Appendix E, Volume I of II

Recommended Alternatives Report

Ruthrauff Basin Management Plan Alternatives Study

Stantec

Prepared for:

PIMA COUNTY
FLOOD CONTROL

Pima County Regional Flood Control District

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February 14, 2017

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Expires 12-31-19

Ruthrauff Basin Management Plan

Drainage Solution Alternatives Scoring Guide by Problem Area
Project #181300392

January 19, 2017

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* Parenthetic number is how the alternative is numbered in the pre-analysis Appendix C memo

** Alternative is found only in the pre-analysis Appendix C memo, not a recommended alternative

1.0 Introduction

The objective of this study was to identify structural and non-structural alternatives to remediate flooding and drainage problems for the Ruthrauff Basin Management Plan (RBMP). The Ruthrauff basin is about 8 square miles in the area southeast of the confluence of the Santa Cruz and Rillito rivers. Due to development without a comprehensive drainage plan or drainage infrastructure this area experiences frequent sheet flooding and ponding. A comprehensive existing conditions study was performed for this basin and, in conjunction with public outreach, was used to develop and analyze alternatives which could alleviate the problems associated with the relatively flat topography and lack of sufficient drainage outlets to the Rillito and Santa Cruz rivers.

This Recommended Alternatives Report presents conceptual alternatives based on 15% plans which provides an initial framework for consideration to address the drainage issues in each of nine problem areas (see Table 1) identified during the evaluation of the existing conditions detailed in Volume I of the Final Report. Additionally, seven alternatives deemed beneficial if applied across the entirety of the basin are also documented.

The development of the alternatives began with evaluation of a review of reported drainage complaints in conjunction with analysis of the existing drainage conditions within the RBMP study area. The result of these efforts was the identification of nine problem areas, within the overall study area, of recurring or chronic issues where structural and non-structural alternatives were of the greatest need. These areas were mapped (see Figure 1) based on the relative density (i.e., number in a given area) of complaints, both ponding and uncategorized. Table 1 lists these nine problem areas along with the general problem statement of each area, and a description of area's boundary.

Table 1 – Alternative Development Problem Areas

Problem Area No.	Existing Problem Statement	Problem Area Boundary*
1	Ponding and flooding issues in low lying areas.	West Curtis Road [S] North Highway Drive and North Camino de la Tierra [W] North Shannon Road [E] Rillito River [N]

Problem Area No.	Existing Problem Statement	Problem Area Boundary*
2	Poor drainage and ponding issues.	West Gardner Lane [S] UPRR [W] Varies: North la Cholla Boulevard, North Plum Avenue and North Kain Avenue [E] Ruthrauff Road [N]
3	Drainage and ponding issues with houses at grade and un-improved streets.	West Gardner Lane [S] North la Cholla Boulevard [W] Romero Road [E] West Wetmore Road [N]
4	Street flooding and property erosion along Pomona Avenue.	West Wetmore Road [S] Ruthrauff Road [W] North Flowing Wells Road [E] Rillito River [N]
5	Ponding issues in the neighborhood east and north of Pelaar Street.	West Prince Road [S] North Flowing Wells Road [W] North Fairview Avenue [E] West Roger Road [N]
6	Flooding issues because of existing culvert frequently blocked with debris.	General area surrounding the intersection of: West Fort Lowell Road and North Flowing Wells Road
7	Ponding and lot drainage problems.	West Roger Road [S] North Stone Avenue [W] North 4th Avenue [E] West Wetmore Road [N]
8	Ponding issues caused by blocked existing drainage structures.	General area surrounding the intersection of: West Roger Road at North Tyndall Avenue
9	Erosion problems and nuisance ponding in Richland Heights neighborhood (un-paved roads).	East Kleindale Road [S] North Mountain Avenue [W] North Martin Ave [E] East Prince Road [N]

*the definition of "boundary" for this project may include area(s) adjacent to the limits shown for each problem area.

After identifying the most urgent problem areas, the development of the alternatives best suited for these areas began. The alternatives selection process relied heavily on

stakeholder outreach. On February 8, 2016 a workgroup meeting was convened that involved project team members and stakeholders from the county, city, and neighborhood organizations (see Appendix B.2). The members of this workgroup were broken up into two teams with a facilitator and a "seedlist" for brainstorming viable ideas for alternatives in each problem area as well as for the RBMP study area termed as "basin-wide alternatives". Some of the suggestions included in the alternative idea "seedlist" were:

1) Structural Alternatives
    - Retention and/or detention basins - online or offline (per Detention/Retention Manual)
    - Bank Stabilization
    - Conveyance channels/Channelization
    - Flood Walls
    - Levees
    - Flood proofing
    - Culverts
    - Road Improvements
        - Curbs
        - Inverted Crown
        - Others
    - Storm drains
    - Diversion channels/structures
    - Low flow channels
    - Restore Disturbed Areas
    - On-site individual lot retention/detention (per Detention/Retention Manual)
    - Stormwater Harvesting Basin (LID Guidance manual)

- Vegetated or Rock Swale (LID Guidance manual)
- Bioretention Systems (LID Guidance manual)
- Infiltration Trenches (LID Guidance manual)
- Permeable Pavements (LID Guidance manual)
- Drywells (LID Guidance manual)
- Other

2) Non-structural Alternatives
    - Delineate additional floodplains
    - Delineate/preserve flow corridors
    - Utilize floodplain regulations
    - Floodplain Land Acquisition Program (FLAP)
    - Infill Development Criteria
        - Disconnect and Minimize Impervious (LID Guidance Manual)
        - Conserve and Protect Natural Flow Paths (LID Guidance Manual)
        - Minimize Disturbance and Soil Compaction (LID Guidance Manual)
        - Alternative Site Layouts (LID Guidance manual)
        - Others
    - Open space regulations/preservation/purchase
    - Flood warning systems
    - Public Education & Outreach
    - Flood Insurance
    - Other

This process resulted in two comprehensive lists of alternatives to be considered which the project team, in consultation with PCRFCD, combined into a single list, by area, of 31 possible alternatives.

The ideas that came out of the February workgroup meeting were first classified as structural or non-structural alternatives and developed accordingly. In general, these alternatives are:

1) Providing drainage through the railroad embankment.
2) Slowing water and reducing flood peaks at multi-use basins.
3) Conveying water in drainage channels.
4) Conveying water in stormdrains.
5) Improving roadways to better convey water.
6) Applying practices across the basin that reduce potential for flooding.

The structural alternatives included channels, detention/retention basins, storm drains, and roadway improvements and were all designed using model results from the existing conditions floodplain mapping. Of the original 31 possible alternatives, six were non-structural methods and were classified as area-specific or area-wide and researched on that basis. The result of the alternatives development process, both structural and non-structural, were documented in a memorandum that became the basis for the alternatives analysis phase of the project (see Appendix C).

The alternatives analysis phase truly began with a workgroup meeting on June 9, 2015 to establish “Performance Criteria” to rank the various remediation recommendations to come out of the alternatives development process (see Appendix B.1). The criteria were chosen in coordination with the PCRFCD as well as the area stakeholders and were weighted to reflect their degree of relevance and resulted in five Performance Criteria. Table 2 records the name of the criteria, how they were defined, and their relative weighting.

Table 2 – Performance Criteria Definitions and Weighting

Performance Criteria	Definition	Weighting
Public Safety	Minimizes risk to the public and improves public access and usage with minimal maintenance	30%
Implementation	Minimize complexity of required agreements, optimize stakeholders' support, ensure compatibility with other agency programs, minimize complexity of regulatory compliance, and optimize timing & phasing	23%
Economic Vitality	Consistency with goals of PAG Vitality Advisory Committee and the City of Tucson Office of Economic Initiatives.	17%
Community	Compatibility with known community or neighborhood historic values, goals, social interactions, health and well-being, and the beneficial and multi-functional use of land	10%
Environmental Sustainability	Preserve, protect, and enhance the land and water while promoting conservation, multi-mode transportation, and minimizing the heat island effect.	20%

The five weighted Performance Criteria were chosen to rank the recommended alternatives. Individually these Performance Criteria were to be evaluated according to between five and eleven weighted "Specific Criteria" and scored using detailed scoring descriptions. The scoring of the criteria, both performance and specific, were based upon the evaluation of a scoring matrix. The initial ranking (i.e., order of priority) of both the recommended structural and non-structural alternatives would rely upon these criteria.

The structural alternatives were analyzed in several steps. The first step involved conducting a fatal flaw analysis using hydraulic calculations. This eliminated several storm drain options (e.g., considering a new storm drain system when the existing downstream system has no additional capacity) and potential roadway improvements (e.g., curb and gutter at a location that would likely increase the potential for adjacent flooding). The remaining alternatives were then hydraulically modeled to determine their effectiveness on the extent and depth of flooding identified during the existing conditions analysis. For

several of the alternatives, only the performance of the alternative, during the 10-year event, was considered as evaluation of a given alternative during the 100-year was deemed impracticable based on engineering judgement and regional experience. The resulting maps (i.e., depth grid comparison of pre- versus post-improvement conditions) can be found in in the Exhibits as identified in Section 2.0 and the preliminary memo in Appendix C.

The first step in the analysis of the non-structural alternatives was to apply them to the areas where they were needed the most. In doing this it was determined that all but one of them, the Floodprone Land Acquisition Program (FLAP), could be applied to the entirety of the RBMP study area. The FLAP program was particularly suited to the largely commercial zone located along the west of North Romero Road between West Prince Road and West Ruthrauff Road as is noted in the alternatives memo (see Section 2.2). Additionally, a maintenance plan, though considered a basin wide alternative, was deemed so crucial that warranted its own section in the RBMP Implementation Plan (see Volume II of II of the Final Report). Documentation related to the other area-wide non-structural alternatives can be viewed in Section 3.0 and other documentation concerning those alternatives can be found Appendix E and Appendix F.1.

<u>Figure 1</u> – Ruthrauff Basin Management Plan: Problem Areas with Public Agency Parcels

2.0 Problem Area Recommended Alternatives

Based on review of the findings for each alternative evaluated by Stantec in consultation with PCRFCD and during several subsequent stakeholder meetings a list of the recommended alternatives was developed. This list represents the alternatives that were deemed most practicable for each noted problem area and included some combinations of several of the individual alternatives. The list contained nineteen problem area-specific alternatives of which two were categorized as non-structural. That is, after the fatal flaw analysis and the hydraulic modeling these alternatives were deemed viable enough to proceed to the scoring stage for the area in which they were designed. Section 2.0 contains descriptions of these recommended alternatives, organized by problem area, and documents the physical, hydraulic, and quantitative calculations for each alternative. The results of the mapping of the alternatives in each problem area and the hydraulic modeling of individual recommended alternatives can be found in the Exhibits as referred to in this section. It should be noted that the recommended structural alternatives in this report are 15% plan conceptual designs and would need further engineering to ensure jurisdictional regulatory compliance and mitigate any utility conflicts.

2.1 Problem Area 1 - North of Curtis Road, Highway Drive, Camino de la Tierra, Emerald Avenue (Exhibit 1-1AA)

Existing Problem Statement: Ponding and flooding issues in low lying areas between Emerald Avenue and Camino de la Tierra.

1. Shannon Road – Drainage channel on east side of road to Rillito, improve existing curb and gutters, and new storm drain system
    a. Drainage Channel
        i. A concrete lined open channel is possible along the eastern edge/side of the subject roadway.
        ii. Indications are that to convey ~100 cfs (Q_{100} varies anywhere from 18 cfs to 106 cfs across Shannon Road and Q_{10} varies anywhere from 9 cfs to 30 cfs) would require a trapezoidal channel section: 4-ft bottom, 2-ft in depth, 4:1 side slopes.
        iii. This means that culverts will be necessary at any/all access points/intersections/alleys (very problematic element as culverts will reduce the capacity of the system as a whole). A 2-barrel 24-inch dia. CMP culvert or similar structure would have an estimated capacity of 20-25 cfs.

iv. Resulting channel longitudinal slope is very flat = 0.25%

v. Overall width of improvement(s) cannot be accurately determined due to limitations of the 2008 LiDAR data.

vi. The results of the hydraulics analyses of this alternative, during both the 100- and 10-year events, are shown in Exhibit 1-1AB and 1-1AC, respectively.

b. Storm Drain System

i. A conceptual analysis of a potential storm drain along the eastern edge of Shannon reveals that a 30-48 inch diameter RCP system may be feasible, utility conflicts notwithstanding. There appears to be an indication of a storm drain along the western edge but no plans were found to verify. Q_{100} varies anywhere from 18 cfs to 106 cfs. 9 cfs<Q_{10}<30 cfs.

ii. L = 1,000', 36-inch RCP, S=0.36%, Q_{cap}~80cfs.

iii. L = 900', 48-inch RCP, S>= 0.4%, Q_{cap}~100 cfs.

iv. Special consideration of this alternative should be given to the condition whereby Rillito River is flowing and if it backs into this storm drain system (i.e., consideration of an outlet gate system).

2. Camino de la Tierra – Drainage Channel on the east side of road to the Rillito with a retention basin and diversion channel east of Highway Drive. Possible combination with Sunset Road project

a. Drainage Channel

i. Based on JEF data 50cfs<Q_{100}<100cfs, 18cfs<Q_{10}<54cfs.

ii. A roadside channel is possible along the eastern edge/side.

1) Cannot be earthen lined (n-value is too high).

2) Concrete lined.

3) Triangular channel section; 2.5-ft depth, 4:1 side slope off road, 3:1 elsewhere, longitudinal slope ~0.3%.

4) Intersection/driveway access points would require culverts which could be problematic as the discharge is relatively large to pass completely beneath a given location (Q_{cap} of a 24-inch pipe ~20cfs/barrel). Therefore, clear span structures may need to be considered at next level of design.

5) Q_{cap} ~125 cfs of the proposed channel.

iii. The results of the hydraulics analyses of this alternative, during both the 100- and 10-year events, are shown in Exhibit 1-1AD and 1-1AE, respectively.

b. Retention basin & diversion channel north and east of Highway Drive

i. Estimated total storm runoff volume, during the 100-year event, at a point just downstream of Camino de la Tierra near the existing U-Haul facility is 28.4 ac-ft. During the 10-year event the estimated total storm runoff volume is 12.9 ac-ft.

ii. Conceptual design demonstrates that a retention basin with a maximum capacity of 37 ac-ft. is feasible.

1) 20-ft buffer between the top of the basin and the parcel boundary.

2) Side slopes = 4:1

3) Maximum ponding depth within the basin is 12-ft.

4) Maximum vertical depth of excavation ~15-ft.

5) Minimum surface area required to install the basin = 5.1 acres.

6) For a 10-year system (assuming that the surface area is maintained):

a) Maximum ponding depth is 3-ft.

b) Maximum vertical depth of excavation ~7-ft.

iii. Located within APN 101-17-007B (U-Haul); southern half of the eastern half thereof. No apparent impact to existing structures (i.e., the portion of the parcel where the basin would be located is not developed).

1) An alternative location may exist within APNs: 101-17-028 A&B (Hendrix LLC) and 101-17-0290 (private). Just south of Harvey Trucking facility. No apparent impact to existing structures (i.e., the portion of the parcel where the basin would be located is not developed).

iv. An interceptor channel commencing north of Curtis Road within an undeveloped parcel (APN 101-17-0240: private) results in a longitudinal slope of about 0.3% and therefore would present a construction challenge. Possible loss of use of alley. Q_{cap} ~25 cfs for an earthen lined channel and Q_{cap} ~60 cfs for a concrete lining.

1) Other major channel location(s) to serve the primary basin location do not appear practicable. Minor adjustment to the current alignment may prove to be beneficial but would require further investigation/modeling to confirm.

Adjustment of the channel alignment may result in access management considerations and improvements (e.g., culvert crossings).

2) The need for a channel is greatly diminished whereby the alternative basin (see 6.c.i above) location is selected. It appears that the closer the basin is located to the south and nearer Camino de la Tierra, the more effective it should be.

v. The results of the hydraulics analyses of this alternative, during both the 100- and 10-year events, are shown in Exhibit 1-1AF and 1-1AG, respectively.

2.2 Problem Area 2 - South of Ruthrauff Road to Gardner Lane and South East along Runway Drive (Exhibit 2-1AA)

Existing Problem Statement: Poor drainage with ponding south of Ruthrauff to Gardner Lane and to Runway Drive southeast

1. Retention basin - Abandoned airport runway.
    a. Estimated total storm runoff volume, during the 100-year event, to Gardner Lane is 88.6 ac-ft. During the 10-year event the estimated total storm volume is 40.2 ac-ft.
    b. Conceptual design demonstrates that two basins in series with a combined maximum capacity of 87.5 ac-ft. are feasible.
        i. 10-ft buffer between the top of the basin and the parcel boundary.
        ii. Side slopes = 4:1
        iii. Maximum ponding depth of the lower basin is 14-ft and 17-ft for the upper basin and is therefore very deep and would require safety considerations both to adjacent vehicle and/or pedestrian traffic.
        iv. A spillway between the two basins is feasible and therefore special gate considerations for a culvert system connecting the two basins does not appear necessary.
        v. Lower basin maximum vertical depth of excavation ~ 19-ft.
        vi. Upper basin maximum vertical depth of excavation ~ 23-ft.
        vii. Minimum surface required to install the proposed retention basin system is 10.5 acres.
        viii. For a 10-year system (assuming that the surface area is maintained):
            1. Maximum ponding depth within the upper basin is 9-ft and 5-ft within the lower basin.
            2. Maximum vertical depth of excavation ~13-ft within the upper basin and ~ 9-ft within the lower basin.
    c. Commencing within APN 106-10-1080 to the north and extending though all parcels up to and including APN 106-10-1640, thereby limiting basin development to Sun Tran Boulevard. Additional area appears to be available to the southeast if reduction in the overall basin depth(s) is necessary.
    d. An inceptor channel commencing along the north line of APN 103-09-018A is possible however an easement would be required as well as roadway culverts beneath North Highway Drive, North Runway Drive and Sun Tran Boulevard. Q_{cap} ~160 cfs for a concrete lined channel without consideration of the overall system reduction due to culvert installation.

An alternative to the open channel (i.e., storm drain) is feasible but not recommended due to the potential for large discharge(s).

i. Other channel alignments do not appear practicable but further investigation is recommended to confirm this observation.

e. Current basin excavation total is ~150,000 yd^3.

f. The results of the hydraulics analyses of this alternative, during both the 100- and 10-year events, are shown in Exhibit 2-1AB and 2-1AC, respectively.

2. Channel – Immediately east of Interstate 10 between Gardner Lane and Ruthrauff Road.

a. Channel No.1 – Gardner Lane then NW along the UPRR

i. The channel consists of a Trap Channel: 8'-bottom, 3:1 side slopes, ~4-ft deep.

b. Channel No.2 - ~650 N. of Channel No.1 running along rear property lines then turning NW along the UPRR to an existing culvert.

i. The channel consists of a Trap Channel: 8'-bottom, 3:1 side slopes, ~4-ft deep.

c. Channel No.3 - ~350 N. of Channel No. 2 running along back property lines then entering Channel No.2

i. The channel consists of a Tri Channel: 3:1 side slopes, ~4-ft deep.

d. Channel No.4 – Wetmore Road then NW along the UPRR

i. The channel segment before Highway Drive consists of a Trap Channel: 4'-bottom, 3:1 side slopes, ~3-ft deep.

ii. The channel segment after Highway Drive consists of a Trap Channel: 8'-bottom, 3:1 side slopes, ~4-ft deep.

e. Channel No.5 - ~850 N. of Channel No. 4 running along Poppy Ave then entering Channel No.4

i. The channel consists of a Tri Channel: 3:1 side slopes, ~4-ft deep.

f. Channel No.6 - ~450 N. of Channel No. 5 running along the northern edge of Zinnia Ave then NW along Highway Drive, crossing to enter the lower end of Channel No.4

i. The channel consists of a Tri Channel: 3:1 side slopes, ~4-ft deep.

g. Based on the above channel system the results are:

i. Gardner Lane UPRR at I-10 crossing ~ 800 cfs.

ii. Ruthrauff Road south of UPPR at I-10 ~ 400 cfs.

iii. Combined flow in ROMP channel ~ 1,200 cfs.

h. The results of the hydraulics analyses of this alternative during the 100-year event is shown in Exhibit 2-1AD.

3. FLAP – Prince Road to Gardner Lane – West of Romero Road; Gardner Lane to Ruthrauff Road – West of La Cholla Boulevard. A comprehensive description of the FLAP process will be included in the Implementation Plan (see Volume II of II of the Final Report).
   a. Prince Road to Gardner Lane
      i. 102 affected parcels – all commercial or mixed-use zoned
      ii. Estimated total parcel value $45.9 million
   b. Gardner Lane to Wetmore Road
      i. 65 affected parcels – all commercial or industrial zoned
      ii. Estimated total parcel value $11.8 million
   c. Wetmore Road to Ruthrauff Road
      i. 102 affected parcels – all but nine parcels are commercial, mixed use or industrial zoned. Nine are residential zoned.
      ii. Estimated total residential parcel value $8.6 million
      iii. Estimated total commercial/misc. parcel value $24.6 million
   d. As there was not a hydraulic analysis associated with this alternative an exhibit showing the results of this alternative was not prepared.

4. Retention basin & diversion channel – Paradise Lane
   a. Estimated total storm runoff volume, during the 100-year event, to the location of the proposed basin is 112.1 ac-ft. During the 10-year event the estimated total storm volume is 44.3 ac-ft.
   b. Due to the large volume of runoff resulting during the 100-year event only the 10-year event appears feasible and therefore was only considered herein.
   c. A conceptual design demonstrates that a single basin with a maximum capacity of 48.0 ac-ft. is feasible.
      i. 10-ft buffer between the top of the basin and the western parcel boundary (i.e., railroad right-of-way) and 20-ft along the southern and eastern parcel boundaries. The northern line of the basin was located to benefit from an existing channel near the northwest corner of the basin.
      ii. Side slopes = 4:1

iii. Maximum ponding depth of the basin is 11-ft.

iv. Maximum vertical depth of excavation ~ 14-ft.

v. Minimum surface required to install the proposed retention basin system is 7.1 acres.

d. Construction of the basin would require acquisition of APNs: 103-06-072B ($175,000), 103-06-071B ($205,000), 103-06-072C ($180,000) and minor portions along the southern edge of 103-06-070E ($668,000 assessment for the entire parcel) and 103-06-070B ($242,000 for the entire parcel).

e. An inceptor channel commencing along the north line of APN 103-06-090B is necessary to enhance the benefit of this retention basin. Q_{cap} ~170 cfs for a riprap lined channel. A hydraulic structure will be required at the southern end of Sullinger Avenue to provide access into APN 103-06-089E (Ferrell Gas).

f. Current basin/channel excavation total is ~105,000 yd^3.

g. The results of the hydraulics analyses of this alternative, during both the 10- and 100-year events, are shown in Exhibit 2-1AF and 2-1AG, respectively.

5. Retention basin – Wetmore Road

a. Estimated total storm runoff volume, during the 100-year event, to the location of the proposed basin is 137.0 ac-ft. During the 10-year event the estimated total storm volume is 59.5 ac-ft.

b. Due to the large volume of runoff resulting during the 100-year event only the 10-year event appears feasible and therefore was only considered herein.

c. A conceptual design demonstrates that a single basin with a maximum capacity of 63.9 ac-ft. is feasible.

i. 10-ft buffer between the top of the basin and the western parcel boundary (i.e., railroad right-of-way) and 20-ft along the southern and eastern parcel boundaries. The northern line of the basin was set within the right-of-way serving Wetmore Road.

ii. Side slopes = 4:1

iii. Maximum ponding depth of the basin is 7-ft.

iv. Maximum vertical depth of excavation ~ 13-ft.

v. Minimum surface required to install the proposed retention basin system is 12.7 acres.

d. Construction of the basin would require acquisition of APNs: 103-06-072C ($180,000), 103-06-070E ($668,000), 103-06-070B ($242,000), 103-06-

068A ($651,000), 103-06-069A ($385,000) and a minor portion along the southern end of 103-06-091F ($196,000 assessment for the entire parcel).

e. An inceptor channel does appear to be necessary for this basin but adjustment of a portion of Wetmore Road (e.g., one-way crown to the south) is recommended to maximize the benefit of this basin.

f. Current basin/channel excavation total is ~165,000 yd^3.

g. The results of the hydraulics analyses of this alternative, during both the 10- and 100-year events, are shown in Exhibit 2-1AH and 2-1AI, respectively.

6. Retention basin & diversion channel – Zinnia Avenue

   a. Estimated total storm runoff volume, during the 100-year event, to the location of the proposed basin is 24.6 ac-ft. During the 10-year event the estimated total storm volume is 11.6 ac-ft.

   b. Due to the large volume of runoff resulting during the 100-year event only the 10-year event appears feasible and therefore was only considered herein.

   c. A conceptual design demonstrates that a single basin with a maximum capacity of 15.0 ac-ft. is feasible.

      i. A minimum of 20-ft buffer between the top of the basin and the adjacent parcel boundaries.

      ii. Side slopes = 4:1

      iii. Maximum ponding depth of the basin is 8-ft.

      iv. Maximum vertical depth of excavation ~ 14-ft.

      v. Minimum surface required to install the proposed retention basin system is 3.7 acres.

   d. Construction of the basin would require acquisition of potions of APNs: 103-05-0300 ($555,000 for the entire parcel) and 103-05-031A (School) ($464,000 for the entire parcel).

   e. An inceptor channel commencing at Wetmore Road and proceeding north along/within the eastern line of APN 103-05-0280 is necessary to enhance the benefit of this retention basin.

   f. Current basin/channel excavation total is ~34,000 yd^3.

   g. The results of the hydraulics analyses of this alternative, during both the 10- and 100-year events, are shown in Exhibit 2-1AJ and 2-1AK, respectively.

7. Retention basin – Highway Drive

a. Estimated total storm runoff volume, during the 100-year event, to the location of the proposed basin is 149.5 ac-ft. During the 10-year event the estimated total storm volume is 66.8 ac-ft.

b. Due to the large volume of runoff resulting during the 100-year event only the 10-year event appears feasible and therefore was only considered herein.

c. A conceptual design demonstrates that a single basin with a maximum capacity of 38.7 ac-ft. is feasible but is insufficient to contain the runoff resulting from the 10-year event. Additional vertical and/or horizontal expansion of the conceptual basin does not appear practicable.

    i. A minimum of 20-ft buffer between the top of the basin and the adjacent parcel boundaries.

    ii. Side slopes = 4:1

    iii. Maximum ponding depth of the basin is 9-ft.

    iv. Maximum vertical depth of excavation ~ 17-ft.

    v. Minimum surface required to install the proposed retention basin system is 8.8 acres.

d. Construction of the basin would require acquisition of potions of numerous parcels. As the basin crosses and adversely impacts Highway Drive and that the minimum storage volume could not be obtained further detail regarding the land acquisition is not provided herein.

e. Current basin/channel excavation total is ~120,000 yd^3.

f. The results of the hydraulics analyses of this alternative, during both the 10- and 100-year events, are shown in Exhibit 2-1AL and 2-1AM, respectively.

2.3 Problem Area 3 - South of Wetmore Road and West of Romero Road (Exhibit 3-1AA)

Existing Problem Statement: Drainage and ponding issues south of Wetmore and west of Romero – homes at grade/unimproved streets

1. Retention Basin/Roadway - west of Romero improve Root Ln with inverted crown and curb/gutter for conveyance to basin at west end of Root Ln along with outlet system
    a. Retention Basin/Outlet Channel
        i. Estimated total storm runoff volume, during the 100-year event, to the eastern half of APN 104-05-3510 is 7.6 ac-ft. During the 10-year event the estimated total storm runoff volume is 4.1 ac-ft.
        ii. Conceptual design demonstrates that a single retention basin is feasible with a maximum capacity of 9.2 ac-ft.
            1) 20-ft buffer between the top of the basin and the parcel boundary
            2) Side slopes = 4:1
            3) Maximum ponding depth of 7-ft.
            4) Maximum vertical depth of excavation ~ 15-ft
            5) Minimum surface area required to install the proposed basin is 1.9 acres.
            6) For a 10-year system (assuming that the surface area is maintained):
                a) Maximum ponding depth within the basin is 3-ft.
                b) Maximum vertical depth of excavation ~11-ft.
        iii. The basin would be located within a portion of APN 104-05-3510.
        iv. Current excavation total is ~22,000 yd^3 for the 100-year event scenario.
        v. Outlet channel appears to be feasible but would require a drainage easement across private property: triangular channel section, 2-ft deep, 4:1 side slopes but access points (e.g., driveways) would need to be improved (i.e., culverts). Q_{cap} ~45 cfs for an earthen lined channel. Final confluence is with southern bar ditch along Gardner Road but it may need to be re-graded as installing a culvert across Gardner would be needed and based on the current design does not appear to allow for sufficient cover.
        vi. The results of the hydraulics analyses of this alternative, during both the 100- and 10-year events, are shown in Exhibit 3-1AB and 3-1AC, respectively. Due to the need to convey runoff into the

conceptual retention basin from the east, it was determined that the preferred approach to accomplish this was to combine the effects of the roadway (b.) below along with this alternative. This approach is also included within the hydraulic analysis as shown within the aforementioned exhibits.

b. Roadways - west of Romero Road along Root Lane and southwest to Gardner, improve streets with rolled curb and gutter, inverted crown, and/or channels for flow conveyance west and out of area and into Alternative a. (see above).

   i. Reconstruct Root Lane to an inverted crown roadway with roll curb on both sides (possible roll curb upgrade to entire Park el Monte neighborhood) for flow conveyance westbound.

   ii. Root Lane improvements would include 1420' of roadway reconstruction; inverted crown with 12' lanes at a 3% maximum cross slope (0.7% longitudinal slope) and 3" high roll curb (no sidewalk).

   iii. Q_{cap} ~62 cfs at a maximum depth of 0.7' (~9") with a mean velocity of 7 ft./s. Q_{100} ~61cfs, Q_{10} ~25cfs.

   iv. This alternative is recommended to operate concurrently with the retention basin explain within Alternative a. (see above).

2.4 Problem Area 4 - North of Ruthrauff Road and West of Flowing Wells Road (Exhibit 4-1AA)

Existing Problem Statement: Street flooding and property erosion along Pomona between Wetmore and the Rillito

1. Retention basin and Channel – South of Rillito Street in conjunction with drainage channel along Flowing Wells to the Rillito.
    a. Estimated total storm runoff volume, during the 100-year event, to the southern edge of Rillito Street is 13.7 ac-ft. During the 10-year event the estimated total storm runoff volume is 2.1 ac-ft.
    b. Conceptual design demonstrates that a single retention basin is feasible with a maximum capacity of 16.4 ac-ft.
        i. 20-ft buffer between the top of the basin and the parcel boundaries
        ii. Side slopes = 4:1
        iii. Maximum ponding depth of 8-ft.
        iv. Maximum vertical depth of excavation ~ 16-ft
        v. Minimum surface area required for this basin is approximately 3.0 acres.
        vi. For a 10-year system (assuming that the surface area is maintained):
            1. Maximum ponding depth within the basin is 1-ft.
            2. Maximum vertical depth of excavation ~9-ft.
    c. The basin would be located within APNs: 104-03-198C and 104-03-200A. Both are developed parcels. Current estimated value of APN 104-03-198C is $165,951 and APN 104-03-200A is $176,425. Both parcels are currently developed/occupied.
        i. An alternative location may exist within APN 104-03-203A but further investigation and analysis would be required. Current estimated value of APN104-03-203A is $92,096. The parcel is currently developed/occupied.
    d. Current excavation total is ~43,000 yd^3 for the 100-year event scenario.
    e. The Flowing Wells channel would be located on the west side of the road within the existing right of way, beginning at Rillito Street and ending at the Rillito River.
        i. Length ~ 1,250 ft.
        ii. Longitudinal slope = 0.4%

iii. Earthen lined triangular channel with 3:1 side slopes and a minimum depth of 3 ft.

f. The results of the hydraulics analyses of this alternative, during both the 100- and 10-year events, are shown in Exhibit 4-1AB and 4-1AC, respectively.

2. Roadways/Channel – Rillito Street, Pomona Avenue, Ruth Street, and Camino Aire Fresco
   a. Assumes a typical Pima County 2-lane urban section:
      i. 11-ft travel lanes
      ii. 6-ft paved shoulders
      iii. Vertical curbs, both sides
      iv. No sidewalks
      v. 10:1 cut/fill slopes
      vi. The above along with the resulting roadway profiles should be considered as maximum obtainable criteria (e.g., adding sidewalks would greatly increase the potential for major conflicts with adjacent existing development).
      vii. Estimated Q_{cap} of each roadway ~ 70 cfs.
      viii. Q_{100} ~30 cfs, Q_{10} ~11 cfs along Pomona Avenue. Discharge data not available for the other streets.
   b. Inverted crowned urban roadway along Rillito Street:
      i. Attempts to intercept runoff south of the mobile park reveals a very flat profile (~0.2%) – but appears to be better than the existing profile slope.
      ii. Improvements should end at Camino Aire Fresco to the east
      iii. Improvements should begin at Pomona Avenue to the west
   c. Inverted crowned urban roadway along Pomona Avenue:
      i. Attempts to collect conveyed flow from Rillito Street and Ruth Street into existing drainage channel at the north end.
      ii. Profile slope is acceptable ~ existing conditions
      iii. There is an existing 60-inch RCP storm drain along the entire length of Pomona Avenue (plans dated 6/2003 part of Wetmore Road project). Plans show ~8-ft of cover.
   d. Inverted crowned urban roadway, Camino Aire Fresco and Ruth Street.

i. Attempts to both intercept runoff from the east and convey into Pomona Avenue section.

ii. Flat segment in profile near Sta. 17+50 that is near a parcel with water tanks (cul-de-sac-like lobe)…perhaps conveyed flow within the street could partially be conveyed across this parcel and into Rillito River directly. 1976 plans show an inlet and 30-inch CMP drain pipe through a 10-ft wide easement through this parcel.

e. The results of the hydraulics analyses of this alternative, during both the 100- and 10-year events, are shown in Exhibit 4-1AD and 4-1AE, respectively.

2.5 Problem Area 5 - North of Prince - West of Fairview Avenue and East of Flowing Wells Road (Exhibit 5-1AA)

Existing Problem Statement: Ponding issues north of Prince Road between Flowing Wells Road and Fairview Avenue

1. Retention basin – South of Pelaar Street
    a. Estimated total storm runoff volume, during the 100-year event, to a point just west of Reno Avenue is 41.1 ac-ft. During the 10-year event the estimated total runoff volume is 21.7 ac-ft.
    b. Conceptual design demonstrates that a single retention basin is hydraulically feasible with a maximum capacity of 40.3 ac-ft.
        i. 20-ft buffer between the top of the basin and the parcel boundaries
        ii. Side slopes = 4:1
        iii. Maximum ponding depth of 9-ft.
        iv. Maximum vertical depth of excavation ~ 13-ft
        v. Minimum surface area ~ 7.0 acres.
        vi. For a 10-year system (assuming that the surface area is maintained):
            1. Maximum ponding depth within the basin is 5-ft.
            2. Maximum vertical depth of excavation ~9-ft.
    c. The basin would be located within a portion of APN 106-06-023A (single parcel that encompasses all mobile homes). This parcel is completely developed (mobile home park) and occupied. The estimated current value of APN 106-06-023A is $2.1 million (14.5 acres in total size).
    d. Current excavation total is ~90,000 yd^3 for the 100-year basin system.
    e. Intercept/diversion channel(s) would need to be investigated further (e.g., alley, Pelaar Street diversion, south end of Reno Drive, Tuttle…etc.).
    f. The location of the proposed basin would likely not relieve flooding noted within the upstream area.
    g. The results of the hydraulics analyses of this alternative, during both the 100- and 10-year events, are shown in Exhibit 5-1AB and 5-1AC, respectively.
    h. Dry wells were evaluated and did not reduce flood depth.

2.6 Problem Area 6 - Fort Lowell Road and Flowing Wells Road (Exhibit 6-1AA)

Existing Problem Statement: Flooding issues at Ft Lowell Road and Flowing Wells Road – culvert frequently blocked with debris

1. Repair channel tiles along Flowing Wells Wash
    a. Repair to an approximately 1000-ft section of the Flowing Wells Wash along West Ft. Lowell Road between North Shawnee Avenue and North El Tovar Avenue
    b. Channel is concrete lined: 8-ft bottom width, 2:1 side slopes and a top with of 40-ft for an approximate surface area is 43778 ft^2.
    c. Each tile appears to be approximately 30-ft in length between joints.

2.7 Problem Area 7 - Stone Avenue & Limberlost Drive (Exhibit 7-1AA)

Existing Problem Statement: Ponding and lot drainage problems near Stone Avenue between Wetmore Road and Limberlost Drive

1. Retention basin – Don Hummel Park
    a. Estimated total storm runoff volume to the western edge of the park is 2.4 ac-ft. during the 100-year event.
    b. Conceptual design demonstrates that a single retention basin is feasible with a maximum capacity of 2.9 ac-ft.
        i. 100-ft wide by the entire width (N-S) of the park (~450-ft)
        ii. Side slopes = 4:1
        iii. Maximum ponding depth of 5-ft.
        iv. Maximum vertical depth of excavation ~ 8-ft
        v. Minimum surface area required to install the basin ~ 1.0 acre
    c. Current excavation total is ~8,000 yd^3.
    d. Intercept/diversion channels do not appear necessary as the upstream overall flow width is nearly equal to the Q_{100} floodplain width.
    e. The results of the hydraulics analyses of this alternative, during both the 100- and 10-year events, are shown in Exhibit 7-1AB and 7-1AC, respectively.

2.8 Problem Area 8 – Roger Road at Tyndall Avenue (Exhibit 8-1AA)

Existing Problem Statement: Ponding issues caused by blocked existing drainage structures at Roger Road and Tyndall Avenue

1. Roadway – Intersection and/or Roger Road
    a. Improvement of the intersection via curb & gutter would require extensive tie-ins with adjacent roadway features (rural type to the east and along the southern edge to the west).
    b. Would recommend either catch basin(s) within low graded zones outside at all corners of the intersection and tie into the storm drain system in this area. Although utility conflicts would likely occur along the southern quarters.
    c. Improvement of intersection through reconstruction of Roger Road and Tyndall Avenue:
        i. Smoothing out the profile of Roger Road may improve drainage however the resulting slope 0.12% would be difficult to obtain a uniform profile across the intersection. And at such a slope the potential for ponding within the paved roadway section would reduce the life expectancy of the pavement material.
        ii. Either approach would likely require installation of cross road surface drains to mitigate runoff. Recommend storm drain inlets alone within Roger Road.
2. Dry Wells – Intersection of Roger Road and Tyndall Ave
    a. The desired dry well design (MaxWell Plus; see Figure 2), per the manufacturer's engineer, each well has a capacity of 2500 gallons (334 ft^3) and an average infiltration rate of 0.3 to 0.5 cfs (1.3 cfs max) depending upon area geology and drain pipe depth. A standard 24' to 30" manhole grate is used as the inlet.
    b. Six dry wells would be placed on the north side of the intersection; three east of Tyndall and three west of Tyndall. Utility conflicts, namely sanitary sewer facilities, and limited space limited the number and location of the wells. Some grading would be needed to assure drainage to the inlets.
    c. At a cost of $15,000 to $20,000 each installed the base cost would be $90,000 to $120,000 not including additional earthworks for grading the area. Assuming an estimated $50,000 for associated excavation and grading the subtotal cost for the listed items would be between $140,000 and $170,000 for this location.
    d. The 100-year design discharge for the intersection is between 106 and 115 cfs per the study done by JEF for this project. The dry wells would do little to mitigate design flows of this magnitude, all six would have a combined

infiltration rate of approximately 3 cfs and maximum combined holding capacity without any settled sediment of 2,004 ft^3.

e. The dry wells may be effective drying the intersection more quickly.
    i. JE Fuller estimates the water surface elevation for the 100-year event to be 1-2 feet.
    ii. Using Pima County MapGuide the flood area for the intersection was estimated to be 161,772 ft^2.
    iii. Assuming an average infiltration rate of 0.5 cfs, from just the wells with no other sources of drainage or infiltration, a ponding depth of 1-2 feet in the intersection, and no sediment load effecting the grate or capacity of the wells the entire volume of water could be infiltrated in 15 to 29 hours. This is well within the typical operating requirements for infiltration within 36 hours.
    iv. Certainly smaller return period storms would be infiltrated much more quickly.

2.9 Problem Area 9 – Prince Road at Mountain Avenue

Existing Problem Statement: Erosion problems and nuisance ponding in Richland Heights neighborhood (un-paved roads)

1. Roadways – Greenlee Road, Vine Avenue, Kleindale Road, Cherry Avenue and Martin Avenue…et.al.
    a. Reconstruction to the noted roadways into a paved inverted crowned roadway section with curbing would require an estimated 6,800-ft of roadway reconstruction.
        i. Estimated cost of: 34-ft roadway, rolled curbing along both sides, 3-inch of AC over 4-inches of ABC); ~$1,100,000. Does not include the cost of other necessary elements (e.g., earthwork, mobilization…etc.).
    b. The local land/home-owners within the subject area do not desire urban roadway characteristics (i.e. paved roads).

3.0 Area Wide – Basin Wide Solutions

Seven of the recommended alternatives were found to be beneficial if applied across the entirety of the Ruthrauff basin. Section 3.0 documents brief descriptions of these alternatives and where additional information can be viewed.

Existing Problem Statement: Ponding and problems across the entire Ruthrauff basin

1. Declare the entire project area a critical basin.
    a. As defined by the City of Tucson Stormwater Detention/Retention Design Manual: "A critical basin is one which has been identified as already having the potential for severe increase in flood hazards as a result of existing watershed conditions. Stormwater detention/retention facilities shall be incorporated within all new developments to the extent necessary to ensure a reduction in the existing…peak discharges from the site. The amount of reduction shall be determined by the regulatory agency which has jurisdiction (i.e., either Pima County or the City of Tucson) …"
    b. In other words, if a basin is declared "critical" the development of any parcel within that basin must present a plan to reduce the stormwater runoff from that parcel is below pre-development levels.

2. Regular maintenance solutions regarding agency and residents' cleaning vegetation from channels and enforcing vegetation removal in channels crossing private land.
    a. A comprehensive Maintenance Plan will be developed and submitted with the Implementation Plan (Volume II of II of the Final Report) that will begin with existing guidance used by both city and county agencies of authority and end with an evaluation of probable annual and suggested maintenance costs of said plan as well as identify potential funding strategies.
    b. The plan will include recommendations for applicable methods of Maintenance for recommended flooding and drainage alternatives as identified in this report. These may include the following types of processes:
        i. Best Management Practices for the general public
        ii. Actions for the 2 local government agencies
        iii. Actions for privately owned flood and drainage facilities (i.e. HOA's, large commercial parcels, mobile home parks, etc.)
        iv. Cooperative actions between the above such as Bush and Bulky Green Waste Pickup or Community Service Day

3. Infill Incentives
    a. A description of, and process for developing, Infill Incentives will be explained in detail in the Implementation Plan (Volume II of II of the Final Report) and will include descriptions of:
        i. Highway Drive Infill Incentives District
        ii. Flowing Wells Area
        iii. Rest of the basin

4. Public information/education/outreach campaign
    a. Possibly included educational information with utility bills
    b. Collaboration with Tucson Clean and Beautiful.
        i. An example of a Tucson Clean and Beautiful campaign can be found online at: https://tucsoncleanandbeautiful.org/adopt-a-park-public-areas/adopting-a-site/

5. Green Infrastructure/Low Impact Development (GI/LID)
    a. A description of GI/LID can be found in a report that was prepared by JE Fuller Hydrology and Geomorphology (JEF) for the Ruthrauff BMP and can be found in Appendix F.1. This evaluation showed the Green Infrastructure provides an incremental reduction in flood peaks and should be encouraged.
6. Dry Wells
    a. Per the desired dry well design (MaxWell Plus; see Figure 2), each well can capture and infiltrate (100 year, 2 hour event within 36 hours) a maximum of 3 acres of residential runoff if used as a remote drain rather than in conjunction with retention basins.
    b. Per the manufacture's engineer, each well has an average capacity of 2500 gallons (334 ft^3) and an average infiltration rate of 0.3 to 0.5 cfs (1.3 cfs max) dependent upon area geology and drain pipe depth. Inlet is standard 24" to 30" manhole grate.
    c. Each new well would cost between $15,000 and $20,000 installed. In addition, each well would require maintenance via vacuum truck every 3-5 years depending upon runoff sediment load in the installation area.
    d. Our analysis indicates that flood depths are not reduced however they may be beneficial in speeding the "drying up" of ponded areas.
    e. All dry wells would need to meet jurisdictional requirements.
7. Floodproofing

a. Floodproofing is a process in which a property is protected from flooding through various construction methods (i.e. floodwalls, watertight doors, raising the home, etc.).
b. This is listed as a basin wide alternative because it can be used across the entire basin however, per the definition, it should be considered on a property by property basis. The construction methods are not intended for individual structures on a case by case basis and are not cost effective when applied to large areas
c. According to *FEMA 551: Selecting Appropriate Mitigation Measures for Floodprone Structures* (https://www.fema.gov/media-library-data/20130726-1609-20490-5083/fema_551.pdf), the general units costs for floodproofing are as follows:
    i. Flood Barriers
        1. Levee/Berm
            a. 2 ft. above ground - $60/lf
            b. 4 ft. above ground - $106/lf
            c. 6 ft. above ground - $170/lf
        2. Floodwalls
            a. 2 ft. above ground - $92/lf
            b. 4 ft. above ground - $140/lf
            c. 6 ft. above ground - $195/lf
    ii. Dry Floodproofing
        1. Waterproofing a concrete block wall or brick-faced wall by applying a polyethylene sheet or other impervious material and covering with a facing material such as brick - $3.50/sf
        2. Acrylic latex wall coating - $3/sf
        3. Caulking/sealant – $2.50/lf
        4. Bentonite grout (below grade waterproofing, 6 ft. deep) - $20/lf
    iii. Structure Elevation
        1. Wood-frame building on piles, posts, or columns - $36/sf
        2. Wood frame on block foundation walls - $32/sf
        3. Brick - $43/sf
        4. Slab on grade - $45/sf
    iv. Wet Floodproofing costs can vary depending upon the method used. This is generally accomplished by retroactively moving all

water vulnerable equipment (i.e., HVAC, appliances, electrical, etc.) above the predicted flood elevation.

4.0 Conclusion

A meeting was convened at Stantec on July 28, 2016 consisting of Stantec team members as well as representatives from PCRFD, JEF, and the Wheat Group to evaluate the nineteen area-specific alternatives and seven area wide alternatives that had been deemed viable through the fatal flaw analysis. The objective of this meeting was to score and rank the recommended alternatives through the lens of the performance criteria developed in the June 9, 2015 Workgroup meeting.

The recommended alternatives were ranked on two tiers. The first was based on scoring by the performance criteria alone and in the second the criteria score was merged with cost estimates for the 15% design level for each alternative. The costs estimates for this prioritization include only the preliminary opinion costs of construction only and do not include costs related to: design, construction administration, contingency, property acquisition, agency permitting/coordination nor environmental related expenses. It is recommended that a more comprehensive analysis of all costs related to the execution of construction for the individual alternatives be evaluated during a future project(s) as described in the Implementation Plan (see Volume II of II of the Final Report).

The recommended alternatives, including structural and non-structural, are summarized in the following table (Table 3). This table shows the combined criteria scores for all the alternatives documented in Section 2.0 and Section 3.0 as well their ranking, both by criteria alone and with opinion of costs included. The individual scoring sheets developed by the scoring teams are located in Appendix D.

On August 31, 2016 a workgroup was convened at the Stantec offices consisting of government and neighborhood stakeholders. This was the last of the workgroup meetings planned for after all the alternatives analysis and scoring had been performed. It was intended to inform the attendees what the recommended remediation alternatives were and how they ranked per cost and performance criteria. The project team then answered stakeholder questions and listened to their concerns. The agenda and meeting summary for this workgroup meeting are included within the Workgroup Summaries (see Appendix B.3).

Table 3 – Ruthrauff BMP Specific Weighted Scoring Rankings

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Table 3 - Ruthrauff BMP Specific Weighted Score Rankings

Planning Area	Performance Criteria Combined Specific Criteria Weighted Value	Public Safety	Implementation	Economic Vitality	Community	Environmental Sustainability	Total Score
		3.00	2.33	1.67	1.00	2.00	10.00

EXISTING PROBLEM AREAS

	Alternative						Total Score	Rank Based on Score	Est. Cost	Cost/Score	Rank Based on Cost	Combined (Rank*Rank)	Ranked Results
Problem Area 1	Existing Problem Statement:	Ponding and flooding issues in low lying areas between Emerald Ave. and Camino de la Tierra											
	Alternative 1: Shannon Road -- drainage channel east side of road to Rillito.	76.5	27.6	53.0	60.8	23.3	**490**	14	$871,308	$1,780	8	112	13
	Alternative 2: Camino de la Tierra -- drainage channel on east side of road to the Rillito with a retention basin and diversion channel north and east of Highway Drive.	78.0	38.9	72.5	71.0	66.4	**649**	6	$2,441,872	$3,761	12	72	10
Problem Area 2	Existing Problem Statement:	Poor drainage with ponding south of Ruthrauff to Gardner Lane and to Runway Drive Southeast											
	Alternative 1: Construct retention/detention basin at the site of the old airport runway	78.2	40.2	79.5	41.0	59.1	**620**	8	$3,382,258	$5,455	16	128	16
	Alternative 2: Channel immediately east of I-10 between Gardner Lane and Ruthrauff Road	85.6	65.8	59.0	90.0	45.8	**690**	2	$3,142,801	$4,554	15	30	5
	Alternative 3a: FLAP/Consolidate parcels for Future Private Owner -- (acquisition/demolition only)	52.5	65.2	97.0	76.3	69.0	**686**	3	$93,420,000	$136,244	18	54	7
	Alternative 3b: FLAP/Consolidate parcels for Future Private Owner -- (resale of 3a lands)								$53,800,000				
	Alternative 4: Retention basin and diversion channel - Paradise Lane	69.6	35.3	79.5	70.8	64.2	**623**	7	$2,684,492	$4,310	14	98	12
	Alternative 5: Retention basin at Wetmore Road	65.7	35.3	79.5	62.4	53.2	**581**	10	$4,669,076	$8,040	17	170	17
	Alternative 6: Retention basin at Highway Drive	56.8	35.3	79.5	62.4	53.2	**554**	12	$806,217	$1,455	5	60	9
	Alternative 7: Retention basin and diversion channel at Verbena Avenue	63.2	35.3	79.5	74.8	60.7	**601**	9	$2,541,829	$4,232	13	117	14
Problem Area 3	Existing Problem Statement:	Drainage and ponding issues south of Wetmore and west of Romero -- homes at grade/unimproved streets											
	Alternative 1: Retention Basin/Roadway -- west of Romero improve Root Ln with inverted crown and curb/gutter for conveyance to basin at west end of Root Ln along with outlet system	74.8	70.5	70.5	76.3	72.2	**727**	1	$1,236,439	$1,701	7	7	1

Table 3 - Ruthrauff BMP Specific Weighted Score Rankings

Planning Area	Performance Criteria Combined Specific Criteria Weighted Value	Public Safety	Implementation	Economic Vitality	Community	Environmental Sustainability	Total Score
		3.00	2.33	1.67	1.00	2.00	10.00

EXISTING PROBLEM AREAS

	Alternative						Total Score	Rank Based on Score	Est. Cost	Cost/Score	Rank Based on Cost	Combined (Rank*Rank)	Ranked Results
Problem Area 4	Existing Problem Statement:	Street flooding and property erosion along Pomona between Wetmore and the Rillito											
	Alternative 1: Retention Basin and Channel -- South of Rillito Street in conjunction with drainage channel on Flowing Wells to the Rillito	76.5	41.9	70.5	76.8	80.2	**682**	4	$942,661	$1,382	4	16	2
	Alternative 2: Roadway/Channel -- Inverted crown roadways, curb/gutter, storm drains on Pomona, Rillito, Ruth and Camino Aire Fresca	54.4	65.0	54.5	31.9	34.5	**507**	13	$961,545	$1,898	9	117	14
Problem Area 5	Existing Problem Statement:	Ponding issues north of Prince Rd between Flowing Wells Rd and Fairview Ave											
	Alternative 1: Retention Basin - South of Pelaar Street	71.7	45.8	70.5	70.0	73.4	**656**	5	$2,326,738	$3,545	11	55	8
Problem Area 6	Existing Problem Statement:	Flooding issues at Fort Lowell Rd and Flowing Wells Rd -- culvert frequently blocked with debris											
	Alternative 1: Repair channel tiles along Flowing Wells Wash	24.4	85.3	35.5	79.7	25.3	**462**	15	$753,628	$1,632	6	90	11
Problem Area 7	Existing Problem Statement:	Ponding and lot drainage problems near Stone Ave between Wetmore Rd and Limberlost Dr											
	Alternative 1: Retention basin - Don Hummel Park	49.4	55.5	41.0	14.8	47.1	**455**	16	$182,898	$402	1	16	2
Problem Area 8	Existing Problem Statement:	Ponding issues caused by blocked existing drainage structures on Roger Rd at Tyndall Ave											
	Alternative 1: Roadway -- Intersection and/or Roger Road	56.6	83.1	40.0	57.6	38.2	**564**	11	$422,214	$748	2	22	4
	Alternative 2: Dry wells -- Intersection of Roger Road and Tyndall Ave	29.0	68.0	33.0	30.0	46.5	**424**	17	$411,475	$971	3	51	6

Table 3 - Ruthrauff BMP Specific Weighted Score Rankings

Planning Area	Performance Criteria Combined Specific Criteria Weighted Value	Public Safety	Implementation	Economic Vitality	Community	Environmental Sustainability	Total Score
		3.00	2.33	1.67	1.00	2.00	10.00

EXISTING PROBLEM AREAS

	Alternative						Total Score	Rank Based on Score	Est. Cost	Cost/Score	Rank Based on Cost	Combined (Rank*Rank)	Ranked Results
Problem Area 9	Existing Problem Statement:	Erosion problems and nuisance ponding in Richland Heights neighborhood (un-paved roads)											
	Alternative 1: Road Improvements - Greenlee Road, Vine Avenue, Kleindale Road, Cherry Avenue, Martin Avenue...etc.	27.2	42.0	47.0	63.6	23.4	368	18	$1,283,205	$3,483	10	180	18

Ranking Legend: Problem Areas	
Top 3	
4 thru 8	
Last 10	

Table 2 - Ruthrauff BMP Specific Weighted Score Rankings

Planning Area	Performance Criteria Combined Specific Criteria Weighted Value	Public Safety	Implementation	Economic Vitality	Community	Environmental Sustainability	Total Score
		3.00	2.33	1.67	1.00	2.00	10.00

EXISTING PROBLEM AREAS

	Alternative	Total Score	Rank Based on Score	Est. Cost	Cost/Score	Rank Based on Cost	Combined (Rank*Rank)	Ranked Results
Basin Wide Alternatives	Existing Problem Statement: Ponding and flooding problems across the entire Ruthrauff basin							
	Alternative 1: Declare entire project area a critical basin	22.6	79.8	65.0	62.0	63.6	**552**	3
	Alternative 2: Regular maintenance and solutions regarding agency and residents' cleaning vegetation from channels and enforcing vegetation removal in channels crossing private land	34.3	67.8	62.0	70.8	49.9	**535**	5
	Alternative 3: Infill incentives	46.8	70.5	89.5	78.6	76.2	**685**	1
	Alternative 4: Public information/education/outreach campaign -- possibly in utility bills (Tucson Clean and Beautiful)	17.3	99.5	86.0	70.0	62.6	**623**	2
	Alternative 5: GI/LID	3.9	62.7	81.0	78.7	82.3	**536**	4
	Alternative 6 : Dry wells	3.9	37.0	50.0	46.6	32.3	**293**	6
	Alternative 7 : Floodproofing	5.4	62.3	6.0	36.4	18.2	**244**	7

Ranking Legend: Basin Wide	
Top 3	
Last 4	

Appendix A – Abbreviations

ABC	All Bituminous Concrete
ADOT	Arizona Department of Transportation
COT	City of Tucson
FLAP	Floodprone Land Acquisition Program
GI/LID	Green Infrastructure/Low Impact Development
JEF	JE Fuller Hydrology and Geomorphology, Inc.
lf	linear foot
PCRFCD	Pima County Regional Flood Control District
RBMP	Ruthrauff Basin Management Plan
sf	square foot
Stantec	Stantec Consulting Services, Inc.

Appendix B – Workgroup Summaries

This appendix includes the attendance, minutes, and other documents of importance pertaining to the workgroup meetings convened for this alternatives development and analysis.

B.1 – Workgroup 1: June 9, 2015

Documents included in this appendix in order of insertion:

- Agenda
- Notes for alternative evaluation scoring flowchart
- Importance matrix
- Criteria weighting matrix
- Wheat Design Group example criteria for environmental sustainability
- Preliminary performance criteria
- Combined group specific criteria weight sheets

PIMA COUNTY
FLOOD CONTROL

ALTERNATIVES WORKGROUP MEETING AGENDA

LOCATION: Ellie Towne Flowing Wells Community Center
DATE: Tuesday, June 9th, 2015
TIME: 10:00 am – 2:30 pm

1. **10:00 - Introductions and Opening Comments** Evan Canfield, District PM

2. **10:10 - Meeting Purpose** Chuck Williams, Facilitator
   - Brief Project Status and Update
   - Initiate Alternatives Workgroup Process
   - Review & Augment Alternatives Seedlist (time permitting)

3. **10:20 - Project Status** John Wise, Consultant PM
   - Background & Overview
   - Project Area
   - Schedule

4. **10:30 - Alternatives Workgroup Involvement** Chuck Williams
   - Select Stakeholders Included in Developing & Scoring Alternatives
   - Alternatives Process
     a) Performance Criteria Established Already (RBMP Team)
        i. Community
        ii. Economic Vitality
        iii. Environmental Sustainability
        iv. Implementation
        v. Public Safety

b) Develop Performance Criteria Weighting Values (By Whole Workgroup)

c) Review of Specific Criteria Spreadsheet (By Whole Workgroup)

5. 11:00 - Develop Specific Criteria & Specific Criteria Weighting Values

a) Develop Specific Criteria (By Subgroup)

b) Develop Specific Criteria Weighting Values (By Subgroup)

6. 1:30 – Review and Augment Seedlist of Alternatives (By Whole Workgroup) (time permitting)

a) Review of Typical Problems

b) Review of Existing Seedlist of Alternatives and Discussion of Augmentation of the list of Alternatives

7. 2:20 - Summary/Next Steps Chuck Williams

8. 2:30 - Adjourn Evan Canfield

Stantec

June 9, 2015

Alternatives Evaluation Criteria and Scoring Flow Chart

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1) Establish 5 performance criteria.

2) Determine relative weighting valves for performance criteria.

3) Develop specific scoring criteria.

4) Determine relative weighting valves for special criteria.

5) Refine seedlist of alternative solutions for the Ruthrauff drainage problems.

6) Select potential alternatives for each problem type and/or location.

7) Score each problem alternative using performance and specific criteria valves.

8) Add costs to top ranked alternatives.

9) Evaluate for fatal flaws.

10) Determine recommended alternative.

PERFORMANCE CRITERIA WEIGHTING VALUES SCORING MATRIX

Performance Criteria:		Preference	Preference	Preference	Preference	**Total points**
		A or B	A or C	A or D	A or E	
A.	Community					
		B or C	B or D	B or E		
B.	Economic Vitality					
		C or D	C or E			
C.	Implementation					
		D or E				
D.	Public Safety					
E.	Sustainability					

	Summary of Highest Rated Criteria from Workgroups			
			6/9/2015	
	Weight	**Most Important**	**2nd Most Important**	**3rd Most Important**
Public Safety	**30%**	Identify Maintenance Needs	Provide Usable Floodplain Maps and Data	Design Drainage for All Weather Access
Implementation	**23%**	Optimize Stakeholders' Support	Minimize Complexity of Regulatory Compliance	Optimize Multiple Funding Sources
Environmental Sustainability	**20%**	Maximize use of renewable water and minimize use of potable water resources	Promote systems with adaptability and resilience	Mitigate the urban heat island effect
Economic Vitality	**17%**	Leadership - meeting objectives of all stakeholders (regional, county, city, community)	Economic value of beneficial sustainable impacts (for example evaluate alternatives with business case evaluator)	Quality of Life - enhance community growth and development
Community	**10%**	Maximize community connectivity, access and use of multi-modal transportation	Optimize beneficial use of land	Compatibility with known community or neighborhood values, goals and plans within the Study Area

	COMPARABLE IMPORTANCE	Prevent transport of contaminants to receiving waters.	Beneficial use of stormwater for habitat creation or enhancement.	Preserve areas of existing vegetation/habitat.	Support multiple transportation modes.	Conserve resources.	Maximize use of renewable water and minimize use of potable water resources.	Maximize beneficial use of land.	Mitigate the heat island effect.	Minimize maintenance needs and intensive maintenance practices.	Promote systems with adaptability and resilience.	TOTAL	WEIGHTED TOTAL
		B	C	D	E	F	G	H	I	J	K		
A	Maintain wash and watershed functioning.	A/B	A/C	A/D	A/E	A/F	A/G	A/H	A/I	A/J	A/K	5	0.909
B	Prevent transport of contaminants to receiving waters.		C	D	B/E	B/F	G	H	I	B/J	K	2	0.364
C	Beneficial use of stormwater for habitat creation or enhancement.			C/D	E	C/F	G	C/H	C/I	C/J	K	4	0.727
D	Preserve areas of existing vegetation/habitat.				D	D/F	G	D	I	D/J	K	5	0.909
E	Support multiple transportation modes.					E/F	G	E/H	I	E/J	K	3.5	0.636
F	Conserve resources.						G	F/H	I	F/J	K	3.5	0.636
G	Maximize use of renewable water and minimize use of potable water resources.							G	G/I	G	G/K	8.5	1.545
H	Maximize beneficial use of land.								I	J	K	3	0.545
I	Mitigate the heat island effect.									I	I/K	8	1.455
J	Minimize maintenance needs and intensive maintenance practices.										K	4	0.727
K	Promote systems with adaptability and resilience.											8.5	1.545
												55	10

RUTHRAUFF BMP SPECIFIC CRITERIA WEIGHTING EVALUATION

ENVIRONMENTAL SUSTAINABILITY CRITERIA - Wheat Design Group

No.	Performance Criteria	Specific Criteria Weighting		Specific Criteria Scoring Descriptions
1	**Maintain wash and watershed functioning.**	0.91	10	Post-construction runoff volume, sediment load, and time to peak are decreased.
	Gauges the ability of an alternative to maintain runoff volumes, time to peak flow, and sediment load.		5	Alternative results in runoff volumes, time to peak, and sediment load maintained at pre-construction levels.
			0	Post-construction runoff volume, sediment load, and time to peak are increased.
2	**Prevent transport of stormwater contaminants to receiving waters.**	0.36	10	Manages stormwater on site and includes biofiltration components to sequester contaminants.
	Evaluates alternatives based on their ability to manage stormwater on site and create opportunities for passive filtration.		5	Runoff is conveyed off site via methods that allow for some passive filtration before reaching receiving waters.
			0	Untreated stormwater is conveyed off site by conventional means with no chance of filtration before reaching receiving waters.
3	**Beneficial use of stormwater for wildlife and human habitat creation or enhancement.**	0.73	10	Maintains water on site and uses it to expand existing wildlife and human habitat or create new habitat. Tree canopy cover is increased.
	Allows for the natural filtration of flood and rainwater and its use in supporting native, drought-tolerant plants and improves soil quality. Includes consideration of designated riparian habitat within the project area.		5	Conveys water off site toward other existing habitat areas.
			0	Conveys water off site via non-permeable structures, preventing it from being used to support new or existing habitat on or near the site.
4	**Preserve areas of existing vegetation/habitat.**	0.91	10	No significant areas of vegetation/habitat will be destroyed.
	This criterion considers the extent to which an alternative requires the clearing of existing vegetation/habitat for construction.		7	Less than half of the the area of existing vegetation/habitat will be cleared.
			2	More that half of the the area of existing vegetation/habitat will be cleared.
			0	Requires clearing of all existing vegetation/habitat.
5	**Support multiple transportation modes.**	0.64	10	Links activity centers and includes amenities or incentives that entice the use of alternative transportation modes (shade, water, seating, etc.).
	Gauges an alternative's ability to enhance opportunities for walking, biking, and busing to key/common/popular destinations, reducing emissions from vehicular transportation.		5	Links activity centers but doesn't encourage use of alternative transportation modes with physical environment amenities or other incentives.
			0	Promotes use of single occupant vehicles. Inhibits or creates barriers to alternative transportation modes.
6	**Conserve resources.**	0.64	10	Optimized for reduction of materials and only uses products with low carbon impact and embodied energy.Uses locally-sourced materials. Has net zero use of energy.
	Compares alternatives based on their consumption of materials, the carbon impacts, and the embodied energy of required materials. Use of recycled, less processed, and less transported materials will be encouraged through this criterion. Use of locally-sourced materials is preferable.		7	Uses typical material volumes and makes partial use of products with low carbon impact and embodied energy.
			2	Uses typical materials and volumes.
			0	Uses excessive and high embodied energy materials. Consumes energy.
7	**Maximize use of renewable water and minimize use of potable water resources.**	1.55	10	Contains elements that significantly minimize use of potable water and promote water reuse and recycling. Employs water-saving irrigation technology. Includes upstream and onsite water harvesting and limits or reduces predevelopment level runoff. If applicable, solution includes schedule for changes in irrigation needs based on season and maturity.
	Rewards alternatives that support water conservation, minimize runoff, maximize reuse of treated effluent from wastewater treatment facilities, and provide recharge and irrigation opportunities. Makes use of new irrigation technology that optimizes efficiency of water application.		7	Limits on-site runoff. Provides some minimization of potable water use and some opportunity for water reuse and recycling. Maintains existing washes and includes upland/upstream passive uses of harvested water.
			2	Limits on-site runoff but does not support water reuse and recycling. Maintains existing washes, uses constructed earthen channels. No upland/upstream uses of harvested water.
			0	Leads to increased runoff and does not support water reuse and recycling. Use of lined channels.
8	**Maximize beneficial use of land.**	0.55	10	Enhances natural resource lands, encourages mixed-use redevelopments, and promotes moderate densites.
	Alternatives that promote or permit clusters of moderate densities and mixed-use developments in areas considered suitable for development will score well. Alternatives that respect valuable natural resource lands will also score well. Promotes in-fill/redevelopment over use of previously undeveloped land.		7	Enhances natural resource lands, but discourages mixed-use redevelopments or promotes low densities.
			2	No negative impact on natural resource lands, but discourages mixed-use redevelopments or promotes low densities.
			0	Negatively impacts natural resource lands, discourages mixed-use redevelopments, and promotes low densities.

9	**Mitigate the urban heat island effect.**					**10**	Alternative decreases existing impermeable surfaces and adds to the urban forest.
	This criterion considers the extent to which an alternative minimizes impermeable surfaces which contribute to the urban heat island effect. The criterion also promotes the enhancement of our urban forest, which mitigates urban heat island effect, improves soil and air quality, decreases energy use/cost, and improves human comfort.		**1.45**			**7**	Alternative maintains exsiting areas of impermeable surfaces, but adds to the urban forest.
						2	Alternative increases impermeable surfaces that contribute to the heat island effect but positively contributes to the urban forest, mitigating the effects of the additional impermeable surfaces.
						0	Alternative increases impermeable surfaces that contribute to the heat island effect and does not positively contribute to the urban forest.
10	**Minimize maintenance needs and intensive maintenance practices.**					**10**	Alternative has the ability to utilize a community-based maintenance regime. System generates little to no waste. "Waste" generated by the system and maintenance activites can be incorporated back into the system. (Ex: Plant material from purning can be chipped and added to the planting basin, replenishing the mulch supply.)
	This criterion considers the extent to which an alternative minimizes the frequency or intensity of maintenance activities. It considers whether or not an alternative can make use of community-based maintenance efforts.		**0.73**			**5**	Alternative requires standard level of maintenance and requires a mixed maintenance regime that allows for at least some community involvement.
						0	Alternative would require more frequent or intensive maintenance compared with similar alternatives. No opportunity to utilize community-based maintenance.
11	**Promote systems with adaptability and resilience.**					**10**	The system has long-term viability and is highly adaptible to meet changing needs.
	This criterion considers the extent to which an alternative is able to adapt/respond to changing conditions without complete re-design and re-implementation. Can the system be added on to or modified to accommodate changes? Is this a short-term or long-term solution?		**1.55**			**5**	The system is moderately adaptible to change. Some elements are fixed, while others have the ability to be modified.
						0	The soloution has fixed parameters and would have to be torn out, re-designed, and re-implemented in order to accommodate changes in factors that influence the functioning of the system.
	Total Specific Criteria Weighting		**10**				

RUTHRAUFF BASIN MANAGEMENT PLAN DRAFT
PERFORMANCE CRITERIA
6/8/2015

The following criteria will be used during the alternative evaluation process to ultimately choose a recommended alternative. Each alternative will be measured on how well the alternative meets the criteria. The five major performance criteria are:

- Community
- Economic Vitality
- Environmental Sustainability
- Implementation
- Public Safety

These criteria are described in more detail below. Each of these criteria will have a weight assigned to it so that the level of importance of each of the major criteria will not necessarily be equal (e.g., Public Safety may be weighted as two times as important as the Economic Vitality criteria.). Assigning the weights to the criteria will be accomplished by using input from the project team, project partners, and participating stakeholders.

PUBLIC SAFETY CRITERIA

- Remove or protect existing structures from floodprone areas.
    - This criteria measures the basic capacity of the alternative to protect existing structures from flood and flood related hazards.
- Provide all-weather access to existing structures.
    - This criteria measures the degree to which all-weather access (depth of flow less than one foot across the roadway during the 100-year flood) to existing development.
- Reduces maintenance due to sediment and erosion.
    - This criteria measures the degree to which maintenance operations are reduced following runoff events.
- Avoids potential for an attractive nuisance and associated risk to public safety.
    - This criteria measures the degree to which the alternative minimizes the potential for creation of structures or facilities which may entice children or juveniles to recreate in an unplanned or unacceptable manner at the structure or facility (e.g., skateboarding on the concrete slopes of a channel or detention basin).
- Removes flood/erosion hazard or otherwise provides opportunity for maximization of developable property.
    - This criteria measures the capacity of an alternative to free undeveloped land from flood and erosion hazards so that it can be developed in an economically constructive manner (e.g., residential housing, commercial centers, etc.)

- Maps new floodway, erosion hazard zones or other no-build corridors.
    - This criteria measures the capacity of an alternative to identify areas of high hazard where new construction should not take place. It increases flood safety by minimizing the potential for creation of new development subject to flood and erosion hazards.
- Purchases or preserves flood and erosion hazard areas.
    - This criteria measures the capacity of an alternative to retire flood and erosion prone areas from possible development, thereby eliminating the potential for creation of new development subject to flood and erosion hazards.
- Promotes public awareness of flood and/or erosion hazards.
    - This criteria measures the degree to which an alternative promotes awareness of flood and erosion hazards, which in turn discourages unwise use and occupation of those areas.

IMPLEMENTATION CRITERIA

- Optimize Multiple Funding Sources
    - This element evaluates how well an alternative scores relative to single source funding or cost sharing from multiple funding sources.
- Minimize Complexity of Required Agreements
    - This element evaluates how well an alternative scores relative to the complexity of and number of required agreements (i.e. contracts, intergovernmental agreements, etc.) required for implementation.
- Optimize Stakeholders' Support
    - This element evaluates whether we can expect stakeholders to support, approve and adopt the alternative. Consider the criteria each individual stakeholder will utilize to evaluate each alternative, i.e. regulatory, permitting, funding participation, etc. and the likelihood that they support the alternative. Additionally this element considers the general consensus of the multiple stakeholders for such support, approval and adoption of the alternative.
- Ensure Compatibility with other Agency Programs
    - This element ranks how well an alternative accommodates other Agency Programs (i.e., land use, parks, trails, transportation, etc.). Accommodating other Programs has a positive effect on gaining consensus towards a preferred alternative. Each alternative should be ranked relative to each other as to how effectively the alternative accommodates other Agency Programs. The more an alternative accommodates other Agency Programs the higher the score.
- Minimize Complexity of Regulatory Compliance
    - This element evaluates the level of difficulty or complexity for local, state and federal permitting required for an alternative. Regulatory compliance can make an alternative less desirable or less feasible if creates increased cost, project delays, insurmountable mitigation requirements, or a denial of the permit. Alternatives should be evaluated as to the relative difficulty

or complexity in gaining the necessary regulatory permits that lead to successful implementation. An alternative that has the least relative difficulty or complexity in gaining regulatory permits receives the higher score. Each alternative should be ranked relative to each other.

- Optimize Timing & Phasing
    - This element evaluates whether there are meaningful opportunities to phase the alternative or elements of the alternative. The public safety and flood hazard mitigation alternatives might be implemented however the accompanying aesthetics and recreational elements might have the ability to be deferred. The opportunity for phasing improves the overall implementation of the more critical functions of the alternative.

ECONOMIC VITALITY CRITERIA

- Consistency with goals of PAG Vitality Advisory Committee (Infrastructure – streets and utilities- - achieve economic diversification and vitality)

- Envision – Leadership
    - Pursue synergies with products and other systems, stakeholder involvement, useful life of alternatives
- Envision – Natural World
    - Preserve local habitat and biodiversity
- Business Case Evaluator
    - Evaluate economic value of beneficial sustainable impacts for alternatives
- Envision – Quality of Life
    - Help community grow and develop, preserve and enhance local resources
- Climate and Risk
    - Long term adaptability
- Consistent with goals or programs of the City of Tucson Office of Economic Initiatives (IDA – Infill Districts, COT Chamber of Commerce)

ENVIRONMENTAL SUSTAINABILITY CRITERIA

- Maintain wash and watershed functioning.
    - Gauges the ability of an alternative to maintain runoff volumes, time to peak flow, and sediment load.
- Prevent transport of stormwater contaminants to receiving waters.
    - Evaluates alternatives based on their ability to manage stormwater on site and create opportunities for passive filtration.
- Beneficial use of stormwater for habitat creation or enhancement.
    - Allows for the natural filtration of flood and rainwater and its use in supporting native, drought-tolerant plants. Includes consideration of designated riparian habitat within the project area.
- Preserve areas of existing vegetation/habitat.

    - This criterion considers the extent to which an alternative requires the clearing of existing vegetation/habitat for construction.
- Support of multiple transportation modes.
    - (Pima Prospers, Section 4.9, Goal 3, Policy 3). Gauges an alternative's ability to enhance opportunities for walking, biking, and busing to key/common/popular destinations, reducing emissions from vehicular transportation.
- Resource conservation.
    - Compares alternatives based on their consumption of materials, the carbon impacts, and the embodied energy of required materials. Use of recycled, less processed, and less transported materials will be encouraged through this criterion.
- Maximize use of renewable water and minimize use of potable water resources.
    - Rewards alternatives that support water conservation, minimize runoff, maximize re-use of treated effluent from wastewater treatment facilities, and provide recharge and irrigation opportunities.
- Maximize beneficial use of land.
    - Alternatives that promote or permit clusters of moderate densities and mixed-use developments in areas considered suitable for development will score well. Alternatives that respect valuable natural resource lands will also score well.
- Mitigate the heat island effect.
    - This criterion considers the extent to which an alternative minimizes impermeable surfaces which contribute the urban heat island effect. The criterion also promotes the enhancement of our urban forest, which mitigates urban heat island effect and improves air quality. y

COMMUNITY CRITERIA

- Compatibility with known community or neighborhood historic values, goals and plans within the Study Area:
    - Assessing the extent to which each alternative achieves consistency with community or neighborhood historic values, goals and plans.
- Compatibility with comments received at the public and neighborhood association meetings:
    - Assessing the extent to which each alternative achieves consistency with requests made by community members, including those received at public and neighborhood meetings.
- Enhance social interactions, health and well being:
    - Assessing alternatives regarding their provision of opportunities for meaningful social interactions, healthy activities and lifestyles, and increasing well being.
- Maximize beneficial use of land:
    - Assessing alternatives regarding their impact on land uses. Alternatives that promote or permit clusters of moderate densities and mixed-use developments in areas considered suitable for development will score

well. Alternatives that respect and enhance the highest and best uses of valuable natural resource lands will also score well.

- Integrated design and compatibility with multi-functional facilities and sites:
    - Assessing alternatives on the extent of their integration with other infrastructure elements, facilities, and sites.

RUTHRAUFF BMP SPECIFIC CRITERIA WEIGHTING EVALUATION

7-Jul-15

Master List

PUBLIC SAFETY CRITERIA

No.	Performance Criteria	Specific Criteria Weighting				Specific Criteria Scoring Descriptions
1	**All Weather Access.** This criteria measures the degree to which all-weather access (depth of flow < 1' across the public roadway during the 1% chance flow event) to development is provided.	1.8			10	Significant improvement to access.
					6	Moderate improvement to access.
					2	Minimal improvement to access.
					0	No improvement to access.
2	**Reduced Inundation of Existing Structures.** This criteria measures the basic capacity of the alternative to protect existing structures from flood related hazards.	1.4			10	Significant reduction in the inundation of structures.
					6	Moderate reduction in the inundation of structures.
					2	Minimal reduction in the inundation of structures.
					0	No reduction in the inundation of structures.
3	**Usable Floodplain Maps and Data.** This critera measures the degree to which map and data products can be used (functionability), understood, and accessed to identify areas of hazards.	2.1			10	Significant level of functionality, usability, and understandability.
					6	Moderate level of functionality, usability, and understandability.
					2	Minimal level of functionality, usability, and understandability.
					0	No level of functionality, usability, and understandability.
4	**Identification of Maintenance Needs.** This criteria identifies the degree to which an alternative identifies maintenance needs for existing and new infrastructure and scheduling of that maintenance.	2.3			10	Maintenance needs are well identified and planned for.
					5	Maintenance needs are somewhat identified and planned for.
					0	Maintenance needs are not identified and planned for.
5	**Public Awareness of Infrastructure.** This criteria measures the degree to which an alternative promotes awareness of flood and erosion hazards which in turn discourages unwise use and occupation of those areas.	1.3			10	Significant increase in awareness.
					6	Moderate increase in awareness.
					2	Minimal increase in awareness.
					0	No increase in awareness.
6	**Reduction of Erosion Hazard Areas.** This criteria measures the capacity of an alternative to bree undeveloped land from flood and erosion so that it can be developed in an economically constructive manner.	0.7			10	Significant increase in developable land.
					6	Moderate increase in developable land.
					2	Minimal increase in developable land.
					0	No increase in developable land.
7	**Purchase or Preserve Flood and Erosion Hazard Areas.** This criteria measures the capacity of an alternative to retire flood and erosion prone areas from possible development, thereby eliminating the potential for creation of new development subject to flood and erosion hazards.	0.4			10	Significant increase in purchased or preserved areas.
					6	Moderate increase in purchased or preserved areas.
					2	Minimal increase in purchased or preserved areas.
					0	No increase in purchased or preserved areas.
	Total Specific Criteria Weighting	10.0				

IMPLEMENTATION CRITERIA							
No.	Performance Criteria		Specific Criteria Weighting				Specific Criteria Scoring Descriptions
1	**Optimize Multiple Funding Sources.** This element evaluates how well an alternative scores relative to single source funding or cost sharing from multiple funding sources.		2.1			10	The alternative has a high probability of being funded by more than one another agency/entity other than PCRFCD.
						5	The alternative has a high probability of funding participation by at least one other agency/entity.
						3	The alternative has a high probability of being funded solely by PCRFCD.
2	**Minimize Complexity of Required Agreements.** This element evaluates how well an alternative scores relative to the complexity of and number of required agreements (i.e. contracts, intergovernmental agreements,etc.) required for implementation.		0.5			10	The alternative is less difficult to implement when considering land ownership, physical constraints and number and types of required agreements.
						5	The alternative is moderately difficult to implement when considering land ownership, physical constraints and number and types of required agreements.
						0	The alternative is very difficult to implement when considering land ownership, physical constraints and number and types of required agreements.
3	**Optimize Stakeholders' Support** This element evaluates whether we can expect stakeholders to support, approve and adopt the alternative. Consider the criteria each individual stakeholder will utilize to evaluate each alternative, i.e. regulatory, permitting, funding participation, etc. and the likelihood that they support the alternative. Additionally this element considers the general consensus of the multiple stakeholders for such support, approval and adoption of the alternative.		2.4			10	General consensus by stakeholders.
						5	Moderate concensus reported by stakeholders
						0	Lack of general consensus by stakeholders.
4	**Ensure Compatibility with other Agency Programs** This element ranks how well an alternative accommodates other Agency Programs (i.e., land use, parks, trails, transportation, etc.). Accommodating other Programs has a positive effect on gaining consensus towards a preferred alternative. Each alternative should be ranked relative to each other as to how effectively the alternative accommodates other Agency Programs. The more an alternative accommodates other Agency Programs the higher the score		0.5			10	The alternative complements all known applicable adopted agency programs.
						8	The alternative is compatible with all known applicable adopted agency programs.
						5	The alternative is compatible with approximately 50% of known applicable adopted agency programs.
						0	The alternative is not compatible with all known applicable adopted agency programs.
5	**Minimize Complexity of Regulatory Compliance** This element evaluates the level of difficulty or complexity for local, state and federal permitting required for an alternative. Regulatory compliance can make an alternative less desirable or less feasible if creates increased cost, project delays, insurmountable mitigation requirements, or a denial of the permit. Alternatives should be evaluated as to the relative difficulty or complexity in gaining the necessary regulatory permits that lead to successful implementation. An alternative that has the least relative difficulty or complexity in gaining regulatory permits receives the higher score. Each alternative should be ranked relative to each other.		2.4			10	The alternative is relatively simple to comply with all known regulatory systems.
						5	The alternative is average in ability to comply with all known regulatory systems.
						0	The alternative is relatively difficult to comply with all known regulatory systems.

6	**Optimize Timing & Phasing** This element evaluates whether there are meaningful opportunities to phase the alternative or elements of the alternative. The public safety and flood hazard mitigation alternatives might be implemented however the accompanying aesthetics and recreational elements might have the ability to be deferred. The opportunity for phasing improves the overall implementation of the more critical functions of the alternative.		0.9			10	The alternative does not require phasing and is relatively simple to implement, or lends itself easily to phasing.
						7	The alternative has elements that are compatible with a multiple phasing approach
						3	The alternative has elements that are compatible with a multiple phasing approach but is more complex to implement.
						0	The alternative cannot be phased and is difficult to implement.
7	**Maintenance Feasibility** This element evaluates how feasible it is to maintain the proposed alternative and how much the alternative will increase or decrease required maintenance.		1.2			10	Maintenance of the alternative is very feasible and/or the alternative results in a little or no increase in required maintenance.
						5	Maintenance of the alternative is moderately feasible and/or the alternative results in a modest increase in required maintenance.
						0	Maintenance of the alternative is difficult or not feasible and/or the alternative results in a substantial increase in required maintenance.
	Total Specific Criteria Weighting		10.0				
ECONOMIC VITALITY CRITERIA							
No.	**Performance Criteria**		**Specific Criteria Weighting**				**Specific Criteria Scoring Descriptions**
1	**Leadership - meeting objectives of all stakeholders (regional, county, city, community)**		3.0			10	Strongly consistent with goals and plans of all stakeholder groups
						9	Strongly consistent with goals and plans of some stakeholder groups, but not all
						6	Moderately consistent with goals and plans of all stakeholder groups
						5	Moderately consistent with goals and plans of some stakeholder groups, but not all
						3	Low consistency with goals and plans of all stakeholder groups
						2	Low consistency with goals and plans of some stakeholder groups, but not all
						0	No consistency with goals and plans of all stakeholder groups
2	**Preserve/restore local habitat and biodiversity**		1.5			10	Highly promotes preservation/restoration of local habitat and biodiversity
						5	Moderately promotes preservation/restoration of local habitat and biodiversity
						0	Has a negative impact on preserving/restoring local habitat and biodiversity
3	**Economic value of beneficial sustainable impacts (for example evaluate alternatives with business case evaluator)**		2.0			10	High ranking for economic value of beneficial sustainable impacts
						5	Moderate ranking for economic value of beneficial sustainable impacts
						0	Negative ranking for economic value of beneficial sustainable impacts

4	**Quality of Life - enhance community growth and development**		2.0			10	High impact on enhancing community growth and development
						5	Moderate impact on enhancing community growth and development
						0	Negative impact on enhancing community growth and development
5	**Resilience and Risk - ability of alternatives to perform in a wide range of conditions**		1.5			10	High adaptability of alternative to perform in a wide range of conditions
						5	Moderate adaptability of alternative to perform in a wide range of conditions
						0	Negative adaptability of alternative to perform in a wide range of conditions
	Total Specific Criteria Weighting		10.0				
COMMUNITY CRITERIA							
No.	**Performance Criteria**		**Specific Criteria Weighting**				**Specific Criteria Scoring Descriptions**
1	**Compatibility with known community or neighborhood values, goals and plans within the Study Area:** Assessing the extent to which each alternative achieves consistency with community or neighborhood values, goals and plan such as the rural character and aesthetic.		1.9			10	Actively preserves and promotes the majority of community and neighborhood plan elements and assists with meaningful implementation; agrees with their probable future direction as well
						7	Promotes the majority of community and neighborhood plan elements
						3	Partially promotes community and neighborhood plan elements
						0	Is not consistent with community and neighborhood values, plan elements and their implementation
2	**Compatibility with comments received at the public and neighborhood association meetings:** Assessing the extent to which each alternative achieves consistency with requests made by community members, including those received at public and neighborhood meetings.		1.6			10	Goes above and beyond the intent of specific community requests
						7	Actively promotes implementation of community requests
						3	Presents minor obstacles to community requests
						0	Presents significant obstacles to community requests
3	**Enhance social interactions, health and well being:** Assessing alternatives regarding their provision of opportunities for meaningful social interactions, healthy activities and lifestyles, and increasing well being, such as parks, the Loop, and quality of life.		1.0			10	Creates a safe area with a sense of place and history, and facilitates social interaction and healthy choices
						7	Creates a moderately safe area with a sense of place and history, and facilitates social interaction and healthy choices
						3	Creates a minimally safe area with a sense of place and history, and facilitates social interaction and healthy choices
						0	Creates a somewhat impersonal and sterile area
4	**Optimize beneficial use of land**: Assessing alternatives regarding their impact on land uses including long term plans and future land use. Alternatives that promote or permit clusters of moderate densities and mixed-use developments in areas considered suitable for development will score well. Alternatives that respect and enhance the highest and best uses of valuable natural resource lands will also score well.		2.1			10	Enhances natural resources lands, complements adjacent land use, optimizes efficient and beneficial use of land and resources
						7	Moderate enhancement of natural resources lands, adjacent land use, efficient and beneficial use of land and resources
						3	Minimal enhancement of natural resources lands, adjacent land use, efficient and beneficial use of land and resources
						0	Negatively impacts natural resources lands, discourages mixed use developments, or promotes low densities

5	**Integrated design and compatibility with multi-functional facilities and sites**: Assessing alternatives on the extent of their integration with other infrastructure elements, facilities, and sites such as UofA Farm, parks, the Loop.		**1.0**			**10**	Highly integrated with other infrastructure elements and forms part of a multi-function site
						7	Compatible with other uses and creates the opportunity for siting other functions within or nearby
						3	Compatible with other uses/functions
						0	Not integrated with other uses and incompatible with multi-function sites
6	**Maximize community connectivity, access and use of multi-modal transportation.** Assessing alternatives on the extent they ensure access, ingress and egress for shopping, recreation, employment, healthcare facilities, and schools.		**2.4**			**10**	Optimizes and improves to the greatest extent possible connectivity, access and use of multimodal transportation
						7	Moderately improves connectivity, access and use of multimodal transportation
						3	Minimally improves connectivity, access and use of multimodal transportation
						0	Impedes or blocks connectivity, access and multimodal transportation
	Total Specific Criteria Weighting		**10.0**				

ENVIRONMENTAL SUSTAINABILITY CRITERIA							
No.	**Performance Criteria**	**Specific Criteria Weighting**					**Specific Criteria Scoring Descriptions**
1	**Maintain wash and watershed functioning.**		**0.91**			**10**	Post-construction runoff volume, sediment load, and time to peak are decreased.
	Gauges the ability of an alternative to maintain runoff volumes, time to peak flow, and sediment load.					**5**	Alternative results in runoff volumes, time to peak, and sediment load maintained at pre-construction levels.
						0	Post-construction runoff volume, sediment load, and time to peak are increased.
2	**Prevent transport of stormwater contaminants to receiving waters.**		**0.36**			**10**	Manages stormwater on site and includes biofiltration components to sequester contaminants.
	Evaluates alternatives based on their ability to manage stormwater on site and create opportunities for passive filtration.					**5**	Runoff is conveyed off site via methods that allow for some passive filtration before reaching receiving waters.
						0	Untreated stormwater is conveyed off site by conventional means with no chance of filtration before reaching receiving waters.
3	**Beneficial use of stormwater for wildlife and human habitat creation or enhancement.**		**0.73**			**10**	Maintains water on site and uses it to expand existing wildlife and human habitat or create new habitat. Tree canopy cover is increased.
	Allows for the natural filtration of flood and rainwater and its use in supporting native, drought-tolerant plants and improves soil quality. Includes consideration of designated riparian habitat within the project area.					**5**	Conveys water off site toward other existing habitat areas.
						0	Conveys water off site via non-permeable structures, preventing it from being used to support new or existing habitat on or near the site.
4	**Preserve areas of existing vegetation/habitat.**		**0.91**			**10**	No significant areas of vegetation/habitat will be destroyed.
	This criterion considers the extent to which an alternative requires the clearing of existing vegetation/habitat for construction.					**7**	Less than half of the the area of existing vegetation/habitat will be cleared.
						2	More that half of the the area of existing vegetation/habitat will be cleared.
						0	Requires clearing of all existing vegetation/habitat.
5	**Support multiple transportation modes.**		**0.64**			**10**	Links activity centers and includes amenities or incentives that entice the use of alternative transportation modes (shade, water, seating, etc.).
	Gauges an alternative's ability to enhance opportunities for walking, biking, and busing to key/common/popular destinations, reducing emissions from vehicular transportation.					**5**	Links activity centers but doesn't encourage use of alternative transportation modes with physical environment amenities or other incentives.
						0	Promotes use of single occupant vehicles. Inhibits or creates barriers to alternative transportation modes.
6	**Conserve resources.**		**0.64**			**10**	Optimized for reduction of materials and only uses products with low carbon impact and embodied energy.Uses locally-sourced materials. Has net zero use of energy.
	Compares alternatives based on their consumption of materials, the carbon impacts, and the embodied energy of required materials. Use of recycled, less processed, and less transported materials will be encouraged through this criterion. Use of locally-sourced materials is preferable.					**7**	Uses typical material volumes and makes partial use of products with low carbon impact and embodied energy.
						2	Uses typical materials and volumes.
						0	Uses excessive and high embodied energy materials. Consumes energy.
7	**Maximize use of renewable water and minimize use of potable water resources.**					**10**	Contains elements that significantly minimize use of potable water and promote water reuse and recycling. Employs water-saving irrigation technology. Includes upstream and onsite water harvesting and limits or reduces predevelopment level runoff. If applicable, solution includes schedule for changes in irrigation needs based on season and maturity.

	Rewards alternatives that support water conservation, minimize runoff, maximize reuse of treated effluent from wastewater treatment facilities, and provide recharge and irrigation opportunities. Makes use of new irrigation technology that optimizes efficiency of water application.		**1.55**			**7**	Limits on-site runoff. Provides some minimization of potable water use and some opportunity for water reuse and recycling. Maintains existing washes and includes upland/upstream passive uses of harvested water.
						2	Limits on-site runoff but does not support water reuse and recycling. Maintains existing washes, uses constructed earthen channels. No upland/upstream uses of harvested water.
						0	Leads to increased runoff and does not support water reuse and recycling. Use of lined channels.
8	**Maximize beneficial use of land.**		**0.55**			**10**	Enhances natural resource lands, encourages mixed-use redevelopments, and promotes moderate densites.
	Alternatives that promote or permit clusters of moderate densities and mixed-use developments in areas considered suitable for development will score well. Alternatives that respect valuable natural resource lands will also score well. Promotes in-fill/redevelopment over use of previously undeveloped land.					**7**	Enhances natural resource lands, but discourages mixed-use redevelopments or promotes low densities.
						2	No negative impact on natural resource lands, but discourages mixed-use redevelopments or promotes low densities.
						0	Negatively impacts natural resource lands, discourages mixed-use redevelopments, and promotes low densities.
9	**Mitigate the urban heat island effect.**		**1.45**			**10**	Alternative decreases existing impermeable surfaces and adds to the urban forest.
	This criterion considers the extent to which an alternative minimizes impermeable surfaces which contribute to the urban heat island effect. The criterion also promotes the enhancement of our urban forest, which mitigates urban heat island effect, improves soil and air quality, decreases energy use/cost, and improves human comfort.					**7**	Alternative maintains exsiting areas of impermeable surfaces, but adds to the urban forest.
						2	Alternative increases impermeable surfaces that contribute to the heat island effect but positively contributes to the urban forest, mitigating the effects of the additional impermeable surfaces.
						0	Alternative increases impermeable surfaces that contribute to the heat island effect and does not positively contribute to the urban forest.
10	**Minimize maintenance needs and intensive maintenance practices.**		**0.73**			**10**	Alternative has the ability to utilize a community-based maintenance regime. System generates little to no waste. "Waste" generated by the system and maintenance activites can be incorporated back into the system. (Ex: Plant material from purning can be chipped and added to the planting basin, replenishing the mulch supply.)
	This criterion considers the extent to which an alternative minimizes the frequency or intensity of maintenance activities. It considers whether or not an alternative can make use of community-based maintenance efforts.					**5**	Alternative requires standard level of maintenance and requires a mixed maintenance regime that allows for at least some community involvement.
						0	Alternative would require more frequent or intensive maintenance compared with similar alternatives. No opportunity to utilize community-based maintenance.
11	**Promote systems with adaptability and resilience.**		**1.55**			**10**	The system has long-term viability and is highly adaptible to meet changing needs.
	This criterion considers the extent to which an alternative is able to adapt/respond to changing conditions without complete re-design and re-implementation. Can the system be added on to or modified to accommodate changes? Is this a short-term or long-term solution?					**5**	The system is moderately adaptible to change. Some elements are fixed, while others have the ability to be modified.
						0	The soloution has fixed parameters and would have to be torn out, re-designed, and re-implemented in order to accommodate changes in factors that influence the functioning of the system.
	Total Specific Criteria Weighting		**10.0**				

B.2 Workgroup 2: February 8, 2016

Documents included in this appendix in order of insertion:

- Completed sign-in sheet
- Meeting Minutes
- Alternatives seedlist
- Group 1 alternatives list
- Group 2 alternatives list
- Combined workgroup alternatives list

Workgroup Meeting Sign-in

Ruthrauff Basin Management Plan

Date: February 8, 2016

Time: 12:00 PM

Place: Stantec – Conference Room

Next Meeting: TBD at TBD

ATTENDEES	NAME	ORGANIZATION	PHONE NO.	E-MAIL
☒	Evan Canfield	PCRFCD	(520) 724-4636	evan.canfield@pima.gov
☒	Terry Hendricks	PCRFCD	(520) 724-4600	terry.hendricks@pima.gov
☒	Eric Shepp	PCRFCD	(520) 724-4600	eric.shepp@pima.gov
☒	Ian Sharp	JE Fuller	(520) 623-3112	ian@jefuller.com
☒	John Wallace	JE Fuller	(520) 623-3112	john@jefuller.com
☒	John Wise	Stantec	(520) 750-7474	john.wise@stantec.com
☒	Chuck Williams	Stantec	(520) 750-7474	chuck.williams@stantec.com
☒	Paul Baughman	COT		paul.baughman@tucson.gov
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☒	Laura Mielcarek	Wheat Design	(520) 884-7911	laura@wheatdesigngroup.com
☒	Kevin Daily	Flowing Wells Neighborhood Assn. and Community Coalition	(520) 661-4603	kevindaily@yahoo.com
☒	David Cummings	Pima County	(520) 724-6410	
☒	Daniel Tylutki	PC Community Development and Neighborhood Conservation	(520) 243-6752	daniel.tylutki@gmail.com
☒	Dave Crockett	FWID		
☒	Jim Fremling	TDOT		james.fremling@tucsonaz.gov
☒	George Kuck	Flowing Wells Neighborhood Assn. and Community Coalition	(520) 471-6408	george5356@hotmail.com

Ruthrauff Basin Management Plan

Alternatives Workgroup Meeting

Location: Stantec Consulting Ltd.
5151 E Broadway Blvd.
Suite 400
Main Conference Rooms

Date: Monday, February 08, 2016
Time: 12:00 pm

In Attendance:

Evan Canfield	PCRFCD	(520) 724-4636	evan.canfield@pima.gov
Terry Hendricks	PCRFCD	(520) 724-4600	terry.hendricks@pima.gov
Eric Shepp	PCRFCD	(520) 724-4600	eric.shepp@pima.gov
Ian Sharp	JE Fuller	(520) 623-3112	ian@jefuller.com
John Wallace	JE Fuller	(520) 623-3112	john@jefuller.com
John Wise	Stantec	(520) 750-7474	john.wise@stantec.com
Chuck Williams	Stantec	(520) 750-7474	chuck.williams@stantec.com
Paul Baughman	COT		paul.baughman@tucson.gov
Irene Ogata	COT	(520) 837-6960	irene.ogata@tucson.gov
Laura Mielcarek	Wheat Design	(520) 884-7911	laura@wheatdesigngroup.com
Kevin Daily	Flowing Wells Neighborhood Assn. and Community Coalition	(520) 661-4603	kevindaily@yahoo.com
David Cummings	Pima County	(520) 724-6410	
Daniel Tylutki	PC Community Development and Neighborhood Conservation	(520) 243-6752	daniel.tylutki@gmail.com

Dave Crockett	FWID		
Jim Fremling	TDOT		james.fremling@tucsonaz.gov
George Kuck	Flowing Wells Neighborhood Assn. and Community Coalition	(520) 471-6408	george5356@hotmail.com

Minutes:

12:16 pm

Introductions followed by Evan Canfield opening comments concerning project. Briefly described purpose, problem sites, and what has been learned.

12:23 pm

Chuck Williams presented project status and updates. This included showing the project area and how complaints were tracked and grouped in the database.

12:30 pm

Chuck Williams discussed the schedule…everything appears to be on time for a November conclusion. Terry Hendricks mentioned FEMA floodplain mapping cannot be done until Pima County installs culverts.

12:33 pm

Chuck Williams covered the results of previous workgroup involvement including the decisions regarding performance criteria and how they are scored as well as a summary of the highest weighted criteria.

12:35 pm

Chuck Williams describes what the objective of the current workgroups will by introducing an overview of the problems and what kind of suggestions should be produced. He suggests looking at the hydrology/hydraulics then scoring them according to the performance criteria and then determining costs.

12:37 pm

Chuck Williams introduces the "seedlist" for alternatives brainstorming including structural factors, non-structural factors, and no action.

12:42 pm

Chuck Williams introduces who will be in the two groups (see meeting PowerPoint for list) and works through an example of alternatives for Problem Area 5.

12:48 pm

George Kuck of the Flowing Wells Neighborhood Association and Community Coalition asked about addressing maintenance issues regarding the basin. Chuck Williams answered that that was being discussed with the stakeholders. He explained the different approaches including general management plans that were being discussed.

Paul Baughman asked if old irrigation canals in the area could be converted into storm drains. This was answered by David Cummings who pointed out that most of those have been filled in and what remains is patch worked and not designed as outlet drainage.

Daniel Tylutki of Pima County Community Development and Neighborhood Conservation asked which directions the basin flow went and if it all went into storm drains because he didn't understand how the basin worked or why some parts flooded. Chuck Williams replied that all the water in the basin is trying to get to Rillito Creek or the Santa Cruz River via a network of culverts and channels. Ian Sharp pointed out that thought there are channels and culverts that many of them are designed for 2, 5, and 10 year events so in some storms they get quickly overwhelmed.

12:53 pm

Break

1:08 pm

Group work begins (see group notes)

3:02 pm

Groups finish individual work and join for final statements.

Chuck Williams gives closing statements about the plans for the suggestions from the brainstorming session:

- To be as objective as possible
- The suggestions would be combined and reduced to three for each problem area
- The alternatives would be drafted and cost evaluated
- They would help determine the future implementation plan

3:12 pm

Meeting adjourned.

RUTHRAUFF BMP ALTERNATIVES BRAINSTORMING "SEEDLIST"

- **A. Structural Alternatives**
  - Retention and/or detention basins - online or offline (per Detention/Retention Manual)
  - Bank Stabilization
  - Conveyance channels/Channelization
  - Flood Walls
  - Levees
  - Flood proofing
  - Culverts
  - Road Improvements
    - Curbs
    - Inverted Crown
    - Others
  - Storm drains
  - Diversion channels/structures
  - Low flow channels
  - Restore Disturbed Areas
  - On-site individual lot retention/detention (per Detention/Retention Manual)
  - Stormwater Harvesting Basin (LID Guidance manual)
  - Vegetated or Rock Swale (LID Guidance manual)
  - Bioretention Systems (LID Guidance manual)
  - Infiltration Trenches (LID Guidance manual)
  - Permeable Pavements (LID Guidance manual)
  - Drywells (LID Guidance manual)
  - Other

RUTHRAUFF BMP ALTERNATIVES BRAINSTORMING "SEEDLIST"

- **B. Non-Structural Alternatives**
  - Delineate additional floodplains
  - Delineate/preserve flow corridors
  - Utilize floodplain regulations
  - Floodplain Land Acquisition Program (FLAP)
  - Infill Development Criteria
    - Disconnect and Minimize Impervious (LID Guidance Manual)
    - Conserve and Protect Natural Flow Paths (LID Guidance Manual)
    - Minimize Disturbance and Soil Compaction (LID Guidance Manual)
    - Alternative Site Layouts (LID Guidance manual)
    - Others
  - Open space regulations/preservation/purchase
  - Flood warning systems
  - Public Education & Outreach
  - Flood Insurance
  - Other
- **C. No Action**

Alternatives Work Group

Ruthrauff Basin Management Plan

Suggested Alternatives for Problems by Area
181300392
Team #1
February 8, 2016

Problem Area 1 - North of Curtis, Highway Dr., Camino de la Tierra, Emerald Ave

- Shannon Drainage channel east side of road to Rillito, low lying area, very flat.
  1) Camino De La Tierra
     a. Improve road with associated drainage system/fill.
     b. Direct runoff from ponding and backwater area to Camino de la Tierra
  2) Economic Incentive District along Highway Dr.
  3) Improve Shannon Channel?
  4) Improve roads, curbs, gutter
  5) Area wide (Area wide=GI/LID, Maintenance, Public Outreach and Education)

Problem Area 2 - South of Ruthrauff to Gardner and South East along Runway

- Eric – RR would install & PCRFCD would pay for it? Letter Agreement- will find for us. Potential new culverts under RR by ADOT. Major ponding area along the corridor.
- Collector channel from south and along RR. Detention/retention – small basins w/minimal benefits.
  1) Structural Solution (channels & RR w/E-W flow conveyance improvements, inverted crown – Gardner, detention/retention at Gardner
  2) FLAP/Consolidate parcels for Future Private owner
     a. Improvement District/Infill Development Incentives
  3) Area Wide

Area at south of Gardner - low flow depth floodplains. New LOMR w/FLO2D – eliminates majority of "Floodplain".

Problem Area 3 - South of Wetmore and West of Romero

- Homes at grade/unimproved streets. Vacant parcel-private
  1) West end of Root - Ponded water with no outlet to west. County Acquisition. Improve above outlet conditions, detention/retention basin. Drain area to La Cholla.

2) Area wide
3) Homer Davis Elementary on east side of Romero – detention/retention Romero recently improved w/storm drain. Complaint 48 – eastside of Romero – Flood Proofing (may be ok now that Romero is improved).
4) Along Root and SW to Gardner – improve streets w/curb/gutters – inverted crown potential.

Problem Area 4 - North of Ruthrauff and West of Flowing Wells Road

- Mobile homes – many near and/or at grade.
    1) U/S detention/retention along Wetmore – County lot – pathway w/water harvest?
    2) Storm drain in Pamona from Rillito to north.
    3) Area Wide
    4) Storm Drain in Flowing Wells – curb/gutter to Rillito
    5) D/S Outlet Channel to Rillito- evaluate system along Ruth from west.
    6) Dry wells in existing detention/retention basins.

Problem Area 5 - North of Prince - West of Fairview and East of Flowing Wells Rd.

- U/S areas are private.
    1) Storm Drains/Inlets - Flowing Wells east to Past Time/Alley.
    2) Area Wide
    3) Ind. Lot detention/retention.
    4) Street Improvement – with curb/gutter (Inv. crown potential)

Problem Area 6- Fort Lowell and Flowing Wells Road

1) Detention/retention – School East of Flowing Wells Rd.
2) Storm Drains/Inlets
3) Area Wide
4) Curb & Gutter – Flowing Wells Rd.

Problem Area 7- Stone & Limberlost

- Ponding
- Lot Drainage
    1) Detention/retention, utilize U/S Park – Don Hummel Park. Vacant land west of Stone in Camino Villas
    2) Storm Drains/Inlets
    3) Amphi Jr. High – detention/retention.
    4) Area Wide

Problem Area 8- Roger/Tyndall

- Ponding/sump intersection (east of 1st)
- Storm drains clogged
- Maintenance Issues
    1) Storm Drains/Inlets
    2) Road Improvements (Intersection)
    3) Area Wide - Storm Wet Harvest/Maintenance/Public Outreach & Education.

Problem Area 9- Prince/Mountain

1) Curbs/Gutter
2) Street side Water Harvest. U/S of ponding – to reduce D/S flows/and associated flooding/ponding along street areas with issues. School to West of Mountain – utilize for detention/retention.
3) Individual Lot – on site detention/retention.
4) Area Wide

Alternatives Work Group

Ruthrauff Basin Management Plan

Suggested Alternatives for Problems by Area
181300392
Team #2
February 8, 2016

Problem Area 1 - North of Curtis, Highway Dr., Camino de la Tierra, Emerald Ave

- Shannon Drainage channel east side of road to Rillito, low lying area, very flat.
  1) Construct low flow diversion channels from Emerald Drive westward to the north of the subdivision.
  2) Construct dry wells in problem areas to absorb excess water.
  3) Construct a channel north to the existing I-10 underpass at Sunset Road.

Problem Area 2 - South of Ruthrauff to Gardner and South East along Runway

- Collector channel from south and along RR. Detention/retention – small basins w/minimal benefits.
  1) Construct a retention basin at the site of the old airport runway.
  2) Construct channels at western edge of problem area to drain under railroad tracks/I-10 to the Santa Cruz River.

Problem Area 3 - South of Wetmore and West of Romero

- Homes at grade/unimproved streets. Vacant parcel-private
  1) Purchase vacant lots in area for construction of retention/detention basins with drainage outlets.
  2) Construct a channel west of Romero and south of Root to drain problem area.
  3) Construct a storm drains with outlets west of Romero.

Problem Area 4 - North of Ruthrauff and West of Flowing Wells Road

- Mobile homes – many near and/or at grade.
  1) Construct a channel north to Rillito Creek along Pomona, Iroquois, or Camino Are Fresca.
  2) Inverted crown roadways in the right of way to convey flow north to the Rillito Creek.
  3) French drains or retention ponds in conjunction with solving maintenance issues.
  4) Elevate new mobile homes or other form of flood proofing so flow runs underneath housing.

5) Construct storm drain under Pomona north to existing drainage channel to Rillito Creek behind houses west of Pomona.

Problem Area 5 - North of Prince - West of Fairview and East of Flowing Wells Rd.

- U/S areas are private.
  1) Maintenance to clean existing drains in area
  2) detention/retention basins

Problem Area 6- Fort Lowell and Flowing Wells Road

1) Confront maintenance issues' involving existing drainage features per the culvert under Ft. Lowell Road regularly gets clogged with large debris (mattresses, etc.).
2) Public information campaign regarding residents dumping debris in upstream channels to mitigate clogging issues at Ft. Lowell.
3) Repair the cracked concrete in the channel walls.
4)

Problem Area 7- Stone & Limberlost

- Ponding
- Lot Drainage
  1) Investigate tying into existing storm drain connections west of stone near Tucson Mall.
  2) Address maintenance issues regarding observed clogged drains due to overgrown vegetation and sediment in the area.

Problem Area 8- Roger/Tyndall

1) Maintenance issues with clearing clogged drains in the area.
2) Installing trees for roadside water harvesting.
3) Have the area mapped as a critical basin and use infill development criteria to mitigate the problems.

Problem Area 9- Prince/Mountain

1) Using vegetation for roadside water harvesting.
2) Possible maintenance solutions with dirt roads in the area.
3) Construct vegetated swales.

Basin Wide Issues Alternatives

1) Have the entire project area declared a critical basin to increase solution flexibility.

2) Investigate possible solutions for having residents' clean vegetation from channels and enforcing vegetation removal in channels crossing private property.

Alternatives Work Group

Ruthrauff Basin Management Plan

Alternatives for Problems by Area
181300392
Combined Team #1 and Team #2

February 25, 2016

Problem Area 1 - North of Curtis, Highway Dr., Camino de la Tierra, Emerald Ave

- Shannon Drainage channel east side of road to Rillito, low lying area, very flat.
  1) Drainage system -- improved road with associated drainage system/fill/channel improvements to direct runoff from ponding and backwater to Camino de la Tierra and/or Shannon Road for diversion to Rillito Creek or existing underpass at Sunset Road.
  2) Construct dry wells in problem areas to absorb excess water.
  3) Improve existing curbs, gutters

Problem Area 2 - South of Ruthrauff to Gardner and South East along Runway

- Collector channel from south and along RR. Detention/retention – small basins w/minimal benefits.
  1) Construct a retention basin at the site of the old airport runway.
  2) Structural solutions at the western edge of area including detention/retention at Gardner and channels to improve east-west flow conveyance in conjunction with outlet under the RR tracks and I-10 to Santa Cruz
  3) FLAP/Consolidate parcels for Future Private Owner – Improvement District/Infill Development Incentives

Problem Area 3 - South of Wetmore and West of Romero

- Homes at grade/unimproved streets. Vacant parcel-private
  1) County acquisition of unoccupied lots in the area of the west end of Root for retention/detention basins with improved outlet conditions West to La Cholla
  2) West of Romero along Root and SW to Gardner improve streets with curbs and gutters, potential inverted crown, and/or channels for flow conveyance west and out of area
  3) (Ask Ian about status of Complaint 48 with recent storm drain improvements to Romero...may be resolved) Homer Davis Elementary on east side of Romero - detention/retention, flood proofing

Problem Area 4 - North of Ruthrauff and West of Flowing Wells Road

- Mobile homes – many near and/or at grade.
  1) Detention/retention with French drains, dry wells, or possibly water harvesting in conjunction with solving maintenance issues
  2) Construction of storm drain under Pomona to convey flow to existing channel north to Rillito Creek
  3) Inverted crown roadways, curb/gutter, storm drains on N-S streets to convey flow to Rillito Creek

Problem Area 5 - North of Prince - West of Fairview and East of Flowing Wells Rd.

- U/S areas are private.
  1) Area wide maintenance to clean existing drains in area
  2) Acquire lots to construct detention/retention basins
  3) Storm drains/inlets – Flowing Wells east to Pastime/alley

Problem Area 6- Fort Lowell and Flowing Wells Road

1) Confront maintenance issues' involving existing storm drains/inlets (culvert under Ft. Lowell Road regularly gets clogged with large debris like mattresses, etc.) in conjunction with a public information campaign regarding residents dumping debris that causes the clogging issues
2) Detention/retention – Walter Douglas Elementary east of Flowing Wells
3) Repair the cracked concrete in the channel walls along Flowing Wells Wash.

Problem Area 7- Stone & Limberlost

- Ponding
- Lot Drainage
  1) Investigate tying into existing storm drain connections west of stone near Tucson Mall.
  2) Address area wide maintenance issues regarding observed clogged drains due to overgrown vegetation and sediment.
  3) Detention/retention – Amphi Jr. High, U/S Park, Don Hummel Park, or vacant land west of Stone in Camino Villas

Problem Area 8- Roger/Tyndall

1) Maintenance issues with clearing clogged drains in the area and installing trees for roadside water harvesting.
2) Storm drains inlets
3) Road improvements (intersection)

Problem Area 9- Richland Heights

1) GI/LID --- using vegetation for roadside water harvesting, possible maintenance solutions with dirt roads in the area, or construct vegetated swales.
2) Look at school west of Martin Ave. to utilize for detention/retention

Basin Wide Issues Alternatives

1) Have the entire project area declared a critical basin to increase solution flexibility.
2) Investigate possible solutions for having residents' clean vegetation from channels and enforcing vegetation removal in channels crossing private property.
3) Mailer to HOA's (One time/periodic?)
4) In utility bills (Tucson Clean and Beautiful?)
5) GI/LID, maintenance (clogged drainage features and overgrown vegetation), public outreach, and education

Check Implementation

1) Area 1: Economic incentive district along Highway Drive
2) Area 2: Railroad would install new culverts under their property and PCRFD would pay for it – Eric will find Letter Agreement
3) Area 8: Have area mapped as critical basin and use infill development criteria to mitigate the problems

B.3 Workgroup 3: August 31, 2016

Documents included in this appendix in order of insertion:

- Completed sign-in sheet
- Agenda
- Meeting Notes

Stakeholders Meeting Sign-in

Ruthrauff Basin Management Plan

Date: August 31, 2016

Time: 12:00 PM

Place: Stantec – Conference Room

Next Meeting: TBD at TBD

ATTENDEES	NAME	ORGANIZATION	PHONE NO.	E-MAIL
☒	Evan Canfield	PCRFCD	(520) 724-4636	evan.canfield@pima.gov
☒	Terry Hendricks	PCRFCD	(520) 724-4600	terry.hendricks@pima.gov
☒	Eric Shepp	PCRFCD	(520) 724-4600	eric.shepp@pima.gov
☒	Ian Sharp	JE Fuller	(520) 623-3112	ian@jefuller.com
☒	John Wallace	JE Fuller	(520) 623-3112	john@jefuller.com
☒	John Wise	Stantec	(520) 750-7474	john.wise@stantec.com
☒	Chuck Williams	Stantec	(520) 750-7474	chuck.williams@stantec.com
☒	Paul Baughman	COT		paul.baughman@tucson.gov
☒	Irene Ogata	COT	(520) 837-6960	irene.ogata@tucson.gov
☒	Laura Mielcarek	Wheat Design	(520) 884-7911	laura@wheatdesigngroup.com
☒	Kevin Daily	Flowing Wells Neighborhood Assn. and Community Coalition	(520) 661-4603	kevindaily@yahoo.com
☐	David Cummings	Pima County	(520) 724-6410	
☐	Daniel Tylutki	PC Community Development and Neighborhood Conservation	(520) 243-6752	daniel.tylutki@gmail.com
☐	Dave Crockett	FWID		
☐	Jim Fremling	TDOT		james.fremling@tucsonaz.gov
☒	George Kuck	Flowing Wells Neighborhood Assn. and Community	(520) 471-6408	george5356@hotmail.com
☐	Jan Gordley	Gordley Group		jan@gordleygroup.com

☒	Gregory Bambauer	Parsons Brinkerhoff		Bambauer@pbworld.com
☐	Jerry James	ADOT		jjames@azdot.gov
☒	Rod Lane	ADOT		rlane@azdot.gov
☒	Elizabeth Leibold	COT		Elizabeth.Leibold@tucsonaz.gov
☒	Joe Alwin	Stantec	(520) 750-7474	joe.alwin@stantec.com
☒	Todd Crouthamel	Stantec	(520) 750-7474	todd.crouthamel@stantec.com

ALTERNATIVES STAKEHOLDER MEETING AGENDA

LOCATION: Stantec
5151 East Broadway
Suite 400
Main Conference Rooms

DATE: Wednesday, August 31, 2016

TIME: 12:00 pm – 3:00 pm (Working Lunch Provided)

1. **12:00 - Introductions and Opening Comments**

2. **12:10 - Meeting Purpose**

   a) Brief Project Status and Update

   b) Review & Input on Draft Recommended Alternatives

   c) Discuss Next Steps

3. **12:20 - Previous Workgroup Involvement**

   a) Performance Criteria Established

      i. Community

      ii. Environmental Sustainability

      iii. Economic Vitality

      iv. Implementation

      v. Public Safety

   b) Performance Criteria Weighting Values Established

   c) Seedlist of Potentially Feasible Alternatives to Evaluate

4. 12:40 - Project Status

a) Project Area

b) Progress since last meeting

- Draft Alternatives Development
- Triage by Agency Technical Subgroup
- Fatal Flaw Analysis
- Scoring by Performance Committees
- Ranking by Points & Area
- Cost Development
- Ranking by Combined Scores & Cost

c) Schedule

- Public Meeting: Wednesday, November 16, 2016
- Potential Basin Management Plan Adoption, Spring 2017

5. 1:00 - Break

6. 1:15 - Today's Workgroup Involvement

a) Review of Draft Recommended Alternatives

b) Workgroup Input

7. 2:45 - Summary/Next Steps

8. 3:00 - Adjourn

RUTHRAUFF BASIN MANAGEMENT PLAN

ALTERNATIVES WORKGROUP MEETING NOTES

LOCATION: Stantec
5151 East Broadway
Suite 400
Main Conference Rooms

DATE: Wednesday, August 31, 2016

TIME: 12:00 pm – 3:00 pm

ATTENDEES: Evan Canfield, Terry Hendricks, Eric Shepp, Ian Sharp, John Wallace, John Wise, Chuck Williams, Paul Baughman, Irene Ogata, Laura Mielcarek, Kevin Daily, George Kuck, Gregory Bambauer, Rod Lane, Elizabeth Leibold, Joe Alwin, Todd Crouthamel

ABSENTEES: David Cummings, Daniel Tylutki, Dave Crockett, Jim Fremling, Jan Gordley, Jerry James

1. **Introductions and Opening Comments – Evan**
   Project Overview

2. **Meeting Purpose - Chuck**

   a) Brief Project Status and Update
      - Draft Alts (47 – Feb. 16)
      - Work Group Image & Fatal Flaw Analysis
      - Scoring based on Perf Criteria and then added costs.
      - 15% level plans

   b) Review Draft Recommended Alternatives
      - Flowing Wells Community Center – Public Meeting
      - 11/16/16 Ellie Towne – Wed.

   c) Discuss Next Steps
      - Spring 2016 – PCRFCD & COT to potentially 'Adopt"

3. **Previous Workgroup Involvement**

   a) Performance Criteria Established - June '15

      i. Community

      ii. Environmental Sustainability

      iii. Economic Vitality

iv. Implementation

v. Public Safety

b) Performance Criteria Weighting Values Established
- For the above each 'Team' developed Specific Criteria w/ weighting criteria. Work Group determined weighting for each Perf. criteria.

c) Seedlist of Potentially Feasible Alternatives to Evaluate - discussed

4. Project Status

a) Project Area

b) Progress since last meeting

- Draft Alternatives Development
- Triage by Agency Technical Subgroup
- Fatal Flaw Analysis
- Scoring by Performance Committees
- Ranking by Points & Area
- Cost Development

c) Schedule

5. Break

6. Today's Workgroup Involvement

d) Review of Draft Recommended Alternatives

e) Workgroup Input

Area 2:

Alternative 1 --

- Ret. Basin – Elizabeth recommended including option for draining – i.e. Pump Station
- Retention – poor infiltration history in City; need another option – needs to drain in 24 hrs.
- Maintenance is a key issue.

Area 1:

Alternative 1 --

- Shannon Rd.
  - Caman Rd area – reduce not eliminate flooding & ponding.

Alternative 2 --

- Camino del la Tierra
- Ret. Basin – O & M critical

- Sunset Rd. improvement & design in future – may impact & benefit draining/flooding in Area 1.

- Any specific issues w/future Sunset TI & drainage conditions might impact TI/I-10/road corridor.

Area 2 (cont.):

Alternative 2 --

- Channel – Gardner Lane/Ruthrauff Rd.
- Alt 2 – Basin locations & utility impacts.
- RR spur impacts? As well as new culverts under RR.
- Challenge of channels & ROW.

Alternative 3 --

- Alt 3- FLAP

Alternative 4, 5, 6, and 7 --

- Ret. Basins – some minimal to larger benefits to reduce floodplains/ponding.

***RR Contact – Elizabeth has name(s) & will provide.

FLAP Cost – Land Acquisition & demo cost

- Does not include selling/redevelopment return cost.

Terry – Disaster Declaration – can get a Grant to purchase Flood prone lands– i.e. FLAP

Area 3: Root Lane

Alternative 1 --

- Alleys & utilities critical

Area 4:

Alternative 1 --

- Ret & Channel – improves conditions D/S
  - D/S culvert – very small - drains to Rillito
  - Includes Flowing Wells Ret. and Channel on west side of road to Rillito

Alternative 2 --

- Roads & Channels Improvements

Area 5:
Alternative 1 --

- George K. – Comment on Retention and Common Areas at the concept stage – ensure Multi-use is encouraged!!! Multi use – will be encouraged for multiple agency/jurisdiction cooperation.
- Elizabeth – Manual requires 8 to 1 (at least one side – to allow pedestrian egress)
- Flowing Wells Irrigation Easements in area – potential issue.
- Laura – Acquiring portion of Mobile Home Park – Costly
- Kevin – Major issues w/street parking, buses, and kids.

Area 6:
Alternative 1 --

- Channel Damage

Area 7:
Alternative 1 --

- Don Hummel Park
  - Minimal floodplain improvement benefits
  - Ranking Low – based on minimal cost, combination rank is high
- Elizabeth – drainage report in area is available.

Area 8:
Alternative 1 --

- Intersection re-design
- 1st Ave. storm drain – minimal (size/capacity)

Alternative 2 --

- Dry wells

Area 9: **Richland Heights West– unpaved roads**

- Road improvements (residents want roads unpaved)
- Utilize GI/LID - could truly benefit this area
  - Elizabeth – City meeting with residents (4x +/-)
    - Will coord. w/Evan as to discussions with residents

Richland Hts. East

- Laura – If Alt is not prioritized – how does GI/LID get considered.
  - Area Wide will cover & identify specific locations to incorporate GI/LID, such as Richland Hts. with GI/LID

Area Wide:

1) Critical Basin Designation for Ruthrauff watershed – Paul, spoke w/City Engr. – would definitely consider this designation.
   - Reduce developed site runoff quantity at or below existing condition runoff.

2) Regular O&M – Private & Public requirements
   - Terry – Riparian cleaning 'vs' maintenance
   - Elizabeth – COT, Private – Drainage Facilities required to conduct Annual O&M and provide an Inspection Report.
   - Terry - County – can enforce private facilities O&M also.

3) Infill Incentives – along I-10 /RR/Highway Drive & commercial designated areas - Redeveloped Area potential
   - Paul – Detail Flow Depth, Floodplain Maps w/FLO2D - yes
     - Located in, provided in existing Condition Report.

4) Public Info/Education/Outreach

5) GI/LID Irene: COT Water- GI incentives for facilities within ROW.
   - Elizabeth – ensure facilities are not impacted by larger flows.
   - Ex. Model/FLO2D modeled specific areas – w/ benefits.
   - Seattle – "One Water" Org. - going to GI/LID.

6) Dry Wells – new design works better than in past.
   - Still depends on soils & infiltration
   - O&M is critical
   - Drainage Manual & Subd. Des. Stds. COT has 17-point check list to consider dry wells.

7) Flood Proofing – utilize by individual/private parcel/structures

7. Summary/Next Steps

1) FTP site – send link to Elizabeth (COT stormwater utility is under consideration)
2) Rod Lane/ADOT
   - Will coordinate with Evan on Flowing Wells Wash as-builts
3) Irene – COT Water – GI/LID + stormwater/wash authority - may do a basin study to evaluate benefits.

8. Adjourn

2:30 pm

Appendix C – Internal Alternatives Memo

The memo produced after internal discussion and in consultation with PCRFD containing the vetted alternatives that were to be analyzed for viability and practicality.

Ruthrauff Basin Management Plan

Drainage Solution Alternatives by Problem Area - DRAFT
181300392

July 13, 2016

Problem Area 1 - North of Curtis Road, Highway Drive, Camino de la Tierra, Emerald Avenue (Exhibit 1-1AA)

1. Channel - Shannon Road
    a. A concrete lined open channel is possible along the eastern edge/side of the subject roadway.
    b. Indications are that to convey ~100 cfs (Q_{100} varies anywhere from 18 cfs to 106 cfs across Shannon Road and Q_{10} varies anywhere from 9 cfs to 30 cfs) would require a trapezoidal channel section: 4-ft bottom, 2-ft in depth, 4:1 side slopes.
    c. This means that culverts will be necessary at any/all access points/intersections/alleys (very problematic element as culverts will reduce the capacity of the system as a whole). A 2-barrel 24-inch dia. CMP culvert or similar structure would have an estimated capacity of 20-25 cfs.
    d. Resulting channel longitudinal slope is very flat = 0.25% (Los Angeles County allows for no less than 0.2% so it is possible, not sure Pima County has a minimum concrete channel slope requirement).
    e. Overall width of improvement(s) cannot be accurately determined due to the 2008 LiDAR data.
    f. The results of the hydraulics analyses of this alternative, during both the 100- and 10-year events, are shown in Exhibit 1-1AB and 1-1AC, respectively.

2. Dry Wells – Shannon Road
    a. Approximate drainage area for nuisance flooding is 103.5 acres (4,510,440 ft^3) of residential neighborhood. Flows in nuisance areas, per JE Fuller FLO2D model, show design flows between 18 cfs on the fringes and 108 cfs mid floodplain with water surface elevations of 1-2 ft. 9 cfs<Q_{10}<30 cfs.
    b. For the desired dry well design (MaxWell Plus; see Figure 1), each well can capture and infiltrate (100 year, 2 hour event within 36 hours) a maximum of 3 acres of residential runoff if used as a remote drain rather than in conjunction with retention basins.

c. Per the manufacture's engineer, each well has an average capacity of 2500 gallons (334 ft^3) and an average infiltration rate of 0.3 to 0.5 cfs (1.3 cfs max) dependent upon area geology and drain pipe depth. Inlet is standard 24" to 30" manhole grate.

d. Assuming no new retention basins are to be built in the nuisance area, 30-50 wells would be required at a cost of between $13,000 and $15,000 apiece installed. In addition, each well would require maintenance via vacuum truck every 3-5 years depending upon runoff sediment load.

e. Due to the limited benefit resulting from this alternative a hydraulic analysis was not undertaken.

3. Curb & Gutter – Shannon Road

   a. Based on a review of the information for this area:

      i. West side has existing vertical curbing (no gutters).

      ii. East side only has vertical curbing at intersection returns and concrete swales (not valley gutters or gutter pans) exist along the east side.

      iii. Ponding occurs along the eastern edge of this road.

   b. Construction of curbing along the eastern edge of Shannon Road would only increase the potential for flooding of homes along the east side (it basically creates a dam that backs runoff up).

   c. Due to the adverse impact(s) associated with this alternative, a hydraulic analysis was not undertaken.

4. Storm drain – Shannon Road

   a. A conceptual analysis of a potential storm drain along the eastern edge of Shannon reveals that a 30-48 inch diameter RCP system may be feasible, utility conflicts notwithstanding. There appears to be an indication of a storm drain along the western edge but no plans were found to verify. Q_{100} varies anywhere from 18 cfs to 106 cfs. 9 cfs<Q_{10}<30 cfs.

   b. L = 1,000', 36-inch RCP, S=0.36%, Q_{cap}~80cfs.

   c. L = 900', 48-inch RCP, S>= 0.4%, Q_{cap}~100 cfs.

   d. Special consideration of this alternative should be given to the condition whereby Rillito River is flowing and if it backs into this storm drain system (i.e., consideration of an outlet gate system).

   e. A limited hydraulic analysis (i.e., manual computations) was undertaken for this alternative.

5. Channel - Camino de la Tierra
    a. Based on JEF data 50cfs<Q_{100}<100cfs, 18cfs<Q_{10}<54cfs.
    b. A roadside channel is possible along the eastern edge/side.
        i. Cannot be earthen lined (n-value is too high).
        ii. Concrete lined.
        iii. Triangular channel section; 2.5-ft depth, 4:1 side slope off road, 3:1 elsewhere, longitudinal slope ~0.3%.
        iv. Intersection/driveway access points would require culverts which could be problematic as the discharge is relatively large to pass completely beneath a given location (Q_{cap} of a 24-inch pipe ~20cfs/barrel).
        v. Q_{cap} ~125 cfs of the proposed channel.
    c. The results of the hydraulics analyses of this alternative, during both the 100- and 10-year events, are shown in Exhibit 1-1AD and 1-1AE, respectively.

6. Retention basin & diversion channel - East of Camino de la Tierra
    a. Estimated total storm runoff volume, during the 100-year event, at a point just downstream of Camino de la Tierra near the existing U-Haul facility is 28.4 ac-ft. During the 10-year event the estimated total storm runoff volume is 12.9 ac-ft.
    b. Conceptual design demonstrates that a retention basin with a maximum capacity of 37 ac-ft is feasible.
        i. 20-ft buffer between the top of the basin and the parcel boundary.
        ii. Side slopes = 4:1
        iii. Maximum ponding depth within the basin is 12-ft.
        iv. Maximum vertical depth of excavation ~15-ft.
        v. Minimum surface area required to install the basin = 5.1 acres.
        vi. For a 10-year system (assuming that the surface area is maintained):
            1. Maximum ponding depth is 3-ft.
            2. Maximum vertical depth of excavation ~7-ft.
    c. Located within APN 101-17-007B (U-Haul); southern half of the eastern half thereof. No apparent impact to existing structures (i.e., the portion of the parcel where the basin would be located is not developed).

i. An alternative location may exist within APNs: 101-17-028 A&B (Hendrix LLC) and 101-17-0290 (private). Just south of Harvey Trucking facility. No apparent impact to existing structures (i.e., the portion of the parcel where the basin would be located is not developed).

d. An interceptor channel commencing north of Curtis Road within an undeveloped parcel (APN 101-17-0240: private) results in a longitudinal slope of about 0.3% and therefore would present a construction challenge. Possible loss of use of alley. Q_{cap} ~25 cfs for an earthen lined channel and Q_{cap} ~60 cfs for a concrete lining.

   i. Other major channel location(s) to serve the primary basin location do not appear practicable. Minor adjustment to the current alignment may prove to be beneficial but would require further investigation/modeling to confirm. Adjustment of the channel alignment may result in access management considerations and improvements (e.g., culvert crossings).

   ii. The need for a channel is greatly diminished whereby the alternative basin (see 6.c.i above) location is selected. It appears that the closer the basin is located to the south and nearer Camino de la Tierra, the more effective it should be.

e. The results of the hydraulics analyses of this alternative, during both the 100- and 10-year events, are shown in Exhibit 1-1AF and 1-1AG, respectively.

Problem Area 2 - South of Ruthrauff Road to Gardner Lane and South East along Runway Drive (Exhibit 2-1AA)

1. Retention basin - Abandoned airport runway.
    a. Estimated total storm runoff volume, during the 100-year event, to Gardner Lane is 88.6 ac-ft. During the 10-year event the estimated total storm volume is 40.2 ac-ft.
    b. Conceptual design demonstrates that two basins in series with a combined maximum capacity of 87.5 ac-ft are feasible.
        i. 10-ft buffer between the top of the basin and the parcel boundary.
        ii. Side slopes = 4:1
        iii. Maximum ponding depth of the lower basin is 14-ft and 17-ft for the upper basin and is therefore very deep and would require safety considerations both to adjacent vehicle and/or pedestrian traffic.
        iv. A spillway between the two basins is feasible and therefore special gate considerations for a culvert system connecting the two basins does not appear necessary.
        v. Lower basin maximum vertical depth of excavation ~ 19-ft.
        vi. Upper basin maximum vertical depth of excavation ~ 23-ft.
        vii. Minimum surface required to install the proposed retention basin system is 10.5 acres.
        viii. For a 10-year system (assuming that the surface area is maintained):
            1. Maximum ponding depth within the upper basin is 9-ft and 5-ft within the lower basin.
            2. Maximum vertical depth of excavation ~13-ft within the upper basin and ~ 9-ft within the lower basin.
    c. Commencing within APN 106-10-1080 to the north and extending though all parcels up to and including APN 106-10-1640, thereby limiting basin development to Sun Tran Boulevard. Additional area appears to be available to the southeast if reduction in the overall basin depth(s) is necessary.
    d. An inceptor channel commencing along the north line of APN 103-09-018A is possible however an easement would be required as well as roadway culverts beneath North Highway Drive, North Runway Drive and Sun Tran Boulevard. Q_{cap} ~160 cfs for a concrete lined channel without consideration of the overall system reduction due to culvert installation. An alternative to the open channel (i.e., storm drain) is feasible but not recommended due to the potential for large discharge(s).

i. Other channel alignments do not appear practicable but further investigation is recommended to confirm this observation.

e. Current basin excavation total is ~150,000 yd^3.

f. The results of the hydraulics analyses of this alternative, during both the 100- and 10-year events, are shown in Exhibit 2-1AB and 2-1AC, respectively.

2. Channel – Immediately east of Interstate 10 between Gardner Lane and Ruthrauff Road (previous analysis of the effectiveness of this alternative was completed prior to this document).

   a. Channel No.1 – Gardner Lane then NW along the UPRR

      i. The channel consists of a Trap Channel: 8'-bottom, 3:1 side slopes, ~4-ft deep.

   b. Channel No.2 - ~650 N. of Channel No.1 running along rear property lines then turning NW along the UPRR to an existing culvert.

      i. The channel consists of a Trap Channel: 8'-bottom, 3:1 side slopes, ~4-ft deep.

   c. Channel No.3 - ~350 N. of Channel No. 2 running along back property lines then entering Channel No.2

      i. The channel consists of a Tri Channel: 3:1 side slopes, ~4-ft deep.

   d. Channel No.4 – Wetmore Road then NW along the UPRR

      i. The channel segment before Highway Drive consists of a Trap Channel: 4'-bottom, 3:1 side slopes, ~3-ft deep.

      ii. The channel segment after Highway Drive consists of a Trap Channel: 8'-bottom, 3:1 side slopes, ~4-ft deep.

   e. Channel No.5 - ~850 N. of Channel No. 4 running along Poppy Ave then entering Channel No.4

      i. The channel consists of a Tri Channel: 3:1 side slopes, ~4-ft deep.

   f. Channel No.6 - ~450 N. of Channel No. 5 running along the northern edge of Zinnia Ave then NW along Highway Drive, crossing to enter the lower end of Channel No.4

      i. The channel consists of a Tri Channel: 3:1 side slopes, ~4-ft deep.

   g. Based on the above channel system the results are:

      i. Gardner Lane UPRR at I-10 crossing ~ 800 cfs.

      ii. Ruthrauff Road south of UPPR at I-10 ~ 400 cfs.

      iii. Combined flow in ROMP channel ~ 1,200 cfs.

h. The results of the hydraulics analyses of this alternative for the 100-year event is shown in Exhibit 2-1AD.

3. FLAP – Prince Road to Gardner Lane – West of Romero Road; Gardner Lane to Ruthrauff Road – West of La Cholla Boulevard
   a. Prince Road to Gardner Lane
      i. 102 affected parcels – all commercial or mixed-use zoned
      ii. Estimated total parcel value $45.9 million
   b. Gardner Lane to Wetmore Road
      i. 65 affected parcels – all commercial or industrial zoned
      ii. Estimated total parcel value $11.8 million
   c. Wetmore Road to Ruthrauff Road
      i. 102 affected parcels – all but nine parcels are commercial, mixed use or industrial zoned. Nine are residential zoned.
      ii. Estimated total residential parcel value $8.6 million
      iii. Estimated total commercial/misc. parcel value $24.6 million
   d. As there was not a hydraulic analysis associated with this alternative an exhibit showing the results of this alternative was not prepared.

4. Retention basin & diversion channel – Paradise Lane
   a. Estimated total storm runoff volume, during the 100-year event, to the location of the proposed basin is 112.1 ac-ft. During the 10-year event the estimated total storm volume is 44.3 ac-ft.
   b. Due to the large volume of runoff resulting during the 100-year event only the 10-year event appears feasible and therefore was only considered herein.
   c. A conceptual design demonstrates that a single basin with a maximum capacity of 48.0 ac-ft is feasible.
      i. 10-ft buffer between the top of the basin and the western parcel boundary (i.e., railroad right-of-way) and 20-ft along the southern and eastern parcel boundaries. The northern line of the basin was located to benefit from an existing channel near the northwest corner of the basin.
      ii. Side slopes = 4:1
      iii. Maximum ponding depth of the basin is 11-ft.
      iv. Maximum vertical depth of excavation ~ 14-ft.

v. Minimum surface required to install the proposed retention basin system is 7.1 acres.

d. Construction of the basin would require acquisition of APNs: 103-06-072B ($175,000), 103-06-071B ($205,000), 103-06-072C ($180,000) and minor portions along the southern edge of 103-06-070E ($668,000 assessment for the entire parcel) and 103-06-070B ($242,000 for the entire parcel).

e. An inceptor channel commencing along the north line of APN 103-06-090B is necessary to enhance the benefit of this retention basin. Q_{cap} ~170 cfs for a riprap lined channel. A hydraulic structure will be required at the southern end of Sullinger Avenue to provide access into APN 103-06-089E (Ferrell Gas).

f. Current basin/channel excavation total is ~105,000 yd^3.

g. The results of the hydraulics analyses of this alternative, during both the 10- and 100-year events, are shown in Exhibit 2-1AF and 2-1AG, respectively.

5. Retention basin – Wetmore Road

a. Estimated total storm runoff volume, during the 100-year event, to the location of the proposed basin is 137.0 ac-ft. During the 10-year event the estimated total storm volume is 59.5 ac-ft.

b. Due to the large volume of runoff resulting during the 100-year event only the 10-year event appears feasible and therefore was only considered herein.

c. A conceptual design demonstrates that a single basin with a maximum capacity of 63.9 ac-ft is feasible.

i. 10-ft buffer between the top of the basin and the western parcel boundary (i.e., railroad right-of-way) and 20-ft along the southern and eastern parcel boundaries. The northern line of the basin was set within the right-of-way serving Wetmore Road.

ii. Side slopes = 4:1

iii. Maximum ponding depth of the basin is 7-ft.

iv. Maximum vertical depth of excavation ~ 13-ft.

v. Minimum surface required to install the proposed retention basin system is 12.7 acres.

d. Construction of the basin would require acquisition of APNs: 103-06-072C ($180,000), 103-06-070E ($668,000), 103-06-070B ($242,000), 103-06-068A ($651,000), 103-06-069A ($385,000) and a minor portion along the southern end of 103-06-091F ($196,000 assessment for the entire parcel).

e. An inceptor channel does appear to be necessary for this basin but adjustment of a portion of Wetmore Road (e.g., one-way crown to the south) is recommended to maximize the benefit of this basin.

f. Current basin/channel excavation total is ~165,000 yd^3.

g. The results of the hydraulics analyses of this alternative, during both the 10- and 100-year events, are shown in Exhibit 2-1AH and 2-1AI, respectively.

6. Retention basin & diversion channel – Zinnia Avenue

   a. Estimated total storm runoff volume, during the 100-year event, to the location of the proposed basin is 24.6 ac-ft. During the 10-year event the estimated total storm volume is 11.6 ac-ft.

   b. Due to the large volume of runoff resulting during the 100-year event only the 10-year event appears feasible and therefore was only considered herein.

   c. A conceptual design demonstrates that a single basin with a maximum capacity of 15.0 ac-ft is feasible.

      i. A minimum of 20-ft buffer between the top of the basin and the adjacent parcel boundaries.

      ii. Side slopes = 4:1

      iii. Maximum ponding depth of the basin is 8-ft.

      iv. Maximum vertical depth of excavation ~ 14-ft.

      v. Minimum surface required to install the proposed retention basin system is 3.7 acres.

   d. Construction of the basin would require acquisition of potions of APNs: 103-05-0300 ($555,000 for the entire parcel) and 103-05-031A (School) ($464,000 for the entire parcel).

   e. An inceptor channel commencing at Wetmore Road and proceeding north along/within the eastern line of APN 103-05-0280 is necessary to enhance the benefit of this retention basin.

   f. Current basin/channel excavation total is ~34,000 yd^3.

   g. The results of the hydraulics analyses of this alternative, during both the 10- and 100-year events, are shown in Exhibit 2-1AJ and 2-1AK, respectively.

7. Retention basin – Highway Drive

   a. Estimated total storm runoff volume, during the 100-year event, to the location of the proposed basin is 149.5 ac-ft. During the 10-year event the estimated total storm volume is 66.8 ac-ft.

b. Due to the large volume of runoff resulting during the 100-year event only the 10-year event appears feasible and therefore was only considered herein.

c. A conceptual design demonstrates that a single basin with a maximum capacity of 38.7 ac-ft is feasible but is insufficient to contain the runoff resulting from the 10-year event. Additional vertical and/or horizontal expansion of the conceptual basin does not appear practicable.

   i. A minimum of 20-ft buffer between the top of the basin and the adjacent parcel boundaries.

   ii. Side slopes = 4:1

   iii. Maximum ponding depth of the basin is 9-ft.

   iv. Maximum vertical depth of excavation ~ 17-ft.

   v. Minimum surface required to install the proposed retention basin system is 8.8 acres.

d. Construction of the basin would require acquisition of potions of numerous parcels. As the basin crosses and adversely impacts Highway Drive and that the minimum storage volume could not be obtained further detail regarding the land acquisition is not provided herein.

e. Current basin/channel excavation total is ~120,000 yd^3.

f. The results of the hydraulics analyses of this alternative, during both the 10- and 100-year events, are shown in Exhibit 2-1AL and 2-1AM, respectively.

8. Retention basin & diversion channel – Verbena Avenue
    a. Estimated total storm runoff volume, during the 100-year event, to the location of the proposed basin is 42.9 ac-ft. During the 10-year event the estimated total storm volume is 17.2 ac-ft.
    b. Due to the large volume of runoff resulting during the 100-year event only the 10-year event appears feasible and therefore was only considered herein.
    c. A conceptual design demonstrates that a single basin with a maximum capacity of 17.9 ac-ft is feasible.
        vi. A minimum of 20-ft buffer between the top of the basin and the adjacent parcel boundaries.
        vii. Side slopes = 4:1
        viii. Maximum ponding depth of the basin is 9-ft.
        ix. Maximum vertical depth of excavation ~ 11-ft.
        x. Minimum surface required to install the proposed retention basin system is 3.3 acres.
    d. Construction of the basin would require acquisition APN: 103-07-083E ($585,000).
    e. An inceptor channel commencing at the east end of Verbena Avenue and proceeding east along/within the northern line of APN 103-07-098A is necessary to enhance the benefit of this retention basin.
    f. Current basin/channel excavation total is ~35,000 yd^3.
    g. The results of the hydraulics analyses of this alternative, during both the 10- and 100-year events, are shown in Exhibit 2-1AN and 2-1AO, respectively.

Problem Area 3 - South of Wetmore Road and West of Romero Road (Exhibit 3-1AA)

1. Retention basin and channel - at the west end of Root Lane
    a. Estimated total storm runoff volume, during the 100-year event, to the eastern half of APN 104-05-3510 is 7.6 ac-ft. During the 10-year event the estimated total storm runoff volume is 4.1 ac-ft.
    b. Conceptual design demonstrates that a single retention basin is feasible with a maximum capacity of 9.2 ac-ft.
        i. 20-ft buffer between the top of the basin and the parcel boundary
        ii. Side slopes = 4:1
        iii. Maximum ponding depth of 7-ft.
        iv. Maximum vertical depth of excavation ~ 15-ft
        v. Minimum surface area required to install the proposed basin is 1.9 acres.
        vi. For a 10-year system (assuming that the surface area is maintained):
            1. Maximum ponding depth within the basin is 3-ft.
            2. Maximum vertical depth of excavation ~11-ft.
    c. The basin would be located within a portion of APN 104-05-3510.
    d. Current excavation total is ~22,000 yd^3 for the 100-year event scenario.
    e. Outlet channel appears to be feasible but would require a drainage easement across private property: triangular channel section, 2-ft deep, 4:1 side slopes but access points (e.g., driveways) would need to be improved (i.e., culverts). Q_{cap} ~45 cfs for an earthen lined channel. Final confluence is with southern bar ditch along Gardner Road but it may need to be re-graded as installing a culvert across Gardner would be needed and based on the current design does not appear to allow for sufficient cover.
    f. The results of the hydraulics analyses of this alternative, during both the 100- and 10-year events, are shown in Exhibit 3-1AB and 3-1AC, respectively. Due to the need to convey runoff into the conceptual retention basin from the east, it was determined that the preferred approach to accomplish this was to combine the effects of No.2 below along with this alternative. This approach is also included within the hydraulic analysis as shown within the aforementioned exhibits.

2. Roadways - west of Romero Road along Root Lane and southwest to Gardner, improve streets with rolled curb and gutter, inverted crown, and/or channels for flow conveyance west and out of area and into Alternative 1 (see above).

a. Reconstruct Root Lane to an inverted crown roadway with roll curb on both sides (possible roll curb upgrade to entire Park el Monte neighborhood) for flow conveyance westbound.

b. Root Lane improvements would include 1420' of roadway reconstruction; inverted crown with 12' lanes at a 3% maximum cross slope (0.7% longitudinal slope) and 3" high roll curb (no sidewalk).

c. Q_{cap} ~62 cfs at a maximum depth of 0.7' (~9") with a mean velocity of 7 ft/s. Q_{100} ~61cfs, Q_{10} ~25cfs.

d. This alternative is recommended to operate concurrently with the retention basin explain within Alternative 1 (see above).

e. A downstream open channel system, under the condition whereby the retention basin is not selected, to convey flow to La Cholla Boulevard and ultimately to Gardner Lane would require a triangular channel section, 3-ft deep, 4:1 side slopes if earthen lined. Q_{cap} ~108 cfs. However, as points of access and roadway crossings would require large culverts (e.g., 5-barrel 24-inch dia. corrugated metal pipe) this optional channel does not appear to be feasible without extensive modification of all downstream conveyance facilities.

3. Storm drain – Root Lane

a. The discharge occurring during the 100-yr event within/near Root Lane is 61 cfs. Q_{10} ~25cfs.

b. L = 1400-ft, 36" RCP, S = 0.7%, Q_{cap} ~ 65 cfs

c. The lack of existing drainage infrastructure in the immediate area makes this alternative impracticable. This would require a mile or more of new pipe beyond the end of Root Lane to tie into existing storm drains or daylight into an existing channel.

Problem Area 4 - North of Ruthrauff Road and West of Flowing Wells Road (Exhibit 4-1AA)

1. Retention basin and channel – South of Rillito Street
    a. Estimated total storm runoff volume, during the 100-year event, to the southern edge of Rillito Street is 13.7 ac-ft. During the 10-year event the estimated total storm runoff volume is 2.1 ac-ft.
    b. Conceptual design demonstrates that a single retention basin is feasible with a maximum capacity of 16.4 ac-ft.
        i. 20-ft buffer between the top of the basin and the parcel boundaries
        ii. Side slopes = 4:1
        iii. Maximum ponding depth of 8-ft.
        iv. Maximum vertical depth of excavation ~ 16-ft
        v. Minimum surface area required for this basin is approximately 3.0 acres.
        vi. For a 10-year system (assuming that the surface area is maintained):
            1. Maximum ponding depth within the basin is 1-ft.
            2. Maximum vertical depth of excavation ~9-ft.
    c. The basin would be located within APNs: 104-03-198C and 104-03-200A. Both are developed parcels. Current estimated value of APN 104-03-198C is $165,951 and APN 104-03-200A is $176,425. Both parcels are currently developed/occupied.
        i. An alternative location may exist within APN 104-03-203A but further investigation and analysis would be required. Current estimated value of APN104-03-203A is $92,096. The parcel is currently developed/occupied.
    d. Current excavation total is ~43,000 yd^3 for the 100-year event scenario.
    e. Intercept/diversion channel into the basin does not appear to be practical south of the mobile home park. Although a channel slope of nearly 0.5% is obtainable, however, the resulting channel depth would exceed 6-ft or a total width of nearly 40-feet. Additional investigation would be required for this project element. A storm drain alternative also does not appear feasible due to a resulting discharge of 145 cfs (RCP 54-inch dia.).
    f. The results of the hydraulics analyses of this alternative, during both the 100- and 10-year events, are shown in Exhibit 4-1AB and 4-1AC, respectively.

2. Storm drain system – Pomona Avenue…et.al.
    a. This option appears impractical. This option would require a new storm drain system to be installed above or in close proximity to the existing RCP storm drain under Pomona Avenue and would likely not relieve flooding depths to the east of the storm drain unless additional storm drain(s) segments are installed within the problem area. Dismissing all potential conflicts, the minimum storm drain diameter for a new system along or beneath Pomona Avenue would be approximately 60-inches in diameter for the southern segment and 72-inches for the northern segment.
    b. It seems feasible based on known field conditions (private property and utility conflicts not withstanding) to have a 48-inch dia. RCP storm drain under Camino Aire Fresco with inlets.
        i. Q_{100} ~93 cfs per FLO2D model the resulting storm drain would consist of: slope = 0.7%, n = 0.013, Q_{cap} ~120 cfs. Q_{10} ~19 cfs.
        ii. Conditionally this segment would only be practical with a new outlet to Rillito Creek (likely where Fresco turns into Ruth). Otherwise an additional storm drain segment would need to be constructed under Ruth Street to Pomona Avenue to tie into existing outlet channel.
    c. A limited hydraulic analysis (i.e., manual computations) was undertaken for this alternative. An exhibit of the hydraulic benefit was not prepared for this alternative due to numerous conflicts revealed during consideration of this option.

3. Roadways – Rillito Street, Pomona Avenue, Camino Aire Fresco and Ruth Street
    a. Assumes a typical Pima County 2-lane urban section:
        i. 11-ft travel lanes
        ii. 6-ft paved shoulders
        iii. Vertical curbs, both sides
        iv. No sidewalks
        v. 10:1 cut/fill slopes
        vi. The above along with the resulting roadway profiles should be considered as maximum obtainable criteria (e.g., adding sidewalks would greatly increase the potential for major conflicts with adjacent existing development).
        vii. Estimated Q_{cap} of each roadway ~ 70 cfs.
        viii. Q_{100} ~30 cfs, Q_{10} ~11 cfs along Pomona Avenue. Discharge data not available for the other streets.

b. Inverted crowned urban roadway along Rillito Street:
    i. Attempts to intercept runoff south of the mobile park reveals a very flat profile (~0.2%) – but appears to be better than the existing profile slope.
    ii. Improvements should end at Camino Aire Fresco to the east
    iii. Improvements should begin at Pomona Avenue to the west
c. Inverted crowned urban roadway along Pomona Avenue:
    i. Attempts to collect conveyed flow from Rillito Street and Ruth Street into existing drainage channel at the north end.
    ii. Profile slope is acceptable ~ existing conditions
    iii. There is an existing 60-inch RCP storm drain along the entire length of Pomona Avenue (plans dated 6/2003 part of Wetmore Road project). Plans show ~8-ft of cover.
d. Inverted crowned urban roadway, Camino Aire Fresco and Ruth Street.
    i. Attempts to both intercept runoff from the east and convey into Pomona Avenue section.
    ii. Flat segment in profile near Sta. 17+50 that is near a parcel with water tanks (cul-de-sac-like lobe)…perhaps conveyed flow within the street could partially be conveyed across this parcel and into Rillito River directly. 1976 plans show an inlet and 30-inch CMP drain pipe through a 10-ft wide easement through this parcel.
e. The results of the hydraulics analyses of this alternative, during both the 100- and 10-year events, are shown in Exhibit 4-1AD and 4-1AE, respectively.

4. Retention basin and diversion channel – southeast corner of Fairview Avenue and Limberlost Drive.
    a. Estimated total storm runoff volume, during the 100-year event, to the western edge of Fairview Avenue is 22.0 ac-ft. During the 10-year event the estimated total runoff volume is 9.1 ac=ft.
    b. Conceptual design demonstrates that a single retention basin is feasible with a maximum capacity of 22.0 ac-ft.
        i. 20-ft buffer between the top of the basin and the parcel boundaries
        ii. Side slopes = 4:1
        iii. Maximum ponding depth of 11-ft.
        iv. Maximum vertical depth of excavation ~ 14-ft
        v. Minimum surface area required ~ 3.5 acres

vi. For a 10-year system (assuming that the surface area is maintained):

1. Maximum ponding depth within the basin is 4-ft.
2. Maximum vertical depth of excavation ~7-ft.

c. The basin would be located within APN 104-09-127J. Current estimated value of APN 104-09-127J is $1,000.

d. Current excavation total is ~42,000 yd^3 for the 100-year basin scenario.

e. Intercept/diversion system will be necessary either along the eastern edge of Fairview Avenue (Q_{100}~200cfs, Q_{10}~40cfs) or reconstructing Limberlost Drive (Q_{100}~119cfs, Q_{10}~35cfs).

i. Initial review of an inceptor open channel along the eastern side of Fairview Avenue revealed extensive conflicts between minimum channel longitudinal slope and sufficient width to construct a minimum channel (45-ft wide to facilitate a triangular shape channel with 3:1 side slope and a maximum depth of 7-ft). An unknown inlet basin/grate appears to exit within the vicinity (additional investigation would be necessary to determine if this existing drainage structure could be used to redirect runoff into the proposed basin).

ii. Reconstruction of a portion (~700-ft) of Limberlost Drive from Fairview Avenue to Main Street may be a more practical alternative to that shown within 4.e.i. Reconstructed section would consist of a one-way crowned road to convey surface runoff into the proposed basin.

f. Due to the shallow depth of the proposed basin, multi-purpose considerations (e.g., ball fields, park…etc.) appear possible. The consideration of including dry well(s) within the basin is also feasible however due to the limited capacity of each dry well (0.25-0.5 cfs) and the potential of each dry well to pose a conflict with a given use (e.g., dry wells within a baseball field), dry wells are not recommended here.

g. The results of the hydraulics analyses of this alternative, during both the 100- and 10-year events, are shown in Exhibit 4-1AF and 4-1AG, respectively.

Problem Area 5 - North of Prince - West of Fairview Avenue and East of Flowing Wells Road (Exhibit 5-1AA)

1. Area-wide maintenance
    a. See Appendix A

2. Retention basin – South of Pelaar Street
    a. Estimated total storm runoff volume, during the 100-year event, to a point just west of Reno Avenue is 41.1 ac-ft. During the 10-year event the estimated total runoff volume is 21.7 ac-ft.
    b. Conceptual design demonstrates that a single retention basin is hydraulically feasible with a maximum capacity of 40.3 ac-ft.
        i. 20-ft buffer between the top of the basin and the parcel boundaries
        ii. Side slopes = 4:1
        iii. Maximum ponding depth of 9-ft.
        iv. Maximum vertical depth of excavation ~ 13-ft
        v. Minimum surface area ~ 7.0 acres.
        vi. For a 10-year system (assuming that the surface area is maintained):
            1. Maximum ponding depth within the basin is 5-ft.
            2. Maximum vertical depth of excavation ~9-ft.
    c. The basin would be located within a portion of APN 106-06-023A (single parcel that encompasses all mobile homes). This parcel is completely developed (mobile home park) and occupied. The estimated current value of APN 106-06-023A is $2.1 million (14.5 acres in total size).
    d. Current excavation total is ~90,000 yd^3 for the 100-year basin system.
    e. Intercept/diversion channel(s) would need to be investigated further (e.g., alley, Pelaar Street diversion, south end of Reno Drive, Tuttle…etc.).
    f. The location of the proposed basin would likely not relieve flooding noted within the upstream area.
    g. The results of the hydraulics analyses of this alternative, during both the 100- and 10-year events, are shown in Exhibit 5-1AB and 5-1AC, respectively.

3. Storm drains –Pastime Road/alley
    a. Existing storm drain system: along Flowing Wells Road is 36-inch RCP.

b. Proposed storm drain should be no larger than 36-inch RCP.

c. Inlets along/within alley would be subjected to clogging.

   i. May be prudent to also include segments upstream and to the south to help intercept flow.

d. Required pipe diameter to convey the nearly estimated maximum flow of 375 cfs (Q_{100}) ~ 84 inches (7-ft)(Q_{cap}~451 cfs) and therefore is not feasible for this location.

e. Required pipe diameter to convey the nearly estimated maximum flow of 120 cfs (Q_{10}) ~ 54 inches (4.5-ft)(Q_{cap}~138 cfs) and therefore is not feasible for this location

f. Q_{cap} of existing storm drain(s) within the area is unknown.

4. Dry Wells & Retention basin – South of Pelaar Street

   a. An analysis of the retention basin proposed under option 2 whereby the basin incorporates several dry wells within the bottom of the basin was undertaken. The analysis included six dry wells within the base and the result of this alternative revealed that there is no apparent benefit regarding the reduction of flood depth(s) when incorporating dry wells within the basin.

   b. The results of the hydraulics analyses of this alternative, during both the 100- and 10-year events, are shown in Exhibit 5-1AD and 5-1AE, respectively.

Problem Area 6 - Fort Lowell Road and Flowing Wells Road (Exhibit 6-1AA)

1. Maintenance
    a. See Appendix A

2. Retention basin – Walter Douglas Headstart School
    a. Estimated total storm runoff volume to a point just northeast of the intersection of Flowing Wells Road and Navajo Street is 12.7 ac-ft.
    b. Conceptual design demonstrates that a single retention basin is <u>not</u> hydraulically feasible with a maximum capacity of only 3.0 ac-ft.
        i. 20-ft buffer between the top of the basin and the parcel boundaries
        ii. Side slopes = 4:1
        iii. Maximum ponding depth of 14-ft (maximum depth that can be obtained).
        iv. Maximum vertical depth of excavation ~ 15-ft
    c. The basin would be located within southeast corner of the school's field.

3. Repair channel tiles
    a. Repair to an approximately 1000-ft section of the Flowing Wells Wash along West Ft. Lowell Road between North Shawnee Avenue and North El Tovar Avenue
    b. Channel is concrete lined: 8-ft bottom width, 2:1 side slopes and a top with of 40-ft for an approximate surface area is 43778 ft^2.
    c. Each tile appears to be approximately 30-ft in length between joints.

Problem Area 7 - Stone Avenue & Limberlost Drive (Exhibit 7-1AA)

1. Tying into existing storm drain
    a. RCP pipe of unknown diameter is located beneath/along Stone Avenue. Additional analysis would be necessary to determine if this existing system has available capacity to convey estimated discharge to the intersection. Q_{100} ~255 cfs and would therefore require a minimum dedicated storm drain pipe of 72-inch RCP. Q_{10} ~52 cfs at the location of interest.

2. Area-Wide Maintenance
    a. See Appendix A

3. Retention basin – Don Hummel Park
    a. Estimated total storm runoff volume to the western edge of the park is 2.4 ac-ft during the 100-year event.
    b. Conceptual design demonstrates that a single retention basin is feasible with a maximum capacity of 2.9 ac-ft.
        i. 100-ft wide by the entire width (N-S) of the park (~450-ft)
        ii. Side slopes = 4:1
        iii. Maximum ponding depth of 5-ft.
        iv. Maximum vertical depth of excavation ~ 8-ft
        v. Minimum surface area required to install the basin ~ 1.0 acre
    c. Current excavation total is ~8,000 yd^3.
    d. Intercept/diversion channels do not appear necessary as the upstream overall flow width is nearly equal to the Q_{100} floodplain width.
    e. The results of the hydraulics analyses of this alternative, during both the 100- and 10-year events, are shown in Exhibit 7-1AB and 7-1AC, respectively.

Problem Area 8 – Roger Road at Tyndall Avenue (Exhibit 8-1AA)

1. Maintenance and trees
    a. See Appendix A

2. Storm drain – Roger Road
    a. There is an existing storm drain (43"x27" CMPA) and associated inlets along the northern edge of Roger Road with an estimated capacity (JEF analysis) of 37 cfs carrying about 15 cfs during 100-year event. However, based on the regional analysis of the existing system the downstream system is over capacity thereby limiting the effectiveness of the segment along Roger Road. Without system capacity improvements downstream any alternatives that consider diverting runoff into a subsurface system, or the existing system, would prove to be ineffective. In addition, the existing segment beneath Roger Road appears to be about 50% clogged with sediment based on recent field review.
    b. The problem area represents a low spot in the road where water ponds and existing single scupper cannot handle flow.
    c. The flow to this scupper is causing scour and pavement damage to the north side of Roger Road between Tyndall and the storm drain. It is reducing the effectiveness of the drain with sediment build up as well.
    d. One alternative would be to install a grate on-grade with drop drain to tie into the existing storm water pipe at the intersection of Roger Road and Tyndall. However, as explained within item a. above any alternatives that would utilize the existing storm drain system will prove to be ineffective. In addition, there are several sewer mains within the intersection that could pose a conflict to this type of alternative.
        i. Conflicts notwithstanding, it is estimated that the Q_{100} ~115 cfs with a water surface elevation of 1.5' to 2.0' above existing grade. Assuming complete submersion with an efficiency of 85%, a 9' x 2' grate with associated catch basin could intercept the entire flow to this location. Q_{10} ~54 cfs.
    e. Possible concrete valley gutter on west side of Roger Road west of Tyndall Avenue to relieve scour and sediment buildup around existing storm drain.
    f. Assuming an independent storm drain located beneath Roger Road and discharging toward the west, a minimum RCP diameter required for the Q_{10} would be 48-inches and 60-inches for the Q_{100} discharge. The ultimate downstream location of this new storm drain segment would need to be determined and analyzed as it would likely confluence with the existing

system and a determination of the capacity of any existing storm drains does not appear to be available.

3. Roadway – Intersection and/or Roger Road
    a. Improvement of the intersection via curb & gutter would require extensive tie-ins with adjacent roadway features (rural type to the east and along the southern edge to the west).
    b. Would recommend either catch basin(s) within low graded zones outside at all corners of the intersection and tie into the storm drain system in this area. Although utility conflicts would likely occur along the southern quarters. Based on the findings stated within item 2.a above any alternative that would tie into the existing system would likely prove to be ineffective.
    c. Improvement of intersection through reconstruction of Roger Road and Tyndall Avenue:
        i. Raising the intersection does not appear practicable due to the roadway profile of Roger Road. Roger Road is basically a drainage convey channel (regional low point) although there is a very minor (<0.5-ft) relative low point at the intersection of Roger Road with Tyndall Avenue. Therefore, the intersection cannot be raised without adversely impacting adjacent dwellings.
        ii. Smoothing out the profile of Roger Road may improve drainage however the resulting slope 0.12% would be difficult to obtain a uniform profile across the intersection. And at such a slope the potential for ponding within the paved roadway section would reduce the life expectancy of the pavement material.
        iii. Either approach would likely require installation of cross road surface drains to mitigate runoff. Recommend storm drain inlets alone within Roger Road.
4. Dry Wells – Intersection of Roger Road and Tyndall Ave
    a. The desired dry well design (MaxWell Plus; see Figure 1), per the manufacturer's engineer, each well has a capacity of 2500 gallons (334 ft^3) and an average infiltration rate of 0.3 to 0.5 cfs (1.3 cfs max) depending upon area geology and drain pipe depth. A standard 24' to 30" manhole grate is used as the inlet.
    b. Six dry wells would be placed on the north side of the intersection; three east of Tyndall and three west of Tyndall. Utility conflicts, namely sanitary sewer facilities, and limited space limited the number and location of the wells. Some grading would be needed to assure drainage to the inlets.

c. At a cost of $10,000 to $15,000 each installed the base cost would be $60,000 to $90,000 not including additional earthworks for grading the area. Assuming an estimated $50,000 for associated excavation and grading the subtotal cost for the listed items would be between $110,000 and $140,000 for this location.

d. The 100-year design discharge for the intersection is between 106 and 115 cfs per the study done by JE Fuller for this project. The dry wells would do little to mitigate design flows of this magnitude, all six would have a combined infiltration rate of approximately 3 cfs and maximum combined holding capacity without any settled sediment of 2,004 ft^3.

e. The dry wells may be effective drying the intersection more quickly.

   i. JE Fuller estimates the water surface elevation for the 100-year event to be 1-2 feet.

   ii. Using Pima County MapGuide the flood area for the intersection was estimated to be 161,772 ft^2.

   iii. Assuming an average infiltration rate of 0.5 cfs, from just the wells with no other sources of drainage or infiltration, a ponding depth of 1-2 feet in the intersection, and no sediment load effecting the grate or capacity of the wells the entire volume of water could be infiltrated in 15 to 29 hours. This is well within the typical operating requirements for infiltration within 36 hours.

   iv. Certainly smaller return period storms would be infiltrated much more quickly.

Problem Area 9 – Prince Road at Mountain Avenue (Exhibit 9-1AA)

1. Maintenance and trees

2. Retention basin – northwest corner of Greenlee Road and Vine Avenue

   a. Estimated total storm runoff volume to the subject area is 9.0 ac-ft during the 100-year event. During the 10-year event the estimated total storm runoff volume is 4.9 ac-ft.

   b. Conceptual design demonstrates that a single retention basin is feasible with a maximum capacity of 9.5 ac-ft.

      i. Basin would require five parcels: APNs: 113-05-1030, 113-05-1040, 113-05-105A, 113-05-1060 (City) and 113-05-107A.

ii. 20-ft buffer between the top of the basin and the parcel boundaries
iii. Side slopes = 4:1
iv. Maximum ponding depth of 5-ft.
v. Maximum vertical depth of excavation ~ 8-ft
vi. Minimum surface area required to install the basin ~ 3.1 acre
vii. For a 10-year system (assuming that the surface area is maintained):
    1. Maximum ponding depth within the basin is 3-ft.
    2. Maximum vertical depth of excavation ~6-ft.

c. Current excavation total is ~24,000 yd^3 for the 100-year scenario.
d. Intercept/diversion channels do not appear necessary but reconstruction of a portion (~600-ft) of Greenlee Road from Mountain Avenue to Vine Avenue will be necessary. Reconstructed section would consist of a one-way crowned road to convey surface runoff into the proposed basin.
e. It should be noted that the location of the proposed basin is downstream of the noted drainage complaints and therefore would likely not reduce future drainage complaints/concerns.
f. The results of the hydraulics analyses of this alternative, during both the 100- and 10-year events, are shown in Exhibit 9-1AB and 9-1AC, respectively.

3. Roadways – Greenlee Road, Vine Avenue, Kleindale Road, Cherry Avenue and Martin Avenue…et.al.
    a. Reconstruction to the noted roadways into a paved inverted crowned roadway section with curbing would require an estimated 6,800-ft of roadway reconstruction.
        i. Estimated cost of: 34-ft roadway, rolled curbing along both sides, 3-inch of AC over 4-inches of ABC); ~$1,100,000. Does not include the cost of other necessary elements (e.g., earthwork, mobilization…etc.).
    b. As the local land/home-owners within the subject area do not desire urban roadway characteristics, the above recommendation was deemed inappropriate for this specific location.

Appendix D – Completed Ruthrauff BMP Specific Weighted Scoring Sheets

The completed specific criteria score sheets produced at the end of the alternatives analysis to facilitate priority ranking.

Ruthrauff BMP Specific Weighted Scoring Sheet Master

Planning Area	Performance Criteria / Specific Criteria / Weighted Value	PUBLIC SAFETY							
		1	2	3	4	5	6	7	Total
		1.80	1.40	2.10	2.30	1.30	0.70	0.40	
Scored by:		EXISTING PROBLEM AREAS							
IS 7/28/16	Alternative								
Problem Area 1	Existing Problem Statement:	Ponding and flooding issues in low lying areas between Emerald Ave. and Camino de la Tierra							
	Alternative 1: Shannon Road -- drainage channel east side of road to Rillito, improve existing curbs and gutters, and new storm drain system	10	6	10	10	2	5	0	76.50
	Alternative 2: Camino de la Tierra -- drainage channel on east side of road to the Rillito with a retention basin and diversion channel north and east of Highway Drive, Possible combination with Sunset Rd project	10	6	10	10	2	6	2	78.00
Problem Area 2	Existing Problem Statement:	Poor drainage with ponding south of Ruthrauff to Gardner Lane and to Runway Drive southeast							
	Alternative 1: Construct retention/detention basin at the site of the old airport runway	8	6	10	10	2	8	8	78.20
	Alternative 2: Channel immediately east of I-10 between Gardner Lane and Ruthrauff Road	10	10	10	10	2	10	0	85.60
	Alternative 3: FLAP/Consolidate parcels for Future Private Owner -- Improvement District/Infill Development Incentives	0	0	0	0	0	0	10	4.00
	Alternative 4: Retention basin and diversion channel - Paradise Lane	6	5	10	10	2	4	6	69.60
	Alternative 5: Retention basin at Wetmore Road	5	4	10	10	2	3	6	65.70
	Alternative 6: Retention basin at Highway Drive	2	2	10	10	2	2	6	56.80
	Alternative 7: Retention basin and diversion channel at Verbena Avenue	4	4	10	10	2	2	6	63.20
Problem Area 3	Existing Problem Statement:	Drainage and ponding issues south of Wetmore and west of Romero -- homes at grade/unimproved streets							
	Alternative 1: Retention Basin/Roadway -- west of Romero improve Root Ln with inverted crown and curb/gutter for conveyance to basin at west end of Root Ln along with outlet system	6	8	10	10	2	6	5	74.80
Problem Area 4	Existing Problem Statement:	Street flooding and property erosion along Pomona between Wetmore and the Rillito							
	Alternative 1: Retention Basin and Channel -- South of Rillito Street in conjunction with drainage channel on Flowing Wells to the Rillito	8	8	10	10	2	5	2	76.50
	Alternative 2: Roadway/Channel -- Inverted crown roadways, curb/gutter, storm drains on Pomona, Rillito, Ruth and Camino Aire Fresca	2	2	10	10	2	2	0	54.40
Problem Area 5	Existing Problem Statement:	Ponding issues north of Prince Rd between Flowing Wells Rd and Fairview Ave							
	Alternative 1: Retention Basin - South of Pelaar Street	6	6	10	10	2	5	6	71.70
Problem Area 6	Existing Problem Statement:	Flooding issues at Fort Lowell Rd and Flowing Wells Rd -- culvert frequently blocked with debris							
	Alternative 1: Repair channel tiles along Flowing Wells Wash	0	0	0	10	0	2	0	24.40
Problem Area 7	Existing Problem Statement:	Ponding and lot drainage problems near Stone Ave between Wetmore Rd and Limberlost Dr							
	Alternative 1: Retention basin - Don Hummel Park	0	2	10	10	2	0	0	49.40
Problem Area 8	Existing Problem Statement:	Ponding issues caused by blocked existing drainage structures on Roger Rd at Tyndall Ave							
	Alternative 1: Roadway -- Intersection and/or Roger Road	4	2	10	10	2	0	0	56.60
	Alternative 2: Dry wells -- Intersection of Roger Road and Tyndall Ave	1	0	2	10	0	0	0	29.00
Problem Area 9	Existing Problem Statement:	Erosion problems and nuisance ponding in Richland Heights neighborhood							
	Alternative 1: Road Improvements - Greenlee Road, Vine Avenue, Kleindale Road, Cherry Avenue, Martin Avenue...etc.	0	0	0	10	0	2	7	27.20
Basin Wide Alternatives	Existing Problem Statement:	Ponding and flooding problems across the entire Ruthrauff basin							
	Alternative 1: Declare entire project area a critical basin	0	2	6	2	2	0	0	22.60
	Alternative 2: Regular maintenance and solutions regarding residents' cleaning vegetation from channels and enforcing vegetation removal in channels crossing private land	2	2	0	9	5	1	0	34.30
	Alternative 3: Infill incentives	0	0	0	0	0	0	0	0.00
	Alternative 4: Public information/education/outreach campaign -- possibly in utility bills (Tucson Clean and Beautiful)	0	1	2	0	9	0	0	17.30
	Alternative 5: GI/LID	1	1	0	0	0	1	0	3.90
	Alternative 6 : Dry wells	1	1	0	0	0	1	0	3.90
	Alternative 7 : Floodproofing	0	2	0	0	2	0	0	5.40

IMPLEMENTATION

Planning Area	Performance Criteria / Specific Criteria / Weighted Value	1 / 2.10	2 / 0.50	3 / 2.40	4 / 0.50	5 / 2.40	6 / 0.90	7 / 1.20	Total
Scored by:	EXISTING PROBLEM AREAS								
JW 7/28/16	Alternative								
Problem Area 1	Existing Problem Statement:	Ponding and flooding issues in low lying areas between Emerald Ave. and Camino de la Tierra							
	Alternative 1: Shannon Road -- drainage channel east side of road to Rillito, improve existing curbs and gutters, and new storm drain system	2	0	0	0	5	10	2	27.60
	Alternative 2: Camino de la Tierra -- drainage channel on east side of road to the Rillito with a retention basin and diversion channel north and east of Highway Drive, Possible combination with Sunset Rd project	4	5	3	2	5	6	2	38.90
Problem Area 2	Existing Problem Statement:	Poor drainage with ponding south of Ruthrauff to Gardner Lane and to Runway Drive southeast							
	Alternative 1: Construct retention/detention basin at the site of the old airport runway	5	0	3	3	8	2	0	40.20
	Alternative 2: Channel immediately east of I-10 between Gardner Lane and Ruthrauff Road	5	3	7	5	10	5	5	65.80
	Alternative 3: FLAP/Consolidate parcels for Future Private Owner -- Improvement District/Infill Development Incentives	5	10	3	4	10	5	10	65.20
	Alternative 4: Retention basin and diversion channel - Paradise Lane	3	5	2	2	5	7	2	35.30
	Alternative 5: Retention basin at Wetmore Road	3	5	2	2	5	7	2	35.30
	Alternative 6: Retention basin at Highway Drive	3	5	2	2	5	7	2	35.30
	Alternative 7: Retention basin and diversion channel at Verbena Avenue	3	5	2	2	5	7	2	35.30
Problem Area 3	Existing Problem Statement:	Drainage and ponding issues south of Wetmore and west of Romero -- homes at grade/unimproved streets							
	Alternative 1: Retention Basin/Roadway -- west of Romero improve Root Ln with inverted crown and curb/gutter for conveyance to basin at west end of Root Ln along with outlet system	7	7	7	5	8	10	4	70.50
Problem Area 4	Existing Problem Statement:	Street flooding and property erosion along Pomona between Wetmore and the Rillito							
	Alternative 1: Retention Basin and Channel -- South of Rillito Street in conjunction with drainage channel on Flowing Wells to the Rillito	4	1	3	3	8	3	2	41.90
	Alternative 2: Roadway/Channel -- Inverted crown roadways, curb/gutter, storm drains on Pomona, Rillito, Ruth and Camino Aire Fresca	10	5	2	5	8	10	5	65.00
Problem Area 5	Existing Problem Statement:	Ponding issues north of Prince Rd between Flowing Wells Rd and Fairview Ave							
	Alternative 1: Retention Basin - South of Pelaar Street	5	5	0	5	10	7	0	45.80
Problem Area 6	Existing Problem Statement:	Flooding issues at Fort Lowell Rd and Flowing Wells Rd -- culvert frequently blocked with debris							
	Alternative 1: Repair channel tiles along Flowing Wells Wash	3	10	10	10	10	10	10	85.30
Problem Area 7	Existing Problem Statement:	Ponding and lot drainage problems near Stone Ave between Wetmore Rd and Limberlost Dr							
	Alternative 1: Retention basin - Don Hummel Park	7	6	3	0	8	10	2	55.50
Problem Area 8	Existing Problem Statement:	Ponding issues caused by blocked existing drainage structures on Roger Rd at Tyndall Ave							
	Alternative 1: Roadway -- Intersection and/or Roger Road	7	8	7	10	10	10	8	83.10
	Alternative 2: Dry wells -- Intersection of Roger Road and Tyndall Ave	5	7	8	6	8	10	3	68.00
Problem Area 9	Existing Problem Statement:	Erosion problems and nuisance ponding in Richland Heights neighborhood							
	Alternative 1: Road Improvements - Greenlee Road, Vine Avenue, Kleindale Road, Cherry Avenue, Martin Avenue...etc.	3	3	0	0	7	10	7	42.00
Basin Wide Alternatives	Existing Problem Statement:	Ponding and flooding problems across the entire Ruthrauff basin							
	Alternative 1: Declare entire project area a critical basin	10	8	8	10	5	10	8	79.80
	Alternative 2: Regular maintenance and solutions regarding residents' cleaning vegetation from channels and enforcing vegetation removal in channels crossing private land	4	5	9	7	7	10	5	67.80
	Alternative 3: Infill incentives	7	5	6	7	6	10	10	70.50
	Alternative 4: Public information/education/outreach campaign -- possibly in utility bills (Tucson Clean and Beautiful)	10	10	10	9	10	10	10	99.50
	Alternative 5: GI/LID	8	4	6	5	5	10	5	62.70
	Alternative 6 : Dry wells	3	3	3	2	4	10	2	37.00
	Alternative 7 : Floodproofing	4	6	7	7	5	10	8	62.30

ECONOMIC VITALITY

Planning Area	Performance Criteria / Specific Criteria / Weighted Value	1 / 3.00	2 / 1.50	3 / 2.00	4 / 2.00	5 / 1.50	Total
Scored by: JSW 7/28/16	EXISTING PROBLEM AREAS — Alternative						
Problem Area 1	Existing Problem Statement: Ponding and flooding issues in low lying areas between Emerald Ave. and Camino de la Tierra						
	Alternative 1: Shannon Road -- drainage channel east side of road to Rillito, improve existing curbs and gutters, and new storm drain system	6	5	5	5	5	53.00
	Alternative 2: Camino de la Tierra -- drainage channel on east side of road to the Rillito with a retention basin and diversion channel north and east of Highway Drive, Possible combination with Sunset Rd project	9	5	5	8	8	72.50
Problem Area 2	Existing Problem Statement: Poor drainage with ponding south of Ruthrauff to Gardner Lane and to Runway Drive southeast						
	Alternative 1: Construct retention/detention basin at the site of the old airport runway	9	7	7	8	8	79.50
	Alternative 2: Channel immediately east of I-10 between Gardner Lane and Ruthrauff Road	6	5	5	8	5	59.00
	Alternative 3: FLAP/Consolidate parcels for Future Private Owner -- Improvement District/Infill Development Incentives	9	10	10	10	10	97.00
	Alternative 4: Retention basin and diversion channel - Paradise Lane	9	7	7	8	8	79.50
	Alternative 5: Retention basin at Wetmore Road	9	7	7	8	8	79.50
	Alternative 6: Retention basin at Highway Drive	9	7	7	8	8	79.50
	Alternative 7: Retention basin and diversion channel at Verbena Avenue	9	7	7	8	8	79.50
Problem Area 3	Existing Problem Statement: Drainage and ponding issues south of Wetmore and west of Romero -- homes at grade/unimproved streets						
	Alternative 1: Retention Basin/Roadway -- west of Romero improve Root Ln with inverted crown and curb/gutter for conveyance to basin at west end of Root Ln along with outlet system	9	7	6	6	6	70.50
Problem Area 4	Existing Problem Statement: Street flooding and property erosion along Pomona between Wetmore and the Rillito						
	Alternative 1: Retention Basin and Channel -- South of Rillito Street in conjunction with drainage channel on Flowing Wells to the Rillito	9	7	6	6	6	70.50
	Alternative 2: Roadway/Channel -- Inverted crown roadways, curb/gutter, storm drains on Pomona, Rillito, Ruth and Camino Aire Fresca	6	6	5	5	5	54.50
Problem Area 5	Existing Problem Statement: Ponding issues north of Prince Rd between Flowing Wells Rd and Fairview Ave						
	Alternative 1: Retention Basin - South of Pelaar Street	9	7	6	6	6	70.50
Problem Area 6	Existing Problem Statement: Flooding issues at Fort Lowell Rd and Flowing Wells Rd -- culvert frequently blocked with debris						
	Alternative 1: Repair channel tiles along Flowing Wells Wash	5	3	3	5	0	35.50
Problem Area 7	Existing Problem Statement: Ponding and lot drainage problems near Stone Ave between Wetmore Rd and Limberlost Dr						
	Alternative 1: Retention basin - Don Hummel Park	6	3	4	3	3	41.00
Problem Area 8	Existing Problem Statement: Ponding issues caused by blocked existing drainage structures on Roger Rd at Tyndall Ave						
	Alternative 1: Roadway -- Intersection and/or Roger Road	5	3	3	5	3	40.00
	Alternative 2: Dry wells -- Intersection of Roger Road and Tyndall Ave	4	3	3	3	3	33.00
Problem Area 9	Existing Problem Statement: Erosion problems and nuisance ponding in Richland Heights neighborhood						
	Alternative 1: Road Improvements - Greenlee Road, Vine Avenue, Kleindale Road, Cherry Avenue, Martin Avenue...etc.	6	3	5	5	3	47.00
Basin Wide Alternatives	Existing Problem Statement: Ponding and flooding problems across the entire Ruthrauff basin						
	Alternative 1: Declare entire project area a critical basin	9	7	5	5	5	65.00
	Alternative 2: Regular maintenance and solutions regarding residents' cleaning vegetation from channels and enforcing vegetation removal in channels crossing private land	9	5	5	5	5	62.00
	Alternative 3: Infill incentives	9	10	8	9	9	89.50
	Alternative 4: Public information/education/outreach campaign -- possibly in utility bills (Tucson Clean and Beautiful)	10	8	8	8	8	86.00
	Alternative 5: GI/LID	6	9	9	9	9	81.00
	Alternative 6 : Dry wells	5	5	5	5	5	50.00
	Alternative 7 : Floodproofing	2	0	0	0	0	6.00

Ruthrauff BMP Specific Weighted Scoring Sheet Master

Planning Area	Performance Criteria	COMMUNITY						
	Specific Criteria	1	2	3	4	5	6	Total
	Weighted Value	1.90	1.60	1.00	2.10	1.00	2.40	
Scored by:		EXISTING PROBLEM AREAS						
HEC 7/29/16	Alternative							
Problem Area 1	Existing Problem Statement:	Ponding and flooding issues in low lying areas between Emerald Ave. and Camino de la Tierra						
	Alternative 1: Shannon Road -- drainage channel east side of road to Rillito, improve existing curbs and gutters, and new storm drain system	7	7	3	3	3	10	60.80
	Alternative 2: Camino de la Tierra -- drainage channel on east side of road to the Rillito with a retention basin and diversion channel north and east of Highway Drive, Possible combination with Sunset Rd project	10	7	0	10	3	7	71.00
Problem Area 2	Existing Problem Statement:	Poor drainage with ponding south of Ruthrauff to Gardner Lane and to Runway Drive southeast						
	Alternative 1: Construct retention/detention basin at the site of the old airport runway	7	7	0	3	3	3	41.00
	Alternative 2: Channel immediately east of I-10 between Gardner Lane and Ruthrauff Road	10	10	3	10	7	10	90.00
	Alternative 3: FLAP/Consolidate parcels for Future Private Owner -- Improvement District/Infill Development Incentives	7	7	7	10	7	7	76.30
	Alternative 4: Retention basin and diversion channel - Paradise Lane	7	10	7	7	3	7	70.80
	Alternative 5: Retention basin at Wetmore Road	7	10	7	3	3	7	62.40
	Alternative 6: Retention basin at Highway Drive	7	10	7	3	3	7	62.40
	Alternative 7: Retention basin and diversion channel at Verbena Avenue	7	10	7	7	7	7	74.80
Problem Area 3	Existing Problem Statement:	Drainage and ponding issues south of Wetmore and west of Romero -- homes at grade/unimproved streets						
	Alternative 1: Retention Basin/Roadway -- west of Romero improve Root Ln with inverted crown and curb/gutter for conveyance to basin at west end of Root Ln along with outlet system	7	7	7	10	7	7	76.30
Problem Area 4	Existing Problem Statement:	Street flooding and property erosion along Pomona between Wetmore and the Rillito						
	Alternative 1: Retention Basin and Channel -- South of Rillito Street in conjunction with drainage channel on Flowing Wells to the Rillito	7	3	10	7	10	10	76.80
	Alternative 2: Roadway/Channel -- Inverted crown roadways, curb/gutter, storm drains on Pomona, Rillito, Ruth and Camino Aire Fresca	0	7	3	7	3	0	31.90
Problem Area 5	Existing Problem Statement:	Ponding issues north of Prince Rd between Flowing Wells Rd and Fairview Ave						
	Alternative 1: Retention Basin - South of Pelaar Street	7	7	7	7	7	7	70.00
Problem Area 6	Existing Problem Statement:	Flooding issues at Fort Lowell Rd and Flowing Wells Rd -- culvert frequently blocked with debris						
	Alternative 1: Repair channel tiles along Flowing Wells Wash	10	10	3	7	3	10	79.70
Problem Area 7	Existing Problem Statement:	Ponding and lot drainage problems near Stone Ave between Wetmore Rd and Limberlost Dr						
	Alternative 1: Retention basin - Don Hummel Park	0	3	3	0	7	0	14.80
Problem Area 8	Existing Problem Statement:	Ponding issues caused by blocked existing drainage structures on Roger Rd at Tyndall Ave						
	Alternative 1: Roadway -- Intersection and/or Roger Road	7	7	7	3	3	7	57.60
	Alternative 2: Dry wells -- Intersection of Roger Road and Tyndall Ave	3	3	3	3	3	3	30.00
Problem Area 9	Existing Problem Statement:	Erosion problems and nuisance ponding in Richland Heights neighborhood						
	Alternative 1: Road Improvements - Greenlee Road, Vine Avenue, Kleindale Road, Cherry Avenue, Martin Avenue...etc.	7	3	7	7	7	7	63.60
Basin Wide Alternatives	Existing Problem Statement:	Ponding and flooding problems across the entire Ruthrauff basin						
	Alternative 1: Declare entire project area a critical basin	7	7	3	7	3	7	62.00
	Alternative 2: Regular maintenance and solutions regarding residents' cleaning vegetation from channels and enforcing vegetation removal in channels crossing private land	7	10	3	7	7	7	70.80
	Alternative 3: Infill incentives	10	3	7	10	10	7	78.60
	Alternative 4: Public information/education/outreach campaign -- possibly in utility bills (Tucson Clean and Beautiful)	7	7	7	7	7	7	70.00
	Alternative 5: GI/LID	10	7	10	7	7	7	78.70
	Alternative 6 : Dry wells	3	3	3	3	10	7	46.60
	Alternative 7 : Floodproofing	3	7	3	3	3	3	36.40

ENVIRONMENTAL SUSTAINIBILTY

Planning Area	Performance Criteria / Specific Criteria / Weighted Value	1 / 0.91	2 / 0.34	3 / 0.73	4 / 0.91	5 / 0.64	6 / 0.64	7 / 1.55	8 / 0.55	9 / 1.45	10 / 0.73	11 / 1.55	Total
Scored by:	EXISTING PROBLEM AREAS												
LM 7/28/16	Alternative												
Problem Area 1	Existing Problem Statement: Ponding and flooding issues in low lying areas between Emerald Ave. and Camino de la Tierra												
	Alternative 1: Shannon Road -- drainage channel east side of road to Rillito, improve existing curbs and gutters, and new storm drain system	10	0	5	2	5	2	2	2	0	0	0	23.25
	Alternative 2: Camino de la Tierra -- drainage channel on east side of road to the Rillito with a retention basin and diversion channel north and east of Highway Drive, Possible combination with Sunset Rd project	10	10	7	7	5	2	7	10	7	5	5	66.36
Problem Area 2	Existing Problem Statement: Poor drainage with ponding south of Ruthrauff to Gardner Lane and to Runway Drive southeast												
	Alternative 1: Construct retention/detention basin at the site of the old airport runway	8	7	5	2	5	2	5	10	7	5	8	59.06
	Alternative 2: Channel immediately east of I-10 between Gardner Lane and Ruthrauff Road	10	0	5	0	7	2	2	10	5	5	5	45.76
	Alternative 3: FLAP/Consolidate parcels for Future Private Owner -- Improvement District/Infill Development Incentives	5	5	8	5	5	5	7	8	8	5	10	69.04
	Alternative 4: Retention basin and diversion channel - Paradise Lane	10	8	8	7	6	5	5	7	7	5	5	64.22
	Alternative 5: Retention basin at Wetmore Road	7	7	9	5	2	5	2	5	8	5	5	53.20
	Alternative 6: Retention basin at Highway Drive	7	7	9	5	2	5	2	5	8	5	5	53.20
	Alternative 7: Retention basin and diversion channel at Verbena Avenue	8	8	9	6	3	5	5	5	8	5	5	60.65
Problem Area 3	Existing Problem Statement: Drainage and ponding issues south of Wetmore and west of Romero -- homes at grade/unimproved streets												
	Alternative 1: Retention Basin/Roadway -- west of Romero improve Root Ln with inverted crown and curb/gutter for conveyance to basin at west end of Root Ln along with outlet system	10	10	10	7	5	2	7	10	8	8	5	72.19
Problem Area 4	Existing Problem Statement: Street flooding and property erosion along Pomona between Wetmore and the Rillito												
	Alternative 1: Retention Basin and Channel -- South of Rillito Street in conjunction with drainage channel on Flowing Wells to the Rillito	10	10	10	8	2	7	8	8	10	5	8	80.19
	Alternative 2: Roadway/Channel -- Inverted crown roadways, curb/gutter, storm drains on Pomona, Rillito, Ruth and Camino Aire Fresca	8	0	0	10	5	2	2	2	5	3	0	34.50
Problem Area 5	Existing Problem Statement: Ponding issues north of Prince Rd between Flowing Wells Rd and Fairview Ave												
	Alternative 1: Retention Basin - South of Pelaar Street	10	10	10	7	5	2	7	7	10	8	5	73.44
Problem Area 6	Existing Problem Statement: Flooding issues at Fort Lowell Rd and Flowing Wells Rd -- culvert frequently blocked with debris												
	Alternative 1: Repair channel tiles along Flowing Wells Wash	10	0	0	0	2	2	2	2	5	3	0	25.30
Problem Area 7	Existing Problem Statement: Ponding and lot drainage problems near Stone Ave between Wetmore Rd and Limberlost Dr												
	Alternative 1: Retention basin - Don Hummel Park	8	10	10	5	5	2	7	0	0	2	5	47.07
Problem Area 8	Existing Problem Statement: Ponding issues caused by blocked existing drainage structures on Roger Rd at Tyndall Ave												
	Alternative 1: Roadway -- Intersection and/or Roger Road	10	0	0	10	8	2	2	2	5	3	0	38.24
	Alternative 2: Dry wells -- Intersection of Roger Road and Tyndall Ave	10	10	0	10	8	5	2	2	5	7	0	46.48
Problem Area 9	Existing Problem Statement: Erosion problems and nuisance ponding in Richland Heights neighborhood												
	Alternative 1: Road Improvements - Greenlee Road, Vine Avenue, Kleindale Road, Cherry Avenue, Martin Avenue...etc.	5	0	0	5	7	2	2	2	0	6	0	23.44
Basin Wide Alternatives	Existing Problem Statement: Ponding and flooding problems across the entire Ruthrauff basin												
	Alternative 1: Declare entire project area a critical basin	5	3	9	9	0	8	8	9	8	2	5	63.61
	Alternative 2: Regular maintenance and solutions regarding residents' cleaning vegetation from channels and enforcing vegetation removal in channels crossing private land	10	0	2	5	0	8	0	5	5	10	8	49.93
	Alternative 3: Infill incentives	6	5	10	8	0	8	9	10	8	8	8	76.15
	Alternative 4: Public information/education/outreach campaign -- possibly in utility bills (Tucson Clean and Beautiful)	5	2	5	5	7	7	7	7	5	8	8	62.58
	Alternative 5: GI/LID	8	5	10	8	5	8	10	8	10	5	8	82.33
	Alternative 6 : Dry wells	5	5	5	0	0	9	8	5	0	2	0	32.27
	Alternative 7 : Flood proofing	3	0	0	0	0	2	5	2	0	3	2	18.15

Appendix E – Electronic Appendices (see enclosed external hard drive)

E.1 – JEF GI/LID Report

The full GI/Lid report produced by JE Fuller including appendices.

E.2 – CADD Files

All CADD files related to the analysis of the recommended alternatives.

E.3 – Spatial Files

All XML and GIS files related to the development and analysis of the recommended alternatives

E.4 – FLO2D Files

All the FLO2D files used in evaluating the recommended alternatives.

Figures

Figure 2

Dry Well Typical Section: MaxWell Plus®

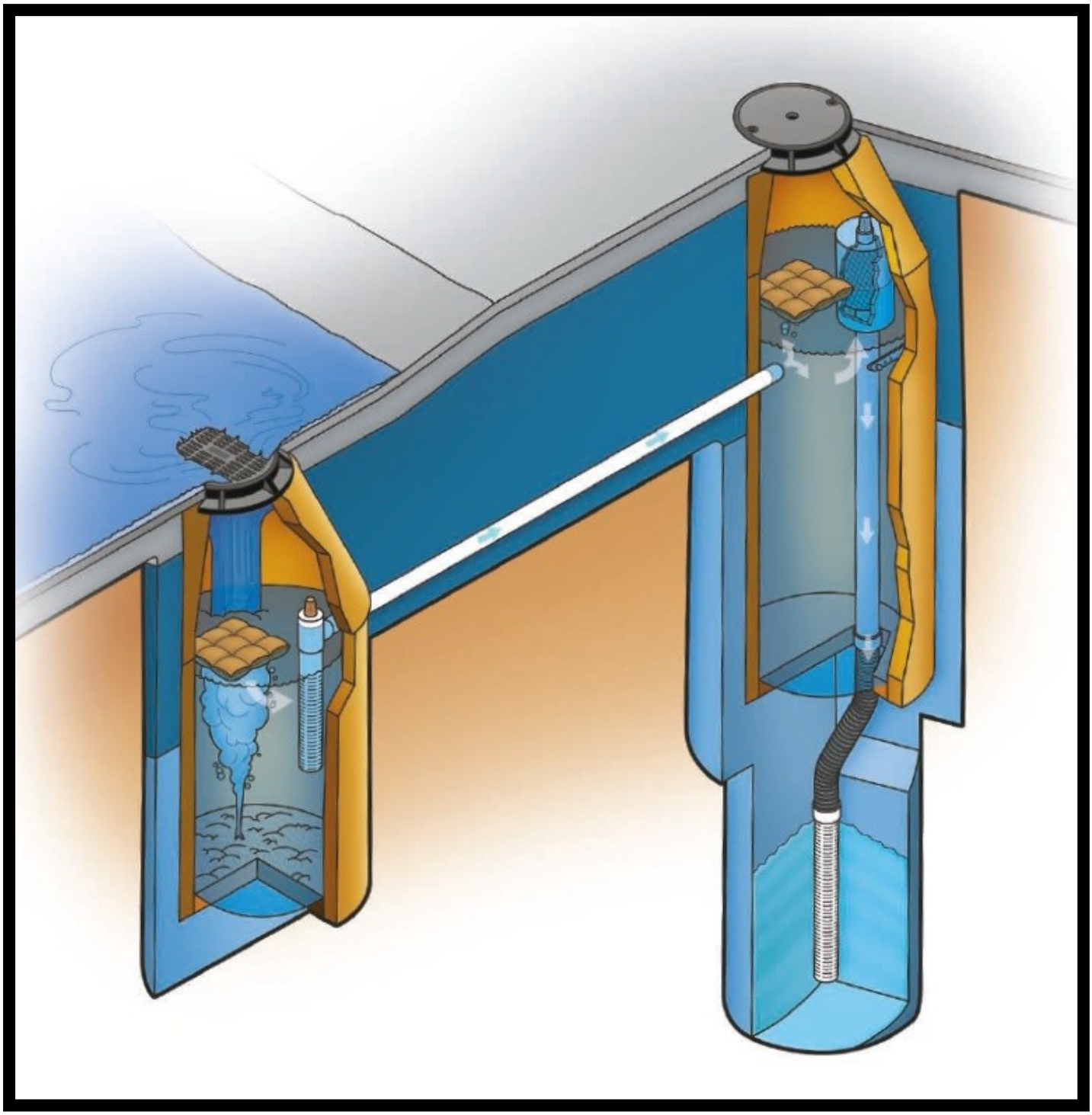

Image courtesey of Torrent Resources Inc.

Manufactured and installed
exclusively by Torrent Resources Inc.
U.S. Patent No. 4,923,330

Exhibits

Ruthrauff Basin Management Plan: Problem Area 1
Draft Structural Alternatives

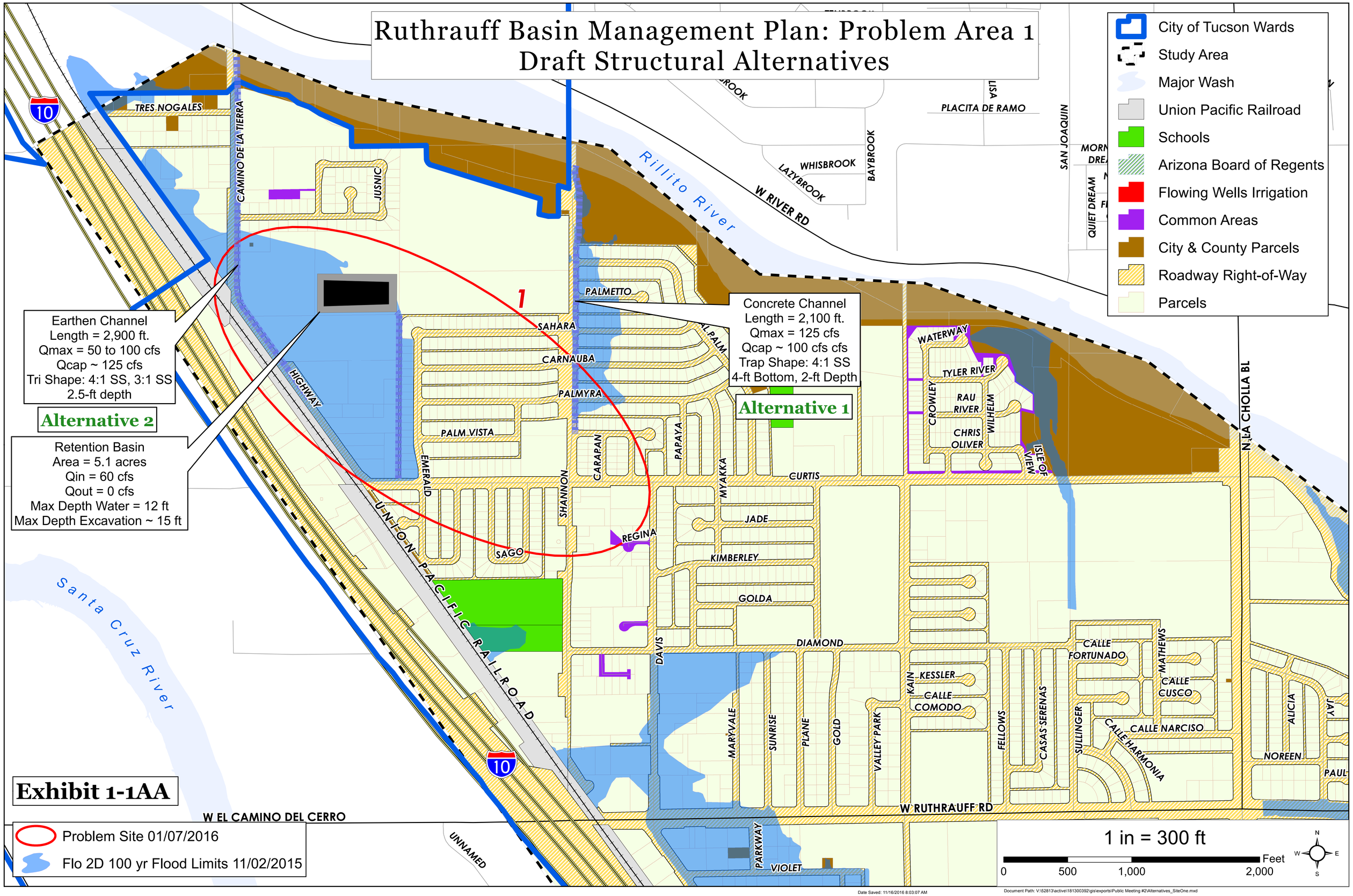

Exhibit 1-1AA

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Ruthrauff Basin Management Plan: Problem Area 2
Draft Structural Alternatives

Channels
Length = varies
Qmax = varies
Shape = varies
Max. Depth = varies

Alternative 2

Retention Basin
Area = 8.8 acres
Max Depth Water = 9 ft
Max Depth Excavation = 17 ft

Alternative 6

Retention Basin & Channel
Area = 3.3 acres
Max Depth Water = 9 ft
Max Depth Excavation = 11 ft

Alternative 7

Retention Basin & Channel
Area = 12.7 acres
Max Depth Water = 7 ft
Max Depth Excavation = 13 ft

Alternative 5

Retention Basin & Channel
Area = 7.1 acres
Max Depth Water = 11 ft
Max Depth Excavation = 14 ft
QCap = 170cfs

Alternative 4

Retention Basins (2)
Area = 10.6 acres
Qin = 451 cfs
Qout = 4 cfs
Max Depth Water = 19 ft
Max Depth Excavation ~ 23 ft

Alternative 1

Diversion Channel
into Basins
Length = 1,300 ft
Qmax = 113 cfs
Qcap ~ 100 cfs
Tri Shape: 3:1 SS
2.5 ft depth

City of Tucson Wards (WARD_COT)
Study Area
Major Wash
Union Pacific Railroad
Schools
Arizona Board of Regents
Flowing Wells Irrigation
Common Areas
City & County Parcels
Roadway Right-of-Way
Parcels

Problem Site 01/07/2016
Flo 2D 100 yr Flood Limits 11/02/2015

Exhibit 2-1AA

1 in = 300 ft
0 500 1,000 2,000 Feet

Date Saved: 11/3/2016 2:12:22 PM
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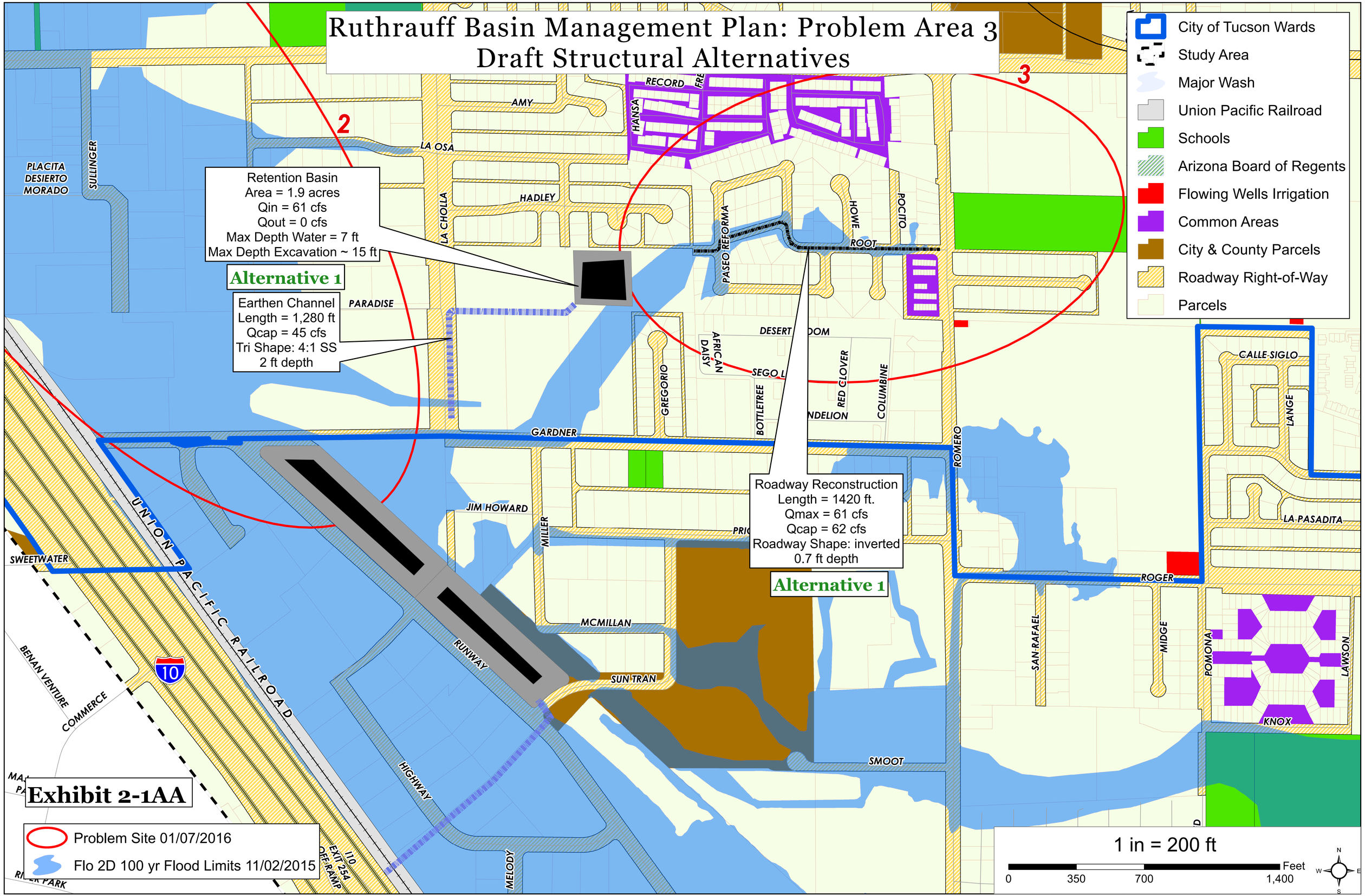
Ruthrauff Basin Management Plan: Problem Area 3
Draft Structural Alternatives



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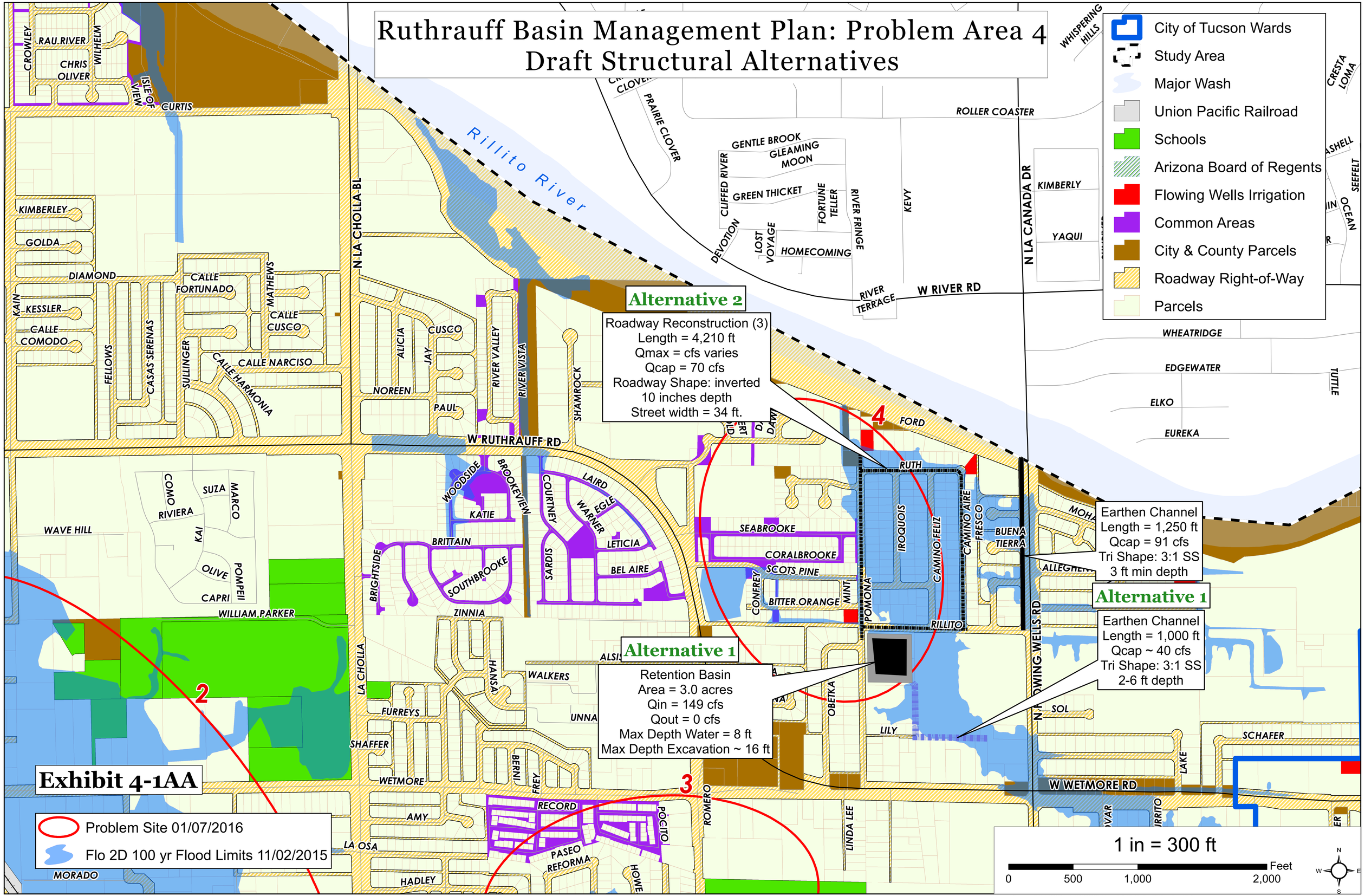
Ruthrauff Basin Management Plan: Problem Area 4
Draft Structural Alternatives



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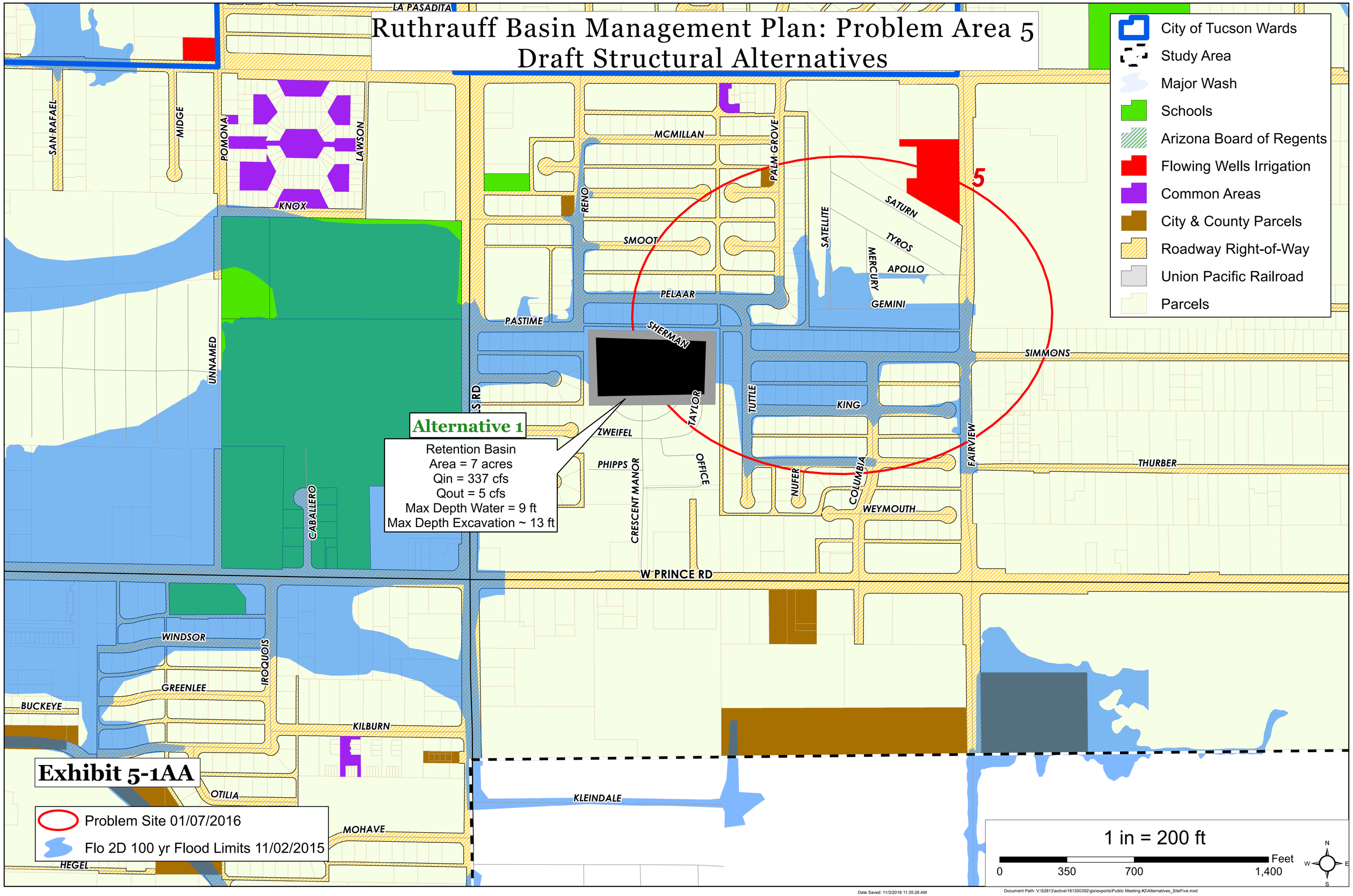
Ruthrauff Basin Management Plan: Problem Area 5
Draft Structural Alternatives



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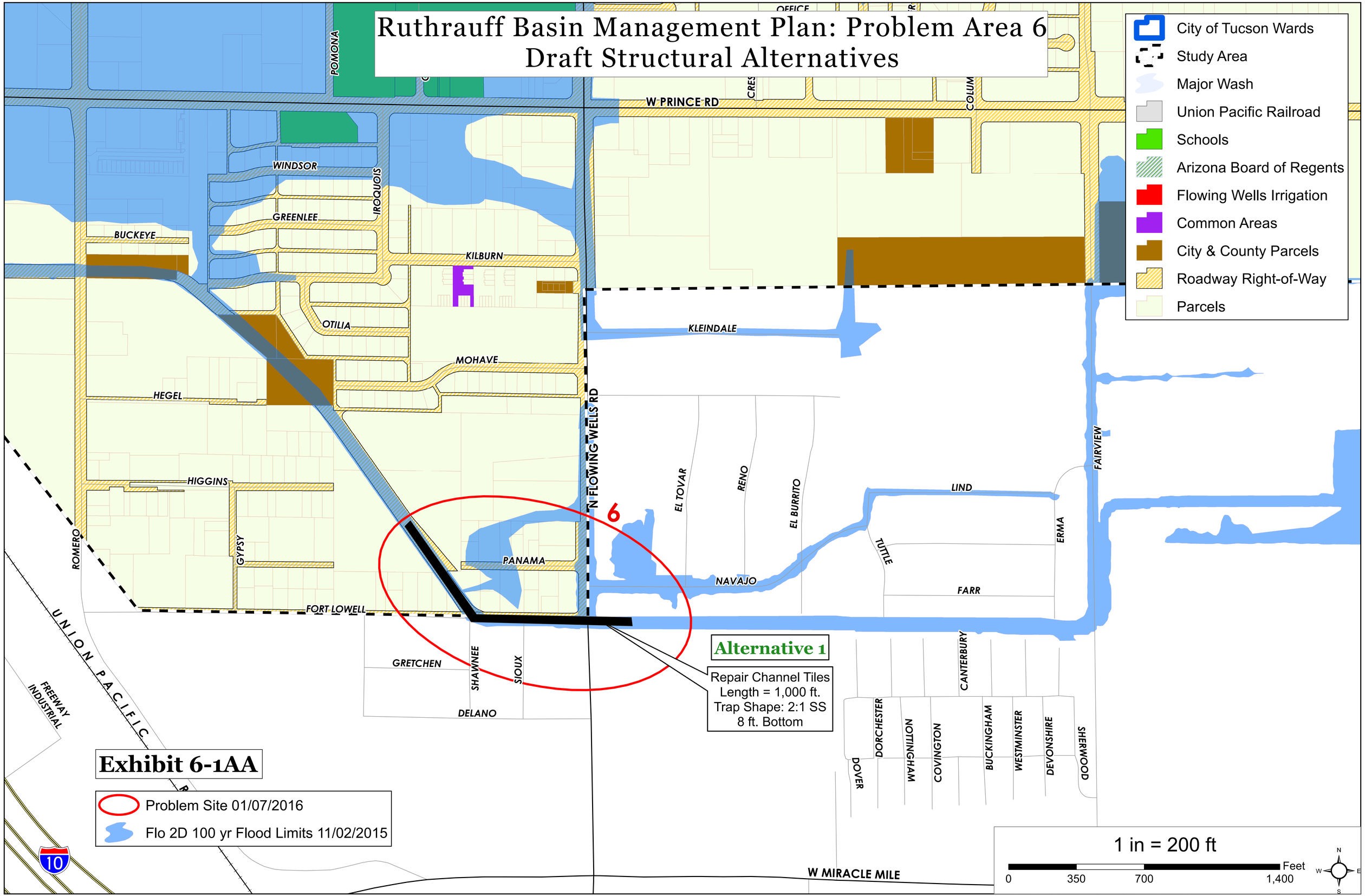
Ruthrauff Basin Management Plan: Problem Area 6
Draft Structural Alternatives



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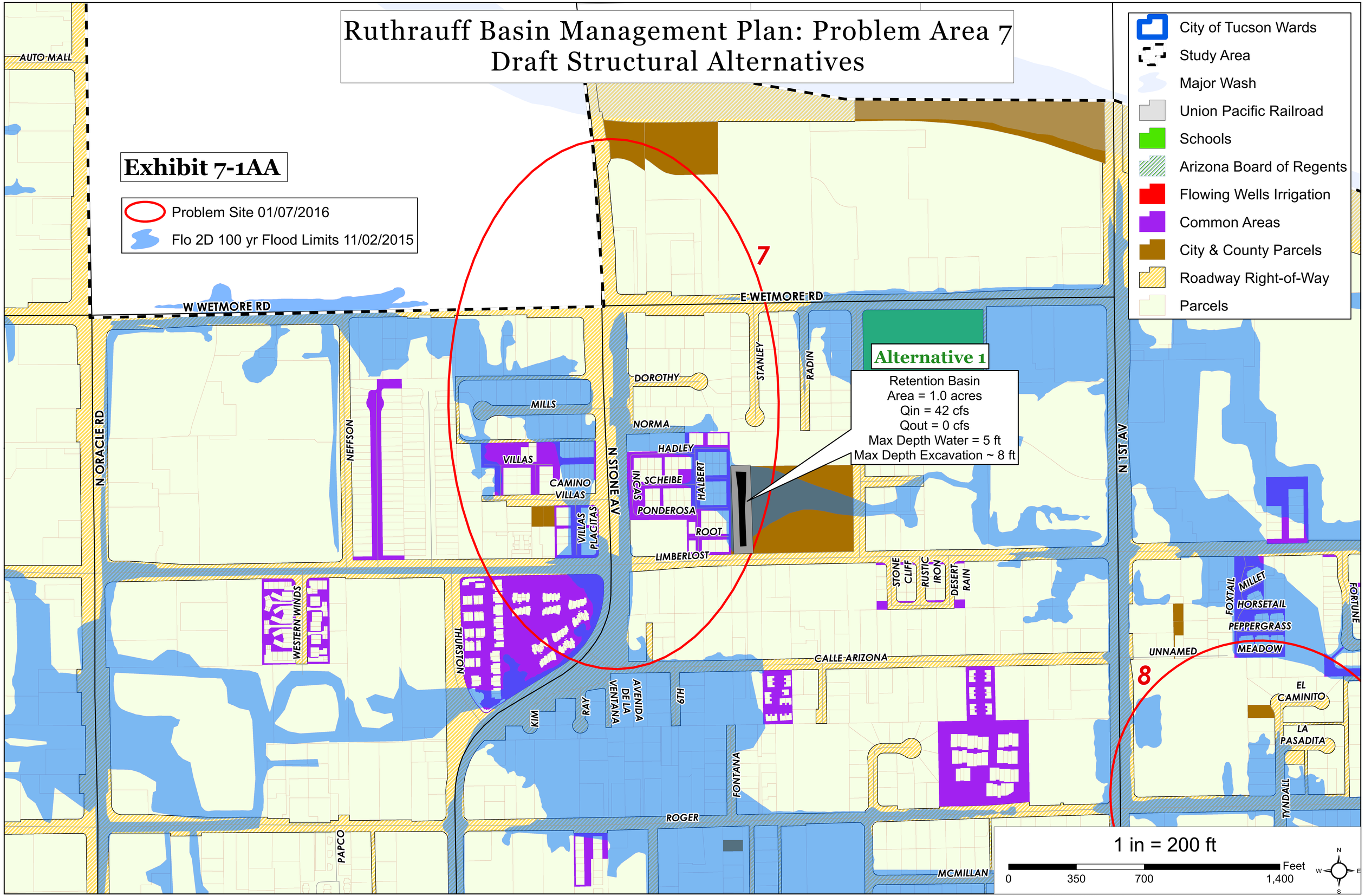
Ruthrauff Basin Management Plan: Problem Area 7
Draft Structural Alternatives



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Ruthrauff Basin Management Plan: Problem Area 8
Draft Structural Alternatives

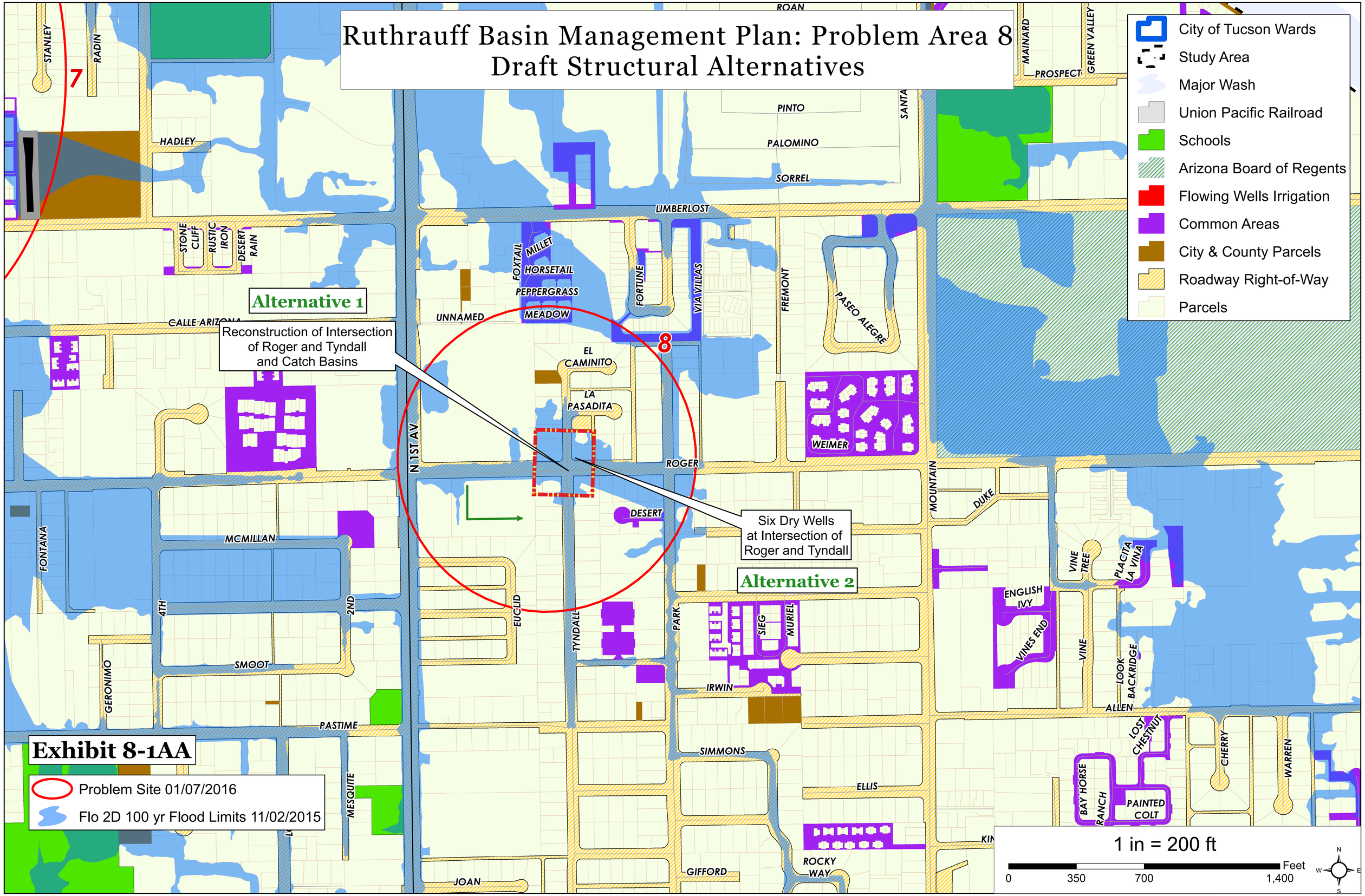

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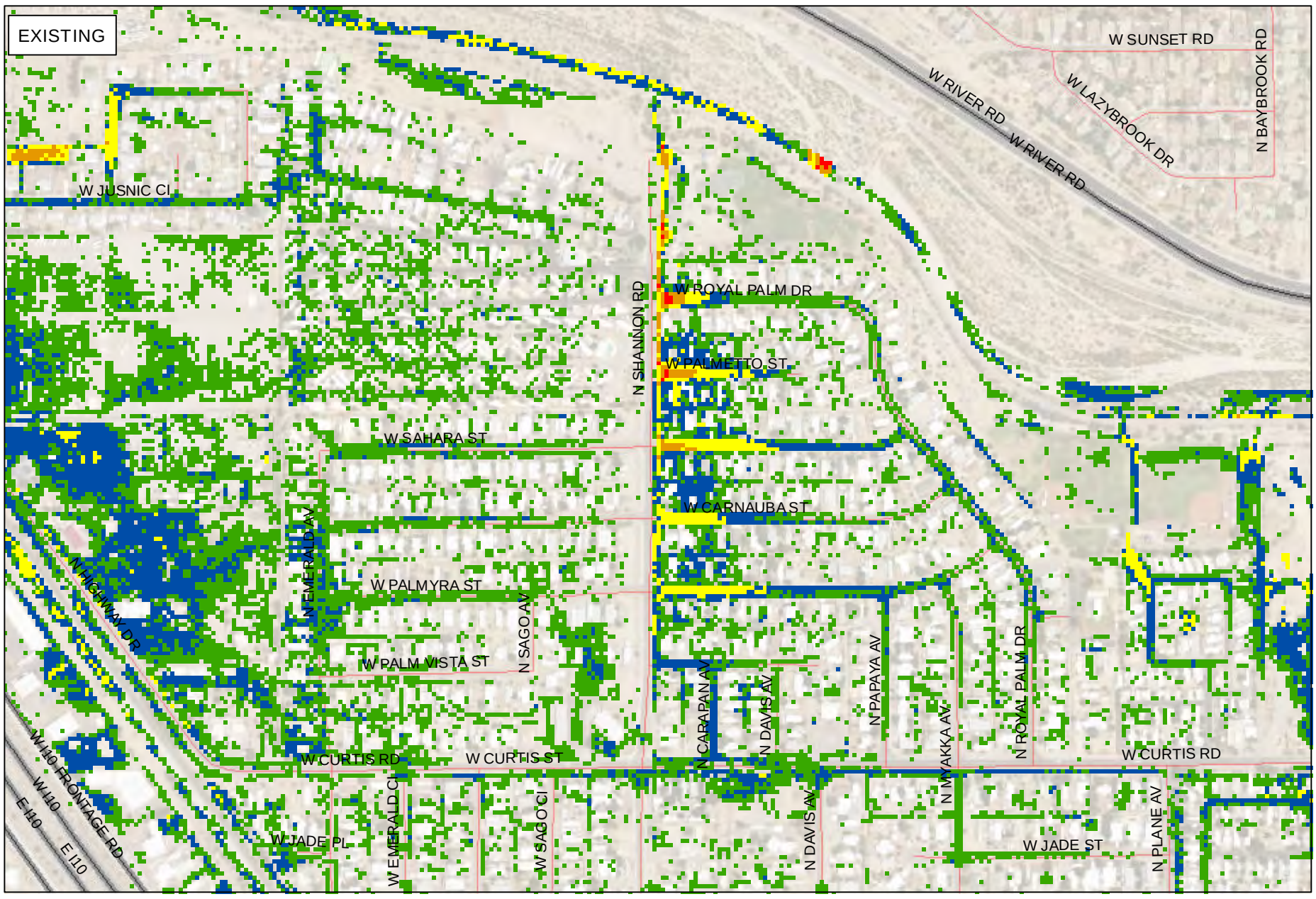
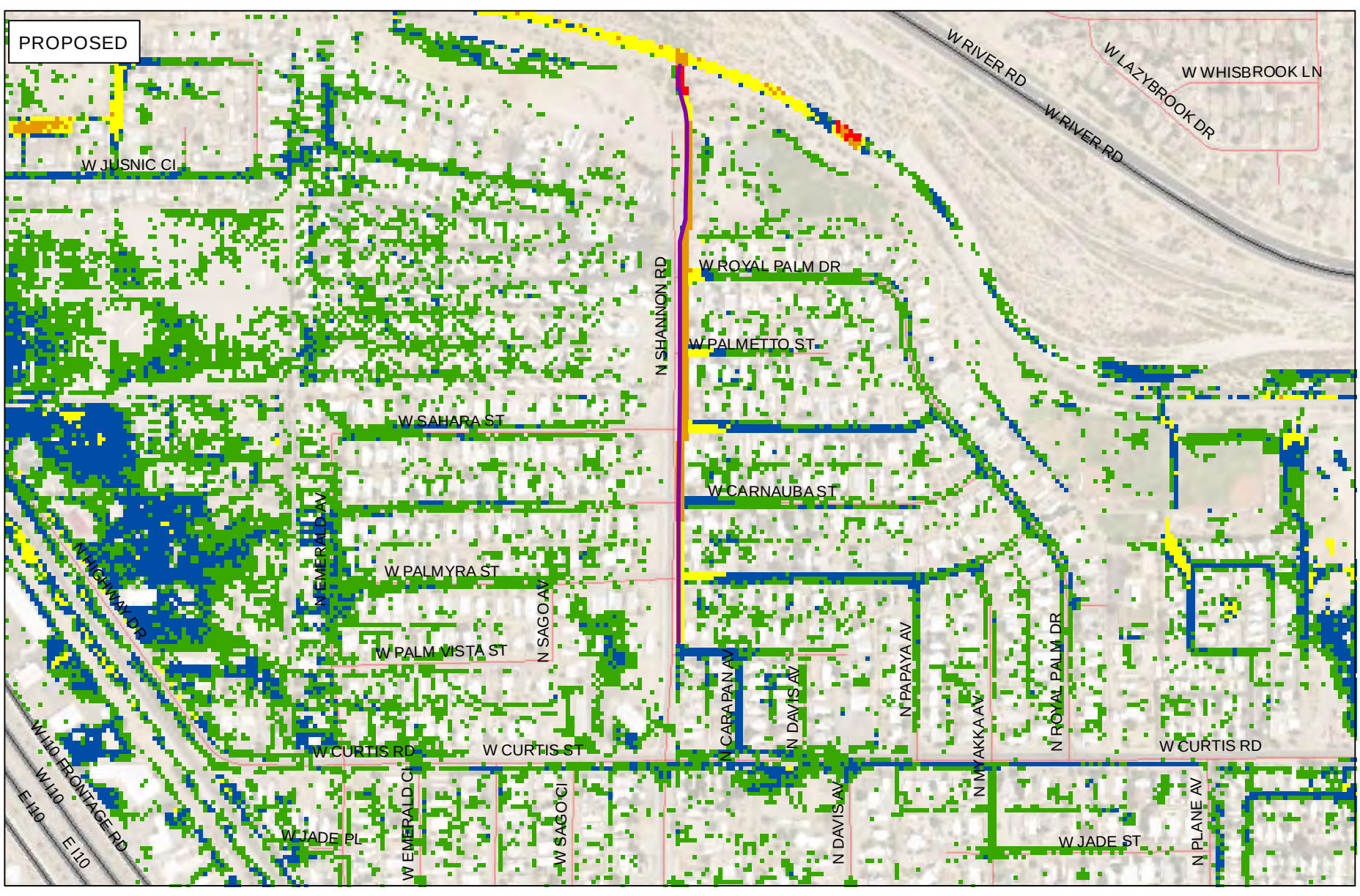
Exhibit 1-1AB





Legend

Major streets

Minor streets

Var

< 0.2 | 0.2 - 0.5 | 0.5 - 1.0 | 1.0 - 2.0 | 2.0 - 3.0 | > 3.0

N

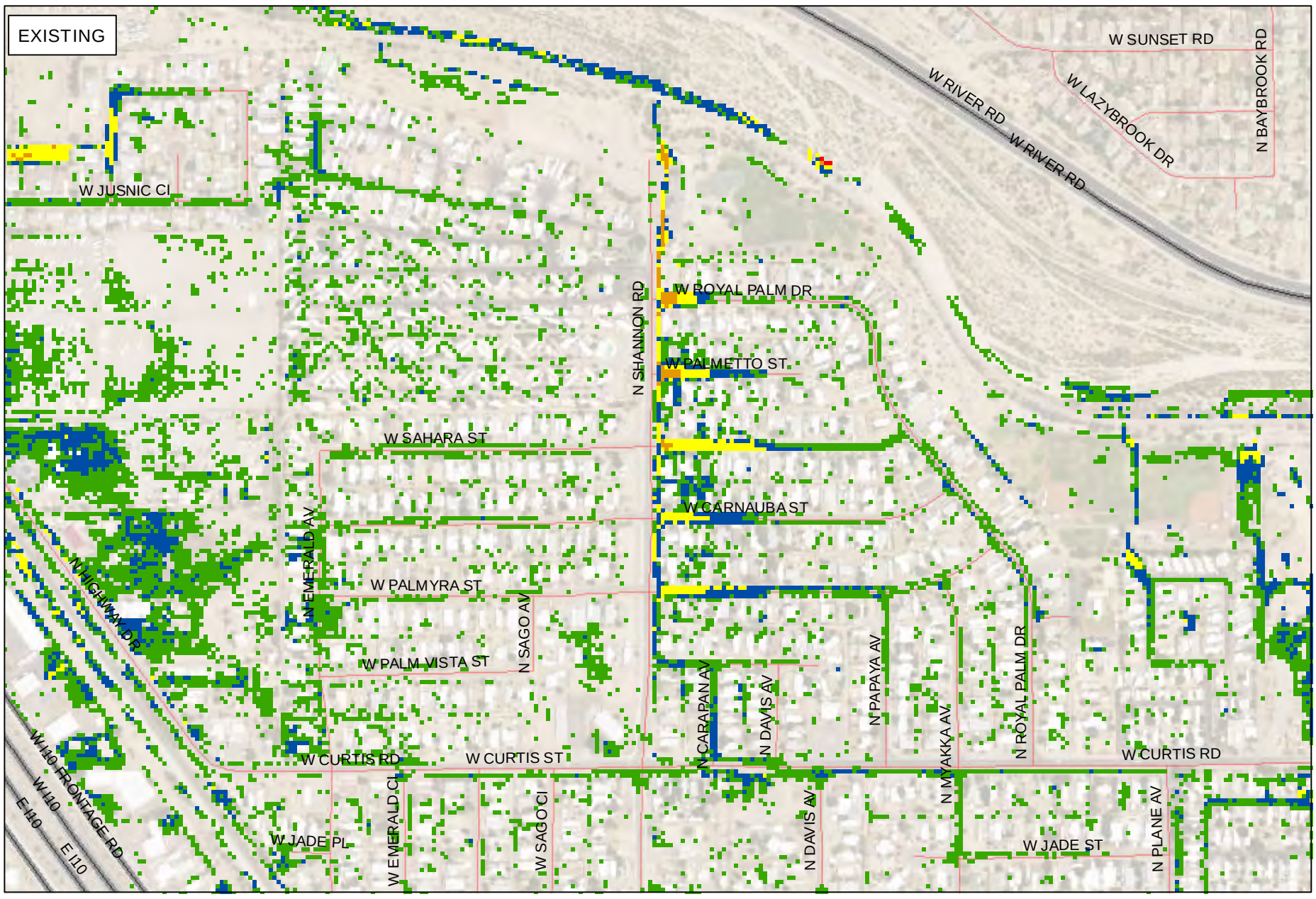
1 inch = 500 feet

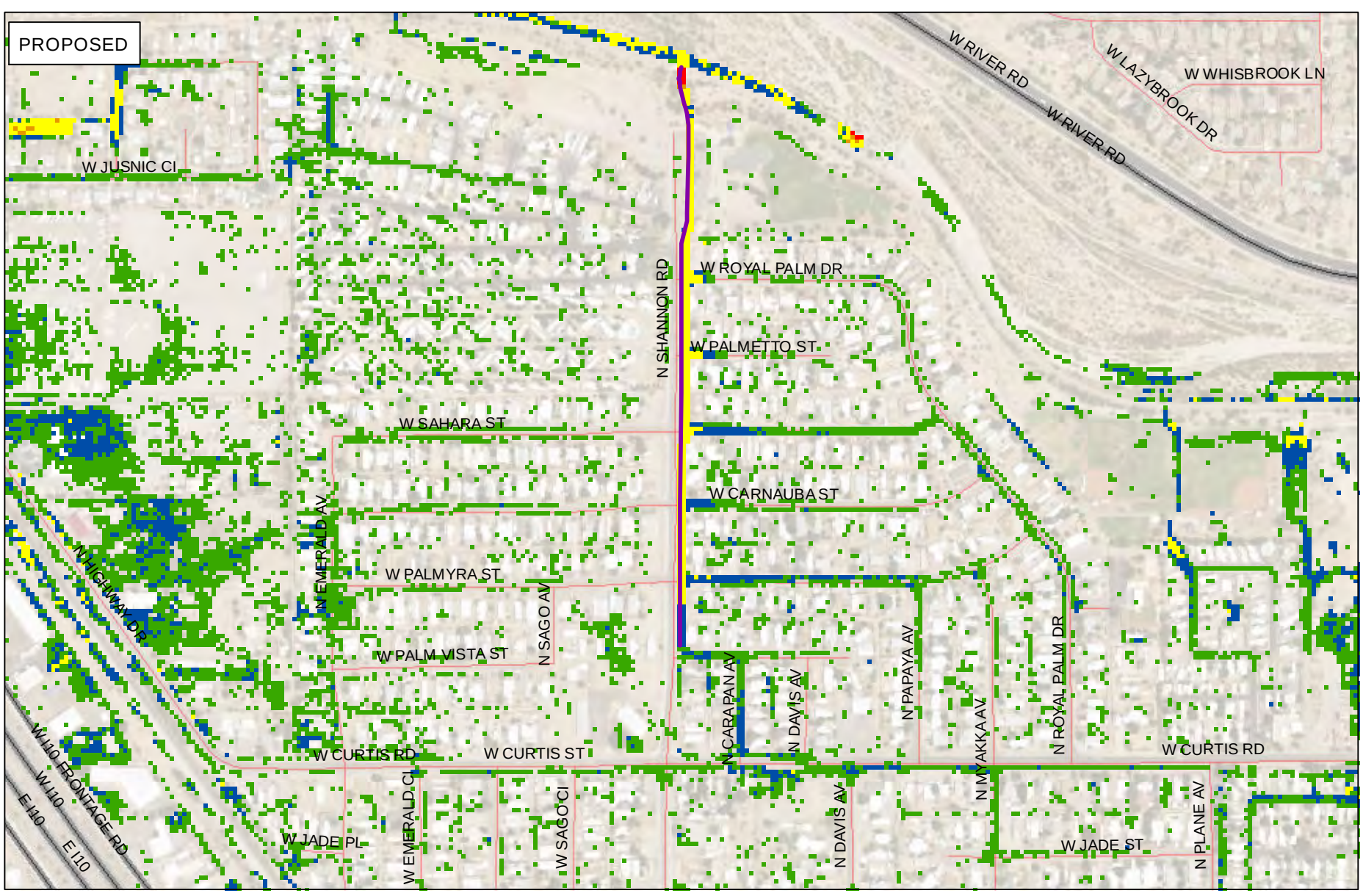
JE Fuller
40 E. Helen St.
Tucson, AZ 85705

Ex vs Prop - Area1-Alt1 - Q100
Date: 4/18/2016

Ruthrauff Basin Management Plan - Alternative 1 - Area 1 - Shannon Channel - 100-yr

Exhibit 1-1AC





Legend

Major streets

Minor streets

Var

< 0.2 | 0.2 - 0.5 | 0.5 - 1.0 | 1.0 - 2.0 | 2.0 - 3.0 | > 3.0

N

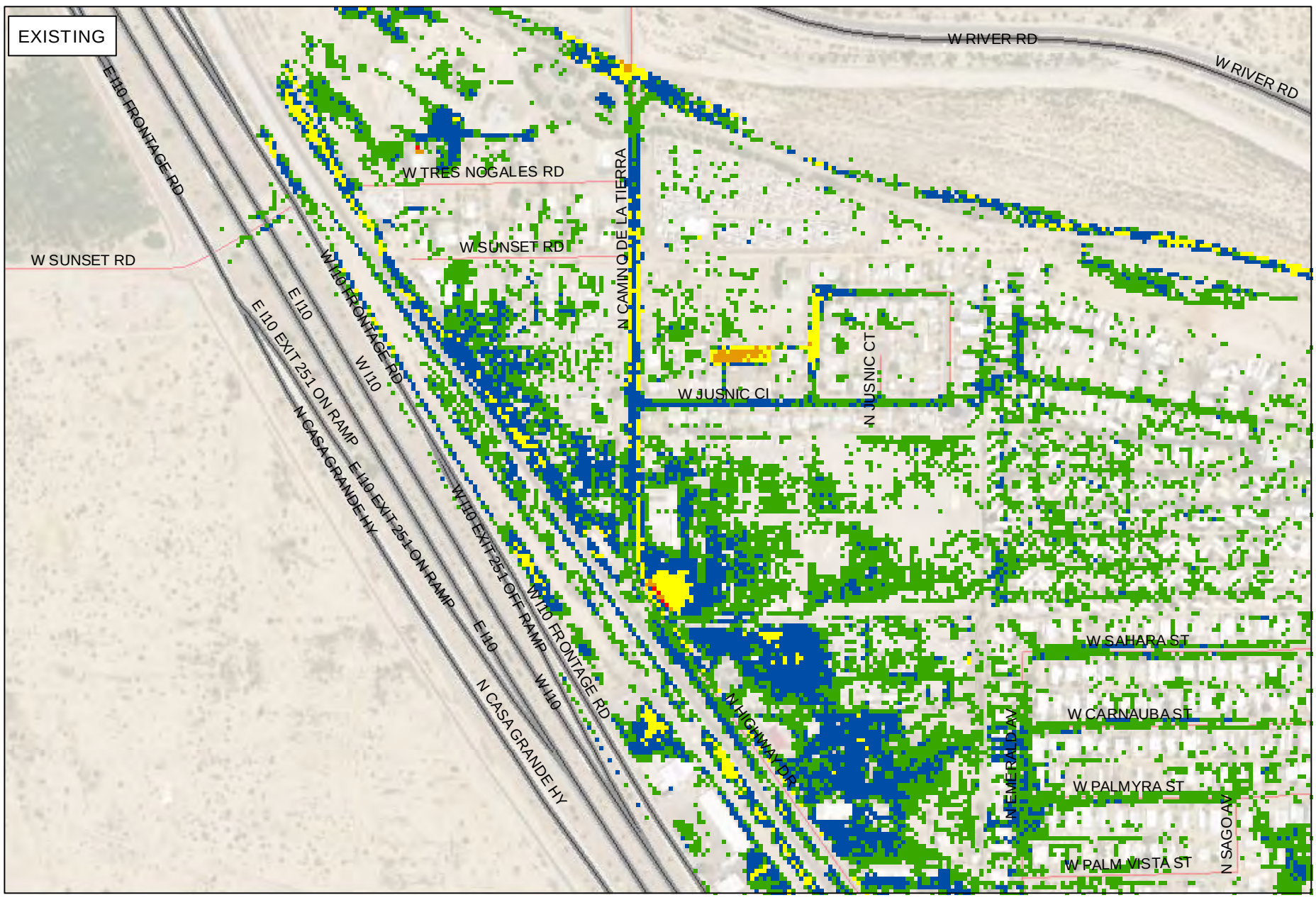
1 inch = 500 feet

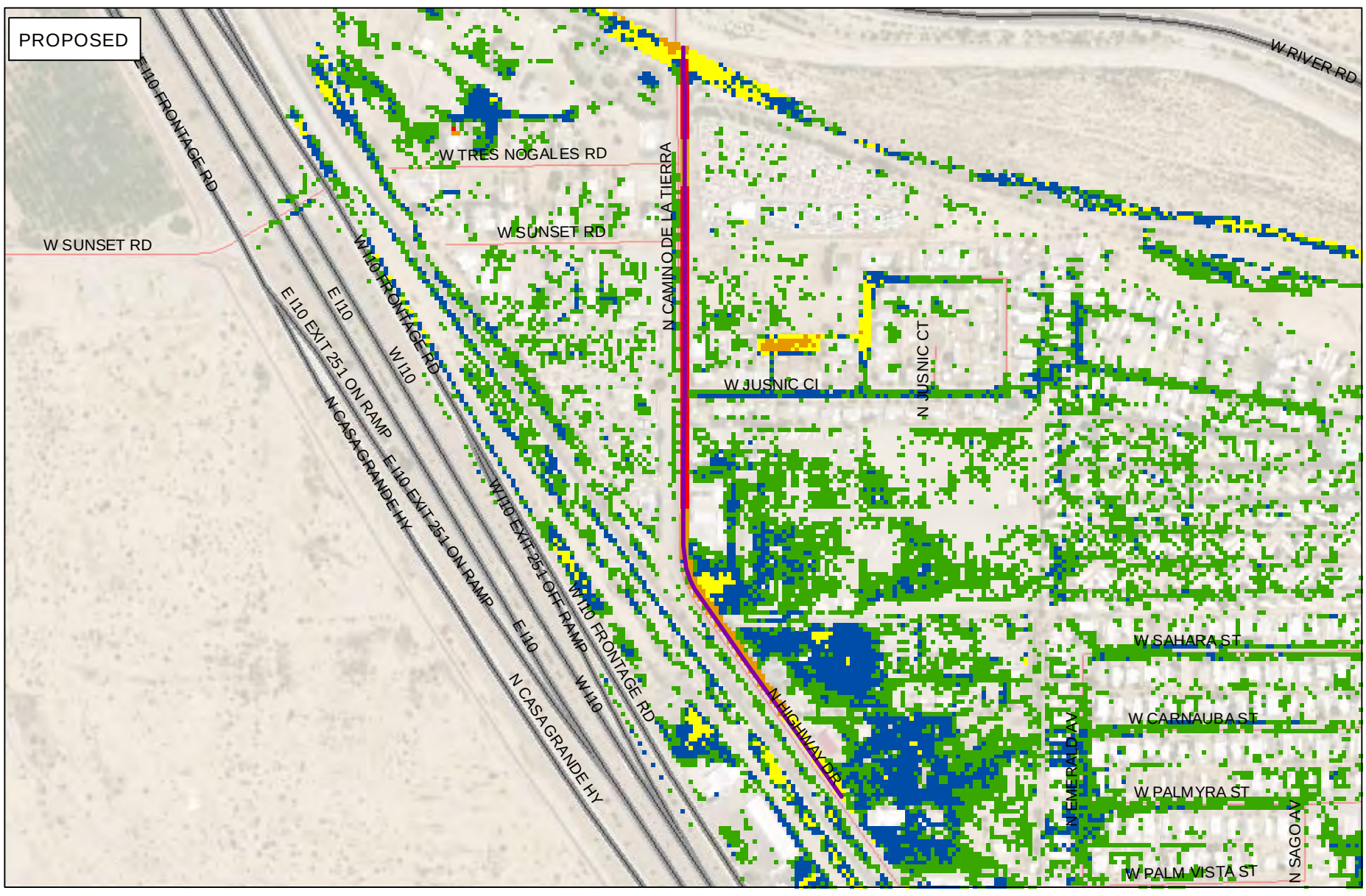
JE Fuller
40 E. Helen St.
Tucson, AZ 85705

Ex vs Prop - Area1-Alt1 - Q10
Date: 4/18/2016

Ruthrauff Basin Management Plan - Alternative 1 - Area 1 - Shannon Channel - 10-yr

Exhibit 1-1AD





Legend

Major streets

Minor streets

Var

< 0.2 | 0.2 - 0.5 | 0.5 - 1.0 | 1.0 - 2.0 | 2.0 - 3.0 | > 3.0

N

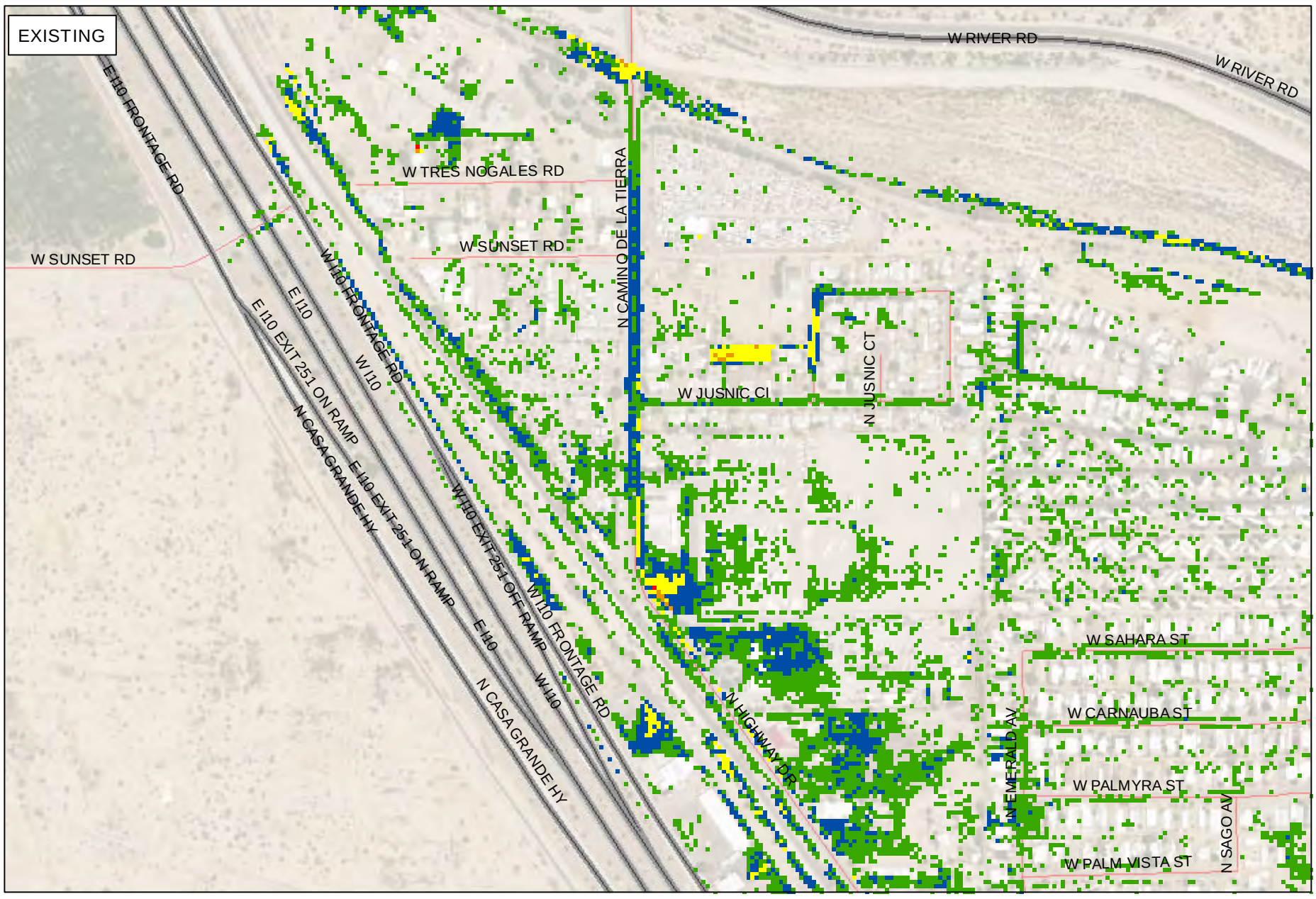
1 inch = 500 feet

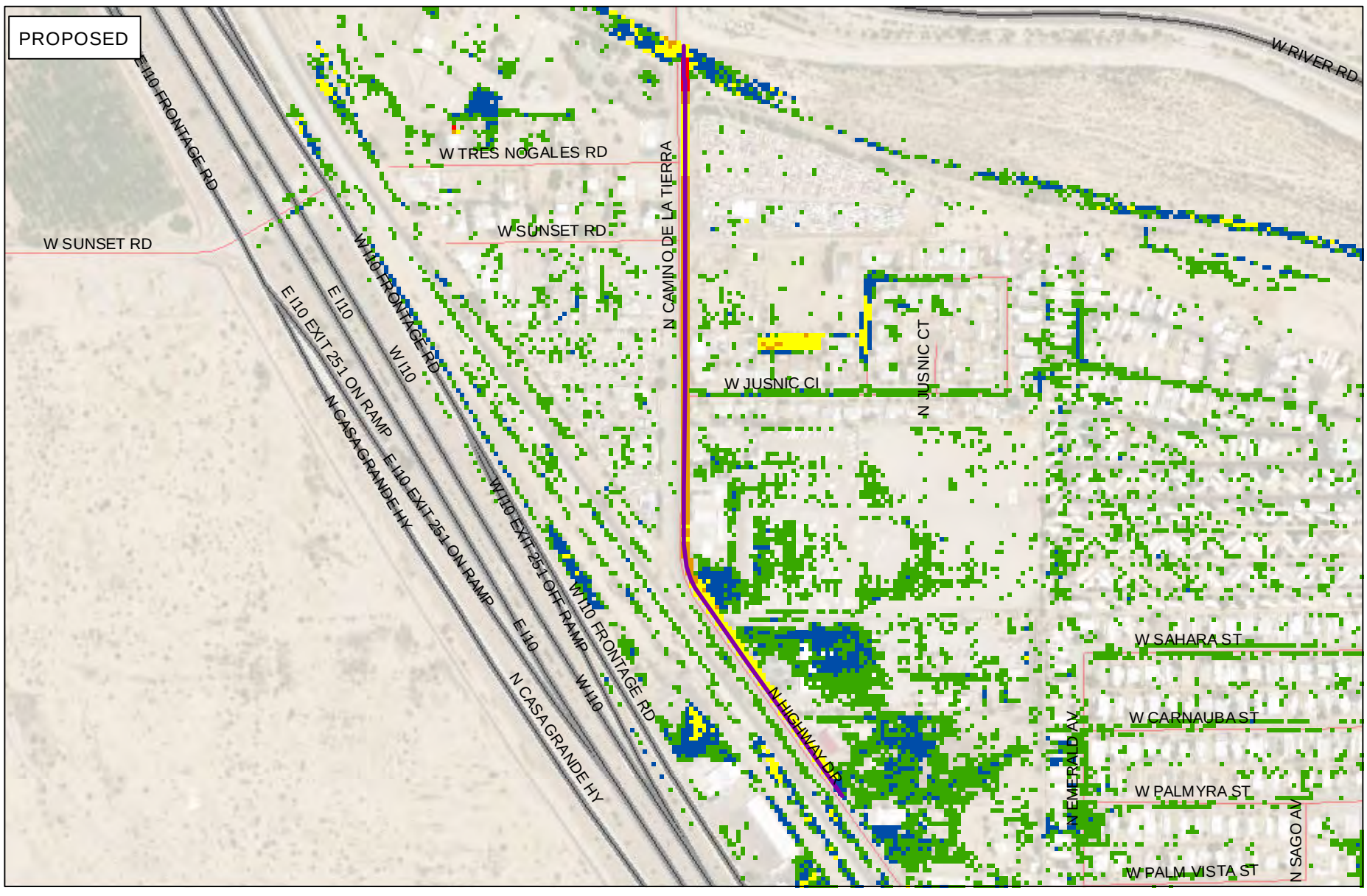
JE Fuller
40 E. Helen St.
Tucson, AZ 85705

Ex vs Prop - Area1-Alt5 - Q100
Date: 4/18/2016

Ruthrauff Basin Management Plan - Alternative 2a (5) - Area 1 - Camino de la Tierra Channel - 100-yr

Exhibit 1-1AE





Legend

Major streets

Minor streets

Var

< 0.2 | 0.2 - 0.5 | 0.5 - 1.0 | 1.0 - 2.0 | 2.0 - 3.0 | > 3.0

N

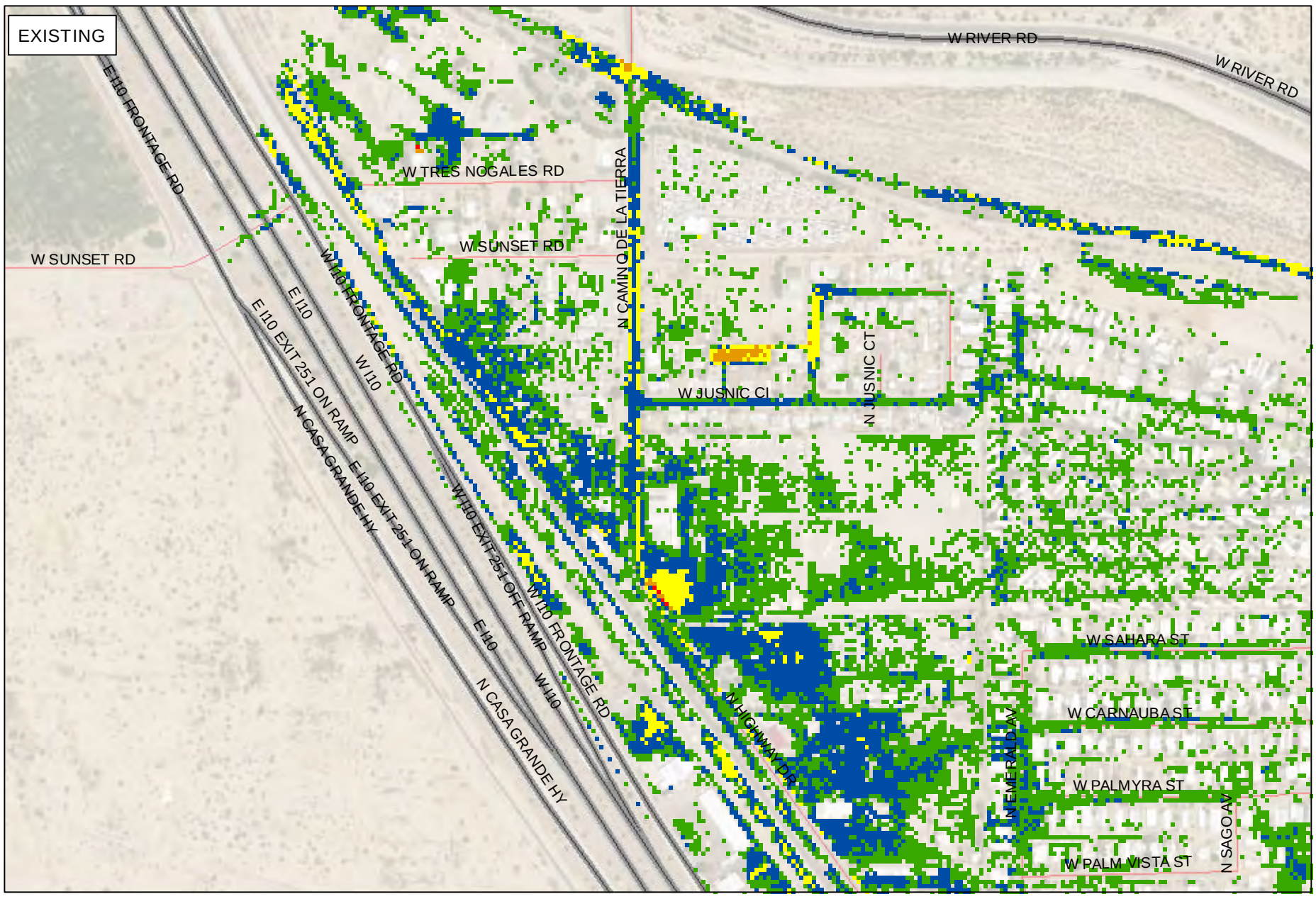
1 inch = 500 feet

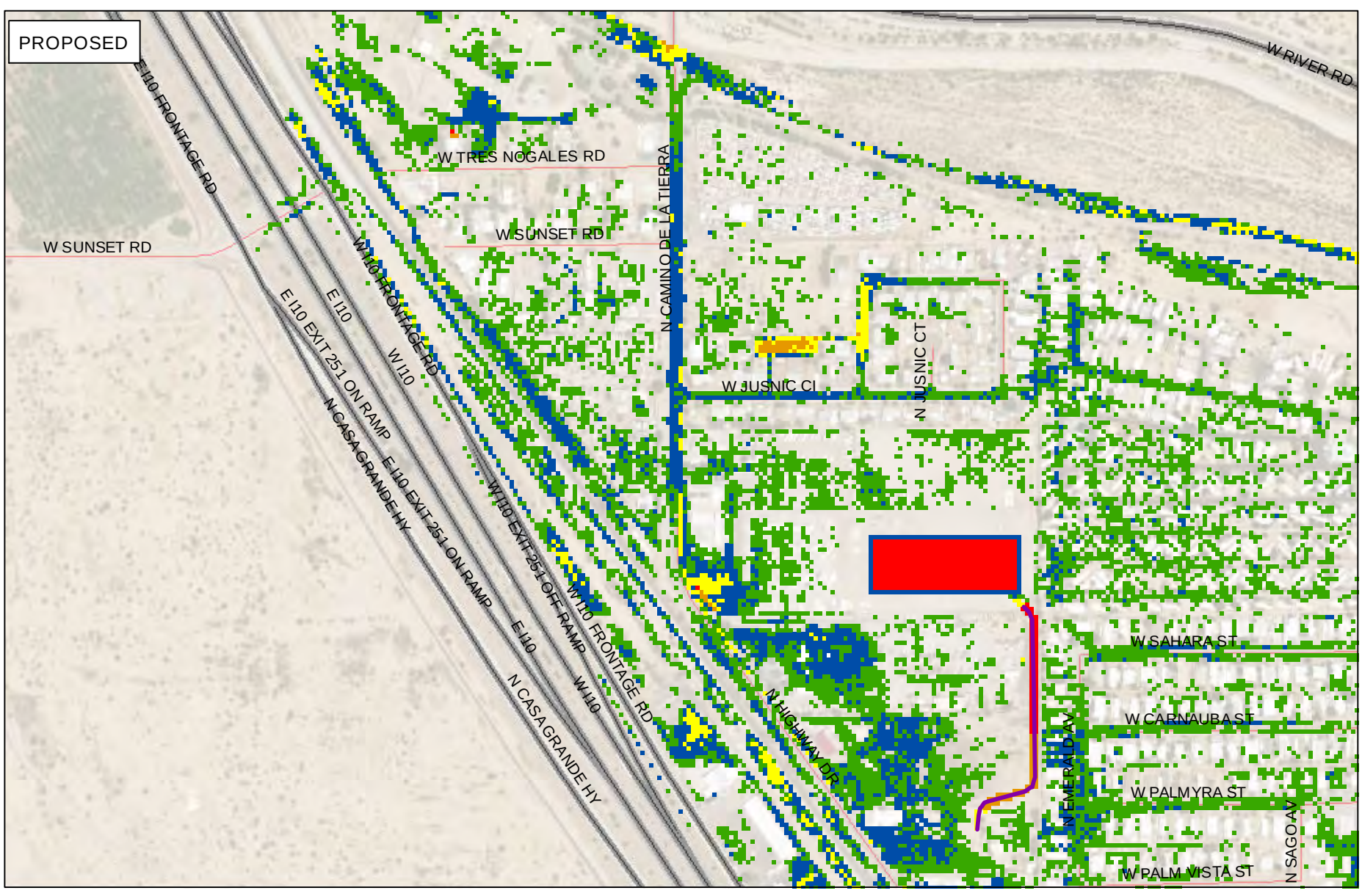
JE Fuller
40 E. Helen St.
Tucson, AZ 85705

Ex vs Prop - Area1-Alt5 - Q10
Date: 4/18/2016

Ruthrauff Basin Management Plan - Alternative 2a (5) **- Area 1 - Camino de la Tierra Channel - 10-yr**

Exhibit 1-1AF





Legend

Major streets

Minor streets

Var

< 0.2 | 0.2 - 0.5 | 0.5 - 1.0 | 1.0 - 2.0 | 2.0 - 3.0 | > 3.0

N

1 inch = 500 feet

JE Fuller
40 E. Helen St.
Tucson, AZ 85705

Ex vs Prop - Area1-Alt6 - Q100
Date: 4/18/2016

Ruthrauff Basin Management Plan - Alternative 2b (6) **- Area 1 - Basin & Channel - 100-yr**

Exhibit 1-1AG

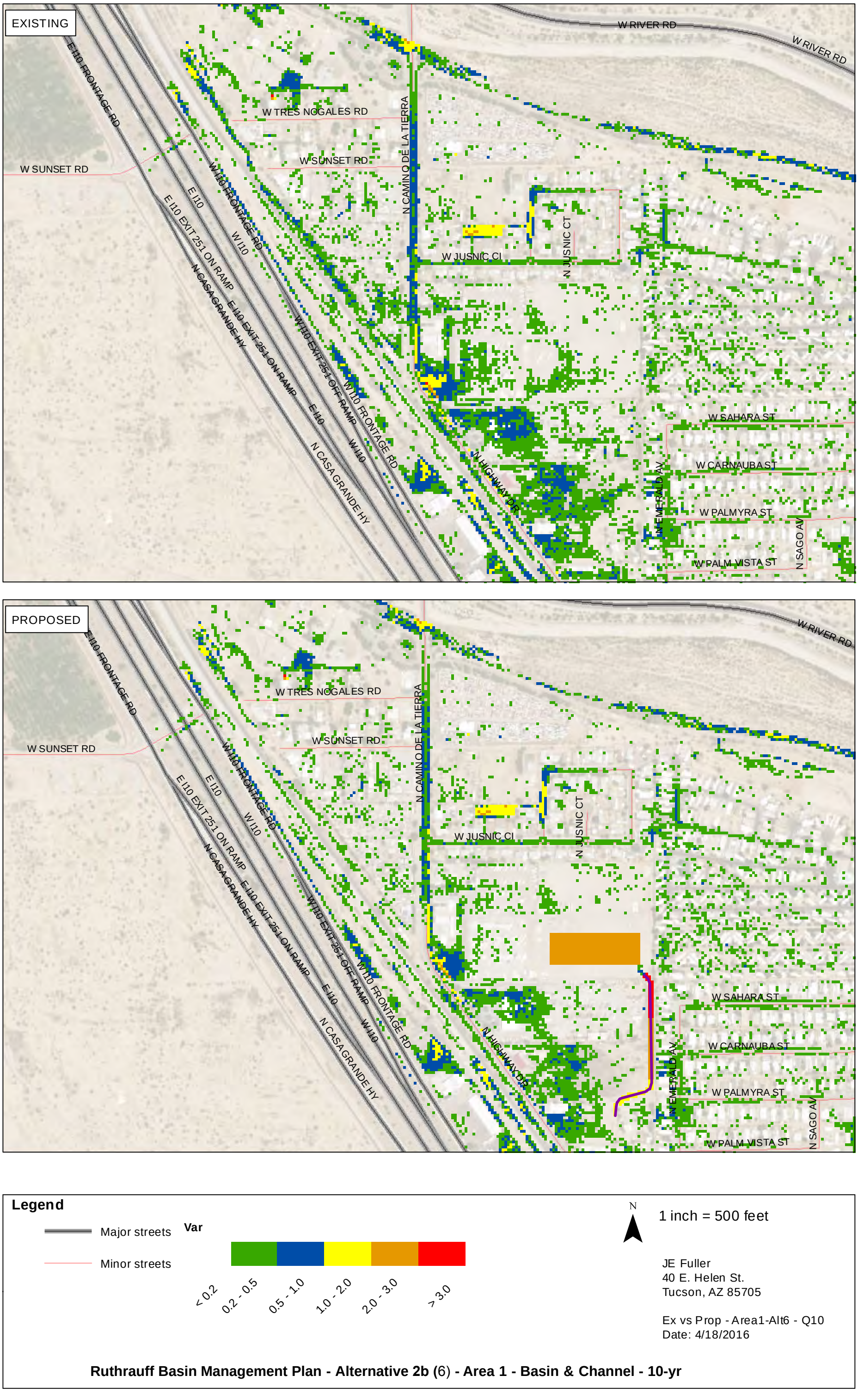
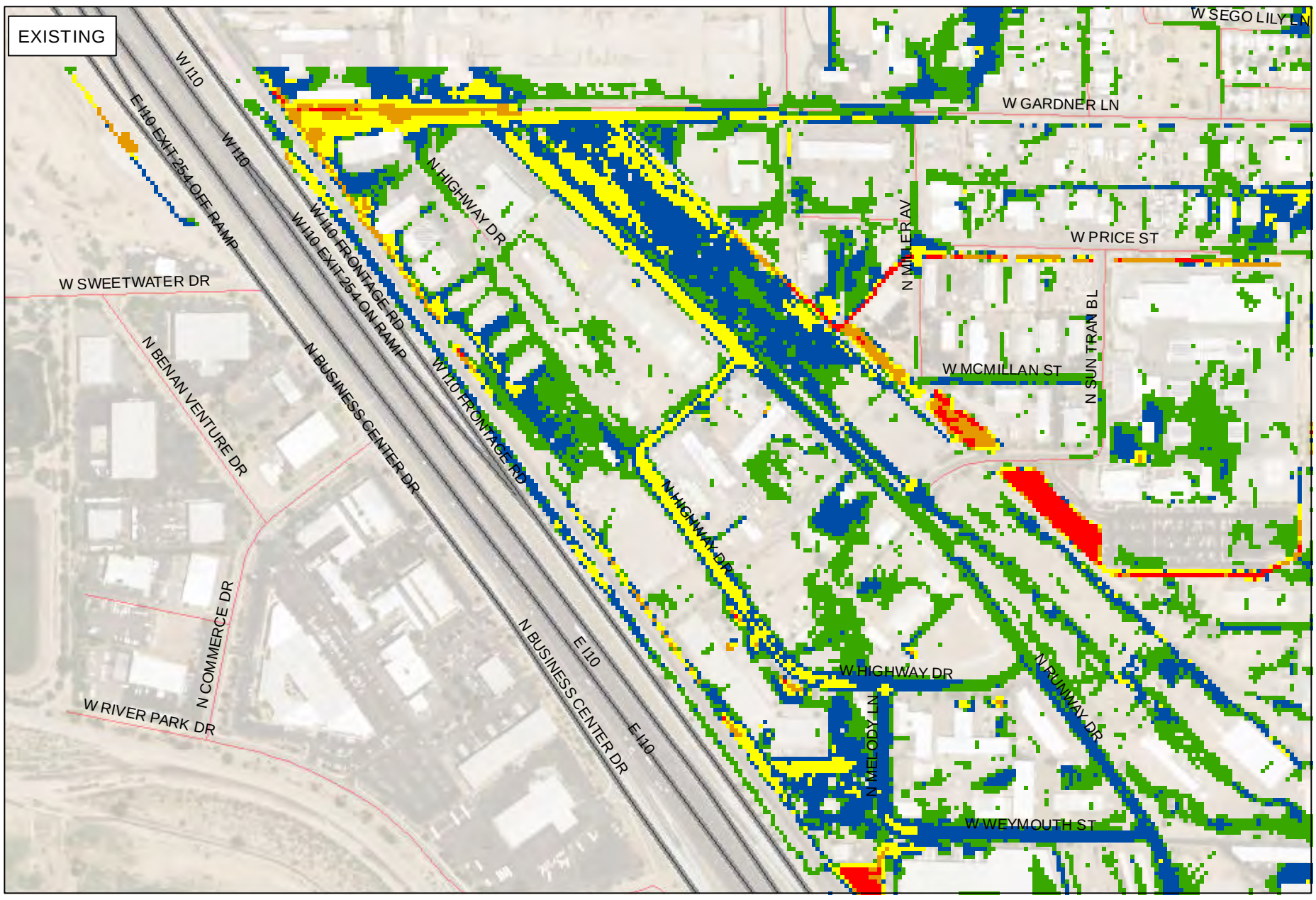
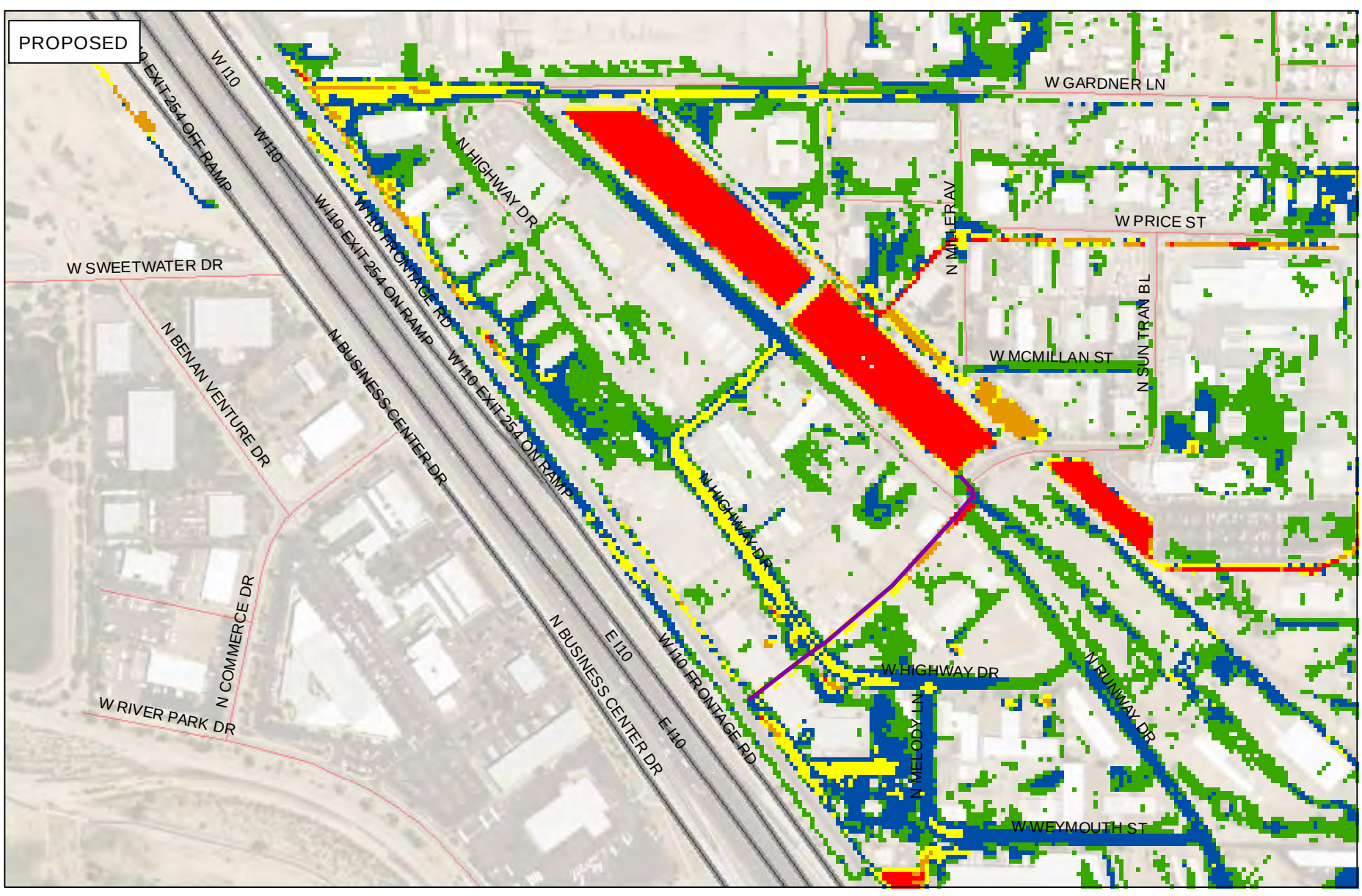


Exhibit 2-1AB





Legend

Major streets

Minor streets

Var

< 0.2 | 0.2 - 0.5 | 0.5 - 1.0 | 1.0 - 2.0 | 2.0 - 3.0 | > 3.0

N

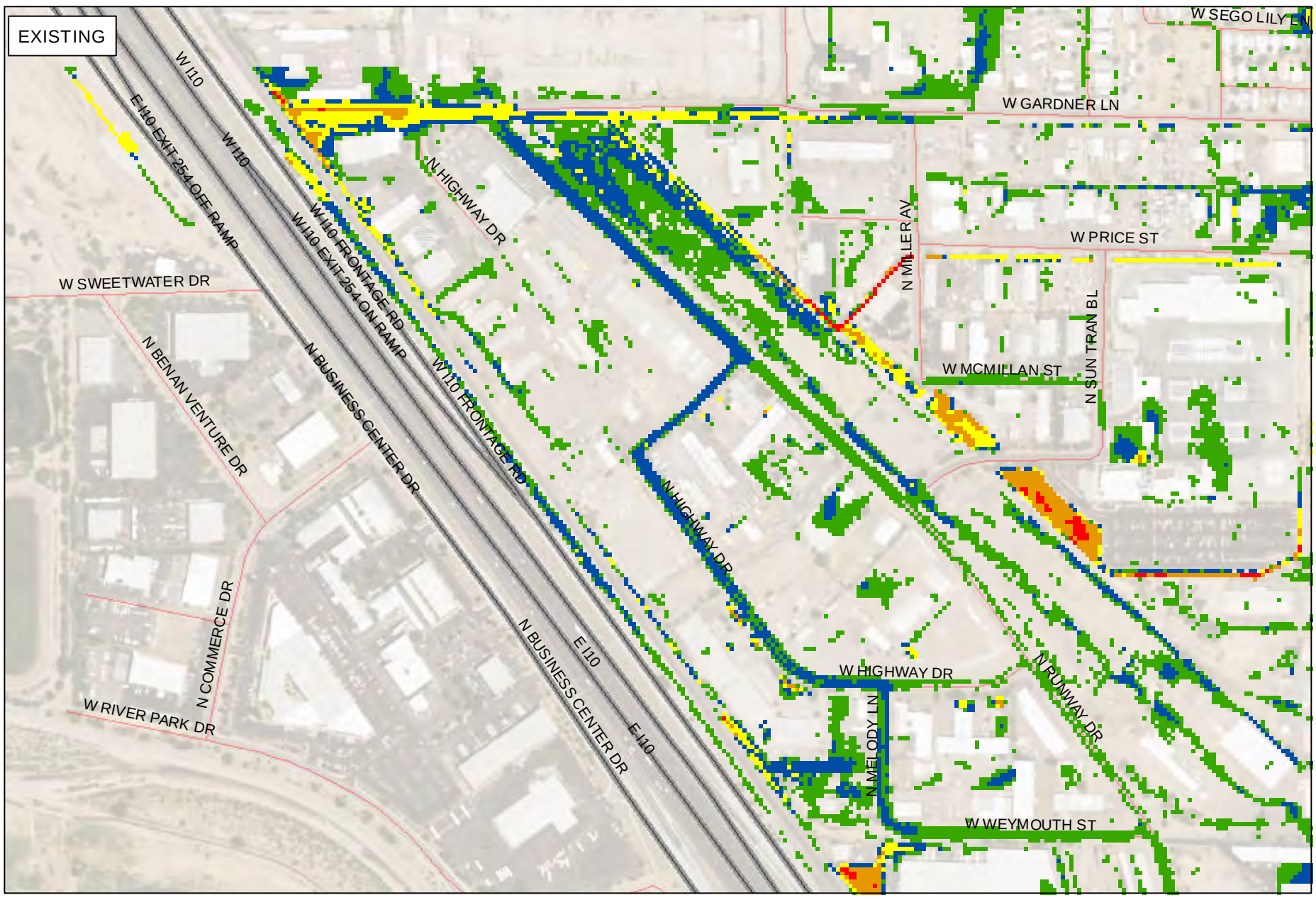
1 inch = 500 feet

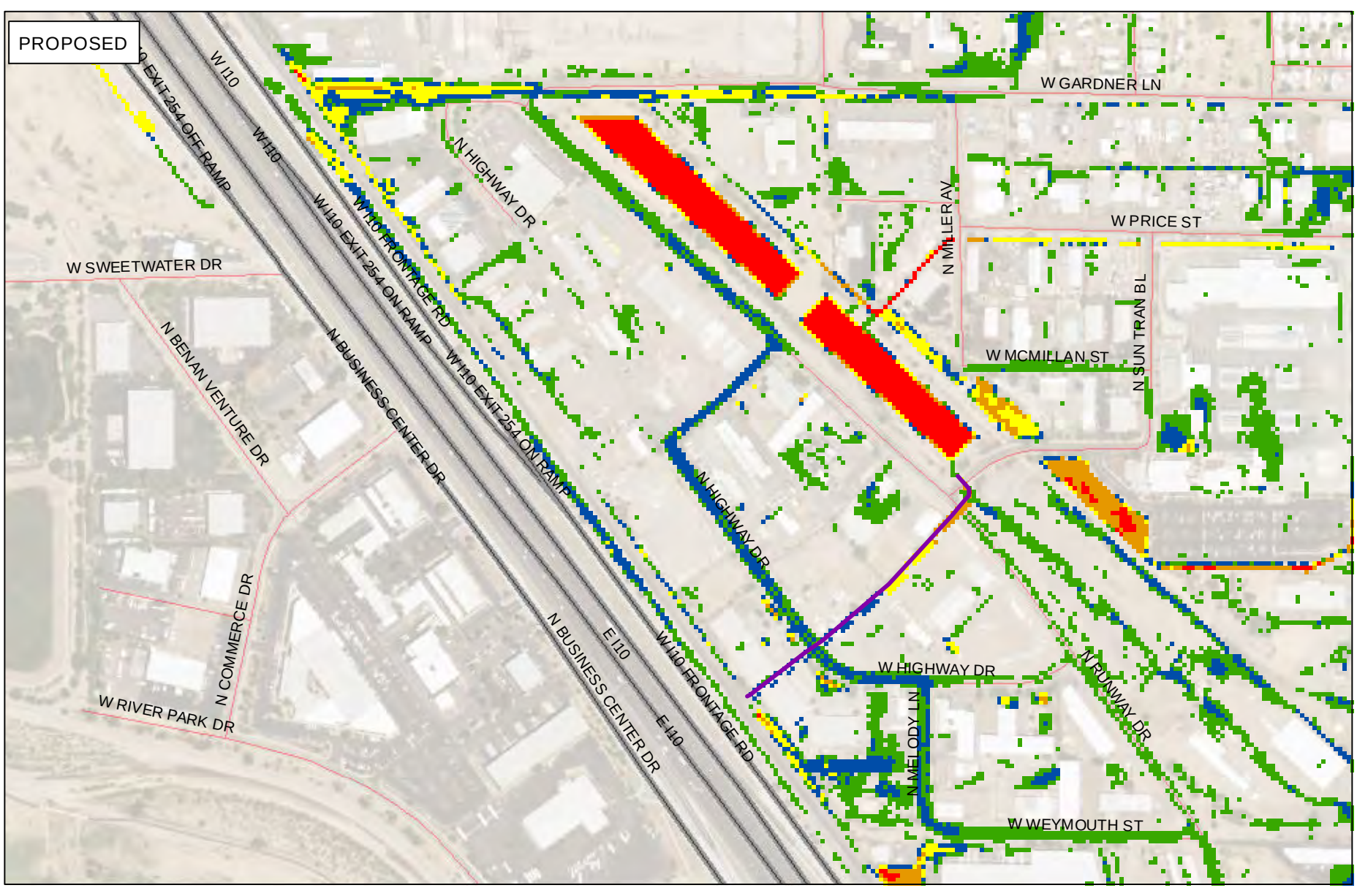
JE Fuller
40 E. Helen St.
Tucson, AZ 85705

Ex vs Prop - Area2-Alt1 - Q100
Date: 4/18/2016

Ruthrauff Basin Management Plan - Alternative 1 **- Area 2 -** Airport Runway **Basin & Channel - 100-yr**

Exhibit 2-1AC





Legend

Major streets

Minor streets

Var

< 0.2 | 0.2 - 0.5 | 0.5 - 1.0 | 1.0 - 2.0 | 2.0 - 3.0 | > 3.0

N

1 inch = 500 feet

JE Fuller
40 E. Helen St.
Tucson, AZ 85705

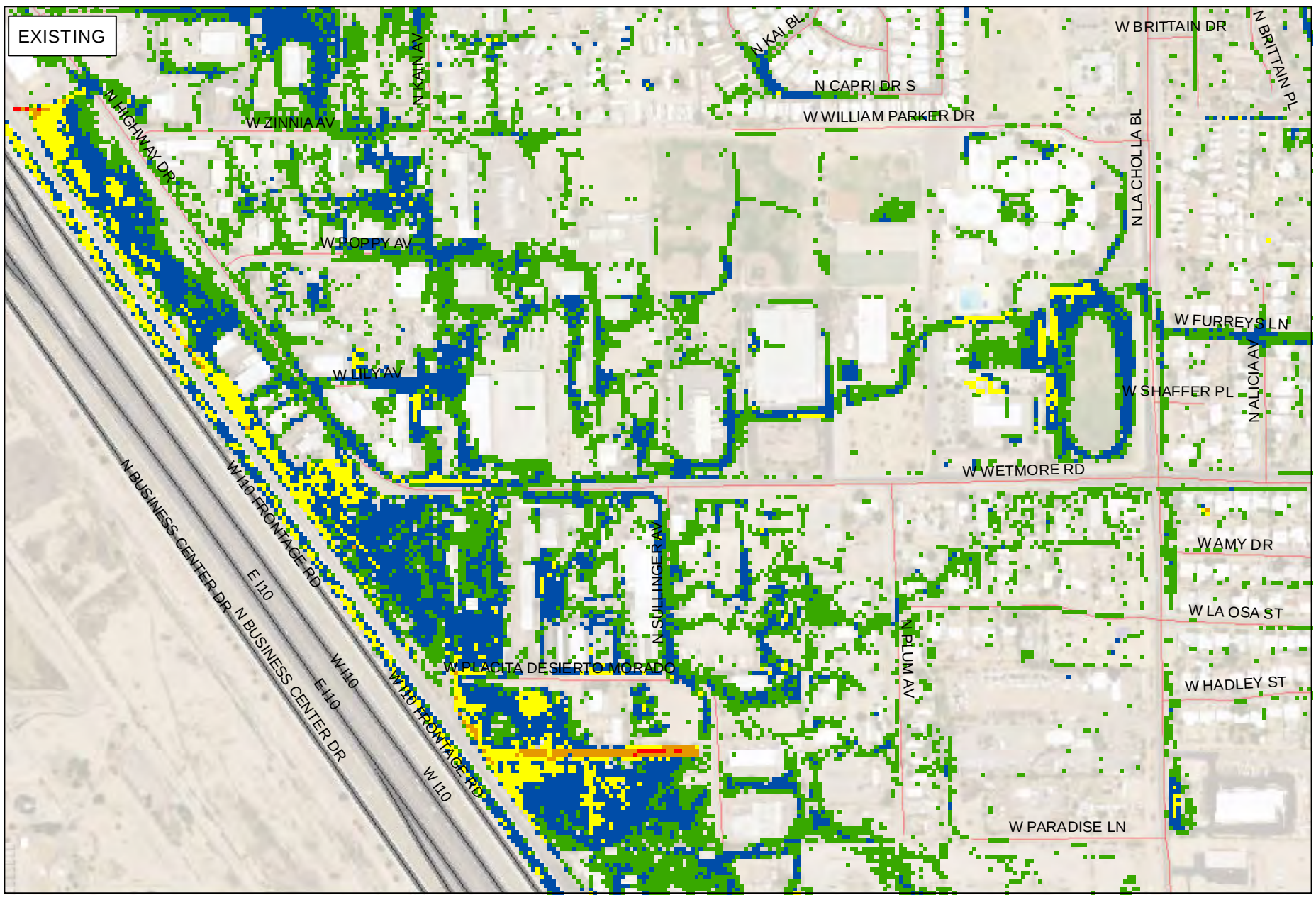
Ex vs Prop - Area2-Alt1 - Q10
Date: 4/18/2016

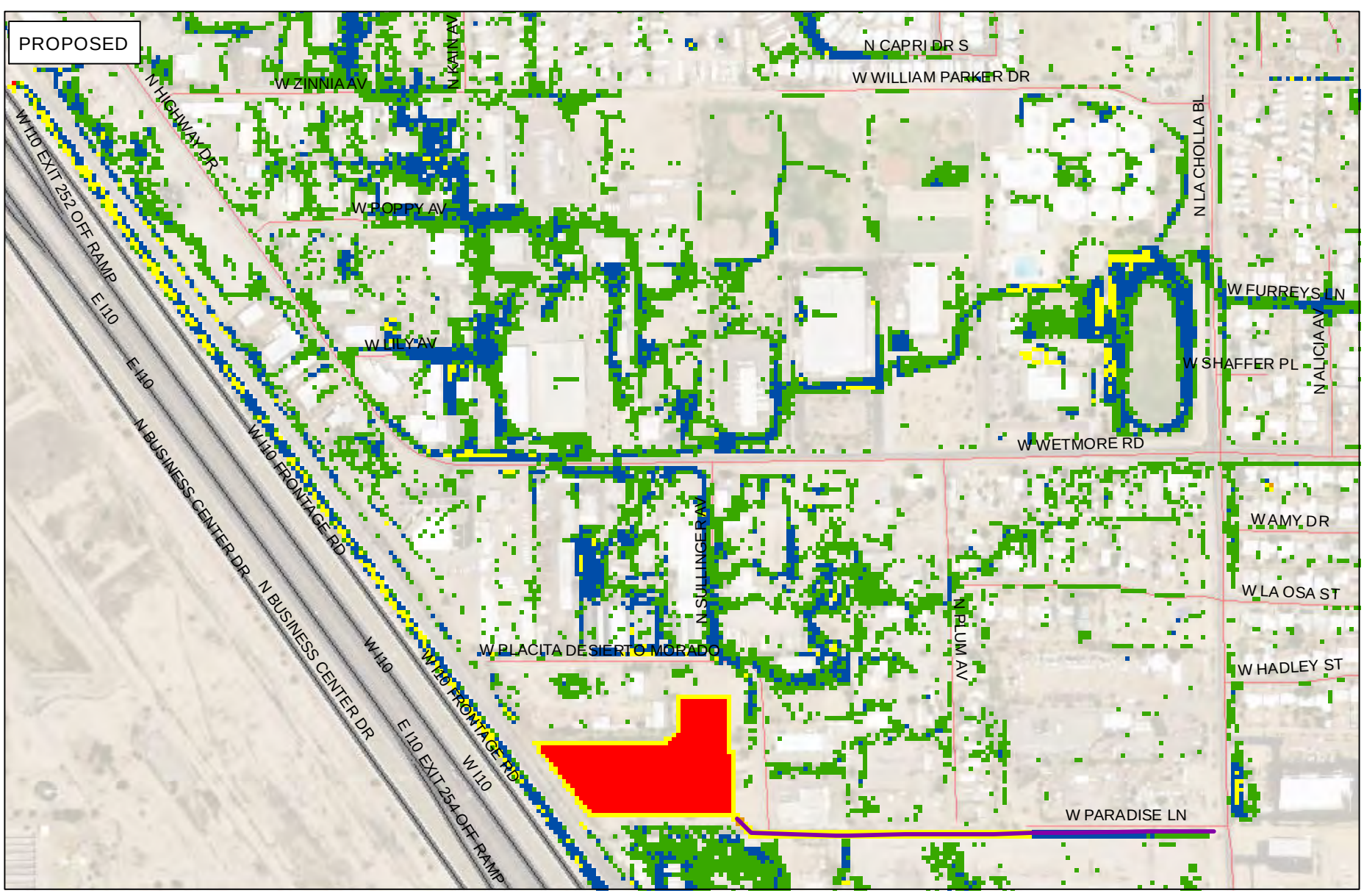
Ruthrauff Basin Management Plan - Alternative 1 **- Area 2 -** Airport Runway **Basin & Channel - 10-yr**

Exhibit 2-1AD

Analysis of Potential Flows to ROMP Channel

Exhibit 2-1AF





Legend

Major streets

Minor streets

Var

< 0.2 | 0.2 - 0.5 | 0.5 - 1.0 | 1.0 - 2.0 | 2.0 - 3.0 | > 3.0

N

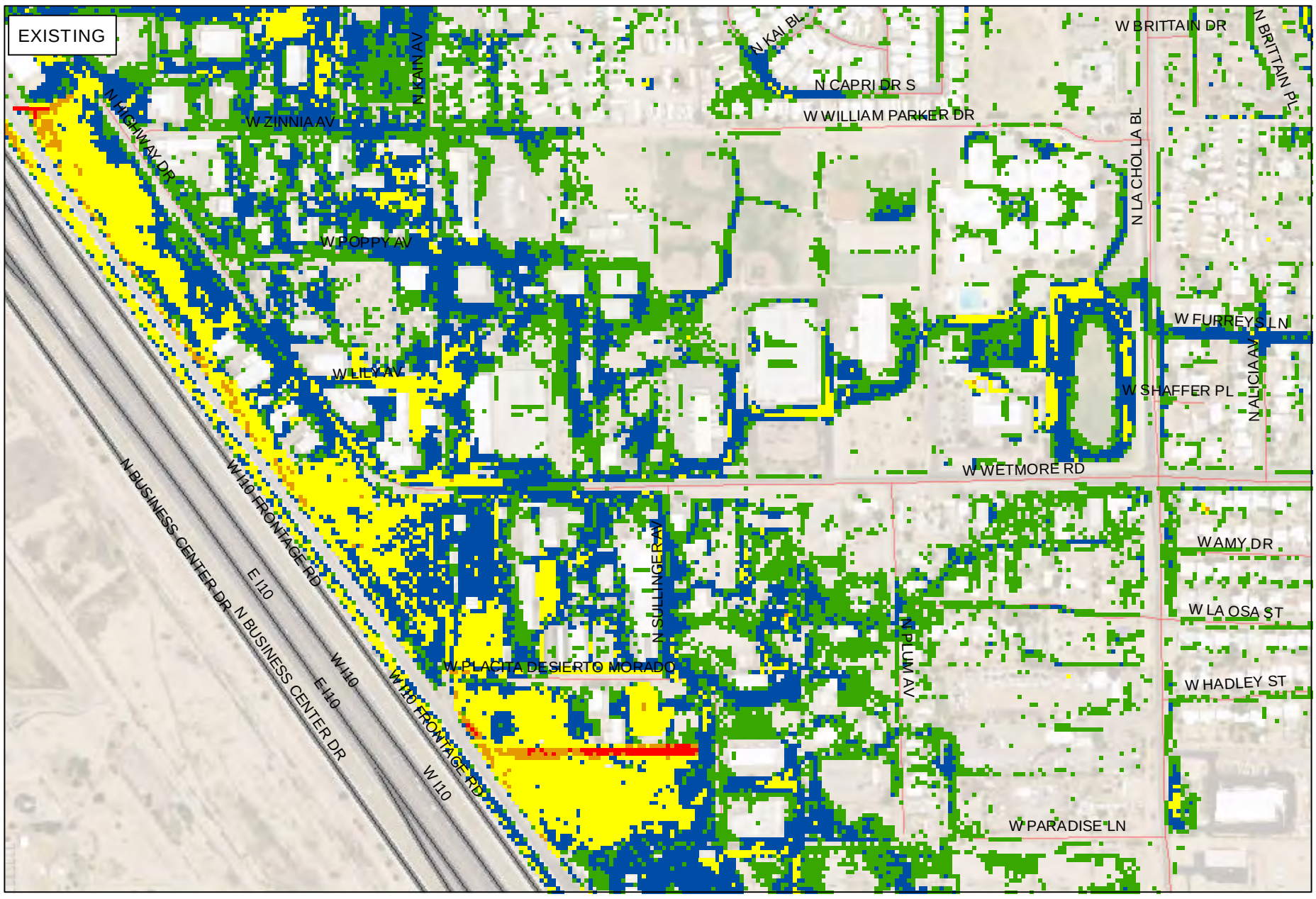
1 inch = 500 feet

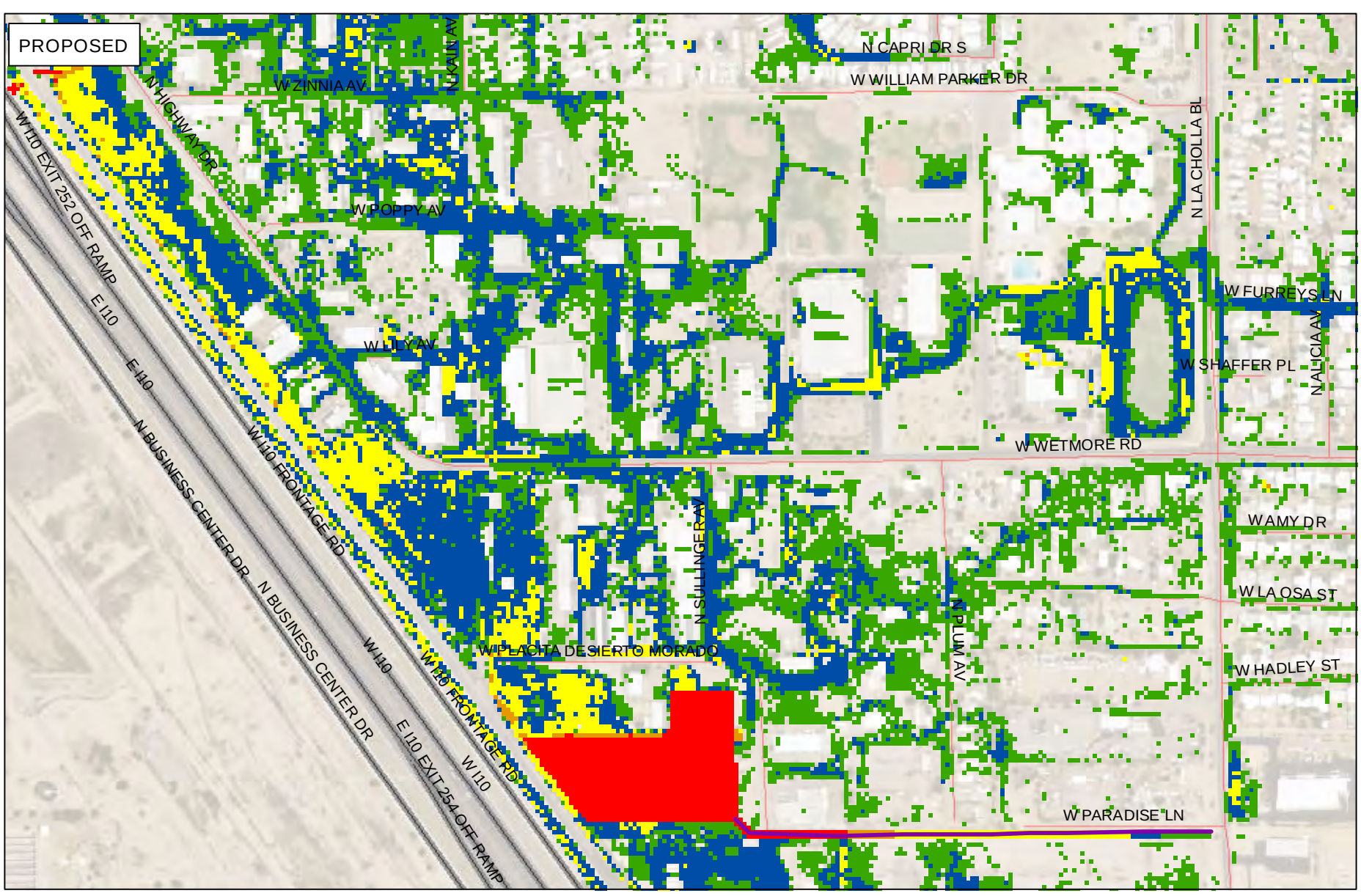
JE Fuller
40 E. Helen St.
Tucson, AZ 85705

Ex vs Prop - Area2-Basin10 - Q10
Date: 5/2/2016

Ruthrauff Basin Management Plan - Alternative 4 - Area 2 - Paradise Ln. Basin - 10-yr

Exhibit 2-1AG





Legend

Major streets

Minor streets

Var

< 0.2 | 0.2 - 0.5 | 0.5 - 1.0 | 1.0 - 2.0 | 2.0 - 3.0 | > 3.0

N

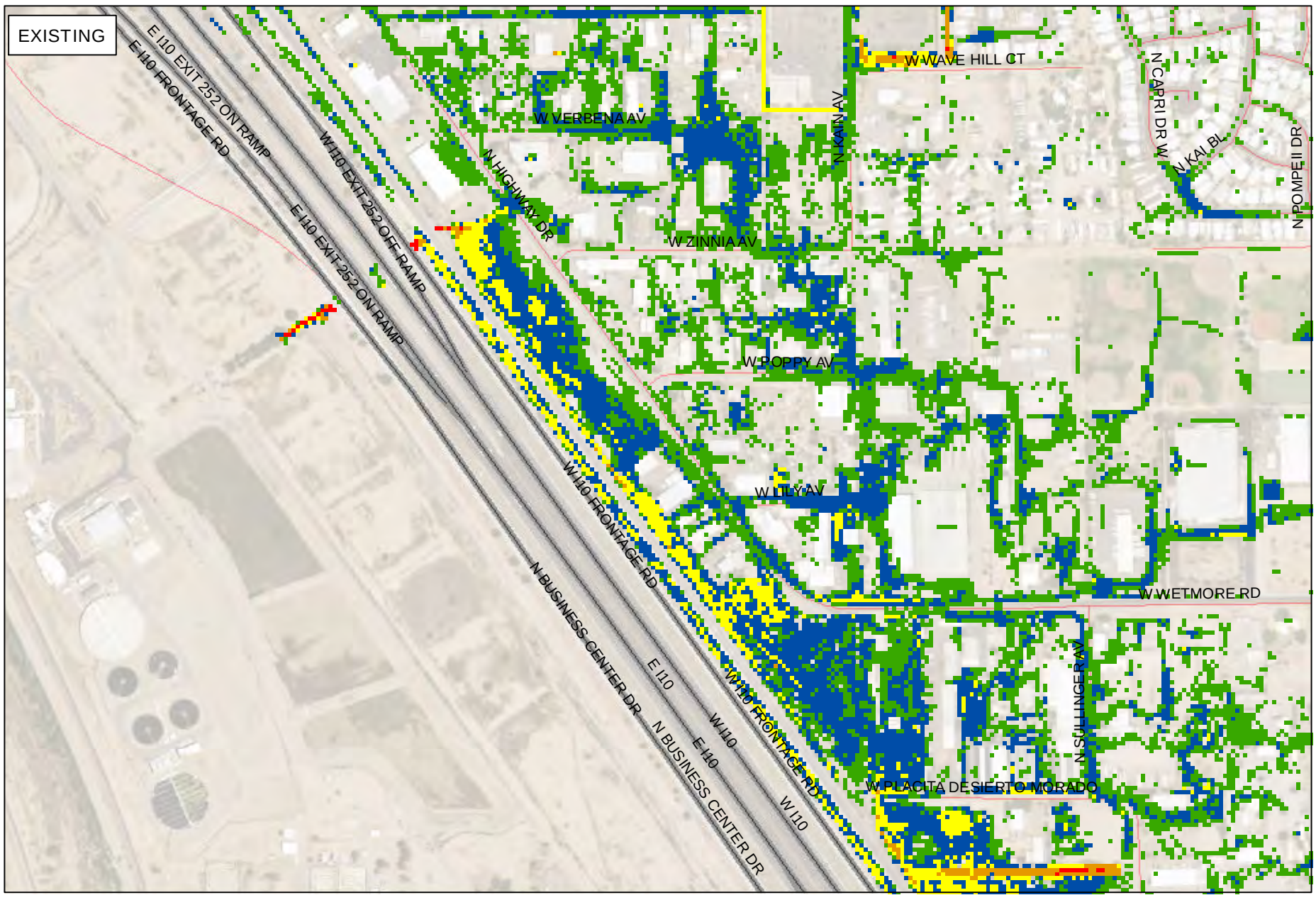
1 inch = 500 feet

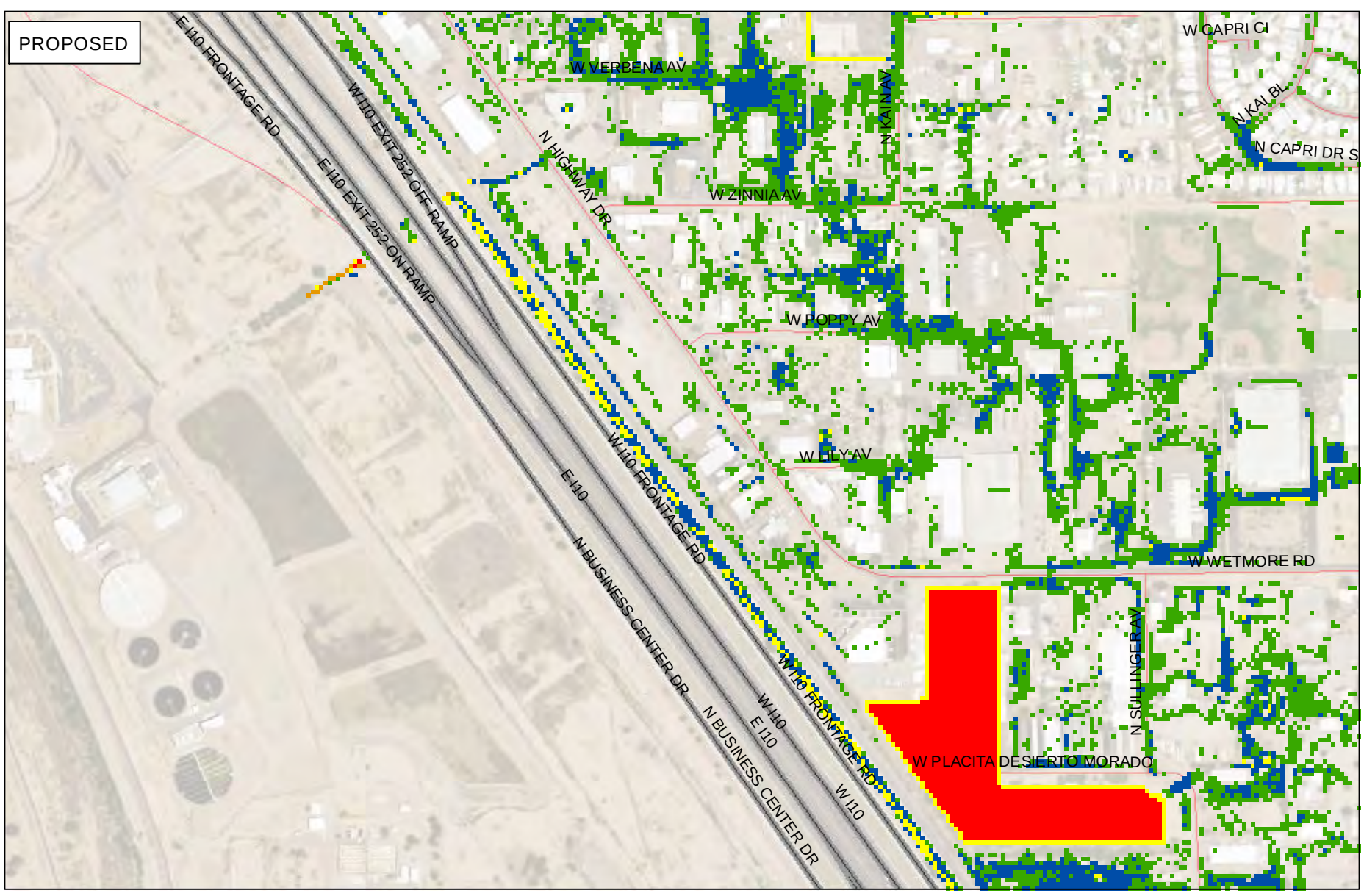
JE Fuller
40 E. Helen St.
Tucson, AZ 85705

Ex vs Prop - Area2-Basin10 - Q100
Date: 5/2/2016

Ruthrauff Basin Management Plan - Alternative 4 **- Area 2 -** Paradise Ln. Basin **- 100-yr**

Exhibit 2-1AH





Legend

Major streets

Minor streets

Var

< 0.2 | 0.2 - 0.5 | 0.5 - 1.0 | 1.0 - 2.0 | 2.0 - 3.0 | > 3.0

N

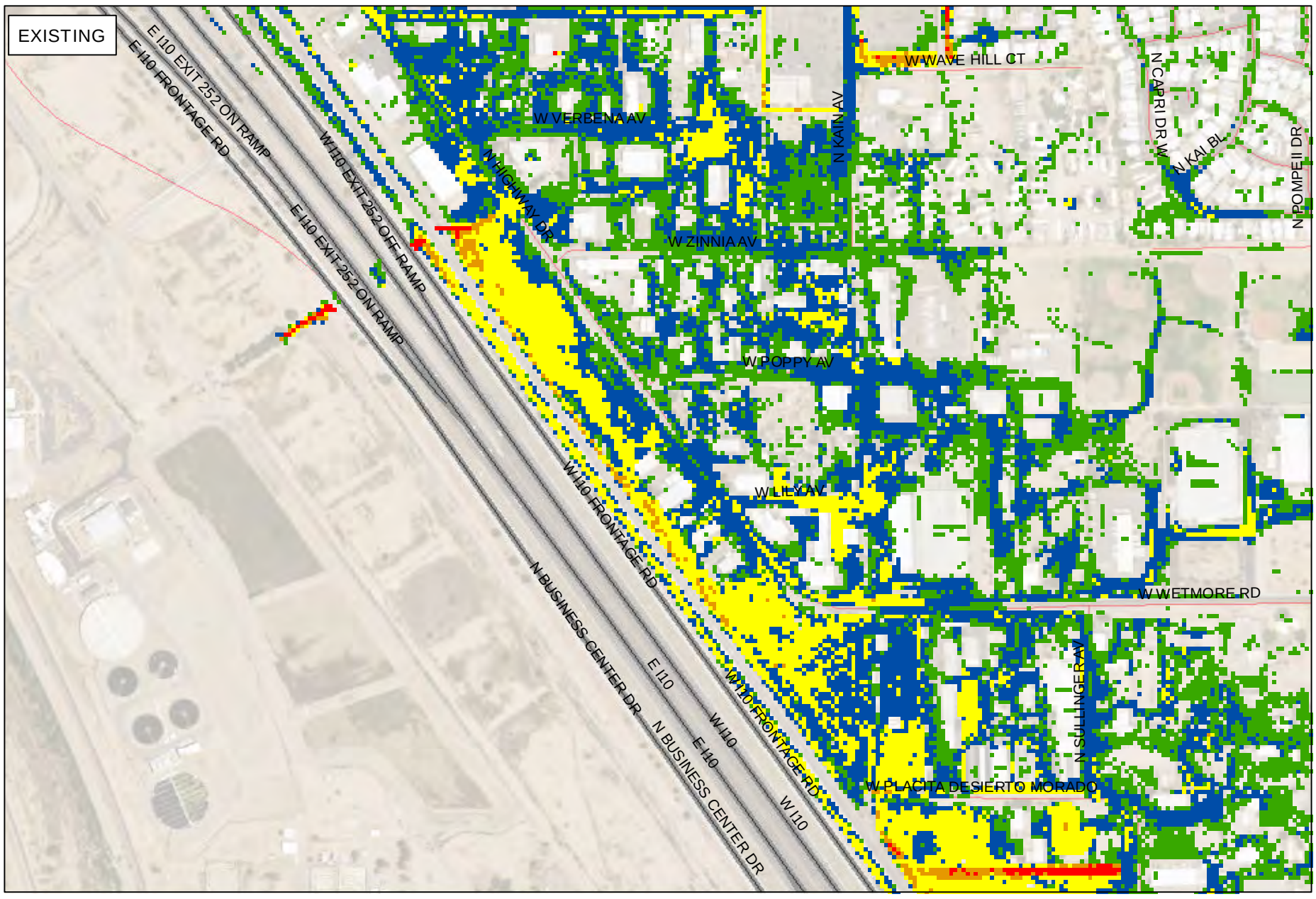
1 inch = 500 feet

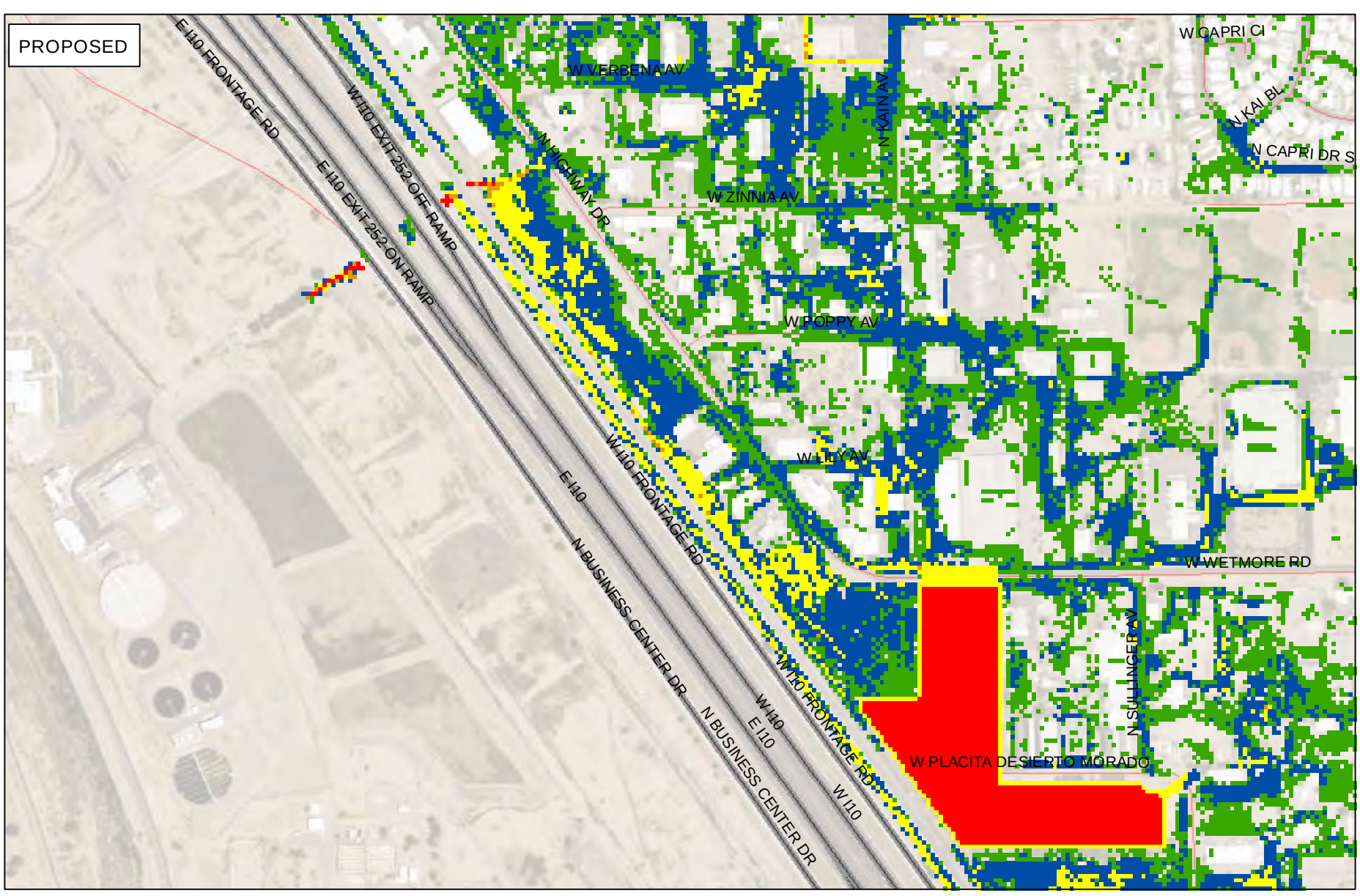
JE Fuller
40 E. Helen St.
Tucson, AZ 85705

Ex vs Prop - Area2-Basin11 - Q10
Date: 5/2/2016

Ruthrauff Basin Management Plan - Alternative 5 **- Area 2 -** Wetmore Rd. Basin **- 10-yr**

Exhibit 2-1AI





Legend

Major streets

Minor streets

Var

< 0.2 | 0.2 - 0.5 | 0.5 - 1.0 | 1.0 - 2.0 | 2.0 - 3.0 | > 3.0

N

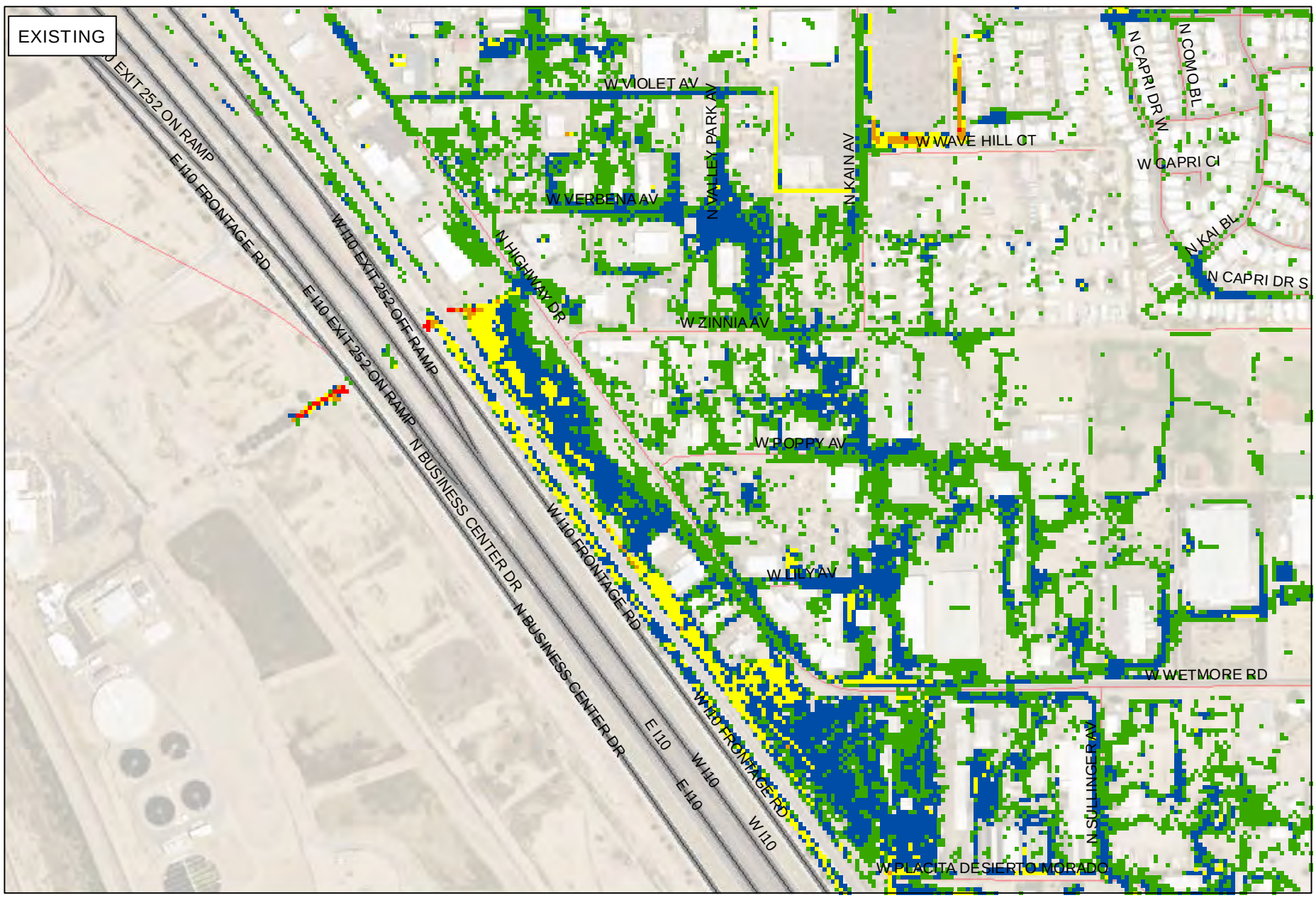
1 inch = 500 feet

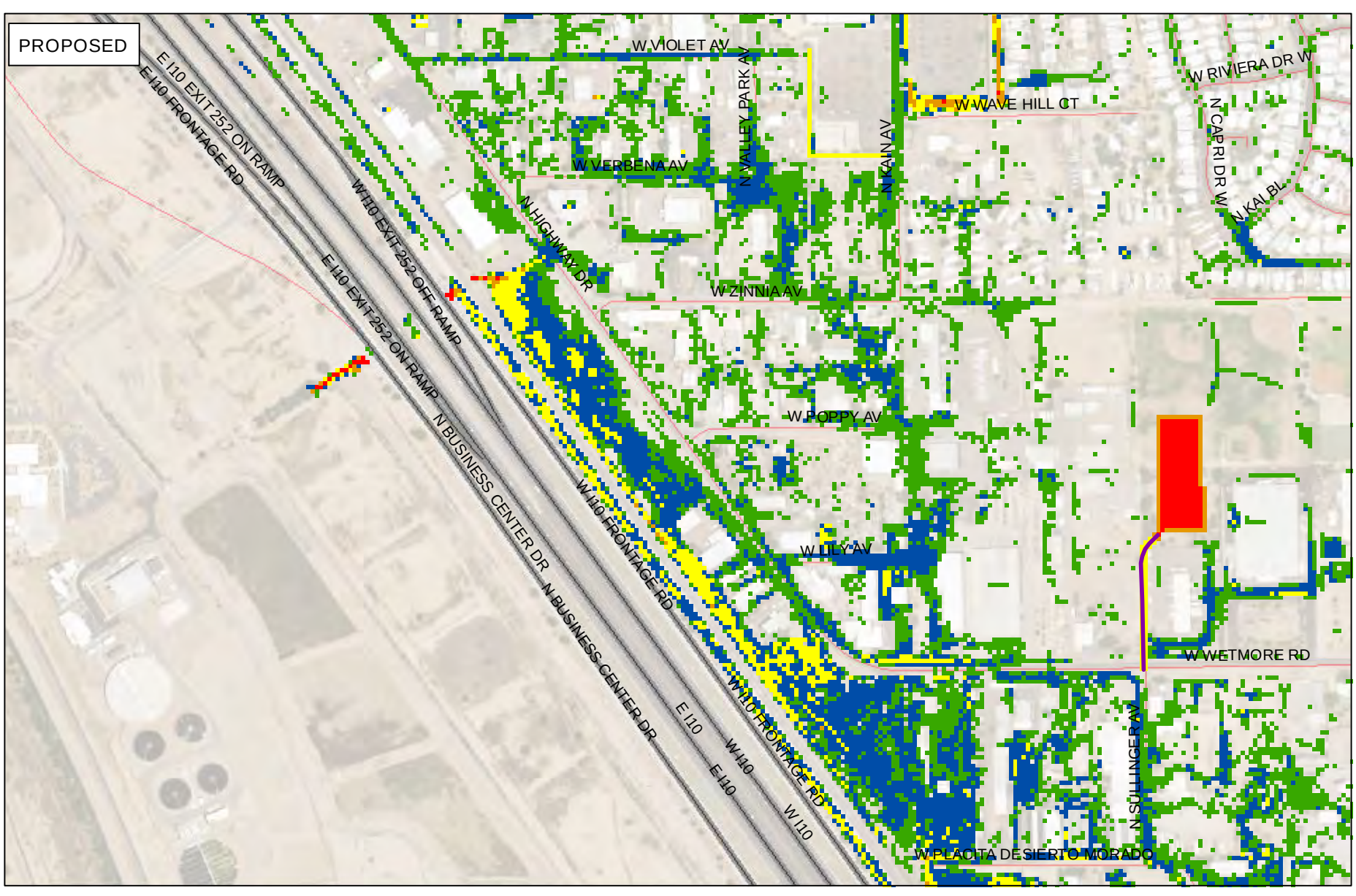
JE Fuller
40 E. Helen St.
Tucson, AZ 85705

Ex vs Prop - Area2-Basin11 - Q100
Date: 5/2/2016

Ruthrauff Basin Management Plan - Alternative 5 **- Area 2 -** Wetmore Rd. Basin **- 100-yr**

Exhibit 2-1AJ





Legend

Major streets

Minor streets

Var

< 0.2 | 0.2 - 0.5 | 0.5 - 1.0 | 1.0 - 2.0 | 2.0 - 3.0 | > 3.0

N

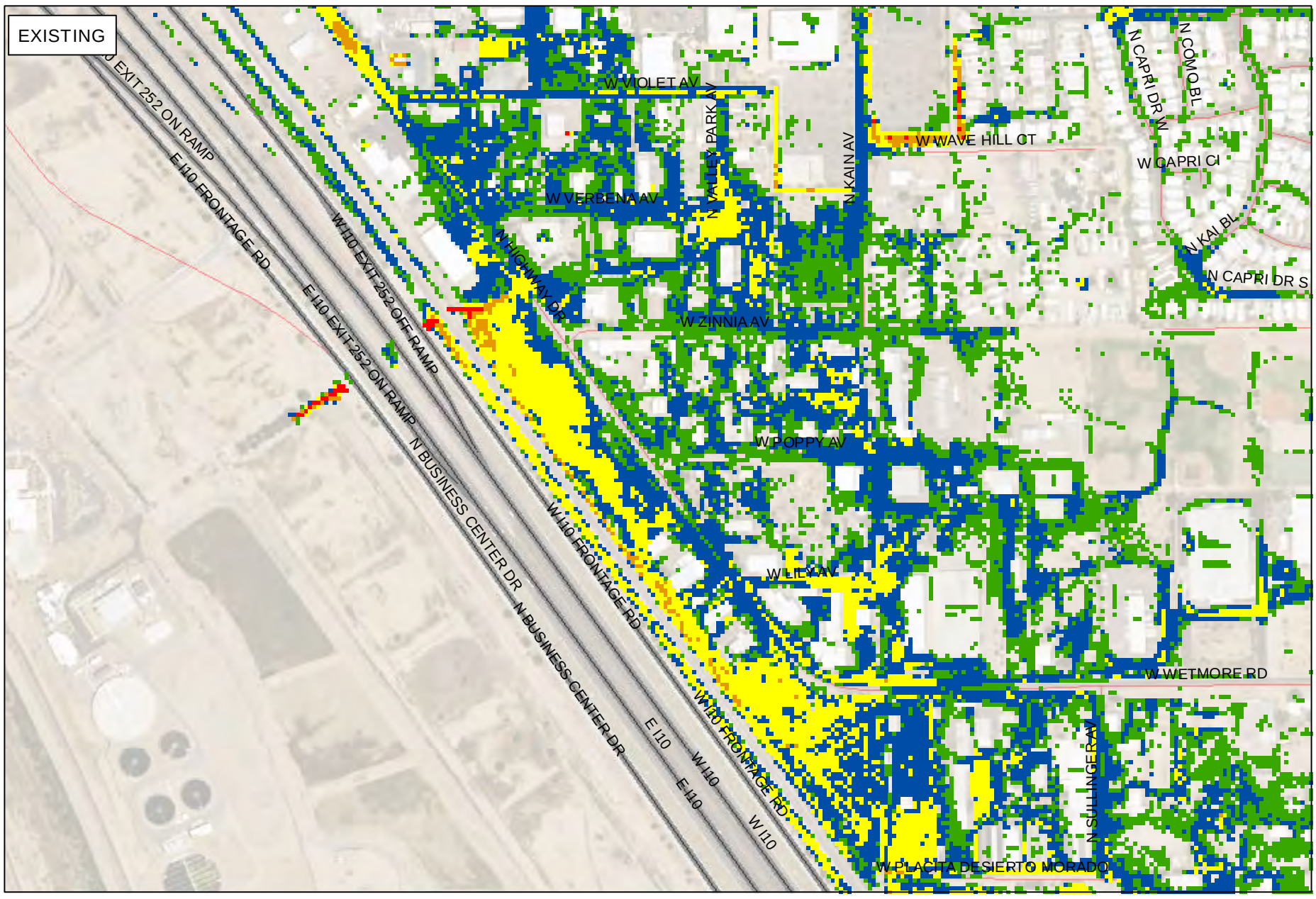
1 inch = 500 feet

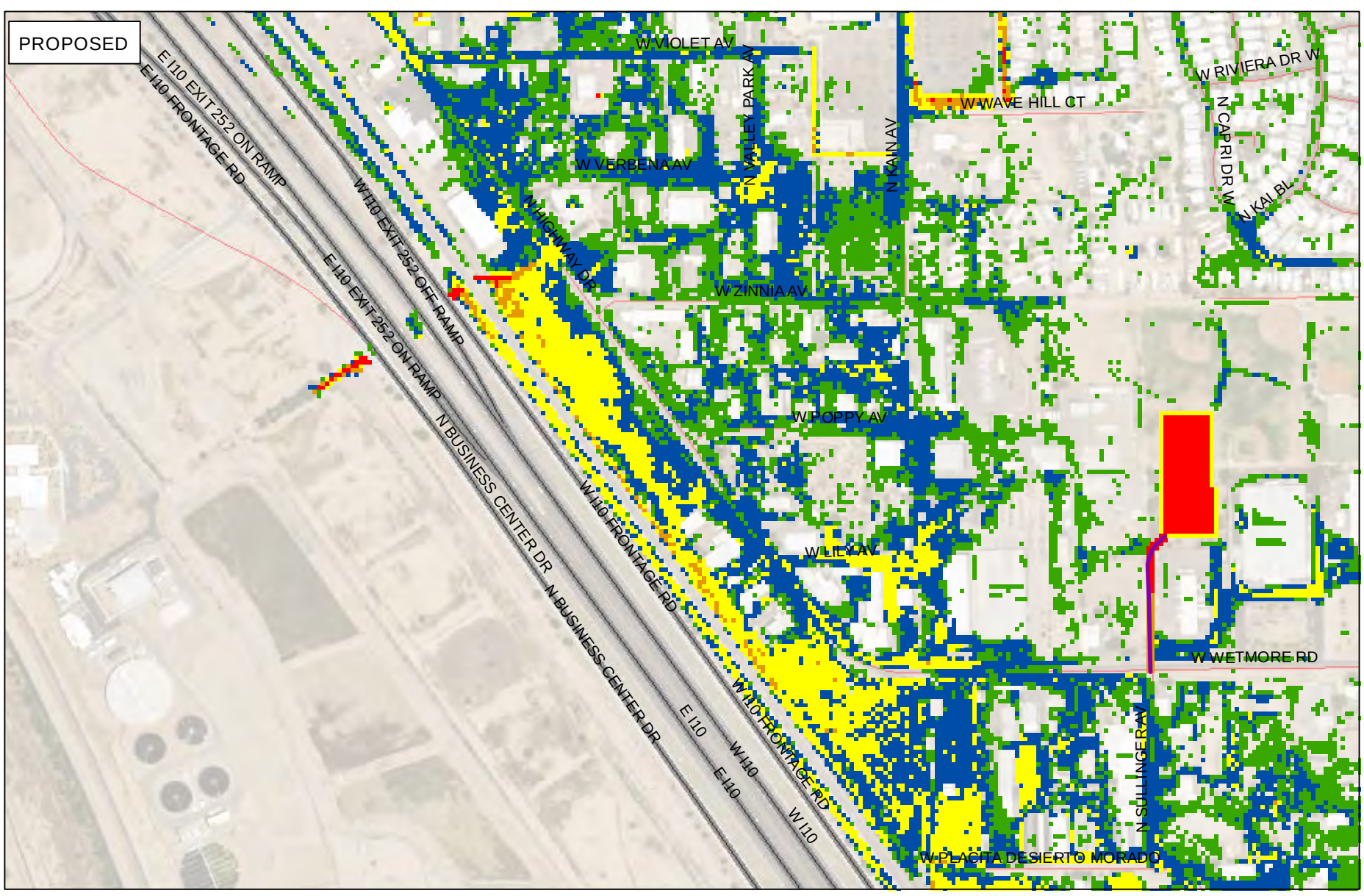
JE Fuller
40 E. Helen St.
Tucson, AZ 85705

Ex vs Prop - Area2-Basin12 - Q10
Date: 5/2/2016

Ruthrauff Basin Management Plan - Alternative 6 **- Area 2 -** Zinnia Ave. Basin **- 10-yr**

Exhibit 2-1AK





Legend

Major streets

Minor streets

Var

< 0.2 | 0.2 - 0.5 | 0.5 - 1.0 | 1.0 - 2.0 | 2.0 - 3.0 | > 3.0

N

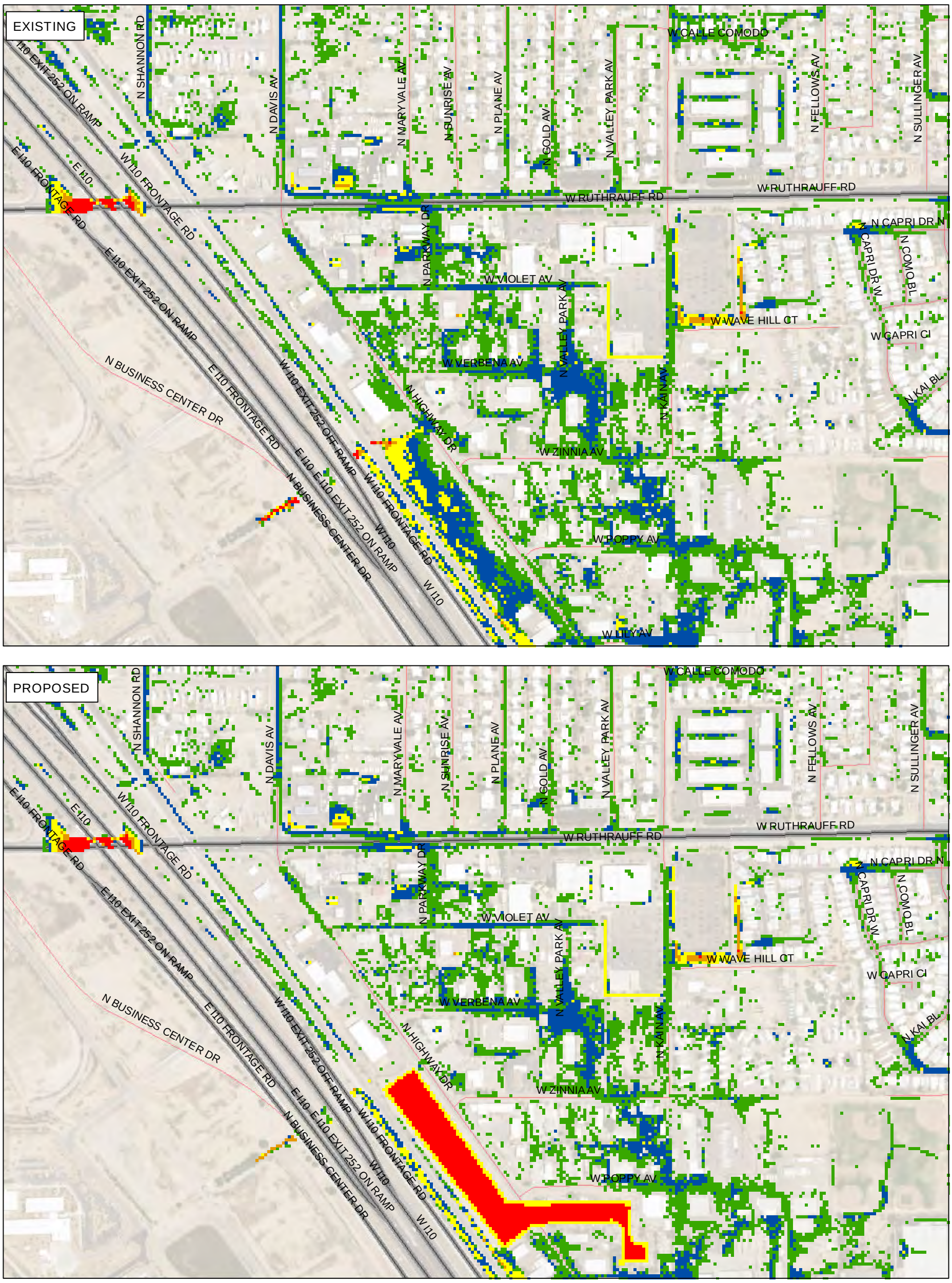
1 inch = 500 feet

JE Fuller
40 E. Helen St.
Tucson, AZ 85705

Ex vs Prop - Area2-Basin12 - Q100
Date: 5/2/2016

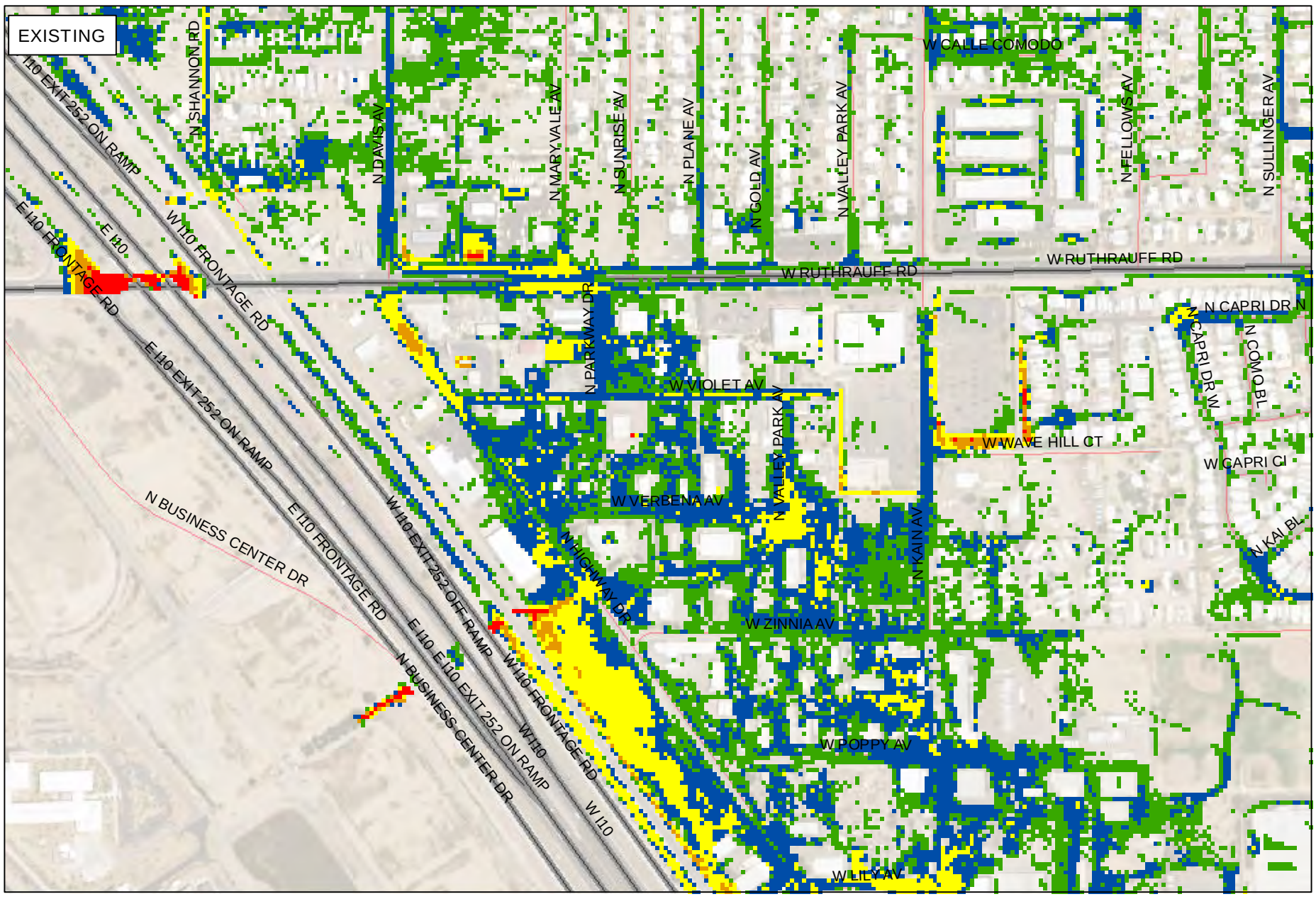
Ruthrauff Basin Management Plan - Alternative 6 **- Area 2 -** Zinnia Ave. Basin **- 100-yr**

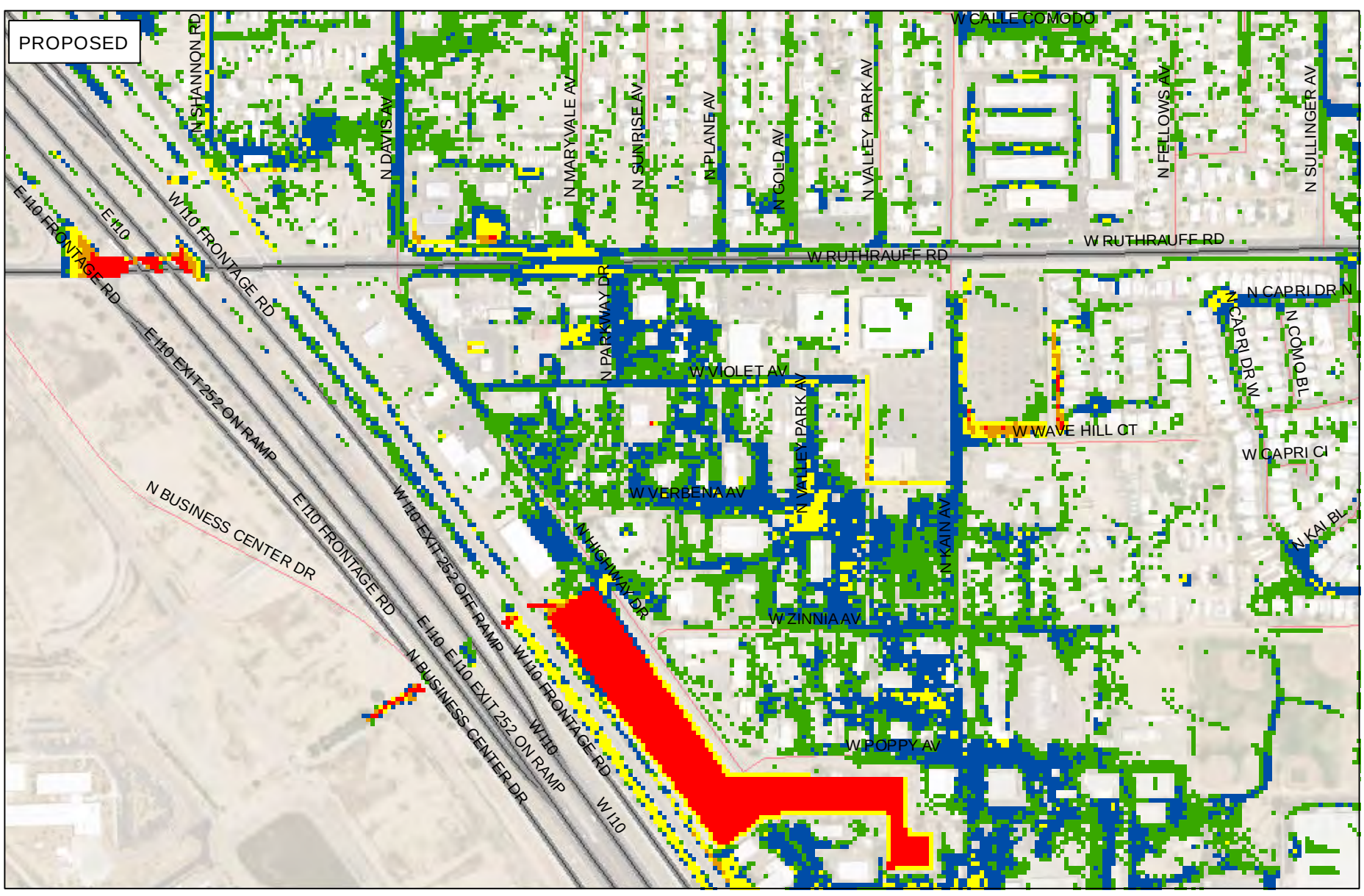
Exhibit 2-1AL



Ruthrauff Basin Management Plan - Alternative 7 **- Area 2 -** Highway Dr. **Basin - 10-yr**

Exhibit 2-1AM





Legend

Major streets

Minor streets

Var

< 0.2 | 0.2 - 0.5 | 0.5 - 1.0 | 1.0 - 2.0 | 2.0 - 3.0 | > 3.0

N

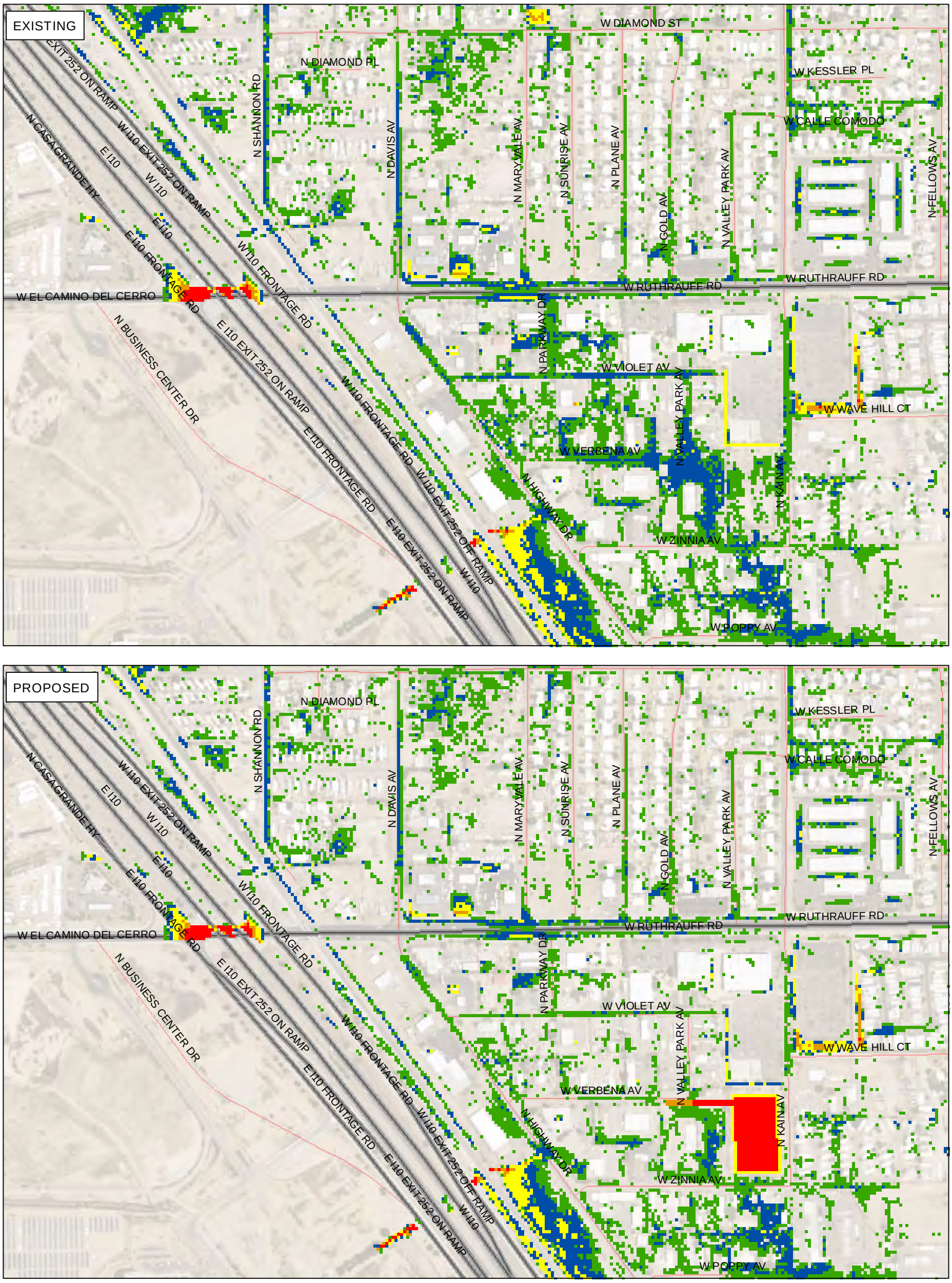
1 inch = 500 feet

JE Fuller
40 E. Helen St.
Tucson, AZ 85705

Ex vs Prop - Area2-Basin13 - Q100
Date: 5/2/2016

Ruthrauff Basin Management Plan - Alternative 7 **- Area 2 -** Highway Dr. **Basin - 100-yr**

Exhibit 2-1AN



Legend

Major streets

Minor streets

Var

< 0.2 | 0.2 - 0.5 | 0.5 - 1.0 | 1.0 - 2.0 | 2.0 - 3.0 | > 3.0

N

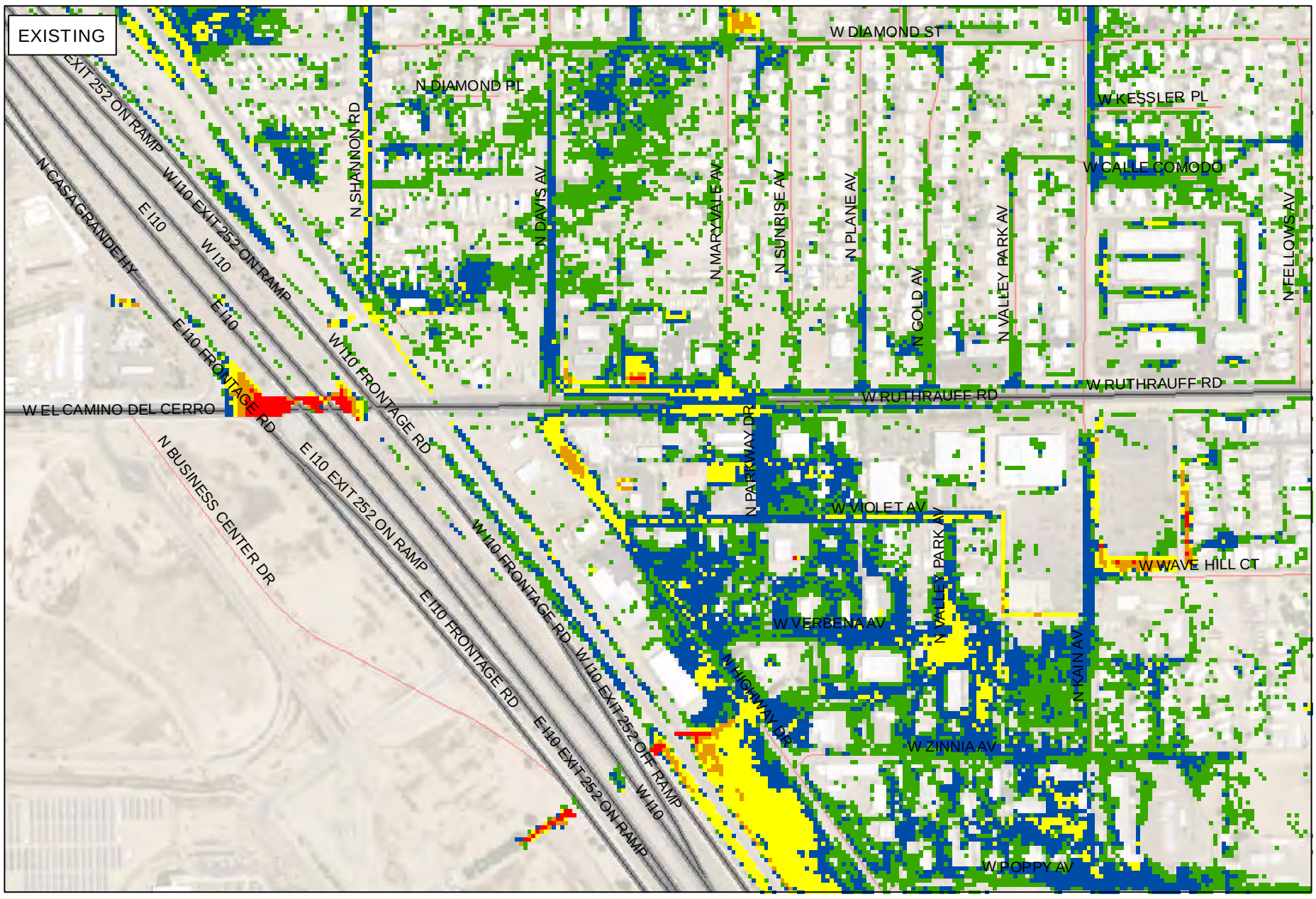
1 inch = 500 feet

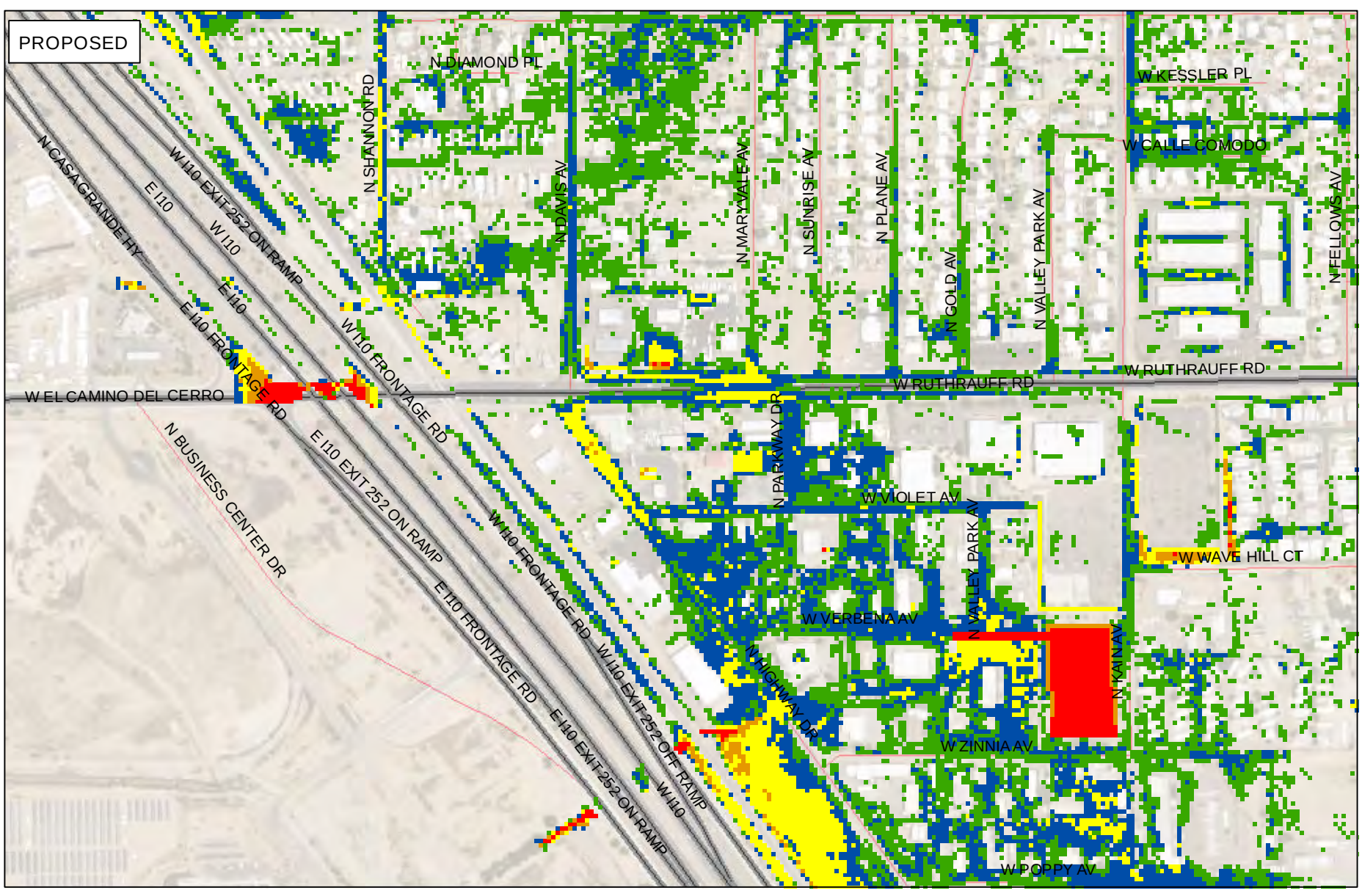
JE Fuller
40 E. Helen St.
Tucson, AZ 85705

Ex vs Prop - Area2-Basin15 - Q10
Date: 5/2/2016

Ruthrauff Basin Management Plan - Alternative 8 **- Area 2 -** Verbena Ave. **Basin - 10-yr**

Exhibit 2-1AO





Legend

Major streets

Minor streets

Var

< 0.2 | 0.2 - 0.5 | 0.5 - 1.0 | 1.0 - 2.0 | 2.0 - 3.0 | > 3.0

N

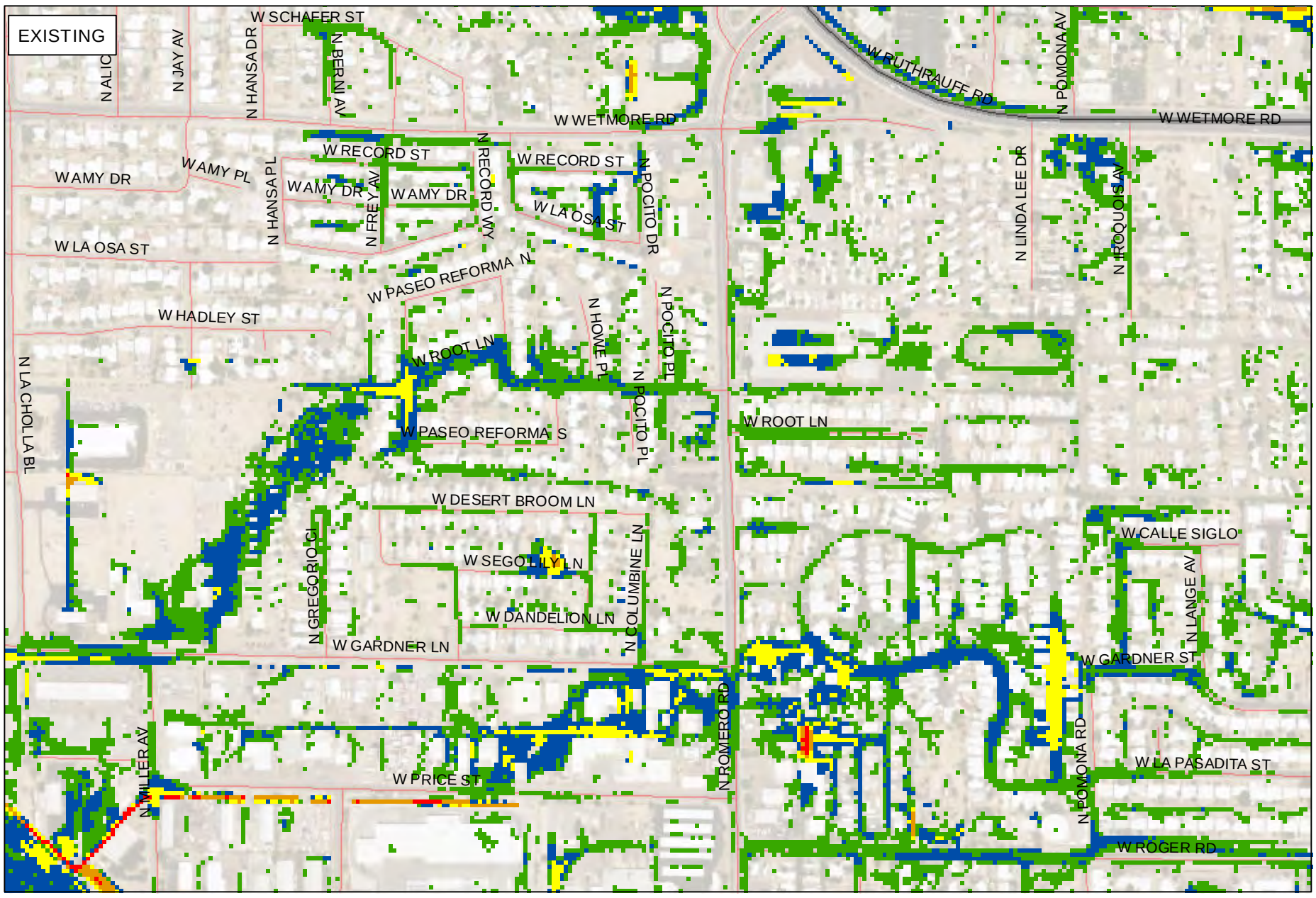
1 inch = 500 feet

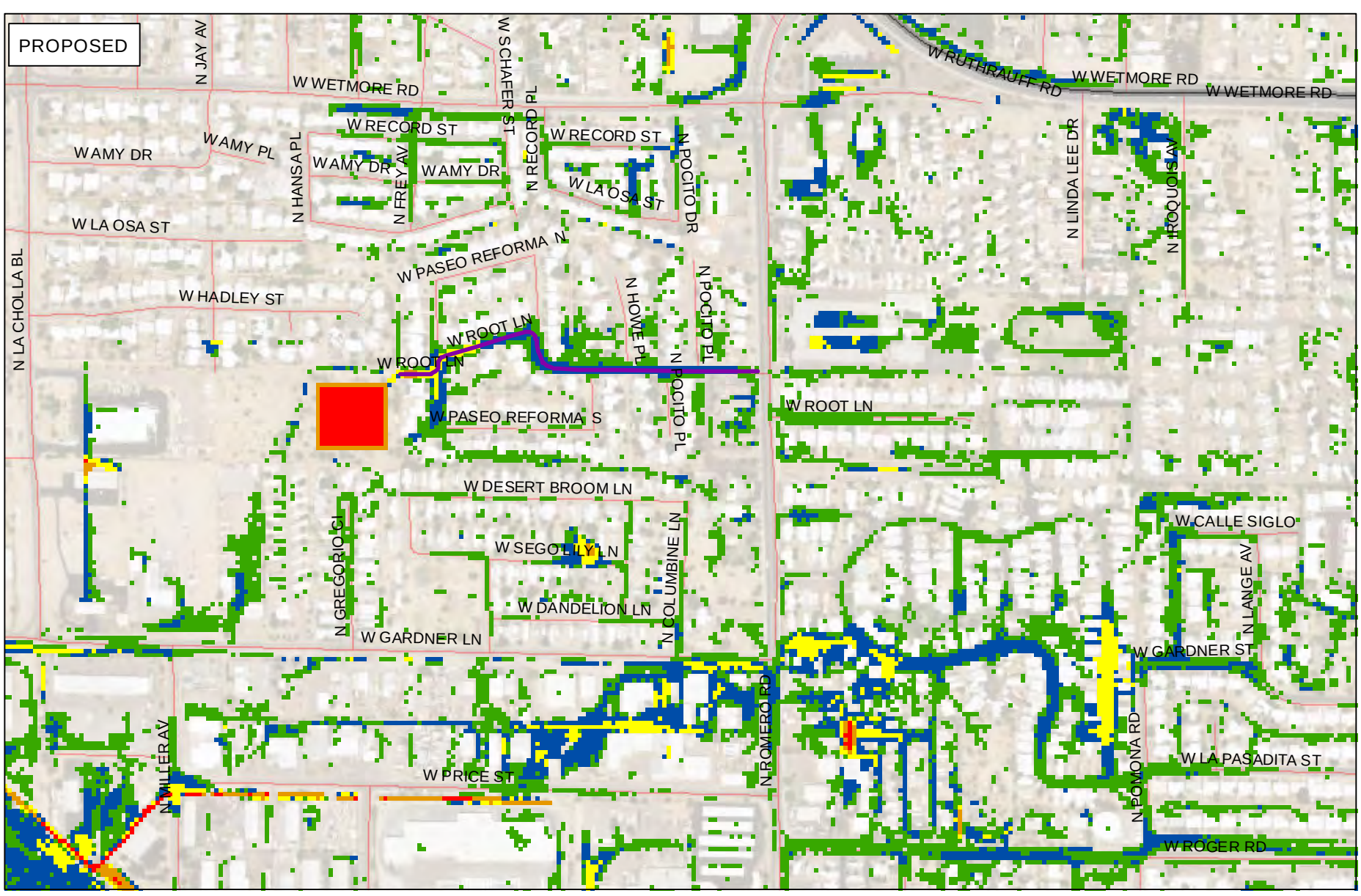
JE Fuller
40 E. Helen St.
Tucson, AZ 85705

Ex vs Prop - Area2-Basin15 - Q100
Date: 5/2/2016

Ruthrauff Basin Management Plan - Alternative 8 **- Area 2 -** Verbena Ave. **Basin - 100-yr**

Exhibit 3-1AB





Legend

Major streets

Minor streets

Var

< 0.2 | 0.2 - 0.5 | 0.5 - 1.0 | 1.0 - 2.0 | 2.0 - 3.0 | > 3.0

N

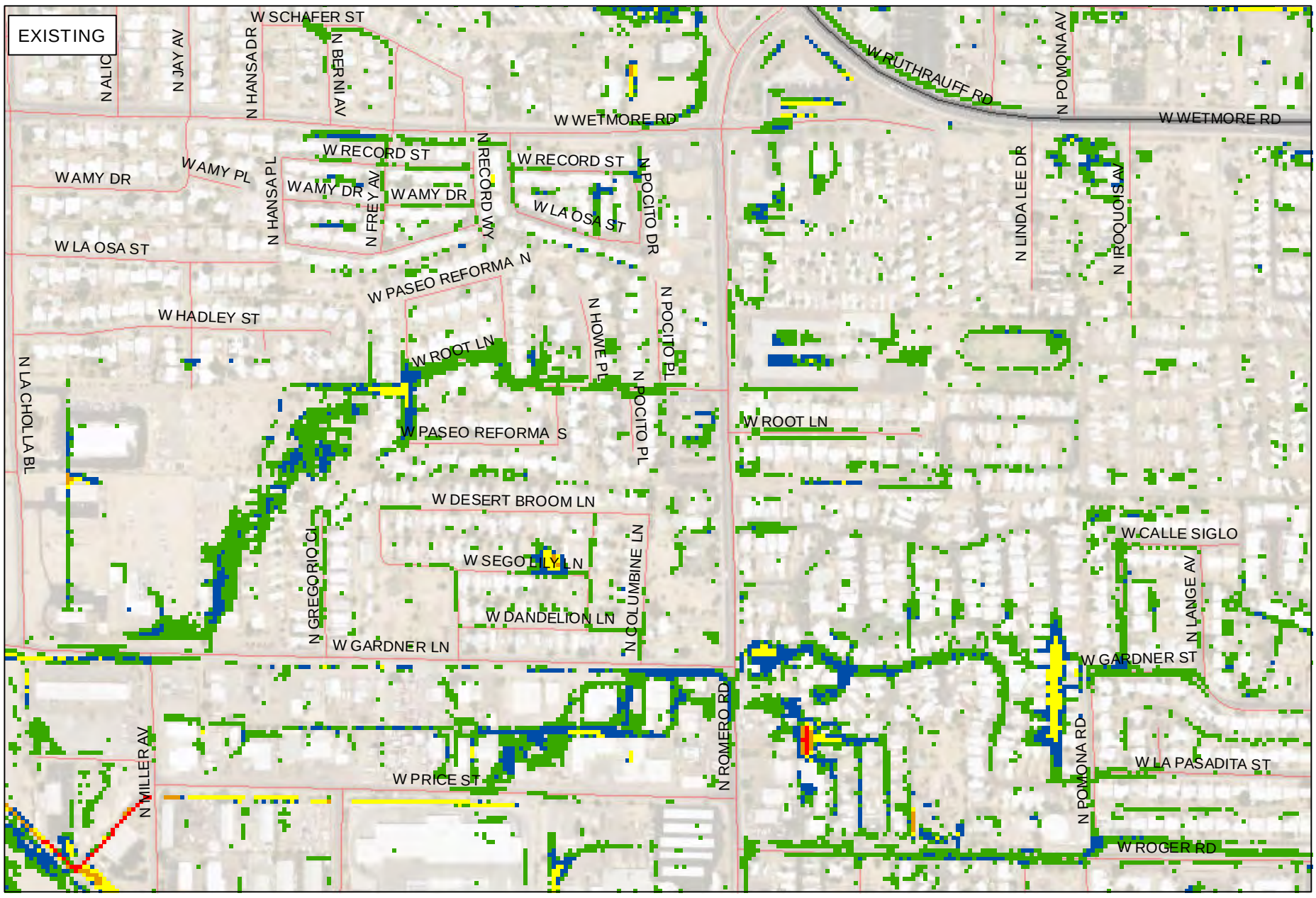
1 inch = 500 feet

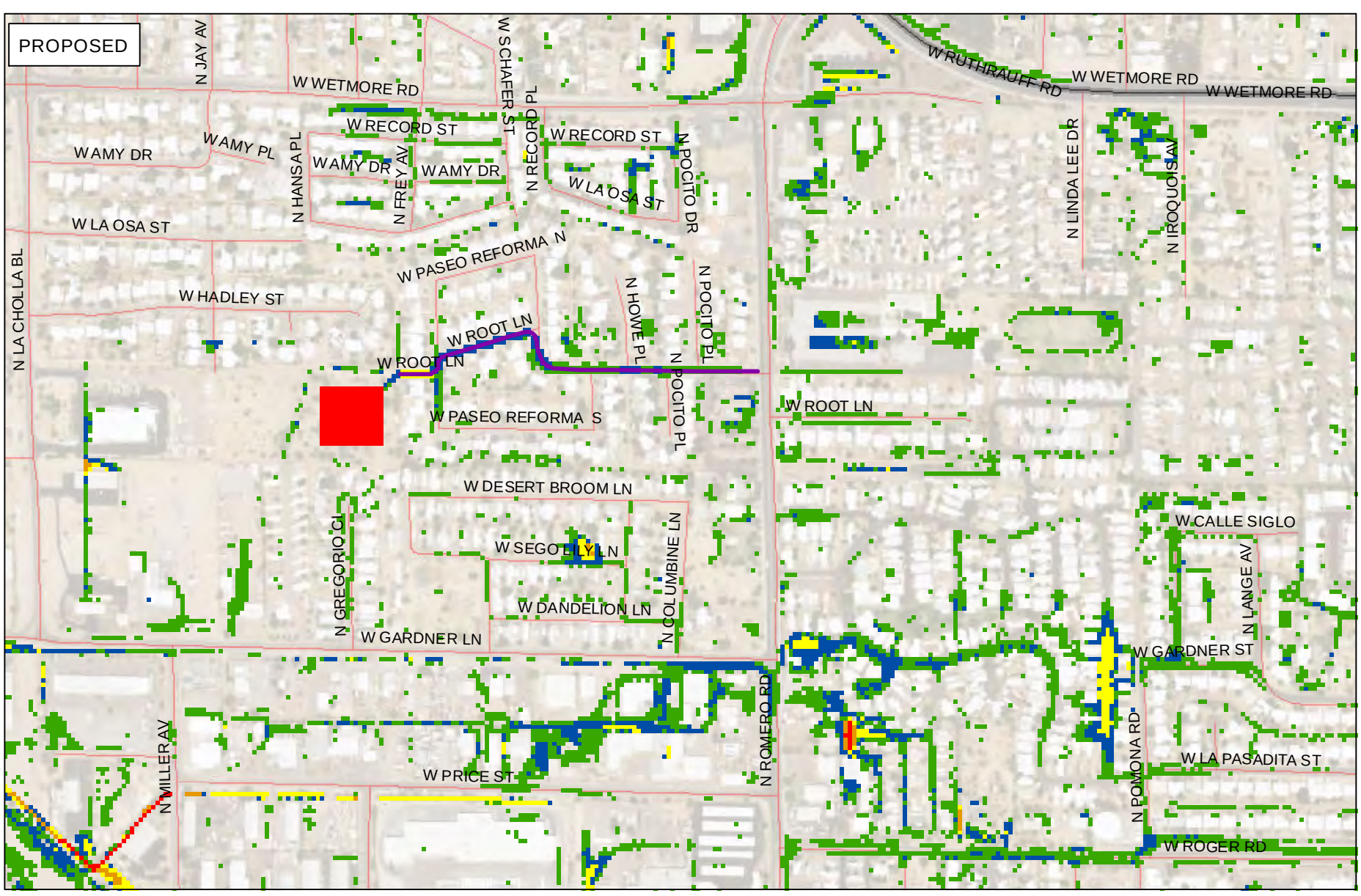
JE Fuller
40 E. Helen St.
Tucson, AZ 85705

Ex vs Prop - Area3-Alt1 - Q100
Date: 4/18/2016

Ruthrauff Basin Management Plan - Alternative 1 (1 & 2) **- Area 3 - Root Lane Basin & Street Imp. - 100-yr**

Exhibit 3-1AC





Legend

Major streets

Minor streets

Var

< 0.2 | 0.2 - 0.5 | 0.5 - 1.0 | 1.0 - 2.0 | 2.0 - 3.0 | > 3.0

N

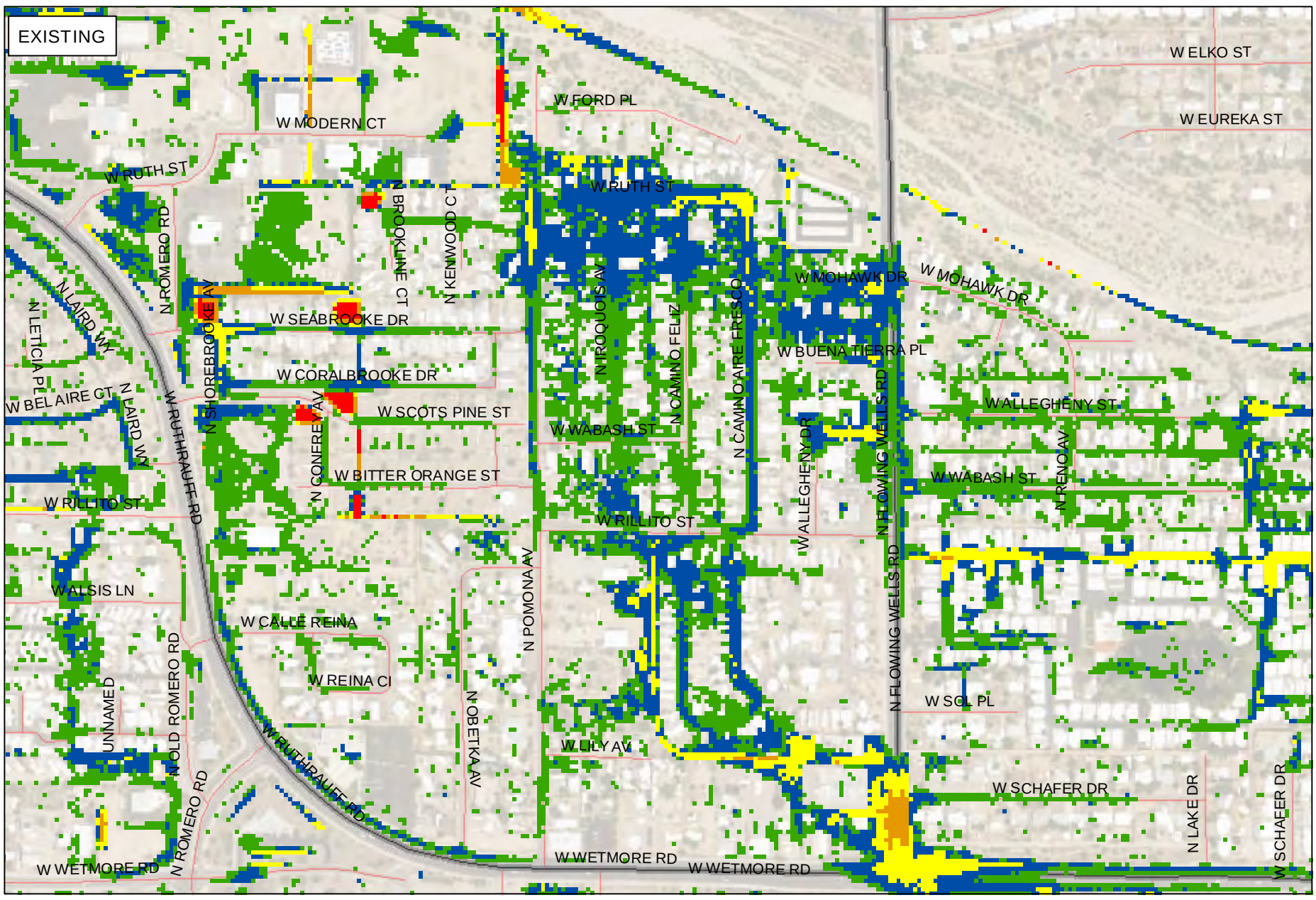
1 inch = 500 feet

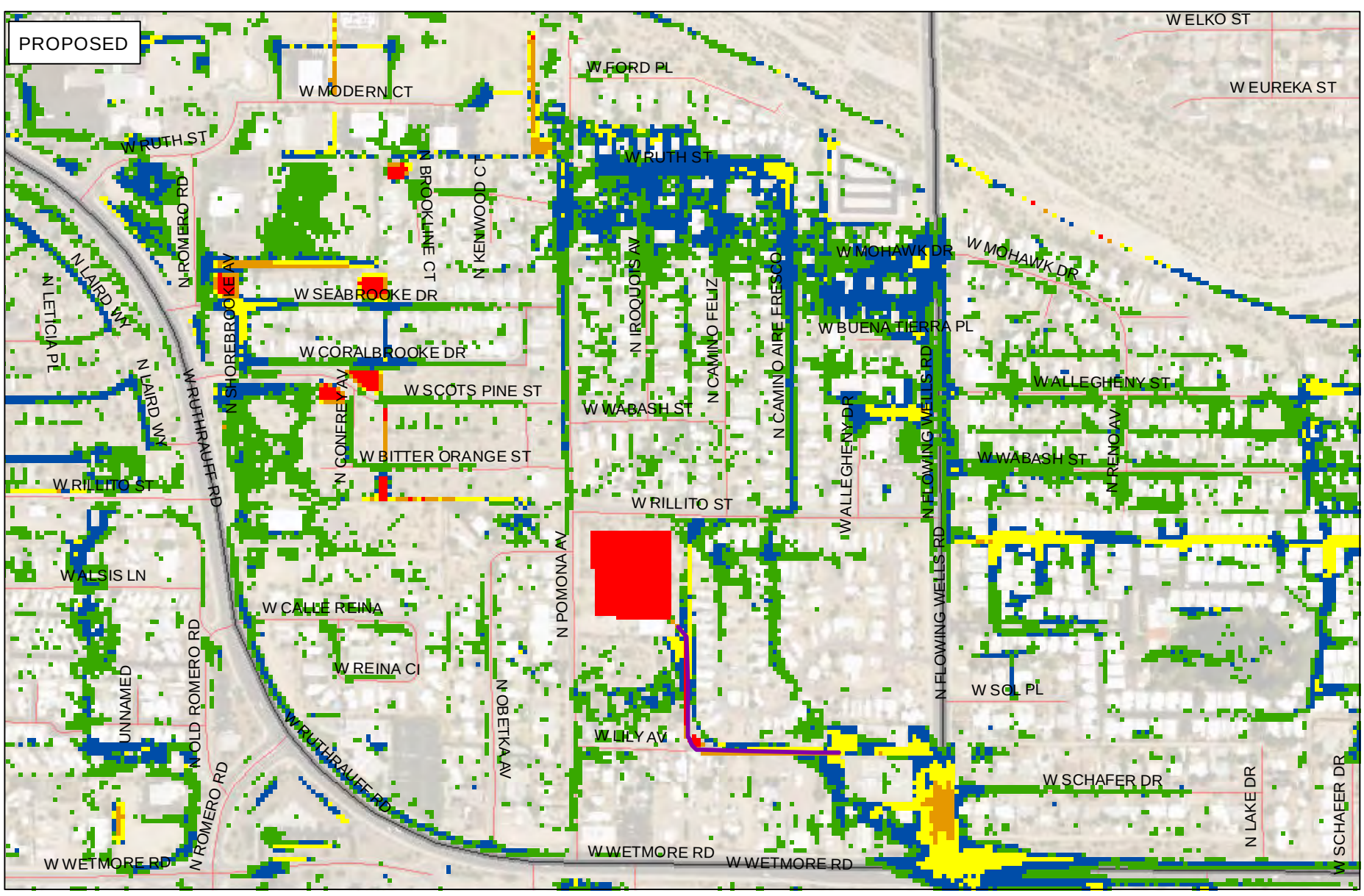
JE Fuller
40 E. Helen St.
Tucson, AZ 85705

Ex vs Prop - Area3-Alt1 - Q10
Date: 4/18/2016

Ruthrauff Basin Management Plan - Alternative 1 (1 & 2) - Area 3 - Root Lane Basin & Street Imp. - 10-yr

Exhibit 4-1AB





Legend

Major streets

Minor streets

Var

< 0.2 | 0.2 - 0.5 | 0.5 - 1.0 | 1.0 - 2.0 | 2.0 - 3.0 | > 3.0

N

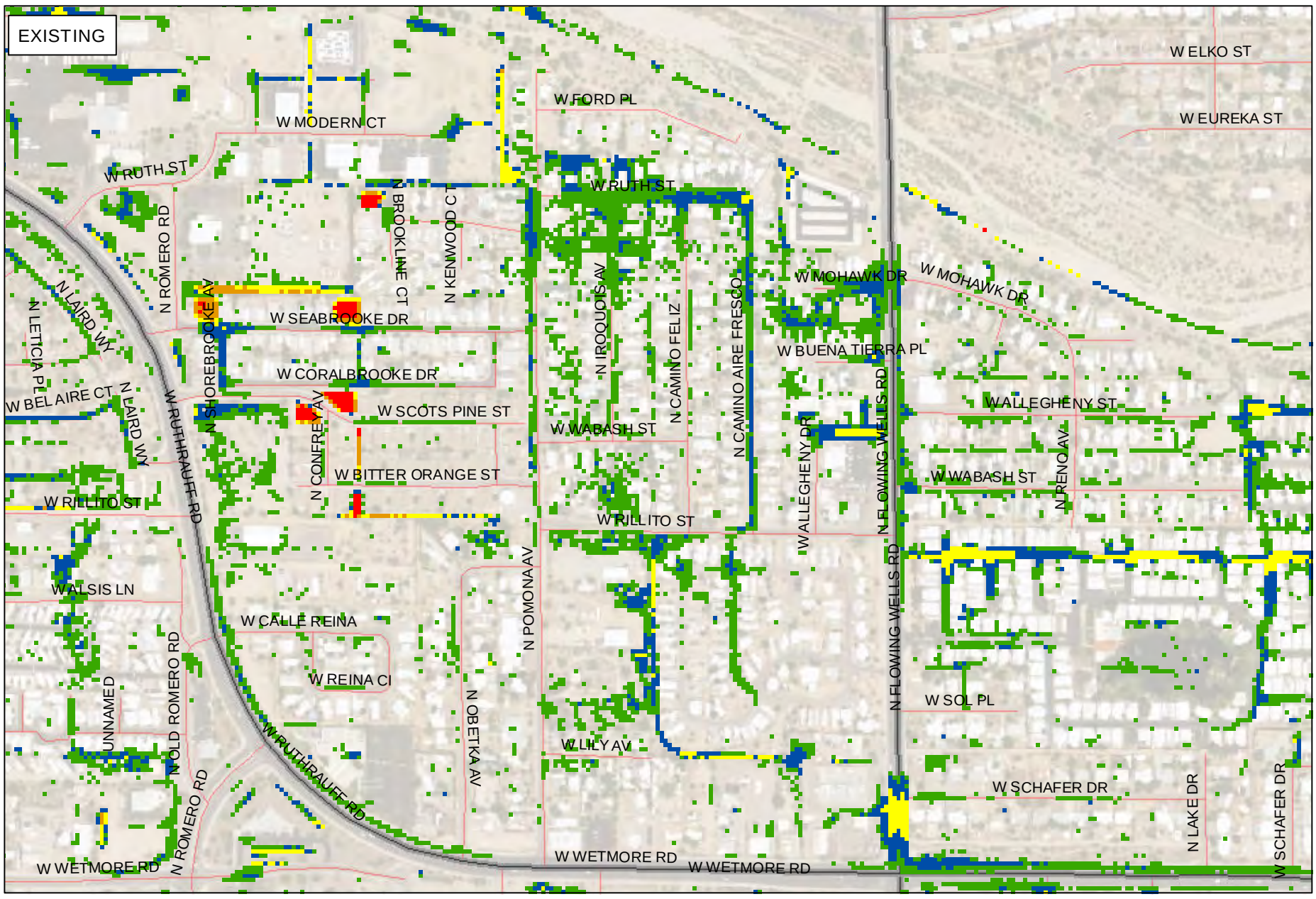
1 inch = 500 feet

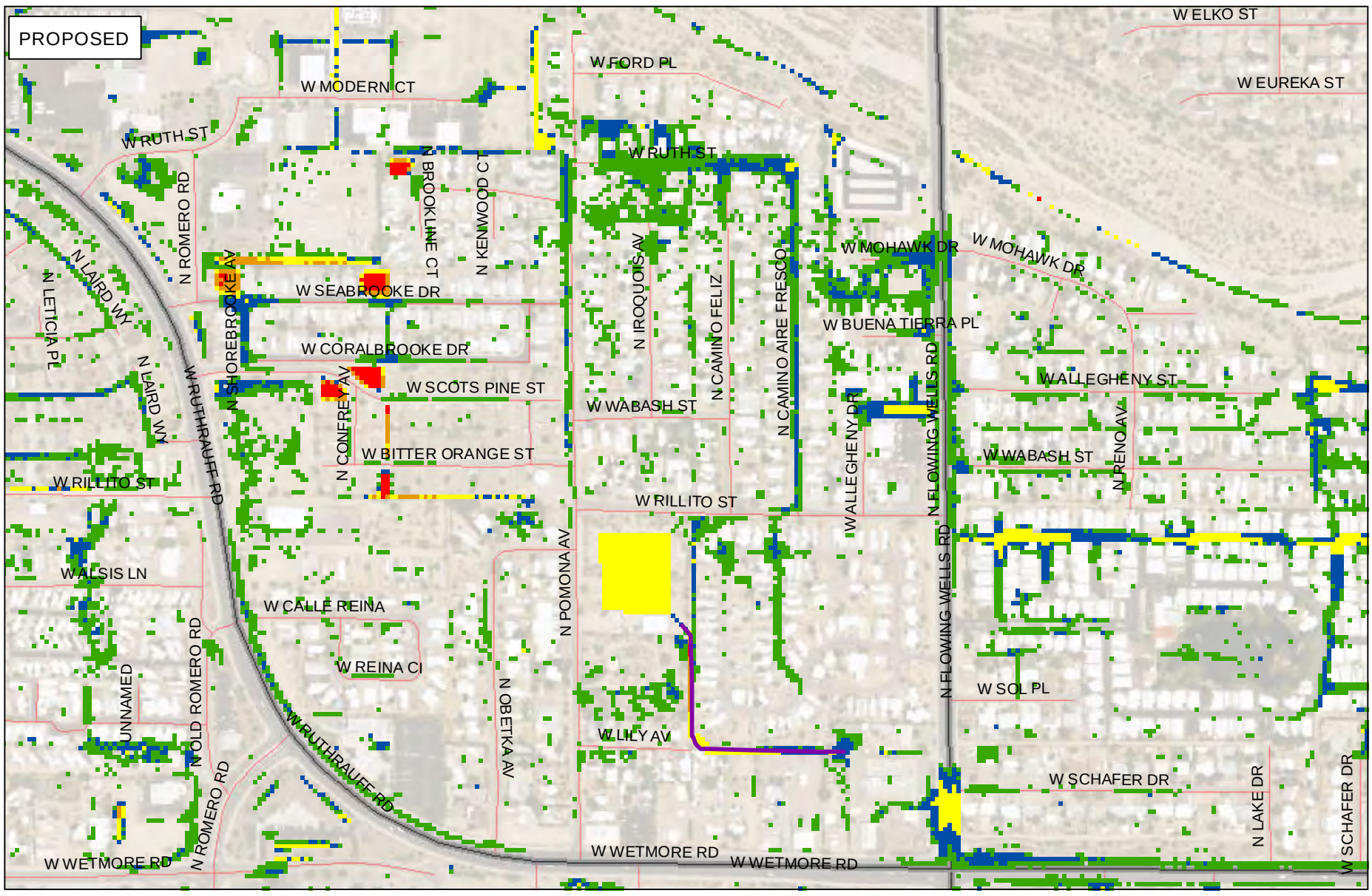
JE Fuller
40 E. Helen St.
Tucson, AZ 85705

Ex vs Prop - Area4-Alt1 - Q100
Date: 4/18/2016

Ruthrauff Basin Management Plan - Alternative 1 **- Area 4 -** Rillito St. **Basin & Channel Imp. - 100-yr**

Exhibit 4-1AC





Legend

Major streets

Minor streets

Var

< 0.2 | 0.2 - 0.5 | 0.5 - 1.0 | 1.0 - 2.0 | 2.0 - 3.0 | > 3.0

N

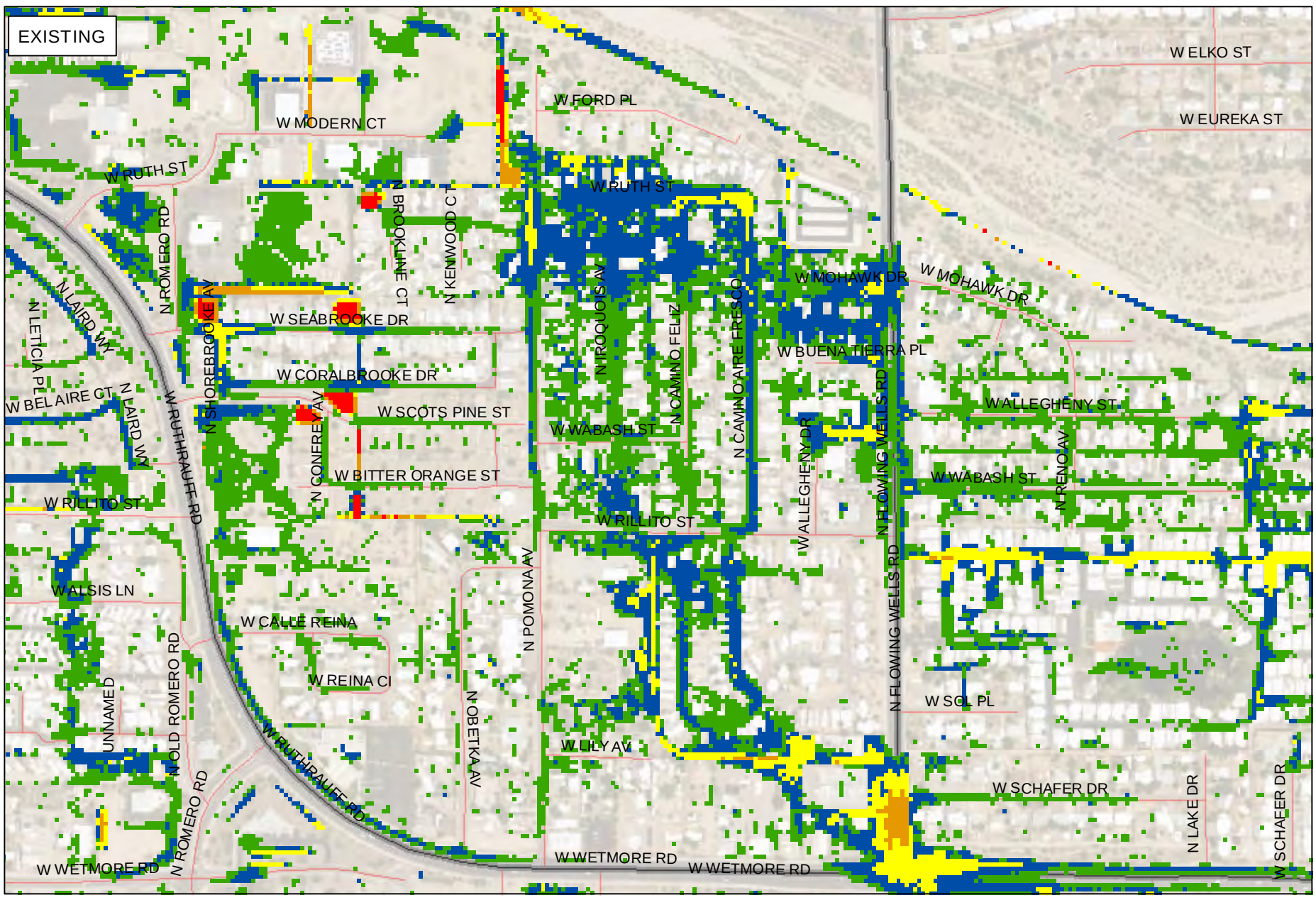
1 inch = 500 feet

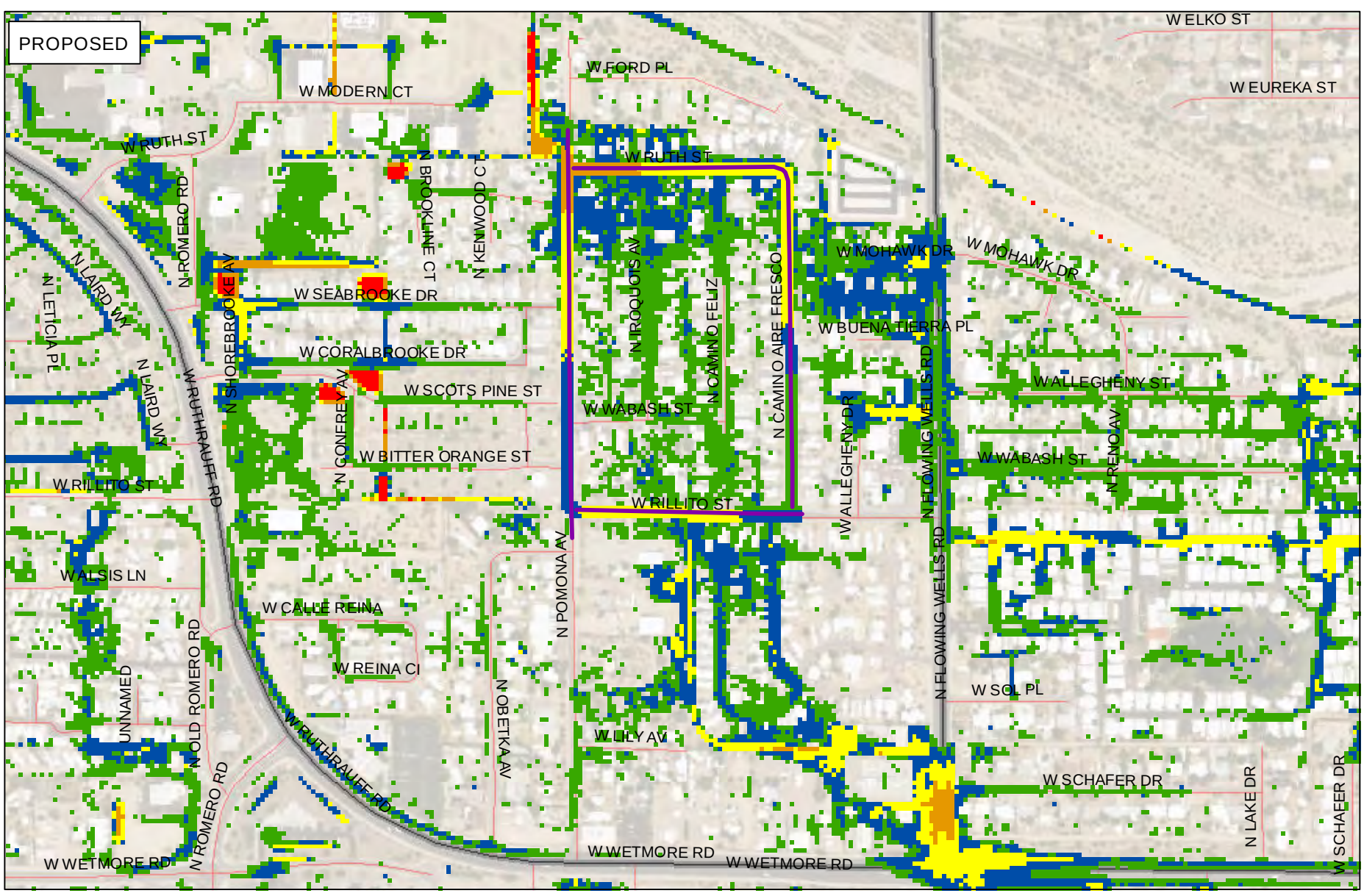
JE Fuller
40 E. Helen St.
Tucson, AZ 85705

Ex vs Prop - Area4-Alt1 - Q10
Date: 4/18/2016

Ruthrauff Basin Management Plan - Altrnative 1 **- Area 4 -** Rillito St. **Basin & Channel Imp. - 10-yr**

Exhibit 4-1AD





Legend

Major streets

Minor streets

Var

< 0.2 | 0.2 - 0.5 | 0.5 - 1.0 | 1.0 - 2.0 | 2.0 - 3.0 | > 3.0

N

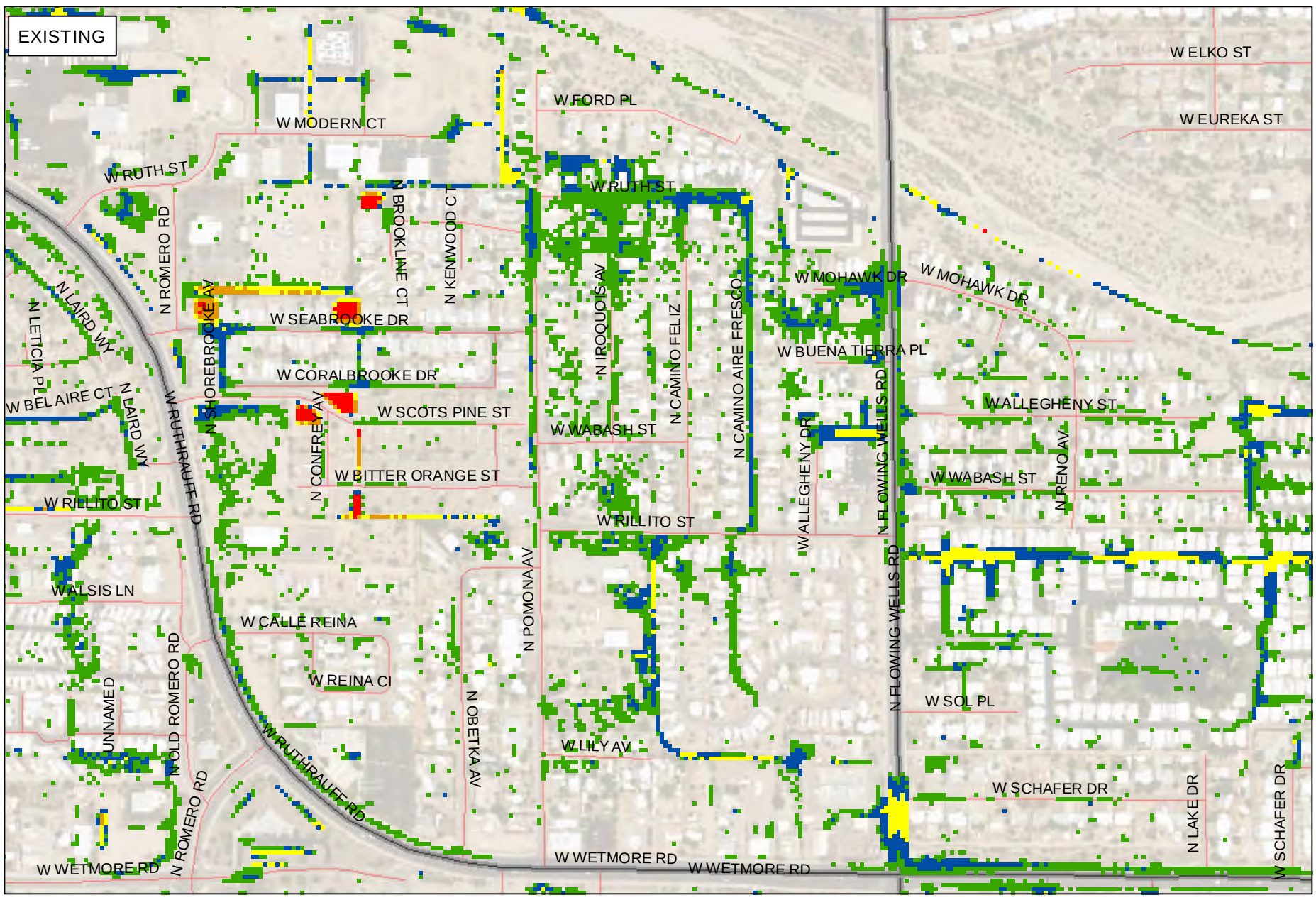
1 inch = 500 feet

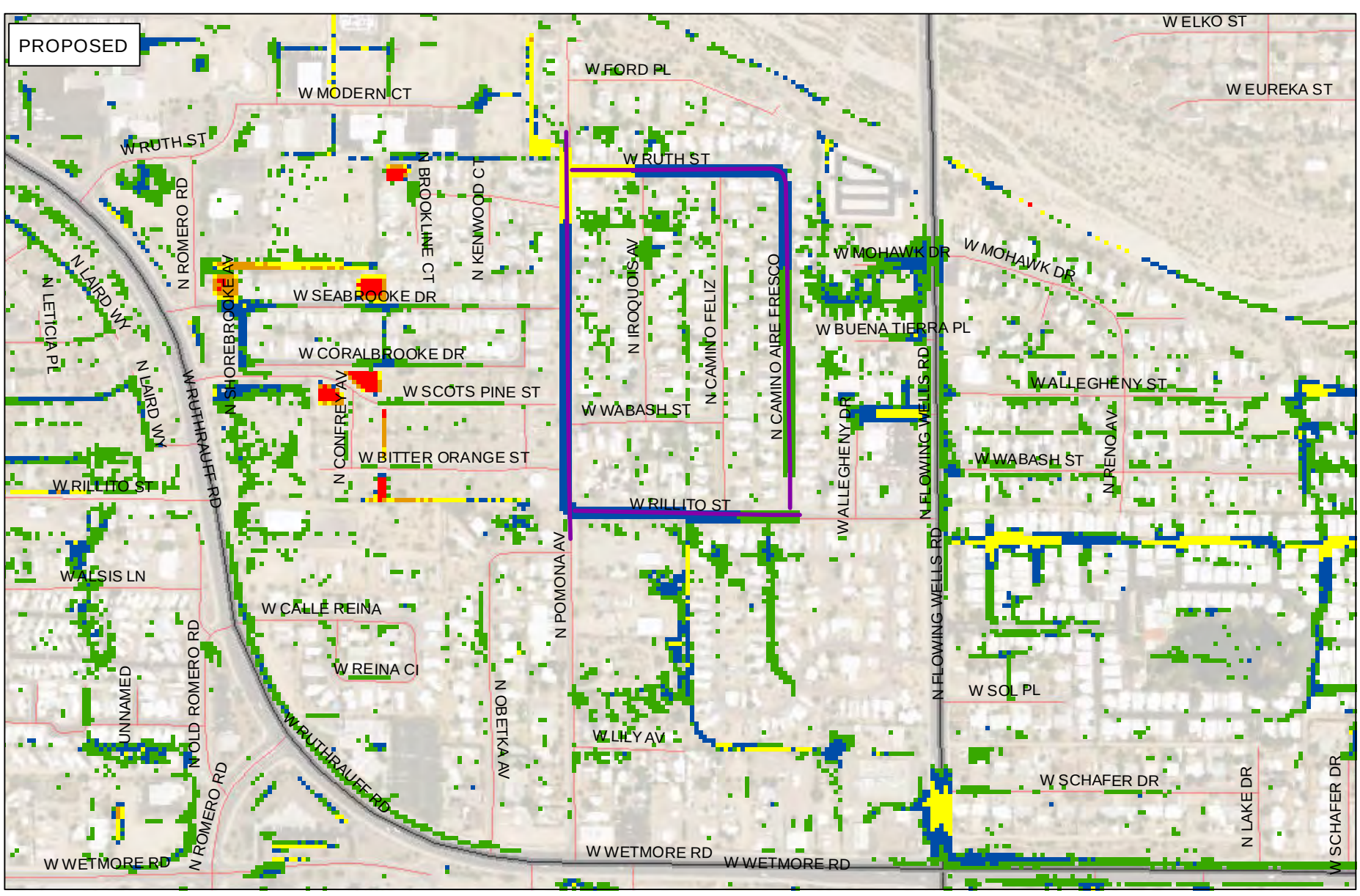
JE Fuller
40 E. Helen St.
Tucson, AZ 85705

Ex vs Prop - Area4-Alt3 - Q100
Date: 4/18/2016

Ruthrauff Basin Management Plan - Alternative 2 (3) **- Area 4 - Improved Roadways - 100-yr**

Exhibit 4-1AE





Legend

Major streets

Minor streets

Var

< 0.2 | 0.2 - 0.5 | 0.5 - 1.0 | 1.0 - 2.0 | 2.0 - 3.0 | > 3.0

N

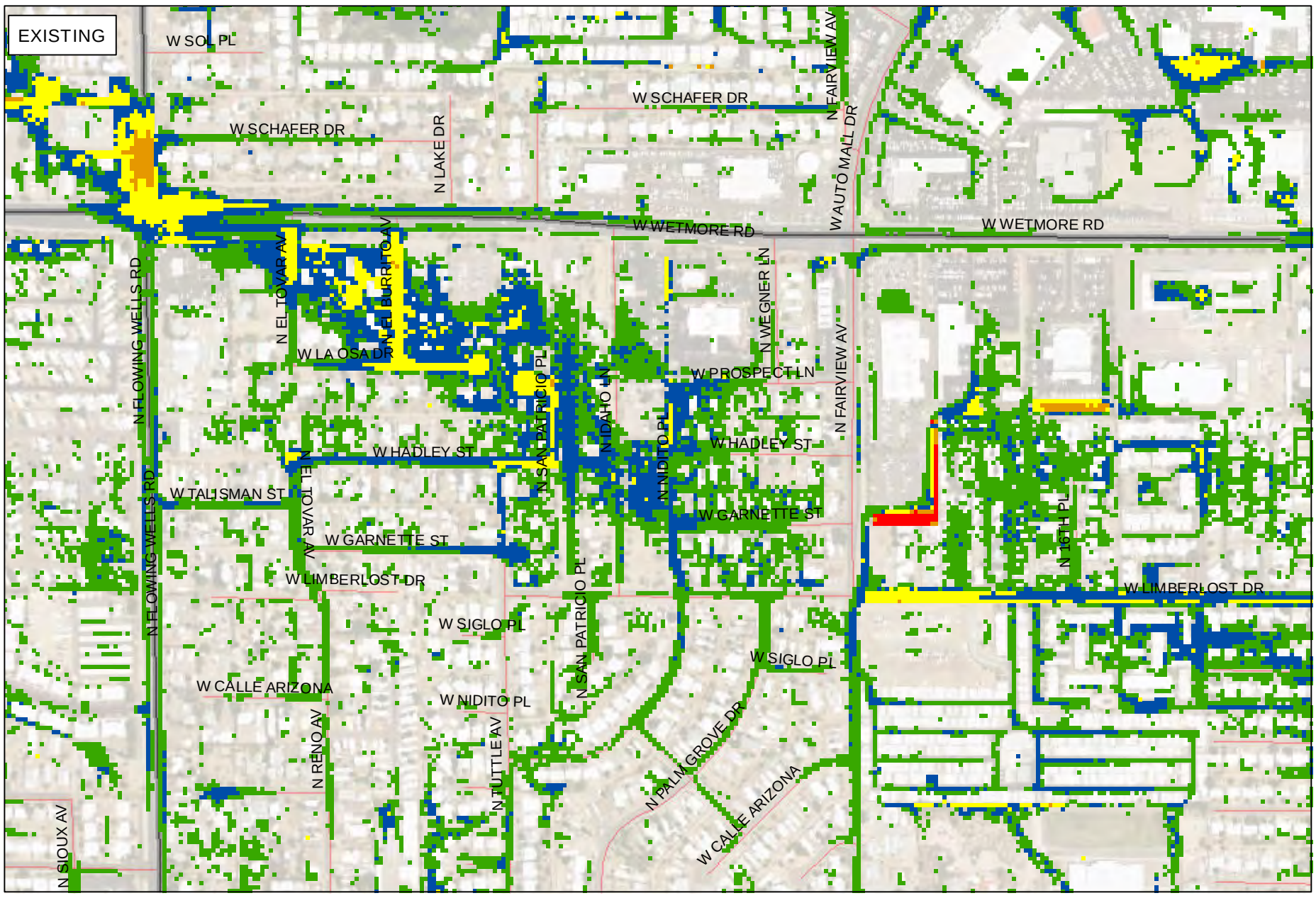
1 inch = 500 feet

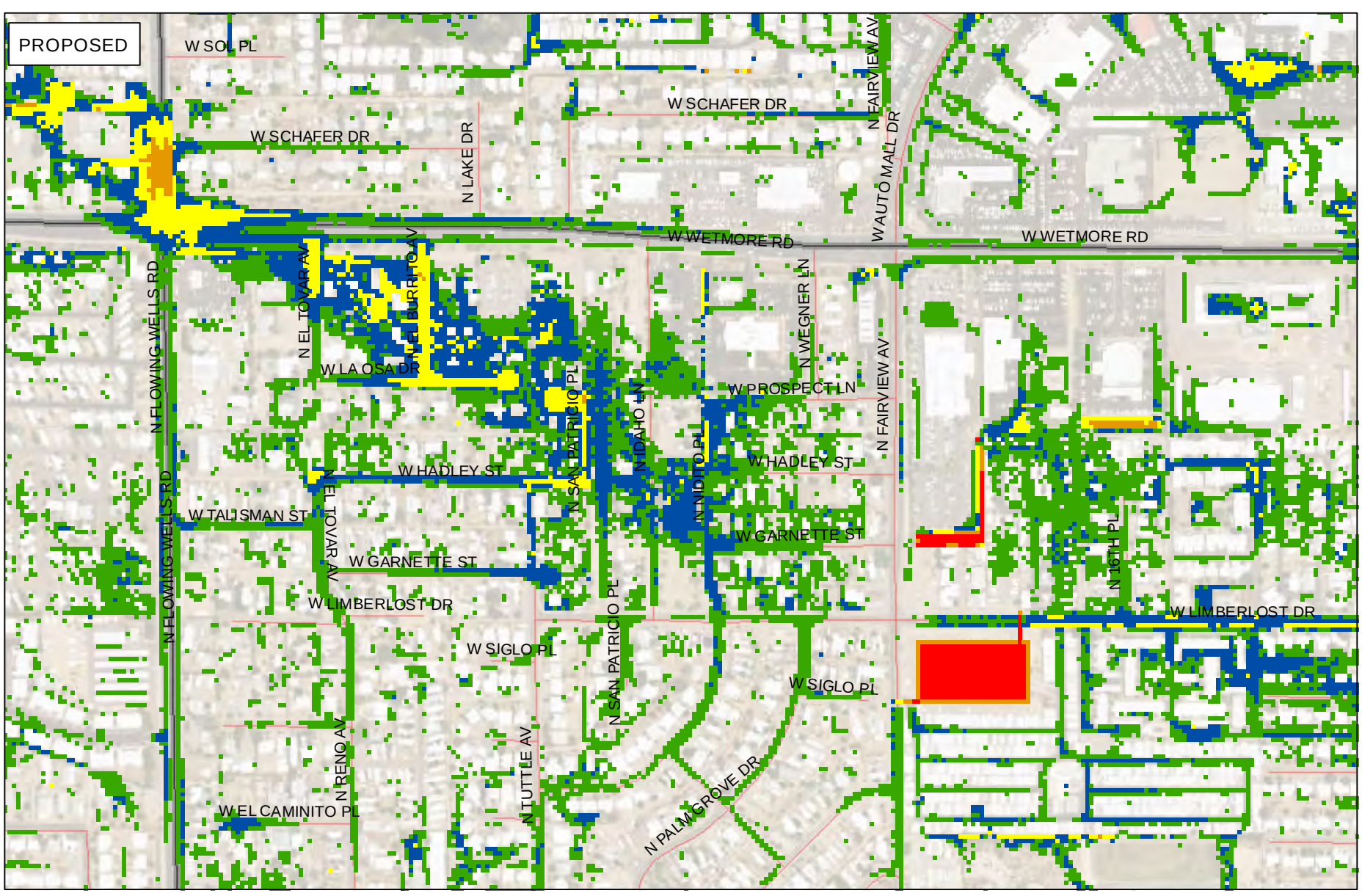
JE Fuller
40 E. Helen St.
Tucson, AZ 85705

Ex vs Prop - Area4-Alt3 - Q10
Date: 4/18/2016

Ruthrauff Basin Management Plan - Alternative 2 (3) **- Area 4 - Improved Roadways - 10-yr**

Exhibit 4-1AF





Legend

Major streets

Minor streets

Var

< 0.2 | 0.2 - 0.5 | 0.5 - 1.0 | 1.0 - 2.0 | 2.0 - 3.0 | > 3.0

N

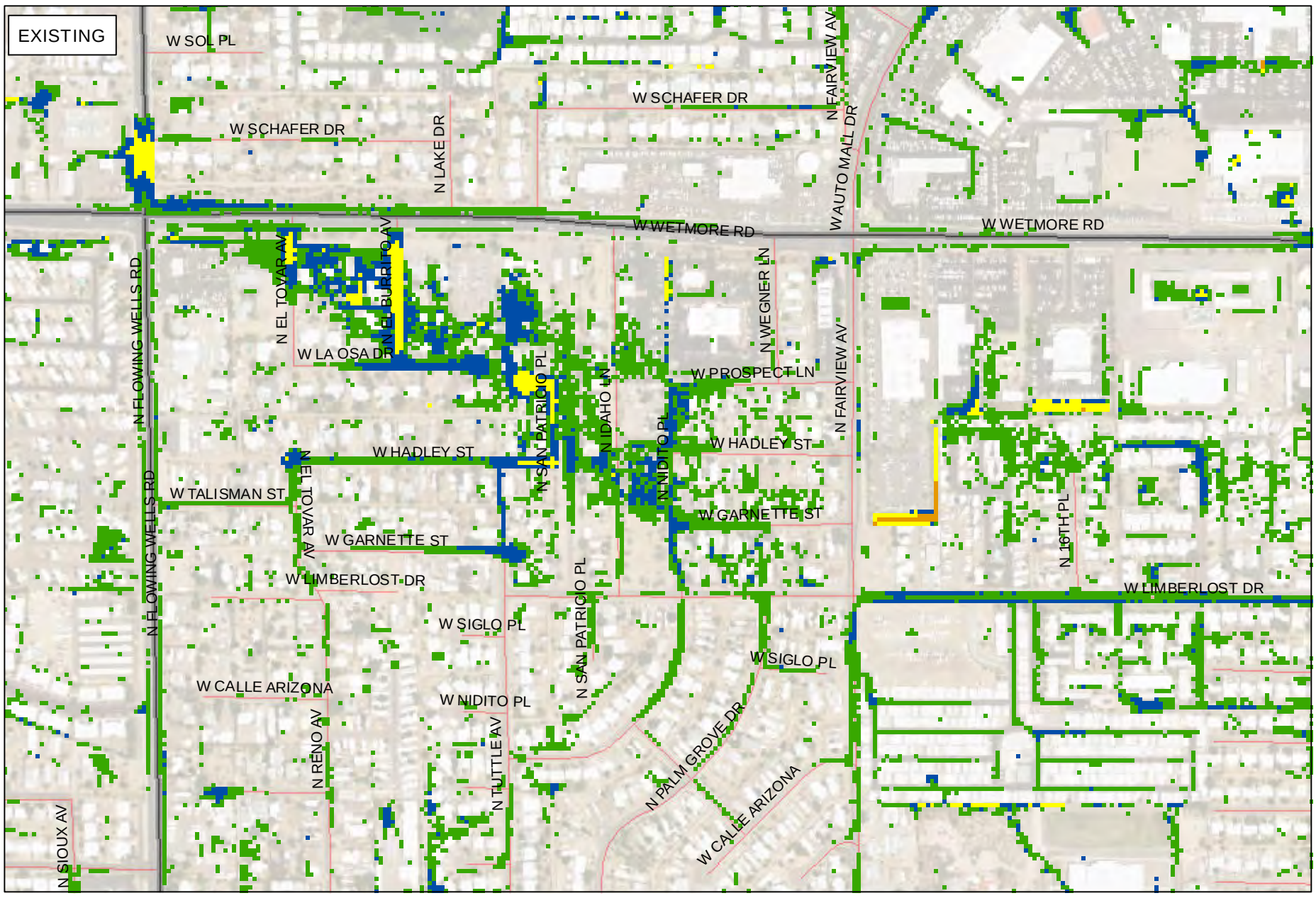
1 inch = 500 feet

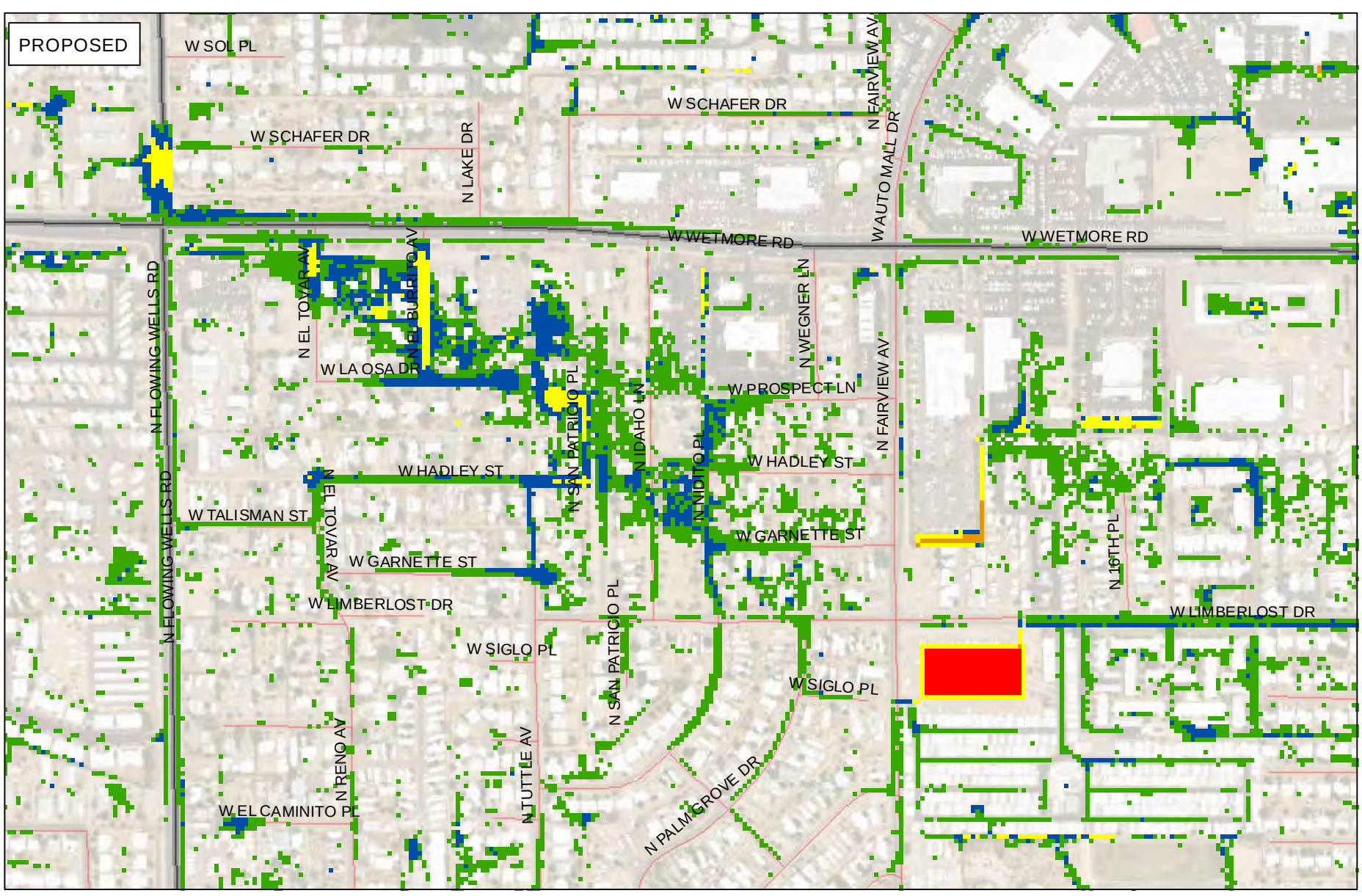
JE Fuller
40 E. Helen St.
Tucson, AZ 85705

Ex vs Prop - Area4-Alt4 - Q100
Date: 4/18/2016

Ruthrauff Basin Management Plan - Alternative 4 - Area 4 - Limberlost Basin - 100-yr

Exhibit 4-1AG





Legend

Major streets

Minor streets

Var

< 0.2 | 0.2 - 0.5 | 0.5 - 1.0 | 1.0 - 2.0 | 2.0 - 3.0 | > 3.0

N

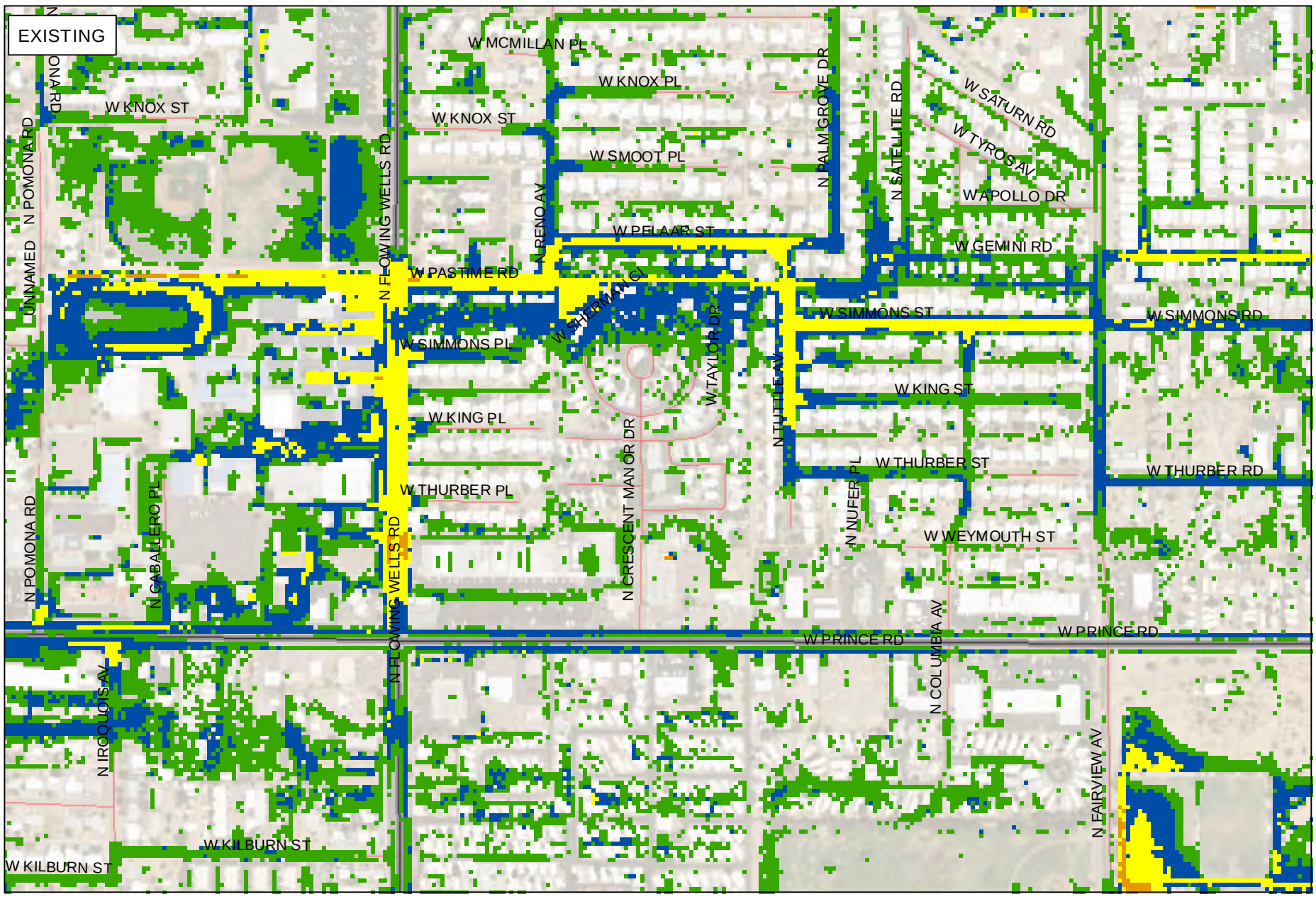
1 inch = 500 feet

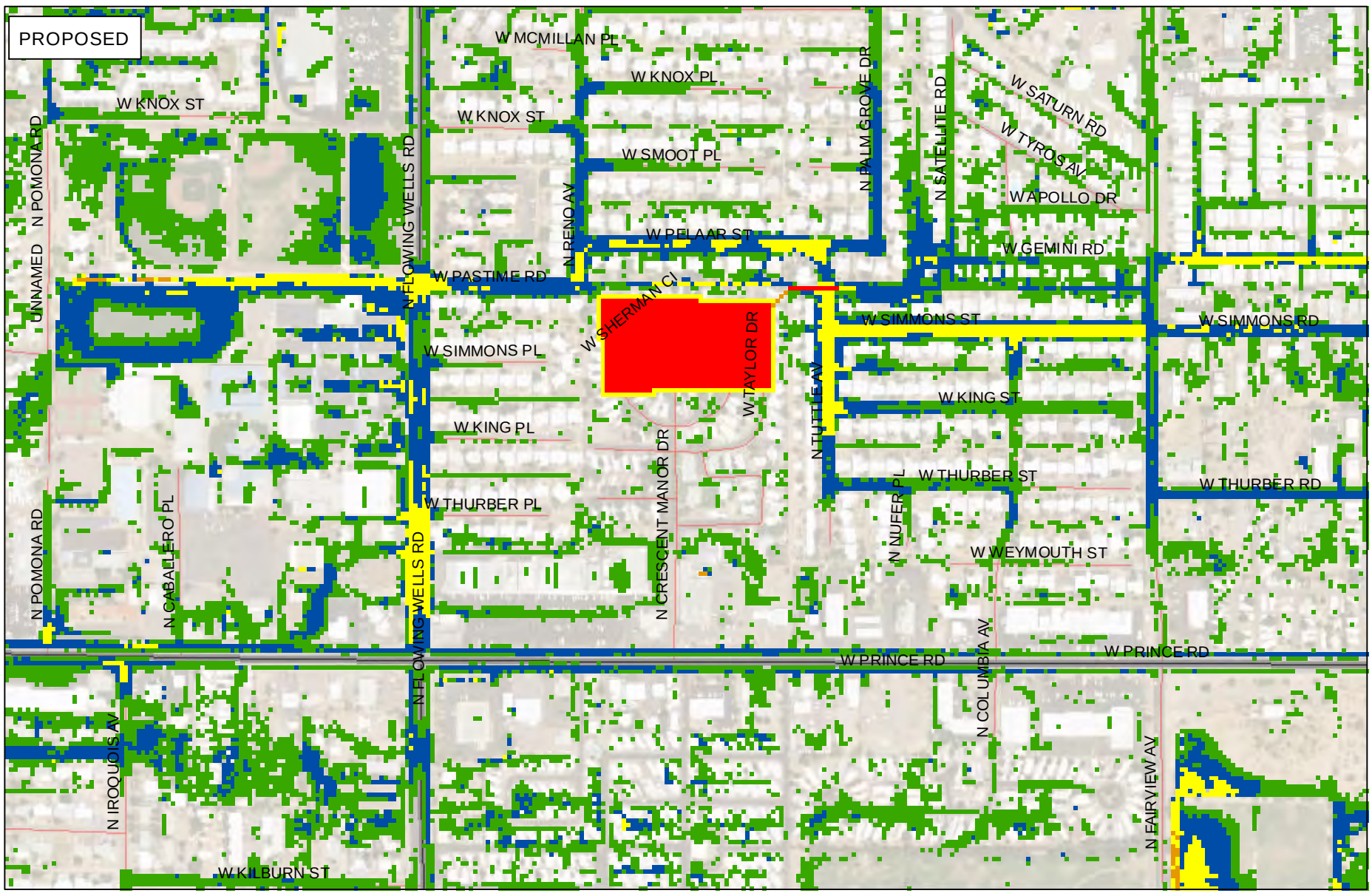
JE Fuller
40 E. Helen St.
Tucson, AZ 85705

Ex vs Prop - Area4-Alt4 - Q10
Date: 4/18/2016

Ruthrauff Basin Management Plan - Alternative 4 - Area 4 - Limberlost Basin - 10-yr

Exhibit 5-1AB





Legend

Major streets

Minor streets

Var

< 0.2 | 0.2 - 0.5 | 0.5 - 1.0 | 1.0 - 2.0 | 2.0 - 3.0 | > 3.0

N

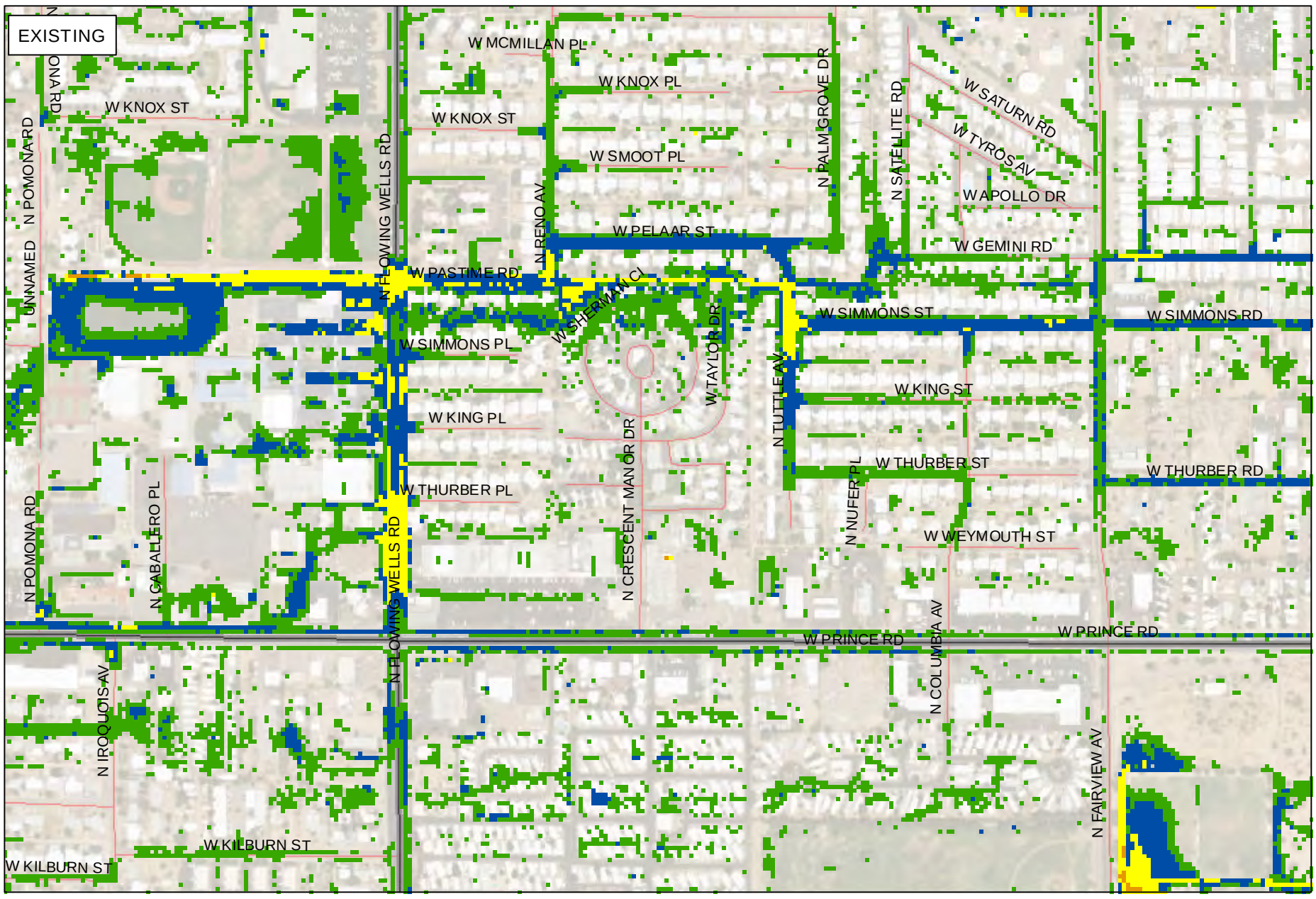
1 inch = 500 feet

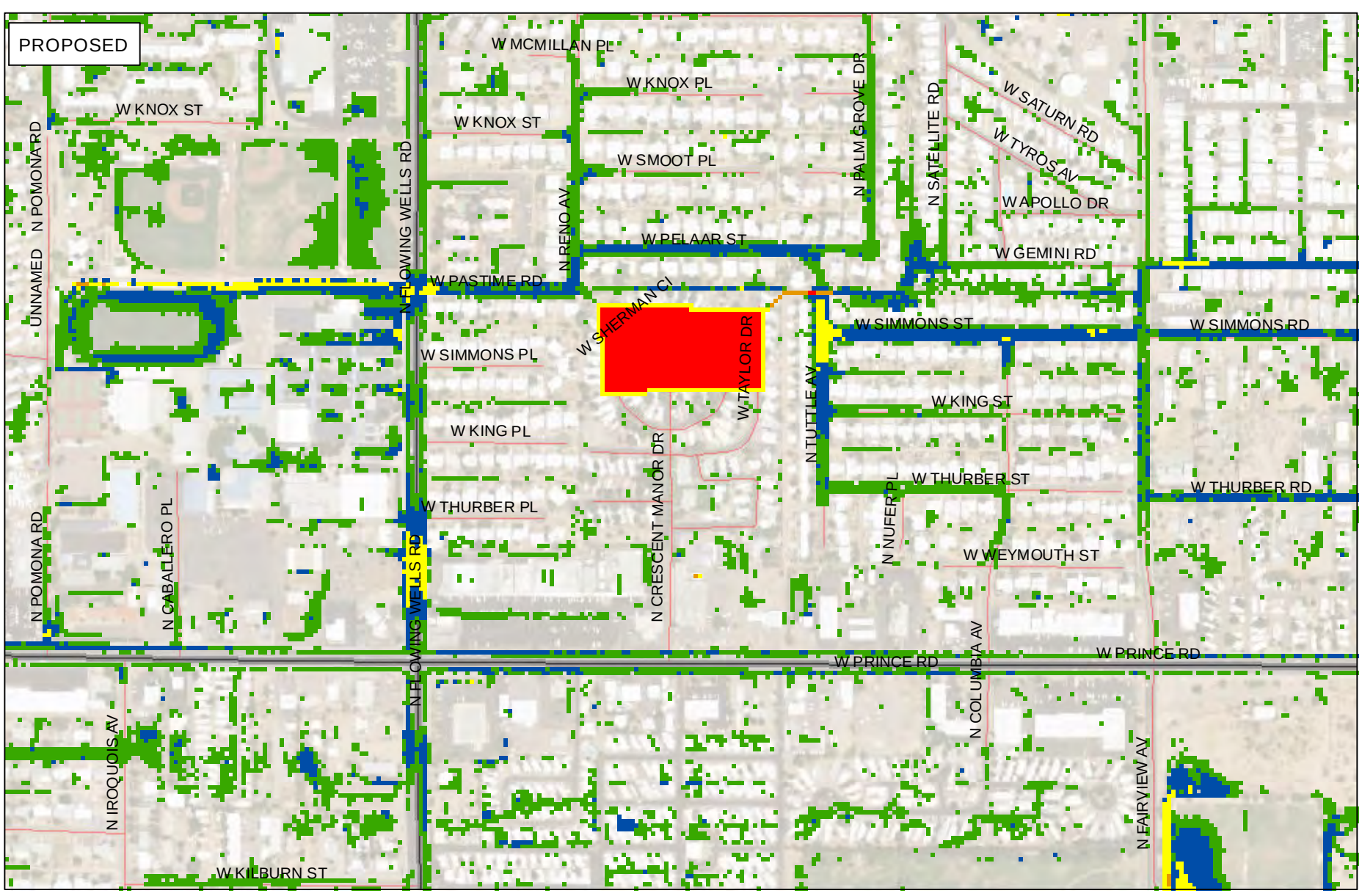
JE Fuller
40 E. Helen St.
Tucson, AZ 85705

Ex vs Prop - Area5-Alt1 - Q100
Date: 4/18/2016

Ruthrauff Basin Management Plan - Alternative 1 (2) **- Area 5 -** Pelaar St. Basin **Wells Basin - 100-yr**

Exhibit 5-1AC





Legend

Major streets

Minor streets

Var

< 0.2 | 0.2 - 0.5 | 0.5 - 1.0 | 1.0 - 2.0 | 2.0 - 3.0 | > 3.0

N

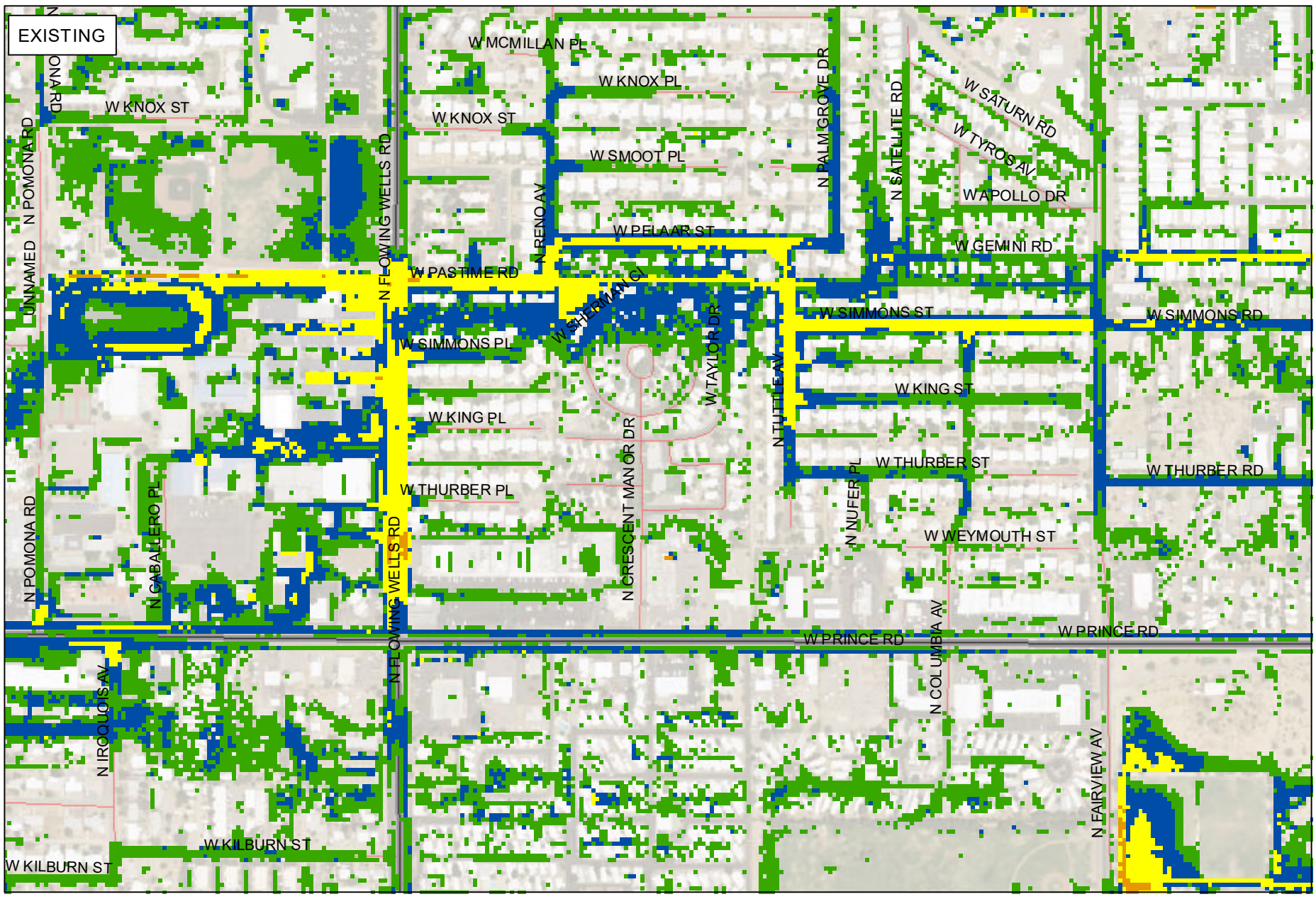
1 inch = 500 feet

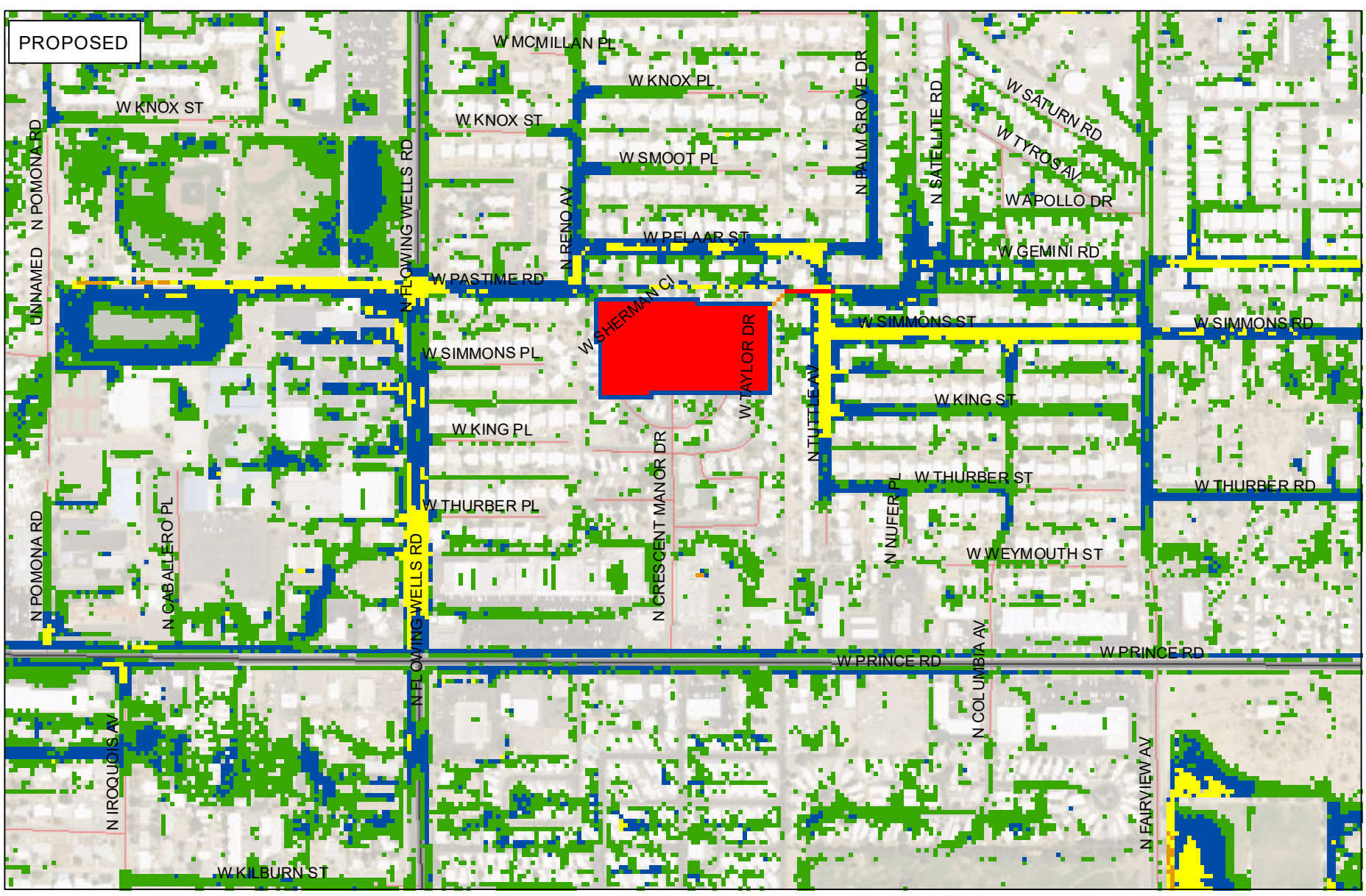
JE Fuller
40 E. Helen St.
Tucson, AZ 85705

Ex vs Prop - Area5-Alt1 - Q10
Date: 4/18/2016

Ruthrauff Basin Management Plan - Alternative 1 (2) **- Area 5 -** Pelaar St. **Basin - 10-yr**

Exhibit 5-1AD





Legend

Major streets

Minor streets

Var

< 0.2 | 0.2 - 0.5 | 0.5 - 1.0 | 1.0 - 2.0 | 2.0 - 3.0 | > 3.0

N

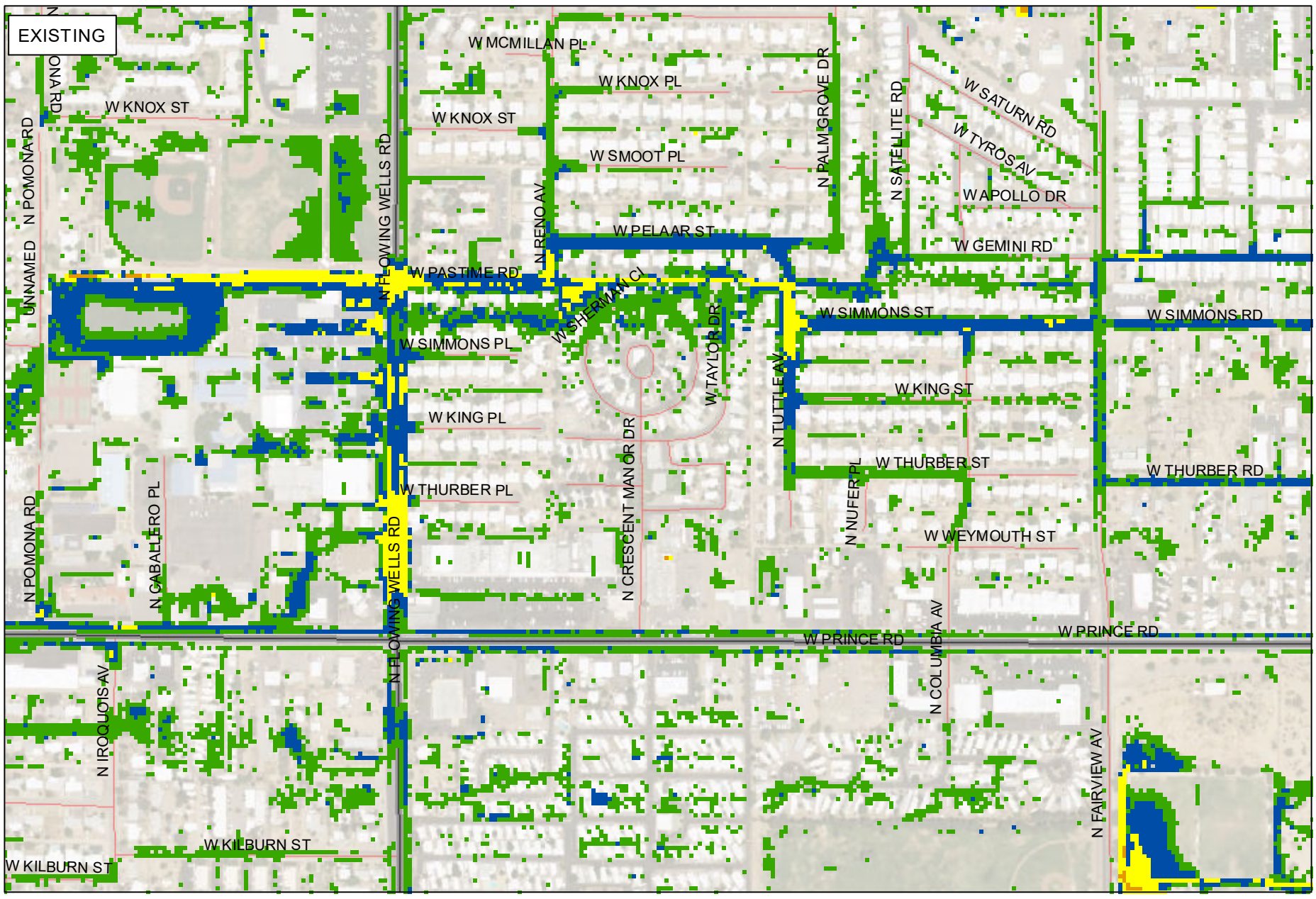
1 inch = 500 feet

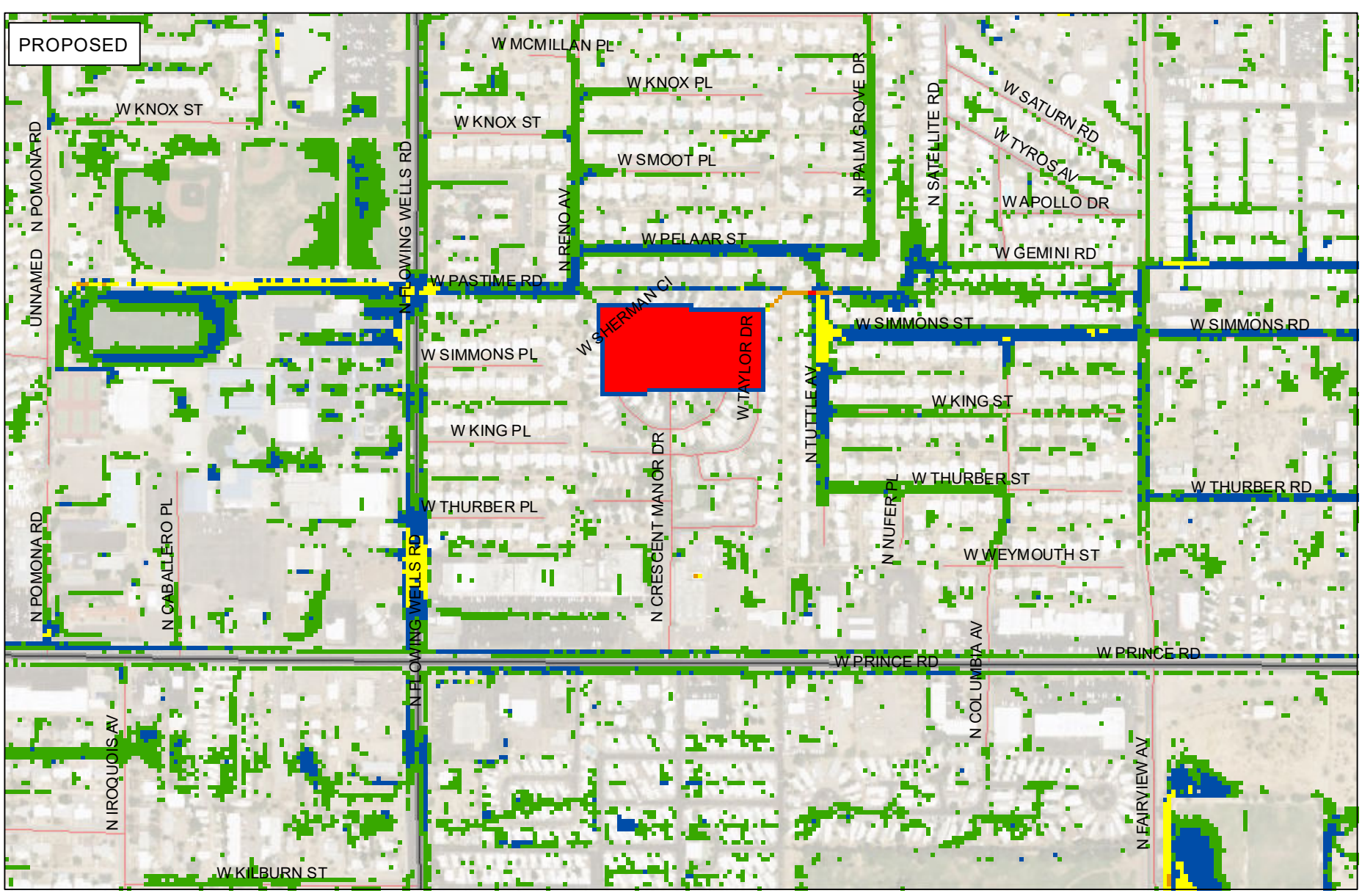
JE Fuller
40 E. Helen St.
Tucson, AZ 85705

Ex vs Prop - Area5-Alt1A - Q100
Date: 4/25/2016

Ruthrauff Basin Management Plan - Alternative 4 - Area 5 - Pelaar St. Basin with Dry Wells- 100-yr

Exhibit 5-1AE





Legend

Major streets

Minor streets

Var

< 0.2 | 0.2 - 0.5 | 0.5 - 1.0 | 1.0 - 2.0 | 2.0 - 3.0 | > 3.0

N

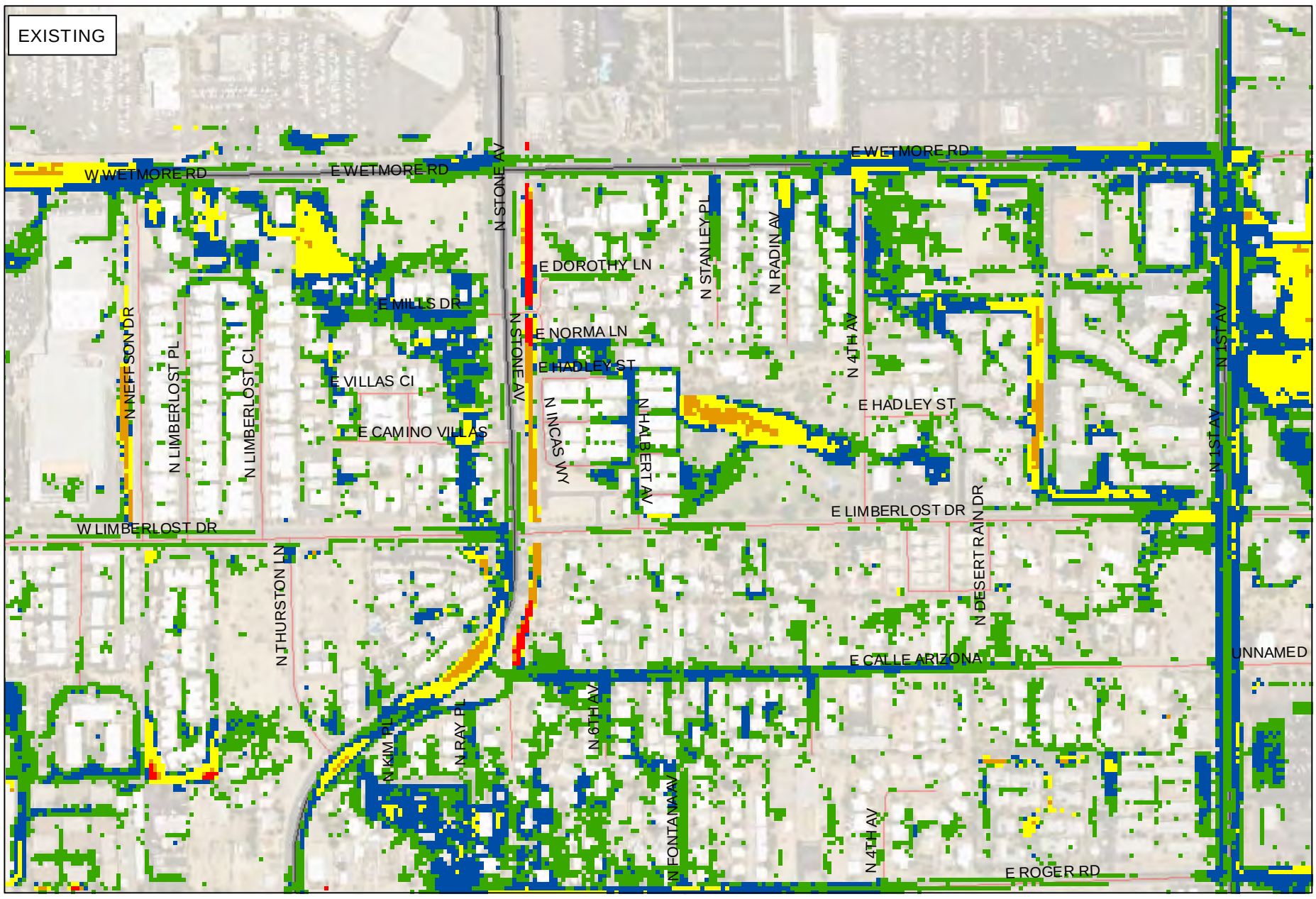
1 inch = 500 feet

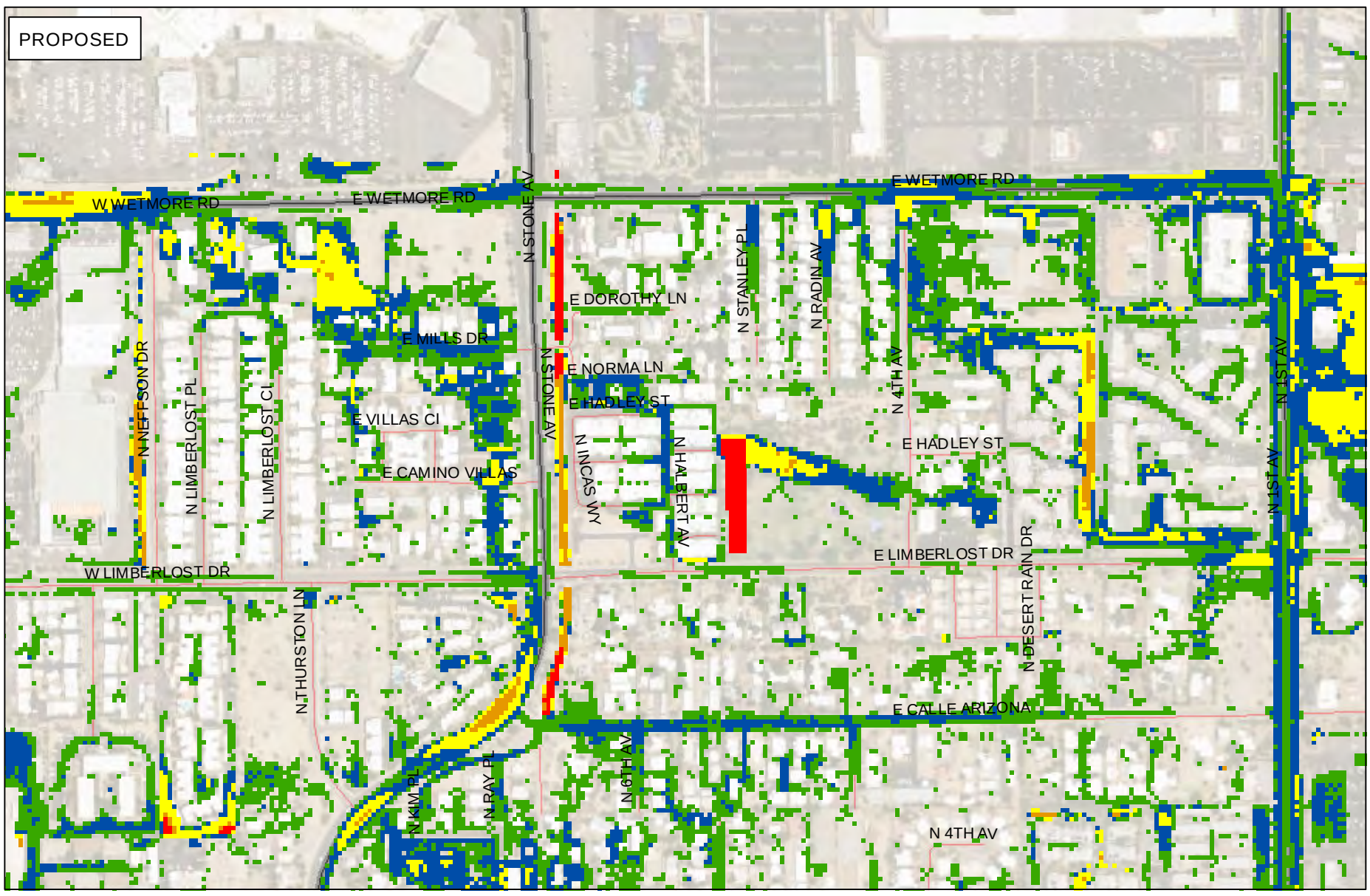
JE Fuller
40 E. Helen St.
Tucson, AZ 85705

Ex vs Prop - Area5-Alt1A - Q10
Date: 4/25/2016

Ruthrauff Basin Management Plan - Alternative 4 - Area 5 - Pelaar St.Basin with Dry Wells - 10-yr

Exhibit 7-1AB





Legend

Major streets

Minor streets

Var

< 0.2 | 0.2 - 0.5 | 0.5 - 1.0 | 1.0 - 2.0 | 2.0 - 3.0 | > 3.0

N

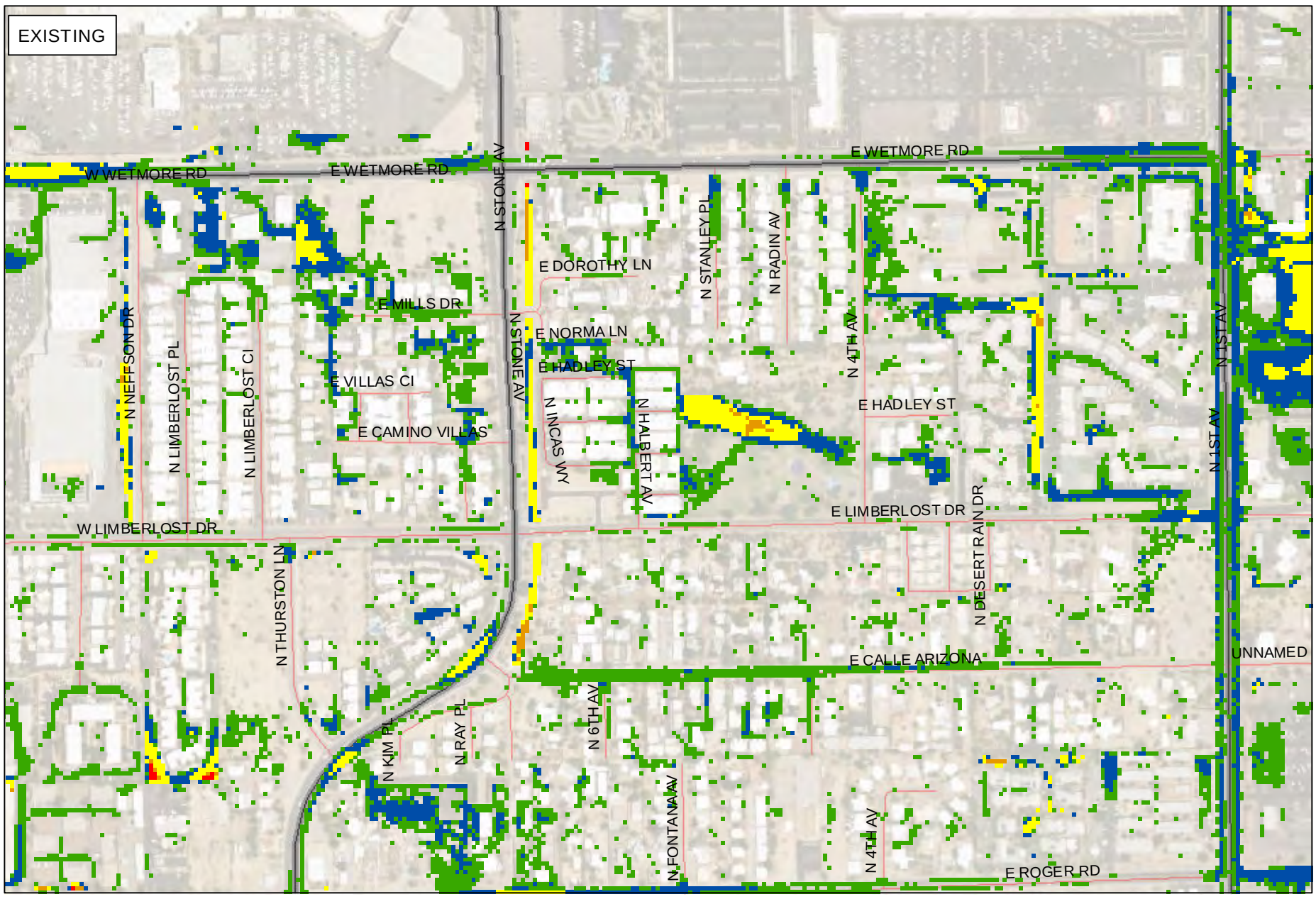
1 inch = 500 feet

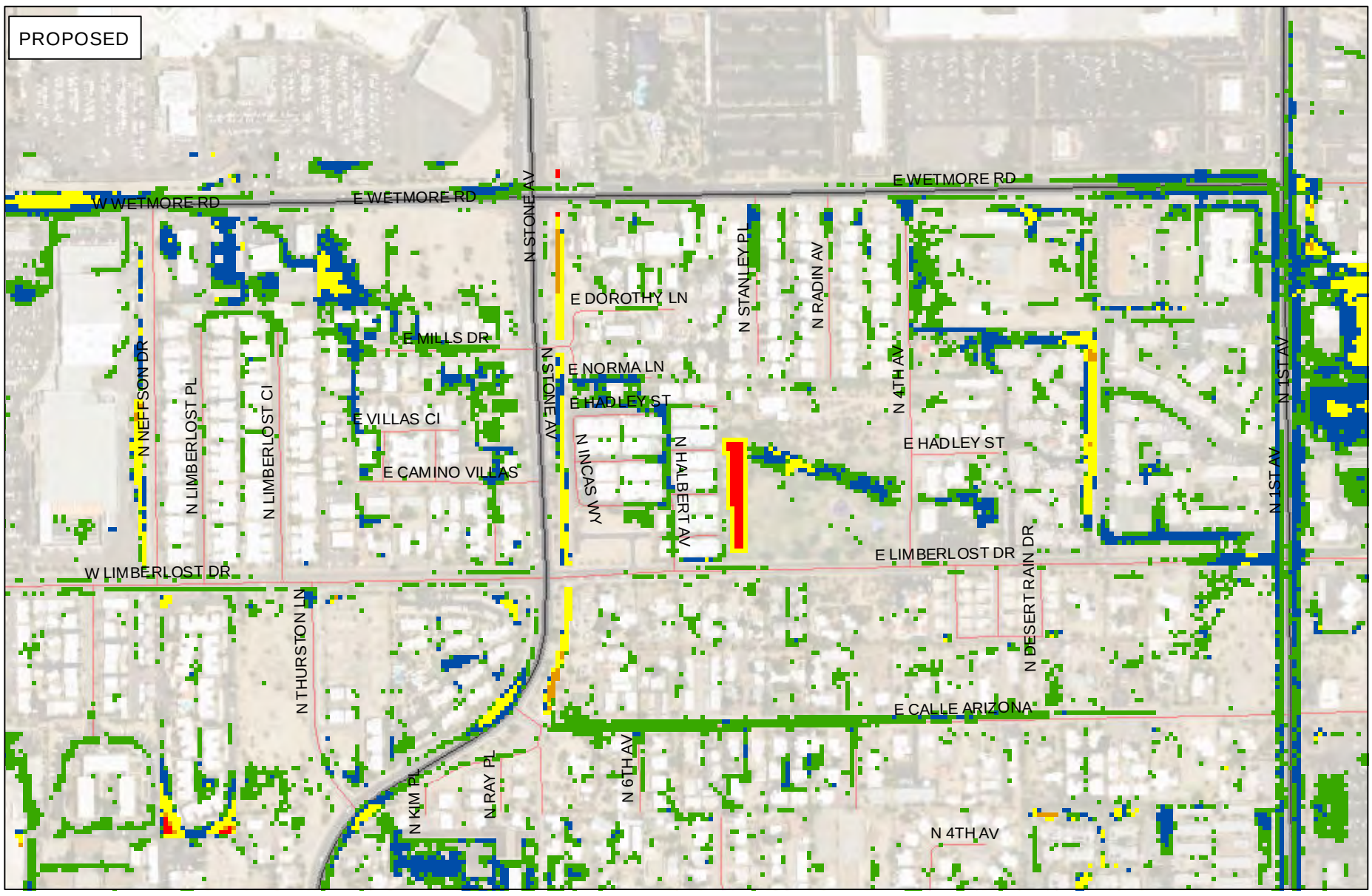
JE Fuller
40 E. Helen St.
Tucson, AZ 85705

Ex vs Prop - Area7-Alt3 - Q100
Date: 4/18/2016

Ruthrauff Basin Management Plan - Alternative 1 (3) **- Area 7 - Hummell Park Basin - 100-yr**

Exhibit 7-1AC





Legend

Major streets

Minor streets

Var

< 0.2 | 0.2 - 0.5 | 0.5 - 1.0 | 1.0 - 2.0 | 2.0 - 3.0 | > 3.0

N

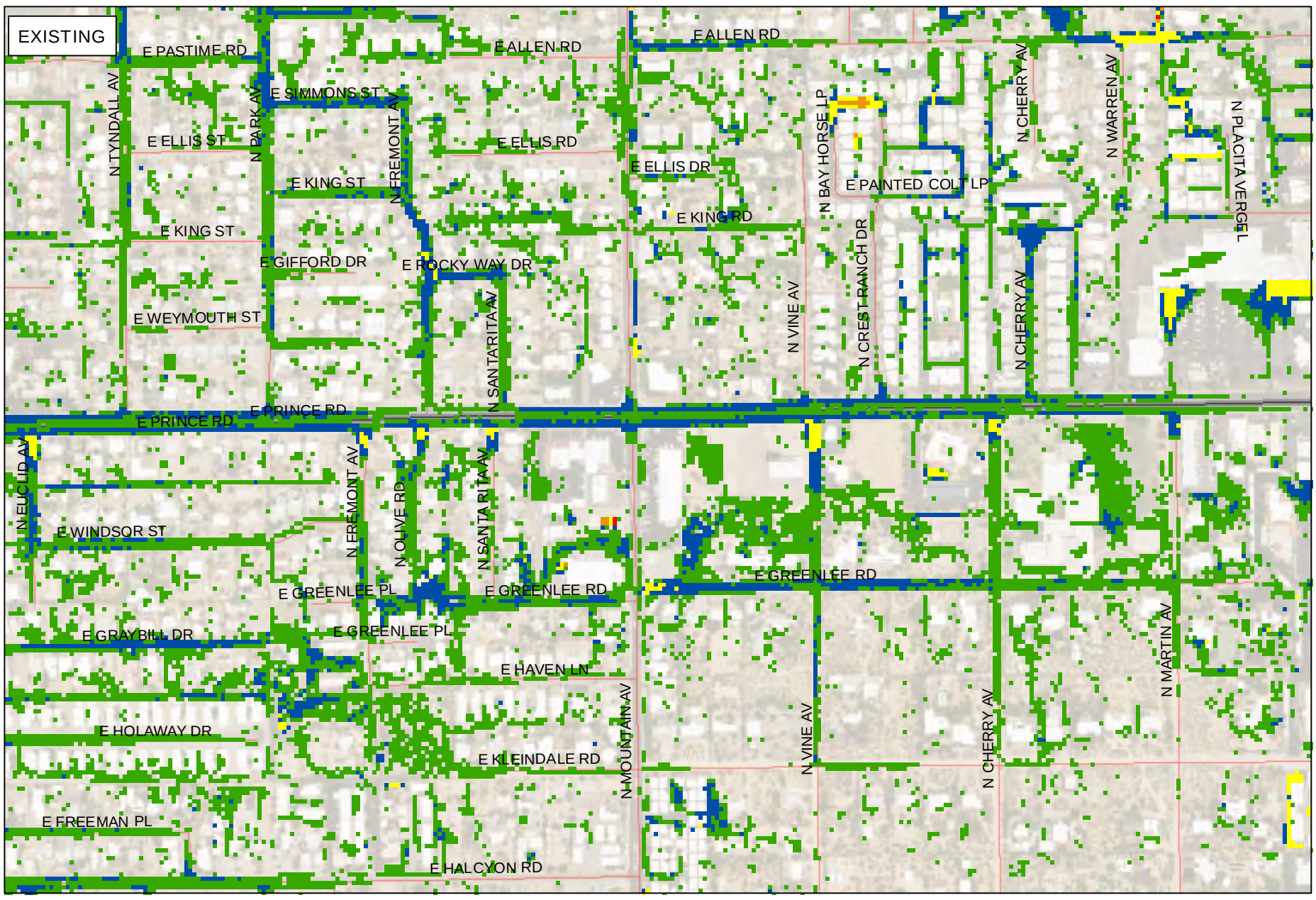
1 inch = 500 feet

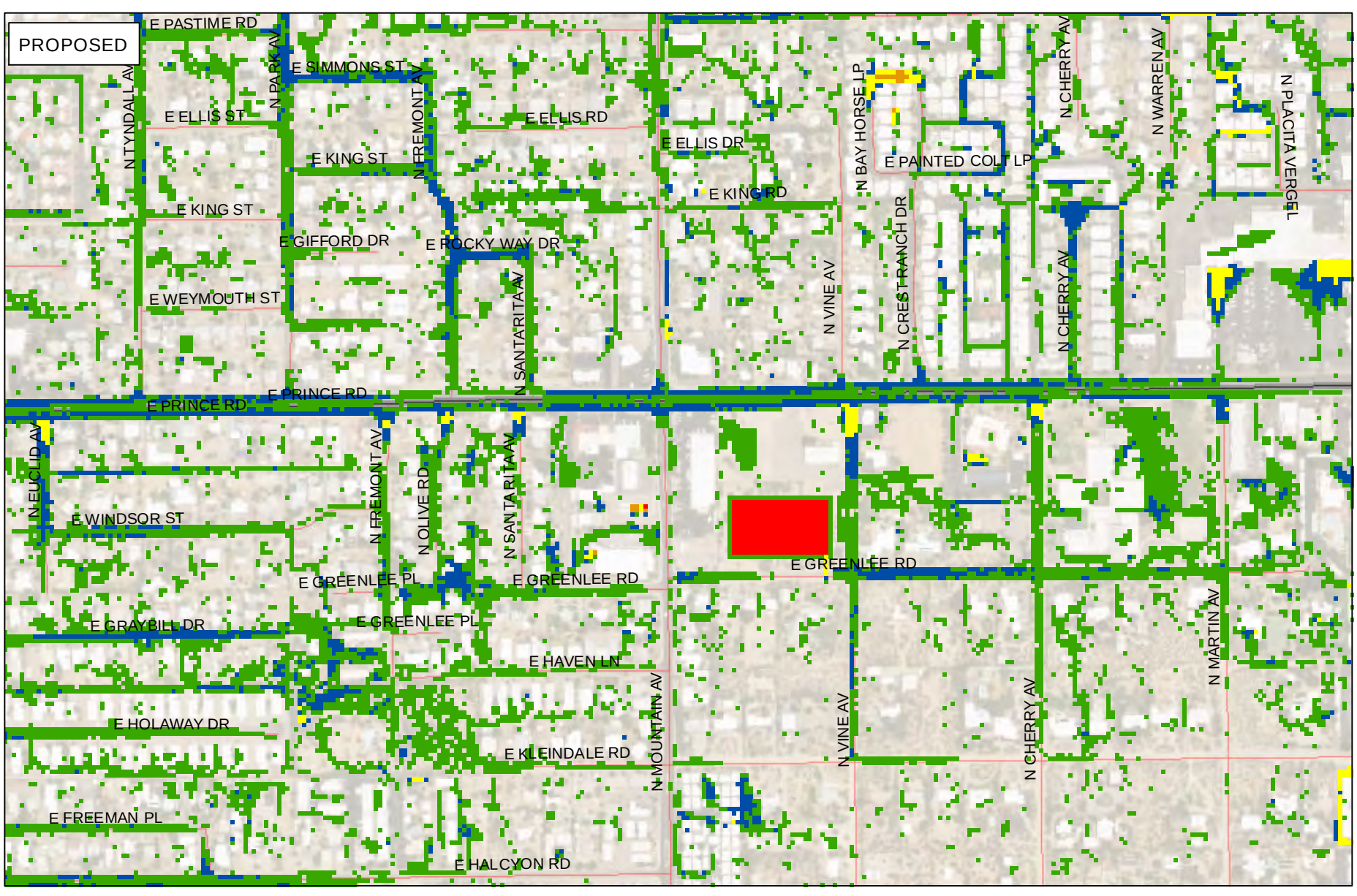
JE Fuller
40 E. Helen St.
Tucson, AZ 85705

Ex vs Prop - Area7-Alt3 - Q10
Date: 4/18/2016

Ruthrauff Basin Management Plan - Alternative 1 (3) - Area 7 - Hummell Park Basin - 10-yr

Exhibit 9-1AB





Legend

Major streets

Minor streets

Var

< 0.2 | 0.2 - 0.5 | 0.5 - 1.0 | 1.0 - 2.0 | 2.0 - 3.0 | > 3.0

N

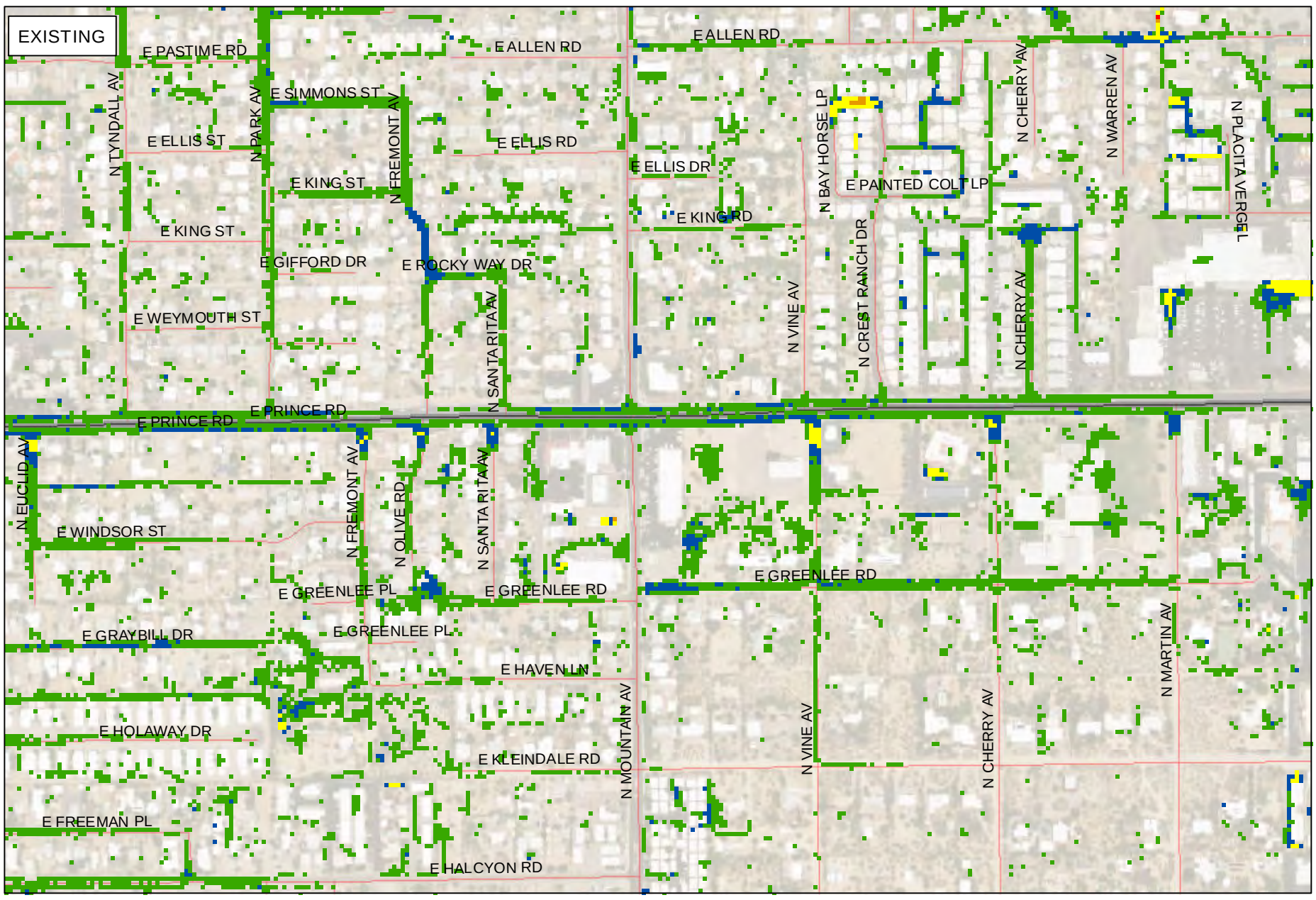
1 inch = 500 feet

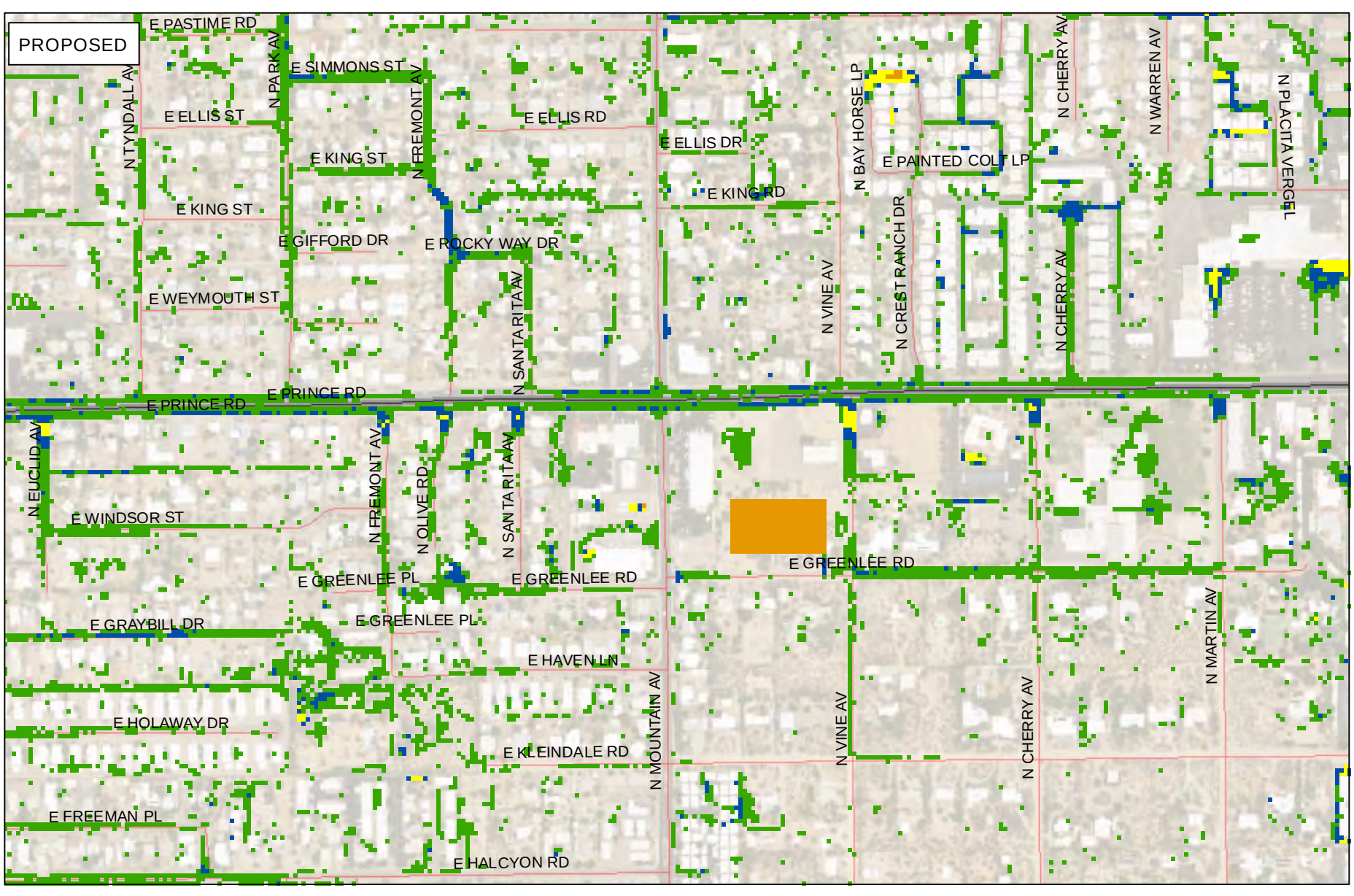
JE Fuller
40 E. Helen St.
Tucson, AZ 85705

Ex vs Prop - Area9-Alt1 - Q100
Date: 4/18/2016

Ruthrauff Basin Management Plan - Alternative 2 - Area 9 - Greenlee Basin - 100-yr

Exhibit 9-1AC





Legend

Major streets

Minor streets

Var

< 0.2	0.2 - 0.5	0.5 - 1.0	1.0 - 2.0	2.0 - 3.0	> 3.0

N

1 inch = 500 feet

JE Fuller
40 E. Helen St.
Tucson, AZ 85705

Ex vs Prop - Area9-Alt1 - Q10
Date: 4/18/2016

Ruthrauff Basin Management Plan - Alternative 2 - Area 9 - Greenlee Basin - 10-yr