COMMUNITY AREA STUDY -- OLD JAMESTOWN AREA

An evaluation of a part of unincorporated St. Louis County for the St. Louis County Planning Commission, with the participation of the Old Jamestown Area Advisory Committee. Prepared by the St. Louis County Department of Planning. Adopted by the Planning Commission on April 4, 1988.

Below are pages 20-25 of the study. The full report is available at:
http://www.stlouisco.com/Portals/8/docs/Document%20Library/planning/community%20planning%20and%20revitalization/north%20county/Old%20Jamestown%20Community%20Area%20Study.pdf

ENVIRONMENTAL FEATURES

Analysis

Since World War II, St. Louis County has experienced a period of phenomenal population and housing growth (144 and 217 percent respectively). As development accelerated to meet this growing demand, urbanization moved away from the City of St. Louis and those surrounding inner-ring communities to areas adjacent to the system of major arterials that crisscrossed much of the remaining rural land in St. Louis County.

Historically, the land that was first developed has been relatively free of the physical constraints that characterize much of today's remaining acreage. Construction and engineering costs of this early development were relatively low. Often these lands had little or no forest cover, had slopes of less than ten percent, were not in the floodplain, and were free of restrictive surface or subsurface conditions that would otherwise render them unsuitable for development.

Today, conditions have dramatically changed. Much of the remaining undeveloped or vacant land can be classified as marginal or restrictive especially for intensive residential and commercial development. Several environmental conditions contribute to this; they are:

a) extensive forest cover,
b) moderate to steep slopes (usually greater than ten percent) and irregular terrain,
c) unfavorable soils or geologic conditions, (such as outcrops or sinkholes) or
d) location within a floodplain.

In many cases these environmental conditions can be mitigated to allow for development. However, development will be more expensive in terms of the engineering and contruction costs, and each development will have to acknowledge the carrying capacity of the land or cause environmental degradation. In such cases, no further development should be encouraged without corrective measures and existing development should be prohibited from compounding the problem.

St. Louis County has instituted a policy requiring the submission of geotechnical reports for certain developments in areas considered potentially unsuitable because of soil or geologic conditions. These reports are meant to review the suitability of a particular development, given the physical properties of the bedrock and overlying unconsolidated materials onsite. With the assistance of the Department of Geology and Land Survey of the Missouri

Department of Natural Resources, an established 18-unit classification system based on topography, soils, drainage and engineering properties of soils was adapted to use as an indication of need for a geotechnical analysis. Eight of the eighteen units have been designated as requiring report submission for the entire County. Within the Old Jamestown Study Area, two of the eight units are present. These units, IIb and IIc, occur over all but the western and northern perimeter of the study area, including all the area where sink holes also occur. Consequently a geotechnical report would be required throughout the area influenced by karst formations. In addition to other factors of soil stability given consideration in the reports, the influence of sinkholes on construction design and technique should be highlighted as related to structural, road, stormwater, and other utility improvements. Groundwater effects should likewise be addressed as related to active sinkholes. Findings of a geotechnical report are applied during review of subdivision plats and improvement plans, and where appropriate, reflected in ordinances formulated for special procedure zonings.

Many of these limiting environmental conditions do exist in the study area. Through an inventory process, aimed at revealing the natural features and characteristics that are intrinsic to the study area, road physiographic regions depicting the existing environmental status can be derived. Three such physiographic regions were identified by this process within the study area. They are:

- approximately four square miles of the study area's seven and a quarter square miles are characterized by a karst-type topography (upland areas, low relief with numerous surface depressions, rapid groundwater percolation, and few surface streams)

- approximately one square mile of the study area is characterized by rolling or steeply rolling hills (upland areas, dissected by numerous small streams; erosion has been severe along steeper slopes, and slopes generally range between ten to over twenty percent)

- the remainder is characterized by a smooth rolling-type topography (upland areas, average slope varies between five and fifteen percent, portions located within the Coldwater Creek floodplain, and extensive forest cover in that floodplain)

Within these regions, environmental conditions can vary based upon the actual site-specific location.

The region of karst topography located in the study area is recognized as being one of the finest examples of deep funnel-shaped sinkholes in the central United States. This type of topography presents serious constraints to urban development. Problems associated with karst topography include: soil creep near sinkhole depressions, localized flooding around those features, and potential groundwater contamination from stormwater runoff and sewage effluent.

An upland area of rolling to steeply rolling hills borders the Missouri River and forms an impressive escapment from the vicinity of Pelican Island to the Columbia Bottoms area. This type of topography limits urban development when slopes are greater than twenty percent. Problems associated with development on steep slopes include increased erosion and foundation instability.

There are large areas of nearly level land located in the study area. This type of topography does not usually inhibit urban development. This area is concentrated along Lindbergh

Boulevard from east of Old Halls Ferry Road to west of Highway 367 (Lewis and Clark Boulevard).

Much of the physiographic uniqueness of this area is attributable to the underlying geology. Climatic conditions, acting over long periods of time on these rock units, have shaped relief, elevation, and slope. Those rock units which are exposed in the Old Jamestown Study Area cover three separate geologic time periods, each of which reflects different environmental conditions at the time of deposition, and a distinct interval of time or age in earth history. A detailed analysis is included in the Appendix.

Karst Formations

With approximately four square miles of the study area being directly influenced by some visible type of karst feature, an understanding of the basic concepts surrounding their formation and the potential environmental risks they present is essential to the implementation of planning recommendations and guidelines for affected sites. Without consideration of this information, recommendations and guidelines that have been developed may not be correctly tailored to all the environmental concerns.

Four conditions are essential to the development of karst topography. Each condition exerts a level of influence on the development of karst features in the area. In the Old Jamestown Study Area, these features have formed in ideal conditions.

The first condition that is integral to karst development is the presence of a soluble rock type at or near the surface; typically this is a limestone. The karsted areas in Old Jamestown are underlain by the St. Louis Formation which is a limestone.

The second condition fundamental to the development of karst features is that the shallow bedrock be a soluble rock type which is also dense, highly jointed, and usually thinly bedded. This results in numerous vertical and horizontal joints through which water is transmitted, slowly enlarging the openings by dissolving the rock. This is a point that is frequently overlooked when karst topography is discussed. Often, it is assumed that the major prerequiste for karst formation is the presence of a permeable or porous limestone. As a matter of fact, mass permeability is unfavorable for the formation of the cavities by dissolution. Permeability as permitted by numerous joints and bedding planes is ideal. If a rock is highly porous and permeable throughout, rainfall will be absorbed en masse and move through the whole body of the rock rather than be concentrated along joints which is essential to karst formation. In the study area, the St. Louis Formation is a dense, thinly bedded, and highly jointed limestone, perfect for karst development.

The third condition which favors the development of sinkholes is the existence of an entrenched valley which lies lower than the upland area which is underlain by the soluble and highly-jointed rock unit. This condition favors the collection and downward movement of the groundwater through the rock. Good water circulation is a prime prerequisite; moving water encourages solution (the dissolving of the rock). The Missouri River watershed encompasses the entire karst region in Old Jamestown.Groundwater flow is directly into the Missouri River from this watershed.* The Missouri River, since the last glacial episode, has continued to cut through soil and rock layers in forming this substantial entrenched valley. The karst plain in the Old Jamestown Study Area lies above the valley floor of the Missouri River, thereby facilitating the movement of groundwater through the subterranean drainage system. [* Groundwater flows documented in the St. Louis County Department of Planning's report titled, Analysis of Five Watersheds, p.8c. (Prepared for the U.S. Army Corps of Engineers as part of the Metro Study, 1976.)]

Finally, the fourth condition is the occurrence of adequate rainfall. Without sufficient amounts of precipitation, groundwater movement is slowed and, as a result, solution of the limestone would be reduced to inconsequential levels. The St. Louis Metropolitan Area receives in excess of 33 inches of precipitation annually. This amount of precipitation is more than sufficient to continue to power the karst cycle.

It is apparent that the four conditions essential to karst development exist in the Old Jamestown Study Area and have etched a distinctive landscape. Landforms that are characteristically found in karst regions, including the Old Jamestown Study Area, include:

1) Sinkholes - depressions that vary in depth from a mere indentation of a few feet to a maximum of 200 feet or more. In area, sinkholes can range from a few square yards to several acres. The most common form is a funnel shape which broadly opens upward.

2) Sinkhole ponds or karst lakes - sinkholes which have become clogged with inwashed clay to such an extent that they will hold water above the regional water table.

3) A karst plain - a plain on which sinkholes, subterranean drainage, and other karst features are developed.

4) Disappearing streams or losing streams - surface streams that disappear underground into a sinkhole.

These physical features are the outward sign that solution has occurred and is continuing to occur beneath the soil layer. The resultant landform can eventually dictate the location and level of development in a karst area. This becomes a consideration because of the fragile nature of a karst environment. For example, a system of sinkholes can act as a virtual sieve allowing large volumes of surface water and groundwater to move throughout the system. With the ability to move water at this high rate, groundwater degradation becomes a major concern due to the limited amount of filtration the water receives as it passes through the soil and rock layers.

Similarly, sewage effluent can present an even greater problem in a karst area. Without adequate filtration, sewage effluent, especially from septic systems, can enter the groundwater system virtually untreated. It is important that in karst areas, septic systems be properly installed, maintained, and regularly monitored to insure compliance to accepted standards of operation. A mechanically aided aeration septic system generally is needed because of steep slopes and the presence of sinkholes which reduce the possible size of the fields.

The basic hydrology of a karst area, as has been shown, is the movement of groundwater through the rock units along joints and bedding planes. Karst areas generally seem to remain relatively stable over time. This can be attributed to the protracted rate at which solution occurs. Concerns have been expressed that new development in this area will cause increases in stormwater runoff, groundwater depletion, and the discharge of sewage effluent, thereby speeding up the rate of solution substantially, and that this increased rate will then lead to incidences of sinkhole collapse and groundwater degradation.

Although, there are numerous examples of these occurrences happening across the country, this may not always be the case. Each karst region, whether it be Florida, Indiana, Kentucky,

New Mexico, or Missouri, is unique and will react differently to changes in the karst cycle. Because of the variability among regions, it is imperative that the recommendations and guidelines be area-specific and actually address conditions that exist in that area. Influences that have shaped events in Florida, like sandy soils, a high water table, and a sub-tropical climate, are not all characteristic of the Old Jamestown Study Area. If parallels are too tightly defined between different geographic regions, those intrinsic characteristics that govern how soil and rock units will react to natural or man-made changes are not really being taken into account. Ideally, to insure this does not occur, each new building site should have a detailed on-site soil and geologic investigation performed to identify these characteristics.

Future implementation of recommendations and guidelines should reflect existing conditions in the area along with sound engineering and design principles. The Missouri Department of Natural Resources has developed an "Empirical Rating System" to be used in the determination of limitations for the siting of individual liquid-waste disposal systems. It is described in Engineering Geology Report #7, Geologic Aspects of Individual Home Liquid-Waste Disposal in Missouri. Limitations in the study area correlate to at least a moderate range and indicate that significant groundwater pollution hazards exist. Application of the empirical ratings system should be repeatedly applied in the future to avoid sites or circumstances where a "severe range" of limitations is present. In that case it is indicated that "regional groundwater contamination is likely" and that the "hazards are so severe that elaborate and costly engineering procedures may not be totally successful."

There are a number of general characteristics that all the karsted areas in Old Jamestown exhibit; these provide an overall framework for the development of more specific recommendations and guidelines. These characteristics are:

1) The area has a high aesthetic value given its unique landscape.
2) The ridges between sinkholes generally offer the best potential building sites.
3) The sides of sinkholes characteristically have slopes that are too severe (9 to 30 percent) to permit development.
4) The bottoms of sinkholes are unsuitable for development since they act as natural drainage points for the area.
5) Karst areas are generally unsuited for man-made water impoundments.

Laclede Gas Company's Storage Facility

The largest, single landowner in the Old Jamestown Study Area is the Laclede Gas Company. Currently, this utility owns in excess of 550 acres. This represents just under twelve percent of the total area within the study boundaries. Because of this ownership, the Laclede Gas Company has and will continue to exert a strong influence in the area.

These underground storage facilities and the surrounding 550 acres are situated just south of Old Jamestown Road along Sinks Road. The entire Laclede Gas Holdings lie in the karsted region of the study area. Physiographically, this means the area is characterized by numerous surface depressions (sinkholes) ranging from a fraction of an acre to about two acres in size, a limited number of well-defined surface streams, localized shallow water impoundments in some of the surface depressions, rapid groundwater percolation, and low relief. Additionally, due to the nature of this facility's operation, the terrestrial community has remained relatively unchanged over the past three decades. Portions exhibit an extensive forest cover (oak and hickory), or where clearing has occurred, lie idle or in pasture. This area provides an excellent habitat for a variety of wildlife (white-tail deer, gray squirrel, cottontail rabbit, opossum, raccoon, etc.) and birds, representing an unmatched open space in an urbanizing area.

At this time, the Laclede Gas Company operates a storage and transmission facility for propane and natural gas. Also on site are a number of oil producing wells. These wells annually produce over 8000 barrels of crude. The crude oil production is a by-product of the storage process. This facility currently carries a 29 billion cubic foot inventory of natural gas and a 33 million cubic foot inventory of propane. Interestingly, the propane is used as an additive to the natural gas during periods of extreme cold to enhance its heating content. Essential to the operation is a variety of wells, piping, storage facilities, and transmission equipment. Presently, on site, there are 28 observation wells, 50 injection/withdrawl wells, a man-made propane storage cavern, and 6 recapitulating compressors for injection purposes.

Representatives from the Laclede Gas Company have stated that their current policy calls for the facility with its surrounding 550 acres to be operated essentially in its current capacity over both the short-term and forseeable future, and felt it would be impossible to predict any change at this time.

Drainage Areas

The surface drainage of water within the study area is divided between three watersheds. Roughly one-third drains southward to the Cold Water Creek watershed and the balance drains toward the Missouri River in the Mill Creek Watershed or the Missouri River Sub. 3 Watershed. It is within the Mill Creek and Missouri Sub. 3 Watersheds that karsting occurs. This results in an additional watershed, in a functional sense. Surface water within this karst watershed does not flow directly to tributaries leading to the lowest point in the watershed. Instead, it may flow to the ground water or other unidentified discharge points.* The ridge lines which separate these drainage areas are shown on Map 4. It should be noted that the confluence of Cold Water Creek with the Missouri River is near, but not within the study area.
[* Watershed boundaries taken from the Zurheide-Hermann and East-West Gateway Coordinating Council report, St. Louis County Water Pollution Control
Study Phase II - Areas Tributary to the Missouri River, p. 19.]

As previously noted, the presence of sinkholes influences the stormwater drainage of the area. However, it is impossible without further geologic data, to determine the relation of the surface water in the watershed to groundwater within or adjacent to it. As shown on Map 4, the sinkholes tend to be concentrated in the Missouri River watershed. This results in an irregular pattern of surface water drainage which is a function of localized variations in slope and sinkhole location. Normally, a well-defined network of tributaries forms as a result of erosive forces and collects surface water within a watershed, finally discharging it at the lowest point. In the karsted area, the sinkholes intercept this runoff and interrupt the formation of the usual stream tributaries. This complicates the prospect of improving stormwater drainage where such discharges must be prohibited from going into sinkholes. Still more difficult to accommodate are discharges from wastewater sources which are more critical than stormwater discharges as a source of ground water pollution. In order for sewage treatment in this general area to be centralized at the Coldwater Creek Treatment Facility, it would be necessary to provide force mains and lift stations to convey it over the ridge line separating the watersheds. If not collected and centrally treated, such discharges must necessarily remain within the watershed and consequently in the vicinity of karst formations. The "Empirical Rating System" developed by DNR (pg. 24) substantiated by other findings and engineering studies, should be applied during the review of affects of both new and existing development in the karst area. The cost of either a central or adequate household system is escalated by the karst topography.