

An Identification and Assessment of Immediately Developable Parcels for the Duluth Airport Authority, Utilizing GIS Technology.

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Abstract

Under the direction of the Arrowhead Regional Development Commission (ARDC), Duluth, Minnesota a study was conducted to help identify parcels near the Duluth International Airport that would be prime for immediate development. The study involved the collection and analysis of data utilizing Geographic Information Systems (GIS). The analysis of the data is to be used as a guide for development strategies for parcels near the Duluth International Airport. It is expected that the results of this analysis can be used as a tool in guiding the development of the Northern Development Area, which would be of great economic benefit for the Duluth International Airport, City of Duluth, City of Hermantown and the State of Minnesota. This analysis can also be of great benefit to perspective developers in their site selection process and could be easily modified to meet any specific objectives they may have.

Introduction

In May of 2000, I was hired as a Geographic Information System Intern for the Arrowhead Regional Development Commission (ARDC) in Duluth, Minnesota. The ARDC services Region 3 of 13 State of Minnesota development regions. ARDC is a regional planning agency for the following seven counties of Northeast Minnesota: Aitkin, Carlton, Cook, Itasca, Koochiching, Lake and St. Louis. In addition to serving the seven county area, ARDC serves 180 townships and 70 cities located within the seven counties.

To better understand the scope of my project it is important to understand the background of a much

broader project, of which my project is a part. Originally, the Duluth Airport Authority approached the Metropolitan Interstate Committee (MIC) with a proposal to examine the potential for development of land north of the Duluth International Airport and adjacent to the new access road (Stebner Road) going into the Northwest Airlines Maintenance Facility. This 962-acre area is known as the Northwest Development Area (Figure 1). This area is a prime industrial and business development site due to the recent infrastructure improvements and the extension of Stebner Road to the Northwest Airlines Maintenance Facility. One of the problems

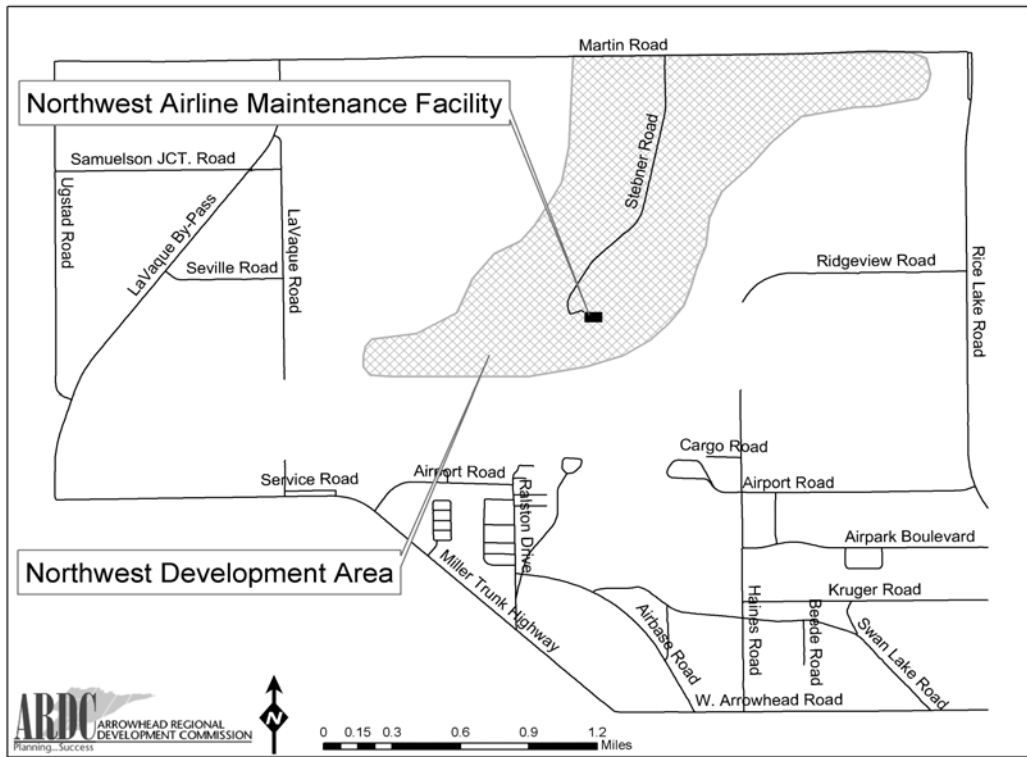


Figure 1. Northwest Maintenance Facility and Northwest Development Area.

associated with this development area is the fact that many of the sites that are potentially developable consist of wetlands and other poorly drained soils. Additional development concerns in this area include utility extension costs and restrictive buffers associated with the Duluth International Airport and the Minnesota Air National Guard (MNANG). The MIC's previous work with the Airport Authority in an Airport Overlay Zone Study, along with ARDC's GIS capabilities have greatly aided in the development of the project.

According to ARDC Planner Andy McDonald, the objective of the project is, "to assist the Duluth Airport Authority and other jurisdictions/agencies in the orderly development of the Duluth International Airport and adjacent areas, assess potential

development impacts upon the roadway network adjacent to the Duluth International Airport and to identify optimal parcels for new development in the Northern Development Area." The final objective, identifying optimal parcels for new development, is much of what my project is involved with.

The overall study involved five main work activities, many of which I was directly involved. Those activities include the following: geographic information collection and creation, geographic information analysis, development of land use information, examination of future development impacts to the local road system, and finally the production of a final product.

Geographic Information Collection and Creation

A great deal of work went into collecting geographic information for this project. The geographic information that was collected or created included creating a parcel map of the Duluth Airport and adjacent properties. An inventory and development of existing land use information at the parcel level was also gathered. Information layers including roads, water features, utilities, jurisdictional boundaries and trails were obtained. A wetlands data layer was developed through existing data and Digital Orthographic Quadrangle (DOQ) interpretation. A future land use layer including development options was gathered. A data layer with Minnesota Air National Guard Munitions Maintenance Facility with a 1250 ft. “safety arc” buffer zone and Airport Surveillance Radar (ASR) antenna with 1500 ft. no build buffer and ½ mile electronic free buffer was developed. Existing and future runway coverage with safety zone buffers was also created. Primary, horizontal, conical, approach, precision instrument approach, and transitional airspace coverage zones were developed. A zoning coverage was created. Assessor database information was gathered and incorporated with the parcel map. Finally, existing average daily traffic (ADT) information was incorporated with the road network surrounding the airport.

Geographic Information Analysis

Several geographic information analyses were deemed to be important for the project including overlay and

distance analyses. Airspace coverage zones were overlain onto the parcel map to identify parcels that fall into these zones. Another overlay analysis performed was the MnANG Munitions Maintenance Facility “safety arc” buffer on the parcel map to identify parcels within this zone. Additionally, the ASR Radar antenna 1500-foot clearance area buffer and ½ mile electronic equipment clearance area buffer was overlain onto the parcel map to identify parcels within these zones. Existing and future runway safety buffer zones were overlain on the parcel map to identify parcels that may be impacted. The final overlay analysis was the wetland coverage onto the parcel map to identify parcels that may need wetland mitigation. Finally, a distance analysis was performed in the Northern Development Area to obtain parcel location in relation to utility service.

Development of Land Use Information

For this project, compatible land use information was compiled for safety and air space zones. Locations best suited for future development in the areas adjacent to the Northwest Airlines Maintenance facilities were identified. Future land use scenarios listed in the Duluth International Airport Master Plan and Aviation Development Plan were examined. Additionally, a meeting with the Airport Authority and area economic development officials to examine future development scenarios was conducted. Trip generation rates for future development scenarios were produced. A model of future land use with TranPlan roadway model (a regional roadway model) was developed. Potential future roadways were developed. Finally, the results of

the Airport Overlay Zone Study were examined.

Examination of Future Development Impacts to the Local Road System

Future development could have negative effects on the existing road system. For this reason, future development impacts to local roads were examined. Roadway-modeling results were evaluated to identify roads with potential capacity problems. Trip generation information was analyzed for future development scenarios to identify the impact to local roads. Guidance on future land development that lessens roadway impacts was also provided.

Creation of a Final Product

The final product for this project consisted of the following four elements: 1) an airport area parcel map with various data layers 2) a Roadway Access Control Plan for specific properties abutting airport property under consideration for development 3) an identification of parcels best suited for future development and 4) recommendations to reduce impacts on the local roadway network when development occurs.

Study Area

The study area for this project is defined as the area bounded by the major roadways surrounding the airport for the purpose of creating a parcel map and examining current and future land use. Examination of development impacts to the local road system encompassed a much broader area than the defined study area, but was not a part of my project. For most data layers it was

agreed that the boundary would fall within Martin Road to the north, Arrowhead Road to the south, Rice Lake Road to the east and Ugstad Road to the west. These roads bound the following public land survey system (PLSS) sections: Township 51 North Range 15 West Sections 34-36, Township 51 North Range 14 West Section 31, Township 50 North Range 14 West Sections 6-7 and Township 50 North Range 15 West Sections 1-3, 11-12 (Figure 2).

One of the many challenges with this project was coordinating data collection efforts with the appropriate jurisdictional entities. This study area included the four following municipalities: Canosia Township, Rice Lake Township, City of Duluth and City of Hermantown (Figure 3).

Methods

The identification and assessment of immediately developable parcels for the Duluth International Airport consisted of the following steps: determination of the data needs for the project, assessment of the data that was currently available, acquisition of available data and completion of any necessary conversion, development of criteria for immediately developable parcels and finally completion of an analysis of the data to determine which parcels are the most immediately developable.

Data Needs

For this analysis there were several data sets that were needed. These data sets can be divided into three categories: cultural features, natural features and

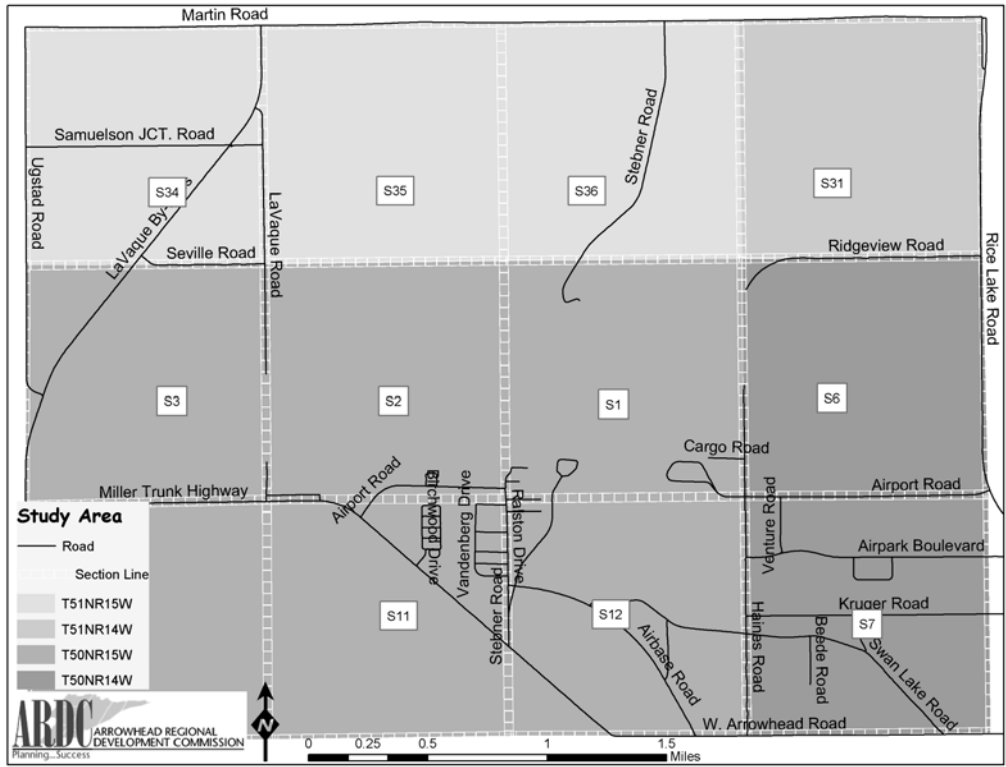


Figure 2. Public land survey and road network boundaries of the study area.

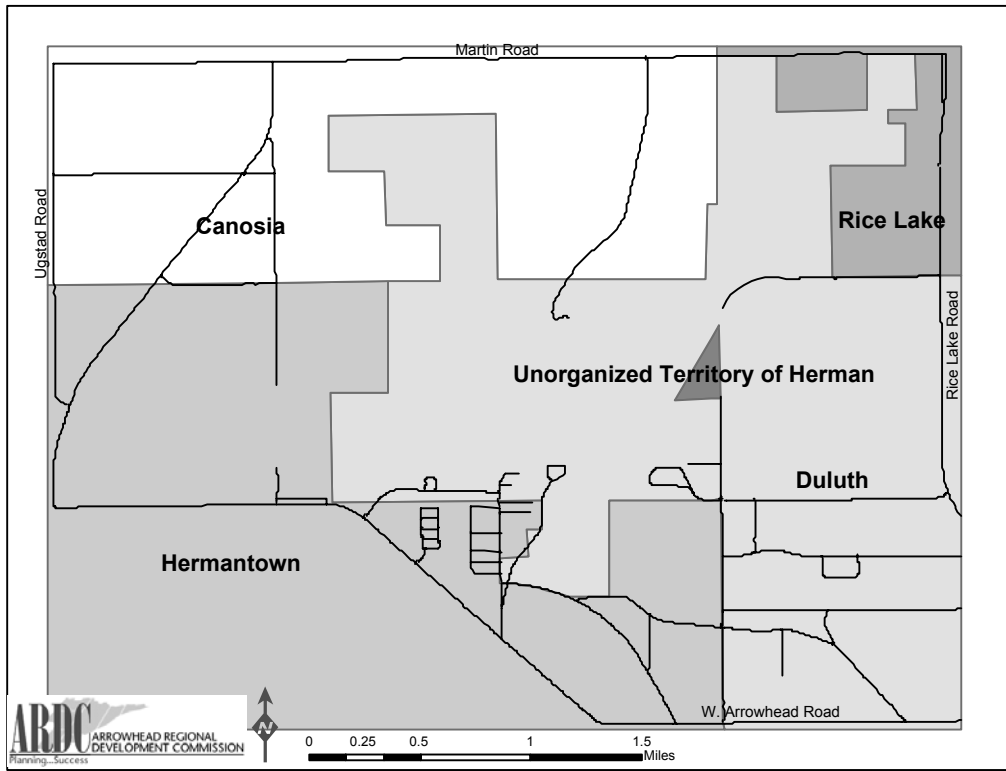


Figure 3. Municipalities included in study area.

infrastructure.

The cultural feature data sets that were needed included an “accurate” parcel map of the study area. Included with this parcel map was attribute information in regard to each parcel. One of the key attributes in the parcel map was existing land use information. Additionally, jurisdictional boundaries, future land use, Minnesota Air National Guard (MnANG) Munitions Maintenance Facility 1250 foot “safety arc” buffer zone, Airport Surveillance Radar (ASR) antenna 1500 foot no build buffer zone and ½ mile electronic free buffer, existing and future runway safety zones, airspace coverage zones and a zoning coverage were gathered.

Natural feature data sets that were needed include water features and wetlands. To help identify these features, digital orthographic quadrangles (DOQs) were gathered.

There are several infrastructure-related data sets that were gathered for this project. These data sets include roads, utilities, MnANG Munitions Maintenance Facility location, ASR antenna location, existing runway location, and future runway location.

Data Acquisition/Creation

Once it was determined what the data needs were, it was time to start acquiring and creating data. This first data set created was the parcel map. With the help of the St. Louis County Engineering Department, ½ section maps were duplicated and digitized using Environmental Systems Research Institute (ESRI) ArcInfo 8 software. The section and ½ section corners of the maps were used as registration points and a shareware program SECTIC, available from Minnesota’s Land

Management Information Center, St. Paul, MN (www.lmic.state.mn.us) was used to derive the Universal Transverse Mercator (UTM), North American Datum (NAD) 1983 XY coordinates for these points. Once all of the twenty-two ½ section maps were digitized, the coverage created in ArcInfo was built for polygon topology. Once polygon topology was established, unique identification numbers could be entered for each polygon (parcel) that could later be used to join other parcel attributes. The unique identifier used for the parcel map was the parcel code, a unique code used by St. Louis County to identify parcels.

Once the parcel map was complete, assessment information was gathered from the City of Duluth Assessor’s Office and also the St. Louis County Assessor’s office. Information from the Assessor’s Office was provided in a database format as well as a hard copy format. The legal descriptions, included in the hard copy data, of each parcel were used to verify the accuracy of the parcel map. Because the hard copy ½ section maps were not 100 percent up-to-date, it was necessary to use legal descriptions to identify the location of recent parcel divisions. In a recent attempt by Pro-West and Associates of Walker, Minnesota to create a portion of a parcel map for St. Louis County, 150 of 900 (16.7%) parcels could not be drawn with the legal descriptions provided to them by St. Louis County (Gellatly 2001). According to St. Louis County Principal Appraiser John Gellatly, “Researching and correcting (which often means interpreting) bad legals (a legal description that is not technically correct. A bad legal may or may not be able to be drawn out or match the

boundaries of an adjoining parcel legal description.) is a major time outlay which is inherent to parcel mapping. A large variety of surveyors, engineers, lawyers and whomever have written the 100,000+ legal descriptions that make up St. Louis County. Some of them had bad information when they wrote the legals. Some of them used information that has gone bad over the decades. And some of them just wrote badly” (Gellatly 2001). Of the 736 total parcels in the study area for this project, 17 (2.3%) could not be rectified using legal descriptions. It was decided that this didn’t represent a large portion of the study area therefore this was an acceptable amount of error in the parcel map. Once all parcel divisions were updated, the Assessor database information was joined to the parcel map by parcel code. This was done using ESRI’s ArcView 3.2 software.

The next data sets gathered were the existing and future airport boundaries, existing runway safety zones and existing airspace coverage zones. This data was extracted from data that was originally created by Airport Consulting Services Group, Inc. (ACSG) of Naperville Illinois. Originally, these data sets were to be derived from paper copy maps provided by the Duluth Airport Authority and from Federal Aviation Administration (FAA) Advisory Circular 150/5070-6A descriptions of the zones. After some of the zones were created using the FAA and Duluth Airport Authority information, which was very time consuming, it was discovered by the Airport Manager Ray Klosowski, that much of this data existed in an AutoCAD Release 14 format done by ACSG. A copy of this information was received and the data was extracted

from the CAD drawings and converted to ESRI shapefiles. Because the data provided by ACSG was not in a known coordinate system, world files were used to register the existing drawings to data in a known coordinate system (UTM, NAD83). Creating the world files was done in ArcView utilizing the extension CAD Tools available at the ArcScripts page of ESRI’s web site.

The next data sets gathered were roads, the ASR tower location, ASR 1500 foot no build buffer and ½ mile electronic free buffer, the existing and future runway, and MNANG Munitions Maintenance Facility location and 1250 foot no build buffer. These data sets were all created by obtaining the UTM coordinate positions of the features with a Trimble Geoexplorer II Global Positioning System (GPS) receiver. Driving the route in an automobile and allowing the GPS to gather point information along the driven route obtained the road network. The ASR and Munitions Maintenance Facility locations were obtained by locating the perimeter of each with the GPS and the runway location was obtained by locating the runway corners with the GPS. Due to obvious access restrictions, it was necessary to locate MNANG and Airport features with the assistance of the Duluth International Airport and MNANG personnel. Once the data was gathered it was imported into a program that converts raw data into data that can be used in ArcView and ArcInfo software. The program used to import the raw data was the Trimble Pathfinder Office. This program converted the point data to line or polygon data. The data were differentially corrected to 3-5 meter accuracy. The buffers for the ASR tower and Munitions Maintenance

Facility were created using the ArcView extension Xtools available at the ArcScripts page of ESRI's web site. Xtools is an Oregon Department of Forestry-developed ArcView Extension with many tools useful for doing GIS analysis using ArcView. The future runway was created in ArcView by adding the dimensions specified in the Airport Master Plan, for the expected future runway expansion, to the existing runway.

The water, gas and sanitary sewer utility locations were obtained from the City of Duluth Engineering Department and also the City of Hermantown. The data were provided as paper maps. These maps were digitized in a similar fashion as the parcel map though road intersections were used as registration points for the data. After the hard copy maps were digitized, a section of the gas utilities were digitized "on-screen" in ArcView because new lines were installed over the summer along Airport Road from Rice Lake Road to Haines Road. The new utilities had not been updated by the City of Duluth Engineering Department and it was determined that updating the data by on-screen digitizing would not cause major problems in the data analysis.

The municipal boundaries and general water feature boundaries were extracted for the study area from the Minnesota Department of Transportation's (MNDOT) 1999 Basemap. The data was converted from an ArcInfo Coverage to a shapefile and clipped down to the extent of the study area using the ArcView extension Xtools.

Originally, the wetland and DOQ data for this project was obtained from the Minnesota Department of

Natural Resource's Data Deli web site (deli.dnr.state.mn.us). Three-meter resolution United States Geologic Survey (USGS) DOQ's were obtained for the study area. The wetland data set obtained was United States Fish and Wildlife Service National Wetland Inventory (NWI) data, although the NWI data is not intended for parcel level analysis. As stated in the NWI metadata, "NWI information is not intended to be used as a precise locator of wetland boundaries, for site specific planning or management...". At the time, this data was the only available wetland data for the study area. It was determined that for this analysis and also any future analysis in the Duluth area, much more detailed wetland coverage would be needed. For this reason, the MIC partnered with the City of Duluth to acquire funds and coordinate an effort to have many of the Duluth area wetlands delineated for use at the parcel level. After obtaining funding, the Natural Resources Research Institute (NRRI) began wetland delineation, which was completed in December of 2000.

The final data set obtained was a zoning coverage of the study area. In a previous project completed by ARDC, a zoning coverage for Canosia Township and the City of Hermantown had been completed. Hard copy zoning maps were obtained from the Duluth International Airport for Rice Lake Township and the City of Duluth. The zoning information on these maps were digitized and combined with the existing digital data to produce a single zoning coverage.

Results/Discussion

Once all the necessary data had been

obtained or created it was time for analysis of the data. The first analysis completed was an overlay of various airspace safety zones over the Northern Development Area and parcel map to determine parcels within the Northern Development Area that would be affected by the airspace safety zones. Utilizing the Xtools extension in ArcView, the existing land use safety zones A, B and C (Figure 4) were intersected with the Northern Development Area to determine how many acres of the Northern Development Area would be affected by each land use safety zone. There are restrictions to the use of land that falls within each land use safety zone. All land use safety zones are bound by the following restrictions, “No use shall be made of any land in any of the safety zones which creates or causes interference with the operation of radio

or electronic facilities on the airport or with radio or electronic communications between the airport and aircraft, makes it difficult for pilots to distinguish between airport lights and other lights, results in glare in the eyes of pilots using the airport, impairs visibility in the vicinity of the airport, or otherwise endangers the landing, taking off, or maneuvering of aircraft” (Minnesota Rule 8800.2400). Land use safety zone A is subject to the following additional restrictions: it can not contain buildings, temporary structures, exposed transmission lines, or similar hazards, and is restricted to uses which will not create, attract, or bring together an assembly of persons within it. Permitted uses may include uses such as agriculture (seasonal crops), horticulture, raising of livestock, animal husbandry, wildlife habitat, light outdoor recreation (non-spectator),

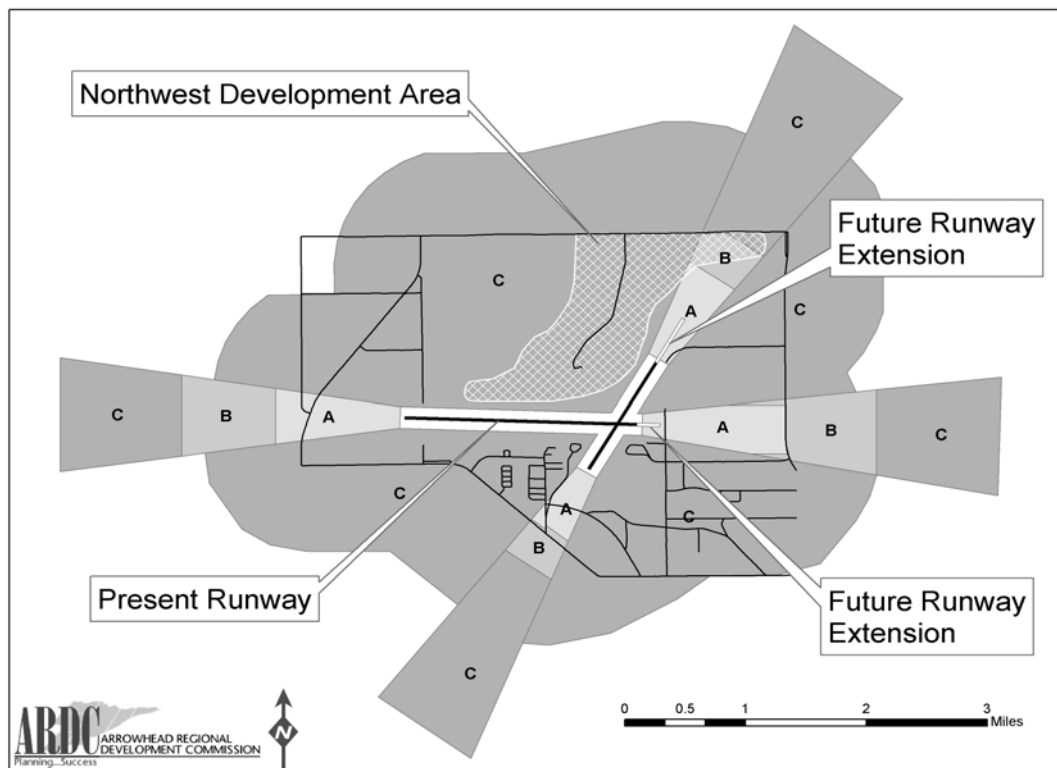


Figure 4. Land use safety zones A, B and C.

cemeteries, and auto parking. Land use safety zone B is subject to the following additional restrictions: each use must be on a site whose area is no less than three acres, each use must not create, attract, or bring together a site population that would exceed 15 times the site acreage and each site must have no more than one building plot upon which any number of structures may be erected.

“A building plot shall be single, uniform, and non-contrived area, whose shape is uncomplicated and whose area shall not exceed the following minimum ratios with respect to the total site area (Table 1):

Table 1. Population/Area Ratios

Site Area at Least (Acres)	But Less Than (Acres)	Ratio of Site Area to Building Plot Area	Building Plot Area Square Feet	Max. Site Pop. (15 Persons/Acre)
3		12:1	10900	45
	4	12:1		
4		10:1	17400	60
	6	10:1		
6		8:1	32600	90
	10	8:1		
10		6:1	72500	150
	20 and up	6:1		
20		4:1	218000	300

The following uses are specifically prohibited in zone B: churches, hospitals, schools, theaters, stadiums, hotels and motels, trailer courts, camp grounds, and other places of public or semipublic assembly” (Minnesota Rule 8800.2400). The only restrictions to land use in

safety zone C is the previously mentioned general restrictions that pertain to all land use safety zones.

Upon completion of the intersection of data, it was determined that approximately 4 acres of land within the Northern Development Area were zone A, 66 acres were zone B and 892 acres were zone C (Figure 5).

Being that the restrictions of land use for land use safety zones A and B do not allow for industrial or business development, these areas will be excluded from consideration as best developable parcels.

Additional safety zones that potentially would affect development in the Northern Development Area are the future runway protection zone, future building restriction line and future runway visibility zone. Being that the future runway protection zone and future building restriction line fall within the existing land use safety zone A and B, which have already been excluded from consideration as best developable parcels, these safety zones need not be considered further. The future runway visibility zone does fall within a portion of the Northern Development Area and will need to be considered. After performing an identity operation, utilizing Xtools, on the Northern Development Area and the future runway visibility zone it was determined that approximately 3 acres of the Northern Development Area would be affected by the future runway visibility zone (Figure 5 and 6).

The runway visibility zone is subject to the following line of sight standards, as provided by FAA Advisory Circular 150/5300-13 p56-57 Section 503:

- a. Along Individual Runways.
An acceptable runway

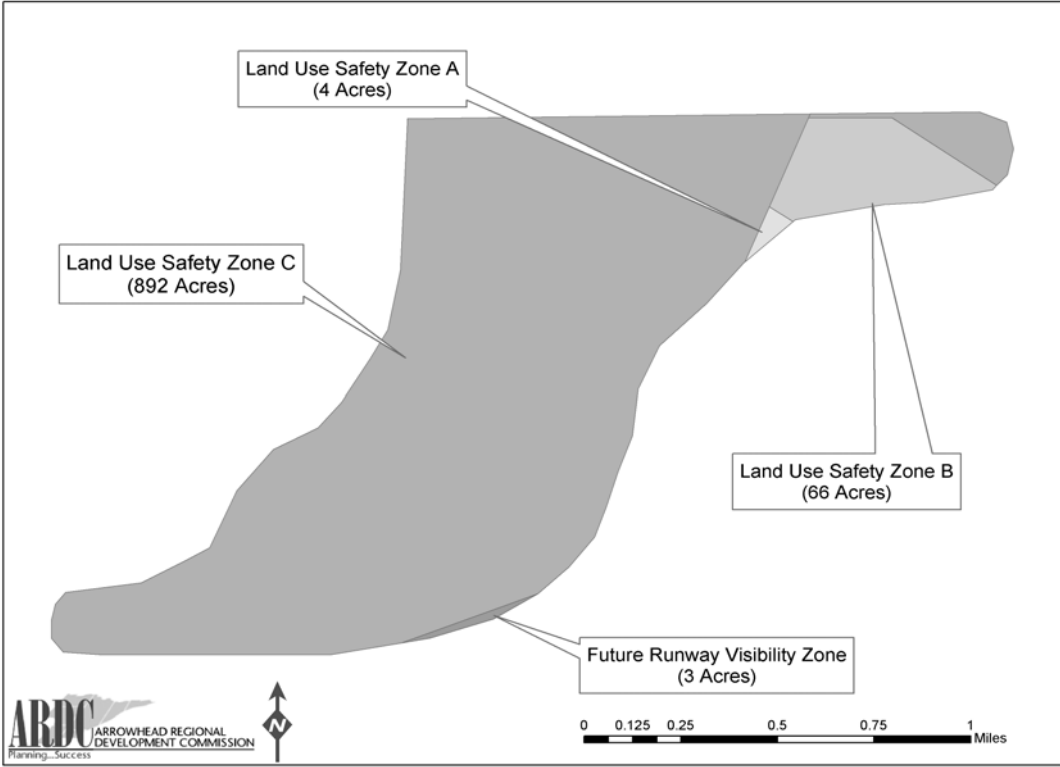


Figure 5. Land use safety zones and runway safety zones within the Northern Development Area.

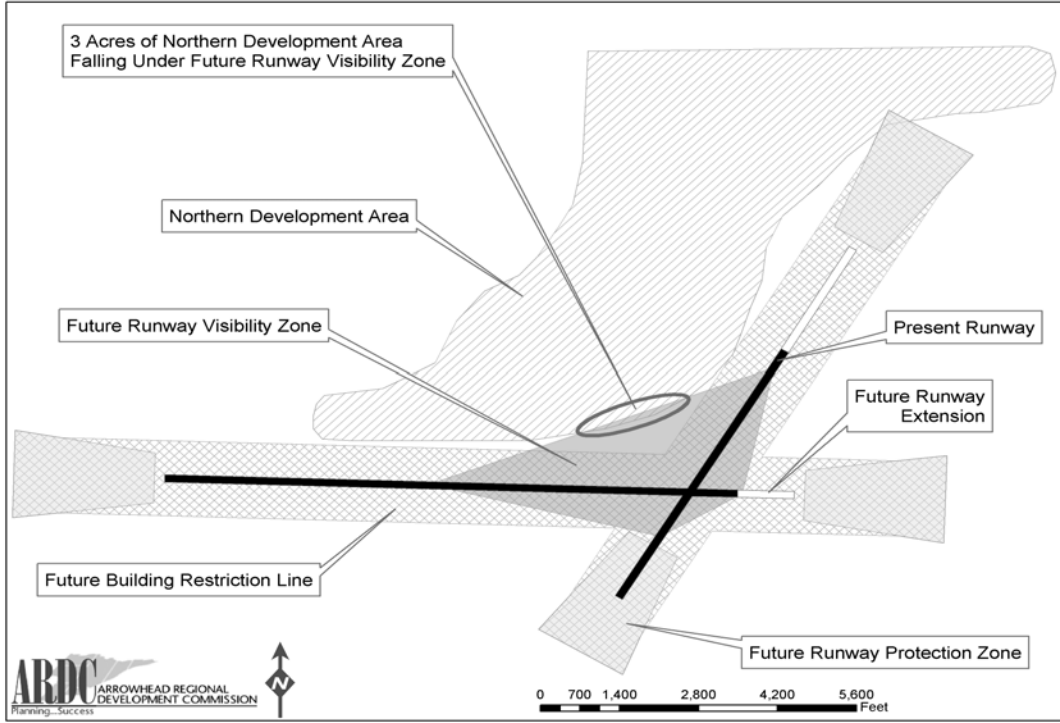


Figure 6. Safety zones affecting the Northern Development Area.

profile permits any two points five feet (1.5m) above the runway centerline to be mutually visible for the entire runway length. However, if the runway has a full-length parallel taxiway, the runway profile may be such that an obstructed line of sight will exist from any point five feet (1.5m) above the runway centerline to any other point five feet (1.5m) above the runway centerline for one-half the runway length.

b. Between Intersecting

Runways. A clear line of sight between the ends of intersecting runways is recommended. Terrain needs to be graded and permanent objects need to be designed or sited so that there will be an unobstructed line of sight from any point five feet (1.5m) above one runway centerline to any point five feet (1.5m) above an intersecting centerline, within the runway visibility zone. The runway visibility zone is an area formed by imaginary lines connecting the two runways' visibility points.

Due to height restrictions within the runway visibility zone and the potential for future runway expansion, it was determined that no site that falls within

the future runway visibility zone will be considered as best developable parcels.

In addition to safety zones surrounding the airport and runway there are also safety zones associated with the MNANG Munitions Maintenance Facility and the Airport ASR Tower. There is a 1250-foot no-build buffer around the Munitions Maintenance Facility, 1500 foot no build buffer and 2640 foot electronic free area around the ASR Tower (Figure 7). Due to the restrictions in the areas that fall within the previously mentioned buffers, these areas will not be considered as best developable parcels. This will exclude approximately 230 acres at the southwest end of the Northern Development Area (Figure 8).

After considering all safety zones related to the airport and the MNANG a total of 304 of 962 acres were excluded from consideration as best developable parcels within the Northern Development Area. In fact, the 304 acres that were excluded may have little or no potential for development based on their restrictions (Figure 8).

Once potential sites were eliminated on the basis of safety, an examination of remaining sites was done considering wetlands. Because remediation would have to be completed if any wetlands were to be disturbed, non-wetland sites were considered the most immediately developable and wetland sites were excluded from consideration. As previously mentioned, the NRRI completed wetland delineation for the airport area in December 2000. This data was used to consider developable sites in the remaining 658 acres within the Northern Development area (Figure

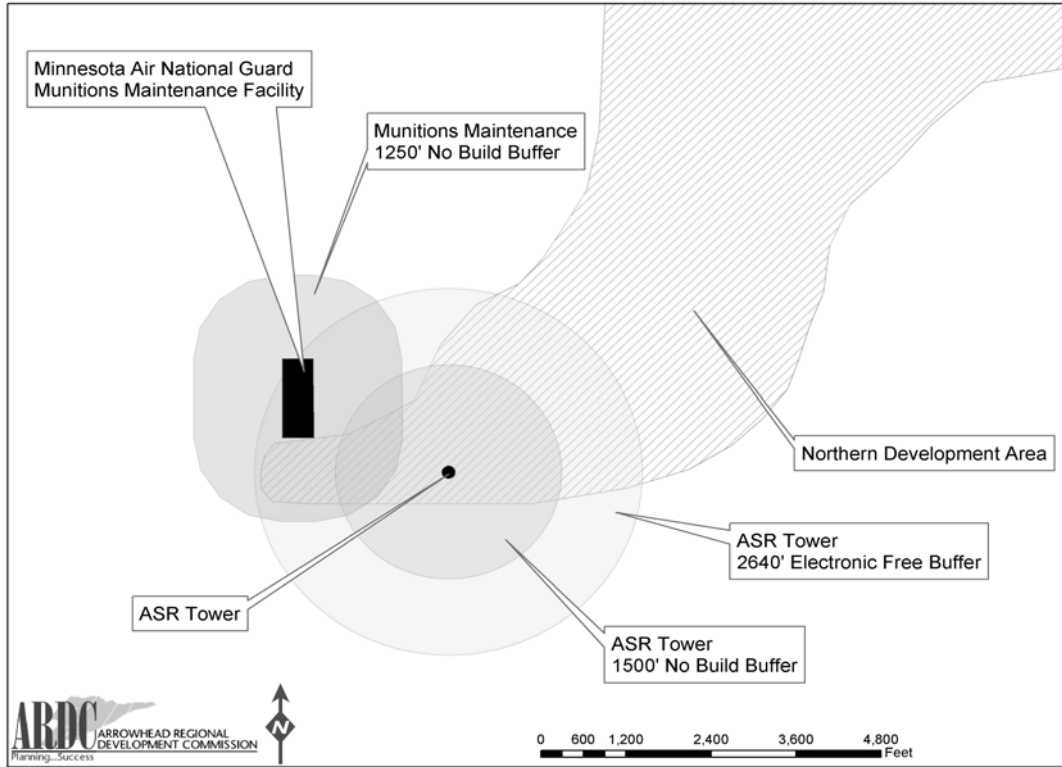


Figure 7. ASR and Munitions Maintenance Facility and restrictive buffers.

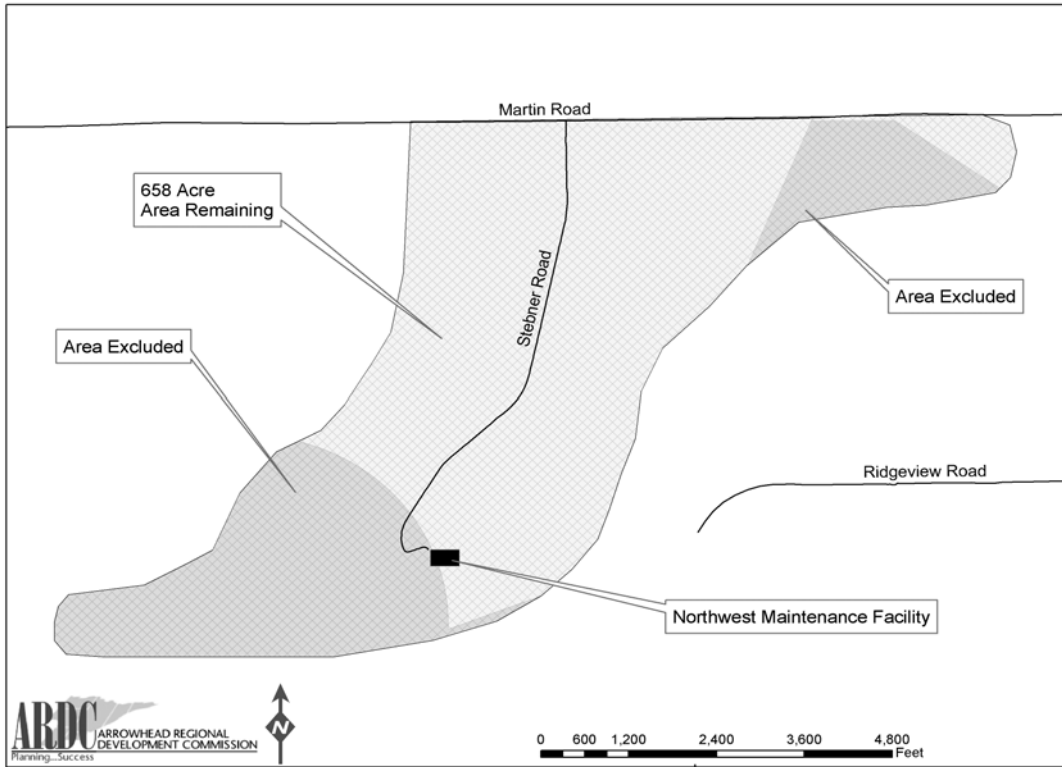


Figure 8. 304 acres excluded from the Northern Development Area prior to wetland evaluation.

8).

Using the Xtools extension in ArcView, the portion of the Northern Development Area that was still in consideration as an immediately developable parcel was used to clip the wetland coverage (Figure 9). Once the wetland coverage was clipped down it was possible to determine, by erasing remaining “developable” features with the clipped wetlands, that 255.5 acres of the Northern Development Area would have to be excluded from consideration due to the parcels consisting of some sort of wetland. At this point the remaining portion of the Northern Development area was considered a “most immediately developable” parcel based on no need for wetland remediation on these sites and few restrictions in regard to FAA and MNANG safety zones (Figure 10).

The final analysis that was

completed consisted of a distance to utilities and roads analysis for the remaining 402.5 acres in the Northern Development Area. The distance analysis would generally allow for a “rank” of all parcels that could be considered for development. If development were to occur in the remaining “suitable” sites for development, utility services would need to be extended. Presently, the City of Duluth Water and Gas Department has 10-inch water and gas mains extended to the Northwest Airlines Maintenance Facility. Both of these services are capable of expanding in the event of future development. Sanitary sewer service, including a force main, gravity main and lift station, have been extended to the Northwest Airlines Maintenance Facility. The existing sanitary sewer system has the capacity for expansion in the Northern

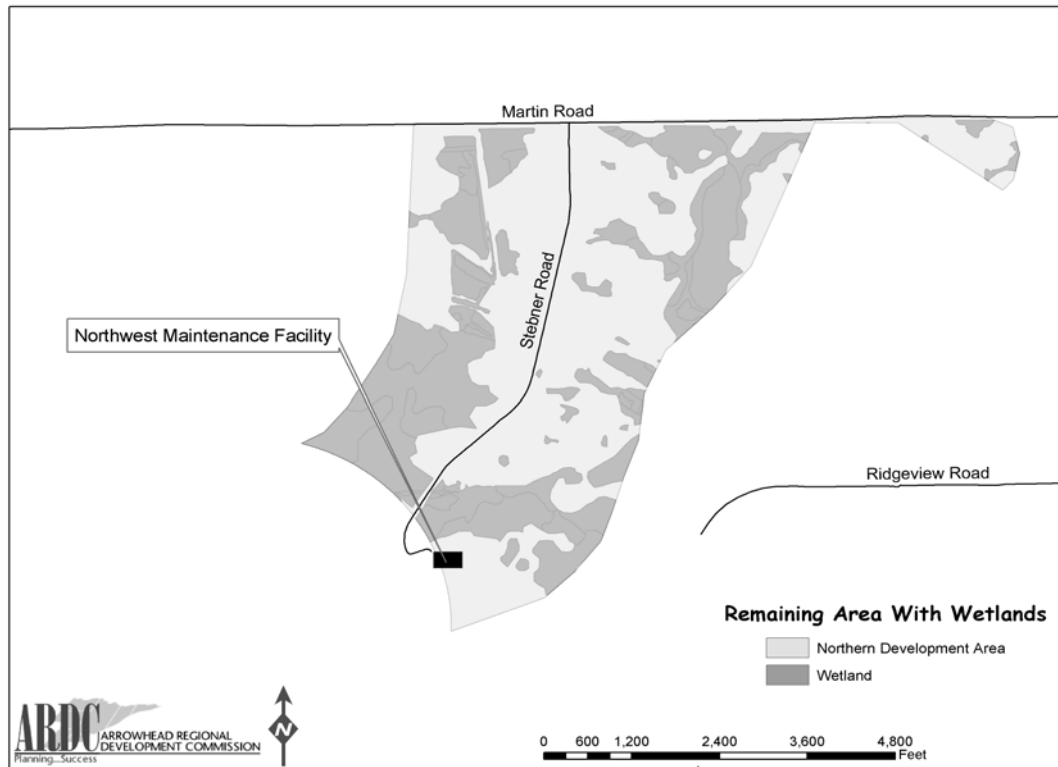


Figure 9. Remaining 658 acres of the Northern Development Area with underlying wetlands.

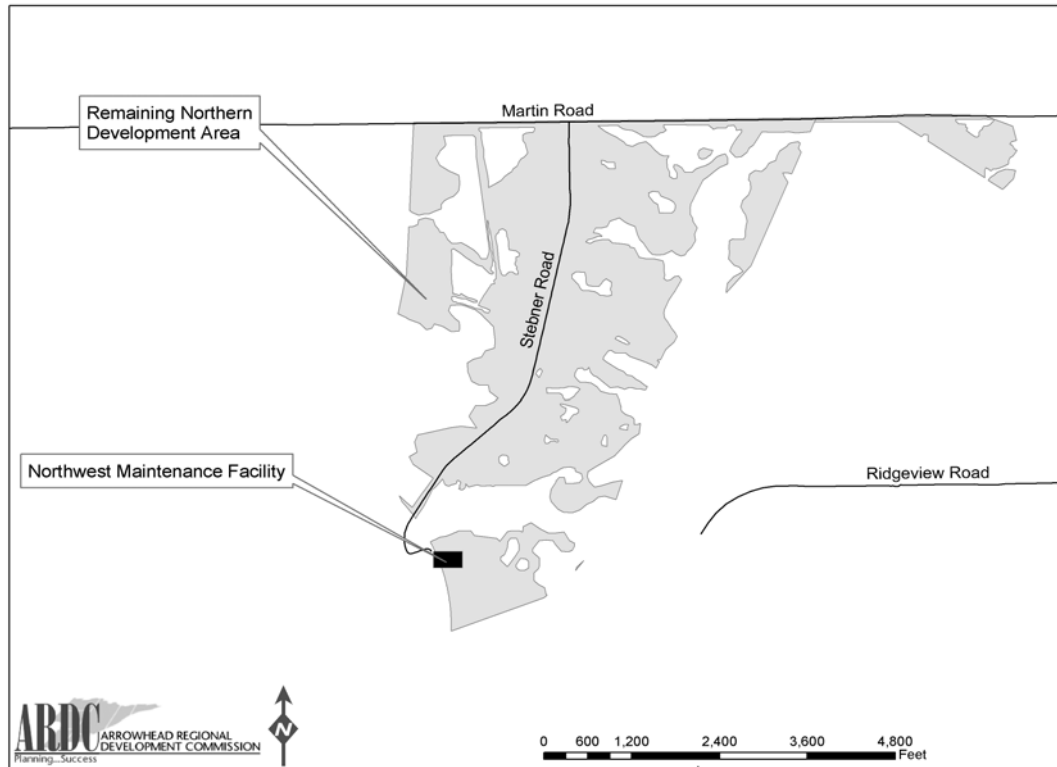


Figure 10. Remaining Northern Development Area with exclusion of 255.5 acres of wetland.

Development Area (Aviation Economic Development Plan). Since the likeliest extension of sewer and water service would begin from the Northwest Maintenance Facility, 1000 ft buffers from each existing utility were created in ArcView. Due to the Northwest Development Area being approximately 8000 feet in length, eight buffers were used (Figures 11-12). To determine the estimated cost of extending sewer and water service, the average cost per foot values were obtained from the City of Duluth Public Works and Utilities Department. The average cost per foot is as follows: \$70/foot for average depth and minimal street repair, \$85/foot for moderate amounts of pavement repair and \$100-125/foot if rock is encountered. There is no charge for extending gas services. The following

table outlines the potential costs for extending sewer and water service (Table 2).

After determining the average cost per 100 linear feet of utility

Table 2. Cost distance analysis of sewer and water utilities.

Distance (Ft.)	Average Cost (\$)	Mid Cost (\$)	Highest Cost (\$)
1000	70,000	85,000	100,000
2000	140,000	170,000	200,000
3000	210,000	255,000	300,000
4000	280,000	340,000	400,000
5000	350,000	425,000	500,000
6000	420,000	510,000	600,000
7000	490,000	595,000	700,000
8000	560,000	680,000	800,000

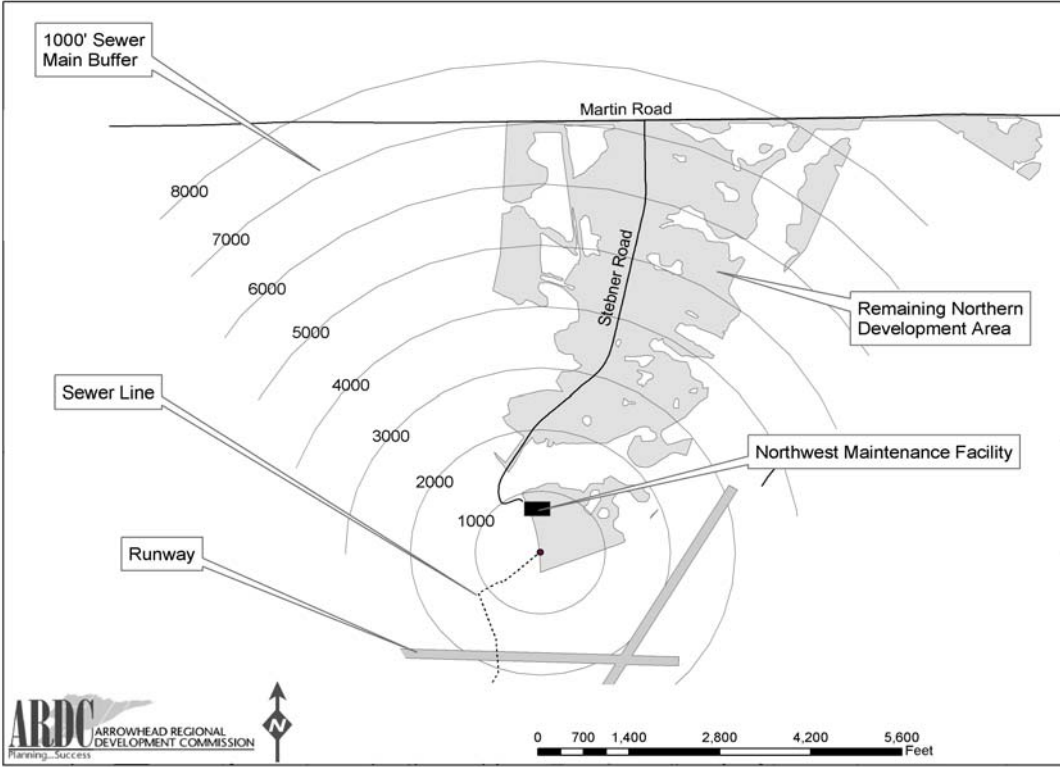


Figure 11. 1000-foot sewer utility buffers.

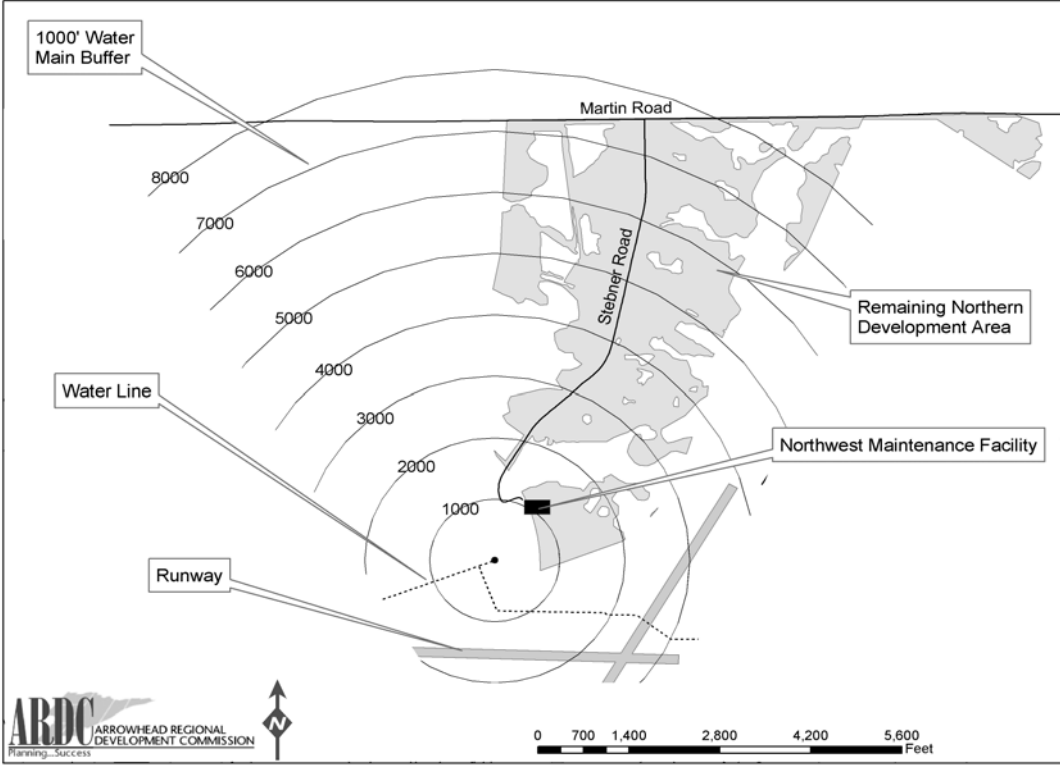


Figure 12. 1000-foot water utility buffers.

extension, it was possible to “rank” the remaining areas of the Northern Development Area to determine parcels that would be the most cost effective to develop. The following figure shows the remaining areas of the Northern Development Area after considering airport safety and wetlands. The remaining areas are shaded to show an increase in cost per 1000 feet of utility service (Figure 13). The figure clearly shows areas in the Northern Development Area that can be developed without wetland mitigation, minimal safety concerns and estimated cost of utility extension. Clearly, if cost were the greatest concern, areas near the Northwest Maintenance Facility would be the most suitable for development. Also shown on figure 13 are the parcel divisions for the Northern Development area. It was expected that the parcel

map would play a large role in this project and therefore much time was put into its development. Unfortunately, the only role the parcel map had was to identify ownership and current land use of parcels that would be optimum for future development. It is expected that the results of this analysis can be used as a tool in guiding the development of the Northern Development Area, which would be of great economic benefit for the Duluth International Airport, City of Duluth, City of Hermantown and the State of Minnesota. This analysis can also be of great benefit to perspective developers in their site selection process and could be easily modified to meet any specific objectives they may have.

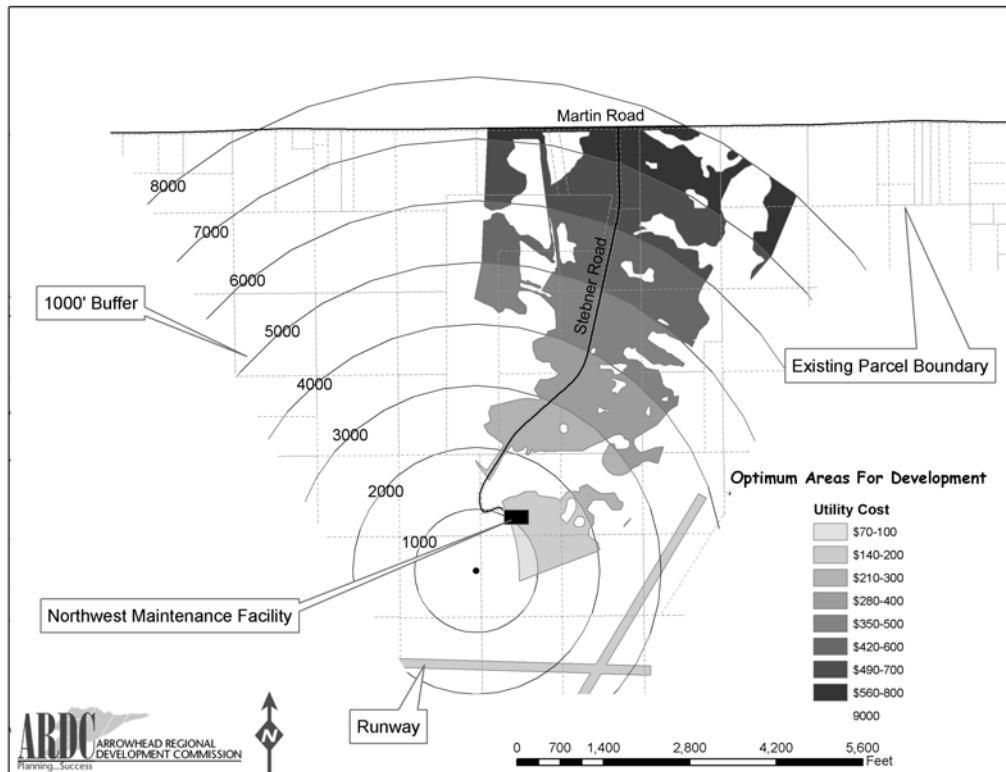


Figure 13. Optimum areas meeting all development requirements in the Northern Development Area.

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