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Managing Risk and Operating in Environmentally Sensitive Areas: The Wetlands of the Northwest Louisiana Haynesville Shale

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Abstract

The aerial extent of the Haynesville Shale play has been analyzed with regard to regulatory and permitting processes such that unavoidable surface impacts can be planned in a manner that allows operators to minimize both risk and cost from operations in environmentally sensitive areas – the wetlands of northwest Louisiana.

A workflow has been developed and applied for operators with significant leaseholds seeking to understand the volume of wetlands that may be impacted due to construction of drilling pads, reserve pits, access roads, flowlines, pipelines and gathering systems that comprise field infrastructure. Working under new rules since 2008, regulatory agencies require offsets for unavoidable impacts to wetlands to occur in the watershed where the impacts are planned to occur. With limited mitigation acreage available in an area where surface rights are locked up by landowners and operators, the need for creative wetland analyses and mitigation solutions has risen to need-to-know-now status.

Of the 4.3 million surface acres in the Louisiana and Texas Haynesville Shale play, more than 23% of the Louisiana play area is considered jurisdictional wetlands by the US Army Corps of Engineers. After operators avoid and minimize their wetlands impacts, GIS analysis of current and past land compositions and uses can be used to forecast future unavoidable wetland impacts from oil and gas development activities. Results of this analysis are used to formulate an appropriate compensatory mitigation solution that can be readily approved by regulatory agencies.

Surface impact analysis employs a unique methodology and workflow that has shown to generate significant real-dollar savings for operators, allows compensatory mitigation plans to be proactively developed thereby accelerating agency regulatory processes, and transfers risk and liability from oil and gas operators to those delivering wetland mitigation solutions.

Introduction and Statement of Theory

An era of increased regulatory agency scrutiny for oil and gas operators developing U.S. onshore resource plays has served to heighten operator awareness of regulatory and permitting processes. Company executives, EH&S managers, and resource play and asset managers alike are faced with wide-ranging perceptions of industry's view of environmental issues, based on both Macondo deepwater Gulf of Mexico spill impacts and the general public's view of regulatory-exempt hydraulic fracturing processes affecting the nation's aquifers -- thereby potentially impacting drinking water. While potential drinking water impacts are governed by the Clean Water Act's Water Quality section 401, compliance with another portion of the Clean Water Act, section 404, states that all discharges into waters of the United States require permits from the U.S. Army Corps of Engineers. Discharges refer to surface impacts (fill dirt, dredged material, stones, and almost anything else) that can be put or applied to "waters;" waters may be open, navigable waters like rivers, streams and lakes and also lands with certain hydrologic, soil and vegetative characteristics that have yielded a regulatory agency jurisdictional determination as "wetlands." Guided by 1977 Executive Order 11990, the President George H. W. Bush administration implemented the policy that states that projects causing unavoidable impacts to wetlands are required to be offset by suitable mitigation of project impacts resulting in "no net loss" of wetlands.

Surface impacts to wetlands are normally avoided by effective location of drilling pads and associated work surfaces outside jurisdictional wetland boundaries. When avoidance and minimization efforts result in operating areas containing wetlands,

regulatory agencies require identification of suitable compensatory wetland mitigation prior to making the impact, that is, prior to construction. Wetland mitigation, therefore, is a key component of the U.S. Army Corps of Engineers (USACE) section 404 permitting process allowing operations in wetlands. Regulatory guidance, in the form of the "Final Rule" on Compensatory Mitigation for Losses of Aquatic Resources published in 2008, provided USACE districts a hierarchical preference for the type of compensatory wetland mitigation to be selected when the agency is considering approval of section 404 permits. This preferred form of mitigation is called mitigation banking. Mitigation banks are dedicated sites where physical restoration of wetland functions and values occur for the purpose of offsetting unavoidable impacts to wetland functions and values elsewhere in the same watershed. Mitigation banks produce mitigation credits that can be purchased by operators and field infrastructure companies with operational surface impacts like drilling pads, access roads, flowlines, laterals, pipelines, gathering systems, processing plants, and their associated rights of way work areas causing both permanent and temporary wetland impacts. Purchase of these credits for use as compensatory wetland mitigation accompanying section 404 permits eliminates operator liability for their project impacts by transferring the liability to the mitigation bank, whose sole role is to provide offsetting wetland mitigation credits for such impacts.

A search of the SPE OnePetro database using the term "wetland" for the years 2000 through 2010 was conducted on 8 June 2010 and yielded 44 results. The singular "wetland" was used as a search term as the author noted results using the plural "wetlands" too restrictive and yielding few results. Not a single paper was identified that related to the regulatory environment faced by oil and gas producers *post* the implementation of the landmark "Final Rule" on compensatory mitigation for unavoidable impacts on wetlands environments. To eliminate any potential confusion resulting from terminology, "wetland" or "wetlands" herein refer to naturally occurring or restored natural wetlands, not "engineered wetlands" or "constructed wetlands" used as a water treatment mechanism. Natural wetlands provide tremendous ecological benefits including storm water retention, erosion minimization, water filtration, biofiltration and management of agricultural runoff, and enabling of habitats for multitudes of species.

Analysis of potential, future unavoidable wetland impacts can be accomplished by understanding spatial and temporal variations in the context of geographic information systems (GIS). By combining multi-layered imaging and company operational knowledge, wetland impact acreage can be estimated and forecasted. This methodology was found particularly useful by operators seeking to secure an inventory of mitigation credits for future projects as a limited supply of mitigation credits would mean potential delays in planned field development activities. By understanding and planning for the requirements of regulatory processes, operators optimized business processes and improved relations with governmental regulatory agencies thereby reducing processing time for permit applications, reducing operational risk through the purchase of mitigation credits and lowering operating costs by inventorying mitigation credits at known costs prior to engaging in operational activities.

Problem and Situation Analysis

Defining Wetlands

Wetlands are difficult to define as they are comprised of physical components located at the intersection of land and water. Traditional wetland definitions include areas of fluctuating water levels that may be intermittently to permanently flooded (hydrologic characteristics), that host certain plant life (vegetative characteristics) and that have soils that hold water for specified periods of time even when there is no precipitation or other surface water source (hydric soils). From this tri-partite relationship between hydrology, physiochemistry and biota has emerged the current approach to defining jurisdictional wetlands based on three indicators – hydrology, soils and vegetation. (Mitsch and Gosselink, 2007)

Each USACE district provides detailed inistructions on processes determination of lands as wetland, guided by the 1987 Wetland Delineation Handbook. Numerous localized, interim Regional Supplements to this handbook have also been promulgated by the USACE since 2000. (USACE, 2010)

The Regulatory Framework

Formally, a Department of the Army (DA) permit is required for the discharge of dredged (excavated) and/or fill material into the waters of the United States AND/OR the construction of any structure or work occurring in or affecting navigable waters of the United State under Section 404 of the Clean Water Act of 1972 and Section 10 of the River and Harbors Act of 1899.

The USACE Vicksburg District governs most section 404 permitting in the northwest Louisiana Haynesville Shale play, while a portion of the play area is governed by the Fort Worth District due to the Corps' operational boundaries.

In addition to obtaining USACE approval for a 404 permit, coordination between other state and federal agencies must take place before a proposed project with environmental impacts to wetlands may commence. Each agency scrutinizes 404 permits considering their own jurisdictional missions and can approve or deny a permit. Agencies involved in permitting in

northwest Louisiana's Haynesville Shale include:

- The Louisiana Department of Environmental Quality (LA DEQ) is the authorizing agency for compliance with Section 401 of the Clean Water Act that requires permittees to acquire a Water Quality Certification along with a DA permit. Any stipulation set forth in a state certification will be represented in the federal permit. The Corps will not issue a permit until the certification is approved, conditioned, or waived by the state. LA DEQ contact information is provided in the Appendix below alongside the other agencies mentioned in this paper.

- The Environmental Protection Agency (EPA) -- The EPA has the authority to interpret and implement the provisions of the Clean Water Act (CWA), but the USACE has responsibility to administer the Department of the Army permit program under Section 404 of the CWA. In practice this gives the USACE day-to-day responsibility for Section 404 issues and gives the EPA review and policy responsibilities. Various memoranda of agreements between the Corps and the EPA assure that the two agencies interpret the law uniformly. The EPA also has enforcement responsibilities to ensure compliance with the CWA.

- The U.S. Fish and Wildlife Service (FWS) -- The FWS, under the Fish and Wildlife Act, reviews proposed permitted undertakings to ensure wildlife resources are protected or conserved by the indirect or direct loss and damage caused by the proposed activity including impacts to wildlife habitat areas.

- State and Tribal Historic Preservation Offices (SHPO/THPO) -- Mandated by the National Historic Preservation Act of 1966 (NHPA), National Environmental Policy Act of 1969, and 33 CFR 325, Appendix C – a section of the "Final Rule," all complete permit applications are sent to the SHPO/THPO for assessment of, and comments for, potential affects to historic properties listed, or eligible for listing, in the National Register of Historic Places.

- Other state agencies involved in DA permitting include Louisiana Department of Wildlife and Fisheries and Louisiana Department of Natural Resources and the Louisiana Division of Archeology.

To comply with the aforementioned Executive Order and subsequent administration policies, the USACE and the EPA reached an interagency agreement to implement a "no net loss" of wetlands program, nationwide, for the USACE permit program. This agreement mandated a significant reduction of wetland losses through avoidance and minimization and that compensatory mitigation become part of nearly every USACE permit action, specifically to compensate for the unavoidable loss of wetlands across the Nation. All USACE permit authorizations must demonstrate that all reasonable and practicable means have been taken to avoid and minimize impacts to jurisdictional areas. Only after avoidance and minimization have been addressed can and will mitigation be considered.

Permitting

A permitting program is provided by both Section 10 and Section 404 allowing regulated activities to occur within waters of the United States. Permits for both regulations are generally administered under a single, combined process by the USACE. There are different forms of permits, depending on the nature of the regulated activity. Permits may be classified as "general" or "individual." General permits are pre-existing authorizations issued on a national basis (Nationwide Permits or NWPs) or on a regional basis (Regional Permits or Regional General Permits or RGPs) that have already been subject to the public review process. Individual permits (IPs) are used to authorize individual projects that may not be covered by a general permit or exceed the limitations of a general permit. Individual permits must undergo a public review process that typically lasts at least 30 days, but may be longer based on USACE activity levels and resources available for permit processing.

General permits are often applicable to common, small scale fill activities which have been determined by the USACE to result in minimal impacts to regulated areas. If an activity meets the criteria and special conditions of a general permit, then the activity can be authorized by the USACE in a relatively short period of time, typically 30 to 45 days. If an activity does not meet the criteria of a general permit, then an individual permit is necessary which can require 4 months or more to complete and approve. The USACE has broad discretion to require an individual permit even if an activity meets the requirements of a general permit. Regional permits are issued by individual USACE districts and are usually activity specific or address unique conditions within a geographic area, whereas NWP are for specific activities and are utilized throughout the nation. There are currently 50 NWPs, of which a few are of interest to oil and gas operations. NWPs relevant to the oil and gas industry include numbers 6 (survey activities), 8 (oil and gas structures in the OCS), 12 (utility line activities), 14 (linear projects), 21 (oil spill cleanup) and 47 (pipeline safety programs). (USACE, 2010)

Many USACE districts that service regions with extensive oil and gas activity have one or more Regional General Permits that specifically address oil and gas industry related tasks. Such is the case for the Fort Worth and Tulsa Districts under RGP-11, the Vicksburg District under RGP-19 and the Little Rock District, most recently, with 2009-00100-GG.

An individual permit is required for many Section 10 actions and for Section 404 activities which are deemed to cause significant impacts to jurisdictional areas. Examples of significant impacts include impacts to jurisdictional areas which exceed general permit allowances, impacts to unique or high-quality wetlands, and cumulative impacts (impacts that by themselves may not be significant, but when added to other similar impacts in an area become significant). An individual permit involves significantly more agency and public review and processing procedures. As mentioned above, individual permits typically require 4 to 24 months to process depending on the complexity of the action and whether or not an Environmental Impact Statement is required by the USACE. Additionally, the proposed project plan must demonstrate avoidance and minimization of impacts.

Benefits of Planning and Analysis

Interestingly, while permitting for operations in wetlands has been required for years, many operators are unaware of either the benefits or risks associated with permitting. Costing environmental items (so-called "bugs and bunnies" items) within an AFE for a proposed well is atypical. Wetland permitting may be a part of a centralized, shared environmental or regulatory or permitting department within an operator or a function within an operating or asset business unit. Regardless of where the personnel reside or report, it is possible to accelerate the permitting process through proactive planning and interaction with appropriate regulatory agencies even though all agencies regularly state that they consider mitigation on a permit by permit basis. Agency permit processors are people who manage large workloads and appreciate knowing if a volume of permits are going to be heading their way. Considering permit-processor's time-to-process, on a per-permit basis, having a ready mitigation solution (credits) located and on-hand speeds permit processing time. Operators benefit from this improved, predictable permit processing time and also can reduce costs by using upfront knowledge of future impacts to proactively source credits from mitigation banks.

A note on economic considerations and benefits -- environmental issues may be explicitly thought of in terms of economic costs. Most AFEs for new drills do not include a line item for environmental permitting or execution costs. These costs are often considered external to the core business operation, yet are necessarily-borne costs due to permitting requirements **prior to** commencing field operations. Economic operational efficiency can occur even with the inclusion of these external costs. Efficiency does not require that all external costs totally disappear, only that they be properly included in overall social-market tradeoffs. (Field, 2001) As such, these costs can and should be internalized – no longer are environmental costs viewed by upstream operators as externalities.

Operational Risks from Lack of Planning

There are significant risks and liabilities to be considered with regard to compliance and enforcement of wetland permits. The EPA, in their National Enforcement Initiatives for Fiscal Years 2011 – 2013 has targeted the Energy industry to ensure compliance with environmental laws. "EPA will develop an initiative to assure that energy extraction activities are complying with federal requirements to prevent pollution of our air, water and land." (EPA, 2010) Both the USACE and EPA have responsibilities for enforcement and compliance resulting from their joint memoranda.

The USACE is charged with enforcement of the provisions and prohibitions of Section 10 and Section 404. Regulated activities conducted without the proper permit are subject to enforcement actions and various penalties. The USACE is authorized to administratively issue "cease and desist" orders, require removal of constructed facilities, restitution of jurisdictional areas impacted, require after-the-fact permits, and/or levy fines of up to $25,000 day per violation. The USACE may also refer cases to the EPA or the US Attorney General's Office for civil or criminal prosecution resulting in restitution, fines up to $2 million, and/or jail terms up to 15 years.

The EPA's enforcement responsibilities are defined under the Clean Water Act sections 309(a) Administrative Orders including cease and desist, restoration, after the fact and additional required mitigation and 309(g) Administrative Penalties including Class I and Class II penalties. Monetary damages from Class I actions do not exceed $37,500 per incident and Class II actions $177,500 per incident. Any of the section 309 infractions can lead to civil referral to the Department of Justice (DOJ). Most recently, however, the EPA has been noticed enforcing at the criminal level via referral to the DOJ through the EPA Criminal Investigation Division (CID). (EPA, 2010)

Timing risk is real issue for operations requiring permits. The USACE as a governmental agency is resource constrained. A backlog of permits can build very quickly, particularly at a single district addressing thousands of permits for drilling and associated infrastructure-related impacts. Upfront planning yields knowledge of where and when impacts are planned; starting early with the USACE permit process increases likelihood of processing delay minimization.

When in doubt about an impact to a wetland, use the USACE wetland determination methods and approaches noted on each District's website and file a section 404 permit. The best case result of this filing would be a finding of no significant impact while the worst case result will be the need to mitigate for wetland impacts.

Case Study: Northwest Louisiana Haynesville Shale

Scope and Magnitude Determination

Identification of potential, future surface impacts in the Haynesville Shale was a multi-layered problem. Operators typically learn about wetlands and other environmental impacts when, for example, drilling locations are staked by landmen and associated field surveyors. These folks first try to avoid locations in wetlands and, when they must operate in a wetland, seek to minimize their impacts by, say, reorienting an orthogonal drilling pad to be more slanted thereby avoiding a "corner impact." Regardless of such avoidance and minimization techniques, in field development of plays with a significant percentage of wetlands in key operating areas as above required by government regulations, the time will come when unavoidable wetlands will inevitably be impacted. The challenge for operators is to know early enough where and how many impacts will occur so as to have an adequate supply of compensatory mitigation solutions (credits) that allow prompt, smooth processing of section 404 permits with the USACE and other agencies.

To proactively address this challenge, the first step was to recognize the large aerial extent of the Haynesville Shale play area. A study area was developed using the reference map in Figure 1, focusing on the northwest Louisiana area only. Next, a map with a surface grid was used to develop a GIS layer for reference consistency. Public data was used for this component, available from the Louisiana Department of Natural Resources (LA DNR) at their Haynesville Shale website with URL: http://dnr.louisiana.gov/haynesvilleshale/. This data was selected for analysis purposes because, in addition to the map and its reference grid blocks being posted on a website, the grid blocks themselves were made available in "shapefile" format -- an input format for the ESRI ArcView system used for this analysis. These surface grid blocks are called "units" by LA DNR and cover 1 square mile (640-acre) areas. Figure 2 shows the starting Haynesville Shale Units reference map, vintage 1/21/2010.

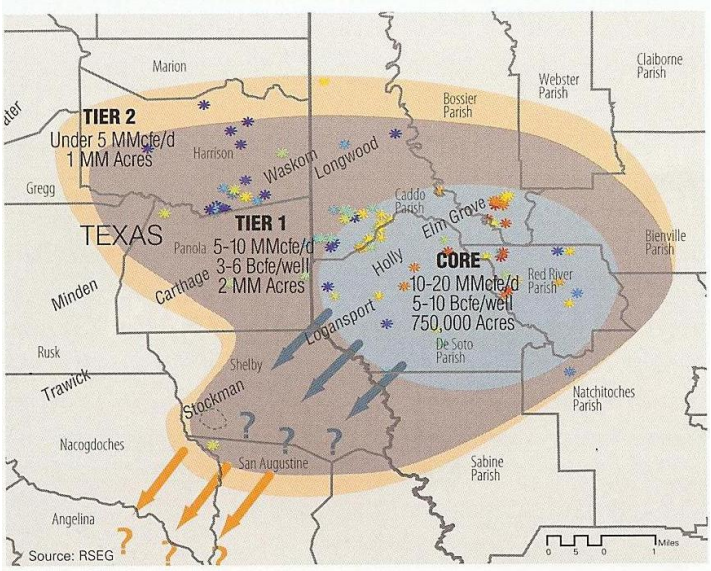

Figure 1. Aerial Extent of Haynesville Shale (Oil and Gas Investor, 2009)

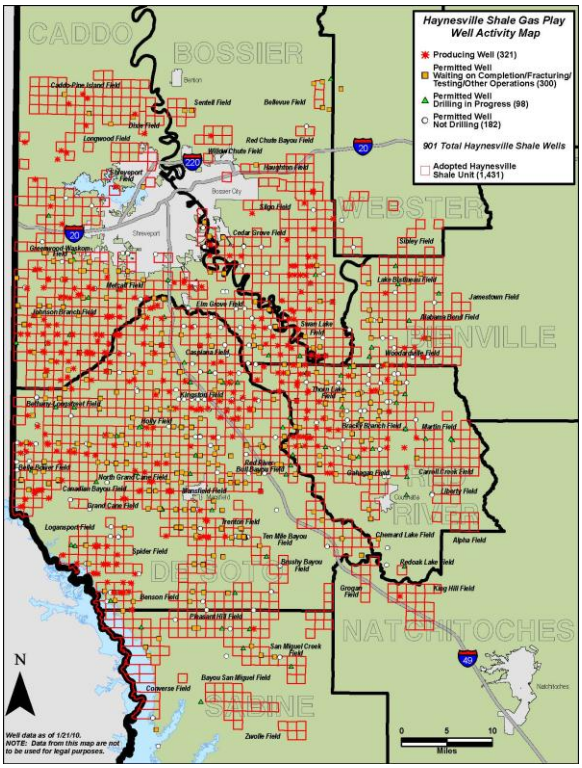

Figure 2. Haynesville Shale Unit Map (LA DNR, 1/21/2010)

With surface boundaries now identified, datasets were selected and captured to qualify wetlands within the aerial extent overlain by the grid blocks. GIS analysis of wetlands in northwest Louisiana used multiple datasets including a National Wetlands Inventory layer developed and managed by the U.S. Fish and Wildlife Service, U.S. Geological Survey-sourced National Land Cover Dataset extracted from Landsat Thematic Mapper satellite data, an NOAA Land Cover dataset comprised of Landsat 5 Thematic Mapper scenes analyzed according to the Coastal Change Analysis Program, the Department of Agriculture's Soil Conservation Service data layers, Light Detection and Ranging (LIDAR) data, and historical aerial photographs. Together this multi-layered dataset provided the inputs needed to understand hydrology, vegetation and soils in the analysis area that can be identified as components comprising wetlands. The results of that effort are shown in Figure 3, as a base map with surface grids and a colored wetland layer.

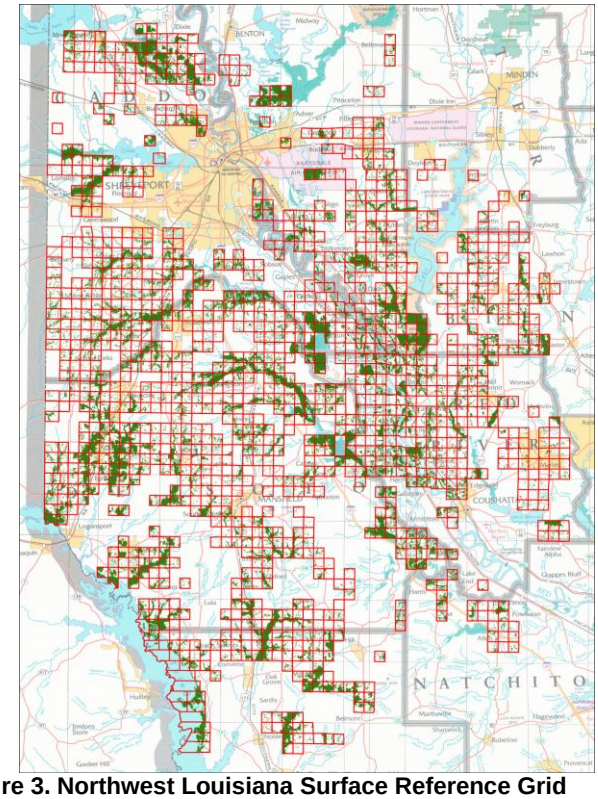

Figure 3. Northwest Louisiana Surface Reference Grid and Wetlands Layer, RES Analysis, 1/2010

With the spatial extent now mapped, the temporal issues associated with field development need to be taken into consideration. The LA DNR updates the map and reference grid at least monthly. Figures 2 and 3 above used the January 2010 vintage data, figures 4 and 5 were derived in a similar manner using November 2010 vintage data and are shown below.

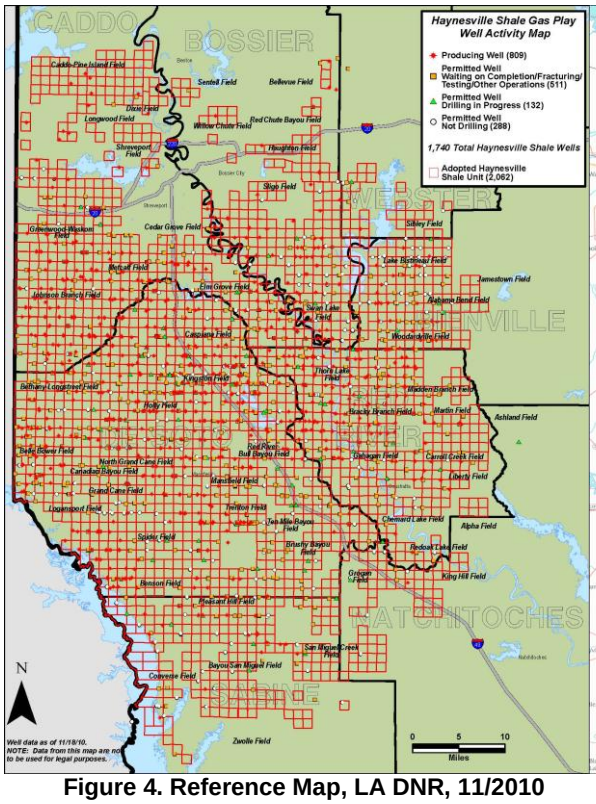

Figure 4. Reference Map, LA DNR, 11/2010

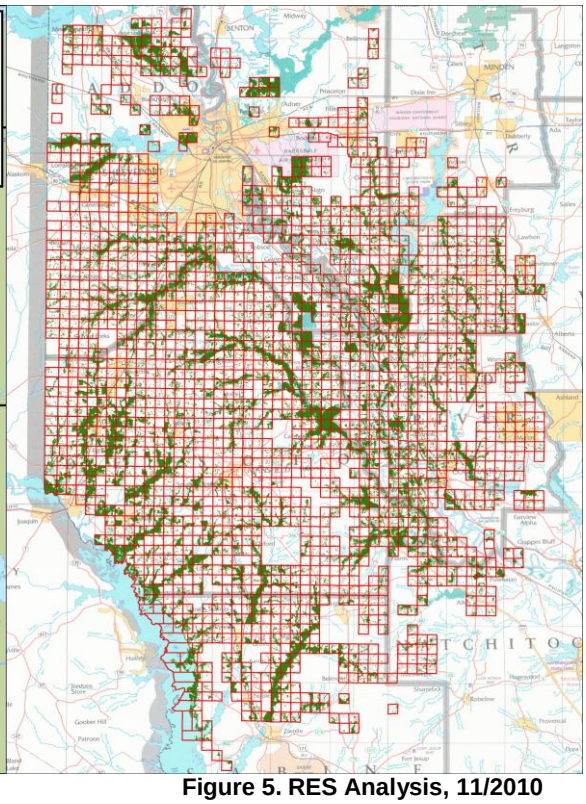

Figure 5. RES Analysis, 11/2010

The results of this analysis are tabulated as follows:

Data Vintage	Number of Surface Unit-Acres in Study	Number of Wetland Acres in Study	% Wetlands
January 2010	891,561	217,751	24.42%
November 2010	1,339,105	231,009	17.25%

As with most studies based on aerial extents, there is no surprise to the results above -- a much larger study area may or may not have a correspondingly larger percent of wetlands. As analysis scales are reduced from play-level to field-level, however, more wetlands become visible as seen below.

Workflow

With the scope and magnitude of the wetlands understood at the play-wide level, analysis can take place at smaller scales to determine localized wetland impacts requiring section 404 permits. A simplified workflow that guides this analysis is shown in Figure 6 below.

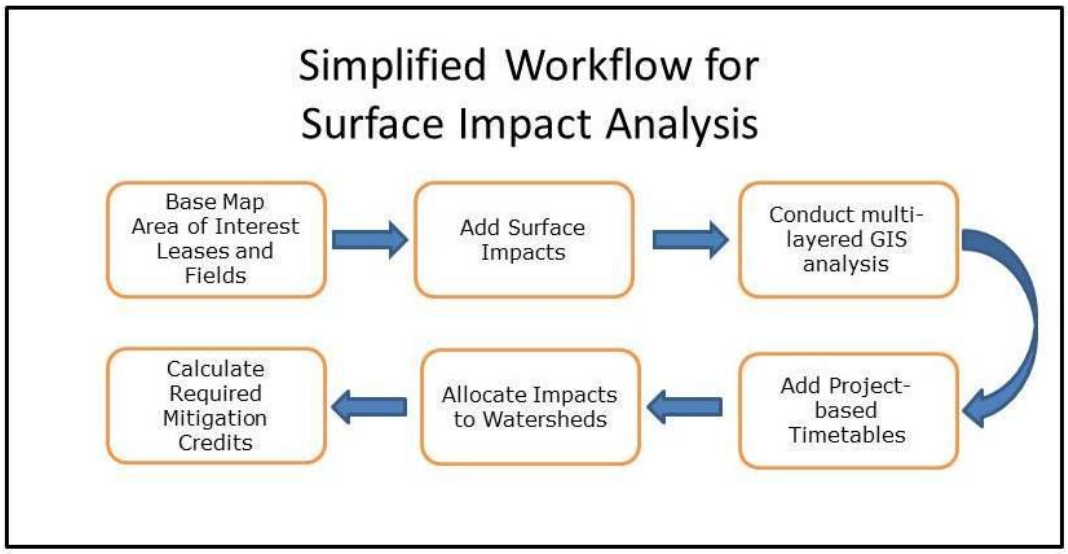

Figure 6.

A component of an integrated approach to wetland mitigation (Krauss, 2009), this workflow has been used for analysis of hundreds of thousands of acres to determine the probability and volume of potential wetlands impacts from future projects. Multilayered GIS analysis using footprints of surface impacts (drilling pads, roads, pipelines and their rights-of-way areas, etc.) various reference base map databases, wetlands databases and vegetation and soil databases are used to calculate impact acreage (spatial extent of impacts). This data is combined with project plans and operational timetables and used to determine the temporal extents of project impacts. These impacts are then allocated to "watersheds," a term used by the USACE and regulatory agencies to formalize the functions and values of any given geographic area. Watersheds for the entire United States have been catalogued by the United States Geological Survey (USGS) based on hydrologic characteristics – how water flows in these areas. The USGS has created a sophisticated watershed numbering system resulting in a database of hydrologic unit codes or "HUCs." HUC codes at the 8-digit level were used as boundaries for analysis activities.

Following tabulation of impact acreage by watershed and consideration of timing issues, the remaining steps of the workflow address identification of wetland mitigation banks that can deliver the required mitigation to offset the impacted acreage. Mitigation banks are also identified by watershed or HUC and mitigation bank service areas can be mapped or correlated to impact areas.

Mitigation banks provide mitigation credits as offsets to wetland impacts. Therefore a conversion of units from impact acres to mitigation credits is required. This step is often quite complex because it involves much more than a simple "units conversion." The USACE and other agencies require that wetland impacts and their offsets be understood in their environmental and ecological contexts. Land has a baseline value prior to an impact and a different value after an impact. Mitigation bank offsets or mitigation credits also have baseline values (raw land prior to wetland restoration) and uplifted values (land *post* restoration). Tools provided by the USACE to determine these functional and values are called Functional Assessment Methods. These methods will calculate the number of credits per acre of impact – most often resulting a ratio

different than one to one. Just as there are 39 USACE districts, there are least as many assessment methods employed by these districts. The USACE Vicksburg District uses a functional assessment method called the Charleston Method. (USACE, 2002)

Figures 7 and 8 below show graphical representations of analysis results at the field level using two example Haynesville Shale fields in northwest Louisiana. Data sources applied for these analyses were a base map from the ESRI US Base Map database and three wetlands sources (FWS National Wetland Inventory 1998, National Land Cover Database 2005 and USGS Louisiana GAP Land Cover, 2000). Wetlands are shown in green. The red 8-digit HUC code visible each map is from a USGS HUC database layer. On these maps are field boundaries provided by the LA DNR as shapefiles and representative well locations, shown as red dots, extracted from the LA DNR SONRIS database (2009). It is easy to see which wells fall in wetlands. The resulting metadata from this spatial analysis includes latitude/longitude for well locations and field boundaries as well as wetlands in acres. The temporal analysis component is derived from operator drilling plans inclusive of planned drilling pad sizes to determine when and in what volume unavoidable wetland impacts will occur.

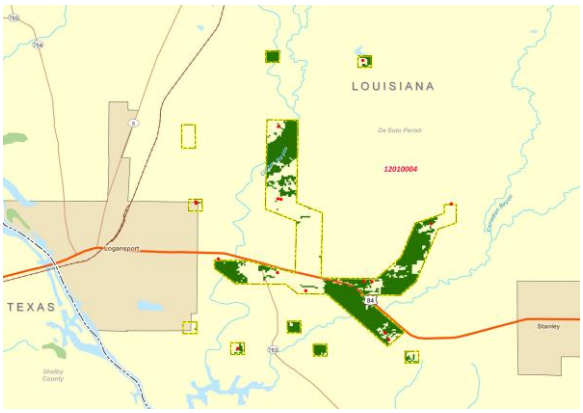

Figure 7. Logansport Field

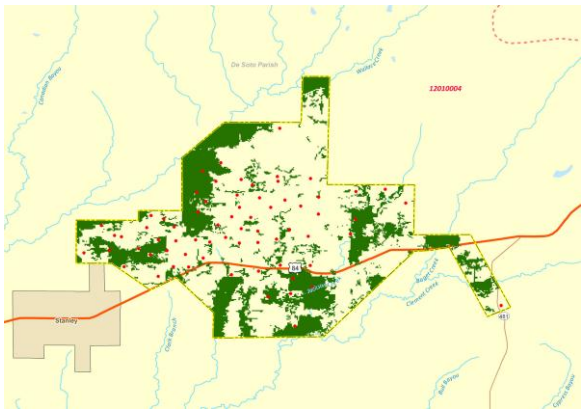

Figure 8. Spider Field

A localized, typically sub-1-meter scale, GIS analysis is performed at the wellsite level by surveyors when staking well locations. This onsite weltand delineation is required to obtain data necessary for 404 permit applications. The GIS analysis performed and discussed in this paper employs a look-ahead and forecasting approach and is not a substitute for field "ground truth" wetland delineation. It is notable that the results of a benchmark of 17 randomly selected wells using wetland impact forecasting analysis applying the above workflow compared to actual, processed 404 permits for those future well locations resulted in forecasted impacts within 10% of actual field measurements.

Mitigation Banks

A mitigation bank is designed to establish wetland credits in advance that can be drawn upon over time. Wetlands are restored, enhanced or preserved thereby generating mitigation credits according to a schedule as defined by the USACE in its contract with the mitigation bank. As development projects in the planning region require mitigation for wetlands impacts, credits are drawn from the mitigation bank. The bank sponsor sells credits to Permittees (operators with projects that have unavoidable wetland impacts) and keeps a ledger of sales and balances. As such, permitting a mitigation bank requires considerable planning, design and regulatory review and approval *prior* to its establishment in order that values can be ascribed to various wetlands and the credit system can be accepted by the regulatory agencies.

The distinct advantage to the Permittee of buying credits from mitigation banks is the benefit of removing any future regulatory exposure. Once the credits are purchased and the Permittee receives approval for that project, the Permittee has no further liability with regard to wetland impacts and has no further involvement or requirements to guarantee a mitigation bank's success.

Summary

With proper upfront planning, data capture and analysis can result in reliable forecasts of future, unavoidable impacts from operational activities in environmentally sensitive areas, including wetland and stream environments. These GIS-based methods have been applied spatially at play-scale and field-scale and have been demonstrated to be accurate to within 10% of on-the-ground measurements. The temporal dimension of project planning can be incorporated into this methodology. With a knowledge base of where and when impacts are planned to occur, mitigation credits can be sought in appropriate watersheds as offsets to operational impacts. Oil and gas operators and midstream infrastructure providers are then in the position of having identified and reduced operational risk by proactively budgeting future costs and enabled to source a competitive

supply of mitigation credits, and are empowered to accelerate permitting processes and be proactive with permit-apprving regulatory agencies.

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Appendix
Regulatory Agencies associated with Northwest Louisiana Haynesville Shale Permitting

US Army Corps of Engineers
CEMVK
4155 Clay Street
Vicksburg, MS 39180
(601) 631-5052
http://www.mvk.usace.army.mil/offices/od/odf/apply.htm (Permitting)
http://www.mvk.usace.army.mil/offices/od/odf/mitigation.htm (Mitigation)

Louisiana Department of Environmental Quality
7290 Bluebonnet Blvd
Baton Rouge, LA 70810
(504) 765-0741
http://www.deq.louisiana.gov/portal/

Louisiana Department of Natural Resources
625 North 4"' Street
PO Box 94396
Baton Rouge, LA 70804
(504) 342-4503
http://dnr.louisiana.gov/cons/conserv.asp

Louisiana Department of Wildlife and Fisheries
PO Box 98000
Baton Rouge, LA 70898
(504) 765-2360
http://www.wlf.louisiana.gov/

Louisiana Division of Archaeology
Capitol Annex Building
1051 North Third Street, Room 405
Baton Rouge, LA 70802
(504) 342-8170
http://www.crt.state.la.us/archaeology/

Louisiana Division of Historic Preservation
PO Box 44247
Baton Rouge, LA 70804
(504) 342-8160
http://www.crt.state.la.us/hp/

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U. S. Army Corps of Engineers. 2010. http://www.usace.army.mil/cecw/pages/reg_supp.aspx.

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U. S. Environmental Protection Agency. 2010. http://www.epa.gov/oecaerth/data/planning/initiatives/initiatives.html.