A Comparative Evaluation of Floodplain Delineations for the Ona Mine Site, Hardee County, Florida

Prepared for

Charlotte County
and the
Peace River/Manasota Regional
Water Supply Authority

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by

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1.0 INTRODUCTION AND PURPOSE

Complete and accurate delineation of the floodplain is an essential part of the planning process that must precede any type of land alteration activity, including phosphate mining. Chapters 62C-16 and 40D-4 of the Florida Administrative Code require mining applicants to provide reasonable assurances that proposed mining activities will not result in adverse water quantity impacts. Net loss of historic floodplain storage is one type of adverse water quantity impact. The Environmental Resource Permit (ERP) Basis of Review adopted by the FDEP by reference states that no net encroachment into the floodplain, up to that encompassed by the 100-year event, will be allowed unless equivalent compensating storage is provided between the seasonal high water level and the 100-year flood level.

The proposed Ona Mine encompasses segments of Horse Creek, Brushy Creek, Brady Creek, Oak Creek, Hickory Creek, as well as their numerous tributaries. Although no encroachment into the 100-year floodplain of Horse Creek is proposed by IMC at this time, the proposed mining activities would substantially encroach on the floodplains of Brushy, Brady, Oak, and Hickory Creeks.

This paper provides an evaluation of the pre-mining floodplain delineations prepared by IMC and its consultants for the site of the proposed 20,500-acre Ona Mine in Hardee County, Florida, and submitted to the FDEP. A comparison of IMC's floodplain mapping is made to more recent delineations prepared by SDI Environmental Services, Inc. based on Ardaman and Associates' recent CHAN modeling and SDI's revised CHAN modeling.

The original floodplain delineations presented in this report are preliminary in nature, and were prepared for the sole purpose of evaluating the completeness and accuracy of the previous floodplain delineations prepared by IMC and its consultants. The delineations are not intended for any other use.

2.0 PAST FLOODPLAIN STUDIES

This section summarizes the history of floodplain evaluation efforts conducted in connection with the Ona Mine Site to date.

2.1 DAMES AND MOORE, 1993

In March of 1993, Joe Ruperto and Dan Vickstrom of Dames and Moore prepared a Technical Memorandum titled "Agrico New Mine Development Preliminary Floodplain Analysis". The objective of this study was to delineate the approximate limits of the 25-year and 100-year floodplain within a study area that included most of what is now known as the IMC Ona Mine site. The study used a limited number of cross sections and approximate calculation methods to delineate the floodplains for preliminary planning purposes. The results of that study are presented as Figure 1.

2.2 ARDAMAN AND ASSOCIATES, 1998

The October 29, 1998 report prepared by Herbert G. Stangland, Jr. and David A. Deloach of Ardaman and Associates, titled "Flood Evaluations for IMC-Agrico Company Ona Mine Tract, Hardee County, Florida", served as the basis for floodplain delineations on the Ona Mine Site for the Development of Regional Impact (DRI) application. The Ardaman report utilized detailed study methods, employing the HEC-RAS and CHAN software to determine mean annual, 25-, and 100-year flood elevations.

Mapping of the floodplain limits, based on the computed flood elevations, was subsequently prepared by Ardaman and Associates and submitted to IMC-Agrico in the form of three oversize maps dated January 18, 1999, and signed by Herbert Stangland, Jr. To date, full copies of original signed maps have not been made available for SDI's review. Requests for this information have yielded only 8 ½" x 11" copies of the title blocks of the maps, along with some electronic GIS shape files that appear similar to IMC's floodplain delineations as described in the following subsection.

2.3 IMC, 2000-2002

IMC's April 2000 Consolidated Development Application (CDA) contained a map of the mean annual, 25-year, and 100-year floodplain limits (CDA Map C-3). The map shown in Figure 2 was prepared by IMC, signed by Ted Smith, and cites the 1998 Ardaman report

as the source of the flood elevations. Along Horse Creek and Brushy Creek, the map appears to agree reasonably well with the 1993 Dames and Moore mapping. However, the floodplains of Hickory Creek and Oak Creek north of S.R. 64 that appeared on the 1993 mapping are completely missing from the April 2000 map (see Figure 2). Furthermore, the IMC map appears to be inconsistent with the CHAN model results presented in the Ardaman report. As described in the next section, the floodplains of Brady Creek, Hickory Creek, and Oak Creek north of S.R. 64 were omitted on IMC's map even though the CHAN output included flood elevations in these areas.

In the first request for additional information, IMC was asked to amend Map C-3 to show the floodplains of Oak and Hickory Creek (RAI #10). IMC responded that they had previously reached an agreement with the agency workgroup that only the floodplains of 3rd order and higher streams and tributaries would be mapped, and that Hickory Creek and Oak Creek north of S.R. 64 are both 2nd order streams. While it is true that Hickory Creek is a second order stream on the Ona property, Oak Creek is a 3rd order stream north of S.R. 64, as illustrated in Figure 3, an undated map prepared by Ardaman and Associates, Inc. Therefore, this map contradicts IMC's statement regarding the order status of Oak Creek north of S.R. 64.

In the CDA and subsequent RAI's, IMC failed to submit calculations quantifying the volume of encroachment into the mean annual, 25- or 100-year floodplains, either during mining or after reclamation, or quantify any compensating storage as required by the ERP basis of review.

2.4 ARDAMAN AND ASSOCIATES, 2003

In September of 2003, Ardaman and Associates submitted CHAN model input and output in support of a revised comparison of pre-mining and post-reclamation peak discharge rates and flood elevations. The CHAN model setup for Brushy, Brady, Oak and Hickory Creeks, and resulting flood elevations, are very similar to those contained in the 1998 Ardaman report. SDI mapped the 2003 Ardaman and Associates 25-year flood elevations in Brushy, Brady, Oak and Hickory Creeks, as described in the next section.

3.0 EVALUATION METHODOLOGY

In order to provide an evaluation of the completeness and accuracy of the floodplain mapping prepared in support of the Ona Mine permits, it was necessary to evaluate the following:

1. The storm event modeling used to compute the flood elevations,
2. The order status of streams on the Ona property, and
3. The mapping of the limits of inundation that would result from the computed flood elevations.

Because of the incised nature of the Horse Creek floodplain through the Ona Property, and because IMC does not propose to mine within the 100-year floodplain of Horse Creek, this evaluation was limited to the floodplains of Brushy, Brady, Oak, and Hickory Creeks. IMC relied upon the CHAN computer model prepared by Ardaman and Associates for the floodplain mapping in these basins.

3.1 STORM EVENT MODELING

SDI has reviewed the CHAN model set-up for the areas in question and found that in general, the level of detail in the CHAN model appears to be adequate for this type of analysis. Although the model source code was not available for review, the modeling techniques and input parameters appear to be generally consistent with accepted water resources engineering methods commonly used in south and west-central Florida. However, a notable exception to this is the use of the weir equation to represent certain stream channel segments. For example, in the Oak Creek system, most of the stream segments north of S.R. 64 were modeled as weirs. This approach ignores the hydraulic losses due to friction associated with the roughness of stream beds and floodplains, and therefore generally gives lower flood elevations than would result from modeling the segments as open channels. There are at least five stream segments in the model of Upper Oak Creek that suffer from this mischaracterization. Another problem that was identified was a connectivity error resulting from an improper node type specification within one of the eastern tributaries of Brushy Creek, which resulted in flow from that tributary being “lost” from the simulation.

3.2 STREAM ORDER STATUS

Approximate stream alignments were delineated on 1"=1,000' scale plots of the pre-mining one-foot topographic contour mapping, as provided by IMC in the form of GIS shape files. In addition to the one-foot topography, other sources of information regarding stream channel alignment that were reviewed included GIS coverages of detailed hydrography from the USGS and the SWFWMD, the SCS/NRCS soil survey for Hardee County, IMC's most recent high-resolution aerial photography of the site, and personal field observations. Stream order status was assigned to each stream segment based on the standard convention that a second order stream begins at the confluence of two first order streams, a third order stream begins at the confluence of two second order streams, and so on. No attempt was made to map every first order tributary, only those necessary for establishing the order status for higher order streams. Figure 4 illustrates the SDI stream alignments and stream orders on the Ona Mine site. In many areas, the SDI stream order designations agree with the Ardaman designations. However, the Ardaman map omits several important first and second order streams. This results in incorrect order status designations for some of the third order streams, including the segment of Upper Oak Creek north of S.R. 64 that falls roughly within Section 20. This third order segment is represented as a second order stream on the Ardaman and Associates map. Another notable discrepancy is the third order tributary to Brushy Creek that lies within Section 26, which is also represented as a second order stream on the Ardaman map.

3.3 FLOODPLAIN MAPPING

After correcting the connectivity problem described in subsection 3.1, the CHAN model prepared by Ardaman and Associates was executed by SDI for the 25-year storm event. The peak stages within Brushy Creek were generally within one tenth of one foot, when compared to results from the uncorrected model. Using the computed flood elevations from the corrected CHAN model, floodplain limits were hand-delineated on 1"=1,000' scale plots of the pre-mining one-foot topographic contour mapping. These work maps also contained the pre-mining CHAN subbasins and the SDI stream channel alignments, for reference. The 25-year floodplain was delineated at each CHAN model node location. In accordance with standard engineering practice, flood elevations were interpolated between contours and along stream segments connecting adjacent nodes. The floodplain limits were then digitized in AutoCAD and converted into a GIS shape file.

The results of this mapping effort are shown on Figure 5. By comparing this figure with the IMC map submitted to the FDEP (Figure 2), it is apparent that IMC's map is inconsistent with the results of the model it cites as the source of the flood elevations; and therefore it mischaracterizes the true extent of the 25-year floodplain. The floodplains of Brady Creek, Hickory Creek, and Oak Creek north of S.R. 64 were omitted on IMC's map even though the CHAN output included flood elevations along all of these creeks.

Figure 5 under-represents the full width of the Oak Creek floodplain, because as described in Section 3.1, the CHAN model prepared by Ardaman and Associates contains improper representations of several stream channels in Upper Oak Creek. In order to characterize the magnitude of the errors associated with representing the Oak Creek stream segments as weirs, one of the reaches in question for which a recently surveyed cross section was available was converted into a channel reach. This correction resulted in an increase in 25-year flood stage of approximately 1.4 feet, at the upstream end of the reach. As illustrated graphically in Figure 6, the revised flood stage at this location resulted in a significant increase in the horizontal extents of the floodplain.

Using the revised model with the two changes previously described, the floodplain mapping procedure was repeated for the mean annual and 100-year storm events. For display and comparison purposes, the floodplains of first and second order tributaries were assigned to separate shape files based on SDI's stream order delineations. It should be noted that the floodplains of some of the 3rd order streams encompass portions of the alignments of 2nd order tributaries. In these cases, the floodplains were assigned to the higher order streams.

In order to provide "apples to apples" comparisons to IMC's floodplain delineations, it was necessary to compare only the portions of the floodplains attributable to 3rd order and higher-order streams. This is because an agreement with the agency workgroup (according to IMC in the first RAI response) apparently allowed IMC to limit their mapping effort to 3rd order and higher-order streams. However, because the headwaters of Brady Creek accept flood discharges from Brushy Creek, and Brady Creek flows back into Brushy Creek downstream, the floodplain of Brady Creek is an integral part of the floodplain of Brushy Creek (a fourth order stream). By similar logic, all of the interconnections between the Oak Creek and Brushy Creek floodplains are also attributable to their respective 3rd and 4th order streams. These interconnections cannot be severed without impacting the primary conveyance systems.

4.0 RESULTS

Figure 7 contains the results of the mean annual, 25-year, and 100-year floodplain mapping prepared by SDI. From the Figure, numerous interconnections of the floodplains of Brushy, Oak, and Brady Creek are apparent. It should be noted that because at least four of the stream segments of upper Oak Creek remain modeled as weirs in the revised model, it is highly likely that the map still under-represents the full extent of the floodplain of Upper Oak Creek.

Figures 8, 9, and 10 compare IMC's floodplain delineations to SDI's revised mapping for the mean annual, 25-year, and 100-year events, respectively. From these comparisons, it is apparent that large expanses of the floodplains were omitted on IMC's maps, even by their own criteria of only including the floodplains of 3rd and 4th order streams. Table 1 compares the areas of the Ona Mine site within the mean annual, 25-year, and 100-year floodplains based on SDI's delineations, with those calculated from IMC's delineations.

Table 1. Comparison of Ona Mine Site Floodplain Areas.

Storm Event	Floodplain Areas of Brushy, Brady and Oak Creeks Within the Ona Mine Boundary (acres)		
	IMC	SDI (3rd and 4th order)	Difference
Mean Annual	1,797	2,710	913
25-year	2,424	4,326	1,902
100-year	2,826	4,968	2,142

The above comparisons indicate that IMC omitted several hundred to over two thousand acres in their representations of the floodplains on the Ona Mine site.

5.0 CONCLUSIONS AND RECOMMENDATIONS

Due to incomplete mapping of the existing floodplains, the proposed encroachment into the floodplains by mining activities, and the absence of floodplain compensation calculations, IMC has failed to provide reasonable assurance that the mining activities will not adversely affect conveyance and storage on adjacent lands [Rule 40D-4.301(1)(b), F.A.C. and Basis of Review for ERP Applications – Adopted for DEP by Reference].

Furthermore, the information supplied by IMC in the CDA and responses to RAI's to FDEP mischaracterize the true extent of the mean annual, 25-year and 100-year floodplains on the Ona Mine site, as demonstrated by the floodplain mapping prepared by Dames and Moore in 1993, by mapping the Ardaman and Associates 1998/2003 flood elevations, and by SDI's mapping of the revised CHAN model results in 2003.

In order to provide the reasonable assurances required by rule, IMC would either have to avoid mining within the drainage basins of Brushy, Brady, Oak, and Hickory Creeks, or it would have to provide the following additional steps:

1. Obtain additional survey cross sections of the segment of Oak Creek between S.R. 64 and two miles due north of S.R. 64.
2. Amend the CHAN model to include these cross sections in the representation of Oak Creek as a series of channel reaches and stage-area nodes.
3. Based on the revised CHAN model results, map the mean annual, 25-year, and 100-year floodplains of Oak Creek north of S.R. 64, including its interconnections with Brushy Creek.
4. Calculate the volume of fill within the 100-year floodplains due to the proposed mining activities, both during mining and after reclamation is complete.
5. Revise the post-reclamation CHAN model cross sections and stage-area curves to include any and all proposed encroachments into the 100-year floodplains.
6. Map the mean annual, 25-year, and 100-year floodplains on the site under post-reclamation conditions.
7. Quantify the volume of compensating storage provided on or off the property.
8. Prepare a during-mining CHAN model scenario to include the proposed dragline crossings and all other encroachments into the 100-year floodplain.
9. Prepare comparison of pre-mining, during mining, and post-reclamation peak flood elevations for all storm events and for all CHAN model nodes.
10. Revise the mining and reclamation plans to include volumes of compensating storage necessary to equal or exceed the volumes of fill within the 100-year floodplain, and as otherwise necessary to ensure that there will be no increase in computed flood stages on any property not legally controlled by IMC.

The during mining CHAN scenario (item 8) would be required because IMC is proposing several encroachments into the floodplains of all of the major creeks on the property, during mining, that would be in place for up to several years. These encroachments include dragline crossings and mine cell isolation berms. The encroachments have the potential to cause adverse flooding impacts on lands not controlled by IMC and therefore should be included in the floodplain analysis.

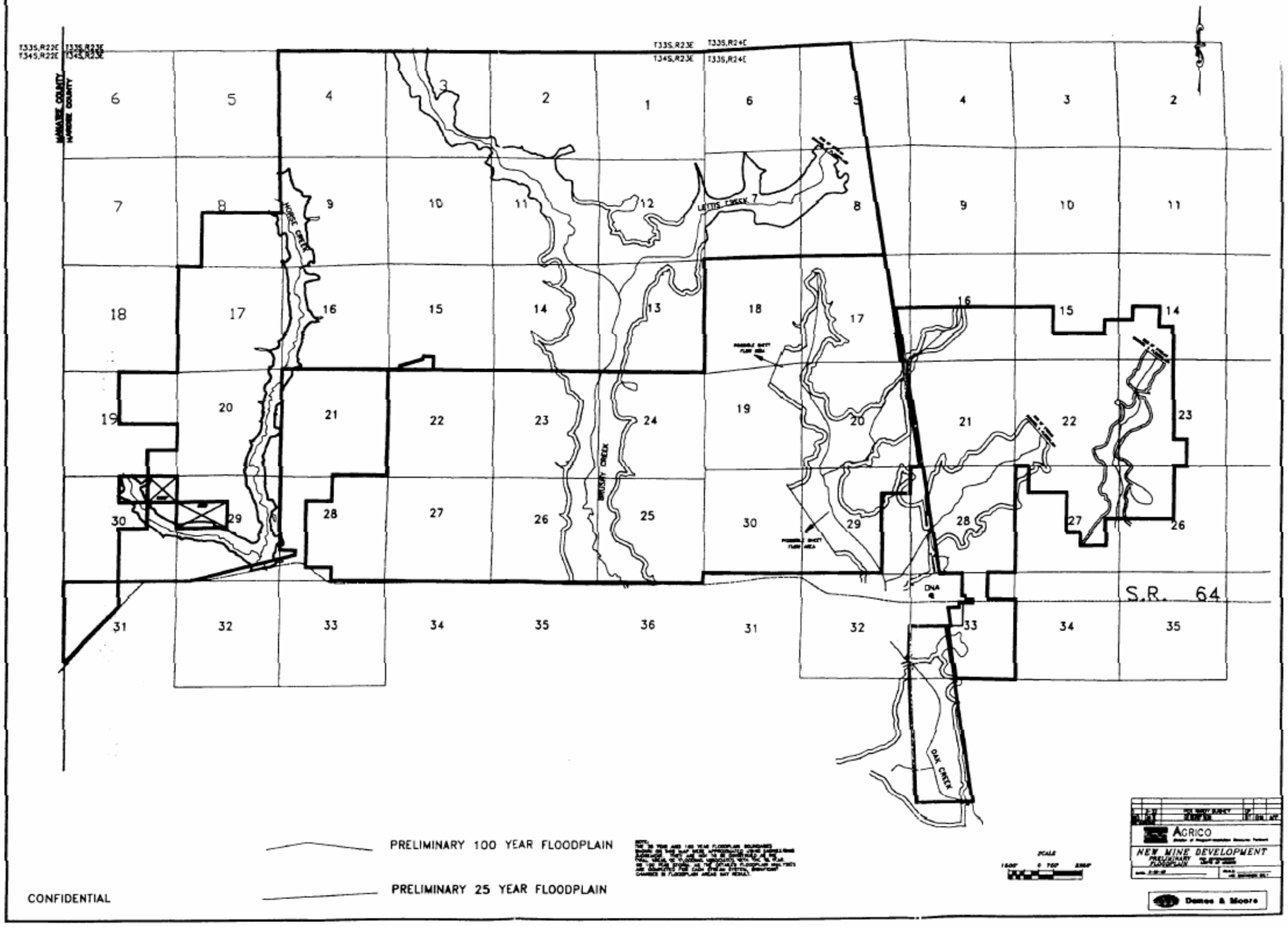

Figure 1. Dames and Moore 1993 Approximate Delineations

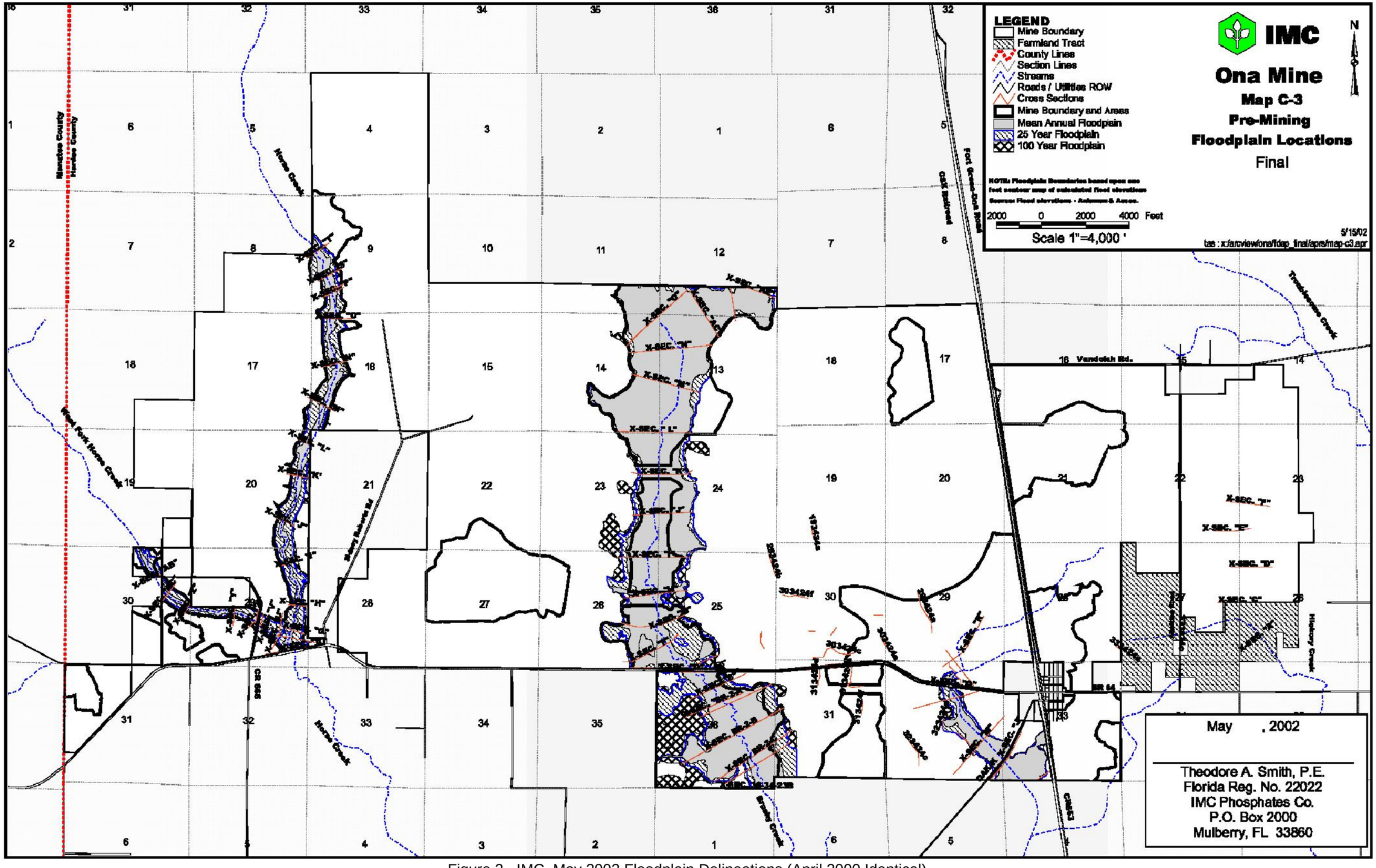

Figure 2. IMC, May 2002 Floodplain Delineations (April 2000 Identical)

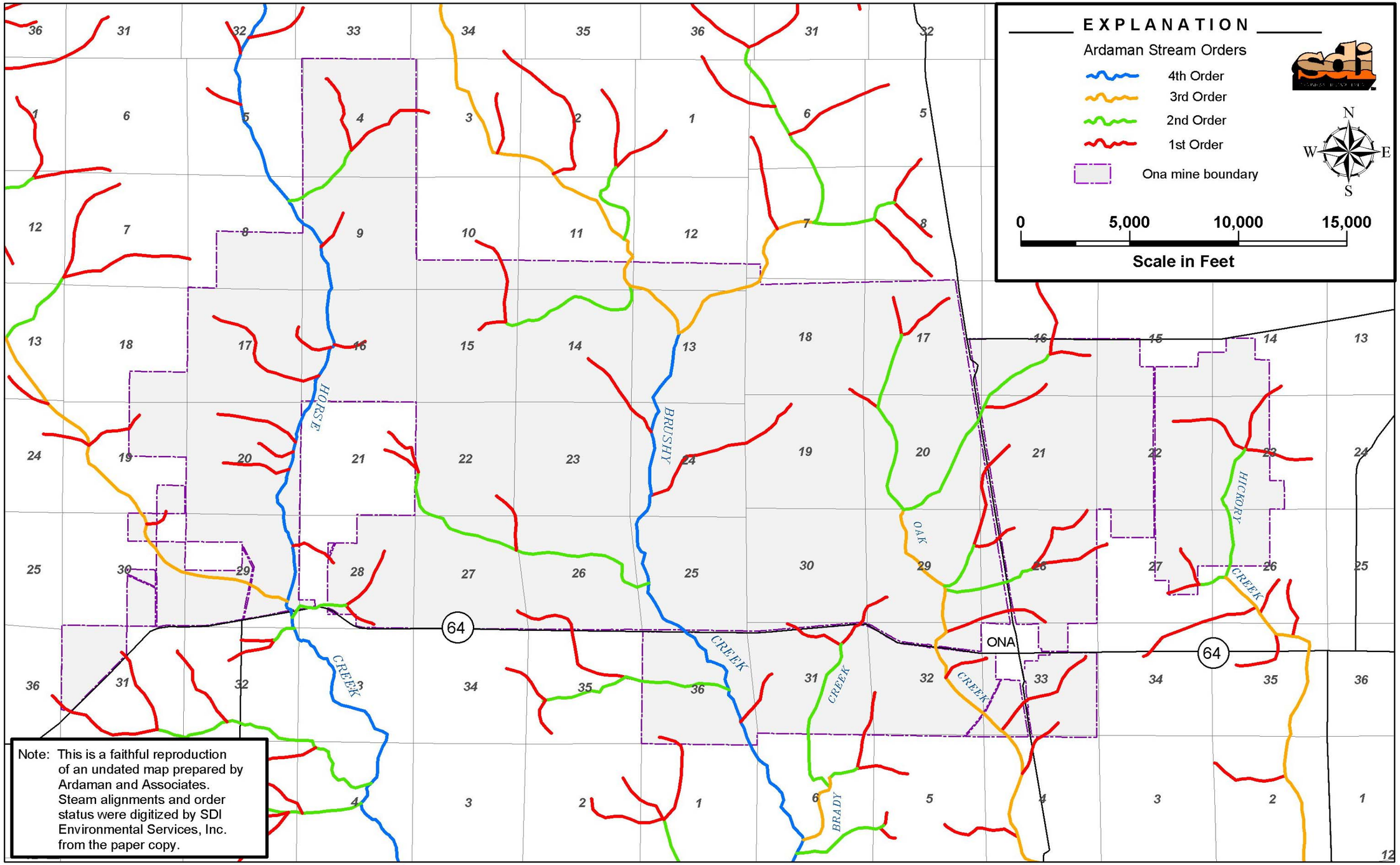

Figure 3. Stream Orders as Delineated by Ardaman and Associates, Inc.

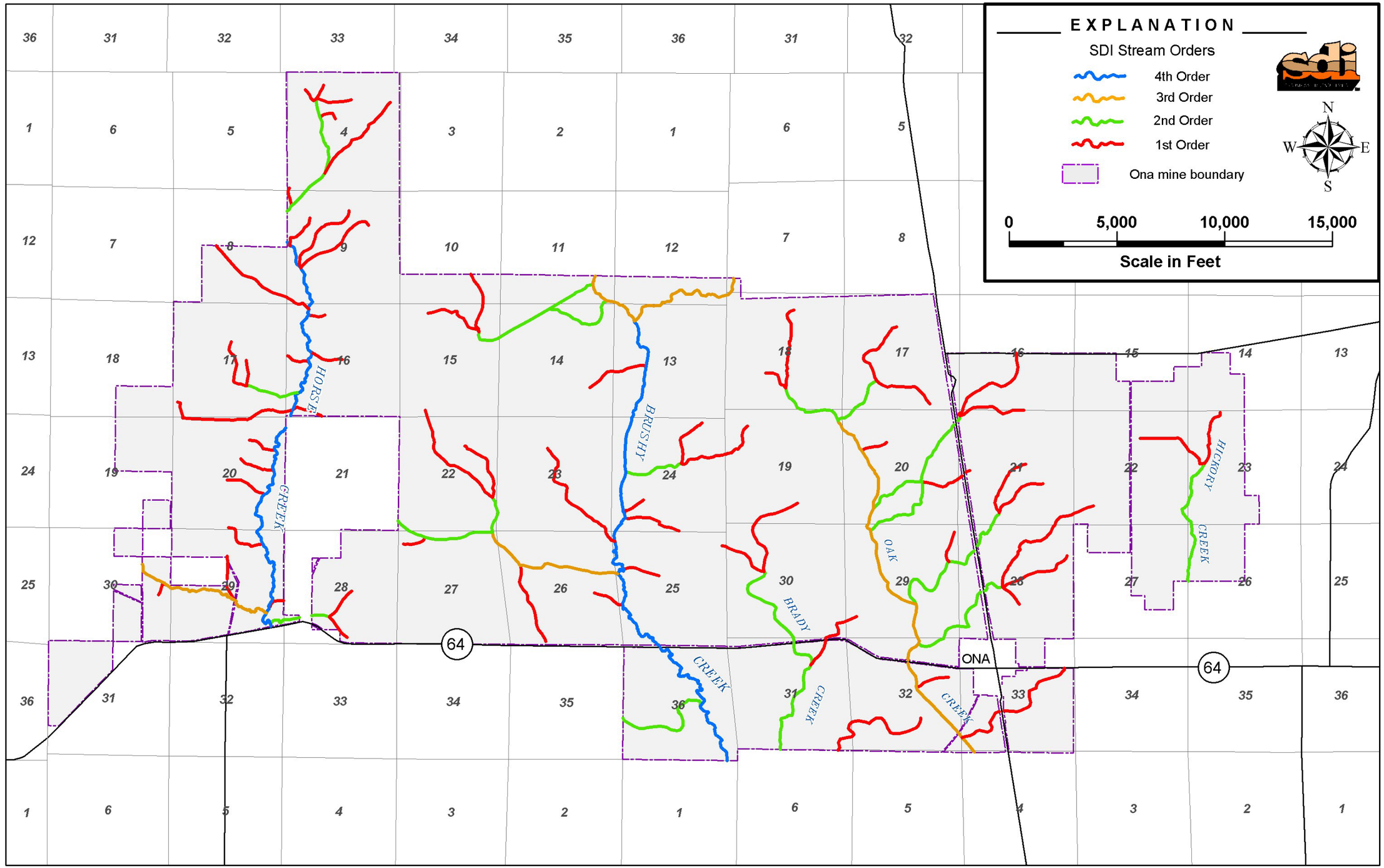

Figure 4. Stream Orders within the Ona Mine Boundary as Delineated by SDI Environmental Services, Inc.

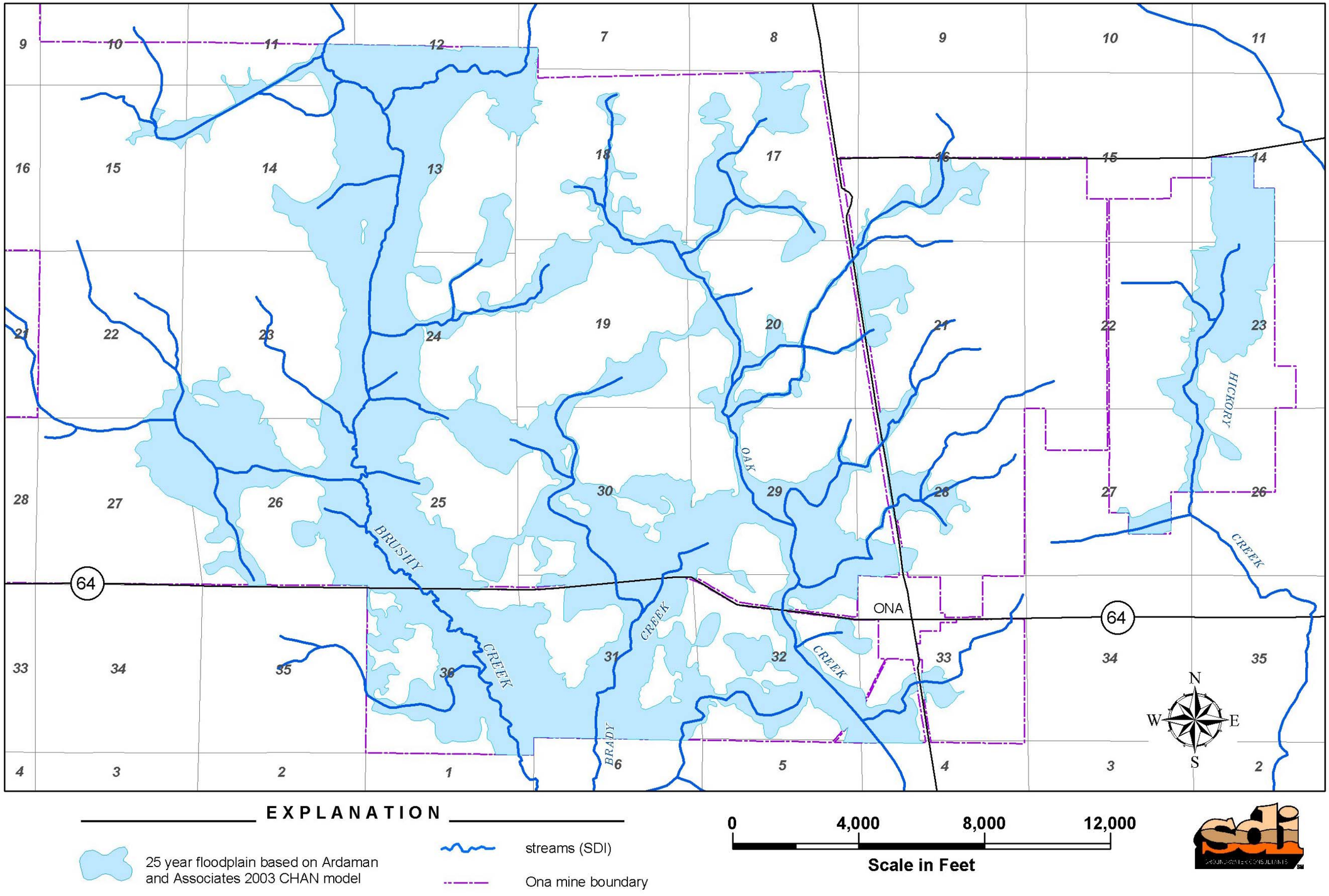

Figure 5. 25-Year Floodplain Mapping Based on Ardaman and Associates, Inc., 2003 CHAN Model

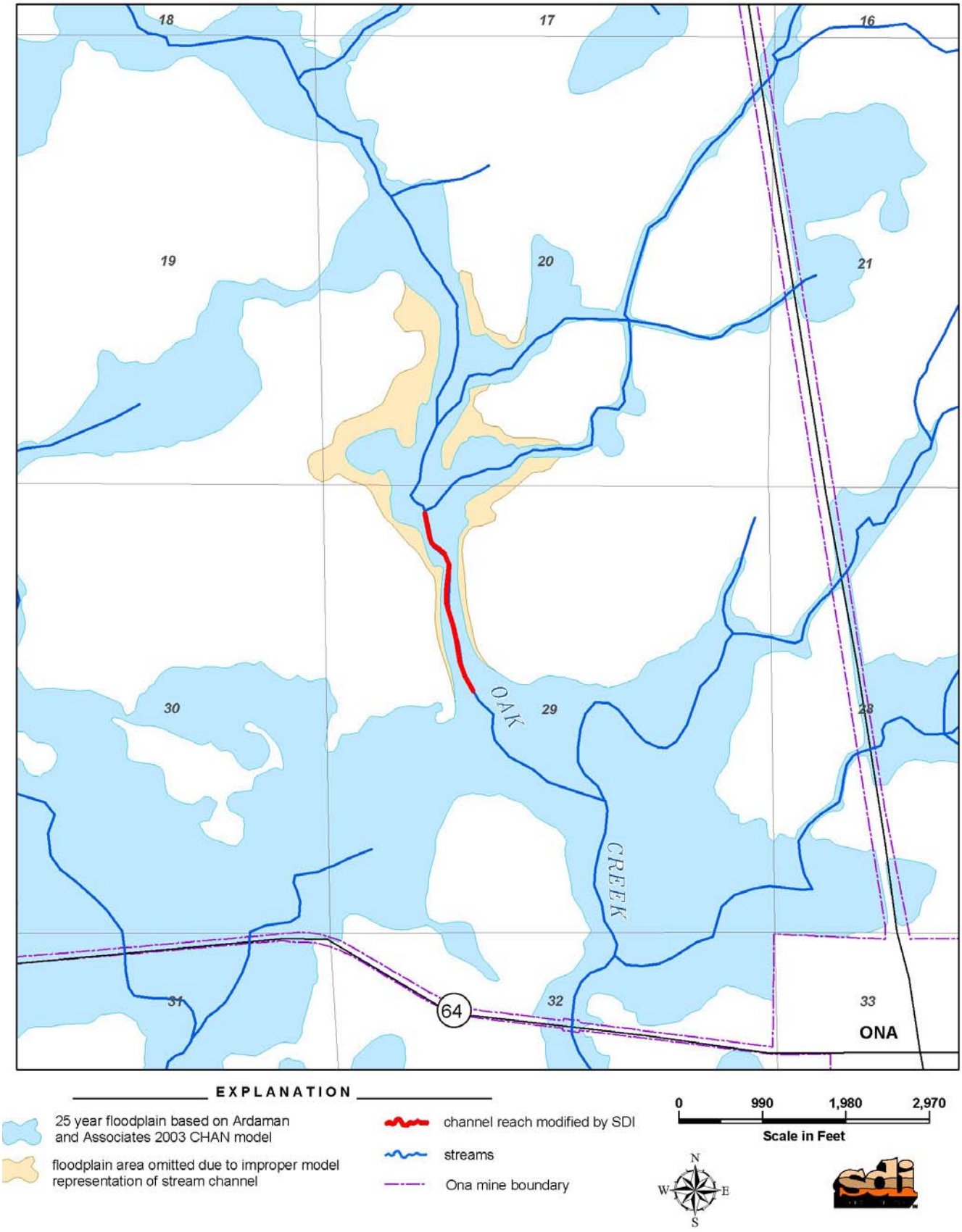

Figure 6. Illustration Showing Error in 25-Year Floodplain Associated with Modeling Stream Channels as Weirs

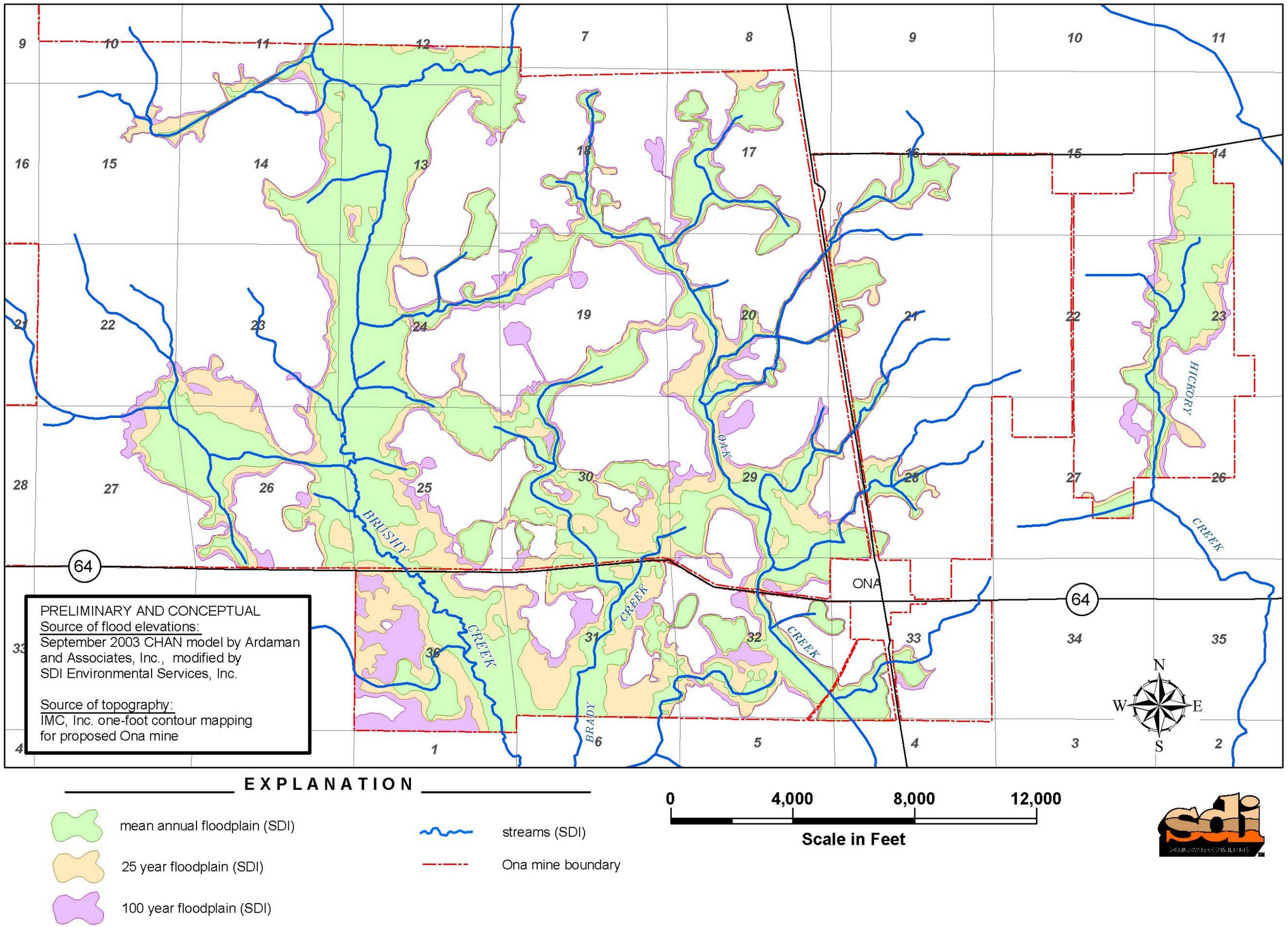

Figure 7. Floodplain Limits of Brushy, Oak, Brady, and Hickory Creeks (all locations)

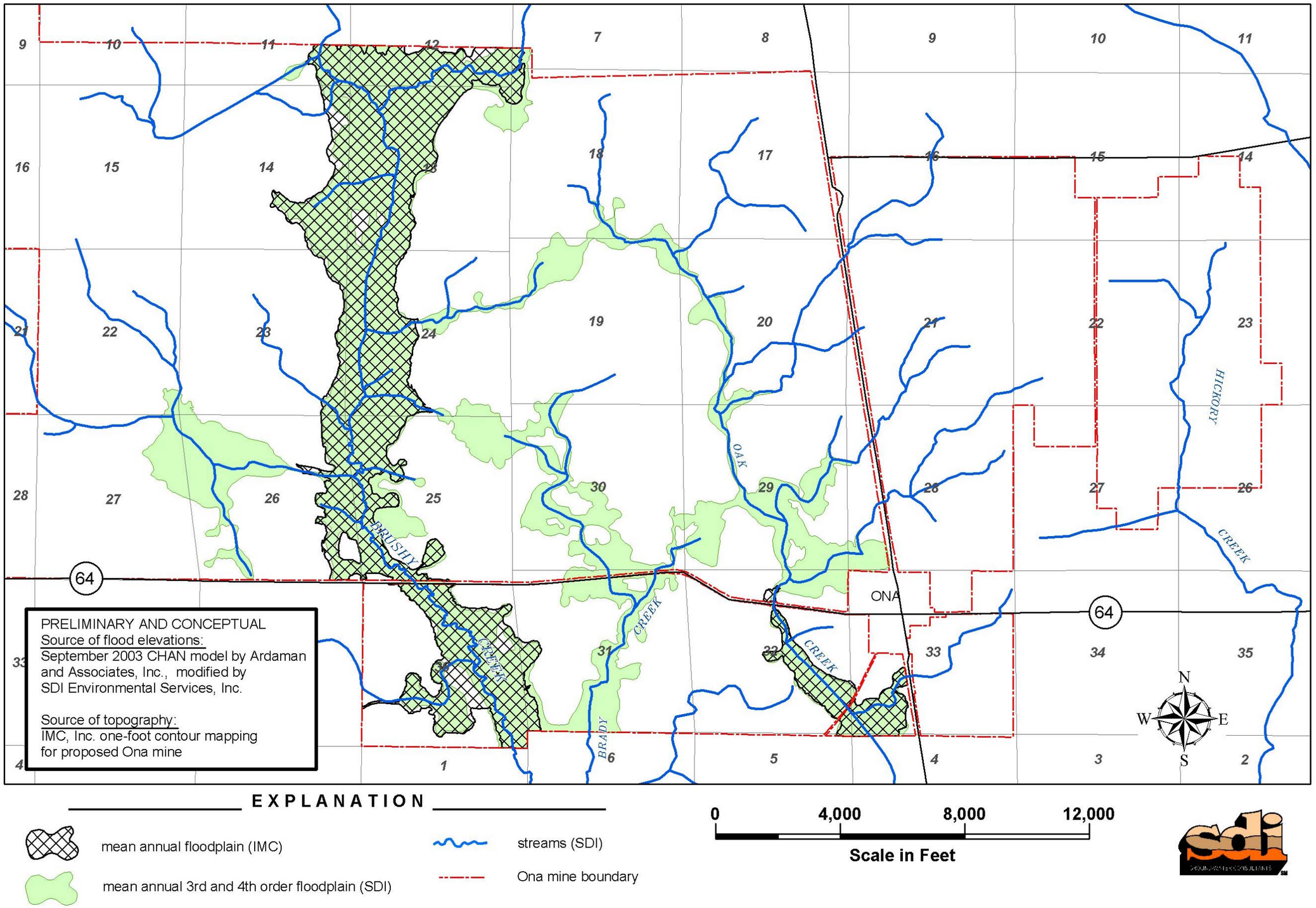

Figure 8. Mean Annual Floodplain Comparison (3rd and 4th Order Streams)

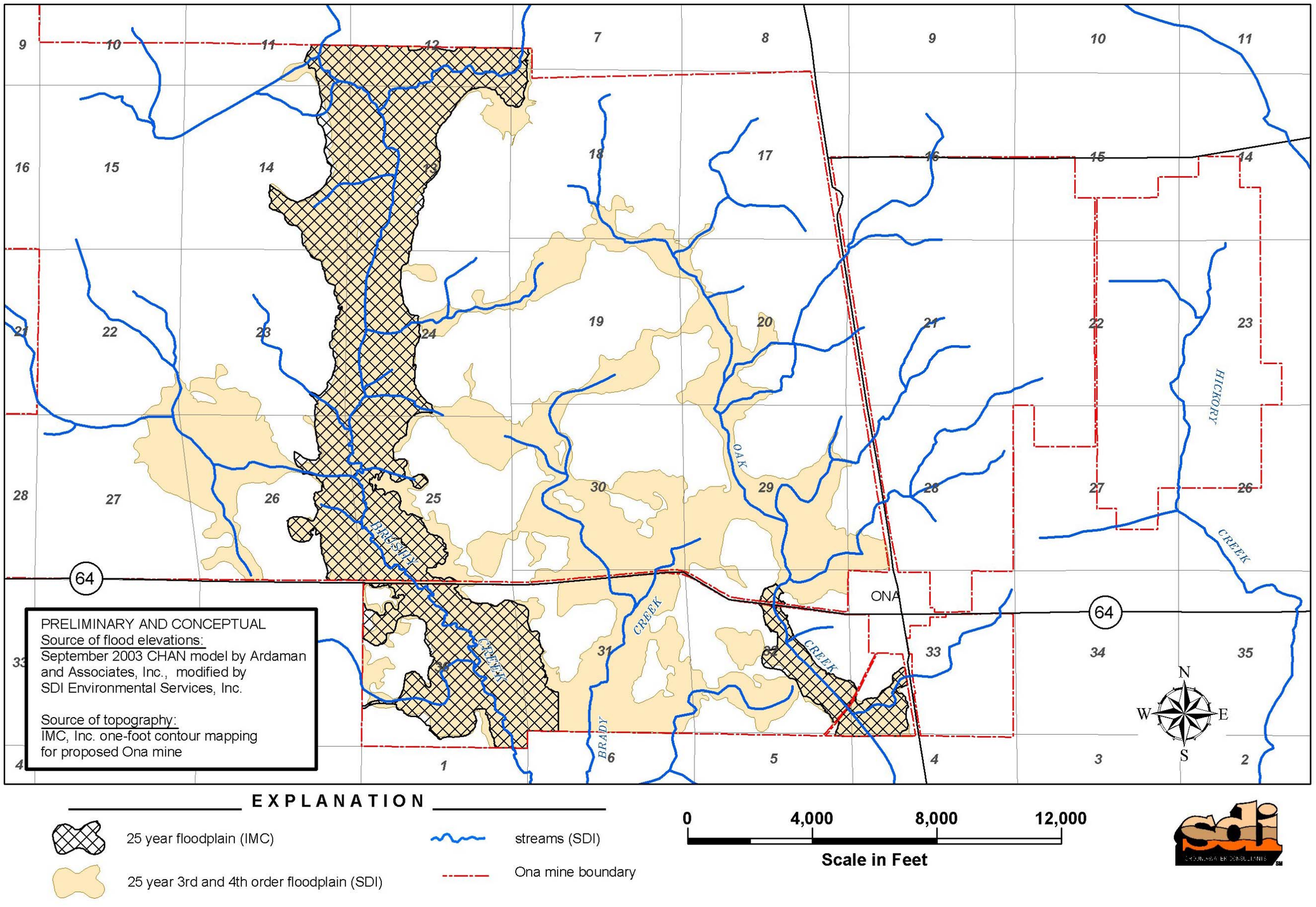

Figure 9. 25-Year Floodplain Comparison (3rd and 4th Order Streams)

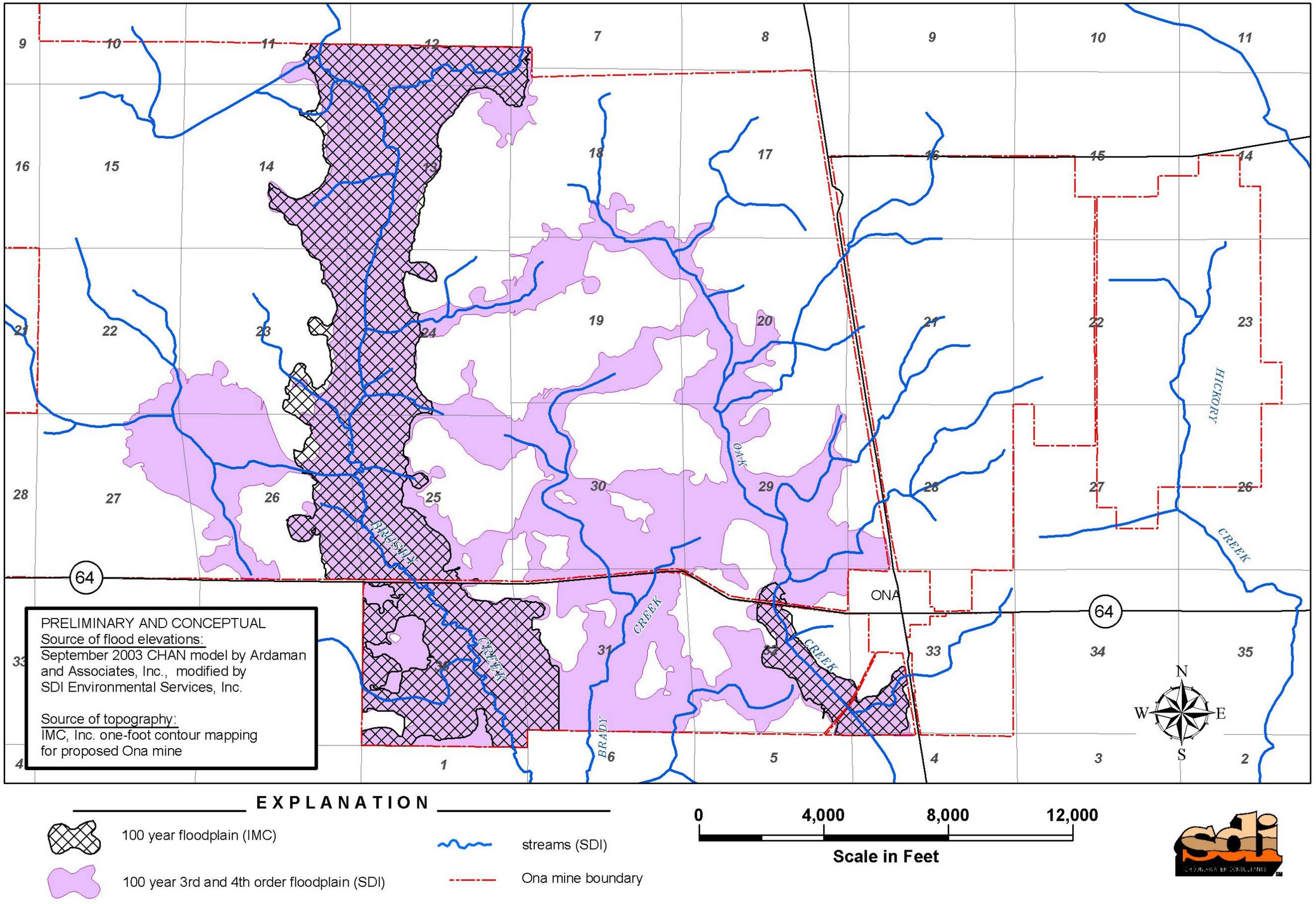

Figure 10. 100-Year Floodplain Comparison (3rd and 4th Order Streams).