



ENGINEERING REPORT

MIDLAND COUNTY MONAHANS AND SOUTH DRAW INTERIM FLOOD PLANNING FRAMEWORK

Midland County, Texas



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TABLE OF CONTENTS

1.0 EXECUTIVE SUMMARY 1
 1.1 Purpose 1
 1.2 **Interim Flood Planning Framework**..... 1

2.0 DESCRIPTION OF DRAINAGE AND FLOODING CONCERNS 1
 2.1 Playa Drainage 2
 2.2 Drainage in Draws 2
 2.3 Impact of Interstate 20 3

3.0 BASIS OF FLOOD RISK FOR THIS REPORT 4

4.0 GENERAL PRINCIPLES FOR DRAINAGE AND FLOOD REDUCTION 4
 4.1 Floodway Easements 5
 4.2 Playa and Caliche Easements 5
 4.3 Playa Overflow Easements 6
 4.4 Use of Future Condition Flooding Estimates 7
 4.5 Resolving Playa Flooding Issues 8
 4.6 Limited Chanelization 8

5.0 SPECIFIC RECOMMENDATIONS 9
 5.1 **Panel A** 9
 5.2 **Panel B** 9
 5.3 **Panel C** 10
 5.4 **Panel D** 10
 5.5 Panel E 10
 5.6 **Panel F** 10
 5.7 **Panel G** 11
 5.8 **Panel H** 12
 5.9 **Panel I** 12

TABLE OF CONTENTS (continued)

6.0 IMPLEMENTATION13

EXHIBITS

- EXHIBIT A: WEST FLOOD FACTOR MAP
- EXHIBIT B: EAST FLOOD FACTOR MAP
- EXHIBIT C: INTERIM FLOOD PLANNING PANEL INDEX

INTERIM FLOOD PLANNING PANELS
PANELS A-I

1.0 EXECUTIVE SUMMARY

1.1 PURPOSE

Midland County was awarded a grant by Texas Water Development Board (TWDB) in early 2021. This grant funds an analysis of flood risks expected after nearly full development of the Monahans and South Draws south of Interstate 20.

TWDB is also managing a statewide flood planning process, intended to identify and prioritize flood reduction projects in all regions. Our efforts will assist TWDB in their process and possibly make some local projects eligible for state funding.

A key end product for the study is intended to be GIS mapping of future risk zones with a great deal more accuracy than the current FEMA floodplain maps. These maps will assist the County in reviewing and approving developments in the next few decades, and in targeting funds for resolving flooding and drainage issues. Identification of drainage solutions for a few locations is also included in the scope.

1.2 INTERIM FLOOD PLANNING FRAMEWORK

Two factors have combined to make identification of drainage solutions more urgent than originally expected: TxDOT I-20 design schedules and 2021 summer rainfall. This Report is a response to the need to establish a direction for future infrastructure planning in advance of the study completion.

A major element of the project scope is to coordinate with TxDOT and the cities of Odessa and Midland on drainage and floodplain issues that exist now or are anticipated. Because TxDOT plans full reconstruction of I-20 in Midland County over the next few years and plans are being prepared now, Midland County needs to provide an adopted plan that TxDOT can rely on as a framework for planning their own drainage infrastructure.

In addition, flooding events during June/July 2021 revealed a need for a coordinated response that can diminish the likelihood of future flooding and prevent new flood-prone development from occurring. This Report establishes general principles that can be used by County staff in coordinating with private individuals as well as local cities and TxDOT.

When the full grant study is complete, this Report will be replaced with a more detailed document providing more specific guidance for adjacent jurisdictions and for the County's internal use.

The Flood Planning Framework panels show a desirable outcome for several decades of infrastructure planning. The implementation section at the end of this Report discusses how the Report can be used.

2.0 DESCRIPTION OF DRAINAGE AND FLOODING CONCERNS

Midland County drainage is characterized by playas and draws. The Monahans and South Draw watersheds are split north and south by Interstate 20, which acts as a dam that allows water through in specific locations. Each of these factors has consequences that requires differing responses.

2.1 PLAYA DRAINAGE

Most of the land in Midland County drains to playas, dry lake closed basins that fill and then dry through evaporation and infiltration. Playas vary in depth and size, typically very shallow up to around 20 feet deep. The largest one in Midland County is around 1,700 acres, but most are less than 100 acres. Our study area has at least 210 playas in it. Some playas have enough area that drains to them that they can fill and overflow, creating a chain of ponded areas connected by flowing water during storms. South Draw is actually a chain of playas.

Landowners may not realize the flooding potential of playas, and place structures and roadways within them that later are damaged. Landowners may also attempt to fill playas, resulting in displacement of flood waters onto adjacent property in later rains. Overflow routes rarely carry any water, and there is a tendency to place buildings and other obstructions in them.

As development occurs, paved, roofed or smoothly graded areas replace farm and ranch land. Typically, the result is decreased ability for rainfall to soak into the developed area and more runoff leaving the site. If the site drains to a playa, it will fill to a greater depth than it did previously, and it will fill more frequently.

A large portion of eastern Odessa drains through playas and channels on the two Odessa Country Club golf courses and then into a playa in unincorporated Midland County, which was the location of significant flooding in 2021. This playa system is an example of increasing impacts due to urbanization of the watershed.

2.2 DRAINAGE IN DRAWS

Draws in Midland County are generally dry, poorly defined channels that are sometimes hard to see from the ground, best identified by darker, thicker vegetation patterns on aerial photographs. They do not have steep banks or permanent flow.

Monahans Draw is the chief drainage feature south of Midland and Odessa. It captures all of the runoff from Odessa and from many of most quickly developing areas in unincorporated Midland County. Because of urban runoff, it has more frequent wet periods than purely undeveloped West Texas draws such as Johnson Draw further south in Midland County.

South Draw, the other subject of the grant study, drains about two square miles of southeast Midland through a playa that now contains water almost all of the time, the I-20 Nature Preserve, then across I-20 and into rural subdivisions in unincorporated Midland County. As a chain of playas with connecting overflow routes, some areas of the draw will have flowing water and others will simply capture it. Several caliche pits along the draw are functioning as retention basins and reducing the flooding potential.

Again, landowners are often unaware of the flooding potential along draws in Midland County. Our arid region and flat terrain absorb most rainfalls, so flow in the draw is not a regular occurrence. Buildings and roads might be placed in the draw with no flooding observed for several years.

Developments in areas that drain directly to a draw without passing through a playa will have less impact than developments that drain to playas, because the runoff can flow away. Although there will be more runoff, because the draws are flat and wide, it will spread out rather than up. However, in a watershed as large as Monahans Draw, with rapid development of the area between Midland and Odessa and areas south of I-20 expected, it is inevitable that observed flooding in Monahans Draw will increase.

2.3 IMPACT OF INTERSTATE 20

Interstate 20 forms a band across the watersheds of Monahans and South Draws. The main lanes are typically elevated higher than the adjacent natural ground, but the frontage roads are at the same level as natural ground. Culverts pierce the main lanes at low points, allowing flow to cross from north to south. The frontage roads are designed to flood on both ends of the culverts in all storm events.

The culverts were designed and installed for undeveloped runoff, and as development has occurred, they are increasingly undersized. This means that large storms can create ponding north of the interstate as water waits for a chance to flow under the main lanes, or in some cases, the north frontage road functions as a ditch carrying runoff to the next low point.

Inadequate cross drainage is exacerbated by the lack of ditches upstream and downstream of the cross-drainage culverts. TxDOT often obtains downstream easements to carry runoff from their highway into a nearby playa, but I-20 was constructed without such downstream outfalls for the most part.

As development has occurred, often fill has been placed on properties adjacent to the frontage roads near the culverts. On the north upstream ends, this means that water has only the frontage roads themselves to travel to get into the culvert, leading to access problems during rain events. On the south side, fill blocking the exit route from the frontage roads means water literally is trapped on TxDOT right-of-way. An example is in Midland east of Cotton Flat Road.

TxDOT is planning major upgrades to the interstate over several years. Plans are already mostly complete for some locations. Now is the time to coordinate with TxDOT to implement cross-drainage culverts that will function better on both sides, benefitting landowners, TxDOT and County and City operations. TxDOT wants to raise the frontage roads so they will not flood in smaller rains and increase the size of culverts under the main lanes.

Midland County has had several meetings with TxDOT and its consultants, requesting that TxDOT provide deeper culverts across the interstate in key locations where major flows are expected, and obtain drainage easements up and downstream of each culvert so ditches can funnel water into the cross-drainage culverts.

TxDOT has been receptive to these requests, but in order to comply with their own internal procedures, needs assurance that the downstream ditches will be continued and made a part of a drainage system. This Report serves that purpose.

3.0 BASIS OF FLOOD RISKS FOR THIS REPORT

Because there is a need to produce a drainage planning framework in advance of study completion, this Report relies on the best available information to guide selection of locations for drainage improvements. The available sources are:

- | Published Flood Insurance Study on Monahans Draw in Midland County.
- | HEC-RAS hydraulic model of South Draw for this study that is mostly complete.
- | ICPR hydrologic/hydraulic model of the watershed that passes through the Midland International Air and Space Port, partially completed for this study.
- | ICPR hydrologic/hydraulic model of the watershed generally on both sides of Faudree Road, partially completed for this study.
- | Flood Factor nationwide flood risk website.

The Flood Factor website is the source for Exhibit A and B in this Report. This data is considered more accurate for the playas because it distinguishes between shallow and deep playas. FEMA floodplain maps show many of the playas, but conservatively assume that they all fill. For the larger playas, this is probably an exaggeration. Flood Factor’s analysis, though rough, does indicate a lesser ponding extent for many of the larger playas.

The Flood Factor exhibits show chains of playas that overflow. This information is important because it indicates which locations need to be prioritized and will need defined outfall channels constructed.

4.0 GENERAL PRINCIPLES FOR DRAINAGE AND FLOOD REDUCTION

Every community needs to develop their own drainage approach that take into account the type of drainage present, the complicating factors, and the terrain. Summer 2021 flooding revealed the top problems in Midland County to be related to lack of positive drainage routes, and inadequate flow capacity in a few locations.

In general, it is less expensive to prevent a flooding situation than to resolve it. For this reason, FEMA requires communities that want to make federal flood insurance available to adopt damage prevention regulations. Midland County adopted these regulations in 1992.

The recommended guiding principles that will help Midland County resolve current problems and prevent new ones include:

- | Preventing flooding problems:
 - Protect floodways with easements.
 - Protect playa bottoms and caliche pits that capture flood waters.
 - Protect playa overflow routes with easements.
 - Use full development flood estimates to regulate structure elevations and easement widths.
- | Addressing existing flooding problems:
 - Connect ponding locations with constructed ditches or pipes to drain them without pumping, where flooding has been an issue.
 - Limited channelization projects.

4.1 FLOODWAY EASEMENTS

Monahans and South Draws are mapped in the Flood Insurance Study with *floodways*, the central portion of the stream where FEMA regulation prohibits any fill or buildings, or even solid fences that can block flow. This allows the outer parts of the floodplain area to be developed but still provides for adequate flow conveyance.

Governments often seek to reduce floodplain extents or offset development by deepening and widening channels in the floodways. These projects may be more challenging in Midland County due to the flat slopes. If we dig a ditch five feet deep in one location, we have to extend it downstream at an even flatter slope until we encounter natural ground that is low enough for it to drain out, or “daylight.” This explains why channels in Midland are up to ten feet deep on the west side of the City, but only three to five feet on the east side, where they are close to daylighting into the original draw.

Thus, channelization projects need to be long. Any new project to deepen a channel will encounter oil and gas pipelines, generally quite expensive to lower. For these reasons, channelization is not recommended as the first choice. Instead, it would be better to protect the floodways in their natural condition.

Until now Midland County has not been aware of the flood potential in some flow paths because they are not shown on FEMA flood maps. An example is a subdivision south of I-20 directly in the path of the major drainway that runs out of the airport. It is not shown as flood prone on floodplain maps, but Flood Factor maps show a hazard. Property owners quickly discovered that hazard after their lots and buildings flooded and have constructed small ditches and basins to compensate.

One goal of our grant study is to define floodways for all major flow paths, not just the two currently mapped ones. Once the floodways are identified, Midland County can require drainage easements that prohibit fill and buildings in those locations during plat review. We know most of the routes that will need floodways, and they are shown on the flood planning framework panels. The appropriate width of the floodway and width of easement to be dedicated is yet to be determined. Until the study is complete, the County can use a best estimate for any new subdivisions on those routes.

Admittedly not all developments even come to the County for review, so floodway easements are not a full solution. However, it will be beneficial for the County to adopt a principle that major drainways need floodways and drainage easements their full length.

4.2 PLAYA AND CALICHE PIT EASEMENTS

FEMA maps show playas as ordinary floodplains with no floodways because floodways are defined based on an assumption of flowing water, and playas are standing water. An exception is South Draw, which is assumed to both flow and stand. Thus, FEMA does not prohibit fill in playas. Midland County currently does not have any prohibition on filling in playas, but cities such as Midland, Lubbock and Amarillo have regulations that go beyond the FEMA minimum because playas are a special type of flooding. Filling in a playa will raise the estimated flood elevation and push floodwaters onto adjacent properties.

It would be possible for Midland County to modify the flood damage prevention court order to require any fill in a playa to be balanced with an equal amount of cut. However, due to the limited regulatory power of the County, it may be better to take a different approach.

A more minimal way to protect playas would be similar to a floodway, obtaining drainage easements on the central lowest portions of the major playas when they are platted. This would reduce the fill in the playa and result in an open area with no buildings. If flooding becomes an issue later, the open area could be excavated to catch more runoff. The difficulty in this approach is deciding how large of an area to protect. If Midland County wants to adopt this approach, a method for choosing a size needs to be developed. It is not currently one of the objectives of our grant study.

It may not be practical to protect all playas. For smaller or more shallow playas predicted flooding might not create as much flood risk. Flood Planning Framework panels show the playas identified on the Flood Factor Maps and other sources as being likely to flood at least to a depth of three feet, or to be in a location especially sensitive to flooding.

In summer 2021 several caliche pits situated along South Draw captured a great deal of runoff and provided inadvertent flood protection. In one case, residents complained that a caliche pit that had recently been filled in no longer provided such protection. Thus, caliche pits function like playas if they are in or near the flow path. A caliche pit is the cheapest form of drainage retention basin because it is already constructed. Our grant study will identify pits that capture a lot of runoff and will map them as flood prone. Then Midland County can begin to regulate those locations as if they were natural playas.

4.3 PLAYA OVERFLOW EASEMENTS

South Draw, a chain of connected playas, was the source of significant flooding in 2021. In some locations, the County discovered that a development or just a build-up of sediment was blocking the passage of floodwaters.

Our grant study will identify which playas overflow, and the amount of flow predicted to escape from them. During development, it will be important to place a street or drainage easement along the overflow route to a draw or another playa. This will prevent buildings being placed in a flow path at risk for flooding, and fill will not block the route. If the overflow is substantial, we could establish a floodway to protect it.

South Draw, a chain of connected playas, was the source of significant flooding in 2021. This region was developed long before publication of any floodplain map, and many residences are located within the playas and in the overflow routes between them. In response to their flooding, Midland County provided a pumping operation to remove floodwaters from two playa ponding areas, pumping it into a caliche pit downstream.

4.4 USE OF FUTURE CONDITION FLOODING ESTIMATES

The adopted flood damage prevention court order that Midland County has includes the minimum provision that all new buildings in floodplain areas be built above the expected flood elevation as published in Flood Insurance Rate Maps. These maps, based on conditions in the early 1990's, omit several important flow paths and do not show flood elevations on most of the playas.

Our grant study will provide the missing information on the omitted flow routes and analyze flood risk for all the major playas. We will also go further to show a future fully developed flood elevation computed by assuming the watershed will be developed and generate more runoff. The following paragraphs explain why this is the right approach for Midland County.

City of Midland has required each developer to construct improvements that would offset the impact of their increased runoff, but this may not fully protect the downstream unincorporated Midland County areas. Some developments were "grandfathered" if they were already platted, but not yet built, when Midland Master Drainage Plan was developed.

City of Odessa's Drainage Manual describes a method to compute the size of stormwater retention, but it does not clearly require it in all instances. Developers have provided retention but have sometimes chosen to use a smaller rainfall as the basis of their mitigation improvement sizing. Larger rains can fill the constructed basins and continue downstream, impacting Midland County. There are developments located in what should have been mapped as a floodway but was not treated as such by FEMA, and these are subject to increased flooding with continued development. South County Road 1317 is an example of this.

In addition, Midland County itself has limited ability to require stormwater retention in the unincorporated areas. Even within extra-territorial jurisdictions of Midland and Odessa, where the city regulations apply, they are not as well enforced.

Our flood planning study will provide Midland County with better maps of flood-prone areas, but the official FEMA maps are still based on 1990's conditions. The incomplete and inadequate floodplain maps will eventually be updated by Texas Water Development Board and FEMA. This will expose property owners to flood insurance requirements based on the new FEMA study. Flood elevations and floodways will show results of development that has occurred, thus telling us how deep the water can get and where development should not have taken place, but too late to prevent it.

For all the listed reasons, the safest approach for the County will be to plan for full development and regulate to that level. Buildings in playas especially will be safer if they are raised high enough to account for future increases in ponding. By predicting a fully developed floodway, the County can more effectively protect the needed width of the streams. When the flood maps catch up with reality, landowners will not get such unpleasant surprises.

4.5 RESOLVING PLAYA FLOODING ISSUES

Because many developments occurred long before the County had floodplain maps, and the current ones are not as helpful as they should be, and because of the limited regulatory authority of the County, there are flood problems in playas that need to be resolved.

Any existing ponding locations within the playas, such as caliche pits and portions of playas that have not been developed yet, should be targeted for acquisition of drainage easements. This will at the minimum prevent the displacement of flood waters into already flood-prone properties, and better yet provide a location for a future flood reduction project with further excavation of ponding capacity.

The minimal solution for playas where buildings are subject to flooding is to provide an outfall route that will drain without the need for pumping. This can take the form of a ditch or pipe. Ideally the elevation of the upstream end of the new route is lower than the lowest flooding structure. A pipe or small ditch provides a way for runoff to escape slowly, without pumping. It does not reduce the mapped floodplain extents or prevent structural flooding, but it does reduce the flooding duration and the necessity for governmental response.

Lubbock is an example of a city that has invested many millions of dollars into a pipe system to interconnect their playas, often up to 50 feet deep and very large. In doing so they have greatly reduced floodplain areas in the playa overflow routes, but have not eliminated floodplains at the playas.

It is probably not practical for Midland County to eliminate all flooding in previously developed playas, but Flood Planning panels show opportunities to improve conditions.

4.6 LIMITED CHANNELIZATION

Although floodway protection was recommended as preferable to channel construction, there are some locations where channels will be the best option for Midland County. This Report does not make a final determination of which locations should be selected, but some preliminary direction is possible.

Most culverts under Interstate 20 currently are only one to two feet below the ground level, because there were few natural draws or drainways for them to be constructed into. This presents few options to engineers trying to design drainage systems to prevent or correct flooding issues. We have identified at least three locations where substantial flows need to pass under the interstate. If that flow is placed in the natural drainway that is only one or two feet deep, it will spread out wide. A deeper channel could be much narrower. The best way for orderly development to occur and to prevent wide areas of nuisance ponding is to provide an established route for drainage, in essence create a draw where none is present.

Other locations for constructed channels were described as routes to link playas that already have flood-prone structures in them. It is not desirable to drain playas with ditches if they are not flooding structures.

5.0 SPECIFIC RECOMMENDATIONS

Exhibit C is an index for the Flood Planning Framework panels. Detailed panels A through I depict the recommendations and needs for Midland County as we know them currently. The final Flood Planning Grant Report will include a version with more detail for final adoption.

5.1 PANEL A

Panel A covers the area north of Interstate 20 between Midland and Odessa. Monahans Draw watershed north boundary is roughly aligned with US Hwy 191.

Playas west of FM 1788 and in the area that drains through the airport have previous master drainage plans that comply with City of Midland regulations. Most of the playas from the airport west are predicted to overflow. Overflow routes are not shown but may need protection in the final Report. A large playa system east of the airport does not overflow as studied by FEMA. We have shown easements for the lowest portions connected with a ditch.

Some playas near Avalon Drive are also regulated or owned by City of Midland. Several small retention basins exist or are planned to reduce flows into roadways. Some locations for drainage ditches to provide outfalls for the roadway have also previously been identified.

South of Business 20 at the airport, channel improvements are needed to reduce constant ponding inside the airport and provide a better outfall. An outfall floodway and easements between Business 20 and I-20 needs to be protected.

5.2 PANEL B

Panel B addresses an area centered by FM 588, Faudree Road, and containing a number of well-known flooding issues. This area is partly in the City of Odessa, with a number of drainage improvements previously constructed by or regulated by the City. Odessa Country Club has two golf courses on each side of Faudree Road, both of which provide significant drainage benefit as they are located in two main flow paths.

Summer 2021 highlighted repeated flooding in the playa called "OIME" by the City of Odessa, located along Business 20 east of Faudree Road. This playa filled and flooded several homes and businesses for an extended period this summer, but ponding was not the only issue. Homes along South County Road 1317 also flooded as runoff overtopped the ponds in the golf course to the north. SCR 1317 will no doubt be mapped as a floodway in our study due to the very large watershed upstream of it.

Panel B depicts a means of connecting existing playas, drainage basins and caliche pits with pipes. This system needs to then connect to a culvert under I-20, and from there into a constructed ditch along the natural drainage path (Panel C).

Ditches were considered as connections, but because ditches need steeper slopes, that would require a much deeper culvert at I-20 and much deeper and longer downstream channel. The downstream channel was considered so impractical that pipes are recommended. Pipes, though more expensive, also have the advantage of being easier to route through this mostly developed area.

The actual route for the pipe system has to cross several oil and gas pipelines and weave through numerous private properties. No obvious best route could be identified at this time.

5.3 PANEL C

Panel C shows three main flow paths into an enormous deep playa located south of I-20 and east of FM 1788. FEMA Flood Insurance Study and Flood Factor maps suggest that this playa can actually capture enough flow to flood at a depth of ten feet and overflow. This playa collects all the flow from a large part of eastern Odessa, and all the area from there to the airport.

At least two of the routes into the large playa need floodway determinations, easements, and construction of drainage channels. Development is imminent and implementing these elements will prevent many of the issues experienced in the rest of the watershed.

Several routes from the interstate into the large playa are possible. The panel shows one that may cross fewer pipelines, avoid existing developments, and take an existing caliche pit into the drainage system. Further development of these routes will be needed in separate projects.

5.4 PANEL D

Panel D extends west of the detailed study area for the Flood Planning Grant to the county line. It is centered on Monahans Draw. It also includes some of the deeper playas and the overflow route from the large playa on Panel C.

The area west of our study boundary is shown on Flood Factor maps to have another major outfall from the City of Odessa on it. Although not in our study boundary, it is a similar route that needs to have a floodway definition, easements, and a constructed channel.

5.5 PANEL E

Panel E has overlap with Panel D. It contains a closer view of the overflow route for the playa on Panel C and numerous playas that will need protection. Monahans Draw is also centered in this panel.

Also, of note to the west of the new South County Road 1232 is a large playa, which preliminary studies show to have no overflow. It is shown as easements to protect the four lowest portions of the playa, with interconnecting easements.

5.6 PANEL F

Panel F illustrates the remainder of Monahans Draw to its confluence with Midland Draw. The effective detailed Flood Insurance Study of Monahans Draw ends just east of the 90-degree bend northward in FM 1213. At that point the draw widens into a huge and confusing flat area, where it may overflow into a salt lake and a playa.

Because it is not clear from topographic maps exactly what the current flood hazards for Monahans Draw are in this area, it is not possible to predict what protective easements or drainage improvements might be needed in this vicinity. Completion of the Flood Planning Study will provide more clarity.

The soils on Panel F are sandier and while several areas are shown as playas on Flood Insurance Rate Maps, few of them show up as deeper or major playas needing protection in the Flood Factor Maps. Some playas that appear to merit protection are already developed.

5.7 PANEL G

Panel G is a close view of the upper end of South Draw, east to Cotton Flat Road.

The contributing area for the western arm of South Draw starts north of Business 20 and west of Loop 250, draining through a channel into an easement in a playa north of I-20 owned by TxDOT. The south half of this playa still needs easement protection. This playa is likely to be found to overflow southward across areas already mostly developed.

A route for the overflow is shown on the panel, passing through a caliche pit, connecting through a second small playa, and terminating in a large deep playa west of South County Road 1210 (Midkiff Road). The Midkiff playa probably will not overflow, but the final study will confirm that initial assessment or not.

Our Flood Planning Study is much more complete for South Draw. There is a detailed study for Flood Insurance Rate Maps that served as a starting point, and improvements to a number of known flooding issues have been identified and modeled.

The main South Draw leaves the I-20 Nature Preserve by way of a culvert across I-20. TxDOT has provided preliminary plans for reconstruction of the interstate at this location, showing it is intended to be raised by over a foot, and larger culverts installed. TxDOT has shown a plan that includes an easement south of I-20, but no excavation or enlargement of the existing small ditch.

South of I-20 there are five caliche pits located near the route of South Draw, which fill in most storms due to some ditches that divert water into them. However, a great deal of flow is also diverted away from the pits and flows down West County Road 113 to Midkiff Road. There it flooded several homes in summer 2021.

County staff have been meeting with Endeavor Energy, which owns two of the pits and surrounding land. A proposed system of ditches to connect three of the caliche pits with ditches is illustrated. The suggested solution will eliminate a great deal of flooding on Midkiff Road. Endeavor Energy has been very cooperative and likely this portion of the plan can be implemented soon.

Three additional likely ponding locations are shown between Midkiff and Cotton Flat Roads. These are good targets for easements to preserve them undeveloped.

Additional ditch routes are shown to connect the ponding areas, in addition to one ditch the County has already developed. Since many of these ditches pass through previous developments, they are expected to be narrow and shallow, and to simply provide a positive route for flow. They are drawn in locations that appear to have the least impact on structures.

5.8 PANEL H

Panel H follows South Draw from Cotton Flat Road to FM 715.

Cotton Flat Road brings flow from Midland to South Draw. It has no well-defined roadside ditches. TxDOT has requested that the County establish them. Any ditches on Cotton Flat need an outfall to the east. The road has two dips just north and south of West County Road 120. In summer 2021, ponding west of Cotton Flat was pumped out by the County. A solution is shown that should eliminate the need for further pumping. This area can be drained with a shallow ditch. A possible route is shown, but the final alignment can be determined in a later project.

There is a field west of Rankin Hwy that is undeveloped and could be preserved that way with an easement, where a great deal of runoff can be infiltrated. That field can be drained into another caliche pit east of Rankin Hwy via a ditch and an additional box culvert placed under the highway. TxDOT's District Engineer has expressed approval of this concept and may be able to fund the box culvert. This ditch has to cut through a higher property at Rankin Hwy, so it will be wider and deeper than the first ditch mentioned.

The area on both sides of Lamesa Road is in a very deep playa, over 10 feet. Though no one has seen such extensive flooding, increased urbanization is likely to direct more water into this playa. There are several large caliche pits separated by pipeline routes, but some are not directly connected to the draw and are not likely to fill naturally. The panel shows two that can be connected and used most easily. There is also a ditch under I-20 just west of Lamesa Road that contributes a good deal of runoff from Midland and needs a defined flow path to the draw.

If the playa did overflow, there is no defined route from it to the main South Draw developed channel just west of FM 715. We anticipate that as the flood hazard is restudied in this project, a more complete solution can be targeted in this area. Possibly this playa will not overflow, but if it does, it will need a floodway and easement, and probably a constructed channel.

5.9 PANEL I

Panel I completes the path of South Draw to Midland Draw. From I-20 across FM 715 and US Hwy 158 (Garden City Hwy), it is a constructed channel similar to the ones advocated in other locations. The easement is owned by TxDOT.

There is a history of flooding in the triangle north of I-20 formed by FM 715, Hwy 158, and I20. Solutions to the flooding could be enhanced if South Draw were deepened. It is feasible to deepen South Draw all the way to Midland Draw because currently it enters Midland Draw about four feet up the bank of Midland Draw.

Midland Draw itself is outside the watershed of our Flood Planning Study, but TxDOT is reconstructing the overpass where Midland Draw, FM 307 and I-20 all intersect. In meetings with TxDOT's consultants, we were asked to evaluate whether any improvements to Midland Draw were feasible or advisable. Due to the excessive numbers of crossing pipelines, a minimal approach is recommended. This panel shows an area just up and downstream of I-20 that could be slightly deepened if it benefited the TxDOT design.

6.0 IMPLEMENTATION

The purpose of the Flood Planning Framework Report is to serve as an interim guidance document until the entire Monahans and South Draw Flood Planning Study and Report are completed in 2023. At that time the final Report will be adopted and this document will become obsolete. However, many aspects of this Report are expected to prove workable and be brought forward into the final Report.

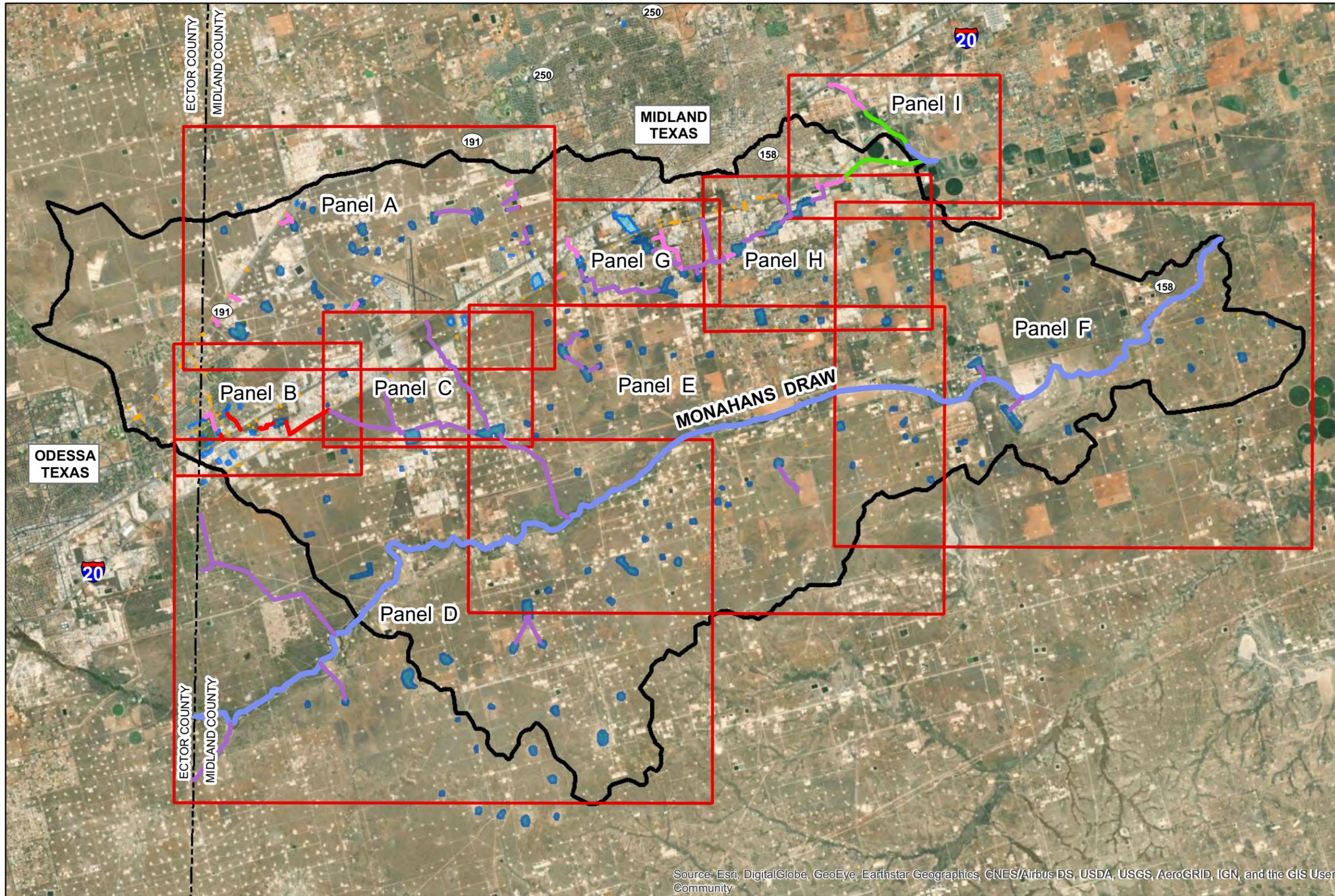
The panels show an ambitious drainage system that will be decades in completion. Midland County will need to coordinate with two cities, TxDOT, numerous landowners and an array of oil and gas interests to implement the recommendations. Opportunities for cost sharing will arise, but the County will need to be alert for opportunities. The Report makes efforts to identify high priority projects, but local needs will change. Development will spur many of the drainage improvements.

The principles for flood prevention and reduction in Section 4.0 should be adopted as the guide for implementation and adaptation of this and the final drainage Report. Implementation will have several elements:

- | Development Review Process
 - Enforce the Flood Damage Prevention order as possible.
 - Modify the Subdivision Regulation court order as needed to better incorporate the flood prevention principles.
 - Key element for development is to obtain easements for drainage on floodways and in playa bottoms.
 - Use full development flood estimates to regulate structure elevations and easement widths.
 - Projects can be funded by developers as part of the overall system in the adopted Report.
- | Flood Reduction Projects
 - Detailed route studies to identify the best path for proposed ditches and pipes.
 - Acquisition of right-of-way or easements through existing developments.
 - Construction likely funded mostly by County, with some TxDOT, Midland and Odessa participation.
- | Outfall Channelization Projects
 - Needed at key drainage routes where flood waters cross I-20 southward and no defined channel exists.
 - Prevent future and existing flooding where easement acquisition will not be sufficient.
 - Detailed route studies to identify the best path for proposed ditches and pipes.
 - Establish route prior to development for least expense.





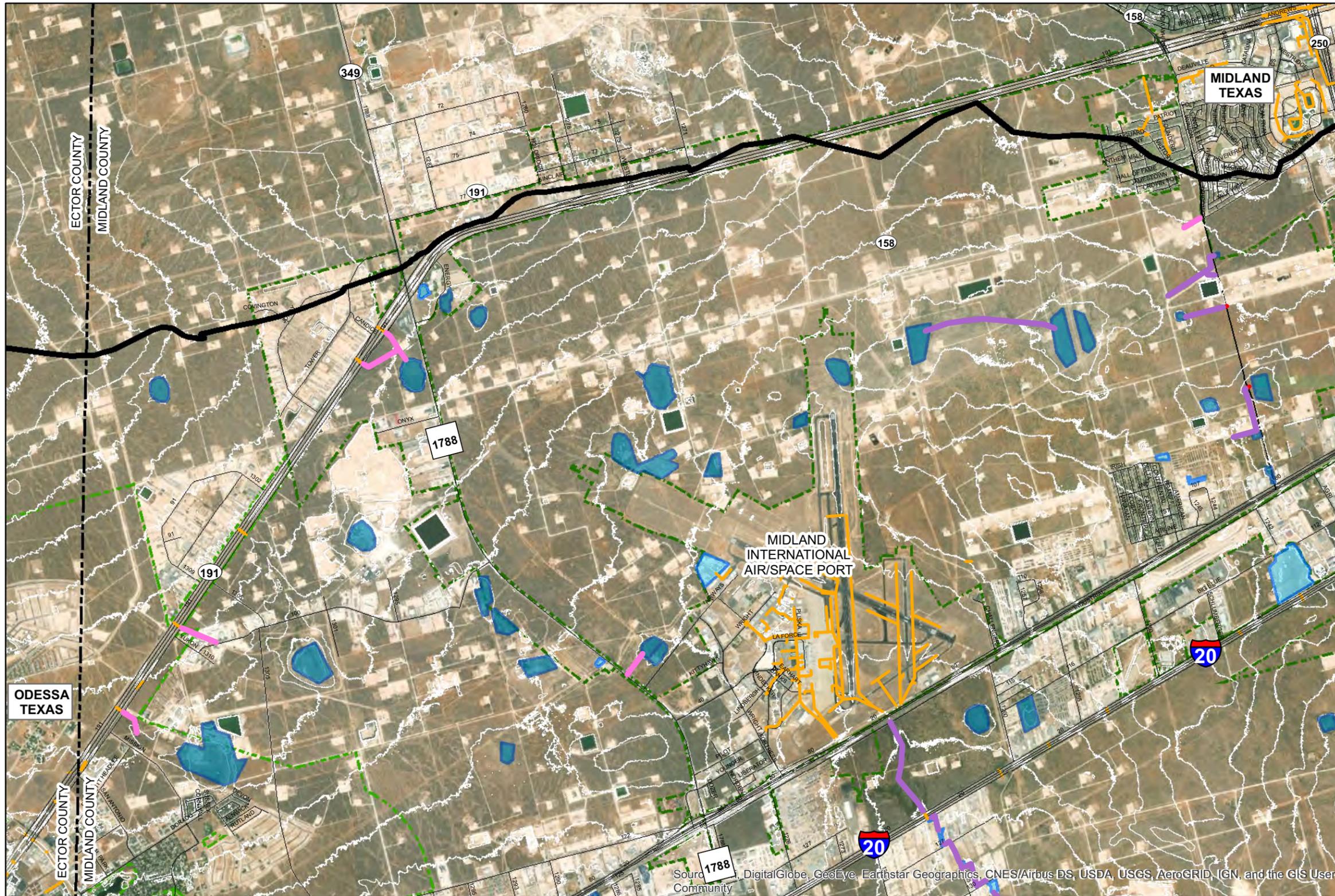


Legend

- Drainage Channel, Proposed
- Drainage Channel, Existing With No Improvements Required
- Easement on Developed Condition Floodway For Monahans or Midland Draw
- Drainage Channel, Existing With Some Improvements Required
- Storm Sewer, Proposed
- Storm Sewer, Existing
- Drainage Basin, Proposed
- Drainage Basin, Existing
- Framework Panel Layout
- Monahans_Draw_Study_Area

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

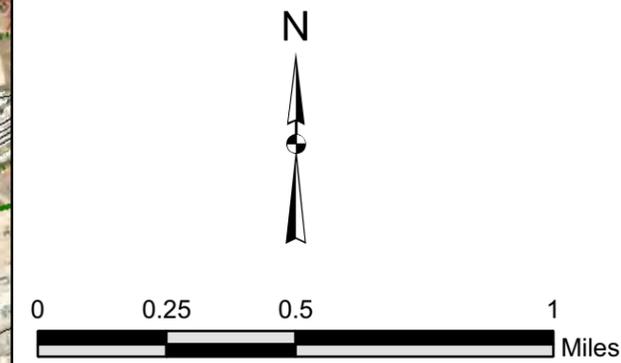
INTERIM FLOOD PLANNING PANELS



Legend

- Drainage Channel, Proposed
- Drainage Channel, Existing With No Improvements Required
- Storm Sewer, Existing
- Drainage Basin, Proposed
- Drainage Basin, Existing
- City and County Streets
- Monahans_Draw_Study_Area
- Midland City Limits
- Odessa City Limits

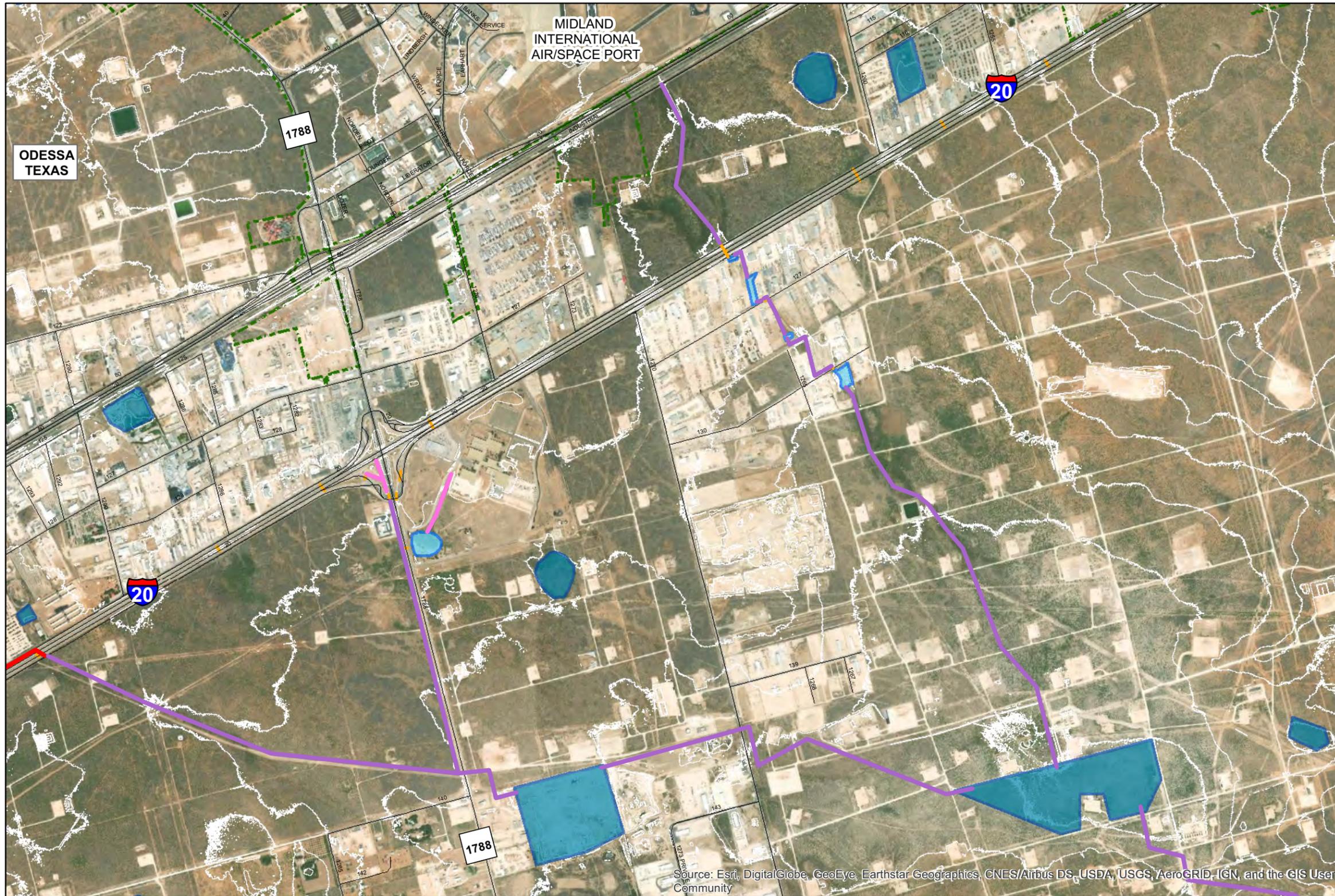
Source: DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



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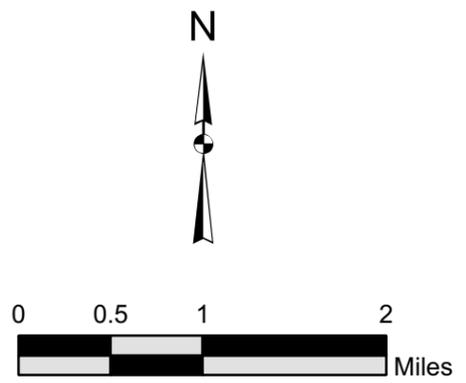
- Drainage Channel, Proposed
- Drainage Channel, Existing With No Improvements Required
- Storm Sewer, Proposed
- Storm Sewer, Existing
- Drainage Basin, Proposed
- Drainage Basin, Existing
- City and County Streets
- Odessa City Limits

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



Legend

- Drainage Channel, Proposed
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- Storm Sewer, Existing
- Drainage Basin, Proposed
- Drainage Basin, Existing
- City and County Streets
- Midland City Limits



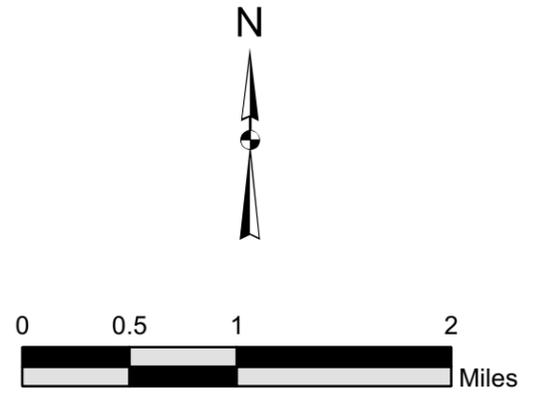
Legend

- Drainage Channel, Proposed
- Easement on Developed Condition Floodway For Monahans or Midland Draw
- Storm Sewer, Existing
- Drainage Basin, Proposed
- Drainage Basin, Existing
- City and County Streets
- Monahans_Draw_Study_Area
- Odessa City Limits
- COUNTY LINE

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

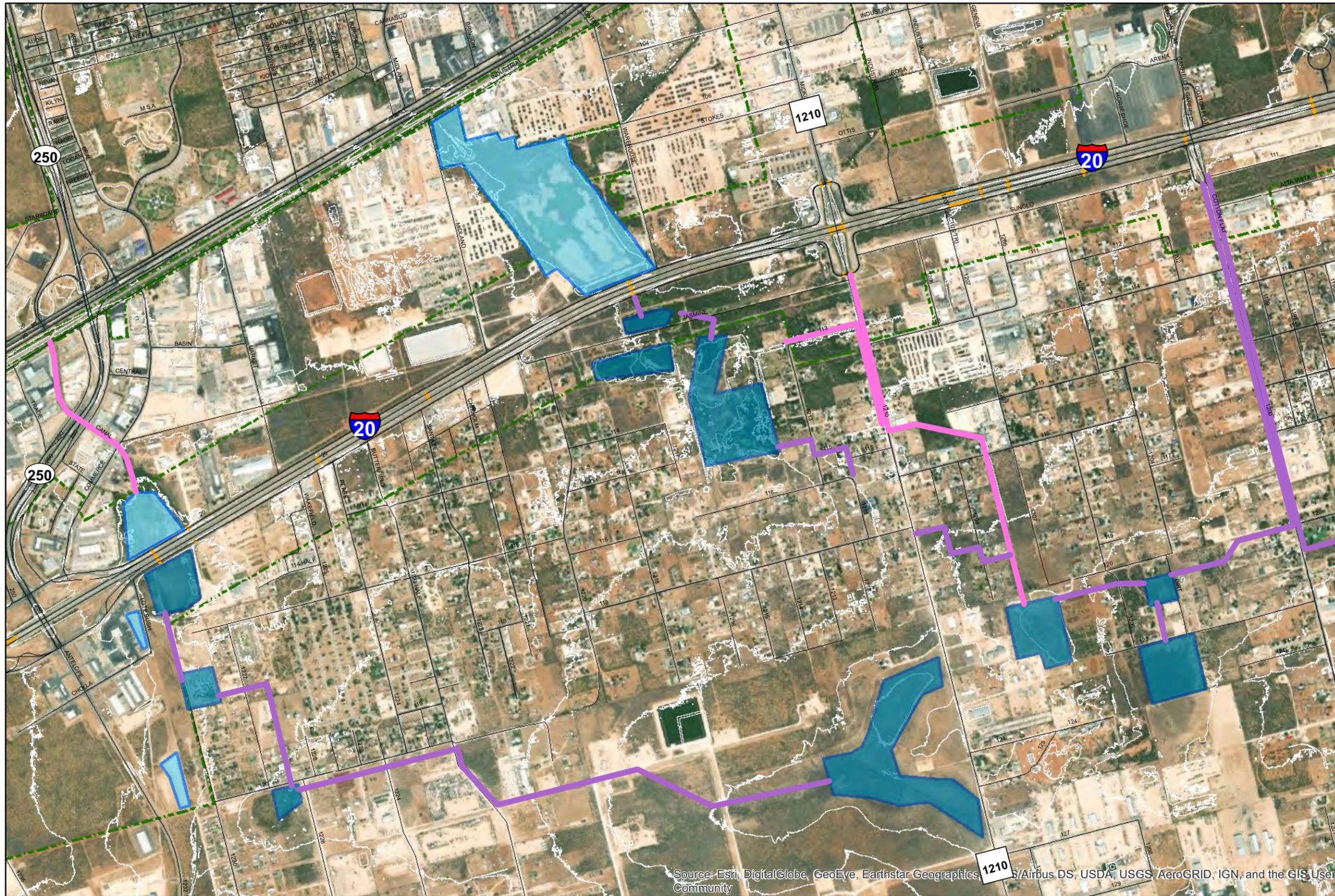


Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



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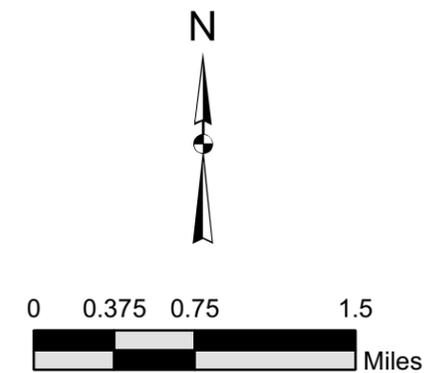
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- Easement on Developed Condition Floodway For Monahans or Midland Draw
- Storm Sewer, Existing
- Drainage Basin, Proposed
- City and County Streets
- Midland City Limits



Legend

- Drainage Channel, Proposed
- Drainage Channel, Existing With No Improvements Required
- Storm Sewer, Existing
- Drainage Basin, Proposed
- Drainage Basin, Existing
- City and County Streets
- - - Midland City Limits

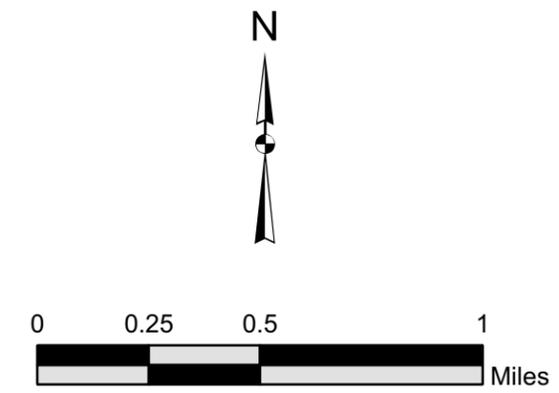
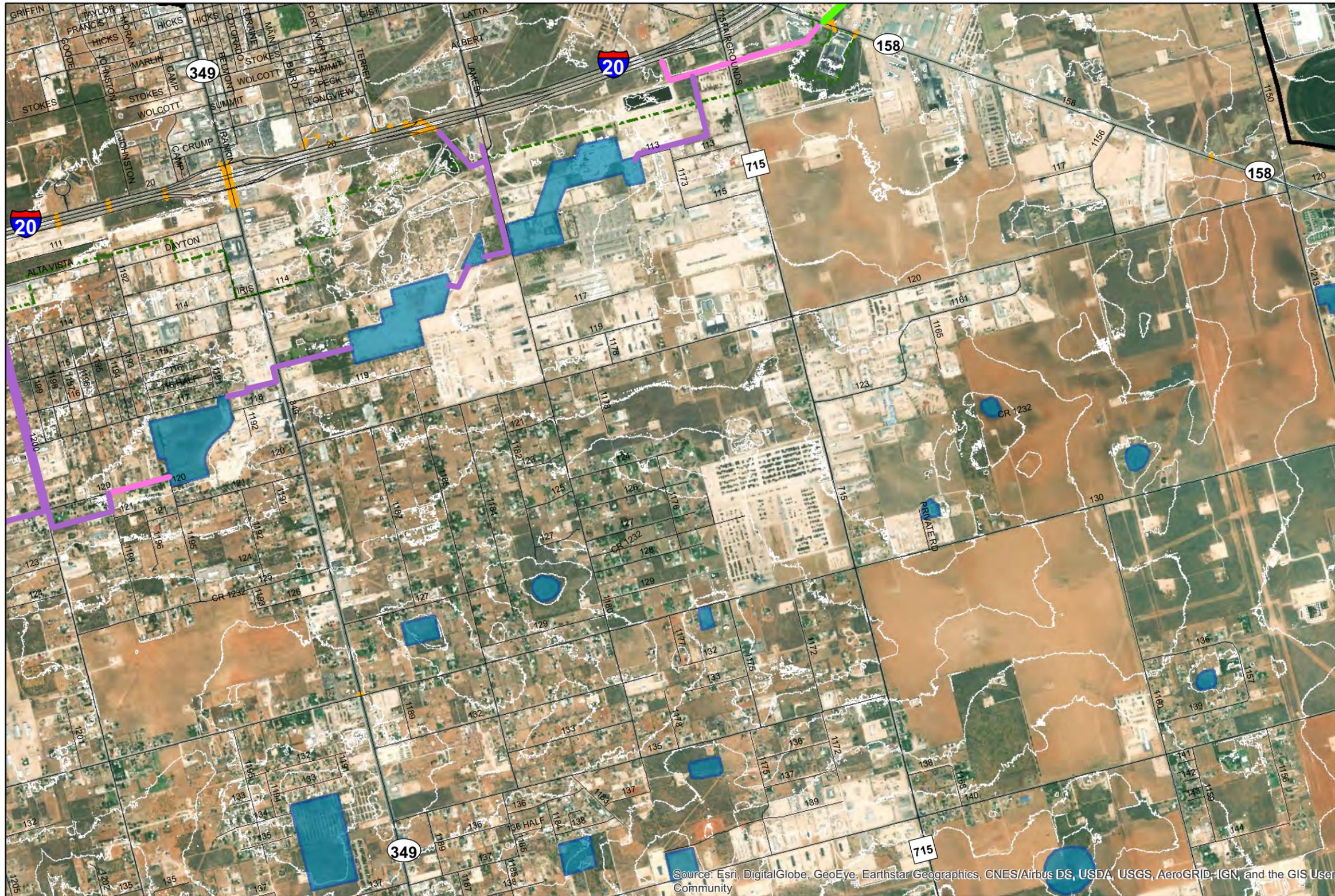
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



Legend

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- Drainage Basin, Proposed
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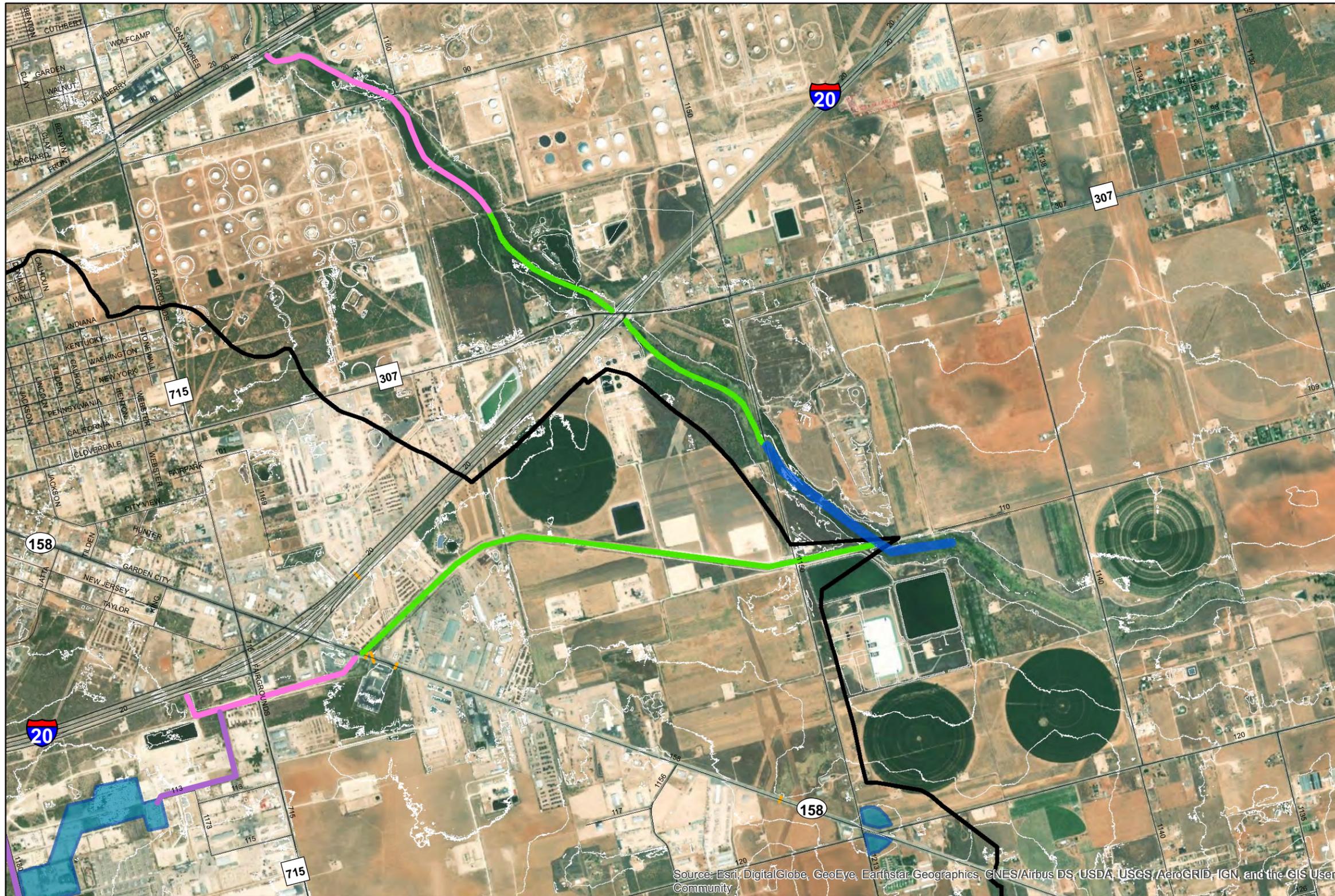
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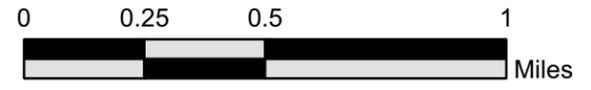
Legend

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- Drainage Channel, Existing With Some Improvements Required
- Easement on Developed Condition Floodway For Monahans or Midland Draw
- Storm Sewer, Existing
- Drainage Basin, Proposed
- Drainage Basin, Existing
- Monahans_Draw_Study_Area
- Midland City Limits

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



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- Storm Sewer, Existing
- Drainage Basin or Easement, Proposed
- Drainage Basin or Easement, Existing
- Monahans_Draw_Study_Area
- City and County Roads