



**US Army Corps
of Engineers**®
Galveston District

**SUPPLEMENTAL
ENVIRONMENTAL
ASSESSMENT
HABITAT ANALYSIS
AND MITIGATION PLAN
APPENDIX A**

**Sabine Pass to Galveston Bay Port Arthur and Vicinity
Segments 2, 3, 4, 5 and 5A**

**U.S. Army Corps of Engineers Southwestern Division Galveston
District**

MARCH 2025

1 Overview

This document presents the compensatory mitigation plan for unavoidable habitat impacts associated with the Port Arthur and Vicinity (PAV) Supplement Environmental Assessment (SEA) of the Sabine Pass to Galveston Bay, Texas Coastal Storm Risk Management and Ecosystem Restoration Project (S2G) and encompasses mitigation plans identified in the PAV Contracts 3B and 3C SEA dated August 8, 2023, and incorporates additional mitigation needs from the entire PAV project. This plan addresses only compensatory mitigation work and not the sequence of other activities performed during project planning to avoid, minimize, rectify, or reduce habitat impacts from each project alternative (see Engineer Regulation (ER) 1105-2-100, Section C-1(e)(8)). Details of those sequence actions are included in the plan formulation and environmental consequences sections of the study's main report and environmental compliance document, and those actions are incorporated into the mitigation objectives of this plan. The planning work performed to document those sequencing actions is complete and led the team to the need to develop a compensatory habitat mitigation plan for unavoidable impacts to fish and wildlife resources. This document details the work performed, including coordination, plan formulation, and environmental compliance, to develop the compensatory habitat mitigation plan.

2 Requirements

The authority and requirements for compensatory mitigation are founded in Federal laws and regulations. The legal foundation for mitigation for ecological resources includes the Clean Water Act, various Water Resources Development Acts, and other environmental laws. These laws are implemented and administered through rules, guidance, regulations, and policies issued by Executive Branch agencies.

The relevant laws and regulations specific to compensatory mitigation planning for Corps of Engineers civil works projects are listed in the References section of this document. The specific procedures followed to develop this compensatory habitat mitigation plan are found in ER 11052- 100, Appendix C. Other forms of mitigation, such as plans for cultural resources conservation or induced flood damages, may also be required for a project. Those types of mitigation requirements are not directly related to fish and wildlife habitat impacts and are not covered in this plan.

Compensatory mitigation is the “restoration (re-establishment or rehabilitation), establishment, enhancement, and/or in certain circumstances preservation of aquatic resources for the purposes of offsetting unavoidable adverse impacts which remain after all appropriate and practicable avoidance and minimization has been achieved” (see 40 CFR 230.92). It is the policy of the Corps of Engineers civil works program, and in accordance with Section 906 of WRDA 1986, as amended, to demonstrate that impacts to all significant ecological resources, both terrestrial and aquatic, have been avoided and minimized to the extent practicable, and that any remaining unavoidable impacts have been compensated to the extent possible. Section 906(d) of WRDA 1986, as amended, requires functional assessments to be performed to define ecological impacts and to set mitigation requirements for impacted habitats. Corps of Engineers policy in ER 1105-2-100, paragraph C-3(e), requires the use of a habitat-based methodology, supplemented with other appropriate information, to describe and evaluate the impacts of the alternative plans, and to identify the mitigation needs.

3 Coordination and Collaboration

Development of this plan involved extensive coordination and collaboration with the project's non-federal sponsor, state and federal natural resource agencies, landowners, and the public. Public input was sought during interagency meetings, public scoping meetings, and during review of the draft report, initial FEIS, and formulation of the 2023 SEA mitigation plan. Comments from the initial S2G study and Environmental Impact Statement (EIS) public were related to habitat impacts and mitigation included protecting migratory bird populations, protecting sea turtle habitats suggestions to mitigate in-kind, and concern with protecting valuable ecosystems. Discussions with area landowners helped characterize local site conditions and gauge opportunities for potential mitigation work in these areas. The final SEA would contain additional details of current public involvement efforts.

An interagency team met throughout initial S2G study, during the 2023 PAV SEA development, and in support of the current SEA. Staff from numerous resource agencies contributed expertise and information to support the identification of impacts and the development of compensatory mitigation plan alternatives, primarily Texas Parks and Wildlife Department and U.S. Fish and Wildlife Service. These organizations will be offered an opportunity to continue to play a role in the design and implementation phases of the mitigation work.

The cooperating and participating agencies are listed below from the original EIS. An early interagency coordination meeting was held to comply with the provisions of the Water Resources Reform and Development Act of 2014 Section 1001. The meeting afforded agencies an opportunity to learn about the project and to provide initial input into the study. These agencies will also be invited to the District's annual consultation meeting for mitigation project coordination and reporting.

- Texas Commission on Environmental Quality
- Texas Department of Parks and Wildlife**
- Texas General Land Office
- U.S. Fish and Wildlife Service
- National Marine Fisheries Service**
- U.S. Environmental Protection Agency*
- Texas Department of Transportation
- Jefferson County Drainage District No. 7
- Orange County Drainage District
- Velasco Drainage District

*Indicates an agency serving as a participating agency under 33 U.S.C. 2348(e).

**Indicates an agency formally serving as a cooperating agency under 40 CFR 1508.5.

A cooperating agency may have jurisdiction over certain resources under Federal law. These agencies may identify specific mitigation measures it considers necessary to allow the agency to grant or approve an applicable permit, license, or related requirements or concurrences. This does not include typical recommendations received in required interagency coordination, and in Fish and Wildlife Coordination Reports. It is normally associated with specific statutory compliance with another Federal agency lead, such as requirements to reduce incidental take in

an Endangered Species Act biological opinion. In those instances, the cooperating agency shall cite the applicable statutory authority for the requirements. These agency mitigation measures or plans are described in further detail later in this document.

4 Ecological Resources

Port Arthur is situated within the Sabine Lake Watershed. The area is characterized by a nearly level, slowly drained plain with an elevation of less than 150 feet, traversed by streams and rivers that flow into the Gulf of Mexico. The region encompasses various ecological features, including barrier islands along the coast, salt grass marshes surrounding bays and estuaries, remnant tallgrass prairies, oak parklands and oak mottes scattered along the coast, and tall woodlands in the river bottomlands.

An interagency team conducted a comprehensive investigation of the habitat resources within the project area. The team gathered information from existing data sources and performed field visits and surveys. Data sources included information from resource agencies, published reports, agency records, and field investigations. Table 1 outlines how each data source was utilized in developing the mitigation plan. Table 1 - Data Sources

Year	Source of Information	Information	Use in Mitigation Planning
2022 - 2023	Interagency Team	Interagency field visits and habitat projections	Inventory and forecast site resources and conditions. Data for models.
2024	Google Earth	Land use information	Planning and design for mitigation.
2024	TPWD's Texas Ecosystem Analytical Mapper	Vegetation types and acreages	Planning and design for mitigation.

The project area encompasses pockets of diverse ecological zones, Gulf Coast Prairies, Marshes, with maintained areas dominating much of the project footprint along existing levee right of ways. Table 2 presents an overview of the habitat resources within the project area that may require mitigation, detailing the quantity of each resource, the type of impact anticipated, and the significance of the resource. These resources are acknowledged as significant from institutional, public, and technical perspectives. The main feasibility report provides an in-depth discussion of these significance factors.

Table 2 summarizes the qualitative assessment of resource significance based on the interagency team's evaluation. These significance assessments are crucial for understanding the ecosystem impacts of the project and the interconnections of the resources within the broader system or watershed and to identify which habitats would be mitigated for. Below Table 2 is further description of significant habitats.

Table 2 - Ecological Resources

Habitat	Quantity	Type of Impact	Significance of Resource
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Gulf Coast Prairie	42 Acres	Direct	High
Marsh	104 Acres	Direct and Indirect	High

Part of the project area is a freshwater wetland/marsh complex flanking the river. This tidal freshwater marsh falls between upper parts of the river basin and the open waters of the estuary. The wetland hosts a diverse community of vegetation including grasses, sedges, and rushes along with patches of submerged aquatic vegetation. The area provides high value avian foraging habitat particularly for wading birds. These marshes are essential estuarine fishery habitat supporting various life stages of important fish and shellfish. The project would directly remove marsh habitat as part of the structural features of the project. In the project area, wetlands occur along the margins in areas adjacent to projected construction zones near existing levees. Few pockets of wetlands are expected to occur fully within the construction area.

The Gulf Coast Prairie areas in the project area are distinguished by their expansive grasslands and intermittent wetlands, creating a mosaic of habitats that support a diverse array of plant and animal species. These prairies are dominated by native grasses such as little bluestem, Indian grass, and switchgrass, which provide essential habitat for a multitude of wildlife, including the endangered Attwater's prairie chicken. The prairies also harbor a variety of wildflowers, which attract numerous pollinators, including monarch butterflies during their annual migrations. Additionally, the intermittent wetlands within these prairies serve as crucial breeding and foraging grounds for various waterfowl and wading birds. Given the ecological significance and sensitivity of these habitats, these areas must also be considered for mitigation in disturbing activities. In the project area, Gulf Coast Prairie occurs along the margins in areas adjacent to projected construction along existing levee and likely within the footprint of the proposed levee expansion areas.

Attachment 1 contains a map book showing the extent of the project footprint assuming a worstcase scenario of impacts, and arrangement of habitats in the area.

5 Significant Net Losses

Based upon the types of habitats in the project area the interagency team determined that the Eastern Meadowlark Habitat Evaluation Procedures model would capture important features of Coastal Prairie, and WVA Freshwater Marsh would capture metrics to evaluate freshwater marsh (including patches of native invasive common reed habitat) to collectively assess the project's impacts on fish and wildlife habitat and other ecological resources. All models are certified for use by the Corps of Engineers Ecosystem Restoration National Planning Center of Expertise. Model outputs measure habitat value in average annual habitat units (AAHU). The tool is also suitable for assessing mitigation potential at alternative mitigation sites in the watershed.

Table 3 displays the Future Without Project (FWOP), Future with Project (FWP) acres and AAHU model output results for each of the impacted habitat types. The impacts are quantified using mapped acreages of significant habitats within the project footprint. Temporary, indirect impacts may also occur to these habitats, although those impacts are not expected to cause losses requiring habitat mitigation. Attachment 2 contains habitat models inputs and outputs for both habitat types analyzed.

Table 3 - Unavoidable Fish and Wildlife Habitat Impacts

Habitat Type	FWOP Acres	FWP Acres	FWOP AAHUs	FWP AAHUs	Net Change AAHUs
Marsh	104	74	58	8	-50
Habitat Type	FWOP Acres	FWP Acres	FWOP AAHUs	FWP AAHUs	Net Change AAHUs
Coastal Prairie	42	0	36	0	-36

Table 4 presents additional information characterizing the significance of the resources from a national, regional, and state perspective. The interagency assessment of project impacts determined that the habitat resources in the project area are significant. This determination is based upon the factors of significance and the magnitude of unavoidable project impacts.

Table 4 - Ecological Resource Significance

Habitat Type	National	Regional	State
Marsh	Wetlands, Clean Water Act, EO11990, Wetlands, supports Federally protected species under ESA	Declining resource in region due to ongoing urbanization and land use practices; supports numerous migratory birds, fish, and amphibian communities and State listed species	Declining resource in region due to ongoing urbanization and land use practices; supports numerous migratory birds, fish, and amphibian communities and State listed species
Coastal Prairie	Limited in project area	Scarce habitat due to ongoing urbanization and land use practices; supports numerous migratory birds, fish, and amphibian communities and State listed species	Scarce habitat due to ongoing urbanization and land use practices; supports numerous migratory birds, fish, and amphibian communities and State listed species; Texas Coastal Prairie Initiative formed to promote habitat conservation

From a planning-perspective the ecological significance of the habitats is useful in defining the goals and objectives of the compensatory mitigation plan.

6 Mitigation Planning Objectives

The project includes mitigation sequencing actions employed during the development and refinement of details for each alternative plan. These sequencing actions include steps to avoid, minimize, rectify, and reduce/eliminate habitat impacts for each alternative. These actions are part of the overall mitigation plan for the project. The need for compensatory mitigation is driven by the remaining unavoidable impacts to significant ecological resources.

The goal of this mitigation plan is to fully compensate for the unavoidable impacts to significant ecological resources that would occur with project implementation. The objectives of the mitigation plan are defined by the results of the habitat impact assessment model using quantified units. The same habitat assessment model is used to estimate potential project impacts and potential outputs of mitigation measures. The objectives of this mitigation plan are to:

- Compensate for the loss of approximately 30 acres of marsh habitat and reduced quality of the remaining 74 acres of marsh (50 AAHUs)
- Compensate for the loss of approximately 42 acres of Coastal Prairie habitat (36 AAHUs)

Other factors may influence planning objectives and the development of strategies, measures, and alternative plans. These may even play a role in plan selection depending on specific project circumstances and opportunities. Some of these factors are based on legal requirements and policies and others are derived from scientific or technical standards. For example, acquisition of lands or interests in lands for mitigation must be acquired before construction of the project commences or concurrently with acquisition of lands and interests in lands for other project purposes; and the physical construction of the mitigation work is required to be carried out before or concurrently with project construction (see Section 906(a) of WRDA 1986, as amended). This introduces an implementation time factor to consider later in plan evaluation and selection. Another example, from a scientific perspective, larger contiguous land tracts may offer better habitat value for fish and wildlife compared to dispersed smaller areas. This may influence site selection and land considerations for a mitigation project.

7 Land Considerations

The interagency team assessed various lands in the study area for potential use as a site for compensatory mitigation work. Parcels within the watershed and capable of supporting the types of habitat(s) impacted by the proposed project were identified. Geographic information system tools were utilized to systematically identify tracts of suitable size and habitat support characteristics. An initial qualitative assessment of mitigation potential was also part of the site analysis. Additional considerations were made for siting mitigation areas to be contiguous with larger tracts of existing habitat.

8 Mitigation Strategies

Planning strategies are different means employed to develop an alternative plan or plans to achieve a project goal. The use of one or more strategies helps teams focus on an approach to developing a plan. For mitigation planning work, strategies may range from the purchase of mitigation bank credits to the construction of a project or projects to achieve the objectives and compensate for unavoidable habitat impacts. Strategies may also involve different approaches to site selection such as the use of public lands or identifying contiguous sites to enhance wildlife corridors or expand wildlife populations. In addition, Section 2036(c) of WRDA 2007, as amended, requires to the Corps of Engineers to consider mitigation banks and in-lieu fee programs where appropriate. Consideration of these options as mitigation strategies may be helpful when available. The strategy of constructing a mitigation project is considered for planning this mitigation project. The government and non-federal sponsor may choose to construct a mitigation project. This construction strategy offers some potential advantages in tailoring a project to specific needs or locations. In addition, the partners may bring special expertise to the project gained from previous work on similar projects in the area.

9 Identify Measures and Formulate Alternative Mitigation Plans

A qualitative analysis of the potential effectiveness of each measure towards achieving the mitigation planning objectives was performed. Table 5 summarizes the results of the initial screening of potential mitigation measures. After the effectiveness screening the team retained [insert number of measures retained measures for further consideration and potential combinability into alternative plans.

Table 5 - Mitigation Plan Measures Considered

Potential Sites	Description	Feasibility	Rationale
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Measure 1. Mitigation Bank	Purchase 255 wetland mitigation credits from an approved mitigation bank.	Feasible	There are mitigation banks within the secondary service area of the impact area. Mitigation banks with service areas including the project impact areas were investigated to determine if sufficient and appropriate mitigation credits were available. One has been identified that could be utilized for mitigation, Sea Breeze. Sea Breeze wetland mitigation bank was utilized under the previous Supplemental Environmental Assessment for PAV 03B and 03C CSRMS and is a potential option; Risk remains if enough credits would be available when needed prior to construction.
Measure 2. PAV02 Project Area	On site wetlands mitigation. Re-establish wetlands with the goal of returning natural or historic functions and characteristics to former or degraded wetlands within the impact area.	Not Feasible	Restoring habitat would be challenging adjacent to developed areas with constant disturbances such as trash and local run-off impacted habitat quality. Tidal connections will be severed after the floodwall construction, minimal acreage exists at this site and would be

Potential Sites	Description	Feasibility	Rationale
			isolated from other, larger contiguous habitat.

<p>Measure 3. PAV04 Project Area</p>	<p>On site wetlands or coastal prairie mitigation.</p> <p>Re-establish wetlands or coastal prairie with the goal of returning natural or historic functions and characteristics to former or degraded wetlands within the impact area.</p>	<p>Not Feasible</p>	<p>Restoring wetlands within the floodwall area is not feasible since all lands are open water converted to hard structures, minimal acreage exists at this site and would be isolated from other, larger contiguous habitat.</p> <p>The staging areas are in high traffic residential neighborhoods so disturbance would be a challenge for restoration, monitoring, and adaptive management. These areas may also be needed for any future flood fight or emergency staging and response.</p>
<p>Measure 4. PAV05 Project Area</p>	<p>On site wetlands or coastal prairie mitigation.</p> <p>Re-establish wetlands with the goal of returning natural or historic functions and characteristics to former or degraded wetlands within the impact area.</p>	<p>Not Feasible</p>	<p>Restoring habitat would be challenging adjacent to developed areas with constant disturbances such as trash and local run-off impacted habitat quality, minimal acreage exists at this site and would be isolated from other, larger contiguous habitat.</p> <p>The temporary staging areas would likely be needed for staging during flood fight and response.</p>
<p>Measure 5. PAV05A Project Area</p>	<p>On site wetlands or coastal prairie mitigation.</p> <p>Re-establish wetlands with the goal of returning natural or historic functions and</p>	<p>Feasible for coastal prairie on lands adjacent to the project.</p>	<p>On-site wetland mitigation for coastal prairie within existing agriculture lands adjacent to the project. Meadowlarks were observed in March 2023 at the Alligator Bayou pumpstation staging area.</p>

Potential Sites	Description	Feasibility	Rationale
	<p>characteristics to former or degraded wetlands within the impact area.</p>		<p>A monitoring and adaptive management plan would need to be developed if this is feasible. The site(s) would need to be monitored, and adaptively managed by USACE. The NFS would assume this responsibility once mitigation success is reach.</p>
<p>Measure 6. Halbouty (DD7)</p>	<p>Off-site wetlands mitigation.</p> <p>Re-establish wetlands with the goal of returning natural or historic functions and characteristics to a former or degraded wetlands outside of the area of loss.</p>	<p>Not feasible</p>	<p>This site is currently used as a detention basin. State agencies involved with field reconnaissance recommended dropping this site in 2022 as potential mitigation because the primary purpose of the site would be stormwater storage. In addition, the site has existing quality habitat and was actively utilized by wildlife.</p>
<p>Measure 7. W Port Arthur (DD7)</p>	<p>Off-site wetlands mitigation.</p> <p>Re-establish wetlands with the goal of returning natural or historic functions and characteristics to a former or degraded wetlands outside of the area of loss.</p>	<p>Not feasible</p>	<p>After further discussion with the NFS, this site was excluded from future consideration for mitigation for future flood risk detention basins.</p>

Measure 8. Proctor Street (DD7)	Off Site Wetlands Mitigation. Re-establish wetlands with the goal of returning natural or historic functions and characteristics to a former or degraded wetlands outside of the area of loss.	Not feasible	This site is a large pond with a waterbird rookery. State agencies present during 2022 field reconnaissance indicated this site could be used for emergent wetland mitigation but should be screened out of further consideration because it could potentially disrupt the primary use of the site – stormwater retention.
Potential Sites	Description	Feasibility	Rationale
Measure 9. FM 635 (DD7)	Offsite wetlands mitigation. Re-establish wetlands with the goal of returning natural or historic functions and characteristics to a former or degraded wetlands outside of the area of loss.	Not feasible	After field reconnaissance in 2022, the NFS indicated the site would be used for storm water detention.
Measure 10. TPWD Wildlife Management Area	Offsite wetlands mitigation. Re-establish 170 acres of wetlands with the goal of returning natural or historic functions and characteristics to a former or degraded wetlands outside of the area of loss.	Feasible	Further communication is needed with TPWD to determine specific footprints. There are several adjacent wildlife management sites near the PAV CSRMS. Specifically, J.D. Murphree was discussed previously with TPWD. Challenges may be encountered with timing of available fill material and hauling it to restoration site.

Table 6 - Initial Screening of Mitigation Measures

Measure	Screening Analysis	Screening Result
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Measure 1	Likely to meet some/all marsh mitigation objective	Carried forward for further analysis
Measure 2	Not likely to meet mitigation objective	Screened out – not carried forward for further analysis
Measure 3	Not likely to meet mitigation objective	Screened out – not carried forward for further analysis
Measure 4	Not likely to meet mitigation objective	Screened out – not carried forward for further analysis
Measure 5	Likely to meet coastal prairie mitigation objective	Carried forward for further analysis
Measure	Screening Analysis	Screening Result
Measure 6	Not likely to meet mitigation objective.	Screened out – not carried forward for further analysis
Measure 7	Not likely to meet mitigation objective.	Screened out – not carried forward for further analysis
Measure 8	Not likely to meet mitigation objective.	Screened out – not carried forward for further analysis
Measure 9	Not likely to meet mitigation objective.	Screened out – not carried forward for further analysis
Measure 10	Likely to meet marsh mitigation objective.	Carried forward for further analysis

Each measure was further assessed to determine the potential to combine it with other measures to form alternative plans. This assessment determined if a measure could stand alone as a plan and whether the measure had any restrictions that would prevent its combination with other measures. Results of the assessment are shown in the table below.

Table 7 - Mitigation Measure Combinability Assessment

Measure	Potential to Stand Alone as a Plan?	Potential to Combine with Other Measures?	Assessment of Measure Combinability				
			1	5	10		
			1	5	10		

Measure 1	No	yes	N/A	No	Yes			
Measure 5	No	yes	No	N/A	Yes			
Measure 10	No	yes	Yes	Yes	N/A			

The measures were then combined into an array of alternative plans aligned with the mitigation planning strategies. A no action alternative is included as a basis for comparison as well as meeting the requirements of the National Environmental Policy Act.

- **No Action Alternative.** Under this scenario no mitigation work would be performed, and the structure, functions and values of project impacted habitats would be permanently lost. The alternative is retained for purposes of a baseline comparison against other action alternatives.
- **Alternative 1: Measure 1 + Measure 5.** Purchase 255 credits from Sea Breeze Mitigation Bank. Restore 60 acres of coastal prairie within the proposed real estate boundary for the western levee extension area by removing agricultural practices and invasive species followed up by planting a native coastal prairie seed mix.
- **Alternative 2: Measure 5 + Measure 10.** Restore 60 acres of coastal prairie within the proposed real estate boundary for the western levee extension area by removing agricultural practices and invasive species followed up by planting a native coastal prairie seed mix. Restore 170 acres of marsh habitat by placing fill material from Sabine Neches Waterway O&M dredging, hauling of the material, and placement of the material onto TPWD-owned property. Upon settling, the new landscape would be planted with submergent aquatic vegetation (SAV) as well as native emergent wetland vegetation.

10 Costs of Mitigation Plan Increments and Alternatives

Cost estimates were prepared for each alternative. The team used various information sources to estimate the costs of the alternatives. Available information included records of recent mitigation bank credit and in-lieu fee program credit sales and details from recently completed nearby ecosystem projects. The study team also considered other cost factors such as site access, fuel and equipment, and the availability of plant materials. Table 7 displays the total costs and outputs for each alternative plan.

Sea Breeze Wetland Mitigation Bank is located in Chambers County, Texas (Figure 6). The primary service area is defined by the 8-digit HUC that the bank is located within, which encompasses East Galveston Bay (HUC 12040202). The secondary service area is defined as the portion of HUC 12040201 (Sabine Lake) occurring within the state of Texas. Debiting ratios are as follows: Primary Service Area 1:1, Secondary Service Area 1.5:1. The service area specifically excludes the following: Bolivar Peninsula (including the adjacent shoreline of Galveston Bay, Rollover Bay, and East Bay) and all lands owned, leased, or managed by TPWD.

Sea Breeze is applicable for use of Riverine Herbaceous/Shrub credits, which can be used as mitigation for impacts to non-tidal wetlands that support an emergent/scrub-shrub wetland community in their current, natural, and/or undisturbed state. Due to the nature of the wetlands

being only inundated by natural storm events, it is determined that the mitigation bank would be suitable for mitigation of impacted wetlands within the project area. Examples of wetlands in this category (in-kind) include wet prairies, wet pastures/agricultural fields, scrub-shrub wetlands, constructed ponds or reservoirs that may exist as a different aquatic resource type (e.g. pond or reservoir), or vegetative community (e.g. tallow dominated) because of a lack of disturbance (e.g. fire suppression), or due to a previous disturbance (Sea Breeze Mitigation Bank, 2017).

The SWG Herbaceous Riverine iHGM Wetland Functional Assessment was not used during data collection of the impact sites. Model variables associated with iHGM have assumed a Functional Capacity Index (FCI) equivalent to AAHUs produced by the WVA model outputs as they were conservatively overestimated to due limited site access to ensure adequate mitigation offsets.

As described in this Appendix, there are approximately 146 acres of projected marsh mitigation to meet the AAHU offset need. The mitigation plan is predicated on an FCI equal for all variables and function categories (biological, chemical, and physical) for palustrine emergent wetlands, and another ratio of 1.5:1 due to the impact's location within the Sea Breeze secondary service area to calculate the required Function Capacity Units (FCU) Based on these assumptions, the following mitigation plan was prepared:

- 1.0 FCI x 170 acres of marsh Impact = 170 FCU's ○ This results in 170 Biological FCU's, 170 Chemical FCU's, and 170 Physical FCU's
- 170 FCU's per Function Category x 1.5 (secondary service area multiplier) = 255 FCU's per Function Category ○ For additional clarification if comparing as a total:
 - 170 FCU's x 1.5 = 255 FCU Credits
- At \$55,000 per credit based on recent estimates, Total mitigation cost of \$14,025,000.

The Sponsor of the Sea Breeze Mitigation Bank, D. Mayes Middleton II Non-Exempt Trust, would be responsible for establishing and maintaining the official ledger for all bank transactions, as well as the legal responsibility for ensuring all mitigation terms are fully satisfied under the Mitigation Banking Instrument (SWG-2016-00086).

Coastal prairie restoration would entail transforming grazed and agricultural lands by removing nonnative species and planting a native coastal prairie seed mix. A conservative estimate of \$60,000 per acre was used to estimate costs of this measure for a total of \$3,600,000. Real estate access would be facilitated by the proposed western levee extension footprint. This includes \$100,000 per year for monitoring efforts for six years as coastal prairie would be expected to achieve success relatively soon due to the faster growth of prairie species.

In 2023, costs to restore 4 acres of marsh habitat on J.D. Murphee WMA were estimated. The cost associated with material acquisition, hauling, and disposal was expected to be approximately \$10,000,000. Access to this area would be challenging to haul fill material to appropriate locations. Mitigation efforts included haul and placement of dredged material to establish appropriate wetland water depths, native species plantings, monitoring, adaptive management, and reporting would cost approximately \$75,000, bringing the total for this mitigation plan to \$10,075,000. The current mitigation plan calls for 170 acres of marsh restoration. Lowest cost estimates of this mitigation plan would easily be doubled from the 2023 estimate due to the large increase in acreage. This assumed massive efficiencies could be found to limit dredged material and hauling costs. For comparison, \$20,000,000 for this

measure. Further refinement of this cost will be included in the final draft. Table 8 – Estimated Costs of Alternative Plans

<i>Alternatives</i>	<i>Total Cost</i>	<i>Plan Outputs</i>
<i>No Action</i>	<i>\$0</i>	<i>0</i>
<i>Alternative 1 – purchase mitigation bank credits + onsite coastal prairie restoration</i>	<i>\$17,625,000</i>	<i>93 AAHU</i>
<i>Alternative 2 – onsite coastal prairie restoration + offsite marsh restoration</i>	<i>\$23,600,000</i>	<i>93 AAHU</i>

11. Incremental Costs

Cost effectiveness analysis is conducted on alternative compensatory mitigation plans to ensure the least cost alternative is identified for each level of output. Subsequently, incremental cost analysis is done on the cost-effective plans to reveal changes in costs as output levels increase and allow for an assessment of whether the increase in output is worth the additional cost. Determination of the final compensatory mitigation plan will utilize these results to identify and describe the least cost plan.

The outputs of different mitigation alternatives may be similar. Each alternative plan should be appropriately scaled to meet or closely meet the mitigation planning objective based upon unavoidable ecological impacts generally expressed in habitat units. Some variations in alternative plan outputs and costs may be expected because of differences in site conditions or other factors at various project locations under consideration.

The resulting information is used to evaluate alternatives and identify a suite of cost-effective solutions or plans. Alternative 1 meets the mitigation need of 93 AAHUs at a cost of \$17,625,000. Alternative 2 meets the mitigation need of 93 AAHUs at a cost of at least \$23,600,000.

11 Plan Selection Considerations

General Screening Criteria below were developed to assess mitigation plans.

- Distance from the impact that is requiring mitigation (within watershed).
- Property Ownership: Ideally the target restoration area would be owned and managed by a state, federal, or special interest entity with established upland protections. The areas should be prioritized by conservation areas, national wildlife management areas followed by wildlife management areas.
- Prioritize areas where the mitigation site would have synergistic effects with existing, ongoing, or likely to be implemented projects where ecosystem-level/landscape scale benefits can be achieved (e.g. reduce fragmentation).
- Ability to restore a self-sustaining wetland site.
- Avoid any areas with Hazardous, Toxic, Radioactive Waste concerns (e.g. CERCLA sites, EPA or state-identified sites that require clean-up)

While potential mitigation sites have not been identified, several factors should be considered when selecting a mitigation site for each habitat type:

i. Marsh Habitat

- a. When selecting a mitigation site for marsh habitats, several critical factors must be considered to ensure the effectiveness and sustainability of the mitigation efforts. Firstly, the site should be located within the same watershed or ecological region to maintain functional connectivity and support similar species and ecological processes. The hydrological characteristics of the site, including tidal influence, water quality, and salinity levels, should closely match those of the impacted marsh habitats. Additionally, the site should be large enough to support the desired ecological functions and provide adequate buffer zones to minimize edge effects. Proximity to existing conservation areas and the presence of similar plant and animal communities are also important considerations. Furthermore, the site should be assessed for potential threats, such as pollution sources, invasive species, and future development pressures, to ensure long-term viability. Engaging with local stakeholders, including landowners, community members, and regulatory agencies, is essential to garner support and facilitate successful implementation and management of the mitigation site for any habitat type. Additionally, the need for efficient placement of dredged material would be required to obtain appropriate water depths. Multiple placement cycles may be needed depending on settling rates.

ii. Coastal Prairie

- a. Ideally, the site should be within the same ecological region to preserve native plant species and support similar wildlife, thus maintaining local biodiversity.
- Being close to the impacted site is also beneficial for the natural spread of seeds and animals. The elevation and hydrological characteristics of the potential site should be evaluated to meet the needs of coastal prairie habitats, which usually require well-drained soils and occasional flooding. Furthermore, the site should be sufficiently large to sustain healthy populations of native species and allow for potential future expansion.

12 Recommended Compensatory Mitigation Plan

The recommended plan for compensatory mitigation is Alternative 1 which entails purchasing in-kind credits from an approved mitigation bank located in the region and restoring coastal prairie habitat on site. This plan is both more cost effective than Alternative 2 and does not have the associated cost and implementation risk that Alternative 2 poses with the need to place material to achieve desired water depths. Placement material may not be available at the time of need in sufficient quantities and for potential re-nourishment in adaptive management scenarios.

13 Implementation Risks

The planning team identified a suite of foreseeable implementation risk factors across each phase of implementation (Pre-Construction Engineering and Design, Construction, and Operations). These factors are based upon experience from similar projects and the

consideration of regional risks generally associated with design and construction work in wet environments. Each risk was assessed and assigned a significance level. Potential risk management measures were identified and will be considered should the need arise during implementation or adaptive management.

The primary risk with the selected mitigation plan is available mitigation bank credits would be expected to fall over time. However, due to the conservative overestimates in both existing marsh habitat to be impacted, quality of habitat present, and project footprint it is highly expected that the actual impacts and subsequent mitigation required for marsh habitat would be much less than presented here as more design detail is developed.

15. Additional Mitigation Requirements

No additional requirements are identified at this time other than standard BMPs associated with construction activities.

14 Monitoring and Ecological Success Criteria

The interagency planning team developed a plan for site monitoring to determine the success of the mitigation work. Table 10 includes the cost and duration of monitoring work and identifies the entity that will be responsible for the monitoring activity. The elements of the monitoring plan are designed to measure the attainment of ecological success criteria at key points over the course of the mitigation construction and operation periods. The costs of monitoring activities prior to and during construction are generally shared. Most post-construction monitoring costs are part of OMRR&R and are the responsibility of the non-Federal sponsor.

Monitoring work also offers an opportunity to build upon partnerships with local interests, non-governmental organizations, universities, and the public. The Corps of Engineers and the non-Federal sponsor are interested in these partnership opportunities. Parties interested in participating in monitoring efforts are encouraged to discuss potential work with the sponsors.

Reports documenting the monitoring activities and the results should be prepared after each activity. Results should be shared with the Corps of Engineers and interested resource agencies. The project team should discuss the project at the District's annual mitigation consultation meeting with resources agencies (per Section 906(d)(4) of WRDA 1986, as amended).

The interagency team identified ecological success criteria for each habitat type that requires compensatory mitigation. The criteria were selected based upon a review of scientific literature related to these types of habitats and in this area. The table below shows each habitat type, the mitigation objective in habitat units, and different success criteria for topography and bathymetry, hydraulic conditions, and vegetation characteristics. Specific metrics are identified and quantified along with time periods for meeting the metrics. Identifying the time periods to attain the criteria is linked to when monitoring activities should be undertaken to measure project performance.

The monitoring program for the mitigation areas focuses on two key performance features of the site: native species establishment and non-native/invasive species management.

14.1 Monitoring Purpose:

14.1.1 Native Species Establishment

Assess the establishment of native prairie species across the 60 acres of land in both pre- and post-construction to provide a basis for determining success and making adaptive management decisions.

14.1.2 Non-native/Invasive Species Management

Assess the management of nonnative/invasive species across the 60 acres of land in both pre- and post-construction to provide a basis for determining success and making adaptive management decisions.

14.2 Monitoring Summary

Monitoring of the mitigation sites would be conducted pre- and post-restoration to assess the success of mitigation. The specific method and techniques would be adapted to the scale of the mitigation site and would follow standard methods for estimating land vegetation coverage.

Desired Outcome:

14.2.1 Native Species Establishment

Establish target coverage within 2 years of construction and begin Monitoring and Adaptive Management efforts.

14.2.2 Abundance and Distribution

Establish self-sustaining native coastal prairie habitat coverage on 80% or more on the 60-acre mitigation site.

14.3 Success Criteria:

14.3.1 Non-native/Invasive Species Management

Establish target coverage within 2 years of construction and begin Monitoring and Adaptive Management efforts.

14.3.2 Abundance and Distribution

Limit non-native/invasive species coverage to less than 10% of the total live density of the 60acre mitigation site.

14.4 Duration

Post construction monitoring over a five-year period post-construction should be sufficient to confirm the coastal prairie is stable and success has been achieved. After success is achieved, monitoring would cease by the project and be recommended for turnover to NFS for OMRRR.

14.5 Monitoring Costs

The monitoring costs of the mitigation sites are based on past projects and contracting efforts to monitor oyster mitigation and restoration sites. The estimated monitoring is anticipated to \$600,000 per year for 6 years (Table 10) and assumes 2 additional years of monitoring due to an unanticipated disturbance such as fire, extended drought, etc.

Table 9 - Estimated Costs of Monitoring per Mitigation Site

Parameter	Methodology	# Sampling Points	Monitoring Frequency	Estimated Cost/Survey	Estimated Total Cost
Native Coverage	Quadrats/Line surveys	1 per 2 acres	Pre and post construction, semiannually (anticipate 6 years) (6 surveys)	\$6,500	\$50,000
Invasive Coverage	Quadrats/Line surveys	1 per 2 acres	Pre and post construction, semiannually (anticipate 6 years) (6 surveys)	Concurrent with above	\$50,000
<i>Total 6-year Monitoring Cost</i>				\$9,500.00	\$600,000.00

15 Monitoring and Adaptive Management

Adaptive management plans are informed by project monitoring results. It is important that a science-based monitoring plan target the collection of performance information to help inform potential adaptive management actions. Adaptive management allows the project team to use monitoring feedback to make changes to project features or operations to improve attainment of ecological success criteria. This contingency plan outlines a range of corrective actions in cases where monitoring demonstrates that mitigation features are not achieving ecological success goals.

Anytime during the monitoring period, if the success of the mitigation plan appears to not be meeting the success criteria, TPWD and other resource agencies would be notified so that the team can evaluate the problems and pursue ways to address the deficiencies in the mitigation. Discussion on meeting the success criteria would be included in each monitoring report. Corrective action would depend on the assessed or probable cause of the failure. Failure of the oyster mitigation site due to natural or anthropogenic drives from poor water quality, harvesting, or improper site conditions would be minimized to the greatest extent practicable through selection of a site that meets the needs of a healthy reef. The most relevant actions that could be used for adaptive management in the context of oyster reef mitigation are re-placing cultch or

stirring up the cultch if substrate has subsided or is otherwise not exposed through seeding with oyster larvae as long as all other factors such as salinity and cultch were not an issue. Based on past local reef restoration projects that account for proper design, the risk of full subsidence is low.

The estimated cost of adaptive management is \$120,000 total mitigation cost (Table 11).

Table 10 - Estimated Adaptive Management Cost by Mitigation Site

Adaptive Measure	Assumptions	Cost
Additional Invasive Species Removal	<ul style="list-style-type: none"> Assume that 10% of the area would need additional invasive species removal (approximately 6 acres). \$10,000/acre 	\$60,000
Additional Native Seeding	<ul style="list-style-type: none"> Assume that 10% of the area would need additional invasive species removal (approximately 6 acres). \$10,000/acre 	\$60,000
<i>Total Cost for Mitigation Site</i>		\$120,000

16References

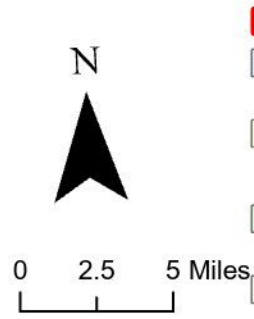
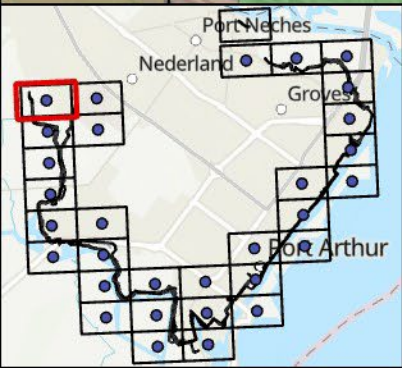
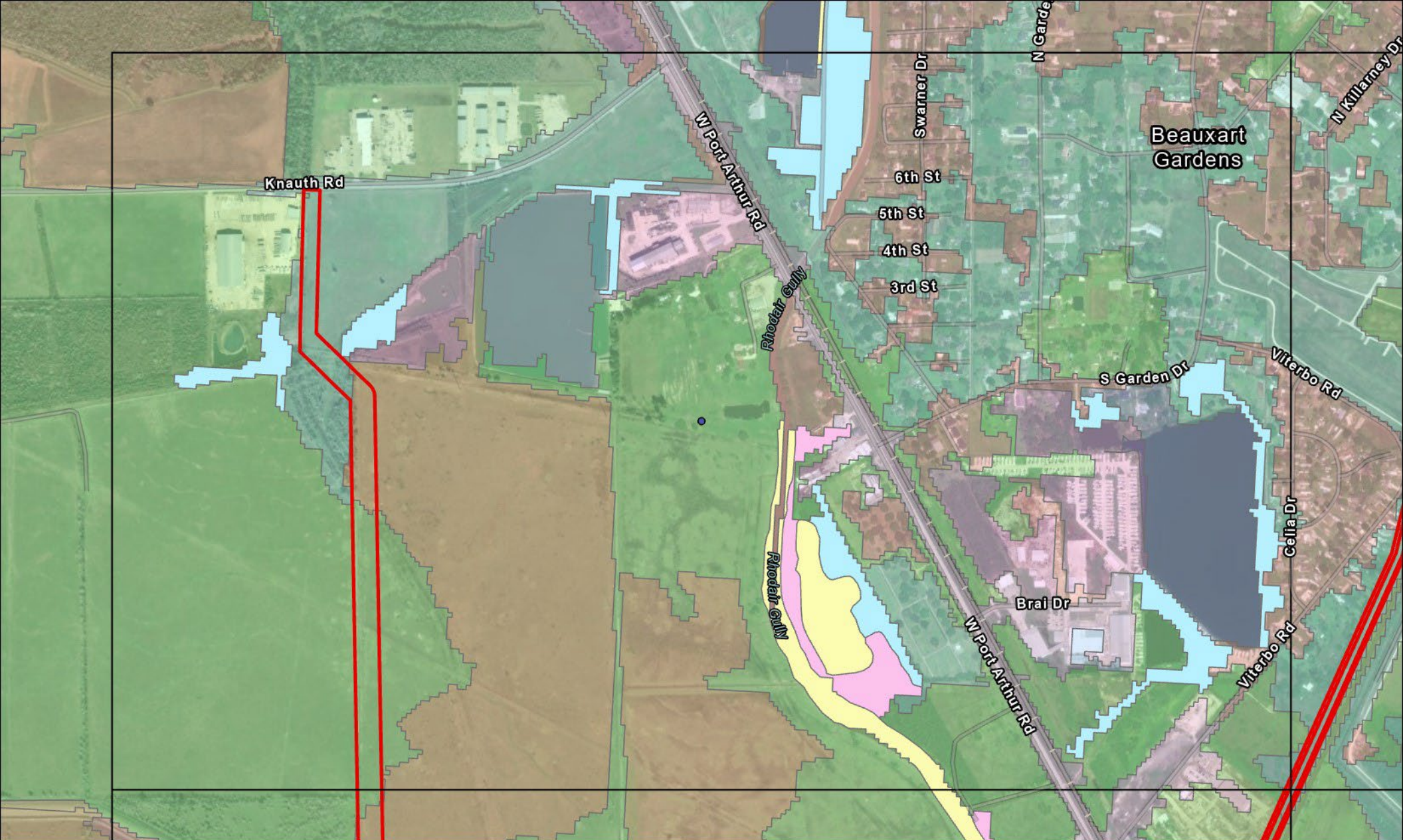
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**US Army Corps
of Engineers**®
Galveston District

APPENDIX A: ATTACHMENT 1 S2G PAV HABITAT MAPBOOK

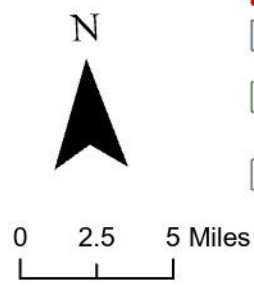
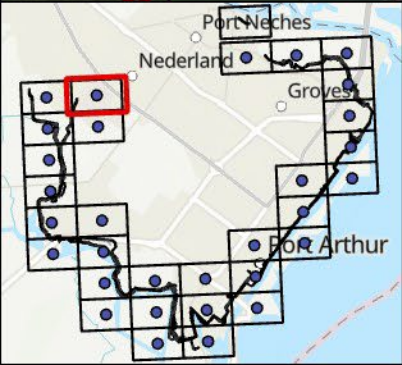


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|---|--|---|
| Project Footprint | Native Invasive: Deciduous Woodland | Pineywoods: Pine Forest or Plantation |
| Barren | Native Invasive: Juniper Shrubland | Pineywoods: Small Stream and Riparian Wet Prairie |
| Chenier Plain: Fresh and Intermediate Tidal Marsh | Non-Native Invasive: Chinese Tallow Forest, Woodland, or Shrubland | Row Crops |
| Gulf Coast: Coastal Prairie | Open Water | Urban High Intensity |
| Gulf Coast: Coastal Prairie Pondshore | Pine Plantation > 3 meters tall | Urban Low Intensity |
| Marsh | | |

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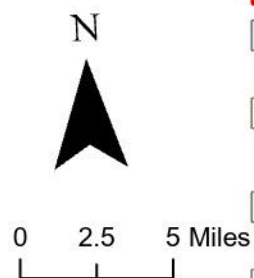
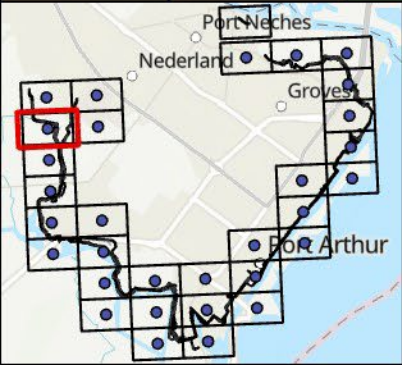
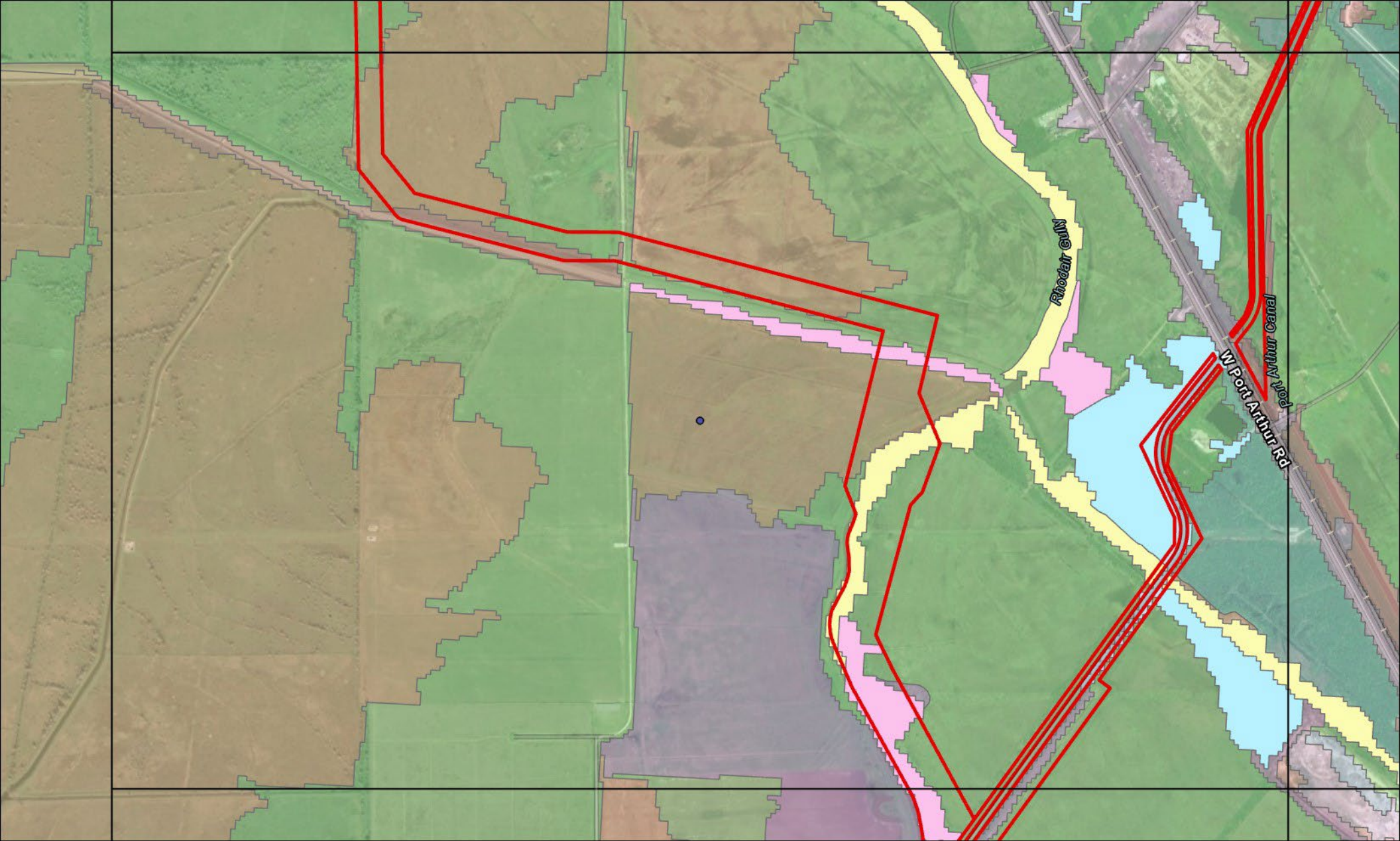




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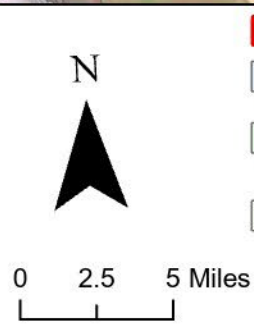
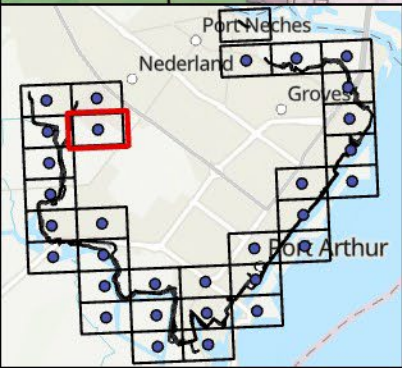
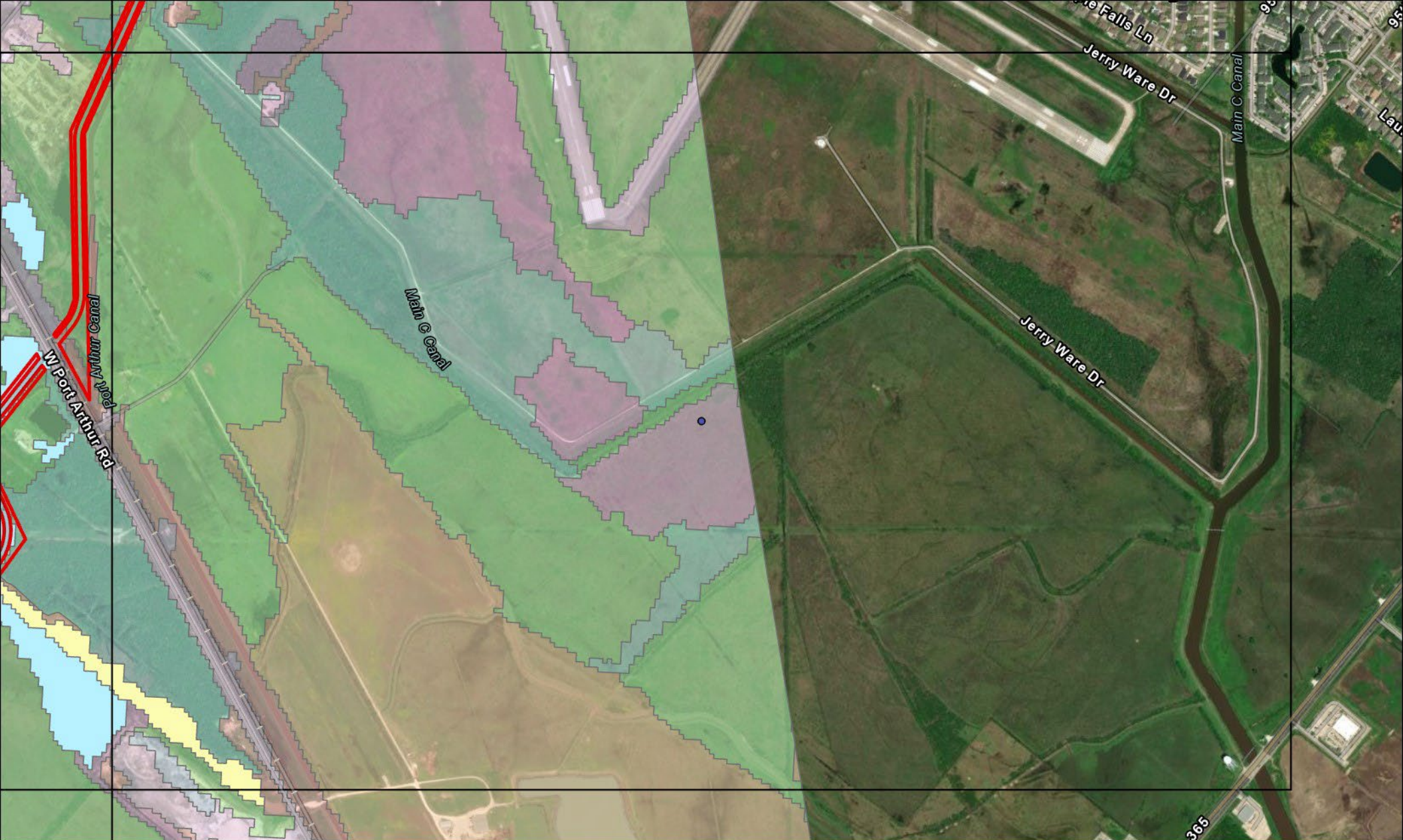


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| Project Footprint | Gulf Coast: Salty Prairie | Pineywoods: Small Stream and Riparian Wet Prairie |
| Barren | Marsh | Row Crops |
| Chenier Plain: Fresh and Intermediate Tidal Marsh | Native Invasive: Deciduous Woodland | Urban High Intensity |
| Gulf Coast: Coastal Prairie | Non-Native Invasive: Chinese Tallow Forest, Woodland, or Shrubland | Urban Low Intensity |
| Gulf Coast: Coastal Prairie Pondshore | Pine Plantation > 3 meters tall | |

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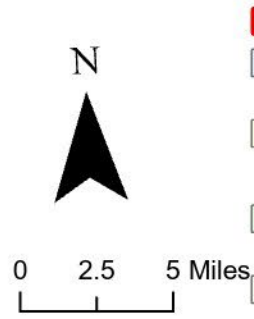
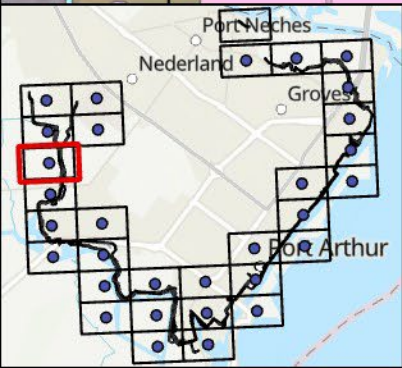
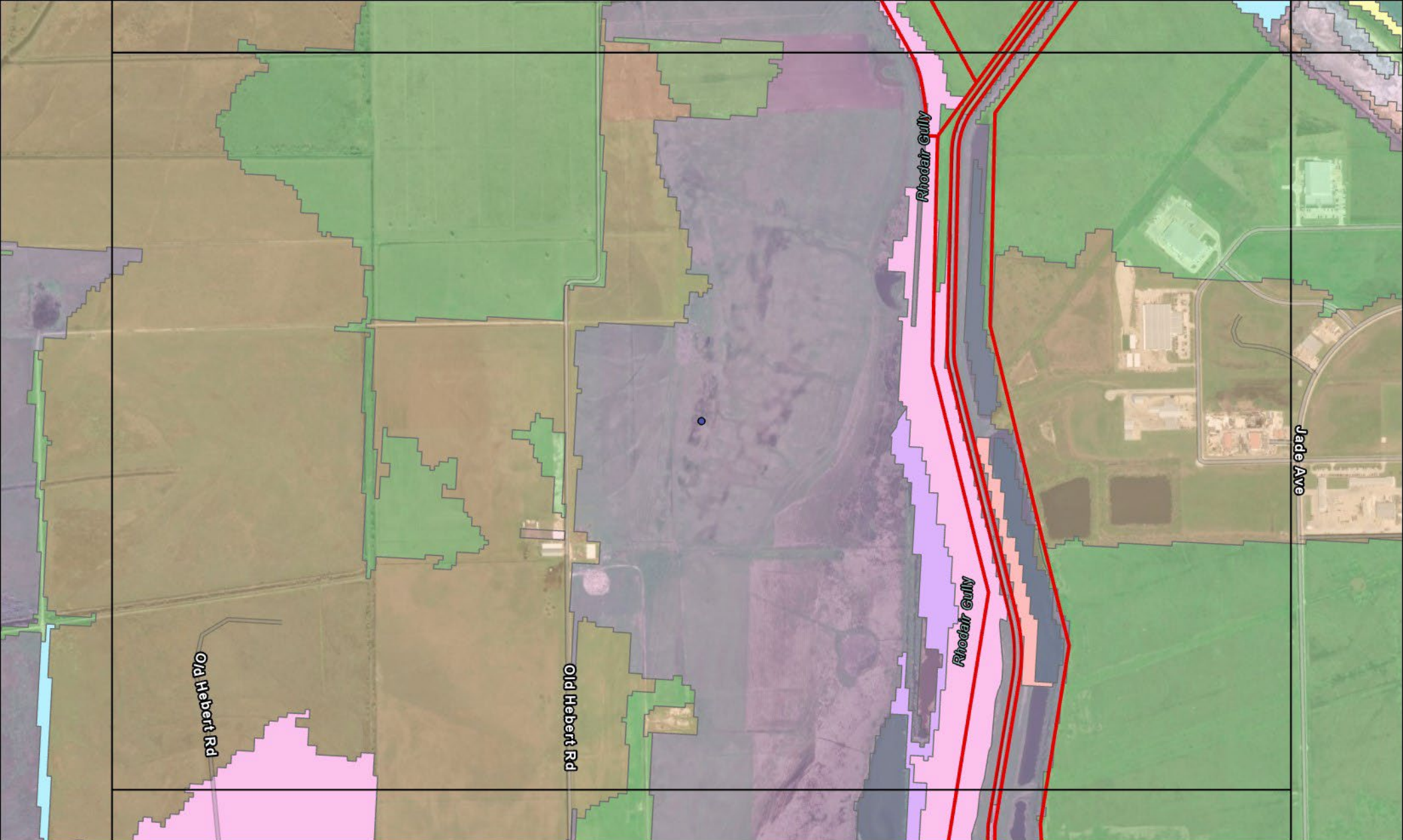


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|  Project Footprint |  Marsh |  Pine Plantation > 3 meters tall |
|  Barren |  Native Invasive: Deciduous Woodland |  Row Crops |
|  Gulf Coast: Coastal Prairie |  Non-Native Invasive: Chinese Tallow Forest, Woodland, or Shrubland |  Urban High Intensity |
|  Gulf Coast: Coastal Prairie Pondshore | |  Urban Low Intensity |

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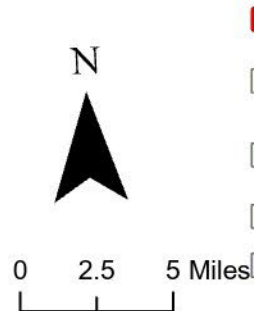
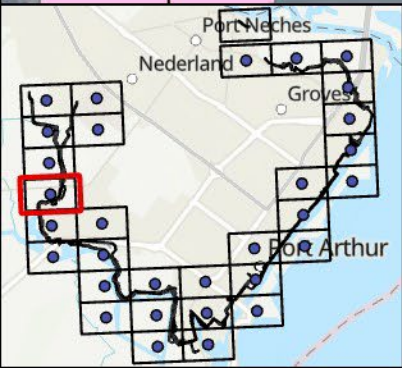
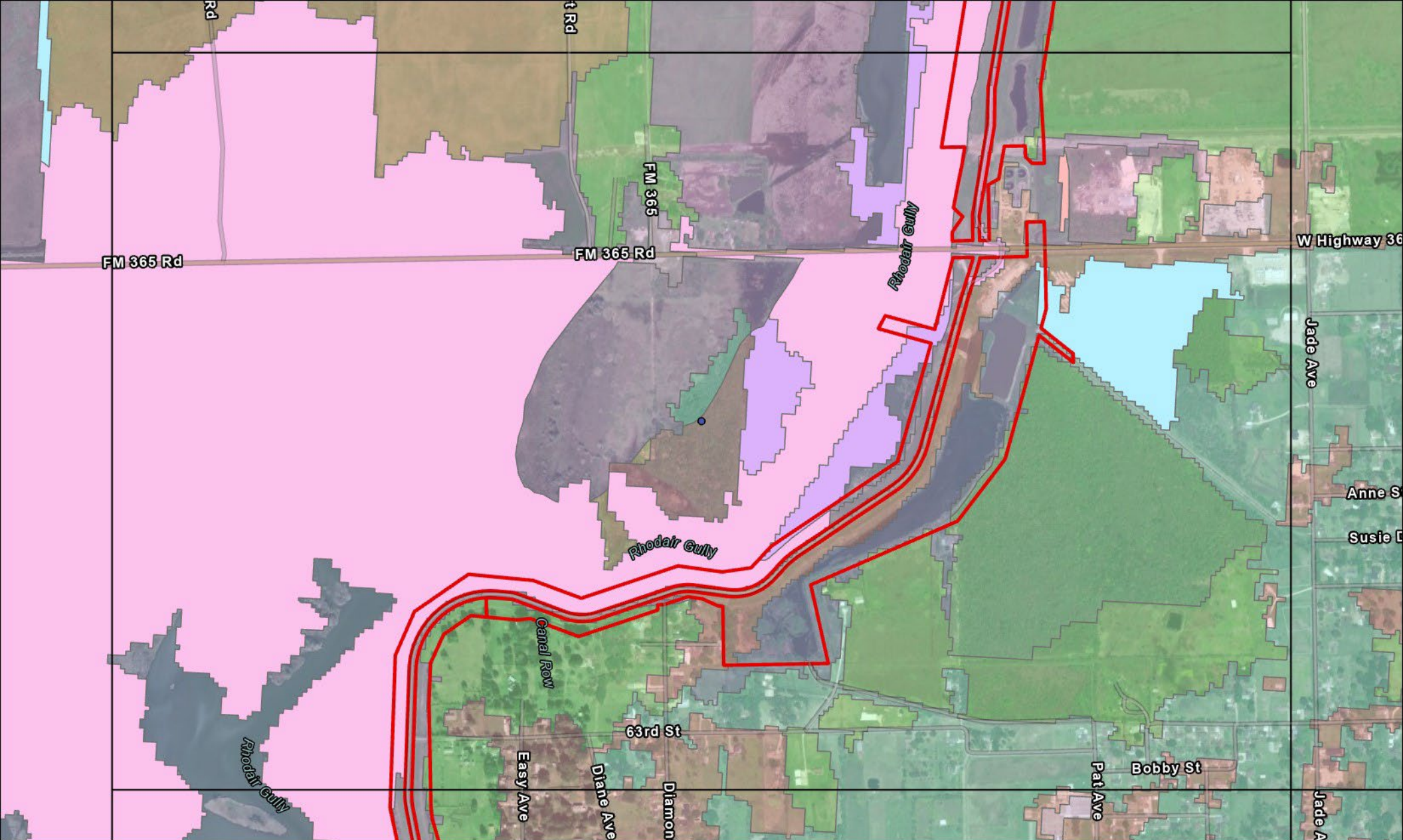


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| Project Footprint | Marsh | Pinewoods: Small Stream and Riparian Herbaceous Wetland |
| Barren | Native Invasive: Common Reed | Pinewoods: Small Stream and Riparian Wet Prairie |
| Chenier Plain: Fresh and Intermediate Tidal Marsh | Non-Native Invasive: Chinese Tallow Forest, Woodland, or Shrubland | Row Crops |
| Gulf Coast: Coastal Prairie | Open Water | Urban High Intensity |
| Gulf Coast: Coastal Prairie Pondshore | Pine Plantation > 3 meters tall | Urban Low Intensity |
| Gulf Coast: Salty Prairie | | |

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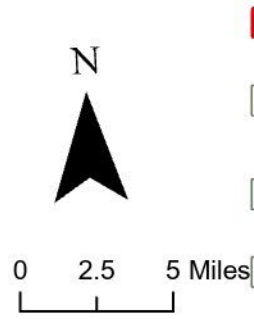
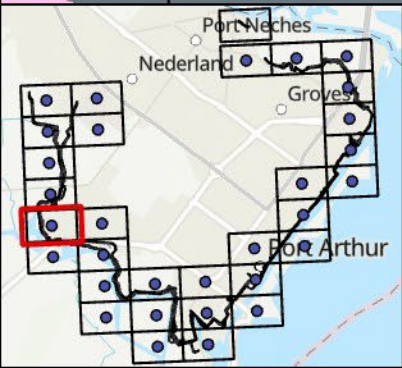
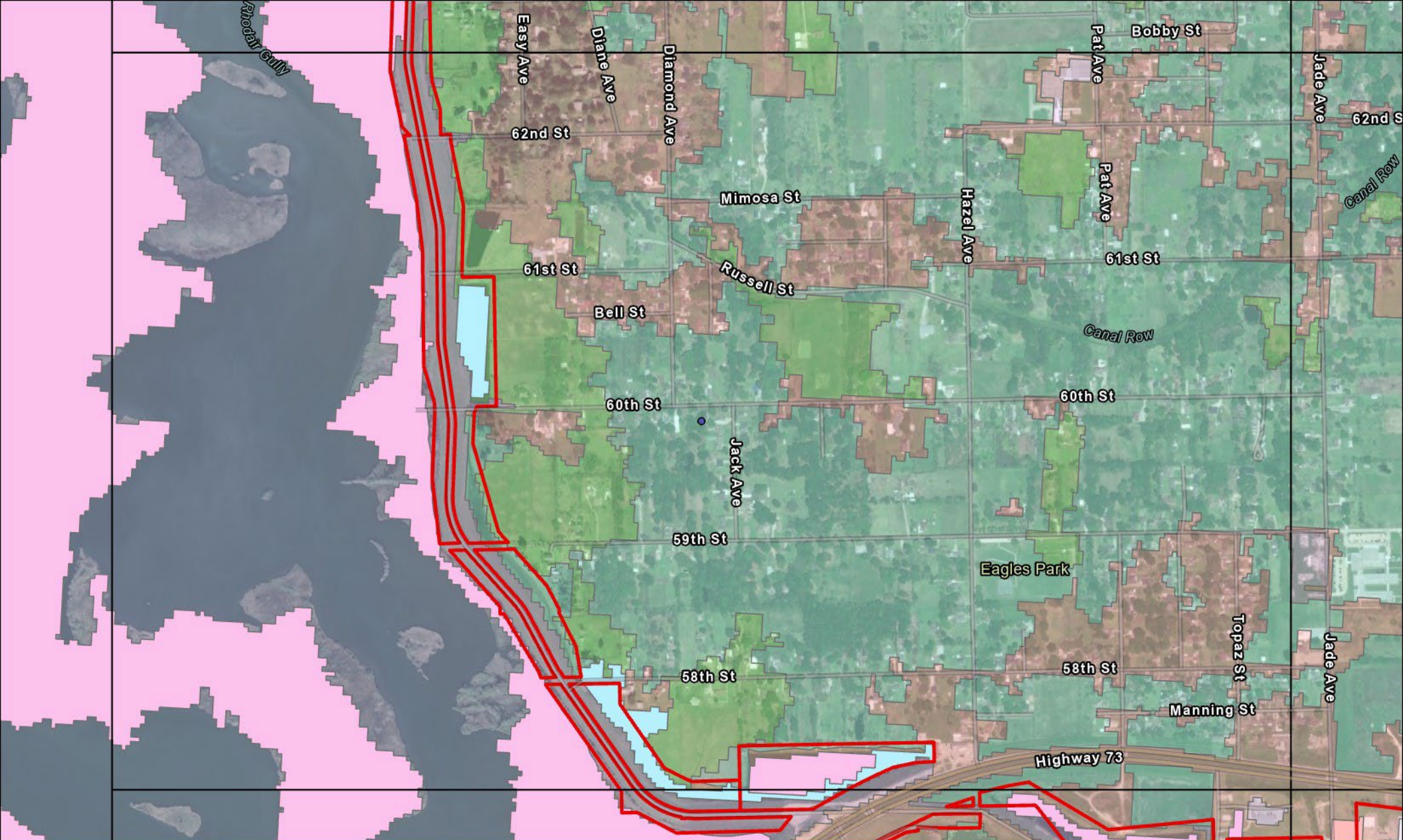


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| Project Footprint | Native Invasive: Common Reed | Pine Plantation > 3 meters tall | Pineywoods: Small Stream and Riparian Wet Prairie |
| Chenier Plain: Fresh and Intermediate Tidal Marsh | Native Invasive: Juniper Shrubland | Pineywoods: Small Stream and Riparian Herbaceous Wetland | Row Crops |
| Gulf Coast: Coastal Prairie | Non-Native Invasive: Chinese Tallow Forest, Woodland, or Shrubland | Pineywoods: Small Stream and Riparian Temporarily Flooded Hardwood Forest | Urban High Intensity |
| Gulf Coast: Coastal Prairie Pondshore | Open Water | | Urban Low Intensity |
| Gulf Coast: Salty Prairie | Pine Plantation 1 to 3 meters tall | | |

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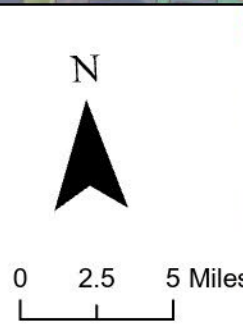
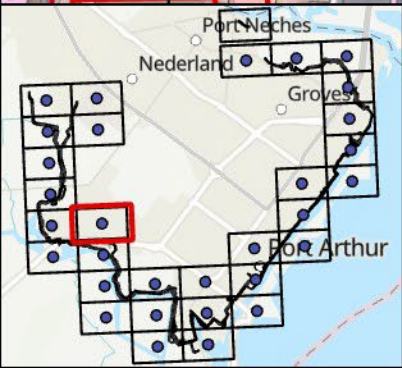
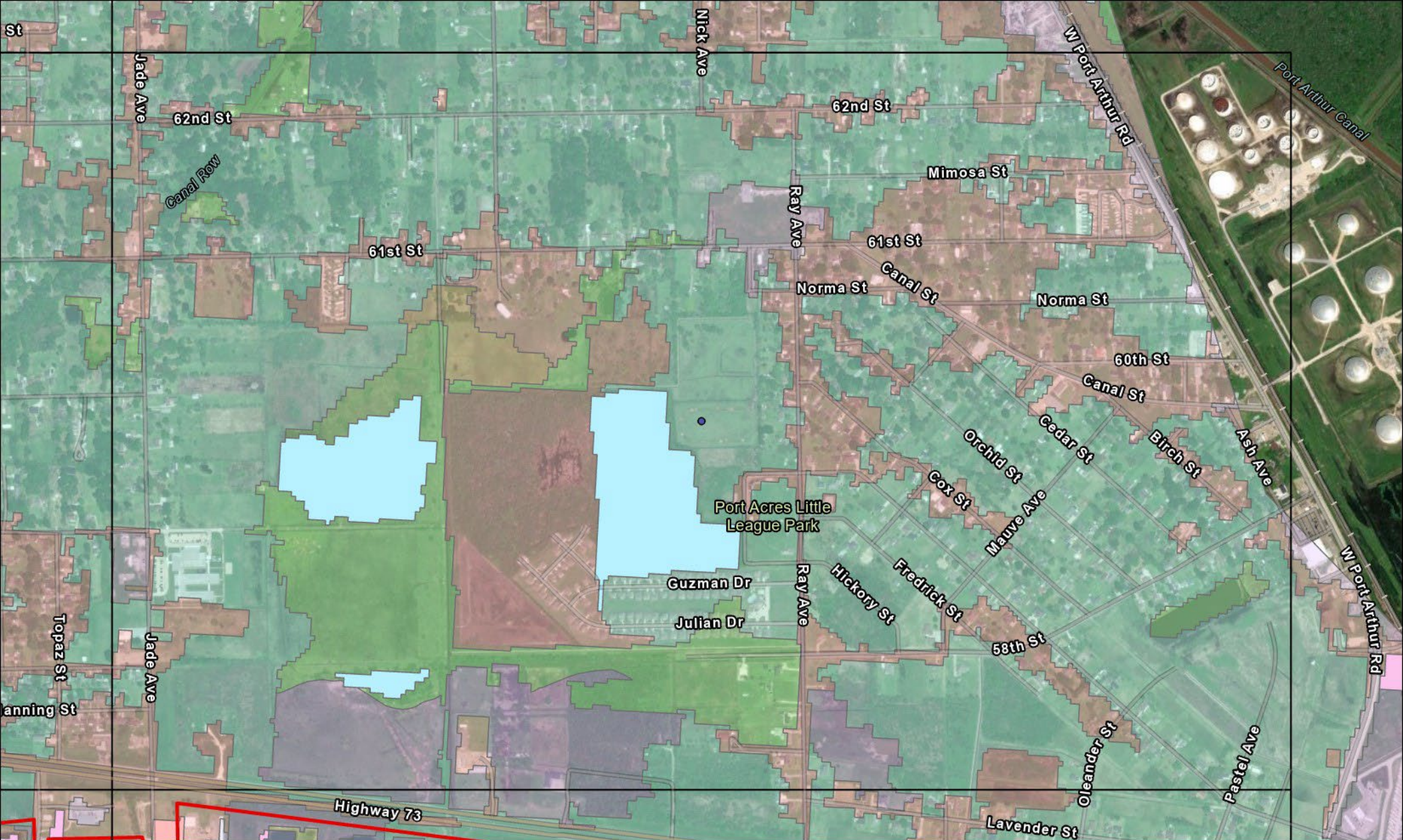


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| Project Footprint | Gulf Coast: Salty Prairie | Open Water |
| Chenier Plain: Fresh and Intermediate Tidal Marsh | Native Invasive: Common Reed | Open Water: Gulf Coast Mixing Zone |
| Gulf Coast: Coastal Prairie | Native Invasive: Deciduous Woodland | Urban High Intensity |
| Gulf Coast: Coastal Prairie Pondshore | Non-Native Invasive: Chinese Tallow Forest, Woodland, or Shrubland | Urban Low Intensity |

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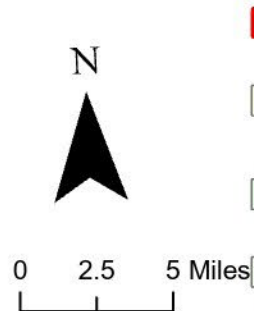
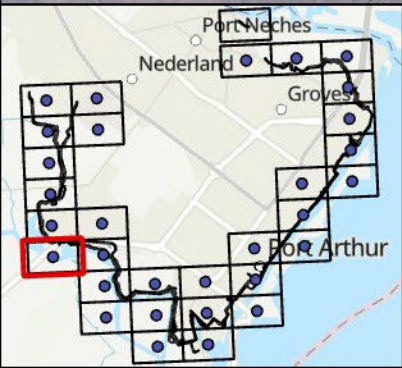
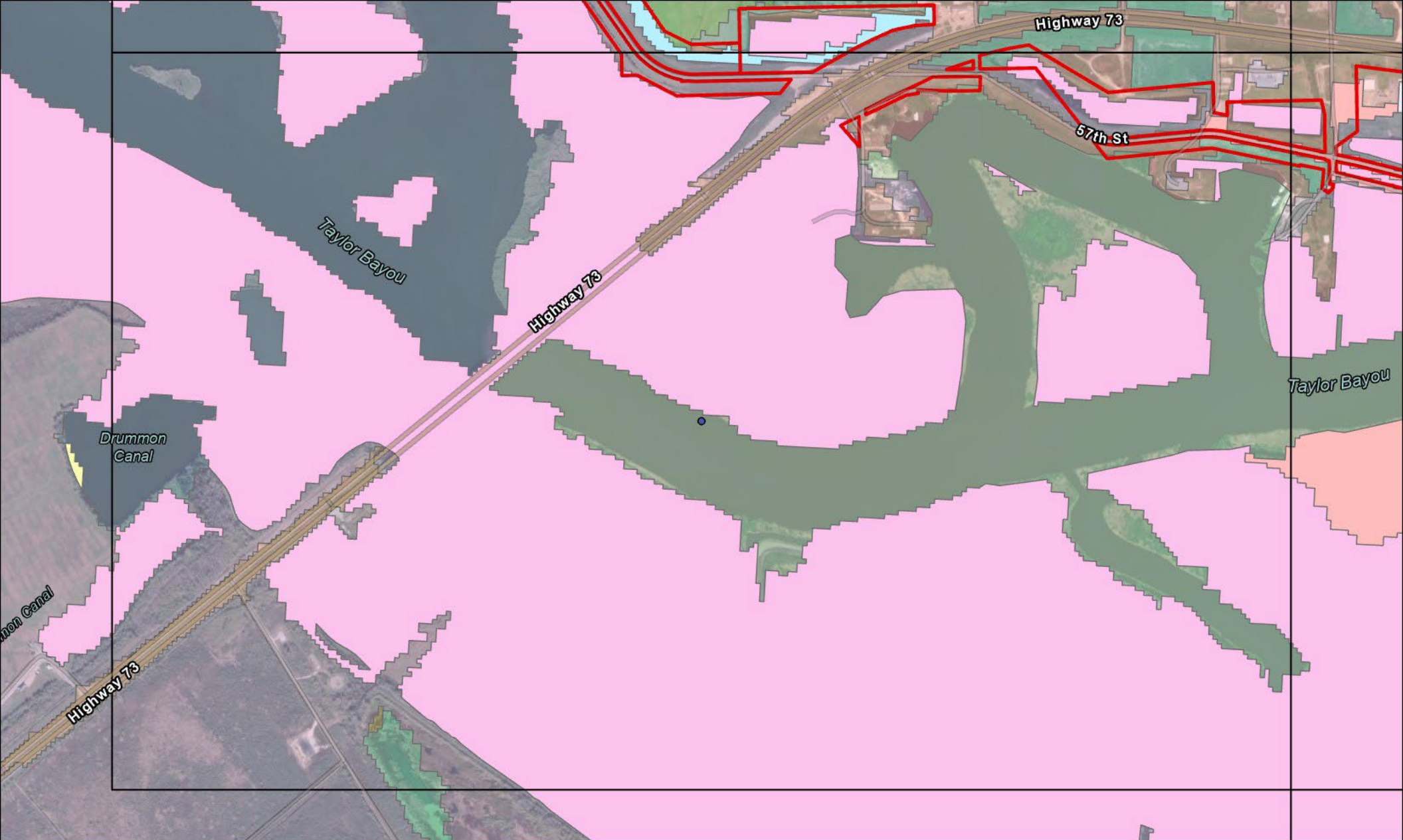


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|  Project Footprint |  Gulf Coast: Salty Prairie |  Pineywoods: Disturbance or Tame Grassland |
|  Chenier Plain: Fresh and Intermediate Tidal Marsh |  Native Invasive: Common Reed |  Row Crops |
|  Gulf Coast: Coastal Prairie |  Non-Native Invasive: Chinese Tallow Forest, Woodland, or Shrubland |  Urban High Intensity |
|  Gulf Coast: Coastal Prairie Pondshore |  Open Water |  Urban Low Intensity |

GRID: 8

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- Project Footprint
- Chenier Plain: Fresh and Intermediate Tidal Marsh
- Gulf Coast: Coastal Prairie
- Gulf Coast: Coastal Prairie Pondshore
- Gulf Coast: Salty Prairie

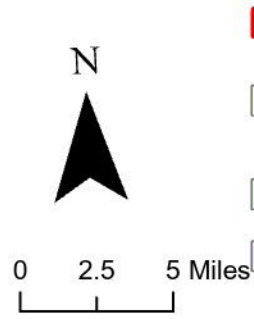
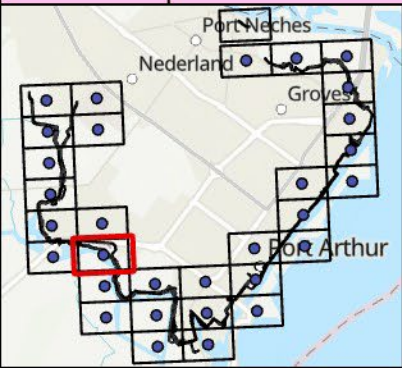
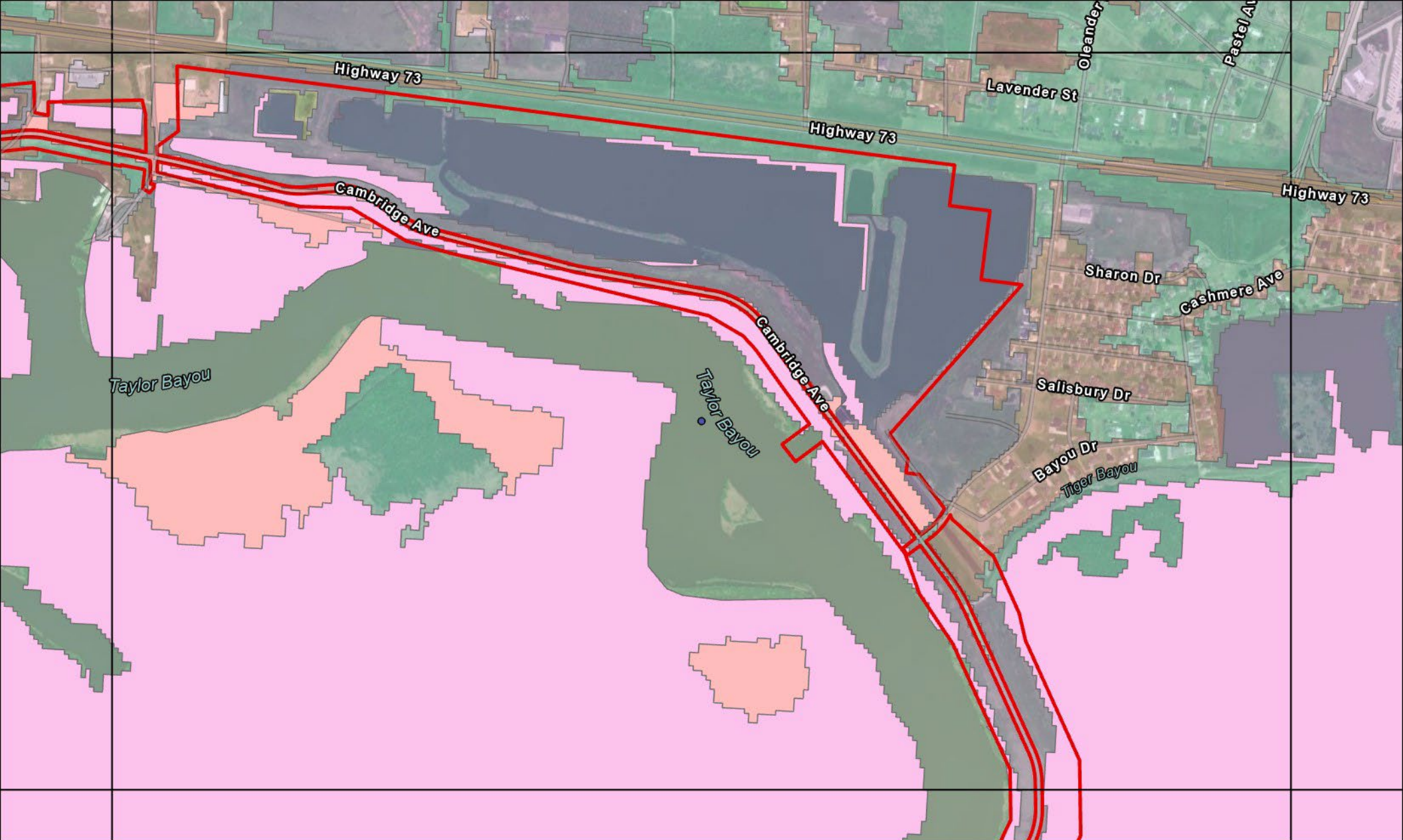
- Gulf Coast: Salty Prairie Shrubland
- Marsh
- Native Invasive: Common Reed
- Native Invasive: Deciduous Woodland

- Non-Native Invasive: Chinese Tallow Forest, Woodland, or Shrubland
- Open Water
- Open Water: Gulf Coast Mixing Zone
- Urban High Intensity
- Urban Low Intensity

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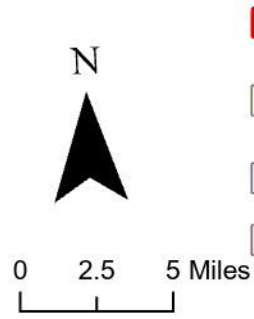
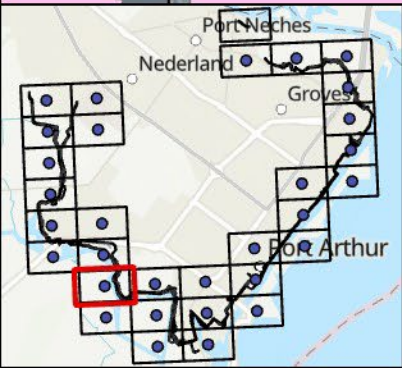
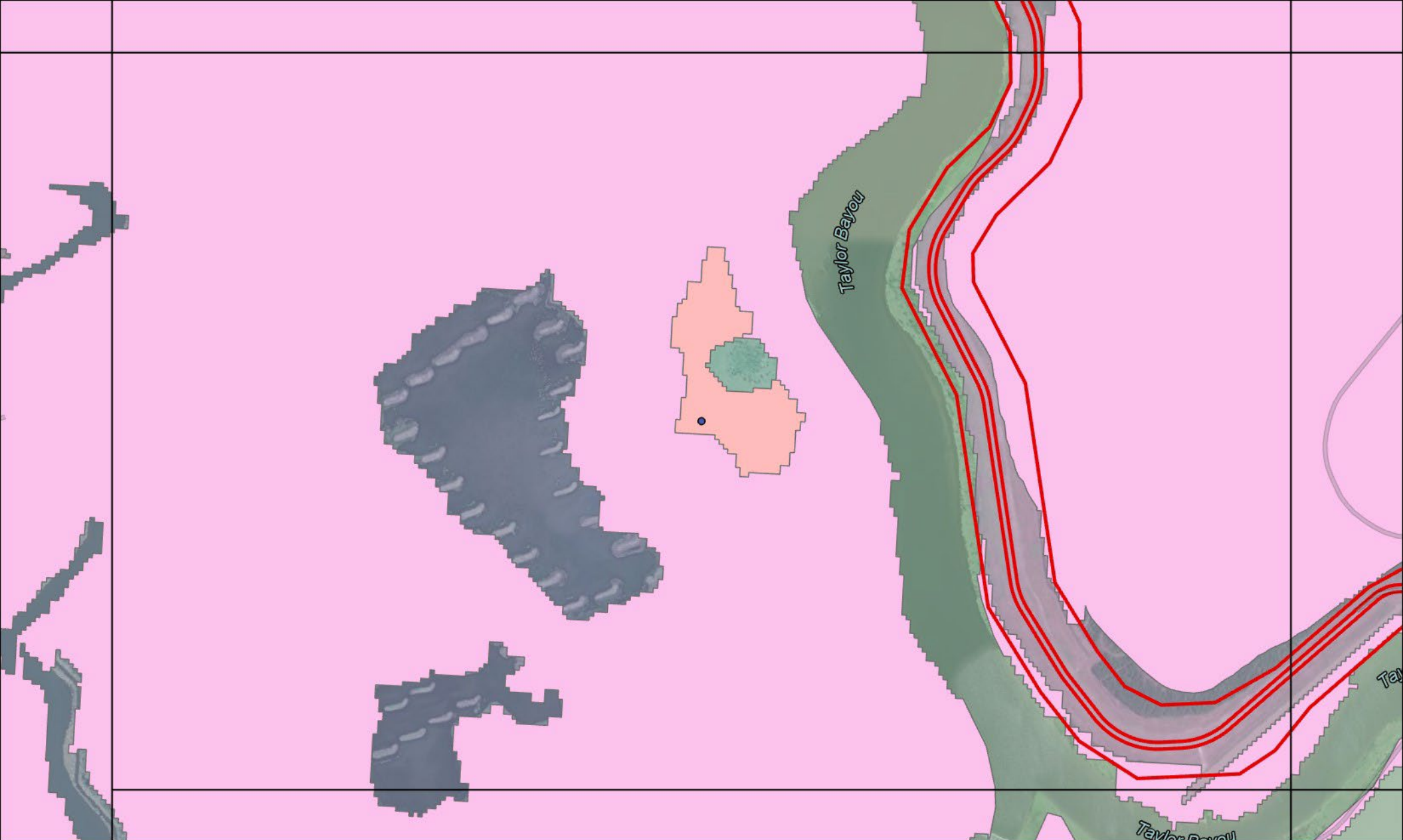


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|---|--|---|
|  Project Footprint |  Native Invasive:
Common Reed |  Pineywoods:
Disturbance or Tame
Grassland |
|  Chenier Plain: Fresh and
Intermediate Tidal
Marsh |  Non-Native Invasive:
Chinese Tallow Forest,
Woodland, or Shrubland |  Pineywoods: Pine Forest
or Plantation |
|  Gulf Coast: Coastal
Prairie |  Open Water |  Urban High Intensity |
|  Gulf Coast: Salty Prairie |  Open Water: Gulf Coast
Mixing Zone |  Urban Low Intensity |

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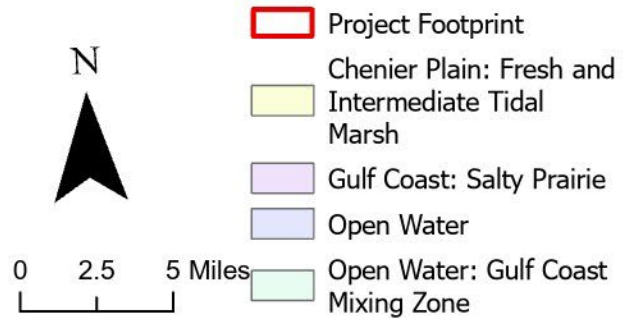
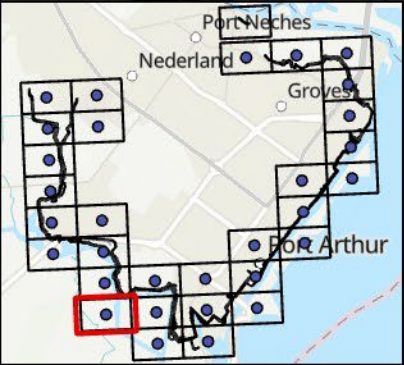
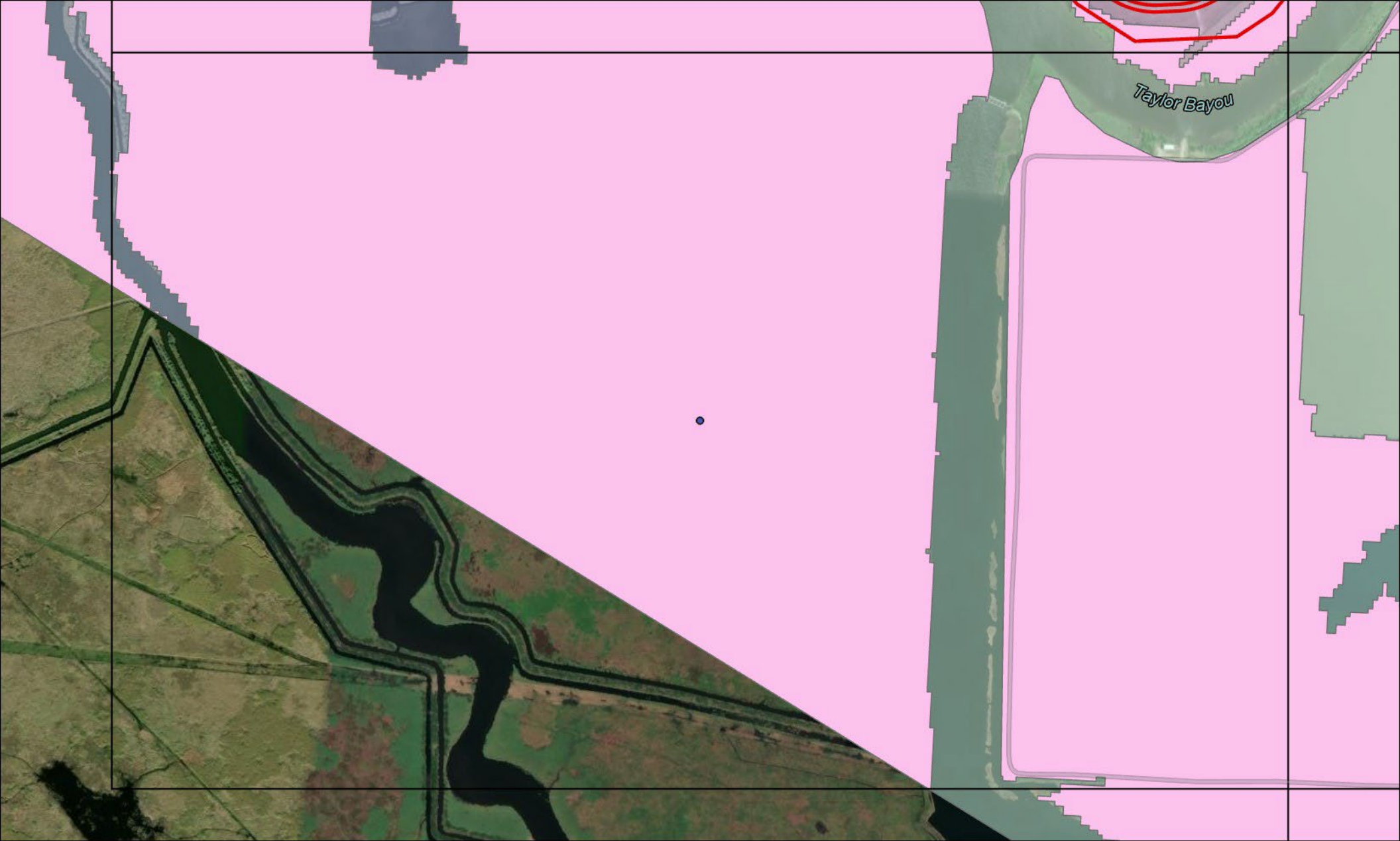


- Project Footprint
- Chenier Plain: Fresh and Intermediate Tidal Marsh
- Gulf Coast: Salty Prairie
- Native Invasive: Common Reed
- Non-Native Invasive: Chinese Tallow Forest, Woodland, or Shrubland
- Open Water
- Open Water: Gulf Coast Mixing Zone

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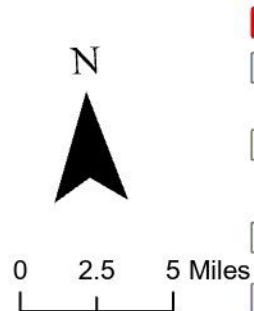
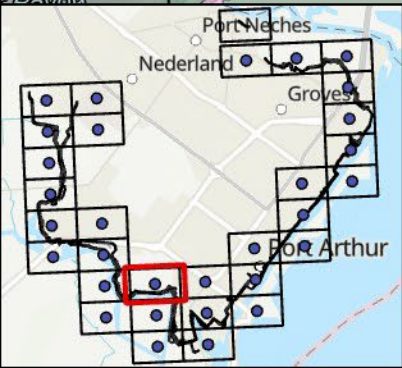
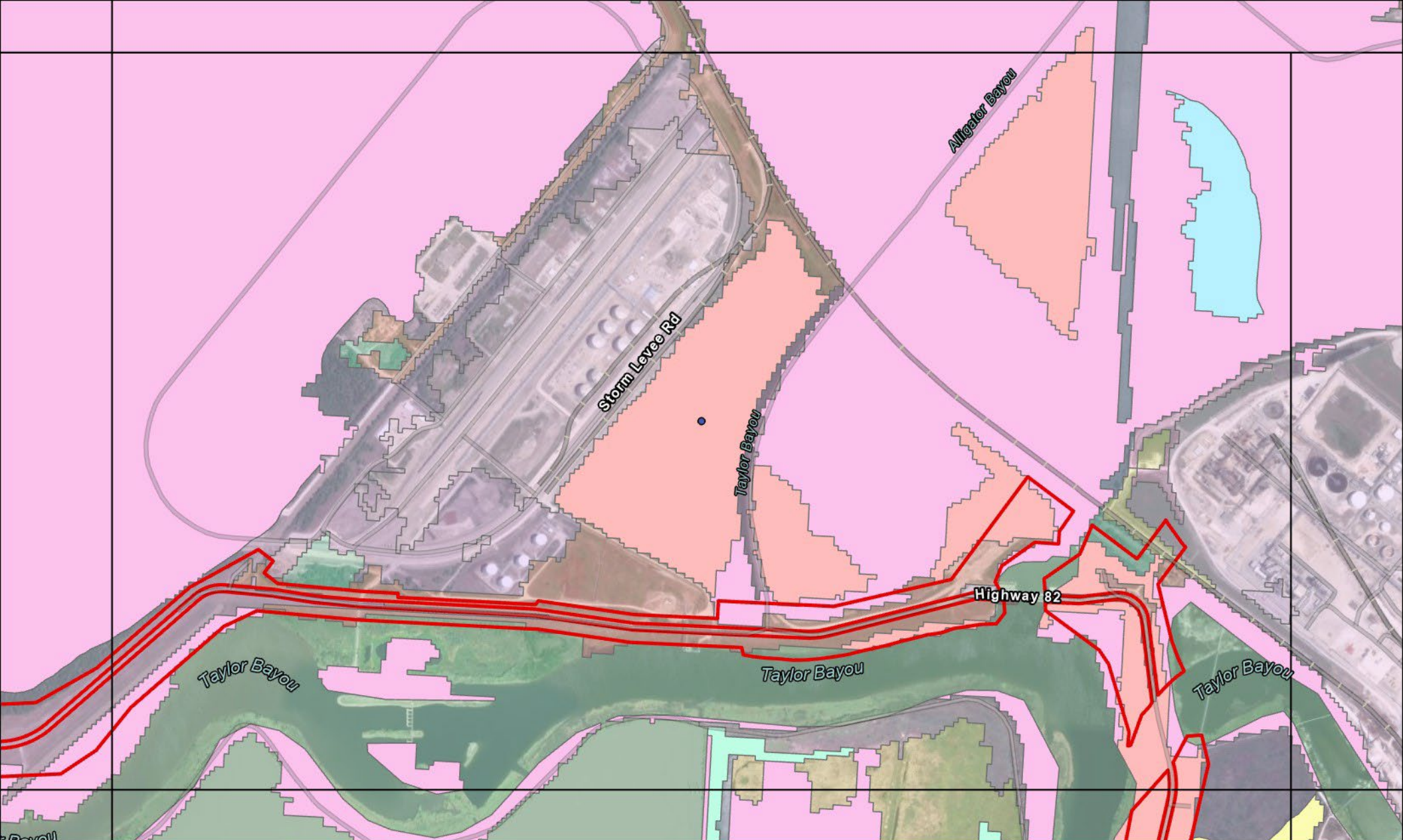




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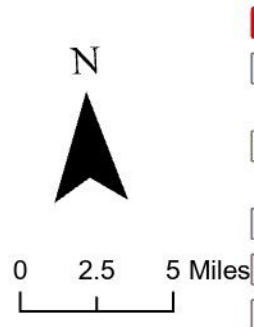
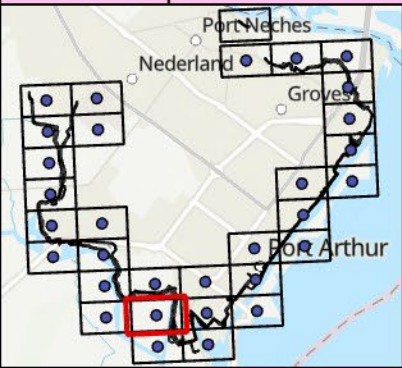


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|---|--|---|
| Project Footprint | Mud Flat | Pine Plantation > 3 meters tall |
| Barren | Native Invasive: Common Reed | Pineywoods: Disturbance or Tame Grassland |
| Chenier Plain: Fresh and Intermediate Tidal Marsh | Non-Native Invasive: Chinese Tallow Forest, Woodland, or Shrubland | Pineywoods: Pine Forest or Plantation |
| Gulf Coast: Coastal Prairie Pondshore | Open Water | Urban High Intensity |
| Gulf Coast: Salty Prairie | Open Water: Gulf Coast Mixing Zone | Urban Low Intensity |
| Marsh | | |

GRID: 13

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- | | | |
|---|--|---|
| Project Footprint | Native Invasive: Common Reed | Pineywoods: Disturbance or Tame Grassland |
| Barren | Non-Native Invasive: Chinese Tallow Forest, Woodland, or Shrubland | Pineywoods: Pine Forest or Plantation |
| Chenier Plain: Fresh and Intermediate Tidal Marsh | Open Water | Urban High Intensity |
| Gulf Coast: Salty Prairie | Open Water: Gulf Coast Mixing Zone | Urban Low Intensity |
| Marsh | | |
| Mud Flat | | |

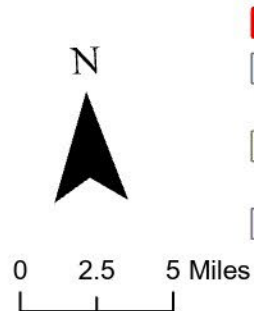
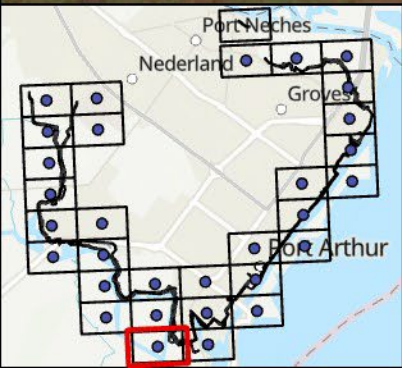
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Taylor Bayou

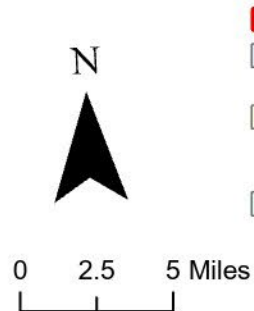
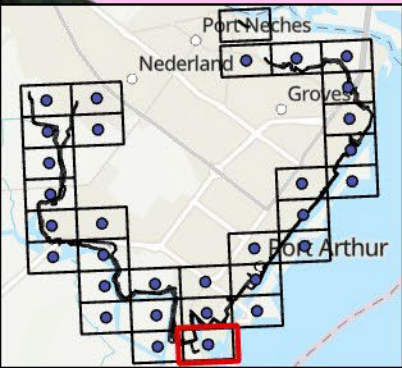
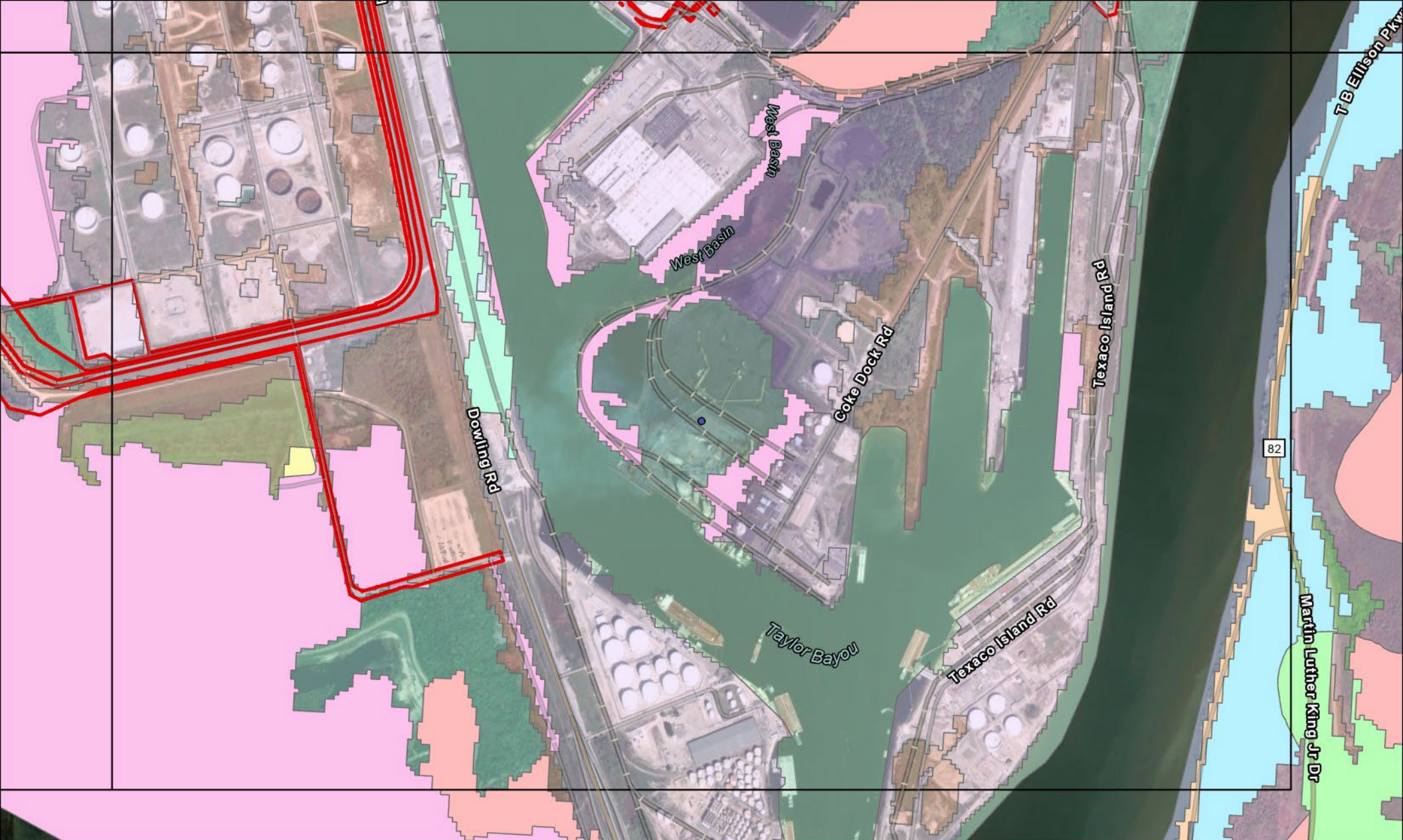


- Project Footprint
- Barren
- Chenier Plain: Fresh and Intermediate Tidal Marsh
- Gulf Coast: Salty Prairie
- Native Invasive: Common Reed
- Non-Native Invasive: Chinese Tallow Forest, Woodland, or Shrubland
- Open Water: Gulf Coast Mixing Zone
- Pinewoods: Disturbance or Tame Grassland
- Urban High Intensity
- Urban Low Intensity

GRID: 15

S2G-PAV



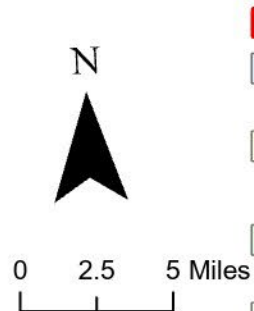
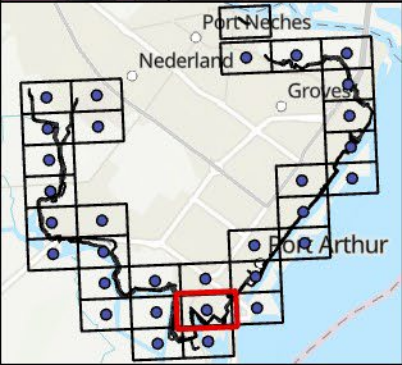
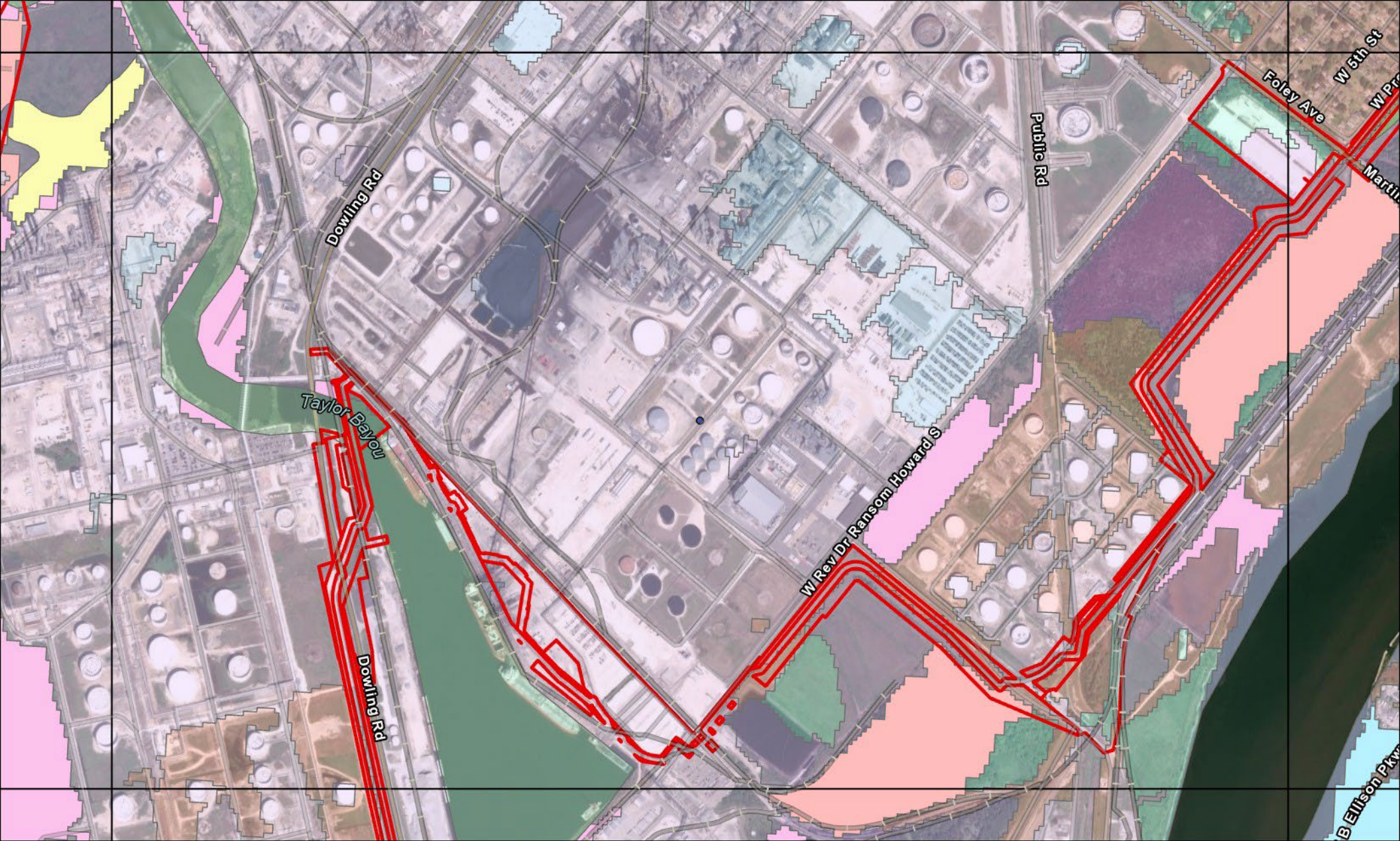


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|---|--|--|--|--|
| Project Footprint | Barren | Chenier Plain: Salt and Brackish Low Tidal Marsh | Marsh | Open Water: Gulf Coast Mixing Zone |
| Chenier Plain: Fresh and Intermediate Tidal Marsh | Coastal and Sandsheet: Deep Sand Grassland | Gulf Coast: Coastal Prairie | Mud Flat | Pine Plantation > 3 meters tall |
| Chenier Plain: Salt and Brackish High Tidal Marsh | Gulf Coast: Coastal Prairie Pondshore | Gulf Coast: Salty Prairie | Native Invasive: Common Reed | Pinewoods: Disturbance or Tame Grassland |
| | | | Non-Native Invasive: Chinese Tallow Forest, Woodland, or Shrubland | Urban High Intensity |
| | | | Open Water | Urban Low Intensity |

GRID: 16

S2G-PAV



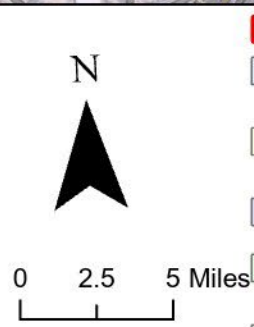
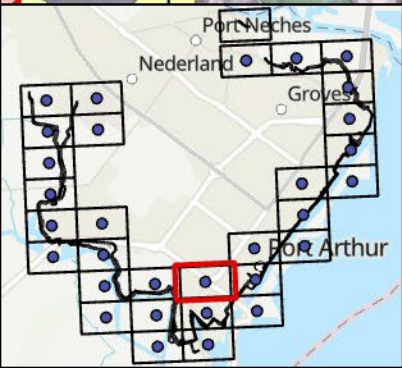
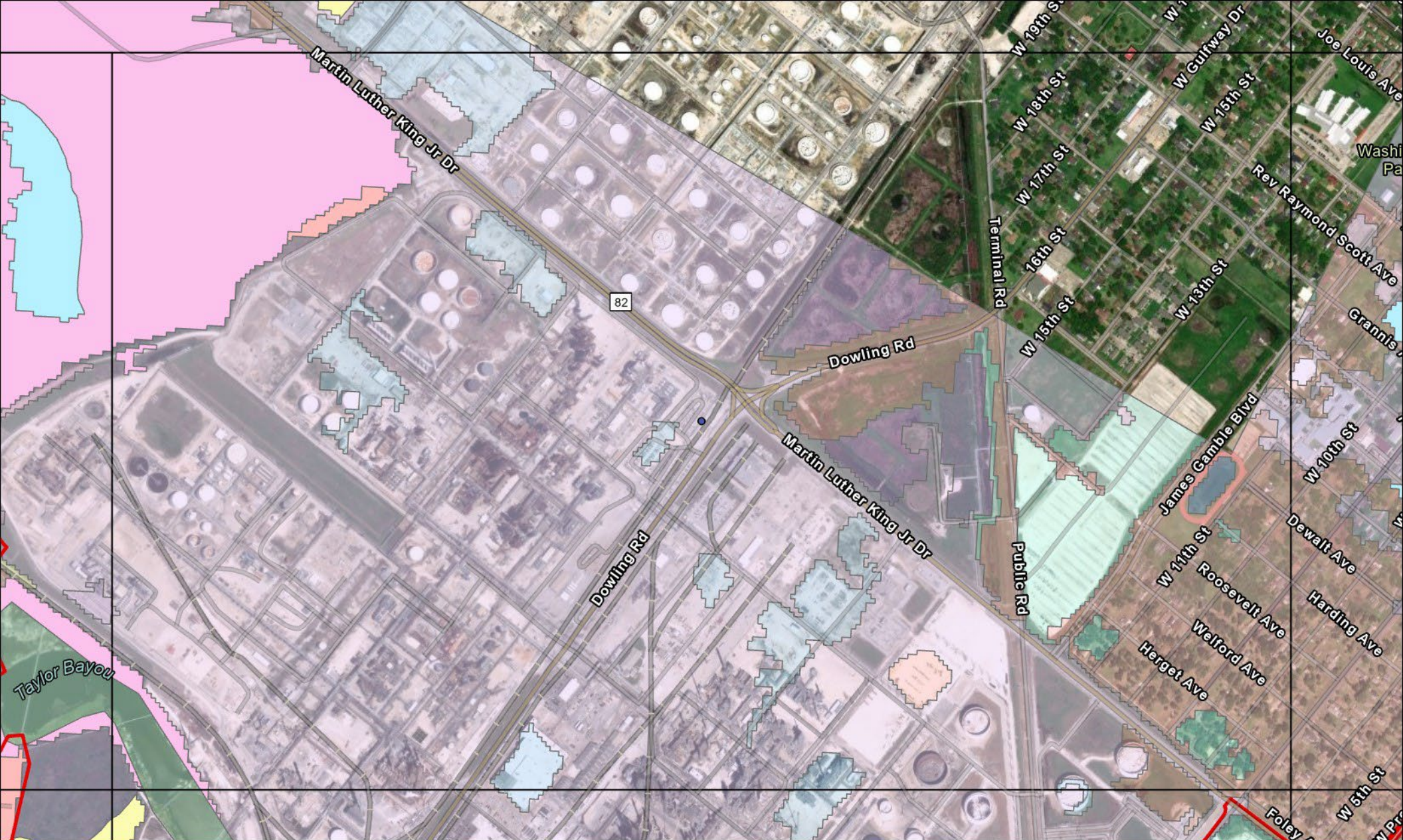


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|---|--|---------------------------------------|
| Project Footprint | Gulf Coast: Salty Prairie | Open Water |
| Barren | Marsh | Open Water: Gulf Coast Mixing Zone |
| Chenier Plain: Fresh and Intermediate Tidal Marsh | Native Invasive: Common Reed | Pineywoods: Pine Forest or Plantation |
| Gulf Coast: Coastal Prairie | Native Invasive: Deciduous Woodland | Urban High Intensity |
| Gulf Coast: Coastal Prairie Pondshore | Non-Native Invasive: Chinese Tallow Forest, Woodland, or Shrubland | Urban Low Intensity |

GRID: 17

S2G-PAV



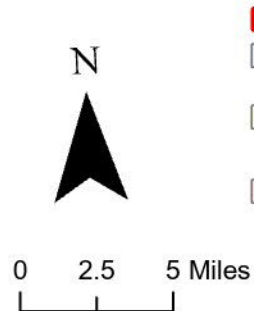
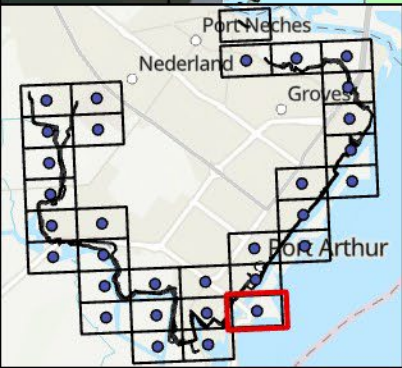
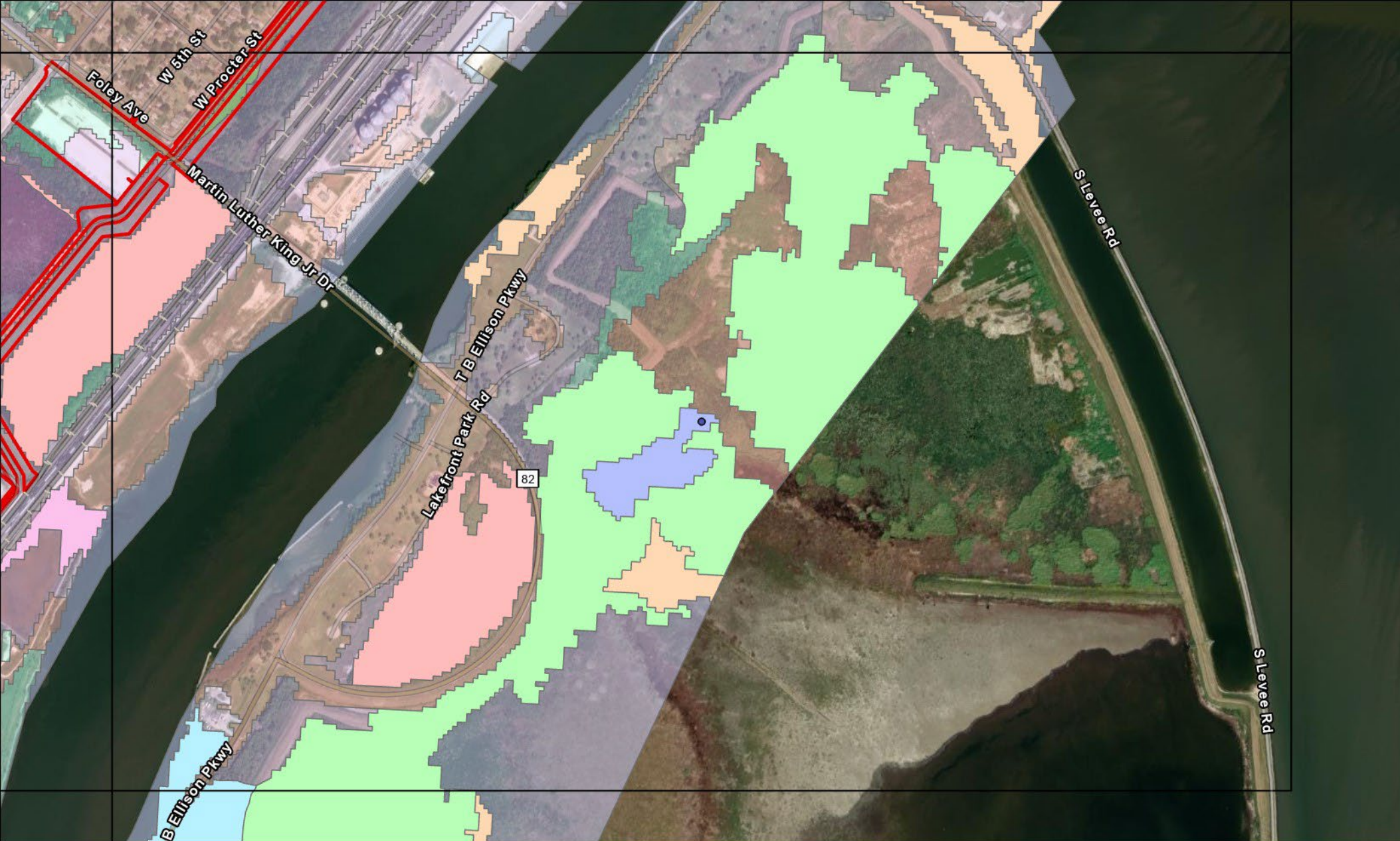


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|---|--|---|
| Project Footprint | Gulf Coast: Salty Prairie | Pine Plantation > 3 meters tall |
| Barren | Marsh | Pineywoods: Disturbance or Tame Grassland |
| Chenier Plain: Fresh and Intermediate Tidal Marsh | Native Invasive: Common Reed | Pineywoods: Pine Forest or Plantation |
| Grass Farm | Non-Native Invasive: Chinese Tallow Forest, Woodland, or Shrubland | Urban High Intensity |
| Gulf Coast: Coastal Prairie | Open Water: Gulf Coast Mixing Zone | Urban Low Intensity |
| Gulf Coast: Coastal Prairie Pondshore | | |

GRID: 18

S2G-PAV



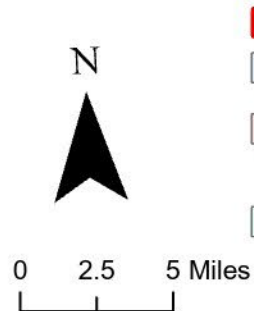
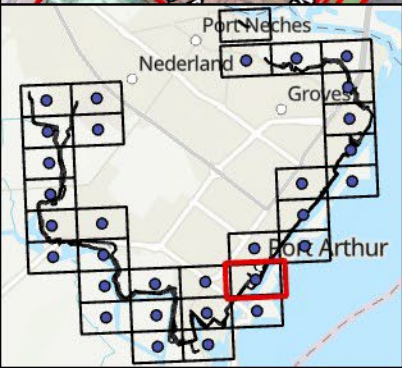
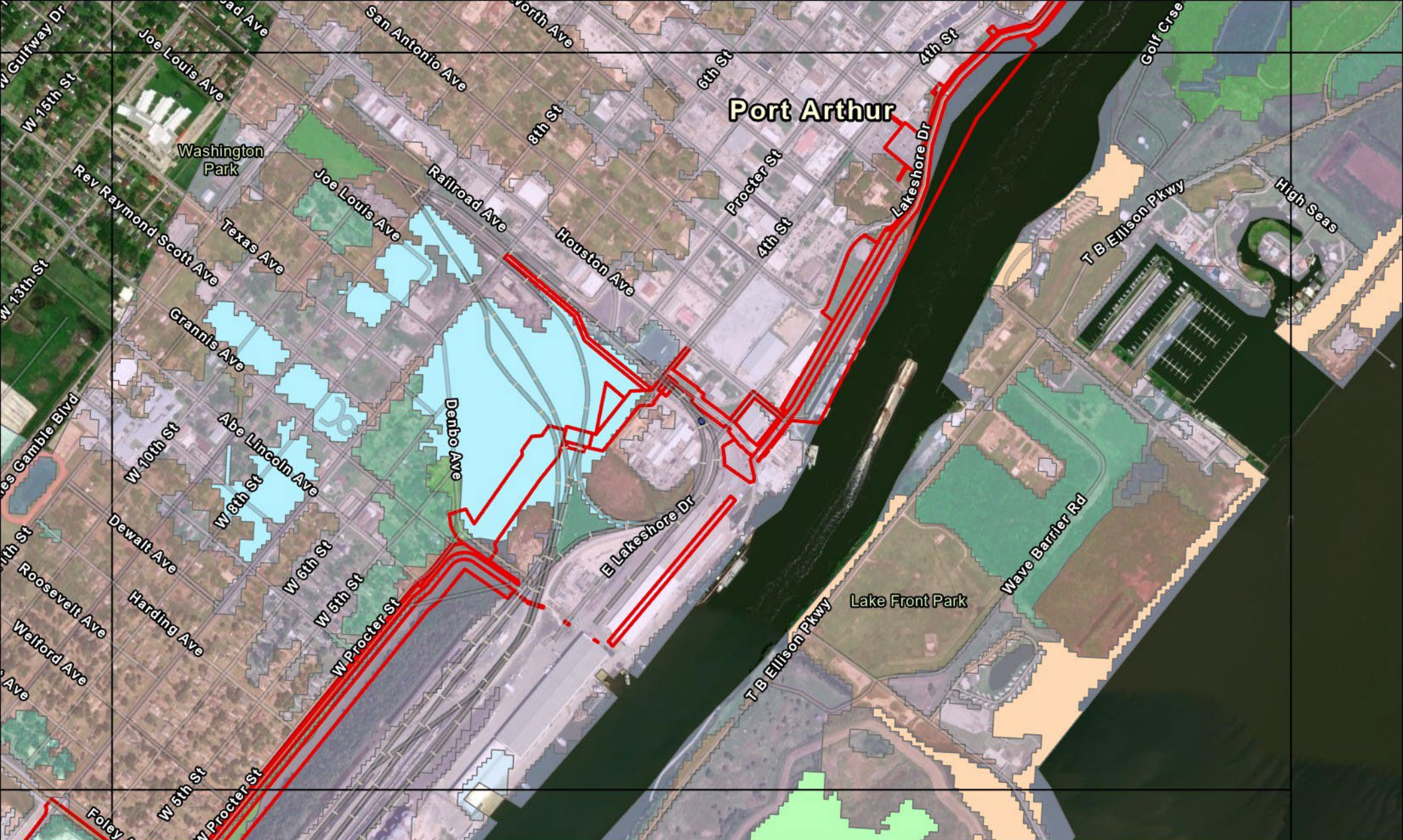


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|---|--|---|--|--|
| Project Footprint | Barren | Chenier Plain: Salt and Brackish High Tidal Marsh | Gulf Coast: Coastal Prairie | Non-Native Invasive: Chinese Tallow Forest, Woodland, or Shrubland |
| Chenier Plain: Fresh and Intermediate Tidal Marsh | Chenier Plain: Salt and Brackish Low Tidal Marsh | Coastal and Sandsheet: Deep Sand Grassland | Gulf Coast: Coastal Prairie Pondshore | Open Water |
| Chenier Plain: Hardwood Fringe Forest | | | Gulf Coast: Near-Coast Baldcypress Swamp | Pinewoods: Pine Forest or Plantation |
| | | | Gulf Coast: Salty Prairie | Urban High Intensity |
| | | | Native Invasive: Common Reed | Urban Low Intensity |

GRID: 19

S2G-PAV



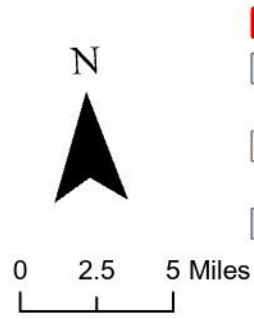
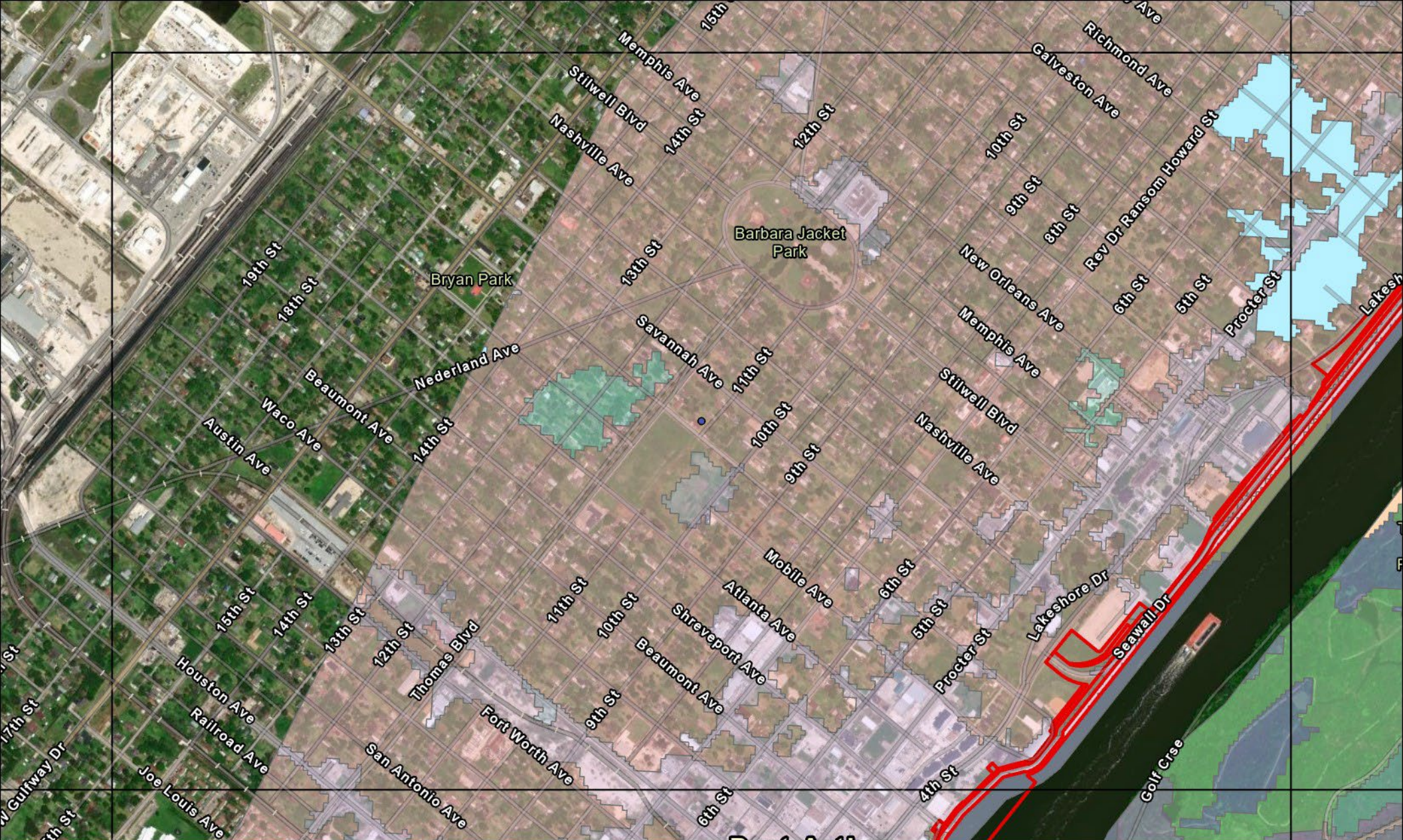


- Project Footprint
- Barren
- Chenier Plain: Hardwood Fringe Forest
- Chenier Plain: Salt and Brackish High Tidal Marsh
- Chenier Plain: Salt and Brackish Low Tidal Marsh
- Coastal and Sandsheet: Deep Sand Grassland
- Grass Farm
- Gulf Coast: Coastal Prairie
- Gulf Coast: Coastal Prairie Pondshore
- Gulf Coast: Salty Prairie
- Non-Native Invasive: Chinese Tallow Forest, Woodland, or Shrubland
- Open Water
- Urban High Intensity
- Urban Low Intensity

GRID: 20

S2G-PAV



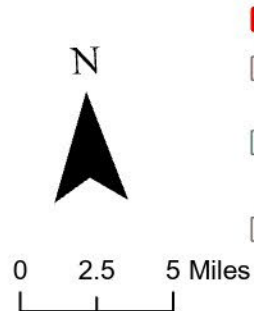
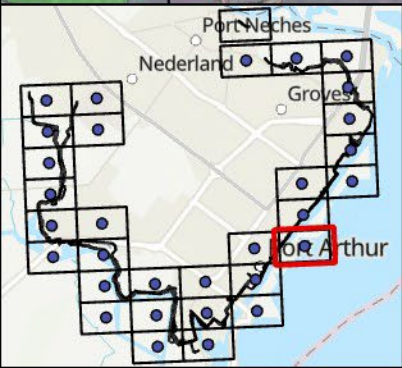
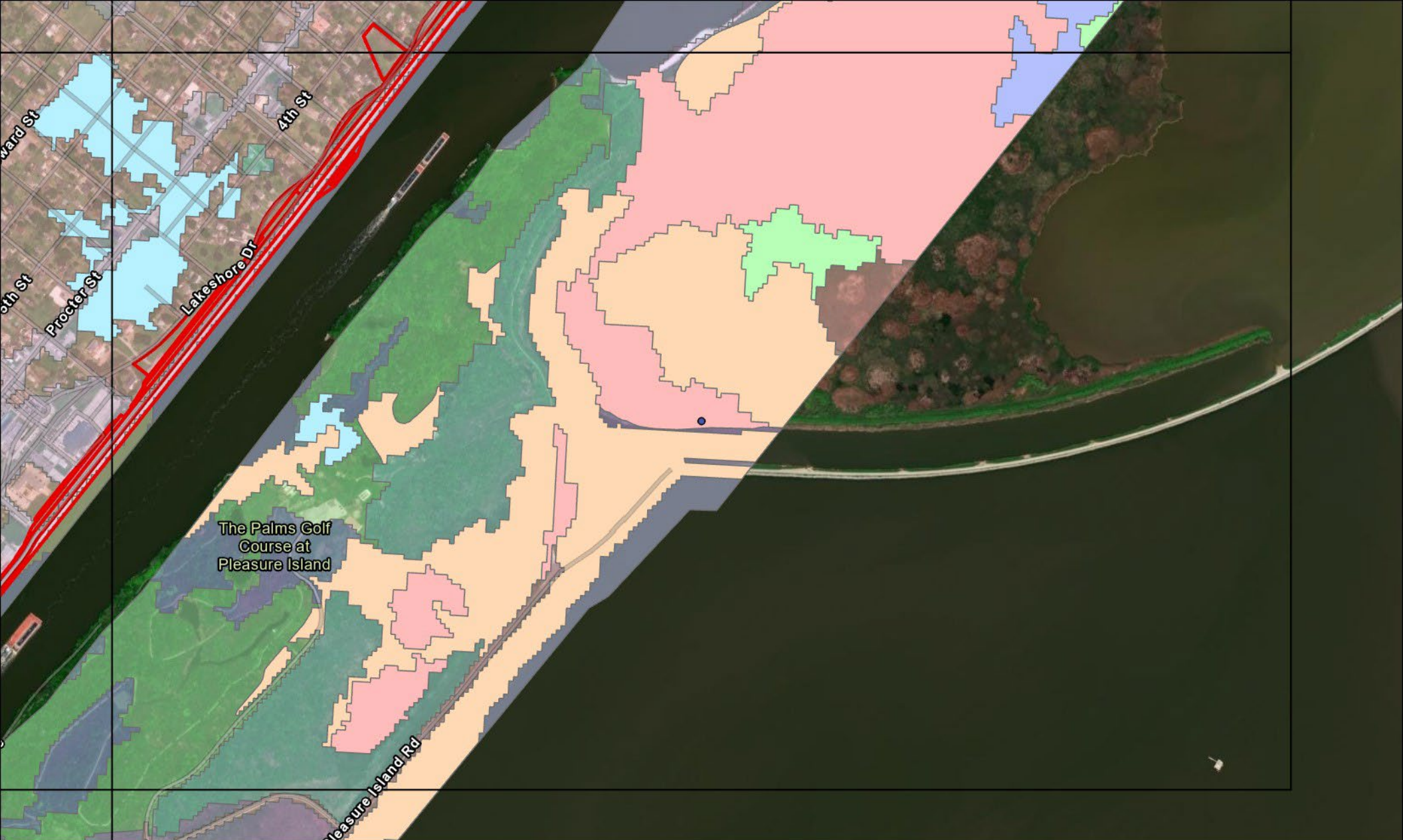


- Project Footprint
- Barren
- Chenier Plain: Salt and Brackish Low Tidal Marsh
- Grass Farm
- Gulf Coast: Coastal Prairie
- Gulf Coast: Coastal Prairie Pondshore
- Gulf Coast: Salty Prairie
- Non-Native Invasive: Chinese Tallow Forest, Woodland, or Shrubland
- Open Water
- Pineywoods: Disturbance or Tame Grassland
- Urban High Intensity
- Urban Low Intensity

GRID: 21

S2G-PAV



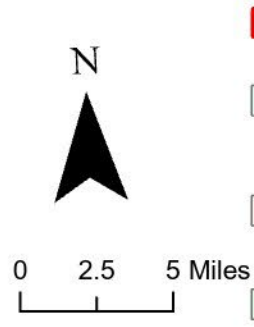
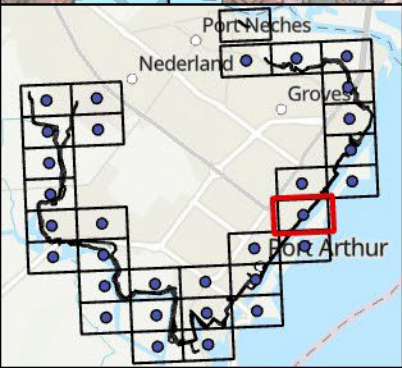
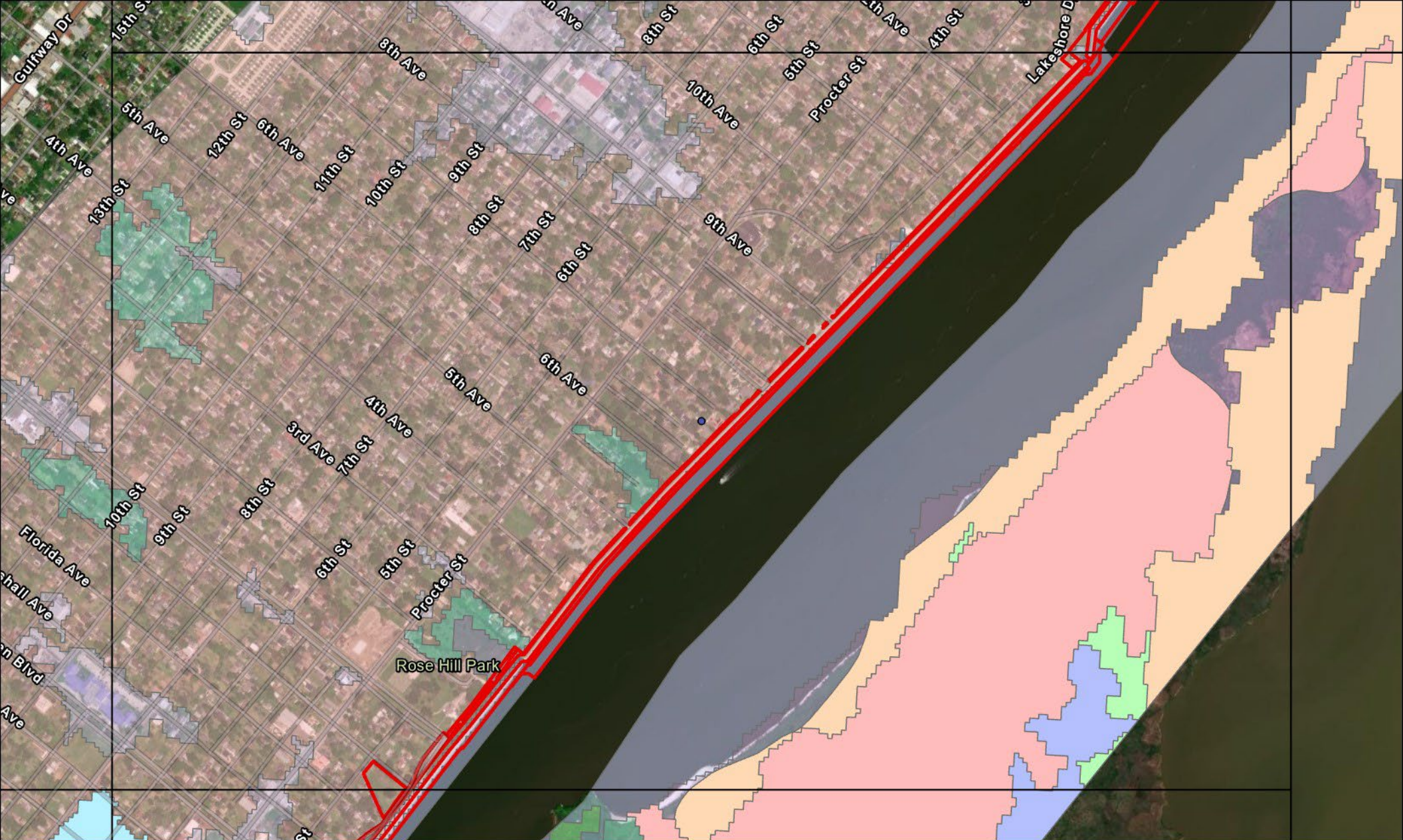


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|---|--|--|--|
| Project Footprint | Grass Farm | Native Invasive: Common Reed | Pinewoods: Disturbance or Tame Grassland |
| Chenier Plain: Hardwood Fringe Forest | Gulf Coast: Coastal Prairie | Native Invasive: Deciduous Woodland | Pinewoods: Pine Forest or Plantation |
| Chenier Plain: Salt and Brackish High Tidal Marsh | Gulf Coast: Coastal Prairie Pondshore | Non-Native Invasive: Chinese Tallow Forest, Woodland, or Shrubland | Urban High Intensity |
| Chenier Plain: Salt and Brackish Low Tidal Marsh | Gulf Coast: Near-Coast Baldcypress Swamp | Open Water | Urban Low Intensity |
| | Gulf Coast: Salty Prairie | | |

GRID: 22

S2G-PAV



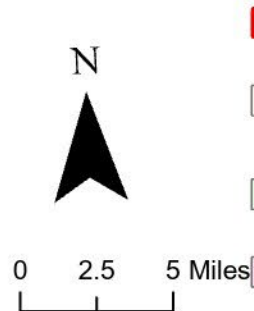
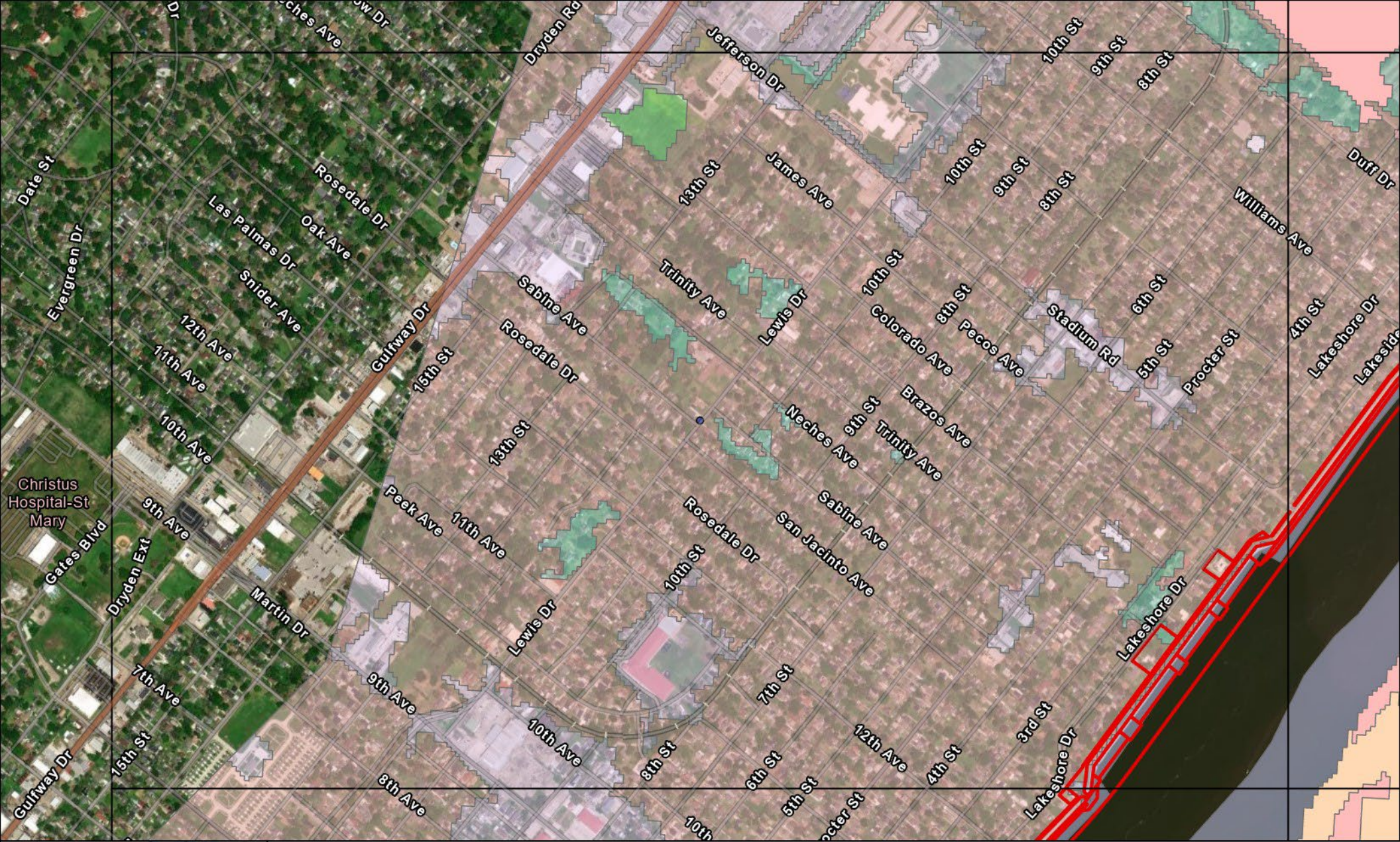


- Project Footprint
- Chenier Plain: Salt and Brackish High Tidal Marsh
- Chenier Plain: Salt and Brackish Low Tidal Marsh
- Gulf Coast: Coastal Prairie
- Gulf Coast: Coastal Prairie Pondshore
- Gulf Coast: Near-Coast Baldcypress Swamp
- Gulf Coast: Salty Prairie
- Native Invasive: Common Reed
- Non-Native Invasive: Chinese Tallow Forest, Woodland, or Shrubland
- Open Water
- Pineywoods: Pine Forest or Plantation
- Urban High Intensity
- Urban Low Intensity

GRID: 23

S2G-PAV



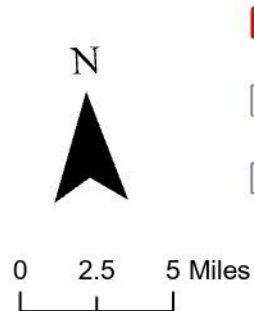
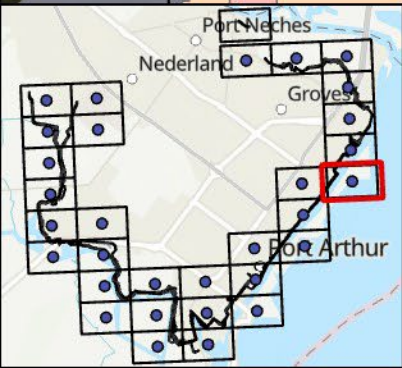
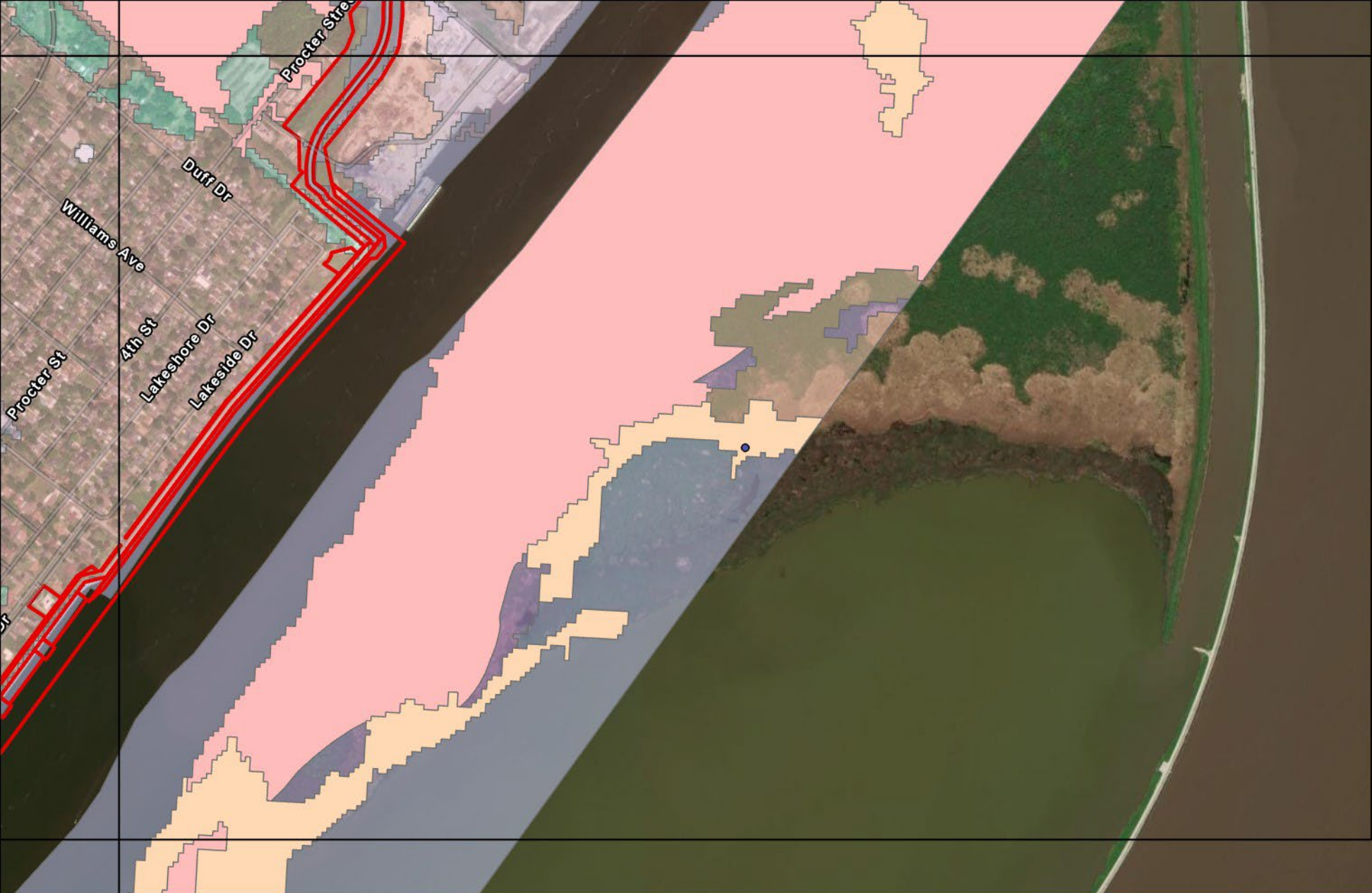


- Project Footprint
- Chenier Plain: Salt and Brackish Low Tidal Marsh
- Gulf Coast: Coastal Prairie
- Native Invasive: Common Reed
- Non-Native Invasive: Chinese Tallow Forest, Woodland, or Shrubland
- Open Water
- Urban High Intensity
- Urban Low Intensity

GRID: 24

S2G-PAV





- Project Footprint
- Chenier Plain: Salt and Brackish Low Tidal Marsh
- Gulf Coast: Salty Prairie

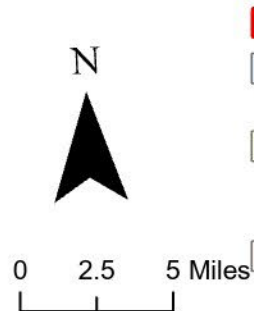
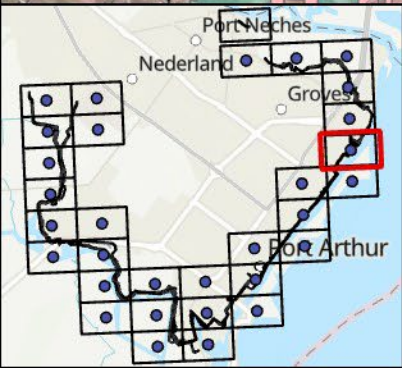
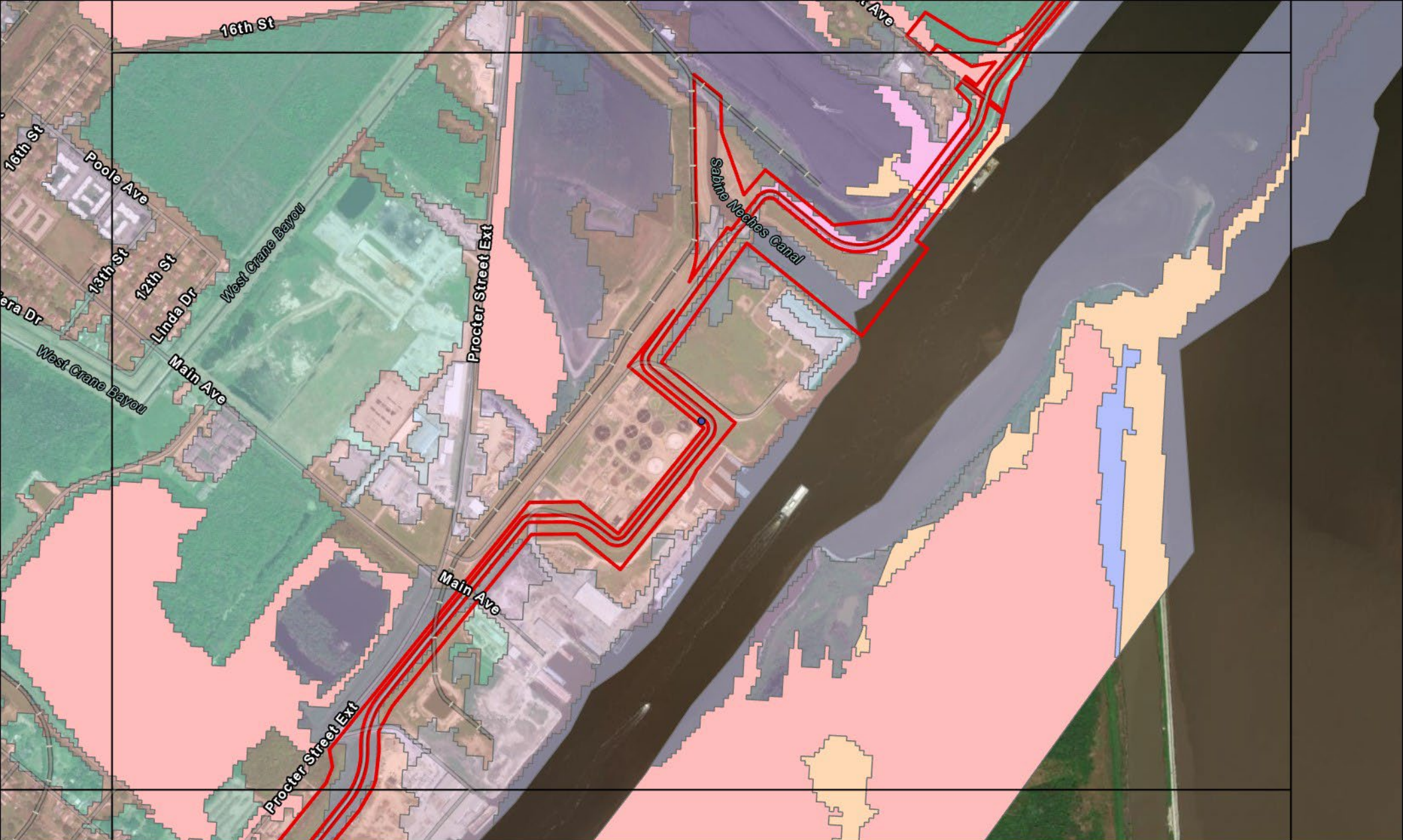
- Native Invasive: Common Reed
- Native Invasive: Deciduous Woodland
- Non-Native Invasive: Chinese Tallow Forest, Woodland, or Shrubland

- Open Water
- Pineywoods: Pine Forest or Plantation
- Urban High Intensity
- Urban Low Intensity

GRID: 25

S2G-PAV



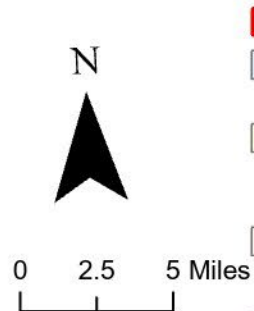
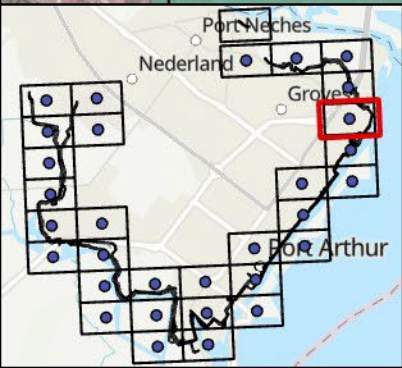
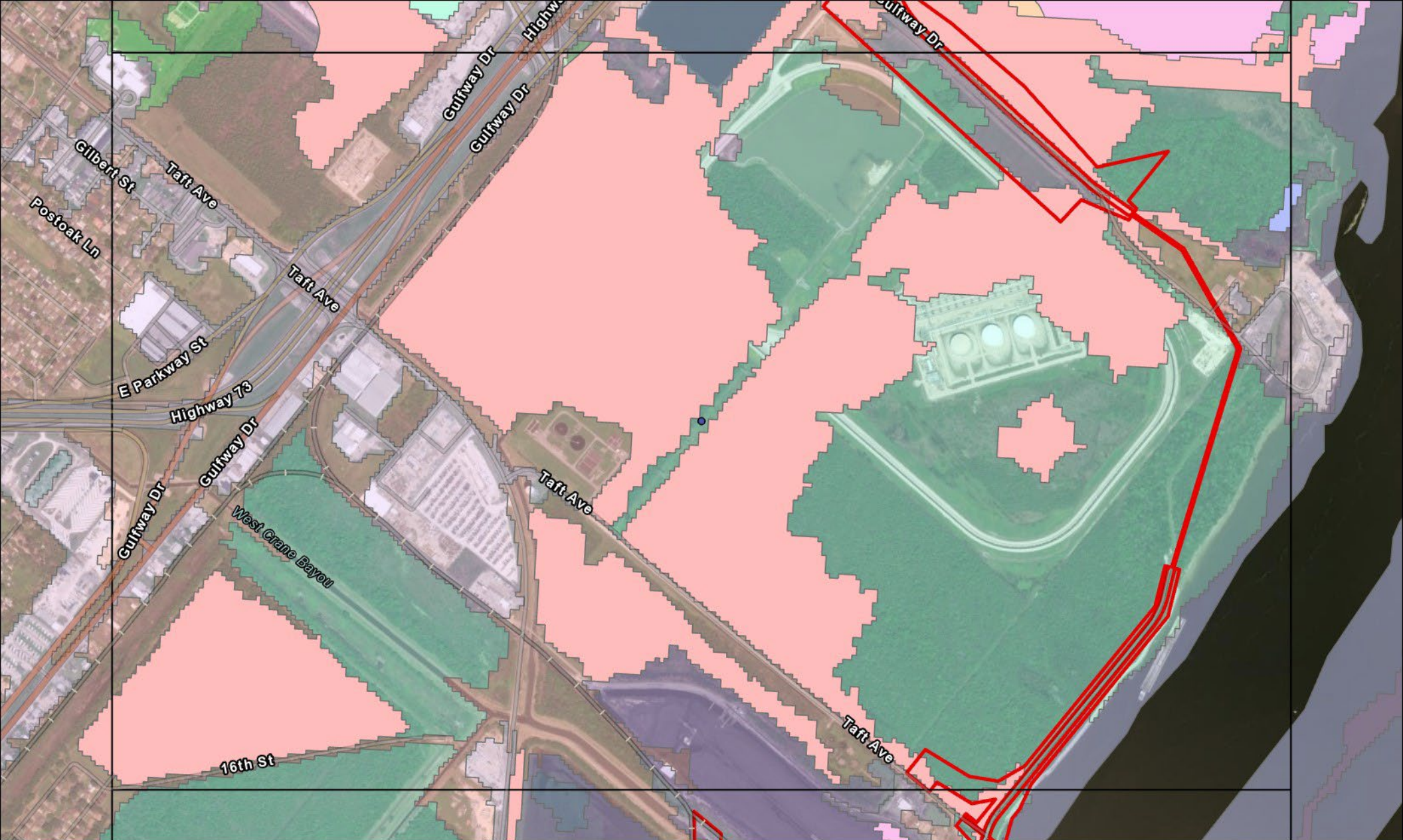


- Project Footprint
- Barren
- Chenier Plain: Fresh and Intermediate Tidal Marsh
- Chenier Plain: Salt and Brackish Low Tidal Marsh
- Gulf Coast: Near-Coast Baldcypress Swamp
- Gulf Coast: Salty Prairie
- Native Invasive: Common Reed
- Non-Native Invasive: Chinese Tallow Forest, Woodland, or Shrubland
- Open Water
- Urban High Intensity
- Urban Low Intensity

GRID: 26

S2G-PAV



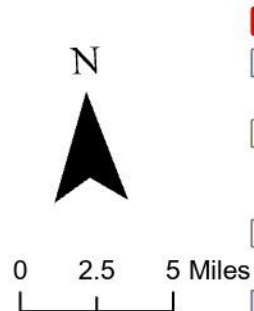
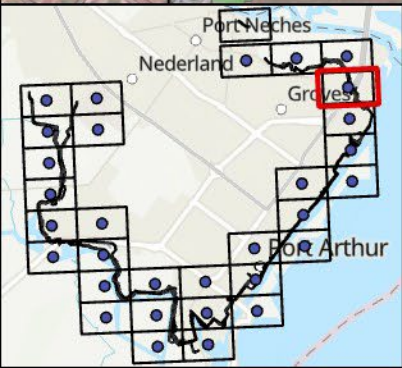
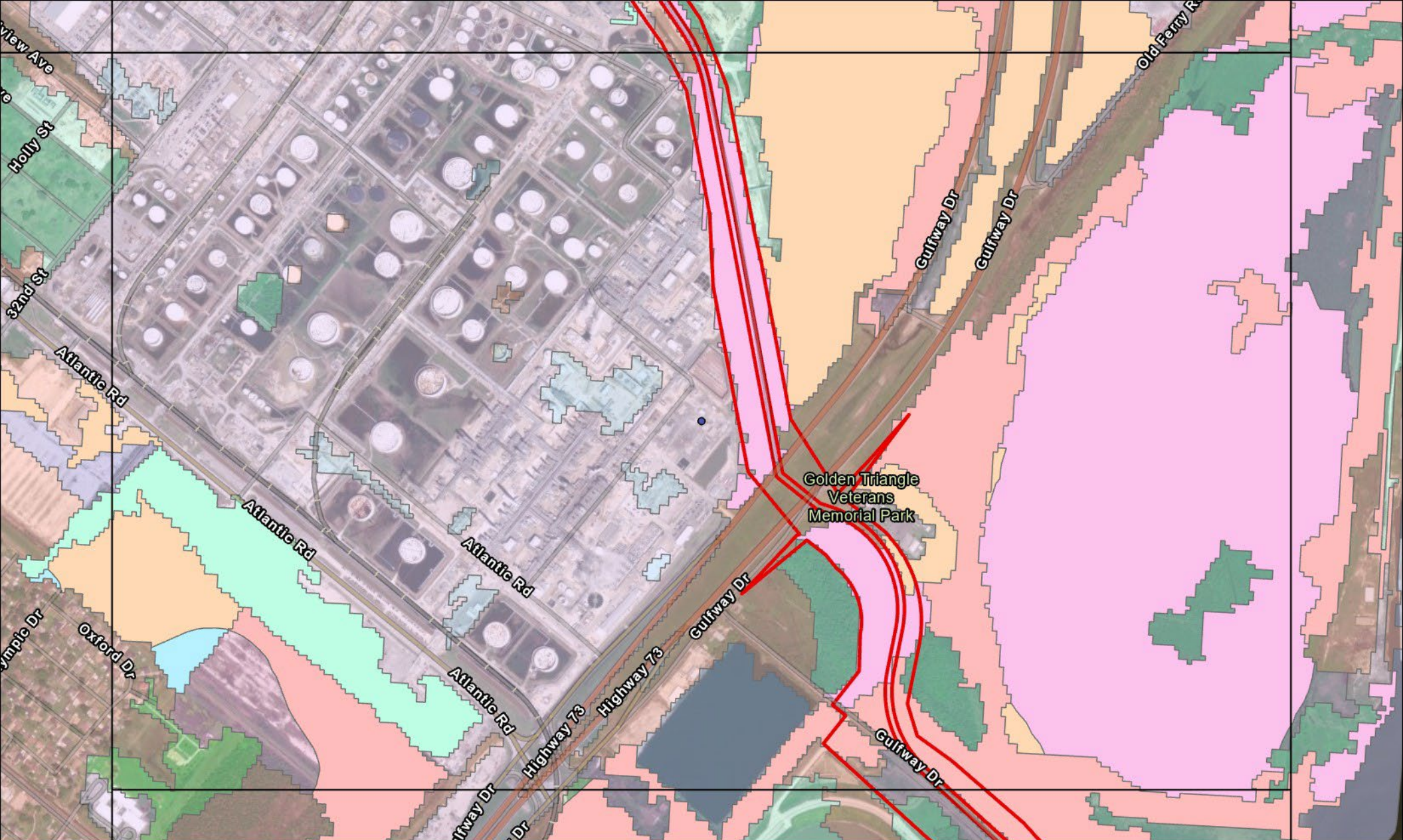


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|---|------------------------------------|--|--|
| Project Footprint | Barren | Gulf Coast: Near-Coast Baldcypress Swamp | Non-Native Invasive: Chinese Tallow Forest, Woodland, or Shrubland |
| Chenier Plain: Fresh and Intermediate Tidal Marsh | Gulf Coast: Salty Prairie | Gulf Coast: Salty Prairie | Open Water |
| Chenier Plain: Salt and Brackish Low Tidal Marsh | Mud Flat | Native Invasive: Common Reed | Pine Plantation > 3 meters tall |
| Gulf Coast: Coastal Prairie | Native Invasive: Juniper Shrubland | Urban High Intensity | Urban Low Intensity |

GRID: 27

S2G-PAV



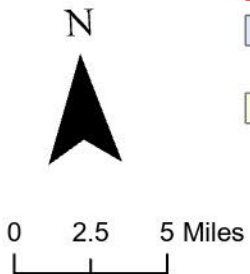
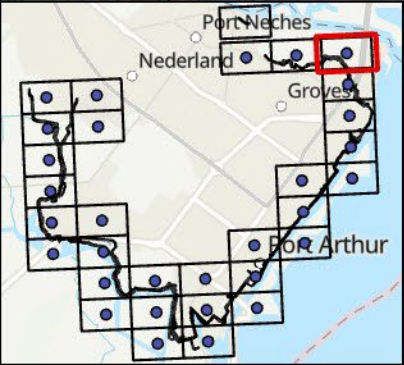
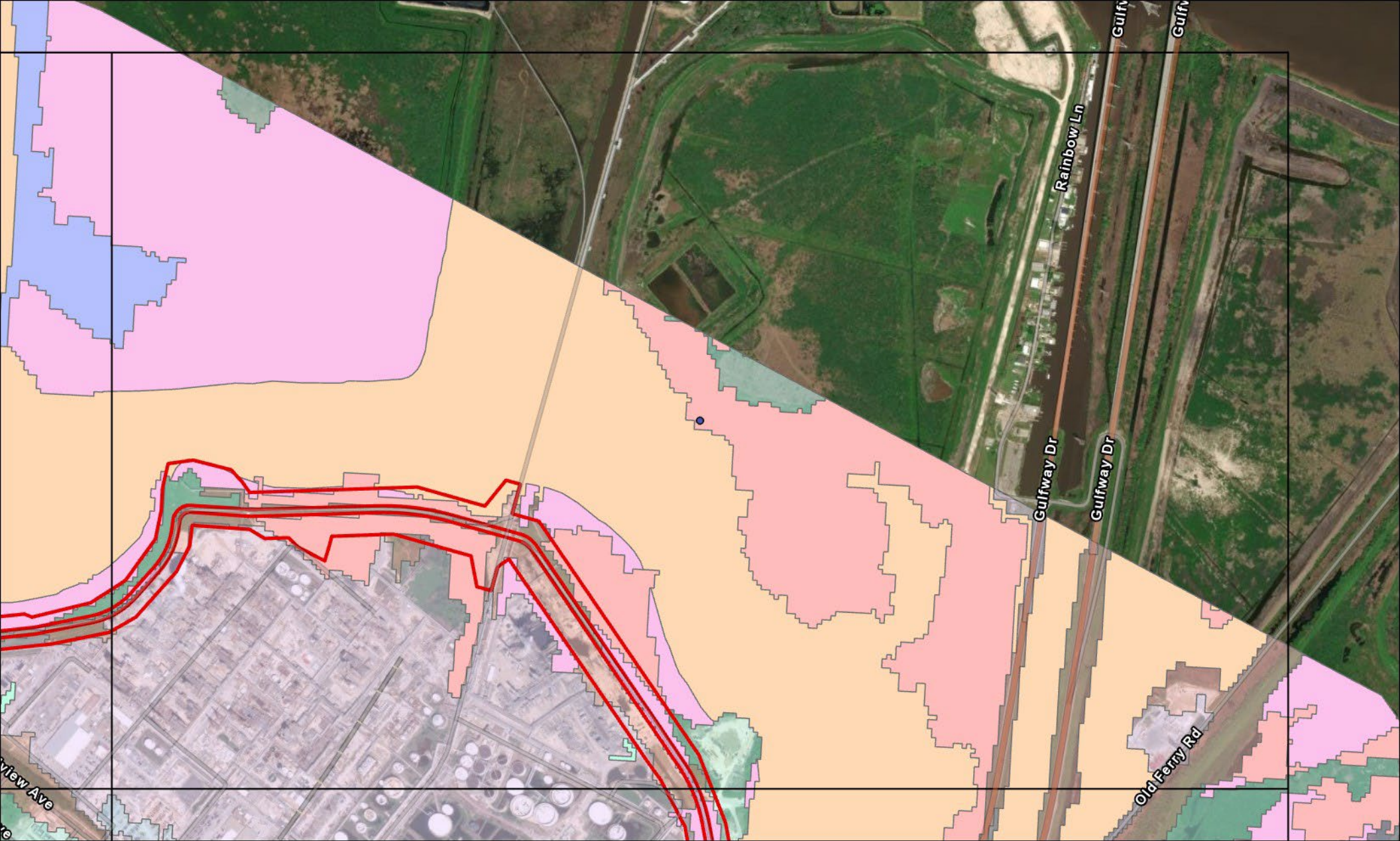


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|---|---------------------------------------|--|
| Project Footprint | Gulf Coast: Coastal Prairie | Non-Native Invasive: Chinese Tallow Forest, Woodland, or Shrubland |
| Barren | Gulf Coast: Coastal Prairie Pondshore | Open Water |
| Chenier Plain: Fresh and Intermediate Tidal Marsh | Gulf Coast: Salty Prairie | Pine Plantation > 3 meters tall |
| Chenier Plain: Salt and Brackish Low Tidal Marsh | Mud Flat | Urban High Intensity |
| Grass Farm | Native Invasive: Common Reed | Urban Low Intensity |
| | Native Invasive: Juniper Shrubland | |

GRID: 28

S2G-PAV






 Project Footprint


 Barren

 Chenier Plain: Fresh and Intermediate Tidal Marsh


 Chenier Plain: Salt and Brackish Low Tidal Marsh

 Gulf Coast: Near-Coast Baldcypress Swamp


 Gulf Coast: Salty Prairie

 Mud Flat

 Native Invasive: Common Reed

 Non-Native Invasive: Chinese Tallow Forest, Woodland, or Shrubland

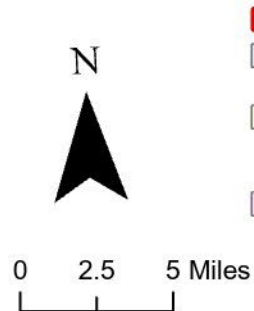
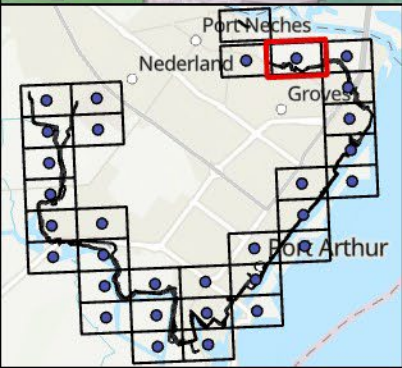
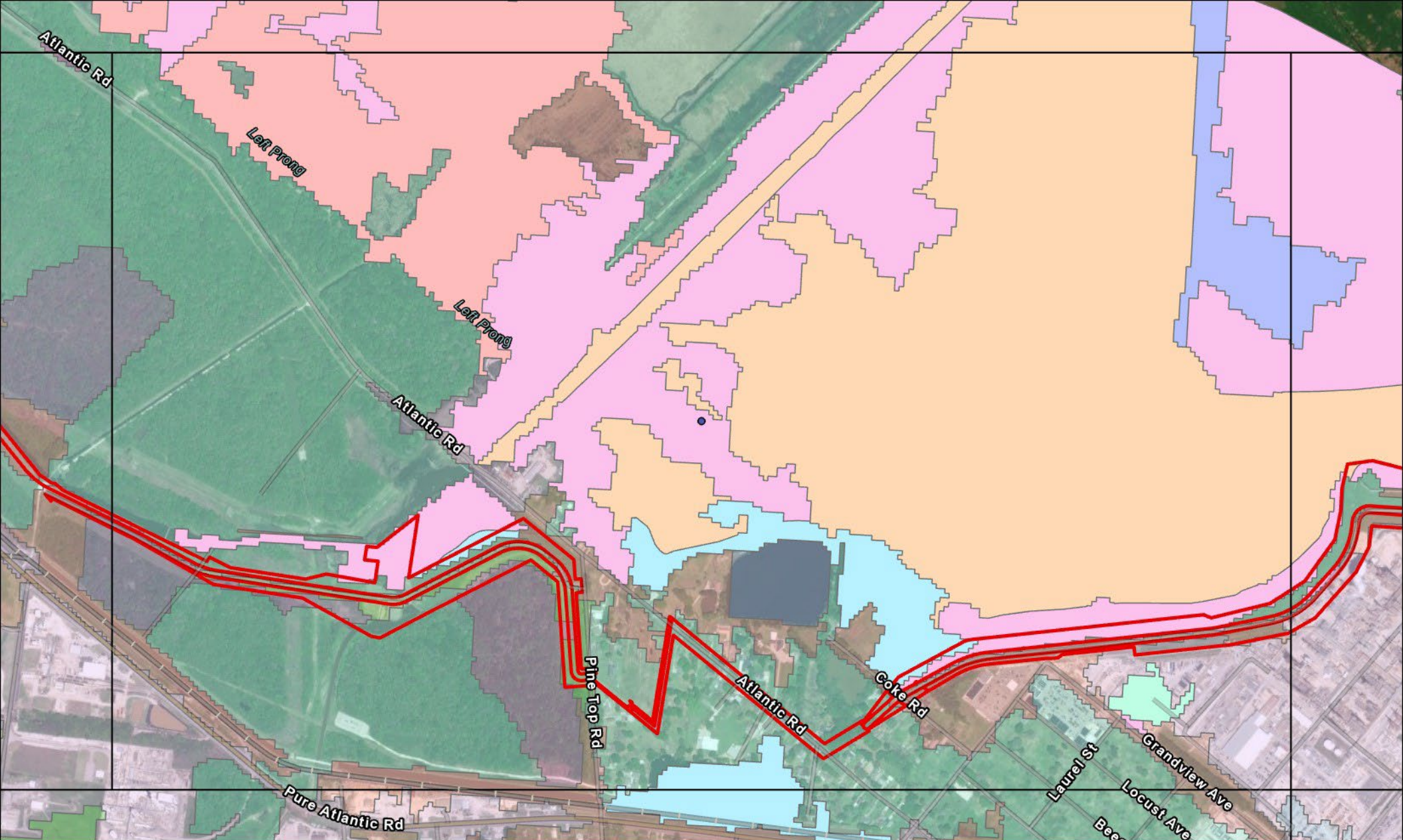
 Urban High Intensity

 Urban Low Intensity

GRID: 29

S2G-PAV



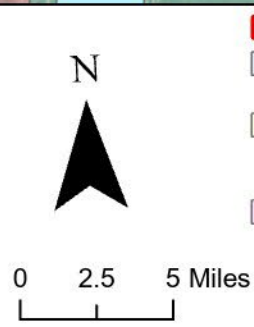
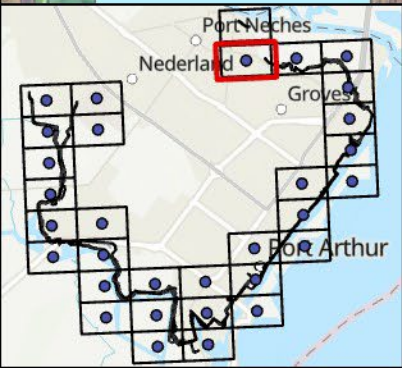
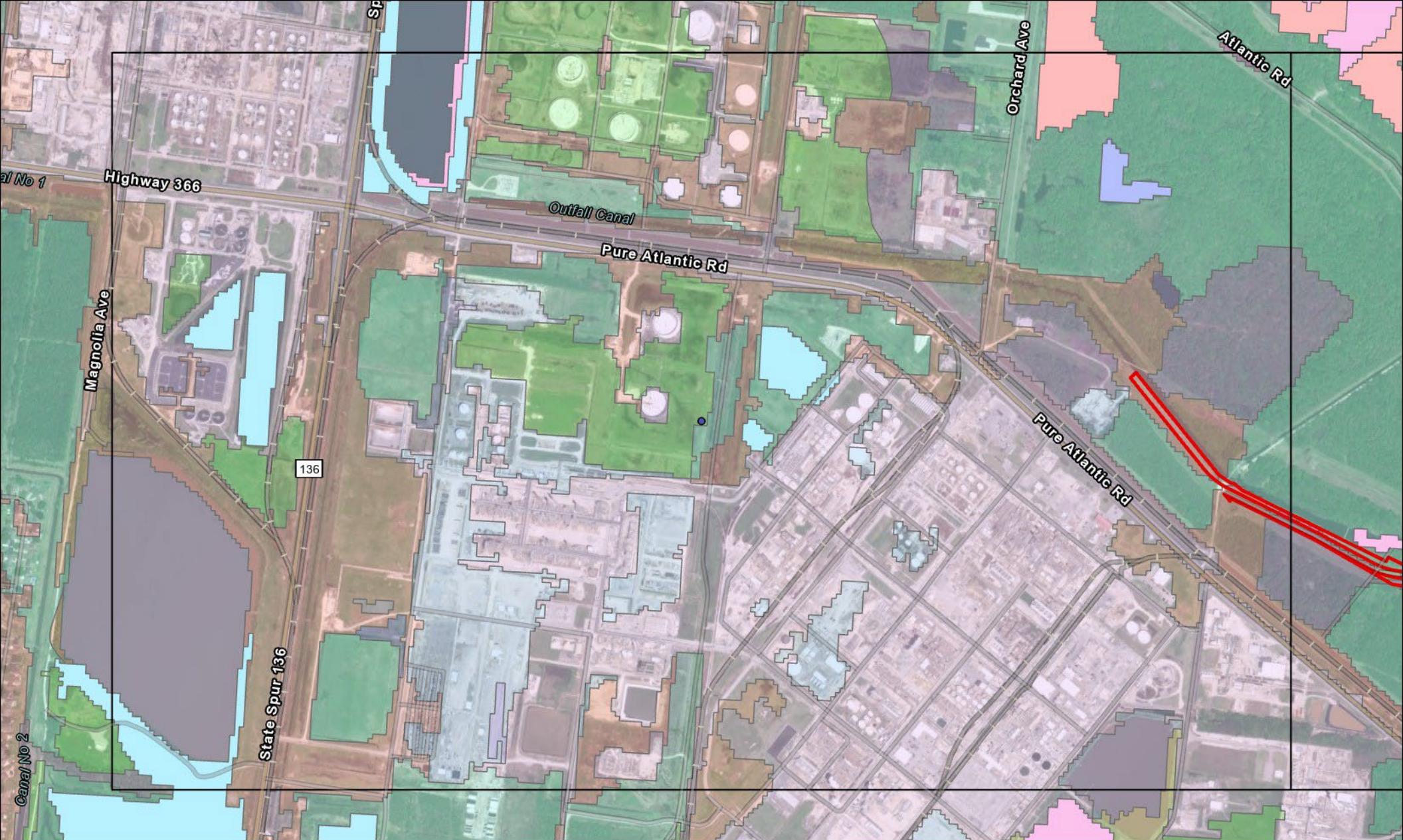


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|--|--|--|--|---|
| Project Footprint | Barren | Chenier Plain: Salt and Brackish Low Tidal Marsh | Gulf Coast: Salty Prairie | Open Water |
| Chenier Plain: Fresh and Intermediate Tidal Marsh | Gulf Coast: Coastal Prairie | Mud Flat | Native Invasive: Common Reed | Pine Plantation > 3 meters tall |
| Chenier Plain: Mixed Live Oak - Deciduous Hardwood Fringe Forest | Gulf Coast: Coastal Prairie Pondshore | Native Invasive: Deciduous Woodland | Non-Native Invasive: Chinese Tallow Forest, Woodland, or Shrubland | Pineywoods: Disturbance or Tame Grassland |
| | Gulf Coast: Near-Coast Baldcypress Swamp | | | Urban High Intensity |
| | | | | Urban Low Intensity |

GRID: 30

S2G-PAV



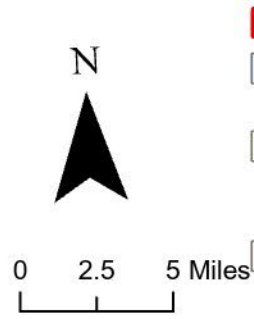
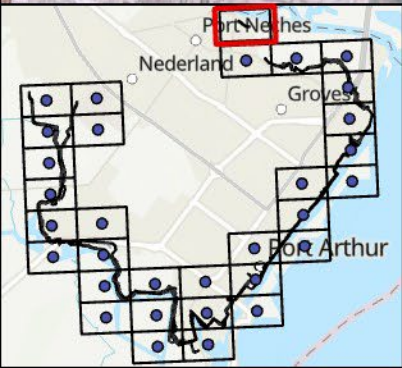
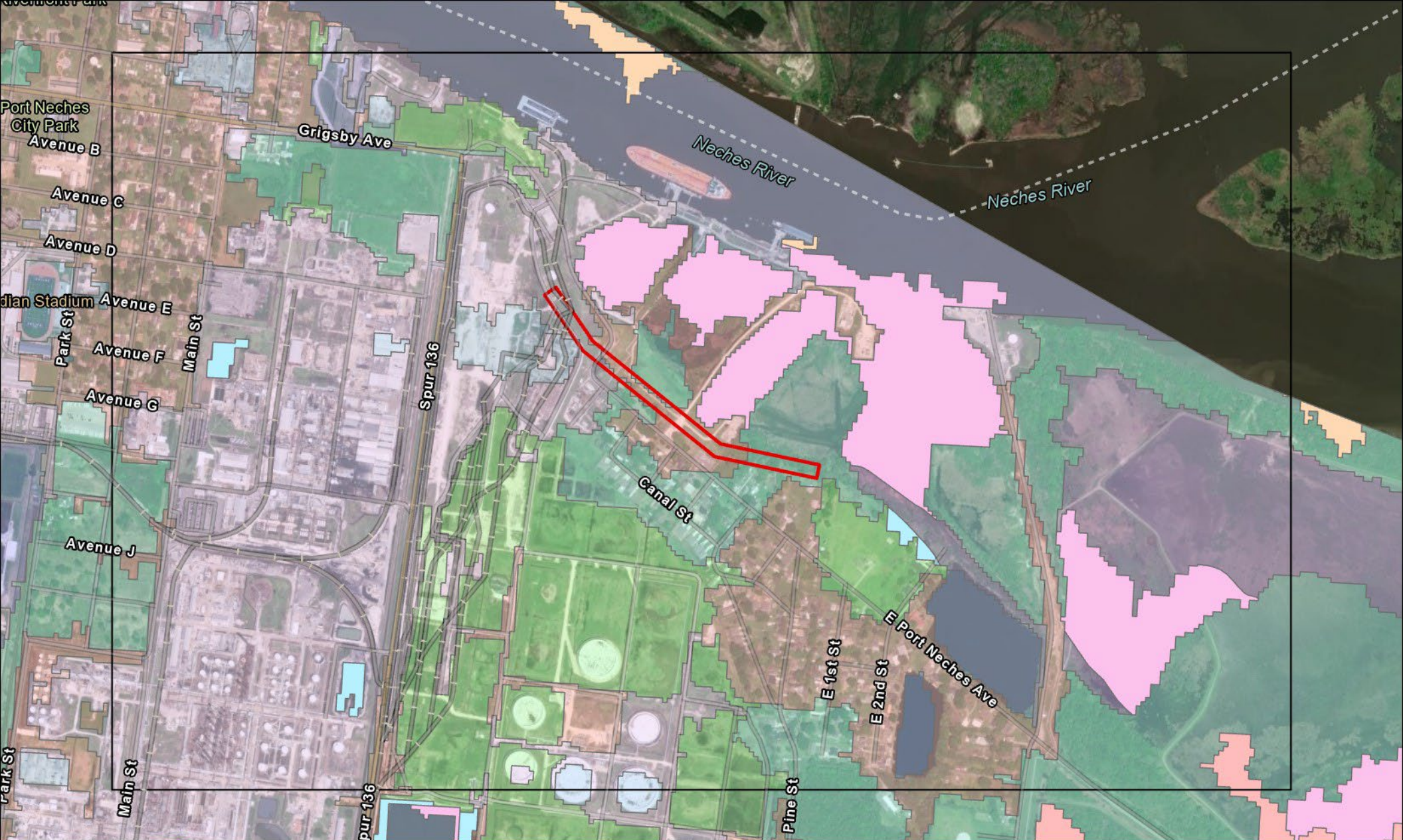


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|--|--|--|--|
| Project Footprint | Grass Farm | Native Invasive: Common Reed | Pinewoods: Disturbance or Tame Grassland |
| Barren | Gulf Coast: Coastal Prairie | Native Invasive: Deciduous Woodland | Urban High Intensity |
| Chenier Plain: Fresh and Intermediate Tidal Marsh | Gulf Coast: Coastal Prairie Pondshore | Non-Native Invasive: Chinese Tallow Forest, Woodland, or Shrubland | Urban Low Intensity |
| Chenier Plain: Mixed Live Oak - Deciduous Hardwood Fringe Forest | Gulf Coast: Near-Coast Baldcypress Swamp | Open Water | |
| | Gulf Coast: Salty Prairie | | |

GRID: 31

S2G-PAV





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|---|---------------------------------------|--|
| Project Footprint | Grass Farm | Non-Native Invasive: Chinese Tallow Forest, Woodland, or Shrubland |
| Barren | Gulf Coast: Coastal Prairie | Open Water |
| Chenier Plain: Fresh and Intermediate Tidal Marsh | Gulf Coast: Coastal Prairie Pondshore | Urban High Intensity |
| Chenier Plain: Salt and Brackish Low Tidal Marsh | Gulf Coast: Salty Prairie | Urban Low Intensity |
| | Native Invasive: Common Reed | |

GRID: 32

S2G-PAV





**US Army Corps
of Engineers**®
Galveston District

APPENDIX A: ATTACHMENT 2 S2G PAV HABITAT MODELS & ACREAGE

Row Labels	Sum of Acres	Habitat Model
Barren	0.002238	
Chenier Plain: Fresh and Intermediate Tidal Marsh	66.014559	freshwater marsh
Chenier Plain: Fresh and Intermediate Tidal Marsh (Changed)	4.897608	freshwater marsh
Chenier Plain: Salt and Brackish Low Tidal Marsh	2.422717	freshwater marsh
Disturbed Area (Changed)	5.108528	
Gulf Coast: Coastal Prairie	41.479807	meadowlark
Gulf Coast: Coastal Prairie Pondshore	13.460285	
Gulf Coast: Salty Prairie	62.028563	
Manmade Structure (Changed)	0.857311	
Marsh	6.103372	freshwater marsh
Native Invasive: Common Reed	24.564065	freshwater marsh
Native Invasive: Deciduous Woodland	1.604623	
Native Invasive: Juniper Shrubland	1.298172	
Non-Native Invasive: Chinese Tallow Forest, Woodland, or Shrubl	67.181258	
Open Water	173.044092	
Open Water (Changed)	20.097002	
Open Water: Gulf Coast Mixing Zone	10.608615	
Pine Plantation > 3 meters tall	0.171707	
Pine Plantation 1 to 3 meters tall	0.588997	
Pineywoods: Disturbance or Tame Grassland	1.856858	
Pineywoods: Pine Forest or Plantation	1.080315	
Pineywoods: Small Stream and Riparian Herbaceous Wetland	1.263647	
Pineywoods: Small Stream and Riparian Wet Prairie	0.346901	
Row Crops	25.863292	
Urban High Intensity	24.245843	
Urban Low Intensity	52.379094	
Grand Total	608.569469	
Total Mitigatable	122.528611	

Coastal Prairie Eastern Meadowlark Model

Condition	Measure	Location	Cover Type	Model	Target Year	Acres	V1	V2	V3	V4	V5	HSI	HUs	CHUs	AAHUs		
FWOP	All S2G-PAV	All S2G-PAV	Coastal Prairie	EAME	0	42	95	65	30.48	0	0	0.87	36				
				EAME	1	42	95	65	30.48	0	0	0.87	36	36			
				EAME	5	42	95	65	30.48	0	0	0.87	36	146			
				EAME	10	42	95	65	30.48	0	0	0.87	36	182			
				EAME	25	42	95	65	30.48	0	0	0.87	36	546			
				EAME	50	42	95	65	30.48	0	0	0.87	36	911			
													1821	36			
Condition	Measure	Location	Cover Type	Model	Target Year	Acres	V1	V2	V3	V4	V5	HSI	HUs	CHUs	AAHUs		
FWP	All S2G-PAV	All S2G-PAV	Coastal Prairie	EAME	0	42	20	100	7.62	0	0	0.00	0				
				EAME	1	42	20	100	7.62	0	0	0.00	0	0			
				EAME	5	42	20	100	7.62	0	0	0.00	0	0			
				EAME	10	42	20	100	7.62	0	0	0.00	0	0			
				EAME	25	42	20	100	7.62	0	0	0.00	0	0			
				EAME	50	42	20	100	7.62	0	0	0.00	0	0			
														0	0		
														Result	-36		
Condition	Measure	Location	Cover Type	Model	Target Year	Acres	V1	V2	V3	V4	V5	HSI	HUs	CHUs	AAHUs		
FWOP- Mitigation Site	All S2G-PAV	All S2G-PAV	Coastal Prairie	EAME	0	60	20	20	7.62	60	40	0.00	0				
				EAME	1	60	20	20	7.62	60	40	0.00	0	0			
				EAME	5	60	20	20	7.62	60	40	0.00	0	0			
				EAME	10	60	20	20	7.62	60	40	0.00	0	0			
				EAME	25	60	20	20	7.62	60	40	0.00	0	0			
				EAME	50	60	20	20	7.62	60	40	0.00	0	0			
														0	0		
Condition	Measure	Location	Cover Type	Model	Target Year	Acres	V1	V2	V3	V4	V5	HSI	HUs	CHUs	AAHUs		
FWP- Mitigation Site	All S2G-PAV	All S2G-PAV	Coastal Prairie	EAME	0	60	20	20	7.62	60	40	0.00	0				
				EAME	1	60	40	40	15	60	10	0.11	7	3			
				EAME	5	60	80	60	30	30	10	0.63	38	90			
				EAME	10	60	80	60	30	30	10	0.63	38	189			
				EAME	25	60	80	60	30	30	10	0.63	38	568			
				EAME	50	60	80	60	30	30	10	0.63	38	947			
														1798	36		
														Result	36		
						Target Acres											
						60	of habitat restoration to offset Coastal Prairie habitat loss										

Freshwater WVA Model

Measure	Location	Cover Type	Model	Target Year	Acres	HSI	HUs	CHUs	AAHUs
All S2G-PAV	All S2G-PAV	Freshwater Marsh	Fresh WVA	0	104	0.31	32		
			Fresh WVA	1	104	0.31	32	32	
			Fresh WVA	5	104	0.56	58	181	
			Fresh WVA	10	104	0.56	58	291	
			Fresh WVA	25	104	0.56	58	874	
			Fresh WVA	50	104	0.56	58	1456	
							2834	57	
Measure	Location	Cover Type	Model	Target Year	Acres	HSI	HUs	CHUs	AAHUs
All S2G-PAV	All S2G-PAV	Freshwater Marsh	Fresh WVA	0	104	0.31	32		
			Fresh WVA	1	74	0.20	15	23	
			Fresh WVA	5	74	0.20	15	59	
			Fresh WVA	10	74	0.20	15	74	
			Fresh WVA	25	74	0.20	15	222	
			Fresh WVA	50	74	0.20	15	370	
							0	0	
							Result	-57	
Measure	Location	Cover Type	Model	Target Year	Acres	HSI	HUs	CHUs	AAHUs
All S2G-PAV	All S2G-PAV	Freshwater Marsh	Fresh WVA	0	170	0.20	34		
			Fresh WVA	1	170	0.20	34	34	
			Fresh WVA	5	170	0.20	34	136	
			Fresh WVA	10	170	0.20	34	170	
			Fresh WVA	25	170	0.20	34	510	
			Fresh WVA	50	170	0.20	34	850	
							1700	34	
Measure	Location	Cover Type	Model	Target Year	Acres	HSI	HUs	CHUs	AAHUs
All S2G-PAV	All S2G-PAV	Freshwater Marsh	Fresh WVA	0	170	0.00	0		
			Fresh WVA	1	170	0.10	17	9	
			Fresh WVA	5	170	0.20	34	102	
			Fresh WVA	10	170	0.60	102	340	
			Fresh WVA	25	170	0.60	102	1530	
			Fresh WVA	50	170	0.60	102	2550	
							4531	90.61	
							Result	57	
					Target Acres				
					170				of habitat restoration to offset Freshwater Marsh habitat loss