

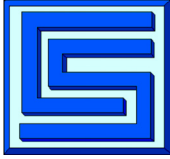
APPENDIX H

Drainage and Hydrology Constraints Report

Introduction

Appendix H provides a copy of the Drainage and Hydrology Constraints Report prepared by Civil Engineering Solutions Inc. This report presents a list of drainage-related constraint issues and identifies hydraulically sensitive areas within the proposed General Plan growth area along with proposed guidelines for developing within and around these areas.

Please see the next page.



**CIVIL ENGINEERING
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Memorandum

To: Rod Campbell
Of: City of Lincoln
Community Development Department

From: Thomas S. Plummer

Job Number: 2001.08

Re: General Plan Update – Drainage and Hydrology Constraints.

Date: February 14, 2006

Dear Rod:

The enclosed document, provides information relating to the impacts and constraints issues, per the Preferred General Plan Update scenario. Please consider the enclosed information, and advise us of any additional information you may require to complete your review.

If you have any questions or comments please contact me at (916) 563-7300.

Sincerely,

Thomas S. Plummer P.E.

CITY of LINCOLN

GENERAL PLAN UPDATE

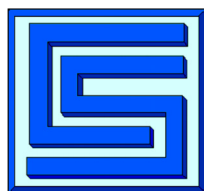
2004
Updated 02-2006

DRAINAGE and SURFACE WATERS

IMPACTS AND CONSTRAINTS

SUMMARY

By:



Civil Engineering Solutions, Inc.

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I. Introduction:

Civil Solutions has performed a detailed review of the proposed land use scenario for the General Plan Update. We have performed impact analysis of the development expansion areas to the local and regional drainage systems. We have listed drainage related constraint issues. We have also identified hydraulically sensitive areas within the expansion and have proposed guidelines for developing within and around these areas.

Exhibit SH-1 shows the current General Plan Area and the floodplain limits of the creeks and tributaries within and adjacent to the current City of Lincoln limits and sphere of influence. The predominant surface water feature in the south area of City of Lincoln is Auburn Ravine. A multi-threaded stream group, known as Markham Ravine, within the central and northern areas of the City is also visible. Further to the north, generally outside of the northern boundary of the City is Coon Creek.

Nearly all of the City lands are tributary to the stream groups listed above, which are tributary to the North Drainage Canal of the Natomas Cross Canal. The exception being at southeast corner of the Twelve Bridges development where approximately 60 acres of land is tributary to Pleasant Grove Creek, which ultimately drains to the Pleasant Grove Canal of the Natomas Cross Canal. The Natomas Cross Canal collects the waters of the North Canal and the Pleasant Grove Canal and conveys them to the Sacramento River.

This analysis will focus on the North Canal tributaries.

EXHIBIT SH-1 – LINCOLN WATERSHED PLAN

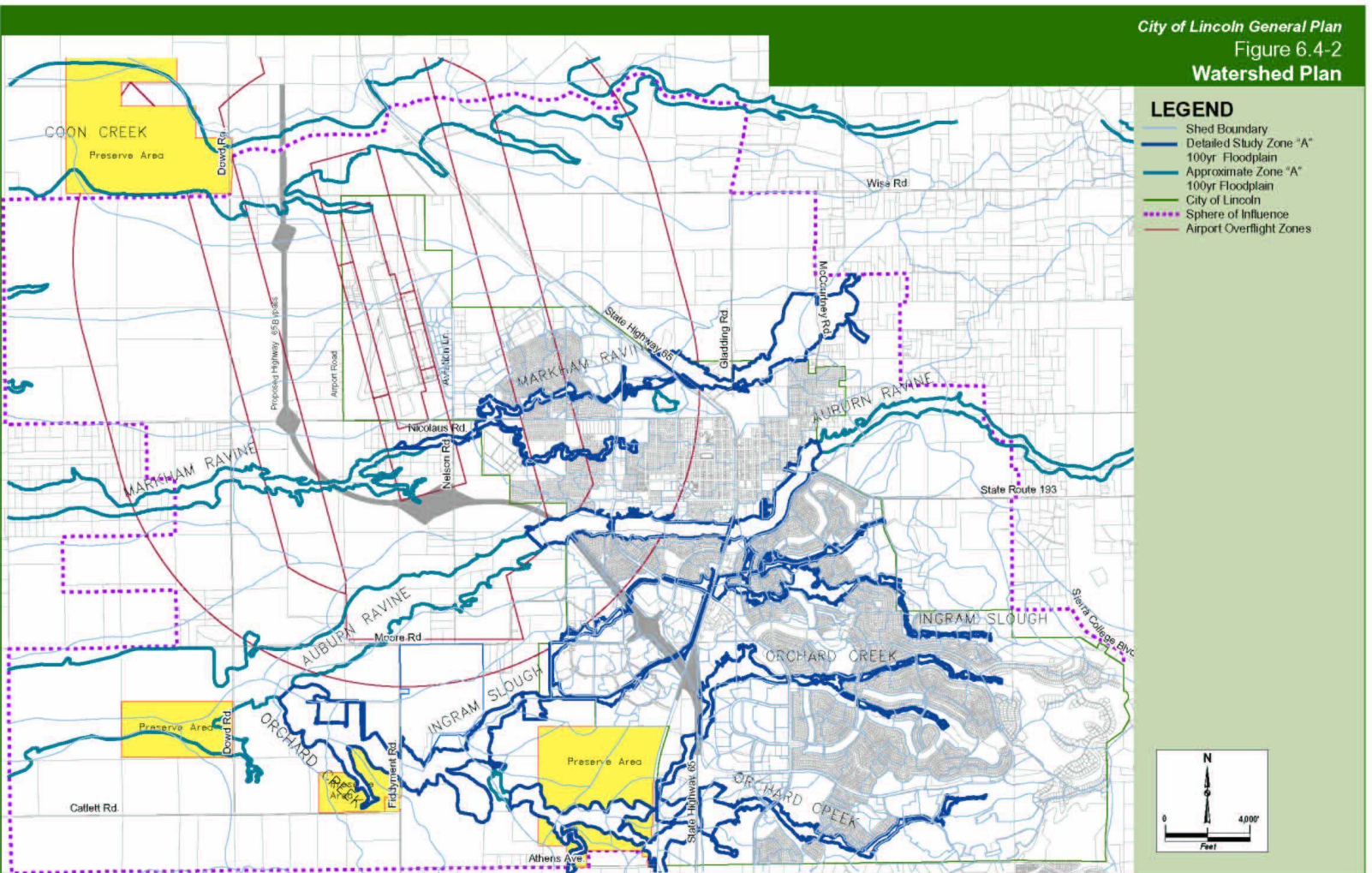
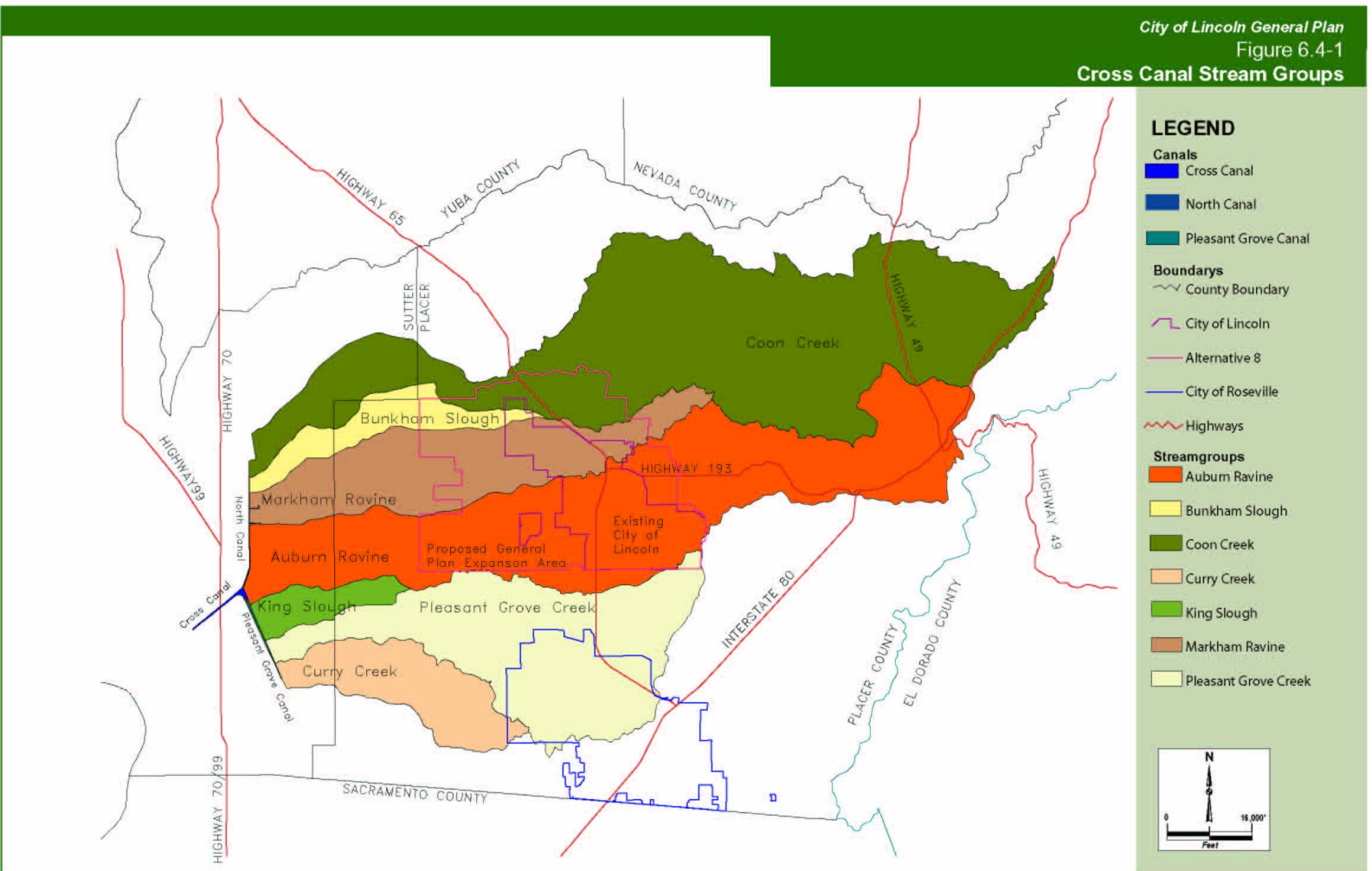


EXHIBIT CC-1 – NATOMAS CROSS CANAL WATERSHEDS



A. Auburn Ravine and the South Lincoln Master Drainage Plan:

The main channel of Auburn Ravine borders the southern limits of the “downtown” area of the City, and divides the “older” established areas of the City from the new Twelve Bridges, Lincoln Highlands, Lincoln Crossings, 3D, and Aitken Ranch developments. Auburn Ravine conveys stormwater runoff and irrigation waters (NID) in a westerly direction. Approximately 30 square miles of area are tributary to Auburn Ravine east of the City Limits, with an estimated peak 100-year flowrate of 14,500 cubic feet per second. Auburn Ravine extends east into the foothills and into the City of Auburn. West of the City of Lincoln, the Ravine combines with Orchard Creek and continues westerly beyond Placer County and into Sutter County, ultimately draining into the North Drainage Canal of the Natomas Cross Canal.

The Auburn Ravine watershed includes several smaller tributaries south of the City, including Ingram Slough and Orchard Creek. Ingram Slough is directly south of Auburn Ravine, and generally occurs as a dual threaded system with northern and southern reaches. Occasionally, the reaches combine and separate throughout the system. East of State Route 65, the Northern Reach is a larger system than the southern reach. Upstream of State Route 65, the two reaches combine to pass through a single bridge, and are separated again west of State Route 65, where the southern reach has the larger conveyance capacity. Much of Ingram Slough has been reconstructed from the pre-development condition manmade irrigation ditch, to a larger capacity, more natural appearing channel feature, with lakes, wetlands, and grassy areas. East of State Route 65, an overflow condition has been maintained, where flows in large storm events overtop the southern bank of Auburn Ravine and are transferred to Ingram Slough. In the 100-year storm event, this transfer flow rate is expected to be approximately 4,000 cubic feet per second. Ingram Slough discharges into Orchard Creek just east of Fiddymment Road.

South of Ingram Slough is the multi-threaded Orchard Creek Stream Group. East of State Route 65, there are two main threads within this City of Lincoln, and smaller fingers extending southeasterly into the City of Rocklin. The smaller fingers converge on the southerly thread of Orchard Creek near State Route 65. The two main threads combine west of State Route 65. Orchard Creek joins Auburn Ravine approximately 1.5 miles west of Fiddymment Road.

The areas tributary to Auburn Ravine, within the City Limits, were studied as a joint project in the “South Lincoln Master Drainage Plan” in 1998. Detailed Stream models for Auburn Ravine, Ingram Slough and Orchard Creek were performed with that analysis, and have been maintained current by Civil Solutions. An application for a project-wide “Conditional Letter of Map Revision” (CLOMR) was submitted to FEMA in 2003. Based on the advise of the Department of Water Resources agent, the submittal was withdrawn, and the application documents were revised for a “Letter of Map Revision” (LOMR) submittal which will be submitted in October of 2004. The LOMR will be based on the As-built conditions of the project to-date.

Impacts analysis for the 24-hour 2-year, 5-year, 10-year, 25-year, 50-year and 100-year storm events were determined, and detention quantities were identified within the Orchard Creek watershed. It was shown in the analysis that the placement of significant quantities of detention

within both the Ingram Slough and Orchard Creek watersheds, could increase peak flow rates in Auburn Ravine, downstream of the City, by making the timing of the peak flows of Orchard Creek and Auburn Ravine occur more closely. As a result detention was recommended within the upper reaches of Orchard Creek only, to account for the entire projects.

A volumetric impacts analysis was also performed with the SLMP to evaluate the impacts of the developments in the 8-day 100-year storm event. The total project wide impact was determined to be 634 AF. In May of 2004 Civil Solutions inventoried the estimated current level of impact in the SLMP as shown in the following table.

SLMP RETENTION IMPACTS
RETENTION FACILITY REQUIRMENTS
CURRENT ESTIMATED STATUS - May 2004

PROJECT IMPACT ITEM	TOTAL REQUIREMENT	% COMPLETE	CURRENT EST VOL REQUIREMENT
DEL WEBB	286	0.75	214.5
TWELVE BRIDGES	150	0.3	45
LINCOLN CROSSINGS + 3D North and South	153	0.3	45.9
AITKEN RANCH	26	0	26
WASTEWATER TREATMENT PLANT	11	1	11
100-YEAR ENCROACHMENT AREAS MITIGATION	34	1	34
	660		376.4

Phase I of the SLMP Mitigation Facility was constructed south of the new Sewer Treatment Plant located at Fiddyment Road, south of Moore Road. Phase I of the facility was built to an estimated capacity of 357 acre feet. This City plans to expand the facility with Phase II and Phase III to a volume of roughly 720 AF in the construction season of 2007, or relocate the volumetric storage facility to an alternate location with more storage capacity in the construction season of 2006.

B. Markham Ravine:

Markham Ravine drains the central areas of the City of Lincoln, and areas north of the existing developed areas. Through the City of Lincoln, Markham Ravine consists of three threads.

The main thread is the Central Branch of Markham Ravine, passing through the City from the East (at the Gladding and Aguiar properties) to the west-southwest. Approximately 3 square miles of rural and partially developed land are tributary to the main branch, east of State Route 65.

The southern thread collects runoff from the central and western areas of the City, west of State Route 65. This tributary to Markham Ravine has been placed into a pipe system throughout most of the developed area of the City. The pipe daylight to a channel system near the intersection of "O" Street and "8th" Street. From this location the flows are channelized west to Joiner Parkway. West of Joiner Parkway flows return to a natural swale flowing generally west and then northwest, joining the main branch of Markham Ravine near Nicolaus Road.

The northern thread of Markham Ravine, also known as Clay Creek, enters the City of Lincoln, crossing State Route 65, at the “Foskett Ranch” subdivision. The tributary remains in a natural swale flows westerly through the Foskett Ranch property. At the project boundary, the creek has been channelized along the north side of Venture Parkway, to the intersection of Lakeside Drive. West of this intersection, the creek flows are piped approximately 1700 feet to a detention basin located along the northern boundary of the Teal Hollow Subdivision. Beyond the culvert restriction at the west end of the detention basin, the flows are returned to the natural swale for approximately 1800 feet to the junction with the main branch of Markham Ravine.

Development impacts within the City of Lincoln were previously evaluated in the following documents “Lincoln Airpark Flood Study” by Murray Smith and Associates in August 1994, and “Supplemental Environmental Impact Report for the General Development Plan Amendment Lincoln Airpark (AKA Aircenter) Project”, dated February 1986. The final studies recommended “stormwater retention facilities” as follows:

- ◆ Facilities of 6 acre feet (AF) and 17 AF at Clay Creek
- ◆ Facilities of 7 AF and 12 AF, near Aviation Boulevard.
- ◆ A 32 AF retention facility in the main branch of Markham Ravine near Lakeside drive.

The final configuration of these facilities as they were constructed was varied. The 32 AF facility near Lakeside drive was constructed as suggested. Channelized detention facilities were constructed as part of the industrial development along Aviation Boulevard to equal the recommended detention parameters. A 19 AF facility was constructed in Clay Creek downstream of Lakeside Boulevard, and detention was constructed in the upstream area of the watershed north of Venture Drive in order to reduce the required sizing of the trunk storm drainage system. The detention areas listed in the study included retention storage capabilities for the 10-year 24-hour volumetric impact estimates of 45 acre feet.

Additional evaluations for the “Foskett Ranch”, Lincoln Air Center, Lakeside Village #6, Cypress Meadows, and Lincoln Highlands projects have subsequently been performed and evaluated with the environmental reviews of each project. The subsequent studies have developed estimated detention estimates for the 24-hour 2-year, 10-year and 100-year storm events, and volumetric impact estimates for the 8-day 100-year storm event. This criteria is identical to the criteria of the City’s Stormwater management Manual (also the Placer County Stormwater Management Manual).

Civil Solutions has reviewed the floodplain models from the most recent FIS update for Markham Ravine. The hydraulic models were deemed to be valid and a good representation of the hydraulics of the Ravine. Civil Solutions has also reviewed the Hydrology basis for the computation of peak flowrates used in the hydraulic models. The hydrology model presented a good overall representation of the watershed characteristics, and peak flow rates at key nodes. However, when we verified the details of the model, we could not match the parameters used with the field observations. As part of the effort of the NLMDP, Civil Solutions recreated the hydrology modeling to include updated parameters from field observations, and updated topography maps. While the two models match up well at the Key locations referenced in the FIS, the two models are

substantially different everywhere in between. The differences do not significantly affect the hydraulics model, but minor changes will be referenced in the NLMDP. However, the updated model will be a much better reference base model for the determination of project impacts in the watershed, based on a better correlation with the existing watershed conditions.

C. Coon Creek:

Coon Creek borders the northern boundary of the proposed General Plan expansion. Roughly 60 square miles are tributary to Coon Creek upstream of State Route 65. The majority of the land of this tributary is currently in agricultural and ranch style use. Our research has not turned up any available detailed hydrologic or hydraulic analysis for this creek.

From inspection of aerial photos and the 10-meter Digital Elevation Model, Coon Creek is a single threaded creek north of the City. Runoff flows to the creek from several small lateral tributaries within the watershed.

There has not been any modeling of Coon Creek or potential impacts to Coon Creek from the City of Lincoln prior to the General Plan Update process (except for some minor shed diversion for zero impact work relating to the “Lakeside Unit 6” project).

Detailed impacts modeling for Coon Creek are being prepared concurrent to the General Plan Update with the “North Lincoln Master Drainage Plan” (NLMDP). Results of that analysis are presented later in this report.

It has not yet been determined when a detailed hydraulic analysis of the creek to define a floodplain with more accuracy than the “Approximate Zone A”, currently shown on the FIRM, would be required. It has been preliminarily proposed to be a second phase of the NLMDP.

II. History of Flooding:

A. Creeks

1. *Auburn Ravine:*

The City has recorded several flooding events in the recent past involving structures along the Auburn Ravine corridor and its tributaries in the City of Lincoln. In 1986, 1995 and 1997, the Auburn Ravine bridge structures at State Route 65, and State Route 193 were overtopped. The existing bridge at the Joiner Parkway crossing of Auburn Ravine did not flood in these events and would not be expected to flood in an event less than the 500-year. Downstream of the City of Lincoln, Flooding was also noted at the Moore Road and Nelson Lane crossings. Several smaller private crossings overtop frequently. Along the south bank of Auburn Ravine, west of State Route 65, Moore Road parallels the creek and is known to flood often. This road was abandoned with the SLMP improvements east of Joiner Parkway, and culvert improvements were made west of Joiner Parkway to improve conveyance capacity. Flooding of the roadway is still expected west of Joiner Parkway as a result of flood stages in Auburn Ravine greater than the 10-year event.

More Recently, the New Years Eve event of 2005/2006 did not result in overtopping of any of the main bridge structures along the Ravine (SR-193, SR-65 and Joiner Parkway). Moore Road along the south bank was flooded both east and west of Joiner Parkway. The Moore Road and Nelson Lane crossings were reported as overtopped. The storm was estimated to be a 10-year event for Auburn Ravine, and a lesser event in the tributaries.

In Orchard Creek, flooding of Fiddymment Road is expected in greater than the 5-year event. Flooding of private drives and agricultural fields is also noted in the SLMP floodplain analysis. Flooding at the Fiddymment Road crossing was not reported in the 12/31/05 event.

At Ingram Slough, significant flooding of the field areas on each side of the slough was noted prior to the construction of the SLMP improvements. Also, reports from local residents indicated that in 1986 and 1995, flows from Auburn Ravine overtopped the southern bank and flowed via overland release into Ingram Slough. The SLMP designed for this issue by constructing a control weir at the south bank of Auburn Ravine, upstream of State Route 65, and an interconnection channel to convey the spillway flows safely to Ingram Slough. Downstream improvements in the SLMP increase conveyance capacity to accommodate the combined flows from Ingram Slough and the Auburn Ravine spills. Flooding has not been experienced in the Slough since the construction of the SLMP improvements began in 1988.

In general the SLMP applied the following requirements for channel design factors with adjacent development areas:

- ◆ Low flow channels will be analyzed with an elevated 'n' value to accommodate the future potential for wetland type vegetation growth. Low flow channel will be designed to convey the normal dry season flowrate, including irrigation pass through flows and nuisance flows.
- ◆ Pedestrian trails will be placed no lower than the peak 2-year water surface elevation, and preferred to be above the 10-year peak water surface elevation.
- ◆ Excavated channels will be graded and planted to produce a natural looking appearance.
- ◆ Finish floor of any adjacent structure to be 3 feet above the design 100-year floodplain.
- ◆ Channel design and bridge structures to pass the 500-year design event below adjacent building pad elevations.
- ◆ Erosion protection: areas of 100-year velocities of 4 feet per second (fps) or less to receive hydroseed protection. Areas between 4 fps and 6 fps require a "lining" type protection (usually for this case a decomposable mat layer to assist in the establishment of grasses and root zones). Areas 6 fps to 8 fps require a "lining" type protection (usually this case requires a permanent mat material or rock). Areas 8 fps or faster require special evaluation for a lining material, usually rock slope protection or equal. Lake areas require protection at the normal pool elevation and far enough up and down slope to cover normal wave action. Potential for scour is evaluated at all bridges to determine footing depths or alternate of stabilizing the creek invert through the bridge to protect footings.

Following the initiation of the construction of the SLMP in 1998, no significant flooding has been recorded within the SLMP (other than the frequent flooding of Moore Road south of Auburn Ravine).

2. *Markham Ravine:*

Flooding within Markham Ravine is known to occur mostly in the rural areas of the City, where culvert and bridge crossings do not provide adequate capacity. East of State Route 65, flooding occurs at Gladding Road and McCourtney Roads annually. West of State Route 65, flooding has occurred at the low areas of Nicolaus Road (not at the bridge location). At Nelson Lane flooding is expected annually. The SR-65 Bridge is expected to overtop in storm events greater than the 10-year, and the Union Pacific Railroad Bridge is only expected to be overtopped in a 50-year or greater event. These estimates were supported by the 12/31/05 event.

Other private crossings of the Ravine are expected to overtop annually.

At the North Tributary, Clay Creek, shallow flooding in the remaining natural areas of the creek is still expected. The developed areas of the Creek are protected from flooding in the 100-year event.

At the southern tributary, 100-year protection is provided from Joiner Park, downstream to the City Limits. Shallow flooding beyond the stream banks is expected in flood events, in the natural stream areas downstream of Joiner Parkway. Upstream of Joiner Park, the

existing channel and storm drain systems may not provide 100-year protection to the existing residential areas in the 5th-8th Street Corridor between H Street and Q Street.

3. *Coon Creek:*

Very little is known about the flooding conditions of Coon Creek at this time. No detailed study of the watershed hydrology has been performed since the “Cross Canal Watershed Study” was performed by CH2MHILL in 1988. Civil Solutions recently verified shed boundaries for the Coon Creek watershed as part of an effort on the NLMDP, and found many issues with the watershed assumptions of the Cross Canal Study of 1988. We will be recommending that the City try to obtain County participation in producing a rectified hydrology study for the watershed, as part of the NLMDP efforts.

B. **Drainage Systems:**

Newer developing areas are required to provide a storm drainage system that conveys the 10-year peak flowrate with a minimum of 0.5 feet of hydraulic freeboard at inlet grates and manhole covers. They are also required to demonstrate that the 100-year peak flow rates can be passed within the storm drainage system and overland while maintaining a minimum 1.0 feet of hydraulic freeboard to pad elevations. For the projects which have developed in the past 10 years or so, we have verified that these guidelines will be met. Additionally, new systems are required to meet the “City of Lincoln, Design Criteria for Allowable Street Encroachments” identified in the improvement standards and the March 1998 Lincoln Stormwater Management Plan.

Within the historic areas of the City of Lincoln, there are 41 separately discharging storm drainage systems, which may not have been designed to these standards. Civil Solutions has reviewed the capacity of two of the main systems which have been noted to have flooding issues, the SR-65 Outfall system and the O&8th Street outfall system.

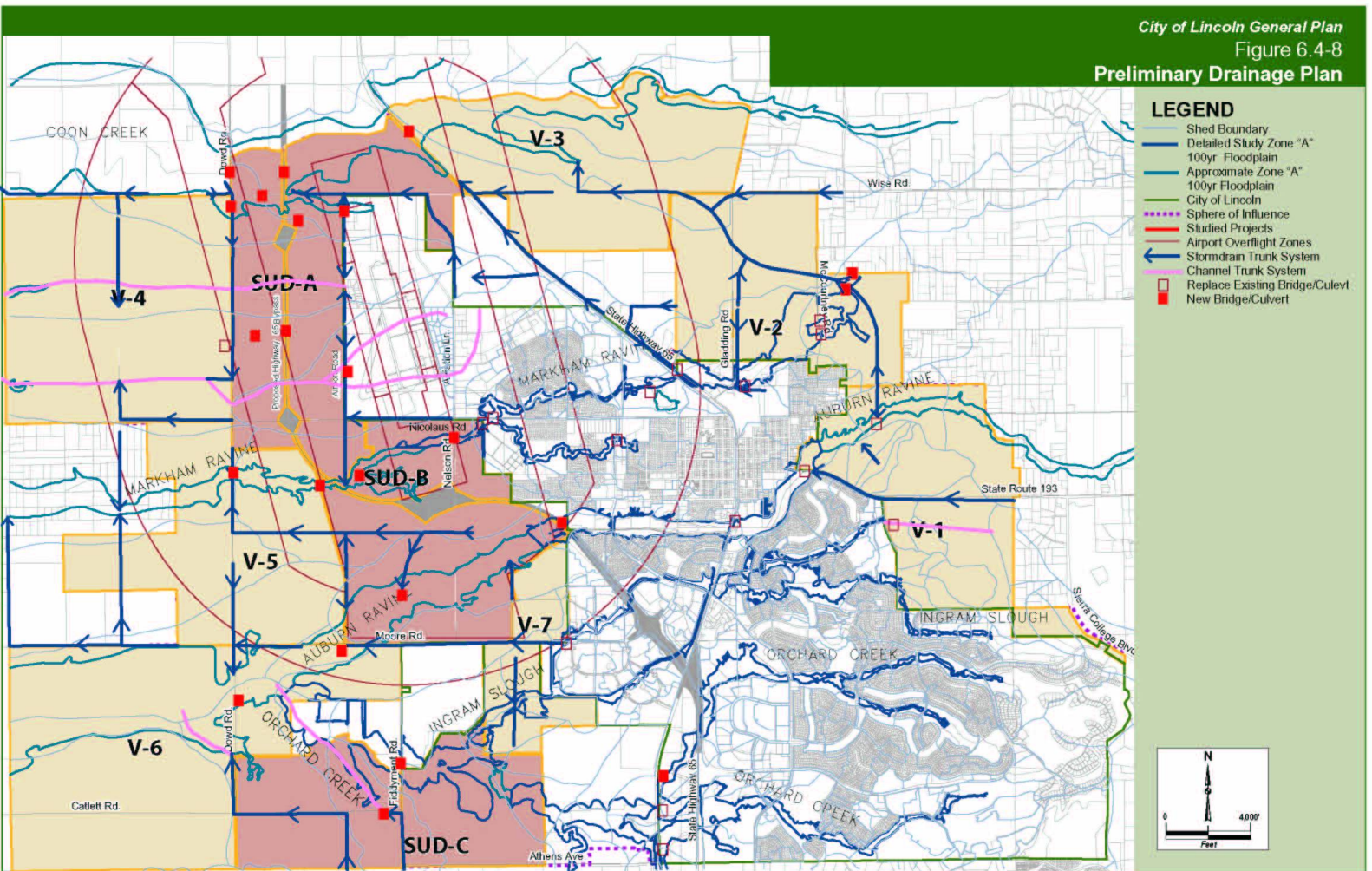
1. ***SR-65 Outfall System:*** The system drains approximately 140 acres of the downtown area of the City of Lincoln, east of the UPRR tracks. Flooding is noted to occur at several locations within the system, but most notably at the intersection of 6th Street and State Route 65 (G Street). At that intersection, frequent flooding of the adjacent structures has been noted and substantial flood fighting efforts have been required to reduce damages. Analysis of the existing system of improvements demonstrated that the system provided less than a peak 2-year event protection at the 6th and G location. The main issue stems from the fact that the northern 40 acres drains towards the sump at this intersection, which does not have any means of overland release. Improvements were currently under construction for a new trunk system to relieve the flooding issues of this system as this report was being written. The new “E Street” trunk system would intercept approximately 90 acres of the watershed and provide 10-year protection for the 6th and G intersection (100-year protection with minor flooding in the roadways) via a new underground release trunk.

(Subsequent to the initial writing of this study, the E Street Trunk Storm Drainage

improvements were made – No flooding was observed in the 12/31/05 event)

2. ***The 8th & O Street Outfall System:*** Several hotspots of flooding are known to occur in this system as shown on the included “Hotspots Exhibit”. Further evaluation of the system shows that a 100-year flood event may have the potential to flood several of the existing houses and Streets adjacent to the channelized portions of the South Markham conveyance, see “8th & O Floodplain Exhibit”. Civil Solutions has previously submitted alternatives analysis of potential repairs to the system which would increase flood protection. These alternatives include new storm drainage systems, and inlet structures to collect runoff in problem areas, new trunk facilities to convey runoff to the downstream channel, and a modified channel configuration to increase conveyance capacity of the channel, and reduce flood elevations within the channel.

EXHIBIT DR-1 – PRELIMINARY DRAINAGE PLAN



III. Impacts Analysis:

A. Creeks:

The City has developed current Hydraulic models for the Markham Ravine (NLMDP) and Auburn Ravine, Orchard Creek and Ingram Slough (SLMP) stream groups. Hydraulic models are not currently available for Coon Creek. Exhibit DR-1 shows a conceptual drainage plan for the General Plan Expansion areas identifying trunk storm drain alignments, new channels, bridge replacements, new bridges, and other facilities necessary for the plan expansion.

1. Floodplain:

Any modifications within the FEMA mapped floodplain of Creek or Ravine is subject the City's "Floodplain Ordinance", the requirements of the "Stormwater Management Manual", and the design standards of the City of Lincoln.

The basics of the floodplain ordinance essentially requires the "Floodplain Manager" of the City, currently the City Engineer, or the City Council (via appeal) to approve of any work within the mapped floodplain areas of the City. This includes any bridgework, culverts, roadways, grading of fill and/or cut areas, plantings, and installation of structures (such as park benches, fences, etc...).

Many projects in the past have proposed improvements within the floodplain. In general, they have been required to show no increases in 100-year floodplain elevations to parcels beyond the project boundary. Sometimes projects have been required to show the same for the 10-year and even the 2-year event. In addition, some project have been required to demonstrate the proposed project would not de-stabilize the low flow channel or create new instabilities within the creek, such as increased erosion (from increased velocities). In all cases the previously mentioned Guidelines for Creek and Channel Work were also enforced as follows:

Guidelines for Creek and Channel Work

- ◆ Low flow channels will be analyzed with an elevated 'n' value to accommodate the future potential for wetland type vegetation growth. Low flow channel will be designed to convey the normal dry season flowrate, including irrigation pass through flows and nuisance flows.
- ◆ Pedestrian trails will be placed no lower than the peak 2-year water surface elevation, and preferred to be above the 10-year peak water surface elevation.
- ◆ Excavated channels will be graded and planted to produce a natural looking appearance.
- ◆ Finish floor of any adjacent structure to be 3 feet above the design 100-year floodplain.
- ◆ Channel design and bridge structures to pass the 500-year design event below adjacent building pad elevations.

- ◆ New Major Arterials and Collector streets which are to be used for emergency egress, will be required to maintain at least one lane above the 500-year flood elevations at Creek Crossings, so that evacuation and emergency access at these crossings can occur.
- ◆ Erosion protection: areas of 100-year velocities of 4 feet per second (fps) or less to receive hydroseed protection. Areas between 4 fps and 6 fps require a “lining” type protection (usually for this case a decomposable mat layer to assist in the establishment of grasses and root zones). Areas 6 fps to 8 fps require a “lining” type protection (usually this case requires a permanent mat material or rock). Areas 8 fps or faster require special evaluation for a lining material, usually rock slope protection or equal. Lake areas require protection at the normal pool elevation and far enough up and down slope to cover normal wave action. Potential for scour is evaluated at all bridges to determine footing depths or alternate of stabilizing the creek invert through the bridge to protect footings.

2. Floodway:

In addition to the requirements for work within the Floodplain, any work within the Floodway is also subject to the requirements of FEMA, usually requiring a project specific Conditional Letter of Map Revision (CLOMR). FEMA requires no net adverse impacts to offsite properties as a general rule on these types of projects. Meaning the 100-year floodplain elevations cannot be increased measurably by the proposed project. Note that this usually means that offsetting increases in capacity will need to be made for any decreases proposed by the project.

3. Overall Floodplain Volumes:

Some work within the floodplain proposed by projects may result in a net loss of 100-year floodplain volumes. As a general rule of hydrology, this is not a good practice, but may be permissible if it is adequately demonstrated that the loss of volume is properly mitigated elsewhere in the project. A good example of this is the SLMP Volumetric Mitigation Facility. Levees were constructed into the floodplain of Orchard Creek. Hydraulically it was demonstrated that this did not result in an increase in floodplain elevations. However, the levees did occupy 34 AF of floodplain area. As a result the project will include 34-acre feet of storage to mitigate the floodplain loss.

B. Hydrologic:

Two significant hydrologic factors are altered by development within a watershed. Development usually increases the impervious surface area of the watershed and reduces runoff response times. The impervious surface area factor affects both peak flow and overall runoff volume. The timing factor generally affects peak flows, and the timing of peak flows at combination points. Both factors usually result in increases to peak flow rates. There are numerous other factors that the hydrologic studies of the watersheds include to also determine impacts from developments, such as slope, friction, and storage.

Generally, development results in an increase to peak flow rates in the creeks and ravines which can be mitigated with the use of detention facilities. The City of Lincoln “Stormwater Management Plan” (SWMP) and the policies of the “Public Facilities Element” (PFE) provide the guidelines for when and how mitigation is required.

For the General Plan Land Use Concept, we have run a scenario per the requirements of the City and determined the approximate detention mitigation quantities as shown in the following table. We used the land use types and percentages identified in the proposed village and SUD areas. Detention mitigation is usually installed on a project by project basis within the City of Lincoln, or sometimes by Specific Plan or Drainage Master Plan Area (such as in the South Lincoln Master Plan). We estimate/approximate that as much as 700 acre feet of storage may be necessary to mitigate the peak flow impacts, of the proposed developments, to below the existing levels.

We use the term “approximate” above, because there are many factors in the developments which could impact these estimates. Once development plans are drawn up, a Preliminary Hydrology Study should be prepared which evaluates the impacts of each development area, or Village, and evaluates the proposed mitigation against the criteria of the SWMP and PFE policies. The above chart should be used as planning type information, not as the final required detention volumes for each village or watershed.

C. Volumetric:

Volumetric impacts are determined based on the difference in runoff volume from a 100-year 8-day storm event. A further assumption is made that precipitation would occur in a similar distribution to the 8-day 1986 record event rainfall. We used the following table to convert Land Use Factors into the factors of imperviousness, and by overlaying a soil type map we were able to determine infiltration local infiltration rates for each component of the proposed plan.

From the imperviousness values and the infiltration rates, volumetric impacts can be directly computed by the rainfall excess procedures. We have determined the current Land Use Scenario to have the following impacts:

RETENTION SUMMARY TABLE

By "Village"	Total Area From LU Tables	Total Storage AF
V-1	1779.7	122.8
V-2	1681.4	121.5
V-3	2040.1	164.1
V-4	2608.9	152.9
V-5	2037.6	135.8
V-6	3214.7	126.1
V-7	683.3	71.2
SUD-A	2122.2	393.0
SUD-B	1844.3	369.2
SUD-C	1869.5	189.2
		1845.8

These impacts represent only the impacts of the expansion areas of the General Plan. There are additional unstudied and undeveloped lands within the current City limits, which are not included in the above matrix. Additionally, lands of the SLMP are also excluded, as they are proposed to be mitigated at the SLMP mitigation facility.

D. Stormwater Quality:

The City of Lincoln is currently developing design standards for the treatment of storm water from development activities. All development will be required to construct mitigation facilities consistent with the requirements of the City's MS4 permit and design standards, prior to discharge into a "water of US", and will be required to obtain all necessary permits to do so.

E. Concentrated Discharge Points:

The development of the General Plan Expansion areas would construct storm drainage systems, in which some new concentrated discharge points to the existing "waters of the US" would be necessary. These discharges will require federal and state permits.

F. Airport Overflight Zone:

All development within Overflight Zone D will be subject to the following special criteria. See Exhibit SP-1 "Studied Projects" for the limits of this Zone.

- ◆ Drainage features within this zone must be minimized due to bird attraction issues. Limit Surface waters and Stagnation Areas
- ◆ Channels should be lined to limit vegetation and to keep waters moving through the area of concern.
- ◆ No Permanent Pools
- ◆ No Wetland Creation
- ◆ SWQ – Use of Subsurface Structural BMP's will be encouraged

G. Other Constraints and Opportunities:

We have identified on Exhibit CO-1 "Constraints and Opportunities Exhibit", the following additional special features which should be observed:

- ◆ #1 : Stream Restoration Projects: Shown on the Exhibit.
 - ◆ Auburn Ravine in SR 193 area
 - ◆ Orchard Creek Near Fiddymont Road (needs to reconstruct flow redirection berms)
 - ◆ Orchard Creek near confluence with Auburn Ravine.
 - ◆ Auburn Ravine SR-65 to Joiner Parkway. (Following removal of NID structure, the low flow channel and banks in this reach should be stabilized and redefined to permit sediment transport at the upstream bridge structures).
- ◆ #2 : Critical Volumetric Floodplain Areas: These areas of the floodplain provide critical

attenuation of peak flows for downstream improvements within the City and downstream of the City. Every effort should be made to maintain the attenuation capabilities of these areas. This does NOT mean that floodplain encroachments will not be allowed, but conveyance and attenuation issues must be carefully evaluated in these zones.

- ◆ #3 : Possible Future Regional DETENTION Sites : Several sites are identified which are likely candidates for additional attenuation features including overbank storage, inline storage, etc... These types of facilities provide the function of detention.

- ◆ #4 : Possible Future Regional RETENTION Sites : Several logical sites are identified which are likely candidates for large offline regional storage facilities. The nature of these facilities is to remove volumes from rainfall events when flooding is occurring along the Sacramento River and the Cross Canal System downstream of the City of Lincoln. These types of facilities provide the function of retention in mitigating the runoff volume changes from the expansion areas.