS should develop a template for developing ICP support instructions. The template should include product dissemination table, product content and preparation instructions, contact information for principal NWS/NOAA Points of Contact

The Value of Decision Support Services

The lack of a strong pre-existing relationship between NWS and USEPA yielded a lack of knowledge concerning the support NWS could provide for spill response. Educating the FOSC, gaining their trust, and demonstrating the value of NWS services was a gradual process. For the State of Michigan, there was a pre-existing relationship between the Michigan State Police Department of Homeland Security and both WFO GRR and WFO DTX. This relationship directly led to prompt engagement of NWS by the MISEOC following the spill. However, because there was no previous experience with the State in utilizing NWS in this manner, there remained a lack of understanding concerning NWS IDSS capabilities. This was demonstrated in the fact that NWS had no assigned workstation within the MISEOC as was the case with most other agencies.

As the event evolved, the USEPA Incident Commander and the MISEOC Commander were impressed by the overall enthusiasm, dedication, and professionalism of all the NWS personnel that provided IDSS at the Marshall ICP and MISEOC in Lansing. Such professionalism helped establish an environment of trust and dependability amongst NWS customers.

This was especially true during two critical severe weather outbreaks on September 21 and again on October 26. During both outbreaks, the IC desired continuous communication with NWS ER Personnel deployed at the scene and in both instances took actions based on NWS counsel to provide for the safety of all response personnel. In the first instance, based on an approaching squall line with a history of 70 mph winds, the IC directed the evacuation of all ICP personnel from approximately 13 trailers. In the second outbreak in October, the IC suspended all operations for the entire day based on the combined tornado and high wind potential.

As stated by the MISEOC Commander, "…having NWS personnel on-site was extremely valuable because of the insights provided beyond the forecast. MISEOC staff place much greater stock in the information when experts are there to explain and lend opinions as to how weather might impact response or recovery operations. NWS representatives routinely provided rainfall data, current wind and humidity, and forecasts, which were all taken into account by the MISEOC during strategy meetings. NWS personnel were not hesitant to provide insights and potential ramifications regarding meteorological impacts on the situation."

At the ICP in Marshall, the FOSC was very complimentary of NWS services during a follow-up interview. He stated that NWS efforts were critical to maintaining the situational awareness of the response, and weather and water information from the NWS were determining factors in whether the IAP for the next day was viable. That included support for on-site safety from weather hazards, tactical decision-making with respect to river flows and water levels, and expert consultation on the dynamics of ice jam formation and break-up. The ability to have that expertise on-scene and in-person during the response was invaluable to USEPA.

This praise is indicative of the value that was eventually placed on NWS services, remarkable considering the lack of experience NWS has in this area. The priority must be to build on the present success moving forward. The USEPA and other FOSC's will undoubtedly request NWS IDSS when the next significant spill occurs; and while they were impressed with NWS support capabilities, NWS must keep in mind that there are no past experiences with which to compare the present level of service. NWS should build a set of emergency response staffing protocols, an advanced suite of customized products/services, and on-site support tools to provide IDSS at a significant oil spill or HAZMAT release under the auspices of the National Response Framework – ESF 10.

Appendix A – NOAA Situation Report

National Weather Service
Central Region Headquarters
Regional Operations Center

National Ocean Service
Office of Response and Restoration

Situation Report #10

West Michigan Oil Spill into the Kalamazoo River

July 26, 2010 - ongoing

Updated Report – 12:00 p.m. CDT Wednesday, August 4

EVENT:

A pipeline leak that occurred Monday, July 26, spilled an estimated one million gallons of oil into a creek leading to the Kalamazoo River (estimated by EPA).

IMPACTS:

As of Monday, August 2, 61 homes are within the evacuation area for which voluntary evacuations have been called. Of those 61, 21 homes have been reported vacant, which includes voluntary evacuations and empty homes.

A Disaster Declaration has been issued by Governor Granholm
http://www.michigan.gov/gov/0,1607,7-168-21975-241302--,00.html

No fatalities or injuries have been attributed to the spill. However, to date, 34 people have reported to area hospitals to seek treatment due to fumes/oil contact through the week.

NOAA OFFICE OF RESPONSE AND RESTORATION (OR&R) OPERATIONS:

OR&R Emergency Response Division staff are providing scientific support to EPA for response operations. Liz Jones, Scientific Support Coordinator is on-scene. Trajectory analysis support for oil transport via river is ongoing.

OR&R Assessment and Restoration Division staff and contractors have been on scene since 7/29/10. Shoreline Cleanup Assessment Teams have been trained and deployed. Natural Resource Damage Assessment (NRDA) activities have begun to evaluate habitats and natural resources within the river and floodplain that have likely been injured by oil. NOAA is working with the U.S. Fish and Wildlife Service (US FWS) and Michigan Department of Natural Resources and Environment staff to conduct evaluations. Oiled turtles and birds have been observed. A few dead fish have been reported. Teams to evaluate fish kills have been deployed. Further mussel and fish evaluations are planned and will be conducted over the next few weeks.

As Federal Lead Administrative Trustee, US FWS is drafting a trustee MOU and funding and participation agreement for review and signoff. The state of Michigan is conducting studies of fish injury that could contribute to the NRDA. NOAA is working to coordinate trustee activities and is providing technical support in the development of study plans.

NOAA Fisheries Restoration Center and General Counsel for Natural Resources staff have also been assigned to the NRDA effort.

NOAA National Weather Service Operations:

Current Conditions and Forecast information:

A thunderstorm complex quickly moved through the area this morning adding up to a quarter of an inch of rain to the basin, however, this should not significantly change river conditions which are near base flow. There's a slight chance of thunderstorms this afternoon and again Thursday with a cold frontal passage Thursday. NWS forecasters provided real-time support regarding thunderstorm activity and rainfall.

Decision Support Activities:

The Central Region (CR) Regional Operations Center (ROC) continues at level 2, operating 'virtually' beyond normal hours. Staff from the Weather Forecast Offices (WFO) at Grand Rapids and Detroit continue to provide onsite support to the EPA-led Incident Command Post (ICP) in Marshall, Michigan, and the State Emergency Operations Center (SEOC) in Lansing. Staffing has been augmented with staff from WFO Northern Indiana, Central Region Headquarters and WFO North Central Lower Michigan (Gaylord) through midweek, next week.

WFO Detroit continues to provide information from HYSPLIT model runs; WFO Grand Rapids continues to provide spot forecast s for the area. NCRFC continues to provide travel time forecasts for specific points along the Kalamazoo River as well as daily river forecasts.

The CR ROC has been coordinating information with FEMA Region V.

Customer Feedback on NWS Products/Services

Equipment/Communication Problems:

No equipment issues were noted.

The contents of this situation report are based on the best information known to the CRH ROC at the time this situation report was prepared, and should be considered preliminary. A later and more thorough investigation may change the information presented in this situation report.

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Appendix B - NWS Modified Spot Forecast

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FIRE WEATHER PLANNING FORECAST FOR KALAMAZOO OIL...NOAA
NATIONAL WEATHER SERVICE GRAND RAPIDS MI
647 AM EDT TUE AUG 3 2010

FORECAST IS BASED ON INCIDENT TIME OF 0700 EDT ON AUGUST 03.
IF CONDITIONS BECOME UNREPRESENTATIVE...CONTACT THE NATIONAL WEATHER
SERVICE.

.DISCUSSION...
ISOLATED TO SCATTERED THUNDERSTORMS ARE EXPECTED TODAY THROUGH
THURSDAY BUT MOST PLACES WILL REMAIN DRY. A COLD FRONT WILL BRING
COOLER TEMPERATURES AND LOWER HUMIDITY BY THE WEEKEND.

.TODAY...

SKY/WEATHER.........MOSTLY CLOUDY (70-80 PERCENT). CHANCE OF
                    SHOWERS AND THUNDERSTORMS.
TEMPERATURE.........MAX 86.
RH..................MIN 59 PERCENT.
WIND (20 FT)........WEST WINDS 7 TO 12 MPH. GUSTY AND ERRATIC WINDS
                    EXPECTED NEAR THUNDERSTORMS.
MIXING WINDS........WEST 3 TO 12 MPH.
MIXING HEIGHT.......4300-4800 FT AGL.

.TONIGHT...

SKY/WEATHER.........PARTLY CLOUDY (50-60 PERCENT). CHANCE OF
                    SHOWERS AND THUNDERSTORMS.
TEMPERATURE.........MIN 70.
RH..................MAX 87 PERCENT.
WIND (20 FT)........SOUTH WINDS 5 TO 8 MPH. GUSTY AND ERRATIC WINDS
                    EXPECTED NEAR THUNDERSTORMS.
MIXING WINDS........SOUTHWEST 5 TO 13 MPH SHIFTING TO THE SOUTH 2
                    TO 3 MPH TOWARD DAYBREAK.
MIXING HEIGHT.......2100-2600 FT AGL DECREASING TO 100-600 FT AGL
                    AFTER MIDNIGHT.

.WEDNESDAY...

SKY/WEATHER.........PARTLY SUNNY (50-60 PERCENT).
TEMPERATURE.........MAX 87.
RH..................MIN 51 PERCENT.
WIND (20 FT)........SOUTH WINDS UP TO 5 MPH EARLY IN THE MORNING
                    BECOMING LIGHT...THEN BECOMING WEST 6 TO 11
                    MPH. GUSTY AND ERRATIC WINDS EXPECTED NEAR
                    THUNDERSTORMS.
MIXING WINDS........WEST 2 TO 9 MPH.
MIXING HEIGHT.......5200-5700 FT AGL DECREASING TO 3000-3500 FT AGL
                    LATE IN THE DAY.
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Appendix C – River Forecast Brief

Kalamazoo River Oil Spill Forecast Information

NWS North Central River Forecast Center
Chanhassen, Minnesota 952-361-6660
Monday, August 03, 2010 0635 PM ET

As part of its larger hydrologic forecasting mission, the NWS North Central River Forecast Center maintains hydrologic computer models that simulate stream flow along the Kalamazoo River at the following locations:

- Marshall, MI (USGS gage at S Kalamazoo Ave)
- Battle Creek, MI (USGS gage at S Kendall St)
- Comstock, MI (USGS gage at River St)
- Plainwell, MI
- Allegan Dam
- New Richmond, MI (USGS gage at 58th St)

Current River Conditions

The river continues to recede towards base flow conditions at this time. Travel times are gradually increasing as flow velocities and river stage decreases. Deep soil moisture conditions remain fairly wet which should keep base flows higher than normal for several days.

Forecast River Conditions

A MCS developed along a boundary across central Iowa and northern Illinois overnight. This complex is progressing east and is currently over the Chicago metro area. The main threat of rain is expected to stay south of the Kalamazoo River Basin today. However isolated thunderstorms and rain showers could impact the area. Basin average rainfall isn't expected to be over 0.25" in the next 24 hours in the basin. As the frontal boundary slides east during day 2 the 24-hour QPF over the basin of concern is expected to be up to an inch.

The expected rainfall over the next couple of days is not expected to have a significant impact on the river and streams. The smaller tributaries could see an increase in stage of around 0.5 foot where as minimal rises and/or continued recession is modeled on the mainstem Kalamazoo River.

Current river forecasts including 24 hours of forecast precipitation at the locations above can be found by clicking on the map at: ***http://water.weather.gov/ahps2/index.php?wfo=grr***

Travel-Time Estimates

Since river flow levels are receding and velocities are slowing, we have increased the travel-times slightly.

From	To	Travel Time (hours)
Marshall	Battle Creek	32
Battle Creek	Comstock	43
Comstock	Plainwell	14
Plainwell	Allegan Dam	7
Allegan Dam	New Richmond	30

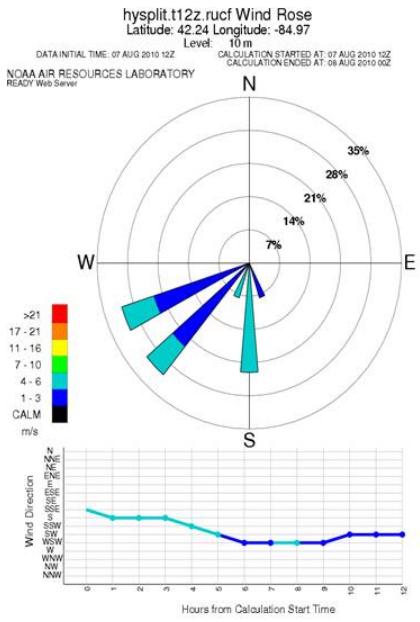
HYDROLOGIC STATEMENT
NATIONAL WEATHER SERVICE GRAND RAPIDS MI
950 AM EDT TUE AUG 3 2010

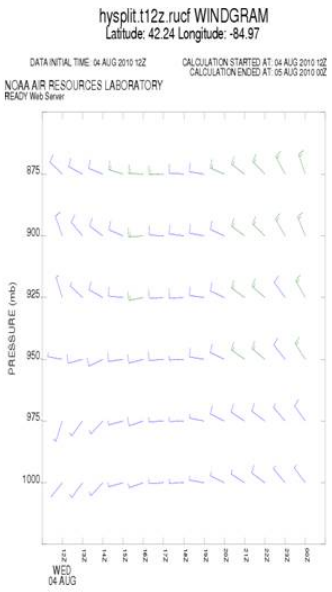
WATER LEVELS ARE HIGH ACROSS THE AREA... BUT ARE FORECAST TO REMAIN BELOW FLOOD STAGE FOR THE FOLLOWING RIVERS OR CREEKS:

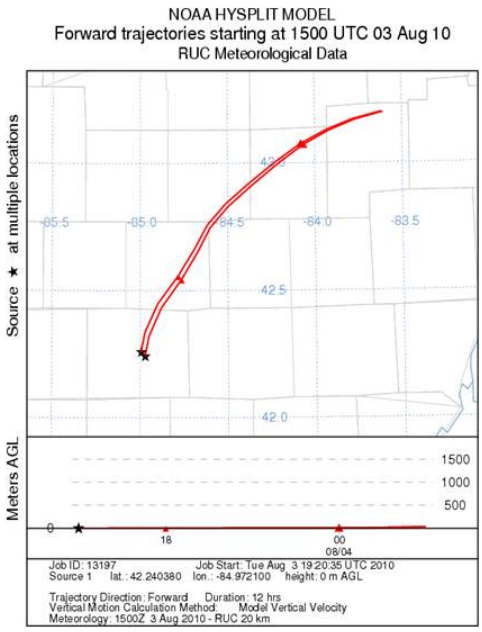
FOR THE KALAMAZOO RIVER AT MARSHALL... THE LATEST STAGE WAS 5.2 FEET AT 7 AM TUESDAY. NO FLOODING IS FORECAST. THE MAXIMUM STAGE FORECASTED IS 5.2 FEET TOMORROW EARLY AFTERNOON. FLOOD STAGE IS 8.0 FEET.

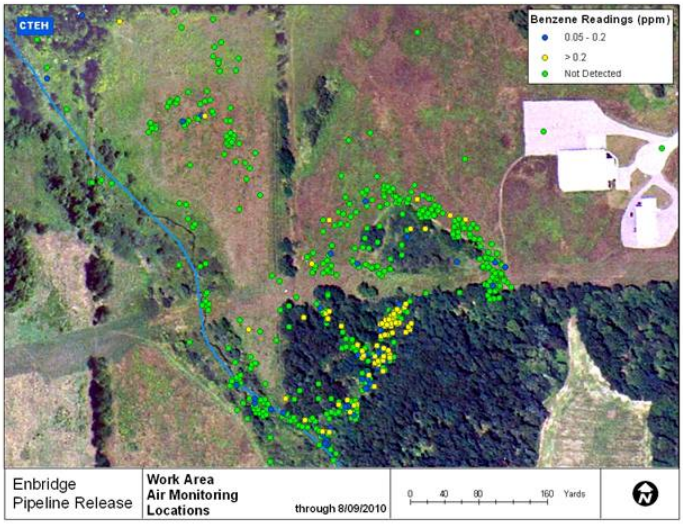
LOCATION	FLOOD STAGE	OBSERVED STAGE	DAY TIME	FORECAST 7AM WED	THU	FRI
KALAMAZOO RIVER						
MARSHALL	8.0	5.2	TUE 07 AM	4.9	4.8	4.8
BATTLE CREEK	9.0	3.7	TUE 08 AM	3.6	3.6	3.6
COMSTOCK	9.0	4.9	TUE 07 AM	4.8	4.7	4.6
NEW RICHMOND	11.0	8.1	TUE 07 AM	7.7	7.5	7.3

Appendix D – HYSPLIT, Wind Rose, and Wind Gram









Appendix E: Daily Briefing Slides

Impacts to Operations

Tonight

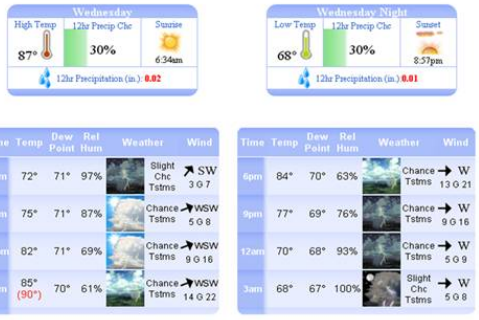
- Continued chance for strong storms – ending after midnight
- Lightning continues to be a threat and could see isolated severe storms
- Basin-wide average rainfall will be under ½"
- Isolated storms could produce localized heavy rainfall

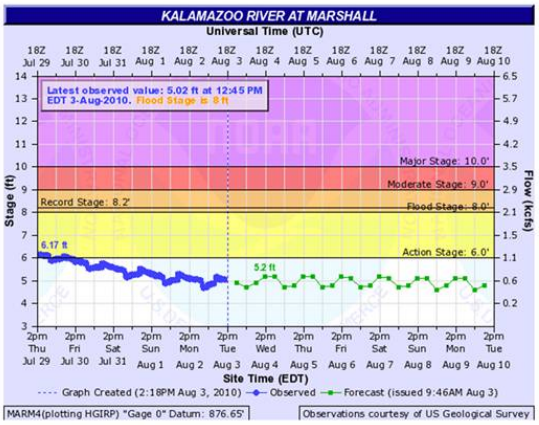
Wednesday

- There is a chance for thunderstorms in the early morning and again in the late afternoon.
- Rainfall amounts are not expected to exceed ½"
- Rainfall beyond Wednesday could cause some minor rises on the local rivers.

Forecast for Wednesday August 4

Wednesday, August 4





Estimated Travel Time

As of 12:00 PM Tuesday, August 3, 2010

From	To	Travel Time (hours)
Marshall	Battle Creek	32
Battle Creek	Comstock	43[1]
Comstock	Plainwell	14
Plainwell	Allegan Dam	7[1]
Allegan Dam	New Richmond	30

1: These estimates may be too low. The largest source of uncertainty for estimating how fast the oil will move downstream is the travel time through Morrow Lake/Morrow Dam and Lake Allegan/Allegan Dam. Our models simulate the movement of a flood crest through these structures, which is not necessarily the same as the movement of a surface contaminant like oil through the reservoirs.